Sound Solutions in Water Resource Recovery: Village of Northport

by Stephen Hadjiyane and Donna Bee

The Long Island Sound is home to a vibrant community of plants and animals, and serves as a major source of food and recreation for more than 8 million people within its watershed. The effluents from Water Resource Recovery Facilities (WRRFs) contribute to ongoing water quality issues, including an unhealthy increase in nitrogen and a significant drop in dissolved oxygen (DO) levels – a condition known as hypoxia.

Hypoxia may occur in bodies of water when an excessive discharge of nitrogen into the water causes eutrophication, or more simply put, an increase in floating planktonic algae. The algae settle to the bottom of the water body as they die and then begin to decay. The decaying process depletes the remaining oxygen. DO levels below 5 mg/L have been observed to stress aquatic life and can even cause fish kills or lead to the development of "dead zones" – large hypoxic areas that are unable to sustain aquatic life.

The Long Island Sound Study (LISS), a bi-state partnership, was formed in 1985 and authorized by the U.S. Environmental Protection Agency to assess the water quality of the Sound and to implement programs that monitor water quality, reduce nitrogen loads, restore habitats, and engage and educate the public. The cooperative developed a Comprehensive Conservation and Management Plan to protect and restore Long Island Sound and prevent extreme hypoxic conditions from occurring.

The Village of Northport, New York WRRF

The Village of Northport is located about 50 miles east of Manhattan, New York, on the North Shore of Long Island at the southeast side of Northport Harbor. The community is home to approximately 7,500 residents and a number of small shops and restaurants in a pedestrian-friendly downtown. But it is best known for its secluded deep water harbor, beautiful waterfront parks, and numerous beaches that draw in visitors from across the region.

Unfortunately, these beaches have been subject to closures over the years due to poor water quality in the harbor. In 2004, the LISS challenged the Village of Northport to protect and enhance the harbor because of its important ecological and recreational value.

View of Northport Harbor, the receiving water for the Village of Northport's WRRF effluent. Waters from Northport Harbor flow into the Long Island Sound. *Gannett Fleming*

The Village's Upgrade Plan

To achieve compliance with nitrogen permit limits, the Village of Northport adopted an aggressive infrastructure upgrade plan at its WRRF. To achieve a reduction in off-shore hypoxia and maintain dissolved oxygen levels in the harbor, The Village plan set a goal of reducing WRRF nitrogen loading by 80 percent, with the expectation that this would be achieved within 15 years.

The Village plan established the following schedule for nitrogen reduction:

Permit Milestone	Percent of Full Reduction Achieved	Effluent Total Nitrogen Limit (lb/d)	Effluent Total Nitrogen Concentration at Permit Flow (0.450 MGD) (mg/L)
2004	40%	35	9.3
2009	75%	21	5.6
2014	100%	10	2.7

Note: MGD = million gallons per day

Since 1970, the WRRF has been transformed from a simple extended aeration process to one of Long Island's most advanced biological nitrogen removal (BNR) wastewater treatment plants. Significant infrastructure improvements that were implemented to help achieve the goals established in the Village plan included:

- Conversion to Modified Ludzack-Ettinger (MLE) process.
- Deep-bed sand denitrification and filtration system and associated methanol supply system that provides for the growth of bacteria to consume unwanted nitrogen.
- Magnesium hydroxide pH control system to ensure reliable denitrification during colder winter months.
- Replacement of the existing comminutor (grinder) with a screen and compactor system to reduce re-ragging problems traditionally experienced at the plant.
- Six-section motor control center with normal and emergency busses and variable frequency drives for process equipment.
- Process management and control system upgrades that enable improved plant operations.

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The Village of Northport made significant upgrades to its water resource recovery facility. *Tony Lopez Photo*

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The Village plan allowed for a phased approach to plant upgrades in consideration of available funding, which also enabled incorporation of the latest BNR technologies that became available as advancements in nitrogen removal were developed over time.

Year	Milestones
1970	• Extended aeration process • Chlorine disinfection
2004	Permit Limit Limit = 35 lbs/day (Phase I Upgrades) • Equalization tank • Extended aeration converted to MLE process • Ultraviolet disinfection
2009	Permit Limit = 21 lbs/day • Dissolved oxygen control system
2014	Permit Limit = 10 lbs/day (Phase II Upgrades) • pH control system • Denitrification filters • Influent screening system

Wastewater Flows

The plant's maximum monthly average permitted flow is 0.450 MGD. In 2005, the WRRF experienced flows above 0.400 MGD due to severe inflow/infiltration (I/I). To address this problem, the Village implemented a 10-year I/I reduction plan that included sewer and manhole lining and investigating cross-connections to sanitary sewers. These corrective measures have resulted in a steady decline in flows (***Figure 1)***.

Process Improvements

Many treatment plants in the New York metropolitan area utilize the MLE process with great success. It is considered one of the best available technologies to remove nitrogen, reliably achieving nitrogen levels ranging from 6 mg/L to 8 mg/L. The Water Environmental Research Foundation (WERF) Nutrient Limit of Technology is 3.0 mg/L total nitrogen. This value assumes approximately 1.0 mg/L is the dissolved organic nitrogen (DON) fraction.

Phase I (2004) upgrades included converting the Village of Northport WRRF to an MLE process with UV disinfection. Phase II (2014) upgrades included installation of denitrification filters and a pH control system (cold weather optimization system) to further reduce nitrogen to levels below 4 mg/L. The Village wastewater nitrogen speciation shows DON ranging from 1.0-1.5 mg/L. The DON refractory portion resists biodegradation.

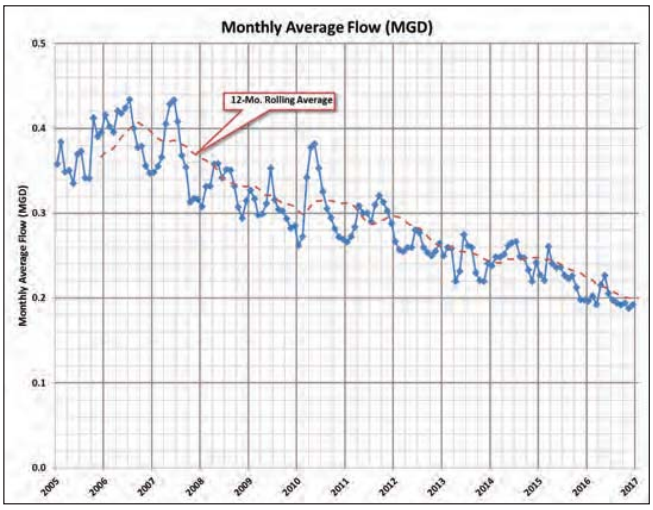

Figure 1. Monthly and rolling average flow (MGD) from 2005 through 2017. Incorporated Village of Northport WWTP, Northport N.Y.
Gannett Fleming

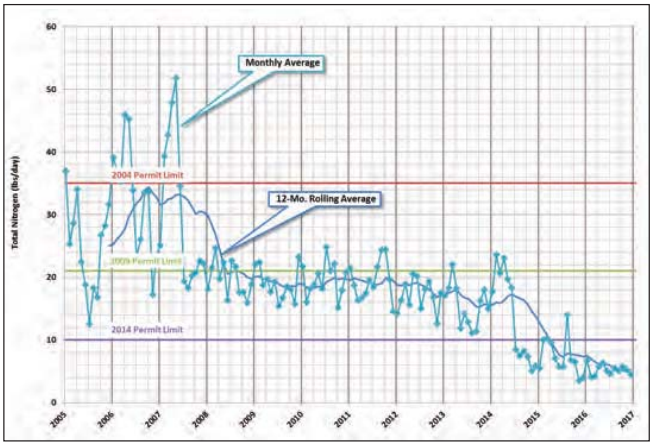

Figure 2. Effluent nitrogen loading (lbs/day) monthly and rolling averages, 2005 to 2017, with permit limits from 2004, 2009 and 2014. Incorporated Village of Northport WWTP, Northport, N.Y.
Gannett Fleming

The improvements resulted in a decrease in nitrogen discharge to the harbor from a high of more than 38 lbs/day in 2004 to less than 5.5 lbs/day in 2016 – well within the 2014 permit limits of 10 lbs/day ***(Figure 2)***.

The denitrification facility is the heart of the upgrade project.
Tony Lopez Photo

The denitrification system blends seamlessly with the existing infrastructure. *Tony Lopez Photo*

Chemical metering pumps precisely regulate the amount of methanol infused into the denitrification system. *Tony Lopez Photo*

The aeration tank and anoxic zone baffles are an integral part of the MLE process. *Gannett Fleming*

True Partnership and Achievement

Using innovative yet practical approaches, the 15-year journey is a model of true partnership that included the Village, the engineer, operators, contractors and NYSDEC. The primary objective of the project – to achieve compliance with the LISS 2014 permit limits – was accomplished by July 2014.

- Nitrogen loading to the Northport Harbor has been reduced to less than 5.5 lbs/day from a high of 38 lbs/day.
- Beaches reopened for public use.
- Decrease in off-shore hypoxia conditions and increase in dissolved oxygen levels.

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