

1. EXECUTIVE SUMMARY

Introduction

New York City is undertaking the most comprehensive nitrogen removal program in the United States. This report summarizes the status of this program and presents highlights of future activities.

Nitrogen removal activities are presently focused on Wastewater Pollution Control Plants (WPCP) discharging to the Upper East River and Jamaica Bay. Five of these WPCPs have been retrofitted for Biological Nitrogen Removal (BNR) as well as two other WPCPs (Red Hook and Oakwood Beach). However, the froth control systems are not yet operational at many of these plants. None of New York City's WPCPs were originally designed to remove nitrogen, other than the removal inherent to the step feed mode of the activated sludge process. Therefore, the BNR retrofits represent a significant technical achievement.

The BNR Process being employed by New York City is Step Feed BNR, which was first used by the City at the Tallman Island WPCP. This Step Feed BNR retrofit consists of installing baffles, mixers, and a froth control system (not optimizing the Step Feed BNR process by adjusting the flows, increasing & balancing process air, changing size of oxic & anoxic zones, and adding chemicals) and will be referred to as a Basic Step Feed BNR retrofit throughout this report. The performance capability of this process is still being evaluated. Preliminary information indicates strongly that this process will form a significant cornerstone in NYC's program to meet current and future SPDES permit requirements. Preliminary process performance data is presented hereinafter.

Basic Step Feed BNR Retrofit Process Performance Projections

All four of the Upper East River WPCPs are being retrofitted to operate in full or in part in the Basic Step Feed BNR mode which requires the installation of baffles, mixers, and a froth control system. The installations of the baffles and mixers were completed at all the Upper East River WPCPs, however, the installation of the froth control systems have not yet been completed at Wards Island, Hunts Point, and Bowery Bay WPCPs. Initial TN projections indicate that these nitrogen control actions will enable the Upper East River WPCPs to comply with current SPDES requirements when the Basic Step Feed BNR retrofits are completed and fully operational.

One WPCP discharging to Jamaica Bay, 26th Ward, has been similarly upgraded. Initial projections show that SPDES TN limits for Jamaica Bay will be met when the 26th Ward WPCP is retrofitted for Basic Step Feed BNR, if calculations are performed on the basis of dry weather flow, but permit limits may be exceeded on total flow basis. Discussions with NYSDEC are underway to determine which method is most appropriate for reporting. The NYCDEP is also planning to send Owls Head WPCP's liquid sludge to a dewatering facility other than the 26th Ward WPCP to alleviate a large portion of the centrate TN load at the plant and enable the Jamaica Bay WPCPs to comply with TN permit limits based on total flow calculations. When implementing BNR on a retrofit basis, certain limitations at the existing WPCPs must be

identified. These limitations are present since nitrogen removal was not contemplated in the original designs. As these limitations are identified, actions are taken to mitigate them. However, many of these actions are long term in nature and the benefit of these actions will not be realized in the near future.

All process performance projections made to date have been based on computer modeling of the Basic Step Feed BNR process. Original projections for removal of total nitrogen (TN) were presented in the Nitrogen Control Action Plan (NCAP) dated June 1994. The basis for these TN projections are listed below:

- Wastewater Characteristics:
 - fiscal year 1994 influent data
 - flow projections for calendar year 2005
 - kinetic data obtained from the literature

- Operating Parameters:
 - dissolved oxygen (DO) in aerobic zones of 2 mg/l
 - return sludge rate (RAS) of 50%
 - aerator effluent solids of 2,000 mg/l

Recently the NYCDEP has refined the TN projections using the BioWin model (recommended by the TAC) along with more recent information and the experience obtained from retrofit operations. The new projections are based on the items listed below:

- Wastewater Characteristics:
 - calendar year 1997 primary effluent data
 - primary effluent characterization obtained from the Tallman Island WPCP work conducted in late 1997 and early 1998.

- Operating Parameters:
 - the site specific actual parameters that could be achieved in full scale operations at each of the WPCPs; in most cases the target process air and/or the RAS rates could not be achieved.

The new projections for removal of TN indicate the performance results summarized below.

- Barring unforeseen operational problems, the Upper East River WPCPs will comply with all current SPDES requirements when nitrogen control actions are implemented, as illustrated in **Figure 1** and **Figure 2**. The actual TN discharges are significantly lower than the projected TN values because Hunts Point and Bowery Bay WPCPs have implemented Basic Step Feed BNR without a Froth Control System. However, these plants have recently discontinued this process because of operational problems associated with froth. There have also been serious problems with the failure of mixers which are critical to the Basic Step Feed BNR process. The plants should be able to

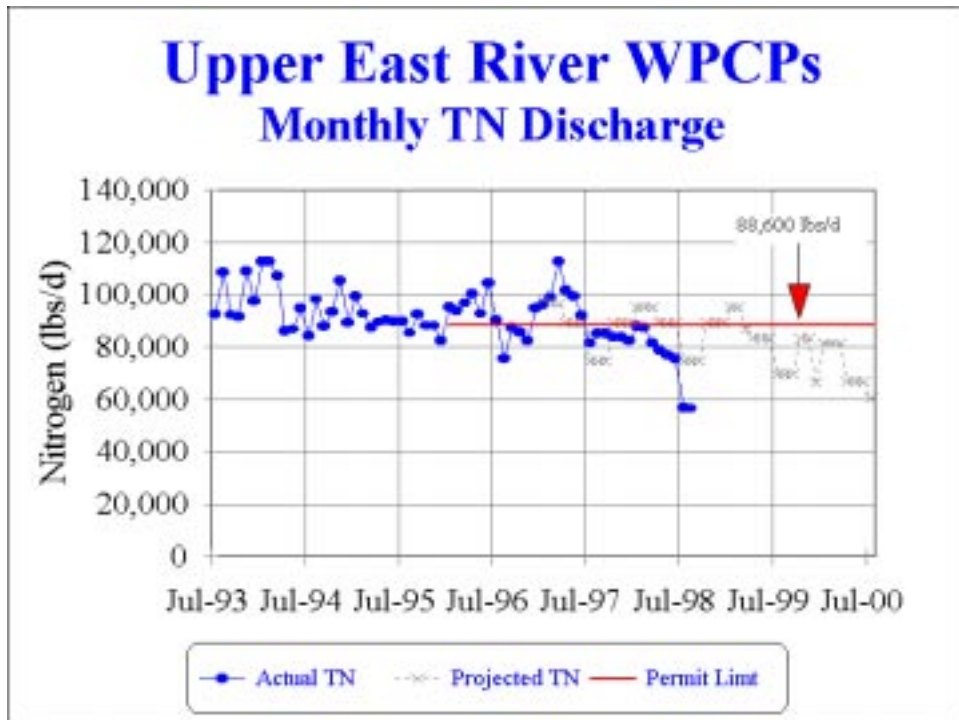


Figure 1

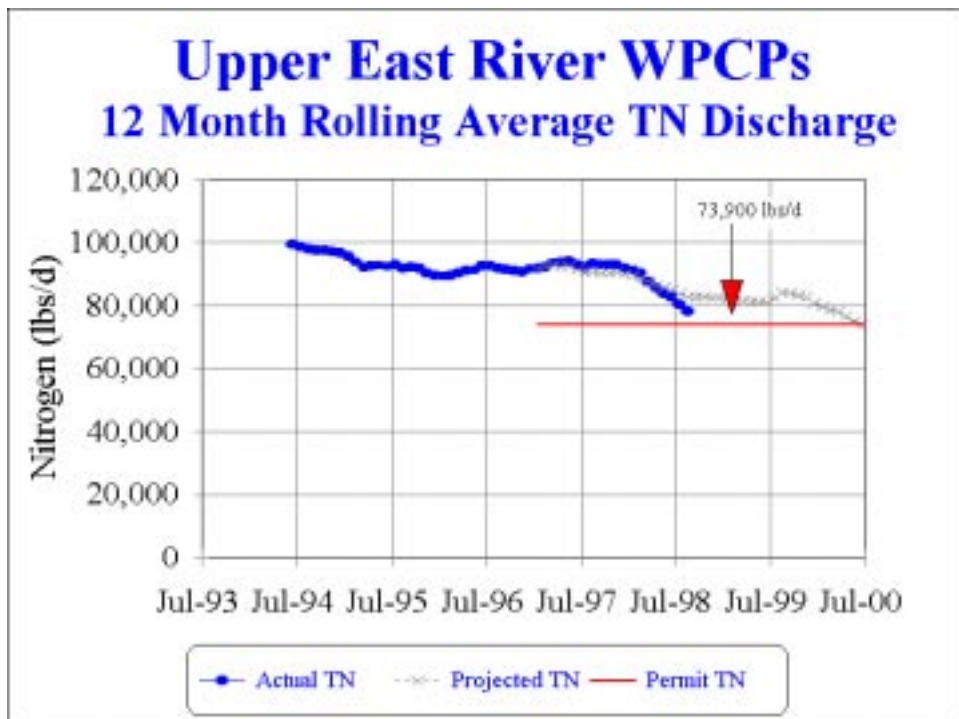


Figure 2

consistently operate in a Basic Step Feed BNR mode when the froth control systems and mixers are operational which is reflected in the TN projections.

- Similarly, the Jamaica Bay WPCPs, when fully operational, barring unforeseen operational problems will comply with the Maximum Monthly limits of the SPDES permit but will slightly exceed the 12 Month Rolling Average, as illustrated in **Figure 3** and **Figure 4**. Therefore, the NYCDEP is modifying its existing sludge dewatering operations to reduce the amount of sludge imported to the 26th Ward WPCP. This will reduce the centrate TN loading at 26th Ward WPCP and will enable the Jamaica Bay WPCPs to consistently comply with SPDES TN permit limits.

Status of BNR Retrofits - Upper East River WPCPs

The implementation of all retrofits for the Upper East River is proceeding. The implementation has been delayed beyond the original January 1996 date and the work is ongoing. Recent progress includes the actions listed below:

- Separate centrate treatment was implemented at the Wards Island, Hunts Point, and Bowery Bay WPCPs.
- Basic Step Feed BNR has gone into operation at Bowery Bay, Hunts Point, Tallman Island (Aeration Tanks 3 & 4) and Wards Island (Aeration Tank 13) WPCPs. However, Hunts Point & Bowery Bay WPCPs had to discontinue Basic Step Feed BNR because of operating problems. The plants will reimplement Basic Step Feed BNR when the froth control systems are operational.
- Wards Island WPCP has increased the sludge age in Battery "A".
- A one year pilot program has begun to develop BNR process control parameters to be used for all WPCPs implementing Basic Step Feed BNR.

Actions to be implemented shortly are listed below:

- Basic Step Feed BNR @ Tallman Island (Aeration Tanks 1 & 2)
- Increase sludge age throughout Wards Island WPCP (Aeration Tanks 4-12)
- Complete the installation of chlorine spray hoods for froth control at Wards Island, Hunts Point, Bowery Bay, 26th Ward, Red Hook, and Oakwood Beach WPCPs.
- Must resolve mechanical problems with the submersible mixers.
- NYCDEP is also looking into exporting centrate from Wards Island to a treatment plant discharging into a water body less sensitive to nitrogen.
- NYCDEP is looking into disposing of Newtown Creek WPCP's digested sludge by contract thereby reducing the centrate TN load at the Hunts Point WPCP.

A summary of all the nitrogen control actions, implementation dates, capital costs, and TN projections for the Upper East River WPCPs are presented in **Table 1**. It should be noted

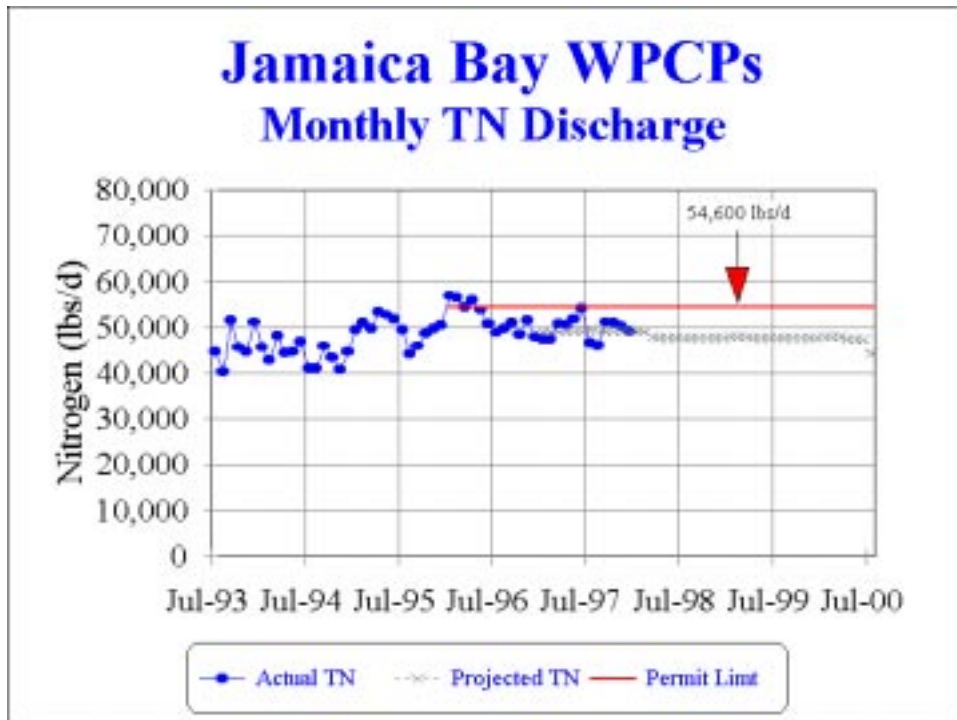


Figure 3

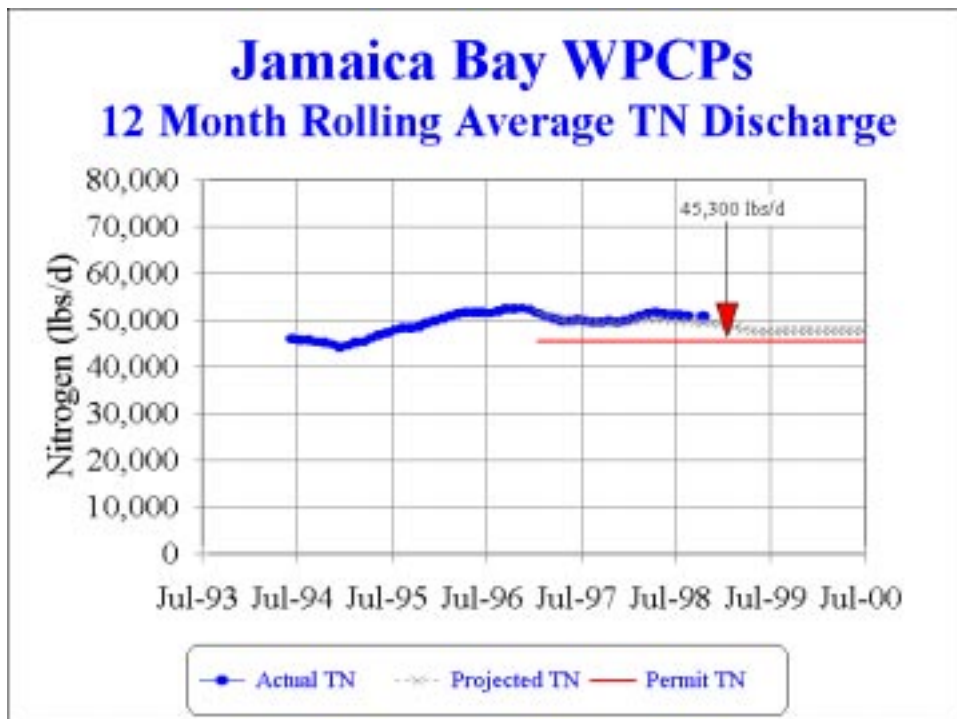


Figure 4

that the TN projections were based on specific wastewater characteristics and fixed operating parameters. Therefore, if for any reason the operating parameters change (ex. Tanks out of service, equipment failures, and process upsets) and/or the actual wastewater characteristics differ from those used in the BioWin Model, then the actual TN discharges will vary from the projected TN discharges presented in **Table 1**. The implementation dates may also vary due to time needed to establish a nitrifying biomass, time needed to familiarize plant personnel with a new process, and process limitations that may be encountered at a plant that was not originally designed for nitrogen removal. It should be noted that the plants have already experienced many operational problems such as mixers failing, uneven air distribution and excessive back pressure associated with the new membrane diffusers, taking aerators out of service to replace broken diffusers, taking final tanks out of service to replace chains, and more frequent maintenance on the process air blowers. The plants also lack the necessary instrumentation and process controls including the ability to balance flows and the process air distribution to ensure the BNR process is operating reliably. These items will be addressed in future stabilization and upgrade projects.

Upper East River WPCPs (Table 1)

WPCPs	Nitrogen Control Actions	Implementation Date	Capital Cost**	Projected Effluent TN (when fully operational)	Permit TN Limits
Wards Island	High Sludge Age (A-D Batteries) Basic Step Feed BNR (E Battery) Separate Centrate Treatment (Aerator #9)	3/99 1/98 10/96	\$574,000	29,260 lbs/d	
Hunts Point	Basic Step Feed BNR Separate Centrate Treatment (Aerator #5)	12/99* 1/94	\$1,782,000	17,270 lbs/d	
Tallman Island	Basic Step Feed BNR	4/97	\$4,700,000	8,580 lbs/d	
Bowery Bay	Basic Step Feed BNR Separate Centrate Treatment	12/99* 8/97	\$4,842,000	13,700 lbs/d	
12 Month Rolling TN				68,810 mg/L	73,900 lbs/d
Maximum Monthly TN				86,660 lbs/d	88,600 lbs/d

* Hunts Point & Bowery Bay WPCPs have implemented Basic Step Feed BNR as of 12/97 & 7/98 respectively but had to discontinue the process due to operating problems.

** It should be noted that there is a significant increase in annual costs due to increased O&M requirements associated with increased air demand, additional equipment, and additional personnel. Capital Costs also don't take credit for Separate Centrate Treatment retrofits done in-house.

The only Jamaica Bay WPCP presently being retrofitted for Basic Step Feed BNR is the 26th Ward WPCP. As indicated, this configuration by itself may not be sufficient to enable Jamaica Bay WPCPs to comply with all current SPDES requirements for removal of TN (12 Month Rolling Average will not be met) based on the BioWin TN projections. The NYCDEP plans additional studies at 26th Ward WPCP to increase mean cell residence time (MCRT). Full scale operating experience combined with pilot experiments at the PO-55 program will be used to evaluate this option. The remaining three WPCPs discharging to Jamaica Bay offer little potential at this time for increased removal of nitrogen as described below:

- Jamaica WPCP - presently severely limited by Final Settling Tanks and Gravity Thickeners; increased sludge age would negatively affect performance of these processes and may compromise ability to meet SPDES permit limits and PSRP

requirements for biosolids.

- Rockaway WPCP - contributes less than 5% of nitrogen to Jamaica Bay, installation of BNR is unwarranted.
- Coney Island WPCP - cannot increase MLSS without risking overloading Final Tanks and compromising SPDES permit.

The NYCDEP is also planning to export the digested sludge from the Owls Head WPCP to a dewatering facility other than 26th Ward outside of the Jamaica Bay area. This will alleviate approximately 2,950 lbs/d of nitrogen from the centrate stream and will enable the Jamaica Bay WPCPs to comply with SPDES TN permit limits. A summary of all the nitrogen control actions, implementation dates, capital costs, and TN projections for the Jamaica Bay WPCPs are presented in **Table 2**.

Jamaica Bay WPCPs (Table 2)

WPCPs	Nitrogen Control Actions	Implementation Date	Capital Costs***	Projected Effluent TN (when fully operational)	Permit TN Limits
26 th Ward	Basic Step Feed BNR Separate Centrate Treatment (Aerator #3)	4/00 6/96 -12/96 & 3/98	\$3,730,000	11,190 lbs/d	
Coney Island	**No Action			15,420 lbs/d	
Jamaica	**No Action			18,550 lbs/d	
Rockaway	**No Action			2,130 lbs/d	
Sludge Relocation	Export Owls Head WPCP's sludge to a dewatering facility other than 26 th Ward WPCP	12/00		- 2,950 lbs/d	
12 Month Rolling TN				44,340 lbs/d	45,300 lbs/d
Maximum Monthly TN				48,510 lbs/d	54,600 lbs/d

* Projected Effluent TN discharges aren't affected by Basic Step Feed BNR because assumptions used in the model weren't sufficient to achieve nitrification year round. The plant will attempt to operate at a higher sludge age than that used in the model and if successful will remove additional TN.

** Effluent Nitrogen projections for the No Action Scenarios are based on Calendar Year 1997 actual effluent TN discharges.

*** It should be noted that there is a significant increase in annual costs due to increased O&M requirements associated with increased air demand, additional equipment, and additional personnel. Capital Costs also don't take credit for Separate Centrate Treatment retrofits done in-house.

Other Nitrogen Control Alternatives

In addition to exporting Owls Head WPCP's digested sludge to a dewatering facility other than 26th Ward, the NYCDEP considered the following nitrogen control alternatives to alleviate the centrate TN loading from the Jamaica Bay area:

- Dewatering sludge from the Jamaica WPCP at the 26th Ward WPCP rather than at Jamaica WPCP - this will allow centrate to undergo partial treatment in Aerator #3, which is currently being used for separate centrate treatment
- Chemically enhancing separate centrate treatment at the 26th Ward WPCP (Aerator #3) to increase nitrogen removal from the 30 to 50 percent

nitrification currently being achieved.

- Exporting centrate from Jamaica Bay (26th Ward or Jamaica WPCPs) to another water body that is not nitrogen limited.