

4. STATUS OF NITROGEN REMOVAL PILOT STUDIES

The NYCDEP has been mandated, under the SPDES requirements, to construct, operate and monitor several pilot studies for the nitrogen program. **Table 18** represents an overview of this program highlighting pilots and testing goals. NYCDEP's testing program is highly intensive, thorough and includes testing goals not mandated under the current SPDES requirements. *(Note: While preparing this document, the Nitrogen Technical Advisory Committee met in May, October, and December. They reviewed the actions being taken by DEP and indicated that NYCDEP is doing everything possible, and probably then some, to research technologies capable of reducing TN discharged from the WPCPs).* The pilots mandated under the SPDES requirements are listed on **Table 15 & Table 16**.

4.1. Phase 1 Pilot Work

Phase 1 Pilot Work (Table 15)

Pilot Work	Description	Due Date	Status of Work
Chemically Enhanced Thickening	Add Polymer to Gravity Thickener Feed at Bowery Bay and Jamaica WPCPs.	6/30/96	The Polymer Study was completed at Jamaica WPCP and Bowery Bay and a report will be submitted to NYSDEC by 12/31/98.
Fixed Media	Install Fixed Media in Tallman Island WPCP's aeration tanks and have CCNY evaluate the effects.	6/30/96	The fixed media evaluation has been completed by CCNY and a report will be submitted to the NYSDEC by 12/31/98.
Internal Recycle	Install Internal Recycle Pumps in Tallman Island WPCP's aeration tank and have CCNY evaluate the effects.	6/30/96	The internal recycle evaluation has been completed by CCNY and a report will be submitted to the NYSDEC by 12/31/98.

All Phase 1 Pilot Work was to be completed by June 30, 1996 and the report was to be submitted to the NYSDEC by December 31, 1996. However, many of these studies were delayed due to contract procurement, equipment failures, process upsets, and contractual problems. As a result, the NYCDEP sent a letter to the NYSDEC requesting additional time for the Phase 1 Pilot Work and Phase 1 reports. The Phase 1 Pilot Work has been completed and the reports will be submitted by December 31, 1998.

4.1.1. Chemically Enhanced Thickening (Phase 1)

NYCDEP has completed the chemically enhanced gravity thickening study at Jamaica WPCP and a report was prepared by M&E. The findings of the study indicated a reduction in the TSS concentration of the gravity thickener overflow but there was no improvement in the gravity thickener underflow concentrations. The NYCDEP has also completed the chemically enhanced thickening study at the Bowery Bay WPCP, which had similar findings to the Jamaica WPCP enhanced gravity thickening study. These reports have been completed and will be submitted to the NYSDEC by 12/31/98.

4.1.2. Fixed Media and Internal Recycle (Phase 1)

CUNY has evaluated the effects of fixed media and an internal recycle on the Basic Step Feed BNR process at Tallman Island WPCP. The main goal of this experiment was to evaluate the full scale operation of the fixed media. Other goals were to characterize the wastewater, determine kinetic rates, evaluate the process performance, compare the different fixed media, identify operational concerns, and measure settling rates. CUNY has characterized the wastewater and determined the kinetic rates. However, CUNY was not be able to fully evaluate the effects of fixed media due to limitations at the plant such as insufficient process air, poor control of sludge wasting, insufficient RAS, and no means of measuring or controlling the flow distribution to each pass of the aeration tank. The fixed media will be further evaluated as part of the PO-55 contract and all the findings will be incorporated into the Phase 2 report and Feasibility Plan. Evaluation of the full scale operation showed that the fixed media maintained its structural integrity throughout the study and there were no problems with short circuiting or rag deposition. There were also no detrimental effects observed on the performance of the final settling tank and it did not impact Tallman Island WPCP's ability to comply with SPDES permit. A report will be submitted to the NYSDEC by 12/31/98.

CCNY has also tested the effects of an internal recycle to enhance TN removals of the Basic Step Feed BNR process. The plant personnel had some trouble starting-up the recycle pumps because the pumps couldn't supply enough lift to overcome the initial suction head. Therefore, auxiliary pumps were used to overcome the initial head and the existing pumps had enough lift to continue pumping the flow against the friction head in the pipes. The plant also had problems measuring the flow through the recycle pumps and had problems balancing the flow to Aerator #3 because of the higher hydraulic gradient which resulted from the internal recycle. The study indicated that there was no benefit in recycling flow from the "D" pass to the "A" pass to the Step Feed BNR process and the internal recycle will be further addressed as part of the PO-55 study. A report will be submitted to the NYSDEC by 12/31/98.

4.2. Phase 2 Pilot Work

Phase 2 Pilot Work (Table 16)

Pilot Work	Description	Due Date	Status
Centrate Treatment	Install a physical/chemical pilot unit to remove nitrogen from the centrate stream.	12/31/97	A Hot Air Stripper and Steam Stripper has been installed and started-up at 26 th Ward as part of the PO-55 contract by M&E.
Thickening Centrifuge	A Centrifugal Thickener must be tested at Bowery Bay WPCP	12/31/97	A centrifugal thickener has been installed and tested at the Bowery Bay WPCP.
Research Studies	CCNY is to conduct research studies pertaining to nitrogen removal, froth control, and final tank settling.	12/31/97	CCNY has completed all of the research studies and prepared the reports, which were submitted to the NYSDEC prior to 12/31/97.
Other Pilot Work	Install two package BNR units and a 1 MGD biofilter	12/31/97	The 1 MGD biofilter was tested at Newtown Creek and the package BNR units are currently being tested as part of the PO-55 contract by M&E.

All Phase 2 Pilot Work was completed and the Phase 2 reports will be submitted to the NYSDEC by December 31, 1998. A Feasibility Plan will also be submitted to the NYSDEC by December 31, 1998 and will incorporate the findings from Phase 1&2 Pilot Work Studies. The Feasibility Plan will address maximum achievable TN using retrofit technology, nitrogen control actions necessary to achieve 50% and 72% TN removal, a preliminary site specific designs, conceptual schedules, and associated cost estimates. The NYCDEP will continue experimenting beyond December 31, 1998 and will submit supplemental experimental findings (on as needed to basis) as a result of additional pilot studies recommended by the Nitrogen Technical Advisory Committee (TAC).

4.2.1. PO-55 Pilot Work (Phase 2)

The PO-55 pilot study incorporated a physical/chemical pilot unit for the centrate stream, two BNR package plants, pilot scale biofilters, and other feasible biological pilot units that were recommended by the TAC and NYCDEP (**Table 17**). These nitrogen removal pilot units consists of Two Step Feed Suspended Growth Systems, Simultaneous Suspended and Attached Growth System, Attached Growth Systems, Separate Stage Centrate Nitrification, Single Stage Centrate Nitrification/Denitrification, Centrate Ammonia Steam Stripping, and Centrate Ammonia Hot Air Stripping. The NYCDEP will operate and evaluate these pilot units beyond 12/31/98 and will submit supplemental data to the NYSDEC which will contain pertinent information. A report will be submitted to the NYSDEC before 12/31/98.

4.2.2. One MGD Biofilter (Phase 2)

Four 1 MGD biofilters were evaluated as part of the Newtown Creek Upgrade. The purpose of this study was to evaluate the use of biofilters to achieve secondary treatment. The biofilters treated effluent from a modified aeration system and a modified step feed aeration system. As part of the SPDES' Nitrogen Control Requirements, NYCDEP must evaluate the use of a 1 MGD biofilter to achieve tertiary treatment of an NYC WPCP. The Newtown Creek Study has given the NYCDEP the O&M requirements associated with a full scale biofilter. A smaller scale biofilter unit has been incorporated into PO-55 to determine kinetic rates and design criteria associated with primary effluent and final effluent to achieve tertiary treatment.

4.2.3. Thickening Centrifuge (Phase 2)

The NYCDEP has installed and tested a full scale thickening centrifuge at the Bowery Bay WPCP. The unit was expected to be operational during the springtime. However, problems encountered with the unit during the initial field testing required major components of the centrifuge to be returned to the manufacturer for repairs which are complete. The thickening centrifuge has been tested on the gravity thickener feed, secondary waste sludge, and gravity thickener underflow with and without a polymer. A report was prepared and will be submitted to the NYSDEC before 12/31/98. The centrifuge will remain in operation and will primarily be tested on the gravity thickener feed. This will assist the plant in complying with PSRP

Summary of PO-55 Projects (Table 17) Nitrogen Control Action Plan

Pilots	Waste Stream	Description of Pilots
Pilot #1	Influent Wastewater	Step BNR Suspended Growth
Pilot #2	Influent Wastewater	Simultaneous Suspended and Attached Growth
Pilot #3-1	Influent Wastewater	Step BNR Suspended Growth (w/o Chemicals)
Pilot #3-2	Influent Wastewater	Tertiary Nitrifying Attached Growth
Pilot #3-3	Influent Wastewater	Nitrifying Trickling filter
Pilot #3-4	Influent Wastewater	Nitrifying Biological Aerated Filter
Pilot #3-5	Influent Wastewater	Denitrifying Upflow Fluidized Bed
Pilot #3-6	Influent Wastewater	Denitrifying Biological Filter
Pilot #3-7	Influent Wastewater	Nitrifying/Denitrifying Fluidized Bed
Pilot #4-1	Centrate	Separate Stage Nitrification
Pilot #4-2	Centrate	Single Stage Centrate Nitrification/Denitrification
Pilot #5	Centrate	Pretreatment System
Pilot #5-1	Centrate	Hot Air Stripper
Pilot 5-2	Centrate	Steam Stripper

requirements and will enable the NYCDEP to further evaluate process performance, O&M requirements, power consumption, and record any problems encountered with the thickening centrifuge.

4.2.4. Research Studies (Phase 2)

The NYCDEP has been involved in a number of research studies in conjunction with CUNY such as:

- The “Characterization and Treatment of the NYC Sludge Dewatering Centrate Study” has been completed, in which CUNY evaluated biological and chemical physical methods of removing nitrogen from the centrate stream. The study was very important because NYCDEP just implemented dewatering in 1992 because of the Ocean Dumping Ban and the centrate stream resulted in a substantial increase in effluent TN values. The NYCDEP was unsure how to handle the centrate stream because of its extremely high TKN levels and the lack of historical references available for treatment alternatives. As a result, CUNY looked into different biological and physical/chemical processes capable of removing nitrogen the centrate stream. This consisted of a detailed characterization to determine the chemical composition of the centrate, identify toxic substances, and determine minimum and maximum loadings for design purposes. CUNY then performed a variety of different bench scale laboratory studies to determine the most feasible technologies to remove nitrogen from the centrate stream. A report has been submitted to the NYSDEC.
- CUNY has also completed "Process Enhancement Study" which investigated froth control methods, examined sampling collection and analysis, and developed a mathematical model to simulate final tank settling as mandated by the SPDES permit. CUNY investigated techniques to identify indicator organisms associated with froth and procedures to quantify the number of filamentous organisms. According to CUNY, the Nocardia Filamentous Counting Technique reported by Pitt and Jenkins is the most reliable. CUNY also evaluated means of controlling froth and recommended surface chlorine spray and surface wasting of the froth. NYCDEP has also looked into enhancing final tank performance with the use of baffles and/or additional overflow weirs. Some preliminary runs were done using CUNY's Final Tank model and the different configurations selected will be evaluated on a Full Scale Study. A report has been submitted to the NYSDEC.
- NYCDEP has recently entered into an Inter-Governmental Agreement to have CUNY perform a specific characterization of the primary effluent at each WPCP or representative WPCPs. The detailed primary effluent characterization will assist the NYCDEP in future plant upgrades to better address tank sizing, chemical requirements, and ensuring the WPCPs will comply with future TN permit limits.

Overview of Nitrogen Program (Table 18)

Pilot	Testing Goals	Remarks
Chemically Enhanced Thickening	<ul style="list-style-type: none"> - Maximize percent capture - Maximize thickened solids concentrations - Evaluate the effects of chemicals on subsequent processes 	<ul style="list-style-type: none"> - Small cost associated with this option - Utilizes existing tanks and equipment - Mandated by the SPDES permit
Fixed Media & Internal Recycle to enhance BNR	<ul style="list-style-type: none"> - Maximize TN removals in aeration tanks - Determine affect of fixed media on final tank settling - Develop kinetic rates - Develop design criteria and costs - Characterize the wastewater - Develop, calibrate, and validate BNR models 	<ul style="list-style-type: none"> - Requires minimum retrofit to the existing aeration tank - Effects of fixed media on BNR are not available in the literature - Fixed media increases sludge age without overloading final tanks - Evaluation being conducted by CUNY - Mandated by the SPDES permit
PO-55	<ul style="list-style-type: none"> - Evaluate removing TN from both the wastewater and centrate stream - Develop kinetic rates - Develop, calibrate, and validate BNR model - Determine operational requirements associated with each process - Develop design criteria 	<ul style="list-style-type: none"> - Will evaluate retrofit and new innovative technologies - Will test both biological processes and physical/chemical processes - Testing being conducted by M&E - Mandated by the SPDES permit
Biofilter	<ul style="list-style-type: none"> - Evaluate process performance - Determine O&M requirements 	<ul style="list-style-type: none"> - Smaller scale biofilters will be evaluated as part of PO-55 to get kinetic rates - One MGD biofilters have been tested at Newtown Creek WPCP - Mandated by the SPDES permit

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Alternate Thickening	<ul style="list-style-type: none"> - Evaluate process performance - Determine operational requirements - Develop design criteria and costs - Will be implemented on a full scale basis if BNR proves to be detrimental to gravity thickening 	<ul style="list-style-type: none"> - Mandated by the SPDES permit to evaluate a thickening centrifuge - Other thickening processes such as Gravity Belts, Rotary Drums, & DAFs will also be evaluated
Research Studies	<ul style="list-style-type: none"> - Characterize centrate stream - Perform literature searches - Determine most feasible technology to remove TN from the centrate stream - Develop preliminary design criteria and cost estimates - Develop final tank settling model - Evaluate froth control methods - Evaluate sampling and analysis at WPCPs 	<ul style="list-style-type: none"> - Research studies in conjunction with CUNY - Research studies based on a number of inter-governmental contracts with CUNY - Studies will enhance BNR performance at the WPCPs - Mandated by the SPDES permit
Malcolm Pirnie Nitrification Pilot Unit	<ul style="list-style-type: none"> - Evaluate nitrifying the centrate stream - Develop kinetic rates - Determine operational requirements - Develop design criteria and costs - Determine feasibility of using membrane filtration instead of secondary clarifiers 	<ul style="list-style-type: none"> - Membrane filtration will be used to separate solids from liquid stream - Different diffuser systems will be evaluated
NitRem Pilot Unit	<ul style="list-style-type: none"> - Evaluate the process efficiency - Determine operational requirements - Develop design criteria and costs 	<ul style="list-style-type: none"> - Alternate technology capable of removing TN from the centrate stream that NYCDEP became aware of after the PO-55 contract was prepared - The process proved to be cost effective based on a desktop evaluation