Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

MONITORING AND RESEARCH DEPARTMENT

REPORT NO. 14-38

STICKNEY PHOSPHORUS TASK FORCE

TECHNICAL MEMORANDUM NO. 1

GUIDANCE FOR BATTERY CONVERSION TO ENHANCED BIOLOGICAL PHOSPHORUS REMOVAL FOR THE STICKNEY WATER RECLAMATION PLANT

October 2014

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FORWARD

The Metropolitan Water Reclamation District of Greater Chicago (MWRD) recognizes the value of phosphorus as a non-renewable resource. In an effort to optimize the sustainable removal of phosphorus from its wastewater influents and the subsequent recovery of phosphorus in various forms suitable for use as an agronomic fertilizer, the MWRD initiated a Phosphorus Removal and Recovery Task Force in 2012. The Task Force initiated a study phase at several of the MWRD's Water Reclamation Plants (WRPs) to evaluate the feasibility of implementing enhanced biological phosphorus removal and to develop operational guidelines for optimizing its effectiveness. The Task Force has created WRP specific study workgroups that are focused on each of the WRPs that have been identified to participate in this initiative. As the workgroups complete various phases of their studies and evaluations they are documenting their findings and recommendations in technical memoranda. These memoranda are written by the WRP specific workgroups and vetted by the Task Force before being published. Their purpose is to capture the state of knowledge and study findings and to make recommendations for implementation of enhanced biological phosphorus removal as they are understood at the time the memoranda are published.

DISCLAIMER

The contents of this technical memorandum constitute the state of knowledge and recommendations developed by the MWRD's Phosphorus Task Force at the time of publication, and are subject to change as additional studies are completed and experience is attained, and as the full context of the MWRD's operating environment is considered.

Guidance for Battery Conversion to Enhanced Biological Phosphorus Removal for the Stickney Water Reclamation Plant

Technical Memorandum 1

Date: August 6, 2013

To: Phosphorus Task Force & Advisory Committee

From: Phosphorus Study/Planning Team

Subject: Conversion to Enhanced Biological Phosphorus Removal in Stickney Batteries

Battery D at the Stickney Water Reclamation Plant (SWRP) was converted in May 2012 to stimulate enhanced biological phosphorus removal (EBPR) after preliminary testing 2011 showed promise. At the July 17, 2013, meeting of the Phosphorus Task Force, the attendees decided that the next beneficial step in the study process is to convert Batteries A, B, and C to EBPR, as well. This is in-line with the schedule the District developed to meet the total phosphorus (TP) limit of 1 mg/L as a monthly average in the upcoming IEPA NPDES permit and will allow time for further testing and monitoring before the permit is issued. In addition, information on the biosolids and centrate streams can be collected for design of the P-recovery system.

The conversion schedule discussed at the meeting and modified in a follow-up meeting on August 1, 2013, is as follows:

Battery A – August 12, 2013
Battery B – August 19 – September 9, 2013
Battery C – October 14, 2013

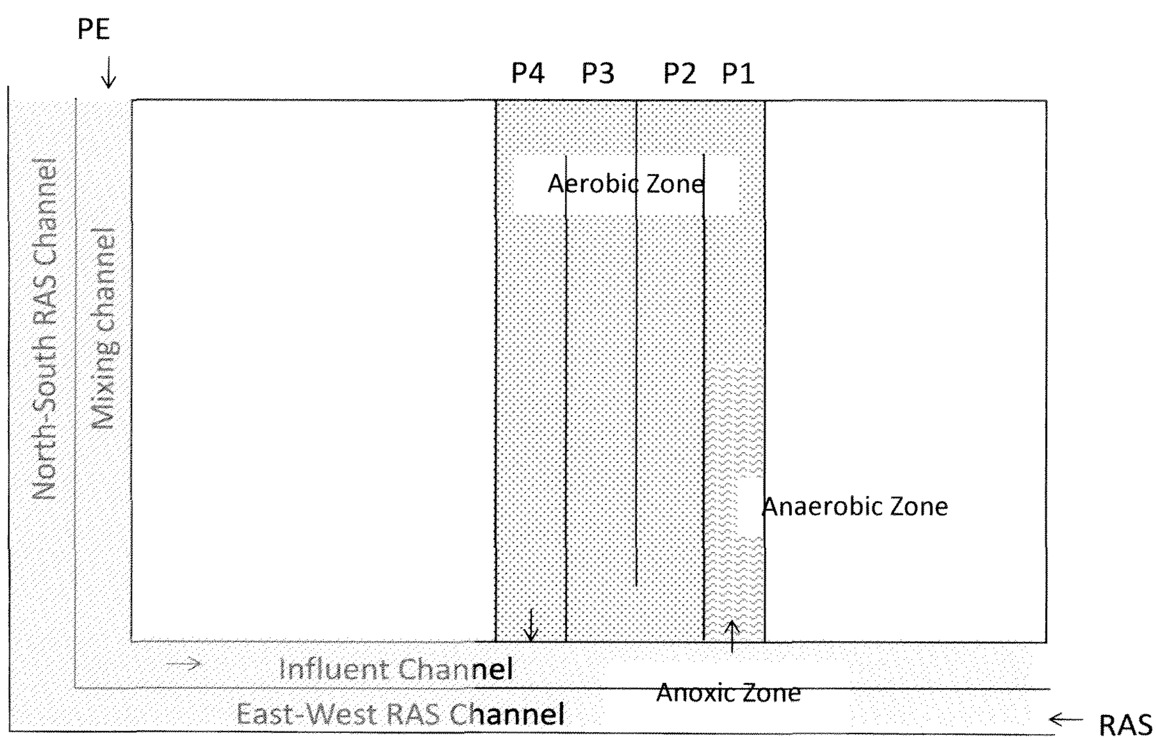
It was also understood from this meeting that the proposed schedule is a tentative one and subject to change if problems are encountered. In particular, if effluent ammonia concentrations begin to increase, the conversion process may need to be halted for further discussion.

The procedure used to establish and build a viable EBPR process in Battery D is straight forward and outlined below. Although the steps were spread across various phases in Battery D, they can be condensed based on the lessons learned in working with Battery D. The Phosphorus Planning team will be available for guidance during the conversion process.

CONVERSION STEPS

1. Prior to conversion, battery should be drained in a manner to capture the solids within the tanks and the channels. This will allow for current deposition before conversion of the battery to EBPR to be noted. Photos of the drained tank should be taken.
2. Once the battery is filled back up and running, close all air valves in the east-west and north-south RAS channels (See Figure 1). Minimize the air lift flows as much as possible. These channels will be the anoxic zones.
3. Fully open all valves in the mixing channels and then turn off the air main serving all valves in that channel, i.e. there should be no air input into the mixing channel. Turn off every other valve in the influent channels; the open valves should be set to the first notch or the lowest level that will generate the minimum amount of air. These channels will also be the anoxic zones.
4. To establish the anaerobic zone, close first seven valves in Pass 1 of each tank, i.e. the valves on the first half of the pass (in Batteries A and B, the first seven sets of four valves should be adjusted). Each valve should then be opened until bubbles just start to appear. A clear liquid level should not form on top of the mixed liquor.
5. To establish the beginning of the aerobic zone, fully open the last five air valves in Pass 1 of each tank, i.e. the valves on the second half of the pass (in Batteries A and B, the last five sets of four valves should be adjusted; in Battery C, the last 6 valves should be adjusted). The target DO concentration is 1 mg/L at the beginning of the aerobic zone.
6. Visually inspect Pass 1 of each tank to ensure the valves are set appropriately for each zone on a bi-weekly basis.
7. Target MLSS concentrations in the converted battery around 3,500 mg/L.

FIGURE 1 – SCHEMATIC OF SWRP EBPR BATTERY



ONGOING MAINTENANCE

Because there are no mixers installed at SWRP, steps must also be taken to limit the solids deposition within the anoxic and anaerobic zones; although steps can be taken, it is expected that there will still be solids deposited when operating in this manner.

1. In the RAS, mixing, and influent channels, all valves should be completely opened once per week for approximately one hour to flush the deposited solids out should manpower be available. Sludge judge measurements should be taken periodically if possible within the channels to determine if the frequency should be increased or decreased.
2. Similarly, the air valves in the anaerobic zone of Pass 1 (first half of pass) in each tank should be fully opened monthly for one hour to alleviate the deposition should manpower be available. Sludge judge measurements can be taken within the passes to determine if the frequency should be increased or decreased.
3. Scum buildup within the anaerobic zone of Pass 1 in each tank was also noted during the demonstration study. This scum can be flushed out of tank during step 2.
4. Tanks should be inspected for solids deposition if drained for maintenance or should the flushing protocol above prove ineffective. Cleaning may be performed at this time if necessary.

ONGOING M&R MONITORING

M&R will continue to monitor the converted batteries for performance and analyze the data as the conversion process progresses.

1. WAS TP and effluent TP and ortho P from each battery will be monitored four days per week. Effluent ammonia concentrations will be monitored and analyzed to determine minimum tankage required for nitrification.
2. Mixed liquor samples will be collected from the converted batteries once per month for nitrification rate testing via respirometry. The frequency of this routine testing is subject to M&R manpower availability.
3. Profile sampling will be used on a limited basis, primarily if there are problems experienced during the conversion, major operational changes occur, or the effluent TP values are not decreasing.
4. M&R will also work with the consultants designing the phosphorus recovery process at the Post-Centrifuge building to see what additional monitoring will be beneficial for their design.

CONVERSION OPTIONS

There are also different methods to convert the remaining three batteries. It is proposed that the conversion process is slightly altered in each of the batteries to gauge the effects.

1. Battery A – Full Conversion: The steps outlined in 'Conversion Steps' are followed and implemented all at once. This will allow for assessment of how quickly a battery can become a fully operational EBPR battery.
2. Battery B – Stepped Conversion: The steps outlined in 'Conversion Steps' are followed, but spaced between each step. For example, 1 – 2 SRTs should pass between each air reduction step. In addition, Pass 1 of a quarter of the battery tanks would be converted at a time, with 1 – 2 SRTs between each set of tanks. The percentage of the battery that is necessary for effective EBPR to meet the NPDES permit can be determined from this stepped conversion and may help in future balances with nitrification capacity for the batteries.
3. Battery C – Conversion using PAO-rich Sludge: Battery C can be seeded with sludge from other EBPR batteries before conversion steps are implemented. The startup time for EBPR using such sludge should be reduced by this method and will be helpful to know when a battery experiences a shutdown in the future.

OPTIMIZATION OPTIONS

The following points are compiled as steps that could help with improving the process. The extent of improvement is unknown at this time.

1. Mixers in anoxic and anaerobic zones.
2. Automated valves for flushing of anoxic and anaerobic zones and optimization of aerobic zone based on DO measurements. If this approach is taken, it would also allow for the settling of mixed liquor in all anoxic and anaerobic zones. The settled solids are expected to produce VFAs to improve EBPR. These zones would need to be flushed (open all the valves) automatically once per day for 15-30 minutes to prevent septicity and settling problems. An ORP probe to signal when septic conditions exist (-200 mV) could also be incorporated in the process control.
3. Covers for some of the fine bubble diffusers.
4. Baffle walls to optimize the effects of the differing zones.