

WASTEWATER TREATMENT MODELING PROJECT

DUE: DECEMBER 1, 2011

The grand challenge: find the operation that best reduces treated effluent total nitrogen and phosphorus using biological processes without extra chemical addition or construction of new unit processes. You will need to suggest an operating plan for the current Metro plant where the variables are:

- Sludge wasting (SRT)
- Aeration conditions
- Origins and introduction of all inflows, including internal recycling of materials: screened (raw) wastewater, primary effluent, return activated sludge, nitrified recirculation, dissolved air flotation (DAF) underflow, gravity thickener overflow, digester material and centrate.

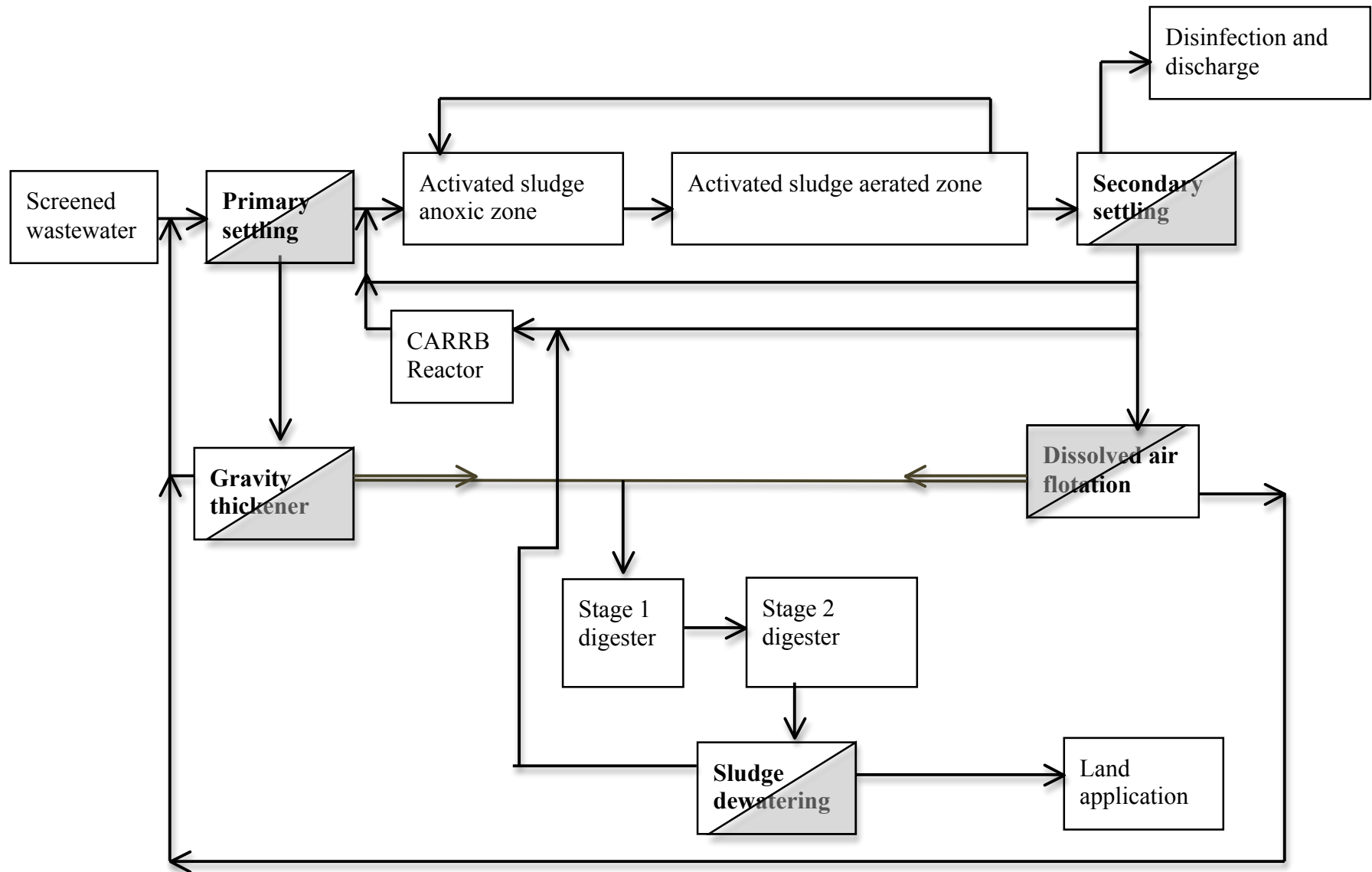
Additional objectives:

- Effluent must meet current permit standards for all contaminants.
- Operation should minimize costs for aeration.
- Operation can improve recovery of valuable products: reclaimable water, energy, solid phase nutrients and organic soil amendment.
- Operation has flexibility to accommodate peak loads, seasonal variation, even more stringent standards

The Metro Wastewater Reclamation District operates a split treatment secondary treatment system where the North Secondary (NSEC) provides nitrification and partial denitrification and the South Secondary (SSEC) provides BOD removal. The District operates the NSEC facility to meet monthly average ammonia discharge limits and a weekly average nitrate plus nitrite limit. The effluent from the North and South facilities is blended to meet discharge permit limits.

The NSEC receives approximately 60% of the influent total flow of 140 million gallons per day (MGD), as well as the liquid residual from the sludge dewatering processes (gravity thickener overflow and centrate) and the return activated sludge (RAS). The NSEC liquid process line consists of a Centrate and Return activated sludge (RAS) Reaeration Basin (CaRRB), followed by 12 parallel activated sludge basins with initial zones that can be operated in anoxic or oxic modes followed by aerated zones. The centrate represents a large portion (as much as 30 to 40 percent) of the ammonia load to the NSEC.

Metro NSEC Process Schematic and Plant Solids Handling



PROJECT SCOPE AND ACTIVITIES

I. BioWin Model of NSEC. Develop a simulation model of the wastewater treatment processes using BioWin and plant operating data using a steady state simulation. Calibrate your model with one data subset and verify with a second independent data subset.

Input

- Plant data provided
 - Influent flow and water quality
 - Effluent flow and water quality
 - Internal recycle stream flow and water quality data
 - Plant design information
- Adjustable variables for calibration
 - Influent organic matter fractionation
 - Kinetic and stoichiometric parameters

Compare model output of effluent quality and to plant performance and to permit limits in steady-state conditions.

Evaluate the sensitivity of the model output to the parameters you varied during calibration.

II. Challenge 1. Adjust process conditions and plant operation to achieve optimal levels of effluent nitrogen and phosphorus, minimize energy (primarily aeration), and if considered, improve resource recovery.

- Adjustable process conditions
 - Dissolved oxygen set-points
 - Clarifier underflow rates
- Adjustable operations
 - Waste activated sludge flow rate (SRT)
 - Return activated sludge (RAS) flow rate and points of return
 - Point of return of gravity thickener overflow, digested solids centrate, dissolved air flotation (DAF) underflow
 - Primary settling basin operation, including bypass
- Identify the limiting process or condition of the NSEC plant with regard to effluent quality, energy consumption and resource recovery, and use BioWin to demonstrate the limitation by adding physical unit, chemicals or other equipment to improve treatment performance.

III. Challenge 2. Select one of the two conditions below and simulate NSEC performance using your optimized model configuration in BioWin.

- Winter operation when wastewater temperature is 12 °C and land application of biosolids is more limited.
- Reduction in effluent standard for total inorganic nitrogen to 5 mg/l.
- What process condition would you change to best meet the condition?

PROJECT DELIVERABLES

Submit a report of your modeling results with the operating strategy for the NSEC facilities to optimize performance (Challenge 1), costs and benefits and response to Challenge 2. Discuss your strategy for optimizing operation and the major drivers that influenced your decisions, including the elements below.

I. NSEC Model development

- BioWin INPUT information:
 - BioWin configuration schematic
 - Table showing all flows (internal and external), tank sizes
 - Table showing all unit process conditions
 - Table of influent water quality characteristics including organic fractionation
- Discuss your calibration methods, particularly which parameters you varied and why
- Table(s) comparing BioWin simulation output to plant operating conditions (MLSS, settler underflow solids, and discussion of differences)
- Table(s) comparing BioWin simulation output to plant effluent water quality and discussion of differences
- Graphs showing output sensitivity to parameters changed in calibration for effluent BOD, ammonia, nitrate, phosphorus, TSS, and aeration basin MLSS.

II. NSEC Process Optimization

- Optimization strategy
 - General approach
 - Variables selected for optimizing, range of variation and rationale
- Results
 - BioWin configuration schematic showing optimized operation
 - Table comparing optimized internal flows with existing flows
 - Table comparing optimized process conditions and operation with existing conditions
 - Table comparing optimized effluent water quality with existing water quality
 - Summary of benefits/costs of optimized operation:
 - Change in energy consumption
 - Resource recovery
 - Other
- Which change provided the biggest “bang for your buck” in improving effluent quality? Discuss the reason the change was effective.
- Which process was the greatest impediment to improving effluent quality? How could that be changed to reach to improve effluent quality further – for example for water reuse or new more stringent standards? What are the costs?

III. Adaptability

- Discuss how your optimized process accommodated the change in either the effluent nitrogen standard or winter operation.