Waste Water Treatment Plant Overview and Tour
Outline

• Definitions
• Chronology
• BNR Process Description
• Plant Performance
• Site Photos
Definitions

- **SWPCC**: Summerside Water Pollution Control Centre

- **Activated Sludge**: Suspended growth treatment process utilizing micro-organisms to treat waste in a series of process reactors and settling tanks. Settled sludge or activated sludge is then recycled to the start of the process.

- **BNR**: Biological Nutrient Removal. Activated sludge process incorporating the use of aerated zones, un-aerated zones and internal recycles.
Definitions

• **PAO**: Phosphorus Accumulating Organism are microorganisms (bacteria) that uptake and store orthophosphate in excess of their biological requirements.

• **BOD**: Biochemical Oxygen Demand is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period.

• **TSS**: Total Suspended Solids is the amount of insoluble solids floating and in suspension in the wastewater
Chronology

Primary Treatment > Tertiary Treatment

- 1972 SWPCC constructed as a primary treatment plant
- 2003 Design team of Delcom & CBCL
- 2005 Pre-design study; BNR is chosen.
- 2006 Design complete, project goes to Tender
- 2006 June construction start-up
- 2007 December substantial completion
- 2008 December plant in full operation
SWPCC – Key Facts

- Capacity for approximately 18,175 people
- Construction Cost = 19 Million
- Average Daily Flow = 11,675 m$^3$/day (3 mgd)
- Potential High Flow = 39,000 m$^3$/day (7,150 gpm)
- BOD = 260 mg/L & TSS = 180 mg/L
What is a BNR?
(Biological Nutrient Removal)

...wastewater treatment methods that utilize biological mechanisms, instead of chemical mechanisms, to remove phosphorus and nitrogen from wastewaters.... (Randall et. al.)
Conventional Activated Sludge Process

Primary Clarifier

Flow in

Return Activated Sludge (RAS)

Secondary Clarifier

Flow out

- Anoxic
- Anaerobic
- Aerobic
BNR - Modified Johannesburg Process

Process used at SWPCC

Primary Clarifier

Flow in

Nitrate Recycle

Return Activated Sludge

Secondary Clarifier

Flow out

- Anoxic
- Anaerobic
- Aerobic
Process Reactor Zones

• **Anoxic Zone:** No dissolved oxygen added; microorganisms utilize nitrate and organic carbon. Majority of denitrification occurs.

• **Anaerobic Zone:** Recycled PAOs are subject to an environment high in organic carbon with no dissolved oxygen (DO). Storage of carbon as polyhydroxybutyrate (PHB) and subsequent phosphorus release occurs.
Process Reactor Zones

- **Aerobic Zone**: Three major processes occur in this zone:
  - removal of BOD not previously taken up in anaerobic and anoxic zones
  - nitrification of ammonia by autotrophic organisms
  - phosphorous uptake. Metabolization of PHB previously stored by P-accumulating organisms in the anaerobic zone
What does all of the work

The biological mechanisms that allow a BNR to operate consists of different types of bacteria, protozoa and metazoan.
Biological Nutrient Removal

How does it work?

1. Nitrification
2. Denitrification
3. Phosphorus Removal
Nitrification

The Biological Conversion of Ammonia to Nitrate
Nitrification

Overview of SWPCC two 7 cell reactors
Nitrification

We’ll look at just one of the reactors
Nitrification

Reactor is broken into 3 types of cells

Pre Anoxic

1

Anaerobic

2

3

Anoxic

4

5

Aerobic

6

7

Mixed Liquor Recycle
Nitrification

Ammonia (from Primary Effluent) travels from Pre Anoxic Zone to Aerobic Zone.
Next step takes place in the aerobic cell

Mixed Liquor Recycle
1. Autotrophic Bacteria oxidize the inorganics to provide energy for growth and maintenance
2. Nitrosomonas convert Ammonia to Nitrite
3. Nitrobacter convert Nitrite to Nitrate
Denitrification

The Biological Reduction of Nitrate to Nitrogen Gas
Now that the Ammonia has been converted into Nitrate, it must be converted to harmless Nitrogen gas.
Nitrates are recycled, via the mixed liquor, from the aeration basin back to the Anoxic Zone for Denitrification to take place
Nitrates are recycled, via the mixed liquor, from the aeration basin back to the Anoxic Zone for Denitrification to take place.
Heterotrophic bacteria use the Nitrates as the terminal electron acceptor (oxygen source) so that they can utilize carbonaceous organic material.
When the heterotrophic bacteria strip the Nitrate of its oxygen, Nitrogen Gas is liberated into the atmosphere.
Phosphorus Removal

The Biological Removal of Phosphorus
Phosphorus Removal

1. Pre Anoxic
2. Anaerobic
3. Anoxic
4. 5.
5. 6.
6. 7.

Aerobic

Mixed Liquor Recycle
Phosphorus Removal

Pre Anoxic → 1 → Anaerobic → 2
Phosphorus Accumulating Organism (PAO) present in Anaerobic Cells via RAS
Organic Material (via Primary Effluent) is introduced from Pre Anoxic Zone
Organic Material (via Primary Effluent) is introduced from Pre Anoxic Zone
Phosphorus Removal

Pre Anoxic

PAO

1

Anaerobic

2
Phosphorus Removal

Anaerobic Cell 1

PAO

PO$_4^{3-}$

PO$_4^{3-}$

PO$_4^{3-}$
Phosphorus Removal

Anaerobic Cell 1

PAO Takes up Organic Matter
To store the organic material, the PAO requires the energy from the phosphate to phosphate bonds
Phosphorus Removal

PAOs travel through Cell 1 and into Cell 2

Pre Anoxic

Anaerobic

1

2
PAOs travel through Cell 1 and into Cell 2
Phosphorus Removal

Pre Anoxic

1

Anaerobic

2

PAO
Phosphorus Removal

Anaerobic Cell 2

PAO

PO$_4^{3-}$ PO$_4^{3-}$ PO$_4^{3-}$
Phosphorus Removal

The phosphate to phosphate bonds are broken
Resulting in increased $\text{PO}_4^{3-}$ in anaerobic cells
Phosphorus Removal

Pre Anoxic

Anaerobic

1

2

3

Anoxic

4

5

Aerobic

6

7

Mixed Liquor Recycle
Phosphorus Removal

PAOs and free phosphates travel through Anoxic Zone to the aeration basin
Phosphorus Removal

PAOs and free phosphates travel through Anoxic Zone to the aeration basin
Phosphorus Removal

1. Pre Anoxic
2. Anaerobic
3. Anoxic
4. Mixed Liquor Recycle
5. Aerobic
6. 7.
Phosphorus Removal
Phosphorus Removal

Aerobic

5

6

7
Phosphorus Removal
Phosphorus Removal

Cell 5-7
Aerobic

PAO

$\text{PO}_4^{3-}$

$\text{PO}_4^{3-}$

$\text{PO}_4^{3-}$
Phosphorus Removal

Stored Organic Material is oxidized in Aerobic Zone
Phosphorus Removal

Cell 5-7
Aerobic

PAO

Energy is produced

PO$_4^{3-}$
PO$_4^{3-}$
PO$_4^{3-}$
Phosphates are drawn towards the energy in order to form bonds
Energy is used to form bonds and uptake more phosphates than originally present
PAO’s uptake phosphates as they travel through the aeration basin
PAO’s are then wasted in WAS and therefore removed from solution in final effluent
SWPCC Process Schematic

- **Key Features:**
  - Variation of the Activated Sludge process.
  - Efficient removal of BOD, TSS, Ammonia, Nitrogen & Phosphorus
  - Will comply with Canada Wide Strategy for Municipal Wastewater Effluent (25/25 non-toxic & Chlorine residual < 0.01)
  - Significantly reduces nutrient loads to the harbour
# SWPCC – Effluent Criteria

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Effluent Requirements</th>
<th>BNR Effluent Objectives</th>
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<tbody>
<tr>
<td>CBOD, mg/L</td>
<td>25</td>
<td>10</td>
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<tr>
<td>TSS, mg/L</td>
<td>25</td>
<td>10</td>
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<tr>
<td>Ammonia, mg/L</td>
<td>16</td>
<td>5</td>
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<tr>
<td>Total N, mg/L</td>
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<tr>
<td>Ortho-phosphate, mg/L</td>
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<tr>
<td>Total P, mg/L</td>
<td>n/a</td>
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</tr>
<tr>
<td>Fecal Coliforms, MPN/100 mL</td>
<td>200 avg, 400 max</td>
<td>200 avg, 400 max</td>
</tr>
</tbody>
</table>
Control Room

Process control and monitoring
Laboratory
Daily testing and monitoring
Headworks Building
Initial screening and flow measurement
Primary Clarifiers
Constructed 1972 – Retrofitted 2007
Process Reactors
Anoxic and Anaerobic Zones
Process Reactors

Anaerobic cells, Aerobic cells and Secondary Clarifiers
Process Reactors
Aerobic Zone with DO control
Secondary Clarifier
Plant Service Water

Treated Effluent Recycled for Operations
RAS Pumping Station
Flow Pacing Matches Plant Flow
UV Disinfection
Dose Pacing – flow and transmissivity
Sludge Treatment Process

Throughput = 3.3 tonnes/d

Sludge Blending Tank

TWAS

Primary

Septage

Feed Pumps

Rotary Presses

Dewatering

Mixer

Cement Kiln Dust

Dryer

N-Viro Process

12 m³/d @ 60% solids

Heat Pulse

Class A Biosolids to Land Application
WAS Thickening
Rotary Drum Thickener

- Thickens WAS from 0.75% to 4% solids.
- Two units (1 duty, 1 stdby)
Dewatering

- Fournier Press
- Design throughput of 600 kg/h at 4% solids
- Expected Cake dryness 20 to 25% solids
Biosolids Treatment Process
Sludge mixer – Lime, Lime Dust and Sludge
Rotary Drum Dryer (N-Viro)

- Max throughput of 4 tonnes/hr (inlet)
- 5,000 cfm of air required.
- Oil fired Burner
- Output = 2.5 tonne/hr at 62% solids (wet).
Odour Control

- Exhaust from N-Viro system cooled and treated in biofilter.
- Odorous air from headworks and sludge storage added.
Biosolids Final Product

- 62% Total Solids content
- Granular consistency
- Spread with lime spreaders
Major Lift Stations

Reads Corner

Eustane St.

Northumberland St.
Minor Lift Stations

Red Bridge
MacKenzie Drive
Crozier Drive
MacArthur Subdivision
Wedge Drive
Harbor Drive
Briggs Street
Granville Street
North St. Eleanor's Lagoon
The End

For Information Contact:
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1-902-432-1274
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Staff: Everett Moase
Paul Cormier
Mike Gillis
Randy McCourt
Joe Noonan
Tours are available on request.

THANK YOU!