

North End Sewage Treatment Plant Environment Act Licence 2684 RRR



Interim Phosphorous Reduction Plan and Nutrient Removal Implementation Plan

January 31, 2020

Original signed by Duane Griffin, P. Eng.
City of Winnipeg Co-Chair

Original signed by Siobhan Burland Ross, P. Eng.
Manitoba Conservation and Climate Co-Chair

Executive Summary

This report consists of an Interim Phosphorous Reduction Plan and a Nutrient Removal Plan for the North End Sewage Treatment Plant (NEWPCC). This report was completed by the Project Steering Committee for the NEWPCC, which consist of representatives from the City of Winnipeg (City) and the Province of Manitoba, and was based upon work undertaken by the City as reported in the December 31, 2019 Progress Report submitted to the Province. A Project Advisory Committee is providing feedback to the Project Steering Committee.

There is consensus for the work that is being conducted in 2020. Additional schedule reviews will be conducted for the remaining years and the schedule will be resubmitted in July 2020. Both the City and the Province of Manitoba are committed to expediting the schedule wherever possible and will continue to look for opportunities to implement nutrient removal as soon as possible.

Interim Phosphorous Plan

- The City will test and model several options for interim phosphorous removal over the next year to determine how much additional phosphorous can be removed
- The recommended option will be presented for both City and Provincial approval
- Both the City and the Province of Manitoba will continue to explore opportunities to implement interim phosphorous removal as soon as possible

Nutrient Removal Plan

- The Nutrient Removal Plan has been in progress since the NEWPCC Master Plan was approved in 2014. The plan consists of three large projects which will come online in order of criticality:
 1. NEWPCC Upgrade: Power Supply and Headworks Facilities - \$408 million;
 2. NEWPCC Upgrade: Biosolids Facilities - \$553 million; and
 3. NEWPCC Upgrade: Nutrient Removal Facilities - \$828 million

All three projects have completed conceptual and preliminary design. The Power Supply and Headworks Facilities projects are currently in various phases of design and construction. The Biosolids Facilities project received approval from the City to proceed with design which will begin in 2020. The Nutrient Removal Facilities project relies on design details from the Biosolids Facilities Project and will be initiated accordingly.

Included in this report is a list of assumptions and constraints that were used to develop both the Interim Phosphorous Plan and the Nutrient Removal Plan. The Project Steering Committee will continue to review and analyze these assumptions and constraints in order to optimize the plans and deliver nutrient removal as soon as possible.

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Figure 1. Interim Phosphorous Reduction Plan

Figure 2. NEWPCC Upgrade Implementation Plan

Project Steering Committee Members

Duane Griffin, P. Eng.	City of Winnipeg
Michelle Paetkau, P. Eng.	City of Winnipeg
Siobhan Burland Ross, P. Eng.	Manitoba Conservation and Climate
Nicole Armstrong	Manitoba Agriculture and Resource Development
Travis Parsons, P. Eng.	Manitoba Water Services Board
Shannon Kohler	Manitoba Conservation and Climate
Asit Dey, P. Eng.	Manitoba Conservation and Climate

1. Introduction

The City of Winnipeg (City) submitted a 'Notice of Alteration Request' to Manitoba Conservation and Climate, requesting an additional two years to establish a plan for interim phosphorous removal compliance. The Notice of Alteration was not approved. In response Manitoba Conservation and Climate established a Project Steering Committee for the North End Sewage Treatment Plant (NEWPCC) Nutrient Removal Upgrade. The Project Steering committee is co-chaired by the City and Manitoba Conservation and Climate and is responsible for:

1. Preparing an Interim Phosphorous Reduction Plan for implementation by February 1, 2020
2. Preparing an implementation plan with realistic timelines for the complete upgrade of the NEWPCC to meet all licence conditions
3. Submitting monthly progress reports on the upgrade process

The plans described are presented in this report and represent the most realistic timeframe for completion of the NEWPCC Upgrade. There is consensus regarding the first year of work (i.e., 2020). The Project Steering Committee will continue to review the later phases of work (i.e., 2021 onward) to look for opportunities to accelerate the schedule while project funding discussions continue.

2. Background

The NEWPCC has been in operation since 1937 and treats about 70% of sewage in Winnipeg. It is the largest and most complex of Winnipeg's three sewage treatment plants and provides all of the City's sludge processing and treatment.

The NEWPCC consists of screening and grit removal, primary clarification, activated sludge treatment via high purity oxygen (HPO) bioreactors, secondary clarification, and ultra violet disinfection. Solids from the NEWPCC and the City's two other sewage treatment plants are treated at the NEWPCC with mesophilic anaerobic digestion.

Currently, the NEWPCC is in the midst of a large multi-year upgrade. It was initiated in 2014 following the approval of the NEWPCC Master Plan and was scheduled to be complete by the end of 2019. The objectives of the NEWPCC Upgrade are as follows:

1. Meet the Province of Manitoba Environment Act Licence and Water Protection Act;
2. Address end-of-life assets;
3. Expand sludge treatment capacity to accommodate future growth; and
4. Manage wet weather flows.

The NEWPCC Plant upgrade was originally estimated to cost \$795.59 million based upon a Class 5 (+100%/-50%) Association for the Advancement of Cost Engineering (AACE)

estimate. The project procurement strategy was that the NEWPCC Upgrade project would be predominantly done as a single, large capital project with smaller ancillary projects. As the design progressed to a Class 3 (+30%/-20%) AACE cost estimate. The project cost increased to \$1.789 billion; increases were attributed to more detailed design of the project, inflation, changes in the US exchange rate, and lessons learned from previous large scale sewage treatment projects (e.g., the South End Sewage Treatment Plant Upgrade).

A review of the procurement strategy indicated that the construction market would not support a single \$1.789 billion project. In February 2019 the project was separated into three construction projects to manage cost, risk, and schedule. A Class 3 cost estimate was developed for each project:

1. NEWPCC Upgrade: Power Supply and Headworks Facilities - \$408 million;
2. NEWPCC Upgrade: Biosolids Facilities - \$553 million; and
3. NEWPCC Upgrade: Nutrient Removal Facilities - \$828 million

The project order was established based on process criticality; each project cannot be operational until its predecessor has become operational. Currently, Project 1 Power Supply and Headworks Facilities is in design and construction phase.

The City of Winnipeg has also been studying possible options for interim phosphorous reduction at NEWPCC and has committed to short listing several options for further study/review. Interim phosphorous reduction utilizes chemicals to remove phosphorous from wastewater whereas the NEWPCC Nutrient Removal Facilities project will use bacteria to remove the phosphorous and treat other wastewater parameters, such as ammonia. The details of both these projects are discussed further in the following sections of this report.

3. Objective 1: Interim Phosphorous Reduction Plan

The plan for Interim Phosphorous Reduction will only address phosphorous removal and will not achieve compliance with other licence parameters, such as nitrogen or ammonia removal. It will also have repercussions on the City's Biosolids reuse programs because the chemically bound phosphorous will not be as biologically available to plants and soils. This may lead to an increase in landfilling Biosolids, reducing their beneficial reuse.

The plan is presented in Figure 1 and uses the existing sludge treatment system (Biosolids Facility). Due to capacity constraints the existing system will not be able to meet the licence requirement for 1 mg/L total phosphorous removal but it is expected that some phosphorous removal may be possible.

The Interim Phosphorous Reduction Plan started in 2019 with the development of an 'Interim Phosphorous Options Report' which described several options for reducing phosphorous at the NEWPCC before all phases of the Upgrade Project are complete. These options were evaluated assuming typical, average flow conditions. The Interim Phosphorous Options

Report concluded, that while some phosphorous removal may be possible, due to capacity constraints of the existing sludge treatment system, none of the options would meet the NEWPCC licence requirement of 1 mg/L phosphorous removal.

The current engineering assignment will determine how much phosphorous can be removed without a process upset. A consultant has been hired to develop computer models and conduct laboratory testing to further understand several short listed chemical phosphorous removal options:

1. Option 1: Side-stream chemical phosphorous removal by dosing a phosphorous removing chemical into the sludge treatment system to prevent phosphorous from the South End Sewage Treatment Plant from releasing back into the system. It will also mitigate phosphorous-based mineral (e.g., struvite) formation.
2. Option 2: Option 1 plus chemically enhanced primary treatment to remove additional phosphorous.
3. Option 3: Option 1 plus chemical phosphorus removal in the high purity oxygen reactors (HPO) and/or secondary clarifiers.

The options will be evaluated based on both average flow conditions and high-flow conditions. Following the testing, modeling, and analysis the City will submit a recommendation for both Regulatory (Manitoba Conservation and Climate) and City Council approval in early 2021. If approved, the City will begin final design and construction of the recommended interim phosphorous option. The interim phosphorous facilities may not be reused in the final design.

The schedule can be seen in Figure 1. The design of the recommended interim phosphorous option is estimated to start in the third quarter of 2021 after Council approval. The actual design and construction timeframe will depend on the recommended option. Without any design work done to date, the schedule is purposely conservative and will be re-estimated once a preferred option is approved. During the first year of testing the Province and the City will seek opportunities to advance design and/or construction including a review of internal approval processes at each level of government that would expedite implementation. Interim Phosphorus Removal will be implemented as soon as safely possible.

While the Project Steering Committee will continue to look for opportunities to accelerate approval, design, and construction, full operation may not begin until the existing sludge treatment system has been stabilized with the new nutrient rich sludge from the South End Sewage Treatment Plant (SEWPCC) Upgrade. The SEWPCC Upgrade is currently scheduled to conclude at the end of 2021.

4. Objective 2: Full Biological Nutrient Removal Facilities

The schedule for full biological nutrient upgrade is presented in Figure 2. This represents a realistic timeframe for the overall project. To meet the schedule presented in Figure 2 the

City has brought in additional resources for project management and contract administration with Veolia through the Winnipeg Sewage Treatment Program. Additional ancillary resources (e.g. legal services) will be procured on an as-needed basis.

The NEWPCC Upgrade started in 2014 with the NEWPCC Master Plan approval and the pre-selection of key wastewater technologies, such as phosphorous recovery. The original 2014 NEWPCC Master Plan assumed a project schedule of approximately six years, under a design- build contract. As the design progressed from conceptual design to preliminary design it became apparent that the costs and complexities (scope of work, complexity of tie-ins, process interdependencies, coordination risks, and ability to maintain operations) of the project were greater than market conditions could support for a single design build. Contracts and trades did not have the capacity to support all these works at once, especially when considering construction activities already occurring at the SEWPCC Upgrade.

In 2019 the City divided the NEWPCC Upgrade project into three phases, as described previously. The Power Supply and Headworks phase has been ongoing since 2016 and is scheduled for completion in 2026. While the Power Supply and Headworks Facilities project is ongoing the City will initiate work for the new sludge treatment system, which is currently scheduled to finish construction in 2028. The NEWPCC Upgrade Biological Nutrient Removal Facilities project is scheduled to start in 2023. In 2026 it is anticipated there would be three large projects (and multiple contracts) occurring on the same site at the same time. This would be in addition to regular construction and maintenance activities.

Detail design for the NEWPCC Upgrade Biological Nutrient Removal Facilities project is scheduled to start in the fourth quarter of 2023. Earlier phases of design have already been completed to develop the AACE Class 3 cost estimate. The project is not scheduled to start sooner because there must be sufficient time for the detail design and construction of tie-ins from the NEWPCC Upgrade Biosolids Facilities work. Construction is scheduled to start in the third quarter of 2026 for the following reasons:

- Physical Site Constraints: The NEWPCC site will be constrained due to the first two projects (e.g., Headworks Facilities and Biosolids Facilities). There are laydown area requirements to store materials and supplies used for construction, as well as land requirements for dirt and excavated materials. As the construction for the Headworks Project is completed in 2026 space will become available for the final Biological Nutrient Removal Project.
- Traffic Flow Constraints: The NEWPCC fronts Main Street, a very busy thoroughfare. To alleviate traffic flow constraints secondary access will be provided west of the NEWPCC. The schedule in Figure 2 represents the traffic flow that the NEWPCC can accommodate from construction from the two access points while still providing traffic flow for sludge hauling from the City's other two sewage treatment plants, hauled liquid waste and leachate from Industrial customers, Biosolids hauling, and chemical/supply delivery for the operating plant.

- Ongoing Construction Activities: In 2026 the Headworks Facilities, Biosolids Facilities, and Nutrient Removal Facilities will all be in some form of construction. The three projects may be supported onsite at this time because the majority of construction works for the Headworks Facilities are assumed to be completed by the time the Nutrient Removal Project starts. Should there be a delay in the Headworks Facilities project, there is a risk that it will result in delays for Nutrient Removal start date. If the NEWPCC Upgrade Headworks Facilities project is completed ahead of schedule there may be opportunities to start the final project earlier.
- Operational Resources: The NEWPCC must run continuously during all construction activities. The operators will, in addition to their regular duties, be required to support coordination of construction activities (e.g. lock out tag out of equipment), receive training for new infrastructure and treatment processes, as well as assist in bringing new works online during commissioning while maintaining wastewater treatment.

5. Assumptions, Risks and Constraints in Developing the Schedule

To develop a construction schedule of this scale and complexity project managers and engineers develop a series of assumptions and constraints that will influence how the projects progress. An assumption is made based on current or expected conditions and experiences, recognizing that those experiences/conditions may change in the future. If an assumption is not valid then it may increase or decrease the length of the schedule.

A constraint is a limitation that is imposed on the project. If the constraint is removed then the time scheduled to complete a project may decrease. If an unidentified constraint is realized then there may be a delay in the schedule. The following are a list of assumptions and constraints that were used to develop the construction schedule illustrated in Figures 1 and 2.

In project management the risks, assumptions, and constraints are documented and mitigated as the schedule progresses. While there are risks that these assumptions and constraints can lengthen the schedule, corrective action may mitigate their impacts. They may also result in opportunities to accelerate the schedule. Throughout the NEWPCC Upgrade the City will manage the project according to industry best practices.

Assumptions:

1. The 2014 NEWPCC Upgrade Master Plan completed a conceptual and preliminary design of a biological nutrient removal (BNR) treatment process. It is assumed that this is the process that will be constructed and implemented.
2. The required funding is available from the City, the Provincial and the Federal governments per the schedule to complete the NEWPCC Upgrade:
 - a. No Provincial or Federal Funding request has been submitted to the Investing in Canada Infrastructure Program for the NEWPCC Nutrient Removal Facilities because the project completion date is outside of the program end date.
 - b. Affordability for City of Winnipeg ratepayers must be considered.

3. The Project Steering Committee will look for opportunities to advance the design and construction to facilitate the completion on the NEWPCC Upgrade project.
4. Due to the cost and complexity of the NEWPCC Upgrade, dividing the project into several smaller project components has helped us move forward, as it was easier to identify funding and to award contracts for the smaller components.
5. There are sufficient professional consultant resources to design the NEWPCC Upgrades per the schedule.
6. There are sufficient construction resources to build the NEWPCC Upgrades per the schedule.
7. The construction tender pricing remains within the cost estimate for the NEWPCC Upgrade.
8. The City will have internal resources available to deliver the NEWPCC Upgrades, as per the schedule:
 - a. City Engineering staff will be executing the Interim Phosphorus Plan which may limit some staff availability for the NEWPCC Upgrade Project.
 - b. There is limited capacity in the NEWPCC Wastewater Operations staff complement to participate in large projects due to daily operational work schedule.
9. The NEWPCC Sewage Treatment Plant will continue to operate and treat wastewater during the construction schedule:
 - a. Sludge hauling from WEWPCC and SEWPCC will not be impacted by the construction activities per the schedule.
 - b. Biosolids hauling from the NEWPCC for beneficial reuse will continue uninterrupted during construction.
 - c. The Hauled Liquid Waste facility truck traffic into and out of the site will not be impacted by the construction activities per the schedule. The NEWPCC location is the only City of Winnipeg Hauled Liquid Waste facility and must remain in service.
10. The NEWPCC Wastewater Operations staff are available and able to facilitate the needs of the contractors working onsite.
11. A number of other construction projects outside of the scope of the NEWPCC Upgrade are required to maintain treatment plant operations. These projects will be managed such that they do not impact the delivery of the NEWPCC Upgrade.
12. Full digester capacity is available.
13. That the Power Supply Upgrade project will be completed on schedule.
14. Biosolids capacity will be managed to remain within the existing digester capacity until the new Biosolids Facilities are brought into service.
15. Phosphorus rich sludge from the SEWPCC BNR Upgrade will be mitigated by the NEWPCC Interim Phosphorus project.
16. Interim Phosphorus reduction with chemical will be approved by the Provincial government under the Environment Act.

Constraints:

1. There is only one sludge treatment (i.e. digestion) process for the entire city. The existing NEWPCC Sewage Treatment Plant has competing load demand on capacity:
 - Annual growth and development (e.g. residential, commercial, industrial)
 - Interim phosphorus generated sludge
 - SEWPCC BNR sludge
 - Capital Region Service Agreements
2. Due to digester capacity it is not possible to achieve 1.0 mg/L phosphorus interim reduction prior to the new Biosolids Facilities being brought into service.
3. The NEWPCC site is very congested and construction lay-down area is very limited and will impact contractor production rates as materials will have to store off site per the construction schedule.
4. The NEWPCC Upgrade project is a very large and complex construction process. The actions of one project can have a cascading impact on other projects and must be actively reviewed and managed to maintain scope, cost, and budget.
5. The existing City of Winnipeg approval process for budgets, awards etc. will be followed.
6. The delivery of the NEWPCC Upgrade Project will occur over a long period of time. During this time the NEWPCC is susceptible to periodic major flooding and/or weather events which could impact the construction schedule.
7. The NEWPCC Sewage Treatment Plant is the oldest City sewage treatment plant. There have been many alterations and modifications to this plant over years. Construction tie-ins from the new facilities to the existing will be difficult due the unknowns with respect to: existing facility records, condition of existing assets, and site geotechnical considerations.
8. The design and construction of the Headworks Facilities, Biosolids Facilities, and Nutrient Removal Facilities must follow in this order because each subsequent project has technical requirements from its predecessor before it can become operational.

6. Recommendation

There is consensus among the Project Steering Committee for the first year of work (i.e. 2020) and the Committee will continue to review the schedule to determine if there are opportunities to accelerate the activities. As schedule assumptions are validated and/or constraints are realized the schedule will be continually reviewed and updated. The schedule will be resubmitted to the Project Advisory Committee by July 31, 2020. The City and the Province will continue to work collaboratively so that Interim Phosphorous Removal and Nutrient Removal at the NEWPCC can be implemented as soon as possible.

Attachments

Figure 1. Interim Phosphorous Reduction Plan

Figure 1: Interim Phosphorous Plan	2019				2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Interim Phosphorous Options Report	Yellow	Yellow																		
Drafting Notice of Alteration Report		Yellow																		
Manitoba Conservation and Climate Review for Interim P Study			Blue	Blue																
Council Review and RFP Development for Interim P Study			Purple	Purple																
Protocols and testing methodology					Yellow															
Modeling and testing						Yellow														
Evaluation and analysis							Yellow													
Summary Report								Yellow												
Council Review and Approval									Purple	Purple										
Manitoba Conservation and Climate Review								Blue	Blue	Blue										
Interim Phosphorous Implementation											Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
SEWPCC BNR Sludge to NEWPCC											Black									

**Project Steering
Committee Consensus**

**Opportunities to advance the schedule will be reviewed regularly.
The timeline will be re-submitted by July 31, 2020**

Legend	
Study, Review, or Pre-selection of Equipment	Yellow
Manitoba Conservation and Climate Review	Blue
Procurement and/or Design	Red
Construction and Commissioning	Green
Winnipeg City Council Review	Purple
SEWPCC BNR Upgrade Milestone	Black
Interim Phosphorous Implementation (tentative, actual schedule will be determined when a preferred option is known)	Red

Figure 2. NEWPCC Upgrade Implementation Plan

Figure 2: NEWPCC Upgrade	2014				2015				2016				2017				2018			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Approval of the NEWPCC Master Plan																				
Biosolids Master Plan Development																				
Manitoba Conservation and Climate Review Biosolids Master Plan																				
Thermal Hydrolysis System Preselection																				
Struvite Recovery System Preselection																				
NEWPCC Site Preparation Works																				
Power Supply																				
Headworks Facilities																				
Biosolids Facilities																				
Nutrient Removal Facilities																				

Figure 2: NEWPCC Upgrade	2019				2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Approval of the NEWPCC Master Plan																				
Biosolids Master Plan Development																				
Manitoba Conservation and Climate Review Biosolids Master Plan																				
Thermal Hydrolysis System Preselection																				
Struvite Recovery System Preselection																				
NEWPCC Site Preparation Works																				
Power Supply																				
Headworks Facilities																				
Biosolids Facilities																				
Nutrient Removal Facilities																				

Project Steering Committee Consensus

Opportunities to advance the schedule will be reviewed regularly. The timeline will be re-submitted by July 31, 2020

Legend	
Study, Review, or Pre-selection of Equipment	
Manitoba Conservation and Climate Review	
Conceptual/Preliminary Design	
Detail Design	
Construction and Commissioning	
Winnipeg City Council Review	
SEWPCC BNR Upgrade Milestone	

Figure 2. NEWPCC Upgrade Implementation Plan

Figure 2: NEWPCC Upgrade	2024				2025				2026				2027				2028			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Approval of the NEWPCC Master Plan																				
Biosolids Master Plan Development																				
Manitoba Conservation and Climate Review Biosolids Master Plan																				
Thermal Hydrolysis System Preselection																				
Struvite Recovery System Preselection																				
NEWPCC Site Preparation Works																				
Power Supply																				
Headworks Facilities																				
Biosolids Facilities																				
Nutrient Removal Facilities																				

Figure 2: NEWPCC Upgrade	2029				2030				2031				2032							
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4				
Approval of the NEWPCC Master Plan																				
Biosolids Master Plan Development																				
Manitoba Conservation and Climate Review Biosolids Master Plan																				
Thermal Hydrolysis System Preselection																				
Struvite Recovery System Preselection																				
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**Opportunities to advance the schedule will be reviewed regularly.
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Legend	
Study, Review, or Pre-selection of Equipment	
Manitoba Conservation and Climate Review	
Conceptual/Preliminary Design	
Detail Design	
Construction and Commissioning	
Winnipeg City Council Review	
SEWPCC BNR Upgrade Milestone	