NEWPCC Upgrade Plan Update

February 28, 2025

Executive Summary

The City of Winnipeg's (City) North End Sewage Treatment Plant (NEWPCC) requires upgrading to meet the effluent quality limits set out in its Environment Act Licence No. 2684 RRR (Environment Act Licence) and The Water Protection Act. Effluent limits are intended to mitigate impacts on water quality.

The City has been working diligently to meet the targets to improve water quality in the Lake Winnipeg watershed. Key activities for 2024 included:

- Construction of the Interim Chemical Phosphorous Removal Facility was completed and chemical phosphorous removal commenced. Full-scale testing throughout 2025 will work to optimize and maximize phosphorus removal.
- Continued construction of the Headworks Facility with the majority of the underground work complete and significant above-ground work in progress. Ancillary projects funded by the Headworks budget are in various phases of design, procurement, and construction.
- Engagement of a Development Partner for the Biosolids project. Preliminary design of the Biosolids Facility has begun with Red River Biosolids Partners.
- Completion of the enhanced preliminary design (EPD) for the Nutrient Removal Facilities project. A revised Class 3 cost estimate, technical assessment of schedule acceleration, preliminary market soundings, update of the NEWPCC constructability review, and updates to wastewater population and loading projections were also completed.

In December 2021, the Province instructed the City to submit a plan that would see the full NEWPCC upgrades, including biological nutrient removal and maximization of nutrient reuse, in operation by December 31, 2030. To achieve this target, the City would need to accelerate the completion of the Nutrient Removal project.

In the previous NEWPCC Upgrade Plan Update, submitted in December 2024, the City recommended proceeding with full compliance in 2032. While this approach does not meet the 2030 timeline, it has the strongest likelihood of meeting the overall desired outcome of a quality state-of-the-art treatment plant that can be delivered on schedule in the most cost-effective manner. Since the last update, the City has completed additional reviews and assessments to validate their recommendation including a technical assessment, preliminary market soundings, and a constructability review.

The findings of the technical, commercial, and constructability assessments all support the recommendation of full compliance in 2032. Accordingly, the City will submit a Notice of Alteration to Environment Act Licence No. 2684 RRR requesting a completion extension for the NEWPCC upgrades to December 31, 2032.

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Introduction

The City of Winnipeg's (City) North End Sewage Treatment Plant (NEWPCC) requires upgrading to meet the specifications of its Environment Act Licence and The Water Protection Act. The NEWPCC Upgrades are principally being delivered through three separate capital projects, identified as:

- NEWPCC Upgrade: Power Supply and Headworks Facilities (Power Supply and Headworks projects)
- NEWPCC Upgrade: Biosolids Facilities (Biosolids project)
- NEWPCC Upgrade: Nutrient Removal Facilities (Nutrient Removal project)

In 2022, Manitoba Environment and Climate Change (the Province) mandated the City to provide a plan that would see the full NEWPCC Upgrades in operation by December 31, 2030, including biological nutrient removal and ensuring maximum nutrient reuse.

This is the fifth update to the NEWPCC Upgrade Plan. This report provides a status update on the ongoing and planned NEWPCC Upgrades. The main focus of the report is on the Nutrient Removal project, the third and final major project required to upgrade NEWPCC to meet its Environment Act Licence.

The City has made significant progress on the Nutrient Removal project, including completion of the enhanced preliminary design (EPD), revised Class 3 cost estimate, technical assessment of schedule acceleration, preliminary market soundings, and updated the NEWPCC constructability review. The results are summarized in this report.

The City continues to work diligently to meet the nutrient targets set by the Province and to improve water quality for rivers and lakes in the Lake Winnipeg watershed.

1. NEWPCC Upgrades Progress Update

Interim Chemical Phosphorous Removal

The Interim Chemical Phosphorous Removal Facilities project will help maximize phosphorous removal and improve other licence parameters (solids removal, ammonia removal, etc.) in the short-term until completion of the NEWPCC Upgrades.

Construction of the Interim Chemical Phosphorous Removal Facility was completed in July 2024 with chemical phosphorous removal starting in June 2024. The average total phosphorus effluent concentration from late June 2024 to January 2025 is approximately 3 mg/L. Further full-scale testing throughout 2025 will determine the extent to which phosphorus can be removed; it is possible that total phosphorous may be at or near licence limits for portions of the year. To date, process impacts from ferric dosing, including effectiveness of ultraviolet light (UV) disinfection, have been identified which has limited the ferric chloride dosing rates.

An analysis of modelled data found that the future biosolids facility would be at capacity by the end of 2031 using the maximum chemical dosage to achieve 1 mg/L phosphorous. This is due to the additional sludge that is produced during chemical phosphorous removal. The modelled data is a conservative estimate and actual results are dependent on many variables, such as:

- actual ferric chloride dosing rates
- the overall health and performance of the treatment bacteria
- the performance of various processes
- wet weather flow
- changes in development
- industrial activity (especially high-strength industry)
- ongoing capital improvements

Remaining digester capacity will be monitored over time. In order to preserve as much digester capacity as possible, the City intends to decrease sludge loading into the existing digesters through various projects. These projects will remove inert and biological solids such as grease and scum at the NEWPCC and improve screening and grit removal at the West End Sewage Treatment Plant (WEWPCC).

Power Supply and Headworks Facilities

The Power Supply project was advanced ahead of the Headworks Facilities to bring electrical supply to the site to power the future upgraded plant. This project was substantially complete in 2020 and the warranty period has ended.

The Headworks Facilities include upgrades to raw sewage pumping, screening, and grit removal. This project is a prerequisite to the Biosolids and Nutrient Removal Facilities that will address regulatory requirements and replace end-of-life equipment.

In 2024, the Design-Builder completed the Issued for Construction designs for the project. Construction has progressed throughout the site, with the following major work items undertaken in 2024:

- Excavation of all deep chambers
- Stabilization of the Main Street Interceptor
- Construction of the dry wells, wet wells, and interior structures for the Raw Sewage Pumping Station
- Installation of pumps and piping in the Raw Sewage Pumping Station
- Erection of the Fine Screening, Solids Handling, and Mechanical Rooms
- Erection of the Main Control Building

The remaining work for the Headworks project includes:

- Completion of the final tunnel
- Completion of modifications to the existing Grit Area
- Completion of chamber construction
- Erection of the Raw Sewage Pumping Station and installation of equipment

- Completion of the new overflow tie-in to the existing outfall
- Installation of process piping, electrical, automation, HVAC, and external finishes in various project areas
- Commissioning, decommissioning of existing equipment, civil works, landscaping, and project closeout

The Power Supply and Headworks Facilities project also funds three ancillary upgrade projects.

Distributed Control System (DCS) Migration

The DCS Migration project will replace the end-of-life DCS with a new Programmable Logic Controller (PLC) system. The first phase, completed in 2023, included a new plant-wide fibre network that will be the backbone of the control system. Migration of process areas commenced in 2025 and will be completed in late 2027.

Primary Clarifier Upgrades

The Primary Clarifier Upgrades project involves the design and construction of a Scum Dewatering Building for the installation of scum filter presses. This will preserve critical digester capacity by diverting the scum load from the digesters.

The filter presses are currently in design with delivery anticipated in 2026. The design of the facility was completed in early 2025 and the construction tender was posted in February 2025. Construction of the Scum Dewatering Building is expected to be complete in 2027.

UV Upgrades

The UV Upgrades project will replace the outdated UV system and is required for the upcoming Biosolids project. The new technology in the UV system is expected to decrease power consumption by about 75%. Construction is expected to occur from late 2025 to late 2026.

Biosolids Facilities

This project will upgrade biosolids treatment at NEWPCC, replace end-of-life equipment, and address regulatory requirements related to the recovery of nutrients, and maximization of biosolids reuse. This project includes new digesters, thermal hydrolysis equipment, and sludge handling facilities. Due to the capacity limitations of the current digesters, the Biosolids project is critical to support growth in the City and the capital region.

The main contract for this project is being delivered using a progressive design build (PDB) delivery model. In December 2023, the City named two shortlisted proponents and released Request for Proposal (RFP) Step 2. Throughout the first half of 2024, the City engaged in eight commercially confidential meetings with the two shortlisted proponents to negotiate the terms of the Development Phase Agreement (DPA) and draft Design Build Agreement (DBA). On May 30, 2024, RFP Step 2 closed and the City team began evaluating the two proposals.

On July 18, 2024, the Standing Policy Committee on Water, Waste and Environment agreed with the Public Service’s recommendation to name Red River Biosolids Partners as the preferred proponent for the DPA for the Biosolids project. Final negotiations with Red River Biosolids Partners concluded on September 5, 2024 and the DPA was fully executed on September 23, 2024.

The Start-Up Period for the DPA began in September 2024. The Start-Up Period included activities such as chartering, preparing work plans, and setting up templates and procedures to be used in the Preliminary Design Period.

The project is on schedule to begin the Preliminary Design Period in Q1 2025. This will involve activities such as collaboratively working on a 30% design, developing a schedule, openly negotiating risk, and developing a Class 3 cost estimate. The Preliminary Design Period is anticipated to finish in Q3 2025.

The Intermediate Design Period, which takes the design from 30% to approximately 60%, is anticipated to begin in Q3 2025 and conclude in Q2 2026. At the end of this period, if the City and Red River Biosolids Partners can agree on a scope, schedule, and cost for the remainder of the design and construction of the project, the City will enter into a DBA with them. The DBA is subject to City award authority approval and approval is anticipated in Q3 2026.

The Biosolids project also has two early work projects that will reduce risk ahead of the main PDB contract.

NEWPCC Piping Installation, Soil Remediation, and Site Compound Development
This project includes the construction of a water main extension, three subsurface utilidors under the rail tracks, removal of contaminated soils, and the development of a site compound. This project is being delivered as a design-bid-build. The tender was awarded in October 2024 and construction is ongoing. Construction is anticipated to be complete in Q3 2025.

NEWPCC Land Drainage System
This project includes the construction of a new land drainage system (LDS) from the Biosolids Facilities to an existing LDS on Main Street. This project is being delivered as a design-bid-build. Design is ongoing and the construction tender is anticipated to be posted in Q3 2025.

Nutrient Removal Facilities

The Nutrient Removal project is the third and final major project required to upgrade NEWPCC to meet its Environment Act Licence. This project will upgrade secondary treatment, replace end-of-life equipment, increase capacity, and address regulatory requirements related to the recovery of nutrients and maximizing biosolids reuse. This project includes new bioreactors, secondary clarifiers, primary sludge fermenters, and waste activated sludge thickeners.

Enhanced Preliminary Design and Class 3 Cost Estimate

The City's Owner's Engineer completed the EPD for the Nutrient Removal project on October 21, 2024.

The key components of the Nutrient Removal project included in the EPD are:

- Upgrades to the existing primary clarification facility including new primary sludge pumps

- Biological nutrient removal (BNR) facility comprised of a new intermediate pump station, eight new BNR reactors, and a new process air supply system
- Secondary clarification facility comprised of eight new circular clarifiers and two new pumping stations for return activated sludge
- Fermentation and waste activated sludge (WAS) thickening facility comprised of four new primary sludge fermenters and two new WAS thickening tanks
- New boiler installation within the existing boiler building
- Modifications to the foul air handling system of the existing hauled wastewater receiving facility
- Yard works including tunnels, galleries, external piping, roads, fencing, and landscaping
- Decommissioning of existing High Purity Oxygen (HPO) reactors, HPO building, and secondary clarifiers

The revised Class 3 cost estimate based on the EPD was developed by Owner's Engineer and was reviewed by an independent cost consultant. The final Class 3 cost estimate and cost review reports were received on November 12, 2024 and December 12, 2024, respectively. The 2024 Class 3 cost estimate for the Nutrient Removal Facilities is $1.491 billion.

Technical Review of Schedule Acceleration

The Province directed the City to submit a multi-year plan, including a funding model, to complete the full NEWPCC upgrades by December 31, 2030. To achieve this target, the City would need to accelerate the completion of the Nutrient Removal project. The City undertook a thorough review of acceleration options and concluded it would not be possible to complete the full upgrade by 2030. As a next step, the City considered a number of phased construction alternatives that would achieve licence compliance for dry weather flows through a combination of new infrastructure and reuse of existing infrastructure. Each alternative provided different levels of interim nutrient reduction.

A technical assessment of the schedule acceleration alternatives was completed by the Owner's Engineer. It included an assessment of treatment performance, constructability, risks, and cost impacts. The design criteria was updated based on eight years of raw influent flow and concentration data (2016-2023) and the year 2050 was selected as the design horizon. A copy of the flows and loads projection report is included in Appendix 2.

The alternatives examined in the technical assessment were:

Alternative 1 – Do Nothing

(No upgrades undertaken – for nutrient loading comparison purposes only)

- No interim nutrient reduction
- No upgrades undertaken, full compliance is never achieved

Alternative 2 – Phased Construction, 4 new BNR Reactors with existing Secondary Clarifiers

(Existing and new infrastructure – run in series)

- Highest interim nutrient reduction
- Full compliance in 2030 for dry weather flows only, full compliance for all flows in 2032

- Lowest schedule acceleration cost
- Complex construction sequencing

Alternative 3 – Phased Construction, Flow Split between New and Existing Secondary Treatment

(Existing and new infrastructure – flow runs in parallel: half through HPOs, half through new BNRs and secondaries)

- Lowest interim nutrient reduction
- Is not in compliance for all nutrients during dry weather flow in 2030, full compliance for all flows in 2032
- Most complex tie-ins to existing plant
- Operationally very complex

Alternative 4 – Phased Construction, 4 new BNR and 4 new Secondary Clarifiers

(All new infrastructure, no existing infrastructure, flows >380 MLD bypass and blend in final effluent)

- Intermediate interim nutrient reduction
- Full compliance in 2030 for dry weather flows only, full compliance for all flows in 2032
- Highest schedule acceleration cost
- Least throw away costs

Alternative 5 – Full Buildout for 2032

(No interim upgrades)

- No interim nutrient reduction
- Full compliance for all flows in 2032 with no partial compliance earlier

A copy of the technical review report, including additional details on the acceleration alternatives, is attached in Appendix 1.Appendix 1

The schedule acceleration alternatives, if successful, provide some improved nutrient removal earlier when compared to Alternative 5 – Full Buildout for 2032. However, the schedule acceleration alternatives also come at a greater cost and with more risk than the 2032 buildout .

The incremental phosphorus removal for the schedule acceleration alternatives was compared to that of Alternative 5. Table 1 outlines the additional capital cost of each alternative, the additional phosphorus removed, and the associated cost per kg of additional phosphorus removed.

Table 1: Additional Capital Costs and Phosphorus Removed for Accelerated Alternatives

Schedule Acceleration Alternative	Additional Capital Cost ($millions) *	Additional Phosphorus Removed (kg) *	Cost/kg of Additional Phosphorus Removed ($/kg) *
2	$90-140	231,410	$389 - 605
3	$121-161	155,490 - 193,450	$625 – 1,035
4	$141-171	231,410	$609 - 739

* Additional cost and phosphorus removed above Alternative 5 – Full Buildout for 2032

A risk assessment was completed for each alternative. The assessment identified that, while each alternative had unique considerations, the risks were generally similar and the realization of these risks could significantly affect the schedule and costs associated with the acceleration alternatives. Schedule impacts could push completion dates beyond 2032. A summary of key risks identified are:

- Design Conflicts: Design of the entire project needs to be reasonably well advanced before any early works commence to avoid conflicts or the cost of redundant infrastructure, which would minimize the schedule savings.
- Increased Commissioning: Both the tie-in of new infrastructure to existing plant and the commissioning process are highly complex and require extensive planning. There could be significant restrictions for this work based on time of year, conflicts with other projects, and plant and operator availability. Schedule acceleration would double commissioning efforts, significantly increasing overall risks.
- Construction Conflicts: Additional planning and coordination would be required to avoid damage to newly commissioned infrastructure while constructing the remainder of the work. This would reduce construction productivity.
- Site Access: The acceleration alternatives will occupy space that may otherwise be used for laydown and staging. This may require the use of existing plant roads for access and laydown which will negatively impact plant operations and reduce construction productivity.
- Increased Resources: Additional resources will be required for all parties to facilitate the increased planning, design, coordination, construction, and commissioning efforts. There is limited availability of resources in the current market.
- Phosphorus Release: The process modifications required for acceleration increase the risk of phosphorus being released in the primary clarifier.
- Acceleration Costs: The cost to accelerate is high for each alternative.
- Infrastructure Condition (Alternative 2 – Phased Construction): Temporary tie-ins to existing infrastructure of unknown condition, much of it known to be at end-of-life, could require remedial work or design changes which would add to cost and schedule.
- Operating Two Plants (Alternative 3 – Phased Construction): Flow splitting between existing and new infrastructure will require additional resources to operate two separate systems and increases the risk of process upsets.

- Performance Issues (Alternative 3 – Phased Construction): During periods of low flows, the HPO system would be underloaded and likely experience foaming and bulking episodes, which could impact solids stream processes and overall plant operability.

Market Sounding

Market sounding interviews were held to canvass interest and solicit feedback on the Nutrient Removal project including the schedule acceleration scenarios being considered.

The market sounding feedback revealed that Constructors continue to be risk-averse due to continued post-COVID market volatility and an abundance of other project opportunities. As such, Constructors were promoting project delivery models with a more balanced risk profile.

During the market sounding, participants were asked the following:

Does the potential schedule acceleration alternative, including potential Early Works to achieve partial Environment Act Licence compliance in Q4 2030, appear achievable? What might be the implications of such acceleration? Would this affect your interest in the project?

The feedback received was:

- Building in stages would increase costs due to the loss of efficiency, throw-away infrastructure, and repeated mobilization/demobilization
- Commissioning and tie-ins are more complex if built in phases
- Design of the entire project needs to be reasonably well advanced before any early works commence to avoid conflicts or the cost of redundant infrastructure, which would minimize the schedule savings
- Several participants advised that they would not pursue this opportunity if schedule acceleration was included

Market interest and the possibility of a failed procurement is a key risk for the Nutrient Removal project. The schedule delay associated with a failed procurement would significantly impact the compliance timelines.

Constructability Review

Following completion of the technical and commercial assessments, the City retained a third-party consultant to undertake an independent constructability review. The constructability review included an integrated cost and schedule risk analysis of Alternative 5 - Full Buildout for 2032, as well as a scenario analysis and updated risk analysis for two of the schedule acceleration scenarios (Alternatives 2 and 4 – Phased Construction) identified in the technical review report. Alternative 3 - Phased Construction was not evaluated further as it had the highest additional cost, was operationally the most complex, had the lowest additional nutrient removal and didn’t meet all nutrient limits for dry weather flow conditions.

The review was completed with the key output being a differential risk register of the alternatives, a summary of which is shown below in Table 2. The table identifies the number of risks that fall within each risk severity category (e.g. Alternative 2 had 8 risks that fell in the High category). The severity score for each alternative was based on the evaluation of risk likelihood and impact, utilizing a standardized rating matrix. The higher the total severity score, the higher the overall risk for that alternative. For more details on the specific risks and severity scores, a copy of the constructability review report is included in Appendix 3.

The independent constructability review concluded that Alternative 5 - Full Buildout for 2032 contains the least amount of overall risk of the three alternatives.

Table 2: Differential Risk Assessment Summary

Description	Risk Severity				Total Severity Score
	Low	Medium	High	Extreme	
Alternative 2 - Phased Construction (Existing and New Infrastructure) - Run in Series	4	6	8	14	347
Alternative 4 – Phased Construction (New Infrastructure, No Existing Infrastructure)	4	6	9	13	336
Alternative 5 - Full Buildout for 2032 (No Interim Upgrades)	5	6	13	9	304

2. Funding Review & Plan

The current total cost for the NEWPCC Upgrades is $3.0 billion. To date, only $581 million is funded by the Provincial and Federal governments. This leaves almost $2.4 billion, or 81% of the upgrade costs, to be funded by the City. This puts tremendous pressure on the City's rate payers.

The current funding status of each NEWPCC Upgrade project is identified in Table 3 and Figure 1.

Table 3: Current Funding Status for the NEWPCC Upgrade Projects

Funding Source	Power Supply and Headworks	Biosolids	Nutrient Removal	NEWPCC Total
	($ millions)			
City	304.99	666.75	1,491.00	2,462.74
Province	96.75	167.38	-	264.13
Federal	116.11	200.87	-	316.98
Total	517.85	1,035.00	1,491.00	3,043.85

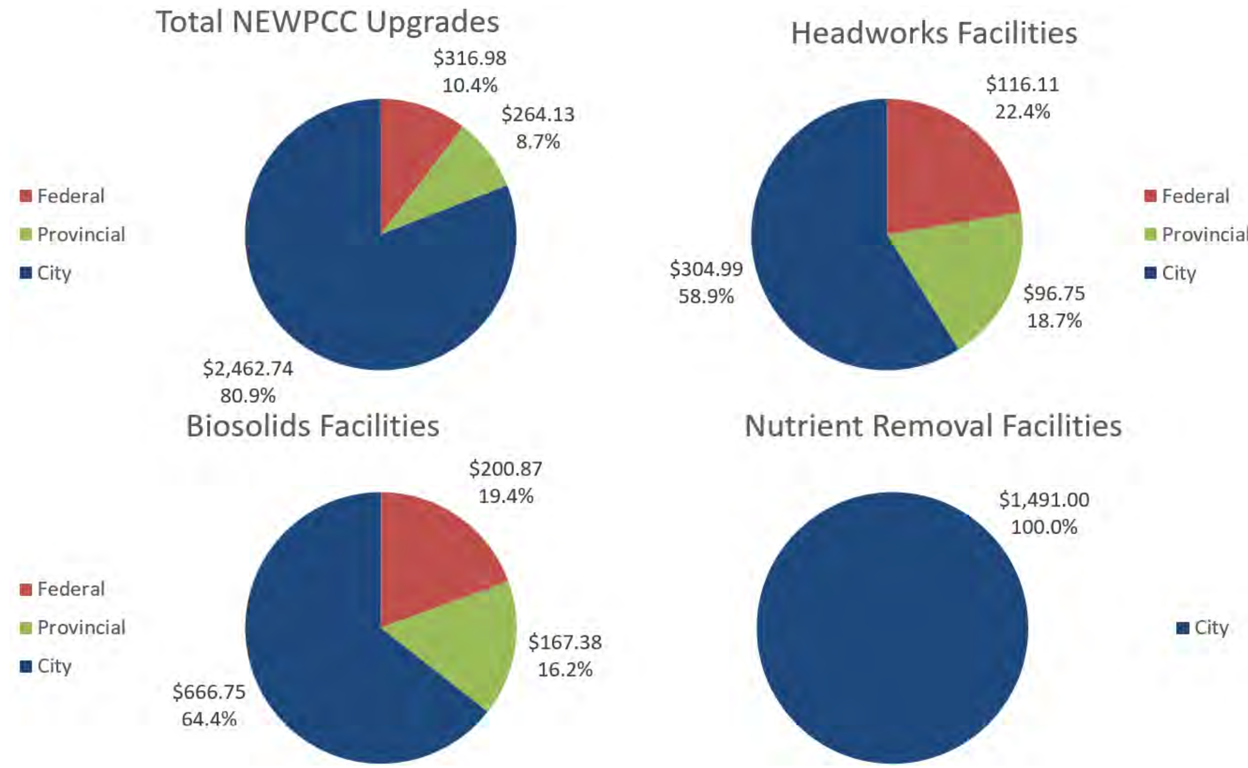

Figure 1: NEWPCC Upgrades – Current Funding Share ($ millions)

Power Supply and Headworks Facilities

$517.85 million

The Power Supply and Headworks Facilities projects are currently fully funded. The completed Power Supply project and other early work that was considered ineligible for funding was entirely funded by the City at a cost of $52.3 million. The Headworks Facilities received Investing in Canada Infrastructure Program (ICIP) funding. This funding is based on a 40% Federal, 33.33% Provincial, and 26.67% City split of eligible costs. The funding amount for Headworks was established based on the initial budget of $356 million and did not include the additional $65 million that was required to award the project when the preferred proponent's proposal price exceeded the allocated initial budget. As well, the Northwest Interceptor Failure, which resulted from a heavy rainfall event in June 2023, required an additional $44.5 million budget increase which was also fully City funded. Together, these additional costs result in a City share greater than the intended ICIP contribution share.

Biosolids Facilities

$1.035 billion

The Biosolids project was approved for ICIP funding on December 20, 2022; the funding was based on the 2018 budget estimate of $552 million. Due to several factors including growth, market conditions, the added requirement of interim chemical phosphorous removal, and project delays, the 2023 cost estimate increased by $483 million to $1.035 billion. Council amended the Biosolids Facilities capital budget on September 29, 2023 to facilitate procurement for this critical work and to demonstrate the City's commitment to completing this project.

The 2024 Water and Sewer rates were set assuming an additional $279 million of Federal and Provincial government funding to reflect the cost sharing principles of the ICIP contribution agreement (eligible costs split of 40% Federal, 33.33% Provincial, and 26.67% City). The City has not received this additional funding therefore this project is not fully funded.

The increased cost of Biosolids has changed the City's share of eligible costs from 26.7% to 58.3%. The City has requested that the Province and Federal governments uphold the cost sharing principles of the original funding agreement. Discussions with Federal and Provincial levels of government are ongoing.

In November 2024, the Manitoba government announced it is planning to increase funding for the Biosolids Facilities project by $30 million, increasing the total provincial commitment to $197.4 million. At the time of this report, there is no funding agreement in place. Once an agreement is formalized, the additional funding will be integrated into the City's rate analyses.

Nutrient Removal Facilities

$1.491 billion

In 2019, the total project cost for the Nutrient Removal project was estimated at $828 million. The City has obtained a 2024 cost estimate of $1.491 billion which is informing a capital budget request that will be considered by Council in March 2025. As this project remains largely unfunded, the City is currently pursuing self-funding via utility rates.

Funding Plan

The significant cost increases for the NEWPCC Upgrade projects, along with no new government cost sharing agreements and restricted debt financing, have resulted in the necessity to increase sewer volume rates to meet the funding shortfall. A revised rate report to reflect the required sewer volume rate will be presented at Council in March 2025.

Funding discussions with the Federal and Provincial levels of government are ongoing. If more funding is not secured, it will have a substantial impact on the affordability of services. The Federal government has recently announced that they would contribute an additional $150 million to the NEWPCC Upgrades. As no formal contracts have been signed, this potential funding is not included in the revised rate report.

3. Conclusions

The City recognizes the importance of the NEWPCC Upgrade schedule in reducing impacts on the Lake Winnipeg watershed. Achieving full licence compliance, including nutrient reduction and beneficial reuse of nutrients, is a priority for the City. The NEWPCC Upgrades are a large and ambitious scope of work, with a total cost exceeding $3.0 billion. Planning work this complex must carefully consider a balance of schedule, risk, and affordability.

The Province requested that the City further review acceleration alternatives to complete the upgrades by 2030. The City identified a number of schedule acceleration alternatives and undertook detailed technical and commercial assessments. The technical and commercial assessments were validated by a third-party, with an independent constructability review. The key findings were:

- The technical assessment concluded that Alternative 2 - Phased Construction was shown to have the greatest impact on nutrient reduction and was the least expensive of the acceleration alternatives. However, the significant costs, risks, and the possibility of schedule overruns exceeding the 2030 timeline result in this alternative not being a feasible option.
- The market sounding concluded that phased construction results in increased costs and is substantially more complex to commission. Phased construction would reduce market interest and could result in a failed procurement.
- The constructability review concluded that Alternative 5 - Full Buildout for 2032 is still a high risk project, but has the lowest total severity score and therefore has the highest likelihood of success.

While the assessments identified the schedule acceleration alternatives are technically viable, significant risks were identified which could lead to project delays and increased costs, potentially jeopardizing the overall objective of these upgrades. In particular, the schedule delay associated with a failed procurement would significantly impact the compliance timelines. Based on the findings of these assessments, the City recommends proceeding with Alternative 5 - Full Buildout for 2032, with full buildout and licence compliance by 2032.

A summary of the updated NEWPCC Upgrade schedule, reflecting a 2032 completion date for the Nutrient Removal project and updated delivery timelines for all projects, is shown in Figure 2.

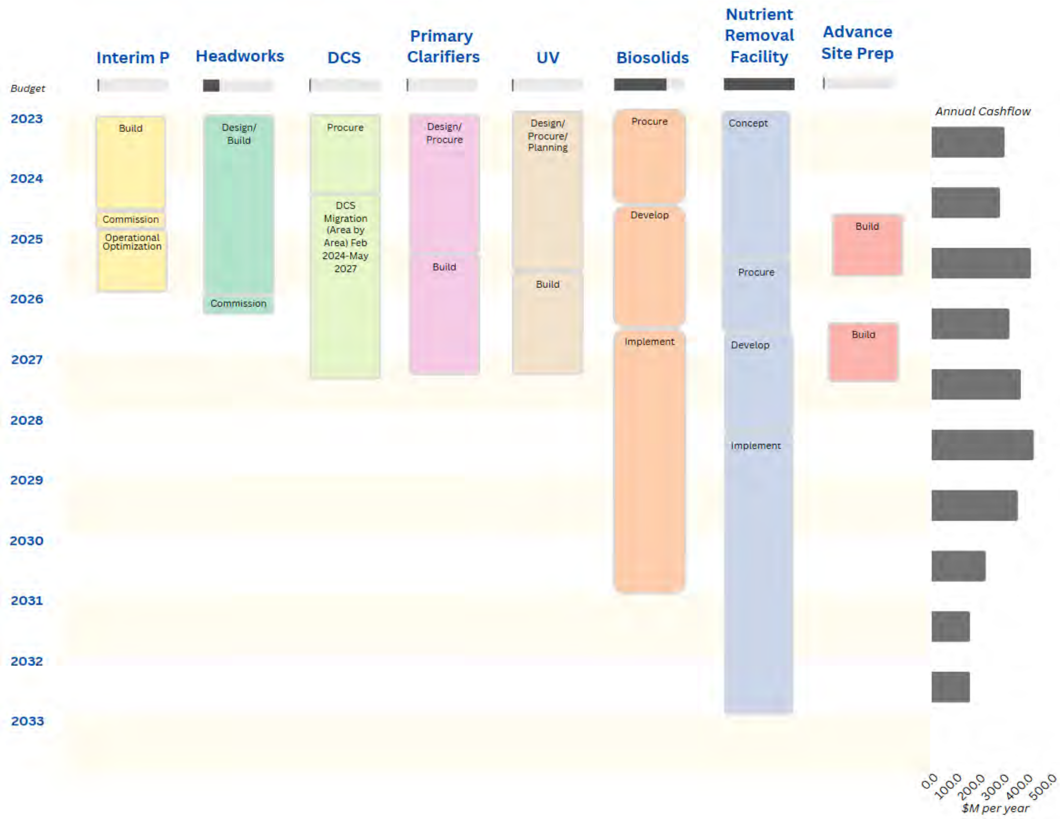

Figure 2: NEWPCC Upgrade Schedule

Next Steps

The City will continue to engage with other levels of government to explore opportunities for external funding for the NEWPCC Upgrade project.

The following work is anticipated to be undertaken in 2025:

Headworks Facilities:

- Continued construction of the Headworks Facilities and other ancillary upgrade projects with the new Headworks Facility anticipated to be in operation in March 2026

Biosolids Facilities:

- Develop a preliminary design, cost, and schedule with target completion in September 2025

Nutrient Removal Facilities:

- Establish the Nutrient Removal project budget subject to City Council approval in Q1 2025
- Submit a Notice of Alteration to Environment Act Licence No. 2684 RRR requesting a completion extension for the NEWPCC upgrades to December 31, 2032
- Commence procurement in Q1 2025 with a planned posting of the Request for Qualifications in Q3 2025
- Conduct additional market sounding interviews in Q2 2025 to solicit input on key procurement and contract terms

Appendix 1 – AECOM Canada Ltd. Technical Review of Schedule Acceleration

NEWPCC Upgrade: Nutrient Removal Facilities

Partial Compliance Report - FINAL

City of Winnipeg

60709390

November 2024

Delivering a better world

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The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

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- represents AECOM's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

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Executive Summary

ES.1 Introduction

The City of Winnipeg (City) is upgrading the North End Sewage Treatment Plant (NEWPCC) to provide increased resiliency, accommodate future wastewater flows, and to provide enhanced treatment capability addressing new regulatory requirements.

The City has decided to implement the NEWPCC Upgrade in three separate capital projects as follows:

1. NEWPCC Upgrade: Power Supply and Headworks Facilities ("Project 1")
2. NEWPCC Upgrade: Biosolids Facilities ("Project 2")
3. NEWPCC Upgrade: Nutrient Removal Facilities ("Project 3")

In May 2023, the update for the Nutrient Removal Facilities (NRF) Enhanced Preliminary Design (EPD) was initiated to update the design year from 2037 to 2050.

To expedite nutrient removal in the final effluent and achieve partial licence compliance by 2030, alternative approaches to construction and commissioning of certain infrastructure in the NRF upgrade is being considered. The remaining NEWPCC NRF infrastructure will be constructed and commissioned by the end of 2032.

ES.2 Objectives and Approach

The NEWPCC NRF EPD included eight (8) new BNR reactors and eight (8) new secondary clarifiers to replace the existing HPO reactors and secondary clarifiers. The WSTP has requested AECOM to review the constructability and effluent quality of several schedule acceleration alternatives. Phase 1, which would be completed by the end of 2030, generally consists of construction and commissioning half of the BNR reactors to achieve partial compliance. Phase 2, which would be completed by the end of 2032, would consist of the remaining NRF infrastructure not included in Phase 1.

The following options are evaluated in this report to compare nutrient loading to the Red River and cost impacts to accelerate the construction schedule:

1. Alternative 1: Continue operating the existing HPO and existing secondary clarifiers as the base case (i.e., establish baseline nutrient loads to Red River);
2. Alternative 2: Construct four (4) new BNR reactors and use in conjunction with the existing secondary clarifiers (decommission HPO reactors);
3. Alternative 3A: Construct four (4) new BNR reactors and four (4) new secondary clarifiers. Split flow between the new BNR trains and the existing HPO reactors and existing secondary clarifiers (with interim P to meet 2.0 mg/L TP);
4. Alternative 3B: Same as Alternative 3A but with interim P to meet 1.5 mg/L TP;
5. Alternative 4: Four (4) new BNR reactors and four (4) new secondary clarifiers treating all flow (decommission HPO reactors and existing secondary clarifiers); and
6. Alternative 5: Eight (8) new BNR reactors and eight (8) new secondary clarifiers, full NRF built out on original schedule (i.e. nutrient loading to the Red River at project completion).

ES.3 Basis of Comparison

Flows and loads for the year 2032 were developed based on historical flows and loads, population projections, and CSO management. The year 2032 corresponds to the last year before the full NRF upgrade is in operation. Biowin modeling was completed for all alternatives to determine final effluent quality and expected nutrient loading to the Red River for an average year in 2032. For all alternatives using the existing HPO reactors, modeling was completed with a maximum of 380 ML/d going to the HPO reactors due to a hydraulic constraint in the existing secondary effluent conduit. Scenarios using the new four secondary clarifiers were also limited to a maximum of 380 ML/d going through the new secondary treatment system to not exceed the design surface overflow rate.

ES.4 Alternatives

Alternative 1: Existing HPO Reactors and Existing Secondary Clarifiers (Baseline Case)

This alternative is used as a benchmark/baseline to estimate effluent ammonia, nitrogen and phosphorus loads discharged to the Red River from the existing plant. This scenario assumes that the existing HPO reactors and secondary clarifiers will be operated based on the current operating philosophy until the year 2032.

It is assumed that the interim phosphorus removal system implemented in 2024 will continue to be used by dosing ferric chloride and limiting the TP concentration in the effluent to 2.5 mg/L.

Performance results for Alternative 1 are summarized in **Table ES1**.

Table ES1: Alternative 1 - Summary of Blended Effluent Quality

Parameter	Descriptor	Load, kg/d	Concentration, mg/L
Ammonia	Avg	5,572	28
TN	Avg	7,318	37
TP	Avg	525	2.5

The effluent ammonia load fluctuates throughout the year, generally staying between 5,000 and 10,000 kg/day, although it experiences brief spikes and dips based on influent variation and seasonal variations in temperature. Throughout the year, the ammonia load remains mostly below the limit, except for a period in summer where it exceeds the limits slightly.

The TN concentrations consistently exceed the TN limit throughout the year. The monthly TP concentration remains fairly stable, fluctuating around 2.5 mg/L for most of the year, with very slight variations. The TP concentration is controlled at 2.5 mg/L with ferric chloride dosing. This TP concentrations is above the proposed TP limit of 1 mg/L.

Alternative 2: Four (4) New BNR Reactors and Existing HPO Secondary Clarifiers

In this alternative four (4) new BNR reactors will be constructed on the southwest side of Parcel A, designed to provide ammonia, nitrogen, and phosphorus removal. The existing 26 secondary clarifiers (10 “squircles”, and 16 rectangular) from the existing HPO secondary treatment system will be used to settle the mixed liquor from the new BNR reactors.

Performance results for Alternative 2 are summarized in **Table ES2**.

Table ES2: Alternative 2 - Blended Effluent Quality

Parameter	Descriptor	Load, kg/d	Concentration, mg/L
Ammonia	Avg	741	3.2
TN	Avg	2,373	11.4
TP	Avg	204	1.0

The effluent ammonia load is projected to be well below the proposed limits throughout the whole year as the BNR reactors provide nearly full nitrification. The monthly TN concentration is maintained below the 15 mg/L limit throughout the year. The TP concentration is projected to remain fairly stable, fluctuating around 1.0 mg/L for most of the year, with some higher concentration in summer due to bypass events.

The four new BNR trains and intermediate pump station (IPS) can be configured in a manner that is consistent with the ultimate build out of the NRF. Coordination with the blower building and associated mechanical equipment will need to be addressed to ensure the Phase 1 piping and future Phase 2 blowers are fully integrated for the future expansion. Elements that are needed for the Phase 1 work, but will not be utilized in Phase 2, include the RAS pumps/piping, mixed liquor piping into the existing HPO tank, and mixers in the HPO.

Risks that are unique to this alternative are primarily related to the tie-in requirements to the existing secondary treatment facility. This includes the sequencing of tie-ins to the HPO inlet piping and requires the six HPO inlet pipes to be sequentially capped and then three reconfigured with the new BNR mixed liquor piping. In a similar manner there are risks associated with the reconfiguration of the existing secondary treatment RAS system. Once it is determined whether new RAS pumps are required, this risk can be more accurately defined. Either way, RAS piping would need to be extended and tied into the new IPS.

The impact to project costs for this alternative include approximately $10-20 million of sunk costs for temporary piping and equipment, as well as an approximately $80-120 million cost premium for schedule acceleration on approximately 40% of the overall NRF upgrade infrastructure in Phase 1.

Alternative 3: Four (4) New BNR Reactors and Four (4) New Secondary Clarifiers and Existing HPO Reactors and Existing Secondary Clarifiers

In this alternative primary effluent will be split between new secondary treatment system and the existing secondary treatment system. Four new BNR reactors and four new circular secondary clarifiers will be constructed on the southwest side of Parcel A, and designed to provide biological ammonia, nitrogen, and phosphorus removal. The existing HPO reactors and existing 26 secondary clarifiers (10 squircles, and 16 rectangular) will provide treatment in terms of BOD removal. The flow between the two plants will be split equally (50/50), which is expected to provide enhanced treatment.

This alternative has been divided into two sub-alternatives Alternative 3A where interim P is used on the HPO stream to reduce total phosphorus to 2.0 mg/L and Alternative 3B where interim P achieves 1.5 mg/L TP on the HPO stream. Performance results for Alternative 3A and 3B are summarized in **Table ES3**.

Table ES3: Alternative 3A and 3B- Blended Effluent Quality

		Alternative 3A		Alternative 3B	
Parameter	Descriptor	Load, kg/d	Concentration, mg/L	Load, kg/d	Concentration, mg/L
Ammonia	Avg	1,348	6.9	1,524	7.8
TN	Avg	4,981	25	4,981	25
TP	Avg	262	1.3	208	1.0

The effluent ammonia load for both Alternative 3A and 3B is projected to be below the proposed limits throughout the whole year, the HPO reactors are projected to provide some ammonia removal due to lower effective loading and increased SRT.

The monthly TN concentration is relatively higher than Alternative 2 and remains above the 15 mg/L limit throughout the year. Half of the wastewater is treated in the HPO reactors which do not remove nitrogen.

The monthly TP concentration in the blended effluent is projected to remain fairly stable, fluctuating around 1.0-2.0 mg/L for most of the year for both Alternative 3A and 3B. The projected blended TP concentration is lower than 2 mg/L due to biological phosphorus removal in the BNR train, with the blended effluent TP slightly lower in Alternative 3B than 3A.

The four new BNR trains and four new secondary clarifiers can be configured in a manner that is consistent with the ultimate build out of the NRF. Coordination with the blower building and associated mechanical equipment will need to be addressed to ensure the Phase 1 piping and Phase 2 blowers are fully integrated. Elements that are needed for the Phase 1 work, but will not be utilized in Phase 2, includes the WAS piping to primary clarifiers for co-thickening.

Risks that are unique to this alternative are primarily related to operation of two separate treatment plants, simultaneously. This is considered to be one of the biggest risks among all the presented alternatives and is expected to put significant additional burden on the operational staff and require additional resources. The process configuration in this Alternative is considerably more complicated than any other alternative while not offering any significant advantages in terms of effluent quality. In general, Alternative 3 is considered to be the most complex and risky option.

The cost impact for accelerating the schedule on approximately 55% of the overall NRF upgrade infrastructure in Phase 1 would result in approximately an $120-160 million cost premium on the project. There are no significant sunk costs for this alternative.

Alternative 4: Four (4) New BNR Reactors and Four (4) New Secondary Clarifiers

In this alternative four new BNR reactors and four new secondary clarifiers will be constructed on the southwest side of Parcel A, and designed to provide biological ammonia, nitrogen, and phosphorus removal.

Performance results for Alternative 4 are summarized in **Table ES4**.

Table ES4: Alternative 4 - Blended Effluent Quality

Parameter	Descriptor	Load, kg/d	Concentration, mg/L
Ammonia	Avg	1,031	4.2
TN	Avg	3,183	15.2
TP	Avg	175	0.9

Similarly to previous Alternatives that incorporate BNR process, the effluent ammonia load is projected to be below the proposed limits throughout the whole year. Due to some bypass flows during summer the model projects that only a single day ammonia exceedance might be expected depending on the peak day flows.

The blended effluent TN concentration remains above the 15 mg/L limits at the beginning of the year due to limitation in nitrification during cold months but drop below the limit in the second half of the year and remains relatively low for the rest of the year. The TP limit of 1 mg/L is projected to be met for most of the year. The model predicts some temporal increase above 1 mg/L, mostly due to bypass flows in the summer.

This alternative is the most compatible with the full NRF Upgrade. The four new BNR trains and four new secondary clarifiers can be configured in a manner that is consistent with the ultimate build out of the NRF. Coordination with the blower building and associated mechanical equipment will need to be addressed to ensure Phase 1 piping and future Phase 2 blowers are fully integrated. The only elements that are needed for Phase 1 work but will not be utilized in Phase 2 includes the WAS piping to the primary clarifiers for co-thickening.

Alternative 4 is relatively free of unique risks related to construction sequencing and schedule slips. Some risk associated with constructing half of the BNR reactors and half of the secondary clarifiers in Phase 1 and later constructing the rest in Phase 2 remain. These are generally related to tying in the new Phase 2 structures and construction of new Phase 2 structures very close to Phase 1 infrastructure.

The cost impact for accelerating the schedule on approximately 60% of the overall NRF upgrade infrastructure in Phase 1, as outlined in Alternative 4, would result in approximately an $140-170 million cost premium on the project. There are no significant sunk costs for this alternative.

Alternative 5: Eight (8) New BNR Reactors and Eight (8) New Secondary Clarifiers (Full Buildout)

This alternative is used as a benchmark/baseline for the estimation of the loads of ammonia, nitrogen and phosphorus released to the Red River with the full NRF plant. The effluent quality is used for comparison purposes against previous alternatives.

Performance results for Alternative 5 are summarized in **Table ES5**.

Table ES5: Alternative 5 - Blended Effluent Quality

Parameter	Descriptor	Load, kg/d	Concentration, mg/L
Ammonia	Avg	305	1.4
TN	Avg	2,341	11.6
TP	Avg	106	0.5

The full BNR plant provides nearly complete nitrification and the daily effluent ammonia loads are all below the proposed limits. The TN is projected to meet the proposed limits throughout the year. Similarly, the monthly effluent TP concentration is projected to meet the new limit through the year with concentrations below 1 mg/l.

ES.5 Conclusion

AECOM completed a review of three alternatives (Alternatives 2, 3, and 4) to determine the feasibility of accelerating a portion of the NRF Project. These three alternatives involve the construction of Phase 1 by the year 2030, and then following commissioning of Phase 1 continue with the remaining construction (i.e., Phase 2) to be complete by 2032, and having a design year of 2050. While all three alternatives were technically feasible, each had different impacts on cost and operational complexity.

Advantages and disadvantages of the analysed Phase 1 options are showed in **Table ES6**.

Table ES6: Summary of Advantages and Disadvantages between Phase 1 Options

Phase 1 Alternatives	Advantages	Disadvantages
Alternative 2 - Four (4) New BNR Reactors and Existing HPO Secondary Clarifiers	• Good effluent quality. Can meet TN, Ammonia and TP limits. • Lowest schedule acceleration cost.	• Complex construction sequencing. • Additional engineering required to minimize conflicts between Phase 1 and Phase 2. • Elements for Phase 1 not needed for Phase 2, resulting in the highest throw away cost. • Lower compatibility with Phase 2 than other options. • Significant risks associated with tie-ins to existing secondary treatment facility. • Higher Phase 2 cost compared to Alternative 4 due to throw away equipment and infrastructure, and deferral and escalation of 4 clarifiers.
Alternative 3 - Four (4) New BNR Reactors and Four (4) New Secondary Clarifiers and Existing HPO Reactors and Existing Secondary Clarifiers	• Better quality effluent than Alternative 1. • Compatible with Phase 2. • No throw away costs except for temporary WAS piping.	• Operationally complex. Requires 2 plants operating in parallel. • Increased staffing requirements. • Chemical dosing required. • Some additional engineering required for a separate effluent conduit. • Higher operating cost than Alternative 4. • Lower effluent quality than Alternative 2 and 4.
Alternative 4 – Four (4) New BNR Reactors and Four (4) New Secondary Clarifiers	• Good effluent quality. Can meet TP, TN and Ammonia limits during most of the year. • No throw away costs except for temporary WAS piping. • Accelerated schedule for new clarifiers reduces escalation costs. • Full compatibility with Phase 2. • Reduced risk for conflicts between Phase 1 and Phase 2.	• Highest schedule acceleration cost.

Alternative 2 involves constructing the least amount of new infrastructure in Phase1, deferring more to Phase 2. It includes constructing four new bioreactors and reusing the existing HPO secondary clarifiers, which will involve a series of complex tie-ins to the existing plant. A portion of the work is not compatible with Phase 2, and will therefore result in sunk costs up to $20M. To accelerate the schedule for Phase 1 to be in operation before the end of 2030, a cost premium of $80-$120M is anticipated.

Alternative 3 involves constructing four new BNR reactors and four new clarifiers, and treating half the flow in the new BNR system and half the flow in the existing HPO system. Operating two facilities in parallel is more complex than the other alternatives evaluated and does not offer any cost or treatment benefits. The cost premium for schedule acceleration is expected to be between $120-$160M.

Alternative 4 involves constructing four new BNR reactors and four new clarifiers, and treating all flow through the new BNR system. It is the same as Alternative 2, but uses new secondary clarifiers instead of the existing HPO clarifiers. The risk associated with the complex tie-ins and the throw away costs associated with Alternative 2 are eliminated. From an operational perspective, this alternative is the least complex, but will result in the highest cost premium, which is expected to be between $140-$170M for schedule acceleration.

While Alternatives 2, 3, and 4 indicate it is feasible to accelerate construction and provide improved treatment by the year 2030, each alternative has different costs and risk implications. The cost for acceleration is highly dependent on the construction start date and the labour force available to the contractor. At this time, it is envisioned that the project will be delivered as a Progressive Design Build, which will allow the WSTP to work with the Contractor to determine the actual cost impacts of schedule acceleration and staged commissioning. Based on this determination, the WSTP could then decide if any of the three alternatives fits their needs during the Progressive Design Build development phase.

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List of Acronyms

BNR	biological nutrient removal
BOD	Biochemical Oxygen Demand
cBOD	Carbonaceous Biochemical Oxygen Demand
EPD	Enhanced Preliminary Design
HPO	high purity oxygen
kg/d	kilogram per day
mg/L	milligrams per litre
ML/d	megalitres per day
NEWPCC	North End Water Pollution Control Centre or North End Sewage Treatment Plant
NRF	Nutrient Removal Facilities
SRT	solids retention time
TKN	total kjeldahl nitrogen
TP	total phosphorus
TSS	total suspended solids
WSTP	Winnipeg Sewage Treatment Program

1. Introduction

1.1 Background

The City of Winnipeg (City) is upgrading the North End Sewage Treatment Plant (NEWPCC) to accommodate future wastewater flows and loads to the plant, to provide enhanced treatment capability to address environmental and public concerns, while meeting enhanced regulatory requirements.

The City has decided to implement the NEWPCC Upgrade in three separate capital projects as follows:

1. NEWPCC Upgrade: Power Supply and Headworks Facilities ("Project 1")
2. NEWPCC Upgrade: Biosolids Facilities ("Project 2")
3. NEWPCC Upgrade: Nutrient Removal Facilities ("Project 3")

In May 2023, the update for the Nutrient Removal Facilities (NRF) Enhanced Preliminary Design (EPD) was initiated to update the design year from 2037 to 2050.

To expedite nutrient removal in the final effluent, the feasibility of accelerating construction and commissioning of certain infrastructure in the NRF upgrade is being considered.

1.2 Anticipated Environmental Act Licence Limits

The City of Winnipeg currently operates the NEWPCC under Environment Act Licence No. 2684 RRR, dated June 2009, that outlines the terms and conditions for the operation of the NEWPCC. However, it does not reflect the most recent discussions between Environment and Climate and the City of Winnipeg. As clarified by the WSTP, the NEWPCC Master Plan was accepted by Environment and Climate. Daily flows less than or equal to 705 ML/d are required to be sampled and meet the required effluent quality. Flows greater than 705 ML/d will not require treatment. The Master Plan also indicates that the effluent TSS and CBOD will each need to meet 25 mg/L on a 98th percentile basis. A summary of the anticipated Environmental Act Licence limits is summarized in **Table 1** and **Table 2**.

Table 1: Anticipated Environmental Act Licence Limits

Parameter	Limit	Unit	Occurrence
Carbonaceous Biochemical Oxygen Demand (cBOD)	25	mg/L	98th Percentile
Total Suspended Solids (TSS)	25	mg/L	98th Percentile
E.Coli	200	MPN/100 mL	Monthly geo. mean
Total phosphorus	1	mg/L	30-day rolling avg.
Total nitrogen	15	mg/L	30-day rolling avg.
Ammonia	Variable	kg N/d	Daily

Table 2: Anticipated Environmental Act Licence Ammonia Discharge Limits

Period	Ammonia Nitrogen (as N), kg/any 24 hour period
January	7,580
February	8,675
March	13,057
April	29,021
May	13,331
June	7,312
July	4,507
August	2,262
September	2,663
October	3,415
November	4,035
December	5,774

2. Objectives and Approach

The NEWPCC NRF EPD included eight (8) new BNR reactors and eight (8) new secondary clarifiers to replace the existing HPO reactors and secondary clarifiers. The WSTP has requested AECOM to review the constructability and effluent quality of four (4) new BNR reactors commissioned by the end of 2030. The remaining NEWPCC NRF infrastructure will be constructed and commissioned by the end of 2032.

The following options are evaluated in this report to compare nutrient loading to the Red River and cost impacts to accelerate the construction schedule:

1. Alternative 1: Continue operating the existing HPO and existing secondary clarifiers as the base case (i.e., establish baseline nutrient loads to Red River);
2. Alternative 2: Construct four (4) new BNR reactors and use in conjunction with the existing secondary clarifiers (decommission HPO reactors);
3. Alternative 3A: Construct four (4) new BNR reactors and four (4) new secondary clarifiers. Split flow between the new BNR trains and the existing HPO reactors and existing secondary clarifiers (with interim P to meet 2.0 mg/L TP);
4. Alternative 3B: Same as Alternative 3A but with interim P to meet 1.5 mg/L TP;
5. Alternative 4: Four (4) new BNR reactors and four (4) new secondary clarifiers treating (decommission HPO reactors and existing secondary clarifiers); and
6. Alternative 5: Eight (8) new BNR reactors and eight (8) new secondary clarifiers, full NRF built out on original schedule (i.e. nutrient loading to the Red River at project completion).

Alternatives 1 and 5 represent baselines for comparison of the partial compliance alternatives. AECOM completed a review of three partial compliance alternatives (Alternatives 2, 3, and 4) to determine the feasibility of accelerating a portion of the NRF Project. These three alternatives involve the construction of Phase 1 by the year 2030, and then following commissioning of Phase 1 continue with the remaining construction (i.e., Phase 2) to be complete by 2032, and having a design year of 2050.

3. Basis of Comparison

3.1 Flows and Loads

Historical daily flows and loads from the NEWPCC raw wastewater pump station were analyzed for the period 2016 to 2020 as part of the NEWPCC Nutrient Removal Facilities (NRF) Upgrade Project to develop the projected 2050 design year projected flows and loads.

To compare anticipated nutrient loads to the Red River, flows and loads projected to 2032 were used for all five alternatives. The year 2032 was selected as the last full calendar year Phase 1 will be in operation prior to Phase 2 coming online at the end of 2032, therefore 2032 would be the highest nutrient loading year for Phase 1 prior to Phase 2 startup.

Projected flows and loads were updated for this report to include analysis of historical daily flows and loads for the period of 2016 to 2023. The City also provided updated NEWPCC catchment populations up to 2023. Details on the updated projection of flows and loads for 2050 and 2032 can be found in the NEWPCC Nutrient Removal Facilities – Updated Flows and Loads Design Criteria Memorandum (AECOM, 2024).

Dynamic Biowin modeling was completed using hourly flow data from 2013 projected to 2032. The year 2013 was used as a baseline for projection as it closely represents an average flow year.

The projected 2032 flows and loads are summarized in **Table 3** and **Table 4**, respectively.

Table 3: Summary of 2032 Flows

Season	Ave daily, ML/d	Max 30 d roll avg, ML/d	Max 7 d roll avg, ML/d	Max day, ML/d	Min day, ML/d
Winter	174	201	268	351	70
Spring	305	448	600	958	147
Summer	264	394	478	718	155
Fall	229	275	342	594	98
AAF	**217**				

[1] *October and November 2019 not included due to outlier storm.*
[2] *October 2019 not included due to outlier storm.*

Table 4: Summary of 2032 Loads

Season	Load type	Loads (incl. Center Port), kg/d			
		TSS	BOD	TKN	TP
Winter	Average	60,081	46,463	10,421	1,152
	Max Month	67,101	48,703	11,127	1,426
	Max Week	86,494	52,831	12,058	1,406
	Max day	136,768	70,102	13,691	1,782
Spring	Average	74,445	46,922	9,482	1,288
	Max Month	92,153	50,950	10,658	1,399
	Max Week	131,655	56,871	11,511	1,669
	Max day	236,453	75,068	17,132	2,744
Summer	Average	57,872	44,170	9,418	1,323
	Max Month	77,125	48,287	10,473	1,473
	Max Week	102,572	53,256	11,929	1,666
	Max day	195,097	78,331	16,441	2,273
Fall	Average	55,861	46,157	9,480	1,385
	Max Month	66,453	49,106	10,481	1,555
	Max Week	82,225	57,234	12,104	1,764
	Max day	147,392	74,881	15,788	2,415
Annual average		**62,065**	**45,928**	**9,700**	**1,287**

4. Alternative 1: Existing HPO Reactors and Existing Secondary Clarifiers (Baseline Case)

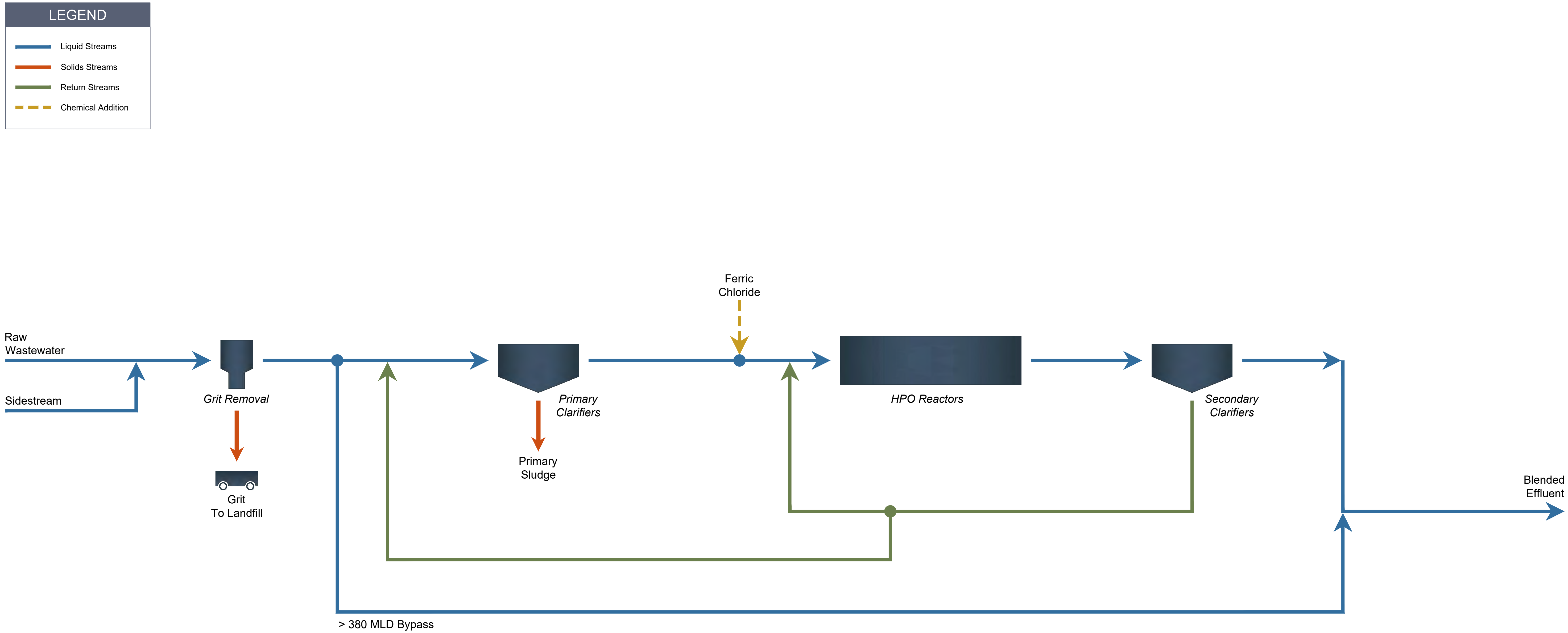
4.1 General Description

This alternative is used as a benchmark/baseline to estimate effluent ammonia, nitrogen and phosphorus loads discharged to the Red River from the existing plant. This scenario assumes that the existing HPO reactors and secondary clarifiers will be operated based on the current operating philosophy until the year 2032.

It is assumed that the interim phosphorus removal system implemented in 2024 will continue to be used by dosing ferric chloride and limiting the TP concentration in the effluent to 2.5 mg/L.

The influent flow to the HPO reactors is limited to 380 ML/d due to hydraulic limitations of the secondary clarifiers. Flows higher than 380 ML/d are bypassed around the plant and blended with the treated effluent for disinfection.

A simplified process flow diagram and site plan for Alternative 1 is shown in **Figure 1** and in **Figure 2**, respectively.



Winnipeg Sewage Treatment Program
NEWPCC Upgrade Project
Enhanced Preliminary Design Report - NRF

General
Alternative 1 - Process Flow Diagram of Main Flow Path
Figure: 1

AREA DESIGNATIONS

- C CENTRATE TREATMENT FACILITY
- C1 SBR BASIN
- C2 SODA ASH SILO
- C3 METHANOL STORAGE
- C4 EXHAUST AIR STACK
- D ANAEROBIC DIGESTER FACILITY (BY OTHERS)
- E ELECTRICAL BUILDING (BY OTHERS)
- F FERRIC CHLORIDE RECEIVING & STORAGE FACILITY
- F1 REPURPOSED SLUDGE DEWATERING BUILDING
- F2 FERRIC CHLORIDE RECEIVING
- F3 FERRIC CHLORIDE STORAGE
- FW FLUSHING WATER FACILITY (BY OTHERS)
- G STANDBY POWER GENERATION FACILITY (BY OTHERS)
- H HEADWORKS FACILITY
- J PHOSPHORUS RELEASE FACILITY (BY OTHERS)
- K DIGESTER GAS HANDLING FACILITY (BY OTHERS)
- M MAIN BUILDING
- N HAULED SLUDGE RECEIVING FACILITY (BY OTHERS)
- P PRIMARY CLARIFICATION FACILITY
- P1 CONTROL CHAMBER BUILDING
- P2 PRIMARY CLARIFIER 1-3
- P3 PRIMARY CLARIFIER 4-5
- P4 SCUM DEWATERING BUILDING (BY OTHERS)
- P5 EXISTING CONDUITS / GALLERY
- R BIOLOGICAL NUTRIENT REMOVAL FACILITY
- R1 INTERMEDIATE PUMPING STATION
- R2 BIOLOGICAL NUTRIENT REMOVAL BUILDING
- S SECONDARY CLARIFICATION FACILITY
- S1 SECONDARY CLARIFIER BUILDING 1
- S2 SECONDARY CLARIFIER BUILDING 2
- S3 MIXED LIQUOR SPLITTER
- S4 RAS SPLITTER
- T PRE-DIGESTION SLUDGE TREATMENT FACILITY (BY OTHERS)
- U UV DISINFECTION FACILITY
- V BIOSOLIDS PROCESSING & LOADING FACILITY (BY OTHERS)
- W FERMENTATION AND WAS THICKENING FACILITY
- X HAULED WASTEWATER RECEIVING FACILITY
- X1 HAULED WASTEWATER RECEIVING
- X2 HAULED LEACHATE RECEIVING
- Z MAINTENANCE FACILITY
- Z1 EAST-WEST GALLERY & PE CONDUITS

NOTE: AREA Y INCLUDES ALL EXTERIOR AREAS OF THE SITE NOT ENCOMPASSED BY ANOTHER AREA, INCLUDING TUNNELS & GALLERIES.

LEGEND-UTILITIES

- ALP AIR, LOW PRESSURE
- DG DIGESTER GAS
- FC FERRIC CHLORIDE
- FOA FOUL AIR
- FSU FERMENTER SUPERNATANT
- FSW FLUSHING WATER
- HRE HIGH RATE EFFLUENT
- HRS HIGH RATE SLUDGE
- INT WASTE WATER INTERCEPTOR
- LDS LAND DRAINAGE SEWER
- ML MIXED LIQUOR
- PE PRIMARY EFFLUENT
- PO PROCESS OVERFLOW
- PRE PHOSPHORUS RECOVERY EFFLUENT
- PS PRIMARY SLUDGE
- RAS RETURN ACTIVATED SLUDGE
- RS(FM) RAW SEWAGE (FORCEMAIN)
- SE SECONDARY EFFLUENT
- SLH HAULED SLUDGE
- TCE TREATED CENTRATE
- WAS WASTE ACTIVATED SLUDGE
- PW POTABLE WATER / WATERMAIN (WM)
- PW POTABLE WATER / SERVICE (WM)
- WWS WASTE WATER SEWER
- TWAS THICKENED WASTE ACTIVATED SLUDGE
- SUB SUBNATANT, DAF
- TBS SLUDGE, THICKNED BOTTOM

LEGEND

- STAGE 1
- STAGE 2
- STAGES 1 & 2
- PARCEL BOUNDARIES
- PROCESS AREA BOUNDARIES

LEGEND-PLAN

EXISTING / NEW

- HYDRANT
- VALVE
- MANHOLE
- CATCH BASIN
- DRAINAGE DIRECTION
- LAMP STANDARD
- PARKING LOT
- OUTLET
- TREE
- PIPE ABANDONMENTS
- SURVEY BAR
- GEODETIC BENCH MARK

KEYNOTES

1. HPO REACTORS TO BE DECOMMISSIONED.
2. SECONDARY CLARIFIERS TO BE DECOMMISSIONED.

NO.	REVISIONS	DATE	DESIGN	CHECK
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AECOM

DESIGNED BY:	CHECKED BY:
DRAWN BY: LMB / JP	APPROVED BY:
SCALE: 1:1500	RELEASED FOR CONSTRUCTION BY:
DATE: 2024-03-27	DATE:
CONSULTANT NO.:	

ENGINEER'S SEAL

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

NORTH END SEWAGE TREATMENT PLANT
BIOLOGICAL NUTRIENT REMOVAL FACILITY
ALTERNATIVE 1
EXISTING HPO & EXISTING SECONDARY CLARIFIERS

CITY DRAWING NUMBER	SHEET	REV.	SIZE
-	-	-	A1

A1 SIZE - 594mm x 841mm

LAST SAVE: 2024/10/03 7:15 PM

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4.2 Performance

Table 5 provides projected average values for three key parameters of effluent quality: Ammonia, Total Nitrogen (TN), and Total Phosphorus (TP). The table contains information on both the average load (in kg/day) and concentration (in mg/L) for each parameter. The average effluent ammonia load is projected to be 5,500 kg/d, which translates to a concentration of approximately 28 mg/L. The average TN and TP concentration is projected to be 37 mg/L and 2.5 mg/L respectively.

Table 5: Alternative 1 - Summary of Blended Effluent Quality

Parameter	Descriptor	Load, kg/d	Concentration, mg/L
Ammonia	Avg	5,572	28
TN	Avg	7,318	37
TP	Avg	525	2.5

Figure 3 shows the projected effluent ammonia load in kg/day over a period of a year for the HPO process, with projected influent loads throughout 2032.

The effluent ammonia load fluctuates throughout the year, generally staying between 5,000 and 10,000 kg/day, although it experiences brief spikes and dips based on influent variation and seasonal variations in temperature. The red line represents the proposed limit for ammonia load. Throughout the year, the ammonia load remains mostly below the limit, except for a period in summer where it exceeds the limits slightly.

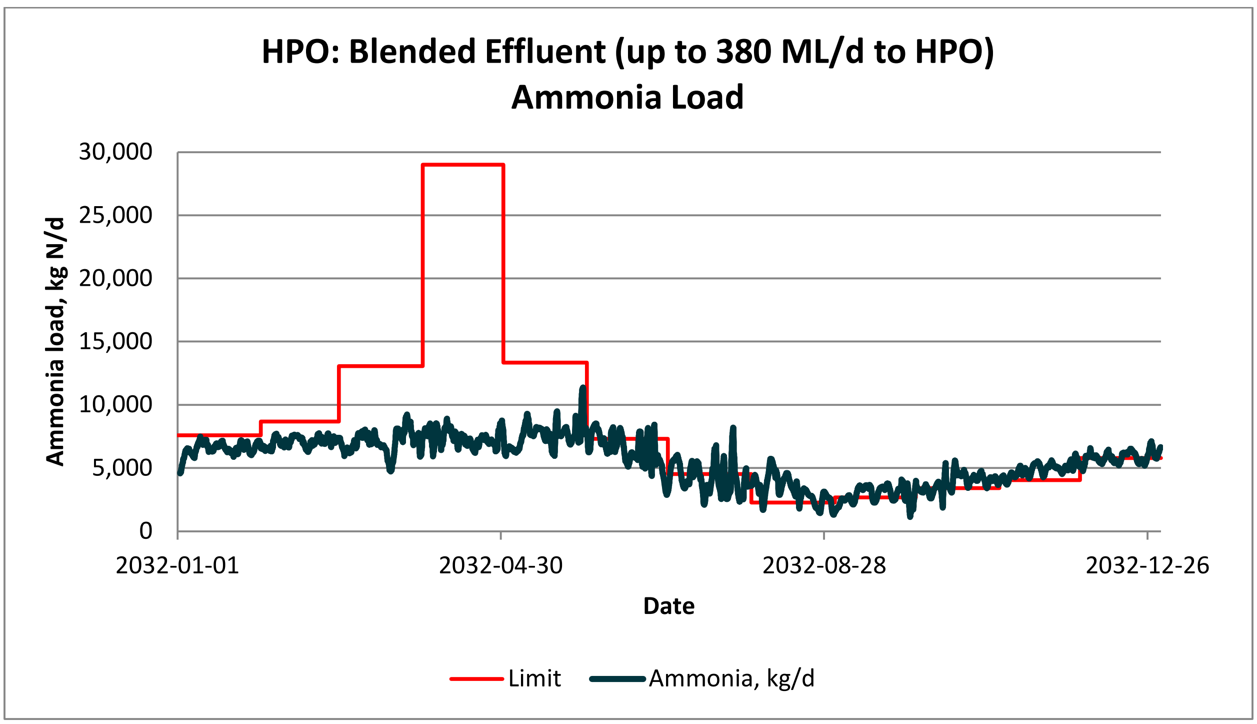


Figure 3: Alternative 1 - Daily Effluent Ammonia Load

Figure 4 displays the projected effluent TN and TP concentrations (in mg/L) over the course of 2032.

The monthly TN concentration shows significant variation throughout the year. It starts around 45 mg/L, rises slightly until mid-February, then steadily declines to around 38 mg/L by mid-July. After that, it gradually increases, reaching around 45 mg/L by December. The TN concentrations consistently exceed the TN limit throughout the year.

The monthly TP concentration remains fairly stable, fluctuating around 2.5 mg/L for most of the year, with very slight variations. The TP concentration is controlled at 2.5 mg/L with ferric chloride dosing. This TP concentrations is above the proposed TP limit of 1 mg/L.

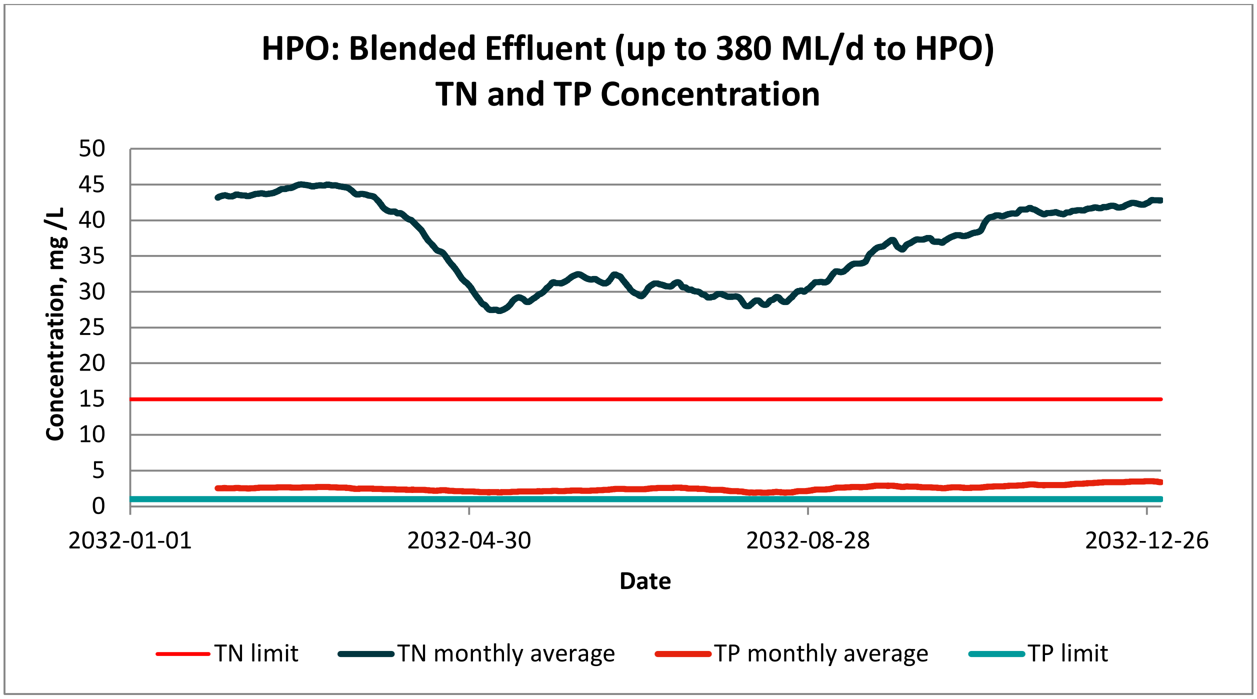


Figure 4: Alternative 1 - Monthly Trends in Effluent TN and TP Concentration

4.3 Compatibility with Full NRF Upgrade

Not applicable.

4.4 Risks

Not applicable.

4.5 Cost Impacts

Not applicable.

5. Alternative 2: Four (4) New BNR Reactors and Existing HPO Secondary Clarifiers

5.1 General Description

In this alternative four (4) new BNR reactors will be constructed on the southwest side of Parcel A, designed to provide ammonia, nitrogen, and phosphorus removal. The existing 26 secondary clarifiers (10 “squircles”, and 16 rectangular) from the existing HPO secondary treatment system will be used to settle the mixed liquor from the new BNR reactors.

Currently the existing HPO reactors split their mixed liquor flow to the existing secondary clarifiers as follows:

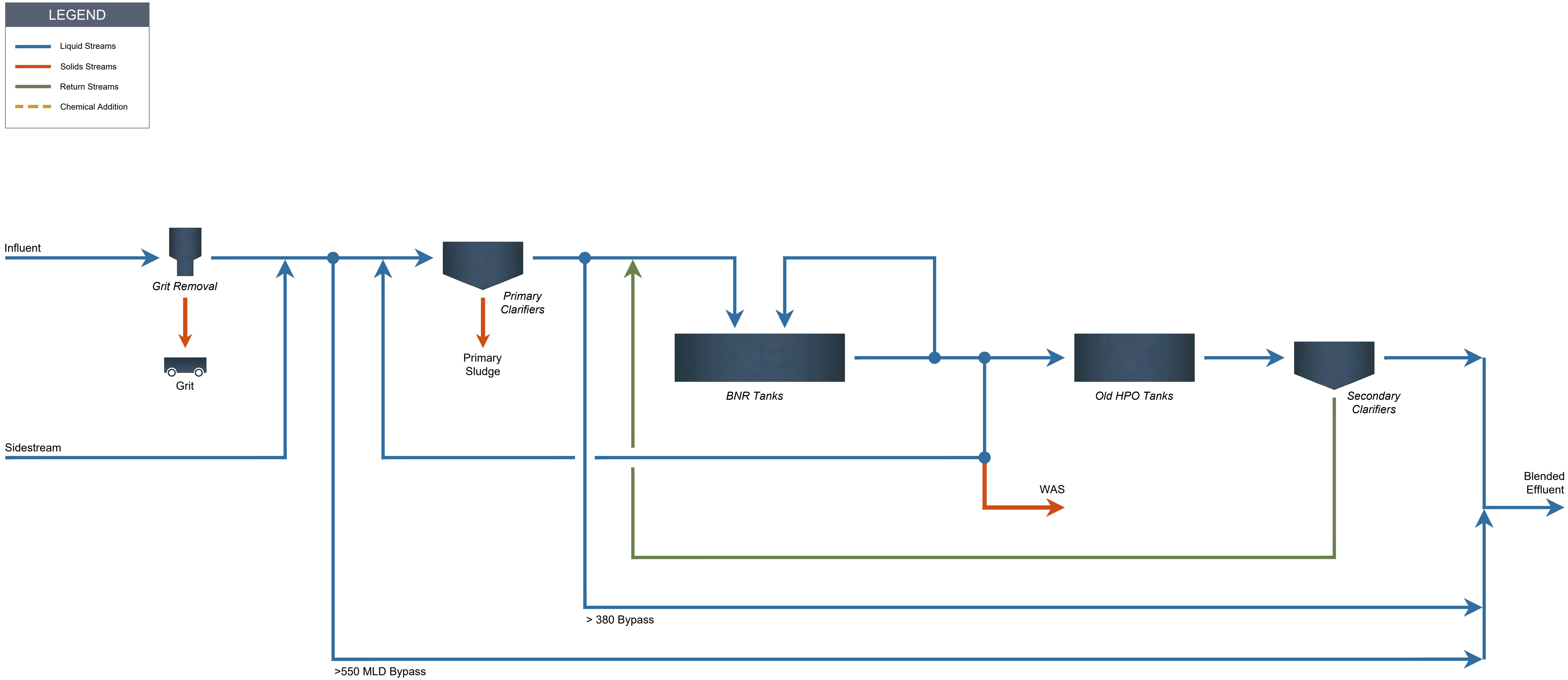
- HPO Trains 1A and 1B – Mixed liquor flow directed to “squircles” 1 to 10
- HPO Trains 2A and 2B – Mixed liquor flow directed to rectangular clarifiers 11 to 18
- HPO Trains 3A and 3B – Mixed liquor flow directed to rectangular clarifiers 19 to 26

Connecting the new BNR reactors to the existing secondary clarifiers inlet channels is complex, as two of the three channels are inaccessible. A more feasible solution, although still complex, would be to tie into the HPO reactor influent piping, and pass the mixed liquor through the HPO tanks to the secondary clarifiers. Three of the HPO tanks would operate in a “mix only” mode and act simply as a flow path to get mixed liquor to the existing secondary clarifiers and the other three HPO tanks would be decommissioned. This would require some temporary piping and tie ins to connect the new mixed liquor splitter chamber to the HPO tanks. The existing HPO inlets would need to be capped to allow this new mode of operation. The sequencing of these tie-ins and capping of the HPO inlet pipes would need to be carefully coordinated. Based on a preliminary sequencing plan, it is likely that the existing HPO facility would need to operate with two HPO reactors out of service for periods up to one month to accommodate each of the three HPO tie-ins. These tie-ins would need to be completed during low flow periods as treatment capacity would be reduced with two HPO reactors and subsequent existing secondary clarifiers that are fed by those particular HPO reactors.

The existing secondary clarifiers have 26 dedicated return activated sludge (RAS) pumps that convey RAS back to the HPO tanks. The pump curves on these 26 pumps need to be reviewed to determine whether they are sized appropriately for the Phase 1 Upgrade. The RAS from the existing secondary clarifiers would be re-routed to the new Intermediate Pump Station (IPS), where it would be combined with primary effluent (PE) and then pumped together to the new BNR reactors. The IPS would be configured so that the pump station would be suitable for both the Phase 1 and Phase 2 NRF Upgrades.

For the Phase 1 NRF Upgrade, waste activated sludge (WAS) thickening and primary sludge fermentation would be deferred until the Phase 2 NRF Upgrade. Therefore, WAS would continue to be wasted from the existing secondary clarifiers and co-thickened in the primary clarifiers.

A simplified flow schematic and site plan for Alternative 2 is shown below in **Figure 5** and **Figure 6**, respectively.



Winnipeg Sewage Treatment Program
NEWPCC Upgrade Project
Enhanced Preliminary Design Report - NRF

General
Alternative 2 - Process Flow Diagram of Main Flow Path
Figure: 5

AREA DESIGNATIONS

- C CENTRATE TREATMENT FACILITY
- C1 SBR BASIN
- C2 SODA ASH SILO
- C3 METHANOL STORAGE
- C4 EXHAUST AIR STACK
- D ANAEROBIC DIGESTER FACILITY (BY OTHERS)
- E ELECTRICAL BUILDING (BY OTHERS)
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- Z MAINTENANCE FACILITY
- Z1 EAST-WEST GALLERY & PE CONDUITS

NOTE: AREA Y INCLUDES ALL EXTERIOR AREAS OF THE SITE NOT ENCOMPASSED BY ANOTHER AREA, INCLUDING TUNNELS & GALLERIES.

LEGEND-UTILITIES

- ALP AIR, LOW PRESSURE
- DG DIGESTER GAS
- FC FERRIC CHLORIDE
- FOA FOUL AIR
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- WWS WASTE WATER SEWER
- TWAS THICKENED WASTE ACTIVATED SLUDGE
- SUB SUBNATANT, DAF
- TBS SLUDGE, THICKNED BOTTOM

LEGEND

- STAGE 1
- STAGE 1, TEMPORARY
- STAGE 2
- STAGES 1 & 2
- PARCEL BOUNDARIES
- PROCESS AREA BOUNDARIES

LEGEND-PLAN

EXISTING	NEW
HYDRANT	
VALVE	
MANHOLE	
CATCH BASIN	
DRAINAGE DIRECTION	
LAMP STANDARD	
PARKING LOT	
OUTLET	
TREE	
PIPE ABANDONMENTS	
SURVEY BAR	
GEODETIC BENCH MARK	

KEYNOTES

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2. SECONDARY CLARIFIERS TO BE DECOMMISSIONED.

NO.	REVISIONS	DATE	DESIGN	CHECK
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AECOM

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DRAWN BY: LMB / JP | APPROVED BY:
SCALE: 1:1500 | RELEASED FOR CONSTRUCTION BY:
DATE: 2024-03-27 | DATE:
CONSULTANT NO.:

ENGINEER'S SEAL

Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

NORTH END SEWAGE TREATMENT PLANT
NUTRIENT REMOVAL FACILITY
ALTERNATIVE 2
4 NEW BNR REACTORS & EXISTING SECONDARY CLARIFIERS

CITY DRAWING NUMBER	SHEET	REV.	SIZE
-	-	-	A1

A1 SIZE - 594mm x 841mm

LAST SAVE: 2024/11/01 9:03 AM
PATH: C:\Users\Monique.Mourad\DC\ACCDocs\AECOM\City of Winnipeg - NEWPCC Upgrades 2023\Project Files\900 Design Collaboration\BNR EPD Update\C-Civil\25-SKT\PD-CITY-Y001_Alternatives_RECOVER.dwg

5.2 Performance

The existing rectangular clarifiers were originally constructed as aeration reactors and are shallower (3.6 m) than the proposed new secondary clarifiers (6m). The “squircles” utilize sludge scrapers with a hopper, while the rectangular clarifiers utilize a suction head removal method. For biological nutrient removal, the controlled removal of RAS is important to manage the sludge blanket and prevent phosphorus release. While the existing clarifiers are shallow there is sufficient surface area for the proposed Phase 1 flows. While the depth and sludge removal system of the existing secondary clarifiers is not ideal, it is expected that with ferric chloride polishing an annual average effluent TP of less than 1 mg/L, and TN less than 15 mg/L can be achieved as listed in **Table 6**. The average effluent ammonia load is projected to be approximately 740 kg/d, which is significantly lower than Alternative 1.

Table 6: Alternative 2 - Blended Effluent Quality

Parameter	Descriptor	Load, kg/d	Concentration, mg/L
Ammonia	Avg	741	3.2
TN	Avg	2,373	11.4
TP	Avg	204	1.0

The existing hydraulic limitations of the existing secondary clarifiers prevent from treating more than 380 ML/d of wastewater. The treated effluent is blended with the bypass flow. **Figure 7** shows the projected daily effluent ammonia load. The effluent ammonia load is projected to be well below the proposed limits throughout the whole year as the BNR reactors provide nearly full nitrification.

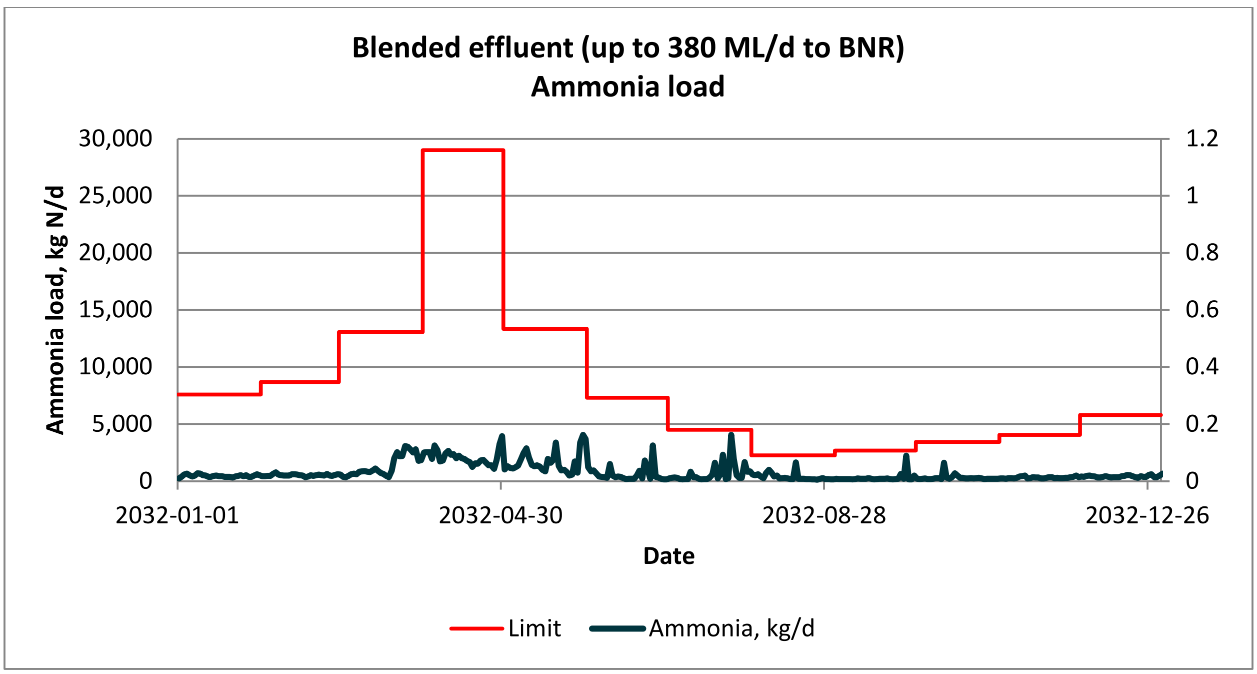


Figure 7: Alternative 2 - Daily Effluent Ammonia Load

Figure 8 shows the projected monthly effluent TN and TP concentrations (in mg/L) over the course of 2032.

The monthly TN concentration is maintained below the 15 mg/L limit throughout the year. The existing HPO reactor will be used as a flow through channel to access the existing secondary clarifiers for the mixed liquor from the BNR reactors, but will not be aerated. Mixers will be installed to provide adequate mixing.

The TP concentration is projected to remain fairly stable, fluctuating around 1.0 mg/L for most of the year, with some higher concentration in summer due to bypass events.

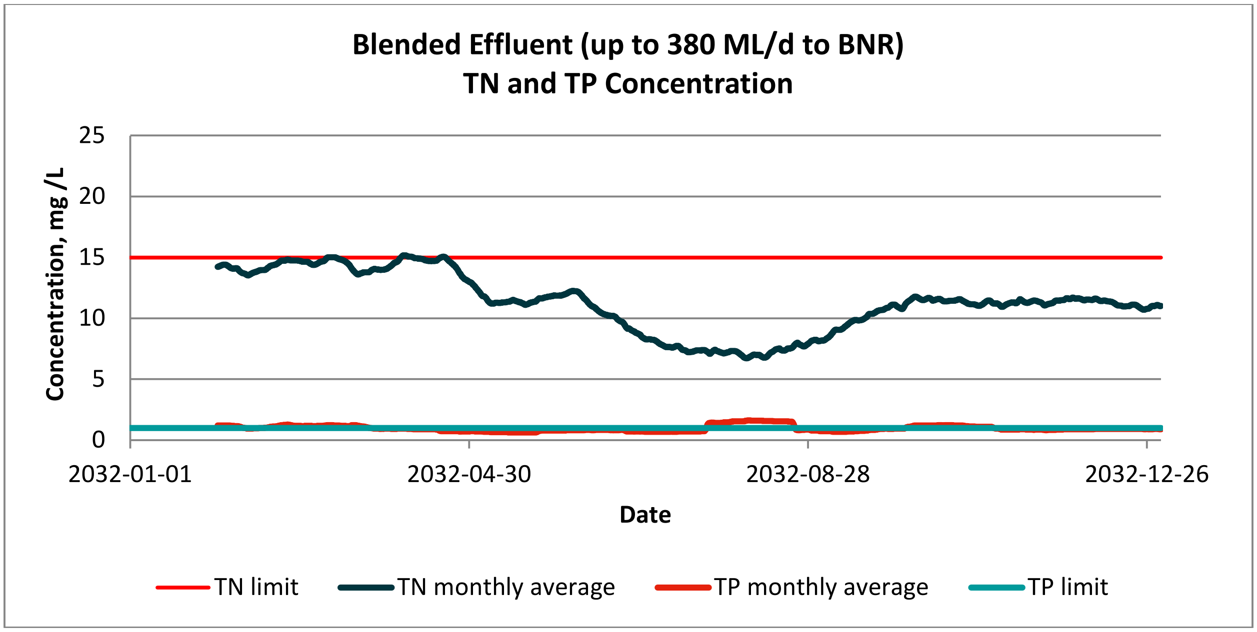


Figure 8: Alternative 2 - Monthly Trends in Effluent TN and TP Concentration

5.3 Compatibility with Full NRF Upgrade

The new four new BNR trains and intermediate pump station (IPS) can be configured in a manner that is consistent with the ultimate build out of the NRF. Coordination with the blower building and associated mechanical equipment will need to be addressed to ensure the Phase 1 piping and future Phase 2 blowers are fully integrated for the future expansion. Elements that are needed for the Phase 1 work, but will not be utilized in Phase 2, include the RAS pumps/piping, mixed liquor piping into the existing HPO tank, and mixers in the HPO.

5.4 Risks

Tie-ins

Risks that are unique to this alternative are primarily related to the tie-in requirements to the existing secondary treatment facility. This includes the sequencing of tie-ins to the HPO inlet piping and requires the six HPO inlet pipes to be sequentially capped and then three reconfigured with the new BNR mixed liquor piping. Conceptually, two HPO reactors will need to be removed from service at a time for likely one month. In a similar manner there are risks associated with the reconfiguration of the existing secondary treatment RAS system. Once it is determined whether new RAS pumps are required, this risk can be more accurately defined. Either way, RAS piping would need to be extended and tied into the new IPS.

This alternative requires extensive potholing to identify obstacles in the routing location for the mixed liquor piping to the existing secondary treatment system to identify any obstacles. Since there are tie-ins to existing piping in existing galleries there is a risk of encountering hazardous materials (asbestos, lead, etc.)

Construction Sequencing

Construction sequencing in Phase 2 also poses a risk in this option. The Phase 2 design should be completed up to 60% prior to start of Phase 1 construction. This is needed to avoid piping conflicts, and other foundation related issues between the Phase 1 and Phase 2 work. Phase 2 construction methods and logistics will face increased complexity due to the constrained area and the presence of Phase 1 infrastructure and tie-ins. The limited space will require careful coordination of materials, equipment, and personnel, potentially increasing both time and cost. The construction area will only be accessible via existing plant roads, which will limit transport routes, slow down delivery, and will interfere with ongoing plant operations. To mitigate these impacts, additional planning, safety measures, and operational scheduling will be essential to maintain construction efficiency while minimizing disruptions to the plant's daily activities.

<u>Co-thickening Sludge</u>

As with all the alternatives using BNR treatment, there is also an increased risk of phosphorus being released in the primary clarifier with the addition of BNR WAS being co-thickened in the primary clarifiers. BNR WAS cannot be sent directly to the Biosolids Facilities without being thickened as the intermediate dewatering system would not have the required hydraulic capacity.

5.5 Cost Impacts

This alternative involves the least amount of new infrastructure of the alternatives evaluated in this memorandum. To the full extent possible, NRF elements were deferred from Phase 1 to Phase 2 to simplify the Phase 1 scope and facilitate scheduling. This included deferring the new secondary clarifiers, secondary effluent conduit, WAS thickening, and primary sludge fermentation. The work for Phase 1 would include construction of a new IPS, 4 BNR reactors, blower building, mixed liquor splitter chamber, RAS pumps and associated piping (pending review of RAS pump curves), and mixed liquor piping and valves. There are also complex tie-ins required, such as the RAS piping reconfiguration, RAS pumps, and the mixed liquor piping to connect to the existing secondary clarifiers.

While most of the work in this alternative is consistent with the ultimate build out of the NRF Upgrade (i.e., Phase 2), there are components that would be considered throw away costs. The infrastructure only required for Phase 1 but not Phase 2 would also have a negative carbon impact as it would only be in use for 2 years before being abandoned when Phase 2 in completed.

The approximate cost impact of Alternative 2 is $90-140 million, determined by the following:

- $10-20 million for infrastructure required for Phase 1 but not Phase 2, therefore a throw away cost, which includes:
    - Mixed liquor and RAS piping;
    - Potentially 26 new RAS pumps; and
    - Tie-ins to existing infrastructure.
- $80-120 million for accelerating the Phase 1 schedule by 24 months on approximately 40% of the overall NRF upgrade infrastructure in Phase 1, which includes:
    - Increased resources required to complete Phase 1 on an accelerated schedule;
    - Increased coordination efforts based on construction sequencing;
    - Increased commissioning efforts; and
    - Reduction in escalation costs for Phase 1 infrastructure.

6. Alternative 3: Four (4) New BNR Reactors and Four (4) New Secondary Clarifiers and Existing HPO Reactors and Existing Clarifiers

6.1 General Description

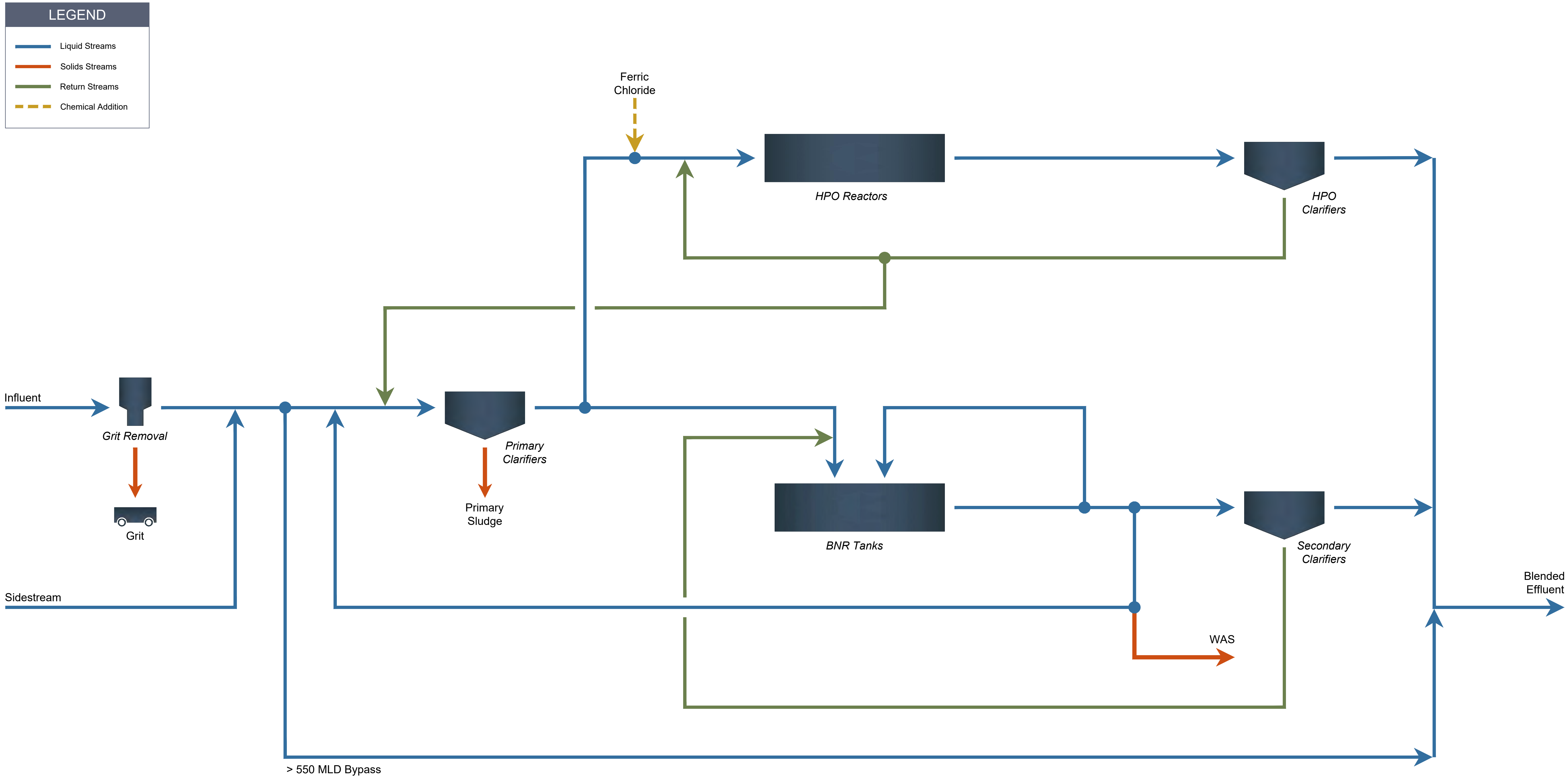
In this alternative primary effluent will be split between new secondary treatment system and the existing secondary treatment system. Four new BNR reactors and four new circular secondary clarifiers will be constructed on the southwest side of Parcel A, and designed to provide biological ammonia, nitrogen, and phosphorus removal. The existing HPO reactors and existing 26 secondary clarifiers (10 squircles, and 16 rectangular) will provide treatment in terms of BOD removal. The flow between the two plants will be split equally (50/50), which is expected to provide enhanced treatment.

Fifty percent of primary effluent will be distributed to the new BNR reactors through the new IPS that ties into the existing primary effluent conduit. The IPS would be configured so that the pump station would be suitable for both the Phase 1 and Phase 2 NRF Upgrades. WAS surface wasted from the BNR reactors would be temporarily routed to be co-thickened in the primary clarifiers until WAS thickening is constructed in Phase 2. Secondary effluent from the new secondary clarifiers will flow by gravity to the existing UV disinfection facility through a new secondary effluent conduit. Due to hydraulic constraints, the effluent from new and existing clarifiers cannot be combined in the existing secondary effluent conduits.

The remaining 50% of primary effluent that is not pumped to the BNR reactors by the IPS will flow by gravity to the existing HPO reactors through the primary effluent conduit that currently feeds the HPO reactors. Existing RAS and WAS systems will continue to operate, with WAS co-thickening in the primary clarifiers. Secondary effluent from the existing secondary clarifiers will flow to the existing UV disinfection facility through the existing secondary effluent conduit and pumped into the UV channels by the existing UV pumps.

For the Phase 1 NRF Upgrade, waste activated sludge (WAS) thickening and primary sludge fermentation would be deferred until the Phase 2 NRF Upgrade. Therefore, WAS from the new BNR would be co-thickened in the primary clarifiers along with the WAS from the existing secondary treatment system.

A simplified flow schematic and site plan for Alternative 3 is shown below in **Figure 9** and **Figure 10**, respectively.



Winnipeg Sewage Treatment Program
NEWPCC Upgrade Project
Enhanced Preliminary Design Report - NRF

General
Alternative 3 - Process Flow Diagram of Main Flow Path
Figure: 9

	AREA DESIGNATIONS		
C	CENTRATE TREATMENT FACILITY	P4	SCUM DEWATERING BUILDING (BY OTHERS)
C1	SBR BASIN	P5	EXISTING CONDUITS / GALLERY
C2	SODA ASH SILO	R	BIOLOGICAL NUTRIENT REMOVAL FACILITY
C3	METHANOL STORAGE	R1	INTERMEDIATE PUMPING STATION
C4	EXHAUST AIR STACK	R2	BIOLOGICAL NUTRIENT REMOVAL BUILDING
D	ANAEROBIC DIGESTER FACILITY (BY OTHERS)	S	SECONDARY CLARIFICATION FACILITY
E	ELECTRICAL BUILDING (BY OTHERS)	S1	SECONDARY CLARIFIER BUILDING 1
F	FERRIC CHLORIDE RECEIVING & STORAGE FACILITY	S2	SECONDARY CLARIFIER BUILDING 2
F1	REPURPOSED SLUDGE DEWATERING BUILDING	S3	MIXED LIQUOR SPLITTER
F2	FERRIC CHLORIDE RECEIVING	S4	RAS SPLITTER
F3	FERRIC CHLORIDE STORAGE	T	PRE-DIGESTION SLUDGE TREATMENT FACILITY (BY OTHERS)
FW	FLUSHING WATER FACILITY (BY OTHERS)	U	UV DISINFECTION FACILITY
G	STANDBY POWER GENERATION FACILITY	V	BIOSOLIDS PROCESSING & LOADING FACILITY (BY OTHERS)
H	HEADWORKS FACILITY	W	FERMENTATION AND WAS THICKENING FACILITY
J	PHOSPHORUS RELEASE FACILITY (BY OTHERS)	X	HAULED WASTEWATER RECEIVING FACILITY
K	DIGESTER GAS HANDLING FACILITY	X1	HAULED WASTEWATER RECEIVING
M	MAIN BUILDING	X2	HAULED LEACHATE RECEIVING
N	HAULED SLUDGE RECEIVING FACILITY (BY OTHERS)	Z	MAINTENANCE FACILITY
P	PRIMARY CLARIFICATION FACILITY	Z1	EAST-WEST GALLERY & PE CONDUITS
P1	CONTROL CHAMBER BUILDING		
P2	PRIMARY CLARIFIER 1-3		
P3	PRIMARY CLARIFIER 4-5		

NOTE: AREA Y INCLUDES ALL EXTERIOR AREAS OF THE SITE NOT ENCOMPASSED BY ANOTHER AREA, INCLUDING TUNNELS & GALLERIES.

LEGEND-UTILITIES

ALP	AIR, LOW PRESSURE
DG	DIGESTER GAS
FC	FERRIC CHLORIDE
FOA	FOUL AIR
FSU	FERMENTER SUPERNATANT
FSW	FLUSHING WATER
HRE	HIGH RATE EFFLUENT
HRS	HIGH RATE SLUDGE
INT	WASTE WATER INTERCEPTOR
LDS	LAND DRAINAGE SEWER
ML	MIXED LIQUOR
PE	PRIMARY EFFLUENT
PO	PROCESS OVERFLOW
PRE	PHOSPHORUS RECOVERY EFFLUENT
PS	PRIMARY SLUDGE
RAS	RETURN ACTIVATED SLUDGE
RS(FM)	RAW SEWAGE (FORCEMAIN)
SE	SECONDARY EFFLUENT
SLH	HAULED SLUDGE
TCE	TREATED CENTRATE
WAS	WASTE ACTIVATED SLUDGE
PW	POTABLE WATER / WATERMAIN (WM)
PW	POTABLE WATER / SERVICE (WM)
WWS	WASTE WATER SEWER
TWAS	THICKENED WASTE ACTIVATED SLUDGE
SUB	SUBNATANT, DAF
TBS	SLUDGE, THICKNED BOTTOM

LEGEND

- STAGE 1
- STAGE 2
- STAGES 1 & 2
- PARCEL BOUNDARIES
- PROCESS AREA BOUNDARIES

LEGEND-PLAN

EXISTING / NEW

- HYDRANT
- VALVE
- MANHOLE
- CATCH BASIN
- DRAINAGE DIRECTION
- LAMP STANDARD
- PARKING LOT
- OUTLET
- TREE
- PIPE ABANDONMENTS
- SURVEY BAR
- GEODETIC BENCH MARK

KEYNOTES

1 HPO REACTORS TO BE DECOMMISSIONED.

2 SECONDARY CLARIFIERS TO BE DECOMMISSIONED.

NO.	REVISIONS	DATE	DESIGN	CHECK
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DRAWN BY: LMB / JP | APPROVED BY:
SCALE: 1:1500 | RELEASED FOR CONSTRUCTION BY:
DATE: 2024-03-27 | DATE:
CONSULTANT NO.:

ENGINEER'S SEAL

Winnipeg
THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

NORTH END SEWAGE TREATMENT PLANT
BIOLOGICAL NUTRIENT REMOVAL FACILITY
ALTERNATIVE 3A/3B
4 NEW BNR REACTORS & 4 NEW SECONDARY CLARIFIERS
& EXISTING HPO & EXISTING SECONDARY CLARIFIERS

CITY DRAWING NUMBER	SHEET	REV.	SIZE
-	-	-	A1

A1 SIZE - 594mm x 841mm

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6.2 Performance

This alternative has been divided into two sub-alternatives Alternative 3A where interim P is used on the HPO stream to reduce total phosphorus to 2.0 mg/L and Alternative 3B where interim P achieves 1.5 mg/L TP on the HPO stream.

6.2.1 Alternative 3A: Interim Phosphorus Removal to 2.0 mg/L in HPO Effluent

Alternative 3 combines wastewater treatment in both the new BNR trains and the existing HPO reactors. The effluent from both plants are blended at the UV system. The projected quality of the blended effluent is summarized in **Table 7** for option A. The average effluent ammonia load is projected to be approximately 1,350 kg/d, which is significantly lower than Alternative 1 but slightly higher than Alternative 2. The average effluent nitrogen and phosphorus loads are significantly lower than Alternative 1 due to the BNR process. The TP concentration in the HPO effluent is controlled at 2 mg/L with ferric chloride using the current interim phosphorus removal system. After blending with the BNR effluent the resulting final effluent TP concentration is projected to be around 1.3 mg/L.

Table 7: Alternative 3A - Blended Effluent Quality

Parameter	Descriptor	Load, kg/d	Concentration, mg/L
Ammonia	Avg	1,348	6.9
TN	Avg	4,981	25
TP	Avg	262	1.3

The treated effluent is blended with the bypass flow. **Figure 11** shows the projected daily effluent ammonia load. Similarly to Alternative 2 the effluent ammonia load is projected to be below the proposed limits throughout the whole year, the HPO reactors are projected to provide some ammonia removal due to lower effective loading and increased SRT.

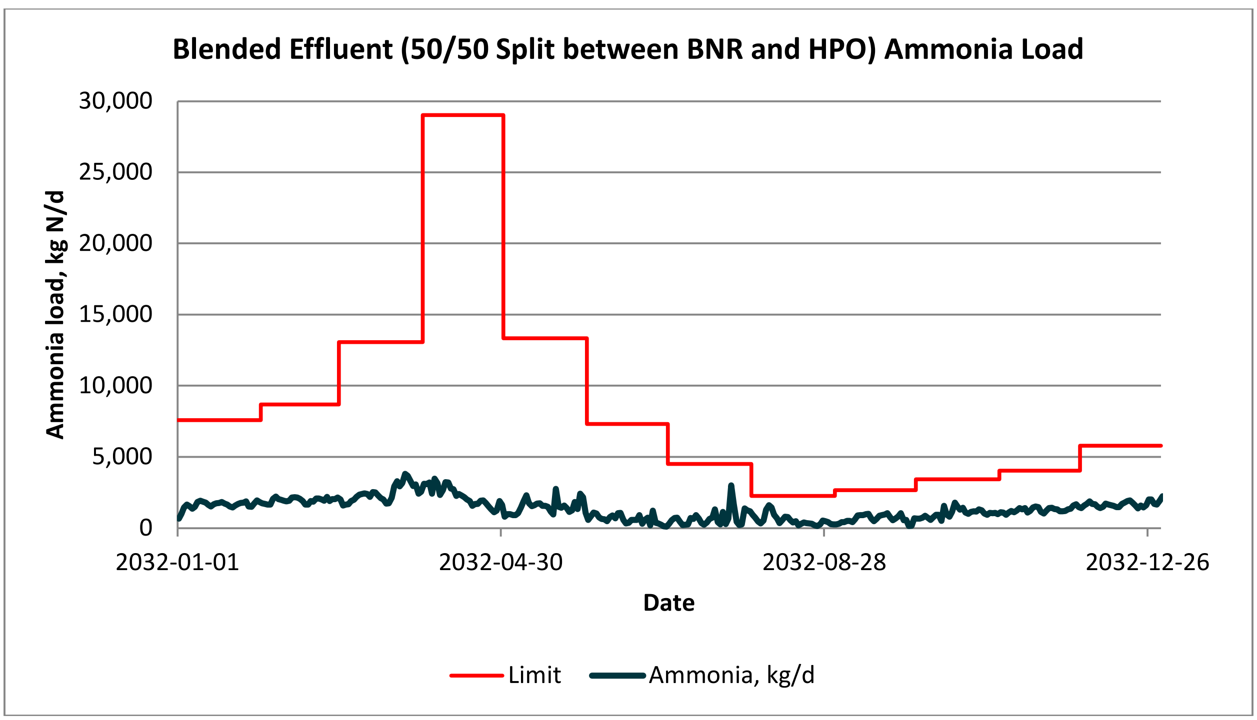


Figure 11: Alternative 3A - Daily Effluent Ammonia Load

Figure 12 shows the projected monthly effluent TN and TP concentrations (in mg/L).

The monthly TN concentration is relatively higher than Alternative 2 and remains above the 15 mg/L limit throughout the year. Half of the wastewater is treated in the HPO reactors which do not remove nitrogen.

The monthly TP concentration in the blended effluent is projected to remain fairly stable, fluctuating around 1.0-2.0 mg/L for most of the year. The projected blended TP concentration is lower than 2 mg/L due to biological phosphorus removal in the BNR train.

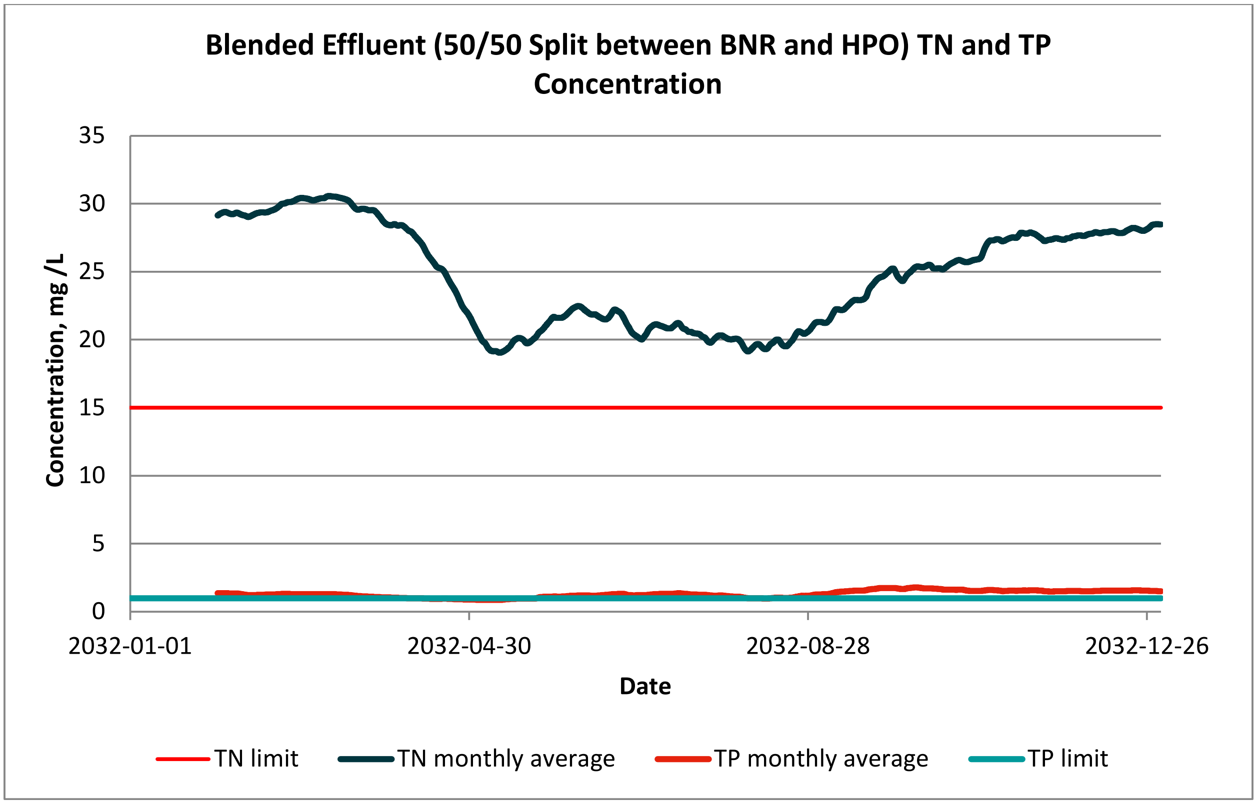


Figure 12: Alternative 3A - Monthly Trends in Effluent TN and TP Concentration

6.2.2 Alternative 3B: Interim Phosphorus Removal to 1.5 mg/L in HPO Effluent

Option B of Alternative 3 is presented to show the effect of increased ferric dosing to control the TP in the HPO effluent at approximately 1.5 mg/L. All other variables remain the same between the two options. **Table 5** presents the projected effluent annual average loads and concentrations for ammonia, TN and TP. The effluent ammonia and TN remain similar to Alternative 3A but the average effluent TP load is projected to decrease to approximately 208 kg/d due to additional chemical dose.

Table 8: Alternative 3B - Blended Effluent Quality

Parameter	Descriptor	Load, kg/d	Concentration, mg/L
Ammonia	Avg	1,524	7.8
TN	Avg	4,981	25
TP	Avg	208	1.0

Figure 13 shows the projected blended effluent daily ammonia loads. The model predicts full compliance with the ammonia limits throughout the year similar to Alternative 3A.

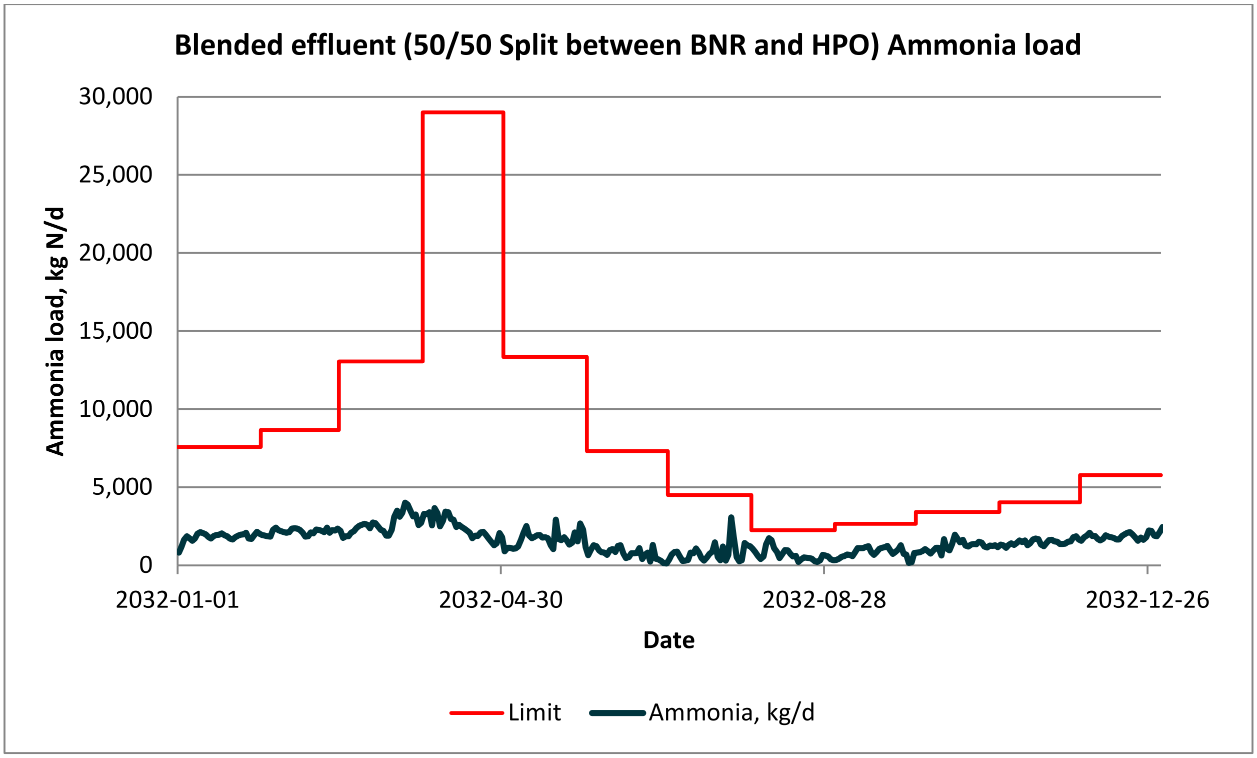


Figure 13: Alternative 3B - Daily Effluent Ammonia Load

The projected monthly effluent TN and TP concentration for Alternative 3B are shown in **Figure 14**. The TN trend is practically the same as for Alternative 3A and is above the 15 mg/L all year. The monthly effluent TP concentration is projected to be slightly lower than Alternative 3A and is projected to meet the 1 mg/L limit for some period of time during the year.

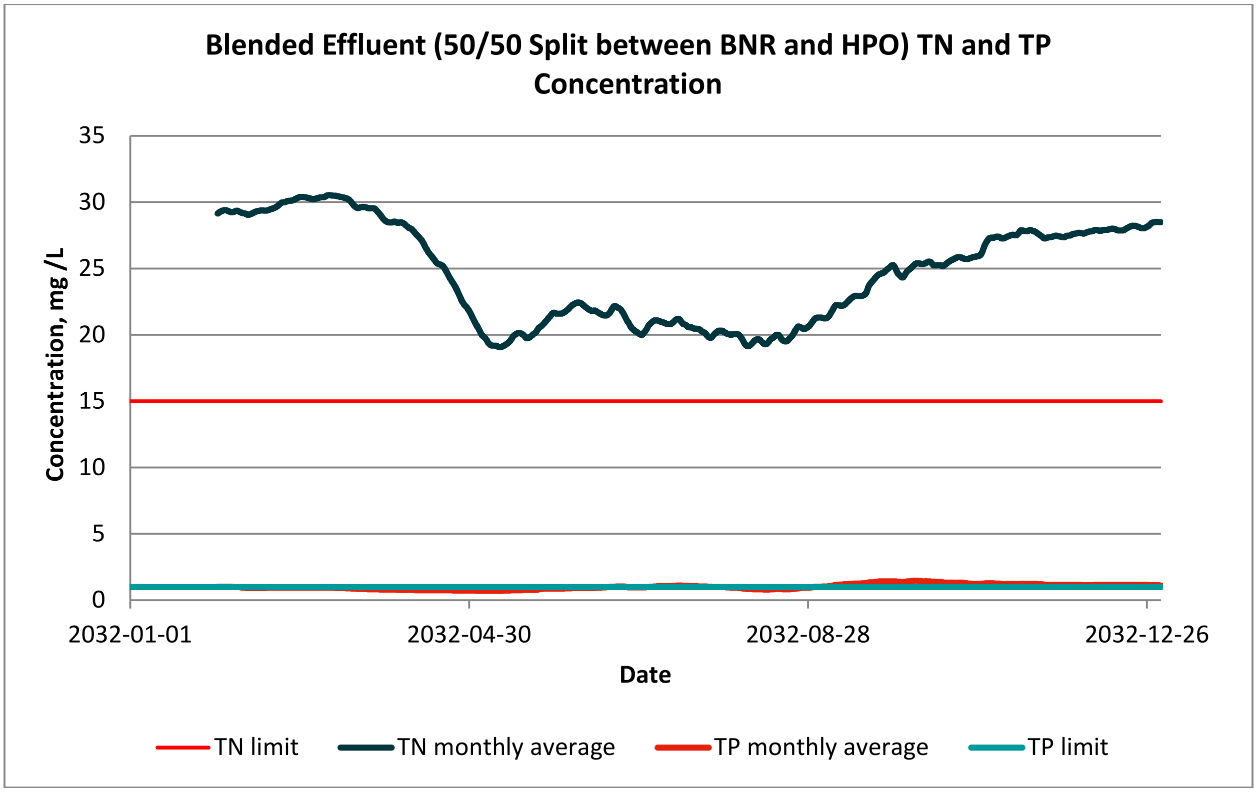


Figure 14: Alternative 3B - Monthly Trends in Effluent TN and TP Concentration

6.3 Compatibility with Full NRF Upgrade

The four new BNR trains and four new secondary clarifiers can be configured in a manner that is consistent with the ultimate build out of the NRF. Coordination with the blower building and associated mechanical equipment will need to be addressed to ensure the Phase 1 piping and Phase 2 blowers are fully integrated. Elements that are needed for the Phase 1 work, but will not be utilized in Phase 2, includes the WAS piping to primary clarifiers for co-thickening.

6.4 Risks

Operation and Maintenance

Risks that are unique to this alternative are primarily related to operation of two separate treatment plants, simultaneously. This is expected to put additional burden on the operational staff and require additional resources. The operation of two plants will require additional staff and significantly increase operational costs. The operation of two plants is also expected to cause operability concerns with equal flow splitting and two different treatment processes. The workload on the operation staff is expected to increase significantly. Increased number of equipment to maintain could also pose higher health and safety risk for the operational staff.

During periods of low flows, the HPO system would be underloaded and likely experience foaming and bulking episodes, which could have impacts on solids stream processes and overall plant operability. Additional risk is posed by the fact that the effluents from both plants cannot be combined in the existing effluent channel. It is necessary to build the new effluent conduit in Phase 1 for the BNR effluent, which impacts the schedule and adds associated construction risk. The facility would need to operate with two control systems, one for HPO and for the new BNR, which inherently carries increased risk.

Some risk is posed by the increased ferric chloride dosing to the HPO reactors to meet low TP concentration in the effluent. The City is currently testing the new Interim Phosphorus chemical dosing system and it has not been confirmed yet that these low concentrations can be achieved without unforeseen detrimental side effects to the overall plant.

<u>Co-thickened Sludge</u>

As with all the alternatives using BNR treatment, there is also an increased risk of phosphorus being released in the primary clarifier with the addition of BNR WAS being co-thickened in the primary clarifiers BNR WAS cannot be sent directly to the Biosolids Facilities without being thickened as the intermediate dewatering system would not have the required hydraulic capacity.

<u>Site Constraints</u>

Phase 2 construction methods and logistics will face increased complexity due to the constrained area and parallel operation of two separate plants. Additional risk to Phase 1 schedule and construction is associated with new underground effluent conduit. The limited space in both Phase 1 and 2 will require careful coordination of materials, equipment, and personnel, potentially increasing both time and cost. The construction area will only be accessible via existing plant roads, which will limit transport routes, slow down delivery, and will interfere with ongoing plant operations. To mitigate these impacts, additional planning, safety measures, and operational scheduling will be essential to maintain construction efficiency while minimizing disruptions to the plant’s daily activities.

Alternative 3 is considered to be the highest risk option with highest concern for operability and operational costs.

6.5 Cost Impacts

This alternative involves more new infrastructure than Alternative 2. Similar to Alternative 2, WAS thickening, primary sludge fermentation, and half of the BNR reactors was deferred to Phase 2, but does include half the secondary clarifiers. The work for Phase 1 would include construction of a new IPS, 4 BNR reactors, blower building, 4 new secondary clarifiers and RAS pumping, mixed liquor splitter chamber, and new secondary effluent conduit.

While most of the work in this alternative is consistent with the ultimate build out of the NRF Upgrade (i.e., Phase 2), there is some piping that would be considered throw away costs. As described above, this includes WAS piping from the BNR reactors to existing primary clarifiers.

The approximate cost impact of Alternative 3 is $121-161 million, determined by the following:

- $1 million for infrastructure required for Phase 1 but not Phase 2, therefore a throw away cost, which includes:
    - WAS piping.
- $120-160 million for accelerating the Phase 1 schedule by 24 months on approximately 55% of the overall NRF upgrade infrastructure in Phase 1, which includes:
    - Increased resources required to complete Phase 1 on an accelerated schedule;
    - Increased coordination efforts based on construction sequencing;
    - Increased commissioning efforts; and
    - Reduction in escalation costs for Phase 1 infrastructure.
- The cost impact does not incorporate increased operation and maintenance costs that would be incurred by the City, including increase in staffing and chemical costs.

7. Alternative 4: Four (4) New BNR Reactors and Four (4) New Secondary Clarifiers

7.1 General Description

In this alternative four new BNR reactors and four new secondary clarifiers will be constructed on the southwest side of Parcel A, and designed to provide biological ammonia, nitrogen, and phosphorus removal.

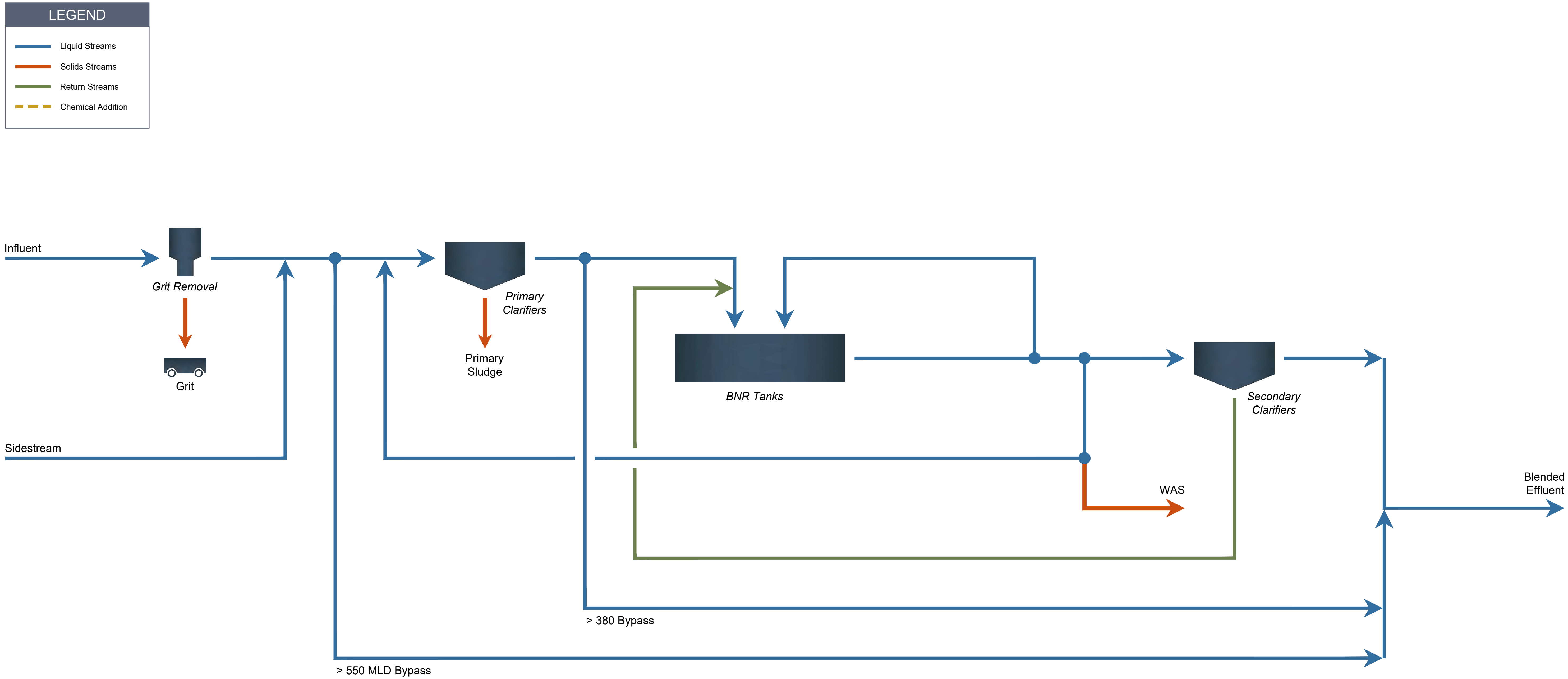
Primary effluent up to 380 ML/d will be pumped to the new BNR reactors through the new IPS that ties into the existing primary effluent conduit. The IPS would be configured so that the pump station would be suitable for both the Phase 1 and Phase 2 NRF Upgrades. WAS surface wasted from the BNR reactors would be temporarily routed to be co-thickened in the primary clarifiers until WAS thickening is constructed in Phase 2. Secondary effluent from the new secondary clarifiers will flow by gravity to the existing UV disinfection facility through a new secondary effluent conduit.

Flows over 380 ML/d will bypass secondary treatment at the IPS by pumping into the new secondary effluent conduit. The bypass is necessary to limit the surface loading rate on the four secondary clarifiers.

For the Phase 1 NRF Upgrade, WAS thickening and primary sludge fermentation would be deferred until the Phase 2 NRF Upgrade. Therefore, WAS would be co-thickened in the primary clarifiers. In order to avoid release of phosphorus in the primary clarifiers, additional ferric dosing to the primary clarifiers would be required.

In this option the existing HPO plant and secondary clarifiers can be fully decommissioned after the four new BNR trains are online.

A simplified flow schematic and site plan for Alternative 4 is shown below in **Figure 15** and **Figure 16**, respectively.



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NEWPCC Upgrade Project
Enhanced Preliminary Design Report - NRF

General
Alternative 4 - Process Flow Diagram of Main Flow Path
Figure: 15

AREA DESIGNATIONS	
C	CENTRATE TREATMENT FACILITY
C1	SBR BASIN
C2	SODA ASH SILO
C3	METHANOL STORAGE
C4	EXHAUST AIR STACK
D	ANAEROBIC DIGESTER FACILITY (BY OTHERS)
E	ELECTRICAL BUILDING (BY OTHERS)
F	FERRIC CHLORIDE RECEIVING & STORAGE FACILITY
F1	REPURPOSED SLUDGE DEWATERING BUILDING
F2	FERRIC CHLORIDE RECEIVING
F3	FERRIC CHLORIDE STORAGE
FW	FLUSHING WATER FACILITY (BY OTHERS)
G	STANDBY POWER GENERATION FACILITY (BY OTHERS)
H	HEADWORKS FACILITY
J	PHOSPHORUS RELEASE FACILITY (BY OTHERS)
K	DIGESTER GAS HANDLING FACILITY (BY OTHERS)
M	MAIN BUILDING
N	HAULED SLUDGE RECEIVING FACILITY (BY OTHERS)
P	PRIMARY CLARIFICATION FACILITY
P1	CONTROL CHAMBER BUILDING
P2	PRIMARY CLARIFIER 1-3
P3	PRIMARY CLARIFIER 4-5
P4	SCUM DEWATERING BUILDING (BY OTHERS)
P5	EXISTING CONDUITS / GALLERY
R	BIOLOGICAL NUTRIENT REMOVAL FACILITY
R1	INTERMEDIATE PUMPING STATION
R2	BIOLOGICAL NUTRIENT REMOVAL BUILDING
S	SECONDARY CLARIFICATION FACILITY
S1	SECONDARY CLARIFIER BUILDING 1
S2	SECONDARY CLARIFIER BUILDING 2
S3	MIXED LIQUOR SPLITTER
S4	RAS SPLITTER
T	PRE-DIGESTION SLUDGE TREATMENT FACILITY (BY OTHERS)
U	UV DISINFECTION FACILITY
V	BIOSOLIDS PROCESSING & LOADING FACILITY (BY OTHERS)
W	FERMENTATION AND WAS THICKENING FACILITY
X	HAULED WASTEWATER RECEIVING FACILITY
X1	HAULED WASTEWATER RECEIVING
X2	HAULED LEACHATE RECEIVING
Z	MAINTENANCE FACILITY
Z1	EAST-WEST GALLERY & PE CONDUITS

NOTE: AREA Y INCLUDES ALL EXTERIOR AREAS OF THE SITE NOT ENCOMPASSED BY ANOTHER AREA, INCLUDING TUNNELS & GALLERIES.

LEGEND-UTILITIES	
ALP	AIR, LOW PRESSURE
DG	DIGESTER GAS
FC	FERRIC CHLORIDE
FOA	FOUL AIR
FSU	FERMENTER SUPERNATANT
FSW	FLUSHING WATER
HRE	HIGH RATE EFFLUENT
HRS	HIGH RATE SLUDGE
INT	WASTE WATER INTERCEPTOR
LDS	LAND DRAINAGE SEWER
ML	MIXED LIQUOR
PE	PRIMARY EFFLUENT
PO	PROCESS OVERFLOW
PRE	PHOSPHORUS RECOVERY EFFLUENT
PS	PRIMARY SLUDGE
RAS	RETURN ACTIVATED SLUDGE
RS(FM)	RAW SEWAGE (FORCEMAIN)
SE	SECONDARY EFFLUENT
SLH	HAULED SLUDGE
TCE	TREATED CENTRATE
WAS	WASTE ACTIVATED SLUDGE
PW	POTABLE WATER / WATERMAIN (WM)
PW	POTABLE WATER / SERVICE (WM)
WWS	WASTE WATER SEWER
TWAS	THICKENED WASTE ACTIVATED SLUDGE
SUB	SUBNATANT, DAF
TBS	SLUDGE, THICKNED BOTTOM

LEGEND

- STAGE 1
- STAGE 2
- STAGES 1 & 2
- PARCEL BOUNDARIES
- PROCESS AREA BOUNDARIES

LEGEND-PLAN

EXISTING / NEW

- HYDRANT
- VALVE
- MANHOLE
- CATCH BASIN
- DRAINAGE DIRECTION
- LAMP STANDARD
- PARKING LOT
- OUTLET
- TREE
- PIPE ABANDONMENTS
- SURVEY BAR
- GEODETIC BENCH MARK

KEYNOTES

1. HPO REACTORS TO BE DECOMMISSIONED.
2. SECONDARY CLARIFIERS TO BE DECOMMISSIONED.

NO.	REVISIONS	DATE	DESIGN	CHECK
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AECOM

DESIGNED BY:
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ENGINEER'S SEAL

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

NORTH END SEWAGE TREATMENT PLANT
BIOLOGICAL NUTRIENT REMOVAL FACILITY
43A/3B
4 NEW BNR REACTORS & 4 NEW SECONDARY CLARIFIERS

CITY DRAWING NUMBER	SHEET	REV.	SIZE
-	-	-	A1

A1 SIZE - 594mm x 841mm

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7.2 Performance

Alternative 4 includes four BNR trains that treat up to 380 ML/d of wastewater and the flows higher than that are bypassed and blended at UV. The average projected quality of the blended effluent is shown in **Table 9**. In this scenario average effluent loads for ammonia, TP and TN are relatively lower than in Alternative 3. The average effluent ammonia load is projected to be around 1,000 kg/d, which is lower than Alternative 3 but slightly higher then Alternative 2. A similar trend is observed for TN. The effluent TP load is projected to be the lower then Alternative 2 and 3 at approximately 175 kg/d.

Table 9: Alternative 4 - Blended Effluent Quality

Parameter	Descriptor	Load, kg/d	Concentration, mg/L
Ammonia	Avg	1,031	4.2
TN	Avg	3,183	15.2
TP	Avg	175	0.9

Figure 17 shows the projected daily effluent ammonia load. Similarly to previous Alternatives that incorporate BNR process, the effluent ammonia load is projected to be below the proposed limits throughout the whole year. Due to some bypass flows during summer the model projects that only a single day ammonia exceedance might be expected depending on the peak day flows.

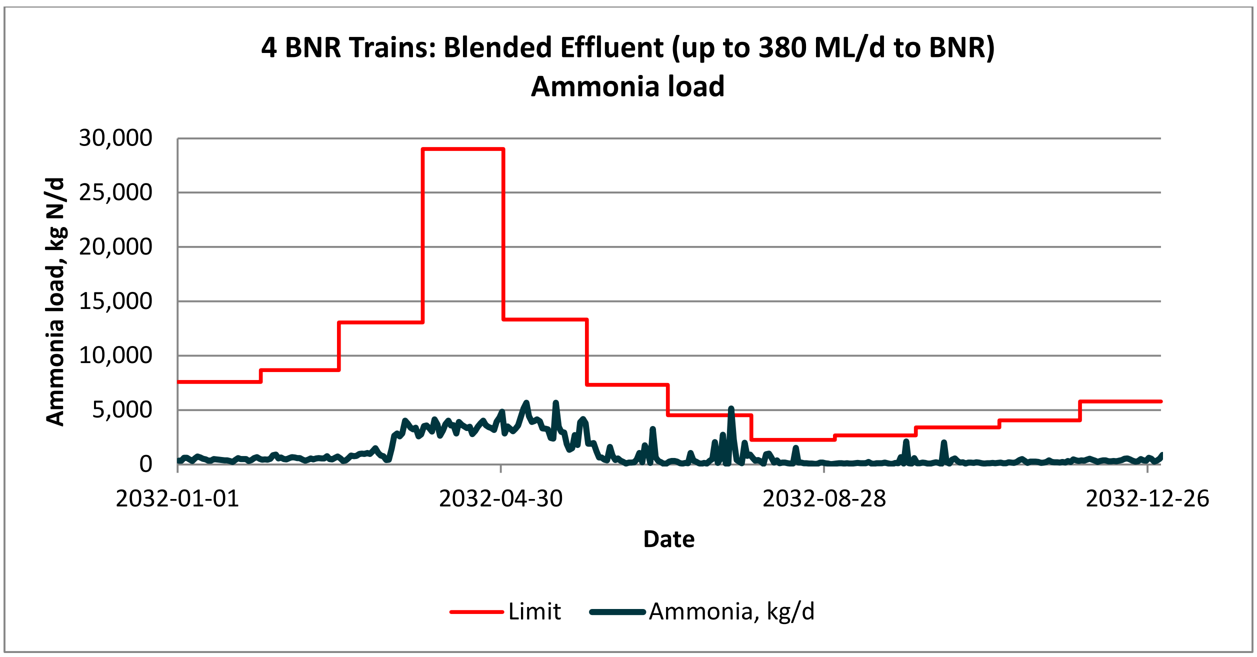


Figure 17: Alternative 4 - Daily Effluent Ammonia Load

Figure 18 shows the projected monthly trends in effluent TN and TP concentrations.

The blended effluent TN concentration remains above the 15 mg/L limits at the beginning of the year due to limitation in nitrification during cold months but drop below the limit in the second half of the year and remains relatively low for the rest of the year.

The TP limit of 1 mg/L is projected to be met for most of the year. The model predicts some temporal increase above 1 mg/L, mostly due to bypass flows in the summer. The effluent quality in this alternative is relatively higher than in Alternative 3.

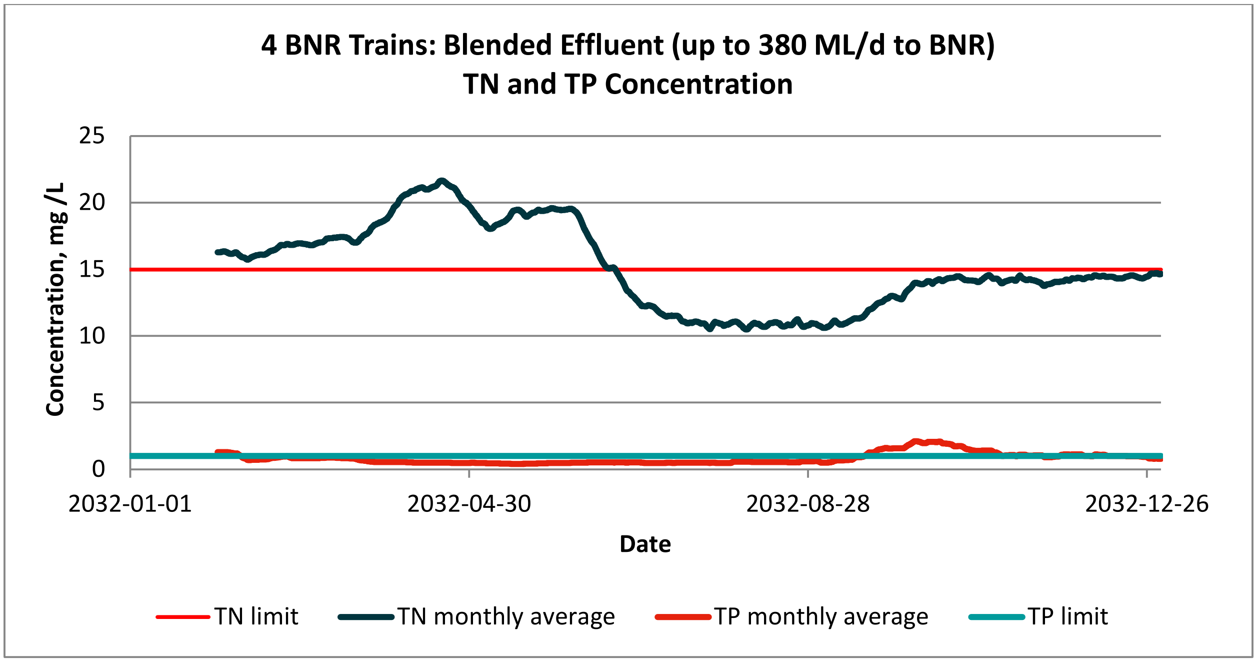


Figure 18: Alternative 4 - Monthly Trends in Effluent TN and TP Concentration

7.3 Compatibility with Full NRF Upgrade

This alternative is the most compatible with the full NRF Upgrade. The four new BNR trains and four new secondary clarifiers can be configured in a manner that is consistent with the ultimate build out of the NRF. Coordination with the blower building and associated mechanical equipment will need to be addressed to ensure Phase 1 piping and future Phase 2 blowers are fully integrated. The only elements that are needed for Phase 1 work but will not be utilized in Phase 2 includes the WAS piping to the primary clarifiers for co-thickening.

7.4 Risks

Construction Sequencing

Alternative 4 is relatively free of unique risks related to construction sequencing and schedule slips. Some risk associated with constructing half of the BNR reactors and half of the secondary clarifiers in Phase 1 and later constructing the rest in Phase 2 remain. These are generally related to tying in the new Phase 2 structures and construction of new Phase 2 structures very close to Phase 1 infrastructure.

Co-thickening Sludge

As with all the alternatives using BNR treatment, there is also an increased risk of phosphorus being released in the primary clarifier with the addition of BNR WAS being co-thickened in the primary clarifiers BNR WAS cannot be sent directly to the Biosolids Facilities without being thickened as the intermediate dewatering system would not have the required hydraulic capacity.

Site Constraints

Construction methods and logistics will face increased complexity due to the constrained area during Phase 2 construction in immediate vicinity of Phase 1 bioreactor and clarifiers. The limited space will require careful coordination of materials, equipment, and personnel, potentially increasing both time and cost. This area will only be accessible via existing plant roads, which will limit transport routes, slow down delivery, and will interfere with ongoing plant operations. To mitigate these impacts, additional planning, safety measures, and operational scheduling will be essential to maintain construction efficiency while minimizing disruptions to the plant's daily activities. Moreover, the operation of Phase 1 plant has to be maintained during all tie ins during Phase 2 construction in order to maintain the treatment which will also pose additional risk and require detail planning in the construction schedule.

7.5 Cost Impacts

This alternative involves the addition of the same Phase 1 infrastructure as Alternative 3, but decommissioning of the existing secondary treatment system. As with Alternative 3, WAS thickening, primary sludge fermentation, half of the BNR reactors, and half the secondary clarifiers was deferred to Phase 2. The work for Phase 1 would include construction of a new IPS, 4 BNR reactors, blower building, 4 new secondary clarifiers and RAS pumping, mixed liquor splitter chamber, new secondary effluent conduit, and decommissioning of the HPO reactors and existing secondary clarifiers.

While most of the work in this alternative is consistent with the ultimate build out of the NRF Upgrade (i.e., Phase 2), there is some piping that would be considered throw away costs. As described above, this includes WAS piping from the BNR reactors to existing primary clarifiers.

The approximate cost impact of Alternative 4 is $141-171 million, determined by the following:

- $1 million for infrastructure required for Phase 1 but not Phase 2, therefore a throw away cost, which includes:
  - WAS piping.
- $140-170 million for accelerating the Phase 1 schedule by 24 months on approximately 60% of the overall NRF upgrade infrastructure in Phase 1, which includes:
  - Increased resources required to complete Phase 1 on an accelerated schedule;
  - Increased coordination efforts based on construction sequencing;
  - Increased commissioning efforts; and
  - Reduction in escalation costs for Phase 1 infrastructure.

8. Alternative 5: Eight (8) New BNR Reactors and Eight (8) New Secondary Clarifiers (Full Buildout)

8.1 General Description

This alternative is used as a benchmark/baseline for the estimation of the loads of ammonia, nitrogen and phosphorus released to the Red River with the full NRF plant. The effluent quality is used for comparison purposes against previous alternatives.

The full NRF buildout includes the following new processes:

Biological Nutrient Removal Facility

This facility comprises of an intermediate pumping station, eight bioreactors and a process air supply system. Process air will be provided by several blowers in a blower building located along the west side of the bioreactors.

The new intermediate pumping station will be located at the southwest corner of the existing HPO reactors. It is needed to lift primary effluent from the existing primary effluent conduits to the bioreactors. The intermediate pumping station can also be used to bypass some or all of the primary effluent around secondary treatment. The existing primary effluent bypass conduit will be blocked off and not reused.

Secondary Clarification Facility

This facility comprises of eight new circular clarifiers and two pumping stations for return activated sludge (RAS). The facility will be located north of the new bioreactors.

The eight new circular secondary clarifiers are configured in two blocks of four clarifiers. One return activated sludge pumping station will serve and be located in the centre of the four clarifiers.

The secondary effluent conduit will tunnel below the existing plant from the secondary clarifiers to convey the secondary effluent to the UV Disinfection Facility.

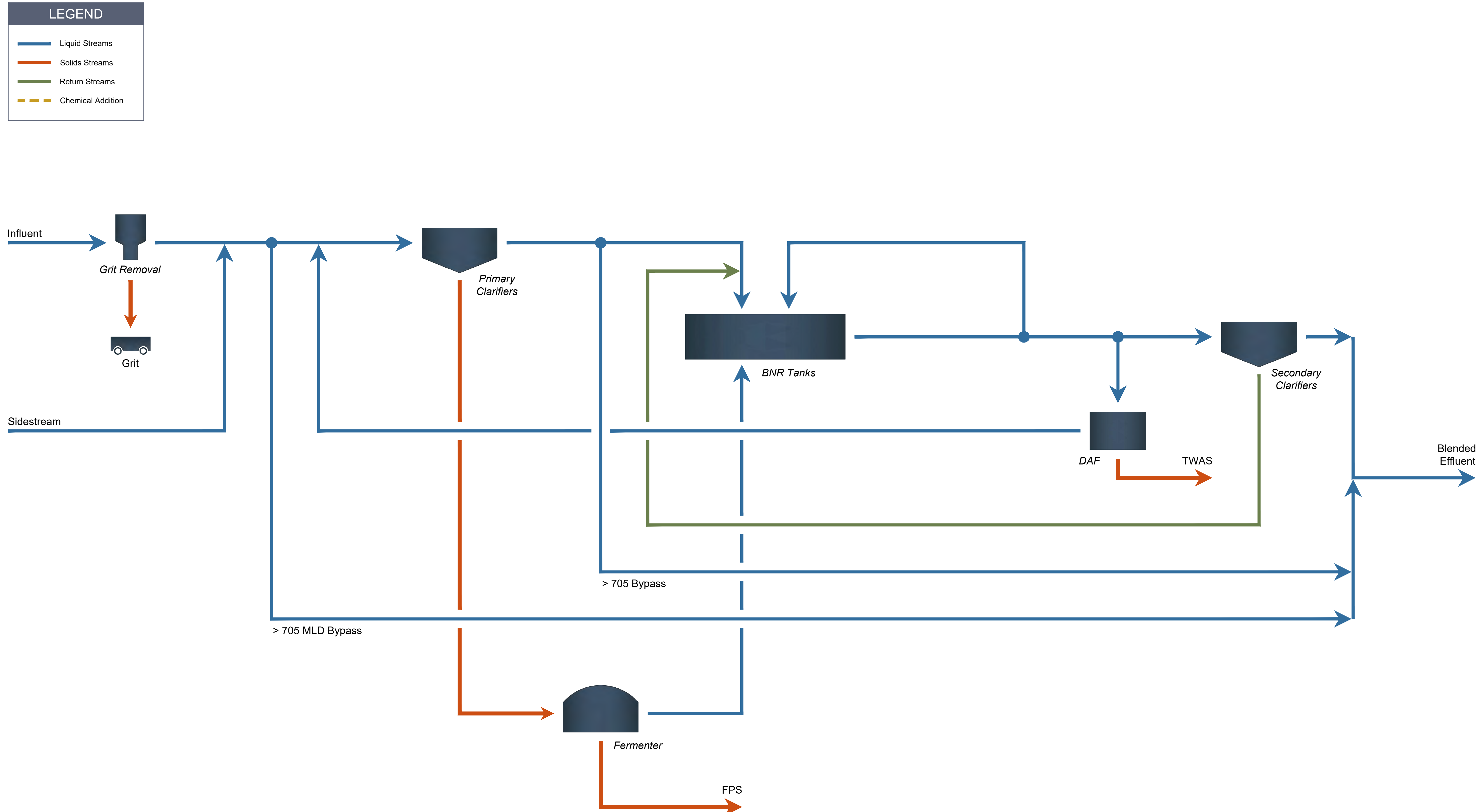
Fermentation and WAS Thickening Facility

This facility, located on Parcel B, comprises of four primary sludge fermenters and two dissolved air floatation (DAF) tanks. The space between the six tanks is enclosed to form a pump and piping gallery in the basement level. Electrical, building mechanical, area control and polymer rooms are located on the ground floor of the building.

The fermenters are fed dilute settled primary sludge from the Area P primary clarifiers. Gravity thickened primary sludge removed from the fermenters is pumped to sludge screens located in Area T. The supernatant, which contains high concentrations of volatile fatty acids (VFAs), is pumped to the bioreactors to facilitate biological phosphorus removal.

Dilute WAS surfaced wasted from the BNR reactors is thickened to between 3 and 5% solids in dissolved air floatation thickeners, and pumped to the phosphorus release tanks in Area J.

A simplified process flow diagram and site plan for Alternative 5 is shown in **Figure 19** and **Figure 20**, respectively.



Winnipeg Sewage Treatment Program
NEWPCC Upgrade Project
Enhanced Preliminary Design Report - NRF

General
Alternative 5 - Process Flow Diagram of Main Flow Path
Figure: 19

AREA DESIGNATIONS

- C CENTRATE TREATMENT FACILITY
- C1 SBR BASIN
- C2 SODA ASH SILO
- C3 METHANOL STORAGE
- C4 EXHAUST AIR STACK
- D ANAEROBIC DIGESTER FACILITY (BY OTHERS)
- E ELECTRICAL BUILDING (BY OTHERS)
- F FERRIC CHLORIDE RECEIVING & STORAGE FACILITY
- F1 REPURPOSED SLUDGE DEWATERING BUILDING
- F2 FERRIC CHLORIDE RECEIVING
- F3 FERRIC CHLORIDE STORAGE
- FW FLUSHING WATER FACILITY (BY OTHERS)
- G STANDBY POWER GENERATION FACILITY (BY OTHERS)
- H HEADWORKS FACILITY
- J PHOSPHORUS RELEASE FACILITY (BY OTHERS)
- K DIGESTER GAS HANDLING FACILITY (BY OTHERS)
- M MAIN BUILDING
- N HAULED SLUDGE RECEIVING FACILITY (BY OTHERS)
- P PRIMARY CLARIFICATION FACILITY
- P1 CONTROL CHAMBER BUILDING
- P2 PRIMARY CLARIFIER 1-3
- P3 PRIMARY CLARIFIER 4-5
- P4 SCUM DEWATERING BUILDING (BY OTHERS)
- P5 EXISTING CONDUITS / GALLERY
- R BIOLOGICAL NUTRIENT REMOVAL FACILITY
- R1 INTERMEDIATE PUMPING STATION
- R2 BIOLOGICAL NUTRIENT REMOVAL BUILDING
- S SECONDARY CLARIFICATION FACILITY
- S1 SECONDARY CLARIFIER BUILDING 1
- S2 SECONDARY CLARIFIER BUILDING 2
- S3 MIXED LIQUOR SPLITTER
- S4 RAS SPLITTER
- T PRE-DIGESTION SLUDGE TREATMENT FACILITY (BY OTHERS)
- U UV DISINFECTION FACILITY
- V BIOSOLIDS PROCESSING & LOADING FACILITY (BY OTHERS)
- W FERMENTATION AND WAS THICKENING FACILITY
- X HAULED WASTEWATER RECEIVING FACILITY
- X1 HAULED WASTEWATER RECEIVING
- X2 HAULED LEACHATE RECEIVING
- Z MAINTENANCE FACILITY
- Z1 EAST-WEST GALLERY & PE CONDUITS

NOTE: AREA Y INCLUDES ALL EXTERIOR AREAS OF THE SITE NOT ENCOMPASSED BY ANOTHER AREA, INCLUDING TUNNELS & GALLERIES.

LEGEND-UTILITIES

- ALP AIR, LOW PRESSURE
- DG DIGESTER GAS
- FC FERRIC CHLORIDE
- FOA FOUL AIR
- FSU FERMENTER SUPERNATANT
- FSW FLUSHING WATER
- HRE HIGH RATE EFFLUENT
- HRS HIGH RATE SLUDGE
- INT WASTE WATER INTERCEPTOR
- LDS LAND DRAINAGE SEWER
- ML MIXED LIQUOR
- PE PRIMARY EFFLUENT
- PO PROCESS OVERFLOW
- PRE PHOSPHORUS RECOVERY EFFLUENT
- PS PRIMARY SLUDGE
- RAS RETURN ACTIVATED SLUDGE
- RS(FM) RAW SEWAGE (FORCEMAIN)
- SE SECONDARY EFFLUENT
- SLH HAULED SLUDGE
- TCE TREATED CENTRATE
- WAS WASTE ACTIVATED SLUDGE
- PW POTABLE WATER / WATERMAIN (WM)
- PW POTABLE WATER / SERVICE (WM)
- WWS WASTE WATER SEWER
- TWAS THICKENED WASTE ACTIVATED SLUDGE
- SUB SUBNATANT, DAF
- TBS SLUDGE, THICKNED BOTTOM

LEGEND

- STAGE 1
- STAGE 2
- STAGES 1 & 2
- PARCEL BOUNDARIES
- PROCESS AREA BOUNDARIES

LEGEND-PLAN

EXISTING / NEW

- HYDRANT
- VALVE
- MANHOLE
- CATCH BASIN
- DRAINAGE DIRECTION
- LAMP STANDARD
- PARKING LOT
- OUTLET
- TREE
- PIPE ABANDONMENTS
- SURVEY BAR
- GEODETIC BENCH MARK

KEYNOTES

1. HPO REACTORS TO BE DECOMMISSIONED.
2. SECONDARY CLARIFIERS TO BE DECOMMISSIONED.

NO.	REVISIONS	DATE	DESIGN	CHECK
-	-	-		

AECOM

DESIGNED BY:	CHECKED BY:
DRAWN BY: LMB / JP	APPROVED BY:
SCALE: 1:1500	RELEASED FOR CONSTRUCTION BY:
DATE: 2024-03-27	DATE:
CONSULTANT NO.:	

ENGINEER'S SEAL

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

NORTH END SEWAGE TREATMENT PLANT
BIOLOGICAL NUTRIENT REMOVAL FACILITY
ALTERNATIVE 5
FULL NRF BUILDOUT

CITY DRAWING NUMBER	SHEET	REV.	SIZE
-	-	-	A1

A1 SIZE - 594mm x 841mm

LAST SAVE: 2024/10/04 3:15 PM
PATH: C:\Users\Monique.Mourd\DC\ACCDocs\AECOM\City of Winnipeg - NEWPCC Upgrades 2023\Project Files\900 Design Collaboration\BNR EPD Update\C-Civil\25-SKT\PD-CITY-Y001_Alternatives.dwg

8.2 Performance

Alternative 5 provides full treatment for the wastewater which is reflected in the lowest average projected effluent loads. The projected effluent ammonia load is equal to approximately 300 kg/d which is the lowest between the presented alternatives. Similarly, the projected average effluent TN and TP loads are relatively lower than the previous alternatives as shown in **Table 10**.

Table 10: Alternative 5 - Blended Effluent Quality

Parameter	Descriptor	Load, kg/d	Concentration, mg/L
Ammonia	Avg	305	1.4
TN	Avg	2,341	11.6
TP	Avg	106	0.5

Figure 21 shows the projected daily ammonia load in the effluent. The full BNR plant provides nearly complete nitrification and the daily effluent ammonia loads are all below the proposed limits. There are only occasional small peaks in the effluent trends due to influent variations.

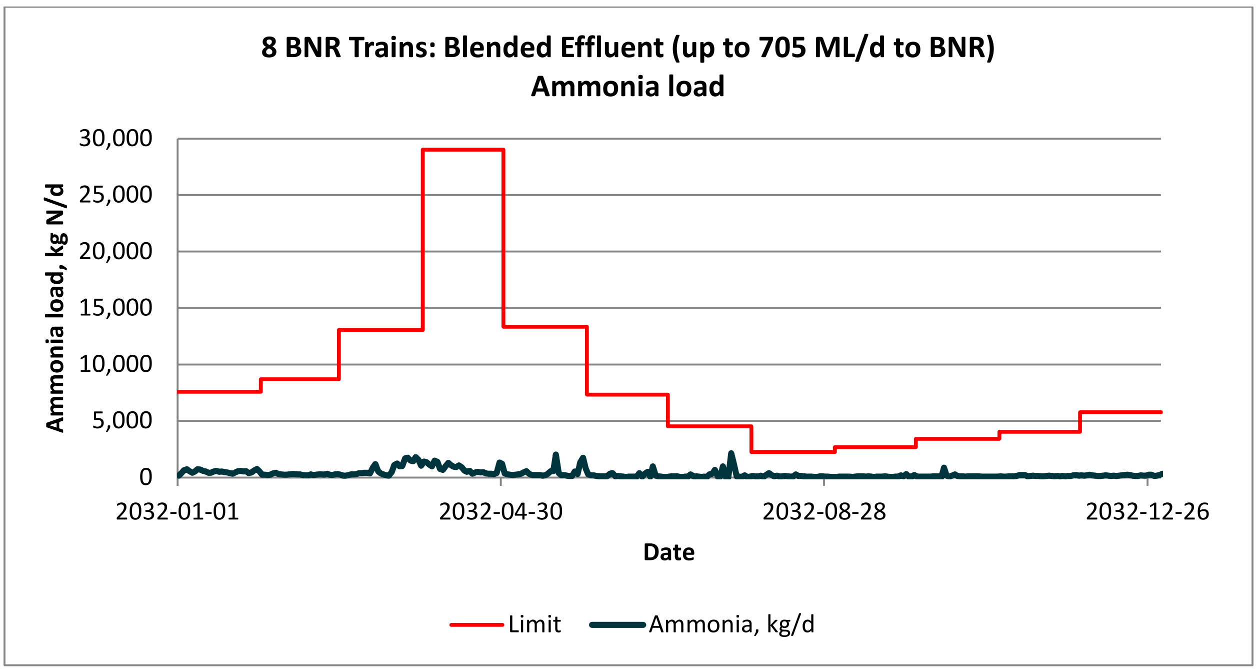


Figure 21: Alternative 5 - Daily Effluent Ammonia Load

Figure 22 shows the projected monthly effluent TN and TP concentrations for full buildout.

The projected monthly effluent TN concentration fluctuates throughout the year. In the beginning of the year the concentration increases to just below 15 mg/l but then decreases during summer to as low as 8 mg/L and stabilizes at around 12 mg/l at the end of the year. The TN is projected to meet the proposed limits throughout the year. Similarly, the monthly effluent TP concentration is projected to meet the new limit through the year with concentrations below 1 mg/L.

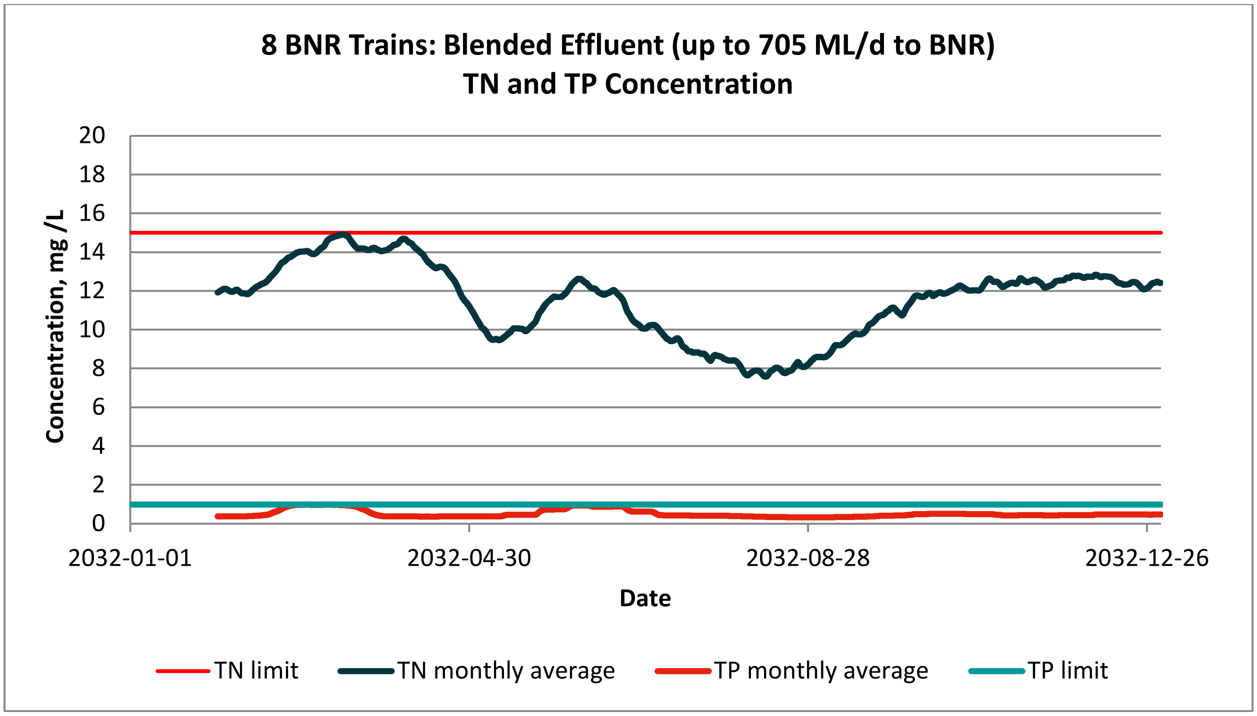


Figure 22: Alternative 5 - Monthly Trends in Effluent TN and TP Concentration

8.3 Compatibility with Full NRF Upgrade

Not applicable.

8.4 Risks

Not applicable.

8.5 Cost Impacts

Not applicable.

9. Conclusions

A comparison of the projected effluent loads to the Red River between all the presented alternatives is shown in **Figure 23** to **Figure 25**. The figures refer to the projected 2032 loads.

Average daily effluent TP loads to the Red River are shown in **Figure 23** and are compared to the influent TP load. Alternatives 2, 4 and 5 are projected to meet the 1 mg TP/l limit with the average effluent load of 208 kg TP/d. In comparison Alternatives 3A and 3B show somewhat higher effluent TP loads at 312 and 260 kg/d, respectively. Alternative 1 is projected to discharge approximately 525 kg TP/d. As shown on the graph the difference between the HPO and any other alternative is around 200-300 kg/d of TP that can be additionally diverted from the River. Considering the fact that the plant already removes almost 800 kg TP/d the Phase 1 plant would increase the removal by about 25% for approximately 2 years before Phase 2 and full buildout.

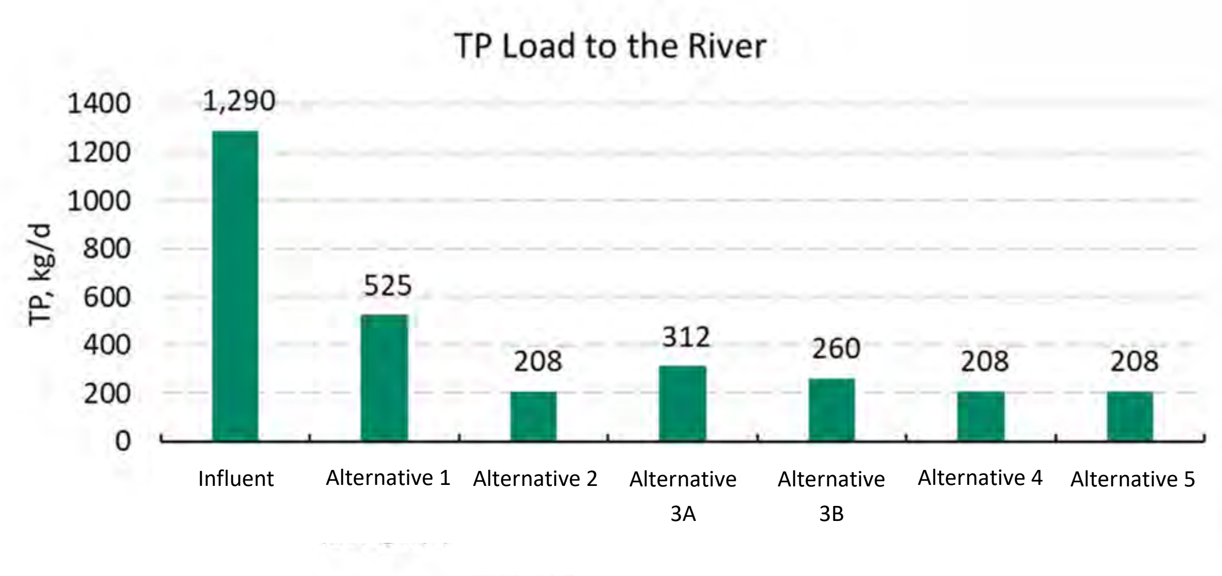


Figure 23: A Summary of Average TP Effluent Load to Red River

When considering the cost impact of accelerating the construction schedule for partial compliance for Alternatives 2 through 4, the cost per kilogram of TP removed above the baseline Alternative 1 was calculated, as shown in **Table 11**. The amount of TP removed is based on Phase 1 operating for 2 full years prior to Phase 2 completion. As outlined in previous sections, the cost impact only accounts for temporary infrastructure and construction schedule acceleration, not increased operation and maintenance costs.

Table 11: Cost per Kilogram of TP Removed

Alternative	Cost Impact	TP removed, kg	Cost / kg TP Removed
Alternative 2	$90-140M	231,410	$389 - 605
Alternative 3A	$121-161M	155,490	$778 - 1,035
Alternative 3B	$121-161M	193,450	$625 - 832
Alternative 4	$141-171M	231,410	$609 - 739

Figure 24 summarizes the projected average daily TN loads to the Red River and compares it to the influent TN load. Only Alternatives 2 and 5 are projected to fully meet the 15 mg/L limit for TN with the lowest average effluent TN load of approximately 2,400 kg/d. Alternative 4 is projected to have a slightly higher effluent TN load meeting the 15 mg/L

only on annual average basis. Alternative 3 is relatively higher at almost 5,000 kg/d but still significantly lower than the baseline Alternative 1. In general, the Phase 1 alternatives are projected to lower the TN load to the river in comparison to the baseline HPO plant by approximately 5,000 kg/d for Alternative 2, 2,300 k/g for Alternative 3 and 4,100 kg/d for Alternative 4. All Phase 1 alternatives provide significant increase in TN removal compared to the existing HPO plant.

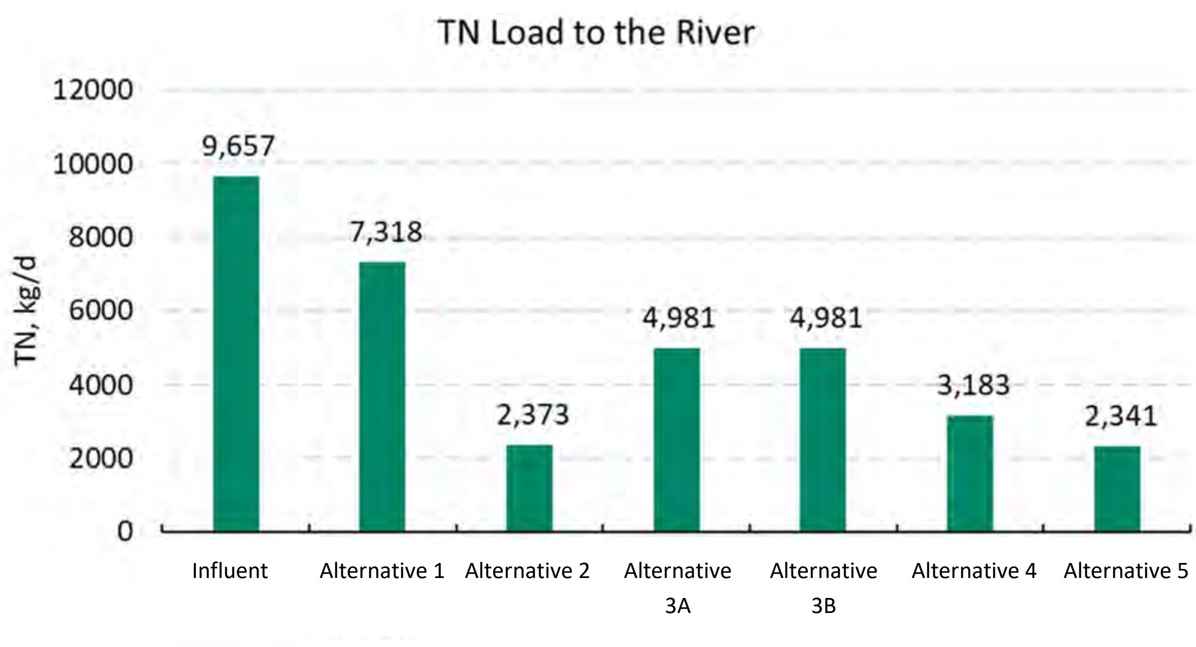


Figure 24: A Summary of Average TN Effluent Load to Red River

Figure 25 compares the projected effluent ammonia loads to the Red River. All Phase 1 alternatives are projected to significantly reduce the effluent ammonia load with Alternative 2 and 4 being somewhat better then Alternative 3.

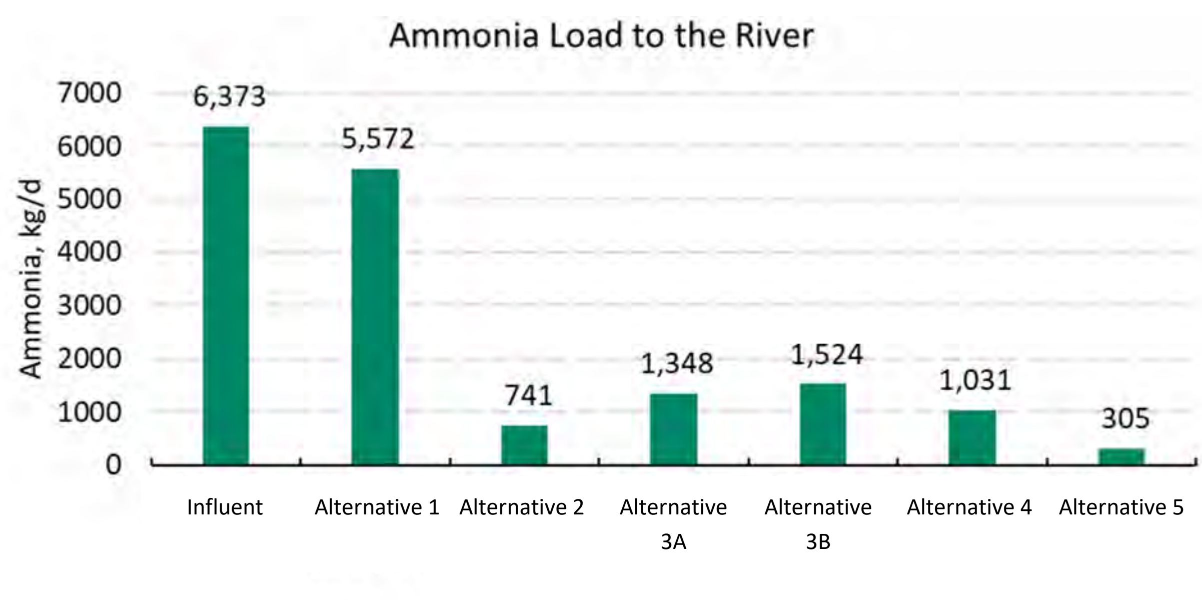


Figure 25: A Summary of Average Effluent Ammonia Load to Red River

9.1 Advantages and Disadvantages

Advantages and disadvantages of the analysed Phase 1 options are showed in **Table 12**. In general Alternatives 2 and 4 provide the best effluent quality. Alternative 2 requires the least amount of new infrastructure but is more complex, carries high risk tie-ins, and contains elements that would be considered throw away costs for the ultimate build out of the facility.

Alternative 3 provides moderate effluent quality but is operationally very difficult since it requires two plants to be operated in parallel and will require additional operator staffing and monitoring. Additionally, this alternative does not provide any cost advantage compared to Alternative 2 or 4.

Alternative 4 will provide good effluent quality and will have very minimal throw away costs. This alternative is more compatible with Phase 2, carries less risk, and will be less complex to operate, but has the highest cost for schedule acceleration.

Table 12: Summary of Advantages and Disadvantages between Phase 1 Options

Phase 1 Alternatives	Advantages	Disadvantages
Alternative 2 - Four (4) New BNR Reactors and Existing HPO Secondary Clarifiers	• Good effluent quality. Can meet TN, Ammonia and TP limits. • Lowest schedule acceleration cost.	• Complex construction sequencing. • Additional engineering required to minimize conflicts between Phase 1 and Phase 2. • Elements for Phase 1 not needed for Phase 2, resulting in the highest throw away cost. • Lower compatibility with Phase 2 than other options. • Significant risks associated with tie-ins to existing secondary treatment facility. • Higher Phase 2 cost compared to Alternative 4 due to throw away equipment and infrastructure, and deferral and escalation of 4 clarifiers.
Alternative 3 - Four (4) New BNR Reactors and Four (4) New Secondary Clarifiers and Existing HPO Reactors and Existing Secondary Clarifiers	• Better quality effluent than Alternative 1. • Compatible with Phase 2. • No throw away costs except for temporary WAS piping.	• Operationally complex. Requires 2 plants operating in parallel. • Increased staffing requirements. • Chemical dosing required. • Some additional engineering required for a separate effluent conduit. • Higher operating cost than Alternative 4. • Lower effluent quality than Alternative 2 and 4.
Alternative 4 – Four (4) New BNR Reactors and Four (4) New Secondary Clarifiers	• Good effluent quality. Can meet TP, TN and Ammonia limits during most of the year. • No throw away costs except for temporary WAS piping. • Accelerated schedule for new clarifiers reduces escalation costs. • Full compatibility with Phase 2. • Reduced risk for conflicts between Phase 1 and Phase 2.	• Highest schedule acceleration cost.

9.2 Summary

AECOM completed a review of three alternatives (Alternatives 2, 3, and 4) to determine the feasibility of accelerating a portion of the NRF Project. These three alternatives involve the construction of Phase 1 by the year 2030, and then following commissioning of Phase 1 continue with the remaining construction (i.e., Phase 2) to be complete by 2032, and having a design year of 2050. While all three alternatives were technically feasible, each had different impacts on cost and operational complexity.

Alternative 2 involves constructing the least amount of new infrastructure in Phase1, deferring more to Phase 2. It includes constructing four new bioreactors and reusing the existing HPO secondary clarifiers, which will involve a series of complex tie-ins to the existing plant. A portion of the work is not compatible with Phase 2, and will therefore result in sunk costs up to $20M. To accelerate the schedule for Phase 1 to be in operation before the end of 2030 a cost premium of $80-$120M is anticipated.

Alternative 3 involves constructing four new BNR reactors and four new clarifiers, and treating half the flow in the new BNR system and half the flow in the existing HPO system. Operating two facilities in parallel is more complex than the other alternatives evaluated and does not offer any cost or treatment benefits. The cost premium for schedule acceleration is expected to be between $120-$160M.

Alternative 4 involves constructing four new BNR reactors and four new clarifiers, and treating all flow through the new BNR system. It is the same as Alternative 2, but uses new secondary clarifiers instead of the existing HPO clarifiers. The risk associated with the complex tie-ins and the throw away costs associated with Alternative 2 are eliminated. From an operational perspective, this alternative is the least complex, but will result in the highest cost premium, which is expected to be between $140-$170M for schedule acceleration.

While Alternatives 2, 3, and 4 indicate it is feasible to accelerate construction and provide improved treatment by the year 2030, each alternative has different costs and risk implications. The cost for acceleration is highly dependent on the construction start date and the labour force available to the contractor. At this time, it is envisioned that the project will be delivered as a Progressive Design Build, which will allow the WSTP to work with the Contractor to determine the actual cost impacts of schedule acceleration and staged commissioning. Based on this determination, the WSTP could then decide if any of the three alternatives fits their needs during the Progressive Design Build development phase.

Leah Daniel, M.Sc., P.Eng.

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Appendix 2 – AECOM Canada Ltd. NEWPCC Updated Flows and Loads Projection

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To: Robert Taylor, P.Eng.
WSTP Major Capital Project Manager
Water and Waste Department
City of Winnipeg

Date: December 3, 2024

Project #: 60709390

From: Leah Daniel, M.Sc., P.Eng.

CC: Linda McCusker, P.Eng.
WSTP Project Director
Waste and Waste Department
City of Winnipeg

Memorandum

Subject: **NEWPCC Nutrient Removal Facilities – Updated Flows and Loads Design Criteria**

1. Design Criteria

1.1 Introduction

This memo updates wastewater population and load predictions for upgrading the North End Sewage Treatment Plant (NEWPCC) based on the addition of historical data provided for 2020-2023. The design criteria are updated based on eight years of raw influent flow and concentration data (2016-2023) provided to AECOM from the Winnipeg Sewage Treatment Program (WSTP). The year 2050 has been selected as the design horizon. A phased construction approach is being considered, with the first phase of construction completed at the end of 2030 for partial licence compliance until phase two is completed at the end of 2032 for full licence compliance.

A summary of major assumptions used to derive the design criteria are as follow:

- The raw sewage flow meter measurements are accurate.
- Sampling has been done in accordance with the most recent version of Standard Methods.
- Residential flows and loads are assumed to grow at a rate proportional to population.
- Industrial and commercial flows and loads (excluding CentrePort) are assumed to grow at a rate proportional to population. This is due to industrial and commercial data not being available.
- Per capita loads from the RM of St. Andrews and West St. Paul are the same as the NEWPCC per capita loads.
- Population equivalent determined based on anticipated CentrePort commercial and industrial flow provided by the City of Winnipeg.

1.2 Population Projections

1.2.1 NEWPCC Catchment Population Projections

The NEWPCC catchment population previously provided by the WSTP in SO972-10DP-REF-0029 for 2005 to 2019 and in S1192-10PD-RFI-0003 for projected population for 2020 to 2050 are summarized in **Table 1.1**. The City's growth rate projections indicate a constant growth rate of 1.00% for the NEWPCC catchment area from 2021 to 2050. Updated NEWPCC catchment population was provided by the WSTP in 2024 for 2020 to 2023 and reflected in **Table 1.1**. The 2022 census had 460,186 for the NEWPCC catchment population, which is in line with the 2022 population included in **Table 1.1**.

These projections include an allowance of 11,400 people from the Windsor Park Catchment Area. It is recognized that currently the City directs wastewater from this catchment to the SEWPCC during the spring and summer, and to the NEWPCC during the fall and winter. From a biosolids generation perspective since all the sludge is processed at the NEWPCC, whether the flow from Windsor Park is directed to SEWPCC or NEWPCC does not impact the biosolids design. However, it is important to make sure that the Windsor Park load is taken into consideration for either one of the treatment plant loads. Therefore, AECOM has provided an allowance for Windsor Park in the NEWPCC flows and loads.

Table 1.1: NEWPCC Catchment Population (revised in 2024)

Year	Population	% Growth	Year	Population	% Growth
2005	409,588	-	2028	503,233	1.000
2006	410,644	0.258	2029	508,265	1.000
2007	411,508	0.21	2030	513,348	1.000
2008	412,996	0.362	2031	518,482	1.000
2009	415,492	0.604	**2032**	**523,666**	**1.000**
2010	418,447	0.711	2033	528,903	1.000
2011	421,605	0.755	2034	534,192	1.000
2012	425,078	0.824	2035	539,534	1.000
2013	428,437	0.79	2036	544,929	1.000
2014	431,594	0.737	2037	550,379	1.000
2015	435,673	0.945	2038	555,882	1.000
2016	439,643	0.911	2039	561,441	1.000
2017	443,852	0.957	2040	567,056	1.000
2018	448,013	0.937	2041	572,726	1.000
2019	452,222	0.939	2042	578,453	1.000
2020	453,319	0.243	2043	584,238	1.000
2021	455,825	0.553	2044	590,080	1.000
2022	462,662	1.500	2045	595,981	1.000
2023	478,809	3.490	2046	601,941	1.000
2024	483,597	1.000	2047	607,960	1.000
2025	488,433	1.000	2048	614,040	1.000
2026	493,317	1.000	2049	620,180	1.000
2027	498,251	1.000	**2050**	**626,382**	**1.000**

Rural Municipality Catchment Population Projections

1.2.1.1.1 RM of St. Andrews

As previously indicated in S0972-10DP-REF-0075, the City has an agreement to receive sewage flows from St. Andrews. Based on information provided by the WSTP the agreement indicates the City will receive wastewater corresponding to a population of 6,369 persons. The maximum peak flow to be accepted by the City will be capped at 220 L/s (19.01 ML/d).

1.2.1.1.2 RM of West St. Paul

Based on information previously provided by the WSTP in S0972-10DP-REF-0075, the 2011 population of West St. Paul was 4,932 persons. This will increase to 8,148 persons by 2032 and 11,310 in 2050. The associated peak 2050 flow from West St. Paul is estimated to be 361.1 L/s (31.2 ML/d).

1.2.1.1.3 CentrePort

The WSTP provided updated information in the Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering – Final Report (KGS Group, 2021) regarding the staging for the development of CentrePort. Based on this report, the average dry weather flow (ADWF) for the 2050 design year is 12.5 ML/d for the portion of CentrePort within the City of Winnipeg. For the RM of Rosser portion of the CentrePort development, the ADWF for the 2050 design year is 11.2 ML/d. This includes development outlined as Phase 2 in the CentrePort Regional Water and Wastewater Servicing Review Report (AECOM, 2011).

For 2032, WSTP indicated only Phase 1A of CentrePort development is anticipated to be complete. On September 11, 2024, WSTP provided updated anticipated flows for Phase 1A from KGS, which were used in developing CentrePort flows and loads for 2032. The anticipated flows for Phase 1A are 2.36 ML/d ADWF and 4.95 ML/d PDWF.

In the North End Facility Flows and Loads Report (Revision 5, 2015) it was assumed that the concentrations from CentrePort would be 75% of the allowable sewer-bylaw limits (i.e., total suspended solids (TSS) = 350 mg/L, biochemical oxygen demand (BOD) = 300 mg/L, Total Kjeldahl Nitrogen (TKN) = 60 mg/L, total phosphorus (TP) = 10 mg/L).

This will result in a 2032 population equivalent from CentrePort ranging from 7,259 and 9,994 depending on the parameter (see **Table 1.3**). For the purpose of the 2032 design load, it is assumed that CentrePort will contribute a population equivalent of 8,500 people.

Table 1.2: CentrePort 2032 Population Equivalent

	Center Port loads			
	TSS	BOD	TKN	TP
Load assuming 75% of by-law, kg/d	826	708	142	24
Pop Eq, ca	7,259	8,426	8,012	9,994

This will result in a 2050 population equivalent from CentrePort ranging from 74,662 to 98,750 depending on the parameter (see **Table 1.3**). For the purpose of the 2050 design load, it is assumed that CentrePort will contribute a population equivalent of 84,000 people.

Table 1.3: CentrePort 2050 Population Equivalent

	Center Port loads			
	TSS	BOD	TKN	TP
Load assuming 75% of by-law, kg/d	8,295	7,110	1,422	237
Pop Eq, ca	74,662	84,643	83,158	98,750

NEWPCC Catchment Population Summary

Table 1.4 provides a summary of the 2050 population equivalent for the NEWPCC Upgrade. The population equivalent is approximately 26% higher than the 2037 population developed in S0972-11DD-RPT-0001 (PDR

Report). The 2032 population equivalent for NEWPCC has also been included for Phase 1 Nutrient Removal Facilities (NRF) upgrade (partial licence compliance) consideration.

Table 1.4: Summary of NEWPCC Catchment Population

Catchment	2016	2037 (PDR Report)	2032	2050
NEWPCC	439,643	523,394	523,666	626,382
RM of St. Andrews	6,369	6,369	6,369	6,369
RM of West St. Paul	4,932	9,184	8,148	11,310
CentrePort (Winnipeg)[1]	NA	40,000	8,500	44,000
CentrePort (Rosser)[1]			0	40,000
Total		**578,947**	**546,683**	**728,061**

[1]Population equivalent based on anticipated commercial and industrial activity

1.3 Wastewater Flows

1.3.1 Historical Flow Analysis

Raw wastewater average daily flow data provided by the WSTP for the period of 2016 through 2023 were assessed. The flow information summarized represents the flow that reaches the NEWPCC and is pumped by the raw sewage pumping station (RSPS). Overflows do occur within the existing collection system and are not captured in the data below. Based on information provided by the WSTP in the CSO Capture Volumes, it is estimated that an additional 783 ML per year of CSO volume will be captured in 2032 and 1,633 ML per year of CSO volume will be captured by 2045.

A summary of the average, maximum 30-day rolling average, maximum 7-day rolling average, and the maximum daily flows between 2016 and 2023 are listed in **Table 1.5** and **Table 1.6**. The ADWF was calculated based on December to February values.

Table 1.5: Historical Monthly Average Raw Wastewater Flows

Years/Months	Daily Average Raw Sewage Flow, ML/d								
	2016	2017	2018	2019	2020	2021	2022	2023	Average
January	129	143	126	130	130	126	125	129	132
February	129	161	125	133	132	124	128	132	136
March	235	236	156	189	173	157	221	141	198
April	242	255	151	209	228	166	417	246	217
May	212	189	159	168	168	161	411	194	179
June	263	180	179	160	204	173	349	185	197
July	198	183	159	192	192	139	260	174	185
August	182	148	149	168	165	193	229	166	162
September	159	166	188	287	143	147	177	156	189
October	174	145	170	373	132	165	171	189	199
November	177	135	137	180	131	157	148	182	152
December	154	127	132	137	126	136	135	143	135
Average	**188**	**172**	**153**	**194**	**160**	**154**	**231**	**170**	
ADWF	**137**	**143**	**128**	**133**	**129**	**129**	**129**	**135**	

Table 1.6: Summary of Historical Raw Wastewater Flows

Flow/Months	Average Daily Flow, ML/d	Max 30 d rolling average, ML/d	Max 7 d rolling average, ML/d	Max day, ML/d	Min day, ML/d
Jan	130	151	189	304	110
Feb	133	159	238	352	96
Mar	189	239	400	867	118
Apr	239	417	606	867	125
May	208	480	539	769	110
June	212	405	486	654	130
July	187	335	339	580	122
Aug	175	261	397	632	120
Sep	178	287	348	604	118
Oct	164	203	283	545	116
Nov	156	191	235	391	118
Dec	136	182	231	203	51
AAF	**175**				
ADWF	**133**				
Max/Min		**480**	**606**	**867**	**51**

1.3.2 Projection of 2050 Design Flow

A stepwise approach was used to project the 2050 design flow. A summary of these steps is as follows:

1. Eight years of historical data (2016-2023) was segregated into the following categories:
   - Combined residential, commercial, and industrial
   - Centrate
   - Inflow & infiltration (I&I) and wet weather
2. Combined residential, commercial, and industrial flow was extrapolated to the year 2050 based on the projected population increase.
3. WWT and I&I was adjusted to 2050 based on the 2050 expanded service area.
4. Estimates for the RMs of St. Andrews and West St. Paul were used as per the City's service agreements.
5. Items 2, 3, and 4 were summed to provide the 2050 projected flow.

Flows Related to Population

These flows are the sum of residential, commercial, and industrial wastewater. From the historical data, it was assumed that the population related flows are equal to the ADWF (December to February) less the centrate flow. Although there has been a historical decline in per capita wastewater generation rates, more recent data for the years 2018 to 2023 indicate there has been no additional decline. Therefore, to maintain a level of conservatism, it was assumed that the per capita wastewater generation rates will not change in the future, and that the dry weather flow will change in direct proportion to the population. A population equivalent of 728,061 persons was used, and includes the NEWPCC catchment, RM of St. Andrews, and the RM of West St. Paul, and CentrePort.

Centrate

The RSPS flow measurement currently includes centrate flow. Since centrate is considered an internal recycle flow, it was subtracted from the influent flow measurements. The amount of centrate generated is a function of the unit processes selected for design. Therefore, centrate flow will not be included as part of the influent flows.

Flows Related to Surface Area

The WSTP (North End Facility Flows and Loads Report) indicated that the current NEWPCC catchment area is 177 km^2 and that an additional 22 km^2 will be added to the catchment area by 2037. Since the additional 22 km^2 will be serviced by new separated sewers, it as assumed catchment area development will generate 50 percent less I&I per square kilometer than the existing collection system.

Other Flows

This category consists of leachate and hauled wastewater. The WSTP estimates that hauled wastewater and leachate together will constitute approximately 0.58 ML/d in 2037 (North End Facility Flows and Loads Report). This equated to less than 0.25 percent of the overall flow. These flows were included in the per capita wastewater generation rates, and projected to increase at the same rate as population growth.

Prediction of Future Flow

To estimate the 2050 flow, each day of historical flow (2016 to 2023) was projected forward to a 2050 value. This was done using the following procedure:

- The ADWF for the selected year was subtracted from the total flow for each day of the year. This provided a population related flow (ADWF) and a wet weather related flow (total minus ADWF) for each day of the year. Note: ADWF values include the hauled waste flow but not centrate flow.
- The ADWF was then adjusted to 2050 by the associated population increase. For example, the 2016 ADWF was adjusted by a population growth factor of 1.42 (i.e. 626,382 ÷ 439,643).
- The WWF was then adjusted based on the expansion of the catchment area and the addition of the WWFs from the RMs and CentrePort.
- Items 2 and 3 were then summed to provide an estimate of the daily 2050 projected flows. This provided eight years of 365 days of projected 2050 flow data.

The values used for the ADWF for each year are provided in **Table 1.7**.

Table 1.7: Population and Historical ADWF Used for 2050 Flow Projection

Year	Population	ADWF incl Centrate, ML/d[2]	ADWF not incl. Centrate, ML/d[3]	Flows per capita L/ca-d
2016	439,643	137	135	308
2017	443,852	143	141	318
2018	448,013	128	126	281
2019	452,222	133	131	290
2020	453,319	129	127	280
2021	455,825	129	127	278
2022	462,662	129	127	275
2023	478,809	135	133	277
2032	546,683			275
2050	717,300			275

In addition to adjusting the WWF component for the additional 2050 catchment area, an adjustment was made to account for the 2050 CSO capture volume. The WSTP indicated in the CSO Capture Volumes, that an additional 1,633 ML per year of CSO flows will be captured by 2045 when the CSO program is estimated to be completed. This annual volume was distributed proportionally to all rain events in a given year. The volume allocated to an event was assumed to be pumped to the plant directly after the peak event flow passes, at a rate of 705 ML/d, or the peak event flow, whichever is lower. In this approach, it was assumed that the 1,633 ML per year of additional CSO capture volume will extend the duration of wet weather events, but not increase the magnitude.

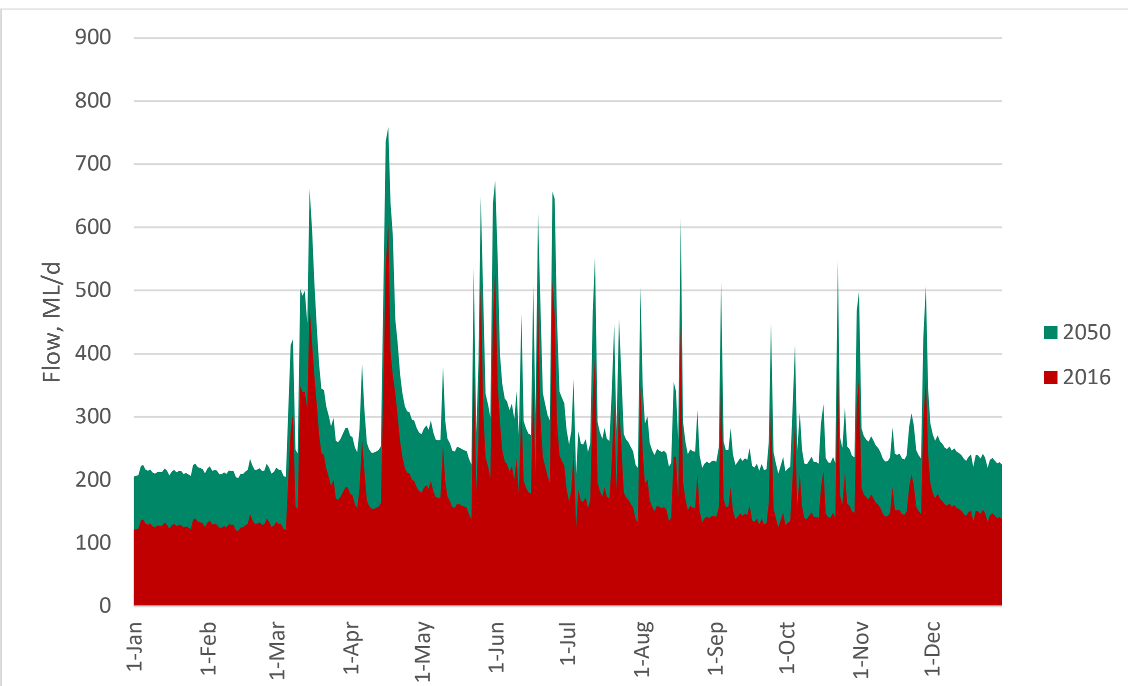

Figure 1.1: Comparison of Flow Profile Between Actual Data from 2016 and the Extrapolated 2050 Design Year

After eight years of historical data flow were converted to eight years of 2050 flows, the data was consolidated into daily average, maximum 30-day rolling average, maximum day, and minimum day values. A summary of this analysis is provided in **Table 1.8**.

Table 1.8: Summary of 2050 Raw Wastewater Flows

Flow/ Months	Avg daily, ML/d	Max 30 d roll avg, ML/d	Max 7 d roll avg, ML/d	Max day, ML/d	Min day, ML/d
Jan	213	239	286	436	186
Feb	218	253	361	527	171
Mar	289	358	530	661	201
Apr	311	405	586	791	204
May	268	361	445	649	184
June	288	400	472	674	209
July	274	376	433	725	202
Aug	248	309	346	615	202
Sep	278	400	471	752	195
Oct	290	311	330	547	191
Nov	237	283	330	507	194
Dec	217	272	339	294	117
AAF	**266**				

For the purpose of the 2050 design, the information in **Table 1.8** was further consolidated into seasonal flow values as shown in **Table 1.9**.

Table 1.9: Summary of 2050 Flows

Season	Ave daily, ML/d	Max 30 d roll ave, ML/d	Max 7 d roll ave, ML/d	Max day, ML/d	Min day, ML/d
Winter	216	255	329	419	158
Spring	289	375	520	700	196
Summer	270	362	417	671	205
Fall	268	331	377	602	194
AAF	**266**				

1.3.3 Projection of 2032 Phase 1 Flows

To provide a prediction of treatment level for the Phase 1 construction for partial licence compliance, which would be in operation at the beginning of 2031 until the end of 2032 when Phase 2 is completed, flow projections were prepared using a similar approach to the 2050 design year. A summary of the 2032 flows are provided in **Table 1.10** and **Table 1.11**.

Table 1.10: Summary of 2032 Raw Wastewater Flows

Flow/ Months	Avg daily, ML/d	Max 30 d roll avg, ML/d	Max 7 d roll avg, ML/d	Max day, ML/d	Min day, ML/d
Jan	166	185	230	368	138
Feb	171	197	294	440	0
Mar	294	294	472	992	148
Apr	333	491	701	992	155
May	289	558	627	890	138
June	284	472	562	756	161
July	264	399	408	669	154
Aug	244	311	463	727	150
Sep	245	344	412	696	147
Oct	222	252	334	630	0
Nov	219	230	280	456	148
Dec	185	221	279	245	72
AAF	217				

Table 1.11: Summary of 2032 Flows

Season	Ave daily, ML/d	Max 30 d roll ave, ML/d	Max 7 d roll ave, ML/d	Max day, ML/d	Min day, ML/d
Winter	174	201	268	351	70
Spring	305	448	600	958	147
Summer	264	394	478	718	155
Fall	229	275	342	594	98
AAF	**217**				

1.4 Wastewater Loads

1.4.1 Historical Load Analysis

NEWPCC raw wastewater concentrations measured during the period of 2016 to 2023 were used to calculate the loads for the 2050 design year. Historical loads were calculated by multiplying the daily concentration and the daily flow. Historical per capita loads were calculated by dividing the annual average loads by the contributing population for each year. The biased average of the per capita loads from 2016 to 2023 were used to estimate the 2050 loading rates.

A summary of the average per capita loads are summarized in **Table 1.12**.

Table 1.12: NEWPCC Raw Wastewater Average Per Capita Values

Parameter	Unit	2016	2017	2018	2019	2020	2021	2022	2023	Biased Average
TSS	g/c-d	102.3	109.9	115.8	132.2	116.0	98.5	126.9	111.4	113.7
BOD	g/c-d	73.5	82.0	85.3	95.1	87.6	87.2	83.2	78.6	84.0
TKN	g/c-d	17.9	17.4	16.0	18.7	18.2	16.9	17.3	18.4	17.7
TP	g/c-d	2.34	2.44	2.18	2.45	2.33	2.49	2.17	2.41	2.4

1.4.2 Projection of 2050 Design Loads

To project the historical wastewater loads to the 2050 design year, the following approach was used:

- The annual average loads were calculated based on the biased average per capita loads (2016 to 2023).
- The average per capita loads were multiplied by the 2050 population to get the annual average loads.
- Each historical day of load was divided by the annual average load to provide a daily peaking factor.
- Annual average loads for 2050 were multiplied by the peaking factors determined in step 3 to produce a 2050 loading pattern.

It was assumed that the increase in load will be directly proportional to the increase of the population. The 2050 loads were calculated using the average per capita loads presented in **Table 1.12** and the assumed 2050 population of 728,061.

Based on this population, the predicted average 2050 loading rates are as summarized in **Table 1.13**.

Table 1.13: Summary of NEWPCC 2050 Average Loading Rates

Catchment	Population (persons)	Per Capita Loading Rate (g/cap-d)	Load (kg/d)
TSS	728,061	113.7	82,796
VSS	728,061	81.2	59,119
BOD	728,061	84.0	61,140
TKN	728,061	17.7	12,860
TP	728,061	2.4	1,718

Loads for each month (2016 to 2023) were used to calculate the peaking factors for all characteristic monthly loads (i.e. average day, maximum day, maximum 7-day rolling overage, maximum 30-day rolling average). For example, the average day peaking factor in February 2016 was calculated as the ratio of the average day in February to the annual average in 2016. Maximum day peaking factor for the same month was calculated as the ratio of the maximum day in February to the annual average in 2016. The peaking factors from all year (2016-2023) were averaged by month to create peaking factors for the 2050 design year.

A summary of 2050 loads are summarized in **Table 1.14**.

Table 1.14: Summary of NEWPCC 2050 Seasonal Loads

Season	Load type	Loads (incl. Center Port), kg/d			
		TSS	BOD	TKN	TP
Winter	Average	83,538	62,133	13,463	1,525
	Max Month	99,732	65,275	14,457	2,041
	Max Week	122,361	71,168	15,321	1,885
	Max day	194,887	94,939	18,064	2,577
Spring	Average	95,002	61,224	12,400	1,709
	Max Month	127,650	67,914	14,027	1,928
	Max Week	178,809	75,570	14,836	2,286
	Max day	336,961	104,572	17,905	4,079
Summer	Average	76,755	59,103	12,357	1,738
	Max Month	95,689	62,824	13,377	1,940
	Max Week	135,207	71,201	15,334	2,212
	Max day	271,158	110,804	18,603	3,009
Fall	Average	76,217	62,481	13,409	1,879
	Max Month	93,187	67,777	13,954	2,085
	Max Week	121,891	81,665	15,800	2,453
	Max day	216,057	110,261	19,767	3,165
Annual average		**79,747**	**82,878**	**61,235**	**12,907**

1.4.3 Projection of 2032 Phase 1 Loads

To provide a prediction of treatment level for the Phase 1 construction for partial licence compliance, which would be in operation at the beginning of 2031 until the end of 2032 when Phase 2 is completed, load projections were prepared using a similar approach to the 2050 design year. A summary of 2032 Phase 1 loads are summarized in **Table 1.15**.

Table 1.15: Summary of NEWPCC 2032 (Phase 1) Seasonal Loads

Season	Load type	Loads (incl. Center Port), kg/d			
		TSS	BOD	TKN	TP
Winter	Average	60,081	46,463	10,421	1,152
	Max Month	67,101	48,703	11,127	1,426
	Max Week	86,494	52,831	12,058	1,406
	Max day	136,768	70,102	13,691	1,782
Spring	Average	74,445	46,922	9,482	1,288
	Max Month	92,153	50,950	10,658	1,399
	Max Week	131,655	56,871	11,511	1,669
	Max day	236,453	75,068	17,132	2,744
Summer	Average	57,872	44,170	9,418	1,323
	Max Month	77,125	48,287	10,473	1,473
	Max Week	102,572	53,256	11,929	1,666
	Max day	195,097	78,331	16,441	2,273
Fall	Average	55,861	46,157	9,480	1,385
	Max Month	66,453	49,106	10,481	1,555
	Max Week	82,225	57,234	12,104	1,764
	Max day	147,392	74,881	15,788	2,415
Annual average		60,316	62,065	45,928	9,700

Appendix 3 – SMA Consulting Ltd. Constructability Review Results Update Report

Date

2025-01-24

Prepared by

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North End Sewage Treatment Plant Upgrades

Constructability Review Results Update Report

January 2025

Statement of Limitations

- SMA warrants that its services were rendered with the degree of care, skill, and diligence normally provided on work of similar nature. The results of SMA's assessment of likely outcomes of a risk analysis should not be taken to indicate certainty of actual future outcomes; new information may arise which would invalidate prior assumptions and low-probability events may occur.
- The Client agrees that it retains full responsibility for acting upon any of the suggestions or information that may arise from this assignment. The Client agrees to indemnify and save harmless SMA Consulting from any and all actions arising from the execution of any and all of the suggestions or information that may arise from the assignment.

Overview

Winnipeg produces approximately 100 billion cubic meters of wastewater per year; the North End Sewage Treatment Plant (NEWPCC) treats approximately 70% of the wastewater received, and is one of the largest and oldest wastewater treatment plants in Canada. The West End and South End Sewage Treatment Plants (WEWPCC/SEWPCC) combined treat an approximate 30 percent of the wastewater received. The City of Winnipeg has been working diligently to meet the targets for nutrient removal set by the Province of Manitoba and improve water quality in the Red River and Lake Winnipeg, where algal blooms and high nutrient levels have been a serious concern. This work has included major upgrades to the SEWPCC as well as investment of hundreds of millions of dollars in the sewer separation program.

The NEWPCC is currently the target of a multi-billion-dollar upgrade program including upgrades to the grit and debris removal in the headworks, construction of UV treatment, a major Biosolids project to replace end-of-life components and use wastewater byproducts for composting and fertilizer, and enhancements to improve the efficiency of treatment and allow operators to run the plant more smoothly. In addition, Winnipeg is currently implementing chemical nutrient removal, and upgrade plans to allow biological nutrient removal are underway. Together, this is a significant scope of work which must occur within the existing footprint of the NEWPCC.

Constructability Review Scope and Methodology

In answer to the Province's request, the City of Winnipeg has commissioned an external third party readiness and general constructability review to assess confidence in the schedule and the overall construction plan. The initial assessment was completed in 2023 and is being followed by regular updates at key milestones as the Biosolids procurement concludes and the Biosolids and Nutrient Removal Facility designs mature. The Winnipeg Sewage Treatment Program (WSTP) has retained SMA Consulting for the review, a specialized construction management consulting firm based in Edmonton. For the initial assessment, in Q4 2023 and Q1 2024, SMA met extensively with the program team and key experts to discuss delivery methods and market capacity, project funding options, key project documents, and the master schedule, as well as to update the risk register and identify key pinch points and solutions. The culmination of this work was the updated master schedule and the report delivered in February 2024.

The constructability exercise was reactivated during 2024, after some significant background work had been accomplished, with the focus on the Nutrient Removal Facility (NRF) as the last major project which is still in the planning stages. The background work included the completion of the Enhanced Preliminary Design and a Class 3 cost estimate, as well as additional technical review of potential schedule acceleration alternatives, a market sounding, and a risk review. This update to the report reflects these updated results.

Understanding and Review Outcomes

Program Overview

There are eight key projects included in the expansion program, which together represent approximately $3.07 billion in new construction at the plant, with annual cash flow of $300 to 400+ million over the next several years. The work will affect close to 50% of the plant area. The project team has integrated numerous lessons learned over the past years, particularly from the SEWPCC work, which included similar upgrades. See Table 1. The projects are shown in the overall site map in Figure 1.

Table 1. Summary of NEWPCC Upgrade Projects

Project	Description	Status	Project Value
Interim Phosphorus Removal	Addition of chemical storage and distribution lines to various areas of the plant to provide chemically enhanced phosphorus removal	In operation, optimization will continue into 2025	$19 million, City of Winnipeg funding
Headworks	Design and construction of a new Headworks facility, being delivered via design build.	In progress, expected completion in 2026	$518 million, City of Winnipeg/ICIP funding. Includes several projects.
Distributed Control System (DCS) Migration	Integration of the existing Distributed Control System to the new Programmable Control System, important for support for all other projects. Being delivered via design bid build.	In progress, completion expected by 2027	
Primary Clarifiers	A combination of existing and new upgrades to accommodate better primary treatment, being delivered via design bid build.	Design	
UV	An upgraded ultraviolet (UV) disinfection system to provide better effluent quality, being delivered via design bid build.	Design	
Biosolids	Design and construction of a new Biosolids treatment facility, being delivered via progressive design build.	In development phase	$1.035 billion, City of Winnipeg/ICIP funding
Nutrient Removal Facility (NRF)	Design and construction of a new biological nutrient removal and secondary clarification facility to treat phosphorus and nitrogen. Market feedback has been received and procurement analysis is under way.	In pre-procurement phase Funding decision expected Q1 2024	$1.491 billion, unfunded
Advance Site Preparation - Biosolids and Nutrient Removal	Preparatory connections, piping, and other work to streamline future construction, delivered via design build	Biosolids construction under way, Nutrient Removal to follow as project progresses	N/A, prework for these projects. Funded by Biosolids and Nutrient Removal projects

Figure 1. Overview of the upgrade projects.

Constructability Challenges and Risks

A high level review of the key challenges and risks of the projects resulted in the following major themes; in 2024 these were validated for the NRF project through an integrated cost and schedule risk analysis. See below:

- **Funding availability.** The City continues to complete the conceptual planning phase for the NRF and will commence the procurement phase in early 2025 to maintain the NRF project schedule. However, funding needs to be confirmed prior to issuing any formal procurement documents. An internal funding decision is expected in Q1 2025.
- **Market capacity.** The Biosolids procurement resulted in only two bids and there are serious doubts about the ability of the market to take on additional work; this could result in further future delays or increases in cost for the NRF project. In addition, based on feedback in the market sounding, an intent to pursue partial compliance via partial operation of the NRF was seen as highly undesirable. A failed procurement for the NRF project due to lack of market interest could result in significant delays.
- **Market escalation.** The impact of tariffs and further escalation on the costs of both the Biosolids and NRF projects could be significant.
- **Resource constraints.** This includes availability of design personnel and project management (PM) resources. The capacity of the local market will be challenged by these two large projects.
- **Maintenance of Plant Operations.** Throughout the work it will be vital for plant operations to continue uninterrupted to avoid harm to the environment or the plant. Multiple commissioning events and the construction itself will require careful planning and the need to maintain plant operations may delay or complicate the construction beyond what was expected.
- **Site conditions and laydown.** Much of the work is in close physical proximity and involves integration with existing infrastructure, some of which is in poor condition. The Biosolids and

NRF projects are planned for open space areas, but there are still risks. These include contamination and the possibility of encountering protected species. In addition, the Biosolids site has a large radio antenna with multiple guy wires that cannot be moved. Ground conditions in Winnipeg are frequently challenging, and the NRF project will involve significant deep excavation. Access and laydown are also especially challenging for the NRF project, with the footprint of the new infrastructure constrained by the existing plant to the north and east and CPKC rail lines to the south and west.

- **Flooding**. The plant is in a sensitive area and there is the potential for high water to delay or affect construction; this applies to all projects, but could impact the NRF more than Biosolids. Some equipment, and certain construction activities such as tie-ins, can only be worked on during dry weather and low flows. High water during the spring season also means plant personnel will have to direct their attention elsewhere, which could delay commissioning.
- **Schedule delays.** The highly interrelated and overlapping nature of the projects, the amount of work planned, and the City's previous SEWPCC experience all indicate that schedule is a major concern. The electrical and mechanical installations and the commissioning process are some of the highest-risk areas. In addition, commissioning can be sensitive to weather and its impact on biological processes. The connections between the new infrastructure and the existing plant will need to be made carefully. There is also the potential for supply chain issues, given the need for specialized controllers and equipment. This is a key risk for both the NRF and the Biosolids projects.

Funding

As noted, a key driver for schedule at the moment is finding funding for the NRF project. Winnipeg is currently pursuing self-funding via utility rates. However, given the size of the projects, it will be important to also pursue external funding sources. Unfortunately, availability of federal funding at the moment is constrained as well; Manitoba has fully utilized all ICIP funds and the deadline for application has closed. Manitoba's Strategic Municipal Investment Fund has also already been committed for 2023-2024. The team will continue to monitor options and pursue funding aggressively.

Delivery Methods and Market Constraints

Most of the projects have either already been procured or have defined delivery methods, and alternative delivery methods are being used for many to increase collaboration. Potential delivery methods were explored for the NRF project, including Public Private Partnership (P3) variants, Design Bid Build (DBB), Design Build and Progressive Design Build (DB and PDB) variants, and Construction Manager (CM) variants.

The key driver for the delivery method was the schedule. DBB approaches often result in the longest duration schedules and flexibly integrating with operations is challenging in a DBB environment, which meant that DBB would not be acceptable. This conclusion was also reinforced by SEWPCC lessons learned. Operational constraints and the lack of a revenue stream made P3 delivery less attractive. PDB/DB and CM variants were seen as the most potentially successful approaches, overlapping in benefit and offering collaboration, flexibility, and schedule options. While there is preference from the City of Winnipeg for PDB given the synergy with the Biosolids project, which is currently in PDB procurement, the ultimate choice is likely to be driven by market forces. The success of a CM or PDB approach is dependent on the experience and qualifications of the contractor and/or design team selected as well as on their familiarity with the delivery method in question, so it will be important to identify market preferences, abilities, and capacity prior to the final selection of the delivery method.

The final procurement assessment for the NRF project will conclude in Q1 2025 and focuses on evaluation of CM, DB, and PDB approaches for suitability.

Schedule

In 2023, the schedule was reviewed against the as-built schedule and lessons learned from SEWPCC and the scope required and validated against industry experience, with a particular focus on the NRF project. Following the review, the baseline schedule for the work was found to extend until the end of 2032, past the 2030 deadline for meeting nutrient targets. In the light of the new information gathered, this schedule was reviewed in 2024 and the end date for reaching licence compliance as quickly and safely as possible remained in 2032; see Figure 2 for the overall program schedule roadmap. The key factor is the NRF project, which is currently in the pre-procurement phase. As noted previously, the project does not yet have capital funding -- for the purposes of this report the assumption of the project team is that funding could be achieved by early 2025, but any delay will translate into a delay to the overall project end date.

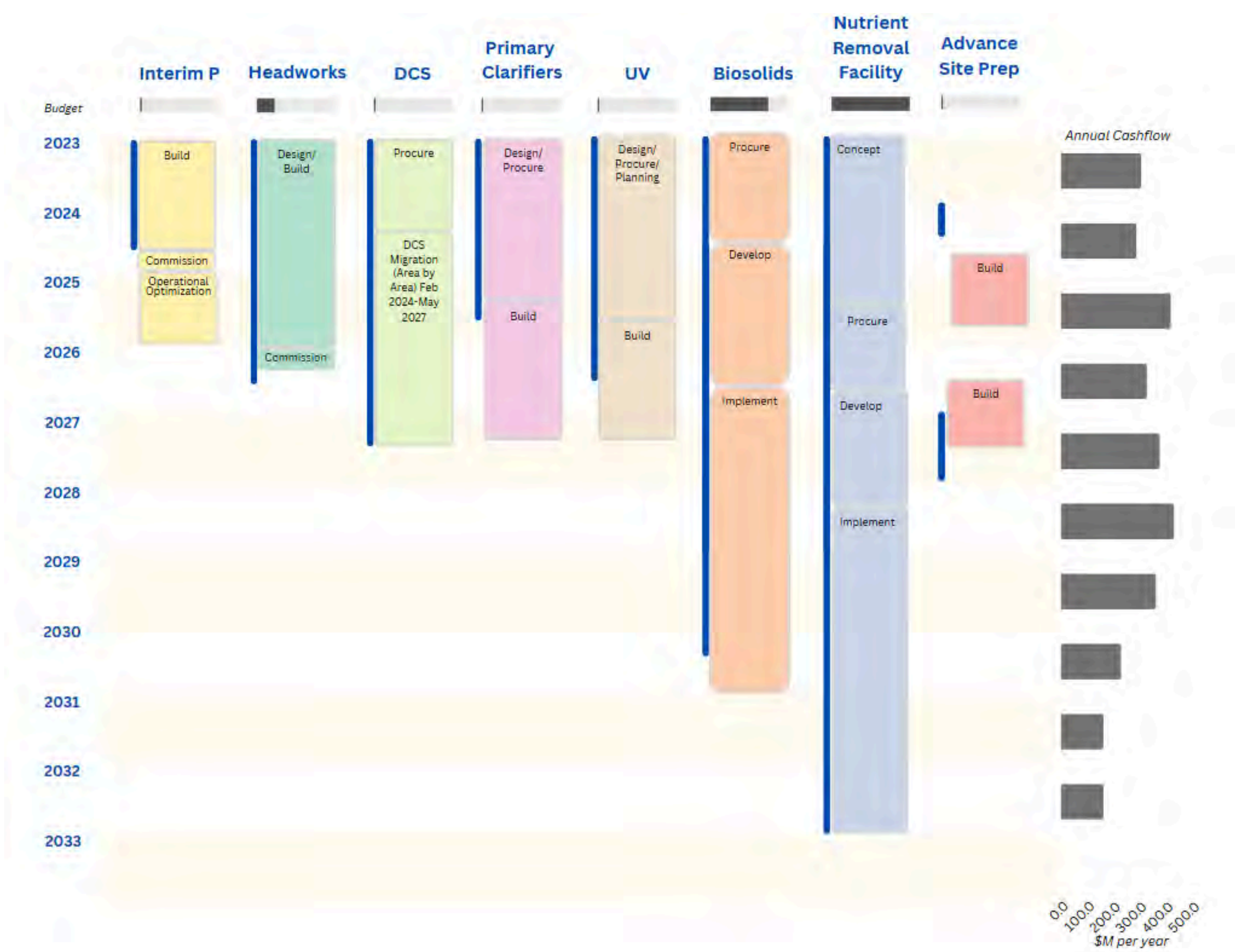

Figure 2. Schedule roadmap of the upgrade work. Blue line indicates the 2023 schedule.

Schedule Acceleration

In 2023, schedule acceleration options were extensively explored. The team began with a comprehensive review of potential options, with analysis of their risk profiles and potential benefits and drawbacks. The conclusion was to move forward with the project as well as with further exploration of delivery of part of the NRF facility. In Q4 2024, AECOM completed a technical review of options (see "NEWPCC Upgrade: Nutrient Removal Facilities Partial Compliance Report") which indicated that the acceleration premium would be substantial.

In 2024, the differential risk analysis was updated based on the technical review of options. See Appendix A. The integrated cost and schedule risk analysis indicated that the most significant risk identified was the potential for insufficient bidders. This risk could result in a possible failed procurement and at least another year's delay. The market sounding indicated that the risks posed by the site access constraints and the need to maintain plant operations were far greater for the partial compliance options, and made potential bidders extremely reluctant to pursue the opportunity if partial compliance is required. This would significantly increase the likelihood of a failed procurement. Risk costs will be presented to Winnipeg City Council in early 2025 as part of the utility rate deliberations, which will result in the funding decision for the NRF.

Conclusion: Moving Forward

The schedule is the key consideration for the upgrade projects, and most importantly what the schedule represents: reducing continued impacts on the Red River and Lake Winnipeg through achieving nutrient removal as efficiently as possible. The team is focused on planning and working toward an overall schedule with an acceptable level of risk and complexity and is expecting to complete the UV upgrade, Distributed Control System (DCS) migration, headworks, Biosolids treatment, chemical treatment for phosphorus, and primary clarifiers by 2030, at an estimated total cost of over $1.5 billion. Approximately 49% of the $3.07 billion program is currently without funding. This is a large and ambitious scope of work and it must be noted that an overly aggressive schedule not only may lead to delays and cost overruns, but also to quality and performance issues, and even risk to the operations of the plant.

Scheduling, Delivery, and Capacity

Planning for these projects has already implemented many lessons learned from the similar SEWPCC projects as well as from previous phases of existing NEWPCC projects, and this incorporation of lessons is expected to continue. These lessons have provided a useful basis for schedule estimates and have informed the project packaging and the selection of delivery methods. Finally, an alternative delivery method such as PDB or CM is appropriate for the size and complexity of the NRF project and may help manage the schedule. These options may add an up-front premium for project cost, but are expected to increase quality and reduce potential for future disputes.

A final consideration is the availability of local resources as well as the City of Winnipeg expertise and capacity. The Biosolids and NRF projects will be executed effectively simultaneously, at a projected annual cash flow of approximately $300 to $400+ million for several years. This is a significant increase over levels of prior annual wastewater work in Winnipeg. The availability of local expertise is constrained but is expected to be able to meet planned demand, and the projects are large enough that they are expected to attract market attention from other provinces. However, a low-competition environment could lead to increased costs as well as potential performance issues, and City staff may not be able to provide enough oversight and management. In addition, Winnipeg's Social Procurement policies and targets may not be met if there is a substantial out of province workforce. This will require careful consideration and planning as well as market outreach; the team is currently carrying out a strategy aimed at attracting interest in the NRF project among contractors and design firms. The recent market sounding received a promising level of interest.

Next Steps

The following steps will be taken by the City of Winnipeg to proceed with the work and to inform further and more detailed constructability review:

- **NRF**
    - **Enhanced Preliminary Design.** This has been completed.
    - **Class 3 Cost Estimate.** The Class 3 Cost Estimate has been delivered and reviewed. An updated Integrated Cost and Schedule Risk Analysis has been performed using the Class 3 estimate and the updated risk register.
    - **Technical Review**. A further technical review of the partial compliance alternatives has been completed.
    - **Market Soundings.** Market soundings have concluded. Plans for future market soundings will continue. Results are still being integrated, but the partial compliance option was universally seen as unattractive.
    - **Delivery Model.** The delivery model will be confirmed in Q1 2025.
    - **Funding.** The City has begun the work to secure internal funding, and continues to seek opportunities for external funding.
    - **Procurement Kickoff.** Preparations for procurement of the NRF will commence in Q1 2025 with a plan to post the RFQ in Q3 2025 if funding is available.
- **Other Projects**
    - **Biosolids**. Development phase will continue; the City is expecting to receive the cost estimate from the development partner in Q4 2024, with design work to continue through 2025.
        - **WEWPCC Grit and Screening.** WEWPCC Grit and Screenings project has been awarded and the investigation portion of the work is under way. This will ensure more reliability for the existing Anaerobic Digester capacity while the Biosolids project is being constructed.
    - **Headworks**. Construction continues and the project is preparing for commissioning.
    - **DCS Migration**. Continued migrations over the course of 2025
    - **Primary Clarification Upgrades.** Primary clarification upgrades will be tendered in Q1 2025.
    - **UV**. Continued design and procurement activities to prepare for construction in late 2025
- **NEWPCC Project Management Review.** The team is working towards better processes within the program to effectively deliver projects, based on an audit conducted by a third party expert.

As both the Biosolids project as well as, most likely, the NRF project are expected to use early contractor engagement delivery models (e.g. PDB or CM), some of the most vital constructability information will come once the consultants and contractors are onboarded. The two largest projects in the program will be designed and built in parallel; there will be many opportunities for synergy and a need for strong interface management, and the team is focused on ensuring that this occurs. Planning for change is a vital part of program management; project schedules will shift over time as challenges are encountered. For a successful outcome, the City will need to manage constructability and interfaces at the program level while ensuring reviews are happening at the project level. Key areas to continue to monitor include issues of limited laydown area, safety of operations and construction traffic flow, schedule sequencing and uncertainty, and market capacity.

APPENDIX A

In the previous constructability report, the team explored some options for potential schedule acceleration for the NRF project. The conclusion was that further technical review of feasibility was required. AECOM completed their technical review of the options in Q4 2024 (see “NEWPCC Upgrade: Nutrient Removal Facilities Partial Compliance Report”) and this formed the basis for further analysis of the best path forward.

AECOM presented six options including the base option, of which two were considered the most potentially feasible. The two alternative options which were carried forward with the base option for further analysis were option 2, which involved construction of 4 BNR reactors but used existing secondary clarifiers, as well as option 4, which involved construction of both 4 new BNR reactors and 4 new clarifiers. Working with the project team, SMA Consulting performed an integrated cost and schedule risk analysis of the base option, as well as a scenario analysis and updated risk analysis for the two potential options identified in the technical report. The schedules for the base option as well as for the partial compliance options were also updated. The options are summarized in Table A1.

Table A1. Options summary

Option	Nutrient Loading	Costs
Alternative 5: Base option. Eight (8) new BNR reactor and eight (8) new secondary clarifiers, full NRF build out on original schedule	*2032 loading* Ammonia: 1.4 mg/L TN: 11.6 mg/L TP: 0.5 mg/L	No additional premium
Alternative 2: Construct four (4) new BNR reactors and use in conjunction with existing secondary clarifiers. Achieve partial compliance in 2030 with full NRF build out by 2032.	*2030-2032 loading* Ammonia: 3.2 mg/L TN: 11.4 mg/L TP: 1.0 mg/L	$90-$140M in sunk costs and acceleration cost premium
Alternative 4: Construct four (4) new BNR reactors and four (4) new secondary clarifiers. Achieve partial compliance in 2032 with full NRF build out by 2032.	*2030-2032 loading* Ammonia: 4.2 mg/L TN: 15.2 mg/L TP: 0.9 mg/L	$140-$170M in acceleration cost premium

Unfortunately, the market sounding feedback for the partial construction options was highly negative; the difficulty of continuing construction in very close proximity to an operational set of BNR reactors and clarifiers was seen as very unattractive (see Figure A1). Constructing the remaining BNR reactors and clarifiers involves significant additional piling and excavation with very little physical separation, and the logistics of laydown and transport on site are extremely challenging.

a. Alternative 2 **b. Alternative 4**

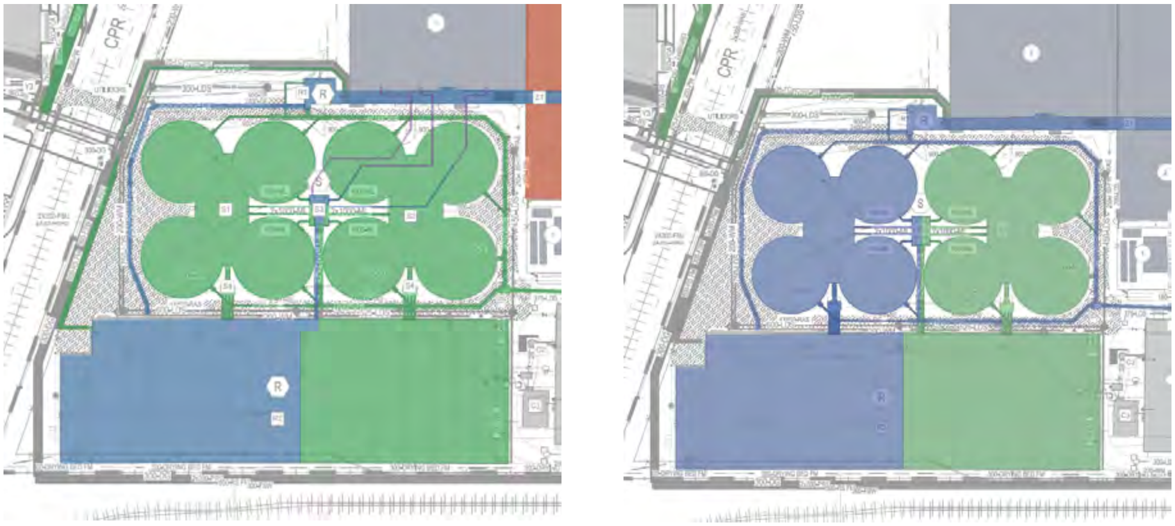

Figure A1. Construction proximity for Alternative 2 and Alternative 4. Blue indicates accelerated infrastructure, with green to be completed for full construction.

The differential risk analysis for the three options (base, option 2, and option 3) is shown below in Table A2. In addition to the operational risk, the potential for a failed procurement (e.g., sole bidder) is already one of the NRF project's most significant schedule risks and could cause more than a full year of delay. As noted, the feedback from the market sounding indicated that the partial compliance options were seen as extremely unattractive to construct, given the space limitations on site and the need to maintain plant operations. Limiting the market further by carrying forward with an option which the market views as too difficult to construct is seen as too high a risk. Given the risk profile, cost premium, and limited benefit, neither partial compliance option is viewed as feasible, and the recommendation from the project team is to proceed with the base approach.

Table A2. Risk results for the three main options

	Low	Med	High	Extm	Total Severity Score
Alternative 5: Base option. Eight (8) new BNR reactor and eight (8) new secondary clarifiers, full NRF build out on original schedule	5 ■	6 ■■■	13 ■■■■■■■■■	9 ■■■■■■■■■	304
Alternative 2: Construct four (4) new BNR reactors and use in conjunction with existing secondary clarifiers	4 ■	6 ■■	8 ■■■■■■	14 ■■■■■■■■■■■	347
Alternative 4: Construct four (4) new BNR reactors and four (4) new secondary clarifiers	4 ■	6 ■■	9 ■■■■■■■■	13 ■■■■■■■■■■	336

A preliminary differential risk register, quantified using the likelihood, magnitude, and severity definitions shown in Table A3, is shown in Table A4. The register includes mitigation actions for each risk.

Table A.3 Likelihood, Magnitude, and Severity Definitions

Likelihood

Descriptor	Rating	Frequency	Probability
Almost certain	5	Is expected to occur during projects of this type	> 95%
Likely	4	More likely as not, regularly occurs during projects of this type	60% < x < 95%
Moderate	3	As likely as not, might occur at sometime during a project of this type	30% < x < 60%
Unlikely	2	Could occur at some time during the project, rarely occurs on projects of this type	5% < x < 30%
Rare	1	Only occur in exceptional circumstances on projects of this type	< 5%

Magnitude

Descriptor	**Negligible**	**Moderate**	**Substantial**	**Severe**	**Disastrous**
	Small effect	Moderate effects	Considerable effects	Serious threat to the organization, public etc.	The impact is totally unacceptable to the organization
	1	2	3	4	5
Safety	Negligible – No injury, near miss	Minor – minor cuts, bruises, muscle strain	Serious – broken bones, muscle and ligament injuries	Serious / permanent injury / illness	Catastrophic – Single or Multiple fatalities
Financial Impact up to a maximum value (re-work / loss etc..)	$0 to $1M	$1M to $5M	$5M to $20M	$20M to $50M	>$50M
Schedule, impact on critical path	Not likely to impact dates; likely to absorb float between planned dates and target dates	1 to 6 months	6 months to 1 year	1 to 2 years	> 2 year
Environment	Negligible Environmental effect	Nuisance / minor but reversible Environmental harm	Moderate but short term Environmental harm	Localized, long term Environmental harm	Extensive long term Environmental harm
Regulatory	negligible, near miss	report required to regulatory body	Inspection by Manitoba Env safety officer etc..	CEC review	Clean Environment Commission (CEC) Hearing

Descriptor	Negligible	Moderate	Substantial	Severe	Disastrous
	Small effect	Moderate effects	Considerable effects	Serious threat to the organization, public etc.	The impact is totally unacceptable to the organization
	1	2	3	4	5
Image / Reputation	Single Public Enquiry	Multiple Public Enquiries and / or informal Councilor and / or MP Request	Moderate Media Political – Formal Council and / or MP Request / Moderate Public Impact	Provincial Government, Major Political & Media Scrutiny / Major Public Impact	Federal Investigation
Morale	No Impact	Grumblings at water cooler	Moderate / Increasing Absenteeism	Major Negative / Loss of Staff / "Go Slow"	Catastrophic Negative / walk out
Legal	No Liability	Damages >$1,000,000 <$5,000,000	Damages >$5,000,000 <$20,000,000	Damages >$20,000,000 <$50,000,000	Damages >$50,000,000

Risk Evaluation Matrix

			Magnitude				
			Negligible	**Moderate**	**Substantial**	**Severe**	**Disastrous**
		0	**1**	**2**	**3**	**4**	**5**
	Rare	**1**	Low	Low	Med	High	High
	Unlikely	**2**	Low	Low	Med	High	Extm
	Moderate	**3**	Low	Med	High	Extm	Extm
	Likely	**4**	Med	High	High	Extm	Extm
Likelihood	**Almost Certain**	**5**	High	High	Extm	Extm	Extm

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Table A.4 Differential Risk Register

Risk Name	Risk Description	Mitigations	Base Option				304	Alternative 2: 4 BNRs				347	Alternative 4: 4 BNRs and 4 Clarifiers				336
			Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.
Inadequate Quality Performance During Construction	If the construction quality does not meet the City's desired quality, then the Design-Builder will have to redo the work and may dispute this, resulting in cost and schedule impacts at best, and a termination of contract as well as the associated cost and schedule delays at worst.	Ensure the Project Team works with the Project partner to develop strong quality management systems from design through commissioning.	Moderate	Substantial	Severe			Moderate	Substantial	Severe			Moderate	Substantial	Severe		
Maintenance of Plant Operations	If there is damage due to construction or commissioning, or if construction or commissioning activities are too highly constrained due to plant operational requirements, this could result in environmental damage, an extended schedule and additional costs for continued resourcing, or the potential need for emergency repairs	Ensure the Project Team works with the contractor, designer and operations to identify interface requirements early in the design, complete adequate investigations to safely design the interface points and develop a system for coordination with all parties to review, sequence and execute interface points efficiently, safely and with the least amount of disruption to the plant.	Moderate	Substantial	Substantial			Almost Certain	Substantial	Substantial			Likely	Substantial	Substantial		
CP Rail Interactions and Damage to Rail	If work in proximity to rail results in damage to the rail line or in slowdowns to rail traffic, or if rail-related restrictions and safety procedures impact construction activities, this could result in costs due to damages or extended schedule and additional costs.	Establish rail interface requirements and restrictions in the contract documents, ensuring input and coordination with CPKC representatives. Complete rail crossings (utilidors, surface crossing) in advance of design-build contract to de-risk.	Moderate	Moderate	Negligible			Moderate	Moderate	Negligible			Moderate	Moderate	Negligible		
Compounding Disputes	If there are multiple disputes, it may become difficult for the project team to adequately address and defend against each dispute, leading to potential losses	Ensure the Project Team develops thorough risk management, claims management and contract management plans to outline the process for success (ex. appropriate and clear escalation process, strong project controls and documentation, retaining a dispute advisor, etc.). Work towards collaboration, relationship building and team work in order to work through issues and disputes early.	Moderate	Substantial				Moderate	Substantial				Moderate	Substantial			

Risk Name	Risk Description	Mitigations	Base Option				304	Alternative 2: 4 BNRs				347	Alternative 4: 4 BNRs and 4 Clarifiers				336
			Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.
Force Majeure	If a force majeure (strikes, quarantine restriction, etc.) occurs, this could result in delays and potentially increase costs depending on the constraints of the contract.	Review the contract and ensure the force majeure regimen is reasonable. The Project Team needs to proactively take steps to mitigate the impacts of a force majeure.	Rare		Moderate			Rare		Moderate			Rare		Moderate		
Environmental Compliance Alignment	If there are design target changes due to regulatory changes, or if there are delays and the project is not able to meet targets, this could result in regulatory consequences and the need to change strategies.	Continue strong communication with the regulator through reporting, site visits, in person meetings and regular updates for any events which may impact schedule or license compliance.	Rare	Severe				Rare	Severe				Rare	Severe			
Scope Creep / Decommissioning	If there are changes to the design, or if previous related projects have removed scope or identified additional scope, or if decommissioning of existing infrastructure triggers additional requirements, this could result in scope creep and associated cost and schedule impacts.	Avoid scope creep through proactive scope management during procurement and design process, including holistic assessment of NEWPCC upgrade necessities and existing contracts. Where additional scope is identified/requested, validate against project drivers, escalating as required should internal disputes arise.	Likely	Severe				Likely	Severe				Likely	Severe			
Development/ Design Performance Issues	If the quality of the design is not to the expected level and/or the design does not comply fully with the design requirements, this could result in increased errors and omissions, schedule delays and disputes, onerous reviews, and increased likelihood of future rework.	Development of and agreement on a strong review process with all key parties involved. Thorough review of procurement documents and specifications.	Likely	Severe	Severe			Likely	Severe	Severe			Likely	Severe	Severe		
Complex Interfaces during Design	If design coordination with other ongoing projects and plant operations is insufficient or poorly managed, then this could result in additional complexity and delays to schedule.	Designation of an interface/integration manager and development of an interface management plan Regular communication among projects.	Likely	Substantial				Almost Certain	Substantial				Almost Certain	Substantial			
Market Escalation	If there is a perception that market conditions could increase higher than forecasted (construction price escalation, steel escalation, oil escalation), there could be cost increases.	Ensure escalation forecasting is completed as part of an integrated cost, schedule and risk analysis and choosing the appropriate contingency value Complete market soundings regularly through the procurement process to gain feedback from key contractors. Ensure a monitoring system is in place during construction. Explore usage of escalation clauses to avoid speculative pricing, with cost increases	Moderate	Disastrous				Moderate	Disastrous				Moderate	Disastrous			

Risk Name	Risk Description	Mitigations	Base Option				304	Alternative 2: 4 BNRs				347	Alternative 4: 4 BNRs and 4 Clarifiers				336
			Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.
		only occurring if actual escalation conditions are realized.															
Sudden and Extreme Market Fluctuation	If there is a spike in construction escalation, a major change in other market factors such as tariffs, or a significant lack of market capacity, there could be a significant increase in bid prices, above expected variation.	Monitoring of market conditions Explore usage of escalation clauses to avoid speculative pricing, with cost increases only occurring if actual escalation conditions are realized Consideration of currency in contract documents.	Rare	Severe				Rare	Severe				Rare	Severe			
Supply Chain Issues	If long lead items and specialized components and equipment are not adequately managed or supply chain constraints arise, this could lead to increased schedule delays and challenges to extended warranty if equipment is ordered too far ahead	Creation of a long lead item register and monitoring of potential issues. Work with the development partner to outline major equipment lead times and issue early procurement works during the development phase.	Unlikely		Substantial			Unlikely		Substantial			Unlikely		Substantial		
Change in Codes and Regulations	If there are scope changes due to changes in bylaws, standards, codes, or provincial or federal regulations, there could be additional costs, rework, or schedule delays.	Regular communication with authorities having jurisdiction Ensuring the WSTP Design Guidelines are up to date for the Development Phase of the Project.	Unlikely	Substantial				Unlikely	Substantial				Unlikely	Substantial			
Funding Delay	If funding approvals are not obtained in sufficient time, then bidders may be hesitant to participate in the bid, the project could be delayed, and escalation will increase.	Maintain ongoing and transparent communication with the market through notices to bidders, market sounding, and other formal communication channels. Continue to engage all levels of government for project support through external funding to limit impacts of funding through rate payments.	Likely	Moderate	Disastrous			Almost Certain	Moderate	Disastrous			Almost Certain	Moderate	Disastrous		
Delays in Approvals (City/OE)	If permits, approvals, and review decisions are not obtained in sufficient time, or if requirements are changed, then the project could be delayed.	Development of permits and approvals register Collaborate with the planning and property department on the requirements/stages of Progressive Design Build and establish a clear permitting approval process to streamline applications.	Moderate	Substantial	Moderate			Moderate	Substantial	Moderate			Moderate	Substantial	Moderate		
Inadequate Risk Allocation	If the Design-Builder's perception of risk on the project is not in alignment with the project team, this could result in cost premiums, the inability to agree on a GMP, and the potential for redesign and schedule delays.	Strong risk management processes Inclusion of risk discussions in market sounding activities Establish a project risk register together with the Design-Builder and agree to	Unlikely	Severe	Moderate			Moderate	Disastrous	Substantial			Moderate	Severe	Moderate		

Risk Name	Risk Description	Mitigations	Base Option				304	Alternative 2: 4 BNRs				347	Alternative 4: 4 BNRs and 4 Clarifiers				336
			Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.
		quantification and allocation as part of Design Build Agreement execution.															
Insufficient Bidders and Constrained Market	If the market is excessively constrained, qualified design firms are not available, or the project is not attractive to bidders, the project may have a failed procurement resulting in delay, or may struggle with quality during the design phase.	Proactive communication with the market about the upcoming project, seek input on project terms through market soundings and other formal communication, incorporate lessons learned from previous NEWPCC projects. Establish a risk profile that balances the City's and prospective bidder's needs.	Moderate	Severe	Disastrous			Almost Certain	Severe	Disastrous			Almost Certain	Severe	Disastrous		
Staffing Capacity and Effectiveness	If there is inadequate staffing and/or management resources, which impacts the City's ability to manage the project and the Contract (ex., managing project scope and processing changes, managing annual cash flow of projects, managing reviews to avoid delays, managing Stage Gate Performance etc.), this could result in additional costs due to claims, schedule delays, taking back risks, and/or reputational impacts.	Addition of internal resources in key areas (recently established stemming from the external audit of the NEWPCC project) Consider staff augmentation via consultants where needed Create a resource management plan and utilize lessons learned from the other major projects.	Moderate	Substantial	Moderate			Likely	Substantial	Moderate			Likely	Substantial	Moderate		
Schedule Acceleration	If there is pressure applied to accelerate or to pursue interim operation, this could result in delays (excluding geotech, flooding, commissioning) may have greater effects on the end date due to ripple effects on multiple work fronts and interfaces.	Detailed constructability review and development of a robust and resilient schedule Rigorous schedule tracking and management during construction Rigorous interface management Ensure planning includes adequate schedule contingency.	Rare	Disastrous													
Social Procurement Targets	If City is not able to meet its social procurement targets due to overwhelming the market, this could result in public and Council disapproval.	Establish a social procurement lead who will lead for both the Biosolids and Nutrient Removal projects Provide ongoing training opportunities for industry to increase knowledge of social procurement requirements. Pilot social procurement requirements during Early Works and Biosolids projects, and refine approach as required based on lessons learned.	Unlikely			Moderate		Moderate			Moderate		Moderate			Moderate	

Risk Name	Risk Description	Mitigations	Base Option				304	Alternative 2: 4 BNRs				347	Alternative 4: 4 BNRs and 4 Clarifiers				336
			Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.
Political Impacts	If the public is asked to fund a significant portion of the expansion, this will result in a significant increase in utility bills and may result in public protest and political intervention	Continue to engage all levels of government for project support through external funding to limit impacts of funding through rate payments.	Moderate			Moderate		Likely			Moderate		Likely			Moderate	
Environmental Concerns	All delays to the project caused by other issues such as environmental challenges will result in extended duration of nutrient loading and damage to the environment.	Strong schedule planning and monitoring to ensure schedule targets are met.	Almost certain			Disastrous		Likely			Disastrous		Likely			Disastrous	
Reuse / Failure of Existing Infrastructure	If existing infrastructure is in poorer condition than expected, is not located where expected, or is not constructed as expected, this will lead to additional costs and delays to tie-in or unexpected failure during construction or operations.	Early investigation and daylighting. Refurbish or replace any existing equipment prior to construction which may impact interfacing points.	Unlikely	Disastrous	Substantial			Moderate	Disastrous	Substantial			Unlikely	Disastrous	Substantial		
Weather Worse than Expected	If the weather is worse than expected (excluding flooding), this could result in delays.	Ensure the schedule adequately considers weather. Strive to build a cushion if possible through acceleration.	Rare		Moderate			Rare		Moderate			Rare		Moderate		
Flooding	If the river level is high enough that it impacts operations, this will delay construction.	Plan around the flooding season for construction Ensure the contract covers eventualities.	Rare	Substantial	Substantial			Rare	Substantial	Substantial			Rare	Substantial	Substantial		
Complex Interfaces and Site Restrictions	If coordination of interfaces and site logistics (including laydown area constraints and shared access) among the different concurrent construction projects is insufficient, or coordination issues/conflicts surface, this may cause schedule delays, lead to constrained work, and/or increased costs.	Designation of a full time logistics coordinator to manage conflicts and associated interface plan Daily coordination meetings and weekly planning meetings with all project leaders and key operational personnel.	Likely	Severe	Substantial			Almost Certain	Severe	Substantial			Almost Certain	Severe	Substantial		
Geotechnical Complexity	If there are unforeseen geotechnical (high groundwater, poor soil), this could result in delays to the project and could potentially add cost due to changes in design.	Sufficient geotechnical investigation including geotechnical report by the owner and an additional geotech investigation by the development partner.	Unlikely	Substantial	Moderate			Unlikely	Substantial	Moderate			Unlikely	Substantial	Moderate		
Excessive Contamination	If the contamination is worse than expected, especially near the rail line, this could result in additional costs and schedule delays.	Early environmental site assessment and complete removal of contaminated soils as part of site servicing contract to de-risk from the design builder.	Moderate	Negligible				Moderate	Negligible				Moderate	Negligible			

Risk Name	Risk Description	Mitigations	Base Option				304	Alternative 2: 4 BNRs				347	Alternative 4: 4 BNRs and 4 Clarifiers				336
			Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev.
Underground Conflicts	If the as-built drawings are found to be inaccurate for existing infrastructure leading to conflicts and design rework or construction stoppage, this could result in additional costs and delays.	Early investigation and daylighting.	Almost certain		Moderate			Almost certain		Moderate			Almost certain		Moderate		
Trenchless Tunnel	If the Secondary Effluent trenchless tunnel alignment is unsuitable, or if there are significant productivity issues, this will lead to additional costs and delays.	Adequate investigation and early constructability-focused review of tunnel design.	Unlikely	Severe	Severe			Unlikely	Severe	Severe			Unlikely	Severe	Severe		
Unexpected Heritage Finds	If unforeseen Heritage Finds (e.g., archaeological, paleontological, etc.) are encountered, this could result in delays and increased costs.	Develop a heritage resources plan.	Unlikely	Negligible	Moderate			Unlikely	Negligible	Moderate			Unlikely	Negligible	Moderate		
Inadequate Commissioning Plan/ Execution	If the commissioning plan is not well coordinated and executed (ex. City is not adequately staffed or trained to support testing and commissioning activities and plan), this could lead to delays to contractor's substantial completion and extend their overhead costs through schedule extension.	Hire a commissioning agent to oversee commissioning, or transition the logistics coordinator into this position Integrate lessons learned from SEWPCC commissioning.	Likely	Moderate	Substantial			Almost Certain	Moderate	Substantial			Almost Certain	Moderate	Substantial		
Delays to Commissioning and Operations	If there are quality issues, conflicting tie-ins (including pipe tie-ins required while the existing wastewater treatment is operational), unexpected temporary measures, sequencing issues, inadequate transitioning between two plants, and/or ineffective integration between systems, this will delay the project and/or operations commencement.	Ensure strong quality management through construction Integrate lessons learned from SEWPCC commissioning Avoid commissioning during cold weather if possible.	Likely	Substantial	Substantial			Almost Certain	Substantial	Substantial			Almost Certain	Substantial	Substantial		