



Environment and Climate Change
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February 23, 2024
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Attention: Agnes Wittmann, Director

**RE: NORTH END SEWAGE TREATMENT PLANT (NEWPCC) UPGRADE PLAN UPDATE
ENVIRONMENT ACT LICENCE NO. 2684 RRR**

Please find attached the revised 2023 NEWPCC Upgrade Plan Update.

Key revisions to the report include:

- The inclusion of supporting data and analysis. The SMA Consulting Ltd. Constructability Review Report is attached as Appendix 1 to the 2023 NEWPCC Upgrade Plan Update.
- Details regarding estimated costs. Appendix A of the SMA Consulting Ltd. Constructability Review Report includes a differential risk assessment and assessment of cost premiums for the evaluated alternatives
- An assessment of each of the considerations and constraints with suggested options for resolving each. A new section “Mitigative Measures” has been included in the 2023 NEWPCC Upgrade Plan Update
- Analysis of the estimated total phosphorus loading and planned phosphorus compliance timelines. A new section “Anticipated Phosphorus Compliance Timelines” has been included in the 2023 NEWPCC Upgrade Plan Update. The City intends to update this section of the report once performance data is available for the Interim Chemical Phosphorus Removal project

This report provides an update on activities undertaken for the various NEWPCC Upgrade projects since the last report submitted on February 15, 2022. It also includes the constructability review requested by the Province that would see the full NEWPCC upgrades complete by December 31, 2030. This review evaluated the concurrent construction of multiple projects and explored opportunities to mitigate constraints to complete the upgrades in a compressed timeframe. Potential scenarios to fund the upgrade work were also reviewed.

The City recognizes the importance of the NEWPCC Upgrade projects in reducing impacts on the Lake Winnipeg watershed. These upgrades are a large and ambitious scope of work. The City has been diligently working to progress them, with the following key highlights:


- The Power Supply Upgrades reached total performance in 2023
- The Interim Chemical Phosphorus Removal project is nearing completion and will be commissioned early 2024

- Construction of the Headworks Facilities is underway and progressing well
- Procurement for the Biosolids Facilities progressive design-builder is in the final stage
- The Nutrient Removal Facilities enhanced preliminary design has begun with an expected completion mid-2024

The City has and will continue to provide regular progress updates to Environment and Climate Change. The City is committed to delivering the upgrades to protect the health of Lake Winnipeg and have made significant investment to date to reduce nutrient loads.

Should you have any questions, please contact me at 204-986-7313 or by email at tshanks@winnipeg.ca.

Sincerely,



Tim Shanks, M. Eng., P. Eng.
Director of Water and Waste Department

ATTACHMENT: NEWPCC Upgrade Plan Update

TS/dr

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NEWPCC Upgrade Plan Update

February 23, 2024

Executive Summary

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

The Province instructed the City to submit a plan that would see the full NEWPCC upgrades in operation by December 31, 2030, including biological nutrient removal and maximizing nutrient reuse. To achieve this target, the City would need to accelerate the completion of the Nutrient Removal Facilities. A constructability review was conducted that reviewed the concurrent construction of multiple projects and evaluated opportunities to complete the upgrades in 2030.

The constructability review highlighted three key risks that need careful consideration when evaluating opportunities to compress schedule: availability of resources, site limitations, and site operability. Three alternatives were evaluated:

- *Alternative 1 – Full Compliance in 2032*
This is the baseline option for the construction of the Nutrient Removal Facilities that the City had presented in the previous NEWPCC Upgrade Plan Update. It follows the original scheduled approach and assumes a Progressive Design Build (PDB) delivery method. This alternative presents the least risk and most cost and schedule certainty.
- *Alternative 2 – Full Compliance in 2030*
This approach assumes a Construction Manager (CM) delivery model using the City's current Owner's Advocate to complete the design work for the Nutrient Removal Facilities. Full compliance, based on an expanded treatment capacity of 625 MLD and biological nutrient removal, could be achieved as early as the end of 2030. This option is the most aggressive approach that also presents the highest risk in terms of cost, schedule, resourcing, quality, and plant operability during the upgrades.
- *Alternative 3 – Partial Compliance in 2030, Full Compliance in 2032*
This approach enables partial compliance in 2030. Compliance is achieved for 312 MLD with biological nitrogen removal and chemical phosphorous removal. For typical years, 312 MLD will treat almost all of the flow to the plant. On average, this would result in compliance with nutrient limits approximately 97-98% of days. Full compliance is achieved in 2032. This approach retains some risks related to cost, schedule, resourcing quality, and plant operability but to a lesser degree than Alternative 2.

The City recognizes the importance of the NEWPCC Upgrade schedule in reducing impacts on the Lake Winnipeg watershed. These upgrades are a large and ambitious scope of work. Planning work this complex must carefully consider a balance of schedule, risk, and affordability.

Based on the results of the review, the City recommends proceeding with Alternative 1 – Full Compliance in 2032. This approach 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. It also best manages the many operational risks associated with upgrading an active treatment plant.

Since Alternative 1 (Full Compliance in 2032) and Alternative 3 (Partial Compliance in 2030, Full Compliance in 2032) require the same steps and actions until 2026, the City will continue to explore ways of achieving partial compliance with the market. It may be possible to work collaboratively with the design-builder to complete the full design, obtain a construction price, minimize risks, and prioritize the portion of construction that would allow for partial compliance to be achieved around 2030.

Alongside the constructability review, the City undertook a review of possible funding scenarios to complete the upgrades. This review highlighted potential affordability concerns for ratepayers if federal and/or provincial funding could not be obtained for the additional cost of the Biosolids Facilities and the Nutrient Removal Facilities projects. To date, the City has secured external funding of \$581.11 million for the \$2.36 billion upgrade projects. This equates to \$1.77 billion, or 75%, of licence compliance work to be funded by ratepayers. The City will continue to look for opportunities to secure additional funding for these critical upgrades.

The constructability and funding reviews are iterative in nature and will continue to be refined as further information on the project schedule and funding is received. The City anticipates being able to provide an update to the NEWPCC Upgrade Plan by the end of 2024 or early 2025. A further update is anticipated following the completion of the development phase of the Biosolids project.

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

- Interim Chemical Phosphorous Removal is in progress and will be complete in the second quarter of 2024.
- Power Supply Upgrades are complete, providing the necessary electrical supply and power to site for the future upgrades.
- Headworks Facilities construction is underway, 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 and tendering.
- Biosolids Facilities is in the procurement phase. Two proponents have been shortlisted to respond to Step 2 of the Request for Proposal to select the design-builder.
- Nutrient Removal Facilities enhanced preliminary design is underway with an expected completion mid-2024. This work will enable the City to obtain a revised class 3 cost estimate for construction. Market soundings to determine potential delivery models for this project will begin early 2024.

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1. Introduction

The City of Winnipeg's North End Sewage Treatment Plant (NEWPCC) requires upgrading to meet the specifications of its Environment Act Licence and The Water Protection Act.

In 2022, Manitoba Environment and Climate Change (the Province) mandated the City of Winnipeg (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 fourth update NEWPCC Upgrade Plan. This report presents the results of a constructability review conducted by SMA Consulting Ltd. that considers the benefits and risks associated with the concurrent construction of multiple projects at NEWPCC in an accelerated timeframe. This report also provides information on funding scenarios for this work. Finally, a status update is provided on the Interim Chemical Phosphorous Removal project and the various ongoing and planned NEWPCC Upgrade projects.

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

2. Constructability Review

Several major projects need to be delivered to meet licence compliance at NEWPCC. The 2022 Plan Update proposed the completion of all the upgrades in 2032. That scope of work requires the concurrent delivery of projects. Figure 1 shows the various overlapping procurement, design, and build phases required to realize this objective. This level of project integration presents a number of challenges and risks that need to be considered when determining a schedule to do this work.

In 2022, the Province mandated the City to review ways to complete the upgrades in 2030. To achieve this target, the City would need to accelerate the completion of the Nutrient Removal Facilities. A constructability review was undertaken with SMA Consulting Ltd. to determine the feasibility of this in conjunction with delivering the other projects identified in Figure 1. The SMA Consulting Ltd. constructability review report is included in Appendix 1. The baseline schedule included a number of constraints and considerations inherent in the 2032 completion timeframe. Accelerating the Nutrient Removal project further increases the complexity of this project. Therefore, careful consideration of these issues is even more critical. Some of the key areas of risk highlighted in the constructability review are outlined following Figure 1.

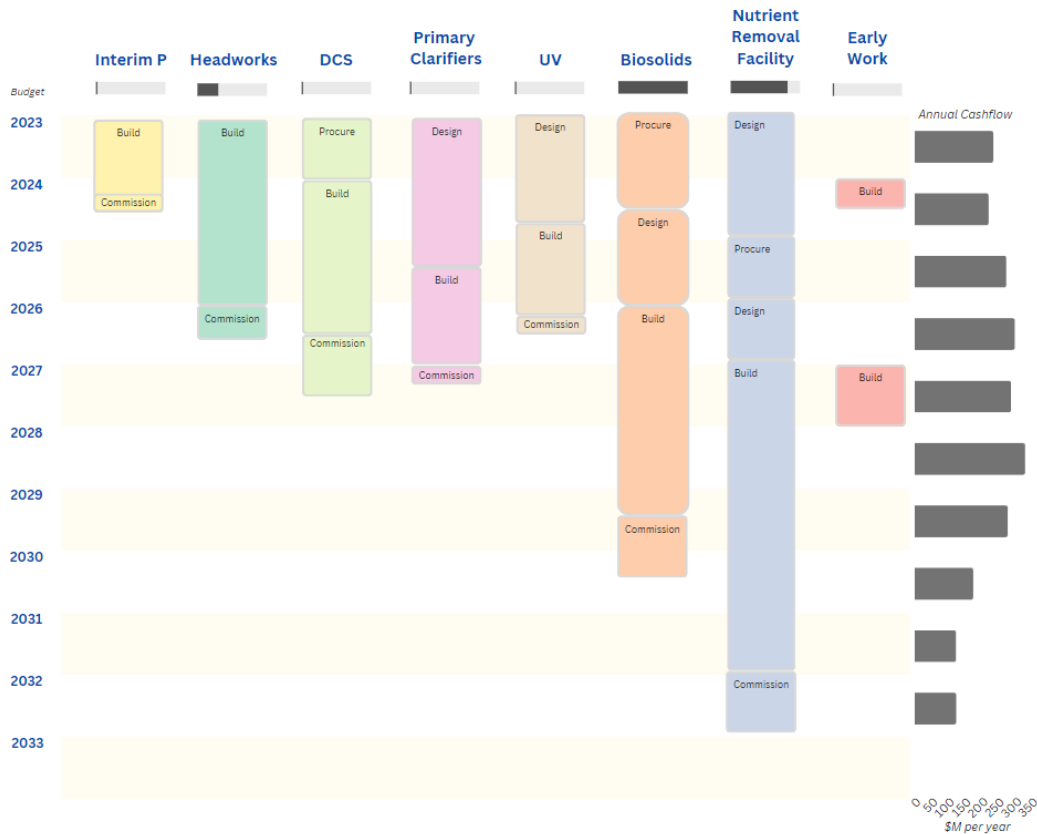


Figure 1: NEWPCC Upgrade Projects (Baseline Schedule)

Considerations & Constraints

Availability of Resources

As part of the constructability review, a high-level market analysis was undertaken which included reviewing the capacity of both the design and the construction markets for this magnitude of specialized work. The following considerations were identified:

- The local, national, and international construction markets are saturated due to the volume of large-scale projects being undertaken, including significant projects in the wastewater sector in North America.
- There are limited professional engineering firms available that could provide design services for these NEWPCC projects. The construction market has communicated the difficulty in retaining designers on other City projects.
- Internal City resources are also limited which impacts both project delivery and the commissioning of projects. The ability to augment resources is limited due to a national shortage of engineers and specialized operators.
- Contractors may have difficulties meeting targets due to the quantity of concurrent projects with similar social procurement requirements.

Site Limitations

The NEWPCC Upgrades are confined to an existing footprint that is bounded by developed areas, existing roads, and railways. A logistical review of the site was undertaken and highlighted the following considerations:

- The limited laydown areas need to be carefully evaluated when considering the concurrent scheduling of projects to ensure the efficiency of construction and safety.
- There are limited entry/exit points to the site which can cause issues for both contractors and City personnel.
- The overlapping workspaces impact safety for ongoing operations as well as construction work; there will be significant volumes of people moving around an operating site.
- Overlapping and/or constrained laydown and construction areas will also have a significant impact on the cost of construction work.

Figure 2 shows the existing plant as well as the upgrade and laydown areas, demonstrating the extent to which the existing footprint is constrained.



Figure 2: NEWPCC Construction and Laydown Map

Plant Operability

All the upgrade projects are being undertaken within the confines of a plant that operates 24/7 and must continue to maintain licence compliance. This presents a number of critical risks that must be considered, including:

- As NEWPCC is the only sludge treatment plant for the entire city, there are no opportunities to take process components offline for significant periods of time.
- Construction tie-ins from new facilities to the existing ones may be difficult and require careful planning and execution due to potential unknowns, including accuracy and availability of existing facility records, condition of existing assets, and site geotechnical considerations.
- The delivery of the NEWPCC Upgrade projects will occur over a long period of time. During this time the NEWPCC is susceptible to periodic major flooding and/or weather events which could impact the construction schedule.

- Various aspects of the upgrades (construction, commissioning, and tie-ins) require shutdowns and/or need to be done during limited windows, such as low flow periods or specific seasons. This provides a constraint on scheduling, particularly with overlapping projects.
- Excessive shutdowns may impact plant performance putting licence compliance at risk.

Mitigative Measures

A summary of the potential mitigative measures and residual risks for the considerations and constraints identified in the previous section is included in Table 1.

Table 1 Mitigative Options for Considerations and Constraints

Consideration/Constraint		Options to Mitigate/Residual Risks
Availability of Resources	Saturation of construction markets	Complete market sounding to gauge interest and delineate risk. Residual risks include cost premiums and schedule overruns if market cannot support a project of this scale.
	Limited professional engineering firms available/National shortage of engineers and specialized operators	Complete market sounding to gauge interest and delineate risk. Early notice of projects may help encourage engineering firms to build-up staff complement. Ensure procurement does not preclude out of Province firms. Residual risks include cost premiums and schedule overruns if professional engineering firms do not have capacity.
	Limited internal City resources	Create temporary positions using capital funds. Unionized environment restricts City's ability to enhance recruitment using salary incentives. Support City resources via strategic partnership with Veolia and/or Owner's Advocate as needed. Residual risk includes potential lack of knowledge of City processes.
	Difficulty meeting social procurement targets	Provide ongoing training opportunities for industry to increase knowledge of social procurement requirements. Pilot social procurement requirements during Early Works and Biosolids projects. Modify social procurement targets as needed if industry cannot respond adequately. Residual risks are considered negligible.
Site Limitations	Limited laydown areas	Develop a model of the site which will be updated/maintained. Inform Bidders during procurement stage of potential overlaps/constraints. Designate a full-time logistics coordinator to manage conflicts. Hold daily coordination meetings and weekly planning meetings with all project leaders and key operating personnel. Residual risk includes potential for cost premiums and schedule overruns due to site limitations.
	Limited entry/exit points	
	Safety impacts of overlapping workspaces on ongoing operations and construction work	
	Cost impacts of overlapping and/or constrained laydown and construction areas	
Plant Operability	No opportunities to take sludge process components offline for significant periods of time	Conduct constructability reviews and thorough planning with Operations to minimize impacts to plant. Conduct regular coordination with Operations during construction. Residual risk includes potential for schedule and cost overruns as operational requirements cannot always be predicted and will ultimately control tie-in and shutdown timing.
	Difficulty with construction tie-ins due to potential unknowns	Conduct early investigation of tie-ins and complete daylighting as needed to delineate risk. Residual risk includes potential for cost overruns due to unknown-unknowns.

	Risk of periodic major flooding and/or weather events and schedule impacts	Include in specifications the potential for flooding and other operational concerns to disrupt construction. Plan work around flooding season. Residual risk includes potential for significant weather events to cause schedule overruns.
	Limited shutdown windows and constraints on scheduling	Integrate lessons learned from SEWPCC into shutdown planning. Heavily concentrate on commissioning planning during the design phase. Conduct regular coordination with Operations. Retain a commissioning agent to oversee commissioning. Avoid commissioning during cold weather, if possible. Residual risk includes the potential for schedule and cost overruns risk as operational requirements will ultimately control tie-in and shutdown timing.
	Impact of excessive shutdowns on plant performance and licence compliance	

Alternative Evaluation

A general constructability review was undertaken to inform the overall upgrade timeframe. Based on the current status of the major projects, the focus for meeting the 2030 timeline was on accelerating the delivery of the Nutrient Removal Facilities. With the identified constraints and considerations in mind, along with lessons learned from the South End Sewage Treatment Plant (SEWPCC) Upgrade project, overall schedule compression presents significant risk to the success of the project as well as the operation of the existing plant. As such, the review examined alternative scenarios for staging the Nutrient Removal work and assessed their risks and benefits.

Three potential alternatives, described below, were evaluated, including the risks and benefits of each. These scenarios will be refined as work progresses on the various projects within the upgrade. Due to ongoing market volatility, detailed market soundings will be required to determine the viability of procurement methods prior to posting Request for Proposals (RFP). Experience gained from the Biosolids Progressive Design Build (PDB) will also help inform the practicality of the procurement delivery method, including timelines and resource requirements.

Alternative 1 – Full Compliance in 2032

This is the baseline option for the construction of the Nutrient Removal Facilities. It follows the originally scheduled approach and assumes a PDB delivery method, see Figure 3.

Advantages:

- The sequential construction plan provides the least logistical challenges in terms of project staging
- Provides the most schedule certainty
- Familiar procurement method
- Least pressure on design, construction, and project management resources
- Least amount of competition for laydown areas and site access
- Least amount of temporary work required resulting in the most cost-effective build
- One commissioning period which minimizes impacts on the operation of the existing plant and provides the most efficient commissioning

Disadvantages:

- Procurement takes time since it's delivered in two phases (design phase, followed by construction phase) and requires the development of technical requirement documentation
- No nutrient removal beyond the interim chemical phosphorous removal until the program is complete
- Full compliance isn't achieved until 2032

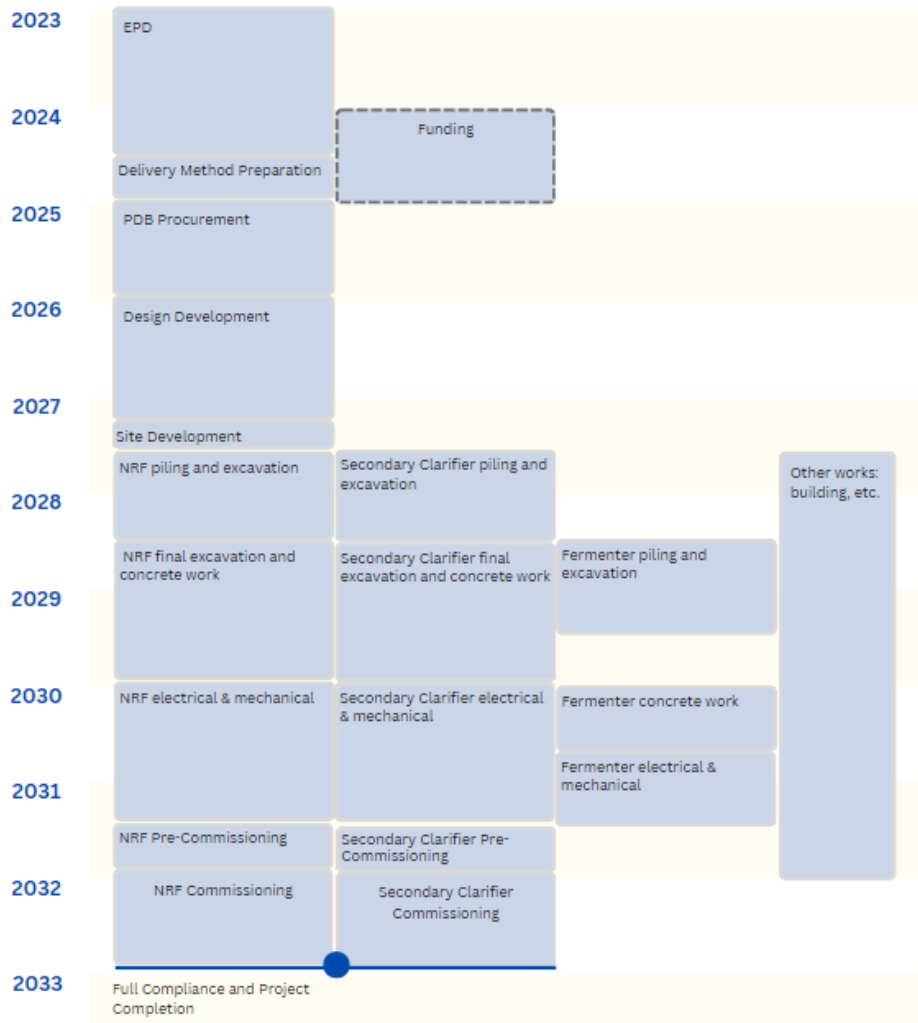


Figure 3: Alternative 1 - Full Compliance in 2032

Alternative 2 – Full Compliance in 2030

This is the most aggressive approach that also presents the highest risk. It assumes a Construction Manager (CM) delivery approach and that the City’s existing Owner’s Advocate could be assigned the full design work. This approach uses the capacity of the existing secondary clarifiers (312 MLD) to achieve partial compliance using biological nitrogen removal and chemical phosphorous removal by the end of 2028. The 312 MLD accommodates all dry weather flow and, in most years, a substantial portion of wet weather flow. On average, this would result in compliance with nutrient limits approximately 97-98% of the time. Full compliance, based on expanded treatment capacity of 625 MLD and biological nutrient removal could be achieved as early as the end of 2030, see Figure 4.

Advantages:

- Design may be able to begin immediately using the Owner’s Advocate team
- Partial compliance is achieved fastest by the end of 2028
- Full compliance is achieved by the end of 2030

Disadvantages:

- Due to the level of complexity in this schedule, it has the greatest likelihood of schedule overrun
- The success of a CM approach is highly dependent on having a qualified and well-versed CM
- Resourcing of the design team would need to be explored
- This approach comes with a significant cost premium to undertake work in a short amount of time in a saturated market
- Increased internal resources required to coordinate concurrent construction work
- Multiple crews working in parallel increases risks related to construction market capacity
- Multiple construction contracts within a confined area increases logistical complexity and safety concerns
- Highest risk to plant in terms of resourcing the work and continuity of processes due to extended commissioning period and multiple treatment scenarios
- Concurrent tenders may strain meeting social procurement targets

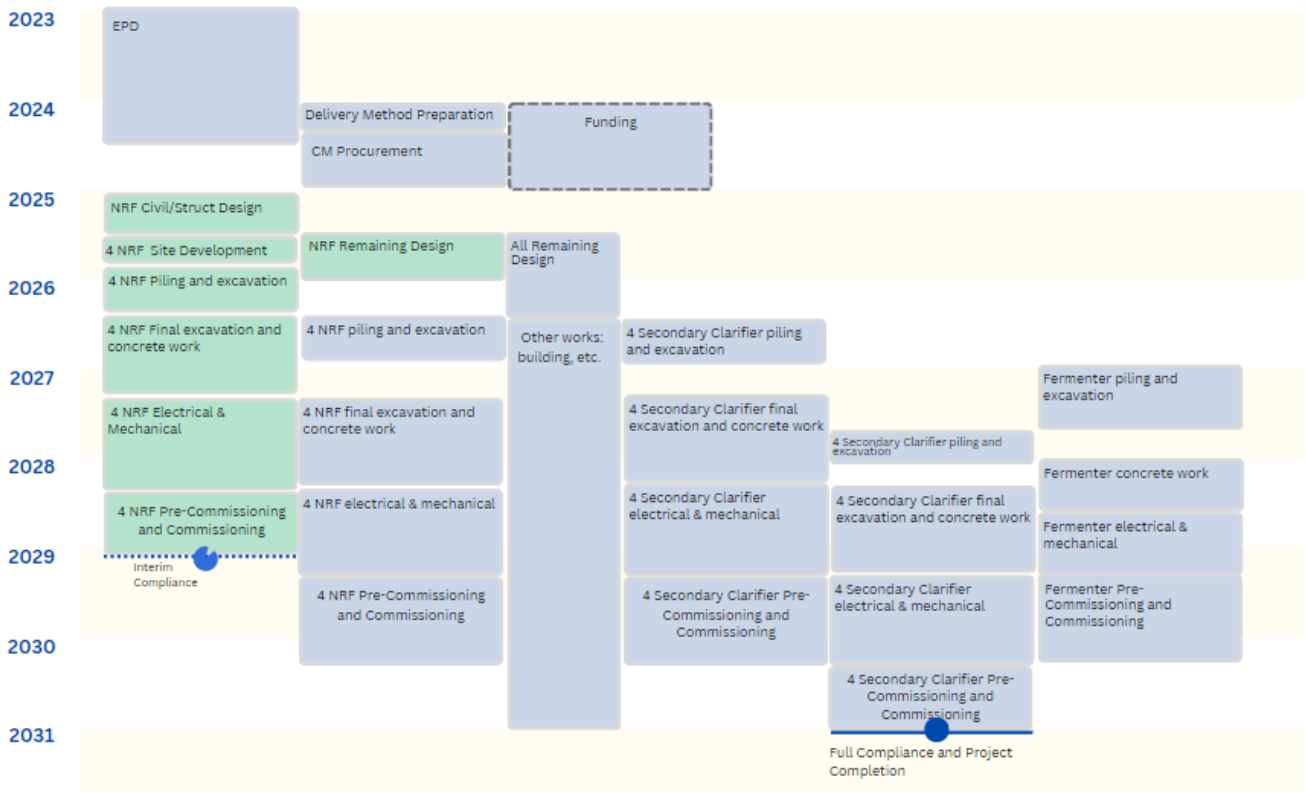


Figure 4: Alternative 2 - Full Compliance in 2030

Alternative 3 – Partial Compliance in 2030, Full Compliance in 2032

This approach provides partial compliance in 2030, with full compliance in 2032. Similar to Alternative 1, it assumes a PDB delivery method. Similar to Alternative 2 it requires some parallel staging of construction works but to a lesser extent. Partial compliance is achieved for 312 MLD with biological nitrogen removal and chemical phosphorous removal, see Figure 5. This would result in plant compliance with nutrient limits approximately 97-98% of days in a typical year.

Advantages:

- Partial compliance is achieved in 2030
- Familiar PDB procurement method could be used

Disadvantages:

- Due to the level of complexity in this schedule, there's still significant schedule risk in this approach
- Cost premium due to temporary works still being required
- Multiple construction contracts within a confined area increases logistical complexity and safety concerns
- Risk to the plant in terms of resourcing the work and continuity of processes remains due to the extended commissioning period and multiple treatment processes
- Market capacity risks remain in the early phases when multiple crews working in parallel are still required
- Procurement of the work in phases may not be palatable to the market, with potential for cost premium or schedule risk if no interested bidders
- Concurrent tenders may strain meeting social procurement targets in the early phases of construction
- A full construction cost will not be available prior to the start of construction
- Full compliance isn't achieved until 2032

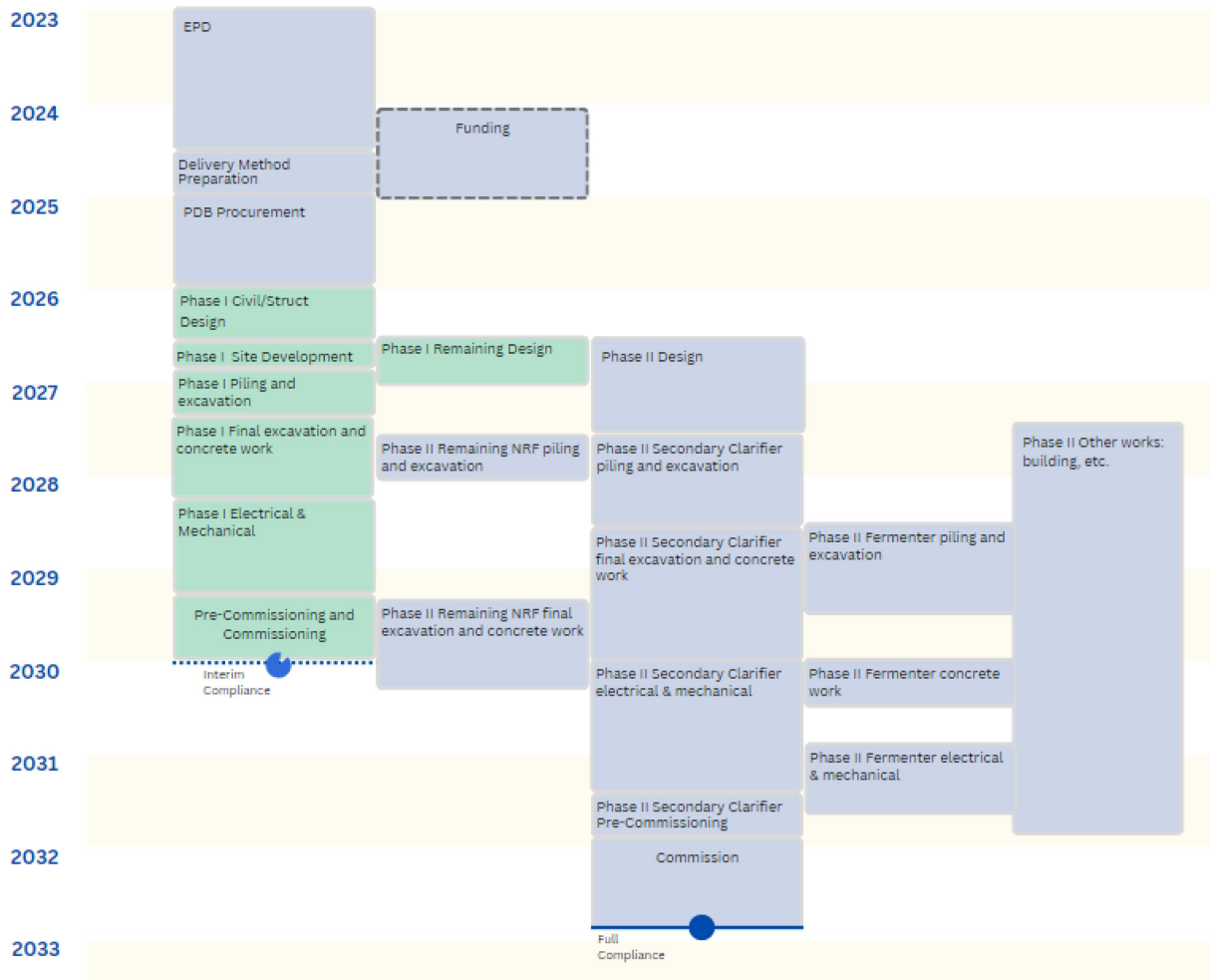


Figure 5: Alternative 3 - Partial Compliance in 2030, Full Compliance in 2032

Anticipated Phosphorus Compliance Timelines

Table 1 provides a summary of the anticipated maximum effluent concentrations and licence compliance timelines for total phosphorus for each evaluated alternative.

The assumed effluent concentration of total phosphorus during interim chemical phosphorus removal was based on AECOM Canada Ltd.'s 2020 NEWPCC Interim Phosphorus Removal Detail Review and Benchscale Testing report. The extent of total phosphorus reduction using interim chemical phosphorus removal will be validated through full scale trial and testing of the facility in 2024. It is anticipated that the interim chemical phosphorus removal system may be able to reduce effluent concentrations of total phosphorus to less than 2.5 mg/L, however this assumption will need to be confirmed by performance data.

The assumed effluent concentration of total phosphorus for flows up to 312 MLD during interim phosphorus compliance was based on performance data from SEWPCC. The extent of phosphorus

reduction assumes digester capacity is available, that infrastructure is available to run side-stream fermentation, and that biological phosphorus removal can be partially established.

Table 1 will be updated in the future to include the performance data for interim chemical phosphorus removal and will estimate total phosphorus loading at that time. A full technical review of the anticipated phosphorus removal during the interim phosphorus compliance period will be performed after completion of the enhanced preliminary design for the Nutrient Removal Facilities.

Table 2 Anticipated Maximum Final Effluent Total Phosphorus

	Alternative 1 Full Compliance in 2032	Alternative 2 Full Compliance in 2030	Alternative 3 Partial Compliance in 2030, Full Compliance in 2032
2024	2.5 mg/L ₁ [full plant capacity]	2.5 mg/L ₁ [full plant capacity]	2.5 mg/L ₁ [full plant capacity]
2025			
2026			
2027		<1.0 mg/L [Up to 312 MLD] ₂	<1.0 mg/L [Up to 312 MLD] ₂
2028			
2029		<1.0 mg/L ₃ [full plant capacity]	<1.0 mg/L [Up to 312 MLD] ₂
2030			
2031			
2032	<1.0 mg/L ₃ [full plant capacity]	<1.0 mg/L ₃ [full plant capacity]	<1.0 mg/L ₃ [full plant capacity]

Notes:

₁: Interim chemical phosphorus removal. Extent of total phosphorus reduction using interim chemical phosphorus removal to be validated through full scale trial and testing of the facility in 2024. Effluent monitoring data from 2022-2023 indicates an average effluent total phosphorus concentration of 2.7 mg/L is achievable through optimization of existing infrastructure (without interim chemical phosphorus removal).

₂: Interim phosphorus compliance (chemical and/or biological removal) for flows up to 312 MLD. A full technical review of the anticipated phosphorus removal will be performed once the enhanced preliminary design is issued in Q2 2024.

₃: Biological phosphorus removal to achieve licence limit of < 1mg/L total phosphorus.

3. Funding Review

The current funding status for the various upgrades at NEWPCC is summarized in Table 3.

Table 3 Funding Status for NEWPCC Upgrade Projects

NEWPCC Nutrient Removal Facilities (\$ millions)	Total Cost	Total Funding		Unfunded	Committed City Costs
		Federal	Provincial		
Interim Chemical Phosphorous Reduction	19.30				19.30
Power Supply and Headworks Facilities	473.38				42.50
		116.11	96.75		218.02
Biosolids Facilities	1035.00	200.87	167.38		666.75
Nutrient Removal Facilities	828.06			810.06	18.00
Estimated Total Costs	2355.74	316.98	264.13	810.06	964.57

Interim Chemical Phosphorous Removal

On February 25, 2021, the City Council (Council) approved the NEWPCC Interim Chemical Phosphorus Removal Upgrades capital project with an AACE Class 4 capital cost estimate of \$10.5 million. A budget increase of \$6.5 million was approved by Council on July 21, 2022. The total updated cost of the project is \$19.3 million and is financed by the City.

Power Supply and Headworks Facilities

The City secured funding for the Headworks Facilities portion of this project under the Investing in Canada Infrastructure Program (ICIP) on May 31, 2021. The Power Supply Upgrade portion was advanced prior to ICIP funding at a cost of \$42.5 million funded by the City. It is currently in operation providing redundancy to the overall power system.

In addition to the Headworks upgrades, the Headworks Facilities funding also includes funds for Distributed Control System (DCS) Migration, Primary Clarification Upgrades, and UV Facility Upgrades. The allocated budgets for the last three projects are based on 2018 estimates; actual costs may increase based on current market conditions.

Biosolids Facilities

The Biosolids Facilities project was approved for ICIP funding on December 20, 2022, based on the 2018 budget of \$552 million. Due to several factors, including growth, changed market conditions, the requirement to provision for interim chemical phosphorous removal and project delays, the 2023 cost estimate increased by \$482 million to \$1.035 billion. Council amended the Biosolids budget on September 29, 2023, to facilitate procurement for this critical work and to demonstrate the City’s commitment to completing this project. The increased cost 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 intent of the original funding split for eligible costs of 40% Federal, 33.33% Provincial, and 26.67% City.

The additional cost of the Biosolids project may have a substantial impact on ratepayers and the affordability of services. Figure 6 illustrates the estimated average household water and sewer bill impact under different Biosolids funding scenarios (family of four, 200 m³ annual consumption).

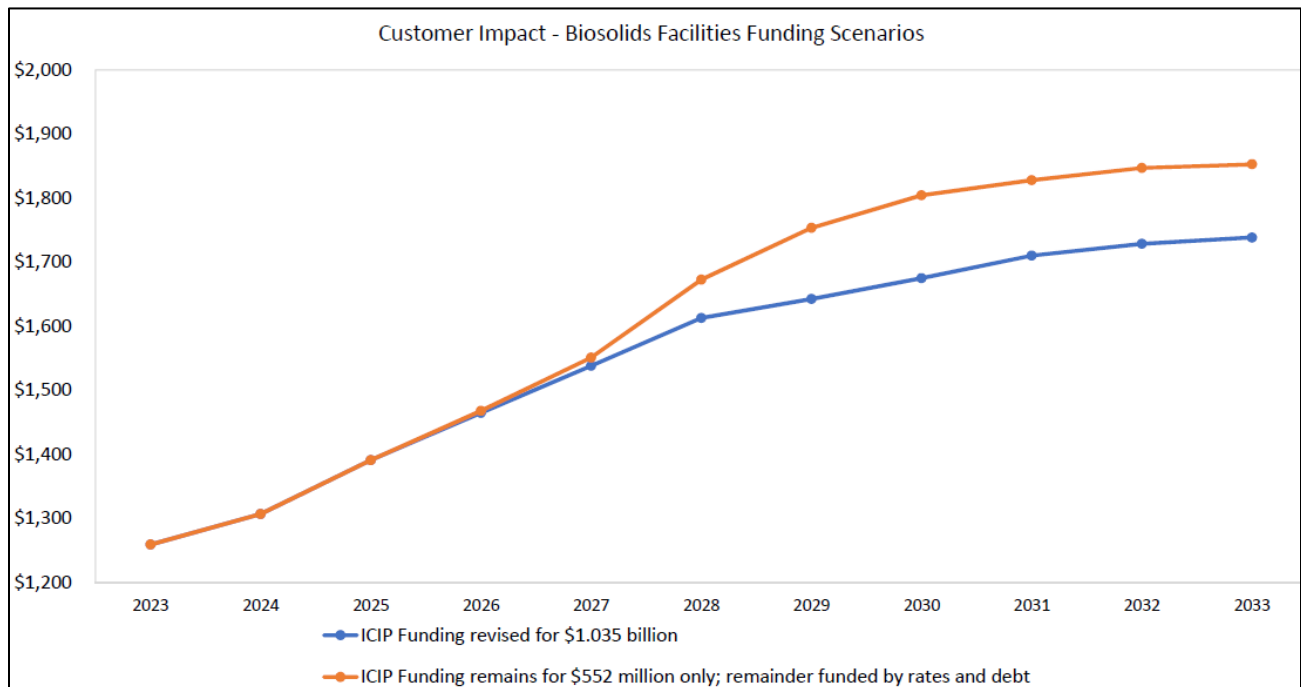


Figure 6: Customer Impacts of Biosolids Budget Increase Scenarios*

* Excludes projected Nutrient Removal project costs. All scenarios are subject to change and are intended for illustrative purposes only.

Nutrient Removal Facilities

The 2018 cost estimate for the Nutrient Removal Facilities is \$828 million. The Enhanced Preliminary Design (EPD) is currently underway and will provide an updated Class 3 estimate for this work by mid-2024.

On January 26, 2023, Council approved 2022 and 2023 capital budgets totaling \$18 million for the Nutrient Removal Facilities. These funds allowed the Public Service to advance the EPD, and complete a market analysis to determine the procurement method and work during the procurement phase up to the award of contract. To date, no external funding has been secured for the remainder of the Nutrient Removal Facilities' design and construction. The City will continue discussions with the Province on a funding structure for this project. Should funding not be secured, the Public Service will submit a budget request and revised rate report to the Council for approval.

The customer impacts if no external funding is secured for the Nutrient Removal project will be substantial and have an effect on the affordability of services. For example, if funding for the Nutrient Removal Facilities is shared equally between federal and/or provincial funding, debt and rates, the annual water and sewer bill for an average residential customer will be 17% or \$3,040 less over the 10-year period than if the project is funded fully by sewer rates alone.

4. NEWPCC Projects Progress Update

Interim Chemical Phosphorous Removal

The Interim Chemical Phosphorous Removal project addresses short-term phosphorous removal at NEWPCC while construction activities for both biological phosphorous removal and other licence parameters (solids removal, ammonia removal, etc.) are in progress.

Design and construction of the Interim Chemical Phosphorous Removal Facility began in 2021. In 2022, the design for the Interim Chemical Phosphorous Removal Facility was completed and a contract was awarded for construction. Construction of the facility and associated rail works continued in 2023.

The Interim Chemical Phosphorous Removal Facility will reach substantial completion in the second quarter of 2024. Following commissioning, total phosphorous is expected to be at or near licence limits for portions of the year through chemical use. Full-scale trial and testing of the facility will determine the extent to which phosphorus can be removed. This is planned to take place over the course of a year to determine the seasonal impacts of chemical dosing.

An analysis of modelled data found that the future biosolids facility would be at 99% capacity by the end of 2031 using chemicals 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:

- 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

To date, the monitored total phosphorous concentrations at NEWPCC indicate the plant has been significantly outperforming anticipated modelled data. Further, the City is working on decreasing sludge loading to the existing digesters through various projects to remove inert and biological solids such as grease and scum removal at NEWPCC and improved grit and screening at the West End Sewage Treatment Plant (WEWPC). The City will maximize phosphorous removal within the existing digester capacity to the greatest extent possible through the various dosing points.

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 completed in 2020 and is now under warranty.

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

A design-build agreement for the Headworks Facilities was executed in 2021.

The Design-Builder has completed the 30% and 60% designs for the project, with 90% and Issued for Construction designs advancing for various areas.

Construction has progressed throughout the site, with the following major work items undertaken in 2022 and 2023:

- Installation of piles
- Excavation of two of three deep chambers and partial excavation of the third
- Completion of microtunnelling for two of three tunnels
- Construction of an underground tunnel for plant employee travel
- Installation of concrete structures for the Solids Handling and Mechanical Rooms
- Erection of the Standby Generator Building and installation of standby generators and associated fuel tanks
- Erection of the Grit Building
- Erection of structural steel for the Main Control Building
- Installation of rebar for the Fine Screening Building with concrete pours ongoing

As of November 30, 2023, the Design-Builder has been paid for 43 of 218 Milestones.

To complete the Headworks upgrades, the Design-Builder will be working on the following:

- Completion of the 90%, and Issued for Construction Design Submissions
- Completion of microtunnelling and chamber construction
- Completion of the Solids Handling and Mechanical Rooms
- Completion of concrete pours for the Raw Sewage Pumping Station and erection of the building
- Completion of the Fine Screening Building
- Completion of the Main Control Building
- Installation of the fine screening system

- Installation of the grit removal system
- Installation of the raw sewage pumps
- 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 NEWPCC Upgrade: Power Supply and Headworks Facilities project also funds three ancillary upgrade projects.

- *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. Implementation of the overall DCS Migration is expected to occur approximately from early 2024 through mid-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. Scum is collected off the primary clarifiers and is currently sent directly to the digesters. Dewatering the scum will allow it to meet a consistency that can be landfilled. 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 2025. Construction of the Scum Dewatering Building is expected to be completed in 2027.

- *UV Upgrades*
The UV Upgrades project will replace the outdated UV system required for the upcoming Biosolids Facilities. The new technology in the UV system is expected to decrease power consumption by about 75%. Work also includes the installation of new transformers to service the building and the UV system. Construction is expected to occur from late 2024 to mid-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 maximizing biosolids reuse. This project includes new digesters, thermal hydrolysis equipment, phosphorous recovery equipment, and sludge handling facilities. Due to the capacity limitations of the current digesters, the Biosolids project is also critical to support growth in Winnipeg and the Capital Region.

On July 21, 2022, Council directed the Biosolids Facilities project to use a Design-Build (DB) delivery model. To maximize participation in the Biosolids Facilities project, the City conducted market soundings in early 2023 on the proposed project terms. The results concluded minimal interest in this project if it proceeded using a traditional DB model. The market strongly recommended a more collaborative delivery model to better share risks. On July 13, 2023, Council approved the use of a PDB procurement model.

RFP Step 1 was released to the market on July 14, 2023, with the goal to shortlist up to three proponents. On December 1, 2023, the City publicly released the names of two shortlisted proponents, who were invited to participate in RFP Step 2 on December 7, 2023.

RFP Step 2 is scheduled to be completed in Q2 2024. By the end of this stage, the City will select one development partner to collaboratively work with on the design and pricing of the Biosolids Facilities. This development phase is anticipated to be completed in Q4 2025.

Due to rapidly changing market conditions, the City obtained a revised cost estimate in 2023. This showed substantial increases in costs. On September 29, 2023, Council increased the Biosolids Facilities capital budget by \$482 million, for an amended budget of \$1.035 billion.

Nutrient Removal Facilities

The Nutrient Removal Facilities is the third and final major project required to upgrade NEWPCC to meet its Environment Act Licence. The EPD for the Nutrient Removal Facilities was initiated in late 2023.

Work in 2024 will focus on completing the EPD, engaging an independent cost consultant to help develop a revised class 3 cost estimate, and commencing market soundings to determine the most appropriate procurement method to use to deliver this project. The City will also continue to review opportunities to accelerate the completion of this project and will continue to refine the overall upgrade schedule as individual project schedules are advanced.

5. Recommendation and Next Steps

Recommendation

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 approximate \$2.3 billion NEWPCC Upgrades are a large and ambitious scope of work. Planning work this complex must carefully consider a balance of schedule, risk, and affordability.

The Province requested that the City review alternatives to complete the upgrades in 2030. While the constructability review identified that a technically feasible alternative exists (Alternative 2), it can't be understated that this comes with a significant risk to the overall objective of these upgrades. An overly aggressive schedule has the potential to not only lead to construction delays beyond 2032 and cost overruns but also to long-term quality and performance issues. Further, the compressed schedule presents significant operating risks to the plant which must be taken into consideration.

The review also identified an option, Alternative 3 – Partial Compliance in 2030, that could possibly meet partial compliance in 2030 with full compliance achieved in 2032. This approach still retains significant risk and presents many unknowns. Even though the PDB procurement method is familiar to the industry, the delivery of the project in a phased approach is atypical and may present

significant procurement challenges, including budget approval since the full cost of the work will not be available prior to starting construction. In addition, the complexity of phased design and construction works could result in a further elongated schedule and would come at a cost premium.

Based on the results of the review, the City still recommends proceeding with Alternative 1, full compliance in 2032. While this approach does not meet the preferred 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. It also best manages the many operational risks associated with upgrading an active treatment plant.

Nevertheless, since Alternative 1 (Full Compliance in 2032) and Alternative 3 (Partial Compliance in 2030, Full Compliance in 2032) options are effectively the same up until 2026 execution, the City intends to use the intervening time to explore ways of achieving partial compliance with the market. It may be possible to work collaboratively with the design-builder to complete the full design, obtain a construction price, minimize risks, and prioritize the portion of construction that would allow for partial compliance to be achieved around 2030.

Next Steps

The constructability and funding reviews are iterative in nature and will be continually refined as further information on the project schedule and funding is received.

The following work is anticipated to be undertaken in the first three quarters of 2024.

- Headworks: Continued construction of the Headworks Facilities and other ancillary upgrade projects
- Biosolids: Engage the Biosolids PDB partner and develop a preliminary construction schedule
- Nutrient Removal:
 - Complete the EPD
 - Engage a third-party cost consultant and develop a revised Class 3 cost estimate
 - Undertake preliminary market sounding

Based on the results of the information above, the City anticipates being able to provide a construction schedule update by the end of 2024 or early 2025. A further update is anticipated following the completion of the development phase of the Biosolids project.

Throughout the schedule refinement process, the City will continue to engage with other levels of government to explore opportunities for external funding for the Nutrient Removal project.

While the City is currently recommending the baseline schedule with completion in 2032, options to advance work packages, with the potential for a partial compliance plan, will continue to be explored and evaluated.

Appendix 1 – SMA Consulting Ltd. Constructability Review



Date
2023-12-22

Prepared by
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North End Sewage Treatment Plant Upgrades

Constructability Review Results Report



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.

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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. 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. This initial assessment will be followed by regular updates at key milestones as the biosolids procurement concludes and the biosolids and nutrient removal facility designs mature. The City of Winnipeg has retained SMA Consulting for the review, a specialized construction management consulting firm based in Edmonton. 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 is the updated master schedule and this report, with a focus on the achievability of 2030 as a target completion date.

Understanding and Review Outcomes

Program Overview

There are eight key projects included in the expansion program, which together represent approximately \$2.35 billion in new construction at the plant, with annual cash flow of \$200 to \$300 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
Biosolids	Design and construction of a new biosolids treatment facility, being delivered via progressive design build.	In procurement	\$1.03 billion, ICIP funding
Nutrient Removal Facility	Design and construction of a new biological nutrient removal and secondary clarification facility to treat phosphorus and nitrogen. Delivery method is actively being pursued but additional market feedback will be required and the decision will be made based on those market soundings.	Unfunded, in preliminary design	\$828 million, unfunded
Headworks	Design and construction of a new Headworks facility, being delivered via design build.	In progress, expected completion in 2025 - Update to schedule coming once Relief Events are confirmed	\$475 million, City of Winnipeg/ICIP funding. Includes several projects.
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	
Interim Phosphorus Removal	Addition of chemical storage and distribution lines to various areas of the plant to provide chemically enhanced phosphorus removal	In progress, completion expected in 2024	\$19 million, City of Winnipeg funding

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Project	Description	Status	Project Value
Early Work - Biosolids and Nutrient Removal	Preparatory connections, piping, and other work to streamline future construction	Planning	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:

- **Funding availability.** The Nutrient Removal Facility project cannot move forward without funding; this is currently one of the most critical schedule risks.
- **Market and resource constraints.** This includes availability of design personnel, project management (PM) resources, and market conditions. 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.
- **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 Nutrient Removal Facility 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 Nutrient Removal Facility project will involve very significant deep excavation. Access and laydown are also especially challenging for the Nutrient Removal Facility project as traffic will likely have to cross the entire length of the plant; the north and east sides are blocked by rail lines.
- **Flooding.** The plant is in a sensitive area and there is the potential for high water to delay or affect construction. Some equipment, and certain construction activities such as tie-ins, can only

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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 previous SEWPCC experience indicated that schedule is a major concern and 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, and 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 Nutrient Removal Facility and the Biosolids projects.

Funding

As noted, a key driver for schedule at the moment is finding funding for the Nutrient Removal Facility project. The team explored the potential for other sources of funding, such as self-funding via utility rates. Projections indicate that this may be challenging, so 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 and reduce schedule. Potential delivery methods were explored for the Nutrient Removal Facility 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.

Schedule

In the light of the previous information gathered, 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 Nutrient Removal Facility project. Following the review, the baseline schedule for the work was found to extend until the end of 2032, which is well past the 2030 deadline for meeting nutrient targets; see Figure 2 for the overall program schedule roadmap. The key factor is the Nutrient Removal Facility project, which is currently in preliminary design. As noted

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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 the end of 2024, but any delay will translate into a delay to the overall project end date. Given the critical nature of the Nutrient Removal Facility project, the team chose to focus the schedule analysis there, and several options were explored for efficiency and acceleration.

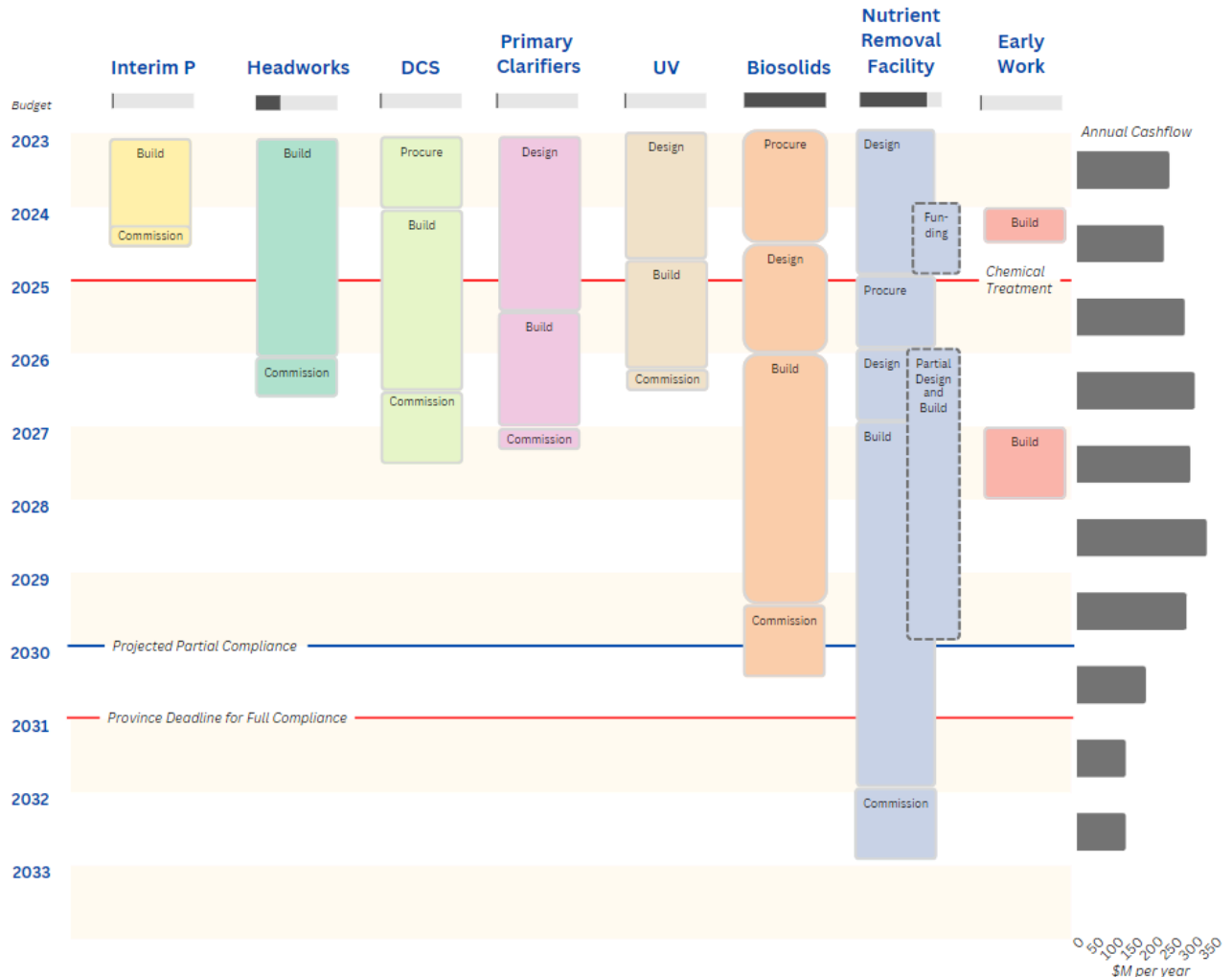


Figure 2. Schedule roadmap of the upgrade work.

Schedule Analysis, Project Staging, and Partial Compliance Option Comparison

The team began with a thorough review of the baseline schedule, comparing against SEWPCC as-built productivity rates and discussing assumptions and sequencing. The current baseline schedule, with compliance in 2032, already assumes improvement over SEWPCC productivity rates. Additional review included the challenges and constraints affecting the project, the overall market and capacity constraints, and the recent lessons learned and schedule data from the SEWPCC nutrient removal facility upgrades. Taken together, these factors indicate that the baseline schedule assumptions are reasonable, and reductions in schedule duration are not likely to be successful and could pose significant risk to the operation of the existing plant.

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The overall focus for schedule option development therefore turned to a project staging approach based on SEWPCC experience. This approach uses the existing secondary clarifiers and prioritizes initial design and construction of nutrient removal tanks in Phase I, taking advantage of the flexibility of alternative delivery methods such as PDB or CM. This initial phase involves construction and commissioning of approximately 20% of the overall project. The phased approach would allow nutrient removal from 312 MLD through a combination of biological nitrogen removal and chemical treatment for phosphorus; SEWPCC experience indicates that operation of the nutrient removal tanks is also expected to result in some biological phosphorus removal without the need for fermenters, which would reduce the amount of chemical treatment required.

The 312 MLD capacity is sized to the capacity of the existing secondary clarifiers accounting for redundancy, and would accommodate all dry weather flow and a substantial portion of wet weather flow. See Table 2. In typical years almost all flow could be treated; in 2020 and 2021 more than 97% of days had average flow less than 312 MLD. The year 2022 was an unusually wet year with 80% of days averaging flow less than 312 MLD.

Table 2. Percent of days where the average exceeds the given flow level

	312 MLD (partial compliance option)	625 MLD (design level)
2020	3%	0%
2021	2%	0%
2022	21%	2%

The options are described below in Table 3 and Figure 3. More details of the options, including schedules, full performance comparison, and differential risk analysis, are shown in Appendix A. The team initially developed a maximum acceleration option (the “Full Compliance in 2030” option) and a phased option (the “Partial Compliance in 2030, Full Compliance in 2031” option), via certain assumptions:

1. Using the existing design team to complete the full design, with a focus on initial completion of the civil and structural design for the initial phase of work.
2. Approval of use of a CM delivery model, novel to Winnipeg Water and Waste, to allow construction of the initial phase to begin as soon as the initial civil/structural design was ready.
3. Additional crews working in parallel for some or all of construction and the capacity of the market, owners, and consultants to handle this aggressive schedule.
4. Ability of Winnipeg to fund either the initial design (if completed prior to funding approval) or the full project.
5. Ability of plant operators to handle multiple or extended commissioning phases and different operation modes.

Even given these assumptions, project completion for the maximum acceleration option (“Full Compliance in 2030”) was still expected at the end of 2030 or beginning of 2031, and there were significant schedule and cost risks associated with some aspects, including extension of the design contract, the schedule required for preparation and use of a novel delivery method, and operational risk due to three or more modes of operation and multiple years of continual commissioning. In addition, as

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this option assumes multiple work faces and work crews for the entire duration, the risk of schedule delays is high. The phased approach (“Partial Compliance in 2030 and Full Compliance in 2031”) was better operationally than the maximum acceleration option as it had fewer modes of operation and two distinct commissioning periods. The relaxation of overlapping activities, with the use of multiple work faces and work crews only for the initial phase, also posed less schedule risk. However, the procurement schedule risk and the potential inability to extend the design contract remained.

To address these risks, a third option was developed (see “Partial Compliance in 2030 and Full Compliance in 2032” in Table 3). This approach made use of the more-familiar PDB delivery method but adopted the phased approach from the “Partial Compliance in 2030 and Full Compliance in 2031” option shown in Table 3. In this option, only four tanks are planned for Phase I. The procurement stage is longer than a CM delivery method, but other benefits remain. As with the “Partial Compliance in 2030 and Full Compliance in 2031” option, this approach is more reasonable from an operational perspective and has less construction-phase risk than the “Full Compliance in 2030” option (Table 3). This is because there are only two modes of operation and two commissioning periods, and the schedule for reaching full completion is more relaxed. The “Partial Compliance in 2030 and Full Compliance in 2032” Approach is projected to achieve partial compliance with treatment of dry weather flows up to 312 MLD in 2030.

With this approach, once the design for Phase I has completed, Phase II design and construction follows; full project completion is still expected by the end of 2032. This option will result in some cost premium given the additional complexity of staging the work in this manner, but achieves up to three more years of biological nitrogen removal. Once the options were developed sufficiently, a differential risk analysis was performed on the “Full Compliance in 2032” option, the “Partial Compliance in 2030 and Full Compliance in 2032” option, and the “Full Compliance in 2030” option. The results of this analysis are shown in Table 4; the “Full Compliance in 2030” option was the highest risk, while the other two options are relatively similar in profile. See Figure 3 for an overview of all options and Appendix A for more details, including the differential risk analysis details and full performance comparison.

Table 3. Phasing and delivery options

	Full Compliance in 2032	Full Compliance in 2030 (Maximum Acceleration Approach, 4 Nutrient Removal Tanks)	Partial Compliance in 2030, Full Compliance in 2031 (5 Nutrient Removal Tanks)	Partial Compliance in 2030, Full Compliance in 2032 (4 Nutrient Removal Tanks)
Description	Original scheduled approach, delivered via PDB	Partial compliance approach with acceleration via multiple crews working in parallel, assuming existing designer and CM delivery	Partial compliance approach with acceleration on initial phase, assuming existing designer and CM delivery	Partial compliance approach with acceleration on initial phase, delivered via PDB
Delivery	PDB	CM	CM	PDB
Completion	Partial N/A Full late 2032	Partial late 2028 Full late 2030/early 2031	Partial early 2029 Full late 2031	Partial late 2029 Full late 2032
Advantages	Operationally least disruptive, least temporary work, least risk of losing schedule	Fastest partial compliance and planned completion	Balance between partial compliance and schedule risk	Balance between partial compliance and schedule risk Familiar delivery model
Challenges and Risks	Slowest planned completion Longest period of no biological nutrient removal Highest risk of extending period of no biological nutrient removal	Risk of potential procurement delays with unfamiliar method, and may not be possible to continue with current design team Most operationally challenging Significant risk of schedule overrun, disputes, and harm to the plant Significant cost premium expected	Risk of potential procurement delays with unfamiliar method, and may not be possible to continue with current design team Moderate operational challenges. 5 tanks does not add value given redundancy needs for secondary clarifiers. Some cost premium expected	Moderate operational challenges Some cost premium expected

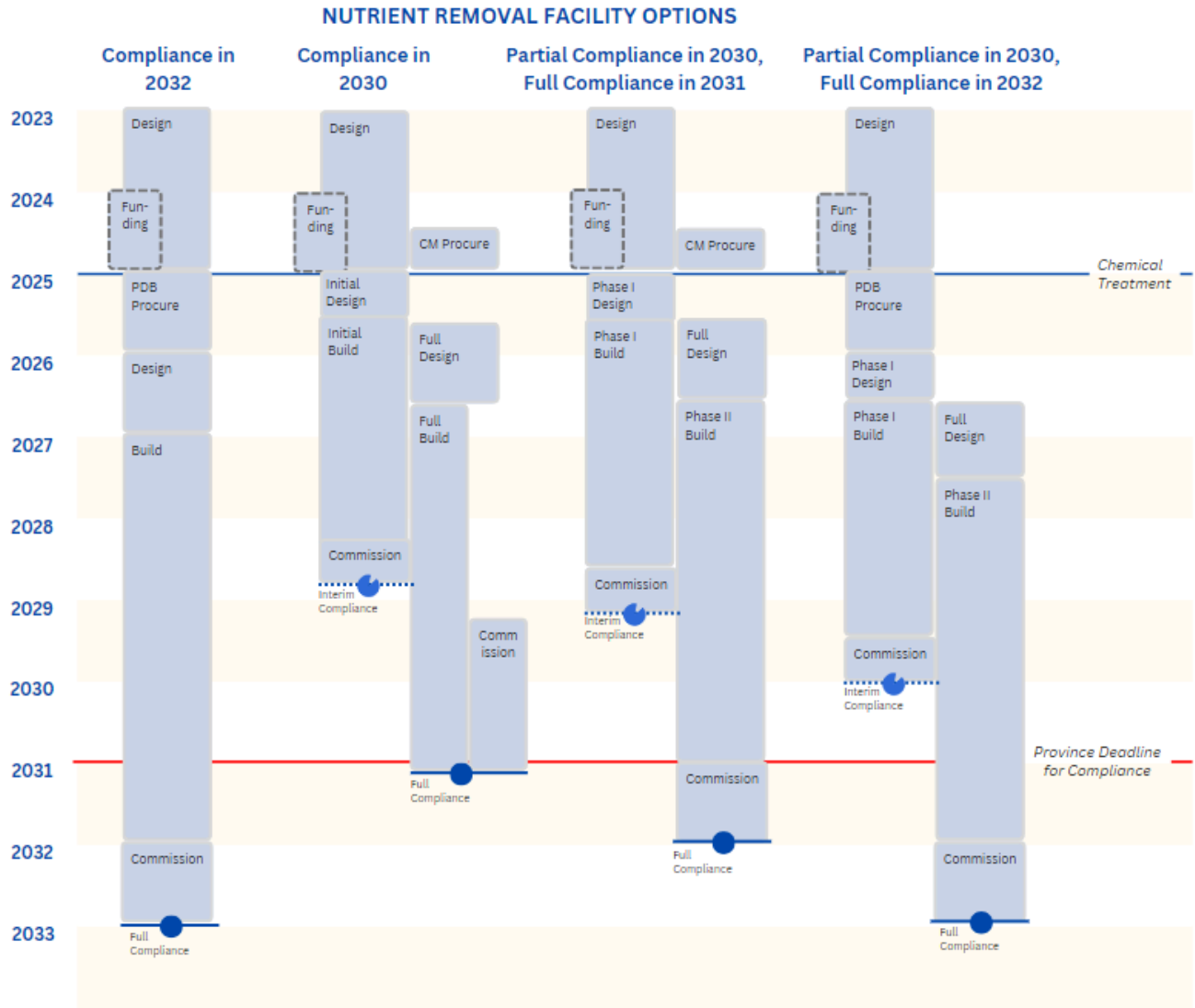


Figure 3. Comparison of Nutrient Removal Facility “Full Compliance in 2032” option vs. Nutrient Removal Facility alternative options

Table 4. Risk results for the three main options

	Low	Med	High	Extm	Total Severity Score
Full Compliance in 2032	8	2	2	2	87
Full Compliance in 2030	0	4	10	0	125
Partial Compliance in 2030, Full Compliance in 2032	3	7	4	0	90

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 by 2030. 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, 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 35% of the \$2.5 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.

Confirm Funding

The Nutrient Removal Facility project is not currently funded. The funding application will require the Enhanced Preliminary Design Class 3 cost estimate, expected in mid 2024; in addition, if the delivery and staging methods chosen carry a cost premium, this must be included in the funding request. The schedules for all delivery options assume funding can be achieved by the end of 2024. Any delay will delay the project.

Confirm Technical Feasibility

While the final completion of the Nutrient Removal Facility project is not expected until 2032, the team has identified a method for achieving partial treatment of dry weather flow by the 2030 deadline. As the preferred alternative (“Partial Compliance in 2030 and Full Compliance in 2032”) and the baseline assumed method (“Full Compliance in 2032”) are effectively the same up until the beginning of execution, the recommendation would be to pursue the feasibility of achieving a partial compliance state through technical review, market outreach, and further discussion, and to determine the approach that will find the best balance among the many constraints.

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The confirmation of technical feasibility is the most critical hurdle. While the partial treatment solution has been initially vetted and appears reasonable, it has not received engineering review, and the design, specifications, and cost of the required temporary connections and controls has not yet been explored. Once the Enhanced Preliminary Design for the facility is complete, this will be explored as a priority. It will also be important to review the potential for NEWPCC to achieve similar performance as the SEWPCC plant, as there are variations in design and influent characteristics between the facilities. The acceleration and phasing is also expected to result in a cost premium compared to the baseline option (“Full Compliance in 2032”), which as noted previously must be accounted for in the project budget.

Scheduling, Delivery, and Capacity

Planning for these projects has already implemented many lessons learned from the similar SEWPCC projects as well as from the history of these 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 Nutrient Removal Facility project and may help reduce schedule further. 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 Nutrient Removal Facility projects will be executed effectively simultaneously, at a projected annual cash flow of approximately \$200 to \$300+ 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 may 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.

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:

- **Enhanced Preliminary Design.** The Nutrient Removal Facility EPD is expected to be completed in mid 2024 and will be used to complete the market soundings, technical review, delivery method and Class 3 Cost Estimate.
- **Class 3 Cost Estimate.** The team will continue to identify and work through funding requirements of the Nutrient Removal Facility project including development of an updated Class 3 Cost Estimate which will be performed in 2024.
- **Technical Review.** A further technical review of the partial compliance approach will be conducted to identify technical risks to the project and plant and to identify temporary works that would be required to get to partial compliance; this will additionally inform the cost estimate.
- **Market Soundings.** These will be conducted in 2024 to determine the right delivery model, market capacities, feedback on partial compliance, and so on.
- **Delivery Model.** The delivery model will be confirmed pending the market sounding and funding sources.

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- **Funding.** The City will continue to explore funding options and begin the work to secure funding once the updated Class 3 Cost Estimate has been finalized.
- **Primary Clarification Upgrades.** Primary clarification upgrades will be estimated and scheduled to increase the wet weather flow treatment based on the Enhanced Preliminary Design of the Nutrient Removal Facility.
- **WEWPCC Grit and Screening.** WEWPCC Grit and Screenings project will be estimated and scheduled to ensure more reliability for the existing Anaerobic Digester capacity while the Biosolids project is being constructed.

As both the Biosolids project as well as, most likely, the Nutrient Removal Facility 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

A preliminary differential risk register, quantified using the likelihood, magnitude, and severity definitions shown in Table A.1, is shown in Table A.2. The register includes mitigation actions for each risk. A more detailed comparison matrix (Table A.3) has also been prepared. This appendix also contains more detailed figures showing the option schedules (Figure A.1, Figure A.2, Figure A.3, and Figure A.4)

Table A.1 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

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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
Likelihood	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
	Almost Certain	5	High	High	Extm	Extm	Extm

Table A.2 Differential Risk Register

Risk	Risk phrasing	Differential?	Notes	Mitigations	Full Compliance in 2032				Total: 83	Full Compliance in 2030				Total: 125	Partial Compliance in 2030, Full Compliance in 2032				Total: 86
					Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev
Funding availability	If funding is not available, the project will be delayed until it can be obtained	Yes	All options assume funding is available in 2024. Partial compliance options may allow project to proceed with initial phase without full funding. Accelerated option has less float.	Continue to coordinate at Provincial and Federal levels Apply as early as possible once EPD is complete	Moderate		Severe		High	Moderate		Substantial		High	Unlikely		Substantial		Low
Availability of design personnel	If qualified design personnel are not available, the project may have a failed procurement resulting in delay, or may struggle with quality during the design phase	Yes	COPS projecting shortages 2022-2031, https://occupations.esdc.gc.ca/sppc-cops/1.3bd.2t.11.shtml?eng_id=64&lang=en Assuming 2 design teams for the partial compliance/accelerated options, which would make it more difficult. Biosolids is taking resources as well.	Work with design firms to understand limitations and encourage hiring Avoid overly "Winnipeg-specific" qualifications criteria for procurement	Unlikely		Moderate	Moderate	High	Likely		Moderate	Moderate	High	Moderate		Moderate	Moderate	Low

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Risk	Risk phrasing	Differential?	Notes	Mitigations	Full Compliance in 2032				Total: 83	Full Compliance in 2030				Total: 125	Partial Compliance in 2030, Full Compliance in 2032				Total: 86
					Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev
PM resources (annual cash flow of projects managed)	If Winnipeg project management resources are stretched due to the volume of projects being managed simultaneously, this could result in logistical challenges, increased disputes, and quality issues	Yes	Concurrent work with Biosolids for the options with full/partial compliance in 2030 will make this more challenging. Example: the plan is for the Biosolids PDB procurement team to transition to NRF procurement, but with an aggressive schedule this would not be possible	Review potential to hire (note, restrictions due to City hiring environment) Consider staff augmentation via consultants where needed	Unlikely			Substantial	Green	Likely			Substantial	Yellow	Moderate			Substantial	Yellow
Environmental concerns	If protected species are found in the naturalized areas of the plant, this could result in delays or require changes in design			Early environmental site assessment															
Contamination	If more contamination than expected is found in the soil, especially near the rail line, this could result in increased costs and delay			Early environmental site assessment															
Ground conditions (esp Winnipeg familiarity)	If ground conditions are worse than expected, especially if the contractors are unfamiliar with typical Winnipeg conditions, this	Yes	Less time for investigation and multiple piling crews at the same time. Headworks experience would be	Sufficient geotechnical investigation	Unlikely		Moderate		Blue	Moderate		Moderate		Green	Unlikely		Moderate		Blue

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					Full Compliance in 2032				Total: 83	Full Compliance in 2030				Total: 125	Partial Compliance in 2030, Full Compliance in 2032				Total: 86
Risk	Risk phrasing	Difference?	Notes	Mitigations	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev
	could result in delays and cost increases		worse with multiple crews.																
Weather worse than expected	If the weather is worse than expected (excluding flooding), this could result in delays			Ensure planning includes adequate schedule contingency for poor weather															
Existing as built and infrastructure conditions	If existing as-builts and tie-in points are not accurate or are in worse condition than expected, this could increase costs			Early investigation and daylighting															
Construction lay down and access	Constrained laydown, shared access, and multiple interfaces may lead to inefficiencies in construction and disputes among contractors, resulting in delays and increased costs	Yes		Thorough 3D scan of site, ongoing maintenance of model, and using a software tool to coordinate plant shutdowns Designation of a full time logistics coordinator to manage conflicts Daily coordination meetings and weekly planning meetings with all project leaders and key operational personnel	Moderate	Substantial	Substantial			Likely	Substantial	Substantial			Moderate	Substantial	Substantial		

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Risk	Risk phrasing	Differential?	Notes	Mitigations	Full Compliance in 2032				Total: 83	Full Compliance in 2030				Total: 125	Partial Compliance in 2030, Full Compliance in 2032				Total: 86
					Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev
Regulatory repercussions	If issues are expected, 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	Yes		Pursue the hybrid option to achieve partial compliance Ensure consistent and detailed communication, especially of risk management activities	Likely			Severe	83	Unlikely			Substantial	125	Moderate			Substantial	86
Constrained market	If the project attracts attention from non-Canadian companies, this could result in exposure to foreign currency fluctuations, increasing cost			Ensure contract indicates currency															
Social Procurement Targets	If Winnipeg is not able to meet its social procurement targets due to overwhelming the market, this could result in public and Council disapproval	Yes	Inability to train fast enough to supply the demand, need to draw in resources from out of province	Provide ongoing training opportunities for industry to increase knowledge of social procurement requirements. Pilot social procurement requirements during Early Works and Biosolids projects. Modify social procurement targets as needed if industry cannot respond adequately.	Unlikely		Moderate	83	83	Likely			Moderate	125	Moderate			Moderate	86

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					Full Compliance in 2032				Total: 83	Full Compliance in 2030				Total: 125	Partial Compliance in 2030, Full Compliance in 2032				Total: 86	
Risk	Risk phrasing	Different?	Notes	Mitigations	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	
Escalation	If there is market concern around escalation, this could result in a cost premium	Yes	Base assumption is included in range values	<p>Conduct market sounding</p> <p>Monitor escalation and ensure adequate contingency is included in cost estimates</p> <p>Escalation clauses included in contracts to retain risk for Winnipeg</p>	Moderate	Substantial				Unlikely	Substantial				Moderate	Substantial				
Impact on current plant operations	If there are operational issues that arise due to tie-ins, commissioning, or other construction activities, or if the recovery period post-shutdown takes longer than expected, this could result in schedule delays and inability to fully treat inflow	Yes	Worse for accelerated, multiple shutdowns for tie-ins. Plant needs time to recover (biological processes) and can't do another shutdown until the health of the plant is back to normal. Can be a month or more.	<p>Constructability reviews and thorough planning sessions for construction phasing which include operators</p> <p>Regular coordination with operators during construction</p> <p>Specification in contract of need for coordination and the potential for flooding and other operational concerns to disrupt construction</p>	Unlikely		Moderate			Likely		Substantial			Unlikely		Substantial			

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Risk	Risk phrasing	Differential?	Notes	Mitigations	Full Compliance in 2032				Total: 83	Full Compliance in 2030				Total: 125	Partial Compliance in 2030, Full Compliance in 2032				Total: 86	
					Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	
Commissioning delays	If there are quality issues or other concerns found during commissioning, this will delay the project	Yes	Experience at SEWPCC	Hire a commissioning agent to oversee commissioning, or transition the logistics coordinator into this position Integrate lessons learned from SEWPCC commissioning Avoid commissioning during cold weather if possible	Unlikely		Moderate			Likely		Moderate					Moderate		Moderate	
Flooding	If flooding occurs at the plant, this will delay construction	Yes	Less ability to respond with the accelerated option (full compliance in 2030), any flooding would be more disruptive. Less ability to plan commissioning around the flood season.	Plan around the flooding season for construction Ensure the contract covers eventualities	Unlikely		Moderate			Moderate		Moderate					Moderate		Moderate	
Force majeure	If there are force majeure events, this will delay construction			Review contract and ensure the force majeure regimen is reasonable																
CP rail interactions and damage to rail	If work in proximity to rail results in damage to the rail line or in slowdowns to			Ongoing communication with CP Adequate coverage of																

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					Full Compliance in 2032				Total: 83	Full Compliance in 2030				Total: 125	Partial Compliance in 2030, Full Compliance in 2032				Total: 86	
Risk	Risk phrasing	Different?	Notes	Mitigations	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	
	rail traffic, this could result in costs due to damages			issue in contract																
Schedule acceleration	If the schedule is accelerated significantly, delays (excluding geotech, flooding, commissioning) may have greater effects on the end date due to ripple effects on multiple work fronts and interfaces.	Yes	Full Compliance 2030 option is most affected.	Detailed constructability review and development of a robust and resilient schedule Rigorous interface management	Rare		Substantial			Likely		Substantial			Unlikely		Substantial			
Supply chain and warranty issues	Supply chain issues could result in delays to supply for key specialized components and equipment, or for challenges to extended warranty if equipment is ordered too far ahead			Identify long-lead equipment Ensure contract and insurance regime allows for provision to order and store specialized equipment early																
Liability caps and market risk appetite	The perception of significant risk in these projects, especially if there are liability caps or liquidated damages, could result in limited market interest and cost premiums	Yes	The accelerated option may be seen as higher risk if there is a liquidated damages regime	Include discussion of risk and liability caps in market sounding Consider liquidated damages regime carefully	Unlikely	Moderate				Likely	Moderate				Unlikely	Moderate				

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					Full Compliance in 2032				Total: 83	Full Compliance in 2030				Total: 125	Partial Compliance in 2030, Full Compliance in 2032				Total: 86	
Risk	Risk phrasing	Different?	Notes	Mitigations	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	Likelihood	Cost Impact	Schedule Impact	Goals Impact	Sev	
Public protest	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			Pursue other funding																
Procurement	If an unfamiliar delivery method is chosen, this could result in significant procurement and approval delays	Yes	Full compliance in 2030 requires a CM delivery model which would have to be approved by Council. It is unfamiliar for Winnipeg Sewage Treatment Program and based on previous City experience with CM project delivery there is little political and public appetite to pursue this delivery approach.	Conduct market sounding and jurisdictional scan to assess benefits of alternate delivery methods Ensure contingency for procurement and approval delays is included in the schedule	Unlikely		Moderate			Likely										

Table A.3 Comparison Matrix

	Full Compliance in 2032	Full Compliance in 2030 (Maximum Acceleration Approach, 4 Nutrient Removal Tanks)	Partial Compliance in 2030, Full Compliance in 2031 (5 Nutrient Removal Tanks)	Partial Compliance in 2030, Full Compliance in 2032 (4 Nutrient Removal Tanks)
Description	Original scheduled approach, delivered via PDB	Partial compliance approach with acceleration via multiple crews working in parallel, assuming existing designer and CM delivery	Partial compliance approach with acceleration on initial phase, assuming existing designer and CM delivery	Partial compliance approach with acceleration on initial phase, delivered via PDB
Delivery	PDB	CM	CM	PDB
Completion	Partial N/A Full late 2032	Partial late 2028 Full late 2030/early 2031	Partial early 2029 Full late 2031	Partial late 2029 Full late 2032
Crews/ Sequencing	Three major workfronts: two piling crews (one for NRF tanks, one for secondary clarifiers), two excavation/concrete crews (same), working in parallel. Once they are done with the NRF tanks or secondaries, they work on the fermenters	Mostly four and up to five major workfronts: two piling crews work together on NRF tanks, then split to work simultaneously on NRF tanks and initial secondary clarifiers. Then fermenter foundation, and then back to finish the secondary clarifier piling.	Up to three major workfronts with the exception of initial commissioning	Up to three major workfronts with the exception of initial commissioning
No Biological Nitrogen Removal (except SBR)	9 years (2024-2032)	5 years (2024-2028) to partial, 8 years to final	6 years (2024-2029) to partial, 9 years to final	6 years (2024-2029) to partial, 9 years to final
Chemical Treatment for Phosphorus	9 years	5 years to partial, 8 years to final	6 years to partial, 9 years to final	6 years to partial, 9 years to final
Operations	1 commissioning period (1 year)	3 different operational phases/commissioning periods (3 years in a "commissioning" state)	2 different operational phases/commissioning periods, 2 years in a "commissioning" state	2 different operational phases/commissioning periods, 2 years in a "commissioning" state
Funding	Full funding	May be able to proceed	May be able to	May be able to proceed

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	Full Compliance in 2032	Full Compliance in 2030 (Maximum Acceleration Approach, 4 Nutrient Removal Tanks)	Partial Compliance in 2030, Full Compliance in 2031 (5 Nutrient Removal Tanks)	Partial Compliance in 2030, Full Compliance in 2032 (4 Nutrient Removal Tanks)
	required	with partial funding	proceed with partial funding	with partial funding
Schedule	Somewhat increased exposure to weather risk	Highest schedule risk: partial compliance acceleration AND crashing the schedule for full compliance. Extended commissioning. May not be possible to continue with current design team.	Partial compliance acceleration May not be possible to continue with current design team.	Partial compliance acceleration
Cost Premium	Additional escalation ~3% on 20% of cost (included in \$828M)	Acceleration premium 20-30% (per Toronto ¹) CM premium 5% (assumed included) Additional cost to support operation (upgrades/temporary works) 10-15%	Acceleration premium 5-10% (per Toronto ¹) CM premium 5% (assumed included) Additional cost to support operation (upgrades/temporary works) 5-10%	Acceleration premium 5-10% Additional cost to support operation (upgrades/temporary works) 5-10% Additional escalation ~3% on 20% of cost
Current estimated budget	\$828M	\$1071M - \$1196M	\$906M - \$989M	\$911M - \$994M

¹D'Andrea, M. and M. Pacholok. 2015. City of Toronto Staff Report: Applying Acceleration and Delay Costs in Construction Contracts. Accessed at <<https://www.toronto.ca/legdocs/mmis/2015/pw/bgrd/backgroundfile-81105.pdf>>. AFS 20863.

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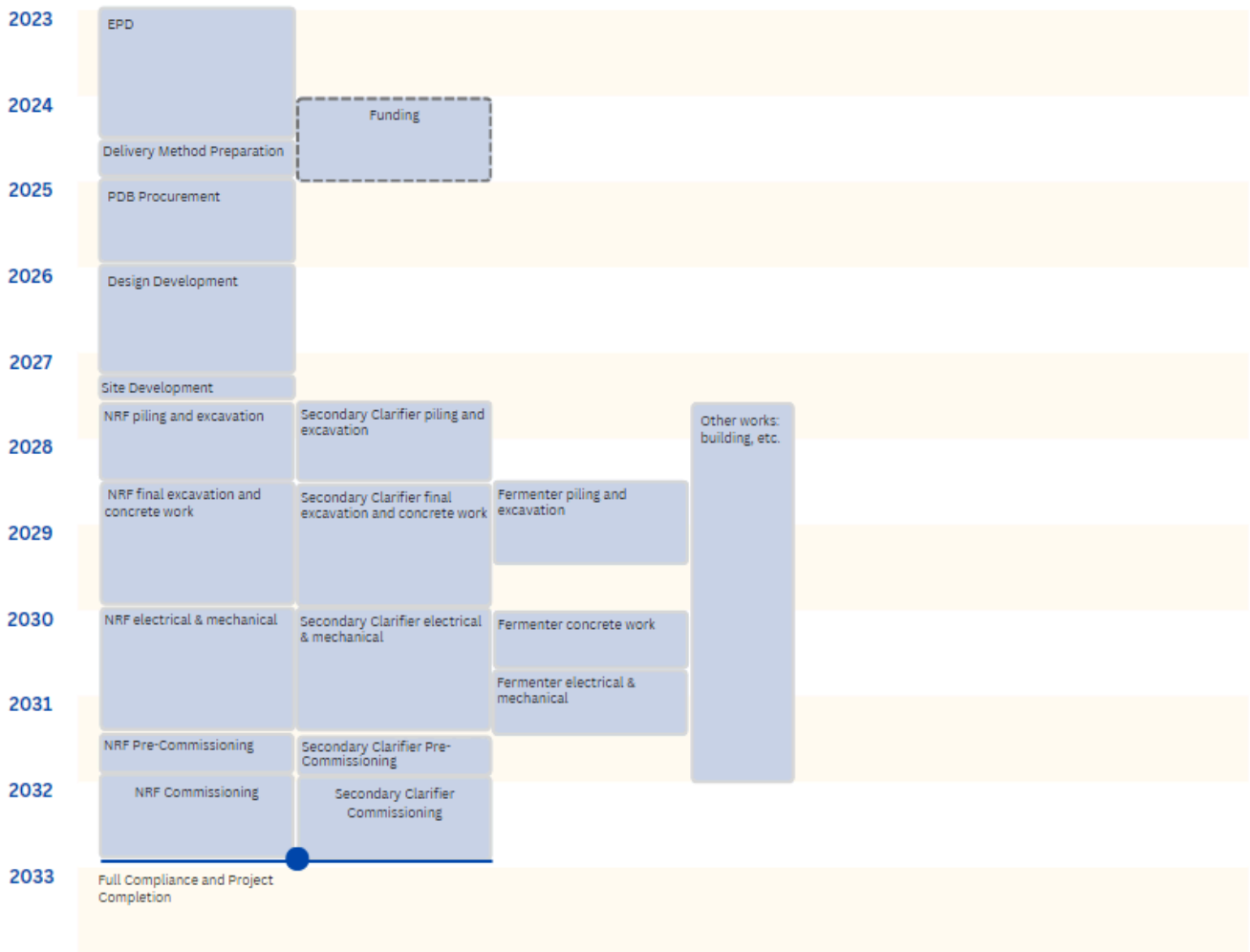


Figure A.1 Full Compliance in 2032

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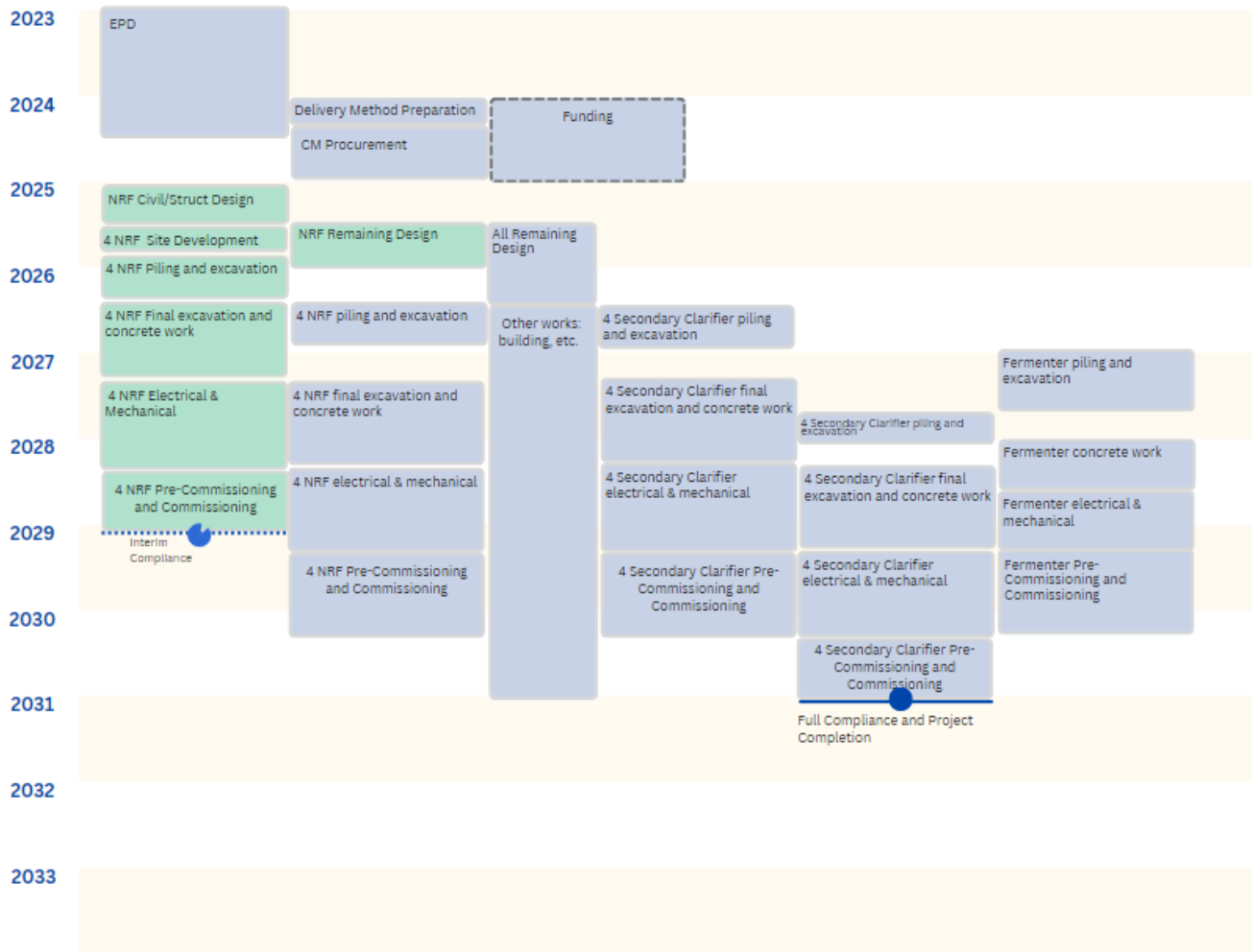


Figure A.2. Full Compliance in 2030 (Maximum Acceleration Approach, 4 Nutrient Removal Tanks)

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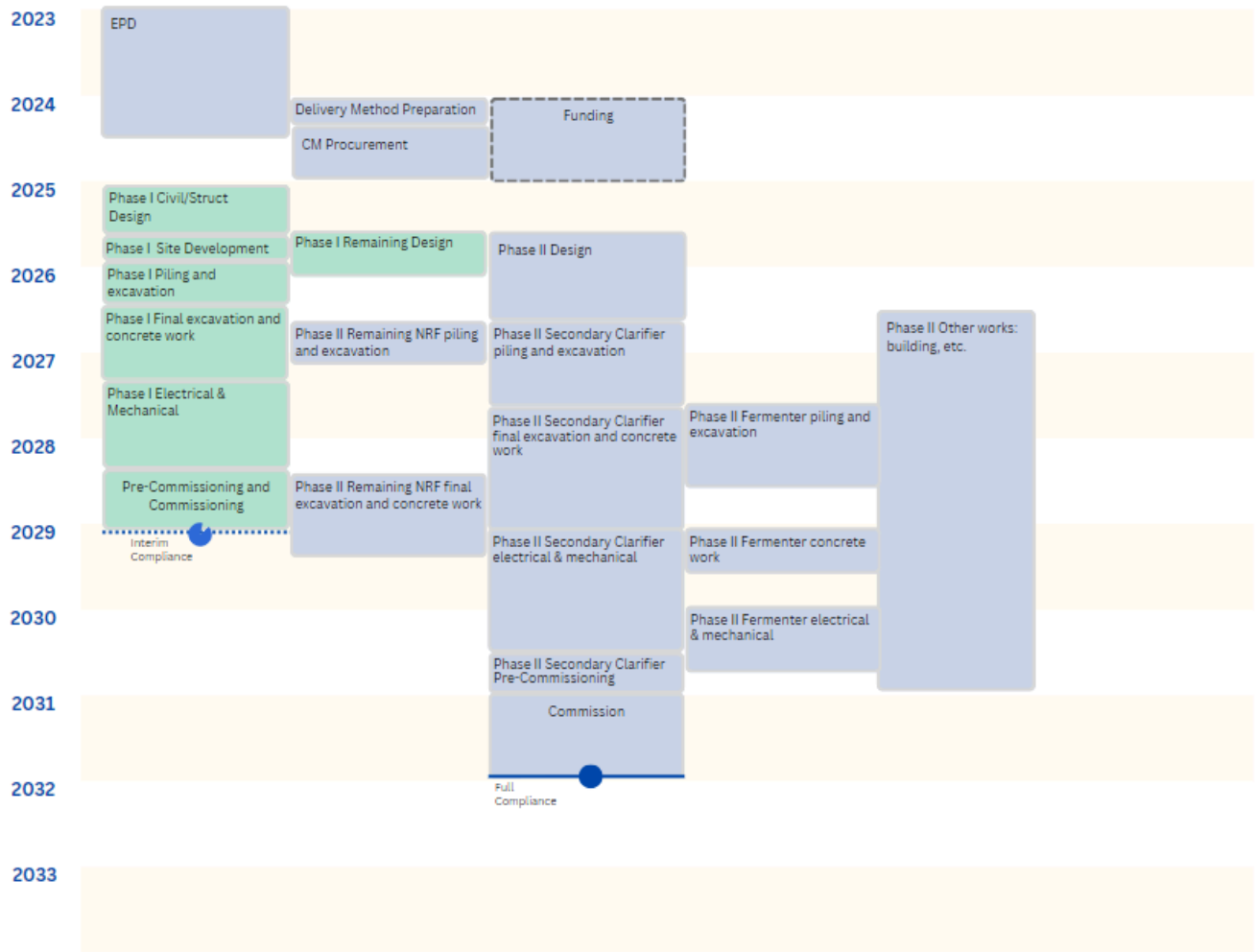


Figure A.3 Partial Compliance in 2030, Full Compliance in 2031 (5 Nutrient Removal Tanks)

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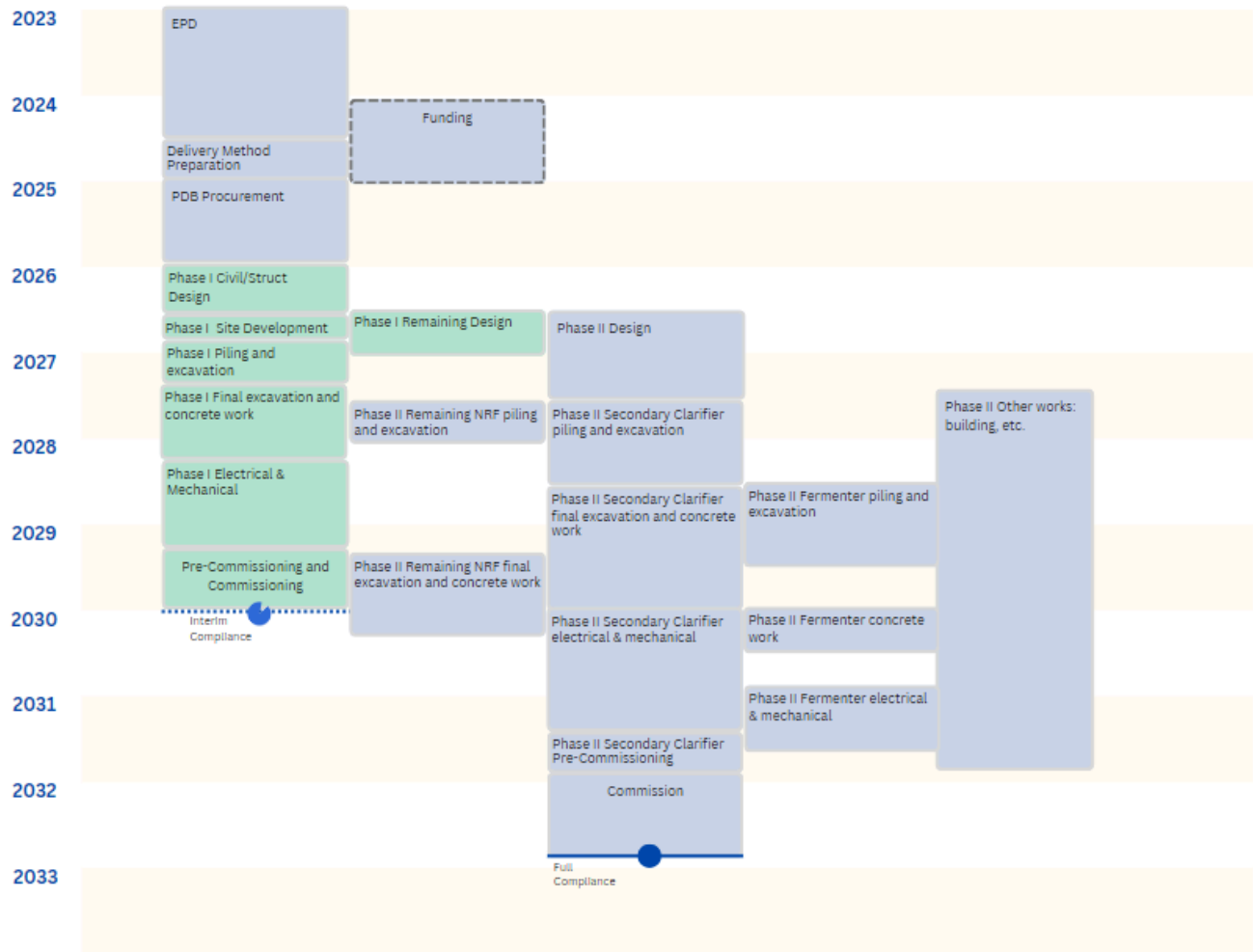


Figure A.4. Partial Compliance in 2030, Full Compliance in 2032 (4 Nutrient Removal Tanks)