Appendix G1

EPCOR WATER SERVICES INC.

List of Wastewater Treatment Programs and Projects in the 2022-2024 PBR

February 16, 2021

Capital Expenditures for EWSI's Wastewater Treatment Programs and Projects (2022-2024 PBR) ($ millions)

	Category	A **Reliability/Life Cycle Sub-Category**	B **2022-2024 PBR Plan**
	Regulatory		
1	Odour Control Improvements Project		5.58
2	**Sub-total: Regulatory**		**5.58**
	Growth/Customer Requirements		
3	Secondary inDense^{TM} Upgrade Project		4.50
4	Install Secondary Baffles		1.00
5	**Sub-total: Growth/Customer Requirements**		**5.50**
	Health, Safety and Environment		
6	Code Compliance Upgrades		0.82
7	**Sub-total: Health, Safety and Environment**		**0.82**
	Reliability and Life Cycle Improvements		
8	Buildings and Site Rehabilitation (2022-2024)	Buildings and Site	2.00
9	Furniture Replacement (2022 - 2024)	Buildings and Site	0.15
10	Operations Center at Mid-Point Entrance	Buildings and Site	1.33
11	Electrical Rehabilitation Program (2022 - 2024)	Electrical	2.50
12	600V Electrical Building Project (EB-2)	Electrical	11.85
13	Aux Control Room Electrical Upgrade Project (EB-1)	Electrical	11.25
14	Loop 5 Rehab and Upgrade	HVAC	0.31
15	HVAC Rehabilitation (2022-2024)	HVAC	1.50
16	Tunnel Ventilation Upgrades	HVAC	3.50
17	Electrical Room HVAC Upgrades	HVAC	1.25
18	Maintenance Shop Ventilation	HVAC	1.50
19	Scum House 1 Ventilation	HVAC	0.50
20	Screen Building 1 Ventilation Upgrades	HVAC	0.50
21	Instrumentation Rehabilitation Program (2022-2024)	Instruments / Other Equipment	3.00
22	Laboratory Equipment (2022-2024)	Instruments / Other Equipment	0.45
23	Fleet Replacements (2022-2024)	Instruments / Other Equipment	0.55
24	Plant Equipment Upgrades (2022-2024)	Instruments / Other Equipment	0.60
25	Digester 4 Upgrades Project	Mechanical	13.40
26	Mechanical Rehabilitation Program (2022-2024)	Mechanical	1.50
27	Clarifier Chain Replacement (2022-2024)	Mechanical	1.00
28	Sludge Pipelines Rehabilitation (2022-2024)	Mechanical	3.50
29	Utilities Rehabilitation (2022-2024)	Mechanical	1.30
30	Rotating Equipment Rehabilitation (2022-2024)	Mechanical	4.20
31	Process Piping Rehabilitation (2022-2024)	Mechanical	3.20
32	Control System Rehabilitation (2022-2024)	Process Projects / IT	1.31
33	Gold Bar Microcomputers	Process Projects / IT	0.24
34	Microstation Replacement	Process Projects / IT	0.34
35	ProjectWise Upgrade	Process Projects / IT	0.06
36	Gold Bar LIMS Upgrades	Process Projects / IT	0.36
37	Gold Bar IVARA Upgrade	Process Projects / IT	0.40
38	Expand Flare Capacity Project	Process Projects / IT	8.00
39	Structural Rehabilitation (2022-2024)	Structural	4.00
40	Diversion Structure Structural Rehabilitation Project	Structural	0.50
41	PE Channel Upgrades - Bypass Chamber Project	Structural	16.96
42	Dewatering Facility Project	Clover Bar	38.36
43	**Sub-total: Reliability and Life Cycle Improvements**		**141.36**

	Category	A **Reliability/Life Cycle Sub-Category**	B **2022-2024 PBR Plan**
	Performance Efficiency and Improvement		
44	NSR Flood Protection		1.00
45	Plant Improvements (2022-2024)		3.50
46	Laboratory Facility Consolidation Project		5.93
47	Secondary Aeration Blower Upgrades Project		8.00
48	**Sub-total: Performance Efficiency and Improvement**		**18.43**
49	**Total Capital Expenditures**		**171.68**

Appendix G2

EPCOR WATER SERVICES INC.

Wastewater Treatment
600V Electrical Building Project (EB-2)
Business Case

February 16, 2021

Table of Contents

1.0 OVERVIEW

1. The 600V Electrical Building Project (EB-2) will relocate and replace the 600V electrical distribution equipment and control system interface from existing locations to a new dedicated electrical building at the Gold Bar Wastewater Treatment Plant (WWTP).

2. The project will address asset lifecycle issues since many of the associated assets are at or near end of expected life.

3. In addition, the project will address safety issues with electrical equipment that is located in areas that are classified as hazardous and or corrosive, are exposed to moisture, and/or are in tunnels that are at risk of unexpected inundation from process upsets.

4. This will reduce the risk of failure of the electrical equipment, resulting in operations that are more reliable.

5. Failure of equipment in this area would affect many of the primary treatment facilities, as they would lose power and capability, thus resulting in partially treated wastewater flowing into the North Saskatchewan River.

6. This project falls into the Reliability/Life Cycle category.

7. The project will be initiated in early 2022 and the project will be completed in 2026.

2.0 BACKGROUND AND JUSTIFICATION

8. In 2018 an electrical code compliance review of the Gold Bar WWTP was completed.

9. In 2019 the Gold Bar WWTP Electrical Long-Range Plan (ELRP) was completed. This was prepared to support EWSI in planning major upgrades and expansions required in the Gold Bar WWTP's electrical distribution system in order to address capacity, asset lifecycle, code compliance, and technology modernization challenges that will be encountered through the year 2056.

10. At Gold Bar WWTP, major electrical distribution equipment is installed in locations that pose a significant risk to safety and plant operations. For example, 600-volt motor control centres (MCC's) are installed in areas which are classified as hazardous and/or corrosive, are exposed to moisture, and/or are in tunnels that are at risk of unexpected inundation from process upsets.

11. It was noted that electrical equipment installed in these locations has been prematurely failing, primarily due to corrosion, putting at risk both property and personnel.

12. In addition, both reports identified numerous instances where existing equipment is approaching (or has already exceeded) the end of its expected life.

13. Failure of equipment in this area would affect many of the primary treatment facilities, as they would lose power and capability, resulting in partially treated wastewater flowing into the North Saskatchewan River. If this situation was to arise, repair and/or replacement of failed gear would likely take months and this is not an acceptable operational approach for the Gold Bar WWTP.

14. This 600V Electrical Building project will relocate existing major 600V distribution equipment servicing the solids treatment portion of the plant from high risk areas into a new dedicated electrical building, Electrical Building 2 (EB-2). This will address existing code compliance issues while improving the reliability and longevity of the replacement equipment.

15. As part of this project, a new 600V substation will be constructed to simplify and optimize the architecture of the plant's 600V distribution system and provide a location from which to supply future plant expansions.

16. EB-2, as referenced in Figure 2.0-1, was identified as the second highest priority behind the Auxiliary Control Room 600V Electrical Building 1 (EB-1) for replacement and relocation of 600V electrical equipment in the ELRP. A total of 453 MCC sections were ranked based on area classification, flood risk, corrosive locations, asset age, future plant development and space constraints. Once ranked, the work was consolidated into three phases to balance the spending and effort over future PBR periods.

17. In conjunction with this project, the Auxiliary Control Room Electrical Building Project (EB-1) will also be delivered. While there will be challenges with switching multiple gear and loads, running the projects concurrently provides the opportunity to benefit from synergies between the projects.

18. The proposed location for the new building is immediately to the north of existing Digester 7, as shown in Figure 2.0-1.

Figure 2.0-1
Electrical Building Project Site Location Overview

3.0 PROJECT DESCRIPTION

19. The scope of the EB-2 project includes a new 2-storey building to house new 600V switchgear, two new 13.8kV-600V power transformers, and an entire floor dedicated to replacement 600V MCC's. The building will be used to house replacement equipment as follows:

- Blend Tank Gallery: Classified as Zone 2 (Hazardous) and Category 2 (corrosive) and at risk from flooding. The 600V distribution equipment in this room currently sub-feeds the electrical distribution equipment that services the fermenters and digester square #1. The design of this space, and various significant openings, make it infeasible to declassify. Replacement and relocation of this equipment is a high priority due to the high risk of an accident and prolonged power interruption due to the equipment location.
- Fermenter Gallery: Classified as Zone 2 (Hazardous) and Category 2 (corrosive) and at risk from flooding. The design of this space, and various significant openings, make it infeasible to declassify. Replacement and relocation of this equipment is a high priority due to the high risk of an accident and prolonged power interruption due to the equipment location.

- Control System Interface: Automated operation of equipment supplied power from the MCC's are controlled by the plant control system. A new cabinet and cabling between the MCC and control devices will be installed to meet this requirement.

20. The following table (Table 3.0-1) summarizes the existing 600V MCC's to be replaced and relocated to EB-2, future projects to be fed, estimated total supplied load, and estimated MCC space requirements (number of vertical sections that will need to be accommodated).

Table 3.0-1
600V Electrical Building Project MCC Analysis

	Equipment	A **Existing Location**	B **Vertical Sections**	C **Estimated Load (Amps)**
1	726-MCC-28892	Fermenter 1-3 Gallery	12	1499
2	726-MCC-28893		15	
3	726-MCC-28890E		11	
4	725-MCC-14009 Fermenter 4	Fermenter 4 Gallery	8	
5	725-MCC-14011	Blend Tank Gallery	8	
6	725-MCC-14012		10	
7	725-MCC-14013E		10	
8	Thermophilic Digestion (Future)	Digester Area	n/a – Feeders Only	150
9	Digester Square 2 TRF-46013	Digester Square 2		596
10	Digester Square 2 TRF-46014	Digester Square 2		1082
11		**Sub-Total:**	**74**	**3327**

21. The project will be started in early 2022, with preliminary design and procurement. Ordering of long-lead delivery equipment will be required so that construction and commissioning can be completed by the end of 2026. This project will extend beyond 2024 due to the complex nature of the plant shutdowns required to transfer electrical loads for this and the Auxiliary Control Room Electrical Upgrades Project (EB-1). That project will also extend to 2026.

22. The project will be executed in a traditional design bid build delivery method. A consulting engineering company will complete the design. Equipment supply and construction will be completed by a supplier selected through a competitive process.

23. Development and building permits will be required.

24. Construction of this project will be sequenced to avoid negative impacts to ongoing operations as much as possible. To do so, the following general sequence is anticipated:

- Construct new building;

- Install new distribution equipment;
- Install new cable trays, power feeders and field control cabling; leave protected and coiled for future termination to existing loads;
- Test new distribution equipment. This includes, but is not limited to, manufacturer’s testing and Contractor’s operational testing of protective devices, starters and associated control systems. Detailed quality control and testing requirements will be included in the tender package; and
- Sequentially transfer loads from existing equipment using the Shutdown Process and abandon old switchgear as loads are transferred.

4.0 PROJECT ALTERNATIVE ANALYSIS

25. Three alternatives were considered for this project: Do Nothing, Upgrade the Electrical Equipment in Place, and Construct a New Building and Relocate Electrical Equipment.

26. Doing nothing would result in failure of electrical switchgear in the near future due to the risks faced today. This would affect many of the primary treatment facilities, as they would lose power and capability, thus resulting in partially treated wastewater flowing in to the North Saskatchewan River, which is a violation of Gold Bar’s Approval to Operate. If this situation was to arise, repair and/or replacement of failed gear would likely take months and this was not considered an acceptable operational approach for the Gold Bar WWTP. As such, this alternative was rejected.

27. Upgrading the existing electrical equipment in place holds significant risks. Under this alternative, temporary switchgear would be purchased and installed in a location close to the existing switchgear. Electrical loads would be transferred to the temporary gear and then the existing gear would be demolished and replaced with new. Once the new switchgear was commissioned, the loads would be transferred to new and the temporary gear would be disposed of. While the benefit of not building new is large, this is outweighed by significant abandonment costs associated with demolishing the temporary gear in addition to the extensive internal costs for safely transferring all electrical loads twice which together are estimated to be about $1.5 million. The new equipment would also remain in hazard exposed locations, which is not considered operationally appropriate and which could reduce the life of those assets. For these reasons, this alternative was rejected.

28. The third alternative was to construct a new building and equip it with new switchgear. Once the new switchgear is commissioned, the loads would be transferred and the existing switchgear would be demolished. Given that most of the existing equipment is end of life there would be little or no early financial write offs associated with this alternative. Capital costs were estimated to be the same for this option however there were significantly lower risks both to implement, due to fewer load transfers, and ongoing because equipment was located in a safer location.

29. The construction estimates for alternatives two and three were nearly identical while alternative three avoids the retirement cost of the temporary equipment and relocates electrical gear to a more appropriate location, hence achieving a preferred long term solution. As such, the third alternative was selected.

5.0 COST FORECAST

30. The project cost forecast is derived from the construction and engineering estimates from the ELRP.

31. A contingency of 21% of external costs is included in the cost forecast. This is based on the current level of project development. Project scope was defined by way of a long-range plan, which is considered conceptual level design.

32. Projected costs for this project are shown in Table 5.0-1

Table 5.0-1
600V Electrical Building Project
($ millions)

		A **2022**	B **2023**	C **2024**	D **2025**	E **2026**	F **Total**
1	**Direct Costs**						
2	Contractors	1.21	6.20	2.17	0.72	0.79	11.08
3	Internal Labour	0.07	0.10	0.09	0.09	0.09	0.44
4	Vehicles and Equipment	-	-	-			-
5	Abandonments	-	-	-			-
6	Contingency	0.20	0.10	0.99	0.71	0.33	2.33
7	Risk Allowance	-	-	-			-
8	**Sub-total Direct Costs**	**1.48**	**6.40**	**3.25**	**1.52**	**1.21**	**13.86**
9	Capital Overhead & AFUDC	0.06	0.29	0.52	0.08	0.19	1.14
10	**Total Capital Expenditures**	**1.54**	**6.69**	**3.77**	**1.60**	**1.40**	**15.00**

33. This project is expected to go into service in 2024 through 2026.

34. EWSI takes a number of steps to minimize the capital expenditures. These include:

- EWSI intends to deliver this project in coordination with the Auxiliary Control Room Electrical Upgrade (EB-1) project, which is expected to result in cost efficiencies by having one group execute both projects (e.g., more fluid communication, coordinated procurement, contractor effectiveness, etc.).
- EWSI has worked with external consultants to evaluate the current condition, expected life and future demands of the entire electrical system at Gold Bar WWTP and developed a long-range plan that creates efficiencies for consolidating efforts and minimizing duplicate effort.
- EWSI will take advantage of longer-term contracts with vendors to effectively manage the supply, quality and construction of required equipment.
- Construction coordinators will be on-site at Gold Bar WWTP to manage the day to day activities of contractors and ensure the project safely stays on time and to specifications.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every requested project is evaluated individually to prioritize projects; based on the highest risk, based on synergies with other projects (using a common shut down).
- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.
- EWSI is considering use of an existing building design that has become a standard within EPCOR Electricity Services for substations. This could help reduce design fees and, because it has been standardized for construction, should result in efficiency gains as well.

6.0 RISKS AND MITIGATION PLANS

35. Table 6.0-1 provides key risks and mitigation plans associated with this project.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Key Health and Safety (H&S) Risks – There are H&S risks associated with working on high voltage switchgear.	EPCOR employs hazardous energy isolation procedures to eliminate the risk of injury from conducting this type of work.
2	Key Process Safety Risks – process safety risks arise during complex plant shutdowns.	Process shutdowns are planned using a planning process and multiple work packages are incorporated as needed. EPCOR also has Process Hazard Analysis procedures to identify specific mitigations required for each outage.
3	Fluctuating global economy – cost for equipment may be impacted by COVID-19.	No specific mitigation available at this time. May need to adjust procurement timing depending on market conditions.

Appendix G3

EPCOR WATER SERVICES INC.

Wastewater Treatment
Aux Control Room Electrical Upgrade Project (EB-1)
Business Case

February 16, 2021

Table of Contents

1.0 OVERVIEW

1. The Auxiliary Control Room Electrical Upgrade Project (EB-1) will relocate and replace the 600V electrical distribution and control system interface equipment from existing locations to a new dedicated electrical building at the Gold Bar Wastewater Treatment Plant (WWTP).

2. The project will address asset lifecycle issues since many of the associated assets are at or near end of expected life.

3. In addition, the project will address issues with electrical equipment that is located in areas that are classified as hazardous and/or corrosive, are exposed to moisture, and/or are in tunnels that are at risk of unexpected inundation from process upsets.

4. This will reduce the risk of failure of the electrical equipment, resulting in operations that are more reliable.

5. Failure of equipment in this area would affect many of the primary treatment facilities, as they would lose power and capability, thus resulting in partially treated wastewater flowing into the North Saskatchewan River.

6. This project falls into the Reliability/Life Cycle category.

7. The project will be initiated in early 2022 and the project will be completed in 2026.

2.0 BACKGROUND AND JUSTIFICATION

8. In 2018, an electrical code compliance review of the Gold Bar WWTP was completed.

9. In 2019, the Gold Bar WWTP Electrical Long-Range Plan (ELRP) was completed. This was prepared to support EWSI in planning a series of major upgrade projects and expansions required in the Gold Bar WWTP's electrical distribution system in order to address capacity, asset lifecycle, code compliance, and technology modernization challenges that will be encountered through the year 2056.

10. At Gold Bar WWTP, major electrical distribution equipment is installed in locations that pose a significant risk to safety and plant operations. For example, 600-volt motor control centres (MCPc's) are installed in areas which are classified as hazardous and/or corrosive, are exposed to moisture, and/or are in tunnels that are at risk of unexpected inundation from process upsets.

11. It was noted that electrical equipment installed in these locations has been prematurely failing due to corrosion or flooding, putting at risk both property and personnel.

12. In addition, both reports identified numerous instances where existing equipment is approaching (or has already exceeded) the end of its expected life.

13. The Auxiliary Control Room is a stand-alone building containing electrical switchgear distributing power to various equipment on the southwest portion of the Gold Bar WWTP for primary treatment. More specifically this switchgear provides power to the grit tanks, screens and primary clarifiers.

14. Failure of this equipment would result in significant disruption to the wastewater treatment process potentially resulting in partially treated wastewater flowing into the North Saskatchewan River.

15. If this situation was to arise, repair and/or replacement of failed equipment would likely take months and this was not considered an acceptable operational approach for the Gold Bar WWTP.

16. This Auxiliary Control Room Electrical Upgrade project will relocate existing major 600V distribution equipment from the high risk areas into a new dedicated electrical building, EB-1. This will address existing code compliance issues while improving the reliability and longevity of the relocated replacement equipment.

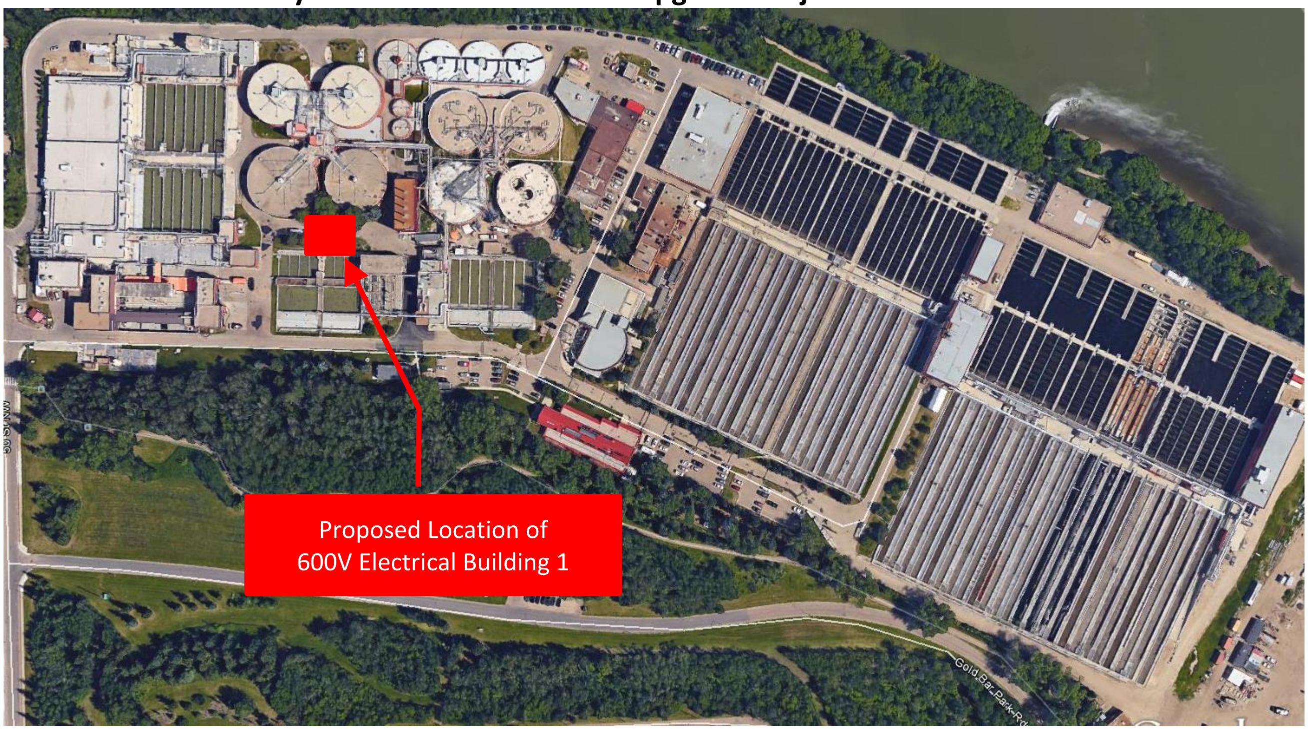
17. As part of this project, a new 600V substation will be constructed to simplify and optimize the architecture of the plant's 600V distribution system and provide a location from which to supply future plant expansions.

18. EB-1, as referenced in Figure 2.0-1, was identified as the highest priority for replacement and relocation of 600V electrical equipment in the ELRP. A total of 453 MCC sections were ranked based on area classification, flood risk, corrosive locations, asset age, future plant development and space constraints. Once ranked, the work was consolidated into three phases to balance the spending and effort over future PBR periods.

19. In conjunction with this project, the 600V Electrical Building Project (EB-2) will also be delivered. While there will be challenges with switching multiple gear and loads, running the projects concurrently provides the opportunity to benefit from synergies between the projects.

20. The proposed location for the new building is southwest of Digester 6 as shown in Figure 2.0-1.

Figure 2.0-1
Auxiliary Control Room Electrical Upgrade Project Site Location Overview



3.0 PROJECT DESCRIPTION

21. The scope of the EB-1 project includes a new 2-storey building to house new 600V switchgear, two new 13.8kV-600V transformers, and an entire floor dedicated to replacement 600V motor control centers. The building will be used to house replacement electrical equipment as follows:

- Tunnel B: Classified as Zone 2 (Hazardous) and Category 2 (corrosive); flood risk; equipment near end-of-life (estimated 2026). Some equipment in this area has had to be prematurely replaced due to recurring failures caused by corrosion. Replacement of this equipment is high priority due to risk of accidental flooding, failure or explosion and associated consequences, including but not limited to injury or death and prolonged power interruption.
- Tunnel C: Classified as Category 2 (corrosive); flood risk; most equipment is near end-of-life. Per information from EWSI maintenance personnel, some equipment has had to be prematurely replaced due to recurring failures caused by corrosion.

Replacement of this equipment is considered a medium priority due to risk of accidental flooding or failure and associated consequences, including but not limited to prolonged power interruption.

- Auxiliary Control Room: Classified as Zone 2 (Hazardous) and Category 2 (corrosive), and the equipment is near end-of-life. The 600V distribution equipment in this room currently sub-feeds numerous other facilities in the primary treatment areas of the plant. Per information from EWSI maintenance personnel, some equipment has had to be replaced due to recurring failures caused by corrosion. Replacement of this equipment is high priority due to risk of accidental flooding, failure or explosion and associated consequences, including but not limited to injury and prolonged power interruption. The arrangement of the auxiliary control room makes it challenging to declassify this area and the space is very cramped with less than ideal working conditions.
- Control System Interface: Automated operation of equipment supplied power from the MCC's are controlled by the plant control system. A new cabinet and cabling between the MCC and control devices will be installed to meet this requirement.
- Future Projects: Transformer capacity and spare 600V breakers (or space for future breaker additions) in the new EB-1 switchgear will be made available to accommodate future projects.

22. The project excludes upgrading of any downstream electrical equipment such as motors, etc.

23. The following table (Table 3.0-1) summarizes the existing 600V MCC's to be replaced and relocated to EB-1, future projects to be fed, estimated total supplied load, and estimated MCC space requirements (number of vertical sections that will need to be accommodated).

Table 3.0-1
600V Electrical Building Project MCC Analysis

	Equipment	A Existing Location	B Vertical Sections	C **Estimated Load (Amps)**
1	706-MCC-14016	Tunnel B	6	1950
2	738-MCC-14033	Tunnel C	12	
3	738-MCC-14034E		4	
4	738-MCC-14020	Aux. Control Rm.	11	
5	738-MCC-14021		11	
6	738-MCC-14019E		7	
7	738-MCC-14021E		7	
8	High Rate Clarifiers (Convert Primary Clarifiers 5-8)	EPT Building Area	n/a – Feeder only	400
9		**Sub-Total:**		**2350**

24. The project will be started in early 2022, with detailed design and equipment selection. Ordering of long-lead delivery equipment will be required so that construction and commissioning can be completed by the end of 2026. This project will extend beyond 2024 due to the complex nature of the plant shutdowns required to transfer electrical loads for this and the 600V Electrical Building No.2 (EB-2) project. The EB-2 project will also extend to 2026.

25. The project will be executed in a traditional design bid build delivery method. Design will be completed by a consulting engineering company, and construction will be completed by a contractor selected through a competitive process.

26. Development and building permits will be required.

27. Construction of this project will be sequenced to avoid negative impacts to ongoing operations as much as possible. To do so, the following general sequence is anticipated:

- Construct new building;
- Install new distribution equipment;
- Install new cable trays, power feeders and field control cabling; leave protected and coiled for future termination to existing loads;
- Test new distribution equipment. This includes, but is not limited to, manufacturer's testing and Contractor's operational testing of protective devices, starters and associated control systems. Detailed quality control and testing requirements will be included in the tender package; and
- Transfer loads from existing equipment using the Shutdown Process and abandon old switchgear as loads are transferred.

4.0 PROJECT ALTERNATIVE ANALYSIS

28. Three alternatives were considered for this project: Do Nothing, Upgrade the Electrical Equipment in Place, and Construct a New Building and Relocate Electrical Equipment.

29. Doing nothing would result in failure of electrical switchgear in the near future due to the risks faced today. This would affect many of the primary treatment facilities, as they would lose power and capability, resulting in partially treated wastewater flowing in to the North Saskatchewan River, which is a violation of Gold Bar's Approval to Operate. If this situation was to arise, repair and/or replacement of failed gear would likely take months and this was not considered an acceptable operational approach for the Gold Bar WWTP. As such, this alternative was rejected.

30. Upgrading the existing electrical equipment in place holds significant risks. Under this alternative, temporary switchgear would be purchased and installed in a location close to the existing switchgear. Electrical loads would be transferred to the temporary gear and then the existing gear would be demolished and replaced with new. Once the new switchgear was commissioned, the loads would be transferred to new and the temporary gear would be disposed of. While the benefit of not building new is large, this is outweighed by significant abandonment costs associated with demolishing the temporary gear in addition to the extensive internal costs for safely transferring all electrical loads twice which together are estimated to be about $1.5 million. The new equipment would also remain in hazard exposed locations, which is not considered operationally appropriate and which could reduce the life of those assets. For these reasons, this alternative was rejected.

31. The third alternative was to construct a new building and equip it with new switchgear. Once the new switchgear is commissioned, the loads would be transferred and the existing switchgear would be demolished. Given that most of the existing equipment is end of life there would be little or no early financial write offs associated with this alternative. Capital costs were estimated to be the same however there were significantly lower risks both to implement, due to fewer load transfers, and ongoing because equipment was located in a safer location.

32. The construction estimates for alternatives two and three were nearly identical while alternative three avoids the retirement cost of the temporary equipment and relocates electrical gear to a more appropriate location, hence achieving a preferred long term solution. As such, the third alternative was selected.

5.0 COST FORECAST

33. The project cost forecast is derived from the construction and engineering estimates from the ELRP.

34. A contingency of 21% of external costs is included in the cost forecast. This is based on the current level of project development. Project scope was defined by way of a long-range plan, which is considered conceptual level design.

35. Projected costs for this project are shown in Table 5.0-1.

Table 5.0-1
600V Electrical Building Project
($ millions)

		A	B	C	D	E	F
		Pre-2022	**2022**	**2023**	**2024**	**2025 and later**	**Total**
1	**Direct Costs**						
2	Contractors	-	1.53	5.38	1.81	0.11	8.83
3	Internal Labour	-	0.04	0.04	0.04	0.08	0.20
4	Vehicles and Equipment	-	-	-	-		-
5	Abandonments	-	-	-	-		-
6	Contingency	-	0.24	0.42	0.69	0.69	2.04
7	Risk Allowance	-	-	-	-		-
8	**Sub-total Direct Costs**	**-**	**1.81**	**5.84**	**2.54**	**0.88**	**11.07**
9	Capital Overhead & AFUDC	-	0.08	0.34	0.63	1.63	2.68
10	**Total Capital Expenditures**	**-**	**1.89**	**6.18**	**3.17**	**2.51**	**13.75**

36. This project is expected to go into service in 2024 through 2026.

37. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI intends to deliver this project in coordination with the 600V Electrical Building (EB-2) project, which is expected to result in cost efficiencies by having one group execute both projects (e.g., more fluid communication, coordinated procurement, contractor effectiveness, etc.).
- EWSI has worked with external consultants to evaluate the current condition, expected life and future demands of the entire electrical system at Gold Bar WWTP and developed a long-range plan that creates efficiencies for consolidating efforts and minimizing duplicate effort.

- EWSI will take advantage of longer-term contracts with vendors to effectively manage the supply, quality and construction of required equipment.
- Construction coordinators will be on-site at Gold Bar WWTP to manage the day to day activities of contractors and ensure the project safely stays on time and to specifications.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every requested project is evaluated individually to prioritize projects; based on the highest risk, based on synergies with other projects (using a common shut down).
- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.
- EWSI is considering use of an existing building design that has become a standard within EPCOR Electricity Services for substations. This could help reduce design fees and, because it has been standardized for construction, should result in efficiency gains as well.

6.0 RISKS AND MITIGATION PLANS

38. Table 6.0-1 provides key risks and mitigation plans associated with this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Key Health and Safety (H&S) Risks – There are H&S risks associated with working on high voltage switchgear.	EPCOR employs hazardous energy isolation procedures to eliminate the risk of injury from conducting this type of work.
2	Key Process Safety Risks – process safety risks arise during complex plant shutdowns.	Process shutdowns are planned using a planning process and multiple work packages are incorporated as needed. EPCOR also has Process Hazard Analysis procedures to identify specific mitigations required for each outage.
3	Fluctuating global economy – cost for equipment may be impacted by COVID-19.	No specific mitigation available at this time. May need to adjust procurement timing depending on market conditions.

Appendix G4

EPCOR WATER SERVICES INC.

Wastewater Treatment
Dewatering Facility Project
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Dewatering Facility Project will construct a new dewatering facility at the Clover Bar Biosolids Recycling Facility (CBBRF).

2. The facility will process biosolids produced in the wastewater treatment process. These biosolids are piped from the Gold Bar Wastewater Treatment Plant (WWTP) and sent on truck from the Alberta Capital Region Wastewater Treatment Plant (ACRWWTP) to the lagoons to be thickened and then onto the dewatering facility. Dewatering is an essential requirement for the management and disposal of biosolids.

3. The new dewatering facility is necessary because the existing City of Edmonton dewatering facility is being demolished in the near future along with the City of Edmonton composter facility. This closure has expedited EPCOR's Biosolids Management Program and planning for a new dewatering facility in order to manage biosolids in the City of Edmonton.

4. The City of Edmonton has requested that EPCOR finance and operate their own dewatering facility for future operational needs at the CBBRF.

5. This project falls in to the Reliability/Lifecycle category.

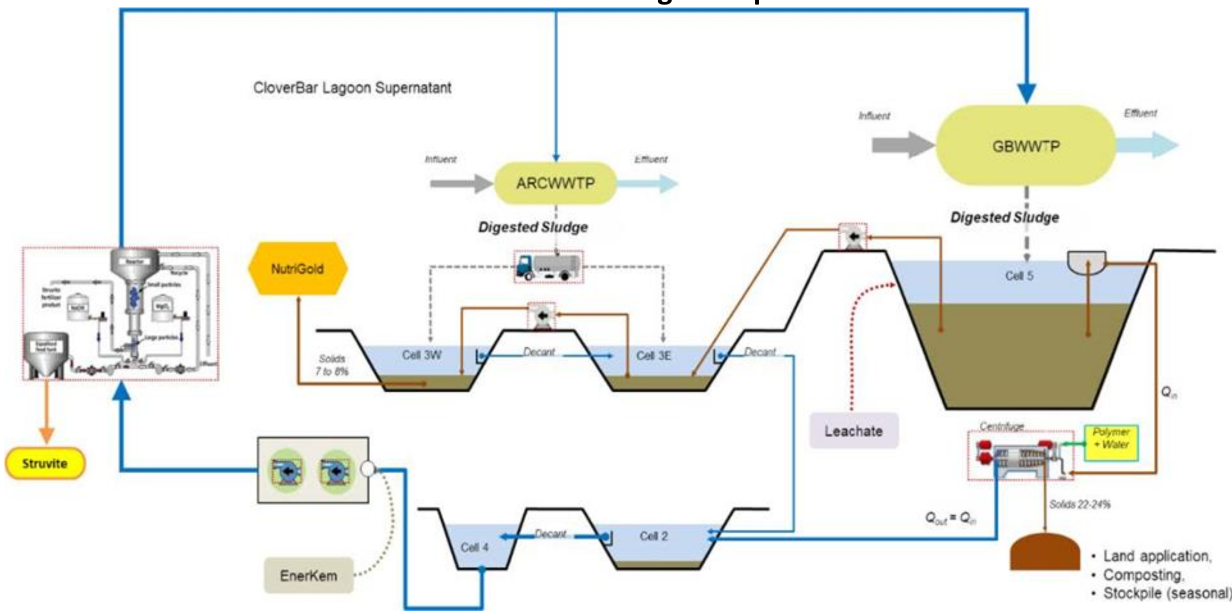
6. The project was initiated in 2020 and the project will be completed in 2024.

2.0 BACKGROUND AND JUSTIFICATION

7. Treatment of wastewater at the Gold Bar WWTP produces digested sludge that must be disposed of or land applied. At present, Gold Bar WWTP produces approximately 20,000 dry metric tonnes (DMT) of sludge per year on average, with an additional 8,000 DMT contributed by ACRWWTP. Wet weather events can result in additional sludge being produced.

8. The digested sludge, commonly referred to as biosolids, is pumped to a holding pond (Cell #5) located at the CBBRF. A number of pipelines between Gold Bar WWTP and CBBRF are used to transport digested sludge from Gold Bar WWTP to CBBRF. By agreement, sludge is also trucked from the ACRWWTP to the CBBRF. After treatment at CBBRF, the supernatant (a liquid separated from the thickened sludge) is pumped back to Gold Bar WWTP and ACRWWTP. See Figure 2.0-1.

Figure 2.0-1
Normal Clover Bar Lagoon Operations



9. In Cell #5, the biosolids are gravity-separated into the settled (or thickened) sludge and the supernatant (the remaining liquid). The thickened sludge is pumped to the existing City of Edmonton dewatering facility located in the northwest corner of the Edmonton Waste Management Centre.

10. In the existing dewatering facility, more liquid is separated from the biosolids (dewatered) in centrifuges with polymer added to achieve a solids concentration in the range of 22-24% solids. Three centrifuges are available for dewatering with a combined output of approximately 40,000 dry tonnes per year.

11. The dewatered solids from CBBRF were used for either composting at the Edmonton Composting Facility (ECF) or hauled by trucks to various sites for land application, either agricultural or non-agricultural (mine reclamation).

12. There are two limiting factors in this process, primarily driven by weather conditions. The season for land application is limited by favourable weather, and during inclement conditions, especially below -30°C, the dewatered biosolids cannot be hauled away and used for land application. It is therefore necessary to have temporary storage of biosolids, currently in Cell #5 at the CBBRF.

13. In 2017, the City of Edmonton Composting Facility (ECF) was shut down temporarily due to structural issues.

14. By 2024, it is expected that the current City of Edmonton Dewatering Facility will cease operations as a result of the ECF closure. EWSI was verbally informed of the permanent ECF closure in May 2019, and the closure publicly announced at the end of May 2019.

15. In 2019, in response to the uncertain future of the City of Edmonton compost facility, EWSI developed a Biosolids Management Program and investigated conceptually the development of a separate dewatering facility.

16. The Biosolids Management Program determined that a replacement dewatering facility was required to be in operation in early 2024.

17. This project focuses on constructing a new biosolids dewatering facility to replace the City of Edmonton facility. EWSI plans to own and operate the new biosolids dewatering facility.

18. It is anticipated that by 2024, the cost to operate the existing dewatering facility will have risen to $450/DMT. In contrast, the direct operating cost of dewatering at the proposed new dewatering facility is currently estimated to be less than $300/DMT in the first year of operation. These costs are based on consideration of staff or contractor labour to operate a 20,000 DMT facility, utilities costs, chemical consumption costs, and average annual costs to maintain the facility (e.g. snow clearing, road maintenance, etc.).

3.0 PROJECT DESCRIPTION

19. The scope for the Dewatering Facility project is to build a new dewatering facility, located at the Clover Bar site.

20. The conceptual design provides the basis for current estimates.

21. A more detailed design for the facility is being prepared in order to develop a capital and operating and maintenance (O&M) expenditure opinion of probable cost that will provide EWSI with further certainty of the level of effort to construct this facility.

22. The key is to keep the facility design as simple as possible to maximize its utility, cost-effectiveness and reliable operations.

23. The new dewatering facility will be located at the CBBRF. The exact location will be finalized through detailed design and consider total costs including capital, operating and financing and other logistical requirements.

24. The current method for removing dewatered biosolids and feeding the silos to load the product on to hauling trucks for land application is challenging. The new facility will provide a better method and configuration to load the dewatered biosolids onto truck for land application.

25. The conceptual design report provided recommendations that will be reviewed and incorporated in the next design stage of this project, including:

- The facility will be designed to enable expansion in the future if needed.
- Project costs include design and construction to dewater 20,000 DMT per year.
- A sludge-holding tank will be designed to buffer peaks or fluctuations of incoming biosolids and load, for better performance of centrifuge dewatering. The exact location and configuration of the sludge holding tank is to be determined during the design phase.
- Final technology selections for the dewatering facility components will be developed as part of the design phase.

26. The project will be initiated in 2020, with detailed design through 2021. Construction will be performed through the 2021 to 2023 period, and the dewatering facility will go in to service in 2024.

4.0 PROJECT ALTERNATIVE ANALYSIS

27. There are three main alternatives:

1. Do Nothing (Status Quo).
2. EWSI Construct a new Dewatering Facility.
3. Temporary Skid Mounted Dewatering Facility.

28. Status Quo is not feasible since the City of Edmonton is expected to cease operations in 2024, resulting in removal of the current dewatering facility. Therefore, this alternative is rejected.

29. Alternative two would mean that EWSI is responsible for constructing (and operating) a new dewatering facility, similar to the existing City of Edmonton facility, based on a 20,000 DMT annual capacity.

30. The engineering design considered several dewatering technologies. These technologies were assessed during the preliminary design, considering operational impacts, energy consumption, odour and costs. Centrifuge dewatering was selected as the optimal solution.

31. This alternative involves a capital investment of $42 million, and associated operating and maintenance costs.

32. This alternative can be delivered on site at the CBBRF, in close proximity to the lagoons.

33. Alternative three means that EWSI sets up a temporary, likely skid mounted, dewatering facility. This arrangement would be akin to a turnkey contract operation.

34. The operating window for this alternative is six months, from May to October each year, as this type of facility operates open to the elements (i.e., is not housed in a building or insulated from cold temperatures). The temporary facility would be removed by the contractor each winter, resulting in mobilization and demobilization effort and costs.

35. The shorter, six month operating window means that the facility needs to process 20,000 DMT in six months to achieve the same annual output as the permanent facility alternative. EPCOR would handle biosolids transport and application. An all-weather haul and stockpile location is required, preferably directly off the highway, to match dewatered material production. A typical agricultural site can be forced to shut down because of wet fields and soft gravel roads, so the dewatered biosolids cannot be applied in these conditions.

36. The space requirement for the temporary facility is significant since it requires space for the dewatering equipment, temporary storage and the truck-turning radius. There is some doubt as to whether a sufficient space currently exists at the CBBRF, and civil work to prepare the ground may be necessary for the required footprint.

37. There are other concerns with proceeding with a temporary facility, including the requirement for available water capacity. There is a potential for additional costs to be incurred to upsize the existing water supply. The shortened dewatering season places more pressure on the biosolids program to move material. Since the program can be highly weather dependent with wet fields preventing agricultural land application, there is a greater need for space for stockpiling during the growing season, which is a challenge. With a permanent constructed facility, excess dewatered material can be stored over-winter on the fields without adverse impacts to the farmers' ability to work their fields, and the material can be immediately applied in the spring, resulting in efficiencies for the farmer. A temporary facility's operating window

overlaps with the agricultural season, and this same space would not be available for stockpiling material, so alternatives would need to be found, likely at additional cost.

38. Based on a review of the advantages and disadvantages of the alternatives, the decision was made to proceed with constructing a dewatering facility (alternative two). The drawbacks of the temporary facility, coupled with the space issues at CBBRF, were too significant to proceed with alternative three.

5.0 COST FORECAST

39. The project cost forecast is based on estimates developed in the conceptual validation stage, plus an assessment of EWSI overheads, internal costs and risk allowances.

40. A contingency of 17% is included in the cost forecast. This is to cover the cost of unknowns that cannot be identified or anticipated during the current preliminary design phase. These challenges may include for example:

- Changes in the scope of the project;
- Delay in the delivery of long-lead equipment;
- Completing construction work in a live plant (CBBRF) can interrupt day-to-day activities or cause constraints for construction;
- Unexpected site conditions; and
- COVID-related constraints and complications.

41. Projected costs for this project are shown in Table 5.0-1

Table 5.0-1
Dewatering Facility Project
($ millions)

		A **Pre-2022**	B **2022**	C **2023**	D **2024**	E **Total**
	Direct Costs					
1	Contractors	2.97	12.26	12.88	0.28	28.39
2	Internal Labour	0.67	0.43	0.63	0.18	1.91
3	Contingency	0.00	1.00	4.00	1.00	6.00
4	**Sub-total Direct Costs**	**3.64**	**13.69**	**17.51**	**1.46**	**36.30**
5	Indirect Costs	0.00	0.94	2.14	2.62	5.70
6	**Total Capital Expenditures**	**3.64**	**14.63**	**19.65**	**4.08**	**42.00**

42. The project is expected to go in to service in 2024.

43. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI has taken advantage of longer-term relationships with consultants, contractors and suppliers to effectively manage the quality of design, supply, and construction of required upgrades.
- All activities related to project management, construction coordination and inspection will be undertaken internally by EWSI, eliminating the need for external project management services. The delivery of major equipment is procured with direct contract with suppliers thus eliminating additional cost of contractors' premium.
- Construction coordinators will be on-site at Gold Bar WWTP to manage the day to day activities of contractors and ensure the project safely stays on time and to specifications.
- Contracted services are performed by qualified external contractors and done on a competitive unit price basis.
- The installations will be consistent with EWSI's construction standards, which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every requested project is evaluated individually to prioritize projects; based on the highest risk and synergies with other projects (e.g. using a common shut down). Construction methods will be used to meet requirements at the lowest cost.

- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.

6.0 RISKS AND MITIGATION PLANS

44. Table 6.0-1 provides key risks and mitigation plans associated with this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Completing construction work in a live plant (CBBRF) can interrupt regular day to day activities or cause constraints on construction.	This risk will be managed with appropriate planning and communication between all parties involved.
2	Changes in the scope of the project.	Detailed discussions with project stakeholders to optimize project solutions.
3	Delay in the delivery of long-lead equipment.	Signing direct contracts with manufacturers of major equipment, scheduling participation in Factory Acceptance Tests. Timing ordering of equipment so delivery is not the critical path in the construction, and applying contingencies in the construction schedule.
4	Unexpected site conditions.	Detailed site investigations were completed as part of Preliminary design and will be completed later at the Detailed design stage. A risk allowance will also be maintained in the project cost estimate.

Appendix G5

EPCOR WATER SERVICES INC.

Wastewater Treatment
Digester 4 Upgrades Project
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Digester 4 Upgrades Project will provide major rehabilitation and upgrades to Digester 4, along with replacement of systems and components that are end of life or have failed. Originally built in 1956, Digester 4 is one of the oldest digesters at the Gold Bar Wastewater Treatment Plant (WWTP), and much of the infrastructure associated with this digester is due for rehabilitation.

2. The Digester 4 Upgrades project is part of a larger set of digester upgrade projects, initiated to ensure that the digesters are upgraded at the appropriate rate and are capable of handling increased solids loading in a continuous, safe and stable operation.

3. Existing process risks, such as foaming and ineffective solids processing, will be reduced by updating the current gas mixing system to a linear motion mixing system. Improved mixing allows use of the full digester capacity, essentially creating more space in the digesters to keep pace with the City of Edmonton's growth.

4. The Digester 4 Upgrades project was planned for the current PBR period, however due to additional scope on the Digester 3 project, and the plan as described below to perform one digester upgrade at a time, this project was put on hold until the Digester 3 Upgrades Project is completed.

5. Digester 3 went into service in 2020. There are a number of reasons why the plan is to upgrade one digester at a time, including limited space on site, competent contractor availability and the costly nature of the upgrades. Further, it is important to ensure that there is always available capacity within the plant to treat peak flows.

6. This project falls under the PBR category of Reliability/Life Cycle.

7. The project forecast cost is $14.58 million. This includes $1.18 million spent prior to 2022, and the remaining $13.40 million of the cost planned in the 2022-2024 PBR period.

8. The project will be initiated in 2021 and is expected to go in to service in 2024.

2.0 BACKGROUND AND JUSTIFICATION

9. Gold Bar WWTP treats wastewater by removing contaminants using a series of treatment stages. The contaminants that are removed ("solids") in each stage require additional treatment. Therefore, wastewater treatment plants also contain equipment for treating the solids of which digesters are a major component. The solids treatment facilities at Gold Bar WWTP include eight anaerobic digesters. The digesters treat and stabilize the solids, generating biogas in the process, prior to the solids being pumped to the Clover Bar Lagoons for re-use.

10. Digester 4 is one of the oldest digesters at the Gold Bar WWTP. The digester has operated since 1956 with no major rehabilitation or upgrades. Much of the infrastructure associated with the digester is overdue for major rehabilitation and/or upgrades to ensure reliable and safe operation, and achievement of complete mixing of sludge for optimal performance.

11. EWSI completed similar rehabilitation and upgrades during 2012-2016 on Digesters 1 and 2, and during 2017-2021 on Digester 3. Experience gained during the rehabilitation and upgrading of these digesters, that are of similar age and operational history, suggests that the components of Digester 4 will be in fair to poor condition and will require replacement.

12. The mixing system is obsolete and frequently plugs with debris, rendering it ineffective. Biogas piping, internal concrete protection (gas proofing), external roof membrane, safety equipment, sludge piping and other ancillary systems have exceeded their life cycle replacement and in many cases have been found to have failed.

13. The Gold Bar WWTP experienced significant digester foaming in the summer and fall of 2009. Foaming is an abnormal operational condition that traps hazardous gases and reduces the available volume of the digester to treat sludge. This has the potential to over-pressurize the digester and creates a situation where gases need to be released directly to the atmosphere, which is unsafe and would result in an Environmental Protection and Enhancement Act (EPEA) violation.

14. EPCOR conducted a root cause analysis of the digester foaming and a preliminary risk assessment of the contributing factors. The root cause analysis identified large swings in digester loading and or significant changes in digester feed composition resulting from the start-up of the Enhanced Primary Treatment facility. The team concluded that it was imperative that measures are put in place to minimize foam propagation that could compromise of the biogas and pressure

relief safety systems. Mitigation alternatives for the existing digesters were discussed and evaluated at workshops in 2016 and 2017.

15. In 2016, a review of digester mixing systems was initiated to screen options for mixing. This work resulted in a recommendation for mechanical linear motion mixing technology to be implemented as the mixing system for Digester 3. The intent upon proof of performance was to expand this technology to remaining digesters as each was rehabilitated. Digester 3 is due to go in to service in 2020 and the technology will continue to be monitored for its effectiveness.

16. Mechanical mixing eliminates risks associated with gas mixing, such as safety risks from gas compression and piping of biogas and financial risks because gas compression requires more electricity. Mechanical mixing systems are also safer for operations and maintenance staff as these are easier isolations, there are no protocols required for working around biogas, and no need to buy specialty valves and instruments for gas handling.

17. The Solids Loading to Gold Bar WWTP and Digester Capacity Analysis Report (2019) identified loading conditions and capacity for the digesters. The report recommended completing the rehabilitation of Digesters 4-6 to maximize available digester capacity. The Gold Bar WWTP Integrated Resource Plan (IRP) identifies the lack of ability to expand the footprint of the plant as a confining factor and as such, the existing footprint must be used as effectively as possible. Even if there was room to expand, a new digester is cost prohibitive. As the population served by Gold Bar WWTP grows, the plant will receive more wastewater to process. The linear motion mixing technology allows the digester to be full to the roof instead of needing headspace of 10%-15% required with gas mixing. Across the eight digesters, a capacity gain of 10% is equivalent to 80% of a new digester. Therefore implementing this technology is key to the continued servicing of wastewater within the Gold Bar WWTP footprint.

18. The project team will leverage lessons learned from the Digester 3 upgrades, which is due to go into service in 2020.

19. Based on some leakage experienced on Digester 3, and work to determine solutions and compare alternatives, the interior of Digester 4 will be lined with a cementitious, epoxy liner on the walls, from the base of the HDPE liner to the junction with the floor, and the entire floor and cone surface. This will prevent sludge from leaking into the ground and into the North Saskatchewan River, which is less than 50 metres away from Digester 4. Installing the liner while the scaffolding is in place for the rehabilitation work will also realize construction efficiencies.

20. Once digester upgrades are completed for Digesters 1-4, and the associated conversion to Linear Motion Mixing is fully implemented, the gas compression and handling systems for these digesters will be decommissioned, which will result in improved safety for plant personnel and approximately $27 thousand in annual savings of electricity per digester.

21. The current plan upgrades one digester at a time. There are a number of reasons why this approach is taken, including limited space on site (each upgrade requires two overhead cranes), competent contractor availability and the costly nature of the upgrades. Further, it is important to ensure that there is available capacity within the plant to treat peak flows.

3.0 PROJECT DESCRIPTION

22. The scope for the Digester 4 Upgrades project includes removing the old roof and old gas pumping system and replacing with the new linear motion mixing system, lining the inside of the digester, installing a new roof, and any other rehabilitation identified during the project.

23. The project will be initiated in Q4 of 2021, with detailed design and procurement through Q1 of 2022. The construction period will be from Q1 2022 through to Q3 2024, with commissioning throughout the final 2 quarters of the construction period. Digester 4 will go into service in Q4 of 2024.

24. Phases of the project are per Table 3.0-1

Table 3.0-1
Digester 4 Upgrades Project Timelines

	Project Phases	A **Q4 2021**	B **2022 Q1**	C **2022 Q2**	D **2022 Q3**	E **2022 Q4**	F **2023 Q1**	G **2023 Q2**	H **2023 Q3**	I **2023 Q4**	J **2024 Q1**	K **2024 Q2**	L **2024 Q3**	M **2024 Q4**
1	Initiation / Approvals	X												
2	Requirement Review and Scope Approval	X	X											
3	Detail Design	X	X											
4	Procurement	X	X											
5	Construction		X	X	X	X	X	X	X	X	X	X	X	
6	Commissioning											X	X	
7	Close-out													X

4.0 PROJECT ALTERNATIVE ANALYSIS

25. Three alternatives were considered: Run Digester 4 to failure, Demolish Digester 4 and build a new digester, and Rehabilitate and upgrade Digester 4.

26. Running Digester 4 to failure was rejected due to safety risks such as a biogas release and operability risks, which would result in high costs to operate unreliable equipment.

27. Demolishing Digester 4 and building a new digester in place was rejected because it was a more expensive alternative. Early estimates indicate that the cost of replacing Digester 4 would be between $25 and $30 million in current dollars.

28. The favoured alternative is to rehabilitate and upgrade Digester 4, in line with the Gold Bar WWTP IRP and with previous digester projects.

29. The decision to move from gas mixing to mechanical mixing was made in previous PBR's and EWSI continues to favor this approach.

5.0 COST FORECAST

30. The project cost forecast is based on the cost for completing the same upgrade on Digester 3. Digester 3 forecast costs at completion are $14.07 million compared to forecast cost for Digester 4 of $14.58 million. The increased cost is related to inflation, offset by some efficiencies in applying the liner during construction rather than retrospectively.

31. A contingency of 6% is included in the cost forecast. This is to cover the cost of unknowns that cannot be identified or anticipated during the design or inspection phase, and typically arise during demolition.

32. Projected costs for this project are shown in Table 5.0-1

Table 5.0-1
Digester 4 Upgrades Project
($ millions)

		A **Pre-2022**	B **2022**	C **2023**	D **2024**	E **Total**
	Direct Costs					
1	Contractors	1.04	3.29	2.24	4.14	10.71
2	Internal Labour	0.15	0.33	0.33	0.33	1.14
3	Vehicles and Equipment	0.00	0.00	0.00	0.00	0.00
4	Abandonments	0.00	0.00	0.00	0.00	0.00
5	Contingency	0.00	0.00	0.00	0.80	0.80
6	Risk Allowance	0.00	0.00	0.00	0.00	0.00
7	**Sub-total Direct Costs**	**1.19**	**3.62**	**2.57**	**5.27**	**12.65**
8	Indirect Costs	0.00	0.39	0.62	0.92	1.93
9	**Total Capital Expenditures**	**1.19**	**4.01**	**3.19**	**6.19**	**14.58**

33. This project is expected to go into service in 2024.

34. EWSI takes a number of steps to minimize the level of capital expenditures. These include:

- EWSI has taken advantage of longer-term contracts with vendors to effectively manage the supply, quality and construction of required equipment, and ensure more favorable pricing.
- Construction coordinators will be on-site at Gold Bar WWTP to manage the day to day activities of contractors and provide site level oversight, to ensure the project stays on schedule and is constructed to specifications.
- Contracted services are performed by pre-qualified external contractors and the project is likely to be bid on a fixed price basis. The bid process will be detailed and thorough, including site visits, interviews, safety history and references as part of the contractor selection. In addition, detailed costs and schedules will be required as part of the submission requirements.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every requested project is evaluated individually to prioritize projects; based on the highest risk and based on synergies with other projects (e.g. using a common shut down).

6.0 RISKS AND MITIGATION PLANS

35. Table 6.0-1 provides key risks and mitigation plans associated with this project.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk	A Mitigation Plan
1	Key Health and Safety (H&S) Risks – There are a number of potential H&S Risks including Hazardous Energy Isolation and confined space entry.	EPCOR follows standard processes to reduce or eliminate H&S risks, including but not limited to: • Ensuring site specific safe work plans and procedures are developed that are compliant with regulatory requirements, at minimum • Procuring qualified contractors with experience working in these conditions • Including safety systems and safety performance in evaluation criteria for the selection of contractors • Completing process hazard analysis, constructability reviews and risk assessments as part of the design and construction stages • Developing a hazard registry specific to the required tasks, and implementing best practices like job-site hazard assessments and daily toolbox meetings to ensure workers are aware of these hazards • Conducting regular site visits and formal, documented inspections during construction.…
2	Key Environmental Risks – Silica dust during construction, and removal and disposal of construction debris	Risks are mitigated by following the EPCOR Life Saving Rules utilizing the tools as described above, with periodic review of work conditions and any changes thereof. Where risks exist, the aim is to engineer them out where possible, apply engineering or administrative controls, and ensure use of Personal Protective Equipment (PPE).
3	Key Financial Risks – further change orders or unknown conditions that cannot be seen until demolition is complete	If a deficiency is identified, an engineering analysis is completed to determine the most cost and constructability efficient solution that maintains EPCOR's health and safety standards.
4	Key Quality Risks – this is the risk that construction is not performed to a sufficiently high standard, in which case for example, leaks could develop or the mixer may not function appropriately.	Examples of how quality risks are managed are: • Rigorous contractor selection process that considers experience, safety performance, and past performance on similar projects. • Comprehensive and clear technical specifications for the work and equipment/materials • Applying lessons learned from the Digester 3 Upgrades project • Inspection and testing plan to ensure only quality products and workmanship are accepted • Contractor, strong specs, using lessons learned from Digester 3 Upgrade.

Appendix G6

EPCOR WATER SERVICES INC.

Wastewater Treatment
Diversion Structure Structural Rehabilitation Project
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Diversion Structure Structural Rehabilitation Project provides major rehabilitation to the Diversion Structure at the Gold Bar Wastewater Treatment Plant (WWTP).

2. This primarily includes rehabilitation and upgrade of the concrete structural components of the Diversion Structure.

3. Inspections conducted in 2017 determined that the Diversion Structure was in poor structural condition, with moderate to severe concrete deterioration noted throughout the structure walls, beams, ceilings, aluminum handrails, and access ladders.

4. The severe nature of the deterioration meant that the risk of structural failure was high, with the potential to result in an environmental release and severe impacts on the treatment process.

5. Allowing the structure to continue deteriorating and run to failure would result in a more costly subsequent emergency repair.

6. In addition, since the structure had to be taken down in stages to manage around seasonal flows, it needed a longer period of time to complete this work. Waiting until the 2022-2024 PBR would have resulted in continued deteriorating conditions and a high risk of failure.

7. Because of the emergent nature of the work, rehabilitation of the structure began in 2018. The project is being delivered in three phases in order to manage plant flows and capacity requirements, and is scheduled for completion in 2022.

8. This project falls into the Reliability/Life Cycle category.

2.0 BACKGROUND AND JUSTIFICATION

9. Gold Bar WWTP has multiple concrete structures that are key components of the wastewater treatment process.

10. The Diversion Structure transports raw wastewater from the EPCOR Drainage Services collection system into the Gold Bar WWTP Influent Channels.

11. In the case of high flow events, when influent coming in to the Gold Bar WWTP exceeds treatment capacity, the Diversion Structure routes excess flows through initial treatment (screening) into the North Saskatchewan River (NSR).

12. The structure also distributes the flows between the various influent channels.

13. Inspections conducted in the spring of 2017 determined that the Diversion Structure was in poor structural condition (Figures 2.0-1 and 2.0-2). Moderate to severe concrete deterioration was noted throughout the structure walls, beams, ceilings, aluminum handrails, and access ladders.

Figure 2.0-1
Concrete Deterioration

Figure 2.0-2
Soffit Deterioration

14. The issues were due to extensive hydrogen sulphide (H_2S) attacks on the structure. H_2S is an odorous and corrosive gas, which is emitted from the wastewater stream due to

microbiological activities. By nature it is very corrosive to bare concrete surfaces. In wastewater treatment infrastructure, concrete deterioration and corrosion is typically most severe above the surface of the wastewater stream.

15. Based on previous experience and research literature, a protective coating or barrier is recommended, intended to minimize exposure of concrete surfaces to H_2S attack. For this structure, the recommendation was to use a cast-in-place High Density Polyethylene (HDPE) liner to protect the concrete. Also recommended was the upgrade of various safety components associated with this structure. This included replacement of existing aluminum handrails and access ladders with stainless steel installation. Existing safety components were severely deteriorated and required replacement both for safety and longevity considerations.

16. Additional safety components proposed for the structure included access hatches and a fall protection system (stainless steel horizontal lifeline), to better support future maintenance activities and inspections of the structure.

17. The severe nature of the deterioration meant that the risk of structural failure was high. Such failure could result in an environmental release and have severe impacts on the treatment process.

18. Allowing the structure to continue deteriorating and run to failure would result in a more costly subsequent emergency repair, as opposed to addressing the issue immediately.

19. In addition, since the structure had to be taken down in stages to manage around seasonal flows, the project needed a longer period of time to complete this work. Waiting until the next PBR would have resulted in a high risk of failure and continued deteriorating conditions.

20. Therefore, because of the emergent nature of the work, rehabilitation of the structure began in 2018 and is scheduled for completion in 2022.

21. It is not possible to take the entire Diversion Structure out of service at once because there is no bypass for the structure. The only way to make any modification is to isolate one channel (either North or South) at any given moment. Hence the project is phased over a period of four years with construction during low flow (dry season) to mitigate the risk of having one channel out of operation.

3.0 PROJECT DESCRIPTION

22. The scope of the project includes rehabilitation and upgrade of the concrete structural components of the Diversion Structure.

23. Since the entire Diversion Structure cannot be taken out of service at once, the project is delivered in three phases, over a four-year period. The phases are shown in Figures 3.0-1 and 3.0-2.

Figure 3.0-1
Diversion Structure Project Phases

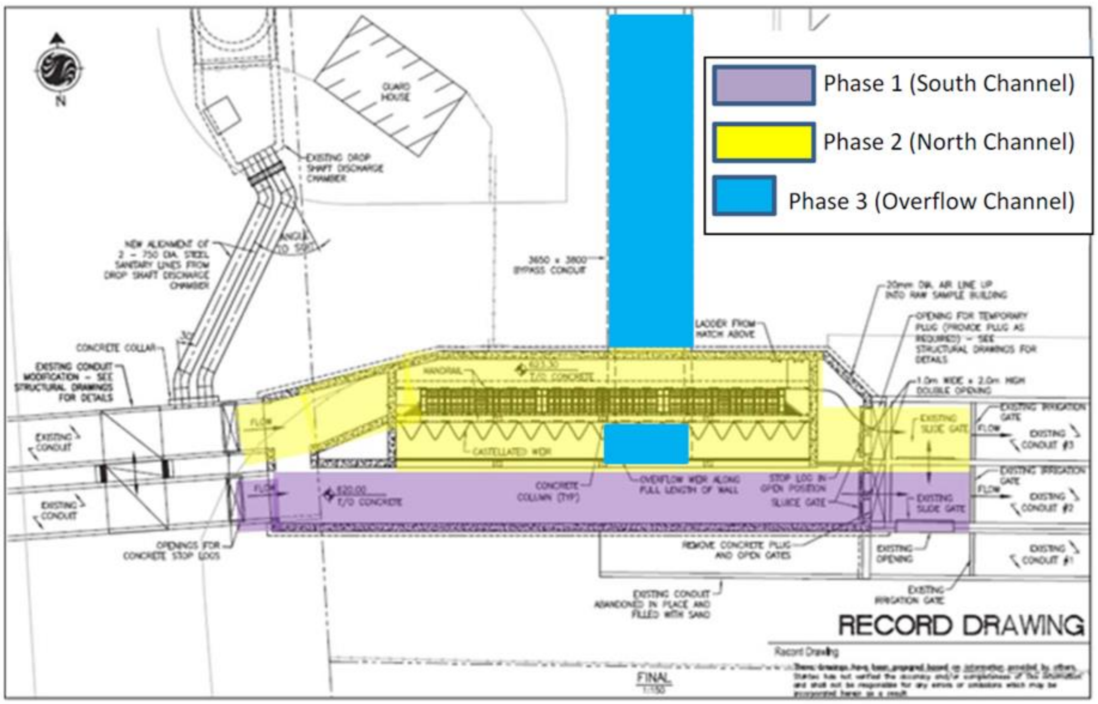
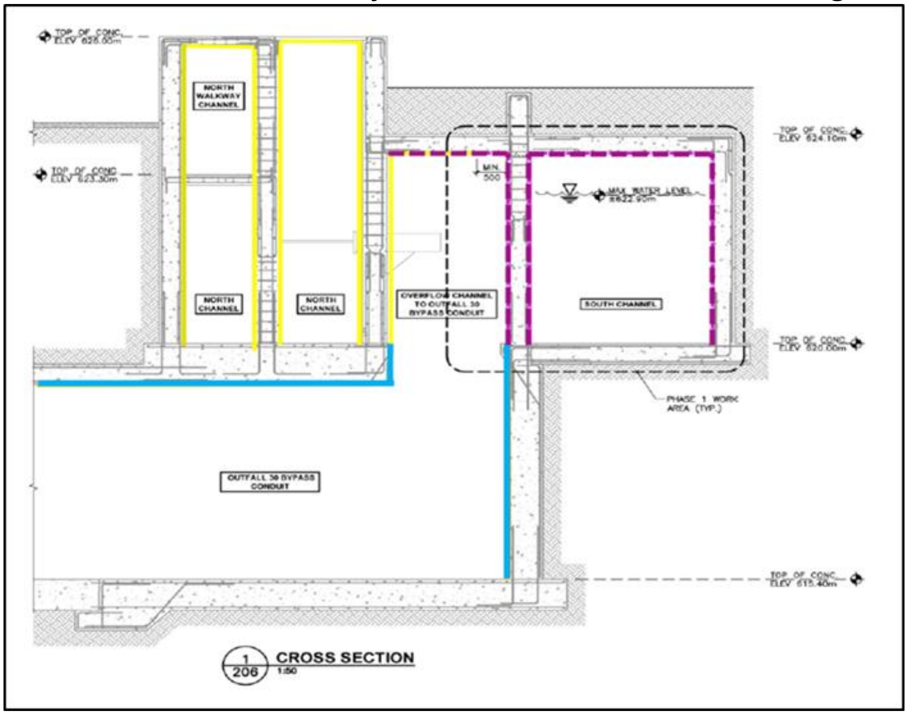


Figure 3.0-2
Diversion Structure Project Phases – Cross Section Drawing



24. The first phase of the project (South Channel) was planned for winter 2018-2019, however could not be completed in that timeframe due to unforeseen early snow melt in March 2019. Snowmelt brought higher than expected inflow to Gold Bar WWTP, and the North Channel alone could not keep up with the increased flow. Construction resumed in October 2019 and phase one was completed by the end of February 2020. The scope of work for phase one included:

- Installation of a HDPE liner to protect concrete surface on the walls and ceiling.
- Purchase of stop logs and installation of stop log frame for future Hazardous Energy Isolation (HEI) of the South Channel.
- Installation of access hatches.

25. Phase two (North Channel) started in January 2020 and will be completed by the end of February 2022. The scope of work for the Second Phase is similar to the first phase and includes:

- Installation of a HDPE liner.
- Supply and installation of stop logs for future Hazardous Energy Isolation (HEI) isolation of the North Channel.
- Inspection and some modifications to the overflow screen.

- Replacement of existing and installation of new safety components.

26. The project team completed an inspection of the Bypass Channel (Phase three) in February 2020 and initiated its design. It includes the following:

- Installation of spray liner to protect concrete on the walls and ceilings.
- Repair of expansion joints and cracks on walls.

27. The project was initiated in 2018 and will go fully in to service in 2022.

4.0 PROJECT ALTERNATIVE ANALYSIS

28. The project alternatives were limited to doing nothing, or rehabilitating the Diversion Structure.

29. Doing Nothing was rejected because of the consequences of the structure failing. If the structure failed it would not be able to support flows in to the Gold Bar WWTP, and EWSI could not meet its operating permits and commitments to its customers.

30. If the Diversion Structure was permitted to run to failure, and was instead managed on an emergency basis, it would be a far more costly repair. The ability to manage and adequately treat flows would also constrain the ability to complete the repairs if the failure were to occur during the wet weather season.

31. Therefore, the decision was taken to rehabilitate the Diversion Structure as soon as practically possible.

32. Since the decision was based on qualitative factors, no quantitative analysis is provided.

5.0 COST FORECAST

33. The project cost forecast is derived from the cost of engineering and construction contracts.

34. A minimal level of contingency is included in the project budget because all major contracts have been signed, and the contractor is very familiar with the site and structure conditions.

35. Projected costs for this project are shown in Table 5.0-1.

Table 5.0-1
Diversion Structure Structural Rehabilitation Project
($ millions)

		A **Pre-2022**	B **2022**	C **Total**
	Direct Costs			
1	Contractors	7.17	0.33	7.50
2	Internal Labour	1.33	0.04	1.37
3	**Sub-total Direct Costs**	**8.50**	**0.37**	**8.87**
4	Indirect Costs	-	0.13	0.13
5	**Total Capital Expenditures**	**8.50**	**0.50**	**9.00**

36. This project is expected to go in to service in 2022.

37. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI has taken advantage of longer-term relationships with consultants, contractors and suppliers to effectively manage the quality of design, supply, and construction of required upgrades.
- All activities related to project management, construction coordination and inspection will be undertaken internally by EWSI, eliminating the need for external project management services. The delivery of major equipment is procured with direct contract with suppliers thus eliminating additional cost of contractors' premium.
- Construction coordinators will be on-site at Gold Bar WWTP to manage the day to day activities of contractors and ensure the project safely stays on time and is constructed to specifications.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit price basis.
- The installations will be consistent with EWSI's construction standards, which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every requested project is evaluated individually to prioritize projects; based on the highest risk and based on synergies with other projects (e.g. using a common shut down). Construction methods will be used to meet requirements at the lowest cost.

- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.

6.0 RISKS AND MITIGATION PLANS

38. Table 6.0-1 provides key risks and mitigation plans associated with this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk Statement	A **Risk Mitigation Plan**
1	Completing construction in a live plant can interrupt regular day to day activities and/or cause constraints on construction.	This risk will be managed with appropriate planning and communication between all involved parties.
2	Key Health and Safety Risks include: • HEI – it is difficult to stop the flow into the North Channel. This is because there is no current provision to isolate the channels of the Diversion Structure. • Confined space entry and construction close to live channel with wastewater flow stream.	• Contractor will utilize previous experience to establish HEI with installation of a temporary stop log. This will remain sealed for the duration of the construction. • Confined space entry and related hazards will be managed through well-developed safety practices.
3	Flooding of the work site if high flow conditions are experienced at Gold Bar.	Work is currently scheduled for completion during low flow conditions, however if the influent flow to the Gold Bar WWTP exceeds a specified level, warnings will be in place, staff will be safely exited from the worksite, and a portion of the construction site will be flooded.
4	Possibility of high H_2S in the workspace.	Air monitoring and ventilation will be in place to manage and minimize the risk of high H_2S levels.

Appendix G7

EPCOR WATER SERVICES INC.

Wastewater Treatment
Expand Flare Capacity Project
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Expand Flare Capacity Project is to construct a new building to house new flares and associated equipment.

2. This will provide the Gold Bar Wastewater Treatment Plant (WWTP) with redundancy capability since under the current setup, one flare alone cannot safely process all potential biogases produced in the wastewater treatment process.

3. A failure in the flare system could result in biogas being released to the environment. This is a hazard to people, the environment, the process, and is a prohibited practice (per Alberta Environment Approval 639-03-06 and Digester Gas Code CSA B149.6).

4. This project falls in to the Reliability/Life Cycle category.

5. The project will be initiated in 2022 and will be completed in 2024.

2.0 BACKGROUND AND JUSTIFICATION

6. Gold Bar WWTP currently has two flares, as shown in Figure 2.0-1.

Figure 2.0-1
Flares at Gold Bar WWTP

7. These two flares are shown in more detail in Figure 2.0-2.

Figure 2.0-2
Candle Stick Flare (left) and Enclosed Burner Flare (right)

8. The flares are primarily used to control biogas pressures and volumes within the anaerobic digesters headspace.

9. Biogas is a by-product of the wastewater treatment process, and is a blend of gases: methane, carbon dioxide, hydrogen sulfide, water vapour, and traces of others. The biogas is generated in the anaerobic digesters and then either utilized to provide heat and energy on site through boilers, or flared.

10. A failure in the biogas pressure control system, including the flares, could result in biogas being released to the environment. This is hazardous to people, the environment, the process, and is prohibited, per Alberta Environment and the Digester Gas Code (per Alberta Environment Approval 639-03-06 and Digester Gas Code CSA B149.6). As such, Gold Bar WWTP is required to have sufficient flaring capabilities within its direct control.

11. The existing flares were installed circa 2004-2008, as part of a flare facility upgrade. Since then there have been concerns regarding existing capacity, operation and maintenance.

12. A recent study was completed in 2019 to review the capacity of existing infrastructure. The study confirmed that the current installation does not provide full redundancy. This means that one of the flares alone cannot handle the full biogas loading for a significant amount of time.

13. The flares require regular preventative maintenance, which involves shutting them down for a period of time. Preventative maintenance work typically involves disassembly, inspection,

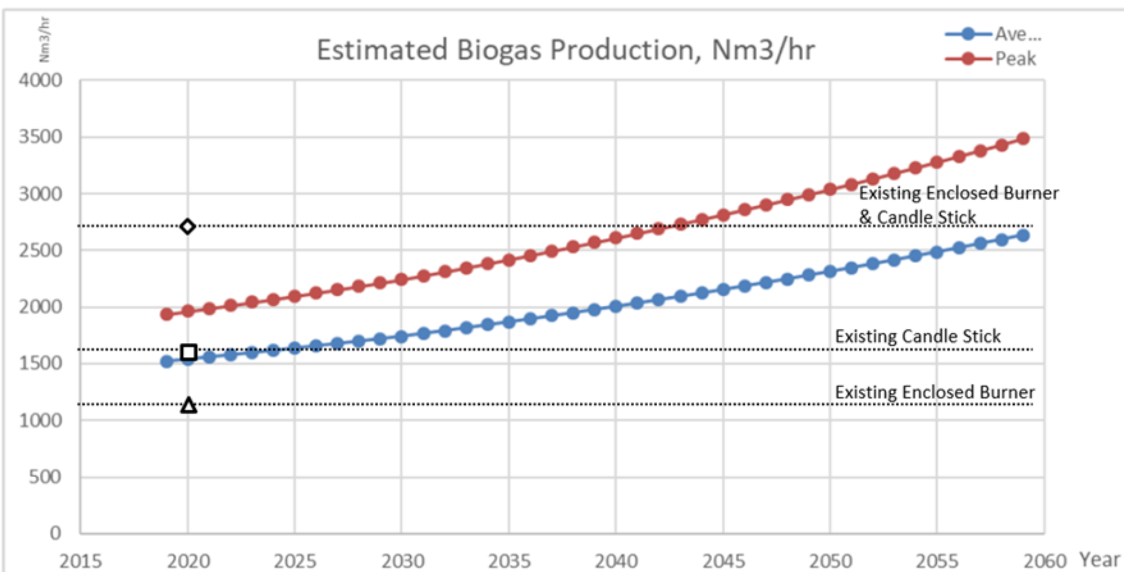
and replacement or reconditioning of parts (e.g., flame arrestors, thermal safety valves, thermocouples, burner nozzles).

14. While one flare is shut down for maintenance, the plant is dependant on the other for full service. While this is possible for short periods of time, it takes careful coordination to ensure this is done safely, and with consideration of the risk to the facility, particularly with the lack of full redundancy.

15. With only one flare in operation, there is therefore a risk of a biogas release. This results in the potentially hazardous situation, as described above.

16. A study was completed to review future biogas projections and capacity requirements up to 2060. Refer to Figure 2.0-3.

Figure 2.0-3
Estimated Hourly Biogas Production and Observed Capacities of Existing Flares



17. In Figure 2.0-3, the red and blue dots are based on modelling and predicted data, whereas the black and white shapes display actual measured data.

18. As seen in Figure 2.0-3, the study identified the lack of capacity in the current installation to provide adequate redundancy in the near term. In addition, it demonstrated the future shortfall in capacity in existing flares, and that around 2042 this would become an issue even on a combined flare basis.

19. The goal of the study was to provide guidance on expanding flare capacity in preparation for future demands. A conceptual design was produced to demonstrate how to expand the current flare capacity, which involved building a new flare facility.

20. The recommendation, to expand for additional capacity, achieved two outcomes. The new flare facility would establish adequate redundancy now, and would support continued expected future demands.

3.0 PROJECT DESCRIPTION

21. The scope for the Expand Flare Capacity project includes construction of a new building to house the new flare and associated equipment. Due to existing site conditions and current code requirements on spacing and location, a new building is required for the new equipment to address minimum clearances from digesters, other flares and other combustible gases.

22. It is expected that one new flare will be constructed now to supplement the existing plant flaring capacity, and establish the necessary redundancy completely within the control of regular Gold Bar WWTP operations. Future flares would be added as capacity, redundancy or replacement is required.

23. In the longer term there will be space for additional flares to be constructed, in order to provide capacity for future expansion and growth (i.e. blind flanges for future tie-in).

24. The current concept is to build the facility on a concrete pad, adjacent to the proposed Renewable Natural Gas (RNG) facility. Biogas piping will already need to be routed to this area, so it is advantageous from the perspective of construction team mobilization and set up of similar equipment to use similar infrastructure (pipe racks). These practical efficiencies will result in cost savings to the project. This flare project will continue to look for other opportunities to minimize cost through collaboration with the proposed RNG facility.

25. Regardless of the operational time of the proposed RNG facility (e.g. operational 90% of the time), Gold Bar WWTP requires sufficient and redundant flaring capacity to handle all of the site's biogas production. Building RNG does not eliminate the need for this project.

26. The new building would contain all the biogas handling equipment (e.g. flame arrestors, thermal safety valves, pressure control valves). Since this equipment would handle biogas saturated with water vapour, sheltering it from the cold climate conditions is required to mitigate the risk of freezing.

27. The flares themselves would be placed on the roof.

28. The building would also be designed to meet the plant's hazardous area classification standards.

29. The project will be initiated in 2022, with detailed design and procurement through 2022 and 2023. The construction period will be 2023 to 2024, with commissioning toward the end of the construction period. The new facility is expected to go in to service in 2024.

30. Phases of the project are per Table 3.0-1

Table 3.0-1
Digester 4 Upgrade Project Timelines

	Project Phases	A **2022 Q1**	B **2022 Q2**	C **2022 Q3**	D **2022 Q4**	E **2023 Q1**	F **2023 Q2**	G **2023 Q3**	H **2023 Q4**	I **2024 Q1**	J **2024 Q2**	K **2024 Q3**	L **2024 Q4**
1	Initiation/Approvals	X											
2	Preliminary Design		X										
3	Detail Design			X	X								
4	Procurement				X	X							
5	Construction					X	X	X	X	X	X		
6	Commissioning								X	X	X	X	
7	Close-out												X

4.0 PROJECT ALTERNATIVE ANALYSIS

31. There are four project alternatives: Defer Upgrade, Install a Temporary Flare, Upgrade the Existing Flare(s), or Build a New Flare Facility.

32. Deferring the upgrade does not resolve redundancy issues or address safety concerns and, on this basis, was rejected as a feasible alternative.

33. Installation of a temporary flare would increase the plant's capacity to process biogas, and has previously been considered to support flare maintenance work, i.e. a temporary install to create capacity while a flare is taken out of service. This would involve a temporary tie-in to the biogas piping system, and a temporary control set-up to integrate the flare into the regular plant operations. This arrangement was not considered practical during the flare maintenance work, as it involves a great deal of coordination over a short period of time. The existing biogas pressure control system does not have established provisions for a temporary system. The work steps required to implement this (including modifications to biogas piping, installation of temporary bypass piping, and bypassing automated safety system controls) are high risk. Other

risks are introduced when trying to integrate a temporary system in to the plant's control system for the biogas, which could detrimentally affect other areas of the operating plant. Any errors in that integration could result in a biogas release or explosion. In addition, this alternative requires EPCOR to rent equipment thus increasing operating expenses. This alternative was evaluated and confirmed to be high risk and therefore, this alternative was rejected.

34. Consideration was given to upgrading or modifying the existing flares in place to increase capacity. The candle stick flare is already the largest size available from the manufacturer (Varec Biogas) and is therefore not capable of providing additional capacity. The enclosed burner flare is available in one size larger, and the existing nozzles could be bored out to slightly increase its capacity. However, this involves taking the flare out of service for an extended period of time, and relying only on one flare to handle all of the biogas produced on-site. This presents the same challenges and risks experienced during maintenance work. While it is possible to do this, it involves a great amount of coordination and may result in only a slight increase in capacity. This option was rejected, as it did not provide sufficient additional capacity to warrant the risks involved with forgoing redundancy during construction and installation.

35. The construction of a new flare facility would allow for an increased biogas handling capacity while the existing flares are still in operation. This would mitigate the risk of a potential biogas release from a flare failure, as additional spare capacity would be available. This also provides space to install the necessary equipment to address the expected increase in biogas production in the years to come. Since there are code requirements that control the location details, and a new facility is required to align with these, the new building will also consider the location details of the future expansions.

36. The fourth alternative, to build a new flare facility, was considered the best option based on its ability to provide redundancy now and additional capacity in the future to meet growth needs. In addition, there would not be any decrease in flare capacity during construction as the two existing flares could continue to operate.

5.0 COST FORECAST

37. The project cost forecast is based on a conceptual design and engineering cost estimates.

38. A contingency of 30% is included in the cost forecast. This is based on the current level of project development, which is currently at conceptual design.

39. Projected costs for this project are shown in Table 5.0-1.

Table 5.0-1
Expand Flare Capacity Project
($ millions)

		A **Pre-2022**	B **2022**	C **2023**	D **2024**	E **Total**
	Direct Costs					
1	Contractors	0.28	0.80	2.50	1.65	5.23
2	Internal Labour	0.07	0.08	0.09	0.09	0.33
3	Contingency	0.00	0.11	1.14	0.68	1.93
4	**Sub-total Direct Costs**	**0.35**	**0.99**	**3.73**	**2.42**	**7.49**
5	Indirect Costs	0.00	0.11	0.27	0.48	0.86
6	**Total Capital Expenditures**	**0.35**	**1.10**	**4.00**	**2.90**	**8.35**

40. This project is expected to go in to service in 2024.

41. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI will take advantage of longer-term contracts with vendors to effectively manage the supply, quality and construction of required equipment.
- Construction coordinators will be on-site at Gold Bar WWTP to manage the day to day activities of contractors and provide site level oversight, to ensure the project stays on schedule and is constructed to specifications.
- Contracted services are performed by pre-qualified external contractors and done on a competitive price basis.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every requested project is evaluated individually to prioritize projects; based on the highest risk, based on synergies with other projects (e.g. using a common shut down). The construction execution plans will be selected and reviewed to ensure project requirements are met at the lowest cost.
- Project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.

6.0 RISKS AND MITIGATION PLANS

42. Table 6.0-1 provides key risks and mitigation plans associated with this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk Statement	A Risk Mitigation Plan
1	Key Health and Safety (H&S) Risks – There are a number of potential H&S Risks including Hazardous Energy Isolation for the duration of the project, and working around biogas and hydrogen sulfide (H_2S) gases.	EPCOR follows standard processes to reduce or eliminate H&S risks, including but not limited to: • Ensuring site specific safe work plans and procedures are developed that are compliant with regulatory requirements, at minimum. • Procuring qualified contractors with experience working in these conditions. • Including safety systems and safety performance in evaluation criteria for the selection of contractors. • Completing process hazard analysis, constructability reviews and risk assessments as part of the design and construction stages. • Developing a hazard registry specific to the required tasks, and implementing best practices like job-site hazard assessments and daily toolbox meetings to ensure workers are aware of these hazards. • Conducting regular site visits and formal, documented inspections during construction.
2	Key Environmental Risks – Process safety risks arise during complex plant shutdowns, construction, or commissioning, resulting in the release of biogas to the environment	Process shutdowns are planned using a planning process and multiple work packages are incorporated as needed. EPCOR has Process Hazard Analysis procedures to identify specific mitigations required for each significant activity.
3	Key Financial Risks – further change orders or unknown conditions that cannot be seen until demolition is complete	If a deficiency is identified, an engineering analysis is completed to determine the most cost efficient and constructible solution that maintains EPCOR's health and safety standards.
4	Key Quality Risks – this is the risk that construction is not performed to a sufficiently high standard, in which case for example, leaks could develop or the flare may not function appropriately.	Examples of how quality risks are managed are: • Rigorous contractor selection process that considers experience, safety performance, and past performance on similar projects. • Comprehensive and clear technical specifications for the work and equipment/materials. • Applying lessons learned from previous biogas related projects. • Inspection and testing plan to ensure only quality products and workmanship are accepted.

Appendix G8

EPCOR WATER SERVICES INC.

Wastewater Treatment
Laboratory Facility Consolidation Project
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The Laboratory Facility Consolidation Project will co-locate Quality Assurance and Environment wastewater and water laboratory functions into the Rossdale Water Treatment Plant (WTP) Water Excellence Lab Building.

2. This will provide a platform for synergistic processes and savings across the two teams and effectively create one laboratory team.

3. Once the Gold Bar lab team has moved to the WTP, the existing Gold Bar lab building will be available for alternative use to the Plant.

4. This project falls into the Performance / Efficiency Improvement category.

5. The project was initiated in 2020 and the project will be completed in 2023.

2.0 BACKGROUND AND JUSTIFICATION

6. The Gold Bar Wastewater Treatment Plant (WWTP) lab building was built in 1991, and transferred from the City of Edmonton to EPCOR with Wastewater operations in 2009.

7. The building houses the wastewater laboratory function, which incorporates employees from the Quality Assurance and Environment (QAE) team.

8. The building has experienced a number of issues over the years, primarily related to its building envelope, and mechanical and electrical systems.

9. In 2019, EWSI commissioned a study (the study) of alternatives for the future of the Gold Bar lab building including continuing to maintain the existing building, significantly upgrading the existing building, demolishing and replacing the existing building at the Gold Bar site or renovating the water laboratory in the Water Excellence Laboratory at the Rossdale site to accommodate the wastewater laboratory function.

10. The study completed a general condition assessment of the existing Gold Bar lab building, using Functional Statements of the National Building Code – 2019 Alberta Edition (Building Code) and requirements of the National Energy Code of Canada for Buildings 2017 (Energy Code) to assess how the building complied with minimum requirements of each code. Laboratories fall under Part 3 of the Building Code and requires compliance to the Energy Code.

11. The study also evaluated alternatives for addressing concerns raised relating to the lab building, including poor environmental control and inability to maintain an adequate thermal environment.

12. The study performed workshops with the Rossdale and Gold Bar lab teams to explore issues that would arise from consolidation of different lab functions, including assessment of advantages and disadvantages of the alternatives.

13. The condition assessment outlined various challenges with the building.

14. The building fails to satisfy almost half of its safety, health, accessibility, fire, structural protection and environmental functions outlined in today's building code standards. These issues must be addressed to meet the requirements of a major renovation Building Permit.

15. The building envelope fails to meet any of the minimum energy performance criteria for the seven major building envelope components. It also does not satisfy another six critical performance measures, essential to meet Energy Code minimum requirements. These issues must be addressed to meet the requirements of a major renovation Building Permit.

16. The difficulty the building systems have to maintain a comfortable thermal environment has a direct and negative impact on employee wellness and productivity.

17. Without a major upgrade to building systems for environmental conditions (building envelope, mechanical and electrical), the building does not meet current building standards. It would also be highly unlikely to meet future, more stringent performance standards.

18. These issues must be addressed to meet the objectives of the City's Sustainable Building Policy.

19. The report recommends that the building requires a life-cycle refit of its major services, if the lab team is to remain in the existing building. The risks associated with not completing any upgrades to address these concerns are high.

20. There are two key drivers for the proposed change.

21. First, the existing lab building contains a number of issues, primarily around the heating system and building envelope that has led to less than reasonable working conditions and testing conditions.

- The lab building does not have an independent heating system and is instead connected to the Gold Bar WWTP hot water system. This means that when there is a plant shutdown or maintenance work on the plant heating, the lab loses heating capability.
- The building's HVAC system is not suited for a lab function. Fumehoods in the lab draw significant volume of air to limit exposure to hazardous fumes, which adds a high ventilation demand and a high demand to the heating system. During winter, the heating system is not able to warm the building to sufficient temperatures. On occasion, temperatures in the lab building drop to around 10 degrees Celsius. Cooler temperatures mean that testing is sometimes not performed within the guidelines of the quality management system.
- The study has confirmed that the lab is in poor physical condition. Any improvements would require substantial upgrades to meet the current iteration of building and energy codes.

22. Second, the other driver is to generate synergies across EWSI's business processes.

- In September 2017, Drainage operations transferred from the City of Edmonton to EPCOR. EWSI has since investigated opportunities to generate synergistic processes and savings across the organization in order to deliver on commitments made during transition.
- As part of the study, the co-location of two existing lab teams from Gold Bar WWTP and the WTP was investigated, since both teams exist under the QAE team using similar expertise and equipment to perform their functions. The study concluded that this is a feasible option.
- A review confirmed that work was capable of flowing differently and more efficiently if the two teams were housed in the same lab building.

23. In order to achieve the goal of co-locating the lab teams and to address the deteriorating conditions of the Gold Bar lab building, this project proposes to consolidate the wastewater laboratory functions currently located at the Gold Bar WWTP with the water laboratory functions in the Water Excellence Lab at Rossdale WTP.

3.0 PROJECT DESCRIPTION

24. The scope for this project includes:

- Preliminary design.
- Detailed Design.
- Procurement of consultant, contractor, and long lead items.
- Stakeholder engagement workshops and review meetings.
- Mechanical, electrical and other utility upgrades at the Rossdale WTP Water Excellence Building to accommodate integration of the wastewater lab function.
- Demolition and renovation of the first floor of the Water Excellence Building to accommodate the integration of the wastewater lab function.
- Providing an alternative space during construction and temporary operational plan to ensure water lab functions can remain ongoing during construction.
- Development of a Lab Move Plan.
- All associated permit requirements and procurement requirements to achieve the project.
- All project management and contractor management activities to achieve the project.

25. The project will be initiated in 2020 and will be available for complete transition of wastewater operations in Q4 of 2023.

4.0 PROJECT ALTERNATIVE ANALYSIS

26. Five alternatives were considered for this project:

- Do Nothing (Status Quo).
- Refurbish the existing Gold Bar WWTP lab.
- Demolish and rebuild the Gold Bar WWTP lab.
- Integrate lab operations at the Rossdale WTP – recommended alternative.
- Contract out lab services to a third party.

27. Only one of the options considers consolidation of functions. The other alternatives were developed to provide context to the relative cost and the logic of integrating lab operations at the Rossdale WTP.

28. Status Quo was rejected due to the inadequate heating system and the ongoing capital upgrades required to the building. The impact of the inadequate heating on employee working conditions and engagement during cold periods, and on the quality of the testing environment were considered critical flaws of this alternative. The NPV of this alternative was modelled for baseline purposes in Table 4.0-1.

29. Refurbishing the existing lab building involved spending capital dollars to ensure it meets Building and Energy Codes. While this alternative would avoid the need to move lab employees to a different site, it would be difficult to achieve without significant disruption to lab employees and operations throughout the refurbishment. In addition, it would not remove issues such as the connection of the heating system to the plant. This alternative was assessed in the NPV analysis, detailed in Table 4.0-1. Based on the higher NPV, a significant capital outlay, and the qualitative risks associated with this alternative, it was rejected.

30. The third alternative to demolish the existing lab building and rebuild new in place was rejected. While the new build would ensure that Building and Energy Codes were met, and more modern systems would reduce maintenance and operational costs, there is a significant capital cost associated with constructing a new building. In addition, it would be challenging to continue lab operations throughout the project because practically there would be nowhere for lab operations to be performed. This alternative was considered cost and practically prohibitive.

31. The fourth alternative was to integrate lab teams at Rossdale WTP lab. This alternative brings the lab expertise together in one location, which creates a platform to generate synergistic processes and savings. Some renovation is required to the first floor of the Rossdale WTP Excellence Building, to create additional space for the wastewater lab testing facilities. This would displace administrative employees, who would be moved to the second floor of the building. The NPV of this alternative was modelled and is shown in Table 4.0-1. This proved to be a cost effective alternative with many qualitative benefits. For these reasons, this was selected as the preferred alternative.

32. Outsourcing Gold Bar lab operations was considered due to its potential to reduce operating expenses through staffing, materials and equipment savings. Practically however there are many qualitative disadvantages to this approach, including but not limited to:

- loss of in-house technical wastewater knowledge and experience (this is particularly important during plant upsets);

- reduction to high quality and speedy support service (this is also especially important during emergencies and or plant upsets);
- potential loss of internal operational and regulatory oversight; and
- a negative impact on employee engagement across various associated teams.

33. To achieve this fifth alternative would require significant longer term planning and organization, particularly in consideration of repurposing specialized employees to alternative roles. In addition, there would need to be a robust strategy to ensure that the benefits of real-time laboratory analytics and skills could continue to be realized. Given its shorter term challenges and significant disadvantages, this alternative was rejected.

34. An NPV was performed in order to provide quantitative feedback on the three feasible alternatives: Status Quo, Refurbish existing lab, and Relocate to Rossdale WTP.

35. The results of this analysis are shown in Table 4.0-1.

Table 4.0-1
NPV and Capital Outlay Analysis of Alternatives
($ millions)

		A	B
	25 Year Summary	**NPV Revenue Requirement**	**Capital Outlay**
1	Status Quo*	81.99	4.00
2	Refurbish existing Gold Bar lab	93.22	18.54
3	Integrate lab teams at Rossdale WTP Lab	89.13	6.48

* Does not resolve current inadequate heating issues in the existing building.

36. The Status Quo revenue requirement is lowest, however because the alternative does not resolve issues with the existing building envelope, this alternative was rejected.

37. Second to this alternative is the co-location at Rossdale WTP and this is supported by a capital outlay and NPV close to the Status Quo, and the added benefit of offering synergistic opportunities within QAE. This supports the decision to proceed with alternative three, Integrate lab teams at the Rossdale WTP lab.

5.0 COST FORECAST

38. The project cost forecast is based on estimates provided in the study, plus internal labour and overheads associated with delivering a project of this size and scope. The estimation class for this estimate is Level 4.

- Construction costs were estimated based on square footage of renovated floor space at Rossdale. The quantities were derived based on a possible new layout of the floorplan provided in the study.
- Design costs were estimated as a percentage of construction costs.
- Internal time was estimated assuming project management will be completed internally.

39. A contingency of 30% is included in the cost forecast, which is consistent with EWSI's contingency guidelines range for this level of project definition. The higher end of the range was used to reflect the following uncertainties related to the project:

- The level of utility upgrades required. The Water Excellence Laboratory may require some upgrades, the extent of which will be determined during detailed design. There are some chemical lines running through the building. It is uncertain at this time how this will affect the addition of a new lab function in the same space and the extent of upgrades that will be required.
- The level of impact of stakeholders on the scope and schedule.
- The level of impact to Rossdale lab operations during construction.

40. The contingency is to cover the cost of unknowns that cannot be identified or anticipated during the design or inspection phase, and typically arise during demolition.

41. Projected costs for this project are shown in Table 5.0-1.

Table 5.0-1
Gold Bar Laboratory Consolidation Project
($ millions)

		A	B	C	D	E
		Pre-2022	**2022**	**2023**	**2024**	**Total**
	Direct Costs					
1	Contractors	0.50	1.99	1.95	0.00	4.44
2	Internal Labour	0.10	0.10	0.11	0.01	0.32
3	Contingency	0.00	0.60	0.59	0.00	1.19
4	**Sub-total Direct Costs**	0.60	2.69	2.65	0.01	**6.95**
5	Indirect Costs	0.00	0.19	0.38	0.01	0.58
6	**Total Capital Expenditures**	0.60	2.88	3.03	0.02	**6.53**

42. The project is expected to go in to service in 2023.

43. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- Construction coordinators will be on-site at Rossdale to manage the day to day activities of contractors and ensure the project stays on time and to specifications.
- All activities related to project management, construction coordination and inspection will be undertaken internally by EWSI, eliminating the need for external consultants.
- Consultants and contractors will be procured via competitive bidding.
- The project will go through a phased process whereby the forecast of the project will be reviewed by senior leadership as the project is more defined. This will ensure that the project is evaluated for its costs and benefits at each stage.
- The design will go through multiple iterations of a risk review process to ensure assumptions are valid. This will help minimize the number of changes required during construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.

6.0 RISKS AND MITIGATION PLANS

44. Table 6.0-1 provides key risks and mitigation plans associated with this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk Statement	A Risk Mitigation Plan
1	Key Health and Safety Risks – There are a number of potential H&S Risks that are related to construction and renovation of an existing space.	EWSI has a comprehensive health, safety and environment program, and associated training requirements to ensure project work meets or exceeds safety and environmental legislation. The health and safety of all workers and the public is the first priority to EWSI, and this is an important focus during project planning and execution. Contractor experience in managing and coordinating trades as well as experience working at EWSI's sites will be evaluated during the procurement phases. EWSI also has a contractor management procedure to provide a detailed framework to manage contractors and outline expectations.
2	Key Operational Risks – current lab operations could be impacted during the construction phase.	A Lab Move Plan will be developed with stakeholders to ensure smooth transitions and continued operations through periods of change and disruption.
3	Key Financial Risks- Risks unknown at this time could arise during the design and construction phases that could put the project objectives at risk. This includes the risk that not all requirements are adequately captured at the design phase.	A requirements and assumptions log will be developed and managed throughout the project. The lessons learned for the Water Excellence Lab Building project will be reviewed, occupants will be consulted, and maintenance personnel will be consulted at the start of the project to understand some of the risks associated with the building. Furthermore, Hazard and Operability studies (HAZOP) will be completed prior to completion of design and once again, when contractor is selected. Project drawings will be Issued For Construction after contractor is selected and construction HAZOP is completed. This will ensure that the design does not result in any unintended consequences for maintenance and operation of the asset, and that risks are identified and mitigated before construction begins.

Appendix G9

EPCOR WATER SERVICES INC.

Wastewater Treatment
Odour Control Improvements Project
Business Case

February 16, 2021

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1.0 OVERVIEW

1. EWSI has made a commitment to all of its stakeholders to continuously improve odour control by actively managing odour sources within the Gold Bar Wastewater Treatment Plant (WWTP).

2. This is a shared outcome as per the current Integrated Resource Plan (IRP) submitted to the Utility Committee.

3. The Odour Control Improvements Project will address odourous emissions from sources emitting the highest odour based on an odour assessment completed in 2019.

4. The Project will consider construction of a dedicated capture and treatment facility (scrubber) in either the diversion structure or the primary clarifiers.

5. The decision to choose either the diversion structure or the primary clarifiers for project execution will be made based on the cost and complexity of the required upgrades for each area, as well as, benefits and level of odour mitigation for each.

6. The remaining odour sources will undergo detailed design and construction in future periods.

7. This project falls in to the Regulatory/HSE category.

8. The project was initiated in 2020 and will be completed in 2024.

2.0 BACKGROUND AND JUSTIFICATION

9. The Gold Bar WWTP provides sanitary and combined sewer wastewater treatment services for the residents of the City of Edmonton.

10. Its prime objective is to safely and reliably treat wastewater in compliance with environmental regulations.

11. Gold Bar WWTP is an operational site that, by its nature, has little direct interaction with the public. The interaction that does occur is typically with the immediate surrounding communities. The majority of these customer service interactions involve concerns regarding odours.

12. The main contributor to odour generation at Gold Bar WWTP is Hydrogen Sulfide (H_2S), which is produced by normal biological activity in wastewater (sewage). The long travel time in the collection system to the plant (which is even longer during dry weather) can cause the wastewater to be extremely odourous on arrival at the plant.

13. With millions of litres of wastewater treated at Gold Bar WWTP every day, ensuring proper odour control is a key and ongoing concern for EPCOR as well as the residents of the communities surrounding the plant.

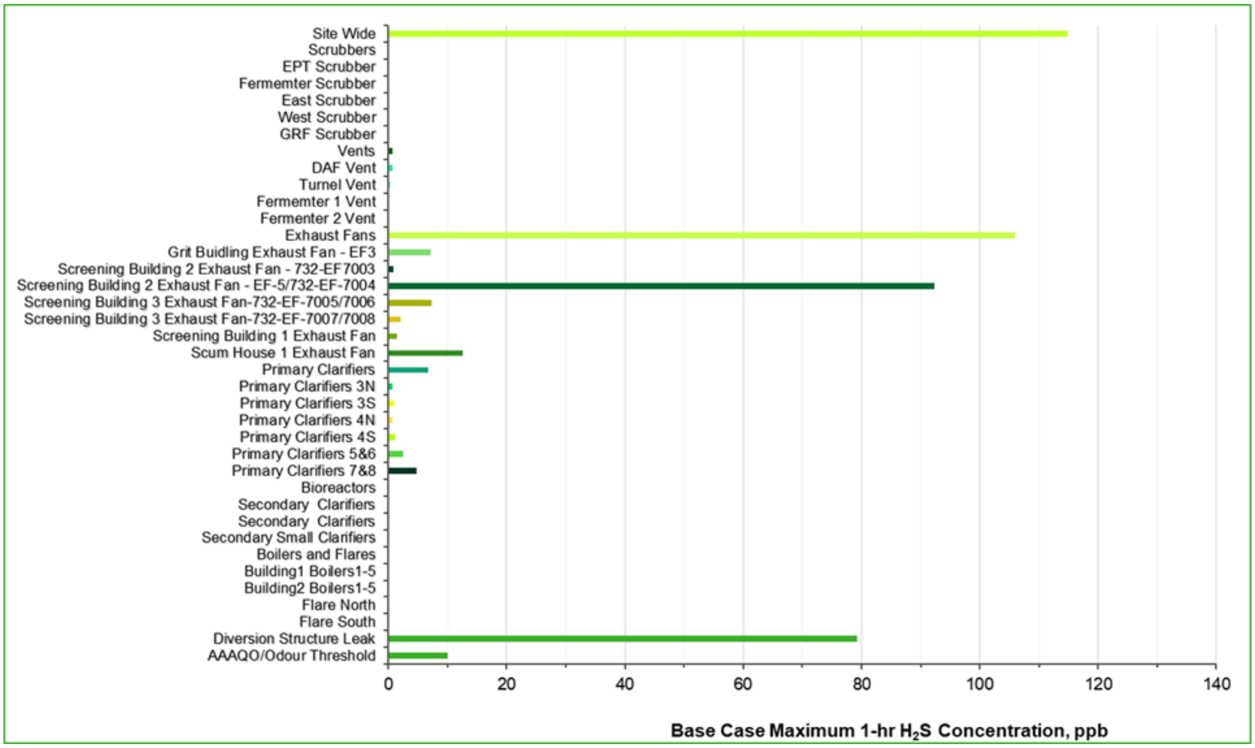
14. An initial odour assessment was performed in 2016 at the Gold Bar WWTP, which informed a number of improvements that have been implemented during the current PBR. In 2019, the odour assessment was repeated in order to guide future improvements. Two cases of dispersion modelling were performed, the base case and the future case.

15. The base case modelled odour and H_2S emissions as currently measured at the plant.

16. The future case was modelled assuming there were no diversion structure leaks, no exhaust fan emissions and that the Grit and Screening Building scrubber had been installed. These items were identified as the top sources of odour in the 2019 study. The Grit and Screening Building sources have been addressed through upgrade projects completed subsequent to the 2019 study, but the diversion structure leaks have not. The primary clarifiers were not suppressed in the future case but they are the next most significant odour source after these sources are addressed.

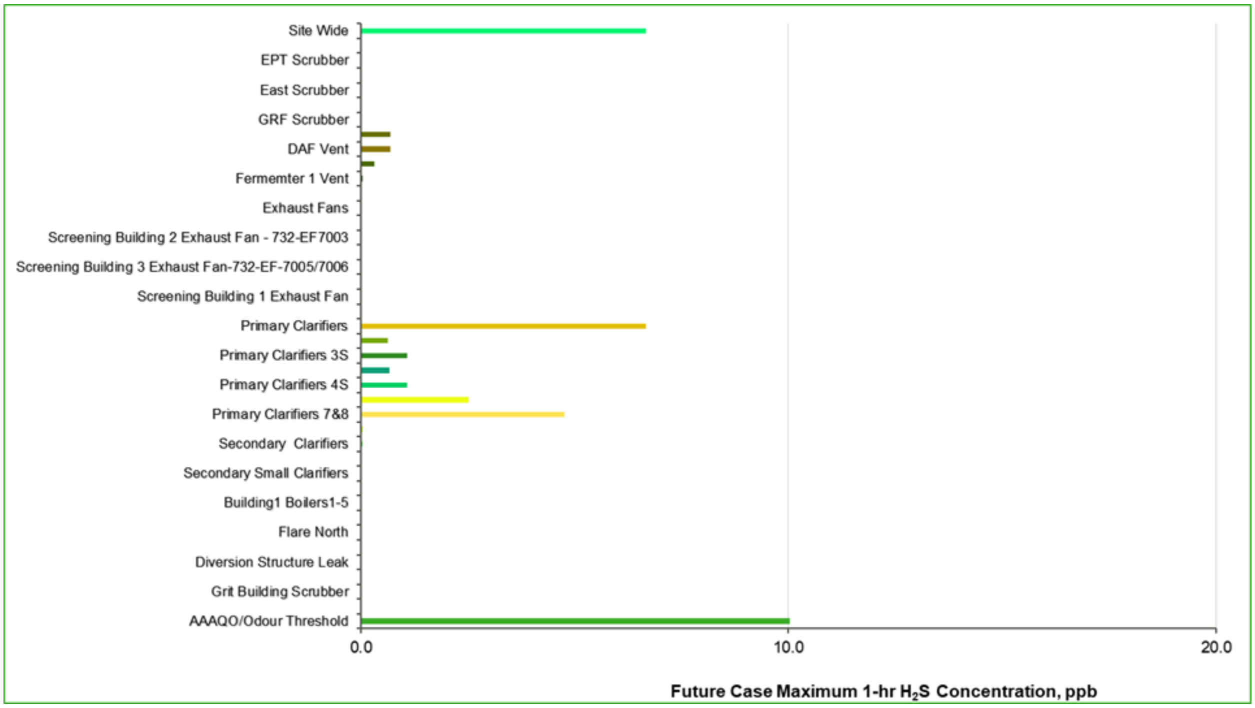
17. The 2019 Odour Assessment and modelling results are shown in Figures 2.0-1 and 2.0-2 below.

Figure 2.0-1
Odour Assessment – Base Case



18. Figure 2.0-1 shows that the key contributors to odour in and around the plant in the base case are generally found site wide, and are mainly because of the exhaust fans, the Screening building and diversion structure leaks. The concentration of the top four causes of odour are at and above 80 parts per billion or ppb, which is higher than the ambient threshold levels established within the Alberta Ambient Air Quality Objectives (AAAQO) by Alberta Environment and Parks (AEP).

Figure 2.0-2
Odour Assessment – Future Case



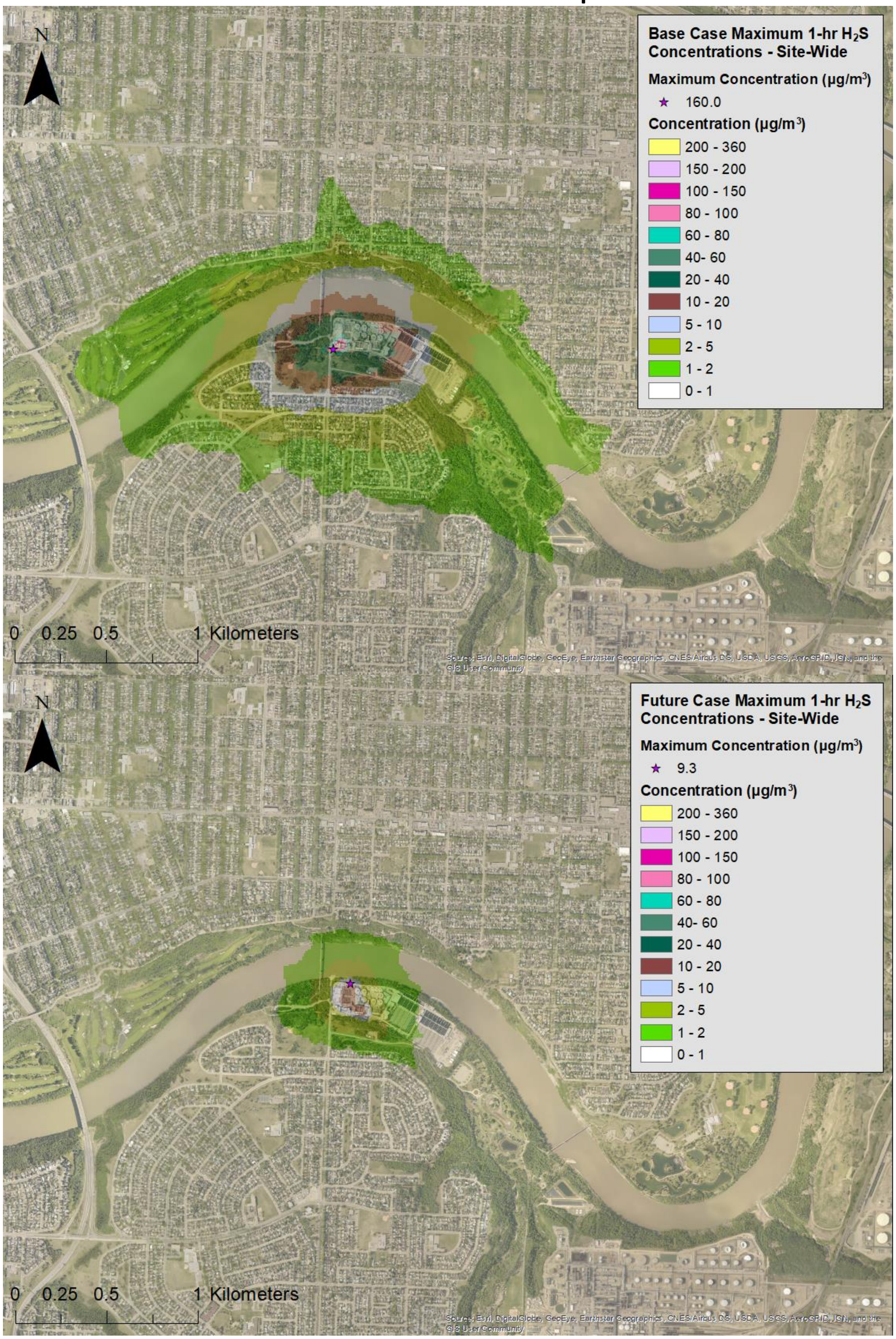
19. Figure 2.0-2 shows that once the upgrades have been completed to resolve the identified issues resulting in odour around the plant today, the expected odour reading will be 10 ppb or less, which is the 1-hour average threshold concentration as per AAAQO.

20. EPCOR has made a commitment to all of its stakeholders to continuously improve odour control by actively managing sources within the Gold Bar WWTP. This is a shared outcome as per the current Integrated Resource Plan (IRP) submitted to the Utility Committee.

21. To postpone the project would mean not addressing known major sources of emission. Fugitive or uncontrolled emissions from the diversion structure can also cause exceedance of the AAAQO and will remain a major source of odour until resolved.

22. Additional model results demonstrate the reduction to odour expected because of this project, as seen below in Figure 2.0-3. The figures demonstrate contours of 1 hour average H_2S concentrations under the current scenario and after the major odour sources are mitigated in the future. The figures show that after project completion, the impacted area reduces significantly, as does the level of odour and the resulting concentration levels outside of the plant boundary are within the prescribed limits of the AAAQO.

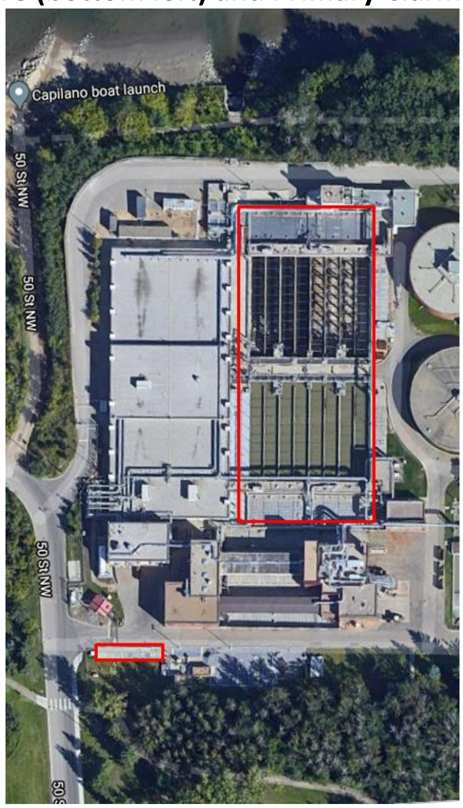
Figure 2.0-3
Base and Future Case – Odour Impact Area



3.0 PROJECT DESCRIPTION

23. This project considers addressing odourous emissions from the diversion structure and the primary clarifiers. Figure 3.0-1 shows these two odour sources within the red outlines.

Figure 3.0-1
Diversion Structure (bottom left) and Primary Clarifiers 5-8 (top right)



24. The proposed solution is the capture and treatment of the foul air in new and/or existing odour treatment facilities (scrubbers) from one of the two odour sources.

25. The complex nature of the diversion structure and its connection to the collection system, bypass channel and outfall makes it extremely challenging for effective isolation, seal and capture.

26. The conceptual design will address both sources (diversion structure and primary clarifiers) and identify practical solutions and conceptual level cost estimates for mitigating both sources.

27. Further stages of the project (detailed design and execution) will focus on one of the two sources for mitigation during the 2022-2024 PBR period. The remaining odour source will be addressed in the future.

28. The project was initiated in 2020, with detailed design and procurement through 2022 and 2023. The construction period is 2023 through to 2024. The project will go into service in Q4 of 2024.

29. Phases of the project are shown in Table 3.0-1

Table 3.0-1
Digester 4 Upgrade Project Timelines

Project Phases	A **2020 & 2021**	B **2022 Q1**	C **2022 Q2**	D **2022 Q3**	E **2022 Q4**	F **2023 Q1**	G **2023 Q2**	H **2023 Q3**	I **2023 Q4**	J **2024 Q1**	K **2024 Q2**	L **2024 Q3**	M **2024 Q4**
1 Initiation/Approvals	X												
2 Preliminary Design	X												
3 Detail Design		X	X	X	X	X							
4 Procurement					X	X	X						
5 Construction							X	X	X	X	X	X	
6 Commissioning												X	X
7 Close-out													X

4.0 PROJECT ALTERNATIVE ANALYSIS

30. EWSI considered four alternatives: do nothing, construct a liquid phase chemical dosing facility, have an in-situ gas phase ionization treatment unit, and have a dedicated capture and treatment facility (scrubber).

31. The first alternative, to do nothing, was rejected as unacceptable. EPCOR has made a commitment to the local community to continuously improve odour control by actively managing sources within the Gold Bar WWTP, and doing nothing would not meet this commitment.

32. Alternative two, having a liquid phase chemical dosing facility has been trialed and proven unsuccessful. In addition, odourous compounds are already released in gas phase before flows enter the facility, so the treatment would have limited effectiveness. This alternative was rejected.

33. An in-situ gas phase ionization treatment unit collects air from the atmosphere, induces ionization and injects the pressurized reactive air into the headspace. This creates positive pressure and makes it very difficult to achieve a seal, resulting in fugitive emissions. The complex nature of the structure however makes it impossible to achieve appropriate contact of the foul air with the injected ionized air. This has been trialed and proven to be unsuccessful. This alternative was rejected.

34. Alternative four, having a dedicated capture and treatment facility (scrubber) in the diversion structure and primary clarifiers is the current proposed solution. It offers the greatest chance of success for on-site treatment.

35. Since the decision was based on qualitative factors, no quantitative analysis is provided.

5.0 COST FORECAST

36. The project cost forecast is largely based on prior experience of executing similar projects on site.

37. A contingency of 13% is included in the cost forecast. This is to cover the cost of unknowns that cannot be identified or anticipated during the design or inspection phase, and typically arise during demolition and construction. These challenges may include for example, extra provisions to allow effective capture and treatment of foul air, or provisions to resolve interference with aboveground or buried infrastructure during construction, etc.

38. Projected costs for this project are shown in Table 5.0-1

Table 5.0-1
Odour Control Improvements Project
($ millions)

		A **Pre-2022**	B **2022**	C **2023**	D **2024**	E **Total**
	Direct Costs					
1	Contractors	0.30	0.58	2.02	1.50	4.40
2	Internal Labour	0.12	0.06	0.06	0.06	0.30
3	Vehicles and Equipment					
4	Abandonments					
5	Contingency	0.00	0.08	0.15	0.44	0.67
6	Risk Allowance					
7	**Sub-total Direct Costs**	0.42	0.72	2.23	2.00	**5.37**
8	Indirect Costs	0.00	0.09	0.19	0.35	0.63
9	**Total Capital Expenditures**	0.42	0.81	2.42	2.35	**6.00**

39. The project is expected to go in to service in 2024.

40. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI will stock only the required equipment to reduce the overall costs of all installations and upgrades.

- A number of activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, minimizing the need for external consultants.
- Construction coordinators will be on-site at Gold Bar WWTP to manage the day to day activities of contractors and ensure the project stays on time and is constructed to specifications.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit price basis.
- The installations will be consistent with EWSI's construction standards, which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Project scope and design will be validated by stakeholders to improve economy of scale and to eliminate future throw-away of infrastructure.

6.0 RISKS AND MITIGATION PLANS

41. Table 6.0-1 provides key risks and mitigation plans associated with this project.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk Statement	A Risk Mitigation Plan
1	Key Health and Safety (H&S) Risks – There are a number of potential H&S Risks including Hazardous Energy Isolation for the duration of the project, confined space entry, etc.	EPCOR follows standard processes to reduce or eliminate H&S risks by conducting Process Hazard Analysis and by implementing appropriate engineered and administrative controls.
2	Key Environmental Risks – Silica dust during construction, and removal and disposal of construction debris	EPCOR conducts Process Hazard Analysis to identify risks and implement appropriate mitigation measures for Environmental risks. Appropriate delineation of construction area, including necessary dust control and debris management measures will be employed to mitigate relevant risks.
3	Key Financial Risks – further change orders or unknown conditions that cannot be seen until demolition is complete	EPCOR manages financial risks by conducting preliminary design and allocation of contingency funds appropriate for the design level. The financial risks will become more evident as further design is completed.

EPCOR

Appendix G10

EPCOR WATER SERVICES INC.

Wastewater Treatment
PE Channel Upgrades – Bypass Chamber Project
Business Case

February 16, 2021

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1.0 OVERVIEW

1. The PE Channel Upgrade – Bypass Chamber Project will provide major rehabilitation and upgrades to the Bypass Chamber part of the primary effluent (PE) Channel system.

2. This project will include rehabilitation of degraded concrete within the bypass chamber, the installation of a gate system in order to isolate channels (by stopping flows) within the PE system, and connectivity for a potential additional downstream PE Channel.

3. Creating the ability to isolate flows means that Gold Bar Wastewater Treatment Plant (WWTP) operations will be able to safely complete necessary upgrades and maintenance work to the rest of the PE Channel system.

4. Regular inspections and maintenance should also prolong the expected life of associated assets and reduce the risk of failure.

5. The upgrade to the Bypass Chamber is part of a group of projects that will upgrade the entire PE Channel system in future PBR periods. The channels downstream of the Bypass Chamber cannot be upgraded until the gate system is installed, as there is no existing mechanism to safely alternate flows between the downstream PE channels.

6. This project falls in to the Reliability/Life Cycle category.

7. The project was initiated in 2019 and will be completed in Q4 of 2024.

2.0 BACKGROUND AND JUSTIFICATION

8. The Gold Bar WWTP consists of a number of channels and chambers that convey wastewater from the entrance of the plant, through various treatment processes, to the outfalls back into the North Saskatchewan River (NSR).

9. Within the plant, PE channels move effluent from the primary clarifiers to the bioreactors, as shown in Figure 2.0-1.

Figure 2.0-1
Primary Effluent Channel Path

10. The red line shows the flow of the primary effluent, moving from the primary clarifiers on the west side of the plant (left hand side of the figure) along the south side of the plant, through the bypass chamber (just north-west of the red building), and on to the bioreactors in the east side of the plant (right hand side of the figure) for secondary treatment.

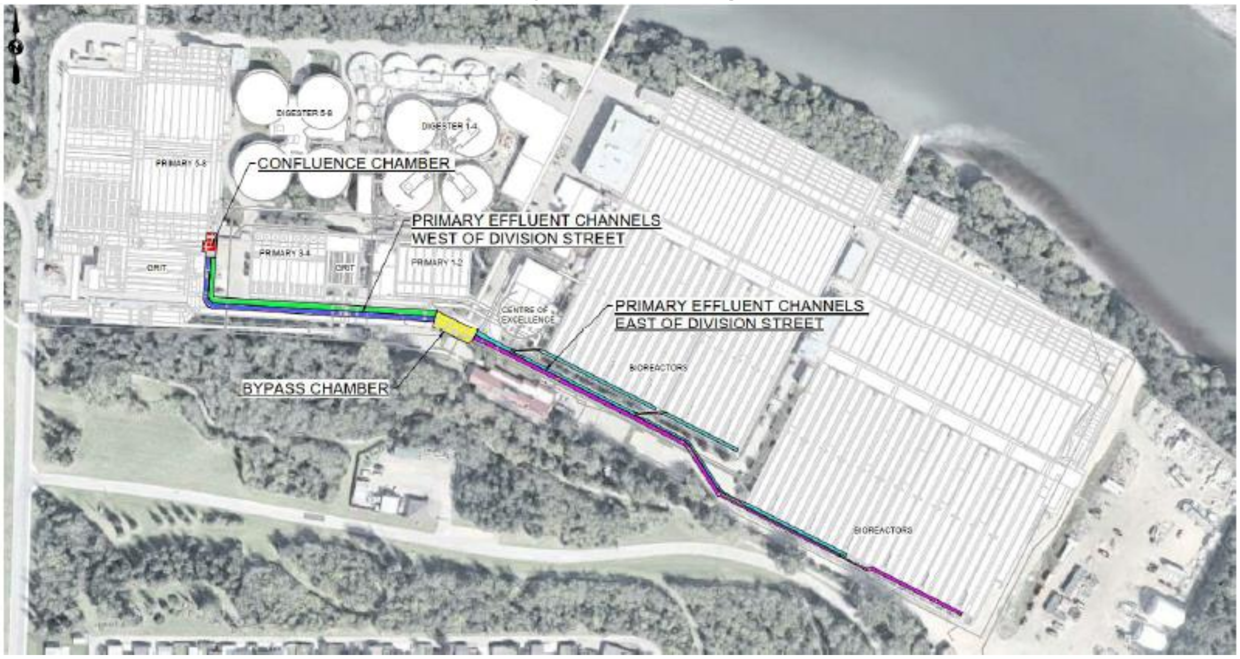
11. The central sections of channels and chambers were constructed in the 1950's and are beyond their expected life.

12. Inspection of the majority of PE channels was completed in 2016, and they were found to be deteriorated and in need of rehabilitation.

13. The current PE Channel configuration does not allow for isolation of any structures: Bypass Chamber, Confluence Chamber, or channel sections (see Figure 2.0-2). An additional channel downstream of the Bypass Chamber may also be considered in the future for increased hydraulic capacity.

14. Because isolation is not possible, the channel inspections were completed through available ports and openings with the channel running live, i.e. with constant flows, which is less safe and risky.

Figure 2.0-2
PE Channel System including Chambers



15. The bypass chamber, highlighted in yellow, in Figure 2.0-2 is a key component of the PE Channel system. The purple and green lines represent the PE channels west (upstream) of the bypass chamber and the blue and pink lines represent the PE channels east (downstream) of the bypass chamber.

16. In order to perform thorough channel inspections and associated upgrades it is necessary to stop flows into portions of the chambers and channel sections. This is achieved by using a gate system within the chamber in other areas of the plant.

17. The gates in the Bypass and Confluence Chambers will be designed to drop down through the chamber and stop flows to one or more chamber or channel sections so that employees can perform detailed inspections, maintenance and upgrades.

18. The Bypass Chamber and Confluence Chamber represent single points of failure in the PE Channel system. In order to facilitate channel upgrades it is necessary to install gates within the chamber structures to manage flows.

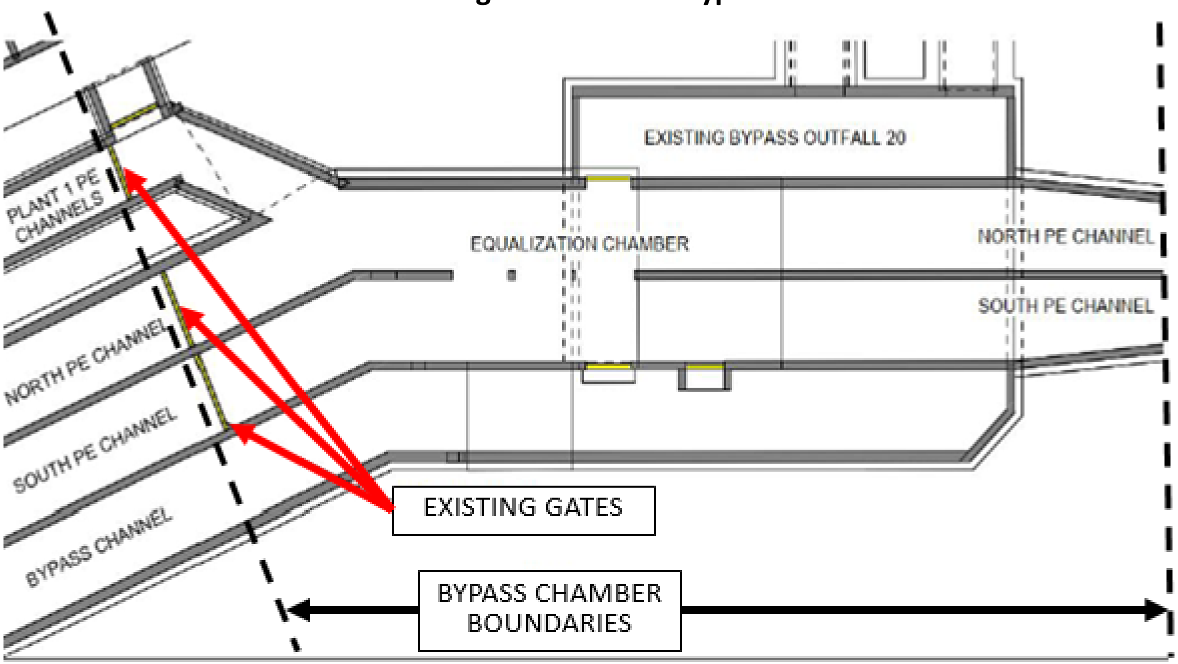
19. The existing isolation gate systems in the PE channels require all flow to be stopped or diverted, and, as such, there has not been any maintenance or upgrades performed on the channels or chambers since they were constructed.

20. This presents a significant risk at the Gold Bar WWTP. As evidenced by inspection, the channels have significantly degraded over time due to lack of maintenance. Potentially if there is a failure, leak or collapse in the PE Channel system, plant employees would not be able to inspect or resolve the issue without having to run temporary piping to divert flows around the area of concern.

21. While temporary piping is a short term workable solution, it is not an appropriate long term solution due to space constraints in this congested area of the site and is not quick or easy to erect on an emergency basis.

22. Inspection of the confluence chamber found it to be in better condition than the bypass chamber, due primarily to the age and the configuration of the Bypass Chamber. Hence it was determined that the first phase of rehabilitating the PE Channel system would be to upgrade the Bypass Chamber. This would eliminate this single point of failure and resolve issues with the most degraded part of the system.

Figure 2.0-3
Current Configuration of the Bypass Chamber



23. In considering the Bypass Chamber in more detail (Figure 2.0-3), it is possible to see that there are a number of channels congregating at the bypass chamber.

24. The North PE and South PE channels, as well as primary effluent from Clarifiers 1 to 4 (shown as Plant 1 in Figure 2.0-3) feeding the chamber can be isolated using existing isolation gates in the current configuration.

25. A fourth channel carries emergency plant bypass flows from the headworks area of the plant, which is then directed underneath the North and South PE Channel to the NSR via Outfall 20. This is used when incoming flows are in excess of plant capacity during high flow events.

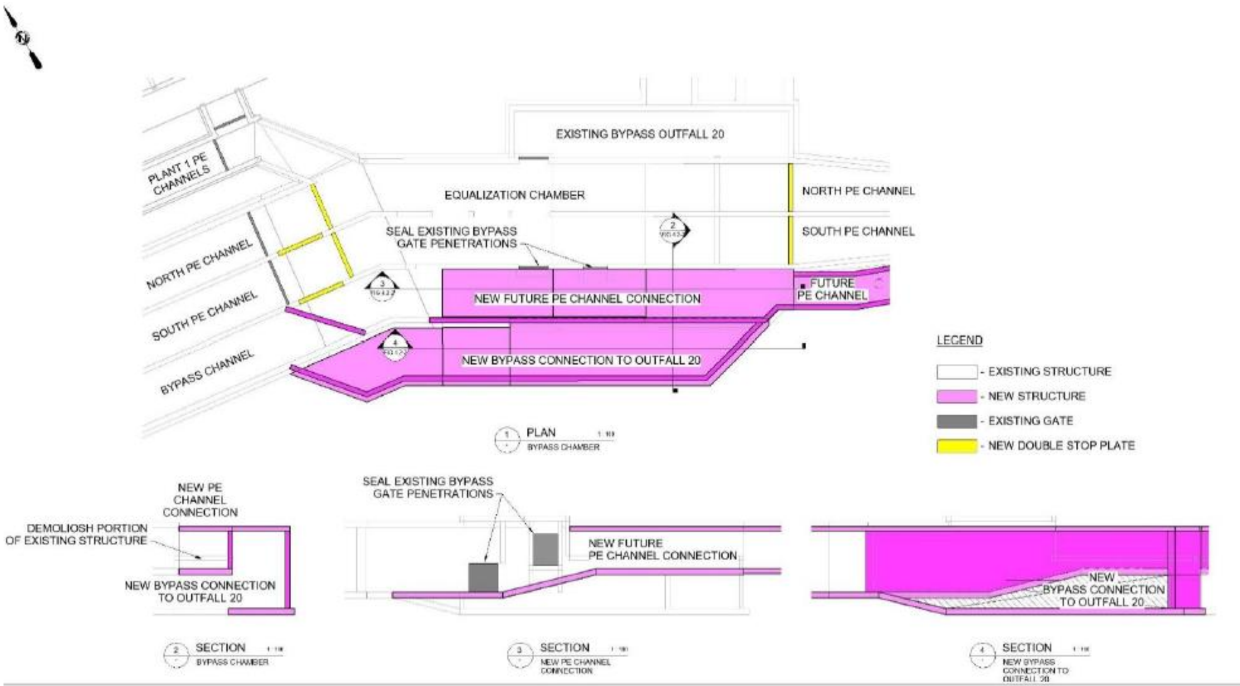
26. However, once the flows enter the chamber there is no means to isolate the north or the south streams leaving the chamber.

27. Various options for upgrading the Bypass Chamber were considered with a goal to achieve the following functionalities:

- Ability to isolate parts of the chamber from incoming flows to allow future inspection and maintenance work without disrupting distribution of flow to the secondary treatment process.
- Ability to independently isolate the North and South PE channels downstream of the chamber.
- Making above modifications and still allow functionality to bypass to Outfall-20.
- Modification to the Bypass Chamber to allow for future PE channel connection in consideration of future additional expected flows. It is more cost effective to perform a short channel construction with a gate while the chamber is under construction than retrospectively in the future.

28. Figure 2.0-4 shows the proposed modifications to the existing Bypass Chamber.

Figure 2.0-4
Proposed Upgrades to the Bypass Chamber



29. Modifications to the existing Bypass Chamber are as follows:

- Install two additional isolation gates on the North and South PE channels feeding the chamber.
- Install a gate on the south wall of the North PE Channel to allow flow diversion to the South PE Channel.
- Install a gate on the south wall of the South PE Channel to allow flow diversion to the new future PE channel connection once constructed.
- Use a section of the existing Bypass channel for future PE Channel connections and seal the existing bypass gate penetrations.
- Construct a new bypass connection to Outfall-20 located to the south of the existing chamber.
- Construct a new structural wall upstream of the bypass channel to allow flow diversion to the new bypass connection to Outfall-20.

30. The Bypass Chamber will be isolated from the PE Channel system and remain out of service throughout construction.

31. During this period, the flow of primary effluent from the channels feeding the Bypass Chamber will be pumped to the channels downstream of the chamber using a temporary bypass pumping system capable of handling the required flows to the downstream secondary treatment.

32. The flow from Plant 1 will be stopped by closing the existing gates that feed into the Bypass Chamber. Similarly, flow from Plant 2 will be stopped by closing the existing gates on the North and South PE channels feeding the chamber.

33. The existing bypass channel, which carries the plant influent overflow to the chamber, can be isolated by closing the two slide gates that open into the chamber as shown in Figure 2.0-4.

34. The existing gates will be inspected and tested prior to implementing the shutdown. Consideration will be given to install a second temporary gate (bulkhead) upstream of the North and South PE channel isolation gate to provide double block isolation.

35. The temporary bypass system will be designed and installed to handle and distribute the maximum flow, per current plant requirements, to the downstream bioreactors.

36. The temporary bypass system will be complete with a control system to allow continuous flows as PE flow rates fluctuate.

37. The cost of using a temporary bypass system to pump flows around the Bypass Chamber accounts for about 24% of the overall cost of the upgrade. The detailed design phase of the project will verify the flows to determine the size of the pumping system required and undertake a cost-benefit analysis of renting the pumping system versus purchasing the pumping system. The analysis will consider the temporary pumping requirement over future upgrades to the PE Channel system, considering that the confluence chamber and PE channels will require rehabilitation in the future.

3.0 PROJECT DESCRIPTION

38. The scope for the PE Channel Upgrade project in this PBR includes design, rehabilitation, construction and commissioning of upgrades to the Bypass Chamber of the PE Channel system.

39. The following forms the basis of the current scope of work:

- Install two additional isolation gates on the North and South PE channel feeding the chamber.

- Install a gate on the south wall of the North PE Channel to allow flow diversion to the South PE Channel.
- Install a gate on the south wall of the North PE Channel to allow flow diversion to the new future PE channel connection once constructed.
- Use the section of the existing Bypass channel for future PE Channel connections and seal the existing bypass gate penetrations.
- Construct a new bypass connection to Outfall-20 located to the south of the existing chamber.
- Construct a new structural wall upstream of the bypass channel to allow flow diversion to the new bypass connection to Outfall-20.

40. This will include detailed design and constructions of all required electrical and controls, and commissioning of the completed system.

41. The project was initiated in 2020, with detailed design and procurement through 2022 and early 2023. Construction will follow through 2023 and 2024. Commissioning will be performed in 2024 with the upgraded Bypass Chamber going into service in 2024.

42. Phases of the project are per Table 3.0-1

Table 3.0-1
PE Channel Upgrades Project Timelines

Project Phases	A **2021 and Prior**	B **2022 Q1**	C **2022 Q2**	D **2022 Q3**	E **2022 Q4**	F **2023 Q1**	G **2023 Q2**	H **2023 Q3**	I **2023 Q4**	J **2024 Q1**	K **2024 Q2**	L **2024 Q3**	M **2024 Q4**
1 Initiation/Approvals	X												
2 Preliminary Design	X												
3 Detail Design		X	X	X	X	X							
4 Procurement				X	X	X							
5 Construction						X	X	X	X	X	X	X	
6 Commissioning										X	X	X	X
7 Close-out													X

4.0 PROJECT ALTERNATIVE ANALYSIS

43. There are three alternatives for this project: Do Nothing (i.e. run to failure), Upgrade the Bypass Chamber and divert primary effluent to the NSR, and Upgrade the Bypass Chamber and establish a temporary pumping system.

44. Doing nothing accepts the Bypass Chamber as a single point of failure within the PE Channel system. This means that operations teams are not able to isolate flows to perform any future upgrades or maintenance on the PE Channel system. This was considered a critical flaw since inspections have shown that significant upgrade work is required throughout the PE Channel system, and hence this alternative was rejected.

45. It is possible to divert PE flows to the NSR through Outfall 30 avoiding the Bypass Chamber. That, however, would eliminate secondary treatment and disinfection from the wastewater, which would contravene Gold Bar's approval to operate and have significant environmental impacts. Hence this alternative was rejected.

46. Upgrading the Bypass Chamber to include the gate system on the upstream and downstream sections provides the ability to shut down various parts of the PE Channel system to enable required rehabilitation of channels. Without upgrading the Bypass Chamber, no future channel upgrades are possible, which leaves a critical flaw in the PE Channel system. This was considered the most appropriate and immediate requirement and as such this alternative was selected.

47. Since the decision is based on qualitative factors discussed above, no quantitative analysis is provided.

5.0 COST FORECAST

48. The project cost forecast is prepared using contractor pricing estimates based on preliminary design and using information provided by the designers. The contractor evaluated the means, methods, and quantities involved to construct the preliminary design and assumed poor condition of the Bypass Chamber. Additional estimates for internal activities such as engineering, construction coordination etc. are also included.

49. A contingency of 22% is included in the project cost forecast. This is based on the current level of design and the unknown condition of the uninspected portion of the chamber.

50. Projected costs for this project are shown in Table 5.0-1

Table 5.0-1
PE Channel Upgrades Project
($ millions)

		A **Pre-2022**	B **2022**	C **2023**	D **2024**	E **Total**
	Direct Costs					
1	Contractors	0.23	2.59	5.08	4.20	12.10
2	Internal Labour	0.05	0.06	0.13	0.12	0.36
3	Contingency	0.00	0.47	1.47	1.22	3.16
4	**Sub-total Direct Costs**	0.28	3.12	6.68	5.54	**15.62**
5	Indirect Costs	0.00	0.16	0.52	0.95	1.63
6	**Total Capital Expenditures**	0.28	3.28	7.20	6.49	**17.25**

51. This project is expected to go in to service in 2024.

52. EWSI takes a number of steps to minimize the level of capital expenditures. These include:

- Work with other EPCOR business units to determine equipment and resource availability to help offset cost.
- A detailed cost-benefit analysis will be completed to determine whether purchasing a temporary pumping system or renting will be more cost effective for this project and future PE Channel Upgrade projects.
- EWSI has taken advantage of longer-term contracts with vendors to effectively manage the supply, quality and construction of required upgrades.
- Construction coordinators will be on-site at Gold Bar WWTP to manage the day to day activities of contractors and ensure the project stays on time and is constructed to specifications.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit price basis.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Every requested project is evaluated individually to prioritize projects; based on the highest risk, and based on synergies with other projects (using a common shut down).
- Every project scope is evaluated to improve economy of scale and to eliminate future throw-away of infrastructure.

6.0 RISKS AND MITIGATION PLANS

53. Table 6.0-1 provides key risks and mitigation plans associated with this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk Statement	A Risk Mitigation Plan
1	Key Health and Safety (H&S) Risks – The key H&S safety risk for this project is properly isolating the Bypass Chamber for construction to protect workers in the chamber and channels.	EWSI has developed isolation design for many of the channel rehabilitation projects completed in past years. This design employs a double-block and bleed arrangement providing robust protection to workers.
2	Key Environmental Risks – The key environmental risk during construction is the potential release of PE flow to the plant site and eventually the NSR.	The design of the temporary bypass pumping will include redundant backup for pumping and power supply as necessary for maximum flows. EWSI will also work closely with regulators to provide adequate awareness and any potential approvals that may be required.
3	Key Financial Risks – The key financial risk is the cost to establish temporary pumping and the unknown condition of the currently submerged portions of the Bypass Chamber.	A Contractor partner currently engaged in large-scale projects at Gold Bar WWTP, provided construction estimates. Conservative estimates were provided for means and methods.
5	Key Reputational Risks – The key reputation risk is noise pollution from the temporary bypass pumping system.	Noise levels will be taken into consideration during design and minimized to acceptable levels. Community engagement will also be conducted to address stakeholder concerns.

Appendix G11

EPCOR WATER SERVICES INC.

Wastewater Treatment
Secondary Aeration Blower Upgrades Project
Business Case

February 16, 2021

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1.0 OVERVIEW

1. Aeration is a critical component of the Biological Nutrient Removal (BNR) process. Without the appropriate level of aeration, there may be a loss of biology in the BNR process, resulting in a failure to remove nutrients from the wastewater and ultimately violation of environmental regulations.

2. The Gold Bar Wastewater Treatment Plant (WWTP) currently has four aeration blowers to supply process air to the BNR system and the tertiary membrane plant.

3. The existing blowers are of different sizes and were installed at several stages of plant upgrades since 1969. These systems have reached end of useful service life, have limited range for operational control and have significant reliability issues.

4. The process air demand is highly variable due to daily and seasonal variation in wastewater flows and loading coming to the plant. This variability in demand results in the differently sized blowers being operated at sub optimal conditions.

5. All existing blowers currently have only one method of control by throttling the inlet flow, using inlet guide vanes (IGV). At lower IGV positions, the blowers are quite inefficient and start to demonstrate significant mechanical vibration issues, increasing the risk of potential failures.

6. The Secondary Aeration Blower Upgrades Project will install an additional blower into Blower Building 2 on site, and replace the motor operating Blower 6 to increase efficiency.

7. Due to the low reliability of the existing blower systems, addition of a new blower with improved control range is recommended to ensure the continued stable operation of the plant. Replacement of an oversized motor on Blower 6 is recommended to significantly improve the efficiency and reduce the power consumption of the overall operation.

8. None of the existing blowers are recommended to be upgraded or demolished at this time. They can be used in combination with the new blower or as backup units and eventually run to failure and replaced in phases as future upgrades to the aeration system are implemented.

9. This project falls in to the Reliability/Life Cycle category.

10. The project will be initiated in 2022 and completed by 2024.

2.0 BACKGROUND AND JUSTIFICATION

11. The Gold Bar WWTP has four aeration blowers, which supply process air to the BNR system and the tertiary membrane plant.

12. For the BNR system, the supplied air is used to create conditions necessary for the biological treatment process to break down nutrients and organic matter. For the tertiary treatment, the supplied air is used to scour the membrane filter modules in order to prevent build up. Both of these processes would cease to function without the required volume of supplied air, resulting in complete breakdown of the secondary and tertiary treatment and subsequent violation of environmental and regulatory targets, and contractual obligations.

13. Blowers 1 and 4 are located in Blower Building 1 and Blowers 5 and 6 are located in Blower Building 2. Blowers 2 and 3 had significantly smaller capacity and were decommissioned after Blower 5 was installed.

14. There are five blower foundations currently installed at the plant, two in Blower Building 1, which are occupied by Blowers 1 and 4 and three in Blower Building 2, two of which are occupied by Blowers 5 and 6, leaving one spare foundation.

15. The design configuration and capacity of existing blowers is shown in Table 2.0-1.

Table 2.0-1
Secondary and Tertiary Process Aeration Blowers at Gold Bar WWTP

	Item	A **Blower 1**	B **Blower 4**	C **Blower 5**	D **Blower 6**
1	Install Year	1969	1969	1977	1996
2	Motor, HP	1,500	1,500	3,500	3,500
3	Rated Capacity (SCFM*)	39,400	39,400	77,000	88,000 De-rated to 50,000 in 2002

* SCFM – Standard Cubic Feet per Minute.

16. The total installed capacity of all blowers based on nameplate data is 205,800 standard cubic feet per minute (SCFM). Considering the largest blower out of service, the maximum available capacity is 128,800 SCFM.

17. At Gold Bar WWTP, Inlet Guide Vanes (IGVs) are used to adjust the aeration volume. This enables the blower motors to operate at constant speed while the inlet air volume is regulated or throttled. However, the efficiency is typically reduced when the inlet is throttled. Also, if the

inlet is throttled below 30%, the blowers start to experience mechanical vibration issues increasing the risk of potential failure.

18. The biological treatment process experiences significant daily and seasonal variation because of changes in weather pattern, incoming flows and loads. The unevenly sized blowers are operated in combination to address daily and seasonal variation in demand, often resulting in throttled inlet conditions that are much lower than recommended by the manufacturer.

19. Blowers 1 and 4 are typically used stand alone at low demands or as top-up blowers during peak demand conditions with one of the larger blowers. They experience frequent starts and stops when operated to match demand conditions, which can result in electricity surging, increasing the risk of failure.

20. Blowers 5 and 6 are never operated together because they are very large and their combined capacity exceeds the process demand. However, having one of these two blowers out of service significantly reduces the overall capacity and the plant is unable to operate if both of these blowers are non-functional. Also, because of their size, these units are the most energy intensive to operate.

21. There are significant concerns with the electrical system for Blowers 1 and 4. The power system shows signs of corrosion and advanced aging. In addition, the blowers use 2300 V motors that are older and no longer widely available. These issues with the electrical system further reduce the overall reliability of these Blowers.

22. Blower 5 historically caused the most reliability issues but it has recently been overhauled and is less likely to cause major issues in the immediate future. Blower 6 has not been overhauled for more than a decade and is more likely to cause reliability issues in the current operation.

23. A 2016 energy audit indicated that the secondary aeration blowers are the source of the largest individual energy demand at the plant (approximately 30% of the total electricity consumption). Thus, there is also significant potential to improve energy efficiency by making appropriate upgrades to the existing blower systems.

24. The current blower systems have significantly lower efficiency compared to modern industry standards. Historically, Blower 5 has been the most maintenance intensive unit but it is the most efficient of the existing blowers, when operated with the inlet air throttled by not more than 55%.

25. The original Blower 6 impeller was downsized in 2002 to provide a lower capacity, as it was too large for the demand at the time, but the associated motor size was never downsized to match the change. Thus, Blower 6 has the lowest efficiency out of all current blowers. There is substantial opportunity for power cost savings with the operation of Blower 6 by installing an appropriately sized motor. These modifications can potentially generate an estimated maximum power cost savings of approximately $80,000 annually.

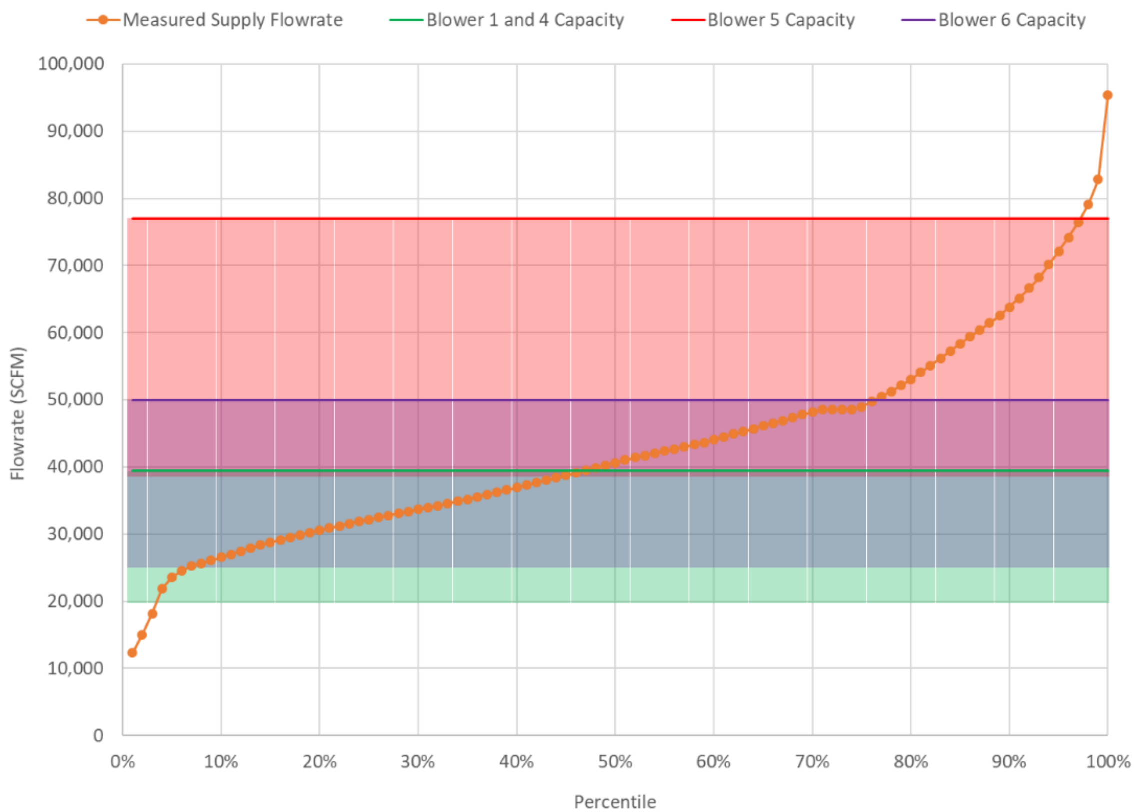
26. Figure 2.0-1 shows the percentile distribution of total measured blower flowrates with the capacities of the available blowers. The shaded region shows effective operational range for each blower.

- Blowers 1 and 4 are each sized to supply the required demand approximately 5%-50% of the time.
- Blower 5 can supply the required demand approximately 50%-97% of the time.
- Blower 6 can supply the required demand approximately 10%-75% of the time, at very low efficiency due to the oversized motor.
- When Blower 5 is out of service, Blowers 1 or 4 is used to fulfill demands beyond the 75th percentile.
- When Blower 5 is available, Blowers 1 or 4 is used to fulfill demands beyond the 97th percentile.

27. Overall, it is currently very difficult for Operations to maintain process air supply reliably and efficiently with the existing blower system. Although the combined capacity is sufficient to meet demand, improvements are recommended to ensure continued reliability of this critical process.

28. It is however not recommended to upgrade any of the existing blowers with Variable Frequency Drives (VFDs), due to very limited improvement potential as per the manufacturer. Also demolition is not recommended, as it is more cost effective to use the existing blowers in combination with a new blower or as backup units and eventually run to failure or replaced strategically.

Figure 2.0-1
Percentile Distribution of Measured Flowrates and Blower Capacities



29. It should be noted that a sharp increase in required flowrate is observed after the 75th percentile demand. Hence, it is recommended to consider sizing a future blower to meet the 75% demand at a minimum.

30. Blower sizing will be reviewed and finalized during design, in conjunction with considering forecast demand and a long term secondary aeration strategy that is consistent with the future capacity and technology used for secondary treatment.

3.0 PROJECT DESCRIPTION

31. The scope of work includes installation of a new single stage blower and installation of associated power supply and controls in Blower Building 2. This option was compared to an option of a new blower equipped with a VFD, and was determined to have a better NPV based on the plant's operating characteristics.

32. Reuse of existing foundations is recommended because constructing new foundations would require significant structural modifications and result in considerable construction costs.

Blower Building 2 has an existing spare foundation, which is suitable and can be used for the installation of the new blower.

33. Further design will confirm the selection and sizing of the new blower. The design will consider the short and long term strategy for secondary aeration based on the current plan for secondary treatment upgrades, per the Gold Bar WWTP IRP. New controls will be fully integrated with the existing plant controls and automation system.

34. The project also includes an overhaul of Blower 6 and replacement of the existing motor with an appropriately sized motor that will improve the operating efficiency.

35. The project will be initiated in 2022, with detailed design and procurement through 2022/2023 and construction during 2023/2024. Commissioning will be performed through 2024. The project will go in to service in Q4 of 2024.

36. Phases of the project are per Table 3.0-1

Table 3.0-1
Secondary Aerations Blowers Upgrade Project Timelines

	Project Phases	A **2022 Q1**	B **2022 Q2**	C **2022 Q3**	D **2022 Q4**	E **2023 Q1**	F **2023 Q2**	G **2023 Q3**	H **2023 Q4**	I **2024 Q1**	J **2024 Q2**	K **2024 Q3**	L **2024 Q4**
1	Initiation/Approvals	X											
2	Detail Design	X	X										
3	Procurement			X	X	X	X						
4	Construction							X	X	X	X	X	
5	Commissioning											X	X
6	Close-out												X

4.0 PROJECT ALTERNATIVE ANALYSIS

37. A number of alternatives were considered:

- Do nothing.
- Improve existing blowers.
- Install new turbo blower.
- Add a new blower to Blower Building 2 and downsize the Blower 6 motor – recommended alternative.

38. Alternative one, to do nothing, was the least costly from a capital perspective; however, the system would continue to be unreliable and inefficient. Since the existing blower systems

have reached the end of their useful life and have major reliability issues, this alternative was rejected.

39. Upon consultation with the manufacturer, it was determined that under alternative two, improving existing blowers, it is not possible to increase flow by a sufficient amount with the installation of VFD's. In addition, the age of the existing blowers and the style of the associated motors makes the addition of VFDs costly without any major benefit. Thus this alternative was also rejected.

40. Alternative three involved installing new turbo blowers. This would increase operational flexibility and reduce power costs, however there were a number of other steps required to make this alternative feasible. Step-down transformers would be required to supply power for turbo blowers, more units would be required due to the maximum possible size of these blowers and there would be more stops and starts on the machines. Construction costs would be higher given the greater number of units. As such, this alternative was rejected.

41. Alternative four, adding a new single stage blower and downsizing Blower 6 motor, gains operational flexibility and reduces power costs. There would be redundancy to enable maintenance activity, and to provide additional flexibility during high and low demand periods, which would reduce the likelihood of any interruption in process air supply and resulting failure of secondary treatment system, and contravention of regulatory effluent quality limits. Incremental operation and maintenance costs for the additional blower are offset with power savings resulting from having a more efficient blower and the improvements to Blower 6. Considering this offset, this project is expected to achieve a net savings of between $0.20 million to $0.25 million per year.

5.0 COST FORECAST

42. The project cost forecast is based on consultation with equipment manufacturers and from previous conceptual work completed by the internal engineering team and a consultant in 2016.

43. A contingency of 6% is included in the cost forecast. This is to cover the cost of unknowns that cannot be identified or anticipated during the design or construction phase, and typically arise during demolition. The majority of the project cost is related to the cost of the new equipment and there is very little construction or demolition scope involved. This is why the

construction contingency is a lower percentage of the total cost than is typical for this level of design.

44. Projected costs for this project are shown in Table 5.0-1.

Table 5.0-1
Secondary Aeration Blower Upgrades Project
($ millions)

		A **2022**	B **2023**	C **2024**	D **Total**
	Direct Costs				
1	Contractors	0.48	5.21	0.60	6.29
2	Internal Labour	0.14	0.09	0.16	0.39
3	Contingency	0.05	0.14	0.25	0.44
4	**Sub-total Direct Costs**	**0.67**	**5.44**	**1.01**	**7.12**
5	Indirect Costs	0.10	0.23	0.55	0.88
6	**Total Capital Expenditures**	**0.77**	**5.67**	**1.56**	**8.00**

45. The project is expected to go into service in 2024.

46. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI will try to minimize the need to stock spare equipment reducing the overall costs of all installations and upgrades.
- A number of activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, minimizing the need for external consultants.
- Construction coordinators will be on-site at Gold Bar WWTP to manage the day to day activities of contractors and ensure the project stays on time and is constructed to specifications.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit price basis.
- The installations will be consistent with EWSI's construction standards, which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Project scope and design will be validated by stakeholders to improve economy of scale and to eliminate future throw-away of infrastructure.

6.0 RISKS AND MITIGATION PLANS

46. Table 6.0-1 provides key risks and mitigation plans associated with this program.

Table 6.0-1
Key Risks and Risk Mitigations

	Risk Statement	A Risk Mitigation Plan
1	Key Health and Safety Risks – There are a number of potential H&S Risks including Hazardous Energy Isolation for the duration of the project.	EPCOR follows standard processes to reduce or eliminate H&S risks by conducting Process Hazard Analysis and by implementing appropriate engineered and administrative controls.
2	Key Environmental Risks – Silica dust during construction, and removal and disposal of construction debris	EPCOR conducts Process Hazard Analysis to identify risks and implement appropriate mitigation measures for Environmental risks. Appropriate delineation of construction area, including necessary dust control, ventilation and debris management measures will be employed to mitigate relevant risks.
3	Key Financial Risks – further change orders or unknown conditions that cannot be seen until demolition is complete. Engineering and construction costs similar to historical trends	EPCOR manages financial risks by conducting preliminary design and obtaining manufacturer's quotes for establishing the project budget. The financial risks will become more evident as further design is completed. A competitive procurement strategy will also be implemented to ensure the best value is achieved.
4	Equipment sourcing, project timing/ completion date, shutdowns to accommodate construction.	The proposed new blower and motor are very large pieces of equipment and will have very long lead times. Sufficient time in the project schedule has been allocated for procurement and installation of the equipment. It is recommended to proceed with the next stage of design as soon as feasible.

Appendix G12

EPCOR WATER SERVICES INC.

Wastewater Treatment
Secondary inDENSE™ Upgrade Project
Business Case

February 16, 2021

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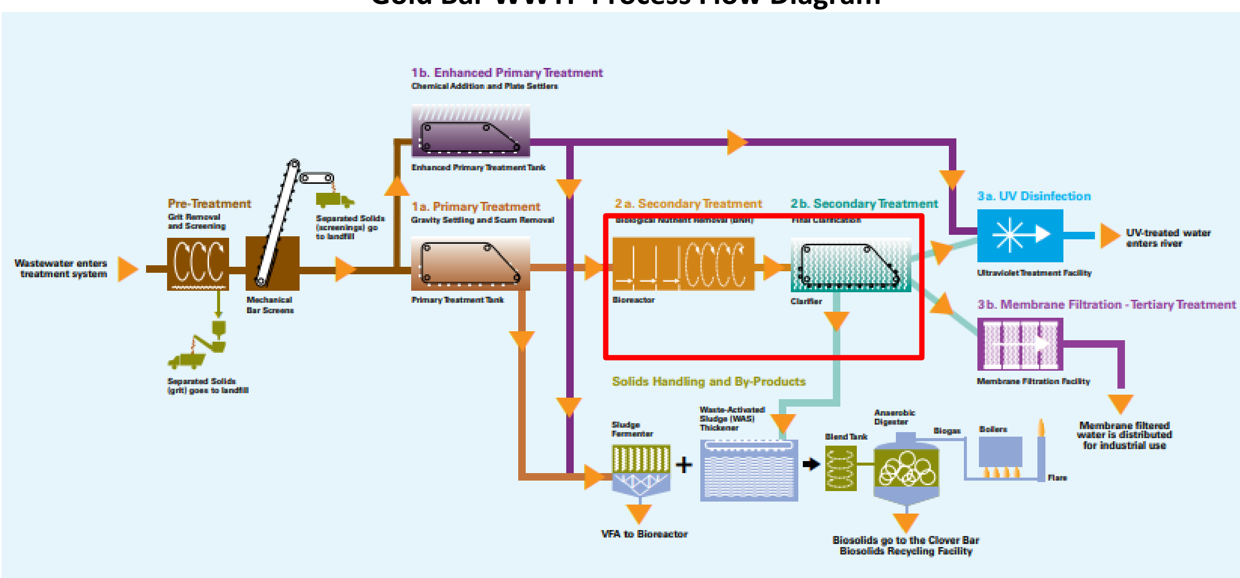
1.0 OVERVIEW

1. The Gold Bar Wastewater Treatment Plant (WWTP) employs a Biological Nutrient Removal (BNR) process for its secondary treatment. BNR is an advanced biological treatment process, which improves final effluent quality by removing nutrients like phosphorus and ammonia-nitrogen from wastewater. Excessive nutrients discharging into surface waters can cause unwanted growth of algae and depletion of dissolved oxygen thereby causing potentially severe issues with the ecosystem.

2. The Secondary inDENSE™ Upgrade Project is to design and install an inDENSE™ system in one of the eleven BNR process trains at Gold Bar WWTP. Each BNR train consists of a bioreactor followed by a clarifier as shown by the red box in the process flow diagram below.

Figure 1.0-1
Gold Bar WWTP Process Flow Diagram



3. This will increase treatment capacity and allow for deferment of the more costly implementation of Membrane Biological Reactors (MBR), which would otherwise have to be in place in at least one train by 2028 or earlier in order to remain compliant with regulated discharge limits.

4. If the Gold Bar WWTP treatment capacity is not increased, it is unlikely that environmental discharge limits will be met, when considering both forecast population growth and an anticipated decrease to future effluent compliance limits.

5. This project falls in to the Growth/Customer Requirements category.

6. The total project spend is $5 million, with $4.5 million of the spend in the 2022-2024 PBR period.

7. The project was initiated in 2020 and will be completed in 2024.

2.0 BACKGROUND AND JUSTIFICATION

8. The Gold Bar WWTP provides full secondary treatment to sanitary wastewater from the City of Edmonton, some regional areas and a portion of the stormwater generated within the older central core area of Edmonton. The secondary treatment process has a total of eleven BNR trains.

9. Each BNR train consists of a bioreactor followed by a clarifier. The purpose of the bioreactors is to grow and maintain the microbiology responsible for the removal of the nutrients. The purpose of the clarifiers is to remove the biomass or activated sludge from the water to meet the effluent limits and return the biomass to the bioreactors. Currently the overall capacity of each train is limited by the nutrient removal capacity of the secondary clarifiers.

10. Current population projections published in the Gold Bar WWTP Integrated Resource Plan (IRP) suggest that after 2028, forecast population growth may cause nutrient removal capacity for BNR to be exceeded.

11. EPCOR anticipates that future environmental discharge limits for nutrient compounds may change based on Total Loadings from all discharge sources to the North Saskatchewan River. Similar to other jurisdictions, some of the effluent compliance limits may be lowered for the upcoming permitting cycle and new limits could be applied by 2035.

12. For the purposes of long range planning in the IRP, EPCOR assumed that load based limits for nutrients and organics will come into effect in 2035 and will mandate total loadings not to exceed 2015 levels. It is also assumed that a total nitrogen removal requirement (rather than the current ammonia removal requirement) may be implemented to align with many other North American jurisdictions.

13. With more stringent effluent criteria, there will be a need to intensify treatment in the current system, because more nutrients will have to be removed from the wastewater to meet the discharge limits.

14. EPCOR has committed to maintain Gold Bar WWTP operations within the existing site footprint and as such, space for expansion on site is constrained.

15. Expanding plant treatment capacity using existing conventional technology while staying within the existing site footprint is not possible. Therefore, technologies that intensify treatment capacity within the existing footprint have been evaluated as a solution.

16. The current IRP recommends the retrofit of existing BNR systems to MBR by installing membranes in the secondary clarifiers to expand capacity, with the first MBR train in operation by 2028 or earlier. EPCOR developed a conceptual design for the conversion of BNR train No.11 to an MBR, with the concept of converting up to seven trains to MBR over the next 40 years as recommended in the IRP. Train No.11 was primarily identified due to its ease of conversion and future integration.

17. While conversion to MBR solves capacity issues at the plant, this conversion is expected to have a very significant installed cost of approximately $70 million per train and substantially increase operating costs by approximately $2 million annually per train.

18. Due to the high costs associated with this option, EPCOR investigated alternative technologies that could be implemented to delay the conversion of the BNR trains to MBR.

19. EPCOR recommends the technology known as inDENSE™.

20. inDENSE™ reduces capacity requirements as compared to other technologies through a densification process (improving the settleability of sludge), and may allow up to a 20% increase in capacity, or 6 million litres per day (MLD) increase in sustained average flowrate, through one BNR train.

21. inDENSE™ is the lowest cost option, with a capital cost of $5 million and incremental annual operating costs of $120 thousand.

22. Implementation of inDENSE™ means that the high cost MBR option can be delayed for a number of years (dependent on inDENSE™ performance, but is estimated to be 16 years), as shown in section 4. In addition, feasibility of new and alternative technologies are continually being evaluated. This provides customers with continued operational excellence within the goal of prudent capital investment.

23. The overall purpose of installing the inDENSE™ technology is to increase capacity of BNR treatment using existing tanks and allow the deferment of MBR implementation, which otherwise would have to be in place in at least one train by 2028. Figure 2.0-1 shows the nutrient removal capacity of the secondary treatment system at Gold Bar WWTP and the projected timeline for MBR retrofits as presented in the current IRP. Figure 2.0-2 shows the recommended approach of installing the inDENSE™ system earlier and more frequently, which allows for deferment of the more costly MBR retrofits.

Figure 2.0-1
Projected Timelines for MBR retrofits as presented in current IRP

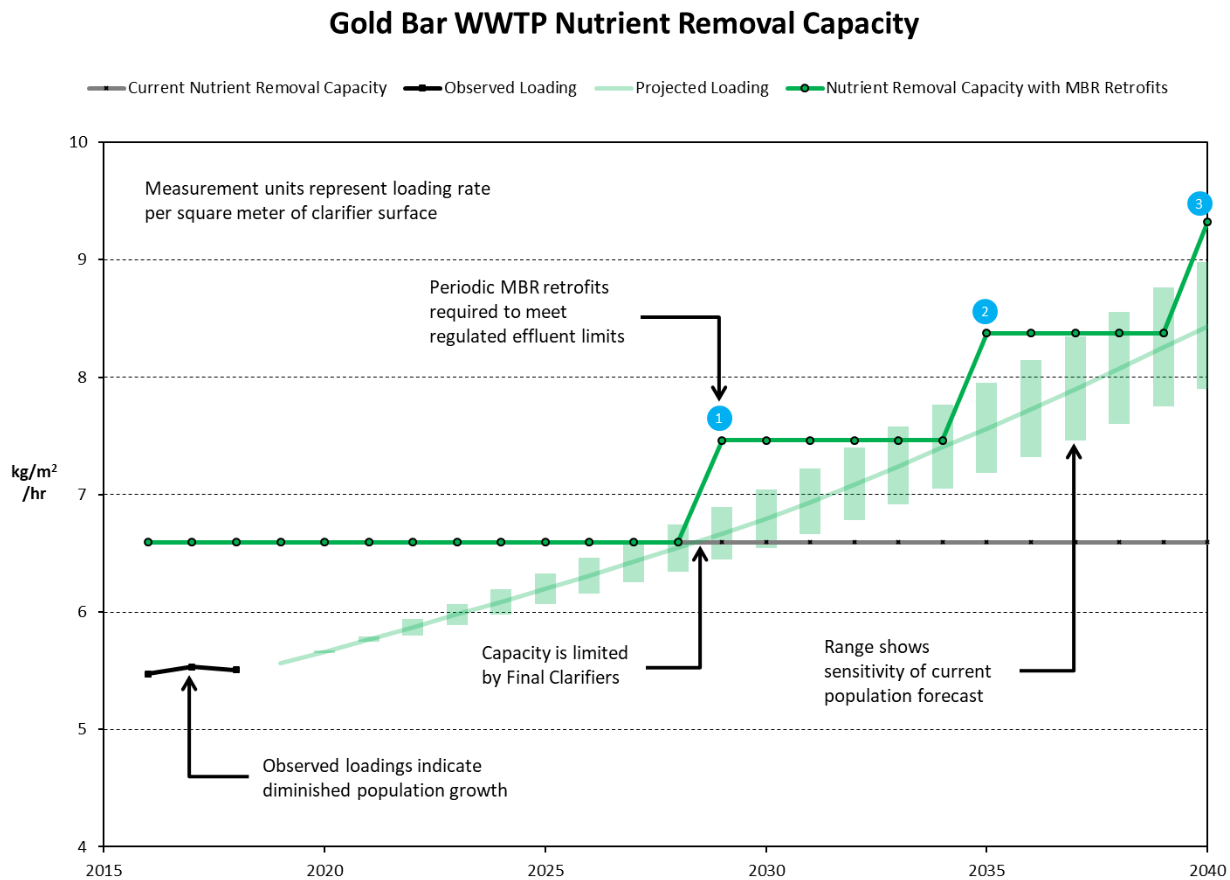
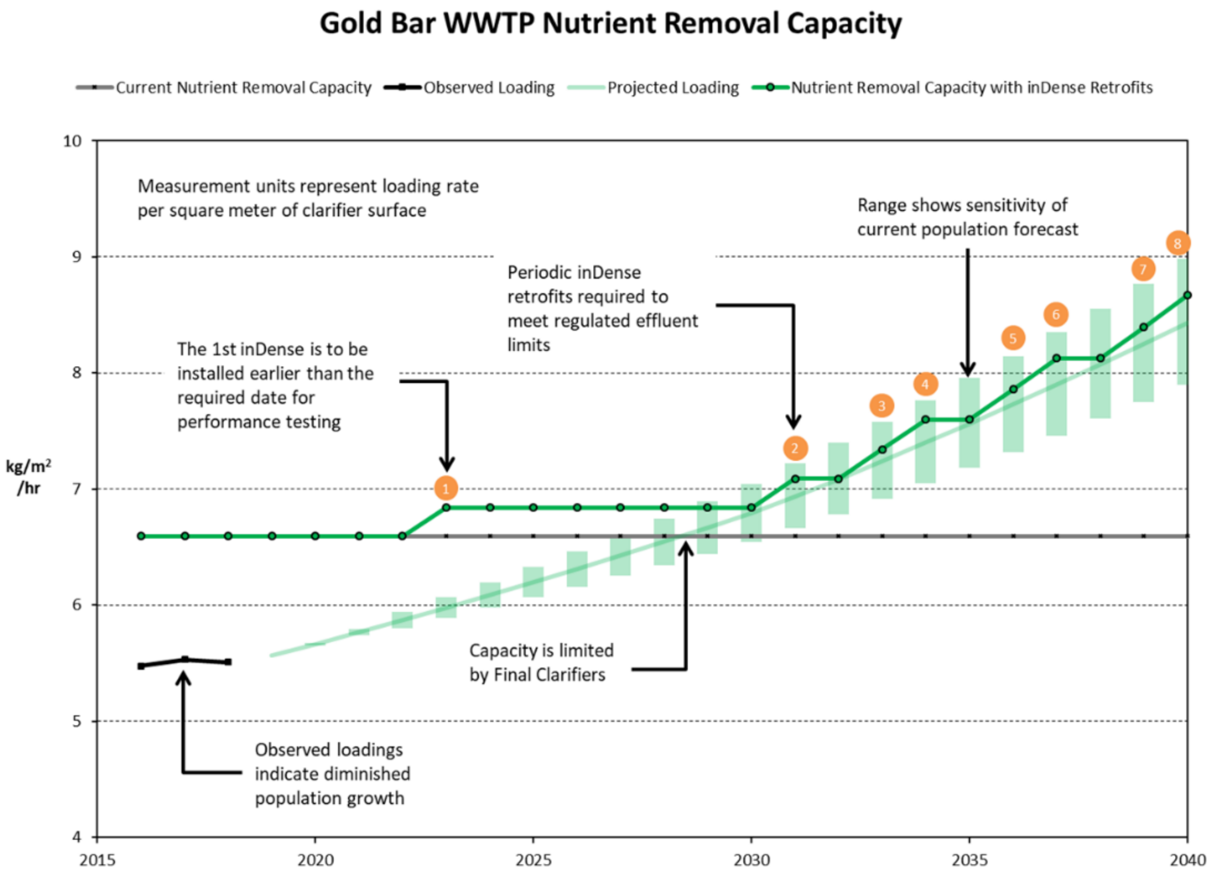


Figure 2.0-2
Recommended inDENSE™ installation timeline



24. Providing performance is satisfactory, three inDENSE™ systems will be added in the 2030-2034 PBR and four more will be installed in the 2035-2039 PBR, based on the capacity requirement. If inDENSE™ performance does not meet expectation, detailed design of the first MBR conversion will be initiated by 2024 with construction completing by 2028.

3.0 PROJECT DESCRIPTION

25. This project will complete the design and implementation of an inDENSE™ system in one of the eleven BNR process trains at Gold Bar WWTP.

26. The inDENSE™ system will be installed as soon as possible to allow appropriate time for performance evaluation, which could take 1-2 years because of the seasonality of biological treatment performance.

27. The project was initiated in 2020 and will be completed by Q4 of 2024.

28. Based on currently available information, a traditional design bid build approach is recommended for the project delivery.

29. Anticipated phases of the project are per Table 3.0-1

Table 3.0-1
Secondary inDENSE™ Upgrades Project Timelines

Project Phases	A 2020	B 2021	C 2022	D 2023	E 2024
1 Design	X	X			
2 Procurement/Construction		X	X	X	
3 Operational Readiness				X	
4 Ready for Hand Over				X	X
5 Project Close Out					X

4.0 PROJECT ALTERNATIVES ANALYSIS

30. A comprehensive list of technology alternatives was considered. A shortlist was created based on their ability to increase plant capacity and allow deferment of MBR conversion by a significant period. The extent of deferment was based on process modelling and contained various assumptions related to performance of each alternative.

31. Lower cost options that could be implemented in stages and not cause negative side-effects or process impacts were preferred.

32. The shortlist of alternatives focused on emerging technologies that would be implemented at the Gold Bar WWTP only after establishing reasonable design parameters. Emerging technologies could offer a substantial benefit to the facility should they prove to achieve their early promise. Due to the emerging nature of technologies, implementation would be on a single, pilot basis and only implemented in additional clarifiers after a proven performance period.

33. A net present value (NPV) calculation was undertaken to determine the most cost effective alternative. This was based on a 25-year test period and requirements for timing of future installations under each alternative. The NPV excluded non-construction or soft costs such as land acquisition, permitting, legal and owner administration costs.

34. Table 4.0-1 shows the shortlisted alternatives implemented on all trains, considered along with their 25-year calculated NPV.

Table 4.0-1
Project Alternatives Analysis

Alternative		A **Description**	B **NPV ($ millions) (25 years)**	C **Potential MBR deferment (years)**
1	Status Quo	Unacceptable as projected demand will exceed current treatment capacity after 2028		
2	Base Case	Install first MBR system by end of 2028 and subsequent conversions every five years	$ 192.98	0
3	Alternative 1	Install inDENSE™	$ 70.05	16
4	Alternative 2	Convert to Aerobic Granular Sludge (AGS) system	$ 117.26	25
5	Alternative 3	Convert to Micro-Carrier Activated Sludge (MCAS) system	$ 195.24	20
6	Alternative 4	Convert to Membrane Aerated Biofilm Reactors (MABR) system with inDENSE™	$ 557.11	30

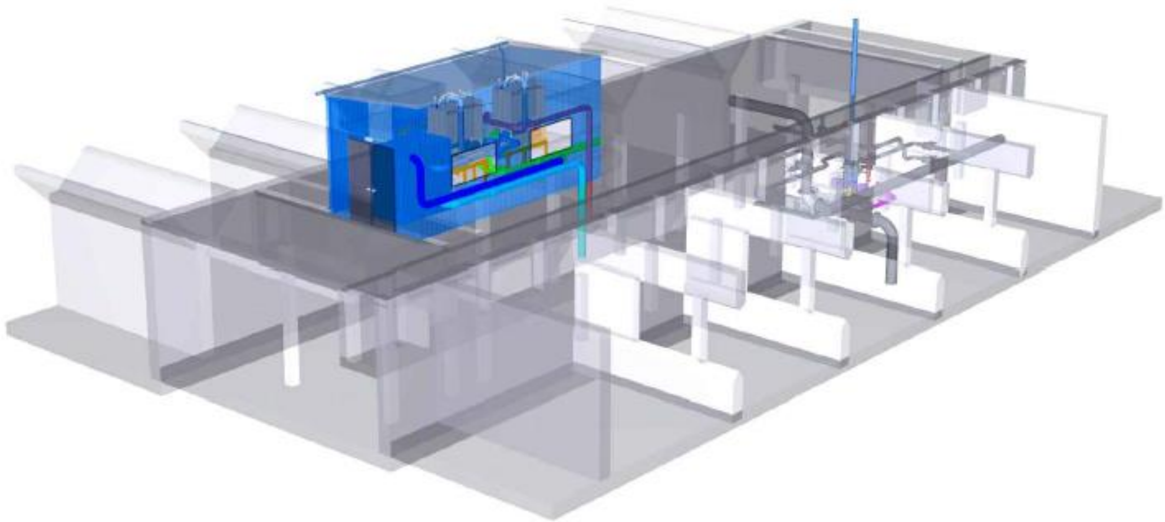
35. Immediate implementation of inDENSE™ was recommended (Alternative 1) based on lowest NPV and minimal operational impact. All technology strategies considered in the NPV assessment are fully compatible with future MBR conversions.

5.0 COST FORECAST

36. The preliminary project cost forecast is based on conceptual design for the implementation of inDENSE™ technology in one secondary clarifier.

37. Upgrades to a single treatment train will include; inDENSE™ hydrocyclone skids housed in a single enclosure above the mixed liquor channel, transfer pumps situated in the tunnel between the bioreactor and secondary clarifier, as shown in Figure 5.0-1 below.

Figure 5.0-1
Conceptual Rendering of an inDENSE™ Installation



38. It is expected that the current Gold Bar WWTP resources will be able to manage the small operating and maintenance activity increase and therefore no additional labour will be required. Additional power costs will be incurred due to the addition of one sludge transfer pump always in operation.

39. A contingency of 23% is included in the cost estimate, as estimates are based on a conceptual study. More accurate estimates for construction and overall project cost will be available upon completion of detailed design, through 2020 and 2021.

40. Projected costs for this project are shown in Table 5.0-1.

Table 5.0-1
Secondary inDENSE™ Upgrade Project
($ millions)

		A **Pre-2022**	B **2022**	C **2023**	D **2024**	E **Total**
	Direct Costs					
1	Contractors	0.30	1.53	1.06	0.07	2.96
2	Internal Labour	0.20	0.08	0.08	0.08	0.44
3	Vehicles and Equipment					
4	Abandonments					
5	Contingency	0.00	0.62	0.20	0.01	0.83
6	Risk Allowance					
7	**Sub-total Direct Costs**	**0.50**	**2.23**	**1.34**	**0.16**	**4.23**
8	Indirect Costs	0.00	0.15	0.28	0.34	0.77
9	**Total Capital Expenditures**	**0.50**	**2.38**	**1.62**	**0.50**	**5.00**

41. This project is expected to go in to service in 2024.

42. EWSI takes a number of steps to minimize the level of these capital expenditures. These include:

- EWSI will try to minimize the need to stock much of the required equipment reducing the overall costs of all installations and upgrades.
- A number of activities related to project management, design, drafting, construction coordination and inspection, and as-built recording will be undertaken internally by EWSI, minimizing the need for external consultants.
- Contracted services are performed by pre-qualified external contractors and done on a competitive unit price basis.
- The installations will be consistent with EWSI's construction standards, which will minimize stock requirements and speed up design and construction.
- Where possible, work will be coordinated with other projects or maintenance activities to minimize costs.
- Project scope and design will be validated by stakeholders to improve economy of scale and to eliminate future throw-away of infrastructure.

6.0 RISKS AND MITIGATION PLANS

43. There are no significant health and safety, or environmental risks associated with the execution of this project.

44. Any financial risk is limited to a scenario where the inDENSE™ system fails to work completely. Based on the experience from a similar installation in Denver, it is extremely unlikely that the system will fail completely. However, performance expectations will be discussed during contract negotiations with the vendor in order to reduce the financial risk resulting from a complete failure to perform.

45. The key financial risk would be realized only if the Gold Bar WWTP needs to move to the more expensive MBR alternative sooner than hoped. The deferment period for MBR will be shortened if the inDENSE™ system is unable to perform as expected.

46. Conversely, the magnitude of financial gain will be determined by the performance of the inDENSE™ technology and the actual duration of the MBR deferment.

Appendix G13

EPCOR WATER SERVICES INC.

Wastewater Treatment
Digester 3 Upgrade Project
Post Implementation Review

February 16, 2021

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1.0 PROJECT DESCRIPTION

1. The Digester 3 Upgrade project was initiated to rehabilitate and upgrade Digester 3 at the Gold Bar Wastewater Treatment Plant (WWTP) to "as new" condition and convert it to a submerged roof design.

2. This program fell under the PBR category of Reliability/Life Cycle.

3. Originally built in 1956, Digester 3 is one of the oldest digesters at Gold Bar. Much of the infrastructure associated with the digester was due for rehabilitation. This project would upgrade Digester 3 to ensure it was fully compliant with requirements of Canadian Standards Association 149.6-11 Digester Gas and Landfill Installations (Digester Gas Code). This standard is intended to ensure that these kinds of installations are designed, operated and maintained in such a way that workers and the general public are safe. Failure to meet these standards could also lead to enforcement actions by Alberta Environment and Parks, which may include warnings, fines or an order.

4. This project was also to implement upgrades to minimize the risk of digester venting and allow Digester 3 to operate reliably and safely at its maximum capacity. These upgrades support EPCOR's Combined Sewer Overflow (CSO) initiative by increasing digester capacity, which allows Gold Bar to treat additional CSO flows.

5. The project forecast cost was $11.3 million and was forecast to be in service in 2018.

2.0 PROJECT COST VARIANCE

6. Table 2.0-1 summarizes the variance of this project compared to the original 2017-2021 PBR term capital plan and compared to the final approved EPCOR budget established in 2020.

Table 2.0-1
Digester 3 Upgrade Project Capital Expenditures
($ millions)

		A **2017-2021 PBR Forecast**	B **Final EPCOR Approved Budget**	C **Actual / Forecast Total**	D **Variance from 2017-2021 PBR**	E **Variance from Final EPCOR Budget**
1	Total Capital Expenditures	11.32	14.50	14.50	3.18	0.00

3.0 VARIANCE ANALYSIS

7. Original cost estimates for this project were developed based on early conceptual design. Column A in Table 3.0-1 provides the project cost estimates at the time of the PBR application in 2016. The projects actual/forecast costs are shown in column B of Table 3.0-1.

Table 3.0-1
Capital Expenditure Variances
($ millions)

		A **2017-2021** **PBR**	B **2017-2021** **Actual / Forecast**	C **Variance**
	Direct Costs			
1	Design/Engineering	0.28	1.19	(0.91)
2	Construction/Commission	8.59	10.29	(1.70)
3	Controls	0.07	0.07	0.00
4	Winter Conditions *	0.08	0.08	0.00
5	Sub-Total Direct Costs	9.02	11.63	(2.61)
6	**Indirect Costs**	**2.27**	**2.84**	**(0.57)**
7	Risks	0.04	0.02	0.02
8	**Total Project Costs**	**11.33**	**14.50**	**(3.17)**

* Winter conditions include the cost of auxiliary activities required during the winter construction season (i.e. hoarding, installation of unit heaters, cost of natural gas, etc.)

8. The cost variances in the project relate to the identification of unanticipated hydraulic leaks in the digester floor and walls in 2019, during commissioning of the digester following the original planned rehabilitation work. The flange connection between the linear motion mixer and the digester was also identified as having leakage concerns. Commissioning was halted and an investigation (root cause analysis team (RCAT)) and structural assessment were completed to determine the sources of the leaks.

9. The investigation identified surface defects on the floor slab and the digester walls. The mixer flange was found to have surface irregularities suspected to have been caused by welding during site assembly of the flanges.

10. As a result, the floor and wall surfaces were sandblasted and prepared for the installation of a high-density polyethylene (HDPE) liner. The HDPE liner was installed in 2020. The flange leak issue was addressed through a re-design of the flange connection and a new machined flange connection installed. The digester was then re-commissioned and successfully passed subsequent leak tests.

11. The RCAT, structural assessment, HDPE liner design and installation, re-design and installation of a new mixer flange connection and re-commissioning of the digester represented changes to the original project scope, and consequently increased project costs compared to the costs anticipated in the PBR plan. Several learnings were derived from this project as a result:

- Structural integrity should be assessed in developing the scope of future digester projects, as their age and harsh operating conditions create a high potential for structural rehabilitation requirements. Hydrostatic leak testing after digester cleaning will assist in defining the structural scope.
- Lining the entire vessel with an epoxy liner, when leaks are identified, is more cost effective and may produce a better quality product than using different products for different sections of the digester. Additional investigation into this application would be required to confirm the suitability of this approach.
- Documentation is limited for structures constructed in the 1950s. Field verification of construction details will provide better project definition and improve the accuracy of cost estimates. The design of rehabilitation for this age of structure cannot assume concrete uniformity.

Appendix G14

EPCOR WATER SERVICES INC.

Wastewater Treatment
Headworks and Primary Aeration Upgrades Project
Post Implementation Review

February 16, 2021

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1.0 PROJECT DESCRIPTION

1. The Pre-treatment Facilities at the Gold Bar Wastewater Treatment Plant (WWTP) consist of raw influent channels, grit tanks and primary influent channels. These facilities remove heavy solid materials (e.g. sand, gravel – collectively termed “grit”), which adversely impact treatment and cause mechanical wear on equipment, from the incoming wastewater. Organic materials adhering to the grit are beneficial to the treatment process, and are separated from the grit in the Pre-treatment Facilities using air. Aeration in the channels were originally designed to keep the grit in suspension until it could be removed in the grit tanks and the Primary Treatment system. The aeration system included 3 blowers, a network of piping and air injection infrastructure.

2. The existing aeration system was unable to supply sufficient air to the Pre-Treatment Facilities, resulting in solids accumulation in the channels, hydrogen sulphide (H2S) attacks on the concrete structure, odours and ineffective operation of the Pre-Treatment Facilities. These impacts resulted in significant maintenance effort to frequently remove the accumulated solids.

3. At that time, much of the aeration piping in the raw influent channels was also not functioning or not in service due to long and complex piping runs with several critical valves being inaccessible.

4. At the time of project initiation, the project scope included:

- provision for aeration of the raw influent channels (Channels 2 and 3) upstream of the grit tanks including new piping, diffusers and two new blowers;
- upgrades to the aeration piping in the East and West Primary Influent Channels downstream of the grit tanks including an additional two new blowers; and
- odour control facilities including a new scrubber system near the grit facilities.

5. Several major primary influent channels and treatment tanks at Gold Bar WWTP have undergone extensive upgrades and rehabilitation to improve efficacy of solids removal and restore structural integrity since that time. Channels have been cleaned routinely to facilitate construction and access to the channels has been improved during recent structural rehabilitation projects facilitating easier future maintenance. In addition, aeration piping was opportunistically upgraded during structural rehabilitation of these channels. As a result, the accumulation of solids in the channels is less of an operational issue than observed previously.

6. As such, the scope of the project was reduced to eliminate the addition of aeration to the raw influent channel, and to utilize blower capacity originally intended for aeration of the raw influent channel to satisfy the air requirement for Grit Tanks 4 to 7. Upgrades to the existing primary influent channel aeration piping also became unnecessary. With improved access implemented in other projects, a regular maintenance program was also instituted for the primary influent channels to reduce solids build up. This also had the potential benefit of reducing odour generation, resulting in a recommendation to remove the odour scrubber from this project's scope and re-evaluate the need for odour management in this system considering the implemented changes.

7. The project is in the Reliability/Life Cycle category.

8. The project forecast cost was $6.72 million during the 2017-2021 period.

2.0 PROJECT COST VARIANCE

9. Table 2.0-1 summarizes the variance of this project compared to the original 2017-2021 PBR term capital plan and compared to the final approved EPCOR budget established in 2019.

Table 2.0-1
Headworks and Primary Aeration Upgrades Project Capital Expenditures
($ millions)

	A **2017-2021 PBR Forecast**	B **Final EPCOR Approved Budget**	C **Actual / Forecast Total**	D **Variance from 2017-2021 PBR**	E **Variance from Final EPCOR Budget**
1 Total Capital Expenditures	6.72	1.37	1.37	5.35	0.00

3.0 VARIANCE ANALYSIS

10. Original cost estimates for this project were developed based on an initial scoping and preliminary design report prepared in 2012. Column A in Table 3.0-1 provides the projects work breakdown structure and cost estimates at the time of the PBR application in 2016. The projects actual costs are shown in column B of Table 3.0-1 broken down in accordance with the projects work breakdown structure.

Table 3.0-1
Capital Expenditure Variances
($ millions)

		A **2017-2021 PBR**	B **2017-2021 Actual**	C **Variance**
	Direct Costs			
1	Downstream Aeration – All Components	0.77	0.00	0.77
2	Upstream Aeration – All Components	0.94	0.00	0.94
3	Odour Control – facility and ancillary equipment	1.70	0.00	1.70
4	Additional aeration to Grit tanks	0.00	0.64	(0.64)
5	New aeration controls and control valves	0.00	0.30	(0.30)
6	**Sub-Total Direct Costs**	3.41	0.94	2.47
7	Indirect Costs – Internal Time and Overheads	2.80	0.43	2.37
8	Risks	0.51	0.00	0.51
9	**Total Project Costs**	6.72	1.37	5.35

11. The project was completed for $5.35 million less than the original budget.

12. This was due to a change in scope, primarily the elimination of aeration in channels upstream of the grit tanks, and elimination of additional aeration in the downstream channels. An odour scrubber was also not implemented at this time to allow for an assessment of odour generation impacts resulting from the changes made to date. This meant that additional piping, blowers, odour capture and associated supporting infrastructure was not required.

13. Aeration around the grit tanks was removed from the project scope to focus debris removal on the grit tanks, which have sufficient solids removal capacity to accomplish this task.

14. The project was due to go in to service in 2019, but the schedule was delayed to early 2020 primarily due to issues with readiness for commissioning activities for new blowers and variable frequency drives (VFD's) on the supplier side. In addition, the commissioning methods needed further refinement, which caused minor delays.

15. Adding VFD's to the new and existing blowers will provide an economic benefit because the large blowers do not need to be continually run at full speed. The ability to fine-tune the aeration rate for the grit tanks will also improve inorganic solids removal, which is expected to have a positive impact on the mechanical equipment downstream.

16. The revised distribution piping layout, redundant blower availability and the ability to monitor and control aeration rates for the grit tanks has allowed Operations to better control the performance of the grit tanks for inorganics removal. Inorganics removal plays a large role in mitigating unexpected wear and failure of downstream solids handling equipment.

17. The ability to better control the performance of the grit tanks, resulting in fewer unexpected failures of solids handling equipment, is expected to avoid unexpected process upsets.

18. In addition, the ability to provide the same benefit of the original project scope through more detailed analysis and design while avoiding the need for additional large, energy intensive facilities will improve Gold Bar WWTP's relationship with stakeholders, shareholders and the community.

19. The primary risk mitigated by the project is process upset due to unexpected failure of grit tank blowers, leading to the passing of inorganics downstream into process equipment not capable of handling the material. Operations and Maintenance now have the necessary redundancy to respond quickly to an emergent situation. These risks have been successfully mitigated.

20. The project reinforced the demonstrated benefit of comprehensive stakeholder involvement during the design phase of the project. This approach enabled a less costly alternative to be developed from a holistic operational perspective, with ancillary benefits realized from channel structural upgrades and adjustments to maintenance activities that still achieved the desired outcomes of the project.

Appendix G15

EPCOR WATER SERVICES INC.

Wastewater Treatment
Hydrovac Sanitary Grit Facility Project
Post Implementation Review

February 16, 2021

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1.0 PROJECT DESCRIPTION

1. The City of Edmonton Drainage Services Branch removed sanitary grit material using hydrovac trucks during sanitary lift station and combined sewer sand trap cleaning activities. The highly odourous residual waste removed was disposed at Clover Bar lagoons where biosolids (digested sludge) were stored. Although this practice was not contrary to any environmental regulation, Drainage Services deemed this disposal method unsustainable and undesirable as it: impacted the quality of the biosolids potentially limiting future land application; may have resulted in an enforcement order in the future, and disturbed the water cap on the lagoons increasing the likelihood of odour releases. It was also not aligned with the City of Edmonton's Biosolids Management Strategy, which formed a part of Drainages *Environmental Protection & Enhancement Act* operating approval. Drainage Services required an alternative option for disposal and treatment of this material, and in 2013 recommended that EWSI construct a hydrovac sanitary grit treatment facility at Gold Bar.

2. EWSI agreed to design, construct, commission, operate, and maintain the new facility provided that the City of Edmonton either: (i) approved the project as part of the 2017-2021 PBR term capital budget; or (ii) pay EWSI all reasonable costs to construct and operate the facility.

3. Drainage Services presented a Business Case for this project to the City of Edmonton Utility Committee on Aug. 27, 2015 and the terms of an agreement with EWSI on Oct. 29, 2015. The Utility Committee approved the agreement on Oct. 29, 2015 and Edmonton City Council approval was granted on Nov. 17, 2015.

4. Upon approval of this agreement to include the project as part of the 2017-2021 PBR term capital budget, EWSI proceeded to design and construct the facility.

5. The project included the design, construction and commissioning of the new facility located in the south-east corner of the Gold Bar site, and the required utility connections. The facility consists of a receiving hopper and a drum screen followed by two grit washers. The drum screen removes material larger than 10 mm and the grit washers separate the grit from the liquid fraction. The washed grit is then collected in a bin. Final effluent is used as the wash water supply for the treatment process and the contaminated reject water (separated liquid fraction) is pumped to the Gold Bar headworks for treatment. The screenings and washed grit are disposed of at landfill, but possible reuse options for the washed grit may be investigated in the future.

6. A building encloses one truck bay, one receiving hopper and all processing equipment resulting in the mitigation of odour and noise concerns. HVAC facilities have been designed to collect the odourous air from within the facility and direct it through an odour scrubber prior to release to atmosphere.

7. The Hydrovac Sanitary Grit Facility project expenditures were estimated to total $21.5 million and the facility was placed in to service in 2017.

8. This project fell under the PBR category of Growth/Customer Requirements.

2.0 PROJECT COST VARIANCE

9. Table 2.0-1 summarizes the variance of this project compared to the original 2017-2021 PBR term capital plan and compared to the final approved EPCOR budget established in 2017.

Table 2.0-1
Digester 3 Upgrade Project Capital Expenditures
($ millions)

		A **PBR Forecast**	B **Final EPCOR Approved Budget**	C **Actual / Forecast Total**	D **Variance from 2017-2021 PBR**	E **Variance from Final EPCOR Budget**
1	Total Capital Expenditures	21.50	19.20	17.90	3.60	1.30

3.0 VARIANCE ANALYSIS

10. Original cost estimates for this project were developed based on conceptual design. Column A in Table 3.0-1 provides the project cost estimates at the time of the PBR application in 2016. The project's actual/forecast costs are shown in column B of Table 3.0-1.

Table 3.0-1
Capital Expenditure Variances
($ millions)

		A **2017-2021 PBR**	B **2017-2021 Actual / Forecast**	C **Variance**
	Direct Costs			
1	Design/Engineering	2.55	2.55	0.00
2	Construction/Commission	14.91	13.23	1.68
3	Internal Costs	0.67	0.81	(0.14)
4	**Sub-Total Direct Costs**	**18.13**	**16.59**	**1.54**
	Indirect Costs			
5	Contingency	1.68	0.00	1.68
6	IDC	1.27	0.76	0.51
7	Capital Overhead	0.42	0.55	(0.13)
8	**Sub-Total Indirect Costs**	**3.37**	**1.31**	**2.06**
9	**Total Project Costs**	**21.50**	**17.90**	**3.60**

11. The cost variances (under-spend when compared to original budget) in this project are primarily as a result of the chosen delivery method for this project.

12. The chosen delivery method was Construction Management at Risk (CMAR). The benefit of this delivery method is the creation of a team early in the design phase between owner, engineer and construction manager (CM). During the pre-construction phase, the CM assisted with cost estimates and provided constructability feedback during preliminary and detailed design.

13. Another benefit of CMAR is the option to accept a Guaranteed Maximum Price (GMP) from the CM. For this project, the GMP set the upper cost limit corresponding to the quantified scope of work expressed in the design documents provided for the GMP estimate. Setting a GMP reduces the risk of cost exceedances for the defined scope of work.

14. In addition, regular progress meetings were held with this team so that issues could be resolved as quickly as possible, which supported project cost control throughout the project period.

15. There were a limited number of significant changes to the original project plan, which meant that the cost estimates did not need to be materially adjusted during the project period.

16. While the project was delivered close to schedule (commissioned in Oct 2017), hand-over of the facility to day-to-day operations was delayed due to the failure of the coarse auger to

function suitably. Redesign and replacement of the auger was completed and the facility fully turned over to operations in April 2018.

17. The original project estimate included sufficient contingency to cover potential unknown events or changes to the project plan.

18. In 2018, the project won two engineering awards at the Consulting Engineers of Alberta (CEA) Showcase Gala, one for Environmental – Award of Excellence and the other for Sustainable Design – Award of Merit.

19. The facility operation continues to be optimized to improve flow pathways and grit settlement, to enable ease of maintenance of system components prone to grit accumulation, and to accept and process a wider range of characteristics of the sanitary grit hauled to the facility. The optimization process is expected to be completed at the end of 2021.

Report to Utility Committee
December 6th, 2019

EPCOR WATER SERVICES INC.

Sludge Line Upgrades

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1.0 OVERVIEW

1. The Gold Bar Waste Water Treatment Plant ("Gold Bar WWTP") produces digested sludge as a by-product of treating wastewater. The digested sludge is transferred by pipeline to the Clover Bar Lagoons ("Lagoons") at the Edmonton Waste Management Center ("EWMC") where the sludge receives further treatment prior to land application. Supernatant (a liquid waste stream generated during the treatment process at the Lagoons) is transferred by pipeline from the Lagoons back to the Gold Bar WWTP for further treatment.

2. The Gold Bar 2017-2021 PBR Application, filed with the City of Edmonton in 2016, included forecast capital expenditures of $3.4 million for the Sludge Line Upgrade Project. This project included continued inspection of sludge pipelines and minor improvements required to facilitate inspections. No sludge line replacement or repairs were included in the scope.

3. During 2016 and 2017, cleaning and inspection of a majority of the older sections of pipelines indicated that significant deterioration had occurred. In May 2017, shortly after completion of the inspections, there was a release of digested sludge in Hermitage Park from a failed pipeline. As a result of the leak, combined with the deteriorated condition, three pipeline segments were removed from service leaving the Gold Bar WWTP with reduced operational flexibility and no redundancy.

4. In early 2017, EWSI conducted a risk analysis based on results of the inspections completed to date and determined that the following rehabilitation and replacement of defective sections of pipeline were required:

- rehabilitation of nine localized defect locations at the EWMC Clover Bar Site (three excavations);
- rehabilitation of nine localized defect locations in Rundle Park (three excavations);
- rehabilitation of nine localized defect locations in Hermitage Park (six excavations) including replacement of a 200 m section in close proximity to Pembina pipelines; and
- replacement of approximately 2.5 km of pipeline from the North Saskatchewan River Park to Clover Bar.

5. Following the inspections and the release event in 2017, EWSI determined that additional work is necessary to clean, inspect and rehabilitate these pipelines to allow the Gold Bar WWTP sufficient redundancy for reliable operations and to mitigate the risk of releases to the environment. In the fall of 2017, EWSI expanded the scope of the Sludge Line Upgrades Project to include rehabilitation of localized defects. Rehabilitation was completed on the 27

defects by spring of 2018 with those segments returning to service and reducing the risk to Gold Bar WWTP operations and restoring some available redundancy. A separate project was also created for replacement of the 2.5 km section of pipelines between the Clover Bar lagoons and the North Saskatchewan River (the “Replace 2.5 km Sludge Line Project”). The new sections of pipeline at Clover Bar will be complete by the end of 2019.

6. As a result of the expanded scope of the original Sludge Lines Project and the additional Replace 2.5 km Sludge Line Project, EWSI’s current capital cost estimates for sludge lines upgrades for the 2017-2021 PBR term is $14.6 million. This cost estimate includes the a forecast of $7.1 million for the original Sludge Line Upgrade Project and an additional $7.5 million for the Replace 2.5 km Sludge Lines Project.

7. This business case is being brought to the attention of the City of Edmonton Utility Committee for information purposes, and to serve as an update of investments made by EPCOR Water Services Inc. (“EWSI”) on the sludge and supernatant pipelines to date as established under these two capital projects.

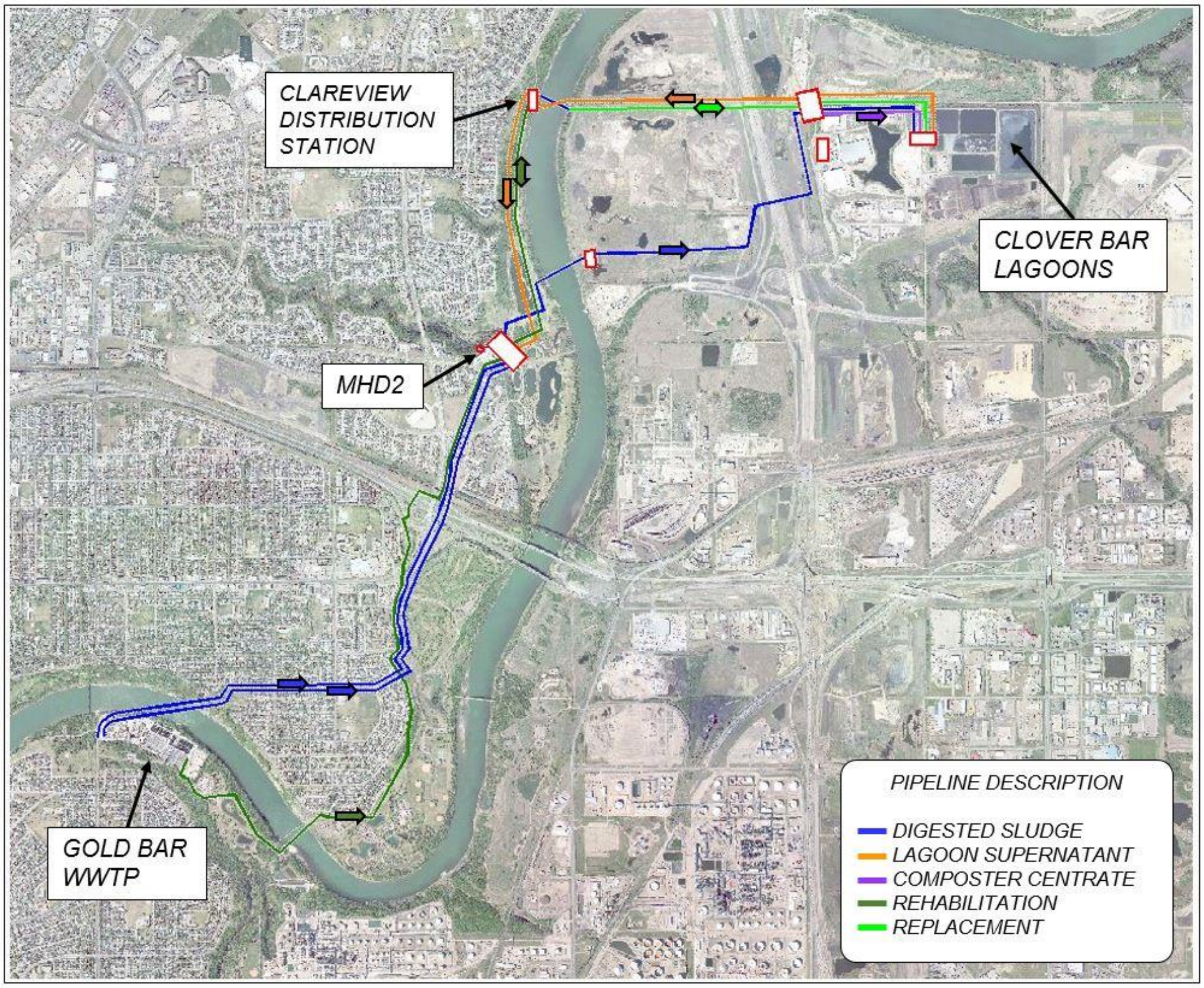
2.0 PROJECT DESCRIPTION

2.1 Background

8. The first sections of the Sludge/Supernatant Pipelines were built in 1972 and have expanded continually since then to a total of approximately 33 km of pipeline. Figure 2.1-1 below illustrates the basic configuration and use of these pipelines.

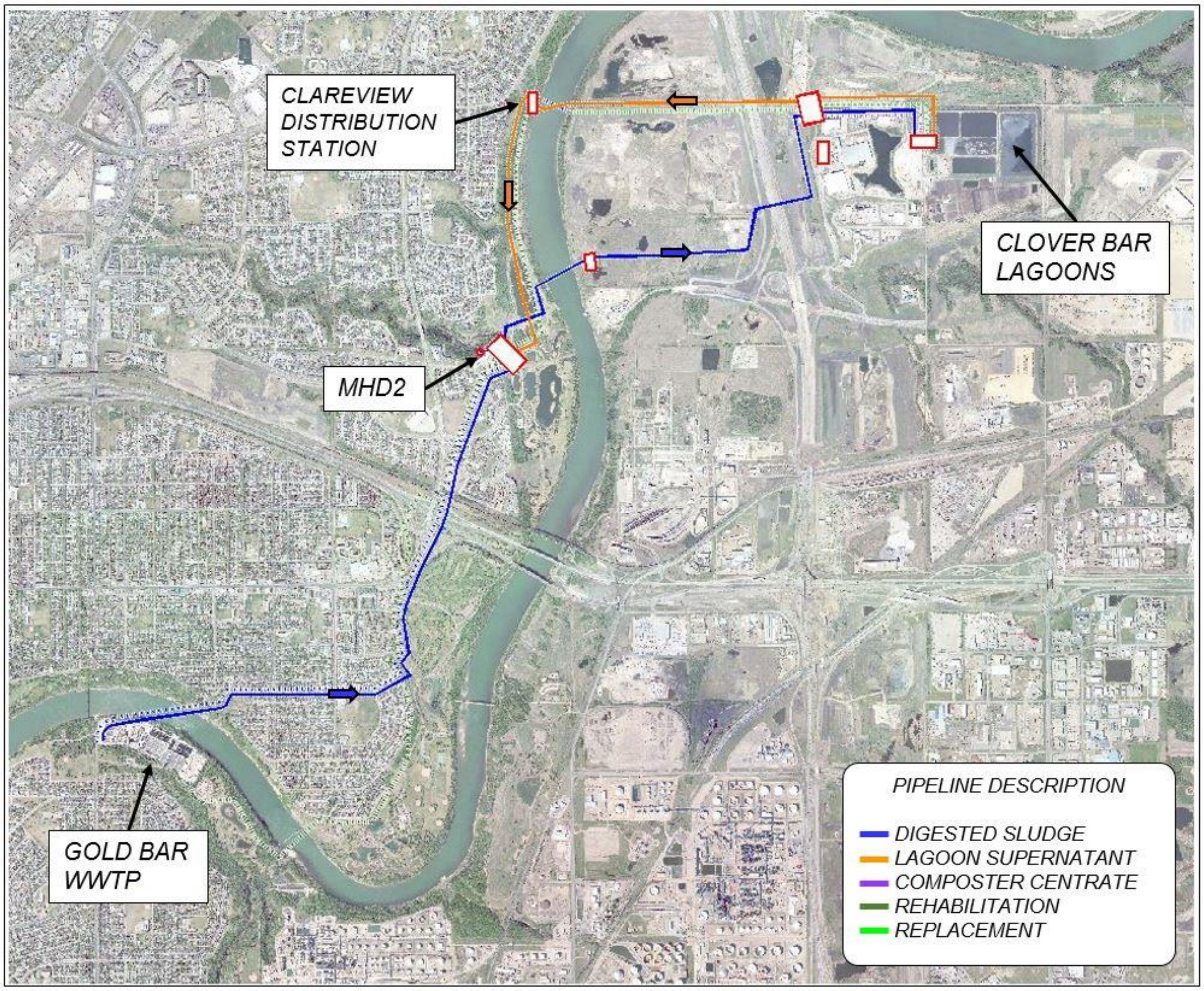
Figure 2.1-1

Sludge and Supernatant Pipeline Overview



9. Typical operation of this system of pipelines is for digested sludge to be pumped from Gold Bar WWTP through one series of the pipeline segments to the Lagoons. Supernatant is pumped from the Lagoons using a separate series of the pipeline segments to Manhole D2 ("MHD2"). Note that the supernatant flows through the drainage collection system from MHD2 to Gold Bar WWTP and/or from Clareview Distribution Chamber to the Alberta Capital Region Wastewater Treatment Plant. Figure 2.1-2 demonstrates a typical flow paths for these pipelines during regular operations.

Figure 2.1-2
Sludge and Supernatant Pipeline Typical Flow Paths



Notes:
a. Multiple flow paths are available between Gold Bar and Clover Bar Lagoons. For clarity, only one path for each Digested Sludge and Lagoon Supernatant is illustrated.
b. Lagoon Supernatant travels from MHD2 to Gold Bar using the Drainage collection system (not illustrated).

10. There are several line segments between Gold Bar WWTP and the Clover Bar Lagoons, which generally allows for three series of pipelines to be used for pumping. Since there are two commodities (digested sludge and supernatant) that are pumped, this allows one series of segments for standby in the event of an issue with a pipeline path. There are also some valve chambers along the routes, which also give some interconnection flexibility.

11. In 2015, the Gold Bar WWTP developed a Sludge/Supernatant Pipeline Inspection Program. This program specified a phased approach for cleaning and inspection of the pipelines

to assess their condition and identify any needed repairs, rehabilitation or upgrades to ensure the integrity of the pipelines.

12. Prior to that time, cleaning of these pipelines was typically completed when required to alleviate operational issues. That is, flow rate reductions would occur due to fouling (i.e. internal struvite build up). Routine cleaning and inspection activities were not established, and pipeline conditions were unknown. Cleaning and removal of pipeline fouling is required to properly inspect and assess the condition.

2.2 **Project Description**

13. In the 2017-2021 PBR, EWSI initiated the Sludge Line Upgrade project to support implementation of the Sludge/Supernatant Pipeline Inspection Program. Results of inspections conducted in 2017 required the scope of this project to be expanded to also include rehabilitation. More specifically, the Sludge Line Upgrade project scope currently includes the following:

- implementation of necessary upgrades to allow completion of cleaning and inspection of all pipeline segments;
- cleaning and the inspection of all pipeline segments;
- completion of any high priority rehabilitation work required to restore the system to reasonable operating condition; and
- Development of Pipeline Master Plans and finalize Pipeline Asset Management Plans for future planning.

14. The Sludge Line Upgrade Project scope was based on a review of the existing system, which included age, materials of construction, previous failures, previous inspections, potential risks, and proposed inspection methodologies. Consideration was also made to prioritize rehabilitation work for areas with higher risk of failures.

15. The Replace 2.5 km Sludge Line Project was also initiated following the inspections and risk analysis. This project includes full replacement of two pipeline segments based on EWSI determination that replacement was immediately necessary due to the high risk of failure of these segments.

3.0 PROJECT JUSTIFICATION

16. The primary risk events that these two projects are intended to mitigate include: (i) operational failures to the Gold Bar WWTP and (ii) releases of digested sludge or supernatant to the environment.

Operational Failures

17. A pipeline failure would limit pumping from Gold Bar WWTP and impact plant capacity until rehabilitation or major replacement work is completed. While there is sufficient volume in the Clover Bar Lagoons to endure a longer outage in supernatant return, interruptions in the pumping of digested sludge impact the operation of the plant immediately. Gold Bar WWTP pumps approximately 2.0 million litres of digested sludge to the lagoons per day with no facilities for sludge storage on-site. An interruption in sludge pumping would lead to solids build up in throughout the WWTP, resulting in mechanical damage and/or a reduction of the overall liquid treatment process.

18. Due to the complexity of the entire wastewater treatment system, operational requirements, design, permitting and construction requirements for cleaning, inspection and rehabilitation need to be carefully staged. It is necessary to ensure that digested sludge can be pumped from the Gold Bar WWTP and supernatant can be pumped from the Lagoons in sufficient quantities at all times. Implementing upgrades and improving the design of these systems allows for enhanced flexibility to operations, ease of future inspections, and enhanced emergency response.

Releases to the Environment

19. A majority of the pipeline system is located within the North Saskatchewan River ("NSR") valley with several river crossings occurring along the way. An unplanned rupture of these pipelines could result a release of sludge/supernatant into the NSR which pose an environmental risk with regulatory and reputation consequences.

4.0 EVALUATION OF ALTERNATIVES

20. Following pipeline inspections and the release event in 2017, EWSI considered the following alternative responses to the situation:

4.1 Alternative 1: Do Nothing – Run to Failure

21. One alternative is to run the pipes to failure but this creates operational and environmental risks that are unacceptable. Pumping digested sludge to the Clover Bar Lagoons is critical to the safe operation of the Gold Bar WWTP as there is no storage at the site of the Gold Bar WWTP. There are also regulatory, reputational, environmental and financial impacts associated with the spill and cleanup of a rupture of pipe and release of supernatant or digested sludge to private land or the North Saskatchewan River. This alternative does not mitigate any risk and therefore is not recommended.

4.2 Alternative 2: Spot Repair and Rehabilitation

22. Under this alternative the regular cleaning and inspection of the pipeline segments provides detailed condition information which is used for decision making. A review of the overall condition of the pipeline (e.g., age, material, location) and the number of found defects is conducted. Defects are typically locations where a certain amount of either internal or external pipeline wall loss has occurred.

23. Spot repairs and rehabilitation on defects are most often conducted by excavation and replacement of a segment of pipe (about 2-5 m) and when the number of found defects are not excessive in quantity along the full line length. These excavations can be challenging and costly, especially when pipeline locations are close to the North Saskatchewan River or in busy parkland areas (e.g. Hermitage Park).

4.3 Alternative 3: Replacement of Full Pipeline Segments

24. A full replacement of a pipeline segment is likely if the frequency and severity of defects identified along that length are significant, and spot repair is not practical or cost effective. Full replacement also provides an opportunity for: (i) improved alignment of pipeline segments for future maintenance; (ii) efficiencies in construction methods such as horizontal directional drilling, and; (iii) using newer pipeline material not susceptible to corrosion such as HDPE versus conventional steel pipe.

25. The following table summarizes the advantages and disadvantages of each alternative

Table 4.3-1

Summary of Alternatives for Rehabilitation

Alternative 1: Run to Failure	Alternative 2: Spot Repair/Rehab	Alternative 3: Full Replacement
	Advantages	
• no capital expenditures	• Most practical rehabilitation strategy for a small defect in long pipeline segment • Lower capital investments per location compared with full replacement • Shorter time for regulatory approvals (considered as maintenance work) • Ability to deal with multiple defects in close proximity • Relatively shorter time frame to complete work compared to full replacement (e.g. days or weeks)	• Lowest risk to Gold Bar WWTP Operations with new pipelines • Lowest risk of release to Environment • Most practical rehabilitation strategy for pipeline segments in very poor condition with significant number of defects • Enables for efficient construction strategies to be utilized (e.g. HDD) • Allows more options for improvements in the overall design (e.g. alignment, materials) • Investment in pipeline segment gives a longer overall expected life
	Disadvantages	
• Highest risk to Gold Bar WWTP operations • Highest risk of release to environment	• Encounter challenges is some locations (e.g. ground water, public, environment) • Limited options for further improvements (e.g. alignment, material) • May not be practical for pipeline segments in very poor condition	• Highest capital investment • Longer time for regulatory approvals • Longer time frame to complete work (e.g. months or years) • Having a segment isolated for construction reduces available redundancy which creates a small operational risk

4.4 Conclusions and Selected Alternative

26. Based on this analysis and risk assessment, EWSI elected to proceed with a combination of spot repairs and rehabilitation (under the Sludge Line Upgrades Project) at locations where failure had already occurred or was likely in the possible in the near future and full replacement of two segments of pipeline (under the Replace 2.5 km Sludge Line Project) at locations where replacement was immediately necessary due to the high risk of failure. This strategy supports the need for redundancy in the WWTP operations and mitigates the risks of potential operational failures or releases to the environment in the poor condition pipeline segments.

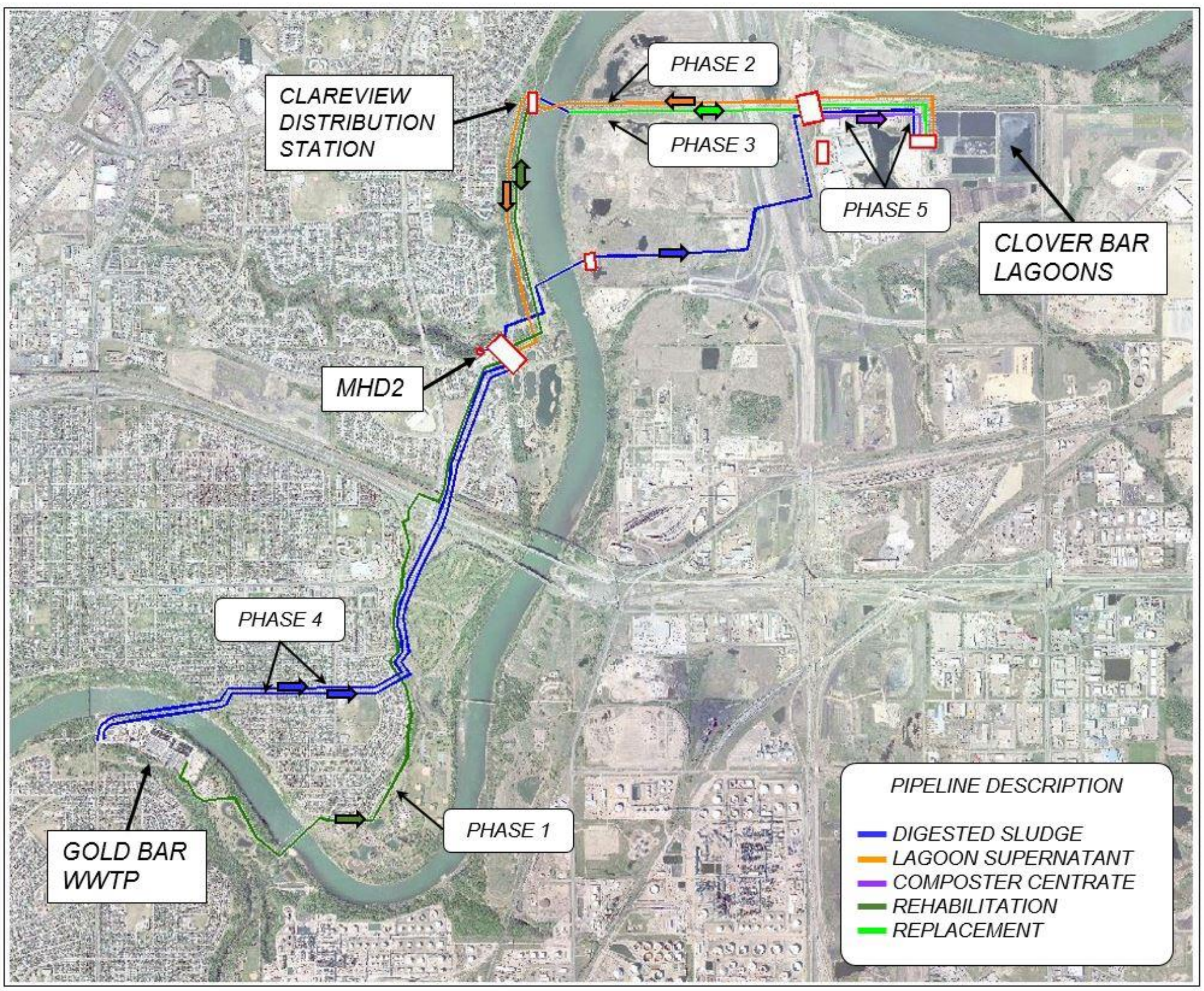
27. Future pipeline considerations were reviewed as a part of this project, including future capacity, materials of construction, and alignment. The objective is that this work would be appropriate for the present and future.

5.0 PROJECT PROGRESS

28. The cleaning and inspection scope of the Sludge Line Upgrade Project was divided into phases to minimize impact on normal operation of the sludge/supernatant system. Figure 5.0-1 shows which pipeline series were inspected for each phase.

Figure 5.0-1

Sludge and Supernatant Pipeline Phases of Work



29. Table 5.0-1 provides the timeframe for each phase of work including the cleaning and inspection work and rehabilitation/replacement work.

Table 5.0-1
Summary of Work by Phase

Phase	Cleaning and Inspection Timeframe	Rehabilitation / Replacement Work	Rehabilitation / Replacement Completion
1 - Gold Bar to MHD2	Spring/Summer 2016	Rehab high risk defects (Rundle Park)	2017
2 - Clover Bar to MHD2	Winter 2016/2017	Rehab high risk defects (Clover Bar, Hermitage Park)	2018
3 - Clover Bar to MHD2	Winter 2016/2017	Replace 2.5km (Clover Bar to NSR)	2019
4 - Gold Bar to MHD2	Fall/Winter 2018	No high risk defects identified	2019
5 - Clover Bar	Fall/Winter 2018	Replace one segment as part of 2.5km (Clover Bar)	2019

30. In the spring and summer of 2016 (after PBR submissions were completed) phase 1 of the pipeline inspection program was executed. Phase 1 included the cleaning, modification of lines for inspection tools and inspection of the oldest pipeline segment from Gold Bar WWTP to Chamber MHD2. The inspection identified the segment had deteriorated significantly and numerous corrective actions were required for the segment to safely remain in service. One rehab was completed in 2016 but the segment was removed from service until further rehabilitation could be completed.

31. During the winter of 2016/2017 phases 2 and 3 of the pipeline inspection program were completed. These phases included cleaning and inspection of six pipeline segments between the Clover Bar Pump Station and Manhole D2. Inspection results for three of the segments indicated significant deterioration had occurred. Shortly after completion of the inspections there was a release of digested sludge in Hermitage Park from a failed pipeline. The sludge release was immediately cleaned with vacuum trucks and that area of the park fenced off until repair could be completed. Subsequent soil sampling showed no adverse environmental impact. As a result of the leak and the deteriorated condition those three pipeline segments were also removed from service leaving the Gold Bar WWTP with reduced operational flexibility and no redundancy.

32. In 2017, EWSI completed a comprehensive risk analysis on the inspection results completed to this point (Phases 1-3) and the following conclusions for rehab and replacement of defective sections were made:

- rehabilitation of nine localized defect locations at the EWMC Clover Bar Site (three excavations);
- rehabilitation of nine localized defect locations in Rundle Park (three excavations);
- rehabilitation of nine localized defect locations in Hermitage Park (six excavations) including replacement of a 200 m section in close proximity to Pembina pipelines; and
- replacement of approximately 2.5 km of pipeline from the North Saskatchewan River Park to Clover Bar.

33. In that fall of 2017, EWSI commenced the work to complete rehabilitation of the localized defects under the Sludge Line Upgrades Project and a initiated a separate project, the Replace 2.5 km Sludge Line, to complete replacement of the 2.5 km section of pipelines. Rehabilitation was completed on the 27 defects by Spring of 2018 with those segments returned to service reducing the risk to the Gold Bar WWTP and restoring available redundancy.

34. In the fall of 2018, Phase 4 of the inspections was completed on the remaining two sections of pipelines between Gold Bar WWTP and Chamber D2. Results showed these two segments to be in acceptable condition with no defects requiring immediate attention.

35. Phase 5 of inspections was completed on two sections of pipeline at Clover Bar. This work was executed under the Replace 2.5 km Sludge Line project to develop scope during detailed design. Based on the results of that inspection the decision was made to replace one of these lines considering the savings of the contractor already installing pipelines in that area. Construction at Clover Bar is expected be complete in November of 2019.

36. Several samples of the defects were analyzed in closer detail, to identify any common characteristics or failure mechanisms. The analysis considered physical properties and material chemistry. While mechanisms were identified for internal and external corrosion, the review determined that the materials installed were consistent with ones typically used. The recommendations made also support the development and implementation of the Pipeline Integrity Program, which is already underway.

6.0 PROJECT COST VARIANCE

37. The 2017-2021 PBR submission for this project was $3.4 million which was based primarily on expected costs for continued inspection of pipelines and minor improvements required to facilitate inspections; replacement and/or rehab was not in scope.

38. 2017-2021 PBR Forecast compared to actuals/forecast capital expenditures for both inspection and rehabilitation work completed under the Sludge Line Upgrades and Replace 2.5 km Sludge Line Project are provided in Table 6.0-1 below.

Table 6.0-1
Sludge and Supernatant Pipeline Capital Expenditures
2017-2021 PBR Term
($000s)

		A	B	C	D	E	F	G
		2016	2017	2018	2019	2020	2021	Total Costs
1	**PBR Forecast**		1.1	1.1	1.1			3.4
	Actual/Forecast							
	Sludge Line Upgrades Project							
2	Inspections	0.4	0.6	1.3	0.2			2.5
3	Rehabilitation		2.4	2.0	0.2			4.6
4	Subtotal	0.4	3.0	3.3	0.4			7.1
	Replace 2.5 km Sludge Line Project							
5	Inspections				0.7	0.6		7.5
6	Rehab		0.2	1.0	5.1			
7	Subtotal		0.2	1.0	0.	0.6		7.5
8	**Total Capital Expenditures**	**0.4**	**3.1**	**4.4**	**6.1**	**0.6**		**14.6**

6.1 Sludge Line Upgrades Project

39. Final project costs for the Sludge Line Upgrades Project are forecasted to be $7.1 million or $3.7 million (111%) greater than the original PBR forecast of $3.4 million. The PBR forecast cost of the project only included the costs of cleaning and inspecting the sludge lines between

Gold Bar WWTP and the Clover Bar Lagoons. Inspections on the older sections of pipelines showed that the sludge lines were in poor condition and required significant additional capital expenditure under this project for rehabilitation / replacement to ensure that these pipelines can continue to operate with minimal risk of leakage.

6.2 **Replace 2.5 km Sludge Line**

40. The Replace 2.5 km Sludge Line Project was not included in the 2017-2021 PBR forecast as the forecast was prepared prior to the inspection work. Costs for this project are forecasted to be $7.5 million. This project provides for replacement of a 2.5 km section of sludge lines located between the Clover Bar Lagoons and the North Saskatchewan River. This section of the sludge lines were found to be in such poor condition that repairs or rehabilitation was not financially viable.

7.0 FUTURE PLANNING / PATH FORWARD

41. Entering into the 2017-2021 PBR period, EWSI's goal was to complete inspections on all of EPCOR's sludge line assets while developing both a Pipeline Master Plan and a Pipeline Asset Management Plan for planning of future work. These inspections and a failure of one section of pipeline, however, drove the need for immediate repair, rehabilitation and replacement of significant portions of these pipelines.

42. The system is currently in an operationally stable state with a low risk of failure in the near term and further inspections are not required in this PBR period. EWSI now has the ability to better plan for future inspections (e.g., means, methods, costs, frequency) based on the information obtained during these inspections. This experience and information also aids in determining what improvements are required.

43. EWSI is currently developing a Pipeline Master Plan for sludge/supernatant piping system. This Master Plan will focus on capacity requirements and the best pipeline practices to identify the current and future needs for the system upgrades. The plan will also serve as a basis for considering future projects in future PBR applications. The Master Plan will be completed by the end of 2019 and will consider the following:

- the overall layout to determine the upgrades required to meet the Gold Bar Integrated Resource Plan (IRP) design horizon of 2060 and the forecast volumes to be pumped to the Clover Bar Lagoons from Gold Bar WWTP;

- the number and size of pipelines required to meet these volume requirements and to provide necessary redundancy for regular maintenance and emergency situations;
- pipeline material selection to provide the longest life, while being strong enough to withstand pressure fluctuations and other environmental aspects; and
- monitoring options to allow for enhanced condition and operational state awareness.

44. EWSI is also developing a Pipeline Asset Management Plan in conjunction with the Master Plan. The Pipeline Asset Management Plan serves two key functions:

i) To develop and document an integrated investment and management plan for the sludge/supernatant system to address all asset needs that will:
    - maintain existing levels of service (base maintenance);
    - accommodate future operational capacity requirements due to population growth and demand changes;
    - adapt to environmental pressures and/or regulator changes; and
    - provide basis for the development of routine cleaning and inspection program, improved monitoring and other system improvements.

ii) To act as a communication document to inform key stakeholders of the required investment required and expected outcomes.

45. Integrated resource planning is the long term planning process used by EWSI for Gold Bar. The Pipeline Asset Management Plan and Pipeline Master Plan are two critical documents that together support the development of the Gold Bar IRP, which will provide details regarding the near, medium, and long term plans, vision, and investment needs, specifically related to pipelines.

46. Planning and costing for future PBR periods is currently underway based on the documents currently in preparation. The goal is to establish a realistic and sustainable forecast per PBR that reduces the likelihood of encountering unforeseen issues that cause significant variance to occur. This information will be included in EWSI's next PBR application. EWSI expects regular future capital investment will be required to support cleaning, inspection, and rehabilitation in the range of $3 to $5 million per PBR term. Replacement of segments as they are identified through inspections are expected to cost approximately $5 million and would be presented separately.