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Final Report for:

FOOTHILLS REGIONAL WATER AND WASTEWATER COLLABORATIVE (FRWWC)

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY

Date: July 11, 2016
2210-047-00

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July 11, 2016
File: N:\2210\047-00\L02-1.0

Attention: Matt Rockley, FRWWC Co-Chair
Suzanne Oel, FRWWC Co-Chair

Dear Mr. Rockley and Ms. Oel:

Re: Regional Wastewater Feasibility Study
Final Report

We are pleased to submit a final copy of the "Regional Wastewater Feasibility Study" Final Report as requested by the Foothills Regional Water and Wastewater Collaborative (FRWWC). This study is completed in conjunction with Urban Systems Ltd. to provide the FRWWC with an assessment of viable sub-regional alternatives that were beyond that considered in the higher level Calgary Regional Partnership (CRP) work for the South Region.

Please contact the undersigned with any questions that you may have.

Yours truly,

MPE ENGINEERING LTD.

Sarah Fratpietro, P.Eng.
Project Manager

SF/pm
Enclosure

CORPORATE AUTHORIZATION

This report has been prepared by MPE Engineering Ltd. and Urban Systems Ltd. under authorization of Foothills Regional Water and Wastewater Collaborative. The material in this report represents the best judgment of MPE Engineering Ltd. and Urban Systems Ltd. given the available information. Any use that a third party makes of this report, or reliance on or decisions made based upon it is the responsibility of the third party. MPE Engineering Ltd. and Urban Systems Ltd. accept no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions taken based upon this report.

Should any questions arise regarding content of this report, please contact the undersigned.

MPE ENGINEERING LTD. (Pipeline and Lift Station Work)

PERMIT TO PRACTICE
MPE ENGINEERING LTD.
PERMIT NUMBER: P 3680
The Association of Professional Engineers and Geoscientists of Alberta

Sarah Fratpietro, P.Eng. MPE Engineering Ltd. Project Manager	Randy Boras, M.Sc. P.Eng MPE Engineering Ltd. Senior Project Specialist

URBAN SYSTEMS LTD. (WWTPs, PESTLE, and Stream Analysis)

Leigh Chmilar, P.Eng. Urban Systems Ltd. Water Engineer	Steve Brubacher, P.Eng. Urban Systems Ltd. Principal

TABLE OF CONTENTS

APPENDICES

Appendix A: Technical Memorandum 1 – Planning and Projections
Appendix B: Technical Memorandum 2 – Stream Analysis
Appendix C: Technical Memorandum 3 – Options & Screening
Appendix D: Technical Memorandum 4 – Preferred Options
Appendix E: Technical Memorandum 5 – Westend Options

EXECUTIVE SUMMARY

The Foothills Regional Water and Wastewater Collaborative (FRWWC) has explored a sub-regional wastewater management strategy for future wastewater collection and treatment servicing in the Sheep and Highwood River watersheds. The goal of this project is to improve the environmental quality of the rivers while meeting the water and wastewater needs of the member communities within the constraints of the system. This report and executive summary is a result of the collaboration of the FRWWC Governance and Technical Committees and the consulting team.

The scope of this study includes building upon the Calgary Regional Partnership (CRP) *Regional Water and Wastewater Servicing Masterplan* (CRP 2014) and recently tendered costs at a "screening level"; establishes Total Cost of Operation (TCO) and Net Present Values (NPV); and considers 10, 25, and 60-year time frames. This study assumes that new Alberta Environment and Parks (AEP) high quality (HQ) effluent standards would need to be considered, and are adopted in the costing of any new plants.

The four scenarios that are explored in the course of this study include:

Option #1: Regional Pipeline from Okotoks and High River to Calgary, new Sub-Regional Wastewater Treatment Plant (WWTP) in the Aldersyde area for the Municipal District of Foothills (MD) flows; retain local plants in Westend, Longview and Nanton as per CRP plan;

Option #2: One Sub-Regional WWTP (NE of Okotoks) designed for 100% of flow from High River, Okotoks, and the MD; retain local plants in Westend, Longview and Nanton as per CRP plan;

Option #3: One Sub-Regional WWTP (NE of Okotoks) servicing only excess (future growth) flow from Okotoks, plus 100% of the flow from High River and MD; retain local plants in Westend, Longview and Nanton as per CRP plan;

Option #4: Regional pipeline from Okotoks and High River to Calgary, sized to also include 100% of MD flow; retain local plants in Westend, Longview and Nanton as per CRP plan.

The consultant team worked with the FRWWC Technical Committee to obtain data, to develop a decision making structure (PESTLE Framework)[1] to assess the viability of options, and to produce a detailed analysis of options.

This study also includes additional analysis of the impacts of these decisions on the Westend Regional Services Commission and a Technical Report (Technical Memorandum #5) that was prepared and presented to the Westend Commission with an invitation for comment and feedback.

In January 2016, upon recommendation from the Technical Committee, the Governance Committee narrowed the scope of the study down to two preferred options for further refinement. Option #3: Sub-Regional Supplemental Wastewater Treatment Plant; and Option #4: Sub-Regional Pipeline to Calgary are explored in greater detail and include refined costing of infrastructure (pipes and plant), and lifecycle operating costs.

Study Findings

This study finds the lowest cost option is Option #4 (Sub-Regional Pipeline to Calgary) with a 60-year Net Present Value (NPV) of $450M, and an initial capital cost of $202M (to provide service to 2041). This option also scored highest on the PESTLE analysis.

This option has the advantages of lowest cost, shortest pipe length and no WWTP for the members to operate. The major challenges with this option are that the City of Calgary may not be able to accept a tie to their Pine Creek WWTP until at least 2025, the associated local bridging costs to meet this date, uncertainty regarding future fees, and current City policies precluding the servicing of non-CRP members.

Option #3 (Sub-Regional Supplemental Wastewater Treatment Plant) is also considered a preferred option by the FRWWC Committees. It has a 60-year NPV of $612M, with an initial capital cost of $343M (plus an additional $65M in 2034 to provide service to 2041).

This option has the advantage of timing (being readily implementable) and it can extend service to all members. The major challenges with this option are the higher cost, the need to operate two WWTPs, the longest pipe length, and uncertainty with the local rivers' carrying capacity when selecting an appropriate outfall location. Future river water quality study is needed.

Technical and Governance Committee Comments

After a thorough analysis of the two preferred sub-regional options, the Technical and Governance Committees determined that no favoured option could be selected, given that the costs for both preferred sub-regional options exceed the current and foreseeable economic viability of the sub-region; and that neither option is feasible at this time without the establishment of the following:

1. Provincial direction on watershed limits and thresholds for phosphorous and effluent loading rates for other parameters,
2. Provincial direction on availability of funding for a regional wastewater solution, and
3. Confirmation from the City of Calgary regarding the fees and tie-in timing for Option 4.

Based upon comment from the Technical and Governance Committees and current circumstances, it appears that the regional direction coming out of this study is toward stand-alone plants in each community, or alternate sub-regional solutions.

One alternate "West / Sheep River" sub-regional concept that may be explored involves collaboration between Okotoks and the Westend Commission to address the specific urgency around a wastewater solution for Westend. This may be considered within the context of Okotoks' growth management plans and the limits to the loading on the Sheep River. A parallel "East / Highwood River" sub-regional concept may also be explored between the M.D. of Foothills and the Town of High River. Any future decision should include river water quality impact studies to address questions about loading.

As put forth by the Governance and Technical Committees, there are several questions that remain in regard to the condition of the watershed and economic feasibility for collaboration on wastewater treatment within the sub-region. These questions have been summarized by Committee members and are going to be discussed at a future FRWWC Technical Committee meeting. This further analysis may involve engaging Alberta Environment and Parks, the Highwood Management Plan Advisory Committee, and the Calgary Regional Partnership.

The FRWWC remains committed to working together as a region with the intent to make best decisions for the watershed.

Recommendations

Should the FRWWC desire to pursue a sub-regional option, the following should be considered:

1. Higher level discussions with AEP regarding effluent quality standards and wet weather flow treatment methods.
2. Higher level discussions with the City of Calgary regarding fees, tie-in timing, and total loading limits.
3. Higher level discussions with the Province regarding potential grant funding and cost sharing.
4. Re-evaluation of the preferred options and consideration of alternate sub-basin alternatives in addition to local solutions, following the outcome of the above mentioned discussions.
5. River water quality study as deemed necessary by the outcome of the previous items.
6. Estimation of local bridging costs as deemed necessary by the outcome of the previous items.

[1] PESTLE framework was developed in consultation with the FRWWC Technical Committee Members to establish criteria for consideration in screening options. Criteria include: alignment with CRP Policies, equity among member municipalities (costs, capacity, decision making), impact on natural, agricultural or environmental sensitive areas, habitats, utilization of existing sites and infrastructure corridors, use of energy, adaptation to demographic shifts, staffing requirements and operational efficiencies, risks to community health and safety, adaptation to climate change, adaptation innovation in treatment technologies. The PESTLE acronym stands for Political, Environmental, Social, Technological, Legal, and Economic.

1.0 INTRODUCTION

1.1 Overview

MPE Engineering Ltd. (MPE), in conjunction with Urban Systems Ltd. (USL), has been retained by the Foothills Regional Water and Wastewater Collaborative (FRWWC) to carry out a regional wastewater treatment feasibility study.

This study provides the FRWWC with an assessment of viable sub-regional alternatives that were not considered in the higher level Calgary Regional Partnership (CRP) *Regional Water and Wastewater Servicing Masterplan* (CRP 2014) for the south sub-region. This sub-region includes Okotoks, High River, Turner Valley, Black Diamond, Nanton, Longview and critical corridors in the Municipal District of Foothills (MD) (Aldersyde and MD Central District).

1.2 Background

In the next 60 years, this south sub-region could more than quadruple in population, putting stress on financial and physical capacity of the local wastewater treatment systems. Communities are already in the position to begin planning for these growth pressures. Okotoks is currently undertaking an evaluation of wastewater treatment options focused on the Town's specific growth needs, including local plant expansion and piping wastewater to the City of Calgary. High River's EPEA Approval will eventually require an upgrade to a tertiary treatment plant. Nanton and Westend are planning for or implementing upgrades. An Aldersyde WWTP is moving through the approval process. Further, Alberta Environment and Parks (AEP) has recently introduced high quality (HQ) "technology based" effluent standards in the sub-region that are more stringent than existing quality (EQ) standards in Okotoks and the City of Calgary. These upcoming or ongoing challenges are present within the entire sub-region, and warrant a sub-regional approach.

The FRWWC is a member-based inter-municipal planning group of municipal governments. Member municipalities include the M.D. of Foothills, plus the Towns of Okotoks, Black Diamond and High River. They are embarking upon a sub-regional solution for water and wastewater in the short (<10 yrs), medium (25 yrs), and long-term (60 yrs). The first stage of the work is to undertake this study, focus upon available wastewater alternatives, and build upon the 2014 CRP work to date.

1.3 Study Scope

The focus of this study is to assess viable sub-regional alternatives that were not considered in the 2014 CRP masterplan for Okotoks, High River, Turner Valley, Black Diamond, Nanton, the MD Central District and Aldersyde industrial corridor.

The major tasks included in this project are to produce five technical memorandums and this report as follows:

- Technical Memorandum 1 – Planning and Projections (USL – primary author):
  - Utilize much of the information already documented and vetted by the CRP process.
  - Obtain and summarize new and important wastewater studies from local municipalities and water basin groups,
  - Obtain latest census information and population projections from partners. Prepare service population projections for each municipality (for 10, 25 and 60 years),
  - Project wastewater flows and biological loads based on typical wastewater characteristics, historical data and projected service populations, and
  - Review and summarize water diversion licenses and EPEA Approvals, identify return flow constraints.
- Technical Memorandum 2 – Stream Analysis (USL – primary author):
  - Review existing data and information and summarize the current conditions, issues, constraints, carrying capacity and potential challenges of the existing water courses in the sub-region:
    - Upper Little Bow River,
    - Highwood River,
    - Sheep River, and
    - Mosquito Creek.
- Technical Memorandum 3 – Options & Screening (MPE – primary author):
  - Summarize design parameters,
  - Provide high level review of four sub-regional wastewater servicing options,
  - Provide Class D (screening level) opinions of probable cost,
  - Provide a PESTLE analysis, and
  - Discuss the advantages and disadvantages of each option.

- Technical Memorandum 4 – Preferred Options (MPE – primary author):
  - Refine two preferred options as selected by the FRWWC Technical and Governance Committees,
  - Provide a conceptual-level design for the two preferred options based on AEP HQ effluent standards,
  - Provide refined capital and O&M opinions of probable cost for the two preferred options and complete a net present value (NPV) and total cost of ownership (TCO) cost analysis, and
  - Break down costs to show estimated contributions from each municipality based upon percent utilization of capital infrastructure.
- Technical Memorandum 5 – Westend Options (MPE – primary author):
  - Summarize Westend Regional Sewage Services Commission (Westend) design parameters,
  - Provide high level review of two wastewater servicing options for Westend,
  - Provide Class D (screening level) opinions of probable cost, and
  - Discuss the advantages and disadvantages of each option.
- Produce a draft final report for FRWWC review and comments (MPE – primary author).
- Produce final report incorporating comments from the FRWWC (MPE – primary author).

Within the various technical memorandums, MPE developed costs and impacts related to the regional pipelines, and USL developed costs and impacts related to the wastewater treatment plants (WWTPs). Each technical memorandum was presented to the FRWWC Technical Committee. The Technical Committee provided comment and then carried recommendations forward to the FRWWC Governance committee.

2.0 SUMMARY OF TECHNICAL MEMORANDUMS

The following sections summarize the findings of each of the five technical memorandums.

2.1 Technical Memorandum 1 (TM1) – Planning and Projections

This memorandum establishes the foundation of the study by summarizing historical populations, flow data, population projections, and existing EPEA Approvals for each of the study areas. The existing Water Licenses are summarized as well, including diversion and return points. Existing treatment facility studies are reviewed in order to summarize current plant conditions and upgrade requirements. The Towns of Longview and Nanton are included in the review, but given the CRP (2014) recommendation to remain on local plants, are not considered further in this study. In any case, a summary for each community can be found in Technical Memorandum 1 (TM1).

2.1.1 Population and Flow Projections

Table 2.1 summarizes the population and flow projections that are adopted in this study, and as provided by the 2014 CRP *Regional Water and Wastewater Servicing Masterplan* report ("The CRP Report"), unless otherwise indicated in TM1. The flows in the table are total community wastewater per capita flows, which include residential, commercial, industrial and inflow and infiltration flows. Future average day dry weather wastewater flows are projected based on the projected populations.

Table 2.1: Population and Average Daily Flow (ADF) Projections – Summary of Adopted Information

Study Area	Population				ADF Flow (L/c/d)			ADF Flow (m^3/d)		
	2010	2026	2041	2076	2010	2041	2076	2010	2041	2076
Black Diamond	2,308	3,377	4,379	6,717	377	321	264	870	1,406	1,773
Aldersyde	793	3,244	5,542	11,800	400	361	361	317	2,001	4,261
Central District	n/a	9,773	18,935	20,425	400	400	371	0	7,574	7,574
High River	11,783	25,369	38,106	54,758	392	352	296	4,619	13,413	16,208
Longview	307	489	660	1,566	385	385	300	118	254	470
Nanton	2,124	3,295	4,392	6,952	287	244	287	610	1,072	1,995
Okotoks	23,201	43,052	61,662	106,164	232	300	232	5,383	18,499	24,630
Turner Valley	2,022	3,304	4,505	7,308	492	321	264	995	1,446	1,929

2.1.2 Water License Summary

The allocations for municipal water use, as licensed under the *Water Act*, for the six identified communities are summarized in ***Table 2.2*** below. Five of the communities draw water from the Bow River basin, and one community, Nanton, draws water from the Oldman River basin. The MD of Foothills receives water from High River for Aldersyde (from the Bow River Basin). All Water Licenses are located within the South Saskatchewan River Basin, with the source being surface water or groundwater 'under the influence' of surface water. As such, these Licenses are potentially transferable (i.e. point of diversion relocated) subject to the *Water Act* provisions and the Approved Water Management Plan. The conditions of such water diversions include the Water License being 'in good standing' and any Water License to be transferred may be subject to a 10% holdback of the transferred allocation.

Table 2.2: Water Act License Summary

Basin	Municipality	Source	Points of Diversion	Annual Allocation (m^3)	Points of Return Flow	Return Flow (m^3/year)
Bow	Okotoks	Sheep River	SW 27-20-29-W4 SW 28-20-29-W4 NW & S 29-20-29-W4 NE 30-20-29-W4	3,359,589	NW 22-20-29-W4	1,539,344
	Black Diamond	Sheep River	SW 8-20-02-W5	954,679	NW 16-20-02-W5	859,211
	Turner Valley	Sheep River	NW 6-20-02-W5	514,389	SW 16-20-02-W5	303,679
	High River	Highwood River	NE & S 6-19-28-W4	4,623,245	SW 29-19-28-W4[1] NE 6-19-28-W4	3,699,609
	Longview	Highwood	NE 17-18-02-W5	98,679	NE 17-18-02-W5	88,811
	M.D. of Foothills (Aldersyde)	Highwood River (via High River Water	4-7-20-28-W4 (point of re-diversion)	476,131	Nil	Nil
	M.D. of Foothills (Central District)	Aquifer	SW-27-21-29-W4	7,600	Not Specified	Not Specified
Oldman	Nanton	Mosquito Creek, Springhill Creek	SW 22-16-28-W4 W 3-16-29-W4 NE 2-16-29-W4	725,366	NE 15-16-28-W4	493,393

2.1.3 Westend Regional Sewage Services Commission (WRSSC)

The WRSSC (Westend) owns and operates the wastewater collection system and treatment facility for the Towns of Black Diamond and Turner Valley. The Westend facility consists of a lift station in Turner Valley, a transmission main, two lift stations within the Town of Black Diamond, and an aerated lagoon with six cells (two anaerobic settling, two partial mix, one completely mixed, and one polishing pond) constructed 20 years ago. A portion of the transmission system was rerouted in 2015 to move the mains out of the flood plain. A transfer pump station at the lagoon site pumps effluent between cells. Treated effluent is discharged into the Sheep River.

[1] High River water licenses indicate point of return flow is to the Highwood River. However, actual point of return flow is to Frank Lake (NW36-18-28-W4). Frank Lake discharges to the Little Bow River at NW33-17-27-W4.

The Westend treatment system is a secondary treatment facility, and the current effluent requirement is CBOD < 25 mg/L, which it is currently able to meet. The current EPEA approval expired in October 2015, and was extended for one year in the interim. Upgrades to the treatment facility are anticipated to commence in 2017. The recommended upgrades were prepared prior to AEP introducing the new HQ criteria. Upgrades will improve the effluent quality, though not to the upcoming HQ criteria.

2.1.4 M.D. of Foothills No. 31

For this study, the Municipal District of Foothills No. 31 (MD) is represented by the populations of Aldersyde and MD Central District. The MD currently has no wastewater treatment facilities in these areas. The MD has confirmed that there is a plant currently being proposed for Aldersyde (Wind Walk Plant), and an application for an Approval to AEP has been submitted. Given the development this plant is to service is now the subject of annexation discussions with the Town of Okotoks, the status of this application is unclear.

The future effluent treatment requirements for any plant within the MD may be dependent on whether a new plant is constructed, or whether wastewater is conveyed to an existing municipality. If a new sub-regional plant is constructed within the MD, the new HQ effluent criteria will likely apply. If effluent is conveyed from the MD to an existing community, the existing quality (EQ) criteria in effect in that community may apply.

2.1.5 High River

The High River treatment facility is a secondary treatment facility that services the Town, the Abild's Industrial Park and the Transcanada Saddlebrook facility. It consists of a conventional aerated wastewater stabilization lagoon built in 1987. The facility includes a complete mixed cell, one partial mixed cell, and a storage cell. The system discharges treated effluent to Frank Lake. The system was designed for a population of 10,000, and in 2010 was servicing a population of over 11,000. The original design assumed that wastewater generation was 90% of potable water demands. It should be noted that Cargill Foods has its own WWTP, and is proposing to expand operations by 25% in the next five years according to a 2010 MD Report (MPE 2010). For this study it is assumed that Cargill Foods will continue to treat its own wastewater and to send effluent to Frank Lake in the long-term. The Cargill Foods wastewater flows have not been included in this study.

The EPEA Approval treatment requirements for High River are currently ≤ 25 mg/L CBOD and ≤ 200 /100 mL fecal coliform counts. The facility is currently capable of meeting this effluent criteria, but there are increasing concerns about the cumulative phosphorus loading into Frank Lake. Frank Lake is a protected wetland, with no influent other than from surface runoff and effluent discharge from the High River and Cargill wastewater treatment plants.

The High River EPEA Approval expires September 1, 2018. This Approval states that an upgrade to include biological nutrient removal must begin by November 1, 2010, or request amendment to the Approval. The High River plant has not yet been upgraded.

2.1.6 Okotoks

The Town of Okotoks currently owns and operates a tertiary wastewater treatment facility with fine screening, grit removal, primary clarification, biological nutrient removal plus sequencing batch reactor, secondary clarification, effluent filtration, UV disinfection, sludge management system and a sludge-in vessel. The CRP report (CRP 2014) concluded that the wastewater treatment plant will exceed its capacity by 2030, based on a capacity of 10,500 m^3/d and assuming the current generation rate of 232 L/c/d. According to Stantec's capacity review completed in early 2016, numerous components of the treatment plant are currently at capacity. The Okotoks EPEA Approval expired in May 2015, and has been extended for one year, to allow for time to plan a wastewater servicing solution that will meet Okotoks growth scenario.

2.2 Technical Memorandum 2 (TM2) – Stream Analysis

Technical Memorandum 2 focuses on assessing the habitats of, and the risks to, the major water sources and receiving streams in the region, specifically, the Upper Little Bow River, Highwood River, Sheep River and Mosquito Creek. The Upper Little Bow River and Mosquito Creek are part of the Oldman River sub-basin and the Highwood River and Sheep River are part of the Bow River sub-basin. These two sub-basins are connected through diversions from the Highwood River to Mosquito Creek and the Highwood River to the Upper Little Bow River. These diversions are part of the Little Bow Storage and Highwood Diversion Plan which supplies water to the Oldman River sub-basin, which typically receives lower precipitation inputs and has higher irrigation demands, and reduced water demand impacts on the lower Highwood River fishery habitat. The Bow River sub-basin and the Oldman River sub-basin are both part of the South Saskatchewan River basin, with the South Saskatchewan River starting at the confluence of Bow and Oldman Rivers.

The Upper Little Bow River, Mosquito Creek, Highwood River and Sheep River are contributors to the South Saskatchewan River, where watershed management and headwater protection is a priority for this sub-basin. In 2006, a moratorium was invoked precluding any new Water Licenses from being issued for the Oldman, Bow and South Saskatchewan sub-basins. This moratorium includes the Upper Little Bow River, Mosquito Creek, Highwood River and Sheep River. Although no new Water Licenses can be issued, with the exception being for storage to improve performance in meeting in-stream needs, current Licenses can be transferred or reallocated.

The Highwood River and the Sheep River are both part of the Bow River Basin. The water quality of the Bow River generally deteriorates along its length. Inputs of concern to the Bow River include stormwater and treated effluent from wastewater treatment plants. The greatest area of concern is around the City of Calgary, the largest municipality in the area. In the lower reaches, specific water quality concerns include TSS, total phosphorus and total dissolved phosphorus. The water quality is considered to be in an unnatural and undesired state, as a result a basin-wide approach is being developed to manage water quality with the initial focus being the development of a phosphorus management plan. Although the focus to date has been management for phosphorus, it is reasonable to assume that this focus could shift to include other parameters, such as nitrogen, in the future.

In all cases, there are concerns with water quality. The main parameter of discussion has been phosphorus, which has resulted in a basin-wide approach to managing phosphorus. With respect to wastewater effluent, this approach varies from imposing a maximum effluent concentration through to a loading requirement which could include the need to balance both wastewater-related effluent and stormwater inputs. The loading requirement will result in more stringent concentrations to be met as the flows increase due to population growth. It is expected that other parameters will be included in a basin-wide management approach in the future. In the short-term, while less stringent effluent criteria may be acceptable, as the population growth transitions into the medium and long-term, the increasing flows will likely result in more stringent effluent criteria, with even the approach to divert effluent to other uses, such as irrigation.

Future water quality studies specific to the potential receiving streams should be carried out when considering treated effluent outfall locations.

2.3 Technical Memorandum 3 (TM3) – Options & Screening

The focus of this memorandum is to review the following four sub-regional options:

1. **Option 1:** Regional Pipeline from Okotoks and High River to Calgary, new Sub-Regional WWTP (in Aldersyde area) for MD flows; retain local plants in Westend, Longview and Nanton as per CRP;
2. **Option 2:** One Sub-Regional WWTP (NE of Okotoks) designed for 100% of the flow from High River, Okotoks, and the MD; retain local plants in Westend, Longview and Nanton as per CRP;
3. **Option 3:** One Sub-Regional WWTP (NE of Okotoks) servicing only excess (future growth) flow from Okotoks, plus 100% of the flow from High River and MD; retain local plants in Westend, Longview and Nanton as per CRP;
4. **Option 4:** Regional pipeline from Okotoks and High River to Calgary, sized to also include 100% of MD flow; retain local plants in Westend, Longview and Nanton as per CRP.

It is important to note that the information presented in Technical Memorandum 3 (TM 3) is at a screening level, to allow basic comparison among the four options. Costs and design elements are further refined in Technical Memorandum 4 for two preferred options (Options 3 & 4), and these should be referenced going forward.

2.3.1 Projected Flows

The projected wastewater maximum day flows (MDF) and peak hour flows (PHF) adopted for this report are summarized in ***Table 2.3*** below.

Table 2.3: Projected Wastewater Flows

Study Area	Maximum Day Flow (m^3/day)			Peak Hour Flow (L/s)		
	2010	**2041**	**2076**	**2010**	**2041**	**2076**
Aldersyde	634	4,002	8,522	15	97	206
MD Central District	0	15,148	15,148	0	366	366
High River	10,855	31,521	38,089	308	776	938
Okotoks	18,841	48,523	83,545	249	691	1,159
TOTAL	**30,329**	**99,193**	**145,304**	**572**	**1,929**	**2,668**

The existing High River aerated lagoon capacity is approximately 8,409 m^3/day (maximum month ADF) and is projected to be at capacity in 2021. The Okotoks WWTP capacity is approximately 23,500 m^3/day (MDF) and is currently at full capacity (given the limited capacity of numerous components).

2.3.2 Design Assumptions

The following summarizes the design assumptions for the four options.

High River

- Wastewater collected at existing Pump Station #1 and pumped at PHF to existing lagoon site,
- Existing aerated lagoon utilized for peak shaving storage,
- New lift station at lagoon site to pump wastewater at MDF to sub-regional system,
- Lagoon storage would provide eight days' emergency storage using 2076 projected flow rates.

Okotoks

- Existing Okotoks WWTP would be utilized for peak shaving storage (with the exception of Option 3),
- The WWTP storage can handle peak wet weather flow (PWWF) into the WWTP up to 265 L/s and 303 L/s for the 25-year and 60-year design (same as assumed in Stantec TM3 (Stantec; 2016) for 25-year and 50-year design),
- New lift station at WWTP site to pump wastewater at peak dry weather flow (PDWF) to sub-regional system.

Aldersyde

- Currently no WWTPs or storage facilities,
- New lift station at Aldersyde to pump wastewater at PHF to sub-regional system.

MD Central District

- Currently no WWTPs or storage facilities,
- New lift station at MD Central District to pump wastewater at PHF to sub-regional system.

City of Calgary Tie-in (Options 1 and 4 only)

- Any future connection from south sub-regional system to tie directly into Pine Creek WWTP,
- Capacity of Pine Creek WWTP: 100,000 m^3/day, once fully expanded capacity will increase to 700,000 m^3/day,
- No wastewater treatment capacity for new regional customers and no connection is likely until the next plant expansion planned for 2025 at the earliest (City Email; 2015).

Pipeline Velocities

- Range of 0.9 m/s to 1.6 m/s.

Pipeline Material

- HDPE up to 1,200mm diameter,
- Prestressed concrete embedded cylinder pipe (RCP) over 1,200mm diameter.

WWTPs

- Achieve effluent that meets AEP HQ criteria,
- Membrane Bioreactors (MBR) with additional chemical treatment for total phosphorous (TP) removal,
- Sludge dewatering by centrifuge at WWTP and hauled to external facility,
- WWTPs designed for MDF, with exceptions:
    - Pumping and headworks equipment designed for PHF,
    - Equalization storage volume equal to 25% MDF.

Phasing of Options

- Construction of each sub-regional option to the 60-year design horizon (2076) would include two phases of construction:
    1. Phase 1 would be constructed in 2020 and have a consistent operational start date of 2021 for construction to the 25-year design horizon,
    2. Phase 2 would be constructed in 2041 to meet the 60-year design horizon.

2.3.3 Option 1

Option 1 includes a sub-regional pipeline from Okotoks and High River to the Calgary Pine Creek WWTP, and a new sub-regional WWTP in Aldersyde for the MD flows. This option is illustrated on ***Figure 3.1*** in ***Appendix A*** of ***TM3***. A summary of the concept for the pipeline and WWTP system for this option are listed below.

Pipeline

The pipelines and lift stations for Phase 1 of Option 1 would include the following:

- 60.9 km of pipeline ranging from 650 mm to 1,200 mm in diameter,
- Six new lift stations, including a Highway 2 lift station installed on the primary pipeline north of Okotoks to pump over a topographical high point en route to the Pine Creek WWTP, and
- 3.1 km of outfall pipeline from Aldersyde WWTP to the Sheep River.

Phase 2 of Option 1 would include the following:

- Twinning of 5 km of pipeline 850 mm in diameter (from Okotoks to the primary pipeline),
- Addition of pumps to five lift stations.

WWTP

The WWTP would be located on the north side of the Hamlet of Aldersyde in the same vicinity as the proposed Wind Walk WWTP. The Aldersyde WWTP would serve the MD Central District and Aldersyde areas for this Option. The design flows for the WWTP include the following:

- Phase 1 ADF : 9,800 m^3/d,
- Phase 1 MDF : 19,000 m^3/d,
- Phase 2 ADF : 11,800 m^3/d,
- Phase 2 MDF : 24,000 m^3/d.

2.3.4 Option 2

Option 2 includes one sub-regional WWTP located NE of Okotoks designed for 100% of the flow from High River, Okotoks, and the MD. This option is illustrated on ***Figure 3.2*** in ***Appendix A*** of ***TM3***. A summary of the concept for the pipeline and WWTP systems for this option are listed below.

Pipeline

The pipelines and lift stations for Phase 1 of Option 2 would include the following:

- 41 km of sub-regional pipeline ranging from 400 mm to 1,450 mm in diameter,
- Six new lift stations, including a Highway 2 lift station installed on the primary pipeline north of Okotoks to pump over a topographical high point en route to the Pine Creek WWTP, and
- 11.4 km outfall pipeline from the Sub-Regional NE WWTP to the Bow River.

Phase 2 of Option 2 would include the following:

- Twinning of 5.7 km of pipeline ranging from 400 mm to 850 mm in diameter (from Aldersyde and Okotoks) to the primary pipeline,
- Addition of pumps to five lift stations.

WWTP

The WWTP would serve all flows from Okotoks, High River and the MD. The plant would be located NE of Okotoks. The design flows for the Option 2 WWTP include:

- Phase 1 ADF : 41,500m^3/d,
- Phase 1 MDF : 87,000 m^3/d,
- Phase 2 ADF : 52,700 m^3/d,
- Phase 2 MDF : 136,000 m^3/d

2.3.5 Option 3

Option 3 includes one sub-regional WWTP located NE of Okotoks servicing only excess (future growth) flow from Okotoks, plus 100% of the flow from High River and the MD. This option is illustrated on ***Figure 3.3*** in ***Appendix A*** of ***TM3***. A summary of the concept for the pipeline and WWTP systems for this option are listed below.

Pipeline

The pipelines and lift stations for Phase 1 of Option 3 would include the following:

- 41 km of sub-regional pipeline ranging from 400 mm to 1,450 mm in diameter,
- Six new lift stations, and
- 11.4 km outfall pipeline from the Sub-Regional NE WWTP to the Bow River.

Phase 2 of Option 3 would include the following:

- Twinning of 5.7 km of pipeline ranging from 400 mm to 850 mm in diameter (from Aldersyde and Okotoks) to the primary pipeline,
- Addition of pumps to five lift stations.

WWTP

The Option 3 WWTP would serve all flows from High River and the MD, and flows from any future growth in Okotoks. The WWTP design flows include:

- Phase 1 ADF : 35,000 m^3/d,
- Phase 1 MDF : 76,000 m^3/d,
- Phase 2 ADF : 47,000 m^3/d,
- Phase 2 MDF : 122,000 m^3/d.

2.3.6 Option 4

Option 4 includes a sub-regional pipeline from Okotoks and High River to the Calgary Pine Creek WWTP, sized to also include 100% of the MD flow. This option is illustrated on ***Figure 3.4*** in ***Appendix A*** of ***TM3***. A summary of the concept for the pipeline system for this option is listed below.

Pipeline

The pipelines and lift stations for Phase 1 of Option 4 would include the following:

- 44.1 km of pipeline ranging from 400 mm to 1,450 mm in diameter, and
- Six new lift stations, including a Highway 2 lift station installed on the primary pipeline north of Okotoks to pump over a topographical high point enroute to the Pine Creek WWTP.

Phase 2 of Option 1 would include the following:

- Twinning of 5.7 km of pipeline ranging from 400 mm to 850 mm in diameter (from Aldersyde and Okotoks) to the primary pipeline,
- Addition of pumps to five lift stations.

2.3.7 WWTP Outfalls

In Option 1, a sub-regional WWTP is proposed to be in Aldersyde, with an outfall to the Sheep River, upstream of its confluence with the Highwood River. For Options 2 and 3, the sub-regional WWTP is proposed to be located northeast of Okotoks, within the MD Central District area. At this time, the outfall is proposed to be located on the Bow River, downstream of the confluence of the Bow River and the Highwood River. A detailed receiving streams assessment and modeling are recommended to determine the potential impacts of nutrient loading to the Bow River, Highwood River and Sheep River and to confirm the location of the proposed outfalls. In the meantime this report adopts the conservative approach of avoiding a major increase in discharge of treated effluent to the Sheep River and Highwood River until such studies are completed.

2.3.8 Costs

Class ‘D’ (screening level) costs were determined for each option for capital costs, O&M costs, and net present value (NPV). The detailed costs are provided in ***Section 4*** of ***TM3*** for each option.

The options listed in order of lowest NPV (most cost effective) to highest NPV (most expensive) are listed below:

- Option 4,
- Option 1,
- Option 3,
- Option 2.

2.3.9 PESTLE Analysis

In order to complete a comprehensive analysis of options, PESTLE criteria were developed at a workshop in September 2015 with the Technical and Governance Committees’ input that consider six different categories:

P: Political
E: Environmental
S: Social
T: Technological
L: Legal
E: Economic

Urban Systems and MPE developed a scoring of each option against these criteria and these results are contained in ***Appendix C*** of ***TM3***. The impact of these criteria was tested by considering two weighting approaches. The first is to weight all categories equally and the second is to apply a weighting factor based on the Committees’ input during the initial workshop. When comparing the PESTLE scoring for each option, the differences in the criteria weighting did not impact the performance of the options.

The results of the PESTLE analysis indicate:

- Option 4 is the lowest cost option and also scores the highest on the PESTLE analysis;
- Option 2 scores second best, but is the most expensive;
- Option 1 scores third and is the second lowest cost option; and
- Option 3 scores last and is the second highest cost option.

2.3.10 Two Preferred Options

The Technical Memorandum 3 was presented to the FRWWC Technical Committee on January 14, 2016. The Technical Committee recommended to the Governance Committee that two preferred options to be refined in Technical Memorandum 4:

- Option 3 (Sub-Regional Supplemental Wastewater Treatment Plant), and
- Option 4 (Sub-Regional Pipeline to Calgary).

With respect to the selection of the two preferred options, an excerpt from the *Foothills Regional Water & Wastewater Collaborative, Briefing Note* (FRWWC, 2016a) concludes:

"Option 3 is determined to be an incremental step and has more versatility than other options. From a cost perspective, Option 3 is more favourable than Option 2. Option 3 is also favourable from a timing consideration, and can include a phased approach. It could be more cost effective, doesn't preclude Option 2, and could lead to a better chance for High River and the MD of Foothills to invest in a central plant. Could also save on operating and maintenance costs over time. CRP supports Option 3 as it fits with the Growth Management Plan. Option 3 also supports the goals for a regional employment center in the Calgary Metropolitan Plan, where is shows a growth node in Aldersyde. There is also potential for incremental tie-in from Westend.

Option 4 has the highest PESTLE rating, has the most non-economic benefits and the lowest costs. Requires inclusion of the MD of Foothills in to the CRP and is subject to the timing of the upgrading of the Pine Creek WWTP. May not preclude Okotoks investing in interim upgrades. There is a potential for Option 4 to become an extension of Option 3 into the future."

2.4 Technical Memorandum 4 (TM4) – Preferred Options

This technical memorandum refines the following two regional wastewater options, as selected by the FRWWC committees in January 2016.

1. **Option 3:** One Sub-Regional WWTP (NE of Okotoks) servicing only excess (future growth) flow from Okotoks, plus 100% of the flow from High River and MD; retain local plants in Westend, Longview and Nanton .
2. **Option 4:** Regional pipeline from Okotoks and High River to Calgary, sized to also include 100% of MD flow; retain local plants in Westend, Longview and Nanton.

After preliminary field proofing, pipeline alignments differ from those presented in Technical Memorandum 3 (TM 3) to avoid existing built up areas, particularly along Highways 2 and 2A.

2.4.1 Option 3 Pipeline Conceptual Design and Phasing

This option is illustrated on ***Figure 4.1*** in ***Appendix A*** of ***TM4***. The following summarizes the concept level design for the Option 3 sub-regional wastewater system for the pipeline, outfall pipe, lift stations and WWTP.

Pipeline

The following provides details for the Option 3 pipe system:

- The existing local lift station (LS) No. 1 in High River would be maintained to pump peak hour flow from the Town to the existing High River aerated lagoon site; this existing lift station would be upgraded once capacity is exceeded. The existing 5.8 km long by 710 mm diameter pipeline to the lagoon site would be utilized.
- The existing High River lagoon would be maintained for peak shaving storage with a new lift station located at the lagoon site to pump maximum day flow through a new 16.6 km pipeline to the sub-regional NE WWTP.
- The existing Okotoks WWTP and outfall to the Sheep River would be maintained to treat wastewater to capacity (23,509 m^3/day).
- A new lift station would be constructed at the Okotoks WWTP to pump wastewater in excess of the WWTP capacity, at peak hour flow to the sub-regional NE WWTP.
- A new lift station would be constructed at Aldersyde to pump wastewater at peak hour flow to the sub-regional NE WWTP.

- A new lift station would be constructed at the MD Central District to pump wastewater at peak hour flow to the sub-regional NE WWTP.
- A new outfall pipeline would be installed from the sub-regional NE WWTP to the Bow River at the confluence with the Highwood River, including an outfall structure with diffuser.
- Construction in two phases: 2020 and 2041
- Total pipeline length 57.9 km
- Pipeline material:
  - HDPE: 42.6 km (400 mm – 900 mm diameter)
  - Prestressed Concrete Pipe (RCP): 15.3 km (1,050 mm – 1,200 mm diameter)
- Velocity Range: 0.9 m/s – 1.6 m/s
- Pipeline appurtenances:
  - Isolation valves spaces roughly 1.5 km
  - Air relief/vacuum valve vaults at high points
  - Drain manholes at major low points
  - Tracer wire with junction boxes
- Total Pipeline Crossings:
  - Highways: 8
  - Railways: 5
  - Rivers: 2
  - High Pressure Gas Lines: 37
  - County Roads: 24
- Pipeline construction by horizontal directional drilling or auguring for crossings

Outfall Pipe

The outfall pipeline is assumed to run to the Bow River instead of the nearby Highwood / Sheep River confluence. This approach is more conservative from both a river health and cost perspective, given current gaps in the understanding of each river's assimilation capacity. It is understood that the Bow River has better wastewater assimilation capacity than the smaller Highwood River. This being said, a receiving water quality assessment would be required ultimately to improve the understanding, and to determine to which river and to what timeline the WWTP effluent should or could discharge. This river assessment is outside the current scope of this study, but can be carried out in future. It should be noted that if the outfall pipeline could be directed to the Highwood River / Sheep River confluence in the medium-term or long-term, significant capital cost savings could be realized.

<u>Lift Stations</u>

There would be six lift stations required for Option 3. ***Table 2.4*** summarizes the design flow for each lift station.

Table 2.4: Option 3 Lift Station Design Flows

Lift Station	Phase 1	Phase 2
	Flow (L/s)	Flow (L/s)
High River Lift Station	776	938
High River Lagoon Lift Station	365	441
Aldersyde Lift Station	97	206
Okotoks Lift Station	359	827
MD Central District Lift Station	366	366
NE WWTP Outfall Lift Station	876	1,410

The lift stations would be submersible type lift stations with the following features:

- Divided interconnected wet well to facilitate staging of pumping equipment, ease of repairs and cleaning of the wet well.
- Three (or four in the larger lift stations) submersible pumps each with VFD, including one standby pump. Space would be provided for the addition of a pump to be installed in Phase 2 to meet the 2076 design flows.
- Pumps would be preceded by a bar rack to protect the pumps from clogging, and the station would be fitted with an overhead mechanical hoist.
- Separate dry valve vault for isolation valves and check valves for each pump, and for flow meter.
- Mechanical building on top of dry valve vault to house:
    - Mechanical and electrical equipment,
    - H_2S odour control injection system,
    - Backup power generator,
- PLC with HMI screen and SCADA system.

2.4.2 Option 3 WWTP Conceptual Design and Phasing

The WWTP design flows and loadings are projected for each contributing community, and then combined in ***Table 2.5***. Since Okotoks WWTP is at capacity, it is assumed that all flows from future Okotoks growth would be sent to the sub-regional NE WWTP.

Table 2.5: Summary of WWTP Design Loadings and Flows

Parameter	Units	2014	2041	2076
Population	capita	15,330	96,915	165,815
AADF	m^3/d	6,020	30,740	45,830
MDF	m^3/d	13,950	76,000	122,000
MDL BOD_5	kg/d	1,950	14,770	26,750
MML BOD_5	kg/d	1,640	10,250	17,450
MDL TSS	kg/d	2,470	19,120	34,480
MML TSS	kg/d	1,880	12,280	21,310
MDL TAN	kg/d	170	1,060	1,820
MML TKN	kg/d	270	1,420	2,300
MML TP	kg/d	55	300	475

Construction of the WWTP can be carried out in discrete phases to provide initial capital cost savings. Three phases of construction overall are envisioned, however for constructability, it is assumed that some buildings and tanks would be constructed in one or two phases to house equipment that would be added later. Envisioned phasing of tanks and buildings is assumed to be:

- Headworks (6 mm screening and grit removal) (2 phases of construction)
- Influent pump station (1 phase of construction)
- Primary Treatment Channels (2 phases of construction)
- MBR System and EQ Tank (3 phases of construction)
- Blower building (2 phases of construction)
- UV channels (2 phases of construction)
- DAFT (2 phases of construction)
- Sludge storage tank (2 phases of construction)
- Centrifuge building (1 phase of construction)
- Administration/workshop building (1 phase of construction)
- Chemical feed facilities (2 phases of construction)

Site selection for the WWTP would need to consider setbacks. The location proposed in ***Figure 4.1*** in ***Appendix A*** of ***TM4*** has been confirmed to be outside of the floodway and flood fringe zones. Land should be secured to allow for the ultimate size of the plant, as plant expansions would be required to accommodate additional process train construction in 2034 and 2049. An area of approximately 3 ha would be required.

For the facility to be constructed in 2020, each participating community is assumed to maintain their existing treatment facilities until 2020 and to treat all wastewater flows in the existing treatment facilities. Capital and operating costs associated with the existing treatment facilities up to 2020 are not included in this analysis.

2.4.3 Option 4 Pipeline Conceptual Design and Phasing

This option is illustrated on ***Figure 4.2*** in ***Appendix A*** of ***TM4***. The following summarizes the concept design for the Option 4 sub-regional wastewater system for the pipeline and lift stations, and also discusses timing for the tie-in to the City of Calgary Pine Creek WWTP.

<u>Pipeline</u>

The following provides details for the Option 4 piping system:

- The existing local lift station (LS) in High River would be maintained to pump peak hour flow from the Town to the existing High River aerated lagoon site; this existing lift station would be upgraded once capacity is exceeded. The existing 5.8 km long by 710 mm diameter pipeline to the lagoon site would be utilized.
- The existing High River lagoon would be maintained for peak shaving storage with a new lift station located at the lagoon site to pump maximum day flow through a new 34.4 km pipeline to the City of Calgary.
- The existing Okotoks WWTP would be utilized for peak shaving storage with a new lift station constructed at the site to pump peak dry weather flow to the sub-regional pipeline to the City of Calgary.
- A new lift station would be constructed in Aldersyde to pump wastewater at peak hour flow to the sub-regional pipeline to the City of Calgary.
- A new lift station would be constructed at the MD Central District to pump wastewater at peak hour flow to the sub-regional pipeline to the City of Calgary.

- A new lift station would be constructed east of Okotoks on the primary sub-regional pipeline to pump (boost) the flow from High River, Aldersyde and Okotoks to the City of Calgary.
- Construction in two phases: 2020 and 2041
- Total pipeline length 47.4 km
- Pipeline material:
  - HDPE: 25.7 km (400 mm – 900 mm diameter)
  - RCP: 21.7 km (1,050 mm – 1,200 mm diameter)
- Velocity Range: 0.9 m/s – 1.6 m/s
- Pipeline appurtenances:
  - Isolation valves spaces roughly 1.5 km
  - Air relief/vacuum valve vaults at high points
  - Drain manholes at major low points
  - Tracer wire with junction boxes
- Total Pipeline Crossings:
  - Highways: 8
  - Railways: 6
  - Rivers: 2
  - High Pressure Gas Lines: 34
  - County Roads: 20
- Pipeline construction by horizontal directional drilling or auguring for crossings

Lift Stations

There would be six lift stations required for Option 4. ***Table 2.6*** summarizes the design flow for each lift station.

Table 2.6: Option 4 Lift Station Design Flows

Lift Station	Phase 1	Phase 2
	Flow (L/s)	Flow (L/s)
High River Lift Station	776	938
High River Lagoon Lift Station	365	441
Aldersyde Lift Station	97	206
Okotoks Lift Station	426	856
Highway 2 Lift Station	888	1,502
MD Central District Lift Station	366	366

The lift stations would be submersible type lift stations with the following features:

- Divided interconnected wet well to facilitate staging of pumping equipment, ease of repairs and cleaning of the wet well.
- Three (or four in the larger lift stations) submersible pumps each with VFD, including one standby pump. Space would be provided for the addition of a pump to be installed in Phase 2 to meet the 2076 design flows.
- Pumps would be preceded by a bar rack to protect the pumps from clogging, and the station would be fitted with an overhead mechanical hoist.
- Separate dry valve vault for isolation valves and check valves for each pump, and for flow meter.
- Mechanical building on top of dry valve vault to house:
  - Mechanical and electrical equipment,
  - H_2S odour control injection system,
  - Backup power generator.
- PLC with HMI screen and SCADA system.

City of Calgary Tie-in Timing Issue

Discussions with City of Calgary staff confirm that there is currently no wastewater treatment capacity available for new regional customers (City Email, 2015). Treatment facilities are currently nearing capacity or have committed capacity in both the north and south catchments. Given current circumstances, there is no possibility of a new regional wastewater connection

from the sub-region until the next plant expansion at Pine Creek. This would likely be 2025, subject to project approval and budget.
This timing is an issue because the existing WWTPs in High River and Okotoks are at or near capacity. A solution is required prior to 2025. High River's WWTP EPEA Approval expires in September 2018, and Okotok's WWTP EPEA Approval expires in May 2016. Both Approvals indicate WWTP upgrades are required to meet higher effluent quality standards.

Further, the Aldersyde industrial area is developing. It too requires a solution to treat the wastewater generated prior to 2025.

Should Option 4 be considered, over the next 10 years each municipality would require an interim solution to "bridge" the capacity of their respective wastewater facilities until a tie to the City of Calgary can be made. This bridging would need to accommodate the increased flow during this period and would need to address any higher effluent quality standards required by AEP. An analysis of potential interim "bridging" options for each municipality is beyond the scope of this study, but is recommended as a next step should Option 4 be selected as the preferred option.

2.4.4 Costs

For each of the two preferred servicing options, the following costs are established:

- Capital cost estimates,
- O&M costs,
- Net present value (NPV),
- Total cost of Ownership (TCO),
- Cost sharing and cash flow for each municipality.

A summary of capital cost estimates for both options are shown in ***Table 2.7***. Land acquisitions costs of $24,000/km are included in pipe capital cost estimates. All costs include allowances of 25% for contingencies and 15% for engineering. Costs are in 2016 Canadian dollars and are exclusive of GST.

For Option 3, the treated effluent outfall is assumed to be located on the Bow River, pending a future river water quality study. Should the water quality study show the outfall could be located closer to the WWTP location (i.e. at the confluence of the Highwood and Sheep Rivers), the shorter outfall pipeline would result in a potential capital cost saving of $38M.

Table 2.7: Summary of Capital Costs

Option	Component	2020	2034	2041	2049	Total
3	WWTP	$125M	$65M	$0	$50M	**$468M**
	Pipelines & Lift Stations	$218M	$0	$21M	$0	
4	WWTP	n/a	n/a	n/a	n/a	**$219M**
	Pipelines & Lift Stations	$202M	$0	$23M	$0	

The detailed projected annual O&M costs are provided in ***Appendix C*** of ***TM4***. The O&M costs are calculated annually for 55 years of operation, starting in 2021 through to 2076. Projected monthly charges from the City of Calgary for the service to the Pine Creek WWTP are applied to Option 4, in accordance with Schedule "E" of the *City of Calgary Wastewater Bylaw* (City 2015). Schedule "E" sets out the monthly charge, which includes a fixed component plus a volume component up to year 2018. The City of Calgary revises Schedule "E" every four years to update the committed regional flows and associated costs the City would need to recoup. Once a formal application to tie-into the City of Calgary wastewater infrastructure is made, the City will update these monthly charges. As the current Schedule "E" only addresses up to year 2018, this memorandum assumes that the rate beyond 2018 increase at an estimated inflation rate of 2.5% per year.

The terms of reference for the work plan requires a TCO analysis be carried out, and is calculated as the arithmetic total of capital and O&M costs over the entire 55 year time horizon, without taking into account the time value of money. TCO analysis is often used as a decision tool for shorter time periods (3 to 5 years) and is included in Technical Memorandum 4 for comparison purposes to the NPV method. Generally, because the NPV analysis does take into account the time value of money, it can be argued that the NPV analysis is more appropriate for longer time horizons, such as is the case here, and is therefore more applicable to this project. The calculated Net Present Value (NPV), using a discount rate of 5% for both options is shown in ***Table 2.8***. For comparison, the TCO calculation is provided in ***Table 3.3*** of ***TM4***.

Table 2.8: Net Present Value

Option	Pipeline NPV	WWTP NPV	TOTAL NPV
3	$297M	$315M	**$612M**
4	$450M	n/a	**$450M**

As mentioned previously, the cost of Option 4 does not include local "bridging" costs until 2025 when a tie to the City of Calgary can be made. These "bridging" costs would increase the total cost of Option 4. Should this option be pursued, these costs should be calculated as a next step, as this is beyond the current scope of work.

The cost sharing and cash flow are calculated for each municipality. Two cost sharing scenarios are reviewed:

1. All costs shared based on the maximum day flow (MDF) contribution of each municipality.
2. Core infrastructure costs shared based on the MDF contribution of each municipality; individual laterals outside the core are fully costed to each benefitting municipality. ***Figure 4.3*** and ***Figure 4.4*** in ***TM4*** **Appendix A** identify the infrastructure components that are considered to benefit each municipality for this scenario.

Tables 2.9 and 2.10 summarize the capital cost sharing and cash flow of each municipality for the proposed phasing of each option under each cost sharing scenario.

Table 2.9: Option 3 Capital Cash Flow

Scenario	Municipality	2020	2034	2041	2049	TOTAL
1 – All Components Shared by All	High River	$109M	$21M	$7M	$16M	**$153M**
	Okotoks	$168M	$32M	$10M	$25M	**$235M**
	MD Central District	$52M	$1 M	$3M	$8M	**$73M**
	Aldersyde	$14M	$3M	$1M	$2M	**$20M**
2 – Cost Shared by Benefiters of Each Component	High River	$147M	$21M	$2M	$16M	**$186 M**
	Okotoks	$108M	$3 M	$16M	$25M	**$181M**
	MD Central District	$71M	$10M	$0.5M	$8M	**$9 M**
	Aldersyde	$17M	$3M	$3M	$2M	**$25M**

Table 2.10: Option 4 Capital Cash Flow

Scenario	Municipality	2020	2041	TOTAL
1 – All Components Shared by All	High River	$64M	$7M	**$71M**
	Okotoks	$99M	$11M	**$110M**
	MD Central District	$31M	$4M	**$35M**
	Aldersyde	$8M	$1M	**$9M**
2 – Cost Shared by Benefiters of Each Component	High River	$115M	$4M	**$119M**
	Okotoks	$62M	$1 M	**$78M**
	MD Central District	$12M	$1M	**$13M**
	Aldersyde	$13M	$3M	**$16M**

2.4.5 Comparison of Options

The major advantages and disadvantages of each option are summarized in ***Table 2.11*** below.

Table 2.11: Advantages and Disadvantages of Each Option

Option	Advantages	Disadvantages
3	One Sub-Regional WWTP servicing only excess flow from Okotoks, plus 100% of the flow from High River and MD; retain local plants in Westend, Longview and Nanton.	
	• No known timing issues. Project could likely proceed to construction of Phase 1 in 2020 (based on allowing time for design, consultations, approvals and financing) • No user fees paid to City of Calgary • Do not need to meet current City of Calgary policies to proceed	• More costly option • Longest length of pipeline required • Two WWTP's – more difficult to retain Operators • Further study required to determine whether a new treated effluent outfall must be to Highwood River or Bow River, and potential timing of outfall location(s)
4	Regional pipeline from Okotoks and High River to Calgary, sized to also include 100% of MD flow; retain local plants in Westend, Longview and Nanton.	
	• Least costly option • As least cost option, more likely to be fully eligible for Water for Life funding • No WWTP for FRWWC to operate • Shortest length of pipeline	• Political issues. MD of Foothills does not meet the current City of Calgary policies to proceed and is not eligible to apply to City Council to connect to the system • Requires ongoing user fees paid to City of Calgary, which are unknown past 2018. • Timing: cannot likely tie-in to City of Calgary WWTP until at least 2025; local interim "bridging" costs need to be determined and will add to total project cost

If Option 3 is determined to be the favoured option. the following additional analysis is recommended:

- Undertake a receiving water quality assessment for the Sub-Regional NE WWTP outfall to assess the feasibility of the outfall to the Bow River and/or the Highwood River.

If Option 4 is determined to be the favoured option, the following additional analysis is recommended:

- Undertake additional refinement of the local alternatives to "bridge" the WWTPs (for capacity and effluent quality) and to identify potential hybrid scenarios for each municipality given timing to tie-in to the City of Calgary is likely at least ten years away.

2.5 Technical Memorandum 5 (TM5) – Westend Options

This memorandum reviews and compares the following two wastewater servicing options for Westend Regional Services Commission (Westend):

1. Option 1: Local Wastewater Treatment Plant serving Westend (Black Diamond and Turner Valley),
2. Option 2: A pipeline from Westend to a sub-regional treatment facility or pipeline system in the Okotoks area.

Within this memorandum, USL develops costs and impacts related to the WWTP in Option 1, and MPE develops costs and impacts related to the regional pipeline in Option 2. The results of this memorandum are meant to "plug in" to the results of the core options already assessed. The preferred regional options proposed in Technical Memorandum 4 are flexible and can include the Westend if desired. The rationale behind not including Westend in options analyzed in Technical Memorandum 3 is three-fold:

- The Westend service area represents a relatively small percentage (6.5%) of the ultimate regional population addressed in MPE/USL TM3 2015. The outcome of this work is not expected to affect the overall outcome of the regional core options.
- Given the existing Westend treatment site has sizable storage lagoons that could be converted to equalization storage, the pipeline flow conveyed from Westend to a regional plant near Okotoks (or to a regional pipeline from Okotoks to Calgary) would have a much lesser impact on any regional facility given it could be pumped during off-peak hours.

- TM3 was prepared in advance of TM5, given TM5 was later added to the overall work plan.

2.5.1 Projected Flows

The projected wastewater maximum day flows (MDF) and peak hour flows (PHF) adopted in this report for Westend are summarized in ***Table 2.12*** below. The maximum day flows and peak hour flows provided in previous studies are included as available.

Table 2.12: Westend Projected Flows

Study Area	Maximum Day Flow (m^3/day)			Peak Hour Flow (L/s)		
	2010	2041	2076	2010	2041	2076
Black Diamond	*Included in Westend total flows*			*Included in Westend total flows*		
Turner Valley						
Westend Total:	**4,065**	**8,556**	**11,106**	**108**	**165**	**214**

The existing Westend aerated lagoon system has a capacity of 4,100 m^3/day (maximum month ADF) and is projected to be at full capacity by 2019.

2.5.2 Phasing of Options

The construction of each Westend option to the 2076 design horizon would include two phases of construction. It has been assumed that the first phase would have a consistent start date of 2020 for construction to the 2041 design horizon for both options. The second phase would be constructed in 2041 for the 2076 design horizon. The timing for the first phase is based on the existing WWTP being projected to reach full capacity within the next four years. This also allows time to design and construct the selected option.

2.5.3 Option 1 Local WWTP

Option 1 includes a new WWTP at the existing Westend lagoon site. The outfall is assumed to be in the same location as the existing, just north of the plant and discharging in to the Sheep River. This option is illustrated on ***Figure 5.1*** in ***Appendix A*** of ***TM5***.

The design assumptions for the Westend WWTP are as follows:

- The location to be at the existing Westend Lagoon site,

- The outfall would remain in the same location, north of the plant on the Sheep River, and would require upgrading to a diffuser,
- Achieve effluent that meets AEP HQ standards,
- Membrane Bioreactors (MBR) with additional chemical treatment for TP removal,
- Sludge dewatering by centrifuge at WWTP and hauled to external facility,
- WWTPs designed for MDF, with exceptions:
  - Pumping and headworks equipment designed for PHF,
  - Equalization storage volume equal to 25% MDF.

The design flows for the Option 1 WWTP include:

- Phase 1 ADF: 41,500 m^3/d,
- Phase 1 MDF: 87,000 m^3/d,
- Phase 2 ADF: 52,700 m^3/d,
- Phase 2 MDF: 136,000 m^3/d.

2.5.4 Option 2 Sub-Regional Pipeline

Option 2 includes a dedicated sub-regional pipeline from the Westend lagoon site along Highway 7 to a new primary sub-regional pipeline tie on the west side of Highway 2A. This option is illustrated on ***Figure 5.1*** in ***Appendix A*** of ***TM5***.

The Option 2 sub-regional pipeline would consist of the following:

- Existing Westend lagoon (three of six cells) maintained for peak shaving storage,
- A new lift station would be installed at the lagoon site to pump wastewater at MDF to the sub-regional system,
- Lagoon storage would provide seven days' emergency storage using 2076 projected flow rates,
- New 25.5 km of 400mm diameter HDPE pipeline from the lift station to the primary sub-regional pipeline,
- Phase 2 would include addition of pumps to the lift station.

2.5.5 Costs

For each Westend wastewater servicing option, the following opinions of probable costs are established:

- Capital cost estimates,
- O&M costs,
- Net present value (NPV).

Capital costs are in 2016 Canadian dollars and include contingencies and engineering. All costs are exclusive of GST. All cost estimates are considered Class D (screening level) opinions of probable cost. Capital cost estimates for the two options are provided in ***Table 2.13***.

Table 2.13: Summary of Westend Capital Cost Estimates

Option		Capital Costs	
		Phase 1 (2020 Construction)	Phase 2 (2041 Construction)
1	WWTP	$20M	$7M
2	Pipeline (to primary sub-regional Pipeline)	$33M	$1M
	Westend contribution of primary sub-regional pipeline (assuming Option 4)	$11M	$1M

The projected O&M costs are provided in ***Table 2.14***. The O&M costs are for 55 years of operation from 2021 to 2076.

Table 2.14: Summary of Annual O&M Costs

Option	Annual O&M Costs	
	Phase 1 O&M Costs (2021 – 2041)	Phase 2 O&M Costs (2042 – 2076)
1 (WWTP)	$2.0M	$2.4M
2 (Pipeline)	$1.1M	$1.4M

The NPV analysis is summarized in ***Table 2.15*** for a high level comparison of the two options. It is important to note that funding from provincial initiatives is not taken into consideration when undertaking this analysis. NPV are based on a discounted rate of 5%.

Table 2.15: Net Present Value

Option	NPV (2020-2076)
1 (WWTP)	$48M
2 (Pipeline)	$55M

Based on the NPV analysis the most cost effective option is Option 1, local WWTP.

3.0 CONCLUSIONS

The Preliminary Conclusions presented and discussed at the March 17, 2016 Technical Committee meeting following review of Technical Memorandum 4 include:

1. The Technical Committee determined that no "favoured" option of the two preferred sub-regional options (Options 3 and 4) could be selected at this time. Option 3 (*Sub-regional Supplemental WWTP*) is readily implementable, but is the higher cost option partly due to a conservative assumption on the outfall location and the HQ AEP treated effluent requirement, so it cannot be fairly compared to recent local options which adopt different effluent quality assumptions. Option 4 (*Sub-Regional Pipeline to Calgary)* is the lower cost option but has a significant timing issue, given the City of Calgary may not allow a tie-in to its Pine Creek Treatment Plant for at least ten years (Year 2025), plus there is a risk the City may charge more to tie-in than their current 2015-2018 rate. Both Options 3 and 4 (or a variation of either) remain preferred sub-regional options to the FRWWC, but selection of one favoured option cannot be made at this time pending a few significant factors yet to be determined. Neither option can be selected at this time, nor can a reasonable comparison to local options be made, pending clarifications. The required clarifications are outlined below.

2. For Option 3 (*Sub-regional Supplemental WWTP*), the main items requiring clarification include:
   a. ***AEP Treated Effluent Requirements:*** Option 3 is the higher cost sub-regional option (versus the other preferred Option 4) but requires a better understanding from AEP as to effluent quality requirements, particularly total phosphorous (TP) loading on the Sheep, Highwood, and Bow Rivers. The treatment plant assumptions adopted in the FRWWC TM4 are conservatively based on AEP's High Quality (HQ) effluent requirement (for example TP=0.15 mg/L), resulting in higher treatment plant costs, while the Town of Okotoks and Westend have indicated recent discussions with AEP suggest they may consider a variance on the effluent quality requirement, and a variance to the treatment process during wet weather events. This could significantly reduce the cost of any sub-regional treatment plant option. As such, a direct comparison of the sub-regional treatment plant option cost to local treatment cost options cannot be made, since each may be based on a different treatment standard.

A variation in the treated effluent requirement or the wet weather treatment requirement could significantly reduce the cost of Option 3. Clarification from AEP and a subsequent re-costing of the treatment plant options may be appropriate.

b. *River Studies and Effluent Pipeline Cost:* A detailed receiving stream assessment and modeling are necessary to better determine the carrying capacity of each river, and intern the location of the treated outfall location (i.e. Sheep River, Highwood River, and/or Bow River) at each stage of growth over the next 60 years. This would also assist in determining the treated effluent requirement in the previous bullet. Locating the outfall closer to the treatment plant (on the Highwood River rather than the Bow River) could save $38M in cost of Option 3.

3. For Option 4 (*Sub-regional Pipeline to Calgary*), the main items requiring clarification include:
   a. *City of Calgary Firm Tie-In Date:* Option 4 is the lowest cost sub-regional option but based on information provided by City staff, cannot proceed until at least Year 2025, when the City can provide capacity in its Pine Creek Treatment Plant. This date must be discussed further with the City, and to clarify if any of the current “reserve” capacity the City that is not currently being used could be used in the meantime by paying customers in the sub-region (versus not generating revenue for the City as may be the situation now).
   b. *Local Bridging Costs:* Should the tie-in to the City not be available for the next 10 years, and a regional pipeline to Calgary remain a preferred option, the local bridging costs in each local municipality must be determined to meet this timeline, and the AEP effluent quality requirements would have to be understood in each community.
   c. *City of Calgary Fees:* To better understand the upfront and future costs to the sub-regional partners, clarification would be required from the City on the likelihood of the rates escalating beyond those in place today, and whether an upfront capital tie-in cost could be anticipated. City staff indicated that currently set rates for 2015-2018 should be used. This was adopted in TM4, with a standard rate of inflation into the future, and with no upfront capital tie in fee as is current City policy. There is a risk this could change.
   d. *City TP Loading:* Clarification could be sought from the City as to whether the sub-regional flow, and associated nutrient loading, would be captured within the City’s existing treatment and annual loading limits as set by AEP.

4. For both preferred sub-regional options, the Foothills Collaborative could approach the Province to determine if grant funding would be available within the next three years for regional and sub-regional wastewater systems, and to what level, under the Water for Life, Alberta Municipal Water and Wastewater Program, Building Canada Fund, and/or any new program.

5. There may be some benefit to looking at an alternate smaller scale “West / Sheep River” sub-regional concept, where Westend directs flows to Okotoks’ local treatment plant. Okotoks is investigating a local plant upgrade, and has a major sanitary trunk main planned from the Town’s west boundary along Highway 7. A Westend pipeline could tie to this trunk, possibly saving on the length of dedicated Westend pipe, even if a cost contribution to an over-size of the Town’s trunk main is required. The costs of this option would have to be calculated, including the cost contribution to the Town’s new treatment facility and the trunk main. There is a possibility of directing flows only during the night to reduce impact and cost contributions to the treatment facility, which can also be investigated.

6. Should the previous alternate sub-regional concept be considered, then a parallel “East / Highwood River” sub-regional concept that involves the MD of Foothills and the Town of High River could also be considered.

4.0 RECOMMENDATIONS

Should the FRWWC desire to pursue a sub-regional option, the following should be considered:

1. Higher level discussions with AEP regarding effluent quality standards and wet weather flow treatment methods.
2. Higher level discussions with the City of Calgary regarding fees, tie-in timing, and total loading limits.
3. Higher level discussions with the Province regarding potential grant funding and cost sharing.
4. Re-evaluation of the preferred options and consideration of alternate sub-basin alternatives in addition to local solutions, following the outcome of the above mentioned discussions.
5. River water quality study as deemed necessary by the outcome of the previous items.
6. Estimation of local bridging costs as deemed necessary by the outcome of the previous items.

5.0 REFERENCES

City Email 2015; Email from Russ Dueck, Planning Engineer, Water Resources, City of Calgary to Sarah Fratpietro, MPE Engineering Ltd., December 16, 2015.

CRP 2014; *Regional Water and Wastewater Servicing Masterplan*, prepared for the Calgary Regional Partnership by CH2MHILL, May 2014.

FRWWC 2016a; *Foothills Regional Water & Wastewater Collaborative, Briefing Note*: Sub-Regional Wastewater Treatment Solutions, Prepared by Lisa Fox, January 28, 2016.

FRWWC 2016b; *Foothills Regional Water & Wastewater Collaborative, Executive Summary*: Sub-Regional Wastewater Treatment Solutions, Prepared by Lisa Fox , April 19, 2016.

MPE 2010; *M.D. of Foothills No. 31 Water, Wastewater and Stormwater Servicing Strategy – Highway 2A Area Structure Plan Final Report*, prepared by MPE Engineering Ltd., March 2010.

Stantec TM3 2015; *Technical Memorandum #3 Regional Wastewater Pipeline Feasibility Study – Hydraulic Analysis for Sanitary Forcemain Options*, Prepared by Stantec Consulting Ltd., October 9, 2015.

APPENDIX A

Technical Memorandum 1 – Planning and Projections

MEMORANDUM

Date:	November 30, 2015
To:	Foothills Regional Water & Wastewater Collaborative
cc:	Lynda Cooke, P.Eng., Randy Boras, M.Sc., P.Eng,, Sarah Fratpietro, P.Eng.
From:	Steve Brubacher, P.Eng., Leigh Chmilar, P.Eng.
File:	2239.0005.01 / 2210-047-00
Subject:	Technical Memorandum 1-Rev 1: Planning and Projections

1. INTRODUCTION

The Foothills Regional Water and Wastewater Collaborative (FRWWC) is exploring a sub-regional management strategy for wastewater collection servicing in the short (< 10 yrs), medium (25 yrs.), and long-term (50 yrs.) future. For consistency with past CRP work, the long-term timeframe has been modified from 50 years to 60 years. In the next 60 years, this sub-region could more than quadruple in population, putting great financial and capacity stresses on the local systems. The focus of this memorandum is to establish the foundation of the study for the following areas: Black Diamond, Turner Valley, MD Foothills No. 31 (Aldersyde & Central District-formerly known as Dewinton), High River, Longview, Nanton, and Okotoks.

Within this memorandum, Urban System Ltd. (USL) summarizes historical populations and flow data, population projections, and existing EPEA Approvals. MPE Engineering Ltd. summarizes water licenses including diversion and return points. This memorandum reviews past studies and strategies, current treatment facilities, their conditions and upgrade requirements, current Approvals and interviews, and provides a location map (Figure 1.1) to depict the locations of existing facilities, including existing Water License points of diversion and return to river locations.

Alberta Environment and Parks (AEP) announced in 2015 that effluent treatment requirements are changing in the future. New plants will be required to treat to High Quality (HQ) effluent criteria of 5 mg/l BOD_5, 5 mg/l TSS and 0.15 mg/l Total Phosphorus. Existing plants will be required to move towards the new criteria when major structural upgrades and expansions are required. This memorandum considers the existing Approval requirements and compares each facility to the future HQ criteria requirements.

2. POPULATION AND FLOW PROJECTIONS

The population growth projections provided by the 2014 CRP Regional Water and Wastewater Servicing Masterplan report ("The CRP Report") were used for this study, unless otherwise indicated, and are shown in Table 2.1 below. The 2026 populations in Table 2.1 were linearly interpolated from the 2010 and 2041 data. The CRP figures are compared to projections provided by past reports and the FRWWC in the subsections following. It should be noted that Longview is not included in the CRP report, but is included in this memo for completeness and information.

Flow generations in the table below are taken from the CRP Report, unless otherwise indicated. The flows in the table are total community sanitary per capita flows, which include residential, commercial, industrial and inflow and infiltration flows. These values are compared with flows from historical reports and flow data in subsequent sections. Future average day dry weather wastewater flows are then projected based on the estimated future populations.

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Table 2.1: Foothills Regional Wastewater Collaborative Population and Average Daily Flow Projections – Summary of Adopted Information

Study Area	Population				Flow (L/c/d)			Flow (m³/d)		
	2010	2026	2041	2076	2010	2041[1]	2076[2]	2010	2041	2076
Black Diamond	2,308	3,377	4,379	6,717	377	321	264	870	1,406	1,773
Aldersyde	793[3]	3,244	5,542[4]	11,800[4]	400[5]	361[6]	361[6]	317	2,001	4,261
Central District	n/a	9,773	18,935	20,425[7]	400[8]	400[8]	371[9]	0	7,574	7,574
High River	11,783	25,369	38,106[10]	54,758[10]	392[11]	352	296	4,619	13,413	16,208
Longview	307[12]	489	660	1,566	385[13]	385[13]	300[13]	118	254	470
Nanton	2,124	3,295	4,392	6,952	287	244	287	610	1,072	1,995
Okotoks	23,201	43,052	61,662[14]	106,164[14]	232	300[15]	232	5,383	18,499	24,630
Turner Valley[16]	2,022	3,304	4,505	7,308	492	321	264	995	1,446	1,929

The above table represents the base information to be adopted in this study. It is important to note that in the CRP Report, significant water use reductions were adopted in the long-term. Such reductions can reduce the costs of water infrastructure, but may not necessarily reduce the cost of wastewater treatment facilities. This is because nutrient loadings for any given population do not necessarily drop with reduced water use. Rather, effluent concentrations increase, sometimes making treatment more challenging. As such, the above flows will not be the sole determinant of treatment capacity and costs. Treatment requirements will be based upon both nutrient loading and flows, which can include a significant peaking allowance for inflow and infiltration (I&I).

1 2014 CRP Report used a 15% generation reduction by 2030 for this flow estimation
2 2014 CRP Report assumed this per capita generation rate for their 2076 assessment of facility capacity
3 Equivalent population in 2010 based upon total average dry weather flow of 317m³/d using 400 L/c/d in 2010 (MD Foothills No. 31 Report, March 2010)
4 Equivalent population for primarily commercial industrial uses estimated from FRWWC RFP; given 1,100 ac-ft projected 50-year (2066) water use assuming 315 L/c/d water demand from CRP Report. Linear growth rate assumed.
5 Assumed in the Foothills Water, Wastewater and Stormwater Servicing Strategy – Hwy 2A ASP, 2010 (MPE)
6 Per capita generation rate determined from total flows (m³/d) and equivalent population estimates for 2041 and 2076 (MD Foothills No. 31 Report, March 2010)
7 60 year projection is based on the FRWWC RFP 50 year projection of 20,000 and the CRP 2014 population for 2041, assuming linear growth.
8 Assumed community generation rate in the MD Foothills No. 31 Report, March 2010.
9 Calculated using total community flow of 7,574 m3/d and a projected population of 20,425 (MD Foothills No. 31 Report, March 2010)
10 Population in 2041 based upon 3.8% growth rate from High River 2015 WTP Study by Stantec using 13,921 base population in 2014. Year 2076 population based on linear growth from 2041 to the 50,000 population target in the FRWWC RFP for 2066 (50 year).
11 Based on flow monitoring reported in the 2010 Engineering Report for High River (ISL)
12 Longview's populations are based on 2011 Statistics Canada population with 2.5% growth rate as per the March 2010 Wastewater Stabilization Pond Study by MPE.
13 Village of Longview Wastewater Stabilization Pond Study, 2010 (MPE) estimated this rate based on an assumed future i/i reduction. Current 385 l/c/d sewage generation rate adopted. In 2076 assumed CRP capped rate of 300 l/c/d.
14 Confirmed by Okotoks to use a linear growth rate of 1271.5 persons/year, from the Okotoks-Calgary Regional Potable Water Pipeline Draft Study, 2015
15 Assumed by the CRP based on a capped population of 35,000. Okotoks is no longer capping population.
16 The population of Turner Valley was included with Black Diamond for the per capita flow projections (2041 and 2076).

3. WATER LICENSE SUMMARY

The allocations for municipal water use, as licensed under the Water Act, for the six identified communities are summarized in Table 3.1 below. The details for each water license are included in Table 3.2 attached to this Technical Memorandum, and the locations of the points of diversion and points of return flow for each municipality are presented in Figure 1.1. Five of the communities draw water from the Bow River basin, and one community, Nanton, draws water from the Oldman River basin. The MD of Foothills receives water from High River for Aldersyde (from the Bow River Basin).

Table 3.1: Water Act License Summary

Basin	Municipality	Source	Points of Diversion	Annual Allocation (m^3)	Points of Return Flow	Return Flow (m^3/year)
Bow	Okotoks	Sheep River	SW 27-20-29-W4 SW 28-20-29-W4 NW & S 29-20-29-W4 NE 30-20-29-W4	3,359,589	NW 22-20-29-W4	1,539,344
	Black Diamond	Sheep River	SW 8-20-02-W5	954,679	NW 16-20-02-W5	859,211
	Turner Valley	Sheep River	NW 6-20-02-W5	514,389	SW 16-20-02-W5	303,679
	High River	Highwood River	NE & S 6-19-28-W4	4,623,245	SW 29-19-28-W4[17] NE 6-19-28-W4[17]	3,699,609
	Longview	Highwood River	NE 17-18-02-W5	98,679	NE 17-18-02-W5	88,811
	MD of Foothills (Aldersyde)	Highwood River (via High River Water System)	4-7-20-28-W4 (point of re-diversion)	476,131	Nil	Nil
	MD of Foothills (Central District)	Aquifer	SW-27-21-29-W4	7,600	Not Specified	Not Specified
Oldman	Nanton	Mosquito Creek, Springhill Creek	SW 22-16-28-W4 W 3-16-29-W4 NE 2-16-29-W4	725,366	NE 15-16-28-W4	493,393

[17] High River water licenses indicate point of return flow is to the Highwood River. However, actual point of return flow is to Frank Lake (NW36-18-28-W4). Frank Lake discharges to the Little Bow River at NW33-17-27-W4.

Three communities draw water from the Sheep River:

- Town of Okotoks
- Town of Black Diamond,
- Town of Turner Valley

Three communities draw water from the Highwood River:

- Town of High River
- Village of Longview
- MD of Foothills (Aldersyde) via the Town of High River

One community draws water from Mosquito Creek and a Springhill Creek tributary:

- Town of Nanton

All Water Licenses are located within the South Saskatchewan River Basin, and with the source being surface water or apparently groundwater 'under the influence' of surface water. As such, these Licenses are considered to be transferable (i.e. point of diversion relocated) (source: http://aep.alberta.ca/water/programs-and-services/river-management-frameworks/south-saskatchewan-river-basin-approved-water-management-plan/documents/SSRB-ApprovedWaterManagementPlan-2006.pdf), subject to the Water Act and the Approved Water Management Plan. The conditions include the Water License being 'in good standing' and any Water License to be transferred is subject to a 10% holdback of the transferred allocation.

Any Water License which does not specify whether the source of water is from surface water or groundwater 'under the influence', may require a hydrogeological investigation to confirm.

Any return flows which are not actually specified in the Water License, but expected by Alberta Environment and Parks as a policy, may ultimately require a legal decision to determine whether return flows are required.

4. WESTEND REGIONAL SEWAGE SERVICES COMMISSION (WRSSC)

4.1 Historical Information

In 2014 the population of Black Diamond and Turner Valley (Westend) was 4,400[18]. The CRP Report estimates per capita wastewater generation is 377 L/c/d in Black Diamond and 492 L/c/d in Turner Valley and that the average wastewater flows are 870 m^3/d and 995 m^3/d, respectively.

18 From the Westend Sewage Services Plan for Operating Approval (MPE, USL, 2014).

The report on the Westend Sewage Services Plan for Operating Approval (The 2014 Westend Report) and more recent data to June 2015 indicate average monthly influent flows (from 2007-2015) to the lagoon ranged from 1,600 m^3/d (370 L/c/d using total population of 4,330), during winter months to over 3,200 m^3/d (739 L/c/d) during the month June. The maximum average dry weather flow (ADWF) was 4,300 m^3/d and maximum peak daily flow was 9,100 m^3/d during the rainiest month (June). The reported average monthly flow into the lagoon between 2007 and 2013 was 1,800 m^3/d (416 L/c/d), which corresponds more closely to the average of the Towns from the CRP Report, as shown previously in Table 2.1.

4.2 Projected Populations

The CRP estimates the future Westend populations as shown previously in Table 2.1.

The 2014 Westend Report indicated that the projected 2037 service populations to be 4,003 for Turner Valley and 3,986 for Black Diamond, for a total Westend Population of 7,989. The Quad regional treated water initiative estimated a total of 8,904 which includes 915 in the surrounding rural area (MD of Foothills). The CRP 2041 projected population is higher than the Westend 2037 predicted population by 895 persons. Considering the former includes rural users, the projections are comparable.

For consistency, the CRP population projection will be adopted as per Table 2.1.

4.3 Projected Wastewater Flows

The projected per capita wastewater generation rates provided by the CRP are found previously in Table 2.1. The current generation rate for both towns combined is estimated to be 431 L/c/d (weighted average), which is comparable to the 416 L/c/d rate more recently identified in the Westend Report.

The CRP projected generation rate for 2030 is 321 L/c/d, and for 2076 is 264 L/c/d. For this study, the CRP rate for 2030 will be used to reflect the projected rate in 2041.

There is a large discrepancy between the projected flows between the CRP and the design flows from the 2014 Westend Report. The CRP projected per capita sewage generation rates do not necessarily reflect the inflow and infiltration (I&I) into the Westend system.

At this point in time for the purposes of this study, it is proposed to adopt the CRP values. In the design of the treatment facilities, the CRP values will set the nutrient loading values, while an appropriate I&I allowance will be added when sizing hydraulic components to reflect the Westend projections. This allowance can be discussed in a future technical memorandum addressing plant and pipeline design parameters, should the FRWWC choose to investigate the Westend options in more detail.

4.4 Existing Water Licenses & Current Approvals

The Town of Black Diamond has one Water License with a total annual allocation of 954,679 m^3 from shallow wells located upstream of Town. The total return flow specified in the License is 859,211 m^3/year back into the Sheep River downstream of Town. Two of three shallow wells were lost and one damaged during the 2013 flood along the Sheep River. An application for relocation of diversion point (for most of the water license amount) upstream to Turner Valley is pending with AEP.

The Town of Turner Valley has five Water Licenses with a total annual allocation of 514,389 m^3 from shallow wells located at the south edge of Town. Due to the 2013 flood, some points of diversion have and/or will be relocated. The total return flow specified in the License is 303,679 m^3/year back into the Sheep River downstream of Black Diamond.
See sections 4.5.1 and 4.5.2 for discussion of the EPEA Approvals.

4.5 Existing Wastewater Facilities

The WRSSC (Westend) owns and operates the wastewater collection system and treatment facility for the Towns of Black Diamond and Turner Valley. The Westend facility consists a lift station in Turner Valley (a town lift station), a transmission main, two lift stations within the Town of Black Diamond, and an aerated lagoon with 6 cells (2 anaerobic settling, 2 partial mix, 1 completely mixed, and polishing pond) that was constructed 20 years ago. There is a transfer pump station at the lagoon site for pumping effluent between cells. The treated effluent is discharged into the Sheep River.

4.5.1 Design Basis & Treatment Level

The Westend system includes a secondary treatment facility, and its current effluent requirement is CBOD < 25 mg/L. The current EPEA Approval was set to expire October 2015, and the WRSCC is currently applying for an interim renewal. The treatment facility is currently capable of meeting its current effluent requirement. Maximum monthly average day flows were used as the basis for the lagoon design.

4.5.2 Capacity

The facility was designed for 25 year design flows, and the capacity of the lagoons was recently analyzed to project when upgrades would be required. Based on hydraulic retention time of the lagoons, the 2014 Westend Report estimated that the following upgrades would be required starting in 2017:

- Upgrades to the 2 Partial Mix Cells would be required by 2017 to achieve the minimum retention time of 28 days (currently 33.5)
- Upgrades to the Completely mixed cell would be required by 2018 to achieve the minimum retention time of 2 days (currently 2.5)
- Upgrades to the Polishing Pond would be required by 2037 to achieve the minimum retention time of 5 days (currently 18)

Costs were estimated for the upgrades proposed in the 2014 Westend Report, but did not consider the upcoming High Quality (HQ) AEP effluent standards.

The current capacity of the collection system or transmission main were not considered.

4.5.3 Effluent Treatment Requirements

The Westend EPEA Operating Approval expires in October 2015. In June 2015, Westend applied for an extension of their Approval with proposed effluent criteria in order to allow time to review and plan upgrades to the treatment system that would be required in 2017. Alberta Environment and Parks (AEP) have indicated that they are following an interim effluent limits policy for the Bow River Basin with the provision that when upgrades to existing plants are required, that they are to be upgraded to produce effluent quality required to address the ongoing issues in the Bow River Basin. AEP has indicated that the criteria will likely be as follows when the plant requires upgrading:

Table 4.1: Current and Future Effluent Requirements

Parameter	Current "Existing Quality" (EQ) Requirement	Future "Higher Quality" (HQ) Effluent Requirement
Ammonia-Nitrogen	n/a	≤ 3.0 mg/L
$CBOD_5$	≤ 25 mg/L	≤ 5 mg/L
Fecal Coliform Counts	n/a (monitor only)	≤ 200 /100 mL
Total Coliform Counts	n/a (monitor only)	≤ 1000 / 100 mL
Phosphorus	n/a	≤ 0.15 mg/L
Total Nitrogen	n/a	≤ 10 mg/L
TSS	n/a (monitor only)	≤ 5.0 mg/L

4.5.4 Planned Upgrades

The 2014 Westend Report had recommended the following upgrades:

- Removal of sludge blanket from all 6 cells to provide more hydraulic capacity
- Add a second completely mixed aeration cell
- Add a third partial mix cell
- Add a bypass to the polishing pond
- Upgrade both lift stations
- Add a storage pond for managing effluents during periods of low Sheep River flows to allow for 10:1 dilution of effluent

This report and recommendations were released prior to the information from AEP regarding the new HQ criteria. There are currently no plans in place to meet the upcoming HQ criteria.

5. MD OF FOOTHILLS NO. 31

For this study, the MD of Foothills No. 31 (MD Foothills) is considered in the populations of Aldersyde (south of Okotoks) and Central District (north of Okotoks, formerly known as Dewinton). A relatively small population allowance for rural MD users is included in the Westend service area populations for Turner Valley and Black Diamond as per the CRP population projections.

5.1 Historical Information

The CRP did not estimate current populations for Central District and Aldersyde, and there is currently no available information regarding past populations of the MD Foothills area. The 2010 Foothills Water, Wastewater and Stormwater Servicing Strategy – Hwy 2A ASP (The 2010 MD Report) indicated that based on a 2006 census, the MD population was 242 (excluding Central District, and including Aldersyde's population of 66), and that there has been no recent residential growth between 2006 and 2010[19].

The 2010 MD Report does consider some residential areas north of Okotoks to be included in future servicing, but it is unclear whether this includes Central District. The areas the report refers to as "Residential North of ASP Area" are Ravencrest and Silvertip, with a combined population of 320 in 2009.

The 2010 MD Report estimated the *residential* wastewater generation rate to be 400 L/c/d for the MD Foothills area (excluding Central District), based on past 2005 CRP data. Using a population of 242 and per capita rate of 400 L/c/d, the 2010 average dry weather flow for residential areas within the MD (excluding Central District) was reported to be 96.8 m^3/d. Using the total current wastewater flow for the area (317 m^3/d) and assuming a generation rate of 400 L/c/d, the equivalent area population for 2010 is 793, reflected in Table 2.1.

Cargill Foods Ltd. (Cargill) is a beef-processing plant that has its own water and wastewater treatment facility on site. Servicing of this is not included in the scope of this study. See Section 6.6 in this report for a discussion of Cargill's water and wastewater facilities. Within the MD area, a large industrial park (Abild's) and the Transcanada Saddlebrook Facility are connected to the High River wastewater treatment system. Although these are treated in another regional municipality (High River) these will be included in the MD sewage generation numbers since they are generated within the MD. Determining where these are best served in the long-term is a future exercise in this study.

5.2 Projected Populations

The Highway 2A ASP for the MD Foothills indicates there are 248 hectares of residential developable area for the MD (Aldersyde), and will not change for the future. This report does not project future populations, only developable area. The 2010 MD Report does not project a future population for areas north of the ASP area.

[19] 2010 Foothills Water, Wastewater and Stormwater Servicing Strategy – Hwy 2A ASP (MPE)

The CRP projects for the population of Central District to reach 18,935 by 2041, and 40,314 by 2076. The FRWWC RFP suggests a 50-year population of 20,000 in Central District. Assuming linear growth between the CRP 2041 population (25-year) and the FRWWC 50-year population, a 2076 population is estimated at 20,425 as shown in previous Table 2.1. The CRP did not project Aldersyde's future population. Given Aldersyde will be largely non-residential development, an equivalent population is provided previously in Table 2.1, which is based on the FRWWC RFP of 1,100 acre-feet (3717 m^3/d) water demand in 50 years assuming 315 L/c/d water demand from the CRP Report and linear growth rate.

5.3 Projected Wastewater Flows

The CRP Report did not project the future wastewater flows for the Aldersyde or Central District.

In evaluating servicing options for the MD, the 2010 MD Report assumes a total design sanitary flow generation of 400 L/c/d. The report uses a sanitary design ADWF (average dry weather flow) of 4,261 for the report area (not including Central District) for the year 2030.

According to the 2010 MD Report, development within the area is anticipated to be mostly industrial/commercial, with little to no increase in residential. Therefore the projected residential ADWF is 96.7 m^3/d, as shown in the table below. Existing commercial and industrial effluent data was used to project total future flows, shown in the table below. The 2010 MD report did not have a future date range listed for these future build-out scenarios, however the 100% build-out numbers are used for their 2030 design assumptions.

Table 5.1: Current and Future MD of Foothills Effluent Flows

	Current Flows	50% Build-out (m^3/d)	100% Build-out (m^3/d)
Residential in ASP area	96.7	96.7	96.7
Industrial & Commercial	134.3	2,063.2	3,888.4
Saddlebrook	0	65.0	65.0
Foothills Regional Indoor Fields House	0	8.5	8.5
Residential North of ASP Area	86.2	202.1	202.1
Total (without Cargill)	**317.2**	**2,436**	**4,261**

Due to the lack of any detailed population projection for Aldersyde, and lack of current or projected wastewater flows for Central District, it is difficult to compare and analyze the project wastewater flows for the MD areas.

Given the foregoing, Table 2.1 reflects some basic assumptions that are adopted to address the MD areas:

- For Central District:

- the CRP 2041 population projection and the FRWWC 50-year populations will be used, and projected into 2076
- the 2041 population is assumed to generate at 400 L/c/d as per the assumptions in the 2010 MD Report
- the 2076 population will generate the same overall daily sewage volume as in 2041, given improved water use, resulting in a lower per capita generation rate (371 L/c/d)

- For Aldersyde:
  - equivalent populations are calculated for 2041 and 2076 based upon projected water use
  - the 2076 sewage generation value is the 100% Build Out (4,261 m3/d) in the MD Report
  - the resulting sewage generation rate (361 L/c/d) is applied to the 2041 equivalent population to calculate a sewage generation value

5.4 Existing Water Licenses & Current Approvals

Most substantial Water Licenses within the MD of Foothills are privately held.

The MD has four Water Licenses at Aldersyde with a total annual allocation of 476,131 m^3 from an aquifer through the waterworks of the Town of High River. There is no total return flow specified in the Licenses.

The MD has one very small Water License in the Central District for Heritage Heights School with a total annual allocation of 7,600 m^3 from an aquifer. There is no total return flow specified in the License.

There are currently no wastewater treatment facilities operated by the MD of Foothills in Aldersyde or the Central District, therefore there are no current EPEA Approvals.

5.5 Existing Wastewater Facilities

The MD of Foothills (Aldersyde and Central District) currently have no wastewater treatment facilities. The MD of Foothills has confirmed that there is a plant currently being proposed for Aldersyde (Windwalk Plant), and an application for an Approval to AEP is about to be submitted. High River is encompassed by the MD, however this memorandum evaluates High River separately.

5.5.1 Design Basis & Level of Treatment

There are currently no wastewater treatment facilities operated by the MD at Aldersyde or Central District. As such, any new plants will be designed to treat to the HQ standard.

5.5.2 Effluent Treatment Requirements

The future effluent treatment requirements will be dependent on whether a new plant is constructed, or whether wastewater is conveyed to an existing municipality. If a regional plant within the MD is to be considered, the new HQ effluent criteria will be required.

5.5.3 Planned Upgrades

The 2010 MD Report evaluates the following options for future servicing of the MD development areas (primarily Aldersyde):

- Direct wastewater to the Town of High River (NPV = $24.19M)
- Direct wastewater to the Town of Okotoks (NPV = $37.5M)
- Direct portions of the wastewater flows to both The Towns of High River and Okotoks. (NPV = $36.6M)

The 2010 MD Report did not specify effluent discharge criteria for the options, as the report proposed to send sanitary flows to existing plants. The most cost effective option evaluated was determined to be directing wastewater to the Town of High River for treatment.

The Windwalk Plant is planned as the first wastewater treatment facility in the Aldersyde area, and the EPEA Approval is pending.

6. HIGH RIVER

6.1 Historical Information

In 2010 the population of High River was 11,783. The 2011 Town of High River WWTP Liquid Waste Management Study - Phase 1 DRAFT (2011 High River WWTP Report) showed the gross average per capita wastewater generation rate between 2003 and 2009 to be 451.4 L/c/d (excluding the June 2005 flood). The 2012 High River Water Report provides sewer data for 2006, 2007 and 2010. It indicated that the average day effluent flow was 4,181 m^3/d, average peak day flow was 4,965 m^3/d, and the maximum peak flow of 8,719 m^3/d in June 2006.

In 2010, ISL Engineering reported on flow monitoring data that found the gross average per capita wastewater generation rate to be estimated at 392 L/c/day based on the combined averages for residential and non-residential flows.

The 2014 CRP Report estimates that the wastewater generation rate is 296 L/c/d with a peaking factor of 1.2, and an average daily flow of 3,488 m^3/d.

There is a discrepancy between the CRP per capita flows and the flows provided by the historical reports. A discussion regarding how this data variability will be addressed in the study is found in Section 6.3.

6.2 Projected Populations

Available reports used past CRP population projections with an annual growth rate of 3.25%, and estimated that by 2030, the population would reach 22,355. The CRP projections for 2041 is 25,775 and for 2076 is 41,572.

The FRWWC RFP has suggested a projected 2066 population for High River of 50,000. The Town of High River is adopting a 2041 population projection of 38,106 calculated as outlined in Stantec's 2015 Water Treatment Plant Study, using a base population of 13,921 in 2014 and an annual linear growth rate of 3.8%. The year 2076 population estimated for this study is based upon a linear growth rate extrapolated from 2041 to the 50,000 population target in the FRWWC RFP for 2066. These projections are as previously shown in Table 2.1.

6.3 Projected Wastewater Flows

The CRP estimated the 2030 generation rate to be 352 L/c/d based on a 15% reduction of potable water use. For its assessment of the treatment capacity by 2076, the CRP assumed a generation rate of 296 L/c/d, as shown in Table 2.1.

The 2011 High River WWTP Report assumed a 30% reduction in water consumption by 2030 and estimated future wastewater flows as shown in the table below[20]. There is no mention of whether these estimates include the Saddlebrook flows. For the purpose of this study, the Saddlebrook flows have been included in the MD sewage generation numbers as outlined in the previous section.

Table 6.1: Current and Future High River Effluent Flows

Year	Population	Wastewater Generation (L/c/d)	ADF (m^3/d)	MDF[21] (m^3/d)	Harmon's Peaking Factor[22]	PHF (m^3/d)
2010	11,783	392	4,600	7,900	2.88	13,300
2030	22,355	274.4	6,200	10,500	2.60	16,200

The CRP Report flow generation rate of 352 L/c/d for 2041 is adopted in Table 2.1 as shown previously. This is only 10% lower than the current flow generation rate estimated by ISL Engineering[23], which is reasonable for a future flow projection, given the per capita water use reduction targets laid out by CRP.

In the design of the treatment facilities, the CRP projected values as set out in Table 2.1 will set the nutrient loading values, while an appropriate I&I allowance will be added when sizing hydraulic components to

20 Town of High River Liquid Waste Management Study – Phase 1, DRAFT, 2011 (Stantec)
21 Calculated as 1.71xAnnual ADF (BSEI 2005 Town of High River Infrastructure Report)
22 Based on AENV Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems
23 Based on flow monitoring reported in the 2010 Engineering Report for High River (ISL)

reflect the High River area. This allowance will be discussed in a future technical memorandum addressing specific plant and pipeline design parameters.

6.4 Existing Water Licenses & Current Approvals

The Town of High River has three Water Licenses with a total annual allocation of 4,623,245 m^3 from shallow wells located in and near the Town. The total return flow specified in the Water Licenses is 3,699,609 m^3/year back into the Highwood River downstream of the Town.

See Section 6.5.3 for a discussion of the EPEA Approvals.

6.5 Existing Wastewater Facilities

The Town of High River owns and operates a wastewater treatment facility that services the Town, the Abild's industrial park and the Transcanada Saddlebrook facility. It is an aerated lagoon system consisting of:

- One lift station
- 4 km HDPE forcemain to the lagoons
- Treatment lagoons adjacent to the Highwood River
- Trunk main to the discharge point at Frank Lake, which is shared by the MD and Cargill foods
- Pump station at Frank Lake
- Frank Lake effluent pipeline consisting of a 2.7 km forcemain and 10.2 km gravity line

It should be noted that Cargill Foods has its own WWTP, and is proposing to expand by 25% in the next 5 years according to the 2010 MD Report.

6.5.1 Design Basis & Level of Treatment

The High River facility is a secondary treatment facility consisting of a conventional aerated wastewater stabilization lagoon built in 1987. It includes a complete mixed cell, one partial mixed cell, and a storage cell. The system was designed for a population of 10,000, and in 2010 was servicing a population of over 11,000. The design assumed that wastewater generation was 90% of potable water demands.

6.5.2 Capacity

The lagoon was designed for an average daily flow of 8,409 m^3/d, and the 2012 High River Water Report indicated that the average day effluent flow was 4,181 m^3/d, and the average peak day flow was 4,965 m^3/d, with a maximum peak flow of 8,719 m^3/d in June 2006.

6.5.3 Effluent Treatment Requirements

The EPEA Approval treatment requirements for High River are currently ≤ 25 mg/L CBOD and ≤ 200 /100 mL fecal coliform counts. The facility is currently capable of meeting its effluent criteria, but there are increasing concerns about the cumulative phosphorus loading into Frank Lake. Frank Lake is a protected wetland, with no influent other than from surface runoff and effluent discharge from the High River and Cargill Plants. There was a diversion structure from the Highwood River that was rendered inoperable in the 2005 floods. See Section 6.7 for further discussion of Frank Lake.

The CRP Report evaluated options based on existing infrastructure remaining in place, and does not speak to the discharge quality requirements.

The High River EPEA Approval expires September 1, 2018. The Approval states that the treatment plant must begin an upgrade to include at biological nutrient removal by November 1, 2010, or request amendment to the Approval. The High River plant has not been upgraded yet.

6.5.4 Planned Upgrades

There have been multiple options considered for the upgrade of the High River Treatment System. In 2009 BSEI and AECOM partnered to provide cost estimates for a Biological Nutrient Removal (BNR) system upgrade to the plant. Five plant configurations/scenarios were evaluated and capital costs were in the order of $9.4M to $11.7M[24].

As an alternative to the above upgrades, the Town requested Stantec (for EPCOR) provide regional and local options for the town. The resulting 2011 Liquid Waste Management Study evaluated the following five options based on the sensitivity of Frank Lake and the stringent effluent discharge criteria for the Highwood River. It was assumed for the study that effluent criteria would be similar to that currently of Okotoks, and tertiary treatment would be required to continue to discharge to the Highwood River, or Frank Lake. The report does not take into consideration the newest AEP effluent criteria, as previously mentioned:

- Option 1 - construct a new advanced WWTP to address nutrient concerns with effluent discharge to the Highwood River;
- Option 2 - construct a new advanced WWTP to address nutrient concerns with effluent discharge to Frank Lake;
- Option 3 - form a regional wastewater collection and treatment system using a raw sewage pipeline connection to the Town of Okotoks,
- Option 4 - form a regional wastewater collection and treatment system using a raw sewage pipeline connection to the City of Calgary's collection and treatment system (Pine Creek WWTP), and
- Option 5 - become a regional treatment hub, receiving wastewater from other municipalities with final discharge to either the Highwood River or Frank Lake

[24] High River WWTP BNR Upgrade Summary Report and Cost Estimates, December 2009 (AECOM)

In 2011 BSEI[25] was commissioned to evaluate more economical alternatives (i.e. lower operational costs) to the previously proposed BNR upgrades. The report proposed a design based on a population of 25,000 in 2032, a per capita generation rate of 364 L/c/d, an average dry weather flow of 9,100 m^3/d and a maximum monthly average daily flow of 11,830 m^3/d. BSEI evaluated the costs of upgrading the existing aerated lagoons with a lagoon product (design and installation) from Nelson Environmental Inc. called OPTAER using two scenarios: discharge at Frank Lake and discharge at the Highwood River. The treatment parameters used for the design for discharge to Frank Lake were as follows:

Table 6.2: 2011 BSEI Design Treatment Parameters for Effluent Release to Frank Lake

Parameter	Influent	System Effluent Limits	Existing EPEA Approval
Design Wastewater Flow (m^3/d)	11,830		
$CBOD_5$ (mg/L)	250.5	10	20
TSS (mg/L)	250	10	20
Total Ammonia - summer (mg/L)		5.0	5.0
Total Ammonia - winter (mg/L)		10.0	10.0
Total Phosphorus (mg/L)	5	1.0	1.0

The OPTAER upgrade for discharge to Frank Lake included retrofitting existing aerators with fine bubble membrane diffusers, constructing seven new submerged attached growth reactors (SAGR), adding an Alum system and implementing a cloth disk filtration system for phosphorus removal and TSS filtration. The estimated capital cost for the treatment system with discharge to Frank Lake was $14.4M, with an annual operating cost of $0.56M.

The effluent discharge criteria used by BSEI for treatment with discharge to the Highwood River were the same as the above criteria with a lower Total Phosphorus criteria (0.5 mg/L). The OPTAER upgrade for discharge to the Highwood River included the same items in the option for discharge to Frank Lake, and added the construction of a UV disinfection system and outfall structure to the Highwood River. The capital cost of the proposed system was $17.7M with an annual operating cost of $0.745M. BSEI recommended the Town proceed with the first option with discharge to Frank Lake.

The CRP has evaluated a few options based on a 30% reduction in water consumption, current Okotoks effluent criteria and assuming there is no additional capacity in the Sheep and Highwood River. The CRP indicated the two preferred options were:

- Regional pipeline to the City of Calgary servicing High River, Okotoks, and the Westend, with a 65-year NPV of $306M.

[25] Town of High River 2011 Alternate Upgrade Study to the Wastewater Treatment Facilities, September 2011 (BSEI)

- Regional pipeline to Calgary servicing High River, Westend, with local plants in Okotoks and Nanton, with a 65-year NPV of $299M (preferred if Okotoks maintained a limited-growth scenario)

The CRP recommended that if Okotoks did not set a population cap, which has now come to fruition, that the preferred option is a regional wastewater pipeline from High River to Okotoks to Calgary, with Westend and Nanton remaining on local treatment systems.

As mentioned in a number of reports, the impacts of increasing or decreasing flows on Frank Lake have to be considered, and better established. Frank Lake does rely on effluent flows to maintain water level in the lake. See Section 6.7 for further discussion of Frank Lake.

No decisions have currently been made as to any upgrades to the High River Wastewater Treatment facility, specifically given the new AEP criteria.

6.6 Cargill

Cargill Meat Solutions is a beef processing plant located approximately 3km north of High River. The plant's water is supplied through the Town of High River potable water system to a Cargill owned potable water reservoir on-site for industrial use. The plant site has its own water pumping and pipeline distribution system. Cargill has expressed interest in expanding its plant operations by 25%, according to the 2010 MD Report. Access to potable water is understood to be a major restriction to expanding the existing production capacity.

Cargill has access to water via three Water Diversion Licenses under the *Water Act*. The first was issued in 1988 for an annual allocation of 1,181,075 m^3/year (957 acre-ft). The second is a temporary transfer by agreement from Ducks Unlimited of almost half of their permanent 2,466,945 m^3/year (2,000 acre-ft) water license, or the equivalent of 1,110,134 m^3/year (900 acre-ft). This agreement expires in 2020 at which point Ducks Unlimited would likely re-assess Cargill's need and their own, with one option being to re-sign the agreement (possibly at an increased volume).

Cargill also has a Water Diversion License issued in 2015 to divert up to 153,300 m^3/year for emergency use during flood and/or drought from two onsite groundwater production wells. Table 6.3 summarizes the Water Diversion Licenses accessed by the Cargill plant under the *Water Act*.

Table 6.3: Summary of the Cargill Plant's Available Water Diversion Licenses

Water Diversion License Number	Source	Annual Allocation (m3/year)	Point of Return Flow
00028480-00-00 (1988)	Highwood River (through the Works of the Town of High River) (surface water)	1,181,075	Frank Lake
00242986-00-00 (temporary transfer from Ducks Unlimited, 2008 to 2020)	Highwood River	1,110,134	Frank Lake

	(through the Works of the Town of High River) (surface water)		
00365745-00-00 (2015-2025)	Production Wells at Cargill Site (groundwater)	153,000	Not Specified
	Total	**2,444,209**	

The Cargill plant has its own wastewater treatment plant (WWTP) on-site. The WWTP consists of screening, grit removal, dissolved air flotation, an anaerobic lagoon system, several aerobic treatment processes, polishing ponds and UV disinfection. Treated effluent from both the Cargill WWTP and the High River WWTP are pumped to Frank Lake. The combined effluent from High River and Cargill enters the northwest corner of Frank Lake (Widgeon Bay). In 2014 the Cargill plant pumped approximately 2,198,112 m^3 (6,022 m^3/day) of treated effluent to Frank Lake. The EPEA Approval for the Cargill WWTP limits total phosphorus in the effluent stream to 40 kg/day based on a maximum daily average (for any month), and up to 80 kg/day as a maximum day loading. See Table 2.3 in Technical Memorandum 2 for a summary of all the effluent quality limits for the Cargill WWTP.

It is assumed that the Cargill plant will continue to treat its own sewage and to send effluent to Frank Lake in the long-term. Their sewage flows have not been included in the regional options in this study.

6.7 Frank Lake

Frank Lake is located approximately 6km east of High River. It is a shallow lake bordered by marshes and low-lying meadows. The lake is considered to be the most important wetland in southwestern Alberta, for breeding water birds (2015 IBA Canada Website).

Ducks Unlimited began improvements at Frank Lake in 1952. Lake levels tended to fluctuate and sustained droughts caused it to dry out. Frank Lake was stabilized in 1988 when Ducks Unlimited joined forces with industry, municipal, provincial, and federal governments to secure a long term supplemental water supply through a pipeline serviced by the High River WWTP, the Cargill WWTP, and an infiltration gallery diverting water from the Highwood River (2015 Ducks Unlimited Website). The Highwood River diversion structure was rendered inoperable due to siltation after the 2005 flood and then again after the 2013 flood. However, Ducks Unlimited has indicated that they are in the process of having this repaired (2015 Ducks Unlimited Email).

The receiving of effluent from the Cargill and High River plants considered that Frank Lake would act as a polishing pond for the effluent. Therefore, the effluent standards were not excessively stringent, especially with respect to nutrient concentrations. Indications are that the capacity of Frank Lake to provide polishing appears to be decreasing over time. There are increasing concerns about the cumulative nutrient loading into Frank Lake that can potentially impact the Little Bow River downstream of Frank Lake (2015 USL/MPE) (2010 High River WWTP Report).

The water balance at Frank Lake is currently very dependent on the effluent volume from the Town of High River and Cargill WWTPs (2004 MPE). If this volume decreased, the diversion allocation from the

Highwood would become more important to sustain water levels in the lake. Ducks Unlimited has indicated that there is no formal agreement in place for Cargill or High River to direct their effluent to Frank Lake (2015 Ducks Unlimited Email).

Should any preferred regional wastewater option reduce effluent volumes delivered to Frank Lake (from High River or Cargill), a closer look at the impact on Frank Lake should be carried out in consultation with Ducks Unlimited. This may also require consideration of increased diversion from the Highwood River, and/or a treated effluent return pipeline from any regional treatment facility. A more detailed assessment is outside the current scope of this study.

7. LONGVIEW

7.1 Historical Information

The CRP Report states the population of Longview was 307 in 2010, as compared to 334, which was reported in the 2010 Longview Wastewater Stabilization Study by MPE (2010 Longview WW Study). According to this report, the wastewater generation rate in 2009 was 431 L/c/d, which was a reduction of approximately 27% from 2007 and 2008.

The 2010 Longview WW Study indicated the average day flow of the system is 129 m^3/d (386 L/c/d based on a population of 334), maximum day flow is 855 m^3/d and peak hourly flow is 37.5 L/s. The study assumed that future repairs would be done on the sewage collection system that would result in the reduced sewage generation rate of 385 L/c/d.

7.2 Projected Populations

The CRP did not project populations for Longview. The 2010 Longview WW Report projected the population of Longview to be 547 in 2030 based on a linear growth rate of 2.5%. The report does not project populations or flows beyond 2030. Table 2.1 includes population projections beyond 2030 using the same 2.5% growth rate.

7.3 Projected Wastewater Flows

The CRP did not project wastewater flows for Longview. The 2010 Longview Report used an average day flow of 211 m^3/d, maximum day flow of 960 m^3/d and a peak hourly flow of 37.5 L/s based on a design population of 547 for 2030. The report used a per capita generation rate of 385 L/c/d. Table 2.1 includes sewage generation rates of 385 L/c/d as per the 2010 Longview Report up to and including for 2041, and assumes a capped 300 L/c/d sewage generation rate for 2076 as per the CRP Report. It should be noted however that Longview is not being considered as an option for regional servicing in this study.

7.4 Existing Water Licenses & Current Approvals

The Village of Longview has one Water License with a total annual allocation of 98,679 m^3 from shallow wells located on the west edge of Town. The total return flow specified in the License is 88,811 m^3 back into the Highwood River southwest of Town.

There are no current EPEA Approvals for the wastewater treatment facility as it now operates under a code of practice. This is discussed in more detail in Section 7.5.1.

7.5 Existing Wastewater Facilities

Longview operated a mechanical WWTP, with a capacity of 409 m^3/d that was exceeded by 2009. Longview replaced this mechanical WWTP with a conventional wastewater lagoon and lift station in 2011, based on the recommendation from the 2010 Longview WW Study by MPE. It consists of a lift station at the top of the low-lying coulee, and a treatment lagoon consisting of a facultative cell and storage cell designed for a projected population of 598 in 2035, an average daily flow of 231 m^3/d, a maximum daily dry weather flow of 300 m^3/d and a maximum wet weather flow of 988 m^3/d.

7.5.1 Design Basis & Level of Treatment

The lagoon was designed for wastewater flow volume, assuming a typical wastewater influent stream. The existing wastewater lagoon operates under the Code of Practice for Wastewater Systems using a Wastewater Lagoon[26]. The Town of Longview requires monthly grab samples and monitors TSS and $CBOD_5$ prior to discharge.

7.6 Capacity

The lagoon currently has future capacity, as it was designed for an average daily flow of 211 m^3/d, a maximum day flow of 960 m^3/d and a peak hourly flow of 37.5 L/s based on a design population of 547 for 2030. The current average day flow of the system is 129 m^3/d, maximum day flow is 855 m^3/d and peak hourly flow is 37.5 L/s with a population of just over 300.

7.6.1 Effluent Treatment Requirements

The Longview Wastewater Treatment Facility operates under the Code of Practice previously mentioned. Lagoons are built to the specified design and drained once per year between late spring and fall and do not have specified effluent criteria.

[26] Village of Longview Wastewater Treatment Study, Feb 2009 (MPE)

7.6.2 Planned Upgrades

There are currently no planned upgrades to the system as it was just upgraded in 2011, and AEP has not indicated that the new HQ effluent limits would be required for Wastewater Lagoons under the Code of Practice mentioned in Section 7.5.1.

8. NANTON

8.1 Historical Information

The population of Nanton in 2010 was 2,166[27]. Historical data between 2005 and 2010 indicated an average wastewater generation rate of 442.7 L/c/d.

Historical flow data indicated the maximum flows to be 59 L/s, however the 2012 WWTP Report indicated that flows may have peaked higher as this appeared to be the upper limit of the flowmeter. The Town's Infrastructure Master Plan reported a ratio of Maximum Dry Weather Flow to Average Day Dry Flow (MDWF:ADDF) of 2.18.

The CRP estimated the Town's flows to be an average of 551 m^3/d for a population of 2,124 in 2010, with a per capita rate of 287 L/c/d, and a peak flow of 734 m^3/d.

8.2 Projected Populations

The Town of Nanton Wastewater Treatment Facility Evaluation Report estimates the population of Nanton to grow to 4,000 by 2041 (2% growth rate from 2009 population).

The CRP estimates the population to reach 4,392 by 2041 and 6,952 by 2076, which is comparable.
The CRP projections are adopted as per Table 2.1.

8.3 Projected Wastewater Flows

Using a population of 4,000, The Nanton Wastewater Facility report used an MDWF:ADDF of 2.5 to be conservative and found the maximum day wet weather flow to be 4,432 m^3/d, the average dry weather flow to be 1,771 m^3/d and the peak hourly flow to be 7,084 m^3/d. The report used a Harmon's peaking factor of 3.33. The Nanton Wastewater Facility Report used the historical per capita rate of 442.7 L/c/d for projected wastewater flows to the year 2041.

The CRP projected the wastewater generation rate to be 244 L/c/d in 2030, based on a 15% reduction. In the assessment of 2076 system capacity, the CRP assumed a per capita generation of 287 L/c/d, and are reflected in Table 2.1 for completeness. It should be noted however that Nanton is not being considered as an option for regional servicing in this study.

[27] Town of Nanton Wastewater Treatment Facility Evaluation Report, May 2012 (BSEI)

8.4 Existing Water Licenses & Current Approvals

The Town of Nanton has three Water Licenses with a total annual allocation of 725,366 m^3 from shallow wells located in and upstream of Town. The total return flow specified in the Licenses is 493,393 m^3/year back into Mosquito Creek downstream of Town. The current EPEA Approval is further discussed in Sections 8.5.1 and 8.5.3.

8.5 Existing Wastewater Facilities

The Town of Nanton owns and operates a tertiary treatment facility consisting of headworks with grit removal, three rotating biological contactors, primary and secondary clarifiers, a polishing pond, an aerobic digester, and a sludge thickener. Treated effluent is discharged to Mosquito Creek. The facility was constructed in 1980, and had upgrades carried out in 2002 which included[28]:

- New two-stage aerobic digester and thickener
- Upgraded headworks equipment
- Alum injection system
- Upgraded aeration equipment
- Added scum removal to the clarifiers

In 2010 one of the rotating biological contactors (RBC) had a mechanical failure, and effluent quality declined. Shortly after the RBC was repaired, another failed. The Town implemented a bylaw shortly after to require local food processing businesses to install grease traps on their effluent, which greatly improved the quality of the influent wastewater, and the treated effluent.

Stantec`s 2013 Wastewater Treatment Facilities Evaluation Report indicated “a number of the critical process units, such as the primary and secondary clarifier have no redundant unit. Therefore if the primary or secondary clarifier needed to be taken out of service for repair, treatment performance would be severely compromised”. The evaluation report also noted “the RBC units have suffered significant damage”. Stantec noted the presence of significant sludge deposits in the vicinity of the effluent overflow and polishing pond which “suggests significant solids carryover from the secondary clarifier and insufficient solids control at the plant”[29].

8.5.1 Design Basis & Level of Treatment

The wastewater facility was designed for a population of 5,000 with an average flow of 1,890 m^3/d (378 L/c/d). Based on historical data, the average TSS was 9.9 mg/L between 2005 and 2010, but exceeded the Approval criteria in 2011 after the failure of the RBC.

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[28] Town of Nanton Wastewater Treatment Facility Evaluation Report, May 2012 (BSEI)
[29] Town of Nanton Waste and Wastewater Treatment Facilities Evaluation Report DRAFT, 2013 (Stantec)

Average BOD has been 7.3 mg/L, and has been steadily increasing towards the 25 mg/L EPEA Approval limit since the RBC failure.

Average phosphorus from 2008 was 1.39 mg/L, which exceeded the Approval limit of 1.0 mg/L. Since 2009 the phosphorus has remained below 0.86 mg/L. The Town has had to use large quantities of Alum to keep the phosphorus levels below the allowable limit.

The current discharge EPEA Approval requirement for treated effluent to Mosquito Creek stipulates that the Town continuously discharge effluent at a dilution ratio of 10:1. During summer months, the Highwood River diversion provides flow to the creek, but between November and February, the diversion is closed, rendering minimum flows in Mosquito Creek to virtually zero. The Town of Nanton has been out of compliance for their dilution requirements since 2011. In the past, the discharge dilution requirements have been relaxed by the Province. Stantec suggested the construction of effluent storage facilities to accommodate at minimum five months of storage, but noted that there was insufficient space available for such upgrades on site.
In 2014 Stantec conducted a facility condition inspection and assessment and noted the following contraventions to the EPEA Approval:

- The polishing pond was inoperable for a period of time (the Approval requires a polishing pond in the process).
- Sludge dewatering was not available at the time of inspection.
- Between 2010 and 2012, BOD and TSS levels were exceeded periodically, but monthly average effluent concentrations were always in compliance.

8.5.2 Capacity

The facility currently has hydraulic flow capacity for the current population, as it was designed for a population of 5,000 and a flow of 1,890 m^3/d and currently receives an average flow of 959 m^3/d. The plant currently does not have capacity to store treated effluent prior to discharge into Mosquito Creek to ensure dilution compliance.

8.5.3 Effluent Treatment Requirements

Nanton's existing EPEA Approval was amended in 2011 and expires March 1, 2021. The current discharge requirements are:

- Continuous 10:1 effluent discharge dilution ratio to Mosquito Creek
- CBOD ≤ 25 mg/L
- TSS ≤ 25 mg/L
- Total Phosphorus ≤ 1.0 mg/L

8.5.4 Planned Upgrades

BSEI evaluated three upgrade alternatives for the plant, which were based on current effluent requirements, a population of 4,000 by 2041, average dry weather flow of 1,771 m^3/d (442.7 L/c/d), maximum wet weather flow of 4,432 m^3/d and peak flow of 7,084 m^3/d. The three options included:

1. Retrofit/Upgrade Existing WWTP (Capital Cost: $10.16M) included:
   a. Major equipment replacement
   b. Addition of flow equalization cell
   c. Effluent storage pond
2. Conventional Lagoon (Capital Cost: $5.76M)
3. Aerated Lagoon (Capital Cost: $6.59M)

Stantec evaluated an additional two options with the same criteria as above:

1. Sequencing Batch Reactor (SBR):Capital Cost: $5.4M
2. Membrane Bioreactor (MBR): Capital Cost: $5.3M

Of the options evaluated, Stantec recommended exploring the SBR and MBR options further, due to their small footprint, capability of nutrient removal over conventional and aerated lagoons, and lower capital costs. They did not consider upgrades to the plant to meet more stringent criteria than the Town's current Approval.

In 2014 the Town expressed concern to AEP that a "mechanical plant has significant operational costs, including a Level III Waste Water Operator, that are difficult to find and retain". The Town requested AEP provide timely assistance with the following:[30]

- "Provide focused inter-department advice and support in assisting [the Town] with approvals of an appropriate technology" and
- "Provide timely funding to resolve the situation in a manner that is cost effective and considerate of the quality of life for the citizens of the Town of Nanton".

There are currently no planned upgrades underway for the Nanton Wastewater Treatment Facility. The Town is not currently being considered for regional wastewater servicing for this study.

[30] Town of Nanton Waste Water Treatment Plant Crisis Report, 2014 (Town of Nanton)

9. OKOTOKS

9.1 Historical Information

The Town of Okotoks' current population is approximately 27,331[31]. Data between 2010 and 2014 indicated the average annual daily flow was 6,145 m^3/d (225 L/c/d), with a maximum monthly average flow 9,315 m^3/d, a maximum daily flow of 21,552 m^3/d (789 L/c/d), and a peak hourly flow of 1,080 m^3/h (39.5 L/c/h).

The CRP estimated the population of Okotoks to be 23,201 in 2010, with a wastewater generation rate of 232 L/c/d.

9.2 Projected Populations

The CRP estimates the population of Okotoks to grow to 39,705 in 2041 and 58,336 by 2076.

The Town of Okotoks 2014 Growth Study projects that its population will reach 82,152 in 2073.

Stantec[30] projected that by 2039 the population would reach 59,119 and 92,172 by 2065. The projections were based upon BSEI's 2013 Conceptual Water Servicing Review and the "Okotoks – Calgary Regional potable water pipeline, Pre-design Study, Feb 2015". Town staff indicated that updated numbers from Stantec's recent report[30] should be used in this study moving forward for planning purposes, and are based on a linear growth rate of 1,271.5 persons/year.

The population projections shown in Table 2.1 reflect the most recent recommended projections and will be adopted in this study.

9.3 Projected Wastewater Flows

Stantec[30] projected that the AADF (Average Annual Daily Flow) in 2039 and 2065 would be 13,292 m^3/d and 20,724 m^3/d, respectively which corresponds to a generation rate of 225 L/c/d using the population projections referred to in Section 9.2. The report project the MDF (Maximum Daily Flow) in 2039 and 2065 at 46,619 m^3/d and 72,683 m^3/d, respectively. The PHF (Peak Hourly Flow) was 2,336 m^3/d and 3,642 m^3/d for 2039 and 2065, respectively.

The 2009 Wastewater Master Plan approved by EPCOR and the Town used a residential generation rate of 360 L/c/d, and 0.42 L/s/ha for commercial developments within Okotoks, and 0.2 L/s/ha outside the Town limits for future flow generation projections. The report used a PDWF (Peak Dry Weather Flow) to ADWF (Average Dry Weather Flow) ratio of 2:1 for planning purposes.

The CRP projected the wastewater generation rate to be 300 L/c/d in 2030, based on a 15% reduction in potable water demand, and a population cap of 35,000. In the CRP assessment of 2076 facility capacity, a per capita generation of 232 L/c/d was assumed.

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[31] Source: Town of Okotoks Wastewater Treatment Plant Design Basis Memo 1-FINAL, November 2015 (Stantec)

The projected wastewater flows in Table 2.1 are adopted for this study, and reflect the future per capita wastewater generation rates from the CRP and the populations from the 2015 Stantec Report[32].

9.4 Existing Water Licenses & Current Approvals

The Town of Okotoks has 18 Water Licenses with a total annual allocation of 3,359,589 m^3 from shallow wells located in and near the Town. The total return flow specified in the licenses is 2,018,010 m^3 back to the Sheep River downstream of the Town. The EPEA Approval is discussed in Section 9.5.3.

9.5 Existing Wastewater Facilities

The Town of Okotoks currently owns and operates a tertiary treatment facility with fine screening, grit removal, primary clarification, biological nutrient removal plus sequencing batch reactor, secondary clarification, effluent filtration, UV disinfection, sludge management system and a sludge-in vessel.

9.5.1 Design Basis & Level of Treatment

The plant was designed for a capacity of 10,500 m^3/d, according to the CRP report.

Stantec[32] summarized effluent flow data from January 2010 through December 2014, and indicated that the facility has been in compliance for all parameters. The historical effluent quality data is summarized in Table 9.1. There are two distinct periods of analysis (January 1, 2010 to December 31, 2011 and January 1, 2012 to December 31, 2014) due to an amendment of the EPEA Approval that was effective beginning January 1, 2012.

Table 9.1: Okotoks Historical Treatment Performance Data

Parameter	Discharge Limit	Maximum Month	% Above Limit	Period of Analysis
BOD_5 (mg/L)	20	6.4	0%	
TSS (mg/L)	20	3.4	0%	2010-01-01 to 2011-12-31
	15	4.8	0%	2012-01-01 to 2014-12-31
Total Phosphorus (mg/L)	1.0	0.7	0%	2010-01-01 to 2011-12-31
	0.5	0.2	0%	2012-01-01 to 2014-12-31
NH_3-N (mg/L)	10	1.7	0%	Oct 1 to Jun 30, 2010-2014
	5	1.3	0%	Jul 1 to Sep 30, 2010-2014
Total Nitrogen (mg/L)	--	10.1	0%	2010-01-01 to 2011-12-31
	15	12.6	0%	2012-01-01 to 2014-12-31
Total Coliform (#/ 100 mL)	1,000	552	0%	Geometric Mean
Fecal Coliform (#/ 100 mL)	200	125	0%	Geometric Mean

Source: Town of Okotoks Wastewater Treatment Plant Design Basis Memo 1-FINAL, November 2015 (Stantec)

32 Source: Town of Okotoks Wastewater Treatment Plant Design Basis Memo 1-FINAL, November 2015 (Stantec)

9.5.2 *Capacity*

According to the CRP, the wastewater treatment plant will exceed its capacity by 2030, based on a capacity of 10,500 m^3/d and assuming the current generation rate of 232 L/c/d. The actual plant capacity is currently being reviewed by Stantec and this report is pending.

9.5.3 *Effluent Treatment Requirements*

The current EPEA Approval requirements (effective January 1, 2012 through May 1, 2016) for Okotoks are shown in the table below.

Table 9.2: Okotoks EPEA Approval Treatment Requirements

Parameter	Criteria
CBOD	≤ 20 mg/L (monthly arithmetic mean of daily samples)
TSS	≤ 15 mg/L (monthly arithmetic mean of daily samples)
Total Phosphorus	≤ 0.5 mg/L (monthly arithmetic mean of daily samples)
Ammonia	≤ 5 mg/L (July 1 to September 30) ≤ 10 mg/L (October 1 to June 30) (monthly arithmetic mean of daily samples)
Total Nitrogen	≤ 15 mg/L (monthly arithmetic mean of weekly calculated weekly concentration)
Total Coliform	≤ 1,000 per 100 mL (monthly geometric mean of weekly samples)
Fecal Coliform	< 200 per 100 mL (monthly geometric mean of weekly samples)

Source: Town of Okotoks Wastewater Treatment Plant Design Basis Memo 1-FINAL, November 2015 (Stantec)

The Okotoks EPEA Approval had expired in May 2015, and has been extended for one year, to allow for time to plan a wastewater servicing solution that will meet the new HQ standards and Okotoks growth scenario.

9.5.4 *Planned Upgrades*

Stantec is currently undertaking a study for the Town of Okotoks to evaluate wastewater servicing options to accommodate the Town's growth strategy.

The design basis used in Stantec's study is summarized in the Table 9.3, and uses the maximum month sustained loadings for the secondary treatment system. The maximum day flow condition was selected as the design basis for sizing equalization basins, aeration blowers, and sludge pumping systems. Peak hourly flow was selected as the design basis for hydraulic sizing of pumping facilities, conduits, physical unit operations (grit systems, sedimentation tanks, and filters), and disinfection.

Table 9.3: Okotoks Design Basis

Parameter	Unit	Year 2039	Year 2065
Population	Capita	59,119	92,172
AADF	m^3/d	13,292	20,724
MDF	m^3/d	46,619	72,683
PHF	$m^3/d\backslash h$	2,336	3,642
MDL BOD_5	kg/d	11,923	18,589
MML BOD_5	kg/d	6,186	9,645
MML TSS	kg/d	8,161	12,724
MML TAN	kg/d	381	594
MML TP	kg/d	117	182

Source: Town of Okotoks Wastewater Treatment Plant Design Basis Memo 1-FINAL, November 2015 (Stantec)

10. Moving Forward

Based on the information gathered in this memorandum, the CRP and other available population projections as well as total sanitary flow projections as provided in Table 2.1 will be adopted in this study, as agreed with the FRWWC Governance and Technical Committees at a meeting on September 10, 2015.

The new higher quality (HQ) AEP effluent targets will need to be considered for any future upgrade plans, and will be adopted in this study. This was also confirmed at the September 10, 2015 meeting.

The table below indicates historical information currently available based on this memorandum, and the further action required to complete this study within the proposed timeframe. Although future flow projections are important for hydraulic sizing, feasible treatment options in this study will be based upon both nutrient loading and flows, which can include a significant peaking allowance for inflow and infiltration (I&I).

Table 10.1: Study Information Moving Forward

Area	Existing Reports Project to 2076 Population?	Existing Reports Project Total Sanitary Per Capita Flows to 2076?	Existing Reports' Upgrades Consider New AEP Standard?	Decision and/or Further Action Required
Black Diamond/Turner Valley (Westend)	No	No	No	Table 2.1 indicates populations and flows to be used in the study. Additional scope change is pending. This change would assess upgrades to address 2076 flows that consider the new AEP standard.
Central District/Aldersyde (MD Foothills)	No	No	n/a	Table 2.1 indicates populations and flows to be used in the study. Since no MD plant currently exists in the MD study area, existing information on future upgrade requirements for the new AEP criteria is not applicable.

Area	Existing Reports Project to 2076 Population?	Existing Reports Project Total Sanitary Per Capita Flows to 2076?	Existing Reports' Upgrades Consider New AEP Standard?	Decision and/or Further Action Required
				Windwalk plant is proposed and EPEA application is about to be submitted. Additional scope change is pending. This would assess an additional MD plant within the existing study options.
High River	No	No	No	Table 2.1 indicates populations and flows to be used in the study. Determine upgrades to 2076 flows and consider new AEP HQ standard for Option 3. Determine and/or adopt minimum flow requirements into Frank Lake to maintain proper lake operation.
Longview	No	No	No	No action required – Longview is not being considered as a regional WWTP option
Nanton	No	No	No	No action required – Nanton is not being considered as a regional WWTP option
Okotoks	Yes	Yes	No	Table 2.1 indicates populations and flows to be used in the study. Obtain TM-2 to TM-5 from Stantec regarding proposed upgrades to meet the new AEP HQ standard.

Sincerely,

URBAN SYSTEMS LTD.

Steve Brubacher, P.Eng.
Principal

Leigh Chmilar, P.Eng..
Water Engineer

/SB/LC

Attach.

U:\Projects_CAL\2239\0005\01\R-Reports-Studies-Documents\R1-Reports\DRAFT\TechMemo1-DRAFT\2015-08-24-MEM-FRWWC Planning and Projections-TM1-DRAFTREV1.docx

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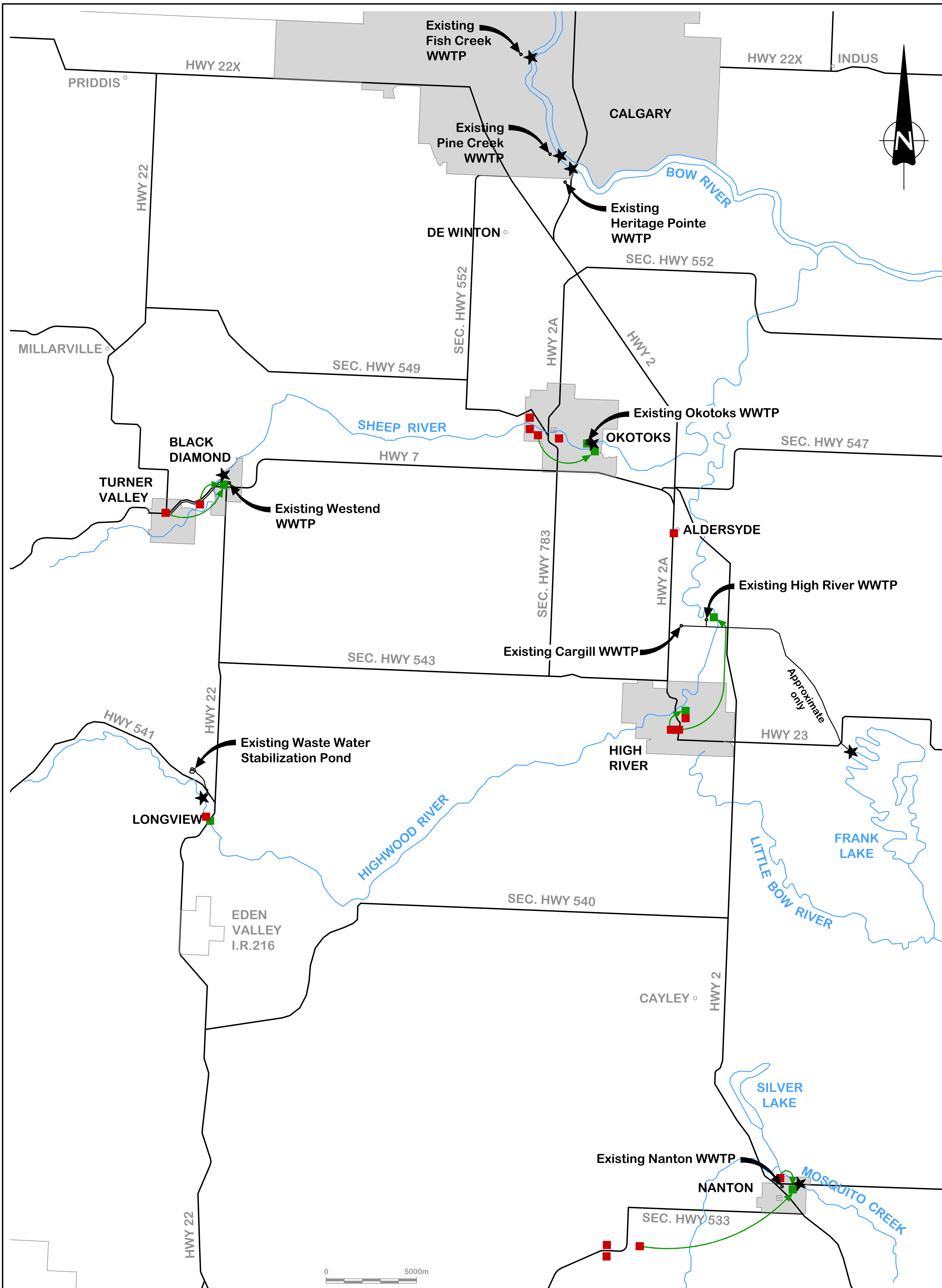
APPENDIX A:

FIGURE 1.1 - FRWWC Sub-Regional Waste Water Treatment Feasibility Study Municipal Water Act Licenses



Point of diversion in water license

Location of return flow in water license, if specified

Effluent outfall pipe

Existing Waste Water Outfall

URBAN systems | MPE Engineering Ltd.

FOOTHILLS REGIONAL WATER & WASTEWATER COLLABORATIVE

FRWWC SUB-REGIONAL WASTE WATER TREATMENT FEASIBILITY STUDY
MUNICIPAL WATER ACT LICENSES (AS OF AUG 26, 2015)

SCALE: 1:200,000	DATE: SEPTEMBER 2015	JOB: 2210-047-00	FIGURE: 1.1

APPENDIX B:

Table 3.2 – FRWWC Water Act License Details

Table 3.2: FRWWC - Water Act Licences Details

Licence Holder	Total Allocation	Environmental Management System (EMS) database identification number	ESRD File Number	Water Act Licence Number / Interim Licence Number	Reason for Issuance	Purpose	Expiry	Priority Number	Annual Allocation		Source	Consumption		Losses		Return Flow		Point of Diversion	Point of Return Flow	Receiving Stream	MPE comment
	m^3								m^3	acre-feet		m^3	other units	m^3	other units	m^3	other units				
Black Diamond	**954,679**	00034414-00-00	16689	9684	Water Allocation	Municipal	no expiry	1978-08-14-02 1979-08-31-01 1979-08-31-04	**954,679**	774	aquifer aquifer aquifer	95,468	7 m gallons 7 m gallons 7 m gallons	0	Nil	859,211	189 m gallons	5-8-20-2-5	11-16-20-2-W5	not specified	shallow wells; likely connected to Sheep River, so likely a transferable licence.
		00034414-00-01			new reporting requirements																amendment
Turner Valley	**514,389**	00032889-00-00	18466	20226	Water Allocation	Municipal	no expiry	1994-02-22-19	**93,650**	76	aquifer	9,547	2.1 m gallons	0	Nil	84,103	18.5 m gallons	12-6-20-2-5	SW 16-20-2-W5	not specified	shallow well; likely connected to Sheep River, so likely a transferable licence; return flow to Sewage Treatment Facility.
		00032889-00-01			add Raw Water Reservoir																amendment
		00032889-00-02			new reporting requirements																amendment
		00032890-00-00	18466	10990	Water Allocation	Municipal	no expiry	1979-01-11-05 1980-11-04-02	**121,835**	99 10	aquifer	24,549	5.4 m gallons	0	Nil	97,286	21.4 m gallons	12-6-20-2-5	SW 16-20-2-W5	not specified	shallow well; likely connected to Sheep River, so likely a transferable licence.
		00032890-00-01			add Raw Water Reservoir																amendment
		00032890-00-02			new reporting requirements																amendment
		00032891-00-00	18466	10989	Water Allocation	Municipal	no expiry	1979-01-11-04 1980-11-04-01 1980-11-04-05	**116,835** **standby**	95 10 standby	aquifer	23,640	5.2 m gallons	0	Nil	93,195	20.5 m gallons	12-6-20-2-5	SW 16-20-2-W5	not specified	shallow wells; likely connected to Sheep River, so likely a transferable licence.
		00032891-00-01			add Raw Water Reservoir																amendment
		00032891-00-02			new reporting requirements																amendment
		00032892-00-00	18466	10987	Water Allocation	Municipal	no expiry	1979-01-11-02 1979-01-11-03	**36,369** **standby**	30 standby	aquifer	7,274	1.6 m gallons	0	Nil	29,095	6.4 m gallons	12-6-20-2-5	SW 16-20-2-W5	not specified	shallow well; likely connected to Sheep River, so likely a transferable licence.
		00032892-00-01			add Raw Water Reservoir																amendment
		00032892-00-02			new reporting requirements																amendment
		00076672-00-00	18466	00076672-00-00	Water Allocation	Municipal	Nov 02, 2024	1999-04-29-003	**145,700**	118	Sheep River	145,700		not specified		not specified		NW 6-20-02-W5	not specified	not specified	shallow wells connected to Sheep River, so a transferable licence; max diversion 851 m^3/day subject to Instream Flow Needs.
		00076672-00-01			add Raw Water Reservoir																amendment
		00076672-00-03			relocate well																amendment
		00034156-00-00	17028	8862	Water Allocation	Industrial (processing)	no expiry	1958-12-31-03 1958-12-31-04	**49,098**	40	aquifer	49,098	5.4 m gallons 5.4 m gallons	not specified		not specified		5-27-20-29-4	not specified	not specified	shallow well; may be connected to Sheep River, so likely a transferable licence.
		00034156-00-01			change name, change purpose to 'Municipal'																amendment
		00035104-00-00	15800	19350	Water Allocation	Municipal	no expiry	1996-11-29-01	**91,278**	74	Sheep River	18,502	15 ac-ft	0	nil	72,775	59 ac-ft	5-29-20-29-4	not specified	not specified	transferable licence; max diversion rate, subject to Instream Objectives.
		00035104-00-02			Diversion conditions																amendment
		00035104-00-03			add 1 well																amendment
		00035105-00-00	15800	10348	Water Allocation	Municipal	no expiry	1979-12-10-01 1985-01-22-05	**791,020**	641	Sheep River	79,102	17.4 m gallons	0	nil	711,918	156.6 m gallons	8-29-20-29-4 and 5-28-20-29-4	NW 22-20-29-W4	Sheep River	transferable licence.
		00035105-00-01			add 1 well																amendment
		00035105-00-02			add 1 well																amendment
		00035105-00-03			new reporting conditions																amendment
		00035110-00-00	15800	10347	Water Allocation	Municipal	no expiry	1952-12-31-02 1985-01-22-04	**81440** **169050**	66 137	Sheep River	25,004	5.5 m gallons	0	nil	225,486	49.6 m gallons	8-29-20-29-4	NW 22-20-29-W4	Sheep River	transferable licence.
		00035110-00-01			add 1 well																amendment
		00035110-00-02			add 1 well																amendment
		00035110-00-03			new reporting conditions																amendment
		00035112-00-00	15800	13513	Water Allocation	Municipal	no expiry	1985-01-22-03 1985-01-22-07	**660,910**	536	Sheep River	131,837	29 m gallons	0	nil	529,165	116.4 m gallons	5-28-20-29-4 and 8-29-20-29-4	NW 22-20-29-W4	Sheep River	transferable licence.
		00035112-00-01			add 1 well																amendment
		00035112-00-02			add 1 well																amendment
Okotoks	**3,359,589**	00035112-00-03			new reporting conditions																amendment
(continued on next page)		00035112-00-04			add 1 well																amendment

Licence Holder	Total Allocation	Environmental Management System (EMS) database identification number	ESRD File Number	Water Act Licence Number / Interim Licence Number	Reason for Issuance	Purpose	Expiry	Priority Number	Annual Allocation		Source	Consumption		Losses		Return Flow		Point of Diversion	Point of Return Flow	Receiving Stream	MPE comment
	m^3								m^3	acre-feet		m^3	other units	m^3	other units	m^3	other units				
Okotoks	**3,359,589**	00072884-00-00	15800	00072884-00-00	Water Allocation	Municipal	no expiry	1992-06-10-011	**11,101**	9	Sheep River	11,101		not specified		not specified		09-30-20-29-W4	NW 22-20-29-4	not specified	transferable licence; max diversion rate of 3208 m^3/day, subject to Instream Objectives.
		00072884-00-01			clerical correction																amendment
		00072884-00-02			add 1 well																amendment
		00072884-00-03			new reporting conditions																amendment
		00074820-00-00	15800	00074820-00-00	Water Allocation	Municipal	Feb 29, 2024	1999-03-22-001	**444,056**	360	Sheep River	444,056		not specified		not specified		09-30-20-29-W4	NW 22-20-29-4	not specified	transferable licence; max diversion rate of 3208 m^3/day.
		00074820-00-01			new reporting conditions																amendment
		00074820-00-02			new monitoring conditions																amendment
		00074820-00-03			add 1 well																amendment
		00074820-00-04			new reporting conditions																amendment
		00191251-00-00	15800	00191251-00-00	Water Allocation	Municipal	Nov 25, 2028	2002-08-29-001	**454,372**	368.4	Sheep River	454,372		not specified		not specified		12-29-20-29-W4	not specified	not specified	transferable licence; max diversion rate of 1649 m^3/day.
		00191251-00-01			add 1 well																amendment
		00191251-00-02			new reporting conditions																amendment
		00202472-00-00	15800	00202472-00-00	Water Allocation	Municipal	Nov 25, 2028	1992-06-10-010	**62,908**	51	Sheep River	62,908		not specified		not specified		05-29-20-29-W4	NW 22-20-29-W4	not specified	transferable licence; max diversion rate of 1649 m^3/day, subject to Instream Objectives.
		00202472-00-01			add 1 well																amendment
		00202472-00-02			new reporting conditions																amendment
		00210793-00-00	210101	00210793-00-00	Water Allocation	Municipal (stormwater pond)	?	2004-06-25-002	**6,916**	5.6	Sheep River trib	6,916		not specified		not specified		NW 27-20-29-W4	not specified	not specified	Preliminary Certificate only; may be expired.
		00268349-00-00	268349	00268349-00-00	Water Allocation	Municipal	Dec 20, 2035	1944-09-15-001	**28,864**	23.4	Sheep River	28,864		not specified		not specified		S 29-20-29-W4	not specified	not specified	transferable licence; max diversion rate of 0.022 m^3/s.
		00268353-00-00	268353	00268353-00-00	Water Allocation	Municipal	Dec 16, 2035	1980-12-04-001	**216,476**	175.5	Sheep River	216,476		not specified		not specified		S 29-20-29 W4	not specified	not specified	transferable licence; max diversion rate of 0.009 m^3/s.
		00283404-00-00	283404	00283404-00-00	Water Allocation Transfer	Municipal (Urban Water Supply)	Sep 18, 2036	1977-03-24-005	**36,634**		aquifer	36,634		not specified		not specified		SE 29-020-29-W4 and SW 28-020-29-W4	not specified	not specified	max diversion rate of 0.02 m^3/s.
		00327785-00-00	327785	00327785-00-00	Water Allocation Transfer	Municipal (Urban Water Supply)	Sep 11, 2038	1944-09-15-001	**45,516**	36.9	Sheep River (East Well Field)	45,516		not specified		not specified		SE 29-020-29-W4 and SW 28-020-29-W4	not specified	not specified	likely a transferable licence; max diversion rate of 0.023 m^3/s.
		00336563-00-00	336563	00336563-00-00	Water Allocation Transfer	Municipal (Urban Water Supply)	Aug 12, 2039	1983-05-31-014	**15,231**		Sheep River (East Well Field)	15,231		not specified		not specified		SE 29-020-29-W4 and SW 28-020-29-W4	not specified	not specified	likely a transferable licence; max diversion rate of 0.012 m^3/s, subject to Instream Objectives.
		00342912-00-00	342912	00342912-00-00	Water Allocation Transfer	Municipal (Urban Water Supply)	April 3, 2039	1977-03-24-004	**85,037**		Sheep River (East Well Field)	85,037		not specified		not specified		SE 29-020-29-W4 and SW 28-020-29-W4	not specified	not specified	likely a transferable licence; max diversion rate of 0.042 m^3/s, subject to Instream Objectives.
		00348644-00-00	348644	00348644-00-00	Water Allocation Transfer	Municipal (Urban Water Supply)	Aug 12, 2039	1964-03-20-002	**99,912**		Sheep River (East Well Field)	99,912		not specified		not specified		SE 29-020-29-W4 and SW 28-020-29-W4	not specified	not specified	likely a transferable licence; max diversion rate of 0.012 m^3/s, subject to Water Conservation Objectives.
		00353780-00-00	353780	00353780-00-00	Water Allocation Transfer	Municipal (Urban Water Supply)	June 15, 2040	1982-03-17-015	**9,770**		Sheep River (East Well Field)	9,770		not specified		not specified		SE 29-020-29-W4 and SW 28-020-29-W4	not specified	not specified	likely a transferable licence; max diversion rate of 0.003 m^3/s, subject to Instream Objectives.
High River	**4,623,245**	00045674-00-00	462	20593	Water Allocation	Municipal	no expiry	1995-01-27-10 1995-01-27-11 1995-01-27-12	**2,522,626**	2044	aquifer	504,616	111.0 m gallons	0	nil	2,018,010	443.9 m gallons	6-6-19-28-4 and 7-6-19-28-4	SW 29-19-28-W4, into Town of High River sewage treatment facility	Highwood River *	shallow well; may be connected to Highwood River, so likely a transferable licence.
		00045674-00-01			?																amendment
		00045675-00-00	462	12974	Water Allocation	Municipal	no expiry	1984-02-13-02 1984-02-13-03 1984-02-13-04	**990,486**	803	aquifer	198,210	43.6 m gallons	0	nil	792,838	174.4 m gallons	11-6-19-28-4 and 12-6-19-28-4	15-6-19-28-W4, into Town of High River sewage treatment facility	Highwood River *	shallow well; may be connected to Highwood River, so likely a transferable licence.
		00045675-00-01			?																amendment
		00045675-00-02			?																amendment
		00045676-00-00	462	8805	Water Allocation	Municipal	no expiry	1927-12-31-01	**62,907**	51	aquifer	222,304	48.9 m gallons	0	nil	888,761	195.5 m gallons	6-6-19-28-W4 and 12-6-19-28-W4 and 7-6-19-28-W4	3-29-19-28-W4, into Town of High River sewage treatment facility	Highwood River *	shallow well; may be connected to Highwood River, so likely a transferable licence.
								1939-06-30-05 1939-06-30-06	**363,877**	295											
								1972-07-07-01 1972-07-07-02	**550,133**	446											
								1977-03-02-02	**4,934**	4											
								1978-03-15-03	**128,282**	104											
		00045676-00-01			?																amendment
		00045676-00-02			?																amendment
Longview	**98,679**	00031154-00-00	20232	12081	Water Allocation	Municipal	no expiry	1982-12-10-01	**98,679**	80	aquifer	9,868	2.2 m gallons	0	nil	88,811	19.8 m gallons	15-17-18-2-5	9-17-18-2-W5	Highwood River	shallow well; likely connected to Highwood River, so likely a transferable licence.
		00031154-00-01			new reporting requirements																amendment

** Note: High River Water Licenses indicate point of return flow is to the Highwood River. However, point of actual return flow is to Frank Lake, which discharges to the Little Bow River.*

Licence Holder	Total Allocation	Environmental Management System (EMS) database identification number	ESRD File Number	Water Act Licence Number / Interim Licence Number	Reason for Issuance	Purpose	Expiry	Priority Number	Annual Allocation		Source	Consumption		Losses		Return Flow		Point of Diversion	Point of Return Flow	Receiving Stream	MPE comment
	m^3								m^3	acre-feet		m^3	other units	m^3	other units	m^3	other units				
Nanton	**725,366**	00031062-00-00	20325	15016	Water Allocation	Municipal	no expiry	1982-08-17-03	**616,741**	500	Mosquito Creek	104,846	85 ac-ft	18,502	15 ac-ft	493,393	400 ac-ft	SW 22-16-28-W4	NE 15-16-28-4	Mosquito Ck	transferable licence; max diversion rate 0.09910896 m^3/s.
		00031062-00-01			new reporting requirements																amendment
		00033114-00-00	18213	13450	Water Allocation	Municipal	no expiry	1978-12-07-02	**18,502**	15	aquifer		0.4 m gallons		nil		3.7 m gallons	10-2-16-29-4	NE 15-16-28-W4	Mosquito Ck	well may be connected to Mosquito Creek, so possibly a transferable licence.
		00033114-00-01			new reporting requirements																amendment
		00045700-00-00		1369	Water Allocation	Municipal (domestic)	no expiry	1954-08-16-001	**90,123**	73	Springhill Creek trib	not specified		not specified		not specified		W 3-16-29-W4	not specified	not specified	transferable licence; max diversion rate of 0.01 m^3/s.
		00045700-00-01			Reduction in Allocation due to Transfer																
MD of Foothills (in DeWinton area)	**7,600**	00196188-00-00	153819		Water Allocation	Municipal	14-Apr-28	2003-02-18-001	**7,600**	6.2	aquifer	not specified		not specified		not specified		SW 27-21-29-W4	not specified	not specified	
		00196088-00-01			amendment																added second production well
MD of Foothills (in Aldersyde area)	**476,131**	00028125-00-00	23346	17846	Water Allocation	Municipal (Urban Water Supply)	no expiry	1990-01-31-03	**119,648**	97	Aquifer through the works of High River	119,648	26.3 million Canadian gallons	Nil		Nil		4-7-20-28-4 (re-diversion site)	not specified	not specified	
		00028125-00-01			amendment																montioring changes
		00038629-00-01	11310	1991 01 15	Silvertip	Municipal	no expiry	1963-04-19-001	**148,020**	120	Highwood River			Nil		Nil		SW 18-20-28-W4	not specified		
		00034029-00-01	17172	1993 03 19	Kennedy			1982-02-04-12	**2,467**	2	Coulee tributary to Highwood River				1 acre-ft	Nil		NW 7-20-28-W4	not specified		being transferred
		00032886-00-01	18470	1985 01 21				1978-02-21-010	**205,995**	167	Mosquito Creek			Nil		Nil		NW 29-18-24-W4	not specified		being purchased

APPENDIX B

Technical Memorandum 2 – Stream Analysis

MEMORANDUM

Date:	November 20, 2015
To:	Foothills Regional Water & Wastewater Collaborative
cc:	Lynda Cooke, P.Eng., Steve Brubacher, P.Eng., Randy Boras, M.Sc., P.Eng., Sarah Fratpietro, P.Eng.
From:	Dr. Joanne Harkness, Aaron Coelho M.Sc., A.Ag.
File:	2239.0005.01/2210-047-00
Subject:	Technical Memorandum 2: Foothills Stream Analysis

1. INTRODUCTION

The Foothills Regional Water and Wastewater Collaborative (FRWWC) is exploring a sub-regional solution for water and wastewater management in the short (< 10 years), medium (25 years), and long-term (50 years). For consistency with past Calgary Regional Partnership work, the long-term timeframe has been modified from 50 years to 60 years. In the next 60 years, this sub-region could more than quadruple in population. With growth, increased water demand and new discharges from sanitary effluent, stormwater and other sources will put additional pressure upon water sources and receiving streams. The purpose of this memorandum is to collate and review available information on key surface waters in the area in order to provide input on the issues, constraints and carrying capacity. This information is summarised below and will be used to inform the treatment and related water management issues.

The feasibility study to explore a regional solution for water and wastewater management is being completed in collaboration by the MPE Engineering Ltd. and Urban Systems Ltd. This memorandum has been completed largely by Urban System Ltd.

1.1 Background Information

The assessment focuses on the major water sources and receiving streams in the Municipal District of Foothills, specifically, the Upper Little Bow River, Highwood River, Sheep River and Mosquito Creek. The attached figure indicates the four key surface waters and related important features. The Upper Little Bow River and Mosquito Creek are part of the Oldman River sub-basin and the Highwood River and Sheep River are part of the Bow River sub-basin. These two sub-basins are connected through diversions from the Highwood River to Mosquito Creek and the Highwood River to the Upper Little Bow River. These diversions are part of the Little Bow Storage and Highwood Diversion Plan which supplies water to the Oldman River sub-basin, which typically receives lower precipitation inputs and has higher irrigation demands, and reduce water demand impacts on the lower Highwood River fishery habitat. The Bow River sub-basin and the Oldman River sub-basin are both part of the South Saskatchewan River basin, with the South Saskatchewan River starting with the confluence of Bow and Oldman Rivers.

The Upper Little Bow River, Highwood River, Sheep River and Mosquito Creek are the major sources of water for municipal drinking water, irrigation and industrial use in the Municipal District of Foothills. They are also receiving bodies for municipal and industrial effluent, and agricultural and storm run-off. In order to assess the factors which could affect municipal servicing in the short, medium and long term, information on water usage, water licences, authorised effluent releases, river flow and water quality were collated and reviewed.

1.2 Information Sources

Existing data and information were collated and reviewed from a range of sources. Information on water licences and authorised effluent releases were obtained from the Alberta Environment and Parks (AEP) water licence viewer and authorisation viewer, respectively. Due to the large number of water licences in the Municipal District of Foothills, only direct surface diversions from the Upper Little Bow River, Highwood River, Sheep River and Mosquito Creek were reviewed. Water diversion from tributaries and the surrounding aquifers was not included in this review, although it should be recognised that water licences on the tributaries have been transferred in the past to the mainstem rivers and that this could occur again in the future. Flow data for the four water courses were obtained from Water Survey Canada. Information regarding water quality concerns was summarised from various reports and water management plans, which were accessed through various sources. Raw water quality data were accessed through the AEP River Network Station Water Quality Database, although the intent of this information review was not to complete a comprehensive assessment of the available water quality data.

The Upper Little Bow River, Highwood River, Sheep River and Mosquito Creek provide habitat for a variety of fish species. The species which are known to be present in these water sources were identified using the Fisheries Inventory Data Queries website and their Provincial and Federal status determined. The Provincial ranking, or listing categories, describe species which require special attention. The Provincial rankings are:

- **At Risk:** Any species known to be at risk after a formal detailed status assessment and legal designation as *Endangered* or *Threatened* in Alberta.
- **May Be At Risk:** Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment.
- **Sensitive:** Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.
- **Secure:** A species that is not *At Risk*, *May Be At Risk* or *Sensitive*.
- **Undetermined:** Any species for which insufficient information, knowledge or data is/are available to reliably evaluate its general status.
- **Not Assessed:** Any species that has not been examined.
- **Exotic/Alien:** Any species that has been introduced as a result of human activities.
- **Extirpated/Extinct:** Any species no longer thought to be present in Alberta (*Extirpated*) or no longer believed to be present anywhere in the world (*Extinct*).
- **Accidental/Vagrant**: Any species occurring infrequently and unpredictably in Alberta, i.e., outside its usual range. These species may be in Alberta due to unusual weather occurrences, an accident during migration or unusual breeding behaviour by a small number of individuals. If a species appears in Alberta with increasing predictability and more frequently, it may eventually be given a different rank. Changes in *Accidental/Vagrant* species may be a good indicator of general ecosystem or climatic changes.

On the Federal level, species ranking is conducted by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), established under Section 14 of the *Species at Risk Act* (SARA). COSEWIC is a committee of experts that assesses and designates, under Sections 15 to 21 of the SARA, those wild species of animal, plant or other organisms that are in danger of disappearing from Canada. Schedule 1 of the SARA is the official list of species that are classified as extirpated, endangered, threatened and of special concern. It should be noted that only species listed on Schedule 1 of the SARA are considered protected under the Act. However, species of special concern, are not protected under the Act, but may be protected provincially or under regional management plans. Below is a listing of the status categories used by COSEWIC:

- **Extinct**: a species that no longer exists.
- **Extirpated**: a species no longer existing in the wild in Canada, but occurs elsewhere.
- **Endangered**: a species facing imminent extirpation or extinction.
- **Threatened**: a species likely to become endangered if limiting factors are not reversed.
- **Special Concern**: a species that is particularly sensitive to human activities or natural events, but is not an endangered or threatened species.
- **Data Deficient**: a species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction.
- **Not At Risk**: a species that has been evaluated and found to be not at risk.

2. UPPER LITTLE BOW RIVER

2.1 Background Information

The Little Bow River is approximately 190 km long and flows from its headwaters in the Town of High River southeast to its confluence with the Oldman River. On route to the Oldman River from the Town of High River, it flows through two reservoirs, the Twin Valley Reservoir and the Travers Reservoir. The Upper Little Bow River is approximately 50 km long and consists of the northern most section of the Little Bow River and flows from the Town of High River to the Twin Valley Reservoir.

A diversion canal from the Highwood River to the Upper Little Bow River is located in the headwaters of the Upper Little Bow River. The original canal was built in the 1890’s, with various modifications and additions since. In 2004, the canal was rehabilitated as part of the Twin Valley Dam and Reservoir project. The project included an expansion of the canal and headworks located in the Town of High River in order to increase the rate of flow diversion from the Highwood River to the Upper Little Bow River. As a result of the works, the current maximum flow rate through the canal is 8.5 m^3/s (300 cu.ft/.sec). The downstream dams and reservoirs, along with the canal expansion, are intended primarily to supply water to meet the agricultural irrigation and municipal demands in the Little Bow basin. Secondary objectives are to maintain sufficient flows to support a healthy riparian and aquatic environment in the Little Bow River.

2.2 Water Usage, Licences and Authorised Effluent Releases

There are many water uses for the Upper Little Bow River including domestic water supply, irrigation, fisheries habitat and recreation (i.e. sport fishing, boating and camping). The recreational uses are more predominant for the Twin Valley Reservoir than the Upper Little Bow River.

There are 78 surface water diversion licences in the Upper Little Bow River Water Management Area that identify the Little Bow River as the source (Table 2.1). The combined maximum annual quantity that may be diverted under these 78 licences is 6,938,066 m^3. There is no return flow requirement for these licences, although the diversion is dependent on demand and the need to meet conveyance flow and/or in-stream flow objectives. The licences authorise the use of water from the Little Bow River for municipal, irrigation, agricultural, commercial and government holdback purposes, with the highest number of licences and the greatest volume requirement both being related to irrigation requirements.

Table 2.1: Surface Water Diversion Licences from the Little Bow River within the Upper Little Bow River Water Management Area

Purpose	Number of Licences	Combined Maximum Annual Quantity Diverted (m^3)
Irrigation	46	5,513,594
Municipal	7	950,865
Agriculture	7	310,248
Government Holdback	16	101,137
Commercial	2	62,222
Total	**78**	**6,938,066**

No approvals for the direct discharge of effluent to the Upper Little Bow River were identified. However, both the Town of High River (EPEA Approval No. 776-02-00) and the Cargill Foods Ltd. beef slaughterhouse (EPEA Approval No. 683-03-00) discharge treated effluent to Frank Lake. Frank Lake is connected to one of the tributaries of the Upper Little Bow River by a canal. Frank Lake is a productive wetland for many different species of birds. During the drought in the 1980's, concerns were raised on the decreasing the water levels in the lake. This was one of the factors in the development of a partnership between industry and municipal, Provincial and Federal governments which resulted in the effluent from the Town of High River and the Cargill Foods Ltd. beef slaughterhouse near High River becoming a long-term water supply for the lake. The receipt of these effluents included the consideration that Frank Lake would act as a polishing area for the effluent. Therefore, the effluent standards were not stringent, especially with respect to nutrient concentrations. For the first few years after the effluents were released to Frank Lake, there was no discharge of water from the lake into the Upper Little Bow River. However, over time, as the water levels in Frank Lake have been increasing both as a result of the effluent inputs and run-off during wet years, there are periodic releases from the lake, especially during the spring freshet conditions, when flows are elevated. The outlet of Frank Lake into the Upper Little Bow River is located approximately 30 km upstream of the Twin Valley Reservoir.

The approval for the Town of High River is for a lagoon system capable of producing an effluent quality of ≤ 25 mg/L as 5 day carbonaceous biochemical oxygen demand ($CBOD_5$), with the release being to Frank Lake as standard and the Highwood River in an emergency. The approval requires an upgrade the wastewater treatment facility to a sequencing batch reactor, which is capable of higher treatment for $CBOD_5$ and total suspended solids (TSS), plus treatment for ammonia and phosphorus. The effluent quality requirements are summarised in Table 2.2. No volumes for the release are stipulated in the approval.

Table 2.2: Effluent Quality Requirements – Town of High River

Parameter	Concentration (as monthly arithmetic mean)
$CBOD_5$	≤ 20 mg/L
TSS	≤ 20 mg/L
Phosphorus	≤ 1 mg/L
Ammonia (1 Oct to Jun 30)	≤ 10 mg/L
Ammonia (1 Jul to 30 Sep)	≤ 5 mg/L

The approval for Cargill Foods Ltd. is for a lagoon system, which treats the industrial wastewater. The effluent is authorised to be released to Frank Lake or used for irrigation. Table 2.3 summarises the effluent quality for the release to Frank Lake. No volume for the release is stipulated in the approval, although the approach to using loading for organic matter, suspended solids, ammonia and phosphorus will allow a balance to be maintained between concentration and flows from the facility.

The Upper Little Bow River provides habitat for 16 identified fish species. For the fish recorded as being present in the Upper Little Bow River, the bull trout (Sensitive) and the spoonhead sculpin (May Be At Risk) have Provincial designations. For the Federal status, the bull trout is designated as Threatened by COSEWIC, however it is not included on Schedule 1 of the SARA.

Table 2.3: Effluent Quality Requirements – Cargill Foods Ltd.

Parameter	Limits	
pH	≥ 6.5 and ≤ 8.5	
Floating Solids	Must not be present except in trace amounts	
Visible Foam	Must not be present except in trace amounts	
Oil or Other Substances	Must not be present in amounts sufficient to create a visible film or sheen	
Faecal Coliform Counts	≤ 200/100 mL (monthly geometric mean	
	Maximum Daily Average (for any month)	**Maximum Day**
BOD_5	≤ 60 kg/d	≤ 120 kg/d
TSS	≤ 150 kg/d	≤ 300 kg/d
Phosphorus	≤ 40 kg/d	≤ 80 kg/d
Ammonia	≤ 125 kg/d	≤ 250 kg/d

2.3 River Flow

The flow in the Upper Little Bow River is controlled by the headworks for the diversion canal from the Highwood River in the Town of High River. Flow data for the Upper Little Bow Canal at High River (05BL015) were obtained from Water Survey Canada. This hydrometric station is the furthest upstream on the Upper Little Bow River. The data from this gauging station represent the available flow for water usage between the Town of High River and the Twin Valley Reservoir. The flows at this location have been recorded since 1910, but for the purpose of this analysis, the focus will be the more recent flow patterns for the last 30 years.

Using the flow data from 1984 to 2014, the diversion of freshet flows from the Highwood River to the Upper Little Bow River typically start in May and reach peak flows by June. The low flow months occur over the winter with the lowest flows being in the January/February time period. Although the typical low flow period is during the winter months, the minimum average monthly flow on record for the Upper Little Bow River was for the month of July (0.06 m^3/s). The maximum average monthly flow was recorded in the month of June (7.55 m^3/s) and the average annual flow at this location on the Upper Little Bow River is 1.05 m^3/s.

2.4 Water Quality

Studies have been completed on both the Little Bow River and Frank Lake, with the primary consideration being to maintain or improve water quality with respect to the downstream reservoirs. The studies have been completed with two main aims:

1. To assess the impact of the reservoirs on water quality, especially with respect to the construction of the Twin Valley Reservoir in the early 2000's.
2. To provide guidance as to actions which need to be taken to protect the water supply to the reservoir, in recognition of the desire to avoid activities which would result in a decrease in water quality for those with water licences.

The primary water quality concern for the Upper Little Bow River relates to the periodic overflow of water from Frank Lake. This overflow started to occur in the early 1990's, once water levels in the lake had been restored. The purpose of directing effluent from the Town of High River and Cargill Foods Ltd. beef slaughterhouse was to replace water losses and maintain water levels in the lake/marsh for waterfowl habitat. This has been achieved. The treatment of both wastewaters prior to the release to Frank Lake was limited as the intent was for the marsh to provide polishing of the effluents, namely the transformation and storage of nutrients. The capacity of Frank Lake to provide polishing appears to be decreasing over time.

Studies from the early 1990's indicated that there were very high levels of nutrients present in both wastewater effluents. These nutrients have the potential to increase aquatic plant growth. Based on the phytoplankton chlorophyll a concentrations, Frank Lake was classified as hyper-eutrophic, which is a very high nutrient-enriched condition. The ability for Frank Lake to handle nutrients changed through the year, with a significant reduction in ammonia, nitrate and total phosphorus occurring during the months of the year when the water was ice-free. However, the ability to handle nutrients decreased significantly by the middle of the winter. Concerns were raised that, while the lake may provide effective nutrient retention, this treatment efficiency may decrease over time and the sediments would become increasingly saturated with phosphorus. The concerns relating to possible increasing nutrient trends for Frank Lake focus on potential water quality impacts and increased nutrient enrichment in the Little Bow River and the downstream Twin Valley and Travers Reservoirs as a result of the periodic overflows from Frank Lake. As a result, there have been efforts to reduce nutrients in the lake through increased treatment of the two effluents which are released to the lake.

More recent data have indicated that Frank Lake remains the primary water quality concern for the Little Bow River. When comparing the water quality of Frank Lake to the Canadian Council of the Ministers of the Environment (CCME) water quality index, the water in Frank Lake ranked "poor" for nutrient concentrations. This is the lowest quality ranking. Concentrations of ammonia, nitrate, total nitrogen, total phosphorus, faecal coliforms and *E. coli* were all described as being elevated. Other water quality issues for the Little Bow River include TSS as a result of bank erosion caused by widening of the river channel and disturbance of riparian habitat as a result of cattle access, elevated periphyton growth, elevated faecal coliform concentrations and potential decreases in dissolved oxygen concentrations overnight as a result of macrophyte respiration. However, these water quality concerns do not apply to the whole length of the river, but rather discrete small areas. The water quality in the Little Bow River with respect to ammonia and total phosphorus is generally described as “good”, which is the second highest quality ranking, with a risk of trending towards to poorer water quality conditions.

The return flows to the river (i.e. effluent releases) have been considered to be highest contributors of nutrients and bacteria, but the contribution of agricultural run-off for nitrogen, phosphorus and bacterial are also recognised. Therefore, it is reasonable to assume that effluent releases and agricultural practices will be a primary focus for the management of water quality objectives for the Little Bow River.

2.5 Issues, Constraints and Carrying Capacity

To summarise,

- There are many different uses of the Little Bow River, and many different water licences are authorised. Concerns with water supply requirements to meet these licenced demands has been the primary reason for increased diversion of water from the Highwood River and the construction of reservoirs.
- Fisheries requirements are also recognised with respect to maintaining water flow. Several different species of fish are present in the Upper Little Bow River, with two species having Provincial designations and one having a designation by COSEWIC. There are no species listed on Schedule 1 of the SARA.
- The main water quality concern for the Little Bow River is the overflow of nutrient-rich water from Frank Lake. The direction is that these nutrients will be increasingly controlled through enhanced wastewater treatment prior to release to the lake.
- The direction which has been set for the Little Bow River is that actions should be taken to prevent deterioration in water quality. Effluent releases and agricultural practices have been identified as the highest contributors of factors which could negatively impact water quality. Therefore, it is reasonable to assume that effluent releases and agricultural practices will be a primary focus for the management of water quality objectives for the Little Bow River.

3. MOSQUITO CREEK

3.1 Background Information

Mosquito Creek originates mainly in the lower foothills of the Willow Creek Municipal District and flows eastward to its confluence with the Women’s Coulee diversion canal near the Cayley Hutterite Colony. From there it flows southeast through the Town of Nanton to its confluence with the Upper Little Bow River at the Twin Valley Reservoir. The 20 km long canal at Women’s Coulee is a diversion from the Highwood River to Mosquito Creek. It was originally constructed in 1933 and small storage reservoir was added in 1949. Downstream of the Town of Nanton near the Twin Valley Reservoir, water from Mosquito Creek is diverted to Clear Lake in order to maintain water levels in the lake. These water management structures are part of the Little Bow Storage and Highwood Diversion Plan which was developed to consider ways of capturing water from the Highwood River during the spring high flow periods and then managing the release of the stored water to accommodate agricultural demands in the Little Bow watershed during the late summer, when flows in the river are much lower but water demands are high.

3.2 Water Usage, Licences and Authorised Effluent Releases

The main water uses of Mosquito Creek include irrigation, supplying water to the Twin Valley Reservoir and Clear Lake for further downstream irrigation demands, providing drinking water for the Town of Nanton and maintaining fisheries habitat. The supply of water to the Twin Valley Reservoir and Clear Lake also provides water for recreation (i.e. fishing, camping and boating).

There are 44 surface water diversion licences in the Mosquito Creek Water Management Area that identify the Mosquito Creek or Women's Coulee as the source (Table 3.1). The combined maximum annual quantity that may be diverted under these 44 licences is 15,159,911 m^3. Due to the number of licences, no further review was completed at this stage to determine the requirements of each licence to return flow back to Mosquito Creek. The licences authorise the use of water for municipal, agricultural, irrigation, commercial, water management and government holdback purposes, with the highest number of licences being for irrigation although the greatest volume requirement relates to the diversion to Clear Lake. The diversion from Mosquito Creek to Clear Lake is located 2 km upstream of the Twin Valley Reservoir. The single municipal licence is for the Town of Nanton water supply.

Table 3.1: Surface Water Diversion Licences from Mosquito Creek/Women's Coulee within the Mosquito Creek Water Management Area

Purpose	Number of Licences	Combined Maximum Annual Quantity Diverted (m^3)
Diversion to Clear Lake	1	11,160,000
Irrigation	27	2,885,580
Municipal	3	725,366
Commercial	6	369,467
Agriculture	5	12,336
Government Holdback	2	6,788
Total	**44**	**15,159,911**

The Town of Nanton wastewater treatment plant is authorised to release effluent to Mosquito Creek (EPEA Approval No. 1006-02-00). The facility consists of a rotating biological contactor with phosphorus removal. The effluent is stored in a polishing pond before release. The effluent quality limits set by the approval are

≤ 25 mg/L for $CBOD_5$ and TSS and ≤ 1.0 mg/L for phosphorus. Limits for all parameters are based on the monthly mean of daily samples. No volume for the release is stipulated in the approval.

Mosquito Creek provides habitat for 14 identified fish species. For the fish recorded as being present in Mosquito Creek, the bull trout (Sensitive), the cutthroat trout (At Risk) and the spoonhead sculpin (May Be At Risk) have Provincial designations. For the Federal status, the bull trout is designated as Threatened by COSEWIC, however it is not included on Schedule 1 of the SARA. The cutthroat trout is designated as Threatened under COSEWIC and is included on Schedule 1 of the SARA.

3.3 Creek Flow

The natural flow in Mosquito Creek is supplemented by a diversion from the Highwood River through the Women's Coulee canal near the Cayley Hutterite Colony, northwest of the Town of Nanton. Flow data for the Women's Coulee canal (05BL025) were obtained from Water Survey Canada. The flows at this location have been recorded since 1977, but there are no flow data available for the months of January, February and December and only partial flow data available for the months of March and November. Focusing on the more recent flow patterns for the last 30 years, the available data from 1984 to 2014 indicate that the diversion of freshet flows from the Highwood River to Women's Coulee typically starts in May and reach peak flows by July. The lowest recorded flows are typically in March and November. The minimum average monthly flow on record for this location was for the month of November (0.002 m^3/s), although it is reasonable to assume that this flow was under ice or even frozen conditions and, therefore, may not be representative of actual creek flows. The maximum average monthly flow was recorded in the month of July (1.06 m^3/s). The average annual flow in Women's Coulee is 0.50 m^3/s.

Flow data for Mosquito Creek near the mouth (05AC031) were obtained from Water Survey Canada. The location of this hydrometric station is downstream from the Town of Nanton and upstream from the diversion to Clear Lake and, therefore, the data represent the available flow to supply the Twin Valley Reservoir and Clear Lake. Continuous flow data for this station are available from 1982 to 2012. Using the full available dataset, the freshet flows in Mosquito Creek start in May and reach peak flows by June. The low flow months occur in the winter with the lowest flows being during the December to February time period. The minimum and maximum average monthly flows in Mosquito Creek at this location were 0.01 m^3/s (November) and 14.25 m^3/s (June), respectively. The average daily flow for this time period is 1.08 m^3/s.

3.4 Water Quality

Historically, the effluent release from the Town of Nanton wastewater treatment plant was the primary concern for this area. Prior to the upgrades at this facility, the effluent was the largest point source of nitrate/nitrite and total dissolved phosphorus to Mosquito Creek, and the excessive periphyton growth immediately downstream of the wastewater treatment plant was considered to be related directly to the effluent release. There were no concerns raised with respect to TSS, coliform bacteria, dissolved oxygen or other forms of nitrogen, and there are now no identified concerns with the excessive periphyton growth as a result of implementing phosphorus treatment prior to effluent release.

Concerns have been raised historically with respect to the concentration of total phosphorus in Mosquito Creek. The data indicate that the phosphorus was mainly in the particulate form and, therefore, not readily biologically available, resulting in a change in focus to total dissolved phosphorus, which is a more relevant parameter for water quality impacts and the growth of aquatic plants.

Documentation indicates that tributaries, including Women's Coulee contribute significant loadings of total dissolved phosphorus, total Kjeldahl nitrogen, total nitrogen, nitrate/nitrite and ammonia to Mosquito Creek. These substances are all considered to be from various non-point sources, including agriculture. Women's Coulee also contributes TSS to Mosquito Creek as a result of erosion. Generally, nutrient concentrations declined along the length of Mosquito Creek, with elevated faecal coliform and *E. coli* concentrations being observed periodically at discrete points along the creek. There are also occasional issues with respect to the dissolved oxygen concentration.

3.5 Issues, Constraints and Carrying Capacity

To summarise,

- There are many different uses of Mosquito Creek, and many different water licences are authorised. Concerns with water supply requirements to meet these licenced demands has been the primary reason for increased diversion of water through Women's Coulee.
- Several different species of fish are present in Mosquito Creek, with three species having Provincial designations and two having a designation by COSEWIC. One of these species (cutthroat trout) is included on Schedule 1 of the SARA.
- Historically, the main water quality concern for Mosquito Creek related to the effluent release from the Town of Nanton wastewater treatment plant. The nutrient concern has since been alleviated due to enhanced wastewater treatment. The current concerns relate to non-point sources, which include agricultural activities.
- The direction which has been set for Mosquito Creek is to improve water quality and provide more stable flows. The focus is to identify and rectify non-point sources of nutrients, which include agricultural activities. There is also the desire to restore riparian areas and encourage more environmentally sustainable agricultural practices.

4. HIGHWOOD RIVER

4.1 Background Information

The Highwood River is approximately 162 km in length and flows south from its headwaters in the eastern slopes of the Rocky Mountains and then east through the Towns of Longview and High River before confluencing with the Bow River southeast of Calgary. The Highwood River is known for its recreational uses and diversion channels that supply water to Mosquito Creek and the Upper Little Bow River.

The Little Bow project was approved in 1998 to support the diversion of water from the Highwood River to the Little Bow River and Mosquito Creek, in order to supply the Twin Valley Reservoir. The diversions and reservoir supply water for the irrigation of 8,096 hectares of agricultural land. Although the primary objective is to supply water for irrigation, secondary objectives include the potential diversion of water for municipal purposes.

4.2 Water Usage, Licences and Authorised Effluent Releases

Water use from the Highwood River is related directly to land use in the Highwood River sub-basin, which includes forestry, recreation, oil and gas operations, ranching and agriculture. There are recreational uses associated with the river which include hiking, fishing, rafting, kayaking, wildlife spotting and biking.

There are 49 surface water diversion licences in the Highwood River Water Management Area that identify the Highwood River as the source (Table 4.1). The combined maximum annual quantity that may be diverted under these 49 licences is 103,099,033 m^3. Due to the number of licences, no further review was completed at this stage to determine the requirements of each licence to return flow back to the Highwood River. The licences authorise the use of water for municipal, agricultural, irrigation, industrial, habitat enhancement, water management, recreation and government holdback purposes. The water management licences are related to the diversion of water from the Highwood River to the Little Bow River and Women's Coulee. The highest number of licences are for irrigation, although the greatest volume requirement relates to the diversion activities to the Oldman River sub-basin (i.e. the Upper Little Bow River and Mosquito Creek).

The Village of Longview was authorised to release effluent directly to the Highwood River (EPEA Approval No. 938-02-00), but the effluent release is now operated under a Code of Practice (EPEA Registration No. 272985-00-00). There are no longer any effluent quality limits from the lagoon system, and the discharges occur once annually.

The Highwood River is an important fisheries resource. The river and its tributaries are reported to have one of the most successful fish habitats in the Bow River basin. The aquatic environment provided by the Highwood River is ideal for fish spawning, rearing and wintering habitats. The Highwood River provides habitat for 10 identified fish species. For the fish recorded as being present in the Highwood River, the bull trout (Sensitive) and the cutthroat trout (At Risk) have Provincial designations. For the Federal status, the bull trout is designated as Threatened by COSEWIC, however it is not included on Schedule 1 of the SARA. The cutthroat trout is designated as Threatened under COSEWIC and is included on Schedule 1 of the SARA.

Table 4.1: Surface Water Diversion Licences from the Highwood River within the Highwood River Water Management Area

Purpose	Number of Licences	Combined Maximum Annual Quantity Diverted (m^3)
Diversion to Little Bow River	1	68,600,000
Diversion to Women's Coulee	2	27,145,930
Irrigation	33	3,228,211
Industrial	2	1,652,866
Habitat Enhancement	1	1,233,482
Agriculture	3	545,200
Recreation	2	416,307
Municipal	3	224,491
Government Holdback	2	52,546
Total	**49**	**103,099,033**

4.3 River Flow

Weather in the Highwood River sub-basin determines water supply. There are no impoundments on the Highwood River and annual precipitation and snowmelt during the spring freshet determine the base flow for the river and its tributaries. Water uses, specifically the diversion of water to Mosquito Creek via Women's Coulee and diversion of water to the Upper Little Bow River, have large impacts on the downstream flow of the Highwood River. The diverted flow can range annually from 7 to 29% of the Highwood River flow, depending on the yearly water demand in the Little Bow watershed. Diversion rates from the Highwood River are managed based on factors such as base river flow conditions, increases in temperature, decreases in dissolved oxygen concentrations or the desire to minimise abrupt fluctuations in water levels/flows to protect fisheries habitat. The goal is to reduce water demand impacts on the Highwood River during low flow periods and stabilise the licenced water supply, while still meeting increasing water demands in the middle part of the Little Bow River basin.

Flow data for the Highwood River below the Little Bow Canal (05BL004) were obtained from Water Survey Canada. The location of this hydrometric station is downstream from the major diversions and upstream from the contributions from the Sheep River and, therefore, the data represent an area of the Highwood

River which is sensitive to low flows. Continuous flow data for this station are available from 1908 to 1916 and then from 1986 to 2012. Using the full data set from 1986, the freshet flows in the Highwood River start in May and reach peak flows by June. The low flow months occur in the winter with the lowest flows being in the January/February time period. The minimum and maximum average monthly flows in the Highwood River at this location were 0.65 m^3/s (January) and 157.79 m^3/s (June), respectively, with an average daily flow of 11.67 m^3/s.

A study of flow data from multiple hydrometric stations over a longer time period indicates that the highest flows for the Highwood River occur primarily during May, June and July, and low flows are mainly during winter and early spring. This seasonal trend follows the precipitation and snow melt pattern.

4.4 Water Quality

In general, water quality in the Highwood River is "good" based on a comparison of data with the CCME water quality index, however, the nutrient conditions are decreasing over time from a "good" rating to "fair". The degradation of water quality could be attributed to a combination of multiple factors including contributions from the Sheep River, diversion of water to the Women's Coulee and the Upper Little Bow River, reduced quality of return flow from licenced diversions, and effluent release and agricultural run-off.

The greatest decrease in water quality for the Highwood River is observed downstream of the confluence with the Sheep River, and is considered to be related to the effluent releases from the Westend Regional Sewage Services wastewater treatment plant and the Town of Okotoks wastewater treatment plant. The nutrient and bacteria concentrations in the Highwood River at this location are elevated in comparison to other upstream data. Algal activity is also a potential concern downstream of the confluence with the Sheep River.

The Women's Coulee and Upper Little Bow River diversions affect downstream flows and water quality in the Highwood River. The effects of the diversions are most relevant during low-flow periods and could result in elevated water temperature, nutrient concentrations and bacteria concentrations.

The direction for the Highwood River is to protect the headwaters and manage the diversions. There are strict water management guidelines for the diversion.

4.5 Issues, Constraints and Carrying Capacity

To summarise,

- There are many different uses of the Highwood River, and many different water licences are authorised. Of greatest significance is the diversion of water from the Highwood River to Mosquito Creek and the Upper Little Bow River in order to meet irrigation demands. This has resulted in concerns regarding base flows in the Highwood River and water quality (temperature and dissolved oxygen concentrations) for fisheries. The diversion rate from the Highwood River is managed to alleviate these concerns.

- Several different species of fish are present in the Highwood River, with two species having Provincial designations and two having a designation by COSEWIC. The cutthroat trout is included on Schedule 1 of the SARA.
- The water quality for the Highwood River is described as being generally "good". The main water quality concerns are the inputs of nutrients and bacteria from the Sheep River as a result of wastewater effluent releases, and elevated temperature, nutrient concentrations and bacteria concentrations and depressed dissolved oxygen concentrations as a result of low flows due to the diversion of water.
- This area has particular pressures relating to the need to manage increasing population, tourism activities and recreation.
- The direction which has been set for the Highwood River is that actions should be taken to protect the headwaters and manage the diversions.

5. SHEEP RIVER

5.1 Background Information

The Sheep River is 107 km long and flows from its headwaters in the mountain valleys of the Elbow-Sheep Wildland Provincial Park in the Highwood Mountain Range of Kananaskis Country. It flows east through the Towns of Turner Valley and Black Diamond and confluences with the Highwood River approximately 8 km east (downstream) of the Town of Okotoks. The Sheep River is the main tributary to the Highwood River. The Highwood River continues north for 8 km until it confluences with the Bow River.

Existing land use along the Sheep River varies. In the upper watershed, through the Sheep River Provincial Park, there are large tracts of forested lands in mountainous terrain, with logging becoming more prevalent in the foothills of the Rocky Mountains. The lower watershed consists of prairies, with agricultural properties, residential subdivisions, golf courses and industrial areas located around the Sheep River as it passes through the Towns of Turner Valley and Black Diamond.

5.2 Water Usage, Licences and Authorised Effluent Releases

There are many water uses for the Sheep River including municipal, domestic and industrial water supply, irrigation, fisheries habitat and recreation (i.e. fishing, camping, tubing, kayaking).

There are 55 surface water diversion licences in the Sheep River Water Management Area that identify the Sheep River as the source (Table 5.1). The combined maximum annual quantity that may be diverted under these 55 licences is 5,113,384 m^3. Due to the number of licences, no further review was completed at this stage to determine the requirements of each licence to return flow back to the Sheep River. The licences authorise the use of water for municipal, agricultural, irrigation, commercial, industrial and government holdback purposes. The highest number of licences relate to municipal use, and this is also the greatest water demand for the Sheep River.

Table 5.1: Surface Water Diversion Licences from the Sheep River within the Sheep River Water Management Area

Purpose	Number of Licences	Combined Maximum Annual Quantity Diverted (m^3)
Municipal	31	3,516,701
Irrigation	6	592,562
Industrial	2	474,890
Commercial	9	464,522
Government Holdback	6	61,009
Agriculture	1	3,700
Total	**55**	**5,113,384**

There are two approvals to release effluent from municipal wastewater treatment plants to the Sheep River. The Westend Regional Sewage Services Commission services the Towns of Turner Valley and Black Diamond and is authorised by EPEA Approval No. 11656-01-00. The facility consists of a series of lagoons with an effluent quality requirement of ≤ 25 mg/L for $CBOD_5$, based on the monthly average of daily samples. The approval does not set a limit on the volume of effluent discharged. This approval is currently under review and more stringent treatment and effluent quality requirements are expected to be required to address water quality concerns in the Bow River basin. The primary focus of these concerns is to manage the cumulative impacts of nutrients released in municipal wastewater effluents. As a result, it is expected that, ultimately, the Westend facility could be expected to meet total nitrogen concentrations of ≤ 10 mg/L and total phosphorus concentrations of ≤ 0.15 mg/L

The Town of Okotoks is authorised by EPEA Approval No. 1028-02-00. The approval is for a mechanical treatment plant, with the effluent quality summarised in Table 5.2. The approval does not set a limit on volume of effluent discharged. This approval is currently under review, which could include more stringent effluent criteria.

Table 5.2: Effluent Quality Requirements – Town of Okotoks

Parameter	Concentration (as monthly mean)
$CBOD_5$	≤ 20 mg/L
TSS	≤ 20 mg/L
Phosphorus	< 1 mg/L
Ammonia (1 Oct to Jun 30)	< 10 mg/L
Ammonia (1 Jul to 30 Sep)	< 5 mg/L
Total Coliform Counts	≤ 1,000/100 mL (geometric mean)
Faecal Coliform Counts	≤ 200/100 mL (geometric mean)

The Sheep River provides important habitat for 15 identified fish species. For the fish recorded as being present in the Sheep River, the bull trout (Sensitive), the cutthroat trout (At Risk) and the spoonhead sculpin (May Be At Risk) have Provincial designations. For the Federal status, the bull trout is designated as Threatened by COSEWIC, however it is not included on Schedule 1 of the SARA. The cutthroat trout is designated as Threatened under COSEWIC and is included on Schedule 1 of the SARA.

5.3 River Flow

Flow data for the Sheep River at Black Diamond (05BL014) were obtained from Water Survey Canada. The flow data range from 1909 to 1916 and then from 1968 to 2012. For the purpose of this analysis, the focus will be the more recent flow patterns for the last 30 years, from 1982 to 2012. The freshet in the Sheep River typically starts in May and reaches its peak in June. The low flow months occur over the winter, with the lowest flows being in the January/February time period. The minimum and maximum average monthly flows in the Sheep River at this location were 0.37 m^3/s (February) and 64.28 m^3/s (June), respectively, with an average daily flow of 5.11 m^3/s. The natural water flows are not able to meet in-stream objectives for many weeks of the year, with the greatest concern for flows being during the winter months.

5.4 Water Quality

Inputs to the Sheep River occur from both non-point source and point sources. All of these inputs have the potential to carry pollutants to the river, which could affect water quality and the aquatic ecosystem. Non-point source contributions include urban and country residential development, golf courses (use of fertilizers) and industrial and agricultural inputs along the river. However, these non-point sources have not been quantified. Point source contributions include municipal stormwater and wastewater inputs from Towns of Turner Valley and Black Diamond, and the Town of Okotoks.

Historically, water quality for the Sheep River around Black Diamond was typically “good” with very few parameters being higher than the Alberta Surface Water Quality Guidelines based on aquatic life, recreation and agricultural uses. The water quality for the Sheep River is considered to be representative of natural conditions. In the spring, there are increases in sediments and total phosphorus, most of which is present in the particulate form and, therefore, is not readily biologically available. The degradation in water quality at this time of year is related to natural erosion in the upland areas. Sedimentation as a result of development activities is also a concern, and increases in sedimentation could impact fisheries habitat and reduce successful spawning.

Nutrients are an emerging concern, with the concentrations being classified as “marginal”, using the CCME water quality index. The lowest water quality category is “poor”, with “marginal” being the next lowest category. The effluent releases from the Westend Regional Sewage Services wastewater treatment plant and the Okotoks wastewater treatment plant have been identified as the primary contributors of nutrients to the Sheep River. Specifically, concentrations of total dissolved phosphorus have been indicated to be high under low river flow conditions. Concerns relating to increases in temperature have also been raised, as there is a 10ºC increase in the maximum water temperature between the headwaters and the foothills.

5.5 Issues, Constraints and Carrying Capacity

To summarise,

- There are many different uses of the Sheep River, and many different water licences are authorised. Concerns with water supply requirements to meet these licenced demands has been raised. The natural flows in the river are not able to meet in-stream objectives for many weeks of the year, with the greatest concern being during the winter months.
- Several different species of fish are present in the Sheep River, with three species having Provincial designations and two having a designation by COSEWIC. The cutthroat trout is included on Schedule 1 of the SARA.
- Seasonal high flows result in elevated sediments and particulate phosphorus during the spring freshet. This decrease in water quality is related to natural factors and erosion in the headwaters. However, concerns regarding the potential for sedimentation in the lower reaches have been raised, with the primary cause being development.
- Data indicate that nutrient concentrations are elevated, with the particular concern being total dissolved phosphorus during low flow months. The low flow months can include both the winter period and the end of summer/early fall period. With respect to algal growth, the most important low flow period would be the end of summer/early fall, as this is the time period when water temperatures are more conductive to encouraging the growth of algae and aquatic plants. The main approach to managing the nutrient inputs is to focus on the contributions from the two wastewater treatment plants (Westend and Okotoks).

6. CONSIDERATION OF OTHER POLICY FRAMEWORKS

6.1 South Saskatchewan Management Plan

The Upper Little Bow River, Mosquito Creek, Highwood River and Sheep River are contributors to the South Saskatchewan River. Watershed management and headwater protection is a priority for the South Saskatchewan sub-basin. The measures taken for the South Saskatchewan sub-basin also apply to the four key water courses in the Foothills Regional Water and Wastewater Collaborative study area.

In 2006, there was moratorium for any new water licences to be issued for the Oldman, Bow and South Saskatchewan sub-basins. This moratorium includes the Upper Little Bow River, Mosquito Creek, Highwood River and Sheep River. This approach serves to reserve unallocated water and restrict future allocations to First Nations, water conservation objectives and outstanding applications. Although no new water licences can be issued, with the exception being for storage to improve performance in meeting in-stream needs, current licences can be transferred or reallocated.

With respect to water quality, the aim is a proactive approach to identify negative trends and to develop actions needed to ensure that regulatory limits are not exceeded. This approach would be based on Provincial water quality guidelines and the development of risk-based limits.

6.2 Bow River Management Plan

The Highwood River and the Sheep River are both part of the Bow River Basin.

In the 1970's and 1980's, high nutrient concentrations and excessive aquatic plant growth were observed in the Bow River. This was also accompanied with low dissolved oxygen concentrations and occasional fish deaths. The lower reaches of the Bow River are highly populated, with approximately one third of the population of Alberta living in this area. Therefore, this area is considered to at a high risk as a result of impacts due to anthropogenic activities.

The water quality of the Bow River generally deteriorates along the length of the Bow. Inputs of concern to the Bow River include stormwater and effluent from wastewater treatment plants. The greatest area of concern is around the City of Calgary, which is the largest municipality in the area. In the lower reaches, specific water quality concerns include TSS, total phosphorus and total dissolved phosphorus. The water quality is considered to be in an unnatural and undesired state.

As a result, a basin-wide approach is being developed to manage water quality, with the initial focus being the development of a phosphorus management plan. The plan aims to reduce and manage phosphorus inputs to the Bow River basin, with aims being to manage nuisance algal growth, clogging of water intakes, impacts to recreational activities and reduction in dissolved oxygen concentrations to below the thresholds needed for the survival of fish.

Phosphorus limits have been imposed for wastewater treatment discharges, and can include loading requirements which need to consider the inputs from stormwater for that community. In the case of the City of Calgary, the improvement to the effluent quality released to the Bow River has resulted in decreases in the phosphorus concentration and periphyton growth. Although the focus to date has been management for phosphorus, it is reasonable to assume that this focus could shift to include other parameters, e.g. nitrogen, in the future.

6.3 Management of Effluent from Municipal Wastewater Treatment Plants

There are numerous wastewater treatment plants in the project area, and as many of these sites rely on conventional and/or aerated lagoon systems, only basic levels of treatment will be achieved. As a result, there is the potential for elevated concentrations of nutrients and bacteria to be released into the surface waters for this general area. This results in concerns relating to eutrophication (nutrient enrichment) of waters and public health risks due to the presence of increasing concentrations of potentially disease-causing micro-organisms.

To address water quality concerns, an Interim Effluent Limits Policy has been developed by AEP, and aims to encourage municipal wastewater systems that release effluent to the Bow River to provide better control of phosphorus in their releases. Table 6.1 summarises the effluent limits which are expected to become the requirement for this area in the future. The parameters identified do not just focus on phosphorus, but the standard parameters which can be treated by a municipal wastewater treatment plant.

Table 6.1: Expected Future High Quality Effluent Criteria

Parameter	Concentration
$CBOD_5$	≤ 5 mg/L
TSS	≤ 5 mg/L
Ammonia	≤ 3 mg/L
Total Nitrogen	≤ 10 mg/L
Total Phosphorus	≤ 0.15 mg/L
Total Coliforms	≤ 1,000 counts/100 mL
Faecal Coliforms	≤ 200 counts/100 mL

This direction is being set specifically for the Bow River Basin, and aims to consider cumulative effects rather than being limited to focusing on a single discharge and the potential for impacts around that discharge. It is also possible that the effluent requirement may be presented in terms of a loading to the receiving environment, which would result in potentially lower flows with elevated concentrations in the initial releases, and translating to increased treatment for lower concentrations as the released flows (and population base) increase.

7. SUMMARY

There are four main water courses in the study area: the Upper Little Bow River, Mosquito Creek, Highwood River and Sheep River. The issues and concerns relating to these water courses are consistent, and can also be found in broader policy frameworks for the Bow River and South Saskatchewan River sub-basins.

In all cases, there are concerns with current and future water demands. This has resulted in the development of storage in order to meet demands, with the primary consideration being irrigation, and the secondary consideration including other uses with the specific mention of municipal requirements. Challenges with water demands are expected to continue in the future and could become exacerbated with drought conditions and multi-year droughts. It is envisaged that there could be some significant discussion in the future regarding the need to return water to the rivers/creek, along with what could be acceptable water quality conditions.

In all cases, there are concerns with water quality, although the water quality conditions vary significantly depending on the water course and the parameter. In some cases, the water quality is considered to be “good” or reflective of natural conditions. In other cases, the water quality is considered to be “poor”, reflective of unnatural conditions or reflective of conditions which are of concern. The main parameter of discussion has been phosphorus, which has resulted in a basin-wide approach to managing phosphorus. With respect to wastewater effluents, this approach varies from imposing a maximum effluent concentration through to a loading requirement which could include the need to balance both sewage-related wastewater effluents and stormwater inputs. The loading requirement will result in more stringent concentrations to be met as the flows increase due to population growth. It is expected that other parameters will be included in a basin-wide management approach in the future. For example, nitrogen and bacteriological parameters could be managed by enhanced municipal wastewater treatment. Sediment control could be managed through changes to agricultural practices and rehabilitation of riparian vegetation to increase riverbank stability.

In the short-term, while less stringent effluent criteria may be acceptable, as the population growth transitions into the medium and long-term, the increasing flows will likely result in more stringent effluent criteria, with even the approach to divert effluent to other uses, such as irrigation.

Sincerely,

URBAN SYSTEMS LTD.

Dr. Joanne Harkness
Water and Wastewater Specialist

Aaron Coelho, M.Sc., A.Ag.
Environmental Consultant

/jh/ac

Attach.

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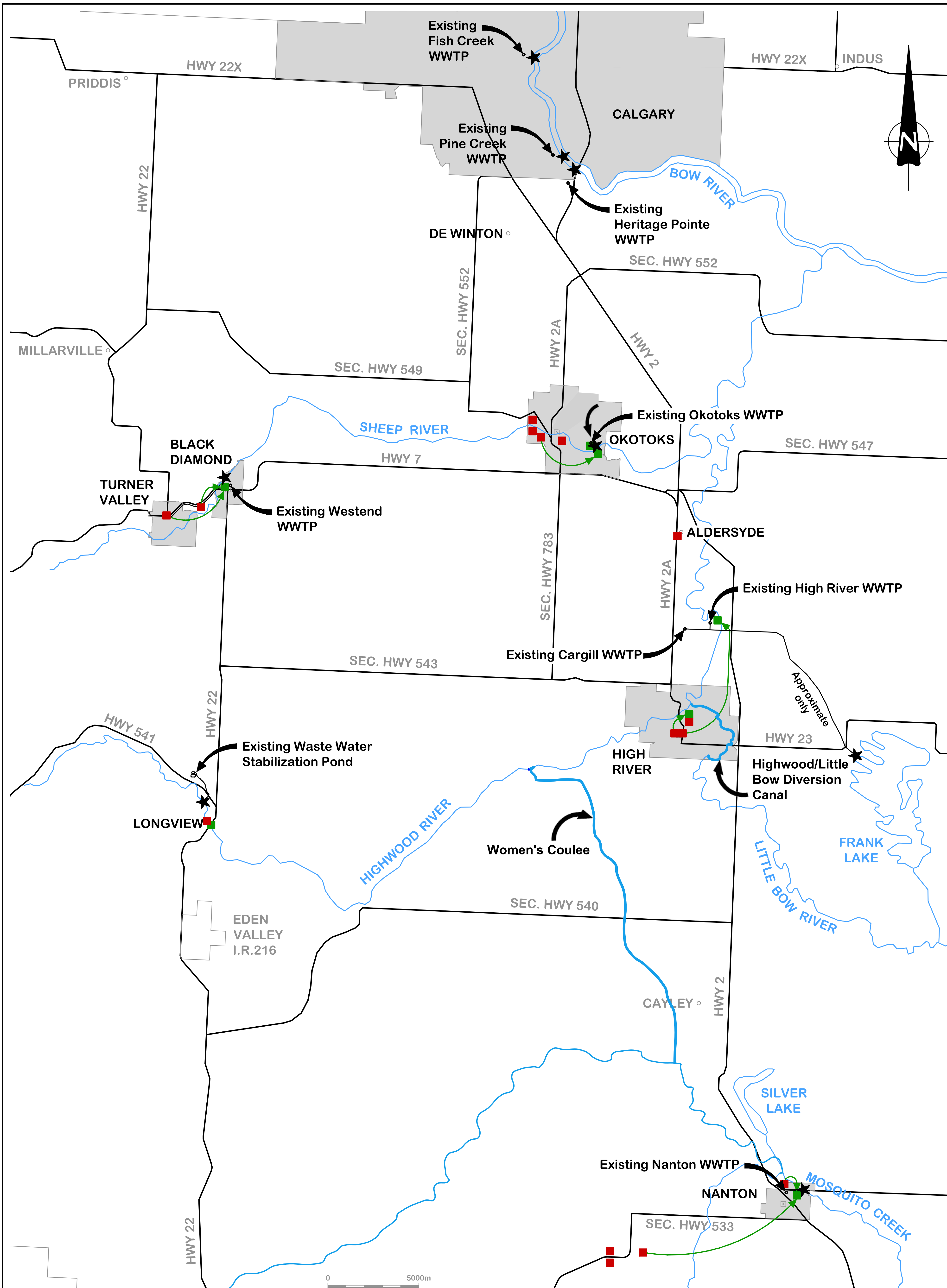
APPENDIX A:

FIGURE 2.1 - FRWWC Sub-Regional Waste Water Treatment Feasibility Study Key Features



■ Point of diversion in water license

■ Location of return flow in water license, if specified

— Effluent outfall pipe

★ Existing Waste Water Outfall

URBAN systems | MPE Engineering Ltd.

FOOTHILLS REGIONAL WATER & WASTEWATER COLLABORATIVE

FRWWC SUB-REGIONAL WASTE WATER TREATMENT FEASIBILITY STUDY KEY FEATURES

SCALE: 1:200,000	DATE: SEPTEMBER 2015	JOB: 2210-047-00	FIGURE: 2.1

APPENDIX C

Technical Memorandum 3 – Options & Screening

MEMORANDUM

Date:	April 21, 2016
To:	Foothills Regional Water & Wastewater Collaborative
cc:	Lynda Cooke, P.Eng., Steve Brubacher, P.Eng., Leigh Chmilar, P.Eng.
From:	Sarah Fratpietro, P.Eng., Randy Boras, M.Sc., P.Eng.
File:	2239.0005.01 / 2210-047-00
Subject:	Technical Memorandum 3: Options & Screening: Rev.1

1. INTRODUCTION

The Foothills Regional Water and Wastewater Collaborative (FRWWC) is exploring a sub-regional management strategy for future wastewater collection servicing in the short (< 10 yrs), medium (25 yrs), and long-term (60 yrs). In the next 60 years, this sub-region could more than quadruple in population, putting stress on financial and physical capacity of the local systems. The focus of this memorandum is to provide the following:

- Summarize design parameters,
- Provide high level review of the options,
- Provide Class D (screening level) opinions of probable cost,
- Provide a PESTLE analysis,
- Discuss the advantages and disadvantages of each option, and
- Provide recommendations for the two preferred options.

This memorandum reviews the following four regional wastewater options:

1. **Option 1:** Regional Pipeline from Okotoks & High River to Calgary, new Sub-Regional WWTP (in Aldersyde) for MD flows; retain local plants in Westend, Longview and Nanton as per CRP;

2. **Option 2:** One Sub-Regional WWTP (NE of Okotoks) designed for 100% of the flow from High River, Okotoks, and the MD; retain local plants in Westend, Longview and Nanton as per CRP;

3. **Option 3:** One Sub-Regional WWTP (NE of Okotoks) servicing only excess (future growth) flow from Okotoks, plus 100% of the flow from High River and MD; retain local plants in Westend, Longview and Nanton as per CRP;

4. **Option 4:** Regional pipeline from Okotoks and High River to Calgary, sized to also include 100% of MD flow; retain local plants in Westend, Longview and Nanton as per CRP.

Within this memorandum, MPE Engineering Ltd. (MPE) developed costs and impacts related to the regional pipelines in the above options, and Urban Systems Ltd. (USL) developed costs and impacts related to the wastewater treatment plants (WWTPs) in Options 1 to 3.

Alberta Environment and Parks (AEP) announced in 2015 that effluent treatment requirements in the Calgary region are changing in the future. New plants will be required to treat to High Quality (HQ) effluent criteria of 5 mg/l BOD_5, 5 mg/l TSS and 0.15 mg/l Total Phosphorus. Existing plants will be required to move towards the new criteria when major structural upgrades and expansions are required. This memorandum considers the future HQ criteria requirements.

2. DESIGN PARAMETERS

This section summarizes the projected wastewater design flows, existing WWTP capacities and pipeline design criteria used for comparing the four wastewater servicing options. The projected populations and average day flows from Table 2.1 of the *Technical Memorandum 1-Rev 1: Planning and Projections* (MPE/USL TM1 2015) are used as base information for this report.

2.1 Projected Wastewater Flows

The projected wastewater maximum day flows and peak hour flows to be adopted for this report are summarized in ***Table 2.1*** below. The maximum day flows and peak hour flows provided in previous studies were used as available. The table includes only the municipalities that will be included in the regional options. Basic flow information for Westend, Nanton and Longview is also presented in MPE/USL TM1 (2015), and more detailed flow information for Westend is presented in MPE/USL TM5 (2016).

Table 2.1: Projected Wastewater Flows

Study Area	Average Day Flow (m^3/day) [1]			Maximum Day Flow (m^3/day)			Peak Hour Flow (L/s)		
	2010	2041	2076	2010	2041	2076	2010	2041	2076
Aldersyde [2, 3]	317	2,001	4,261	634	4,002	8,522	15	97	206
MD Central District	0	7,574	7,574	0	15,148	15,148	0	366	366
High River [5, 6]	4,619	13,413	16,208	10,855	31,521	38,089	308	776	938
Okotoks [7]	5,220	13,847	23,887	18,841	48,523	83,545	249	691	1,159
TOTAL	**13,319**	**41,487**	**52,673**	**30,329**	**99,193**	**145,304**	**572**	**1,929**	**2,668**

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[1] Average day flows are from MPE/USL TM1 (2015).
[2] No previous studies regarding maximum day factor for Aldersyde area found. Assumed maximum day factor of 2.0 for this report.
[3] Aldersyde peak hour factor of 3.5 plus infiltration allowance of 0.02 L/s/ha used as per MPE (2010) report Table 3.9. Does not include Cargill flows.
[4] Central District maximum day factor and peaking factor have not been projected in any previous studies. Assumed to use same factors as Aldersyde.
[5] High River maximum day factor of 2.4 based on actual 2014 flow records from the Town of High River (High River 2014).
[6] High River peaking factors (5.8/5.0/5.0) are based on Harmon's peaking factor calculation as per the Stantec 2011 report, plus infiltration allowance of 0.28 L/s/ha to match peak flows as per ISL (2015) report.
[7] Okotoks maximum day factors (3.5/2.6/3.4) are based on matching 2041 and 2076 projected flows from Stantec TM1 (2015) and Stantec TM3 (2015).

2.2 Summary of Existing WWTP Capacities

The existing WWTP capacities and projected year the WWTPs will be at full capacity are summarized in ***Table 2.2*** below. The table includes only the municipalities that have an existing WWTP and that will be included in the regional options. The High River WWTP is projected to be at full capacity within 5 years. The Okotoks WWTP is currently at its full capacity.

Table 2.2: Summary of Existing WWTP Capacities

WWTP	Existing Capacity (m^3/day)	Projected Year WWTP at Full Capacity
High River	8,409 [8]	2021 [9]
Okotoks	23,509 [10]	2016 [11]

The Westend system capacity is detailed in MPE/USL TM5 (2016). The Nanton WWTP is at 50% of hydraulic capacity. However, the WWTP is in critical failure mode due to mechanical failures, and needs to be replaced immediately (Nanton 2014). The Longview lagoon system has sufficient capacity for the next 14 years according to the 2010 Study (MPE 2010).

2.3 Pipeline Design Criteria

This section summarizes the pipeline design criteria for each municipality, the tie-in to the City of Calgary wastewater system, pipeline velocities and pipe material.

2.3.1 High River

High River has an existing lift station (Pump Station No. 1) that collects and transfers the Town's wastewater to an aerated lagoon via a 710mm diameter HDPE forcemain. Pump Station No. 1 in town has three pumps and can deliver between 260 and 280 L/s with two pumps operating in parallel, and can deliver between 280 and 300 L/s with three pumps in parallel. The aerated lagoon has four cells with a total volume of 312,371 m^3 (Stantec 2011).

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[8] High River existing capacity from Stantec (2011) report based on maximum month daily average flow.

[9] High River projected year at full capacity based on 2014 maximum month flow of 6,475 m^3/day and projected growth rate of 3.8% from MPE/USL TM1 (2015).

[10] Capacity of Okotoks WWTP is based on projected 2016 flows (population 29,874) from Stantec TM1 (2015) and Stantec TM3 (2015). Okotoks existing capacity is based on maximum day flow.

[11]. Stantec TM3 (2015) indicates certain components of the existing WWTP are currently at capacity. Some of these components could be upgraded to provide some additional capacity in the short-term.

The following assumptions are made for High River for each of the regional wastewater servicing options:

- The wastewater will be collected at Pump Station No. 1 and will be pumped at peak hour flow rates to the lagoon site.
- Pump Station No. 1 appears to be near capacity and will be replaced. This pump station may only require a capacity upgrade, however it is assumed it will be replaced as the worst case scenario.
- The Town's aerated lagoon will be maintained and utilized for peak shaving storage. This will minimize the pipeline diameter and lift station power requirements.
- A new lift station will be installed at the lagoon site to pump wastewater at maximum day flows to the regional system.

An added advantage of using the lagoon for peak shaving is that the lagoon can be used as back-up in the event of the regional pipeline being out of service (emergency condition). The existing lagoon volume will provide a minimum of 10 days storage using 2020 projected flow rates and 8 days storage using 2076 projected flow rates. This storage time is calculated using maximum day flows to be conservative. This leaves ample time to locate, repair a line break and put the system back into service. Less storage may still provide reasonable response time and could be considered as part of any future design refinement.

2.3.2 Okotoks

The Stantec report (Stantec TM3 2015) evaluates the feasibility of a regional wastewater transmission system from Okotoks to the City of Calgary (City) Pine Creek WWTP. It indicates that one of the recommended pipeline options (Option 1, Approach 2) is to utilize the storage at the existing WWTP for peak shaving storage. Stantec used peak dry weather flow (PDWF) for pipeline sizing of this option.

The following assumptions are made for Okotoks for each of the regional wastewater servicing options:

- The Okotoks WWTP will be maintained and utilized for peak shaving storage, with the exception of Option 3 (Option 3 utilizes the existing WWTP for treatment to full capacity). This will minimize the pipeline diameter and lift station power requirements.
- The WWTP storage can handle peak wet weather flow into the plant up to 265 L/s for the 25 year design and 303 L/s for the 60 year design. These are the same storage flows assumed in Stantec TM3 (2015) report for the 25 and 50 year scenarios.
- A new lift station will be installed at the Okotoks WWTP to pump wastewater to the regional system.

2.3.3 Aldersyde

There are currently no WWTP's or wastewater storage facilities at Aldersyde.

For Options 2, 3, and 4 it is assumed that a new lift station will be installed at Aldersyde to pump wastewater at peak hour flows to the regional system.

2.3.4 MD Central District

There are currently no WWTP's or wastewater storage facilities within the MD Central District. For each option it is assumed a new lift station will be installed in the MD Central District to pump wastewater at peak hour flows to the regional system.

2.3.5 City of Calgary Tie-in

The City of Calgary (City) has three wastewater treatment facilities: Bonnybrook WWTP, Fish Creek WWTP, and the Pine Creek WWTP. Together, these treatment plants meet the wastewater needs of the City and a number of nearby municipalities. The Pine Creek WWTP is the closest plant to service the regional system for Options 1 and 4. This WWTP opened in 2010 and can treat up to 100,000 m^3/day. It has infrastructure in place to allow for expansion to a capacity of 700,000 m^3/day (population equivalent 1.75 million people) (City 2015).

From discussions with City staff, they confirmed that the City currently has no wastewater treatment capacity for new regional customers. The plant are currently nearing capacity or have committed capacity in both the north and south catchments. There will be no possibility of a new regional wastewater connection until the next plant expansion at Pine Creek. The earliest planned capacity upgrade would likely be 2025, subject to project approval and budget. City staff also indicated that at this time they would anticipate any future connections from the southern regional system to come directly into the Pine Creek WWTP (City Email 2015).

All the municipalities involved in the FRWWC are members of the Calgary Regional Partnership (CRP) with the exception of the MD of Foothills. Current City of Calgary Council policy and direction does not support the extension of wastewater services to municipalities that are not CRP members. This will be an issue for Option 4, which includes the MD of Foothills tie-in to the City WWTP. Resolution of this matter would be at a political level rather than a technical level, so is beyond the scope of this study.

2.3.6 Pipeline Velocities

The pipelines are sized to have a velocity range of 0.9 m/s to 1.6 m/s. Alberta Environmental Protection guidelines indicate that at design pumping rates, a cleansing velocity of at least 0.6 m/s should be maintained. However, a minimum velocity of 0.9 m/s is preferred to ensure there is adequate flushing in the pipeline. A maximum velocity of 1.6 m/s is used because at velocities higher than this, pressure surges can become an issue particularly in the larger diameter pipelines. Also the friction loss becomes higher requiring additional power at the lift stations (or additional lift stations) to push the wastewater through the pipeline.

2.3.7 Pipeline Material

The pipeline material assumed for this study is High Density Polyethylene (HDPE). This is a common material for wastewater forcemains. HDPE pipe is fused at joints, is corrosion resistant and has a long service life. Due to HDPE flexibility and jointless construction, smaller diameter pipe can potentially be installed using narrow trenches reducing ROW and excavation requirements. HDPE is also the prevalent type of pipe used for trenchless installations which can reduce restoration and roadway reconstruction costs and can allow for installation beneath rivers and wetlands with less disruption to the environment.

3. REVIEW OF OPTIONS

This section reviews four sub-regional wastewater servicing options that the CRP (CRP 2014) did not specifically address. This section also reviews the phasing of these options, land considerations and environmental considerations.

3.1 Phasing of Options

The construction of each sub-regional option to the 60-year design horizon (2076) will include two phases of construction. It is assumed that Phase 1 will have a consistent operational start date of 2020 for construction to the 25-year design horizon for all sub-regional options. Phase 2 will be constructed in 2041 to meet the 60-year design horizon. The timing of the first phase is based on the existing WWTPs being projected to reach full capacity within the next 5 years. This also allows time in the process for approval, design and construction of the selected sub-regional option.

3.1.1 Pipeline

The pipelines and pump stations are assumed to be constructed in two phases. Phase 1 is assumed to be constructed in 2020 to include the pipelines and lift station pumps sized for the 25-year design horizon. The pipeline in the first phase is sized to meet a target velocity of 0.9 to 1.1 m/s.

Phase 2 is assumed to be constructed in 2041 for the 60-year design horizon (2076). If the additional flow rate associated with the 60-year design horizon causes the pipeline from Phase 1 to exceed the maximum velocity of 1.6 m/s, then Phase 2 will also consist of twinning the specific pipeline.

The Phase 1 lift stations are assumed to be built with extra space to allow for the addition of pumps in Phase 2 to meet the 2076 design flows.

3.1.2 WWTP

The first phase of the WWTPs will be constructed in 2020 and will include technology designed to achieve effluent that meets the AEP HQ standard. Membrane Bioreactors (MBR) with additional chemical treatment for phosphorus removal is assumed. For all options, sludge is assumed to be dewatered by centrifuge at the WWTP, and hauled to an external facility such as EcoAG in High River.

For all options, the WWTPs are designed for maximum day flows (MDF), with the following exceptions:

- Pumping equipment is designed for peak hourly flows.
- Equalization storage volume equal to 25% of MDF is provided to balance peak flows into the WWTP.

3.2 Land Considerations

The pipe route in each option is assumed to be primarily along the west side of Alberta Transportation Highways 2A and 2. This is the shortest route to Calgary and to the sub-regional WWTP in the options reviewed. However, pipelines installed along Alberta Transportation primary highways are typically required to maintain a 30 m setback from the highway Right-of-Way (ROW). This 30 m offset would put the pipeline line assignment primarily in "greenfield" (farmer's fields) installation areas. This would require permanent easement acquisition from the landowners adjacent to the Highway ROW for the pipeline. However, "greenfield" installations on permanent easements could save significant costs over installation in narrow ditches or road shoulders. It also avoids dealing with existing facilities typically in the ROW (power poles, fibre optics, signs etc), traffic accommodation, and re-establishing road shoulder.

It is noted that the pipeline route assumed for this report is conceptual and is used as the basis for comparison purposes of the four options. A more detailed analysis of the most favourable pipeline route will be undertaken in Technical Memorandum 4.

3.3 Option 1

Option 1 includes a sub-regional pipeline from Okotoks and High River to the Calgary Pine Creek WWTP, and a new sub-regional WWTP in Aldersyde for the MD flows. The local plants in Westend, Longview and Nanton will be maintained as local facilities as per the CRP (CRP 2014). This option is illustrated on ***Figure 3.1*** in ***Appendix A***.

3.3.1 Pipeline

The primary sub-regional pipeline system will consist of:

- Existing local lift station (LS) in High River to pump peak hour flow to the existing High River aerated lagoon site; this existing lift station will be upgraded once capacity is exceeded. The existing 5.8 km long by 710 mm diameter pipeline to the lagoon site will be utilized.
- Existing High River lagoon will be maintained for peak shaving storage with a new lift station located at the lagoon site to pump maximum day flow through a new 30 km pipeline to the City.
- Existing Okotoks WWTP site will be utilized for peak shaving storage with a new lift station at the existing site to pump peak dry weather flow to the sub-regional pipeline to the City.

The Central District sub-regional pipeline system will consist of:

- New lift station in the MD Central District (MD CD) to pump peak hour flows through a new dedicated 20 km wastewater pipeline to a sub-regional WWTP in Aldersyde. Approximately 17 km of this pipeline could be installed in the same trench as the regional pipeline to the City, potentially saving cost.
- New outfall pipeline from the Aldersyde WWTP to the Sheep River.

The outfall pipeline to the Sheep River is assumed to be more acceptable than to the nearby Highwood River because the loading to the Sheep River in this option will be reduced by Okotoks' wastewater stream being transferred to the City. This is a more conservative assumption from both a river health and cost perspective, versus an outfall to the Highwood River. This being said, a receiving stream water quality assessment will be required ultimately to determine to which river the WWTP effluent should discharge. This river assessment is outside the current scope of this study.

The pipeline lengths, design flows and required lift stations for Option 1 are summarized in ***Table 3.1***. The preferred pipeline diameter and associated velocities for each phase are provided in ***Table 3.2***. The new pipelines for each phase are illustrated on ***Figure 3.1***. The lift station power requirements and pumping head (TDH) are summarized in ***Table 3.3***.

Table 3.1: Option 1 – Pipeline Lengths and Design Flows

Pipe Segment	Description	Length (km)	2041 Design Flow (L/s)	2076 Design Flow (L/s)	Lift Stations Required
1	High River LS to Lagoon	5.8	776	938	High River LS
2	High River Lagoon to Okotoks node	11.8	365	441	HR Lagoon LS
3	Okotoks to primary pipeline (Okotoks node)	5.0	426	856	Okotoks LS
4	Okotoks node to Calgary WWTP	18.3	791	1,296	Hwy 2 LS
5	MD Central District to Aldersyde WWTP	20.0	366	366	MD Central District LS
6	Aldersyde WWTP Outfall	3.1	222	274	Aldersyde WWTP LS

Table 3.2: Option 1 – Pipeline Diameter and Velocities

Pipe Segment	Phase 1 Pipelines		Phase 2 Pipelines	
	Pipe Diameter (mm)	Velocity (m/s)	Pipe Diameter (mm)	Velocity (m/s)
1	710 (existing)	1.1	710	1.3
	850	**1.1**	850	1.3
2	**850**	**0.9**	850	1.1
3	**850**	**1.0**	850	1.0
	-	-	**850**	**1.0**
4	**1,200**	**1.0**	1,200	1.6
5	**750**	**1.1**	750	1.1
6	**650**	**0.9**	650	1.1

Table 3.3: Option 1 – Lift Station Power

Lift Station	Phase 1 Power (kW)	Phase 1 TDH (m)	Phase 2 Power (kW)	Phase 2 TDH (m)
High River LS	310	22	425	25
HR Lagoon LS	388	59	530	66
Okotoks LS	315	41	664	43
Highway 2 LS	1,060	74	1,813	77
MD Central District LS	278	42	278	42
Aldersyde WWTP LS	56	14	70	14

The pipelines and lift stations for Phase 1 of Option 1 will include the following:

- 60.9 km of pipeline ranging from 650 mm to 1,200 mm in diameter,
- Six new lift stations, including a Highway 2 lift station installed on the primary pipeline north of Okotoks to pump over a topographical high point en route to the Pine Creek WWTP, and
- 3.1 km of outfall pipeline from the Aldersyde WWTP to the Sheep River.

Phase 2 of Option 1 will include the following:

- Twinning of 5 km of pipeline 850mm in diameter (from Okotoks to the primary pipeline, and
- Addition of pumps to five lift stations.

3.3.2 WWTP

For Option 1 it is assumed that the sub-regional Aldersyde WWTP will be located on the north side of the Hamlet in the same vicinity as the proposed Wind Walk WWTP. The Aldersyde WWTP will serve the MD Central District and Aldersyde areas.

The WWTP design flows for Option 1 are summarized in ***Table 3.4***.

Table 3.4: Option 1 – Sub-Regional Aldersyde WWTP Design Flows

Phase 1 ADF (m^3/day)	Phase 1 MDF (m^3/day)	Phase 2 ADF (m^3/day)	Phase 2 MDF (m^3/day)
9,800	19,000	11,800	24,000

3.4 Option 2

Option 2 includes one sub-regional WWTP located NE of Okotoks designed for 100% of the flow from High River, Okotoks, and the MD. The local plants in Westend, Longview and Nanton will be maintained as local facilities as per the CRP (CRP 2014). This option is illustrated on ***Figure 3.2*** in ***Appendix A***.

3.4.1 Pipeline

The sub-regional pipeline system will consist of:

- Existing lift station in High River to pump peak hour flow to the High River aerated lagoon site; this existing lift station will be upgraded once capacity is exceeded. The existing 5.8 km long by 710 mm diameter pipeline to the lagoon site will be utilized,
- Existing High River lagoon will be maintained for peak shaving storage with a new lift station located at the lagoon site to pump maximum day flow through a new 15 km pipeline to the sub-regional NE WWTP,
- New lift station in Aldersyde to pump peak hour flow to the sub-regional pipeline,
- Existing Okotoks WWTP site will be utilized for peak shaving storage with a new lift station at the existing site to pump peak dry weather flow to the sub-regional pipeline,
- New lift station in the MD Central District to pump peak hour flows through a new 14.6 km pipeline to the sub-regional pipeline,
- New outfall pipeline from the sub-regional NE WWTP to the Bow River at the confluence with the Highwood River.

The outfall pipeline is assumed to run to the Bow River instead of the nearby Highwood / Sheep River confluence. This option is more conservative from both a river health and cost perspective. It is understood that the Bow River has better wastewater assimilation capacity than the smaller Highwood River. This being said, a receiving water quality assessment will be required ultimately to determine to which river the WWTP effluent should or could discharge. This river assessment is outside the current scope of this study. It should be noted that if the outfall pipeline could be directed to the Highwood River / Sheep River confluence in the medium-term or long-term, capital cost savings could be realized.

The pipeline lengths, design flows and required lift stations for Option 2 are summarized in ***Table 3.5***. The preferred pipeline diameter and associated velocities for each phase are shown on ***Table 3.6***. The new pipelines for each phase are illustrated on ***Figure 3.2***. The estimated lift station power requirements and pumping head (TDH) are summarized in ***Table 3.7***.

Table 3.5: Option 2 – Pipeline Lengths and Design Flows

Pipe Segment	Description	Length (km)	2041 Design Flow (L/s)	2076 Design Flow (L/s)	Lift Stations Required
1	High River LS to Lagoon	5.8	776	938	High River LS
2	High River Lagoon to Aldersyde	6.8	365	441	HR Lagoon LS
3	Aldersyde to primary pipeline (Aldersyde node)	0.7	97	206	Aldersyde LS
4	Aldersyde node to Okotoks node	5.0	461	646	
5	Okotoks to primary pipeline (Okotoks node)	5.0	426	856	Okotoks LS.
6	Okotoks node to WWTP node	1.0	888	1,502	
7	MD Central District to primary pipeline (MD CD node)	14.6	366	366	MD Central District LS
8	MD CD node to Sub-Regional NE WWTP	2.1	1,253	1,868	
9	Sub-Regional NE WWTP Outfall	11.4	1,013	1,570	WWTP Outfall LS

Table 3.6: Option 2 – Pipeline Diameter and Velocities

Pipe Segment	Phase 1 Pipelines		Phase 2 Pipelines	
	Pipe Diameter (mm)	Velocity (m/s)	Pipe Diameter (mm)	Velocity (m/s)
1	710 (existing)	1.1	710	1.3
	850	**1.1**	850	1.3
2	**850**	**0.9**	850	1.1
3	**400**	**1.0**	400	1.1
	-	-	**400**	**1.1**
4	**900**	**1.0**	900	1.4
5	**850**	**1.0**	850	1.0
	-	-	**850**	**1.0**
6	**1,300**	**1.0**	1,300	1.6
7	**750**	**1.1**	750	1.1
8	**1,450**	**1.1**	1,450	1.6
9	**1,450**	**0.9**	1,450	1.3

Table 3.7: Option 2 – Lift Station Power

Lift Station	Phase 1 Power (kW)	Phase 1 TDH (m)	Phase 2 Power (kW)	Phase 2 TDH (m)
High River LS	310	22	442	26
High River Lagoon LS	283	43	410	51
Aldersyde LS	46	26	123	33
Okotoks LS	200	26	425	27
MD Central District LS	278	42	278	42
NE WWTP Outfall LS	448	24	712	25

The pipelines and lift stations for Phase 1 of Option 2 will include the following:

- 41 km of sub-regional pipeline ranging from 400 mm to 1,450 mm in diameter,
- Six new lift stations, and
- 11.4 km outfall pipeline from sub-regional NE WWTP to the Bow River.

Phase 2 of Option 2 will include the following:

- Twinning of 5.7 km of pipeline ranging from 400 mm to 850 mm in diameter (from Aldersyde and Okotoks), and
- Addition of pumps to five lift stations.

3.4.2 WWTP

The WWTP design flows for Option 2 are summarized in ***Table 3.8.*** This WWTP will serve all flows from Okotoks, High River and the MD.

Table 3.8: Option 2 – Sub-Regional NE WWTP Design Flows

Phase 1 ADF (m^3/day)	Phase 1 MDF (m^3/day)	Phase 2 ADF (m^3/day)	Phase 2 MDF (m^3/day)
41,500	87,000	52,700	136,000

3.5 Option 3

Option 3 includes one sub-regional WWTP located NE of Okotoks servicing only excess (future growth) flow from Okotoks, plus 100% of the flow from High River and the MD. The local plants in Westend, Longview and Nanton will be maintained as local facilities as per the CRP (CRP 2014). This option is illustrated on ***Figure 3.3*** in ***Appendix A***.

3.5.1 Pipeline

The pipeline system for this option will be similar to that for Option 2 with the exception that the Okotoks WWTP will not be utilized for peak shaving storage since it is being maintained for treatment. A new lift station will be required at the Okotoks plant site to pump wastewater peak flows beyond the WWTP capacity to the new sub-regional NE WWTP.

It is assumed that any excess flows beyond 2016 (population 29,874) will be sent to the sub-regional WWTP. The Town of Okotoks may need to initially "push" their plant to meet the 2020 population of 35,000 but can eventually back off to 29,874 once the sub-regional NE WWTP is in place, allowing for some excess "emergency" capacity in their local plant. To accomplish this some component upgrades may be required in the Okotoks plant (Stantec TM2 STM 2015).

The pipeline lengths, design flows and required lift stations for Option 3 are summarized in ***Table 3.9***. The preferred pipeline diameter and associated velocities for each phase are provided in ***Table 3.10***. The new pipelines for each phase are illustrated on ***Figure 3.3***. The estimated lift station power requirements and pumping head (TDH) are summarized in ***Table 3.11***.

Table 3.9: Option 3 – Pipeline Lengths and Design Flows

Pipe Segment	Description	Length (km)	2041 Design Flow (L/s)	2076 Design Flow (L/s)	Lift Stations Required
1	High River LS to Lagoon	5.8	776	938	High River LS.
2	High River Lagoon to Aldersyde	6.8	365	441	HR Lagoon LS
3	Aldersyde to primary pipeline (Aldersyde node)	0.7	97	206	Aldersyde LS
4	Aldersyde node to Okotoks node	5.0	461	646	-
5	Okotoks to primary pipeline (Okotoks node)	5.0	359	827	Okotoks LS
6	Okotoks node to WWTP node	1.0	821	1,473	-
7	MD Central District to primary pipeline (MD CD node)	14.6	366	366	MD Central District LS
8	MD CD node to Sub-Regional NE WWTP	2.1	1,186	1,839	-
9	Sub-Regional NE WWTP Outfall	11.4	876	1,410	WWTP Outfall LS

Table 3.10: Option 3 – Pipeline Diameter and Velocities

Pipe Segment	Phase 1 Pipelines		Phase 2 Pipelines	
	Pipe Diameter (mm)	Velocity (m/s)	Pipe Diameter (mm)	Velocity (m/s)
1	710 (existing)	1.1	710	1.3
	850	**0.9**	850	1.1
2	**850**	**0.9**	850	1.1
3	**400**	**1.0**	400	1.1
	-	-	**400**	**1.1**
4	**900**	**1.0**	900	1.4
5	**750**	**1.1**	750	1.1
	-	-	**850**	**1.1**
6	**1,300**	**0.9**	1,300	1.6
7	**750**	**1.1**	750	1.1
8	**1,450**	**1.0**	1,450	1.6
9	**1,300**	**1.0**	1,300	1.6

Table 3.11: Option 3 – Lift Station Power

Lift Station	Phase 1 Power (kW)	Phase 1 TDH (m)	Phase 2 Power (kW)	Phase 2 TDH (m)
High River LS	310	22	442	26
High River Lagoon LS	282	43	408	51
Aldersyde LS	46	26	117	32
Okotoks LS	170	26	399	27
MD Central District LS	279	42	279	42
NE WWTP Outfall LS	391	25	642	25

The pipelines and lift stations for Phase 1 of Option 3 will include the following:

- 41 km of sub-regional pipeline ranging from 400 mm to 1,450 mm in diameter,
- Six new lift stations, and
- 11.4 km outfall pipeline from sub-regional NE WWTP to the Bow River.

Phase 2 of Option 3 will include the following:

- Twinning of 5.7 km of pipeline ranging from 400 mm to 850 mm in diameter (from Aldersyde and Okotoks), and
- Addition of pumps to five lift stations.

3.5.2 WWTP

The WWTP design flows for Option 3 are summarized in ***Table 3.12***. This WWTP will serve all flows from High River and the MD, and flows from any future growth in Okotoks.

Table 3.12: Option 3 – Sub-Regional NE WWTP Design Flows

Phase 1 ADF (m^3/day)	Phase 1 MDF (m^3/day)	Phase 2 ADF (m^3/day)	Phase 2 MDF (m^3/day)
35,000	76,000	47,000	122,000

3.6 Option 4

Option 4 will include a sub-regional pipeline from Okotoks and High River to the City of Calgary Pine Creek WWTP, sized to also include 100% of the MD flow. The local plants in Westend, Longview and Nanton will be maintained as local facilities as per the CRP (CRP 2014). This option is illustrated on ***Figure 3.4*** in ***Appendix A***.

3.6.1 Pipeline

The pipeline for this option will be similar to the primary sub-regional pipeline proposed in Option 1, with the exception that a lift station in both Aldersyde and the MD Central District will be required to pump peak flows to the sub-regional pipeline to the City. This option eliminates the dedicated pipeline from Central District and the sub-regional Aldersyde WWTP that are proposed in Option 1.

The pipeline lengths, design flows and required lift stations for Option 4 are summarized in ***Table 3.13***. The preferred pipeline diameter and associated velocities for each phase are provided in ***Table 3.14***. The new pipelines for each phase are illustrated on ***Figure 3.4***. The lift station power requirements and pumping head (TDH) are summarized in ***Table 3.15***.

Table 3.13: Option 4 – Pipeline Lengths and Design Flows

Pipe Segment	Description	Length (km)	2041 Design Flow (L/s)	2076 Design Flow (L/s)	Lift Stations Required
1	High River LS to Lagoon	5.8	776	938	High River LS
2	High River Lagoon to Aldersyde	6.8	365	441	HR Lagoon LS
3	Aldersyde to primary pipeline (Aldersyde node)	0.7	97	206	Aldersyde LS
4	Aldersyde node to Okotoks node	5.0	461	646	
5	Okotoks to main pipeline (Okotoks node)	5.0	426	856	Okotoks LS
6	Okotoks node to MD CD node	13.6	888	1,502	Highway 2 LS
7	MD Central District to primary pipeline (MD CD node)	2.5	366	366	MD Central District LS
8	MD CD node to Calgary WWTP	4.7	1,253	1,868	

Table 3.14: Option 4 – Pipeline Diameter and Velocities

Pipe Segment	Phase 1 Pipelines		Phase 2 Pipelines	
	Pipe Diameter (mm)	Velocity (m/s)	Pipe Diameter (mm)	Velocity (m/s)
1	710 (existing)	1.1	710	1.3
	850	**1.1**	850	1.3
2	**850**	**0.9**	850	1.1
3	**400**	**1.0**	400	1.1
	-	-	**400**	**1.1**
4	**900**	**1.0**	900	1.4
5	**850**	**1.0**	850	1.0
	-	-	**850**	**1.0**
6	**1,300**	**1.0**	1,300	1.6
7	**750**	**1.1**	750	1.1
8	**1,450**	**1.1**	1,450	1.6

Table 3.15: Option 4 – Lift Station Power

Lift Station	Phase 1 Power (kW)	Phase 1 TDH (m)	Phase 2 Power (kW)	Phase 2 TDH (m)
High River LS	310	22	442	26
High River Lagoon LS	383	58	535	67
Aldersyde LS	71	41	173	46
Okotoks LS	317	41	664	43
Highway 2 LS	1,180	73	2,128	78
MD Central District LS	166	25	166	25

The pipelines and lift stations for Phase 1 of Option 4 will include the following:

- 44.1 km of pipeline ranging from 400 mm to 1,450 mm in diameter, and
- Six new lift stations, including a Highway 2 lift station installed on the main line north of Okotoks to pump over a topographical high point en route to the Pine Creek WWTP.

Phase 2 of Option 4 will include the following:

- Twinning of 5.7 km of pipeline ranging from 400 mm to 850 mm in diameter (from Aldersyde and Okotoks), and
- Addition of pumps to five lift stations.

3.7 Environmental and Regulatory Considerations

In Option 1, a sub-regional WWTP is proposed to be in Aldersyde, with an outfall directed north to the Sheep River, upstream of its confluence with the Highwood River. The outfall is downstream of the Westend (Black Diamond and Turner Valley) and Okotoks treatment facilities, both of which discharge effluent into the Sheep River. As mentioned in *Technical Memorandum 2: Foothills Streams Analysis*, the primary contributors of nutrients to the Sheep River are the Westend and Okotoks systems. However, in Option 1, Okotoks wastewater is to be conveyed to Calgary, which discharges to the Bow River. The Westend facility is projected to be at capacity within the next 5 years and in time will likely require an upgrade to meet the current AEP HQ effluent standards. Technical Memorandum 5 reviews the Westend facility upgrade options (WWTP or Pipeline). Once the preferred options are selected, both regionally and for Westend, more detailed analysis on the receiving streams will be required as the nutrient loadings in various reaches of the Sheep River and Bow River will change.

For Options 2 and 3, the sub-regional WWTP is proposed to be located northeast of Okotoks, within the MD Central District area. At this time, the outfall is proposed to be located on the Bow River, downstream of the confluence of the Bow River and the Highwood River. This is downstream of the City of Calgary's outfalls. This location receives added flow from both the Sheep River and the Highwood River. A detailed receiving streams assessment and modelling are recommended to determine the potential impacts of nutrient loading along this reach of the Bow River given the future effluent flows. In the meantime, this report has taken the conservative approach of avoiding a major increase in discharge of treated effluent to the Sheep River and Highwood River until such studies are completed.

In Options 1 and 4, wastewater from High River is conveyed to the City of Calgary, while in Options 2 and 3, wastewater from High River is conveyed to the sub-regional NE WWTP. Therefore in all options treated effluent from High River will no longer be discharged to Frank Lake. As discussed in MPE/USL TM1 2015 the water balance at Frank Lake is currently very dependent on the effluent volume from the Town of High River and Cargill WWTPs (MPE 2004). Ducks Unlimited has indicated that there is no formal agreement in place for Cargill or High River to direct their effluent to Frank Lake (Ducks Unlimited Email 2015). However, a closer look at the impact from any selected option on Frank Lake should be carried out in consultation with Ducks Unlimited and AEP. This may require consideration of increased diversion from the Highwood River, and/or a treated effluent return pipeline from any regional treatment facility. A more detailed assessment is outside the current scope of this study.

In all options the pipelines will have an AEP pipeline index greater than 2690 (pipeline outside diameter in mm multiplied by length in km) and as such will be considered Class 1 pipelines under the *Environmental Protection and Enhancement Act* (EPEA). This will require an EPEA Approval including conservation and reclamation (C&R) activities associated with pipeline construction. This will require a 30-day public advertising period. The pipeline will also require a “Notification” and the pump stations an “Authorization” from AEP as per the provincial *Water Act*. An EPEA Approval is also required for any treatment plant and/or new outfall. *Water Act* approval will also be required for various components of the work, particularly within streams.

Pipeline routing for all options will require multiple crossings of highways and utility right-of-ways, as well as water bodies and potential environmentally sensitive areas. Crossing agreements will be required for all the highway and utility crossings. Watercourse crossings will require both Federal and Provincial approvals. Wildlife, wildlife habitat, wetland and vegetation studies and/or surveys will be required prior to construction to ensure requirements of the federal *Species at Rick Act*, *Migratory Birds Convention Act* and provincial *Wildlife Act*, *Alberta Weed Control Act* and *Water Act* are met. Also a Historical Resources Impact Assessment will likely be required by *Alberta Culture and Tourism* (ACT).

4. COSTS

This section reviews the economic analysis of the regional wastewater servicing options. Capital expenditure and operation and maintenance (O&M) costs are evaluated. Capital costs represented in this report are in projected 2016 dollars and include allowances for contingency and engineering. All costs are exclusive of GST. All referenced costs and cost estimates presented are considered Class D (screening level) opinions of probable cost.

For each regional servicing option, the following are established:

- Capital cost estimates,
- O&M costs,
- Net present value (NPV)

The capital cost estimates and the O&M costs are used to determine the net present value (NPV) of each servicing option. These are utilized to compare, evaluate and hence establish the most cost effective options for the FRWWC regional wastewater servicing.

4.1 Grant Funding Review

The following section reviews the grant funding options that may be most applicable to this project. The Alberta Municipal Water and Wastewater Partnership (AMWWP) program, the Regional System Initiative under the Water for Life Strategy, and Small Communities Fund (SCF) may be the most significant Provincial sources of potential capital funding for this project. There are other sources of grant funding available but they tend to be more restrictive, either funding only specific components of a project or a much lower share of project costs.

4.1.1 Alberta Municipal Water/Wastewater Partnership (AMWWP)

Under the AMWWP program, funding is provided to urban centers under 45,000 population, regional commissions and eligible hamlets within rural municipalities. The construction of high-priority water supply, water treatment, wastewater treatment and disposal facilities are eligible for funding. Local water distribution piping and/or sewage collection systems are not eligible for funding.

Funding is provided as a percentage of eligible approved project costs. For those municipalities under 1,000 population, projects are cost-shared on a 75% government and 25% municipality basis. For communities over 1,000 population (to a maximum of 45,000 population), grant percentage ratios are calculated by a formula. The percentage ratio declines as the population increases.

The program also encourages water conservation and consumption-based rate structures. Under this initiative, municipalities could be subject to a 10% reduction in grants if they have no metering in place and the average annual consumption exceeds the norm for the area. This applies to both water and wastewater projects.

In November 2015, the Province announced that a total of $195 million has been budgeted for the AMWWP program over the next five years (Alberta Government Website 2015).

4.1.2 Alberta Regional Systems Initiative and Water Strategy Initiative (Water for Life)

In 2006, the Province implemented the *"Water for Life"* Initiative. This program falls under the AMWWP Regional Systems Initiative and Water Strategy Initiative. In this program, the Province will fund up to 90% of the capital costs of building new regional municipal water and wastewater pipelines. This program can also provide 100% funding to the "hub" suppliers for any necessary treatment upgrades for the additional regional customers. In order to be eligible for the "Water for Life" initiative, a regional commission or group must consist of two or more municipalities (or eligible hamlets) that are eligible for funding under the AMWWP. The idea is that such projects tend to be more cost effective and environmentally friendly and make it easier to attract certified operators.

In November 2015, the Province announced that a total of $350 million has been budgeted for Water for Life program over the next five years (Alberta Government Website 2015).

4.1.3 New Building Canada Fund: Small Communities Fund (SCF)

The Small Communities Fund (SCF) is a part of the New Building Canada Fund. It was confirmed in the 2014 Federal Budget to designate $94 million in federal funding to support infrastructure projects in Alberta communities with a population of 100,000 or less. Projects are cost-shared on a one-third federal, one-third provincial and one-third municipal basis. Maximum project funding is $3-million for each of the partners.

4.2 Capital Cost Estimates

Capital estimates of probable cost are developed at a screening level for a high level comparison of the four options, and are summarized in ***Table 4.1***. Regional pumping and pipeline costs are based upon historical tender costs in the MPE/USL team database.

The costs for all pipelines are estimated from municipal boundary to receiving centre boundary. This is consistent with the CRP report. (CRP 2014). In addition to pipe construction costs, the following costs are included in pipe capital cost estimates, similar to the CRP report and adjusted for inflation:

- Land acquisition along the pipe alignment, $24,000/km
- Valve chamber allowance for each pipe scenario, $580,000

The following assumptions are used to derive the capital cost estimates for the WWTPs in all options:

- A capital cost curve is derived for MBR WWTPs (capital cost per unit of treatment capacity) based on historical costs in the USL database.
- The costs of land acquisition is not included in the WWTP estimates

Table 4.1: Summary of Capital Cost Estimates

Option	Phase 1 – 2041 Design Horizon			Phase 2 – 2076 Design Horizon			Phase 1 & 2
	Pipelines & Lift Stations	WWTP	Total	Pipelines & Lift Stations	WWTP	Total	Grand Total
1	$216 M	$40 M	**$256 M**	$15 M	$14 M	**$29 M**	**$285**
2	$213 M	$185 M	**$398 M**	$19 M	$132 M	**$151 M**	**$549**
3	$197 M	$165 M	**$362 M**	$19 M	$126 M	**$145 M**	**$507**
4	$190 M	n/a	**$190 M**	$18 M	n/a	**$18 M**	**$208**

There is potential for cost savings for the WWTP outfall pipelines if the future receiving water quality assessments and AEP confirm the effluent can be discharged to a closer river. The potential cost savings for the outfall pipeline are summarized in ***Table 4.2***.

Table 4.2: Potential Savings for Outfall Pipeline

Option	Alternative Outfall Description	Potential Cost Savings
1	Aldersyde WWTP to the Highwood River	$4 M
2	Sub-Regional NE WWTP to the Highwood River / Sheep River Confluence	$68 M
3	Sub-Regional NE WWTP to the Highwood River / Sheep River Confluence	$56 M

4.3 Operation and Maintenance Costs

4.3.1 Pipeline

The O&M costs for the pipelines and lift stations are based on similar assumptions as adopted by the CRP (CRP 2014) and adjusted for inflation. They include the following:

- Power costs: Power costs are based on an assumed $0.17/kWh.
- Labour costs: Labour costs associated with the lift stations are based on average flow rates. Lift stations larger than 20,000 m^3/day are assumed to have annual labour costs of $170,000. Smaller lift stations with flows less than 20,000 m^3/day are assumed to have labour costs of $45,000 per year.
- Repair and rehabilitation (R&R): Pump R&R costs are estimated to be 2% of total pump capital cost.
- Inflation Rate: 2.5% per year

Customers outside the boundaries of the City of Calgary must pay to the City a monthly charge in accordance with Schedule “E” of the *City of Calgary Wastewater Bylaw* (City 2015). Projected monthly charges are applied to Options 1 and 4, both of which have service provided by the City of Calgary. Schedule “E” indicates the monthly charge includes a fixed component plus a volume component up to year 2018. The fixed component is applied to recover costs of upgrades to conveyance infrastructure and treatment facilities internal to the City limits that are required to service the external flows. The volume component is for the operation costs for the WWTP and conveyance infrastructure. The City revises this Schedule “E” every four years to update the committed regional flows and associated costs the City will need to recoup. It is assumed for this study that the rates beyond 2018 remain consistent with the 2018 rate plus inflation of 2.5% per year.

No user fees are added for Options 2 and 3, where wastewater treatment is provided by an independent sub-regional WWTP within the MD of Foothills.

4.3.2 WWTP

The following assumptions are used in estimating the operational and maintenance (O&M) costs for the WWTPs in all Options:

- The O&M costs are assumed based on average annual daily flows. For this memorandum, the mid-point flows between 2016-2041, and 2041-2076 are linearly interpolated to use as an average over the time period. Since flows are directly related to population increase, which is exponential, the average annual operating costs are conservative. The O&M costs will be further refined following the selection of the two preferred options in Technical Memorandum 4.

- Chemicals costs include delivery in liquid form (Liquid Alum and Emulsion Polymer) to the WWTPs, rather than blending at the plant.
- Power usage estimates include mainly space heating and energy from the MBRs, as these two categories comprise the largest use of power for the WWTPs. Power costs are estimated from Fortis Alberta 2015 Rate 61: General Service.
- Labour costs are assumed based on number of full time equivalents (FTE) required per average daily flow.
- Equipment replacement costs (including MBR replacement) are assumed to be $\$0.50/m^3$ of ADF
- Parts and Maintenance supply costs are assumed to be 2% of the capital cost of equipment (excluding MBRs) for each phase.
- Sludge is assumed to be dewatered at the WWTP and hauled to Eco-AG in High River, an external solids processing facility.
- The O&M costs for the existing Okotoks WWTP are unavailable and are not included in Option 3.

The projected annual O&M costs for the two phases are summarized in ***Table 4.3***.

Table 4.3: Summary of Annual O&M Costs

Option	Phase 1 O&M Costs (2021 – 2041)			Phase 2 O&M Costs (2042 – 2076)		
	Pipeline	WWTP	Total/yr	Pipeline	WWTP	Total/Yr
1	$13 M	$4 M	**$17 M**	$17 M	$6 M	**$23 M**
2	$2 M	$16 M	**$18 M**	$3 M	$26 M	**$29 M**
3	$2 M	$13 M	**$15 M**	$3 M	$21M	**$24 M**
4	$16 M	n/a	**$16 M**	$21 M	n/a	**$21 M**

4.4 Net Present Value

A net present value (NPV) analysis is completed for each regional option. The NPV includes the capital cost of construction in 2020 and 2041. The O&M costs are for 55 years of operation from 2021 to 2076. ***Table 4.4*** summarize the NPV analysis. It is important to note that funding from provincial grant initiatives is not taken into consideration when undertaking this analysis. NPV are based on a discount rate of 5%.

Table 4.4: Net Present Value

Option	Pipeline NPV	WWTP NPV	TOTAL NPV
1	$404 M	$100 M	**$504 M**
2	$218 M	$465 M	**$683 M**
3	$204 M	$392 M	**$596 M**
4	$435 M	n/a	**$435 M**

Based on the NPV analysis the two most cost effective options are:

- Option 1
- Option 4

5. PESTLE ANALYSIS

In order to complete a comprehensive analysis of options, pestle criteria were developed at a workshop in September 2015 with the Technical and Governance Committees' input that consider six different categories:

P: Political

E: Environmental

S: Social

T: Technological

L: Legal

E: Economic

A detailed summary of key considerations affecting the performance of the options is outlined in ***Appendix C***. Urban Systems and MPE developed a scoring of each option against these criteria and these results are also contained in ***Appendix C***. The impact of these criteria was tested by considering two weighting approaches. The first is to weight all categories equally and the second is to apply a weighting factor based on the Committees' input during the initial workshop. The following table summarizes the two weightings:

Table 4.5: PESTLE Criteria Weighting

	Equal Weighting	Committee Weighting
Political	17%	17%
Environmental	17%	22%
Social	17%	14%
Technological	17%	13%
Legal	17%	13%
Economic	17%	22%

To illustrate the performance of the options, Option 1 is set as the base case and the other options are plotted against this option. PESTLE scores have been developed based on a comparison to Option 1. The following scores are used:

+2: Significant benefit over Option 1

+1: Benefit over Option 1

0: Performs the same as Option 1

-1: Performs worse than Option 1

-2: Performs significantly worse than Option 1

These scores are weighted in accordance with the above table and plotted against the life cycle cost savings compared to Option 1. Since Option 2 and 3 are more expensive, the life cycle saving for these two options shows as a negative percentage.

The following graphs illustrate the results against both criteria weightings:

Figure 4.1. PESTLE: Committee Weighting

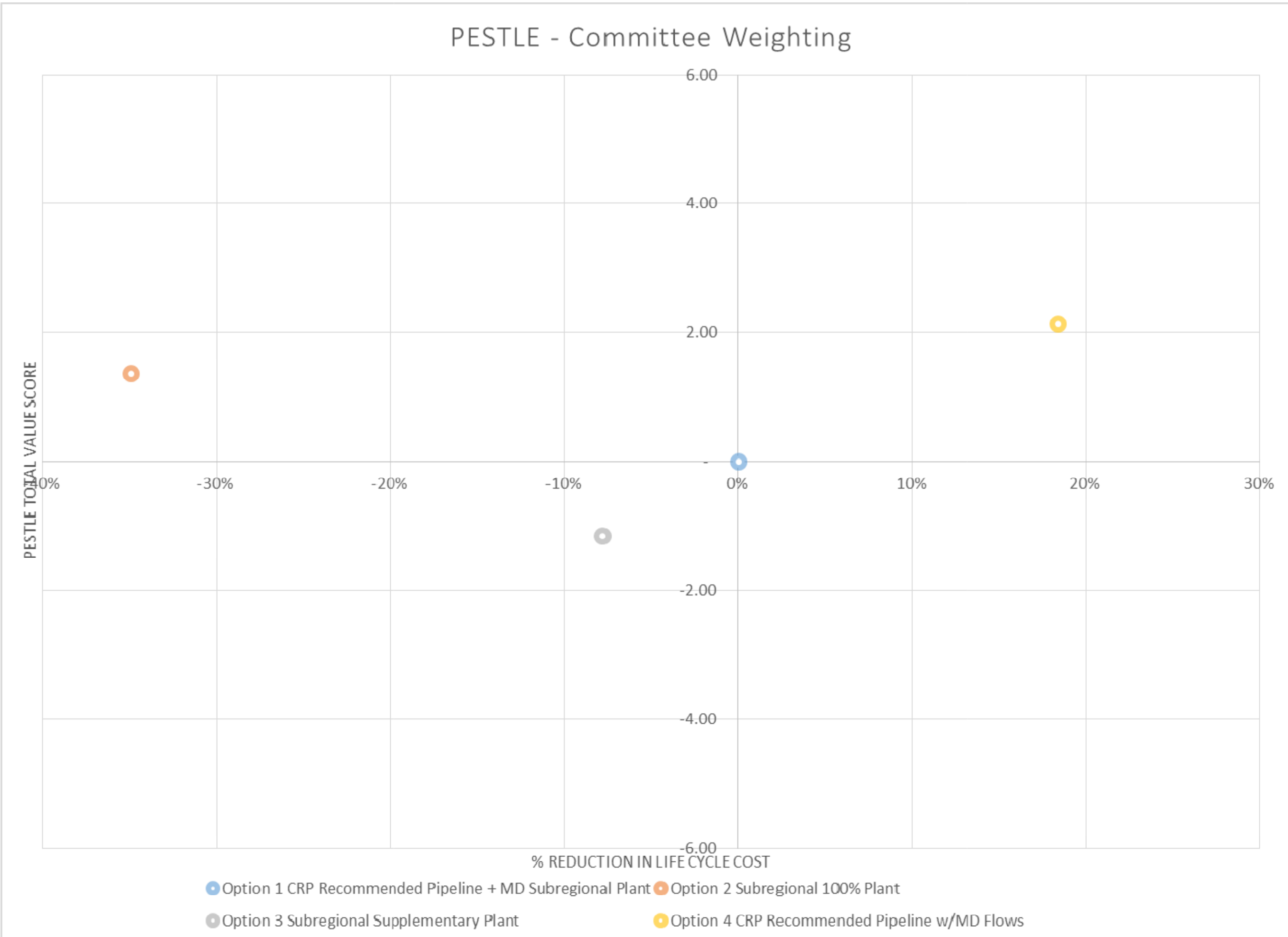
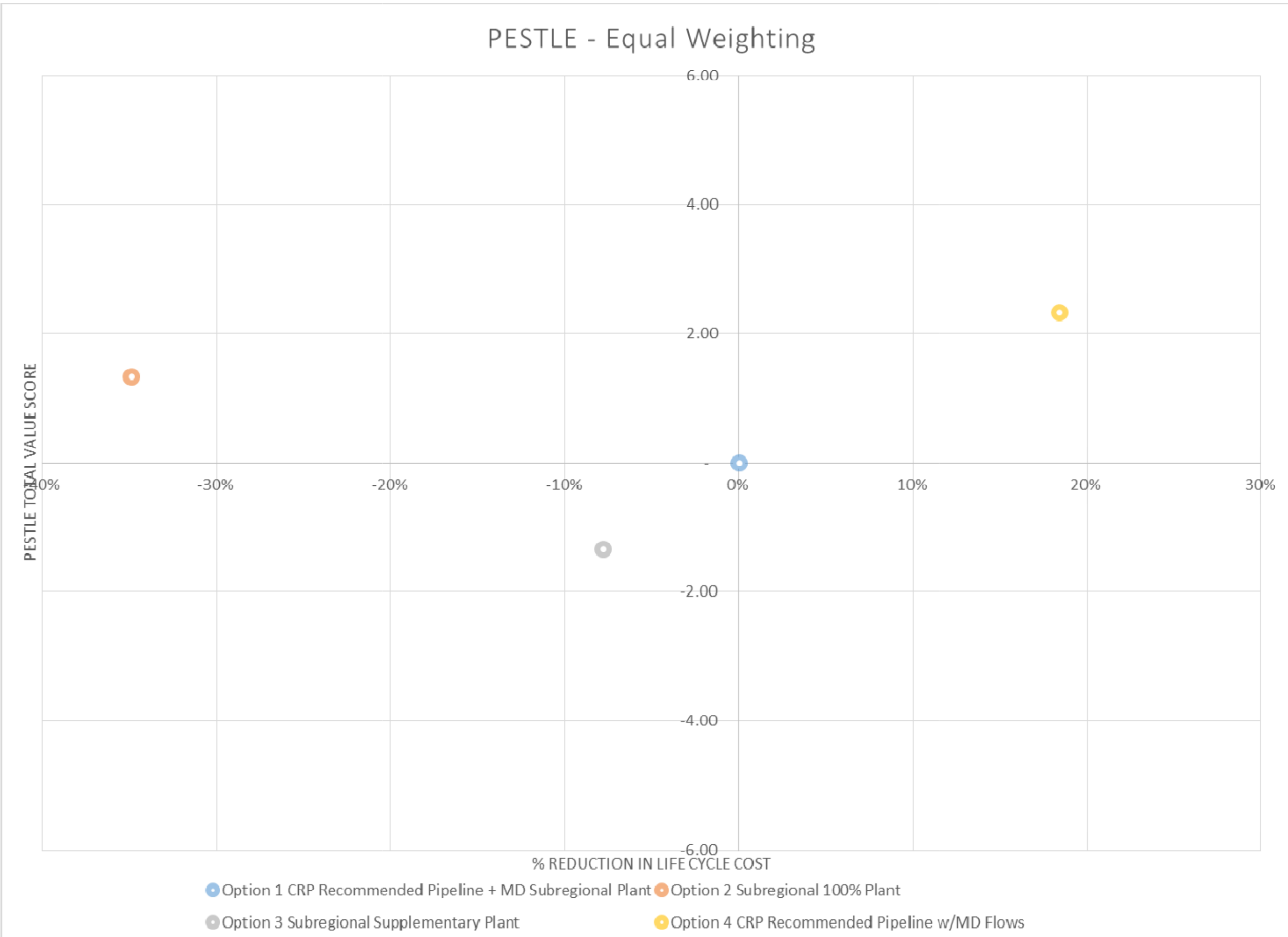


Figure 4.2. PESTLE: Equal Weighting



As illustrated in the above two figures, the criteria weighting does not impact the performance of the options. Option 4 is the lowest cost option and also scores highest on the PESTLE analysis. Option 2 scores second best but is also the most expensive. Option 1 scores third and is the second lowest cost option. Option 3 performs worst and is the third lowest cost option.

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6. SUMMARY DISCUSSION AND COMPARISON OF OPTIONS

A summary of the major advantages and disadvantages of each option are summarized in ***Table 6.1*** below.

Table 6.1: Advantages and Disadvantages of Each Option

Option	Advantages	Disadvantages
1	Regional Pipeline from Okotoks & High River to Calgary, new Sub-regional WWTP for MD flows; retain local plants in Westend, Longview and Nanton as per CRP.	
	• Second least costly option • All municipalities proposed to tie to Calgary meet the current City policies and are eligible to apply to council to connect to the system	• Performs third best on the PESTLE scoring • Longest length of pipelines • Requires additional lift station to pump to City • MD of Foothills WWTP is a stand-alone plant and likely not eligible for Water for Life funding, but likely eligible for AMWWP and BCF • Requires ongoing outside user fees to be paid to City, which are unknown past 2018 • Further study required regarding new MD outfall to Highwood River / Sheep River • Timing: cannot likely tie-in to City WWTP until at
2	One Sub-Regional WWTP designed for 100% of flow from High River, Okotoks, and the MD; retain local plants in Westend, Longview and Nanton as per CRP.	
	• Performs second best on the PESTLE scoring • Shortest length of pipeline (same as Option 3) • Is a regional solution and is most likely to be fully eligible for Water for Life funding	• Most costly option • Further study required regarding new outfall to Highwood River / Bow River
3	One Sub-Regional WWTP servicing only excess flow from Okotoks, plus 100% of the flow from High River and MD; retain local plants in Westend, Longview and Nanton as per CRP.	
	• Shortest length of pipeline (same as Option 2)	• Performs worst on the PESTLE scoring • Second most costly option • Two WWTP's – more difficult to retain Operators • Further study required regarding new outfall to Highwood River / Bow River
4	Regional pipeline from Okotoks and High River to Calgary, sized to also include 100% of MD flow; retain local plants in Westend, Longview and Nanton as per CRP.	
	• Performs best on the PESTLE scoring • Least costly option • Is a regional solution and is most likely to be fully eligible for Water for Life funding • No WWTP for FRWWC to operate	• Political issues. MD of Foothills does not meet the current City policies and is not eligible to apply to council to connect to the system • Requires ongoing outside user fees to be paid to City, which are unknown past 2018 • Requires ongoing outside user fees to be paid to City • Timing: cannot likely tie-in to City WWTP until at least 2025

7. RECOMMENDATIONS

7.1 Preferred Options

- FRWWC confirmed at Meeting #2 that Options 3 and 4 will be recommended to the Governance Committee.

7.2 Next Steps

The following are the next steps as per the proposed work plan following submittal of this Technical Memorandum 3.

1. Meeting #2 - FRWWC to select the two preferred options for further refinement. Consider Westend options.
2. MPE/USL to refine the two preferred options for conceptual design and costing and produce Technical Memorandum 4.
3. Meeting #3 with MPE/USL/FRWWC to select favoured Option.
4. MPE/USL to finalize Draft Final Report based on outcome of Meeting #3 and submit for comments.
5. Meeting #4 with MPE/USL/FRWWC to review Draft Final Report and provide comments.
6. MPE/USL to prepare and submit Final Report.
7. Meeting #5 with MPE/USL/FRWWC to present Final Report.

Sincerely,

MPE ENGINEERING LTD.

Sarah Fratpietro, P.Eng.
Project Manager

"REVIEWED BY:"
Randy Boras, M.Sc., P.Eng.
Senior Project Specialist

SF/rb

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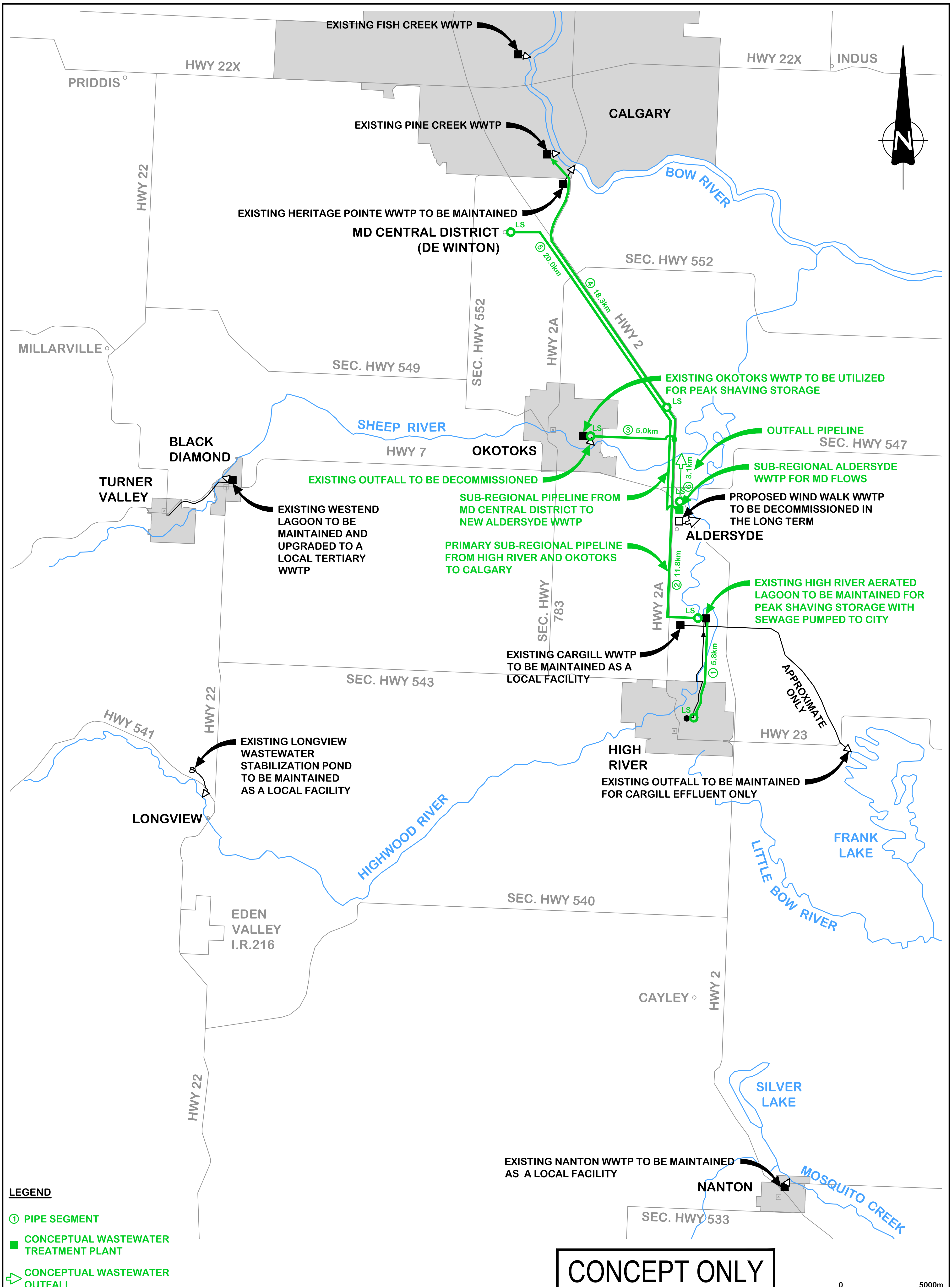
APPENDIX A:

FIGURE 3.1 – OPTION 1 - CRP Recommended, MD on Sub-Regional WWTP

FIGURE 3.2 – OPTION 2 - Sub-Regional WWTP Servicing 100% High River, Okotoks, MD Central District, and Aldersyde

FIGURE 3.3 – OPTION 3 - Sub-Regional WWTP Supplementing Okotoks, and 100% High River, MD Central District and Aldersyde

FIGURE 3.4 – OPTION 4 - CRP Recommended, Including MD Flows



LEGEND

- ① PIPE SEGMENT
- CONCEPTUAL WASTEWATER TREATMENT PLANT
- CONCEPTUAL WASTEWATER OUTFALL
- LS CONCEPTUAL LIFT STATION
- EXISTING WASTEWATER TREATMENT PLANT
- PROPOSED PRIVATE WASTEWATER TREATMENT PLANT
- EXISTING WASTEWATER OUTFALL
- PROPOSED PRIVATE OUTFALL

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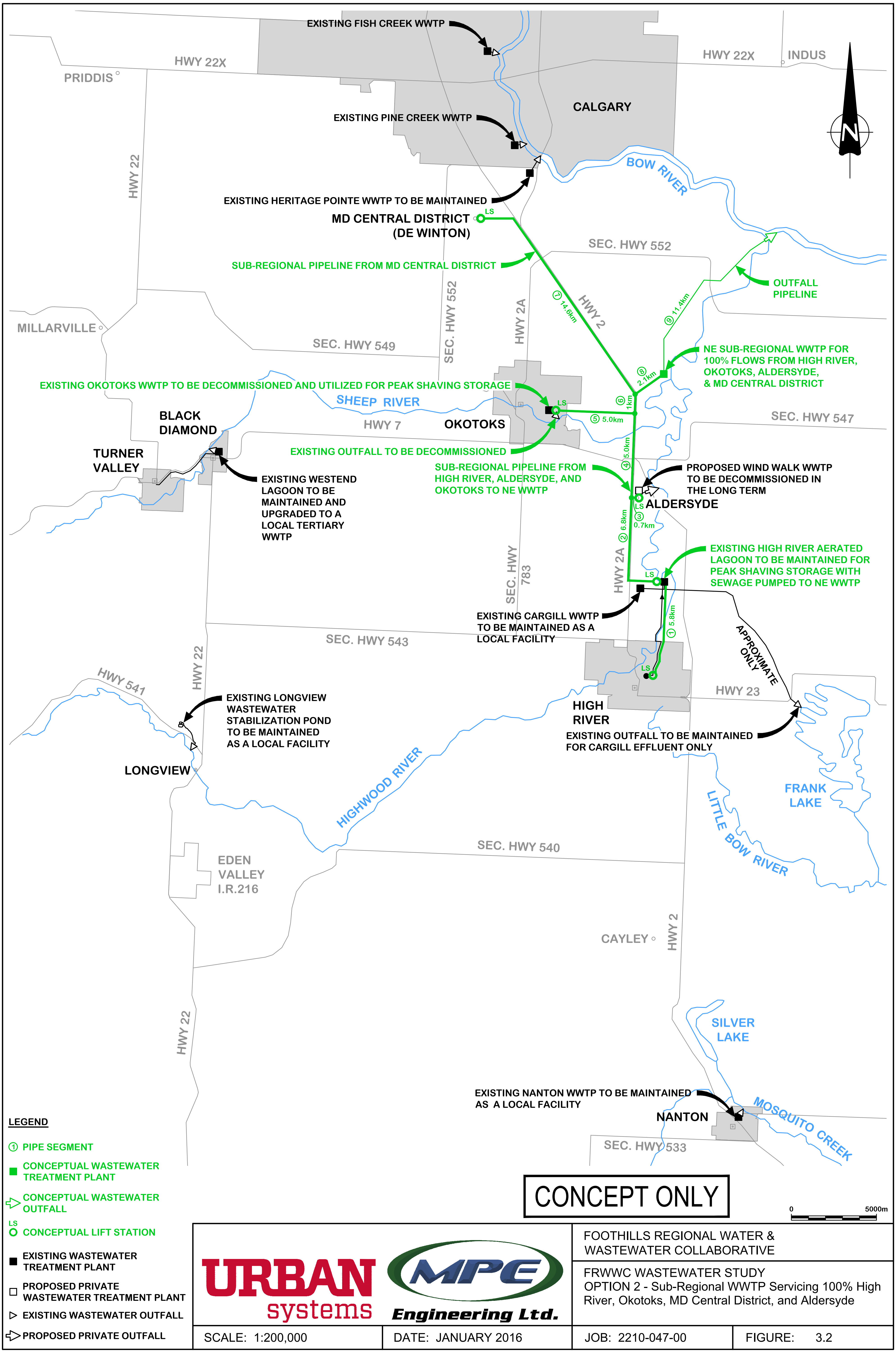
FOOTHILLS REGIONAL WATER & WASTEWATER COLLABORATIVE

FRWWC WASTEWATER STUDY
OPTION 1 - CRP Recommended, MD on Sub-Regional WWTP

SCALE: 1:200,000	DATE: JANUARY 2016	JOB: 2210-047-00	FIGURE: 3.1



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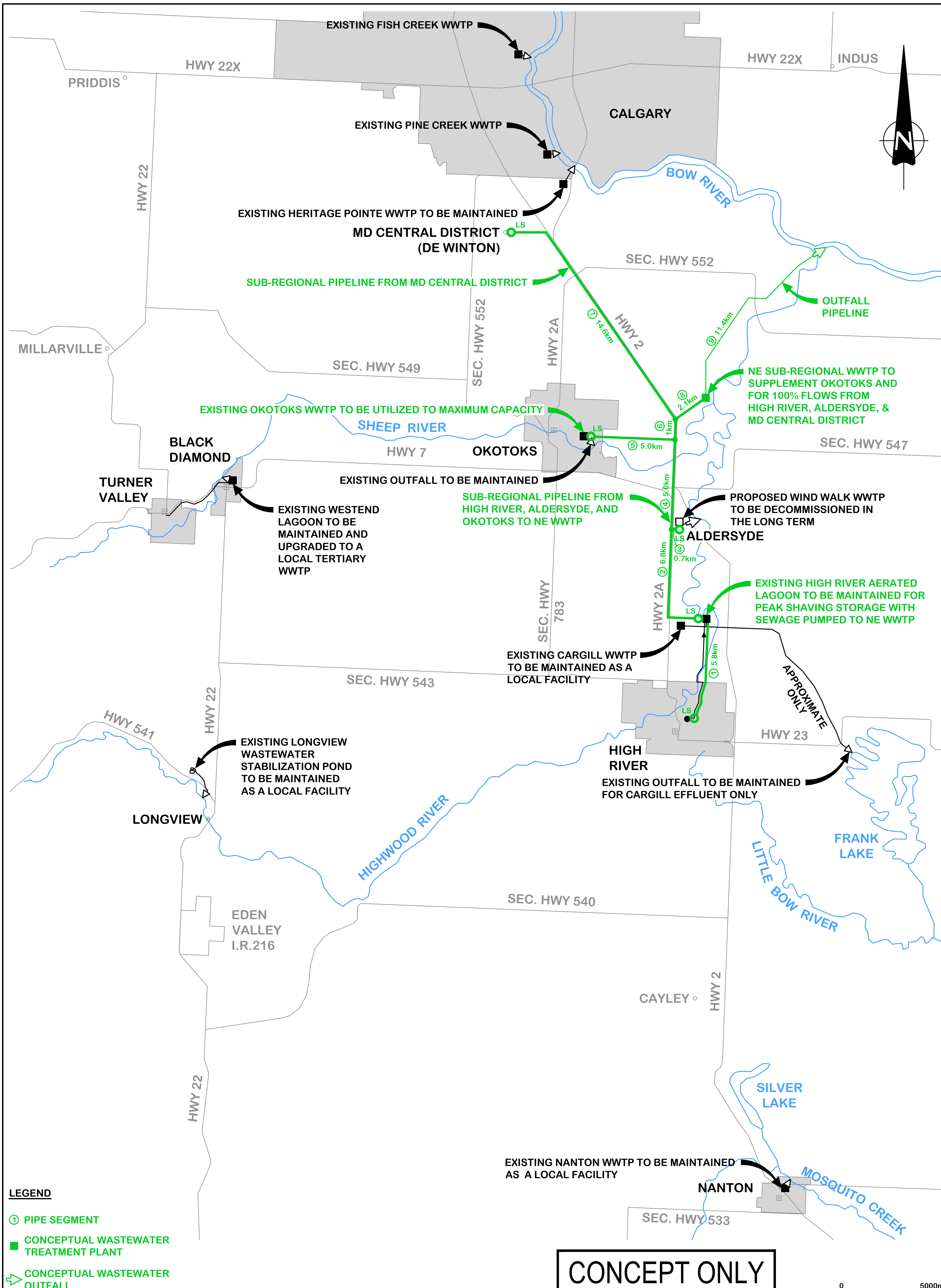
FOOTHILLS REGIONAL WATER & WASTEWATER COLLABORATIVE

FRWWC WASTEWATER STUDY
OPTION 2 - Sub-Regional WWTP Servicing 100% High River, Okotoks, MD Central District, and Aldersyde

SCALE: 1:200,000	DATE: JANUARY 2016	JOB: 2210-047-00	FIGURE: 3.2



LEGEND

- ① PIPE SEGMENT
- CONCEPTUAL WASTEWATER TREATMENT PLANT
- CONCEPTUAL WASTEWATER OUTFALL
- LS CONCEPTUAL LIFT STATION
- EXISTING WASTEWATER TREATMENT PLANT
- PROPOSED PRIVATE WASTEWATER TREATMENT PLANT
- EXISTING WASTEWATER OUTFALL
- PROPOSED PRIVATE OUTFALL

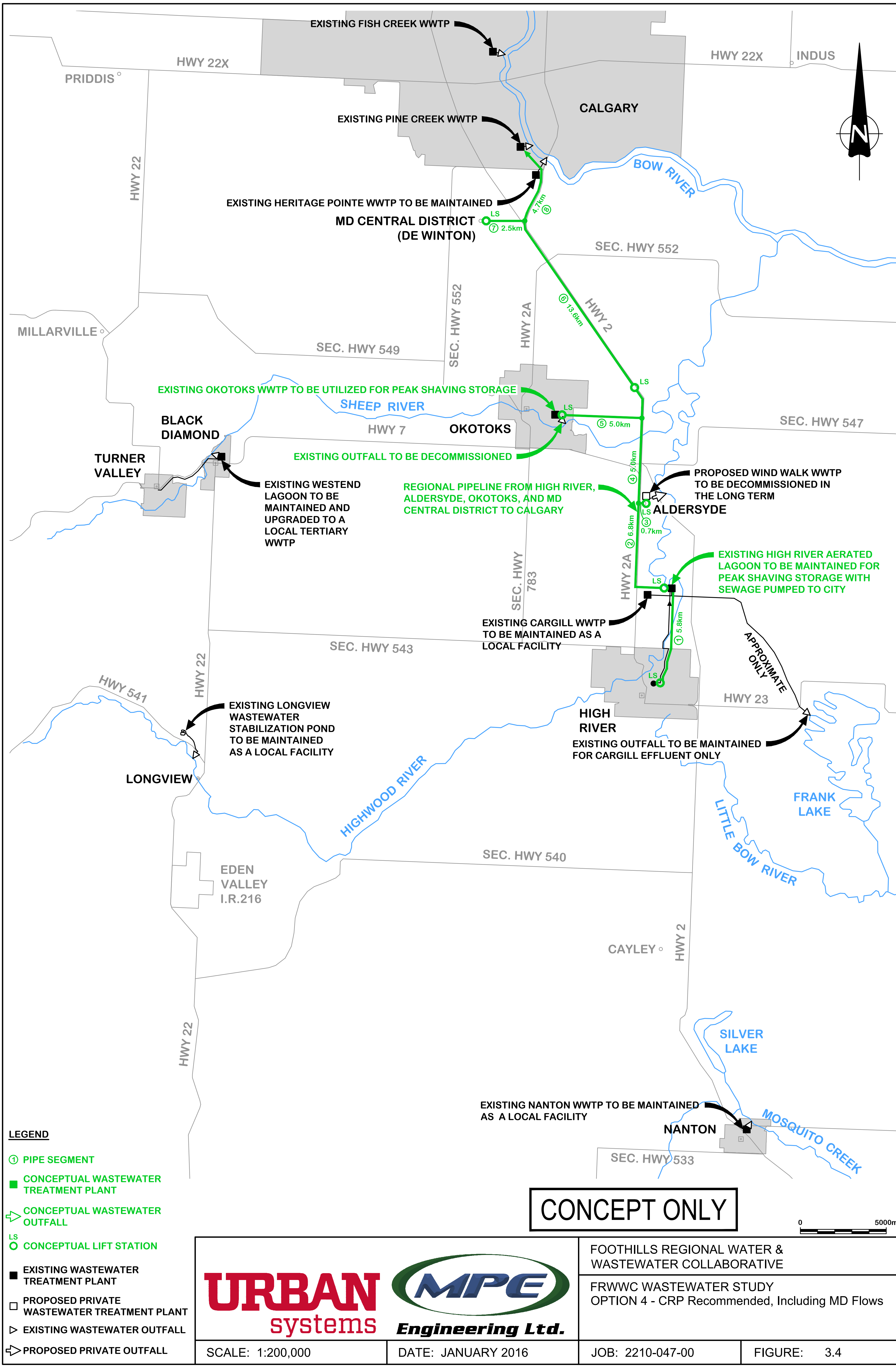
URBAN systems

MPE Engineering Ltd.

FOOTHILLS REGIONAL WATER & WASTEWATER COLLABORATIVE

FRWWC WASTEWATER STUDY
OPTION 3 - Sub-Regional WWTP Supplementing Okotoks, and 100% High River, MD Central District, and Aldersyde

SCALE: 1:200,000	DATE: JANUARY 2016	JOB: 2210-047-00	FIGURE: 3.3


EXISTING FISH CREEK WWTP
HWY 22X
PRIDDIS
HWY 22X
INDUS
CALGARY
EXISTING PINE CREEK WWTP
BOW RIVER
HWY 22
EXISTING HERITAGE POINTE WWTP TO BE MAINTAINED
MD CENTRAL DISTRICT
(DE WINTON)
LS
⑦ 2.5km
4.7km ⑧
SEC. HWY 552
SEC. HWY 552
HWY 2A
⑥ 13.6km
HWY 2
MILLARVILLE
SEC. HWY 549
LS
EXISTING OKOTOKS WWTP TO BE UTILIZED FOR PEAK SHAVING STORAGE
SHEEP RIVER
BLACK
DIAMOND
HWY 7
OKOTOKS
⑤ 5.0km
SEC. HWY 547
TURNER
VALLEY
EXISTING OUTFALL TO BE DECOMMISSIONED
④ 5.0km
EXISTING WESTEND
LAGOON TO BE
MAINTAINED AND
UPGRADED TO A
LOCAL TERTIARY
WWTP
PROPOSED WIND WALK WWTP
TO BE DECOMMISSIONED IN
THE LONG TERM
REGIONAL PIPELINE FROM HIGH RIVER,
ALDERSYDE, OKOTOKS, AND MD
CENTRAL DISTRICT TO CALGARY
ALDERSYDE
③ 0.7km
② 6.8km
HWY 2A
SEC. HWY 783
EXISTING HIGH RIVER AERATED
LAGOON TO BE MAINTAINED FOR
PEAK SHAVING STORAGE WITH
SEWAGE PUMPED TO CITY
① 5.8km
EXISTING CARGILL WWTP
TO BE MAINTAINED AS A
LOCAL FACILITY
APPROXIMATE
ONLY
SEC. HWY 543
HWY 22
HWY 541
HWY 23
EXISTING LONGVIEW
WASTEWATER
STABILIZATION POND
TO BE MAINTAINED
AS A LOCAL FACILITY
HIGH
RIVER
EXISTING OUTFALL TO BE MAINTAINED
FOR CARGILL EFFLUENT ONLY
LONGVIEW
HIGHWOOD RIVER
FRANK
LAKE
LITTLE BOW RIVER
SEC. HWY 540
EDEN
VALLEY
I.R.216
CAYLEY
HWY 2
HWY 22
SILVER
LAKE
EXISTING NANTON WWTP TO BE MAINTAINED
AS A LOCAL FACILITY
NANTON
MOSQUITO CREEK
SEC. HWY 533
LEGEND
① PIPE SEGMENT
CONCEPTUAL WASTEWATER
TREATMENT PLANT
CONCEPTUAL WASTEWATER
OUTFALL
LS
CONCEPTUAL LIFT STATION
EXISTING WASTEWATER
TREATMENT PLANT
PROPOSED PRIVATE
WASTEWATER TREATMENT PLANT
EXISTING WASTEWATER OUTFALL
PROPOSED PRIVATE OUTFALL
CONCEPT ONLY
0
5000m
URBAN systems
MPE Engineering Ltd.
FOOTHILLS REGIONAL WATER &
WASTEWATER COLLABORATIVE
FRWWC WASTEWATER STUDY
OPTION 4 - CRP Recommended, Including MD Flows
SCALE: 1:200,000
DATE: JANUARY 2016
JOB: 2210-047-00
FIGURE: 3.4

APPENDIX B:

PESTLE ANALYSIS

Foothills Regional Wastewater Collaborative				
PESTLE Introductory Summary				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Description	**CRP Recommended Pipeline + MD Subregional Plant (s)**	**Subregional Plant(s)**	**Supplementary Subregional Plant(s)**	**CRP Recommended Pipeline w/MD Flows**
Pipeline to Calgary	Okotoks, High River	None (only pipelines are to subregional plants)	None (only pipelines are to subregional plants)	Okotoks, High River, MD of Foothills + possibly Westend
Length of Pipelines	62 Kilometers	50 Kilometers	50 Kilometers	41 Kilometers
Who Subregional Plant(s) Serves	MD of Foothills	Okotoks, High River, MD of Foothills + possibly Westend	Okotoks Excess, High River, MD of Foothills + possibly Westend	
Number of Treatment Plants (not incl. Calgary)	1	1	2	0
Number of Outfalls (not incl. Calgary)	1	1	2	0
Local Plant Maintained Municipal	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Okotokes (current capacity), Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)
Criteria	**Consideration Points**			
Political				
P1. Alternative conforms or aligns with current CRP policies	Option is within current CRP Plan.	Option does not align with current CRP plan and requires subregional servicing of both CRP and non-CRP members.	Option does not align with current CRP plan and requires subregional servicing of both CRP and non-CRP members.	Option does not align with current CRP plan and requires Calgary to agree to servicing non-CRP members.
P2. Alternative can address equity among municipalities, including costs, capacity, and decision making.	Option requires servicing and cost allocation agreement with City of Calgary for pipeline and between FRWWC members for pipeline costs. MD of Foothills maintains sole control of subregional facility. Cost sharing and cash flow more complicated as large upfront capital investment required as less readily staged.	Option requires cost sharing and governance agreement between members being serviced by subregional plant. Cost sharing and cash flow simplified as treatment plants more readily staged.	Option requires cost sharing and governance agreement between members being serviced by subregional plant. Cost sharing and cash flow simplified as treatment plants more readily staged.	Option requires servicing and cost allocation agreement with City of Calgary for pipeline and between FRWWC members for pipeline costs. Cost sharing and cash flow more complicated as large upfront capital investment required as less readily staged.
P3. Alternative allows for balance, providing for reasonable autonomy among municipalities, while realizing shared benefits.	Those serviced by the pipeline to Calgary will be bound by servicing agreement conditions. Remaining municipalities on local systems are independent.	Structure of agreement solely upto those municipalities serviced by subregional plant. Remaining municipalities on local systems are independent.	Structure of agreement solely upto those municipalities serviced by subregional plant. Remaining municipalities on local systems are independent.	Those serviced by the pipeline to Calgary will be bound by servicing agreement conditions. Remaining municipalities on local systems are independent.
Environmental				
En1. Alternative is resilient to climate and seasonal variability impacts (ie. Drought and river flows).	Calgary carries the majority of risk for those serviced by the Pipeline. MD carries risk for subregional plant. Municipalities not connected will carry their own risks. Risks spread out among the second least number of locations for facilities and outfall locations.	Governance agreement will determine how risk can be shared. Risk spread out among the second least number of facilities and outfall locations.	Governance agreement will determine how risk can be shared. Risk spread out among the greatest number of facilities and outfall locations.	Calgary carries the majority of risk for those serviced by the Pipeline. Risks are carried at the least number of facilities (one) and outfall locations (one, on Bow River from City WWTP)
En2. Alternative reduces or avoids impact on natural/agricultural land/environmentally sensitive areas/aquatic habitats or utilizes existing sites and utility/infrastructure corridors.	Reduces treatment facilities to the second lowest number of locations. Most kms of pipelines. Interim river return flows for High River are not within the same vicinity of where water is extracted but are better than Option 4. When High River is on Calgary Water, as per CRP, then ultimate return flows would be within same vicinity as where water is extracted.	Reduces treatment facilities to the second lowest number of plants. Second least kms of pipeline. River return flows are not within the same vicinity of where water is extracted but are second closest.	Number of treatment facilities are the highest. Second least kms pipelines. River return flows are not all within the same vicinity of where water is extracted but are the closest of all options.	Reduces treatment facilities to the lowest number of locations. Least kms of pipelines. In the interim, river return flows for High River and MD are furthest from the same vicinity of where water is extracted. When High River is on Calgary Water, as per CRP, then ultimate return flows would be within same vicinity as where water is extracted.

Foothills Regional Wastewater Collaborative				
PESTLE Introductory Summary				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Description	**CRP Recommended Pipeline + MD Subregional Plant (s)**	**Subregional Plant(s)**	**Supplementary Subregional Plant(s)**	**CRP Recommended Pipeline w/MD Flows**
Pipeline to Calgary	Okotoks, High River	None (only pipelines are to subregional plants)	None (only pipelines are to subregional plants)	Okotoks, High River, MD of Foothills + possibly Westend
Length of Pipelines	62 Kilometers	50 Kilometers	50 Kilometers	41 Kilometers
Who Subregional Plant(s) Serves	MD of Foothills	Okotoks, High River, MD of Foothills + possibly Westend	Okotoks Excess, High River, MD of Foothills + possibly Westend	
Number of Treatment Plants (not incl. Calgary)	1	1	2	0
Number of Outfalls (not incl. Calgary)	1	1	2	0
Local Plant Maintained Municipal	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Okotokes (current capacity), Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)
Criteria	**Consideration Points**			
En3. Alternative minimizes the use of energy (and greenhouse gas emissions) to build and operate.	Second highest amount of energy use for pumping. Second least number of treatment plants with associated delivery of chemicals and biosolids trucking. Energy use likely marginally higher for treatment than Option 4. Greatest GHG emissions expected for construction.	Second least amount of energy use for pumping. Second least number of treatment plants with associated delivery of chemicals and biosolids trucking. Energy use likely marginally higher for treatment than Option 1.	Least amount of energy use for pumping. Greatest number of treatment plants with associated delivery of chemicals and biosolids trucking. Energy use likely marginally higher for treatment than Option 2.	Greatest amount of energy use for pumping. Least number of treatment facilities for consolidation of trucking requirements. Expected lowest energy costs for treatment. Least amount of GHG to build expected due to pipeline length.
Social				
S1. Alternative readily adaptable to unforeseen demographics or population increases in various locations.	Slightly more flexibile than Option 4.	Marginally less flexible than Option 3. If sufficient site is allowed, treatment plants can offer more flexibility for expansion than buried regional pipelines.	Greatest flexibility from a treatment perspective due to number of plants. If sufficient site is allowed, treatment plants can offer more flexibility for expansion than buried regional pipelines.	Least overall area flexibility from a treatment perspective due to least number of treatment facilities. Given scale of development compared to Calgary likely flexibility within the City treatment capacity depending on how agreement is structured. Pipeline can have flexiblity built in, but location and size of pipelines not as easily modified.
S2. Alternative provides a reliable, robust system that can be adequately staffed with qualified operators.	Third lowest number of operators expected to be required. Third lowest population impact of pipeline failure or indvidual treatment plant upset.	Second lowest number of operators expected to be required. Second lowest population impact of pipeline failure or individual treatment plant upset.	Largest number of operators expected to be required. Lowest population impact of pipeline failure or individual treatment upset.	Calgary responsible for all regional treatment and operator requirements. FRWWC only responsible for pipeline and pump station maintenance. Largest population impacted by pipeline failure or treatment plant upset. Lowest number of operators expected.
S3. Alternative minimizes risk to community health and safety from water quality degradation or source contamination to downstream drinking and/or recreational water users. (Risks due to flooding, explosion, traffic impacts and accidents, chemical spills, security, and disease vectors).	Highest amount of effluent discharged to Sheep River. Chemical spill risk at second lowest number of locations but upstream on Bow River.	Lowest amount of effluent discharged to Sheep River. Chemical spill risk at second lowest number of locations .	Second highest amount of effluent discharged to Sheep River. Chemical spill risk at highest number of locations .	Lowest amount of effluent discharged to Sheep River. Chemical spill risk at least number of locations but upstream on Bow River.
Technological				
T1. Alternative can readily adapt to foreseen improvements in treatment, energy, or other technologies.	Flexibility less than Option 4 due to larger number of facilities.	Flexibility similar to Option 1.	Flexibility is least given most number of plants.	Least number of treatment locations provides greatest flexibility.
T2. Alternative is unlikely to be affected by unforeseen technological changes.	Flexibility less than Option 4 due to number of facilities.	Flexibility similar to Option 1.	Flexibility is least given most number of plants.	Least number of treatment locations provides greatest flexibility.

Foothills Regional Wastewater Collaborative				
PESTLE Introductory Summary				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Description	**CRP Recommended Pipeline + MD Subregional Plant (s)**	**Subregional Plant(s)**	**Supplementary Subregional Plant(s)**	**CRP Recommended Pipeline w/MD Flows**
Pipeline to Calgary	Okotoks, High River	None (only pipelines are to subregional plants)	None (only pipelines are to subregional plants)	Okotoks, High River, MD of Foothills + possibly Westend
Length of Pipelines	62 Kilometers	50 Kilometers	50 Kilometers	41 Kilometers
Who Subregional Plant(s) Serves	MD of Foothills	Okotoks, High River, MD of Foothills + possibly Westend	Okotoks Excess, High River, MD of Foothills + possibly Westend	
Number of Treatment Plants (not incl. Calgary)	1	1	2	0
Number of Outfalls (not incl. Calgary)	1	1	2	0
Local Plant Maintained Municipal	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Okotokes (current capacity), Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)
Criteria	**Consideration Points**			
T3. Alternative can readily be adapted to changing sewer demands caused by climate and seasonal variability and water conservation.	Calgary and the Bow River carries the majority of risk for those serviced by the Pipeline. MD carries risk for subregional plant. Municipalities not connected will carry their own risks. Risks spread out among the second least number of locations for facilities. Given second fewest treatment facilities make this less readily adaptable than Option 4, though smaller facilities can sometimes be modified more quickly.	Governance agreement will determine how risk can be shared. Risk spread out among the second least number of facilities and streams. Second most number of treatment facilities make this less readily adaptable, though smaller facilities can sometimes be modified more quickly.	Governance agreement will determine how risk can be shared. Risk spread out among the greatest number of facilities and streams. Most number of treatment facilities make this the least readily adaptable, though smaller facilities can sometimes be modified more quickly.	Calgary and the Bow River carries the majority of risk for those serviced by the Pipeline. Risks are spread out among the least number of facilities. Fewer treatment facilities make this the most readily adaptable.
Legal				
L1. Alternative is unlikely to be affected by future or foreseen legislative changes.	Calgary carries the majority of risk for those serviced by the Pipeline. MD carries risk for subregional plant. Municipalities not connected will carry their own risks. Risks are spread out among the second least number of locations for facilities.	Governance agreement will determine how risk can be shared. Risk spread out among the second most number of facilities.	Governance agreement will determine how risk can be shared. Risk spread out among the greatest number of facilities.	Calgary carries the majority of risk for those serviced by the Pipeline. Risks are spread out among the least number of facilities.
L2. Alternative is resistant to changes in operator certification or operations requirements.	Calgary carries the majority of risk for those serviced by the Pipeline. MD carries risk for subregional plant. Municipalities not connected will carry their own risks. Risks are spread out among the second least number of locations for facilities. Mix of a large and smaller facility at moderate risk of not attracting operators with higher certification.	Governance agreement will determine how risk can be shared. Risk are spread out among at the second most number of facilities. Mid sized facilities more at risk of not attracting operators with higher certification.	Governance agreement will determine how risk can be shared. Risk spread out among at the greatest number of facilities. Most number of mid-sized and smallest facilities more at risk of not attracting operators with higher certification.	Calgary carries the majority of risk for those serviced by the Pipeline. Risks spread out among at the least number of facilities. Large facility less at risk of not attracting operators with higher certification.
L3. Lands required for alternative are publically owned or able to be accessed with minimal securing rights of way.	Facility risk of finding appropriate sites third highest but pipeline risks highest.	Facility risk of finding appropriate sites second highest but pipeline risks second highest.	Facility risk of finding appropriate sites highest but pipeline second highest.	Facility risk of finding appropriate sites lowest and pipeline risks lowest.
Economic				
Ec1. Alternative provides opportunity to secure grant funding	Second or third greatest grant potential due to second largest regional solution. However, regional plant only services the MD so province may not view as regional solution.	Second or third greatest grant potential due to third largest regional solution. However impact of lack of alignment with CRP may hinder this. It does service more than one municipality so province may look more favourably on this.	Lowest grant potential due to third largest regional solution. Impact of lack of alignment with CRP may further hinder this. Use of Okotoks treatment capacity may be viewed as a positive.	Greatest grant potential due to largest regional solution. However impact of lack of alignment with CRP may hinder this.

Foothills Regional Wastewater Collaborative				
PESTLE Introductory Summary				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Description	**CRP Recommended Pipeline + MD Subregional Plant (s)**	**Subregional Plant(s)**	**Supplementary Subregional Plant(s)**	**CRP Recommended Pipeline w/MD Flows**
Pipeline to Calgary	Okotoks, High River	None (only pipelines are to subregional plants)	None (only pipelines are to subregional plants)	Okotoks, High River, MD of Foothills + possibly Westend
Length of Pipelines	62 Kilometers	50 Kilometers	50 Kilometers	41 Kilometers
Who Subregional Plant(s) Serves	MD of Foothills	Okotoks, High River, MD of Foothills + possibly Westend	Okotoks Excess, High River, MD of Foothills + possibly Westend	
Number of Treatment Plants (not incl. Calgary)	1	1	2	0
Number of Outfalls (not incl. Calgary)	1	1	2	0
Local Plant Maintained Municipal	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Okotokes (current capacity), Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)
Criteria	**Consideration Points**			
Ec2. Alternative provides lowest risk to future operating cost fluctuations	Second highest dependance on servicing agreement with Calgary. Second lowest risk for operating costs of treatment plants as most of this is carried by Calgary. MD carries risk for subregional plant.	No dependence on servicing agreement with Calgary. Second greatest risk to operating cost fluctuations due to number of plants.	No dependence on servicing agreement with Calgary. Greatest risk to operating cost fluctuations due to number of plants.	Highest dependance on servicing agreement with Calgary. Lowest risk for operating costs of treatment plants as this is carried by Calgary.
Ec3. Alternative's cash flow requirements align with financial capacities of municipalities	Highest pipeline costs required at outset. Lowest treatment plant costs can be phased with growth but still must be paid in advance of growth. Large upfront capital investment required as less readily staged.	Second Lowest pipeline costs at outset. Highest initial treatment plant cost but then can be phased with growth but still must be paid in advance of growth. Cash flow simplified as treatment plants more readily staged	Second Lowest pipeline costs at outset. Second highest initial treatment plant cost but then can be phased with growth but still must be paid in advance of growth. Cash flow simplified as treatment plants more readily staged.	Least pipeline costs required at outset. Cash flow more complicated as large upfront capital investment required as less readily staged.

Foothills Regional Wastewater Collaborative				
PESTLE Introductory Summary				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Description	**CRP Recommended Pipeline + MD Subregional Plant**	**Subregional 100% Plant**	**Subregional Supplementary Plant**	**CRP Recommended Pipeline w/MD Flows**
Pipeline to Calgary	Okotoks, High River	None (only pipelines are to subregional plant)	None (only pipelines are to subregional plant)	Okotoks, High River, MD of Foothills + possibly Westend
Length of Pipelines	62 Kilometers	50 Kilometers	50 Kilometers	41 Kilometers
Who Subregional Plant Serves	MD of Foothills	Okotoks, High River, MD of Foothills + possibly Westend	Okotoks Excess, High River, MD of Foothills + possibly Westend	None
Number of Treatment Plants (not incl. Calgary)	1	1	2	0
Number of Outfalls (not incl. Calgary)	1	1	2	0
Local Municipal Plants Maintained	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Okotoks (current capacity), Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)
Private Plants Maintained	Cargill	Cargill	Cargill	Cargill
Criteria	**Consideration Points**			
Political				
P1. Alternative conforms or aligns with current CRP policies	0	-1	-1	-2
P2. Alternative can address equity among municipalities, including costs, capacity, and decision making.	0	2	2	1
P3. Alternative allows for balance, providing for reasonable autonomy among municipalities, while realizing shared benefits.	0	2	2	0
Environmental				
En1. Alternative is resilient to climate and seasonal variability impacts (ie. Drought and river flows).	0	-1	-2	1
En2. Alternative reduces or avoids impact on natural/agricultural land/environmentally sensitive areas/aquatic habitats or utilizes existing sites and utility/infrastructure corridors.	0	1	1	2
En3. Alternative minimizes the use of energy (and greenhouse gas emissions) to build and operate.	0	-1	-2	1
Social				
S1. Alternative readily adaptable to unforeseen demographics or population increases in various locations.	0	1	2	-1
S2. Alternative provides a reliable, robust system that can be adequately staffed with qualified operators.	0	1	-1	2
S3. Alternative minimizes risk to community health and safety from water quality degradation or source contamination to downstream drinking and/or recreational water users. (Risks due to flooding, explosion, traffic impacts and accidents, chemical spills, security, and disease vectors).	0	1	0	2
Technological				
T1. Alternative can readily adapt to foreseen improvements in treatment, energy, or other technologies.	0	0	-1	1
T2. Alternative is unlikely to be affected by unforeseen technological changes.	0	0	-1	1
T3. Alternative can readily be adapted to changing sewer demands caused by climate and seasonal variability and water conservation.	0	1	-1	2
Legal				

Foothills Regional Wastewater Collaborative				
PESTLE Introductory Summary				
	Option 1	**Option 2**	**Option 3**	**Option 4**
Description	**CRP Recommended Pipeline + MD Subregional Plant**	**Subregional 100% Plant**	**Subregional Supplementary Plant**	**CRP Recommended Pipeline w/MD Flows**
Pipeline to Calgary	Okotoks, High River	None (only pipelines are to subregional plant)	None (only pipelines are to subregional plant)	Okotoks, High River, MD of Foothills + possibly Westend
Length of Pipelines	62 Kilometers	50 Kilometers	50 Kilometers	41 Kilometers
Who Subregional Plant Serves	MD of Foothills	Okotoks, High River, MD of Foothills + possibly Westend	Okotoks Excess, High River, MD of Foothills + possibly Westend	None
Number of Treatment Plants (not incl. Calgary)	1	1	2	0
Number of Outfalls (not incl. Calgary)	1	1	2	0
Local Municipal Plants Maintained	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Okotoks (current capacity), Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)	Nanton, Longview, possibly Westend (Black Diamond/Turner Valley)
Private Plants Maintained	Cargill	Cargill	Cargill	Cargill
Criteria	**Consideration Points**			
L1. Alternative is unlikely to be affected by future or foreseen legislative changes.	0	-1	-2	1
L2. Alternative is resistant to changes in operator certification or operations requirements.	0	1	-2	2
L3. Lands required for alternative are publically owned or able to be accessed with minimal securing rights of way.	0	-1	-2	1
Economic				
Ec1. Alternative provides opportunity to secure grant funding	0	1	-2	2
Ec2. Alternative provides lowest risk to future operating cost fluctuations	0	1	0	-1
Ec3. Alternative's cash flow requirements align with financial capacities of municipalities	0	1	2	-1

APPENDIX D

Technical Memorandum 4 – Preferred Options

MEMORANDUM

Date:	April 26, 2016
To:	Foothills Regional Water & Wastewater Collaborative
cc:	Lynda Cooke, P.Eng., Steve Brubacher, P.Eng., Leigh Chmilar, P.Eng.
From:	Sarah Fratpietro, P.Eng., Randy Boras, M.Sc., P.Eng.
File:	2239.0005.01 / 2210-047-00
Subject:	Technical Memorandum 4: Preferred Options: Rev. 1

1. INTRODUCTION

The Foothills Regional Water and Wastewater Collaborative (FRWWC) is exploring a sub-regional management strategy for future wastewater collection servicing in the short (< 10 yrs), medium (25 yrs), and long-term (60 yrs). In the next 60 years, this sub-region could more than quadruple in population, putting stress on financial and physical capacity of the local systems. The focus of this memorandum is to provide the following:

- Refine two preferred options selected by the FRWWC Technical and Governance Committees,
- Provide a conceptual-level design for the two preferred options,
- Contact equipment suppliers to generate budget quotations for major equipment to input into capital and O&M opinions of probable cost,
- Provide refined capital and O&M opinions of probable cost for the two preferred options,
- Complete a net present value (NPV) and total cost of ownership (TCO) analysis for each option,
- Break down costs to show estimated contributions from each municipality based upon percent utilization of capital infrastructure, and
- Complete served area mapping for the preferred options.

This memorandum refines the following two regional wastewater options, as selected by the FRWWC Committees in January 2016:

1. **<u>Option 3:</u>** One Sub-Regional WWTP (NE of Okotoks) servicing only excess (future growth) flow from Okotoks, plus 100% of the flow from High River and MD; retain local plants in Westend, Longview and Nanton as per CRP;

2. **<u>Option 4:</u>** Regional pipeline from Okotoks and High River to Calgary, sized to also include 100% of MD flow; retain local plants in Westend, Longview and Nanton as per CRP.

Within this memorandum, MPE Engineering Ltd. (MPE) developed costs and impacts related to the regional pipelines in the above options. Urban Systems Ltd. (USL) developed costs and impacts related to the wastewater treatment plants (WWTPs) in Option 3 and developed the estimated municipal cost contributions.

2. CONCEPTUAL DESIGN

This section summarizes the conceptual design for the preferred options. The conceptual designs are based on the projected wastewater flows outlined in Technical Memorandum 3 (MPE/USL TM3, 2016).

2.1 Option 3

Option 3 includes one sub-regional WWTP located northeast of Okotoks (NE WWTP) servicing only excess (future growth) flow from Okotoks, plus 100% of the flow from High River and the MD. The local plants in Westend, Longview and Nanton would be maintained as local facilities. This option is illustrated on ***Figure 4.1*** in ***Appendix A***.

2.1.1 Pipeline

The following provides details for the Option 3 piping system:

- The existing local lift station (LS) No. 1 in High River would be maintained to pump peak hour flow from the Town to the existing High River aerated lagoon site; this existing lift station would be upgraded once capacity is exceeded. The existing 5.8 km long by 710 mm diameter pipeline to the lagoon site would be utilized.
- The existing High River lagoon would be maintained for peak shaving storage with a new lift station located at the lagoon site to pump maximum day flow through a new 16.6 km pipeline to the sub-regional NE WWTP,
- The existing Okotoks WWTP and outfall to the Sheep River would be maintained to treat wastewater to capacity (23,509 m^3/day).
- A new lift station would be constructed at the Okotoks WWTP to pump wastewater in excess of the WWTP capacity, at peak hour flow to the sub-regional NE WWTP.
- A new lift station would be constructed at Aldersyde to pump wastewater at peak hour flow to the sub-regional NE WWTP.
- A new lift station would be constructed at the MD Central District to pump wastewater at peak hour flow to the sub-regional NE WWTP.
- A new outfall pipeline would be installed from the sub-regional NE WWTP to the Bow River at the confluence with the Highwood River, including an outfall structure with diffuser.

The outfall pipeline is assumed to run to the Bow River instead of the nearby Highwood / Sheep River confluence. This approach is more conservative from both a river health and cost perspective, given current gaps in the understanding of each river's assimilation capacity. It is understood that the Bow River has better wastewater assimilation capacity than the smaller Highwood River. This being said, a receiving water quality assessment would be required ultimately to improve the understanding, and to determine to which river and to what timeline the WWTP effluent should or could discharge. This river assessment is outside the current scope of this study, but can be carried out in future. It should be noted that if the outfall pipeline could be directed to the Highwood River / Sheep River confluence in the medium-term or long-term, significant capital cost savings could be realized.

2.1.1.1 Pipeline Route

The pipe alignment is based upon a review of available aerial photography images and topographical mapping. The pipeline route is primarily through agricultural lands and some country residential developments. As shown on ***Figure 4.1*** the pipeline route has been adjusted from that presented in

Technical Memorandum 3 (MPE/USL TM3, 2016). This new adjusted route adds approximately 5.5 km of pipe. The major changes to the alignment include:

- Pipe Segment 4 from Aldersyde to the Okotoks tee is re-routed from being adjacent to Highways 2 and 2A to approximately 1 km west of the highways; this reduces the length through built-up areas.
- Pipe Segment 7 from the MD Central District to the Sub-regional NE WWTP is re-routed from the west side of Highway 2 to now cross the highway and head east approximately 6 km then south to the NE WWTP; this avoids a high topographic elevation gain and reduces length through built-up areas adjacent to Highway 2.

It is noted that the pipe route assumed for this memorandum remains at a conceptual level, primarily for comparison purposes between the two options. A more detailed route analysis to determine the most favourable pipeline alignment should be undertaken in a future detailed design stage.

2.1.1.2 Pipeline Length and Diameters

The pipeline diameter for each pipe segment is shown on ***Figure 4.1*** in ***Appendix A***. A summary of the approximate lengths and diameters is provided in ***Table 2.1***.

The pipelines are sized to operate within a velocity range of 0.9 m/s to 1.6 m/s. The minimum velocity of 0.9 m/s ensures adequate flushing velocity. The maximum velocity of 1.6 m/s is adopted because higher velocities can cause problematic pressure surges, particularly in large diameter pipes. Also the friction losses increase, requiring additional power at the lift stations (or additional lift stations). This can increase lifecycle energy costs significantly.

Table 2.1: Option 3 Pipe Diameters and Lengths

Pipeline Diameter (mm)	Phase 1 Length (km)	Phase 2 Length (km)	TOTAL Build-Out Length (km)
400 HDPE	0.7	0.7	1.4
750 HDPE	23.4	--	23.4
850 HDPE	12.4	4.1	16.5
900 HDPE	6.1	--	6.1
1050 RCP	13.6	--	13.6
1200 RCP	1.7	--	1.7
TOTAL	57.9	4.8	62.7

The pipelines in Option 3 are modeled in WaterCAD given the concept level pipeline route and proposed pipe diameters. The resulting hydraulic grade line is included in ***Appendix B***. The ground profile is based on elevations from Abadata and Google Earth information. More accurate surveys would need to be carried out in a future detailed design stage.

2.1.1.3 Pipeline Material

For the conceptual design, HDPE (High Density Polyethylene) pipe is selected for pipeline diameters 900 mm and smaller, and Reinforced Concrete Pipe (RCP) is selected for pipeline 1050 mm and larger. RCP is used for the larger diameters due to the limitation in the availability of HDPE at such diameters. These pipe types are selected as reasonably economical options commonly used for wastewater forcemains. However, other pipe materials could be examined at a future detailed design stage based on a cost comparison at that time, as well as owner and operator preferences.

2.1.1.4 Pipeline Crossings

Pipeline construction is assumed to be by open cut trench method where the land is undeveloped, and horizontal directional drilling or auguring for those sections where the pipeline crosses a highway, MD or local road, water body, railway, canal, high pressure oil and gas pipeline or environmentally sensitive area.

Table 2.2 provides a summary of the crossings that would be required for the proposed Option 3 route. Crossing agreements would need to be obtained for these as part of a future detailed design stage.

Table 2.2: Option 3 Major Crossings

Crossing Type	Phase 1 Number of Crossings	Phase 2 Number of Crossings	TOTAL CROSSINGS
Highways	2 x Hwy 2A, 1 x Hwy 7, 3 x Hwy 2, 1 x Hwy 552	1 x Hwy 2A	**8**
Railways	4	1	**5**
Rivers	Highwood River and Sheep River	None	**2**
High Pressure Oil & Gas Pipelines	33	4	**37**
MD of Foothills Roads	20	4	**24**
TOTAL	**66**	**10**	**76**

2.1.1.5 Pipeline Appurtenances

The pipeline would require numerous appurtenances along its length:

- Isolation valves at pipeline intersections, and spaced roughly 1.5 km apart between intersections (these are included in air relief/vacuum valve vaults where possible),
- Air relief/vacuum valve vaults at high points to prevent air lock and to relieve negative pressures in the pipeline,
- Tracer wire along the pipeline route with junction boxes, and
- Drain manholes at major low points.

2.1.2 Lift Stations

There would be six (6) lift stations required for Option 3. The following table summarizes the design flow and total dynamic head (TDH) required for each lift station.

Table 2.3: Option 3 Lift Station Flow, TDH and Power Requirements

Lift Station	Phase 1			Phase 2		
	Flow (L/s)	TDH (m)	Power (kW)	Flow (L/s)	TDH (m)	Power (kW)
High River Lift Station	776	22	310	938	26	442
High River Lagoon Lift Station	365	64	423	441	74	592
Aldersyde Lift Station	97	49	86	206	57	213
Okotoks Lift Station	359	48	313	827	48	720
MD Central District Lift Station	366	33	219	366	33	219
NE WWTP Outfall Lift Station	876	25	391	1,410	25	642

The lift stations would be submersible type lift stations with the following features:

- Divided interconnected wet well to facilitate staging of pumping equipment, ease of repairs and cleaning of the wet well.
- Three (or four in the larger lift stations) submersible pumps each with VFD, including one standby pump. Space would be provided for the addition of a pump to be installed in Phase 2 to meet the 2076 design flows.
- Pumps would be preceded by a bar rack to protect the pumps from clogging, and the station would be fitted with an overhead mechanical hoist.
- Separate dry valve vault for isolation valves and check valves for each pump, and for flow meter.
- Mechanical building on top of dry valve vault to house:
  - Mechanical and electrical equipment,
  - H_2S odour control injection system,
  - Backup power generator,
  - PLC with HMI screen and SCADA system.

Submersible type lift stations are selected for this conceptual design as they are generally lower cost given the reduced pump station footprint and the use of the wastewater for pump motor cooling. The disadvantage of submersible pumps is that the pumps must be removed from the wastewater for servicing. In-line pumps situated in a dry well could be considered during a future more detailed design stage.

2.1.3 WWTP

2.1.3.1 WWTP Design Flows and Loadings

The WWTP design flows and loadings are projected for each contributing community, and then combined in ***Table 2.4.*** As per Technical Memorandum 3 (MPE/USL TM3) the Okotoks WWTP is at capacity. Therefore it is assumed that all flows from future Okotoks growth would be sent to the sub-regional NE WWTP. Flows from High River, Central District and Aldersyde are taken from Table 2.1 in Technical Memorandum 3 (MPE/USL TM3, 2016). To determine flows in 2014, data is interpolated using the same assumptions as in Technical Memorandum 1 (MPE/USL TM1, 2015). The flows from Central District are assumed to be zero in 2014 as there was no flow estimated in 2010 and there has been little to no growth in the area since.

The wastewater loadings from Okotoks are taken from data provided in Table 5.1 of Stantec's Design Basis Memorandum #1 (Stantec TM1, 2015). No wastewater nutrient data is available for Aldersyde, High River and Central District, therefore the average per capita wastewater loadings are calculated using factors in ***Table 2.4***. Peaking factors for maximum daily loadings (MDL) and maximum monthly loadings (MML) are calculated as shown in ***Table 2.4.***

Table 2.4: Summary of WWTP Design Loadings and Flows

Parameter	Units	2014	2041	2076
Population	capita	15,330	96,915	165,815
AADF	m^3/d	6,020	30,740	45, 830
MDF	m^3/d	13,950	76,000	122,000
MDL BOD_5	kg/d	1,950	14,770	26,750
MML BOD_5	kg/d	1,640	10,250	17,450
MDL TSS	kg/d	2,470	19,120	34,480
MML TSS	kg/d	1,880	12,280	21,310
MDL TAN	kg/d	170	1,060	1,820
MML TKN	kg/d	270	1,420	2,300
MML TP	kg/d	55	300	475

Table 2.5: Annual Per Capita Wastewater Loading Rates

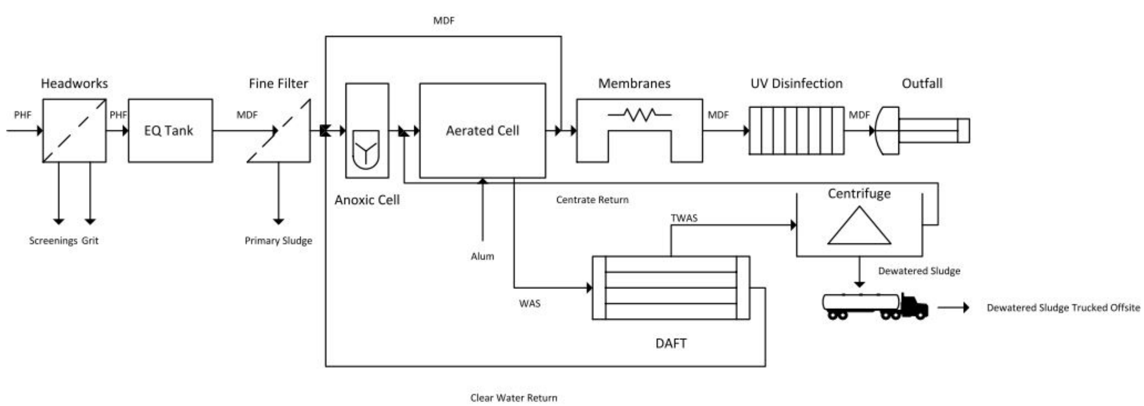
Constituent	Units	Average[1]	Peaking Factor[2] (MDL)	Peaking Factor[3] (MML)
BOD_5	g/capita/day	80	-0.051*LN(x)+1.68	-0.05*LN(x)+1.44
TSS	g/capita/day	90	-0.08*LN(x)+1.91	-0.04*LN(x)+1.43
NH_3 as N	g/capita/day	7.6	-0.08*LN(x)+1.59	-0.074*LN(x)+1.45
TKN as N	g/capita/day	13	-0.08*LN(x)+1.59	-0.074*LN(x)+1.45
TP as P	g/capita/day	3.2	1.26	1.14

Where x = AADF in (MLD)

For the purposes of this memo, two major design phases are considered; construction completion in 2020, and an upgrade in 2041. In order to facilitate phasing of the facility, it is preferable to build phases in discrete portions of the final capacity. Section 2.1.4 provides additional discussion on phasing the treatment plant.

2.1.3.2 WWTP Process

To achieve the Alberta Environment and Parks (AEP) High Quality (HQ) effluent requirements, a Membrane Bioreactor (MBR) system is proposed for the purposes of this memo. A general MBR process flow diagram is provided below:



The headworks facility consists of grit removal and screening designed to remove solids ≤ 6 mm. Initially, the system would consist of two trains, providing 100% redundancy. In the future a third screen would be added to handle the ultimate peak hourly flow of 6,680 m^3/h with 50% redundancy. As the site location is not known, an allowance is also made for an influent pump station if required to provide the needed head for gravity flow through the remainder of the plant to the membrane tanks.

[1] Adapted from Table 3-12, Wastewater Engineering Treatment and Reuse, 4th Edition. Metcalf & Eddy.
[2] Calculated from Table 3.5, Design of Municipal Wastewater Treatment Plants, 5th Edition. Water Environment Federation Manual of Practice No. 8.
[3] Calculated from Table 3.5, Design of Municipal Wastewater Treatment Plants, 5th Edition. Water Environment Federation Manual of Practice No. 8.

AEP requires the use of primary clarification prior to secondary treatment (Membrane Bioreactors) unless it can be demonstrated that it is not required. For this memo it is assumed that fine screening and primary clarification will be achieved using a LEAP primary system or Salsnes filter, and will provide the factors of constituent removal listed in ***Table 2.6*** prior to secondary treatment.

Table 2.6: Removal Factors for Primary Clarification

Constituent	Removal Factor
BOD_5	0.3
TSS	0.6
TKN	0.25
TP	0.2

Equalization storage is assumed for this WWTP, designed for a storage capacity of 25% of MDF (30,500 m^3 at build-out) to assist in buffering peak flows prior to secondary and tertiary treatment. The equalization storage tank would be phased with the MBR process.

Biological treatment is provided in treatment trains incorporating mixed anoxic zones and aerated zones. Recycles between the zones allow nitrification and denitrification to reduce both ammonia and total nitrogen. The biological system is sized using maximum month flows and loads following primary clarification. Alum addition is used to reduce phosphorus through chemical precipitation added directly to the aeration basin. The MBR system achieves phase separation using ultra or microfiltration membranes. The membrane filtration system is designed using maximum day flows.

Using the ultimate (2076) maximum month flows and MML BOD_5 loadings following primary clarification, two staging approaches are evaluated – four (4) process trains and three (3) process trains. Both approaches would see two trains being constructed in 2020, with the remaining trains added in the future. Three (3) trains provide fewer upgrades (and thus a lower capital cost), and provide more process capacity per train. However, the initial BOD_5 loading on the trains is lower than the desired minimum design loading for the membrane bioreactors, therefore four trains are assumed for this memorandum. Initially two (2) trains would be constructed in 2020, with two subsequent upgrades of one train each (in 2034 and 2049) for the ultimate (2076) capacity. Re-evaluation of the stage size should be done during pre-design.

Disinfection would be provided using ultraviolet (UV) light. Initially, two (2) channels would be constructed with two (2) banks of lamps per channel, as required by AEP. Two upgrades of one channel each would be required in the future as flows increase.

The mixed liquor total solids concentration in the MBR process is generally in the range of 8,000 – 10,000 mg/L. This conceptual design allows for pre-thickening of the secondary solids using dissolved air floatation thickeners (DAFT). Initially two DAFT units would be installed, with a third and fourth unit installed in the future. Both thickened secondary sludge and primary sludge from the LEAP Salnes filters would discharge to a mixed solids storage tank, from which thickened sludge would be pumped to centrifuges.

The centrifuge facility would have two-storeys, with centrifuges on the upper floor, depositing dewatered biosolids into roll-off bins located in the loading bay below. It is assumed that dewatered sludge would be trucked offsite for further processing at a regional facility, such as EcoAg in High River.

A lift station and outfall structure would be required, and is included in the pipeline Section 2.1.1.

2.1.3.3 WWTP Site Layout

Alberta Environment and Parks (AEP) requires the following minimum setback distances from the working area of a mechanical wastewater treatment plant:

- 30 m from the property line of the land where the operating mechanical treatment plant is located
- 30 m from the designated right-of-way of a rural road or railway
- 100 m from the designated right-of-way of a primary or secondary highway
- 300 m from the building site for a school, hospital, food establishment or residential use

Site selection for the WWTP will need to consider setbacks, as well as lands that are outside of the 1:100 year floodway or flood fringe zones. The location for the WWTP proposed in Figure 4.1 has been confirmed to be outside of the floodway and flood fringe zones.

Enough land should be secured to allow for the final phasing of the plant, as plant expansions would be required to accommodate additional process trains in 2034 and 2049. An area of approximately 3 ha would be required.

2.1.4 Option 3 Timing and Phasing

2.1.4.1 Pipelines

The conceptual design for the pipelines and lift stations is based on two phases of construction. Phase 1 is assumed to have a consistent operational start date of 2020 for construction to the 25-year design horizon. Phase 2 is assumed to be constructed in 2041 to meet the 60-year design horizon.

Phase 1 would include the installation of 44.3 km of pipeline from each municipality to the Sub-Regional NE WWTP, plus 13.6 km of outfall pipe from the WWTP to the Bow River. Phase 1 would also include the construction of the six (6) lift stations.

Phase 2 would include the installation of 4.8 km of pipeline to twin the lines from Aldersyde and Okotoks. This phase would also include upgrades to five (5) of the lift stations to increase capacity.

2.1.4.2 WWTP

Phasing of the WWTP construction can be carried out in discrete phases to provide initial capital cost savings. Three phases of construction are envisioned, however for constructability, it is assumed that some buildings and tanks will be constructed in one or two phases to house equipment that will be added later. Envisioned phasing of tanks and buildings is assumed to be:

- Headworks (6 mm screening and grit removal) (2 phases of construction)
- Influent pump station (1 phase of construction)

- Primary Treatment Channels (2 phases of construction)
- MBR System and EQ Tank (3 Phases of construction)
- Blower building (2 phase of construction)
- UV channels (2 phases of construction)
- DAFT (2 phases of construction)
- Sludge storage tank (2 phases of construction)
- Centrifuge building (1 phase of construction)
- Administration/workshop building (1 phase of construction)
- Chemical feed facilities (2 phases of construction)

For the facility to be constructed in 2020, each participating community is assumed to maintain their existing treatment facilities until 2020 and to treat all wastewater flows in the existing treatment facilities. Capital and operating costs associated with the existing treatment facilities up to 2020 are not included in this analysis.

2.2 Option 4

Option 4 would include a sub-regional pipeline from Okotoks and High River to the City of Calgary Pine Creek WWTP, sized to also include 100% of the MD flow. The local plants in Westend, Longview and Nanton would be maintained as local facilities. This option is illustrated on ***Figure 4.2*** in ***Appendix A***.

2.2.1 Pipeline

The following provides details for the Option 4 piping system:

- The existing local lift station (LS) in High River would be maintained to pump peak hour flow from the Town to the existing High River aerated lagoon site; this existing lift station would be upgraded once capacity is exceeded. The existing 5.8 km long by 710 mm diameter pipeline to the lagoon site would be utilized.
- The existing High River lagoon would be maintained for peak shaving storage with a new lift station located at the lagoon site to pump maximum day flow through a new 34.4 km pipeline to the City of Calgary.
- The existing Okotoks WWTP would be utilized for peak shaving storage with a new lift station constructed at the site to pump peak dry weather flow to the sub-regional pipeline to the City of Calgary.
- A new lift station would be constructed in Aldersyde to pump wastewater at peak hour flow to the sub-regional pipeline to the City of Calgary.
- A new lift station would be constructed at the MD Central District to pump wastewater at peak hour flow to the sub-regional NE WWTP.A new lift station would be constructed east of Okotoks on the primary sub-regional pipeline to pump (boost) the flow from High River, Aldersyde and Okotoks to the City of Calgary.

2.2.1.1 Pipeline Route

The pipe alignment is based upon a review of available aerial photography images and topographical mapping. The pipeline route is primarily through agricultural lands and some country residential developments. As shown on ***Figure 4.2*** the pipeline route has been adjusted from Technical Memoradum

3 (MPE/USL TM3, 2016). This adjusted route adds approximately 3.3 km of pipe. The major changes to the alignment include:

- Pipe Segment 4 from Aldersyde to the Okotoks tee is re-routed from being adjacent to Highways 2 and 2A to approximately 1 km west of the highways; this reduces length through built up areas.
- Pipe Segment 6 from the Highway 2 Lift Station to the node with MD Central District was re-routed from the west side of Highway 2 to now cross the highway and head straight north approximately 9 km, then east 6 km to the MD Central District node; this avoids a high topographic elevation gain and reduces length through built up areas adjacent to Highway 2.

It is noted that the pipe route assumed for this memorandum is at a conceptual level, primarily for comparison purposes between the two options. A more detailed route analysis to determine the most favourable pipeline alignment should be undertaken in a future detailed designed stage.

2.2.1.2 Pipeline Length and Diameters

The pipeline diameter for each pipe segment is shown on **Figure 4.2** in ***Appendix A***. A summary of the approximate length and diameter is provided in ***Table 2.7***.

The pipelines are sized to operate within a velocity range of 0.9 m/s to 1.6 m/s. The minimum velocity of 0.9 m/s ensures adequate flushing velocity. The maximum velocity of 1.6 m/s is adopted because higher velocities can cause problematic pressure surges, particularly in large diameter pipes. Also the friction losses increase, requiring additional power at the lift stations (or additional lift stations). This can increase lifecycle energy costs significantly.

Table 2.7: Option 4 Pipe Diameters and Lengths

Pipeline Diameter (mm)	Phase 1 Length (km)	Phase 2 Length (km)	TOTAL Build-Out Length (km)
400 HDPE	0.7	0.7	1.4
750 HDPE	2.4	--	2.4
850 HDPE	16.5	4.1	20.6
900 HDPE	6.1	--	6.1
1050 RCP	16.8	--	16.8
1200 RCP	4.9	--	4.9
TOTAL	47.4	4.8	52.2

2.2.1.3 Pipeline Material

For the conceptual design, HDPE (High Density Polyethylene) pipe is selected for pipeline diameters 900 mm and smaller, and Reinforced Concrete Pipe (RCP) is selected for pipeline 1050 mm and larger. RCP is used for the larger diameters due to the limitation in the availability of HDPE at such diameters. These pipe types are selected as reasonably economical options commonly used for wastewater forcemains. However, other pipe materials could be examined at a future detailed design stage based on a cost comparison at that time, as well as owner and operator preferences.

2.2.1.4 Pipeline Crossings

Pipeline construction is assumed to be by open cut trench method where the land is undeveloped, and horizontal directional drilling or auguring for those sections where the pipeline crosses a highway, MD or local road, water body, railway, canal, high pressure oil and gas pipeline or environmentally sensitive area.

Table 2.8 provides a summary of the crossings that would be required for the proposed Option 4 route. Crossing agreements would need to be obtained for these as part of a future detailed design stage.

Table 2.8: Option 4 Major Crossings

Crossing Type	Phase 1 Number of Crossings	Phase 2 Number of Crossings	TOTAL CROSSINGS
Highways	2 x Hwy 2A, 1 x Hwy 7, 2 x Hwy 2, 2 x Hwy 552	1 x Hwy 2A	**8**
Railways	4	2	**6**
Rivers	Highwood River and Sheep River	None	**2**
High Pressure Oil & Gas Pipelines	30	4	**34**
MD of Foothills Roads	16	4	**20**
TOTAL	**59**	**11**	**70**

2.2.1.5 Pipeline Appurtenances

The pipeline would require numerous appurtenances along its length:

- Isolation valves at pipeline intersections, and spaced roughly 1.5 km apart between intersections (these are included in the air relief/vacuum valve vaults where possible),
- Air relief/vacuum valve vaults at high points to prevent air lock and to relieve negative pressures in the pipeline,
- Tracer wire along the pipeline route with junction boxes, and
- Drain manholes at major low points.

2.2.2 Lift Stations

There would be six (6) lift stations required for Option 4. The following table summarizes the design flow and total dynamic head (TDH) required for each lift station.

Table 2.9: Option 4 Lift Station Flow, TDH and Power Requirements

Lift Station	Phase 1			Phase 2		
	Flow (L/s)	TDH (m)	Power (kW)	Flow (L/s)	TDH (m)	Power (kW)
High River Lift Station	776	22	310	938	26	442
High River Lagoon Lift Station	365	65	430	441	77	616
Aldersyde Lift Station	97	51	89	206	60	224
Okotoks Lift Station	426	52	402	856	52	807
Highway 2 Lift Station	888	65	1046	1,502	84	2288
MD Central District Lift Station	366	17	113	366	17	113

The lift stations would be submersible type lift stations with the following features (same as Option 3):

- Divided interconnected wet well to facilitate staging of pumping equipment, ease of repairs and cleaning of wet well,
- Three (or four in the larger lift stations) submersible pumps each with VFD, including one standby pump. Space would be provided for the addition of a pump to be installed in Phase 2 to meet the 2076 design flows.
- Pumps would be preceded by a bar rack to protect the pumps from clogging, and the station would be fitted with an overhead mechanical hoist.
- Separate dry valve vault for isolation valves and check valves for each pump, and for flow meter.
- Mechanical building on top of dry valve vault to house:
  - Mechanical and electrical equipment,
  - H_2S odour control injection system,
  - Backup power generator,
  - PLC with HMI screen and SCADA system.

Submersible type lift stations are selected for this conceptual design as they are generally lower cost given the reduced pump station footprint and the use of the wastewater for pump motor cooling. The disadvantage of submersible pumps is that the pumps must be removed from the wastewater for servicing. In-line pumps situated in a dry well could be considered during a future more detailed design stage.

2.2.3 Option 4 Timing and Phasing

The conceptual design for the Option 4 pipelines and lift stations is based on two phases. Phase 1 is assumed to have a consistent operational start date of 2020 for construction to the 25-year design horizon. Phase 2 is assumed to be constructed in 2041 to meet the 60-year design horizon.

Phase 1 would include the installation of 47.4 km of pipeline from each municipality to the Pine Creek WWTP in the City of Calgary. It would also include the construction of the (6) six lift stations.

Phase 2 would include the installation of 4.8 km of pipeline to twin the lines from Aldersyde and Okotoks to the primary sub-regional pipeline. It would also include the upgrades to (5) five of the lift stations to increase capacity.

2.2.3.1 City Tie-In Timing Issue

From discussions with City of Calgary staff, they confirmed that there is currently no wastewater treatment capacity available for new regional customers (City Email, 2015). Treatment facilities are currently nearing capacity or have committed capacity in both the north and south catchments. Given current circumstances, there is no possibility of a new regional wastewater connection from the sub-region until the next plant expansion at Pine Creek. This would likely be 2025, subject to project approval and budget.

This timing is an issue because the existing WWTPs in High River and Okotoks are at or near capacity. A solution is required prior to 2025. High River's WWTP EPEA Approval expires in September 2018, and Okotok's WWTP EPEA Approval expires in May 2016. Both Approvals indicate WWTP upgrades are required to meet higher effluent quality standards.

Further, the Aldersyde industrial area is developing. It too requires a solution to treat the wastewater generated prior to 2025.

Should Option 4 be considered, over the next 10 years each municipality would require an interim solution to "bridge" the capacity of their respective wastewater facilities until a tie to the City of Calgary can be made. This bridging would need to accommodate the increased flow during this period and would need to address any higher effluent quality standards required by AEP. An analysis of potential interim "bridging" options for each municipality is beyond the scope of this study, but is recommended as a next step should Option 4 be selected as the preferred option.

3. COSTS

This section reviews the economic analysis of the regional wastewater servicing options. Capital expenditures plus operation and maintenance (O&M) costs for the two preferred options are evaluated. Capital costs presented in this report are in 2016 Canadian dollars and include allowances of 25% for contingencies and 15% for engineering. All costs are exclusive of GST. All referenced costs and cost estimates are considered Class C (indicative) opinions of probable cost. These have been developed for comparative purposes between options. Budget level opinions of probable cost can be developed in a future more detailed design stage.

For each regional servicing option, the following are established:

- Capital cost estimates,
- O&M costs,
- Net present value (NPV) and total cost of ownership (TCO),
- Cost sharing and cash flow for each municipality.

The capital cost estimates and the O&M costs are used to determine the net present value (NPV) of each servicing option. These are utilized to compare, evaluate and hence establish the most cost effective options from a lifecycle perspective for the FRWWC regional wastewater servicing.

3.1 Capital Cost Estimates

Capital estimates of probable cost are developed for comparison of the two options, and are summarized in ***Table 3.1***. Costs are based upon historical tender prices in the MPE/USL team database and recent budgetary quotes from suppliers.

The costs for pipelines are based upon the line length between the lift station at each respective municipality and the effluent diffuser at the Bow River in the case of Option 3, and the City of Calgary Pine Creek WWTP in the case of Option 4.

Land acquisitions costs of $24,000/km are included in pipe capital cost estimates. A detailed breakdown for the capital cost of each pipe segment and lift station is included in ***Appendix C***.

The following assumptions are used to derive the capital cost estimates for the WWTPs in all options:

- Construction is assumed to occur over 1 year, however a minimum of three years should be allocated to allow for detailed design, construction and commissioning.
- The plant would be initially constructed in 2020 with two (2) process trains, with a third train added in 2034, and a fourth train added in 2049.
- The costs of land acquisition and utility extension (power, potable water, natural gas, trunk sewer) to the site is not included in the WWTP estimates.
- An allowance for contractor's overhead and profit of 10% is included.
- Costs are in 2016 dollars.

Table 3.1: Summary of Capital Cost Estimates

Option	Component	2020	2034	2041	2049	Total
3	WWTP	$125 M	$65 M	$0	$50 M	**$468 M**
	Pipelines & Lift Stations	$218 M	$0	$21 M	$0	
4	WWTP	n/a	n/a	n/a	n/a	**$219 M**
	Pipelines & Lift Stations	$202 M	$0	$23 M	$0	

There is a potential cost saving for the WWTP outfall pipeline in Option 3 if the future receiving water quality assessment confirms, and AEP accepts, that treated effluent can be discharged to a river location closer to the WWTP site. The potential cost saving for the outfall pipeline is $38 M. This would reduce the total capital cost in Table 3.1 to $430 M for Option 3.

There are potential cost savings for the WWTP which should be further explored during a future more detailed design stage if Option 3 is selected. The cost of chemical supply could be decreased by allowing for more on-site storage in the design of future stages. The fine filter LEAP or Salsnes Screens should be compared to fine screens and gravity primary clarifiers to determine the least life cycle cost option. Cost savings may be realized by using three rather than four construction phases depending on flows and loads at construction of Phase 1. It should also be noted that Okotoks is presently considering upgrades to their existing WWTP. Should these upgrades occur, Okotoks will have more capacity thus reducing the necessary capacity and net present value of the Option 3 WWTP.

Additionally, adaptive management may be employed once the plant is in operation, to confirm actual flows and loadings, such that upgrades could be strategically designed to meet the actual growth demands of the region. Adaptive management is a comprehensive monitoring program consisting of long-term monitoring, modelling and assessment of community growth, actual flows and loadings, and the performance of the implemented system. It involves ongoing evaluation to guide future design and implementation decisions. This approach is being adopted for a WWTP in a nearby Calgary-region community to allow for more flexibility and greater cost savings.

3.2 Operation and Maintenance Costs

3.2.1 Pipeline

The following assumptions are used in estimating the operational and maintenance (O&M) opinions of probable cost for the pipelines and lift stations:

- The O&M costs are estimated based on average annual daily flows. For this memorandum, the total community flows are estimated for each year between 2021 and 2076 based on the assumptions in Technical Memorandum 3 (MPE/USL TM3, 2016).
- Power costs are based on an assumed $0.17/kWh.
- Labour costs associated with the lift stations are based on average flow rates. Lift stations larger than 200 L/s are assumed to have annual labour costs of $170,000. Smaller lift stations with flows less than 200 L/s are assumed to have labour costs of $45,000 per year.
- Pump repair and rehabilitation (R&R) costs are estimated to be 2% of total lift station initial capital costs. The pipeline R&R is estimated to be a total of $250,000 per year for each option.
- Chemical cost allowance for the H_2S reduction system (Biomax) is assumed to be $0.25 per cubic meter of wastewater flow.

The projected annual O&M costs for the entire design horizon are summarized in ***Appendix C***.

3.2.2 City of Calgary Charges

Customers outside the boundaries of the City of Calgary are required to pay a monthly charge in accordance with Schedule “E” of the *City of Calgary Wastewater Bylaw* (City 2015). Projected monthly charges are applied to Option 4, which requires service from the City of Calgary. Schedule “E” sets out the monthly charge, which includes a fixed component plus a volume component, up to year 2018. The fixed component is applied to recover costs of upgrades to conveyance infrastructure and treatment facilities within city limits that are required to service the external flows. The volume component is for the operation costs for the WWTP and conveyance infrastructure. The City of Calgary revises Schedule “E” every four years to update the committed regional flows and associated costs the City will need to recoup. Once a formal application to tie-into the City of Calgary wastewater infrastructure is made, the City will update these monthly charges. As the current Schedule “E” only addresses up to year 2018, this memorandum assumes that the rate beyond 2018 increases at an estimated inflation rate of 2.5% per year.

No City of Calgary user fees are added for Option 3, since wastewater treatment is provided by an independent sub-regional WWTP within the MD of Foothills.

3.2.3 WWTP

The following assumptions are used in estimating the operational and maintenance (O&M) opinions of probable cost for the WWTP in Option 3:

- The O&M costs are estimated based on average annual daily flows. For this memorandum, the total community flows are estimated for each year between 2021 and 2076 based on the assumptions in Technical Memorandum 3 (MPE/USL TM3, 2016).
- Chemicals costs include delivery in bulk liquid form (Liquid Alum and Emulsion Polymer) to the WWTPs approximately every 2 months. Chemical usage (Sodium Hypochlorite and Citric Acid) for MBR cleaning is assumed based on manufacturer requirements:
    - Maintenance clean of each train 2x/week
    - Recovery clean of each train 2x/year
- Power usage estimates include building heating and lighting, and energy use from major process equipment, including pumps, aeration blowers, MBR equipment, UV lamps, and sludge handling equipment. Equipment turndown as needed is assumed. These categories comprise the largest use of power for the WWTPs. Power costs are assumed at $0.17/kWh.
- Labour costs are assumed based on number of full time equivalents (FTE) required per average daily flow.
- Membranes require replacing every 12 years, based on manufacturer's data. It is assumed that an annual sinking fund will be set up to pay for membrane replacement costs.
- Equipment replacement costs (excluding membrane replacement) are assumed to be $0.7 M annually for the first phase (to 2034), $1 M annually for the second phase (to 2049) and $1.3 M annually for the third phase (to 2076). It is assumed that an annual sinking fund will be set up for equipment replacement costs, and that all equipment will be replaced every 20 years.
- Parts and Maintenance supply costs (excluding installation) are assumed to be 2% of the initial capital cost of equipment (excluding membranes) annually, and are assumed to include replacement costs of consumables such as aeration diffusers and UV lamps.
- Sludge is assumed to be dewatered at the WWTP and hauled to Eco-AG in High River, an external solids processing facility. Eco-Ag advises that tipping fees are between $75-250/tonne of waste processed, including trucking. Costs are dependent on the contract arrangement between the client and Eco-Ag, and can change based on location of plant, composition of solids, and laboratory costs. For the purpose of this memorandum a tipping fee of $100/m^3 and a hauling rate of $275/hour for a 30m^3 truck are assumed.
- The existing O&M costs for operating the existing Okotoks WWTP are included in Option 3 ($2.6 M annually). It is assumed that the existing cost will continue to carry forward annually as the plant is assumed to be at capacity.

The projected annual O&M costs for the entire design horizon are summarized in ***Appendix C***.

3.3 Net Present Value and Total Cost of Ownership

A net present value (NPV) and total cost of ownership (TCO) analysis is completed for the two preferred regional options. The analysis includes capital costs for construction in 2020 and 2041 of pipelines and lift stations, and capital costs for construction in 2020, 2034 and 2049 of the WWTP. The O&M costs are for 55 years of operation from 2021 to 2076. ***Table 3.2*** summarize the NPV analysis and ***Table 3.3*** summarizes the TCO analysis. It is important to note that funding from provincial grants or other initiatives is not taken into consideration in this analysis. NPV values are based on a discount rate of 5%.

Table 3.2: Net Present Value

Option	Pipeline NPV	WWTP NPV	TOTAL NPV
3	\$297 M	\$315 M	**\$612 M**
4	\$450 M	n/a	**\$450 M**

The NPV for both options have increased incrementally from Technical Memorandum 3 (MPE/USL TM3, 2016). The main reasons are as follows:

- Updated equipment and materials costs from suppliers are included.
- Longer pipeline lengths are adopted given refinement of the pipeline alignment. This also increases the required horsepower at the lift stations, which increases the power costs.
- More detailed information for H_2S reduction chemical costs are included.
- Okotoks' current WWTP O&M costs are now available and are included in Option 3.
- City of Calgary rates for 2018 are used as the base rates for Option 4, versus the 2016 rates used in TM3.

Table 3.3: Total Cost of Ownership

Option	Pipeline TCO	WWTP TCO	TOTAL TCO
3	\$795 M	\$1,017 M	**\$1,812 M**
4	\$1,624 M	n/a	**\$1,624 M**

The terms of reference for the work plan required a TCO analysis be carried out. In ***Table 3.3*** the TCO is calculated as the arithmetic total of capital and O&M costs over the entire 55 year time horizon, without taking into account the time value of money. TCO analysis is often used as a decision tool for shorter time periods (3 to 5 years) and is included for comparison purposes to the NPV method. Generally, because the NPV analysis does take into account the time value of money, it can be argued that the NPV analysis is more appropriate for longer time horizons, such as is the case here, and is therefore more applicable to this project. However both methods indicate similar results, with the most cost effective option being Option 4. As mentioned previously, the cost of Option 4 does not include local “bridging” costs until 2025 when a tie to the City of Calgary can be made. These “bridging” costs will increase the total cost of Option 4. Should this option be favoured, these costs should be calculated as a next step, as this work is beyond the current scope of work.

3.4 Cost Sharing and Cash Flow for Each Municipality

A cost sharing analysis is completed for the two regional options. Two cost sharing scenarios are reviewed:

1. All costs shared based on the maximum day flow (MDF) contribution of each municipality
2. Core infrastructure costs shared based on the maximum day flow (MDF) contribution of each municipality; individual laterals outside the core are fully costed to each benefitting municipality. ***Figure 4.3*** and ***Figure 4.4*** in **Appendix A** identify the infrastructure components that are considered to benefit each municipality for this scenario.

Tables 3.4 and 3.5 summarize the capital cost sharing and cash flow of each municipality for the proposed phasing of each option under each cost sharing scenario. Costs are in 2016 dollars.

Table 3.4: Option 3 Capital Cash Flow

Scenario	Municipality	2020	2034	2041	2049	TOTAL
1 – All Components Shared by All	High River	$109 M	$21 M	$7 M	$16 M	**$153 M**
	Okotoks	$168 M	$32 M	$10 M	$25 M	**$235 M**
	MD Central District	$52 M	$10 M	$3 M	$8 M	**$73 M**
	Aldersyde	$14 M	$3 M	$1 M	$2 M	**$20 M**
2 – Cost Shared by Benefiters of Each Component	High River	$147 M	$21 M	$2 M	$16 M	**$186 M**
	Okotoks	$108 M	$32 M	$16 M	$25 M	**$181 M**
	MD Central District	$71 M	$10 M	$0.5 M	$8 M	**$90 M**
	Aldersyde	$17 M	$3 M	$3 M	$2 M	**$25 M**

Table 3.5: Option 4 Capital Cash Flow

Scenario	Municipality	2020	2041	TOTAL
1 – All Components Shared by All	High River	$64 M	$7 M	**$71 M**
	Okotoks	$99 M	$11 M	**$110 M**
	MD Central District	$31 M	$4 M	**$35 M**
	Aldersyde	$8 M	$1 M	**$9 M**
2 – Cost Shared by Benefiters of Each Component	High River	$115 M	$4 M	**$119 M**
	Okotoks	$62 M	$16 M	**$78 M**
	MD Central District	$12 M	$1 M	**$13 M**
	Aldersyde	$13 M	$3 M	**$16 M**

4. SUMMARY DISCUSSION AND COMPARISON OF OPTIONS

The major advantages and disadvantages of each option are summarized in ***Table 4.1*** below.

Table 4.1: Advantages and Disadvantages of Each Option

Option	Advantages	Disadvantages
3	One Sub-Regional WWTP servicing only excess flow from Okotoks, plus 100% of the flow from High River and MD; retain local plants in Westend, Longview and Nanton.	
	• No known timing issues. Project could likely proceed to construction of Phase 1 in 2020 (based on allowing time for design, consultations, approvals and financing) • No user fees paid to City of Calgary • Do not need to meet current City of Calgary policies to proceed	• More costly option • Longest length of pipeline required • Two WWTP's – more difficult to retain Operators • Further study required to determine whether a new treated effluent outfall must be to Highwood River or Bow River, and potential timing of outfall location(s)
4	Regional pipeline from Okotoks and High River to Calgary, sized to also include 100% of MD flow; retain local plants in Westend, Longview and Nanton.	
	• Least costly option • As least cost option, more likely to be fully eligible for Water for Life funding • No WWTP for FRWWC to operate • Shortest length of pipeline	• Political issues; MD of Foothills does not meet the current City of Calgary policies to proceed and is not eligible to apply to City Council to connect to the system • Requires ongoing user fees paid to City of Calgary, which have not been established beyond 2018 • Timing: cannot likely tie-in to City of Calgary WWTP until at least 2025; local interim "bridging" costs need to be determined and will add to total project cost

5. RECOMMENDATIONS

If Option 3 is determined to be the favoured option the following additional analysis is recommended:

- Undertake a receiving water quality assessment for the Sub-regional NE WWTP outfall to assess the feasibility of the outfall to the Bow River or the Highwood River.

If Option 4 is determined to be the favoured option the following additional analysis is recommended:

- Undertake additional refinement of the local alternatives to “bridge” the WWTP’s (for capacity and effluent quality) and to identify potential hybrid scenarios for each municipality given timing to tie-in to the City of Calgary is likely at least 10 years away.

5.1 Next Steps

The following are the next steps as per the proposed work plan following submittal of this Technical Memorandum 4.

1. Meeting #3 with MPE/USL/FRWWC to select favoured Option.
2. MPE/USL to finalize Draft Final Report based on outcome of Meeting #3 and submit for comments.
3. Meeting #4 with MPE/USL/FRWWC to review Draft Final Report and provide comments.
4. MPE/USL to prepare and submit Final Report.
5. Meeting #5 with MPE/USL/FRWWC to present Final Report.

Sincerely,

MPE ENGINEERING LTD.

Sarah Fratpietro, P.Eng.
Project Manager

“REVIEWED BY:”
Randy Boras, M.Sc., P.Eng.
Senior Project Specialist

SF/rb

6. REFERENCES

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MPE/USL TM2 2015; *Technical Memorandum: Foothills Stream Analysis*, Prepared for the FRWWC by Urban Systems and MPE Engineering, November 20, 2015.

MPE/USL TM3 2016; *Technical Memorandum 3: Options & Screening*, Prepared for the FRWWC by Urban Systems and MPE Engineering, January 7, 2016.

MPE/USL TM5 2016; *Technical Memorandum 5: Westend Options*, Prepared for the FRWWC by Urban Systems and MPE Engineering, January 7, 2016.

Stantec TM1 2015; *Technical Memorandum #1 Town of Okotoks Wastewater Treatment Plant Design Basis Memorandum*, Prepared by Stantec Consulting Ltd., August 14, 2015.

Stantec TM2 2015; *Technical Memorandum #2 Town of Okotoks Wastewater Treatment Plant – Treatment Capacity Assessment*, Prepared by Stantec Consulting Ltd., September 25, 2015.

Stantec TM3 2015; *Technical Memorandum #3 Regional Wastewater Pipeline Feasibility Study – Hydraulic Analysis for Sanitary Forcemain Options*, Prepared by Stantec Consulting Ltd., October 9, 2015.

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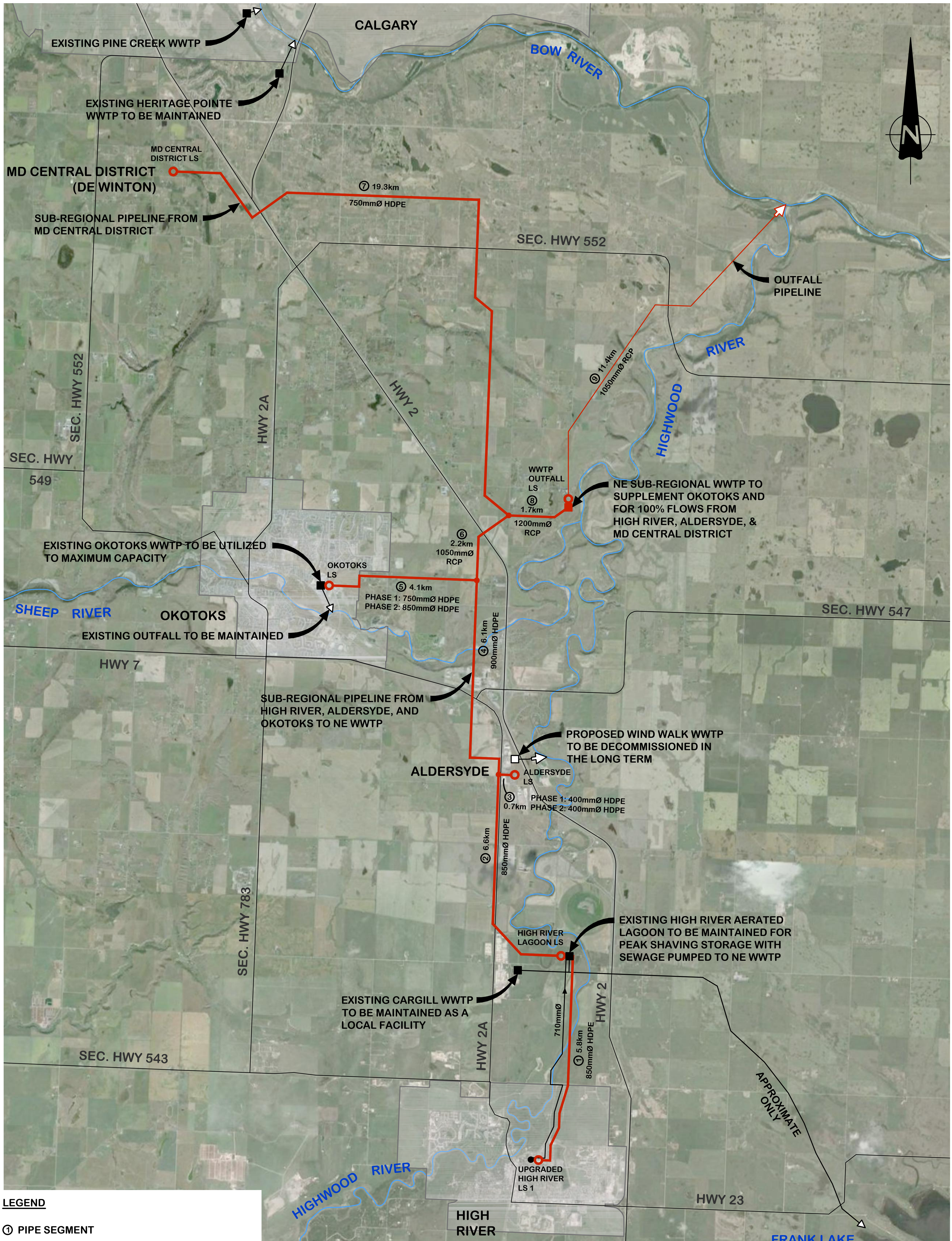
APPENDIX A:

FIGURE 4.1 – OPTION 3 – Concept Design

FIGURE 4.2 – OPTION 4 – Concept Design

FIGURE 4.3 – OPTION 3 –Scenario 2 Cost Sharing Map

FIGURE 4.4 – OPTION 4 –Scenario 2 Cost Sharing Map



LEGEND

- ① PIPE SEGMENT
- CONCEPTUAL WASTEWATER TREATMENT PLANT
- CONCEPTUAL WASTEWATER OUTFALL
- LS CONCEPTUAL LIFT STATION
- EXISTING WASTEWATER TREATMENT PLANT
- PROPOSED PRIVATE WASTEWATER TREATMENT PLANT
- EXISTING WASTEWATER OUTFALL
- PROPOSED PRIVATE OUTFALL

CONCEPT ONLY

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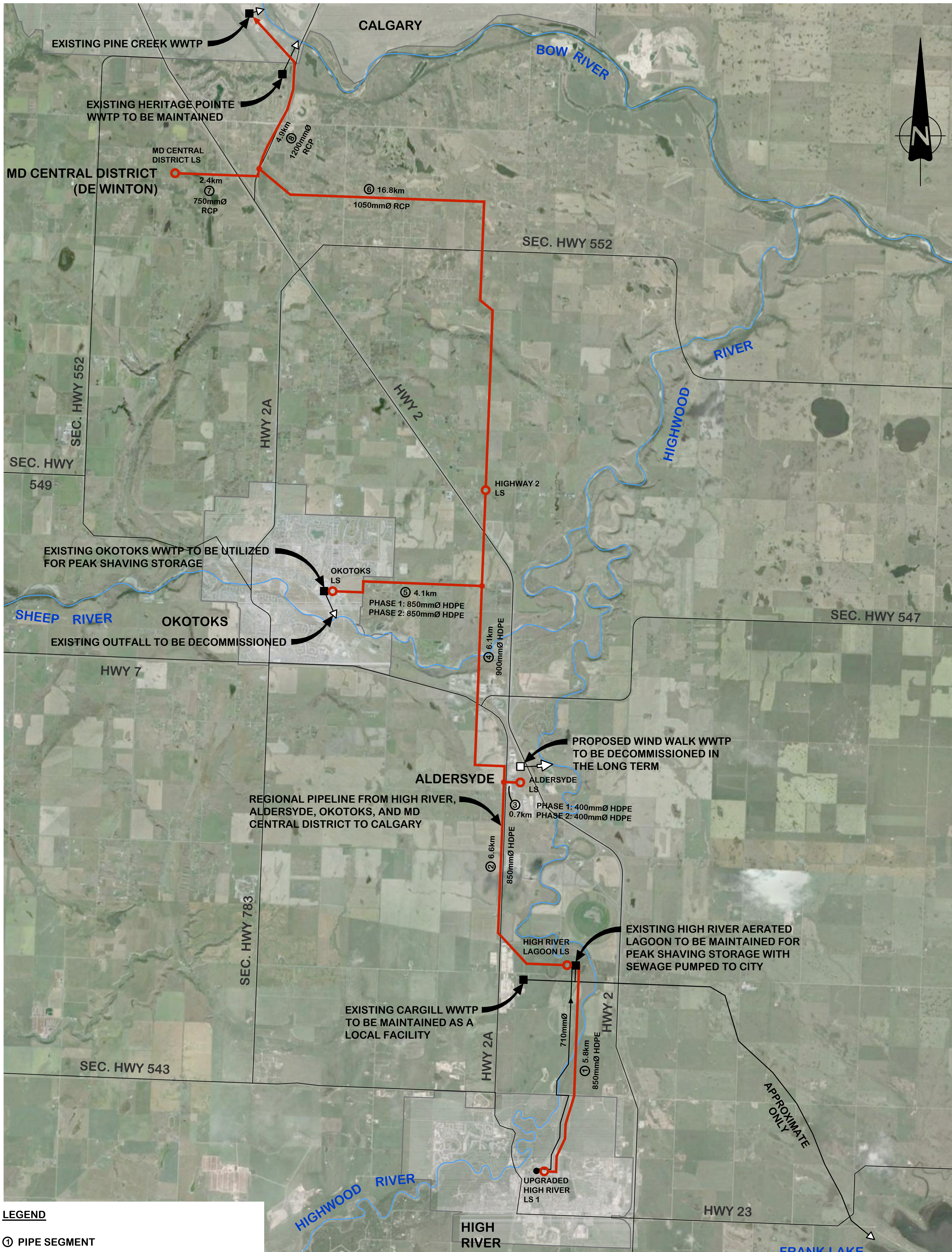
FOOTHILLS REGIONAL WATER & WASTEWATER COLLABORATIVE

FRWWC WASTEWATER STUDY
OPTION 3 - CONCEPT PLAN

SCALE: 1:100,000	DATE: MARCH 2016	JOB: 2210-047-00	FIGURE: 4.1



LEGEND

- ① PIPE SEGMENT
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- CONCEPTUAL WASTEWATER OUTFALL
- LS CONCEPTUAL LIFT STATION
- EXISTING WASTEWATER TREATMENT PLANT
- PROPOSED PRIVATE WASTEWATER TREATMENT PLANT
- EXISTING WASTEWATER OUTFALL
- PROPOSED PRIVATE OUTFALL

CONCEPT ONLY

0 2500m

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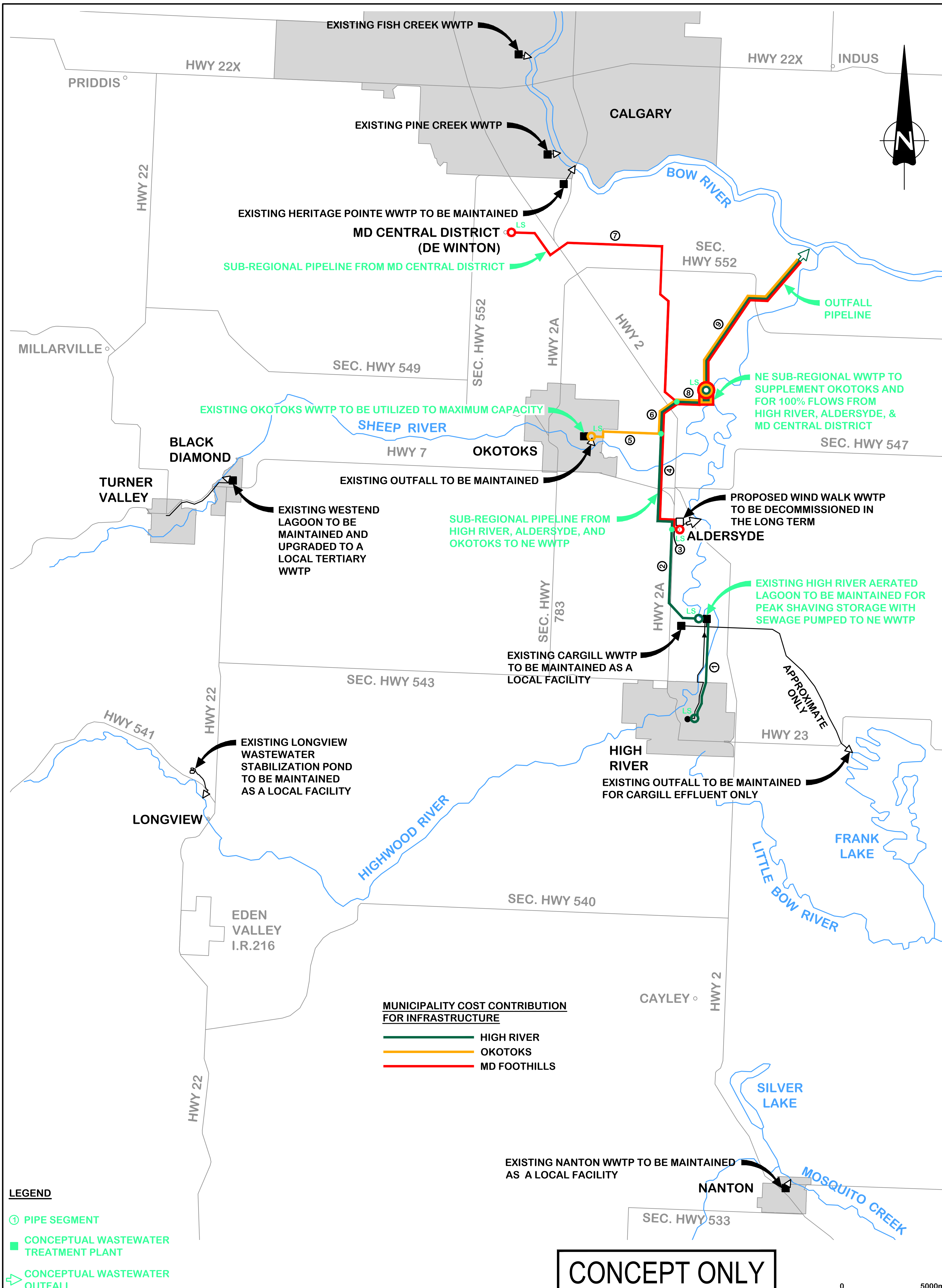
FOOTHILLS REGIONAL WATER & WASTEWATER COLLABORATIVE

FRWWC WASTEWATER STUDY
OPTION 4 - CONCEPT PLAN

SCALE: 1:100,000	DATE: MARCH 2016	JOB: 2210-047-00	FIGURE: 4.2



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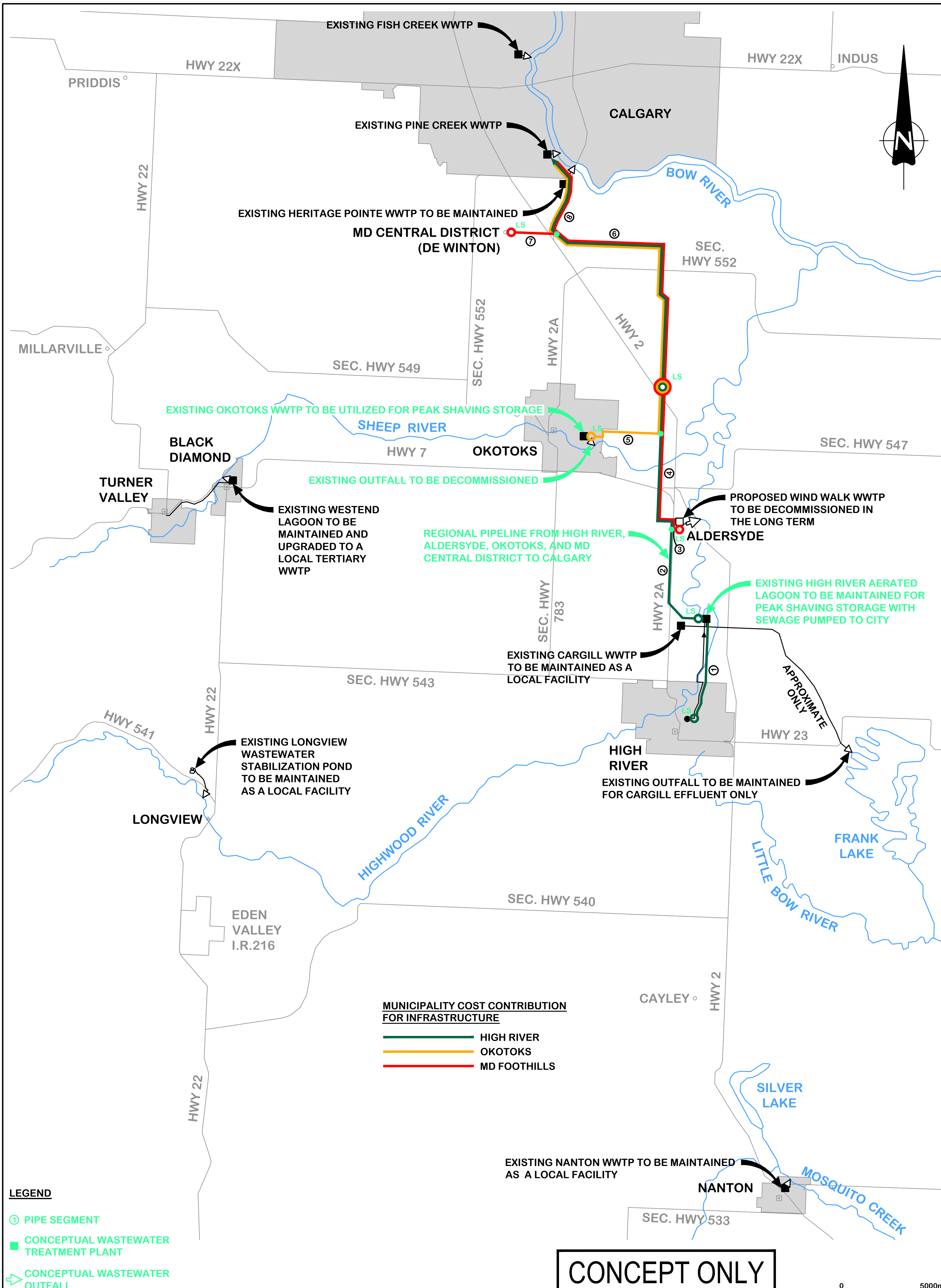
FRWWC WASTEWATER STUDY
OPTION 3 - SCENARIO 2 COST SHARING

SCALE: 1:200,000	DATE: MARCH 2016	JOB: 2210-047-00	FIGURE: 4.3



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FRWWC WASTEWATER STUDY
OPTION 4 - SCENARIO 2 COST SHARING

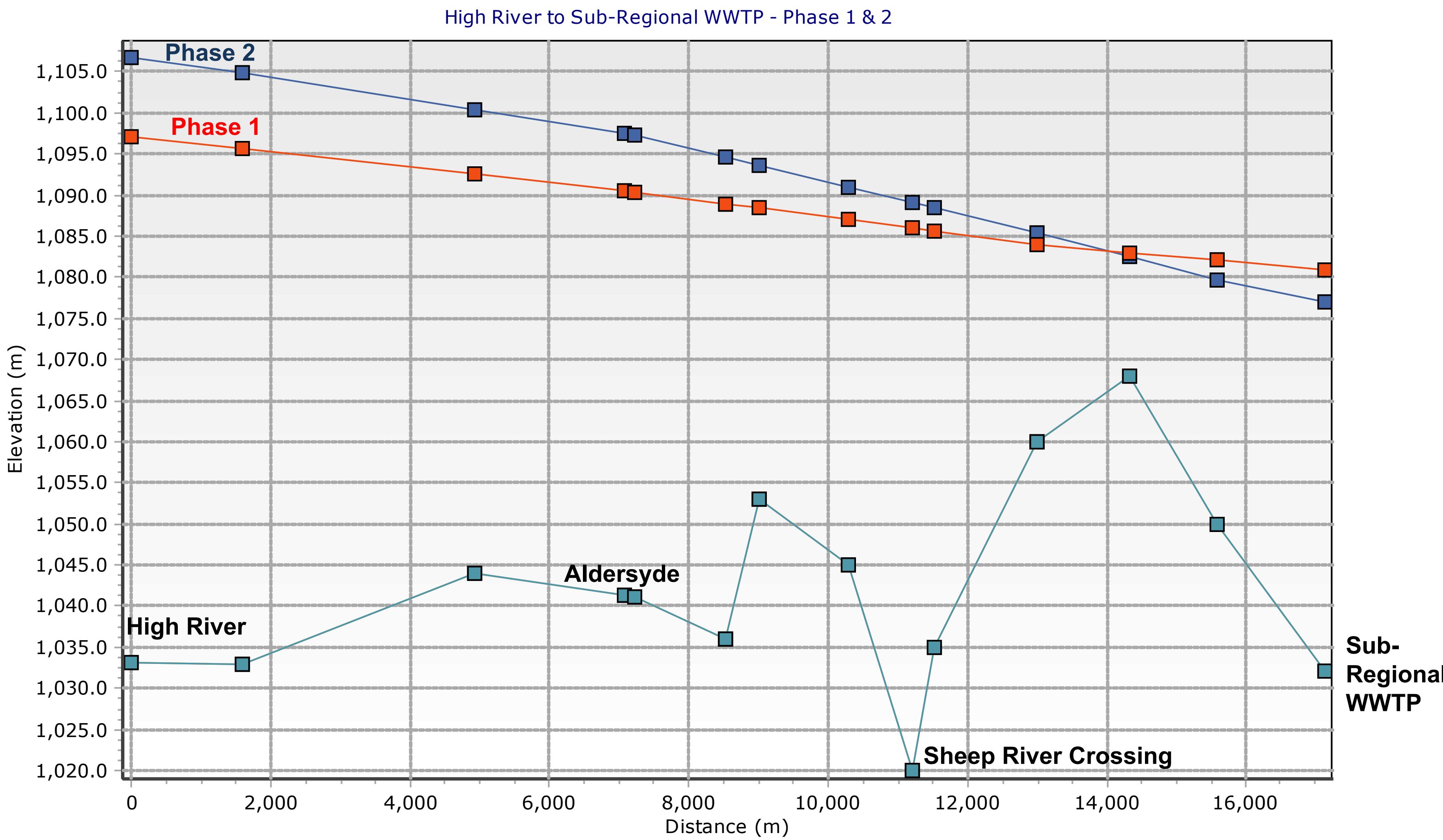
SCALE: 1:200,000	DATE: MARCH 2016	JOB: 2210-047-00	FIGURE: 4.4

APPENDIX B:

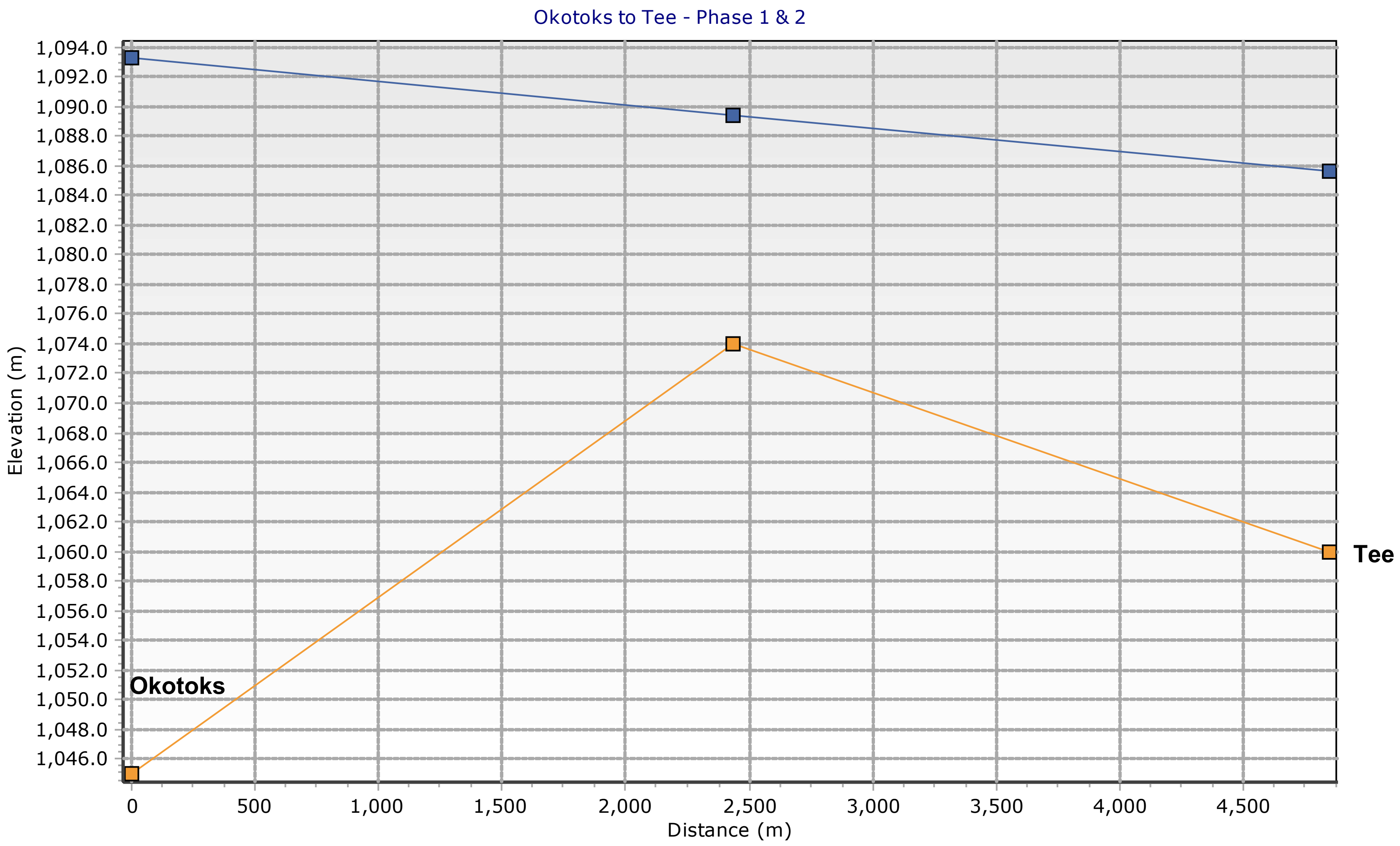
Option 3: Hydraulic Grade Line

Option 4: Hydraulic Grade Line

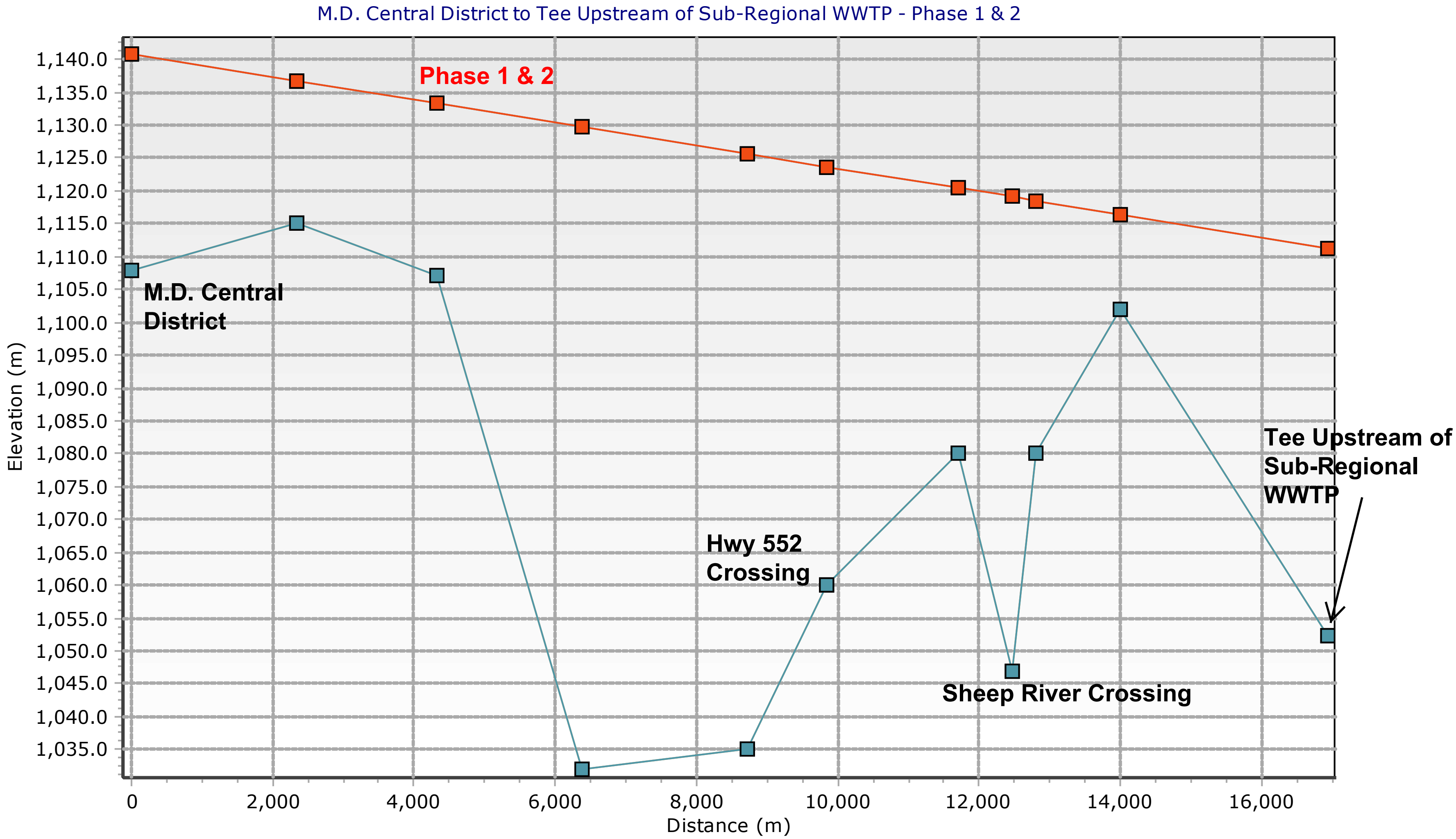
APPENDIX B
OPTION 3
HYDRAULIC GRADE LINE & ELEVATION PROFILE



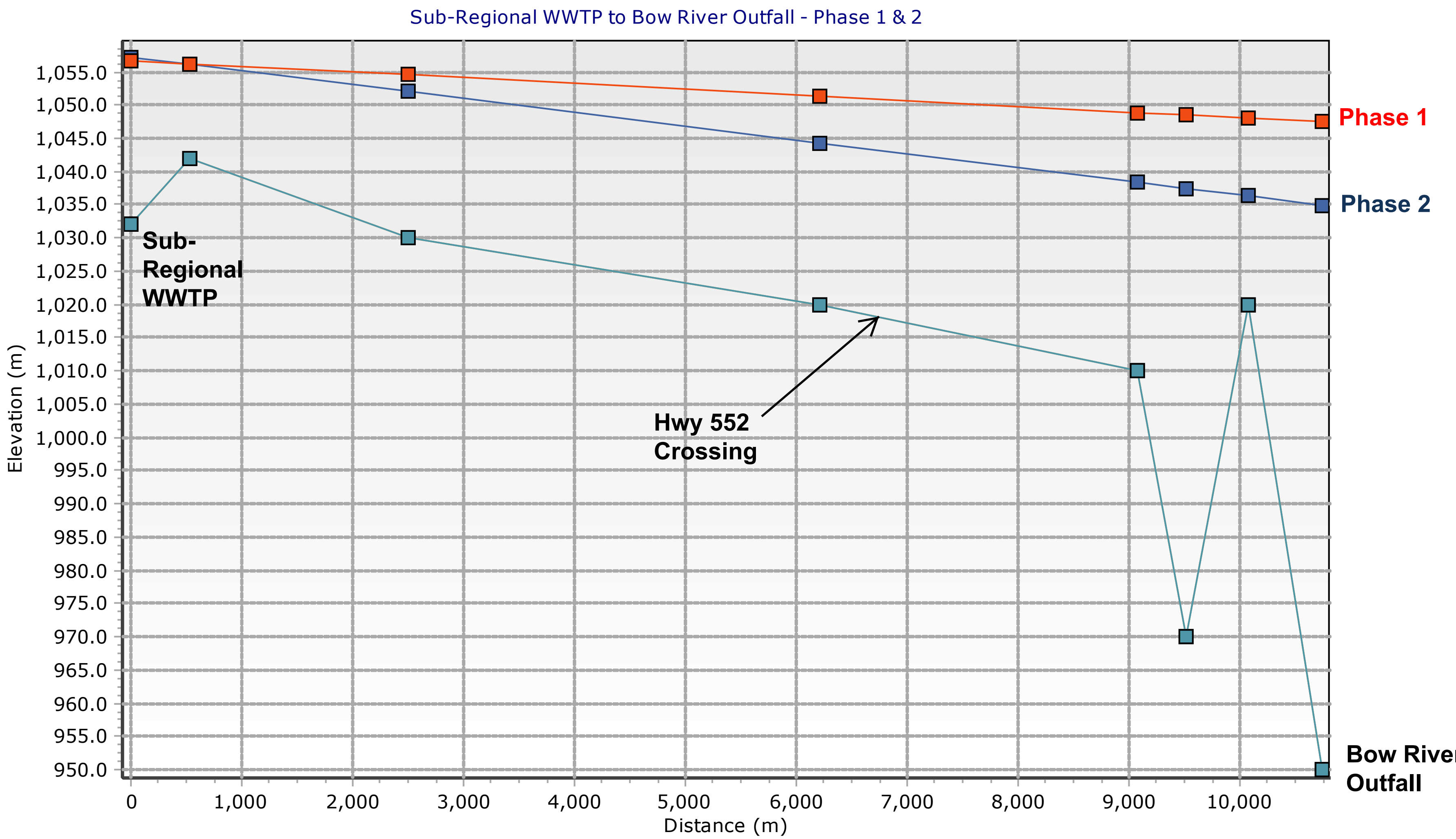
APPENDIX B
OPTION 3
HYDRAULIC GRADE LINE & ELEVATION PROFILE



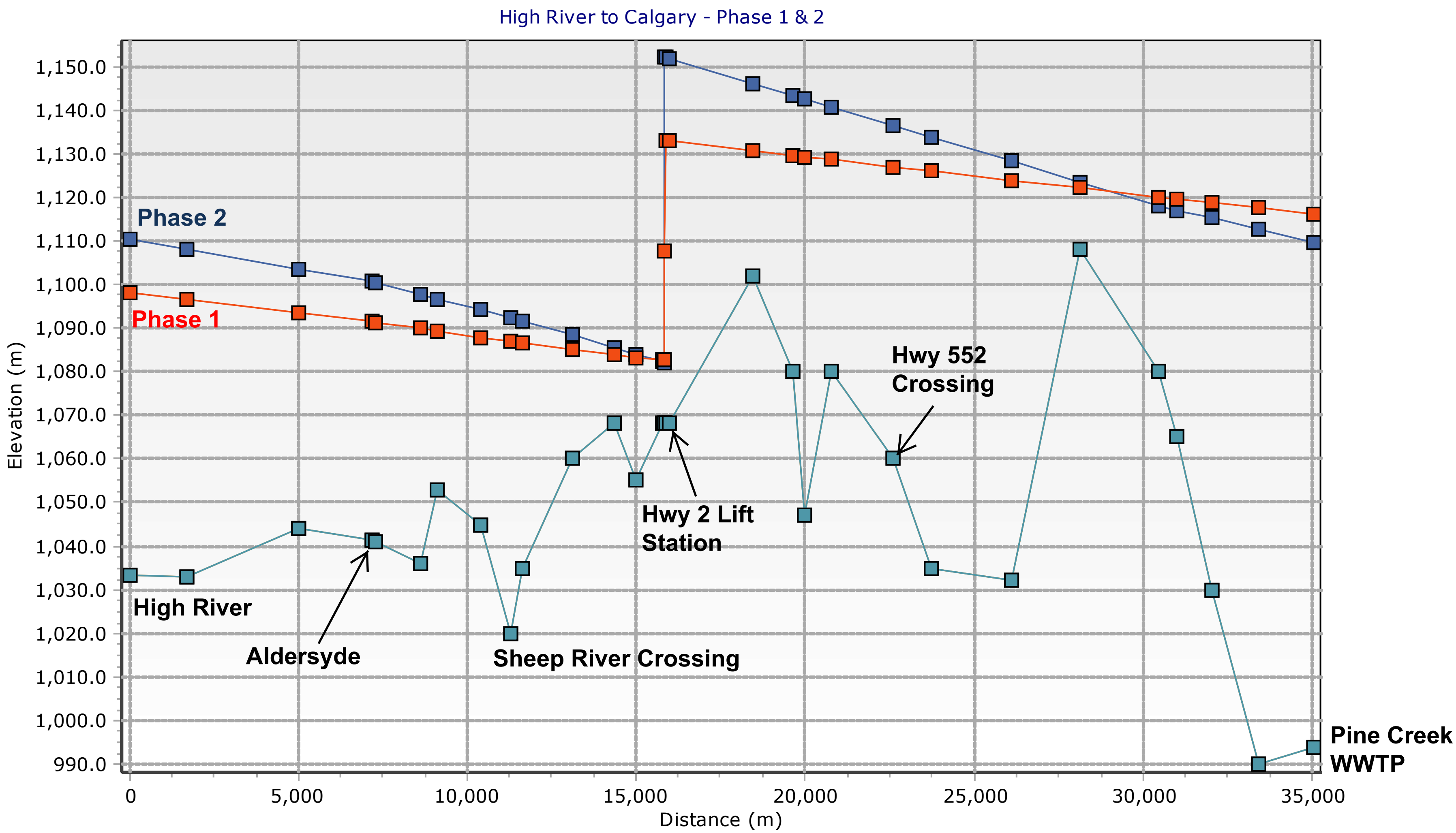
APPENDIX B
OPTION 3
HYDRAULIC GRADE LINE & ELEVATION PROFILE



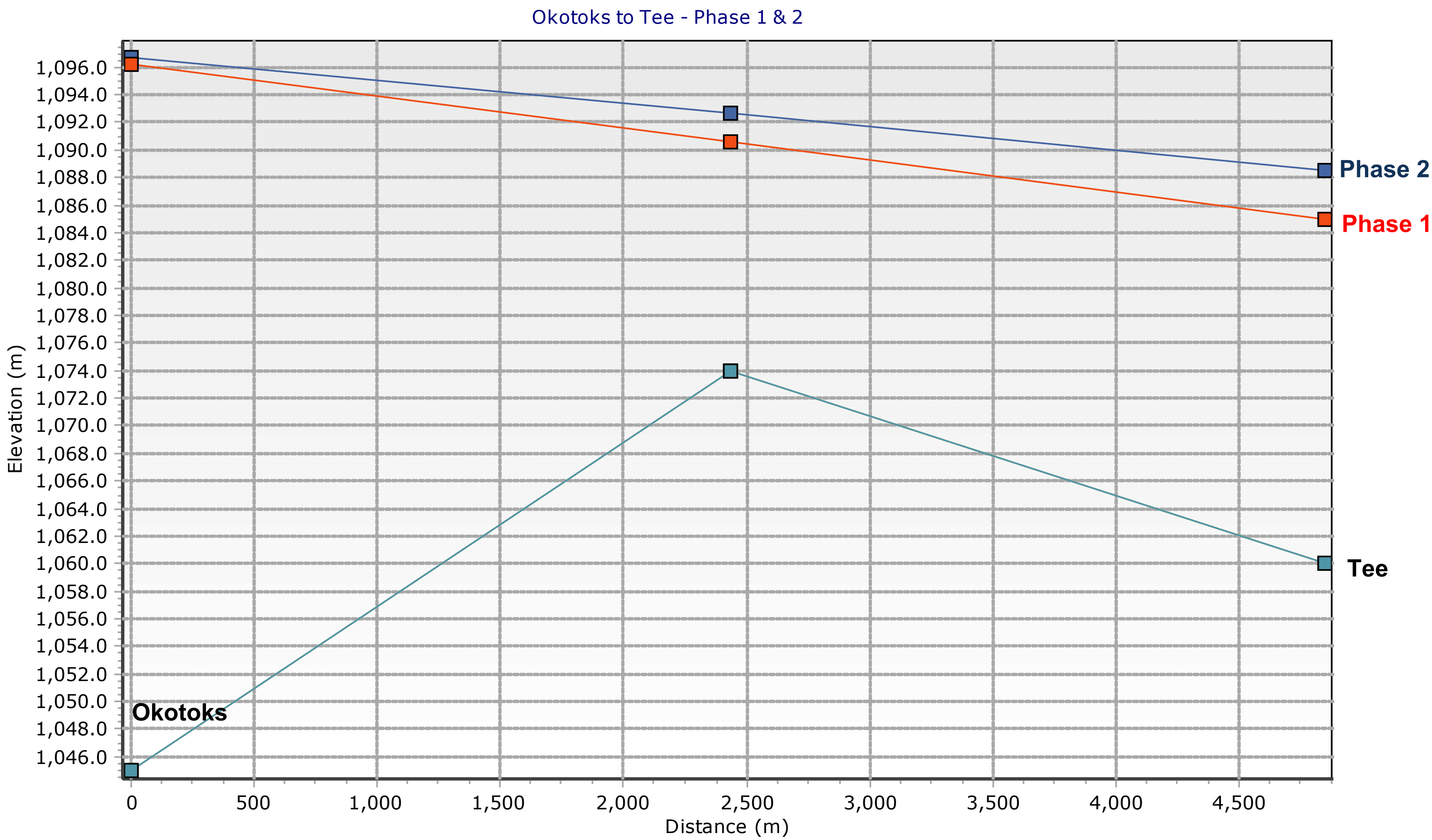
APPENDIX B
OPTION 3
HYDRAULIC GRADE LINE & ELEVATION PROFILE



APPENDIX B
OPTION 4
HYDRAULIC GRADE LINE & ELEVATION PROFILE



APPENDIX B
OPTION 4
HYDRAULIC GRADE LINE & ELEVATION PROFILE



APPENDIX C:

OPTION 3 & 4: Pipeline and Lift Station Capital Costs

OPTION 3: WWTP Capital Costs

OPTION 3: Pipeline and Lift Station O&M Costs

OPTION 3: WWTP O&M Costs

OPTION 4: Pipeline and Lift Station O&M Costs

APPENDIX C: Pipeline and Lift Station Capital Costs

Foothills Regional Water & Wastewater Collaborative
Wastewater Study

Prepared by MPE Engineering Ltd.
Date: March 10, 2016

Pipelines Capital Costs (Costs in 2016 Dollars)

	Option 3	Option 4
Pipe Segment 1	$ 26,134,800	$ 26,584,800
Pipe Segment 2	$ 16,779,600	$ 16,779,600
Pipe Segment 3	$ 607,950	$ 625,200
Pipe Segment 4	$ 31,187,100	$ 31,187,100
Pipe Segment 5	$ 7,653,600	$ 8,496,600
Pipe Segment 6	$ 6,154,200	$ 50,404,800
Pipe Segment 7	$ 38,085,300	$ 6,395,400
Pipe Segment 8	$ 8,174,700	$ 15,945,900
Pipe Segment 9	$ 38,465,400	--
Phase 1 Total - Year 2041 Design Flow - Constructed in 2020	**$ 173,242,650**	**$ 156,419,400**
Pipe Segment 3	$ 604,950	$ 625,200
Pipe Segment 5	$ 9,339,600	$ 9,162,600
Phase 2 Total - Year 2076 Design Flow - Constructed in 2041	**$ 9,944,550**	**$ 9,787,800**
Total Phase 1 & 2	**$ 183,187,200**	**$ 166,207,200**

Lift Stations Capital Costs

	Option 3	Option 4
High River L.S. 2	$ 7,123,600	$ 7,123,600
HR Lagoon L.S.	$ 10,163,377	$ 8,601,817
Aldersyde L.S.	$ 5,154,551	$ 4,917,863
Okotoks L.S.	$ 9,380,485	$ 8,841,957
MD C.D. L.S.	$ 5,250,971	$ 3,155,886
WWTP Outfall L.S.	$ 7,817,918	n/a
Highway 2 L.S.	n/a	$ 12,555,949
Phase 1 Total - Year 2041 Design Flow - Constructed in 2020	**$ 44,890,902**	**$ 45,197,071**
High River L.S. 2	$ 837,963	$ 837,963
HR Lagoon L.S.	$ 486,744	$ 1,248,746
Aldersyde L.S.	$ 2,495,659	$ 1,792,848
Okotoks L.S.	$ 5,013,082	$ 3,261,506
MD C.D. L.S.	$ -	$ 450,841
WWTP Outfall L.S.	$ 2,450,276	n/a
Highway 2 L.S.	n/a	$ 5,750,113
Phase 2 Total - Year 2076 Design Flow - Constructed in 2041	**$ 11,283,725**	**$ 13,342,017**
Total Phase 1 & 2	**$ 56,174,627**	**$ 58,539,088**

Pipelines & Lift Stations Capital Costs

	Option 3	Option 4
Capital Costs in 2016 Dollars		
Phase 1 Total - Year 2041 Design Flow - Constructed in 2020	$ 218,133,552	$ 201,616,471
Phase 2 Total - Year 2076 Design Flow - Constructed in 2040	$ 21,228,275	$ 23,129,817
Total Phase 1 & 2	**$ 239,361,827**	**$ 224,746,288**

Pipelines & Lift Stations Net Present Value [1]

	Option 3	Option 4
Net Present Value	**$ 177,182,114**	**$ 164,802,080**

[1] O & M costs not included.

APPENDIX C: WWTP Capital Costs

Foothills Regional Water & Wastewater Collaborative
Wastewater Study

Prepared by Urban Systems Ltd.

WWTP Capital Costs (in 2016 Dollars) **Date:** **February 29, 2016**

Option 3	**Phase 1 (2020)**	**Phase 2 (2034)**	**Phase 3 (2049)**
Process Equipment	$ 24,412,000.00	$ 13,087,000.00	$ 10,112,000.00
Emergency Generator	$ 473,000.00	$ 281,000.00	$ 281,000.00
Process Piping	$ 8,544,000.00	$ 4,580,000.00	$ 3,539,000.00
Process Tankage (incl. Covers, railings)	$ 20,383,000.00	$ 10,610,000.00	$ 8,812,000.00
Buildings	$ 7,993,700.00	$ 3,672,000.00	$ 1,764,500.00
Laboratory/control room equipment	incl.	incl.	incl.
Electrical/Instrumentation	$ 12,206,000.00	$ 6,543,000.00	$ 5,056,000.00
Yard Piping	$ 650,000.00	$ 275,000.00	$ 275,000.00
Yard Surfacing, Landscaping and Fencing	$ 951,000.00	$ 475,000.00	$ 475,000.00
Sub Total	**$ 75,613,000.00**	**$ 39,523,000.00**	**$ 30,315,000.00**
Commissioning	$ 756,000.00	$ 395,000.00	$ 303,000.00
Mobilization/Demobilization	$ 1,512,000.00	$ 790,000.00	$ 606,000.00
Bonding and Insurance	$ 935,000.00	$ 488,000.00	$ 375,000.00
Contractor Indirects, OH&P	$ 7,788,000.00	$ 4,071,000.00	$ 3,122,000.00
Contingency	$ 21,651,000.00	$ 11,317,000.00	$ 8,680,000.00
Engineering	$ 16,238,000.00	$ 8,488,000.00	$ 6,510,000.00
GRAND TOTAL	**$ 124,500,000.00**	**$ 65,070,000.00**	**$ 49,910,000.00**

WWTP Net Present Value

Net Present Value	**$ 102,800,000.00**	**$ 27,000,000.00**	**$ 10,000,000.00**

APPENDIX C: Pipeline and Lift Station Operation and Maintenance Costs - Option 3

Foothills Regional Water & Wastewater Collaborative Wastewater Study

Prepared by MPE Engineering Ltd.
March 10, 2016

City of Calgary Fees Fixed Component [1]	$	0.4230
City of Calgary Fees Volume Component [1]	$	0.5340
Labour Costs - Pump Stations > 20 MLD	$	170,000
Labour Costs - Pump Stations < 20 MLD	$	45,000
Cost of Power $/kWhr	$	0.17

2%	Capital Cost for Repair & Rehabilitation Allowance
$ 0.25	/m3 ADD, H2S Reduction Chemical Cost
5%	Net Present Value Discount Rate

								Phase 1 Construction Year [2]	2021 - Start Phase 1 O & M costs (in 2016$)																		
	Parameter	Units	NPV 2016 to 2076	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
High River LS2	Population	capita							18,074	18,761	19,474	20,214	20,982	21,779	22,607	23,466	24,357	25,283	26,244	27,241	28,276	29,351	30,466	31,624	32,825	34,073	35,367
	Per Capital Flow	l/c/d							382	380	379	377	376	374	373	371	370	368	367	365	364	362	361	359	358	356	355
	ADD	m3/d							6,898	7,132	7,374	7,624	7,883	8,150	8,426	8,712	9,007	9,312	9,627	9,952	10,288	10,636	10,995	11,366	11,749	12,145	12,554
	Maximum Design Flow	m3/d							67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065
	Horsepower of Duty Pumps	hp							415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415
	Hours Pumping at Maximum Power	hrs							901	932	963	996	1,030	1,065	1,101	1,138	1,176	1,216	1,257	1,300	1,344	1,389	1,436	1,485	1,535	1,586	1,640
	Annual Power Consumption	kWhr/yr							223,141	230,721	238,555	246,651	255,019	263,666	272,601	281,836	291,378	301,239	311,428	321,956	332,836	344,077	355,691	367,692	380,091	392,902	406,137
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							37,934	39,223	40,554	41,931	43,353	44,823	46,342	47,912	49,534	51,211	52,943	54,733	56,582	58,493	60,468	62,508	64,616	66,793	69,043
	Labour Cost	$/yr in 2016$							169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472
	H2S Reduction	$/yr in 2016$							629,400	650,781	672,878	695,715	719,316	743,706	768,910	794,957	821,872	849,686	878,426	908,124	938,810	970,517	1,003,278	1,037,127	1,072,101	1,108,234	1,145,566
	Total		**20,239,398**	**0**	**0**	**0**	**0**	**0**	**979,517**	**1,002,187**	**1,025,616**	**1,049,829**	**1,074,852**	**1,100,712**	**1,127,436**	**1,155,052**	**1,183,590**	**1,213,079**	**1,243,552**	**1,275,039**	**1,307,575**	**1,341,193**	**1,375,929**	**1,411,818**	**1,448,899**	**1,487,211**	**1,526,793**
High River Lagoon LS	Population	capita							18,074	18,761	19,474	20,214	20,982	21,779	22,607	23,466	24,357	25,283	26,244	27,241	28,276	29,351	30,466	31,624	32,825	34,073	35,367
	Per Capital Flow	l/c/d							382	380	379	377	376	374	373	371	370	368	367	365	364	362	361	359	358	356	355
	ADD	m3/d							6,898	7,132	7,374	7,624	7,883	8,150	8,426	8,712	9,007	9,312	9,627	9,952	10,288	10,636	10,995	11,366	11,749	12,145	12,554
	Maximum Design Flow	m3/d							31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521
	Horsepower of Duty Pumps	hp							568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568	568
	Hours Pumping at Maximum Power	hrs							1,917	1,982	2,049	2,119	2,191	2,265	2,342	2,421	2,503	2,588	2,675	2,766	2,859	2,956	3,056	3,159	3,265	3,375	3,489
	Annual Power Consumption	kWhr/yr							649,793	671,867	694,680	718,257	742,622	767,802	793,824	820,714	848,502	877,216	906,888	937,548	969,228	1,001,962	1,035,785	1,070,731	1,106,838	1,144,142	1,182,684
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							110,465	114,217	118,096	122,104	126,246	130,526	134,950	139,521	144,245	149,127	154,171	159,383	164,769	170,334	176,083	182,024	188,162	194,504	201,056
	Labour Cost	$/yr in 2016$							169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711
	Repair & Rehabilitation (2% Capital Cos	$/yr in 2016$							203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268	203,268
	H2S Reduction	$/yr in 2016$							629,400	650,781	672,878	695,715	719,316	743,706	768,910	794,957	821,872	849,686	878,426	908,124	938,810	970,517	1,003,278	1,037,127	1,072,101	1,108,234	1,145,566
	Total		**22,887,374**	**0**	**0**	**0**	**0**	**0**	**1,112,844**	**1,137,978**	**1,163,953**	**1,190,798**	**1,218,541**	**1,247,211**	**1,276,840**	**1,307,457**	**1,339,097**	**1,371,792**	**1,405,576**	**1,440,486**	**1,476,558**	**1,513,830**	**1,552,341**	**1,592,131**	**1,633,242**	**1,675,718**	**1,719,602**
Aldersyde LS	Population	capita							2,478	2,631	2,785	2,938	3,091	3,244	3,397	3,550	3,704	3,857	4,010	4,163	4,316	4,470	4,623	4,776	4,929	5,082	5,236
	Per Capital Flow	l/c/d							390	388	387	386	384	383	381	380	378	377	375	374	373	371	370	368	367	365	364
	ADD	m3/d							966	1,022	1,078	1,133	1,187	1,241	1,295	1,348	1,401	1,454	1,506	1,557	1,608	1,659	1,709	1,759	1,808	1,857	1,905
	Maximum Design Flow	m3/d							8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352
	Horsepower of Duty Pumps	hp							115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
	Hours Pumping at Maximum Power	hrs							1,013	1,072	1,130	1,188	1,245	1,302	1,358	1,414	1,470	1,525	1,579	1,633	1,687	1,740	1,792	1,845	1,896	1,947	1,998
	Annual Power Consumption	kWhr/yr							69,551	73,577	77,571	81,534	85,464	89,362	93,229	97,064	100,867	104,638	108,377	112,084	115,760	119,404	123,015	126,595	130,143	133,660	137,144
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							11,824	12,508	13,187	13,861	14,529	15,192	15,849	16,501	17,147	17,788	18,424	19,054	19,679	20,299	20,913	21,521	22,124	22,722	23,314
	Labour Cost	$/yr in 2016$							45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091	103,091
	H2S Reduction	$/yr in 2016$							88,165	93,269	98,332	103,354	108,337	113,278	118,180	123,041	127,862	132,642	137,382	142,082	146,741	151,360	155,938	160,476	164,974	169,431	173,848
	Total		**5,268,005**	**0**	**0**	**0**	**0**	**0**	**248,336**	**254,124**	**259,866**	**265,562**	**271,212**	**276,817**	**282,376**	**287,889**	**293,356**	**298,778**	**304,153**	**309,483**	**314,767**	**320,005**	**325,198**	**330,344**	**335,445**	**340,500**	**345,509**
Okotoks LS - supplemental	Population	capita							8,901	10,172	11,444	12,715	13,987	15,258	16,530	17,801	19,073	20,344	21,616	22,887	24,159	25,430	26,702	27,973	29,245	30,516	31,788
	Per Capital Flow	l/c/d							226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226
	ADD	m3/d							2,008	2,295	2,582	2,869	3,156	3,443	3,730	4,017	4,304	4,591	4,878	5,165	5,452	5,738	6,025	6,312	6,599	6,886	7,173
	Maximum Design Flow	m3/d							31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032	31,032
	Horsepower of Duty Pumps	hp							419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419	419
	Hours Pumping at Maximum Power	hrs							567	648	729	810	891	972	1,053	1,134	1,215	1,296	1,377	1,458	1,539	1,620	1,701	1,782	1,863	1,944	2,025
	Annual Power Consumption	kWhr/yr							141,775	162,028	182,282	202,535	222,789	243,042	263,296	283,549	303,803	324,056	344,310	364,563	384,817	405,071	425,324	445,578	465,831	486,085	506,338
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							24,102	27,545	30,988	34,431	37,874	41,317	44,760	48,203	51,646	55,090	58,533	61,976	65,419	68,862	72,305	75,748	79,191	82,634	86,077
	Labour Cost	$/yr in 2016$							169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472
	H2S Reduction	$/yr in 2016$							183,271	209,453	235,634	261,816	287,998	314,179	340,361	366,543	392,724	418,906	445,087	471,269	497,451	523,632	549,814	575,995	602,177	628,359	654,540
	Total		**15,311,662**	**0**	**0**	**0**	**0**	**0**	**519,556**	**549,181**	**578,806**	**608,430**	**638,055**	**667,680**	**697,304**	**726,929**	**756,554**	**786,179**	**815,803**	**845,428**	**875,053**	**904,677**	**934,302**	**963,927**	**993,552**	**1,023,176**	**1,052,801**
M.D. Central District LS	Population	capita							4,909	5,610	6,312	7,013	7,714	8,416	9,117	9,818	10,519	11,221	11,922	12,623	13,325	14,026	14,727	15,429	16,130	16,831	17,532
	Per Capital Flow	l/c/d							400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
	ADD	m3/d							1,964	2,244	2,525	2,805	3,086	3,366	3,647	3,927	4,208	4,488	4,769	5,049	5,330	5,610	5,891	6,171	6,452	6,732	7,013
	Maximum Design Flow	m3/d							31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584
	Horsepower of Duty Pumps	hp							293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293
	Hours Pumping at Maximum Power	hrs							545	622	700	778	856	934	1,011	1,089	1,167	1,245	1,323	1,400	1,478	1,556	1,634	1,712	1,789	1,867	1,945
	Annual Power Consumption	kWhr/yr							95,234	108,839	122,444	136,049	149,654	163,259	176,864	190,468	204,073	217,678	231,283	244,888	258,493	272,098	285,703	299,308	312,912	326,517	340,122
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							16,190	18,503	20,815	23,128	25,441	27,754	30,067	32,380	34,692	37,005	39,318	41,631	43,944	46,257	48,569	50,882	53,195	55,508	57,821
	Labour Cost	$/yr in 2016$							169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472
	H2S Reduction	$/yr in 2016$							179,181	204,779	230,376	255,973	281,570	307,168	332,765	358,362	383,960	409,557	435,154	460,752	486,349	511,946	537,544	563,141	588,738	614,336	639,933
	Total		**12,138,254**	**0**	**0**	**0**	**0**	**0**	**507,554**	**535,464**	**563,375**	**591,285**	**619,195**	**647,105**	**675,015**	**702,925**	**730,835**	**758,746**	**786,656**	**814,566**	**842,476**	**870,386**	**898,296**	**926,206**	**954,117**	**982,027**	**1,009,937**
Sub-Regional WWTP Outfall LS	Population	capita																									
	Per Capital Flow	l/c/d																									
	ADD	m3/d							11,836	12,693	13,559	14,431	15,312	16,201	17,098	18,004	18,920	19,844	20,779	21,723	22,678	23,643	24,620	25,608	26,608	27,620	28,645
	Maximum Design Flow	m3/d							75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696	75,696
	Horsepower of Duty Pumps	hp							524	524	524	524	524	524	524	524	524	524	524	524	524	524	524	524	524	524	524
	Hours Pumping at Maximum Power	hrs							1,370	1,469	1,569	1,670	1,772	1,875	1,979	2,084	2,189	2,297	2,405	2,514	2,624	2,736	2,849	2,964	3,079	3,196	3,315
	Annual Power Consumption	kWhr/yr							428,341	459,380	490,688	522,273	554,145	586,314	618,790	651,584	684,706	718,169	751,983	786,161	820,715	855,658	891,003	926,763	962,953	999,588	1,036,681
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							72,818	78,095	83,417	88,786	94,205	99,673	105,194	110,769	116,400	122,089	127,837	133,647	139,522	145,462	151,470	157,550	163,702	169,930	176,236
	Labour Cost	$/yr in 2016$							169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019
	H2S Reduction	$/yr in 2016$							1,080,018	1,158,281	1,237,220	1,316,859	1,397,221	1,478,331	1,560,216	1,642,903	1,726,418	1,810,791	1,896,050	1,982,226	2,069,350	2,157,455	2,246,573	2,336,740	2,427,990	2,520,360	2,613,887
	Total		**39,856,138**	**0**	**0**	**0**	**0**	**0**	**1,427,567**	**1,511,107**	**1,595,368**	**1,680,376**	**1,766,156**	**1,852,735**	**1,940,141**	**2,028,403**	**2,117,549**	**2,207,610**	**2,298,618**	**2,390,604**	**2,483,602**	**2,577,647**	**2,672,774**	**2,769,020**	**2,866,422**	**2,965,020**	**3,064,854**
Pipeline System-Wide Costs	Forcemains Labour, Maintenance & Repair Allowance	$/yr in 2016$							250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
	Total		**3,662,700**	**0**	**0**	**0**	**0**	**0**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**
	GRAND TOTAL		**119,363,531**	**0**	**0**	**0**	**0**	**0**	**5,045,375**	**5,240,041**	**5,436,983**	**5,636,280**	**5,838,012**	**6,042,261**	**6,249,112**	**6,458,656**	**6,670,981**	**6,886,183**	**7,104,358**	**7,325,606**	**7,550,031**	**7,777,739**	**8,008,840**	**8,243,447**	**8,481,677**	**8,723,652**	**8,969,495**

[1] Source: Year 2018 Rates from City of Calgary Bylaw No. 14M2012
[2] Capital Costs not included in this table.

Phase 2 Construction Year [2]	2041 - Start Phase 2 O & M costs (in 2016$)																																			
2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076
36,711	38,106	38,582	39,058	39,534	40,010	40,485	40,961	41,437	41,913	42,388	42,864	43,340	43,816	44,291	44,767	45,243	45,719	46,194	46,670	47,146	47,622	48,097	48,573	49,049	49,525	50,000	50,476	50,952	51,428	51,903	52,379	52,855	53,331	53,806	54,282	54,758
353	352	350	349	347	346	344	342	341	339	338	336	334	333	331	330	328	326	325	323	322	320	318	317	315	314	312	310	309	307	306	304	302	301	299	298	296
12,977	13,413	13,519	13,623	13,726	13,827	13,927	14,025	14,122	14,217	14,310	14,402	14,493	14,582	14,669	14,755	14,840	14,923	15,004	15,084	15,162	15,239	15,314	15,388	15,460	15,531	15,600	15,668	15,734	15,799	15,862	15,923	15,983	16,042	16,099	16,154	16,208
67,065	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040
415	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593	593
1,695	1,450	1,461	1,473	1,484	1,495	1,505	1,516	1,526	1,537	1,547	1,557	1,567	1,576	1,586	1,595	1,604	1,613	1,622	1,630	1,639	1,647	1,655	1,663	1,671	1,679	1,686	1,694	1,701	1,708	1,715	1,721	1,728	1,734	1,740	1,746	1,752
419,811	513,126	517,178	521,164	525,093	528,963	532,775	536,529	540,224	543,861	547,440	550,961	554,423	557,828	561,174	564,461	567,691	570,862	573,975	577,030	580,027	582,965	585,845	588,667	591,431	594,136	596,783	599,372	601,903	604,375	606,789	609,145	611,443	613,682	615,863	617,986	620,051
71,368	87,231	87,920	88,598	89,266	89,924	90,572	91,210	91,838	92,456	93,065	93,663	94,252	94,831	95,400	95,958	96,507	97,047	97,576	98,095	98,605	99,104	99,594	100,073	100,543	101,003	101,453	101,893	102,323	102,744	103,154	103,555	103,945	104,326	104,697	105,058	105,409
169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711
142,472	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231
1,184,135	1,223,965	1,233,629	1,243,138	1,252,509	1,261,740	1,270,833	1,279,787	1,288,601	1,297,277	1,305,814	1,314,212	1,322,471	1,330,592	1,338,573	1,346,415	1,354,119	1,361,683	1,369,109	1,376,395	1,383,543	1,390,552	1,397,422	1,404,153	1,410,745	1,417,198	1,423,512	1,429,687	1,435,724	1,441,621	1,447,380	1,452,999	1,458,480	1,463,822	1,469,025	1,474,089	1,479,014
1,567,686	**1,640,138**	**1,650,491**	**1,660,678**	**1,670,717**	**1,680,606**	**1,690,347**	**1,699,939**	**1,709,382**	**1,718,676**	**1,727,821**	**1,736,818**	**1,745,666**	**1,754,365**	**1,762,915**	**1,771,316**	**1,779,568**	**1,787,672**	**1,795,627**	**1,803,433**	**1,811,090**	**1,818,598**	**1,825,958**	**1,833,168**	**1,840,230**	**1,847,143**	**1,853,907**	**1,860,523**	**1,866,989**	**1,873,307**	**1,879,476**	**1,885,496**	**1,891,368**	**1,897,090**	**1,902,664**	**1,908,088**	**1,913,364**
36,711	38,106	38,582	39,058	39,534	40,010	40,485	40,961	41,437	41,913	42,388	42,864	43,340	43,816	44,291	44,767	45,243	45,719	46,194	46,670	47,146	47,622	48,097	48,573	49,049	49,525	50,000	50,476	50,952	51,428	51,903	52,379	52,855	53,331	53,806	54,282	54,758
353	352	350	349	347	346	344	342	341	339	338	336	334	333	331	330	328	326	325	323	322	320	318	317	315	314	312	310	309	307	306	304	302	301	299	298	296
12,977	13,413	13,519	13,623	13,726	13,827	13,927	14,025	14,122	14,217	14,310	14,402	14,493	14,582	14,669	14,755	14,840	14,923	15,004	15,084	15,162	15,239	15,314	15,388	15,460	15,531	15,600	15,668	15,734	15,799	15,862	15,923	15,983	16,042	16,099	16,154	16,208
31,521	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089
568	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793
3,606	3,085	3,109	3,133	3,157	3,180	3,203	3,226	3,248	3,270	3,291	3,312	3,333	3,354	3,374	3,394	3,413	3,432	3,451	3,469	3,487	3,505	3,522	3,539	3,556	3,572	3,588	3,603	3,619	3,633	3,648	3,662	3,676	3,689	3,703	3,715	3,728
1,222,502	1,459,965	1,471,493	1,482,836	1,494,013	1,505,025	1,515,871	1,526,551	1,537,065	1,547,414	1,557,597	1,567,614	1,577,466	1,587,152	1,596,672	1,606,026	1,615,215	1,624,238	1,633,096	1,641,787	1,650,313	1,658,673	1,666,868	1,674,897	1,682,760	1,690,457	1,697,989	1,705,355	1,712,555	1,719,590	1,726,459	1,733,162	1,739,699	1,746,071	1,752,277	1,758,317	1,764,192
207,825	248,194	250,154	252,082	253,982	255,854	257,698	259,514	261,301	263,060	264,791	266,494	268,169	269,816	271,434	273,024	274,587	276,120	277,626	279,104	280,553	281,974	283,368	284,732	286,069	287,378	288,658	289,910	291,134	292,330	293,498	294,637	295,749	296,832	297,887	298,914	299,913
169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711
203,268	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002	213,002
1,184,135	1,223,965	1,233,629	1,243,138	1,252,509	1,261,740	1,270,833	1,279,787	1,288,601	1,297,277	1,305,814	1,314,212	1,322,471	1,330,592	1,338,573	1,346,415	1,354,119	1,361,683	1,369,109	1,376,395	1,383,543	1,390,552	1,397,422	1,404,153	1,410,745	1,417,198	1,423,512	1,429,687	1,435,724	1,441,621	1,447,380	1,452,999	1,458,480	1,463,822	1,469,025	1,474,089	1,479,014
1,764,939	**1,854,873**	**1,866,496**	**1,877,934**	**1,889,205**	**1,900,308**	**1,911,245**	**1,922,014**	**1,932,616**	**1,943,051**	**1,953,319**	**1,963,420**	**1,973,354**	**1,983,121**	**1,992,721**	**2,002,153**	**2,011,419**	**2,020,517**	**2,029,449**	**2,038,213**	**2,046,810**	**2,055,240**	**2,063,503**	**2,071,599**	**2,079,528**	**2,087,289**	**2,094,884**	**2,102,311**	**2,109,572**	**2,116,665**	**2,123,591**	**2,130,351**	**2,136,943**	**2,143,368**	**2,149,625**	**2,155,716**	**2,161,640**
5,389	5,542	5,721	5,900	6,078	6,257	6,436	6,615	6,794	6,972	7,151	7,330	7,509	7,688	7,866	8,045	8,224	8,403	8,582	8,760	8,939	9,118	9,297	9,476	9,654	9,833	10,012	10,191	10,370	10,548	10,727	10,906	11,085	11,264	11,442	11,621	11,800
362	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361	361
1,953	2,001	2,065	2,130	2,194	2,259	2,323	2,388	2,452	2,517	2,582	2,646	2,711	2,775	2,840	2,904	2,969	3,033	3,098	3,163	3,227	3,292	3,356	3,421	3,485	3,550	3,614	3,679	3,743	3,808	3,873	3,937	4,002	4,066	4,131	4,195	4,260
8,352	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760
115	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285
2,049	987	1,019	1,050	1,082	1,114	1,146	1,178	1,210	1,242	1,273	1,305	1,337	1,369	1,401	1,433	1,464	1,496	1,528	1,560	1,592	1,624	1,655	1,687	1,719	1,751	1,783	1,815	1,846	1,878	1,910	1,942	1,974	2,006	2,037	2,069	2,101
140,596	167,845	173,260	178,675	184,090	189,506	194,921	200,336	205,751	211,166	216,581	221,996	227,412	232,827	238,242	243,657	249,072	254,487	259,902	265,318	270,733	276,148	281,563	286,978	292,393	297,808	303,224	308,639	314,054	319,469	324,884	330,299	335,714	341,129	346,545	351,960	357,375
23,901	28,534	29,454	30,375	31,295	32,216	33,137	34,057	34,978	35,898	36,819	37,739	38,660	39,581	40,501	41,422	42,342	43,263	44,183	45,104	46,025	46,945	47,866	48,786	49,707	50,627	51,548	52,469	53,389	54,310	55,230	56,151	57,071	57,992	58,913	59,833	60,754
45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256
103,091	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004	153,004
178,224	182,560	188,450	194,340	200,230	206,120	212,010	217,900	223,790	229,680	235,569	241,459	247,349	253,239	259,129	265,019	270,909	276,799	282,689	288,579	294,468	300,358	306,248	312,138	318,028	323,918	329,808	335,698	341,588	347,477	353,367	359,257	365,147	371,037	376,927	382,817	388,707
350,473	**409,354**	**416,165**	**422,975**	**429,786**	**436,596**	**443,407**	**450,217**	**457,028**	**463,838**	**470,648**	**477,459**	**484,269**	**491,080**	**497,890**	**504,701**	**511,511**	**518,322**	**525,132**	**531,943**	**538,753**	**545,564**	**552,374**	**559,185**	**565,995**	**572,806**	**579,616**	**586,426**	**593,237**	**600,047**	**606,858**	**613,668**	**620,479**	**627,289**	**634,100**	**640,910**	**647,721**
33,059	34,331	35,603	36,874	38,146	39,417	40,689	41,960	43,232	44,503	45,775	47,046	48,318	49,589	50,861	52,132	53,404	54,675	55,947	57,218	58,490	59,761	61,033	62,304	63,576	64,847	66,119	67,390	68,662	69,933	71,205	72,476	73,748	75,019	76,291	77,562	78,833
226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226
7,460	7,747	8,034	8,321	8,608	8,895	9,182	9,469	9,755	10,042	10,329	10,616	10,903	11,190	11,477	11,764	12,051	12,338	12,625	12,912	13,199	13,485	13,772	14,059	14,346	14,633	14,920	15,207	15,494	15,781	16,068	16,355	16,642	16,928	17,215	17,502	17,787
31,032	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424	71,424
419	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965	965
2,106	950	985	1,021	1,056	1,091	1,126	1,161	1,196	1,232	1,267	1,302	1,337	1,372	1,408	1,443	1,478	1,513	1,548	1,584	1,619	1,654	1,689	1,724	1,760	1,795	1,830	1,865	1,900	1,935	1,971	2,006	2,041	2,076	2,111	2,147	2,182
526,592	547,204	567,471	587,738	608,004	628,271	648,537	668,804	689,070	709,337	729,603	749,870	770,136	790,403	810,669	830,936	851,202	871,469	891,736	912,002	932,269	952,535	972,802	993,068	1,013,335	1,033,601	1,053,868	1,074,134	1,094,401	1,114,667	1,134,934	1,155,201	1,175,467	1,195,734	1,216,000	1,236,267	1,256,374
89,521	93,025	96,470	99,915	103,361	106,806	110,251	113,697	117,142	120,587	124,033	127,478	130,923	134,368	137,814	141,259	144,704	148,150	151,595	155,040	158,486	161,931	165,376	168,822	172,267	175,712	179,158	182,603	186,048	189,493	192,939	196,384	199,829	203,275	206,720	210,165	213,583
169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711
142,472	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871	287,871
680,722	706,914	733,095	759,277	785,459	811,640	837,822	864,003	890,185	916,367	942,548	968,730	994,911	1,021,093	1,047,275	1,073,456	1,099,638	1,125,820	1,152,001	1,178,183	1,204,364	1,230,546	1,256,728	1,282,909	1,309,091	1,335,272	1,361,454	1,387,636	1,413,817	1,439,999	1,466,180	1,492,362	1,518,544	1,544,725	1,570,907	1,597,088	1,623,064
1,082,426	**1,257,521**	**1,287,148**	**1,316,775**	**1,346,402**	**1,376,029**	**1,405,656**	**1,435,283**	**1,464,910**	**1,494,536**	**1,524,163**	**1,553,790**	**1,583,417**	**1,613,044**	**1,642,671**	**1,672,298**	**1,701,925**	**1,731,552**	**1,761,179**	**1,790,806**	**1,820,433**	**1,850,060**	**1,879,686**	**1,909,313**	**1,938,940**	**1,968,567**	**1,998,194**	**2,027,821**	**2,057,448**	**2,087,075**	**2,116,702**	**2,146,329**	**2,175,956**	**2,205,583**	**2,235,209**	**2,264,836**	**2,294,230**
18,234	18,935	18,978	19,020	19,063	19,105	19,148	19,190	19,233	19,276	19,318	19,361	19,403	19,446	19,488	19,531	19,574	19,616	19,659	19,701	19,744	19,786	19,829	19,872	19,914	19,957	19,999	20,042	20,084	20,127	20,170	20,212	20,255	20,297	20,340	20,382	20,425
400	400	399	398	398	397	396	395	394	393	393	392	391	390	389	388	388	387	386	385	384	383	383	382	381	380	379	378	378	377	376	375	374	373	373	372	371
7,293	7,574	7,575	7,577	7,578	7,579	7,580	7,581	7,582	7,582	7,583	7,584	7,584	7,585	7,585	7,586	7,586	7,586	7,587	7,587	7,587	7,587	7,587	7,586	7,586	7,586	7,585	7,585	7,584	7,584	7,583	7,582	7,582	7,581	7,580	7,579	7,574
31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584
293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293	293
2,023	2,101	2,101	2,101	2,102	2,102	2,102	2,103	2,103	2,103	2,103	2,103	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,103	2,103	2,103	2,103	2,103	2,102	2,102	2,101
353,727	367,332	367,395	367,455	367,511	367,564	367,614	367,660	367,703	367,742	367,778	367,811	367,840	367,865	367,887	367,906	367,922	367,933	367,942	367,947	367,949	367,947	367,942	367,933	367,921	367,906	367,887	367,865	367,839	367,810	367,777	367,741	367,702	367,659	367,613	367,563	367,332
60,134	62,446	62,457	62,467	62,477	62,486	62,494	62,502	62,509	62,516	62,522	62,528	62,533	62,537	62,541	62,544	62,547	62,549	62,550	62,551	62,551	62,551	62,550	62,549	62,547	62,544	62,541	62,537	62,533	62,528	62,522	62,516	62,509	62,502	62,494	62,486	62,446
169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711
142,472	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019	105,019
665,530	691,128	691,247	691,359	691,465	691,565	691,658	691,745	691,825	691,899	691,967	692,028	692,083	692,131	692,173	692,208	692,237	692,259	692,275	692,285	692,288	692,285	692,275	692,259	692,236	692,207	692,172	692,130	692,081	692,027	691,965	691,898	691,824	691,743	691,656	691,563	691,128
1,037,847	**1,028,305**	**1,028,434**	**1,028,557**	**1,028,673**	**1,028,782**	**1,028,883**	**1,028,978**	**1,029,066**	**1,029,146**	**1,029,220**	**1,029,286**	**1,029,346**	**1,029,399**	**1,029,444**	**1,029,483**	**1,029,514**	**1,029,539**	**1,029,556**	**1,029,567**	**1,029,570**	**1,029,566**	**1,029,556**	**1,029,538**	**1,029,513**	**1,029,482**	**1,029,443**	**1,029,397**	**1,029,345**	**1,029,285**	**1,029,218**	**1,029,144**	**1,029,064**	**1,028,976**	**1,028,881**	**1,028,779**	**1,028,305**
29,683	30,735	31,194	31,651	32,106	32,560	33,012	33,462	33,911	34,359	34,804	35,249	35,691	36,132	36,571	37,009	37,446	37,880	38,313	38,745	39,174	39,603	40,029	40,454	40,878	41,300	41,720	42,139	42,556	42,971	43,385	43,797	44,208	44,617	45,025	45,431	45,829
75,696	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800
524	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861	861
3,435	2,210	2,243	2,276	2,309	2,342	2,374	2,407	2,439	2,471	2,503	2,535	2,567	2,599	2,630	2,662	2,693	2,724	2,756	2,787	2,817	2,848	2,879	2,910	2,940	2,970	3,001	3,031	3,061	3,091	3,120	3,150	3,180	3,209	3,238	3,267	3,296
1,074,249	1,135,852	1,152,803	1,169,689	1,186,516	1,203,284	1,219,993	1,236,644	1,253,235	1,269,768	1,286,242	1,302,657	1,319,013	1,335,310	1,351,548	1,367,728	1,383,848	1,399,910	1,415,913	1,431,857	1,447,742	1,463,568	1,479,335	1,495,044	1,510,694	1,526,284	1,541,816	1,557,289	1,572,703	1,588,059	1,603,355	1,618,592	1,633,771	1,648,891	1,663,952	1,678,954	1,693,678
182,622	193,095	195,976	198,847	201,708	204,558	207,399	210,229	213,050	215,861	218,661	221,452	224,232	227,003	229,763	232,514	235,254	237,985	240,705	243,416	246,116	248,807	251,487	254,157	256,818	259,468	262,109	264,739	267,360	269,970	272,570	275,161	277,741	280,311	282,872	285,422	287,925
169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711	169,711
105,019	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364	205,364
2,708,611	2,804,566	2,846,421	2,888,115	2,929,663	2,971,065	3,012,323	3,053,435	3,094,402	3,135,223	3,175,899	3,216,429	3,256,815	3,297,055	3,337,149	3,377,098	3,416,902	3,456,561	3,496,074	3,535,441	3,574,664	3,613,741	3,652,673	3,691,459	3,730,100	3,768,595	3,806,946	3,845,151	3,883,210	3,921,124	3,958,893	3,996,516	4,033,995	4,071,327	4,108,515	4,145,557	4,181,912
3,165,964	**3,372,736**	**3,417,473**	**3,462,037**	**3,506,445**	**3,550,699**	**3,594,797**	**3,638,739**	**3,682,527**	**3,726,159**	**3,769,635**	**3,812,956**	**3,856,122**	**3,899,132**	**3,941,987**	**3,984,687**	**4,027,231**	**4,069,620**	**4,111,854**	**4,153,932**	**4,195,855**	**4,237,623**	**4,279,235**	**4,320,691**	**4,361,993**	**4,403,139**	**4,444,129**	**4,484,965**	**4,525,645**	**4,566,169**	**4,606,538**	**4,646,752**	**4,686,811**	**4,726,714**	**4,766,462**	**4,806,054**	**4,844,912**
250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
250,000	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**	**250,000**
9,219,335	**9,812,927**	**9,916,207**	**10,018,956**	**10,121,227**	**10,223,020**	**10,324,334**	**10,425,170**	**10,525,527**	**10,625,406**	**10,724,807**	**10,823,730**	**10,922,174**	**11,020,141**	**11,117,628**	**11,214,638**	**11,311,169**	**11,407,222**	**11,502,796**	**11,597,893**	**11,692,511**	**11,786,650**	**11,880,312**	**11,973,495**	**12,066,199**	**12,158,426**	**12,250,174**	**12,341,444**	**12,432,236**	**12,522,549**	**12,612,384**	**12,701,741**	**12,790,619**	**12,879,019**	**12,966,941**	**13,054,384**	**13,140,171**

APPENDIX C: Pipeline and Lift Station Operation and Maintenance Costs - Option 4

Foothills Regional Water & Wastewater Collaborative Wastewater Study

Prepared by MPE Engineering Ltd.
March 10, 2016

City of Calgary Fees Fixed Component [1]	$	0.4230
City of Calgary Fees Volume Component [1]	$	0.5340
Labour Costs - Pump Stations > 20 MLD	$	170,000
Labour Costs - Pump Stations < 20 MLD	$	45,000
Cost of Power $/kWhr	$	0.17

	2%	Capital Cost for Repair & Rehabilitation Allowance
$	0.25	/m3 ADD, H2S Reduction Chemical Cost
	5%	Net Present Value Discount Rate

Phase 1 Construction Year [2] — 2020; 2021 - Start Phase 1 O & M costs (in 2016$)

	Parameter	Units	NPV 2016 to 2076	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
High River LS2	Population	capita							18,074	18,761	19,474	20,214	20,982	21,779	22,607	23,466	24,357	25,283	26,244	27,241	28,276	29,351	30,466	31,624	32,825	34,073	35,367
	Per Capital Flow	l/c/d							382	380	379	377	376	374	373	371	370	368	367	365	364	362	361	359	358	356	355
	ADD	m3/d							6,898	7,132	7,374	7,624	7,883	8,150	8,426	8,712	9,007	9,312	9,627	9,952	10,288	10,636	10,995	11,366	11,749	12,145	12,554
	Maximum Design Flow	m3/d							67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065	67,065
	Horsepower of Duty Pumps	hp							415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415
	Hours Pumping at Maximum Power	hrs							901	932	963	996	1,030	1,065	1,101	1,138	1,176	1,216	1,257	1,300	1,344	1,389	1,436	1,485	1,535	1,586	1,640
	Annual Power Consumption	kWhr/yr							223,141	230,721	238,555	246,651	255,019	263,666	272,601	281,836	291,378	301,239	311,428	321,956	332,836	344,077	355,691	367,692	380,091	392,902	406,137
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							37,934	39,223	40,554	41,931	43,353	44,823	46,342	47,912	49,534	51,211	52,943	54,733	56,582	58,493	60,468	62,508	64,616	66,793	69,043
	Labour Cost	$/yr in 2016$							170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472	142,472
	H2S Reduction	$/yr in 2016$							629,400	650,781	672,878	695,715	719,316	743,706	768,910	794,957	821,872	849,686	878,426	908,124	938,810	970,517	1,003,278	1,037,127	1,072,101	1,108,234	1,145,566
	Total		**20,243,629**	**0**	**0**	**0**	**0**	**0**	**979,806**	**1,002,476**	**1,025,905**	**1,050,118**	**1,075,141**	**1,101,001**	**1,127,725**	**1,155,341**	**1,183,879**	**1,213,368**	**1,243,841**	**1,275,328**	**1,307,864**	**1,341,482**	**1,376,217**	**1,412,107**	**1,449,188**	**1,487,500**	**1,527,081**
High River Lagoon LS	Population	capita							18,074	18,761	19,474	20,214	20,982	21,779	22,607	23,466	24,357	25,283	26,244	27,241	28,276	29,351	30,466	31,624	32,825	34,073	35,367
	Per Capital Flow	l/c/d							382	380	379	377	376	374	373	371	370	368	367	365	364	362	361	359	358	356	355
	ADD	m3/d							6,898	7,132	7,374	7,624	7,883	8,150	8,426	8,712	9,007	9,312	9,627	9,952	10,288	10,636	10,995	11,366	11,749	12,145	12,554
	Maximum Design Flow	m3/d							31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521	31,521
	Horsepower of Duty Pumps	hp							577	577	577	577	577	577	577	577	577	577	577	577	577	577	577	577	577	577	577
	Hours Pumping at Maximum Power	hrs							1,917	1,982	2,049	2,119	2,191	2,265	2,342	2,421	2,503	2,588	2,675	2,766	2,859	2,956	3,056	3,159	3,265	3,375	3,489
	Annual Power Consumption	kWhr/yr							660,089	682,513	705,688	729,638	754,389	779,968	806,402	833,718	861,946	891,116	921,258	952,403	984,586	1,017,839	1,052,197	1,087,697	1,124,376	1,162,271	1,201,423
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							112,215	116,027	119,967	124,038	128,246	132,595	137,088	141,732	146,531	151,490	156,614	161,909	167,380	173,033	178,874	184,909	191,144	197,586	204,242
	Labour Cost	$/yr in 2016$							170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036	172,036
	H2S Reduction	$/yr in 2016$							629,400	650,781	672,878	695,715	719,316	743,706	768,910	794,957	821,872	849,686	878,426	908,124	938,810	970,517	1,003,278	1,037,127	1,072,101	1,108,234	1,145,566
	Total		**22,585,905**	**0**	**0**	**0**	**0**	**0**	**1,083,652**	**1,108,845**	**1,134,882**	**1,161,790**	**1,189,598**	**1,218,337**	**1,248,035**	**1,278,725**	**1,310,440**	**1,343,212**	**1,377,076**	**1,412,068**	**1,448,226**	**1,485,586**	**1,524,188**	**1,564,072**	**1,605,281**	**1,647,857**	**1,691,844**
Aldersyde LS	Population	capita							2,478	2,631	2,785	2,938	3,091	3,244	3,397	3,550	3,704	3,857	4,010	4,163	4,316	4,470	4,623	4,776	4,929	5,082	5,236
	Per Capital Flow	l/c/d							390	388	387	386	384	383	381	380	378	377	375	374	373	371	370	368	367	365	364
	ADD	m3/d							966	1,022	1,078	1,133	1,187	1,241	1,295	1,348	1,401	1,454	1,506	1,557	1,608	1,659	1,709	1,759	1,808	1,857	1,905
	Maximum Design Flow	m3/d							8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352	8,352
	Horsepower of Duty Pumps	hp							120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
	Hours Pumping at Maximum Power	hrs							1,013	1,072	1,130	1,188	1,245	1,302	1,358	1,414	1,470	1,525	1,579	1,633	1,687	1,740	1,792	1,845	1,896	1,947	1,998
	Annual Power Consumption	kWhr/yr							72,575	76,776	80,944	85,078	89,180	93,248	97,282	101,284	105,252	109,187	113,089	116,958	120,793	124,595	128,364	132,099	135,802	139,471	143,107
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							12,338	13,052	13,760	14,463	15,161	15,852	16,538	17,218	17,893	18,562	19,225	19,883	20,535	21,181	21,822	22,457	23,086	23,710	24,328
	Labour Cost	$/yr in 2016$							45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357	98,357
	H2S Reduction	$/yr in 2016$							88,165	93,269	98,332	103,354	108,337	113,278	118,180	123,041	127,862	132,642	137,382	142,082	146,741	151,360	155,938	160,476	164,974	169,431	173,848
	Total		**5,147,478**	**0**	**0**	**0**	**0**	**0**	**244,116**	**249,934**	**255,705**	**261,431**	**267,110**	**272,744**	**278,331**	**283,873**	**289,368**	**294,817**	**300,220**	**305,578**	**310,889**	**316,154**	**321,373**	**326,546**	**331,673**	**336,754**	**341,789**
Okotoks LS - supplemental	Population	capita							21,254	24,290	27,326	30,362	33,399	36,435	39,471	42,507	45,544	48,580	51,616	54,652	57,689	60,725	63,761	66,797	69,834	72,870	75,906
	Per Capital Flow	l/c/d							226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226	226
	ADD	m3/d							4,796	5,481	6,166	6,851	7,537	8,222	8,907	9,592	10,277	10,962	11,648	12,333	13,018	13,703	14,388	15,073	15,758	16,444	17,129
	Maximum Design Flow	m3/d							36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819	36,819
	Horsepower of Duty Pumps	hp							539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539	539
	Hours Pumping at Maximum Power	hrs							1,141	1,304	1,467	1,630	1,793	1,956	2,119	2,282	2,445	2,608	2,771	2,934	3,097	3,260	3,423	3,586	3,749	3,912	4,075
	Annual Power Consumption	kWhr/yr							367,058	419,495	471,932	524,369	576,806	629,243	681,679	734,116	786,553	838,990	891,427	943,864	996,301	1,048,738	1,101,175	1,153,611	1,206,048	1,258,485	1,310,922
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							62,400	71,314	80,228	89,143	98,057	106,971	115,886	124,800	133,714	142,628	151,543	160,457	169,371	178,285	187,200	196,114	205,028	213,942	222,857
	Labour Cost	$/yr in 2016$							170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839	176,839
	H2S Reduction	$/yr in 2016$							437,638	500,158	562,678	625,198	687,717	750,237	812,757	875,277	937,797	1,000,316	1,062,836	1,125,356	1,187,876	1,250,395	1,312,915	1,375,435	1,437,955	1,500,474	1,562,994
	Total		**26,333,824**	**0**	**0**	**0**	**0**	**0**	**846,877**	**918,311**	**989,745**	**1,061,180**	**1,132,614**	**1,204,048**	**1,275,482**	**1,346,916**	**1,418,350**	**1,489,784**	**1,561,218**	**1,632,652**	**1,704,086**	**1,775,520**	**1,846,954**	**1,918,388**	**1,989,822**	**2,061,256**	**2,132,690**
M.D. Central District LS	Population	capita							4,909	5,610	6,312	7,013	7,714	8,416	9,117	9,818	10,519	11,221	11,922	12,623	13,325	14,026	14,727	15,429	16,130	16,831	17,532
	Per Capital Flow	l/c/d							400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
	ADD	m3/d							1,964	2,244	2,525	2,805	3,086	3,366	3,647	3,927	4,208	4,488	4,769	5,049	5,330	5,610	5,891	6,171	6,452	6,732	7,013
	Maximum Design Flow	m3/d							31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584
	Horsepower of Duty Pumps	hp							151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151
	Hours Pumping at Maximum Power	hrs							545	622	700	778	856	934	1,011	1,089	1,167	1,245	1,323	1,400	1,478	1,556	1,634	1,712	1,789	1,867	1,945
	Annual Power Consumption	kWhr/yr							49,080	56,091	63,103	70,114	77,125	84,137	91,148	98,159	105,171	112,182	119,194	126,205	133,216	140,228	147,239	154,251	161,262	168,273	175,285
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							8,344	9,535	10,727	11,919	13,111	14,303	15,495	16,687	17,879	19,071	20,263	21,455	22,647	23,839	25,031	26,223	27,415	28,606	29,798
	Labour Cost	$/yr in 2016$							170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118	63,118
	H2S Reduction	$/yr in 2016$							179,181	204,779	230,376	255,973	281,570	307,168	332,765	358,362	383,960	409,557	435,154	460,752	486,349	511,946	537,544	563,141	588,738	614,336	639,933
	Total		**10,895,802**	**0**	**0**	**0**	**0**	**0**	**420,642**	**447,432**	**474,221**	**501,010**	**527,799**	**554,589**	**581,378**	**608,167**	**634,957**	**661,746**	**688,535**	**715,324**	**742,114**	**768,903**	**795,692**	**822,481**	**849,271**	**876,060**	**902,849**
Highway 2 LS	Population	capita							41,806	45,682	49,584	53,514	57,471	61,458	65,475	69,524	73,605	77,720	81,870	86,057	90,281	94,545	98,850	103,197	107,588	112,025	116,509
	Per Capital Flow	l/c/d							997	994	991	988	985	983	980	977	974	971	968	965	962	959	956	953	950	947	945
	ADD	m3/d							12,660	13,635	14,618	15,608	16,607	17,613	18,628	19,652	20,685	21,728	22,780	23,842	24,914	25,997	27,092	28,198	29,315	30,445	31,588
	Maximum Design Flow	m3/d							76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692	76,692
	Horsepower of Duty Pumps	hp							1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403	1,403
	Hours Pumping at Maximum Power	hrs							1,446	1,557	1,670	1,783	1,897	2,012	2,128	2,245	2,363	2,482	2,602	2,723	2,846	2,970	3,095	3,221	3,349	3,478	3,608
	Annual Power Consumption	kWhr/yr							1,210,787	1,304,073	1,398,068	1,492,796	1,588,282	1,684,553	1,781,636	1,879,558	1,978,349	2,078,039	2,178,658	2,280,238	2,382,812	2,486,414	2,591,078	2,696,840	2,803,738	2,911,810	3,021,095
	Annual Power Cost per Year in 2016 Dollars	$/yr in 2016$							205,834	221,692	237,672	253,775	270,008	286,374	302,878	319,525	336,319	353,267	370,372	387,640	405,078	422,690	440,483	458,463	476,635	495,008	513,586
	Labour Cost	$/yr in 2016$							170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
	Repair & Rehabilitation (2% Capital Cost)	$/yr in 2016$							251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119	251,119
	H2S Reduction	$/yr in 2016$							1,155,204	1,244,208	1,333,888	1,424,267	1,515,370	1,607,221	1,699,847	1,793,275	1,887,531	1,982,644	2,078,644	2,175,561	2,273,426	2,372,272	2,472,131	2,573,038	2,675,029	2,778,140	2,882,408
	Total		**49,372,664**	**0**	**0**	**0**	**0**	**0**	**1,782,157**	**1,887,019**	**1,992,679**	**2,099,161**	**2,206,497**	**2,314,714**	**2,423,844**	**2,533,918**	**2,644,969**	**2,757,030**	**2,870,135**	**2,984,321**	**3,099,623**	**3,216,081**	**3,333,733**	**3,452,620**	**3,572,784**	**3,694,266**	**3,817,113**
Pipeline System-Wide Costs	City of Calgary Fees - Fixed Component	$/yr in 2016$							6,186	6,717	7,251	7,789	3,040,423	3,239,146	3,439,180	3,640,570	3,843,362	4,047,604	4,253,347	4,460,641	4,669,540	4,880,097	5,092,369	5,306,415	5,522,294	5,740,068	5,959,801
	City of Calgary Fees - Volume Component	$/yr in 2016$							7,809	8,480	9,154	9,833	3,838,265	4,089,135	4,341,660	4,595,897	4,851,904	5,109,742	5,369,473	5,631,164	5,894,880	6,160,690	6,428,665	6,698,879	6,971,407	7,246,327	7,523,721
	Forcemains Labour, Maintenance & Repair Allowance	$/yr in 2016$							250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
	Total		**150,622,525**	**0**	**0**	**0**	**0**	**0**	**263,995**	**265,196**	**266,405**	**267,622**	**7,128,688**	**7,578,282**	**8,030,841**	**8,486,467**	**8,945,265**	**9,407,346**	**9,872,820**	**10,341,805**	**10,814,419**	**11,290,787**	**11,771,034**	**12,255,294**	**12,743,701**	**13,236,396**	**13,733,522**
TOTAL Lift Stations	**GRAND TOTAL**		**285,201,827**	**0**	**0**	**0**	**0**	**0**	**5,621,245**	**5,879,214**	**6,139,542**	**6,402,312**	**13,527,448**	**14,243,714**	**14,965,636**	**15,693,407**	**16,427,227**	**17,167,302**	**17,913,845**	**18,667,076**	**19,427,220**	**20,194,512**	**20,969,192**	**21,751,509**	**22,541,720**	**23,340,089**	**24,146,889**

[1] Source: Year 2018 Rates from City of Calgary Bylaw No. 14M2012
[2] Capital Costs not included in this table.

Phase 2 Construction Year [2]	2041 - Start Phase 2 O & M costs (in 2016$)										
2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
36,711	38,106	38,582	39,058	39,534	40,010	40,485	40,961	41,437	41,913	42,388	42,864
353	352	350	349	347	346	344	342	341	339	338	336
12,977	13,413	13,519	13,623	13,726	13,827	13,927	14,025	14,122	14,217	14,310	14,402
67,065	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040
415	593	593	593	593	593	593	593	593	593	593	593
1,695	1,450	1,461	1,473	1,484	1,495	1,505	1,516	1,526	1,537	1,547	1,557
419,811	513,126	517,178	521,164	525,093	528,963	532,775	536,529	540,224	543,861	547,440	550,961
71,368	87,231	87,920	88,598	89,266	89,924	90,572	91,210	91,838	92,456	93,065	93,663
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
142,472	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231
1,184,135	1,223,965	1,233,629	1,243,138	1,252,509	1,261,740	1,270,833	1,279,787	1,288,601	1,297,277	1,305,814	1,314,212
1,567,975	**1,640,427**	**1,650,780**	**1,660,967**	**1,671,006**	**1,680,895**	**1,690,636**	**1,700,227**	**1,709,671**	**1,718,965**	**1,728,110**	**1,737,107**
36,711	38,106	38,582	39,058	39,534	40,010	40,485	40,961	41,437	41,913	42,388	42,864
353	352	350	349	347	346	344	342	341	339	338	336
12,977	13,413	13,519	13,623	13,726	13,827	13,927	14,025	14,122	14,217	14,310	14,402
31,521	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089
577	826	826	826	826	826	826	826	826	826	826	826
3,606	3,085	3,109	3,133	3,157	3,180	3,203	3,226	3,248	3,270	3,291	3,312
1,241,873	1,520,721	1,532,728	1,544,543	1,556,185	1,567,655	1,578,952	1,590,077	1,601,029	1,611,808	1,622,415	1,632,849
211,118	258,522	260,564	262,572	264,551	266,501	268,422	270,313	272,175	274,007	275,811	277,584
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
172,036	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011
1,184,135	1,223,965	1,233,629	1,243,138	1,252,509	1,261,740	1,270,833	1,279,787	1,288,601	1,297,277	1,305,814	1,314,212
1,737,290	**1,849,498**	**1,861,204**	**1,872,722**	**1,884,071**	**1,895,253**	**1,906,266**	**1,917,111**	**1,927,787**	**1,938,296**	**1,948,636**	**1,958,808**
5,389	5,542	5,721	5,900	6,078	6,257	6,436	6,615	6,794	6,972	7,151	7,330
362	361	361	361	361	361	361	361	361	361	361	361
1,953	2,001	2,065	2,130	2,194	2,259	2,323	2,388	2,452	2,517	2,582	2,646
8,352	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760
120	300	300	300	300	300	300	300	300	300	300	300
2,049	987	1,019	1,050	1,082	1,114	1,146	1,178	1,210	1,242	1,273	1,305
146,709	176,679	182,379	188,079	193,779	199,480	205,180	210,880	216,580	222,280	227,980	233,680
24,941	30,035	31,004	31,973	32,943	33,912	34,881	35,850	36,819	37,788	38,757	39,726
45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256
98,357	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214
178,224	182,560	188,450	194,340	200,230	206,120	212,010	217,900	223,790	229,680	235,569	241,459
346,778	**392,066**	**398,925**	**405,784**	**412,643**	**419,502**	**426,360**	**433,219**	**440,078**	**446,937**	**453,796**	**460,655**
78,942	81,979	82,755	83,531	84,308	85,084	85,860	86,636	87,413	88,189	88,965	89,741
226	226	226	226	226	226	226	226	226	226	226	226
17,814	18,499	18,674	18,849	19,025	19,200	19,375	19,550	19,725	19,900	20,076	20,251
36,819	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920
539	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082
4,238	2,192	2,213	2,234	2,255	2,275	2,296	2,317	2,338	2,358	2,379	2,400
1,363,359	1,415,619	1,429,024	1,442,429	1,455,834	1,469,239	1,482,643	1,496,048	1,509,453	1,522,858	1,536,263	1,549,668
231,771	240,655	242,934	245,213	247,492	249,771	252,049	254,328	256,607	258,886	261,165	263,444
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
176,839	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069
1,625,514	1,688,034	1,704,018	1,720,003	1,735,987	1,751,971	1,767,956	1,783,940	1,799,925	1,815,909	1,831,893	1,847,878
2,204,124	**2,340,758**	**2,359,021**	**2,377,284**	**2,395,548**	**2,413,811**	**2,432,074**	**2,450,337**	**2,468,601**	**2,486,864**	**2,505,127**	**2,523,390**
18,234	18,935	18,978	19,020	19,063	19,105	19,148	19,190	19,233	19,276	19,318	19,361
400	400	399	398	398	397	396	395	394	393	393	392
7,293	7,574	7,575	7,577	7,578	7,579	7,580	7,581	7,582	7,582	7,583	7,584
31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584
151	151	151	151	151	151	151	151	151	151	151	151
2,023	2,101	2,101	2,101	2,102	2,102	2,102	2,103	2,103	2,103	2,103	2,103
182,296	189,308	189,340	189,371	189,400	189,427	189,453	189,477	189,499	189,519	189,538	189,554
30,990	32,182	32,188	32,193	32,198	32,203	32,207	32,211	32,215	32,218	32,221	32,224
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
63,118	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135
665,530	691,128	691,247	691,359	691,465	691,565	691,658	691,745	691,825	691,899	691,967	692,028
929,638	**965,445**	**965,569**	**965,687**	**965,798**	**965,903**	**966,000**	**966,091**	**966,175**	**966,253**	**966,323**	**966,387**
121,043	125,627	127,058	128,489	129,920	131,351	132,781	134,212	135,643	137,074	138,505	139,936
942	939	937	935	934	932	931	929	927	926	924	923
32,744	33,913	34,259	34,603	34,945	35,286	35,625	35,963	36,299	36,634	36,967	37,299
76,692	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769
1,403	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069
3,740	2,289	2,313	2,336	2,359	2,382	2,405	2,428	2,450	2,473	2,495	2,518
3,131,635	4,192,999	4,235,732	4,278,256	4,320,591	4,362,738	4,404,697	4,446,468	4,488,050	4,529,444	4,570,650	4,611,668
532,378	712,810	720,074	727,303	734,500	741,665	748,798	755,899	762,969	770,006	777,011	783,984
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
251,119	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121
2,987,873	3,094,559	3,126,097	3,157,481	3,188,726	3,219,832	3,250,799	3,281,627	3,312,316	3,342,866	3,373,277	3,403,549
3,941,370	**4,343,490**	**4,382,293**	**4,420,905**	**4,459,347**	**4,497,618**	**4,535,718**	**4,573,647**	**4,611,405**	**4,648,992**	**4,686,409**	**4,723,654**
6,181,558	6,405,381	6,458,946	6,512,237	6,565,283	6,618,083	6,670,637	6,722,945	6,775,007	6,826,823	6,878,393	6,929,717
7,803,669	8,086,226	8,153,846	8,221,122	8,288,088	8,354,743	8,421,088	8,487,122	8,552,845	8,618,258	8,683,361	8,748,153
250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
14,235,228	**14,741,607**	**14,862,792**	**14,983,360**	**15,103,371**	**15,222,826**	**15,341,724**	**15,460,066**	**15,577,852**	**15,695,081**	**15,811,754**	**15,927,870**
24,962,403	**26,273,291**	**26,480,584**	**26,686,709**	**26,891,784**	**27,095,807**	**27,298,779**	**27,500,699**	**27,701,569**	**27,901,387**	**28,100,154**	**28,297,870**

2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064
43,340	43,816	44,291	44,767	45,243	45,719	46,194	46,670	47,146	47,622	48,097	48,573	49,049
334	333	331	330	328	326	325	323	322	320	318	317	315
14,493	14,582	14,669	14,755	14,840	14,923	15,004	15,084	15,162	15,239	15,314	15,388	15,460
81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040
593	593	593	593	593	593	593	593	593	593	593	593	593
1,567	1,576	1,586	1,595	1,604	1,613	1,622	1,630	1,639	1,647	1,655	1,663	1,671
554,423	557,828	561,174	564,461	567,691	570,862	573,975	577,030	580,027	582,965	585,845	588,667	591,431
94,252	94,831	95,400	95,958	96,507	97,047	97,576	98,095	98,605	99,104	99,594	100,073	100,543
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231
1,322,471	1,330,592	1,338,573	1,346,415	1,354,119	1,361,683	1,369,109	1,376,395	1,383,543	1,390,552	1,397,422	1,404,153	1,410,745
1,745,954	**1,754,653**	**1,763,203**	**1,771,605**	**1,779,857**	**1,787,961**	**1,795,915**	**1,803,721**	**1,811,379**	**1,818,887**	**1,826,246**	**1,833,457**	**1,840,519**
43,340	43,816	44,291	44,767	45,243	45,719	46,194	46,670	47,146	47,622	48,097	48,573	49,049
334	333	331	330	328	326	325	323	322	320	318	317	315
14,493	14,582	14,669	14,755	14,840	14,923	15,004	15,084	15,162	15,239	15,314	15,388	15,460
38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089
826	826	826	826	826	826	826	826	826	826	826	826	826
3,333	3,354	3,374	3,394	3,413	3,432	3,451	3,469	3,487	3,505	3,522	3,539	3,556
1,643,111	1,653,200	1,663,116	1,672,860	1,682,431	1,691,829	1,701,055	1,710,109	1,718,989	1,727,698	1,736,233	1,744,596	1,752,786
279,329	281,044	282,730	284,386	286,013	287,611	289,179	290,718	292,228	293,709	295,160	296,581	297,974
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011
1,322,471	1,330,592	1,338,573	1,346,415	1,354,119	1,361,683	1,369,109	1,376,395	1,383,543	1,390,552	1,397,422	1,404,153	1,410,745
1,968,811	**1,978,646**	**1,988,314**	**1,997,812**	**2,007,143**	**2,016,305**	**2,025,299**	**2,034,125**	**2,042,782**	**2,051,271**	**2,059,592**	**2,067,745**	**2,075,729**
7,509	7,688	7,866	8,045	8,224	8,403	8,582	8,760	8,939	9,118	9,297	9,476	9,654
361	361	361	361	361	361	361	361	361	361	361	361	361
2,711	2,775	2,840	2,904	2,969	3,033	3,098	3,163	3,227	3,292	3,356	3,421	3,485
17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760
300	300	300	300	300	300	300	300	300	300	300	300	300
1,337	1,369	1,401	1,433	1,464	1,496	1,528	1,560	1,592	1,624	1,655	1,687	1,719
239,381	245,081	250,781	256,481	262,181	267,881	273,581	279,282	284,982	290,682	296,382	302,082	307,782
40,695	41,664	42,633	43,602	44,571	45,540	46,509	47,478	48,447	49,416	50,385	51,354	52,323
45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256
134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214
247,349	253,239	259,129	265,019	270,909	276,799	282,689	288,579	294,468	300,358	306,248	312,138	318,028
467,514	**474,373**	**481,232**	**488,091**	**494,950**	**501,809**	**508,667**	**515,526**	**522,385**	**529,244**	**536,103**	**542,962**	**549,821**
90,518	91,294	92,070	92,847	93,623	94,399	95,175	95,952	96,728	97,504	98,281	99,057	99,833
226	226	226	226	226	226	226	226	226	226	226	226	226
20,426	20,601	20,776	20,951	21,127	21,302	21,477	21,652	21,827	22,002	22,178	22,353	22,528
73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920
1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082
2,421	2,441	2,462	2,483	2,504	2,524	2,545	2,566	2,587	2,607	2,628	2,649	2,670
1,563,072	1,576,477	1,589,882	1,603,287	1,616,692	1,630,097	1,643,502	1,656,906	1,670,311	1,683,716	1,697,121	1,710,526	1,723,931
265,722	268,001	270,280	272,559	274,838	277,116	279,395	281,674	283,953	286,232	288,511	290,789	293,068
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069
1,863,862	1,879,846	1,895,831	1,911,815	1,927,800	1,943,784	1,959,768	1,975,753	1,991,737	2,007,722	2,023,706	2,039,690	2,055,675
2,541,653	**2,559,917**	**2,578,180**	**2,596,443**	**2,614,706**	**2,632,969**	**2,651,233**	**2,669,496**	**2,687,759**	**2,706,022**	**2,724,286**	**2,742,549**	**2,760,812**
19,403	19,446	19,488	19,531	19,574	19,616	19,659	19,701	19,744	19,786	19,829	19,872	19,914
391	390	389	388	388	387	386	385	384	383	383	382	381
7,584	7,585	7,585	7,586	7,586	7,586	7,587	7,587	7,587	7,587	7,587	7,586	7,586
31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584
151	151	151	151	151	151	151	151	151	151	151	151	151
2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104	2,104
189,569	189,582	189,594	189,604	189,611	189,618	189,622	189,625	189,625	189,625	189,622	189,617	189,611
32,227	32,229	32,231	32,233	32,234	32,235	32,236	32,236	32,236	32,236	32,236	32,235	32,234
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135
692,083	692,131	692,173	692,208	692,237	692,259	692,275	692,285	692,288	692,285	692,275	692,259	692,236
966,444	**966,495**	**966,539**	**966,576**	**966,606**	**966,629**	**966,646**	**966,656**	**966,659**	**966,656**	**966,646**	**966,629**	**966,605**
141,366	142,797	144,228	145,659	147,090	148,521	149,951	151,382	152,813	154,244	155,675	157,106	158,536
921	919	918	916	915	913	911	910	908	907	905	903	902
37,629	37,958	38,285	38,611	38,935	39,258	39,579	39,898	40,216	40,533	40,848	41,161	41,473
129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769
3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069
2,540	2,562	2,584	2,606	2,628	2,650	2,672	2,693	2,715	2,736	2,757	2,779	2,800
4,652,497	4,693,139	4,733,592	4,773,856	4,813,933	4,853,821	4,893,522	4,933,033	4,972,357	5,011,492	5,050,440	5,089,199	5,127,769
790,925	797,834	804,711	811,556	818,369	825,150	831,899	838,616	845,301	851,954	858,575	865,164	871,721
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121
3,433,683	3,463,677	3,493,533	3,523,249	3,552,827	3,582,266	3,611,566	3,640,727	3,669,749	3,698,632	3,727,376	3,755,981	3,784,448
4,760,728	**4,797,632**	**4,834,364**	**4,870,926**	**4,907,317**	**4,943,536**	**4,979,585**	**5,015,463**	**5,051,170**	**5,086,707**	**5,122,072**	**5,157,266**	**5,192,289**
6,980,795	7,031,627	7,082,213	7,132,554	7,182,648	7,232,497	7,282,099	7,331,456	7,380,566	7,429,431	7,478,049	7,526,422	7,574,549
8,812,635	8,876,806	8,940,667	9,004,217	9,067,456	9,130,386	9,193,004	9,255,313	9,317,310	9,378,998	9,440,375	9,501,441	9,562,197
250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
16,043,430	**16,158,433**	**16,272,880**	**16,386,771**	**16,500,105**	**16,612,882**	**16,725,103**	**16,836,768**	**16,947,877**	**17,058,429**	**17,168,424**	**17,277,863**	**17,386,746**
28,494,535	**28,690,149**	**28,884,711**	**29,078,223**	**29,270,683**	**29,462,092**	**29,652,450**	**29,841,756**	**30,030,012**	**30,217,216**	**30,403,369**	**30,588,471**	**30,772,522**

2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076
49,525	50,000	50,476	50,952	51,428	51,903	52,379	52,855	53,331	53,806	54,282	54,758
314	312	310	309	307	306	304	302	301	299	298	296
15,531	15,600	15,668	15,734	15,799	15,862	15,923	15,983	16,042	16,099	16,154	16,208
81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040	81,040
593	593	593	593	593	593	593	593	593	593	593	593
1,679	1,686	1,694	1,701	1,708	1,715	1,721	1,728	1,734	1,740	1,746	1,752
594,136	596,783	599,372	601,903	604,375	606,789	609,145	611,443	613,682	615,863	617,986	620,051
101,003	101,453	101,893	102,323	102,744	103,154	103,555	103,945	104,326	104,697	105,058	105,409
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231	159,231
1,417,198	1,423,512	1,429,687	1,435,724	1,441,621	1,447,380	1,452,999	1,458,480	1,463,822	1,469,025	1,474,089	1,479,014
1,847,432	**1,854,196**	**1,860,812**	**1,867,278**	**1,873,596**	**1,879,765**	**1,885,785**	**1,891,656**	**1,897,379**	**1,902,952**	**1,908,377**	**1,913,653**
49,525	50,000	50,476	50,952	51,428	51,903	52,379	52,855	53,331	53,806	54,282	54,758
314	312	310	309	307	306	304	302	301	299	298	296
15,531	15,600	15,668	15,734	15,799	15,862	15,923	15,983	16,042	16,099	16,154	16,208
38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089	38,089
826	826	826	826	826	826	826	826	826	826	826	826
3,572	3,588	3,603	3,619	3,633	3,648	3,662	3,676	3,689	3,703	3,715	3,728
1,760,804	1,768,649	1,776,322	1,783,822	1,791,149	1,798,304	1,805,286	1,812,095	1,818,732	1,825,196	1,831,488	1,837,607
299,337	300,670	301,975	303,250	304,495	305,712	306,899	308,056	309,184	310,283	311,353	312,393
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011	197,011
1,417,198	1,423,512	1,429,687	1,435,724	1,441,621	1,447,380	1,452,999	1,458,480	1,463,822	1,469,025	1,474,089	1,479,014
2,083,546	**2,091,194**	**2,098,673**	**2,105,984**	**2,113,128**	**2,120,102**	**2,126,909**	**2,133,547**	**2,140,017**	**2,146,319**	**2,152,453**	**2,158,418**
9,833	10,012	10,191	10,370	10,548	10,727	10,906	11,085	11,264	11,442	11,621	11,800
361	361	361	361	361	361	361	361	361	361	361	361
3,550	3,614	3,679	3,743	3,808	3,873	3,937	4,002	4,066	4,131	4,195	4,260
17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760	17,760
300	300	300	300	300	300	300	300	300	300	300	300
1,751	1,783	1,815	1,846	1,878	1,910	1,942	1,974	2,006	2,037	2,069	2,101
313,482	319,183	324,883	330,583	336,283	341,983	347,683	353,384	359,084	364,784	370,484	376,184
53,292	54,261	55,230	56,199	57,168	58,137	59,106	60,075	61,044	62,013	62,982	63,951
45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256	45,256
134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214	134,214
323,918	329,808	335,698	341,588	347,477	353,367	359,257	365,147	371,037	376,927	382,817	388,707
556,680	**563,539**	**570,398**	**577,257**	**584,116**	**590,975**	**597,833**	**604,692**	**611,551**	**618,410**	**625,269**	**632,128**
100,609	101,386	102,162	102,938	103,714	104,491	105,267	106,043	106,820	107,596	108,372	109,148
226	226	226	226	226	226	226	226	226	226	226	226
22,703	22,878	23,053	23,229	23,404	23,579	23,754	23,929	24,104	24,280	24,455	24,630
73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920	73,920
1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082	1,082
2,690	2,711	2,732	2,753	2,774	2,794	2,815	2,836	2,857	2,877	2,898	2,919
1,737,335	1,750,740	1,764,145	1,777,550	1,790,955	1,804,360	1,817,764	1,831,169	1,844,574	1,857,979	1,871,384	1,884,789
295,347	297,626	299,905	302,183	304,462	306,741	309,020	311,299	313,578	315,856	318,135	320,414
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069	242,069
2,071,659	2,087,644	2,103,628	2,119,612	2,135,597	2,151,581	2,167,566	2,183,550	2,199,534	2,215,519	2,231,503	2,247,488
2,779,075	**2,797,338**	**2,815,602**	**2,833,865**	**2,852,128**	**2,870,391**	**2,888,654**	**2,906,918**	**2,925,181**	**2,943,444**	**2,961,707**	**2,979,971**
19,957	19,999	20,042	20,084	20,127	20,170	20,212	20,255	20,297	20,340	20,382	20,425
380	379	378	378	377	376	375	374	373	373	372	371
7,586	7,585	7,585	7,584	7,584	7,583	7,582	7,582	7,581	7,580	7,579	7,574
31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584	31,584
151	151	151	151	151	151	151	151	151	151	151	151
2,104	2,104	2,104	2,104	2,103	2,103	2,103	2,103	2,103	2,102	2,102	2,101
189,603	189,594	189,582	189,569	189,554	189,537	189,519	189,498	189,476	189,452	189,427	189,308
32,233	32,231	32,229	32,227	32,224	32,221	32,218	32,215	32,211	32,207	32,203	32,182
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135	72,135
692,207	692,172	692,130	692,081	692,027	691,965	691,898	691,824	691,743	691,656	691,563	691,128
966,575	**966,538**	**966,494**	**966,443**	**966,386**	**966,322**	**966,251**	**966,173**	**966,089**	**965,998**	**965,900**	**965,445**
159,967	161,398	162,829	164,260	165,691	167,121	168,552	169,983	171,414	172,845	174,276	175,706
900	899	897	895	894	892	891	889	887	886	884	883
41,784	42,093	42,400	42,706	43,010	43,313	43,614	43,914	44,213	44,509	44,804	45,098
129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769	129,769
3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069	3,069
2,821	2,841	2,862	2,883	2,903	2,924	2,944	2,964	2,985	3,005	3,025	3,044
5,166,152	5,204,346	5,242,352	5,280,170	5,317,799	5,355,241	5,392,494	5,429,559	5,466,435	5,503,124	5,539,624	5,575,936
878,246	884,739	891,200	897,629	904,026	910,391	916,724	923,025	929,294	935,531	941,736	947,909
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000
366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121	366,121
3,812,775	3,840,964	3,869,013	3,896,924	3,924,695	3,952,328	3,979,822	4,007,177	4,034,393	4,061,470	4,088,409	4,115,208
5,227,142	**5,261,823**	**5,296,334**	**5,330,674**	**5,364,842**	**5,398,840**	**5,432,667**	**5,466,323**	**5,499,808**	**5,533,122**	**5,566,266**	**5,599,238**
7,622,430	7,670,065	7,717,454	7,764,597	7,811,494	7,858,145	7,904,550	7,950,709	7,996,623	8,042,290	8,087,711	8,132,319
9,622,642	9,682,777	9,742,601	9,802,115	9,861,318	9,920,211	9,978,794	10,037,066	10,095,027	10,152,678	10,210,019	10,266,332
250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
17,495,072	**17,602,842**	**17,710,055**	**17,816,712**	**17,922,812**	**18,028,356**	**18,133,344**	**18,237,775**	**18,341,650**	**18,444,968**	**18,547,730**	**18,648,652**
30,955,521	**31,137,470**	**31,318,367**	**31,498,213**	**31,677,008**	**31,854,751**	**32,031,444**	**32,207,085**	**32,381,675**	**32,555,214**	**32,727,702**	**32,897,504**

APPENDIX C: WWTP Annual Operating and Maintenance Costs - Option 3

Foothills Regional Water & Wastewater Collaborative Wastewater Study

Prepared by Urban Systems Ltd.
March 10, 2016

									Phase 1 Construction Year
	Parameter	Units	Unit Rate	NPV 2016 to 2076	2016	2017	2018	2019	2020
Chemicals	Sodium Hypochlorite	$/tote	$ 959.40	**$676,536**		$0	$0	$0	$0
	Citric Acid	$/tote	$1,950	**$1,288,372**		$0	$0	$0	$0
	Alum	$/truckload	$8,120	**$19,248,375**		$0	$0	$0	$0
	Polymer	$/drum	$ 1,256.60	**$7,454,791**		$0	$0	$0	$0
Sludge Hauling									
	Truck Hauling Fee	$/hr	$275	**$4,900,342**		$0	$0	$0	$0
	Tipping Fee	$/m3	$100	**$24,649,294**		$0	$0	$0	$0
Labour									
	Full Time Equivalents Cost	$/year	$108,000	**$20,559,203**		$0	$0	$0	$0
Membrane Replacement Costs									
	Replacement Cost Per Year (12 yea	$/year		**$3,756,049**		$0	$0	$0	$0
Equipment Replacement Costs									
	Replace all equipment (minus mem	$/year		**$13,965,940**		$0	$0	$0	$0
	every 20 years								
Parts and Maintenance Supply									
	2% of capital cost minus membran	$/year		**$6,096,950**		$0	$0	$0	$0
Other Costs (Lab Testing, Office Expenses, training, security)									
		$/m3/day	$ 2.00	**761,452**		0	0	0	0
Power Costs	Total Power Usage	$/kWh	$0.17	**30,869,521**		$0	$0	$0	$0
Total before Okotoks				**$134,226,825**		**$0**	**$0**	**$0**	**$0**
Okotoks Existing WWTP O&M Costs									
	Total $ for 2,588 ML Treated in 201	$/year	$ 2,649,119.00	**$40,752,296**		$0	$0	$0	$0
GRAND TOTAL				**$174,979,121**	**$0**	**$0**	**$0**	**$0**	**$0**

	2021 - Start Phase 1 O&M Costs (in 2016$)												
Parameter	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Sodium Hypochlorite	$17,269	$33,579	$33,579	$33,579	$33,579	$33,579	$33,579	$33,579	$33,579	$33,579	$33,579	$33,579	$33,579
Citric Acid	$33,150	$64,350	$64,350	$64,350	$64,350	$64,350	$64,350	$64,350	$64,350	$64,350	$64,350	$64,350	$64,350
Alum	$544,040	$584,640	$633,360	$682,080	$722,680	$771,400	$820,120	$860,720	$909,440	$958,160	$1,006,880	$1,055,600	$1,112,440
Polymer	$210,206	$227,450	$244,853	$262,421	$280,161	$298,079	$316,181	$334,476	$352,970	$371,670	$390,585	$409,722	$429,091
Truck Hauling Fee	$138,325	$149,600	$160,875	$172,700	$184,250	$196,075	$207,900	$220,000	$232,375	$244,200	$256,850	$269,225	$281,875
Tipping Fee	$695,046	$752,063	$809,606	$867,696	$926,352	$985,598	$1,045,455	$1,105,946	$1,167,095	$1,228,928	$1,291,470	$1,354,748	$1,418,791
Full Time Equivalents Cost	$639,134	$685,449	$732,163	$779,292	$826,848	$874,848	$923,306	$972,238	$1,021,661	$1,071,591	$1,122,046	$1,173,043	$1,224,602
Replacement Cost Per Year (12 yea	$93,551	$187,103	$187,103	$187,103	$187,103	$187,103	$187,103	$187,103	$187,103	$187,103	$187,103	$187,103	$187,103
Replace all equipment (minus mem	$693,193	$693,193	$693,193	$693,193	$693,193	$693,193	$693,193	$693,193	$693,193	$693,193	$693,193	$693,193	$693,193
2% of capital cost minus membran	$305,621	$305,621	$305,621	$305,621	$305,621	$305,621	$305,621	$305,621	$305,621	$305,621	$305,621	$305,621	$305,621
Other Costs ($/m3/day)	23,672	25,387	27,117	28,863	30,624	32,402	34,197	36,009	37,839	39,689	41,557	43,446	45,356
Total Power Usage	$1,303,351	$1,329,161	$1,355,194	$1,381,457	$1,407,959	$1,434,708	$1,461,712	$1,488,981	$1,516,522	$1,544,347	$1,572,464	$1,600,883	$1,629,616
Total before Okotoks	**$4,696,557**	**$5,037,594**	**$5,247,013**	**$5,458,353**	**$5,662,720**	**$5,876,954**	**$6,092,716**	**$6,302,214**	**$6,521,748**	**$6,742,430**	**$6,965,697**	**$7,190,514**	**$7,425,616**
Total $ for 2,588 ML Treated in 201	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119
GRAND TOTAL	**$7,345,676**	**$7,686,713**	**$7,896,132**	**$8,107,472**	**$8,311,839**	**$8,526,073**	**$8,741,835**	**$8,951,333**	**$9,170,867**	**$9,391,549**	**$9,614,816**	**$9,839,633**	**$10,074,735**

	Phase 2 Construction Year	2035 - Start Phase 2 O&M Costs (in 2016$)												
Parameter	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Sodium Hypochlorite	$33,579	$50,848	$50,848	$50,848	$50,848	$50,848	$50,848	$50,848	$50,848	$50,848	$50,848	$50,848	$50,848	$50,848
Citric Acid	$64,350	$95,550	$95,550	$95,550	$95,550	$95,550	$95,550	$95,550	$95,550	$95,550	$95,550	$95,550	$95,550	$95,550
Alum	$1,161,160	$1,209,880	$1,258,600	$1,315,440	$1,372,280	$1,421,000	$1,477,840	$1,534,680	$1,567,160	$1,591,520	$1,624,000	$1,656,480	$1,688,960	$1,721,440
Polymer	$448,700	$468,558	$488,674	$509,059	$529,722	$550,674	$571,927	$593,494	$605,588	$617,683	$629,777	$641,872	$653,966	$666,060
Truck Hauling Fee	$295,075	$308,000	$321,200	$334,950	$347,875	$361,625	$375,925	$390,225	$397,925	$405,900	$414,150	$421,850	$429,550	$438,075
Tipping Fee	$1,483,628	$1,549,287	$1,615,802	$1,683,204	$1,751,527	$1,820,806	$1,891,078	$1,962,389	$2,002,380	$2,042,370	$2,082,360	$2,122,351	$2,162,341	$2,202,331
Full Time Equivalents Cost	$1,276,740	$1,329,479	$1,382,838	$1,436,838	$1,491,500	$1,546,848	$1,602,904	$1,659,689	$1,684,457	$1,709,131	$1,733,718	$1,758,220	$1,782,635	$1,806,964
Replacement Cost Per Year (12 yea	$187,103	$280,654	$280,654	$280,654	$280,654	$280,654	$280,654	$280,654	$280,654	$280,654	$280,654	$280,654	$280,654	$280,654
Replace all equipment (minus mem	$693,193	$1,043,917	$1,043,917	$1,043,917	$1,043,917	$1,043,917	$1,043,917	$1,043,917	$1,043,917	$1,043,917	$1,043,917	$1,043,917	$1,043,917	$1,043,917
2% of capital cost minus membran	$305,621	$454,480	$454,480	$454,480	$454,480	$454,480	$454,480	$454,480	$454,480	$454,480	$454,480	$454,480	$454,480	$454,480
Other Costs ($/m3/day)	47,287	49,240	51,216	53,216	55,241	57,291	59,367	61,470	62,387	63,301	64,212	65,119	66,024	66,925
Total Power Usage	$1,658,671	$2,198,159	$2,227,865	$2,257,928	$2,288,360	$2,319,173	$2,350,380	$2,381,994	$2,395,783	$2,409,519	$2,423,208	$2,436,848	$2,450,441	$2,463,985
Total before Okotoks	**$7,655,106**	**$9,038,052**	**$9,271,644**	**$9,516,084**	**$9,761,954**	**$10,002,866**	**$10,254,870**	**$10,509,389**	**$10,641,130**	**$10,764,873**	**$10,896,874**	**$11,028,188**	**$11,159,365**	**$11,291,230**
Total $ for 2,588 ML Treated in 201	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119
GRAND TOTAL	**$10,304,225**	**$11,687,171**	**$11,920,763**	**$12,165,203**	**$12,411,073**	**$12,651,985**	**$12,903,989**	**$13,158,508**	**$13,290,249**	**$13,413,992**	**$13,545,993**	**$13,677,307**	**$13,808,484**	**$13,940,349**

APPENDIX C: WWTP Annual Operating and Mainter

Foothills Regional Water & Wastewater Collaborative Wast

Prepared by Urban Systems Ltd.
March 10, 2016

			Phase 3 Construction Year	2050 - Start Phase 3 O&M Costs (in 2016$)							
	Parameter	**2048**	**2049**	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**
Chemicals	Sodium Hypochlorite	$50,848	$50,848	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158
	Citric Acid	$95,550	$95,550	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700
	Alum	$1,753,920	$1,778,280	$1,810,760	$1,843,240	$1,875,720	$1,908,200	$1,940,680	$1,965,040	$1,997,520	$2,030,000
	Polymer	$678,155	$690,249	$702,344	$714,438	$726,533	$738,627	$750,722	$762,816	$774,911	$787,005
Sludge Hauling											
	Truck Hauling Fee	$445,775	$453,475	$461,725	$469,425	$477,400	$485,650	$493,350	$501,050	$509,575	$517,275
	Tipping Fee	$2,242,322	$2,282,312	$2,322,302	$2,362,293	$2,402,283	$2,442,273	$2,482,264	$2,522,254	$2,562,244	$2,602,235
Labour											
	Full Time Equivalents Cost	$1,831,207	$1,855,365	$1,879,436	$1,903,421	$1,927,320	$1,951,134	$1,974,861	$1,998,502	$2,022,057	$2,045,526
Membrane Replacement Costs											
	Replacement Cost Per Year (12 yea	$280,654	$280,654	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205
Equipment Replacement Costs											
	Replace all equipment (minus mem	$1,043,917	$1,043,917	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678
	every 20 years										
Parts and Maintenance Supply											
	2% of capital cost minus membran	$454,480	$454,480	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060
Other Costs (Lab Testing, Office Expenses, training, security)		67,822	68,717	69,609	70,497	71,382	72,264	73,143	74,019	74,891	75,760
Power Costs	Total Power Usage	$2,477,482	$2,490,931	$2,897,462	$2,910,817	$2,924,124	$2,937,383	$2,950,594	$2,963,757	$2,976,872	$2,989,940
Total before Okotoks		**$11,422,133**	**$11,544,779**	**$12,581,440**	**$12,711,933**	**$12,842,564**	**$12,973,333**	**$13,103,415**	**$13,225,240**	**$13,355,873**	**$13,485,543**
Okotoks Existing WWTP O&M Costs											
	Total $ for 2,588 ML Treated in 201	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119
GRAND TOTAL		**$14,071,252**	**$14,193,898**	**$15,230,559**	**$15,361,052**	**$15,491,683**	**$15,622,452**	**$15,752,534**	**$15,874,359**	**$16,004,992**	**$16,134,662**

	Parameter	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**
Chemicals	Sodium Hypochlorite	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158
	Citric Acid	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700
	Alum	$2,062,480	$2,094,960	$2,127,440	$2,151,800	$2,184,280	$2,216,760	$2,249,240	$2,281,720	$2,314,200	$2,338,560
	Polymer	$799,099	$811,194	$823,288	$835,383	$847,477	$859,572	$871,666	$883,761	$895,855	$907,949
Sludge Hauling											
	Truck Hauling Fee	$524,975	$533,225	$540,925	$548,900	$557,150	$564,850	$572,550	$581,075	$588,775	$596,475
	Tipping Fee	$2,642,225	$2,682,215	$2,722,206	$2,762,196	$2,802,186	$2,842,177	$2,882,167	$2,922,157	$2,962,148	$3,002,138
Labour											
	Full Time Equivalents Cost	$2,068,909	$2,092,206	$2,115,418	$2,138,543	$2,161,582	$2,184,535	$2,207,402	$2,230,182	$2,252,877	$2,275,486
Membrane Replacement Costs											
	Replacement Cost Per Year (12 yea	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205
Equipment Replacement Costs											
	Replace all equipment (minus mem	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678
	every 20 years										
Parts and Maintenance Supply											
	2% of capital cost minus membran	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060
Other Costs (Lab Testing, Office Expenses, training, security)		76,626	77,489	78,349	79,205	80,059	80,909	81,756	82,599	83,440	84,277
Power Costs	Total Power Usage	$3,002,959	$3,015,931	$3,028,855	$3,041,730	$3,054,558	$3,067,338	$3,080,071	$3,092,755	$3,105,391	$3,117,980
Total before Okotoks		**$13,615,076**	**$13,745,023**	**$13,874,282**	**$13,995,559**	**$14,125,094**	**$14,253,942**	**$14,382,653**	**$14,512,052**	**$14,640,488**	**$14,760,668**
Okotoks Existing WWTP O&M Costs											
	Total $ for 2,588 ML Treated in 201	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119
GRAND TOTAL		**$16,264,195**	**$16,394,142**	**$16,523,401**	**$16,644,678**	**$16,774,213**	**$16,903,061**	**$17,031,772**	**$17,161,171**	**$17,289,607**	**$17,409,787**

	Parameter	**2068**	**2069**	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**
Chemicals	Sodium Hypochlorite	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158	$67,158
	Citric Acid	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700	$128,700
	Alum	$2,371,040	$2,403,520	$2,436,000	$2,468,480	$2,500,960	$2,533,440	$2,557,800	$2,590,280	$2,622,760
	Polymer	$920,044	$932,138	$944,233	$956,327	$968,422	$980,516	$992,611	$1,004,705	$1,016,796
Sludge Hauling										
	Truck Hauling Fee	$604,725	$612,425	$620,400	$628,650	$636,350	$644,050	$652,575	$660,275	$667,975
	Tipping Fee	$3,042,128	$3,082,119	$3,122,109	$3,162,100	$3,202,090	$3,242,080	$3,282,071	$3,322,061	$3,362,041
Labour										
	Full Time Equivalents Cost	$2,298,009	$2,320,446	$2,342,797	$2,365,062	$2,387,241	$2,409,333	$2,431,340	$2,453,261	$2,474,775
Membrane Replacement Costs										
	Replacement Cost Per Year (12 yea	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205	$374,205
Equipment Replacement Costs										
	Replace all equipment (minus mem	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678	$1,304,678
	every 20 years									
Parts and Maintenance Supply										
	2% of capital cost minus membran	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060	$563,060
Other Costs (Lab Testing, Office Expenses, training, security)		85,111	85,942	86,770	87,595	88,416	89,235	90,050	90,862	91,658
Power Costs	Total Power Usage	$3,130,520	$3,143,013	$3,155,457	$3,167,854	$3,180,203	$3,192,504	$3,204,758	$3,216,963	$3,228,942
Total before Okotoks		**$14,889,380**	**$15,017,405**	**$15,145,569**	**$15,273,870**	**$15,401,484**	**$15,528,961**	**$15,649,005**	**$15,776,208**	**$15,902,750**
Okotoks Existing WWTP O&M Costs										
	Total $ for 2,588 ML Treated in 201	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119	$2,649,119
GRAND TOTAL		**$17,538,499**	**$17,666,524**	**$17,794,688**	**$17,922,989**	**$18,050,603**	**$18,178,080**	**$18,298,124**	**$18,425,327**	**$18,551,869**

APPENDIX E

Technical Memorandum 5 – Westend Options

MEMORANDUM

Date: April 21, 2016
To: Foothills Regional Water & Wastewater Collaborative
cc: Lynda Cooke, P.Eng., Steve Brubacher, P.Eng., Leigh Chmilar, P.Eng.
From: Sarah Fratpietro, P.Eng., Randy Boras, M.Sc., P.Eng.
File: 2239.0005.01 / 2210-047-00
Subject: Technical Memorandum 5: Westend Options: Rev.1

1. INTRODUCTION

The Foothills Regional Water and Wastewater Collaborative (FRWWC) is exploring a sub-regional management strategy for future wastewater collection servicing in the short (< 10 yrs), medium (25 yrs), and long-term (60 yrs) future. The FRWWC has requested a review of the Westend Regional Sewage Services Commission (Westend) wastewater servicing options. This review is largely a result of the new Alberta Environment and Parks (AEP) High Quality (HQ) effluent criteria recently proposed for the Calgary region. This requirement was not in place when the CRP (CRP 2014) made its recommendation that Westend remain on their local treatment plant for the long-term (to Year 2076). This memorandum reassesses the costs and other factors for a local WWTP versus a regional pipeline for Westend.

This focus of this memorandum is to provide the following:

- Summarize design parameters,
- Provide high level review of the options,
- Provide Class D (screening level) opinions of probable cost,
- Discuss the advantages and disadvantages of each option,
- Provide recommended next steps.

This memorandum reviews and compares the following two wastewater servicing options for Westend:

1. **Option 1:** Local Wastewater Treatment Plant (WWTP) serving Westend (Black Diamond and Turner Valley) as per CRP (2014).
2. **Option 2:** A pipeline from Westend to a sub-regional treatment facility or pipeline system in the Okotoks area.

Within this memorandum, Urban Systems Ltd. (USL) developed costs and impacts related to the WWTP in Option 1, and MPE Engineering Ltd. (MPE) developed costs and impacts related to the regional pipeline in Option 2.

The results of this memorandum are meant to “plug into” the results of the core options already assessed in Technical Memorandum 3 (MPE/USL TM3 2015). The outcome of this memorandum will be included in the preferred regional core options discussion in the Final Report. The rationale behind not including this in Technical Memorandum 3 (TM3) is two-fold:

- The Westend service area represents a relatively small percentage (6.5%) of the ultimate regional population addressed in TM3. The outcome of this work is not expected to affect the overall outcome of the regional core options.
- Given the existing Westend treatment site has sizable storage lagoons that could be converted to equalization storage, the pipeline flow conveyed from Westend to a regional plant near Okotoks

(or to a regional pipeline from Okotoks to Calgary) would have a much lesser impact on any regional facility given it could be pumped during off-peak hours.

- TM3 is being prepared in advance of TM5, given TM5 was later added to the overall work plan.

2. DESIGN PARAMETERS

This section summarizes the projected wastewater design flows, existing WWTP capacity and pipeline design criteria used for comparing the wastewater servicing options. The projected populations and average day flows from Table 2.1 of the *Technical Memorandum 1-Rev 1: Planning and Projections* (MPE/USL TM1 2015) are used as base information for this report.

2.1 Projected Wastewater Flows

The projected wastewater maximum day flows and peak hour flows to be adopted for this report are summarized in ***Table 2.1*** below. The maximum day flows and peak hour flows provided in previous studies were used when available (MPE 2015).

Table 2.1: Projected Westend Wastewater Flows

Study Area	Average Day Flow (ADF) (m^3/day) [1]			Maximum Day Flow (MDF) (m^3/day)			Peak Hour Flow (PHF) (L/s)		
	2010	2041	2076	2010	2041	2076	2010	2041	2076
Black Diamond	*870*	*1,406*	*1,773*	*Included in Westend Total flows*			*Included in Westend Total flows*		
Turner Valley	*995*	*1,446*	*1,929*						
Westend Total: [2]	**1,865**	**2,852**	**3,702**	**4,065**	**8,556**	**11.106**	**108**	**165**	**214**

2.2 Summary of Existing WWTP Capacity

The existing WWTP capacity and projected year the WWTP will be at full capacity are summarized in ***Table 2.2*** below. The Westend WWTP is projected to be at full capacity by 2019.

Table 2.2: Summary of Existing WWTP Capacity

WWTP	Existing Capacity (m^3/day)	Projected Year WWTP at Full Capacity
Westend Aerated Lagoon	4,100 [3]	2019 [4]

[1] Average day flows are from MPE/USL TM 1 (2015)
[2] Westend maximum day factors for years 2010/2041/2076 of 2.2/3.0/3.0 are based on matching maximum day flows from the MPE (2015) Westend Regional Sewage Report. No information was available for peak factor so assumed to be 5.0 for this report, based upon an estimate using Harmon's equation and an allowance for infiltration.
[3] Westend existing capacity from the MPE (2015) report and is based on maximum month average daily flow.
[4] Westend projected year at full capacity based on the MPE (2015) report.

2.3 Option 1 - WWTP Design Criteria

Alberta Environment and Parks (AEP) announced in 2015 that effluent treatment requirements in the Calgary region are changing in the future. New plants will be required to treat to High Quality (HQ) effluent criteria of 5 mg/l $BOD_{5,}$ 5 mg/l TSS and 0.15 mg/l Total Phosphorus. Existing plants will be required to move towards the new criteria when major structural upgrades and expansions are required. This memorandum considers the future HQ criteria requirements.

2.4 Option 2 - Pipeline Design Criteria

This section summarizes the pipeline design criteria for Option 2.

2.4.1 Westend Lagoon

The Westend aerated lagoon has six treatment cells with a total volume of 198,275 m^3 (MPE 2015). Three of these cells are higher in elevation than the rest and require pumping of wastewater from the lower cells. The total volume of the lower cells is 75,650 m^3. The following assumptions are made for Westend for the regional pipeline Option 2:

- The Westend aerated lagoon lower cells will be maintained and utilized for peak shaving storage. This will minimize the pipeline diameter and lift station power requirements.
- A new lift station will be installed at the lagoon site to pump wastewater at maximum day flows to the sub-regional system.

An added advantage of using the lagoon for peak shaving is that the lagoon can be used as back-up in the event of the regional pipeline being out of service (emergency or maintenance condition). The lagoon volume will provide a minimum of 9 days storage in 2014 and 7 days storage volume based upon projected flows in 2076. This storage time is calculated using maximum day flows to be conservative. This leaves reasonable time to locate, repair a line break and put the system back into service.

2.4.2 Pipeline Velocities

The pipeline is sized to have a velocity range of 0.9 m/s to 1.6 m/s. Alberta Environmental Protection guidelines indicate that at design pumping rates, a cleansing velocity of at least 0.6 m/s should be maintained. However, a minimum velocity of 0.9 m/s is preferred to ensure there is adequate flushing in the pipeline. A maximum velocity of 1.6 m/s is used because at velocities higher than this pressure surges can become an issue particularly in the larger diameter pipelines. Also the friction loss becomes higher requiring additional power at the lift stations (or additional lift stations) to push the wastewater through the pipeline.

2.4.3 Pipeline Material

The pipeline material assumed for this study is High Density Polyethylene (HDPE). This is a common material for wastewater forcemains. HDPE pipe is fused at joints, is corrosion resistant and has a long service life. Due to HDPE flexibility and jointless construction, smaller diameter pipe can potentially be installed using narrow trenches reducing ROW and excavation requirements. HDPE is also the prevalent type of pipe used for trenchless installations which reduce restoration and roadway reconstruction costs and allows for installation under rivers and wetlands with less disruption to the environment.

3. REVIEW OF OPTIONS

This section reviews the two wastewater servicing options for Westend. This section also reviews the phasing of these options, land considerations and environmental considerations.

3.1 Phasing of Options

The construction of each option to the 60-year (2076) design horizon will include two phases of construction. It is assumed that Phase 1 will have a consistent operational start date of 2020 for construction to the 25-year design horizon (2041) for both options. Phase 2 will be constructed in 2041 to meet the 60-year design horizon. The timing for Phase 1 is based on the existing WWTP being projected to reach full capacity within the next 4 years. This also allows time in the process to obtain approvals and design and construct the selected option. Both options include an allowance for reclamation of the existing lagoon cells proposed for abandonment.

3.1.1 WWTP

Phase 1 of the WWTP upgrade is assumed to be constructed in 2020 and to include technology designed to achieve effluent that meets the new AEP HQ standard. Membrane Bioreactors (MBR) with additional chemical treatment for phosphorus removal are assumed. It is assumed that sludge will be dewatered by centrifuge, and hauled to an external facility such as EcoAG in High River.

The WWTP is designed for maximum day flows (MDF), with the following exceptions:

- Pumping equipment is designed for peak hourly flows.
- Equalization storage volume of at least 25% of MDF is provided to balance peak flows into the WWTP.

3.1.2 Pipeline

Phase 1 of the pipeline is assumed to be constructed in 2020 and to include the pipelines and lift station pumps sized for the 25-year design horizon (2041). The pipeline in Phase 1 is sized to meet the target velocity of 0.9 to 1.1 m/s.

Phase 2 is assumed to be constructed in 2041 for the 60-year design horizon (2076). If the additional flow rate associated with the 60-year design horizon causes the pipeline from Phase 1 to exceed the maximum velocity of 1.6 m/s, Phase 2 will include twinning the pipeline.

The Phase 1 lift stations (LS) are assumed to be built with extra space to allow for the addition of pumps in Phase 2 to meet the 2076 design flows.

3.2 Land Considerations

The pipe route in each option is assumed to be primarily along the south side of Alberta Transportation Highway 7. This is the shortest route to the primary sub-regional pipeline. The south side also has less development than the north side. However, pipelines installed along Alberta Transportation primary highways are typically required to maintain a 30 m setback from the highway Right-of-Way (ROW). This 30 m offset would put the pipeline line assignment primarily in “greenfield” (farmer’s fields) installation areas. This would require permanent easement acquisition from the landowners adjacent to the Highway ROW for the pipeline. However, “greenfield” installations on permanent easements could save significant costs over installation in narrow ditches or road shoulders. It also avoids dealing with the facilities typically in the ROW (power poles, fibre optics, signs etc), traffic accommodation, and re-establishing road shoulder.

It is noted that the pipe route assumed for this report is conceptual and is used as the basis for comparison purposes of the options.

3.3 Option 1

Option 1 includes a new WWTP at the existing Westend lagoon site. The outfall is assumed to be in the same location as the existing, just north of the plant and discharging into the Sheep River. It is assumed that this outfall will require upgrading to a diffuser. It should be noted that the costs of a river diffuser depend on the required depth of installation. A receiving stream analysis will be required to determine possible locations for the upgraded outfall. A cost allowance to upgrade the outfall is included in the WWTP cost estimate.

WWTP design flows for each Phase in Option 1 are shown in ***Table 3.1***.

Table 3.1: Option 1 – Westend WWTP Design Flows

Phase 1 ADF (m^3/day)	Phase 1 MDF (m^3/day)	Phase 2 ADF (m^3/day)	Phase 2 MDF (m^3/day)
2,900	8,600	3,700	11,100

3.4 Option 2

Option 2 includes a dedicated sub-regional pipeline from the Westend lagoon site to a new primary sub-regional pipeline along the west side of Highway 2A. This option is illustrated on ***Figure 5.1*** in ***Appendix A***.

The Option 2 sub-regional pipeline system will consist of:

- Existing Westend lagoon (3 of 6 cells) maintained for peak shaving storage,
- New lift station at the existing lagoon site to pump maximum day flow,
- New 25.5 km pipeline from the lift station to the primary sub-regional pipeline.

The pipeline lengths, design flows and required lift stations for Option 2 are summarized in ***Table 3.2***. The preferred pipeline diameter and associated velocities for each phase are provided in ***Table 3.3***. The new pipelines for each phase are illustrated on Figure ***5.1***. The lift station power requirements and pumping head (TDH) are summarized in ***Table 3.4***.

Table 3.2: Option 2 – Westend Pipeline Lengths and Design Flows

Pipe Segment	Description	Length (km)	2041 Design Flow (L/s)	2076 Design Flow (L/s)	Lift Stations Required
1	Westend to Primary Sub-Regional Pipeline	25.5	99	129	Westend LS

Table 3.3: Option 2 – Westend Pipeline Diameter and Velocities

Pipe Segment	Phase 1 Pipeline		Phase 2 Pipeline	
	Pipe Diameter (mm)	Velocity (m/s)	Pipe Diameter (mm)	Velocity (m/s)
1	**400**	**1.1**	400	1.4

Table 3.4: Option 2 – Westend Lift Station Power

Lift Station	Phase 1 Power (kW)	Phase 1 TDH (m)	Phase 2 Power (kW)	Phase 2 TDH (m)
Westend LS	73	41	158	68

The pipelines and lift stations for Phase 1 of Option 2 will include the following:

- 25.5 km of 400 mm diameter pipeline, and
- One new lift station,

Phase 2 of Option 2 will include the following:

- Addition of pumps to the lift station.

3.5 Environmental and Regulatory Considerations

The receiving stream for a Westend WWTP effluent outfall is the Sheep River. The proposed WWTP would be located in the same area as the existing lagoon. The proposed outfall is assumed to be in the same location as the current outfall, directly north of the existing lagoon, and would need upgrading for a new plant. As mentioned in *Technical Memorandum 2: Foothills Streams Analysis*, the primary contributors of nutrients to the Sheep River are the Westend and Okotoks outfalls. Further analysis on the receiving stream to determine assimilative carrying capacity may be required once the preferred option is selected.

In Option 2, the pipeline will have an AEP pipeline index greater than 2690 (pipeline outside diameter in mm multiplied by length in km) and will be considered a Class 1 pipeline under the *Environmental Protection and Enhancement Act* (EPEA). This will require an EPEA Approval including for conservation and reclamation (C&R) activities associated with pipeline construction. This will require a 30-day public advertising period. The pipeline will also require a “Notification” and the pump stations an “Authorization” from AEP as per the provincial *Water Act*. An EPEA Approval is also required for any treatment plant and/or new outfall. *Water Act* approvals will also be required for various components of the work, particularly within streams.

Pipeline routing for all options will require multiple crossings of highway and utility right-of-ways, as well as water bodies and potential environmentally sensitive areas. Crossing agreements will be required for all the highway and utility crossings. Watercourse crossings will require both Federal and Provincial approvals. Wildlife, wildlife habitat, wetland and vegetation studies and/or surveys will be required prior to construction to ensure requirements of the federal *Species at Rick Act*, *Migratory Birds Convention Act* and provincial *Wildlife Act*, *Alberta Weed Control Act* and *Water Act* are met. Also a Historical Resources Impact Assessment will likely be required by *Alberta Culture and Tourism* (ACT).

4. COSTS

This section reviews the economic analysis of the two wastewater servicing options. Capital expenditure and operation and maintenance (O&M) costs are evaluated. Capital costs represented in this report are in projected 2016 dollars and include contingencies and engineering. All costs are exclusive of GST. All referenced costs and cost estimates presented are considered Class D (screening level) opinions of probable cost.

For each wastewater servicing option, the following are established:

- Capital cost estimates,
- O&M costs,
- Net present value (NPV).

The capital cost estimates and the O&M costs are used to determine the NPV of each servicing option. These are utilized to compare, evaluate and hence establish the most cost effective option for the Westend wastewater servicing.

4.1 Grant Funding Review

The following section reviews the grant funding options that may be most applicable to this project. The Alberta Municipal Water and Wastewater Partnership (AMWWP) program, the Regional System Initiative under the *Water for Life* Strategy, and Small Communities Fund (SCF) may be the most significant Provincial sources of potential capital funding for this project. There are other sources of grant funding available but they tend to be more restrictive, either funding only specific components of a project or a much lower share of project costs.

4.1.1 Alberta Municipal Water/Wastewater Partnership (AMWWP)

Under the AMWWP program, funding is provided to urban centers under 45,000 population, regional commissions and eligible hamlets within rural municipalities. The construction of high-priority water supply, water treatment, wastewater treatment and disposal facilities are eligible for funding. Local water distribution piping and/or sewage collection systems are not eligible for funding.

Funding is provided as a percentage of eligible approved project costs. For those municipalities under 1,000 population, projects are cost-shared on a 75% government and 25% percent municipality basis. For communities over 1,000 population (to a maximum of 45,000 population), grant percentage ratios are calculated by a formula. The percentage ratio declines as the population increases.

The program also encourages water conservation and consumption-based rate structures. Under this initiative, municipalities could be subject to a 10% reduction in grants if they have no metering in place and the average annual consumption exceeds the norm for the area. This applies to both water and wastewater projects.

In November 2015, the Province announced that a total of $195 million has been budgeted for the *Water for Life* program over the next five years (Alberta Government Website 2015).

4.1.2 Alberta Regional Systems Initiative and Water Strategy Initiative (Water for Life)

In 2006, the Province implemented the *“Water for Life”* Initiative. This program falls under the AMWWP Regional Systems Initiative and Water Strategy Initiative. In this program, the Province will fund up to 90% of the capital costs of building new regional municipal water and wastewater pipelines. This program can also provide 100% funding to the “hub” suppliers for any necessary treatment upgrades for the additional regional customers. In order to be eligible for the “*Water for Life*” initiative, a regional commission or group must consist of two or more municipalities (or eligible hamlets) that are eligible for funding under the AMWWP. The idea is that such projects tend to be more cost effective and environmentally friendly and make it easier to attract certified operators.

In November 2015, the Province announced that a total of $350 million has been budgeted for *Water for Life* program over the next five years (Alberta Government Website 2015).

4.1.3 New Building Canada Fund: Small Communities Fund (SCF)

The Small Communities Fund (SCF) is a part of the New Building Canada Fund. It was confirmed in the 2014 Federal Budget to designate $94 million in federal funding to support infrastructure projects in Alberta communities with a population of 100,000 or less. Projects are cost-shared on a one-third federal, one-third provincial and one-third municipal basis. Maximum project funding is $3-million for each of the partners.

4.2 Capital Cost Estimates

Opinions of probable capital costs are developed at a screening level for a high level comparison of the two options, and are summarized in ***Table 4.1***. Regional pumping and pipeline costs are based upon historical tender costs in the MPE database. Costs are in 2016 dollars.

In addition to pipe construction costs, the following costs are included in pipe capital cost estimates similar to the CRP report and adjusted for inflation:

- Land acquisition along the pipe alignment, $24,000/km
- Valve chamber allowance for each pipe scenario, $580,000

The following assumptions are used to derive the capital cost estimates for the WWTP:

- A capital cost curve is derived for MBR WWTPs (capital cost per unit of treatment capacity) based on historical costs in the USL database.
- The cost of land acquisition is not included in the WWTP estimate.

Table 4.1: Summary of Capital Cost Estimates

Option		Capital Costs	
		Phase 1 (2020 Construction)	Phase 2 (2041 Construction)
1	WWTP	$20 M	$7 M
2	Pipeline (to primary sub-regional Pipeline)	$33 M	$1 M
	Westend contribution of primary sub-regional pipeline (assuming Option 4)	$11 M	$1 M

4.3 Operation and Maintenance Costs

The following assumptions are used to estimate the operational and maintenance (O&M) costs for the WWTP:

- O&M costs are assumed based on average annual daily flows. For this memorandum, the mid-point flows between 2016-2041, and 2041-2076 are linearly interpolated to use as an average over the time period. Since flows are directly related to population increase, which is geometric, the average annual operating costs are conservative. The O&M costs will be further refined following the selection of the two preferred options in Technical Memorandum 4.

- Chemicals costs include delivery in liquid form (Liquid Alum and Emulsion Polymer) to the WWTPs, rather than blending at the plant.
- Power usage estimates include mainly space heating and energy from the MBRs, as these two categories comprise the largest use of power for the WWTPs. Power costs are estimated from Fortis Alberta 2015 Rate 61: General Service.
- Labour costs are assumed based on number of full time equivalents (FTE) per average daily flow.
- Equipment replacement costs (including MBR replacement) are assumed to be $0.50/m^3$ of ADF.
- Parts and Maintenance supply costs are assumed to be 2% of the capital cost of equipment (excluding MBRs) or each phase.
- Sludge is assumed to be dewatered at the WWTP and hauled to Eco-AG in High River, an external solids processing facility.

The O&M costs for the pipeline and lift station are based on the similar assumptions as adopted in the CRP report (CRP 2014) and adjusted for inflation. They include the following:

- Power costs: Power costs are based on an assumed $0.17/kWh.
- Labour costs: Labour costs associated with the lift stations are based on average flow rates. Lift stations larger than 20,000 m^3/day are assumed to have annual labour costs of $170,000. Smaller lift stations with flows less than 20,000 m^3/day are assumed to have labour costs of $45,000 per year.
- Repair and rehabilitation (R&R): Pump R&R costs are estimated to be 2% of total pump capital cost.
- Inflation Rate: 2.5% per year.

It has been assumed for costing purposes that the Westend pipeline will tie into the primary sub-regional pipeline for Option 4 in *Technical Memo 3: Options & Screening* (MPE/USL TM3 2016). This option ties into the City of Calgary and includes monthly user charges.

The projected O&M costs for the two phases are summarized in ***Table 4.3***.

Table 4.3: Summary of Annual O&M Costs

Option	Annual O&M Costs	
	Phase 1 O&M Costs (2021 – 2041)	Phase 2 O&M Costs (2042 – 2076)
1 (WWTP)	$2.0 M	$2.4 M
2 (Pipeline)	$1.1 M	$1.4 M

4.4 Net Present Value

A net present value (NPV) analysis is completed for both options. The NPV includes a capital cost of construction in 2020 and 2041. The O&M costs are for 55 years of operation from 2021 to 2076.

Table 4.4 summarizes the NPV analysis. It is important to note that funding from provincial grants or other initiatives are not taken into consideration in this analysis. NPV are based on a discount rate of 5%.

Table 4.4: Net Present Value

Option	NPV (2020-2076)
1 (WWTP)	$48 M
2 (Pipeline)	$55 M

Based on the NPV analysis the most cost effective option is Option 1, local stand-alone WWTP.

5. SUMMARY DISCUSSION AND COMPARISON OF OPTIONS

A summary of the major advantages and disadvantages of each option are summarized in ***Table 5.1*** below.

Table 5.1: Advantages and Disadvantages of Each Option

Option	Advantages	Disadvantages
1 (WWTP)	Local Wastewater Treatment Plant (WWTP) serving Westend (Black Diamond and Turner Valley) as per CRP (2014)	
	• Lowest cost • No outside user fees • Local autonomy	• Stand-alone plant may not be eligible for *Water for Life* funding, though chances are better given the regional nature of Westend, (more likely eligible for AMWWP or BCF funding) • Difficult to retain Operators for WWTP
2 (Pipeline)	A pipeline from Westend to a sub-regional system in the Okotoks area	
	• Regional solution likely eligible for *Water for Life* funding	• Higher cost option • May be outside user fees for tying into regional option

6. NEXT STEPS

Westend should review this memorandum and communicate comments to the FRWWC group. The following are the broad next steps as per the proposed FRWWC work plan following submittal of this Technical Memorandum 5.

1. Meeting #2 - FRWWC to select the preferred sub-regional options from TM3 for further refinement. This may impact the options for Westend.
2. Have Meeting #3 with MPE/USL/FRWWC to select favoured Option.
3. MPE/USL to finalize Draft Final Report base on outcome of Meeting #3 and submit for comments.
4. Meeting #4 with MPE/USL/FRWWC to review Draft Final Report and provide comments.
5. MPE/USL to prepare and submit Final Report.
6. Meeting #5 with MPE/USL/FRWWC to present Final Report.

Sincerely,

MPE ENGINEERING LTD.

Sarah Fratpietro, P.Eng.
Project Manager

"REVIEWED BY:"
Randy Boras, M.Sc., P.Eng.
Senior Project Specialist

SF/rb

7. REFERENCES

Alberta Government Website 2015; *Province Boosts Funding for Municipal Clean Water Systems*, Alberta Government Website, November 19, 2015.

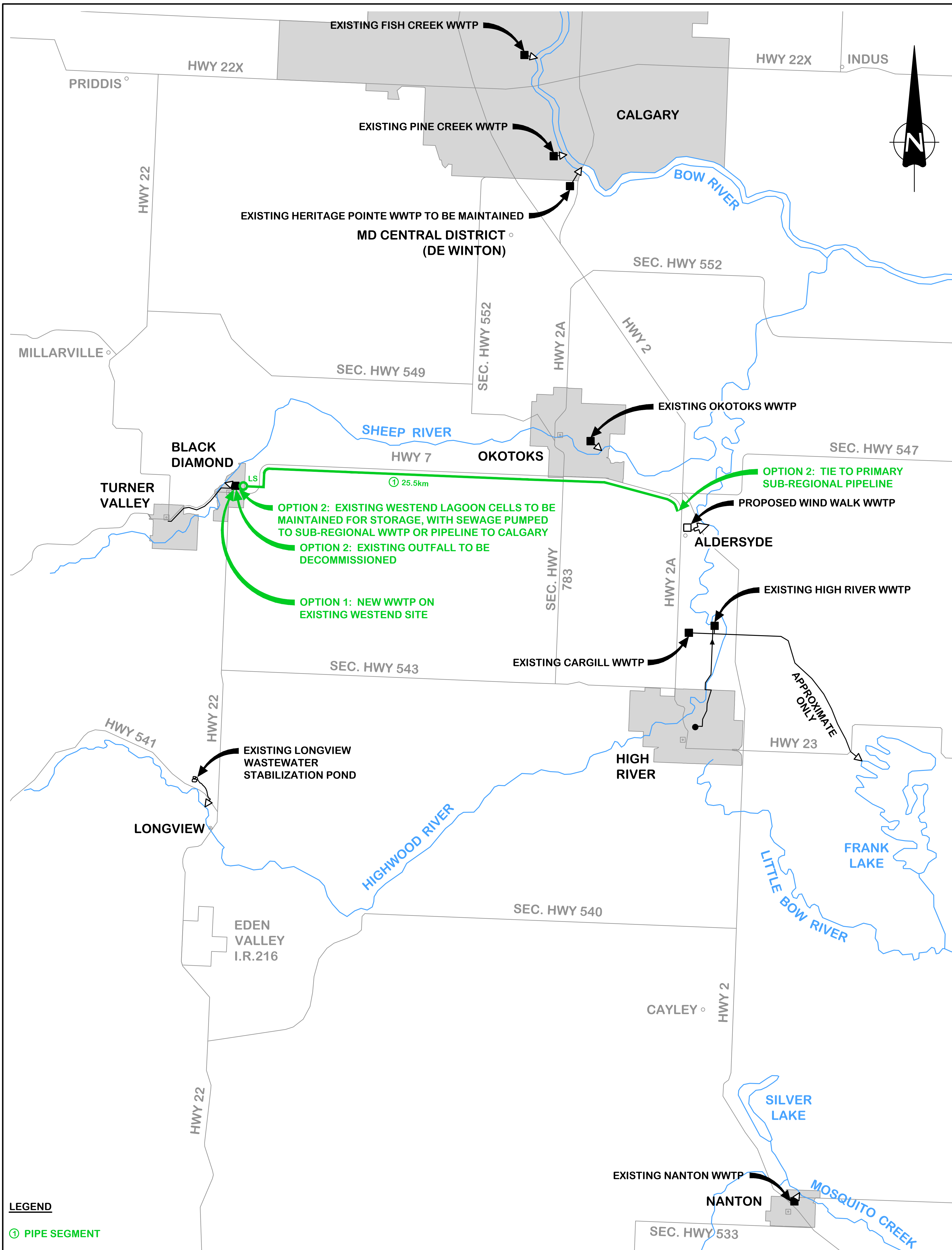
CRP 2014; *Regional Water and Wastewater Servicing Masterplan*, prepared for the Calgary Regional Partnership by CH2MHILL, May 2014.

MPE 2015; *Westend Regional Sewage Services Commission Revised Plan for Operating Approval*, prepared by MPE Engineering Ltd., November 25, 2015.

MPE/USL TM1 2015; *Technical Memorandum 1-Rev 1: Planning and Projections*, Prepared for the FRWWC by Urban Systems and MPE Engineering, November 30, 2015.

APPENDIX A:

FIGURE 5.1 –Westend Pipeline to Okotoks vs Stand-Alone Wastewater Treatment Plant



LEGEND

- ① PIPE SEGMENT
- CONCEPTUAL WASTEWATER TREATMENT PLANT
- CONCEPTUAL WASTEWATER OUTFALL
- LS CONCEPTUAL LIFT STATION
- EXISTING WASTEWATER TREATMENT PLANT
- PROPOSED PRIVATE WASTEWATER TREATMENT PLANT
- EXISTING WASTEWATER OUTFALL
- PROPOSED PRIVATE OUTFALL

URBAN systems

MPE Engineering Ltd.

FOOTHILLS REGIONAL WATER & WASTEWATER COLLABORATIVE

FRWWC WASTEWATER STUDY
Westend Pipeline to Okotoks vs Stand-Alone Wastewater Treatment Plant

SCALE: 1:200,000	DATE: JANUARY 2016	JOB: 2210-047-00	FIGURE: 5.1