Final Report for:

WILLOW CREEK REGION
SHARED WATER
DISTRIBUTION STUDY

Prepared By:

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Date: March 6, 2020
Project #: 2630-005-00

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March 6, 2020
File: N:\2630\005-00\R01-1.0

Attention: Mr. Neil Smith
Chief Administrative Officer

Dear Mr. Smith:

Re: Willow Creek Region
Shared Water Distribution Study

We are pleased to submit the above noted study. We thank you for the opportunity to be of service and to have prepared this report on your behalf. We look forward to assisting you in implementing your plans for the future. If you have any inquiries regarding our report or if clarification is required, please contact the undersigned.

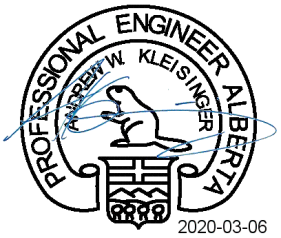
Yours truly,

MPE ENGINEERING LTD.

Blake Smith, C.E.T.
Project Technologist

/bs
Enclosure

Reviewed by:



Andrew Kleisenger, P.E.ng.
Project Engineer

cc: Marian Carlson, CAO, Town of Claresholm
Sue Keenan, CAO, Town of Fort Macleod
Candace Greig, CAO, Town of Stavely
Derrick Krizsan, CAO, MD of Willow Creek

CORPORATE AUTHORIZATION

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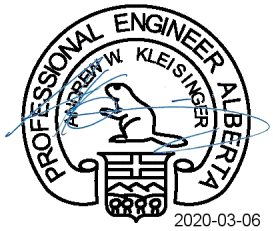
Should any questions arise regarding content of this report, please contact the undersigned.

MPE ENGINEERING LTD.



Andrew Kleisinger, P.Eng.
Project Engineer

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

EXECUTIVE SUMMARY

The Town of Nanton, on behalf of their regional partners – the Town of Claresholm, Town of Fort Macleod, Town of Stavely and the MD of Willow Creek – retained MPE Engineering Ltd. to complete the Willow Creek Region – Shared Water Distribution Study. The primary purpose of the study is to evaluate the existing water supply and treatment related infrastructure within the Willow Creek Region and propose alternatives to overcome limitations in the infrastructure. A secondary purpose of the study is to review the wastewater discharge locations and the impacts on the region's watershed. Based on the evaluation it was determined that the principle issue in the region is the lack of a year-round reliable water source for the Town of Nanton. The positive news that has come out of the study is that the remaining municipalities' water and wastewater infrastructure are in relatively good condition. The Town of Stavely will require some minor upgrades to their water and wastewater systems.

Five alternatives were proposed to resolve the Town of Nanton water supply issue. Further details surrounding other upgrades are found in the body of the report. The proposed alternatives for Nanton water supply are as follows:

Alternative 1: Pine Coulee Raw Water Supply

This alternative reviews the concept of changing the Town's principle raw water source to Pine Coulee Reservoir. A new raw water intake and pump station would be constructed at Pine Coulee and a raw water pipeline would be constructed between Pine Coulee and Nanton. Additional raw water storage is required to mitigate a water shortage risk associated with new water licences from Pine Coulee. The water treatment plant would be upgraded to include a powdered activated carbon (PAC) system to treat taste and odour concerns.

Alternative 2: Raw Water Storage Upgrades

This alternative reviews the concept of maintaining the principle raw water source as Mosquito Creek and increasing the amount of raw water storage. The pumps at Mosquito Creek are adequate to fill the increased volume and would be maintained. The existing Spring Line Extension project would be completed as currently scheduled. The water treatment plant would be upgraded to include a PAC system to address taste and odour concerns.

Alternative 3: Claresholm Regional Water Supply

This alternative reviews the concept of obtaining potable water from the Town of Claresholm. A new pump station and potable water pipeline to Nanton would be constructed with additional capacity to service Stavely and the MD of Willow Creek (including the Hamlet of Parkland). Additional raw water storage at Claresholm may be

required to mitigate a water shortage risk associated with new water licences from Pine Coulee.

Alternative 4: High River Regional Water Supply

This alternative reviews the concept of obtaining potable water from the Town of High River. An expansion to the booster pump station that services the Hamlet of Cayley and potable water pipeline to Nanton would be constructed. The pump station and potable water pipeline would be constructed in close proximity to the exiting potable water infrastructure to the Hamlet of Cayley.

Alternative 5: Pine Coulee Regional Water Supply

This alternative reviews the concept of a new regional water treatment plant near Pine Coulee Reservoir to service the Willow Creek Region including Claresholm, Granum, Stavely, Nanton and rural MD of Willow Creek water users. A new water treatment plant, pump station and potable water pipelines would be constructed. The existing raw water pipeline to Claresholm would be repurposed to a potable water pipeline. A raw water storage reservoir adjacent to the water treatment plant may be required to mitigate a water shortage risk associated with new water licences from Pine Coulee.

Comparison of Alternatives

The alternatives described above were assessed in detail. Due to the water shortage risk associated with new licences from Pine Coulee as well as higher relative costs, Alternatives 1, 3, and 5 are precluded from further consideration.

A present worth analysis was performed to estimate the total life cycle costs for Alternatives 2 and 4. Based on the present worth analysis, Alternative 2 provides the lower net present worth and lower average cost of water of the two alternatives examined over the 25-year design period.

Recommendations

Based on the information and analysis performed for this study, the following actions are recommended for the Town of Nanton:

- Continue with implementation of the Spring Line Extension project to supplement filling of the raw water reservoir during periods of no flow in Mosquito Creek.
- Proceed with a study to compare Alternative 2 and Alternative 4 in greater detail, including consultation with the Town of High River, MD of Foothills, Alberta Environment and Parks, and Alberta Transportation.
- Engage in discussions further with the Town of High River, including the involvement of elected officials.

- Proceed with proposed upgrades to the WWTP.

Based on the information and analysis performed for this study, the following actions are recommended for the Town of Stavely:

- Proceed with a hydrogeological assessment including testing to determine the most appropriate upgrade for increasing raw water allocation.
- Proceed with a wastewater treatment system assessment including wastewater flow monitoring.

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1.1 STUDY BACKGROUND

The Town of Nanton, on behalf of their regional partners – the Town of Claresholm, Town of Fort Macleod, Town of Stavely and the MD of Willow Creek (MD) – retained MPE Engineering Ltd. to complete the Willow Creek Region – Shared Water Distribution Study. The purpose of the study is to evaluate the existing water supply and treatment related infrastructure within the Willow Creek Region and present conclusions and recommendations for the long term sustainable supply of water to the region. Figure 1.1 presents an overview of the region as well as an overview of existing systems that service the region's municipalities.

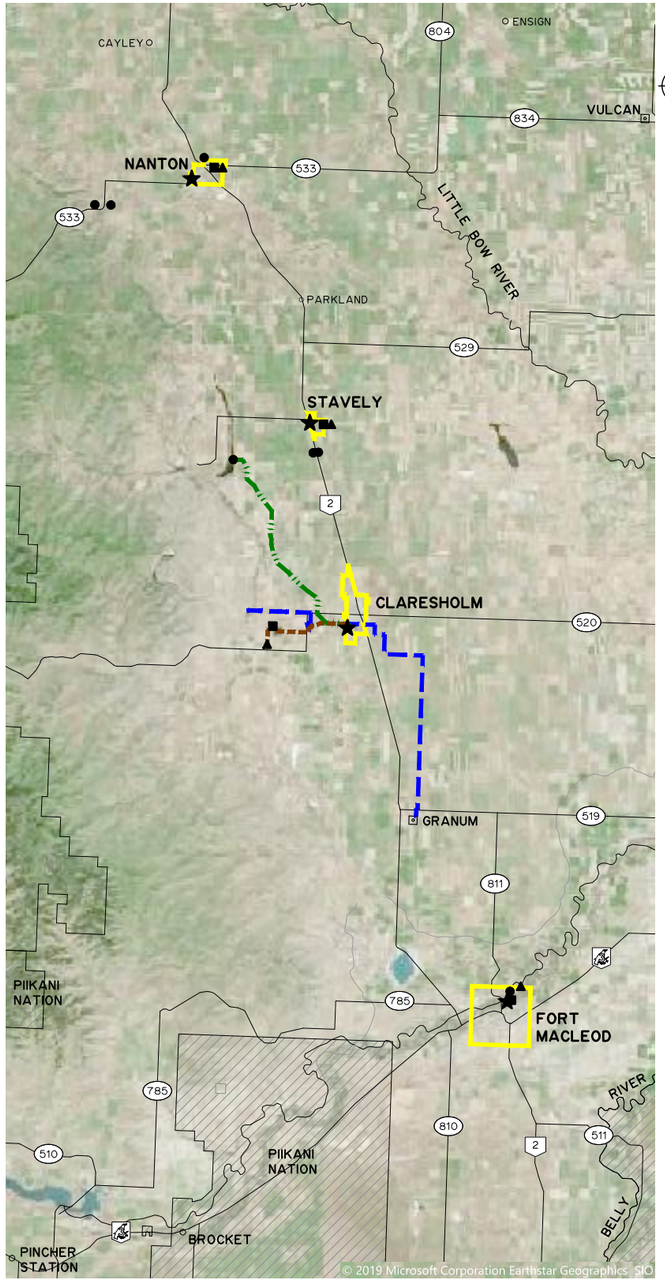
1.2 SCOPE OF WORK

In general, the study scope of work includes the following:

- Assessment of the region's water resources, including the effectiveness, capacity and geographical challenges.
- Assessment of the region's water system infrastructure, including its ability to effectively treat and transmit water to residents.
- Review of wastewater discharge locations and the impacts on the region's watershed.
- Identification of potential issues related to the region's water supply.
- Development of recommended improvements to the region's water supply systems, including a review of regionalization options where technically and economically feasible.
- Review options for regional system governance models. Including cooperatives, commissions, municipally controlled for profit corporations.
- Develop a summary report outlining all study findings including conclusions and recommendations.

1.3 DATA COLLECTION AND ANALYSIS

The Towns of Nanton, Stavely, Claresholm and Fort Macleod are required by Alberta Environment and Parks (AEP) to record Water Treatment Plant information on a daily, weekly and monthly basis. Historical records were obtained from the individual municipalities. Population data was obtained from Statistics Canada (statcan.gc.ca).



LOCATION PLAN
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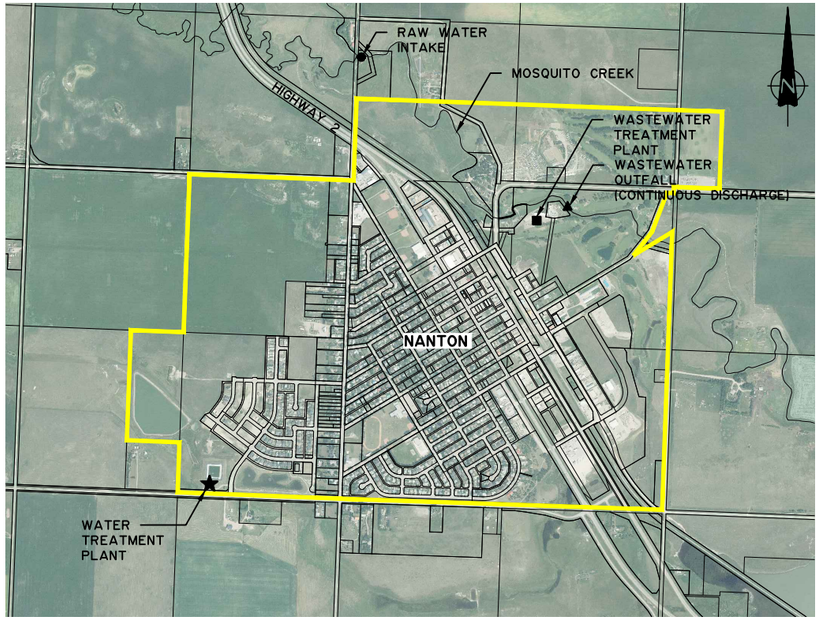

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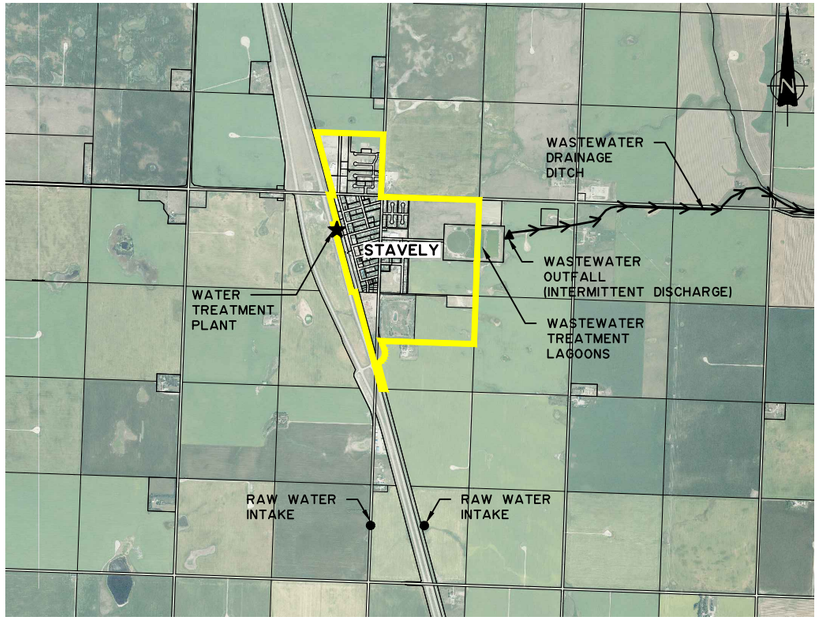

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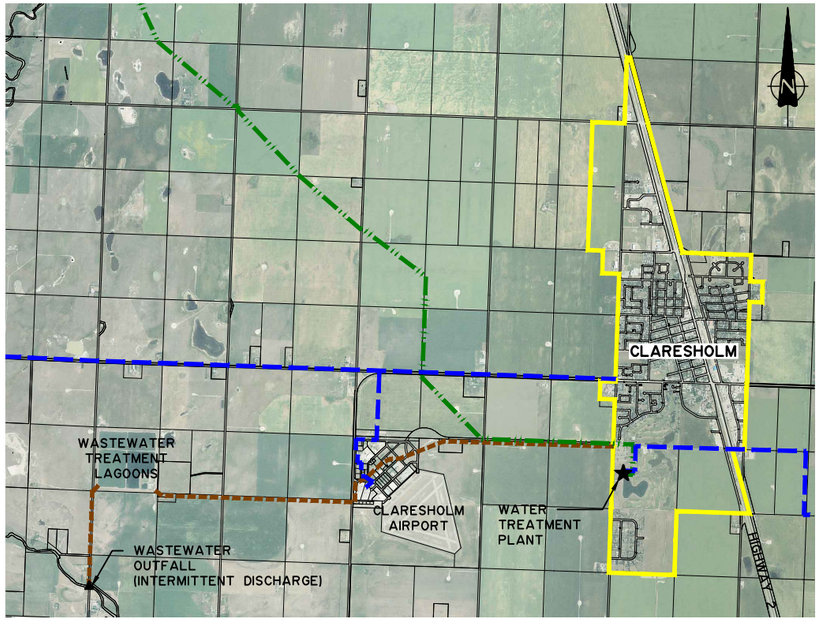

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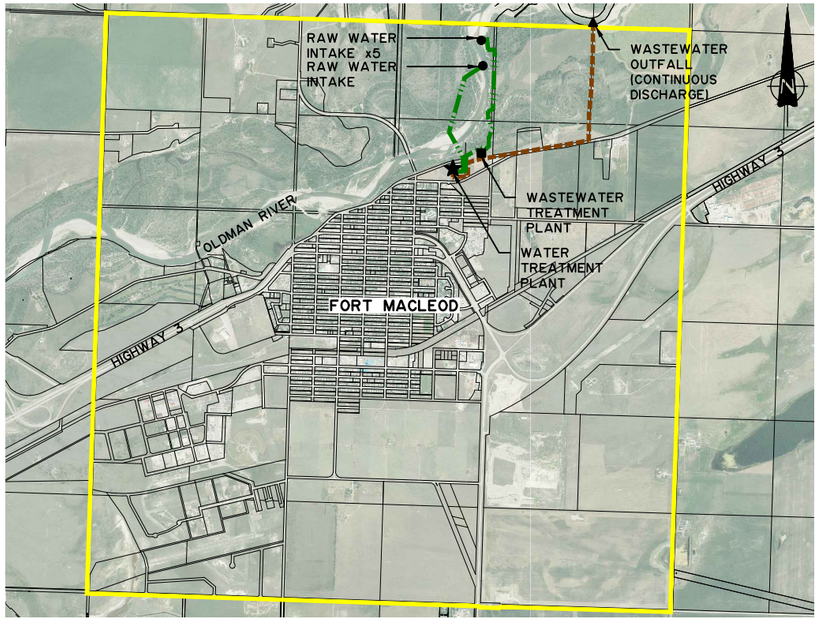

TOWN OF FORT MACLEOD
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LEGEND

- TOWN BOUNDARY
- EXISTING POTABLE WATER PIPELINE
- EXISTING RAW WATER PIPELINE
- EXISTING WASTEWATER PIPELINE
- EXISTING RAW WATER INTAKE
- EXISTING WATER TREATMENT PLANT
- EXISTING WASTEWATER OUTFALL
- EXISTING WASTEWATER TREATMENT FACILITY

MPE Engineering Ltd.

SHARED WATER DISTRIBUTION STUDY
EXISTING SYSTEMS LOCATIONS

SCALE: AS NOTED	DATE: DECEMBER 2019	JOB: 2630-005-00	FIGURE: 1.1

2 DEVELOPMENT OF WATER SUPPLY REQUIREMENTS

2.1 POPULATION PROJECTIONS

Historical population figures were obtained from Statistics Canada census information. The most recent census data available is from 2016. Based on typical projected growth rates for southern Alberta a projected growth rate of 1.5% was chosen by the municipalities for Nanton, Stavely, Claresholm, Granum and Fort Macleod. A projected growth rate of 1.0% was chosen for the MD. Table 2.1 provides historical and projected populations for the 25-year design horizon.

Table 2.1 – Population Projections

Location	Growth Rate Projection	Historical Data					Projected Population					
	%/yr	1996	2001	2006	2011	2016	2019	2024	2029	2034	2039	2044
Nanton	1.5%	1,665	1,841	2,055	2,132	2,130	2,227	2,399	2,585	2,785	3,000	3,232
Stavely	1.5%	453	442	435	505	541	566	609	657	707	762	821
Claresholm	1.5%	3,427	3,622	3,700	3,758	3,780	3,953	4,258	4,587	4,942	5,324	5,735
Granum	1.5%	337	392	415	447	406	425	457	493	531	572	616
Fort Macleod	1.5%	3,034	2,990	3,072	3,117	2,967	3,103	3,342	3,601	3,879	4,179	4,502
MD of Willow Creek	1.0%	5,106	5,412	5,337	5,107	5,179	5,336	5,608	5,894	6,195	6,511	6,843

2.2 HISTORICAL WATER USAGE

Historical water usage data was provided by the municipalities spanning from 2012 to 2018, Table 2.2 presents a summary of the total yearly, average day and maximum day usage data for the range of reports supplied by the municipalities.

2.3 WATER DEMAND PROJECTIONS

The historical water usage data and the projected populations for the municipalities were used to calculate the future (2044) water demands.

Per capita consumption for future demands was assumed to remain at the current rates. The current and projected water demands for each community are provided in Table 2.3. Similar to other regional studies, a 20% allocation is recommended to be included in the projections for rural demands for any regional options considered.

Table 2.2 – Historical Treated Water Demand																				
	2013			2014			2015			2016			2017			2018			Historical Average		
	Total Year Usage	Avg Day	Max Day	Total Year Usage	Avg Day	Max Day	Total Year Usage	Avg Day	Max Day	Total Year Usage	Avg Day	Max Day	Total Year Usage	Avg Day	Max Day	Total Year Usage	Avg Day	Max Day	Total Year Usage	Avg Day	Max Day
	m^3	m^3/day	m^3/day	m^3	m^3/day	m^3/day	m^3	m^3/day	m^3/day	m^3	m^3/day	m^3/day	m3	m3/day	m3/day	m3	m3/day	m3/day	m3	m3/day	m3/day
Town of Nanton	265,148	726	1,621	263,715	723	1,489	361,161	989	1,892	346,433	947	1,833	345,762	947	1,813	370,203	1,014	1,948	325,404	891	1,948
Town of Stavely	85,836	235	403	83,823	230	385	85,519	234	603	81,730	223	513	895,54	245	611	95,040	260	482	86,917	238	611
Town of Claresholm	x	x	3,595	580,847	1,591	x	636,613	1,744	4548	623,537	1,704	3,858	683,421	1,872	4,271	x	x	x	631,105	1,728	4,548
Town of Granum	x	x	384	57,250	157	x	58,374	160	779	61,014	167	851	70,609	193	551	x	x	x	61,812	169	851
Town of Fort Macleod	853,325	2,338	4,707	Not Available	Not Available	Not Available	930,232	2,549	6,214	875,296	2,392	5,588	916,683	2,511	6,636	926,386	2,538	6,478	900,384	2,465	5,925

Table 2.3 – Water Demand Projections												
Location	Current 2019							Projected 2044				
	Population	Average Day		Peaking Factor	Max Day		Annual Consumption	Population	Average Day	Peaking Factor	Max Day	Annual Consumption
		m^3/day	Lpcd		m^3/day	Lpcd	m^3		m^3/day		m^3/day	m^3
Town of Nanton	2,227	924	415	2.1	1,979	888	337,380	3,232	1,341	2.1	2,871	489,519
Town of Stavely	566	250	442	2.6	639	1,129	91,266	821	363	2.6	927	132,422
Town of Claresholm	3,953	1,801	456	2.6	4,761	1,205	657,356	5,735	2,613	2.6	6,908	953,787
Town of Granum	425	174	409	5.1	890	2,096	63,432	616	252	5.1	1,291	92,036
Town of Fort Macleod	3,103	2,575	830	2.7	6,835	2,203	940,004	4,502	3,737	2.7	9,917	1,363,895
TOTAL	15,609	5,724	2,552		15,104	7,521	2,089,438	21,748	8,306		21,915	3,031,660

3 SUMMARY OF REGIONAL WATER INFRASTRUCTURE

3.1 SITE INSPECTIONS

Site inspections of the existing water and wastewater infrastructure in Nanton and Stavely were completed in the months of May and June 2019. Site Inspections were completed by Andrew Kleisinger and Kim Schurtz of MPE Engineering Ltd. Tyler Ray of Ghostpine Environmental Services joined MPE for the site inspection of the Stavely wastewater lagoon outfall.

Site inspections of the existing water and wastewater infrastructure in Claresholm and Fort Macleod were not completed as part of this study. MPE has extensive experience with the existing infrastructure in these communities as we have been involved with significant upgrades in recent years. Claresholm and Fort Macleod both report their water and wastewater infrastructure to be in good working condition.

The results of the Nanton and Stavely existing water and wastewater infrastructure site inspections are presented in the Section 6 – Identification of Issues. The results of the Stavely wastewater lagoon outfall site inspection are presented in Section 4 – Environmental Assessment.

3.2 SUMMARY OF WATER INFRASTRUCTURE

An inventory of the key water infrastructure found in each of the municipalities was completed. A summary of the infrastructure is presented in Table 3.1. An overview of the existing infrastructure in the study region is presented in Figure 1.1. The infrastructure in each municipality is discussed in further detail in the following sections.

Table 3.1 – Facility Matrix

Location	Raw Water						Disinfection		Treated Water Storage		Distribution Pumping			Comments
	Raw Water Source	Raw Water Pumping	Capacity	Clarifier	Filtration	Design Treatment Capacity (m^3/day)	Primary Disinfection	Secondary Disinfection	Type	Volume (m^3)	Type	Quantity / HP	Capacity[1]	
Town of Nanton	Surface	2 x 100H.P. - at Mosquito Creek	46.7L/s (4,035m3/d)	DAF	Rapid Gravity Sand Filtration	3,800	Chlorine Gas	Chlorine Gas	One Concrete Reservoir Below Ground	4,655	End Suction Centrifugal	2 x 60 H.P. 1 x 20 H.P.	Total: 189 L/s (16,330m3/d) Firm: 104 L/s (8,986 m3/d)	- PLC System not integrated - Filter Backwash decant into Raw Water Reservoir uncontrolled - Raw water high NTU, taste and odour issues
Town of Stavely	High Quality Ground Water	1 x 10 H.P. 1 x 15 H.P.	5.0L/s (436m3/d) 9.5L/s (818m3/d)	N/A	Slow Sand Filtration	800	Sodium Hypochlorite	Sodium Hypochlorite	Two Concrete Reservoirs Below Ground	1,136	Centrifugal	1 x 5 H.P. 2 x 10 H.P.	Total: 40 L/s (3,456m3/d) Firm: 30 L/s (2,592m3/d)	
Town of Claresholm	Surface	Gravity flow from Pine Coulee Reservoir	Low Reservoir Level 145L/s (12,528 m3/d) High Reservoir Level 189L/s (16,330 m3/d)	DAF	Membrane	8,840 Current 14,000 Ultimate	Chlorine Gas	Sodium Hypochlorite	Three Concrete Reservoirs	5,469	Vertical Turbine	WTP 1 x 30 H.P. WTP 3 x 50 H.P. WTP 1 x 60 H.P. Hwy2 1 x 30 H.P. Hwy2 3 x 60 H.P.	WTP Total : 232 L/s (20,045 m3/d) WTP Firm : 181 L/s (15,638 m3/d) Hwy2 Total: 213 L/s (18,403 m3/d) Hwy2 Firm: 153 L/s (13,219 m3/d)	
Town of Fort Macleod	Surface	Caisson 2 x 25 H.P. Caisson 1 x 50 H.P. Infiltration 2 x 20 H.P. Infiltration 3 x 30 H.P.	Caisson 90L/s (7,776 m3/d) Infiltration 150 L/s (12,960 m3/d)	N/A	Rapid Sand Filtration	12,960	UV	Sodium Hypochlorite	Three Concrete Reservoirs	9,544	End Suction Centrifugal	1 x 25 H.P. 3 x 100 H.P. 1 x 125 H.P.	Total: 320 L/s (27,648 m3/d) Firm: 219 L/S (18,922 m3/d)	

(1) Assume 60 psi on the distribution pumping for calculating the distribution pumping capacity

3.2.1 Town of Nanton

The Town of Nanton receives its raw water from two sources. The main source of raw water is Mosquito Creek. Raw water is drawn through an infiltration gallery which is connected to a wet well and submersible pumps. The pumps transfer the water through a 200mm pipeline to an approximately 204,000 m^3 raw water storage reservoir. The raw water storage reservoir was de-sludged in 2019.

The secondary source of raw water is a spring located approximately 12 km southwest of Town. The spring water is transferred to the WTP through a 100mm pipeline. The spring pipeline is reduced to 50mm prior to entering the WTP. The Town of Nanton has retained MPE to provide design, tendering and construction engineering services to extend the spring waterline to connect to the raw water reservoir. This work was recommended by AEP as a means of alleviating water quality issues caused by inconsistent blending. This work is schedule to be completed in 2020.

The water treatment process includes DAF clarification, rapid gravity sand filtration and chlorine gas disinfection to provide potable water to the Town of Nanton. A photo of the Nanton WTP is shown below in Figure 3.1.

Figure 3.1 – Nanton Water Treatment Plant

3.2.2 Town of Stavely

The Town of Stavely receives its raw water from a well located approximately 2 km south of the Town. Raw water is pumped from the well to the WTP.

The water treatment system utilizes slow sand filtration and sodium hypochlorite disinfection to provide potable water to the Town of Stavely. A photo of the Stavely WTP is shown in Figure 3.2.

Figure 3.2 – Stavely Water Treatment Plant

3.2.3 Town of Claresholm

The Town of Claresholm receives its raw water from Pine Coulee Reservoir. Raw water is transferred to a 227,000 m³ aerated raw water storage reservoir and the WTP though a 500mm gravity pipeline.

The water treatment system utilizes DAF clarification, membrane filtration and chlorine gas disinfection to provide potable water to the Town of Claresholm. The Town of Claresholm also supplies potable water to Granum via a potable water pipeline and other relatively small portions of the MD. The Claresholm WTP is relatively new, with construction being completed in 2010. A photo of the Claresholm WTP is shown in Figure 3.3.

Figure 3.3 – Claresholm Water Treatment Plant

3.2.4 Town of Fort Macleod

The Town of Fort Macleod receives its raw water from the Oldman River from two sources. The original source is an intake structure and pump station located approximately 1km north of the WTP on the west bank of the Oldman River. The new source consists of a series of wells and pumps located approximately 1 km north of the WTP on the east bank of the Oldman River. The new source was added in 2019. The raw water for both sources is pumped directly to the WTP.

The water treatment system utilizes flocculation, rapid sand filtration, Ultra-Violet disinfection and Sodium Hypochlorite disinfection to provide potable water to the Town of Fort Macleod. A photo of the Fort Macleod WTP is shown in Figure 3.4.

Figure 3.4 – Fort Macleod Water Treatment Plant

3.2.5 MD of Willow Creek

The MD of Willow Creek has very limited water infrastructure. The MD has a water treatment system for the Hamlet of Moon River Estates. The MD contracts water operations and maintenance services for this system from Lethbridge County. The MD purchases potable water and contracts operations and maintenance from the Town of Claresholm to distribute to the Claresholm Airport area and the West Water Co-op.

The Town of Granum recently voted to dissolve the Town of Granum and become part of the MD. The MD is in discussions with the Province for amalgamating the Town of Granum into the MD. The MD will ultimately assume responsibility for the Granum water system. The Granum water system receives potable water from the Town of Claresholm.

3.3 SUMMARY OF DIVERSION LICENCES

Each of the municipalities in the study region has their own raw water diversion licences. The majority of the municipalities have sufficient licence for the projected 2044 annual consumption with the exception of Stavely. Stavely will require additional raw water allocation by 2027 at the projected growth rate. A summary of the raw water diversion licences is found in Table 3.2.

It should be noted that the Town of Claresholm projected max day for 2044 is only 4 m^3/day less than the allowable maximum day diversion rate. The Town has raw water storage to offset maximum day demands as required.

Table 3.2 – Raw Water Diversion Licence Summary

Location	Licence number	Raw Water Source	Priority Number	Expiry Date	Point of Diversion / Re-diversion	Annual Licence Allocation	Max Day Diversion Rate	Projected Annual Consumption (2044) (1)	Projected Max Day	Annual Surplus	Max Day Surplus
						m^3	m^3/day	m^3	m^3/day	m^3	m^3/day
Town of Nanton	00031062-00-00	Mosquito Creek	1982-08-17-03	N/A	SW 22-16-28-W4M	616,740	8,510	562,947	2,871	143,916	6,503
	00045700-00-01	Tributary to Springhill Creek - 10km SW of Nanton on Hwy 533	1954-08-16-001	N/A	W1/2 3-016-29-W4M	90,123	864				
	00033114-00-00	Well - 10km SW of Nanton on Hwy 533	1978-12-07-02	N/A	10-2-16-29-W4M	186,390	281	N/A	N/A	186,390	281
Town of Stavely	00036030-00-00	Well	1974-07-03-01	N/A	SE-5-014-27-W4M	92,510	851	152,286	927	(32,516)	745
	00223047-00-00	Well	2005-06-27-01	N/A	SW-04-014-37-W4M	27,260	821				
Town of Claresholm	00031805-00-00	Coulee Tributary to Willow Creek (Golf Course)	1979-08-23-03	N/A	NW 23-12-27-W4M	98,680	2,340	N/A	N/A	N/A	N/A
	00034490-00-00	Well - Airport Water Supply	1986-08-27-01	N/A	11-7-12-27-W4M	41,940	393	N/A	N/A	N/A	N/A
	00261922-00-00	Pine Coulee Reservoir	1909-06-16-001	N/A	NW 35-013-28-W4M	1,301,235	6,912	1,096,855	6,908	204,380	4
Town of Fort Macleod	00045796-00-00	Oldman River	1908-05-23-01 1980-01-03-01	N/A	NE-13-009-26-W4M NE-13-009-26-W4M	900,442 949,781	14,690	1,568,479	9,917	281,744	4,773
M.D. of Willow Creek	00027444-00-00	Well - 5km SE of Stavely	1989-09-12-01	N/A	16-34-013-27-W4M	24,549	655	N/A	N/A	N/A	N/A
	00032751-00-00	Well - 20km SE of Claresholm	1952-12-31-06	N/A	13-12-012-25-W4M	9,092	327	N/A	N/A	N/A	N/A
	00033653-00-00	Well (Moon River)	1977-12-19-08	N/A	2-13-009-24-W4M	12,729	393	N/A	N/A	N/A	N/A
	00033564-00-00	Wells (One Standby) (Moon River)	1977-12-19-01 1977-12-19-07	N/A	2-13-009-24-W4M	22,276	655	N/A	N/A	N/A	N/A
	00035391-00-00	Well - 2km N of Fort Macleod	1973-08-27-02	N/A	NW-24-009-26-W4M	49,552	655	N/A	N/A	N/A	N/A
	00359529-00-00	Pine Coulee Reservoir (Westside Co-op)	2016-02-18-003	12-Jul-41	NW 35-013-28-W4M	10,000	294	N/A	N/A	N/A	N/A
	00382750-00-00	Pine Coulee Reservoir (Leavings Co-op)	Preliminary Certificate	12-Jul-21	NW 35-013-28-W4M	156,200	475	N/A	N/A	N/A	N/A

Note: (1) Apply a factor of 1.15 (85% efficiency) to the projected treated water demand to project the raw water consumption

4 ENVIRONMENTAL ASSESSMENT

4.1 TOWN OF STAVELY WASTEWATER OUTFALL LOCATION ASSESSMENT

MPE retained Ghostpine Environmental Services (GES) to provide valuable insight into avoiding potential environmental conflicts as needed on the various alternatives.

GES and MPE completed an on-site assessment of the Town of Stavely lagoon discharge in June 2019. The full details of the review can be found in Appendix A. A brief summary of the comments from the review are included below:

- The storage cell was being discharged during the site review.
- GES and MPE followed the drainage course.
- Where the drainage course crosses TWP Rd 142 the culvert is undersized and vegetative growth restricts flow resulting in localized flooding of a small area of farmland to the south.
- Water reaches small pond areas within the seasonally dry Clear Brook Creek.
- GES does not feel water from the lagoon ever reaches the fish-bearing water body downstream (Clear Lake).

5 HYDROGEOLOGICAL REVIEW

MPE retained Waskasoo Hydrogeological Services (WHS) to complete an assessment of the groundwater systems near Stavely and Nanton. The groundwater systems near Claresholm, Fort Macleod and the MD were not assessed as part of this report because these municipalities utilize surface water for water supply and water supply issues were not identified. The full report can be found in Appendix B.

5.1 IDENTIFICATION OF THE REGION'S GROUNDWATER SYSTEMS

Two types of aquifers are present in the region near Stavely and Nanton, bedrock aquifers and valley aquifers. Bedrock aquifers generally have low potential, even for domestic needs in some locations. Valley aquifers are ancient river valleys filled with sand and gravel. Where present and containing sufficient saturated sand and gravel, they often constitute prolific aquifers.

The Cretaceous Willow Creek Formation is a bedrock aquifer which lies under the majority of the region. The Town of Nanton wells, one of which is licensed but not currently used, have drawn water from this aquifer in the past.

The Stavely Valley is a valley aquifer that passes approximately 2 km south of Stavely in an east-west direction. The Town of Stavely draws their water from this aquifer.

WHS identified other potential aquifers near the study area – Blackie Valley and Okotoks Valley. These aquifers are at similar or greater distance from Nanton, and outside the study area. As such, these options have not been considered further.

There is also a spring located west of the Town of Nanton, which is currently utilized by the Town of Nanton and the Rural Springhill Water Users Society.

5.2 DISCUSSION OF THE REGION'S GROUNDWATER SUPPLY

5.2.1 Town of Nanton

The groundwater supply in close proximity to the Town of Nanton comes from the Cretaceous Willow Creek Formation. The Town of Nanton has a licence to divert water from a spring located west of the Town. The licence allows for 100 acre-feet to be diverted. 27 acre-feet of this allocation goes to the Springhill Water Users Society, leaving 73 acre-feet or 90,123 m^3 available to the Town.

The Town of Nanton owns a licensed but not currently operating well located west of the Town. The well is licensed for 15 acre feet or 18,502 m^3. The available information for this well, although incomplete, suggests that a withdrawal rate of 125 igpm may be sustainable. Additional testing of the well is required to determine its true capacity.

An additional well previously held a licence to produce 43 igpm. The licence was cancelled by AEP in 1996 for unknown reasons.

A review of the available historical data for the spring and the Town of Nanton wells completed by WHS suggests that there is a theoretical possibility to provide the projected 2044 demands from the nearby groundwater sources. Significant additional testing and investigation is required before a recommendation can be made to pursue the local groundwater source as a sustainable long-term supply. The raw water storage reservoir would remain in place and replacement of the WTP may be required to change from treating surface water to groundwater. A summary of the potential groundwater supply near the Town of Nanton is shown in Table 5.1.

Table 5.1 – Nanton Groundwater Supply

Source	Theoretical Capacity	
	m^3/year	m^3/day
Spring	90,123	247
Well #1	102,834	282
Well #2	298,939	819
Total Groundwater	491,896	1,348
2044 Annual Consumption	489,519	-
2044 Maximum Day Demand	-	2,871

5.2.2 Town of Stavely

The Town of Stavely owns two (2) licensed wells located south of the Town that draw from the Stavely aquifer. Only one of the wells is currently being utilized. The WHS report indicates that the Stavely Valley aquifer is a prolific aquifer with a capacity in excess of the total current and future demands for the Town of Stavely.

5.3 Review of Potential Sources of Additional Supply

5.3.1 Town of Nanton

The WHS report indicates that there are several other potential sources of additional supply for the Town of Nanton. The process to treat groundwater is different than the process to treat surface water. The Nanton WTP is designed to treat surface water, although the Town currently operates as a mix of surface water and a relatively small percentage of groundwater. In order for the Nanton WTP to use a higher percentage of groundwater or to switch to strictly groundwater, significant upgrades to the existing WTP or a new WTP would likely be required. The potential sources of additional supply are discussed briefly in the following sections. The distance from Nanton and the required WTP upgrades preclude all of the following options from further consideration. If the other recommended alternatives in the report prove not feasible, further investigation into these alternatives could be considered.

5.3.1.1 ALTERNATIVE VALLEY AQUIFERS

The WHS report indicates there are several highly productive wells in the Silver Valley in Range 26 of Township 19. The Blackie and Okotoks Valleys may also be considered as potential sources for additional supply. These potential sources are approximately 25 to 30 km from Nanton.

5.3.1.2 PINE COULEE RELIEF WELLS

AEP owns and operates three (3) wells located east of Pine Coulee Reservoir that draw from the Stavely Valley aquifer. The wells are used to reduce excess pressure in the aquifer and prevent piping of soils in the area by maintaining the groundwater level within a certain range. Water from the wells is currently pumped to the Pine Coulee Reservoir. The AEP wells are hydraulically connected to the Town of Stavely wells.

The relief wells are reported to each have a capacity of 1,728 m^3 per day. It is also reported that the wells are typically operated one at a time. It is unknown if more than one well can sustainably be operated at the same time. The relief wells may have sufficient capacity to provide the projected 2044 demands. It is not known at this time whether AEP would consider allowing the groundwater from the source to be directed to municipal use. Discussions with AEP and confirmation of the well capacities is required before this alternative can be considered.

5.3.1.3 NEW STAVELY VALLEY AQUIFER WELLS

The WHS report indicates that several wells could be constructed in the Stavely Valley Aquifer, a minimum of five (5) km east of the Town of Stavely supply. This potential source is approximately 30 km southeast of Nanton.

5.3.2 Town of Stavely

The projected 2044 water demand for the Town of Stavely is greater than the allocations on the Town's current water licences. In order to service the future projected demands, the Town of Stavely will require additional raw water allocation by 2027 based on a growth rate of 1.5%. The WHS report identified 3 potential sources of additional supply which are discussed in the following sections.

5.3.2.1 INCREASE PUMPING FROM THE EXISTING WELL

The WHS report indicates that the capacity of the existing well is far greater than the projected 2044 demand. The capacity of the existing raw water pump is not sufficient to meet the projected 2044 demand. Section 6.6.2 provides greater detail on the pumping shortfall.

5.3.2.2 CONSTRUCTION OF A NEW PRODUCTION WELL

A third option outlined in the WHS report is the construction of a new production well approximately 50m north of the existing production well. The addition of another production well would provide redundancy to the raw water supply system.

5.3.2.3 PINE COULEE RELIEF WELLS

The Pine Coulee Relief Wells are discussed in Section 7.3.1.2 as a potential source of additional supply for the Town of Nanton. The wells are also a potential source of supply for the Town of Stavely. The relief wells have a capacity of more than double the 2044 maximum day demand for the Town of Stavely. Discussions with AEP is required to determine if this alternative is feasible. This option is not included further as the other two groundwater options are much more cost effective.

6 IDENTIFICATION OF ISSUES

A review of each of the various municipalities water systems was completed. The results of the review are presented in the following sections.

6.1 TOWN OF NANTON

The Town of Nanton experiences a number of issues with their water and wastewater systems. The issues are related to raw water supply and storage, taste and odour complaints, and the wastewater treatment plant.

6.1.1 Review of Site Inspections

Site inspections of the existing water and wastewater infrastructure were completed. A summary of the site inspection observations related to the water supply and treatment system are included below:

- The water supply from Mosquito Creek is subject to low flow periods. The Town cannot obtain raw water during the low flow period. The low flow period varies from season to season, but is generally from October 1st to April 30th. The Town is reliant upon the raw water storage at the Water Treatment Plant during this time.
- The raw water storage pond has a high volume of solids. A desludging project was completed in the summer of 2019 with some success.
- The backwash waste pond decants uncontrolled into the raw water storage reservoir. This is in contravention to the AEP Standards and Guidelines and there are potential water quality implications.
- There are known water quality issues related to manganese, taste, and odour.
- There are potential raw water supply issues.
- The infrastructure at the WTP is aging.

A summary of the issues related to the wastewater treatment plant (WWTP) and disposal system is found below:

- A new Membrane Bioreactor (MBR) WWTP has been operating for approximately 2 years.
- Single points of failure have been identified, which have caused major operational challenges.
- Return activated sludge (RAS) pumps have no redundancy. The loss of one pump cuts plant capacity in half.
- There is no spare membrane pulse tank.
- RAS and mixer control cables are not properly secured.
- Blower capacity is an issue. Operations staff would like to utilize blowers for different processes instead of blowers dedicated to one aspect of the process only.

- Lack of plant control system dial-out capability. There is no Supervisory Control and Data Acquisition (SCADA) auto-dialer. This could lead to a major issue in the event of a critical process failure.
- No access was provided to the Air Handling Unit (AHU) and related filtration system. Future required maintenance will be a major undertaking.
- Original construction project had no contingency. Items that may have been corrected or added during a typical construction project were seemingly not addressed during construction of this plant.
- The WWTP has higher than anticipated operating costs compared to the previous system.

6.1.2 Raw Water Supply and Storage

Mosquito Creek, the Town's primary source of raw water, is a seasonal waterway with highly variable flow. The water in Mosquito Creek comes primarily from the Highwood River though the Women's Coulee Diversion. AEP's 2008 Highwood Diversion Plan identifies the operating season as April 1st through September 30th. The Town of Nanton is only able to withdraw from the creek while there is sufficient flow in the Creek. The Town has historically been able to withdraw water from the creek outside of the operating season listed above. The Town should continue to take advantage of the extended season, filling the reservoir when possible, to lower the risk of a water shortage. However; this will vary from year to year and should not be relied on.

The Town of Nanton utilizes a spring as a secondary raw water source. The spring source does not provide sufficient flow to be used as the primary source. The spring source is currently connected directly to the water treatment plant and is blended with the water from the raw water storage reservoir immediately prior to treatment. The Town does not presently have the ability to store the spring water. The storage reservoir "bladder" located northeast of the WTP has been abandoned for some time and is not thought to be usable infrastructure.

Due to the lack of adequate year-round raw water supply, the Town operates a raw water storage reservoir to provide for the low and/or no flow periods. A review of the available raw water data over the last 4 years (2015 to 2018) during the "winter period" or October 1 to April 30 was completed. The data is presented in Table 6.1.

Table 6.1 – Nanton Historical Raw Water Winter Demands					
Month	Average Daily Flow Demands				
	2015 m3/day	2016 m3/day	2017 m3/day	2018 m3/day	Average m3/day
January	945	904	903	866	904
February	904	1,041	879	813	909
March	989	970	921	875	939
April	1,186	941	985	892	1,001
October	919	1,179	1,054	926	1,020
November	1,098	1,044	958	849	987
December	916	871	970	843	900
Total Flow	210,685	211,408	202,179	183,756	202,007
Population	2,131	2,130	2,162	2,194	
Average Day (m^3)	994	993	953	866	951

The data shows that the average raw water demand for the winter period is approximately 202,000 m^3. The maximum capacity of the existing raw water storage reservoir is approximately 204,000 m^3. This capacity does not account for sludge, ice, a minimum withdrawal level, etc. due to limited available data on the reservoir. The data shows that the Town is dangerously close to running out of water during the winter. The Town has indicated that they have come close to running out of raw water in the past. The reasons that the Town has not run out of water can be attributed to Mosquito Creek withdrawal outside the normal period and varying use of the spring source. Table 6.2 presents projected raw water winter demands.

Table 6.2 – Nanton Projected Winter Demands				
Year	Population	Raw Water Usage		Reservoir Surplus
		Average Day	Total	
		m^3/day	m^3	m^3
2019	2,227	951	201,612	2,388
2020	2,261	966	204,690	-690
2021	2,295	980	207,768	-3,768
2022	2,329	995	210,846	-6,846
2023	2,364	1,010	214,015	-10,015
2024	2,399	1,024	217,183	-13,183
2029	2,585	1,104	234,022	-30,022
2034	2,785	1,189	252,128	-48,128
2036	2,900	1,238	262,539	-58,539
2039	3,000	1,281	271,592	-67,592
2044	3,232	1,380	292,595	-88,595

The 2044 projected winter demand is approximately 90,000 m^3 greater than the existing raw water reservoir capacity. Coincidentally, the spring source licence allocation is also approximately 90,000 m^3. As a short-term solution, there is potential to shift the spring diversion entirely to the winter period to help offset the raw water storage requirement. The Town of Nanton has retained MPE to provide design, tendering construction engineering services to extend the spring waterline to connect to the raw water fill line, upstream of the raw water storage reservoir. This project will also alleviate water quality issues related to the inconsistent blending of spring water with the water from the raw water storage reservoir. This change was a recommendation of AEP. This work is schedule to be completed in 2020.

6.1.2.1 AEP Raw Water Storage Guidelines

The existing raw water storage reservoir does not meet current AEP guidelines. According to AEP's 2012 Standards and Guidelines for Municipal Waterworks, raw water reservoirs should be constructed with a minimum of two cells to provide redundancy. Each cell should be sized to provide 75% of the annual raw water needs. The Town of Nanton currently has a single storage cell that provides only 51% of current annual raw water needs and 35% of the projected 2044 annual raw water needs. In order to meet the AEP guidelines an additional 640,000 $m^3$of raw water storage would be required, or more than three times the storage capacity of the existing raw water storage reservoir.

6.1.3 Taste and Odour Complaints

Town administration and operations staff have indicated that a common complaint from the residents is that the treated water has an undesirable taste and odour. The Town of Nanton completed a project to de-sludge the reservoir in 2019. The removal of sludge from the reservoir should have a positive effect

on the taste and odour of the treated water. The taste and odour of the treated water should be re-evaluated in the spring and through the following years. Improvements are suggested in Section 7 that can be completed as part of a larger upgrade if the taste and odour complaints are still prevalent.

6.1.4 Wastewater Treatment Plant

The Town of Nanton commissioned a new Membrane Bioreactor (MBR) WWTP in 2017. The plant has had numerous operational challenges. The Town has indicated that the operational costs are significantly higher than anticipated.

6.2 TOWN OF STAVELY

The Town of Stavely reports that there are no major concerns with the day-to-day operation of the existing water and wastewater systems. A review of the available information shows that there are some shortfalls in the systems.

6.2.1 Review of Site Inspections

Site inspections of the existing water and wastewater infrastructure were completed. A summary of the site inspection observations related to the Town of Stavely water and wastewater infrastructure is found below:

- The water system is reported to operate without major concerns and water quality seems to be adequate.
- Several issues with the sewage lagoons were identified:
    - There is no flow control through system, particularly with the anaerobic cell,
    - Sludge inventory in the facultative cell,
    - Bank stabilization issues,
    - Uncontrolled dumping of septic trucks into the facultative cell,
    - Site access is not controlled - there is an open gate and adjacent area currently used for waste material dump site.

6.2.2 Raw Water Supply

As shown in Figure 5.2, the current raw water licence allocation is not sufficient to service the projected 2044 population. There is sufficient water allocation to service up to a population of approximately 640, or up to the year 2027 at the projected 1.5% growth rate.

A review of the Town's raw water pumping capacity reveals that it does not meet current AEP guidelines. Pump capacities should be such that with the largest unit out of service, the remainder will be able to supply the treatment plant with 110% of the maximum daily design flow (MDD). See a summary of secondary raw water pumping below:

- Total Capacity: 9.5 L/s (820.8 m³/day)
- Firm Capacity: 5.0 L/s (436 m³/day)
- Existing MDD: 7.40 L/s (639 m³/day)
- 2044 MDD: 10.7 L/s (927 m³/day)

In the event that the primary raw water pump is not in operation, the Town will not be able to provide the MDD required flow to the WTP.

6.2.3 Wastewater Treatment

A cursory review of the wastewater treatment system was completed. The Town of Stavely utilizes wastewater stabilization ponds (lagoons) for treatment of its wastewater. The wastewater lagoons are located just east of the Town. The treatment system consists of two (2) equal sized anaerobic cells, one (1) facultative cell and two (2) storage cells. Records provided by the Town indicate that the wastewater lagoons were last updated in 1985. According to AEP regulation, the Town is authorized to release effluent once a year between late spring and fall.

Average Daily Design Flow (ADDF) was used, along with available record drawings to determine the volumes and retention times for each cell. The retention times were determined for both the current and 25-year projected flows. In the absence of wastewater flow data, historical dry weather water usage data was reviewed and used as a basis to determine the ADDF. Table 6.3 provides a summary of the data. Other communities within southern Alberta that meter their sanitary flows have been shown to have an ADDF of approximately 6% to 11% higher than their average dry weather flows. As the Town of Stavely has no wastewater flow data, the average dry weather water usage and the above relationship was used to determine an approximate ADDF of 10% above the average dry weather usage.

Table 6.3 – Stavely Historical Dry Weather Water Usage							
Month	Average Daily Design Flows						
	2013 m3/day	2014 m3/day	2015 m3/day	2016 m3/day	2017 m3/day	2018 m3/day	Average m3/day
January	226	216	270	212	253	271	252
February	244	209	245	235	220	280	245
March	262	205	229	215	223	274	235
April	240	181	174	191	170	236	193
October	252	274	232	247	227	251	239
November	231	248	227	264	222	224	234
December	205	264	214	261	252	210	234
Population	519	526	534	541	549	557	
Average Day (m^3)	237	228	227	232	224	249	233
Average Day (LPCD)	457	434	426	429	408	448	433

Table 6.4 summarizes the estimated volume and the current and 25-year projected retention times for each cell based on the ADDF.

Table 6.4 – Wastewater Lagoon Summary				
Treatment Cell	Volume	Retention Time (days)		
	(m^3)	Current	25 Year (1.5% growth)	AEP Requirement
Anaerobic Cells (2)	2,400	9	6	4
Facultative Cell	29,889	113	77	60
Storage Cells	100,700	380	258	365

The data shows that the existing storage cells do not have adequate capacity to provide the required 365 days of retention time for the projected 25-year ADDF.

Annual lagoon wastewater discharge records for 2013 to 2018 were also reviewed to determine the volume of discharged wastewater. The annual wastewater records suggest that the actual ADDF may be significantly lower than the estimated ADDF, though wastewater discharge records do not indicate a flow measurement methodology. Wastewater flow monitoring and a more in depth review of the Town's lagoons is recommended to confirm ADDF, cell volumes and retention times.

6.3 TOWN OF CLARESHOLM

The Town of Claresholm does not currently face any major issues with the existing water or wastewater systems. The WTP was replaced in 2010. The Town has suitable water infrastructure to support the projected 2044 population and beyond.

6.4 TOWN OF FORT MACLEOD

The Town of Fort Macleod does not currently face any major issues with the existing water or wastewater systems The Town of Fort Macleod has recently upgraded their raw water supply, WTP and WWTP. The Town has suitable water infrastructure to support the projected 2044 population and beyond.

6.5 MD OF WILLOW CREEK

The MD of Willow Creek relies primarily on the neighbouring towns for support and did not report any concerns. The primary focus for the MD in this study is to explore the potential for a regional approach to water and wastewater management. Regional pipelines may provide opportunities for rural water users to have access to raw or treated water.

7 DEVELOPMENT OF ALTERNATIVES

Alternatives were developed and investigated in consultation with the municipalities, AEP and Alberta Transportation (AT) in order to address the issues identified in Section 6. The alternatives for each municipality are discussed in the following sections. Discussions surrounding the cost implications of the options are provided in Section 8.

It is evident from a review of the information gathered throughout the course of this study that the Town Nanton faces the most serious issues. The underlying issue behind all of the water supply and treatment issues that Nanton is facing is the lack of year-round access to a suitable raw water supply. Several alternatives were investigated during the course of this study to resolve the Town of Nanton water supply issues including:

- Alternative 1: Pine Coulee Raw Water Supply
- Alternative 2: Nanton Raw Water Storage Expansion
- Alternative 3: Claresholm Regional Water Supply
- Alternative 4: High River Regional Water Supply
- Alternative 5: Pine Coulee Regional Water Supply

A review of the information gathered throughout the course of this study shows that the Town of Stavely will require additional water allocation before 2027 based on a 1.5% growth rate. The review also shows that the Town of Nanton and the Town of Stavely have wastewater treatment issues that should be addressed.

7.1 ALTERNATIVE 1: PINE COULEE RAW WATER SUPPLY

Pine Coulee Reservoir was constructed in the late 1990's to provide a long-term solution to the area's water supply problems. Pine Coulee Reservoir is located approximately 17 km south of the Town of Nanton, with the deepest portion of the reservoir located near the south end.

There is potential to change the Town of Nanton raw water source from Mosquito Creek to Pine Coulee Reservoir. A pipeline would be constructed from Pine Coulee Reservoir to Nanton and could potentially serve rural water users along the pipeline route.

Recent discussions with AEP indicate that the province is becoming increasingly concerned with the security of the supply of water in the province. A component of an application for a new or updated diversion licence from Pine Coulee Reservoir will be the development or update of a Water Shortage Response Plan to address the reality of water shortage in the event of a drought. Any new water licences from Pine Coulee will be cut-off from their allocation when the reservoir reaches an elevation of 1044m. An allocation from Pine Coulee for Nanton would be a new licence. The AEP Water Act would not permit the transfer of the existing licences.

As shown in Figure 7.1, the reservoir level is trending down as more water from the reservoir is allocated. Under this alternative the Town of Nanton will have to maintain the raw water storage reservoir adjacent to the WTP. An increase in raw water storage may be required to provide the Town with a larger buffer to prevent running out of water when the level in Pine Coulee does not allow the Town to withdraw allocation.

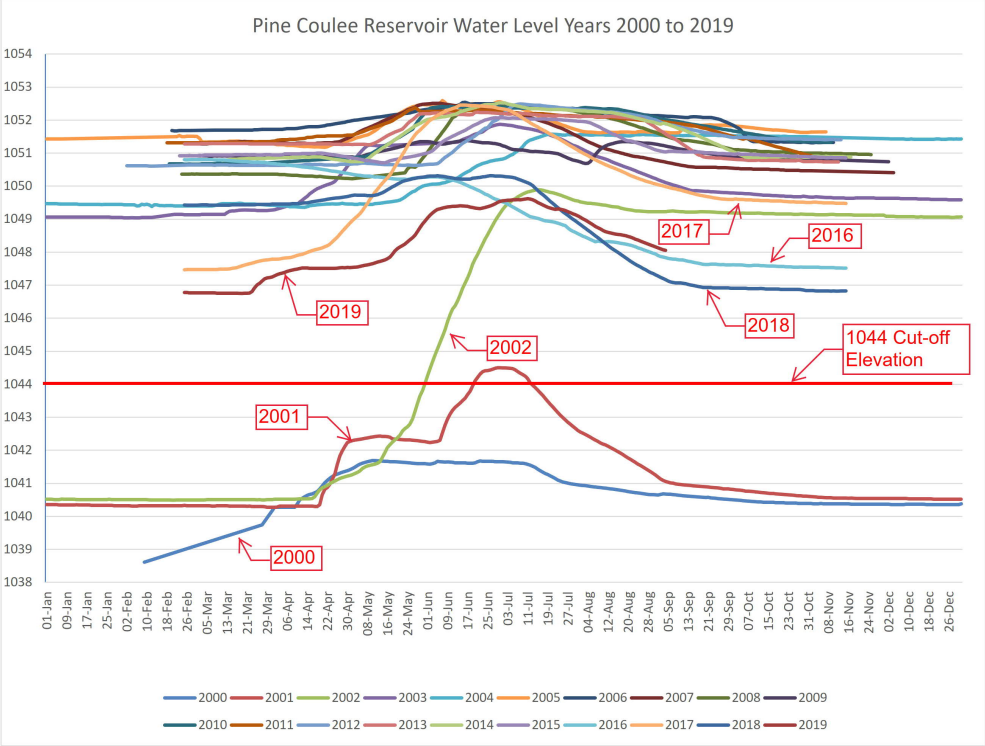


Figure 7.1 – Pine Coulee Reservoir Historical Levels

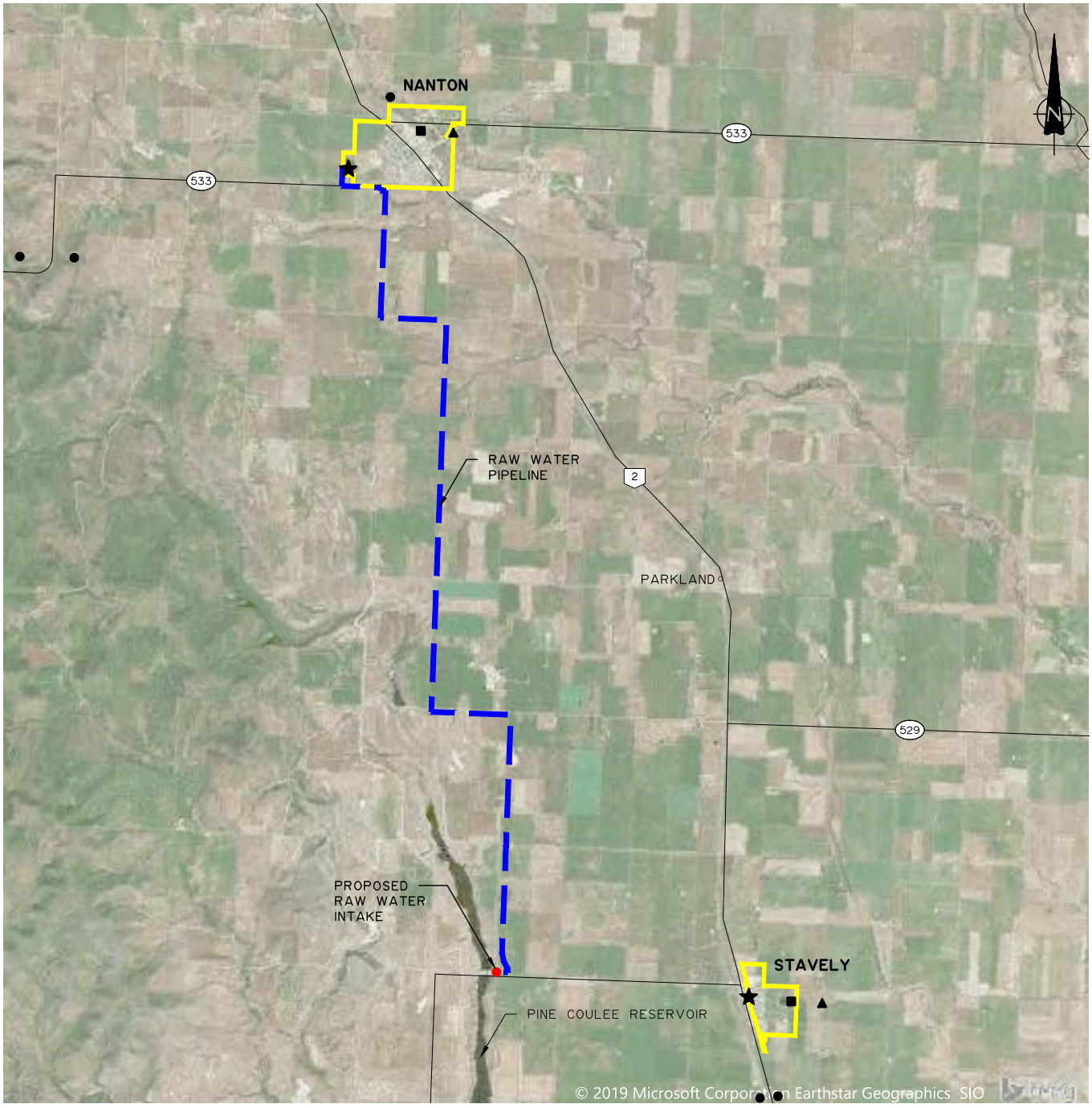
7.1.1 Required Upgrades

Proposed upgrades to the water supply and treatment facilities include:

- New raw water intake and pump station from Pine Coulee near Highway 527,
- New regional raw water pipeline from the pump station to the Nanton raw water reservoir,
- WTP upgrades to treat new raw water source,
- Water Shortage Response Plan as a requirement for a new licence.
    - Potential requirement for increase in raw water storage

The risk of utilizing Pine Coulee Reservoir as a raw water source, the relative high cost of a pipeline and potential raw water storage upgrades precludes this alternative from further consideration.

Figure 7.2 provides an overview of the proposed upgrades required to change the raw water supply from Mosquito Creek to Pine Coulee Reservoir.



LEGEND

- TOWN BOUNDARY
- PROPOSED RAW WATER PIPELINE
- PROPOSED RAW WATER INTAKE
- EXISTING RAW WATER INTAKE
- EXISTING WATER TREATMENT PLANT
- EXISTING WASTEWATER OUTFALL
- EXISTING WASTEWATER TREATMENT FACILITY

MPE Engineering Ltd.

SHARED WATER DISTRIBUTION STUDY
PROPOSED ROUTE
ALTERNATIVE 1
PINE COULEE RAW WATER SUPPLY

SCALE: 1:150 000	DATE: DECEMBER 2019	JOB: 2630-005-00	FIGURE: 7.2

7.2 ALTERNATIVE 2: RAW WATER STORAGE UPGRADES

The Town of Nanton receives its raw water from Mosquito Creek. During the operating season AEP follows the Water Management Plan for the Watersheds of the Upper Highwood and Upper Little Bow Rivers. The plan includes a list of priority objectives to meet operational and environmental flow targets. Municipal demands are included in the list as first priority. Data for the last 30 years from a monitoring station located approximately 18 km southeast of Nanton was analysed. Figure 7.3 presents the flow monitoring station data.

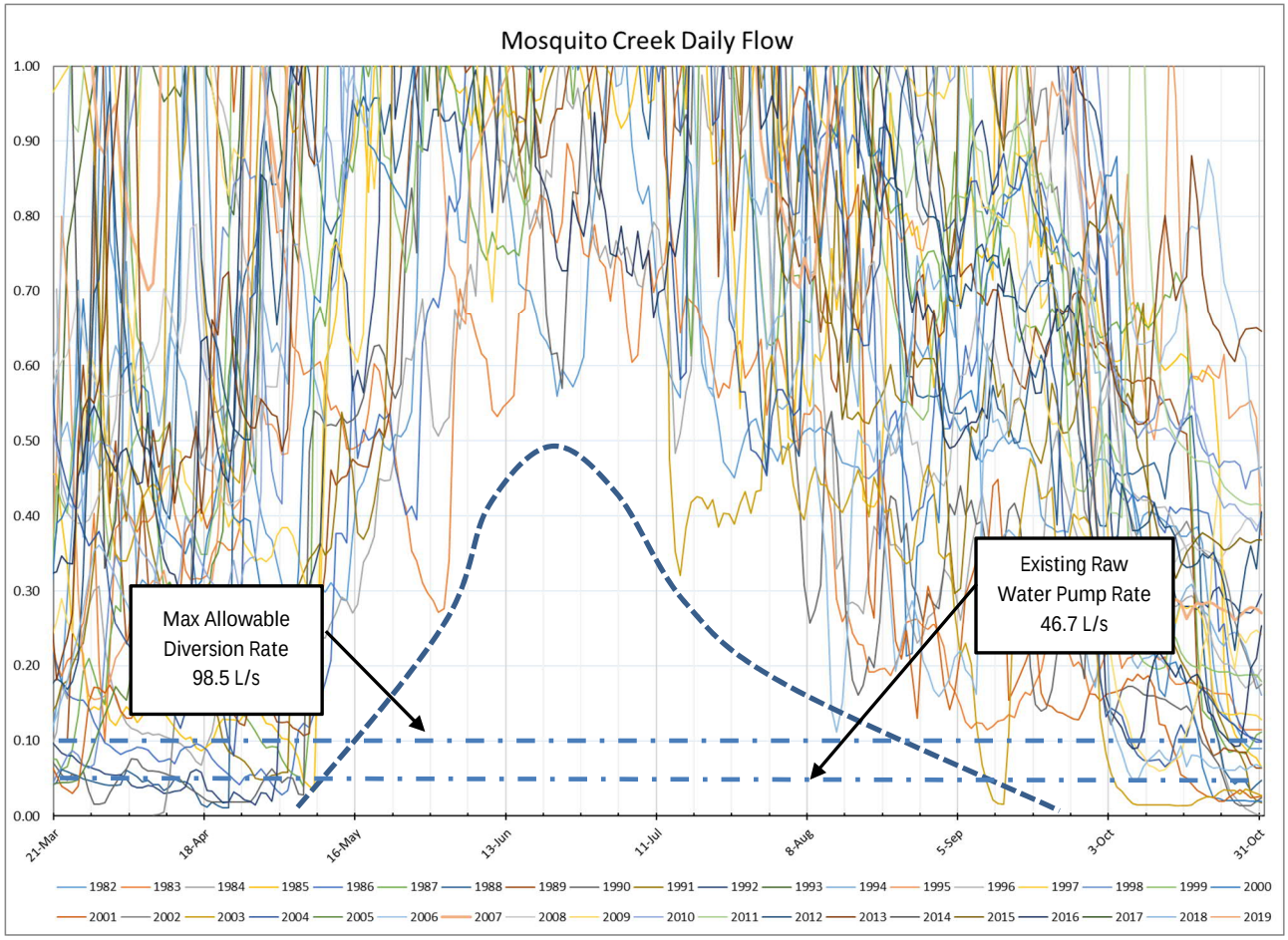


Figure 7.3 – Mosquito Creek Flow Data

An analysis of the data reveals that there is a period of reliable flow from early May to Late September or approximately 120 days. There is potential for the Town of Nanton to maintain Mosquito Creek as the raw water source. The volume of raw water storage would be increased and the Spring Line Extension project would be completed as currently scheduled. This will allow the Town to store additional water and switch to the spring line allocation (approximately 90,000 m³) during periods when there is no flow available in Mosquito Creek.

As shown in Section 6.1.2, the Town of Nanton has a winter period raw water shortage issue. The 2044 projected winter period raw water storage shows a deficit of approximately 90,000 m³. The Spring Line Extension project will help offset the raw water storage deficit and reduce the volume of storage required. Preliminary analysis of the area north of the existing WTP shows that approximately 75,000 m³ of raw water storage can be constructed within the existing property lines. The amount of storage should be maximized to reduce the water shortage risk.

The total raw water storage volume with the existing reservoir and the proposed reservoir will be approximately 279,000 m³. The existing pump station has the capacity to pump the total volume of the reservoir in approximately 70 days, or 60% of the pumping window.

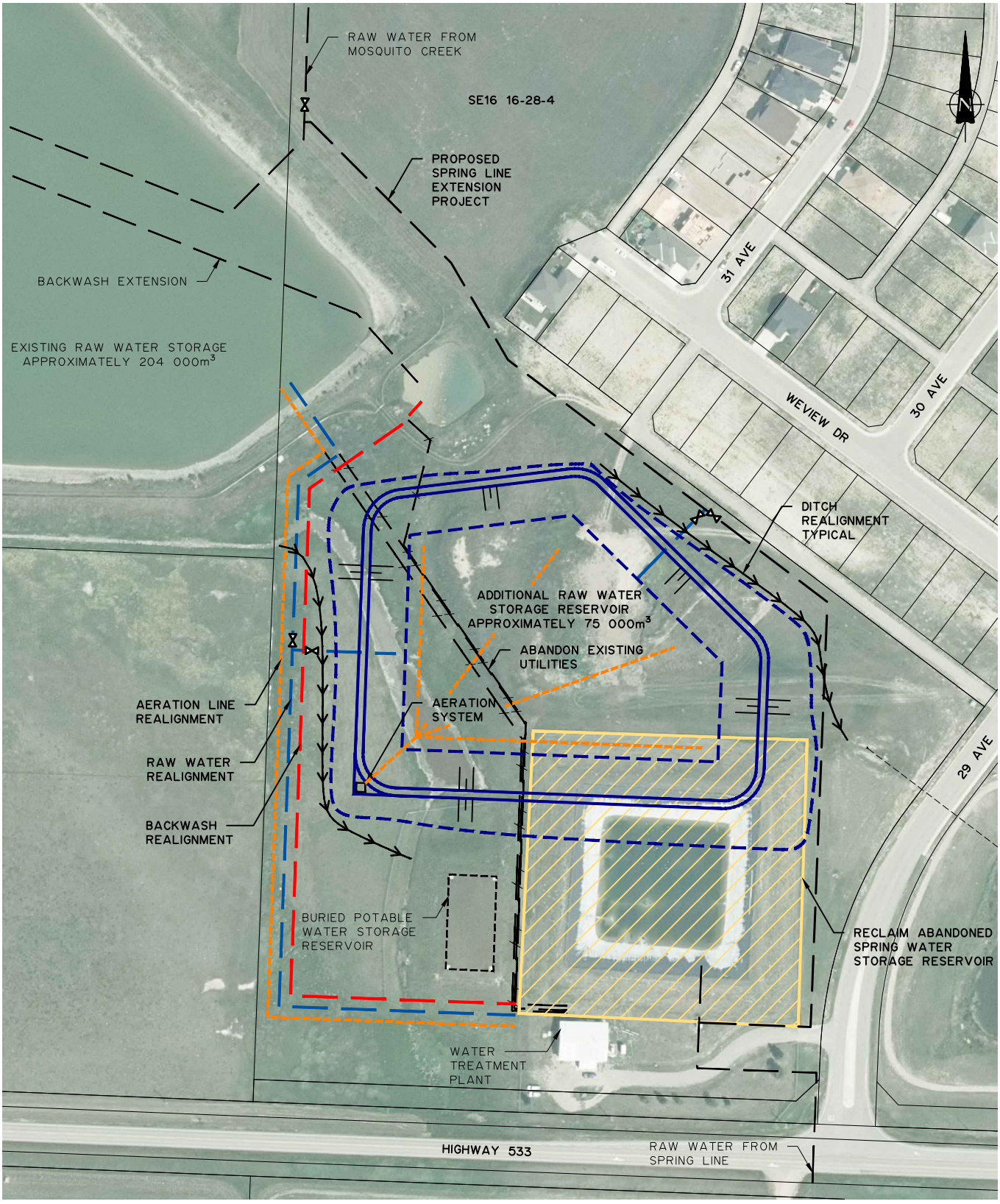
A powdered activated carbon (PAC) system should be installed at the WTP to address taste and odour concerns. This upgrade is not expected to increase the operator training level requirement as demonstrated at other similar water treatment plants.

7.2.1 Required Upgrades

Proposed upgrades to the water supply and treatment facilities include:

- Expand the raw water storage to provide an additional cell with a minimum of 75,000 m³ of storage.
- Add an aeration system to the new storage reservoir.
- Add interconnecting piping to provide redundancy and allow for maintenance of the raw water reservoir cells.
- Upgrade existing WTP with a PAC system to address taste and odour complaints.

An overview of this alternative is presented in Figure 7.4.



MPE Engineering Ltd.

SHARED WATER DISTRIBUTION STUDY
ALTERNATIVE 2
RAW WATER STORAGE UPGRADES

SCALE: 1:2500	DATE: DECEMBER 2019	JOB: 2630-005-00	FIGURE: 7.4

7.3 ALTERNATIVE 3: CLARESHOLM REGIONAL WATER SUPPLY

The Town of Claresholm is located approximately 38 km south of the Town of Nanton. The Claresholm WTP has adequate capacity to support the Town of Nanton 2044 potable water requirements. There is potential to construct a potable water pipeline from the Town of Claresholm to the Town of Nanton and service the Town of Stavely and rural water users along the pipeline route. For the purposes of this study, it is assumed that no upgrades within the Town of Claresholm potable water distribution system are required to support the supply of potable water to the region.

New licences for the Town of Nanton, Town of Stavely and the MD for rural water users are required from Pine Coulee Reservoir and would be subject to the reservoir level conditions described under Section 7.1.

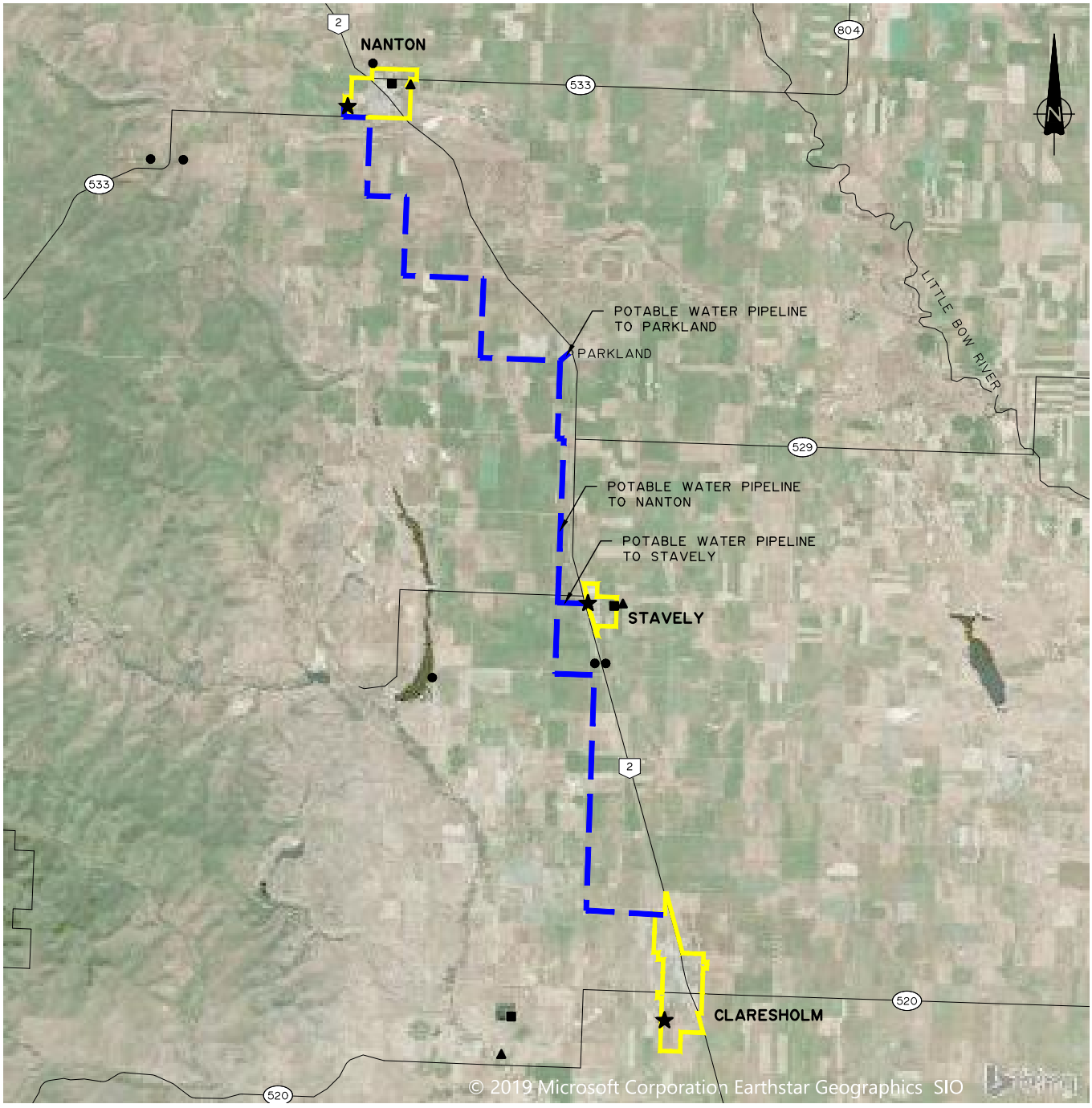
7.3.1 Required Upgrades

Proposed upgrades to the water supply include:

- New potable water pipeline from Claresholm to Stavely,
- New potable water pipeline from Stavely to Nanton,
- Upgrades to the Claresholm WTP,
- Decommission the Stavely WTP,
- Decommission the Nanton WTP,
- Water Shortage Response Plan.

The risk of utilizing Pine Coulee Reservoir as a raw water source and the relative high cost of a pipeline from Claresholm to Nanton precludes this alternative from further consideration.

An overview of this alternative is presented in Figure 7.5.



LEGEND

- TOWN BOUNDARY
- PROPOSED POTABLE WATER PIPELINE
- EXISTING RAW WATER INTAKE
- EXISTING WATER TREATMENT PLANT
- EXISTING WASTEWATER OUTFALL
- EXISTING WASTEWATER TREATMENT FACILITY

MPE Engineering Ltd.

SHARED WATER DISTRIBUTION STUDY
PROPOSED ROUTE
ALTERNATIVE 3
CLARESHOLM REGIONAL WATER SUPPLY

SCALE: 1:250 000	DATE: DECEMBER 2019	JOB: 2630-005-00	FIGURE: 7.5

7.4 ALTERNATIVE 4: HIGH RIVER REGIONAL WATER SUPPLY

The Town of High River is located approximately 25 km north of the Town of Nanton. Preliminary discussions with the Town of High River indicate that there is sufficient capacity in the existing WTP to support the Town of Nanton potable water requirements. The Town of High River has indicated that they are willing to help their neighbours, but cautioned that multiple parties have expressed interest in obtaining water from the Town. There is a limited amount of water available from the Town of High River's existing infrastructure and ultimately the decision of where water is provided will be up to Town Council.

There is potential to construct a potable water pipeline from the Town of High River to the Town of Nanton and service rural water users along the pipeline route. For the purposes of this study, it is assumed that no upgrades within the Town of High River potable water distribution system are required to support the supply of potable water to the Town of Nanton. This assumption should be confirmed in further consultation with the Town of High River.

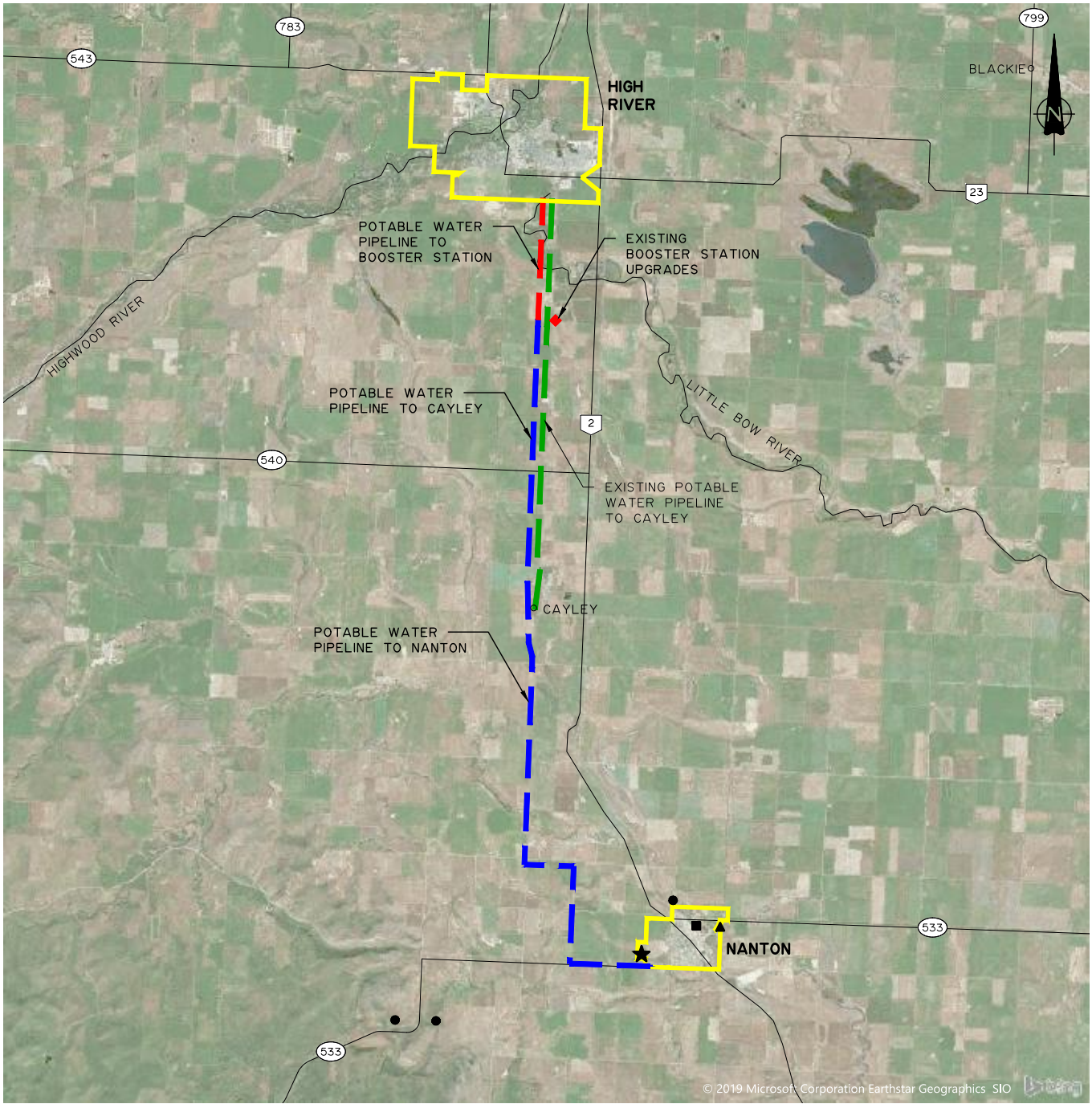
Preliminary discussions with AEP indicate that the Town of Nanton's Mosquito Creek licence would be transferrable to the Town of High River's water source.

7.4.1 Required Upgrades

The proposed upgrades to the water supply include:

- Connection to High River potable water distribution system,
- Upgrades to the existing Cayley pump station,
- New pipeline from High River to Nanton,
- Connection to the Nanton potable water storage reservoir,
- Water Shortage Response Plan.

An overview of this alternative is presented in Figure 7.6.



LEGEND

- TOWN BOUNDARY
- PROPOSED POTABLE WATER PIPELINE
- PROPOSED POTABLE WATER PIPELINE
- EXISTING POTABLE WATER PIPELINE
- EXISTING BOOSTER STATION WITH UPGRADES
- EXISTING RAW WATER INTAKE
- EXISTING WATER TREATMENT PLANT
- EXISTING WASTEWATER OUTFALL
- EXISTING WASTEWATER TREATMENT FACILITY

MPE Engineering Ltd.

SHARED WATER DISTRIBUTION STUDY
PROPOSED ROUTE
ALTERNATIVE 4
HIGH RIVER REGIONAL WATER SUPPLY

SCALE: 1:200 000	DATE: DECEMBER 2019	JOB: 2630-005-00	FIGURE: 7.6

7.4.2 Cayley to Nanton Interim Phase

During initial consultation with the Town of High River the question was raised as to whether the existing Cayley pipeline could support the Town of Nanton as a seasonal solution or an interim phase of Alternative 4. This feasibility of this option was investigated.

Cayley water usage in 2014 and 2015 was 27,576 m^3 and 32,202m^3, respectively (High River Utility Master Plan). Averaged over the year this represents a flow of 1.02 L/s. According to the control philosophy for the Cayley pipeline, the booster station and Cayley pump building inlet are set to a maximum of 7.0 l/s and the pumps each have a capacity of 7.2 L/s. There is sufficient capacity within the existing Cayley pipeline to allow for Nanton to withdraw up to 6.0 L/s or approximately 190,000 m^3 per year without modification to the pipeline from High River to Cayley. Without upgrades to the pump station and pipeline from High River to Cayley the pipeline is unable to supply the existing demand. The Town of Nanton will still be required to obtain raw water (albeit less raw water) from Mosquito Creek and to operate the WTP. This alternative would be considered a temporary or partial solution and is not analyzed further in this report.

7.5 Alternative 5: Pine Coulee Regional Water Supply

Alternative 5 proposes construction of a new regional WTP near Pine Coulee Reservoir. The new WTP would receive water from Pine Coulee reservoir and service the Towns of Claresholm, Granum, Stavely, Nanton, and many rural water users located along the various pipeline alignments. Existing potable water storage and pumping facilities would be maintained and upgraded as necessary in each municipality. The existing raw water supply pipeline to the Town of Claresholm would be repurposed as a potable water pipeline.

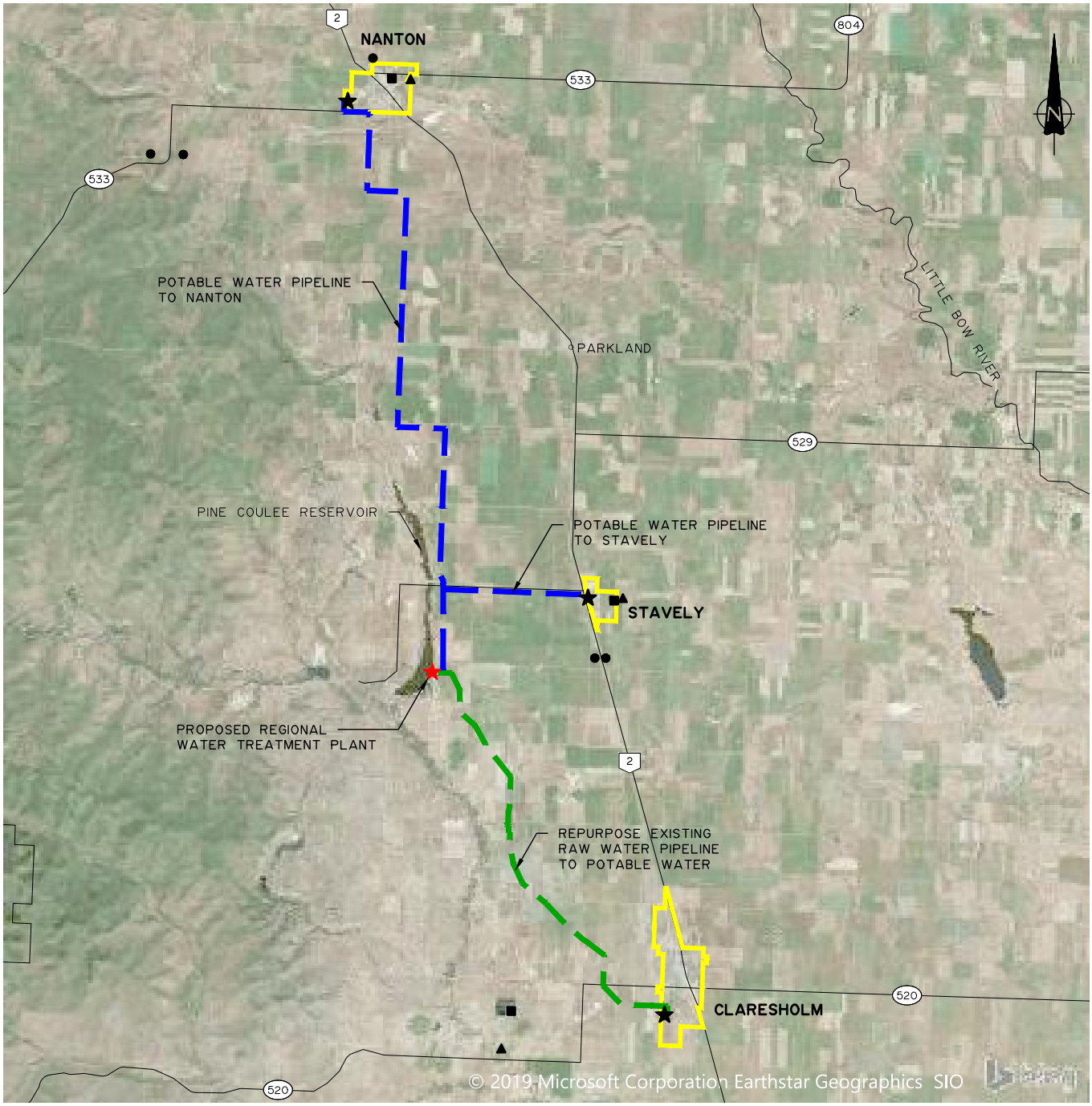
7.5.1 Required Upgrades

The proposed regional water treatment and supply system will include:

- Reconfigure piping from the existing Pine Coulee Reservoir intake,
- New water treatment plant,
- New pump station(s),
- Repurpose existing raw water pipeline to Claresholm as a potable water pipeline,
- New regional water pipelines to Nanton and Stavely,
- Decommission WTPs in Claresholm, Nanton and Stavely
- Water Shortage Response Plan.

The risk of utilizing Pine Coulee Reservoir as a raw water source for new licences, the high cost of a new WTP and regional pipelines, and decommissioning existing facilities with several years of useful life precludes this alternative from further consideration.

An overview of this alternative is presented in Figure 7.7.



LEGEND

- TOWN BOUNDARY
- PROPOSED POTABLE WATER PIPELINE
- EXISTING RAW WATER PIPELINE
- PROPOSED WATER TREATMENT PLANT
- EXISTING RAW WATER INTAKE
- EXISTING WATER TREATMENT PLANT
- EXISTING WASTEWATER OUTFALL
- EXISTING WASTEWATER TREATMENT FACILITY

MPE Engineering Ltd.

SHARED WATER DISTRIBUTION STUDY
PROPOSED ROUTE
ALTERNATIVE 5
PINE COULEE REGIONAL WATER SUPPLY

SCALE: 1:250 000	DATE: DECEMBER 2019	JOB: 2630-005-00	FIGURE: 7.7

7.6 STAVELY RAW WATER SUPPLY UPGRADES

The Town of Stavely receives raw water primarily from a well located approximately 2 km south of the Town. The Town of Stavely will require additional raw water licence allocation to meet the projected 2027 water demands at a growth rate of 1.5% and beyond. Section 5 outlines options for additional allocation. A detailed hydrogeological report including testing is recommended to confirm the most suitable upgrade required to increase the allocation available to the Town.

7.7 WASTEWATER TREATMENT

7.7.1 Town of Nanton

The Town of Nanton is facing numerous operational challenges with their WWTP. Several upgrades and improvements were identified that will help with the operation of the WWTP, including estimated costs are identified in Table 7.1.

Table 7.1 – Nanton WWTP Upgrades

Upgrade	Estimated Cost
Spare RAS Pump	$65,000
Spare Membrane Pulse Tank	$45,000
Additional Process Blower	$485,000
Secure RAS And Mixer Control Cables	$15,000
SCADA Autodialer System	$65,000
UPS Backup for SCADA System	$50,000
Access to Odour Control System	$70,000

Additional wastewater flow from neighbouring communities (Stavely, Cayley or Parkland) may help to improve treatment performance and lower the unit cost for treatment. If/when these neighbouring communities require upgrades for wastewater treatment, consideration should be given to pumping the wastewater to Nanton.

7.7.2 Town of Stavely

As identified in Section 6.2, the Town of Stavely has a potential wastewater storage deficit. A separate study on the Town of Stavely wastewater system is recommended. The study should include wastewater flow monitoring, ideally over the course of several seasons, in order to accurately determine ADDF requirements. An accurate ADDF will allow for appropriate timing of any required wastewater treatment and storage upgrades.

If the study concludes that there is a storage deficit, the Town may have a number of options to consider:

- Expand existing wastewater storage
- Pump wastewater to the Nanton WWTP

7.8 Opportunities for Regional Collaboration

Alternatives 1, 3 and 5 are precluded from further analysis given the relative risk of the raw water source and/or relative cost implications. Only Alternative 4 will involve regional collaboration. Under this option the Town of High River will collaborate with the Town of Nanton to provide a reliable source of potable water and extend its role as a regional hub for potable water. Rural residents of both the MD of Foothills and the MD of Willow Creek may potentially benefit from a new regional potable water pipeline.

8 OPINION OF PROBABLE COST

8.1 CAPITAL COSTS

Order of magnitude capital cost estimates for the Town of Nanton water supply alternatives have been prepared. These costs are provided in Table 8.1. Details of the estimates are available in Appendix C.

Table 8.1 – Capital Cost Estimates

Alternative	Estimated Cost
Alternative 1: Pine Coulee Raw Water Supply	$14,600,000
Alternative 2: Raw Water Storage and Pumping Upgrades	$4,100,000
Alternative 3: Claresholm Regional Water Supply	$14,000,000
Alternative 4: High River Regional Water Supply	$8,700,000
Alternative 5: Pine Coulee Regional Water Supply	$34,500,000

Alternatives 1, 3 and 5 are precluded from further consideration as described in Section 7 in the respective sub-sections. Alternatives 2 and 4 will be explored further in the following sections.

8.2 GRANT PROGRAMS

To assist the municipalities in the implementation of the potential projects, several funding sources, both provincial and federal, could be pursued. The following sections describe the provincial funding assistance that will be most applicable to water and wastewater treatment capital projects. The Alberta Municipal Water and Wastewater Partnership (AMWWP) program, and the Regional System Initiative under the Water for Life Strategy will be the most significant possible sources of capital funding for this project.

8.2.1 Alberta Municipal Water and Wastewater Partnership (AMWWP)

The AMWWP offers shared funding to municipalities for the development of municipal water treatment and supply systems as well as wastewater treatment and disposal facilities. This fund is accessible to cities under the population of 45,000, Towns, villages, summer villages, regional commissions, and eligible hamlets within rural municipalities. Water distribution and wastewater collection systems are not eligible for funding.

Under AMWWP for municipalities with a population between 1,000 and 3,000, is calculated as a percentage of eligible project costs based on the municipalities official population when the grant is approved. The funding percentage is based on the formula [(0.5 x Population) + 250] x 100 / Population. The percentage of funding for Nanton as calculated using the 2016 population would be 61.7%.

8.2.2 Regional Systems Initiative - Water for Life Strategy

In 2006, as part of the "Water for Life Strategy" the Province of Alberta began the Regional Systems Initiative. The Province will fund 90% of the capital costs of constructing regional municipal water or wastewater pipelines. The Province will provide 100% funding to the "hub" suppliers to make the necessary expansions and improvements to service the regional customers.

8.3 Funding Breakdown

Funding for the proposed alternatives will vary, as per the guidelines of the respective funding sources. Table 8.2 outlines the capital costs for which each community would be responsible under the available provincial funding sources.

Table 8.2 – Funding Allocation

Alternative	Eligible Project Cost	Funding Program	Funding Percentage	Nanton Contribution
Alternative 1: Raw Water Storage Upgrades	$4,100,000	AMWWP	61.7%	$1,570,000
Alternative 2: High River Regional Water Supply	$8,700,000	Water for Life	90.0%	$870,000

8.4 Present Worth Analysis

A present worth analysis has also been prepared to examine the life cycle costs of the two selected alternatives. The present worth analysis includes both the capital cost as well as the operation and maintenance costs over 25 years of the life of the facility. The present worth analysis also assumes that the local share will be debentured over a 25-year period based on interest rates received from the Alberta Capital Finance Authority. Table 8.3 provides details on the present worth analysis. Refer to Appendix D for the complete details of the present worth analysis.

Table 8.3 – Present Worth Analysis

Alternative	Net Present Worth of Debenture *	Net Present Worth of Operation and Maintenance Costs	Total Net Present Worth	2019 Cost of Water	2044 Cost of Water
Raw Water Storage and Pumping Upgrades	$1,389,000	$7,666,000	$9,055,000	$1.35	$1.55
High River Regional Water Supply	$768,000	$10,855,000	$10,793,000	$1.44	$2.11

* 25 year debenture @ 2.651% as of December 10, 2019. Obtained from Alberta Capital Finance Authority website.

The present worth analysis for Alternative 2 does not allow for significant treatment upgrades within the 25-year planning horizon. Due to the age of the facility, it is likely that some level of treatment process upgrade will be required during the 25-year design horizon.

9 IMPLEMENTATION CONSIDERATIONS

9.1 REGIONAL SYSTEM GOVERNANCE MODELS

In the case that a regional alternative is selected as the most suitable solution, a governance model must be chosen. There are various methods to govern the construction, operation and maintenance of a regional water system. The governance method chosen may influence the portion of the total costs of construction and the water rate for which a member community may be responsible. The governance model chosen by the regional member communities does not influence the amount of funding received from Alberta Transportation. The formulas for determining the available grants remain the same. The difference is how the member communities decided to allot the funds among the various portions of the project (i.e. plant upgrades, pipelines, etc.) and the governing organization that is created to operate and maintain the regional system. Three models are used to illustrate the costs associated with the various regional alternatives; Buy/Sell, Regional Commission, and Municipal Controlled For-Profit Corporation.

9.1.1 Buy/Sell (Intermunicipal Agreements)

Under the Buy/Sell governance model, the available funding has been applied to the construction costs according to the AMWWP funding formulas. The remaining costs are borne by the member communities based on the individual flow rates of each community to the overall capacity of the system. For this study it has been assumed that each community would individually secure a 25-year debenture for their portion of the construction costs. The operation and maintenance of the regional water treatment plant would be the responsibility of the hub community as they would retain ownership of the infrastructure. The hub community would sell water to the regional customers at a rate equal to the cost of producing water plus a government regulated profit margin (~5-10%).

9.1.2 Regional Services Commission

Under the Regional Services Commission governance model, the available funding would be applied to the construction costs at a blended rate for the entire cost of the project. The remaining costs would be borne by a Commission made up of members of each community. The Commission would secure a single 25-year debenture for all the remaining construction costs and would recoup the costs by selling water at a base rate to each of the member communities. Therefore, each member community would pay for the construction costs based on the individual flow rates of each community to the overall capacity of the system, but would pay it through the water rate structure of the Commission. The operation and maintenance of the regional water treatment system would be the responsibility of the Commission, as the Commission would now own the infrastructure, rather than the hub community. The operation and maintenance costs would be reflected in the base water rate charged to each community.

9.1.3 Municipal Controlled Corporation

Municipal controlled corporations are for-profit corporations that are controlled by a municipality or group of municipalities for the purposes of providing a regional municipal service or facility. Approval from the Minister of Municipal Affairs must be obtained by the municipalities that wish to establish a municipal controlled corporation prior to the establishment of the corporation.

10 CONCLUSIONS

10.1 IDENTIFICATION OF PRIMARY ISSUES

Through the course of this study it has become apparent that the primary issue of the region is the lack of a year-round accessible and long-term reliable supply of raw or potable water to the Town of Nanton. The Town of Stavely also has some other relatively minor issues. The Town of Claresholm and the Town of Fort Macleod water and wastewater systems are in relatively good condition and have not reported any concerns. The MD of Willow Creek relies primarily on the neighbouring towns for support and did not report any concerns.

10.1.1 Town of Nanton

10.1.1.1 WATER SUPPLY

The primary issue for the Town of Nanton is the lack of a year-round accessible and long term reliable raw water supply. The Town is only able to withdraw from their primary raw water source, Mosquito Creek, during a limited window. This window typically from May 1 to September 30. Outside of this window the Town relies on their raw water storage reservoir. The Town has come close to running out of water in past winter seasons. Should the winter period be extended in either or both directions, the Town would be in danger of running out of water. The Town of Nanton has also reported taste and odour complaints.

10.1.1.2 WASTEWATER TREATMENT

The Town of Nanton commissioned a new MBR WWTP in 2017. The Town reports numerous operational challenges and significantly higher than anticipated operational costs.

10.1.2 Town of Stavely

10.1.2.1 RAW WATER SUPPLY

The Town of Stavely will reach the limit of their current licence allocation by the year 2027 at the projected 1.5% growth rate.

10.1.2.2 WASTEWATER TREATMENT

A cursory review of the wastewater treatment system indicates that the storage cell may be nearing capacity. A number of other issues were also identified during the site review, warranting a more thorough review.

10.2 VIABLE WATER SUPPLY ALTERNATIVES

Five water supply alternatives were reviewed as part of this study. Alternatives 1, 3 and 5 were precluded from further consideration due to relative high cost compared to other alternatives, the risk involved with

a new supply from Pine Coulee Reservoir, and the fact that none of the other municipalities have significant issues that cannot be resolved locally. Alternatives 2 and 4 were determined to be the most viable and considered in further detail. Alternative 2 is an option that involves local upgrades. Alternative 4 is a regional option that involves two new parties that were not included as regional partners for the study - the Town of High River and the Municipal District of Foothills.

In order to conclusively determine the most appropriate and cost effective long-term solution, a more in-depth study and further consultation with affected parties should be completed. This would include AEP for and AT for both alternatives and the Town of High River and the Municipal District of Foothills for Alternative 4. The other Willow Creek regional partners should be excused from participating in the study.

10.2.1 Alternative 2: Raw Water Storage Upgrades

The data illustrates that the limiting factor in the existing raw water supply infrastructure is the available raw water storage volume. Constructing additional raw water storage will allow the Town of Nanton to provide a reliable supply of potable water when raw water is not available from Mosquito Creek.

Analysis of available flow data from Mosquito Creek over the past 30 years shows that there is an approximately 120-day window from early May to late September when the Town is able to reliably withdraw water from the Creek. The existing pump station has capacity to fill the proposed total storage volume in a 70-day period.

The spring line extension work currently in detailed design will also aid in reducing the water shortage risk.

In order to address taste and odour concerns a PAC system is proposed to be installed in conjunction with the raw water storage expansion and pumping upgrades.

The capital cost estimates show this alternative to be the least costly of all the upgrades in terms of lower capital cost and provides the lowest average cost of water over the 25-year design period.

10.2.2 Alternative 4: High River Regional Water Supply

The Town of High River is the closest municipality with sufficient infrastructure to provide a supply of potable water to the Town of Nanton. Initial discussions with the Town of High River indicate that the Town is willing to help their neighbours, though the Town of High River cautioned that multiple parties have expressed interest in obtaining water from the Town. There is a limited amount of water available from the Town of High River's existing infrastructure and ultimately the decision of where water is provided will be up to Town Council.

One advantage of this option is that the Town of Nanton would be able to decommission their raw water storage reservoir and WTP. This would reduce the amount of Town resources required. The Town has indicated that historically it has been difficult to retain the qualified personnel necessary to run the plant.

11 RECOMMENDATIONS

At the conclusion of this review, the following recommendations have been developed for the Town of Nanton:

- Continue with implementation of the Spring Line Extension project to supplement filling of the raw water reservoir during periods of no flow in Mosquito Creek.
- Proceed with a study to compare Alternative 2 and Alternative 4 in greater detail, including consultation with the Town of High River, MD of Foothills, Alberta Environment and Parks, and Alberta Transportation.
- Engage in discussions further with the Town of High River, including the involvement of elected officials.
- Proceed with proposed upgrades to the WWTP.

The following recommendations have been developed for the Town of Stavely:

- Proceed with a hydrogeological assessment including testing to determine the most appropriate upgrade for increasing raw water allocation.
- Proceed with a wastewater treatment system assessment including wastewater flow monitoring to determine the need for and appropriate timing of upgrades.

12 REFERENCES

Alberta Environment, "Water Management Plan for the Watersheds of the Upper Highwood and Upper Little Bow Rivers – Volume 2 – Highwood Diversion Plan", March 2008.

Alberta Environment, "Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems", Drinking Water Branch, Environment Policy Branch, Environmental Assurance Division, Edmonton, Alberta, March 2013.

Alberta Environment, "Water for Life – Alberta's Strategy for Sustainability", website: http://www.waterforlife.gov.ab.ca, Edmonton, Alberta, November 2003.

Alberta Transportation. Alberta Municipal Water and Wastewater Partnership (AMWWP) Grant Procedures Manual, 2006.

Appendix A
GHOSTPINE ENVIRONMENTAL REPORT

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December 11, 2019
Ghostpine No.: 5204
Ghostpine Rev.: 0

Re: Site Visit of the Stavely Lagoon Discharge

Introduction

MPE Engineering Ltd. (MPE) requested Ghostpine Environmental Services Ltd. (Ghostpine) to assess the Town of Stavely lagoon discharge, as part of the Town of Nanton Shared Water Distribution Study. The focus of the assessment is to determine fish habitat suitability in the discharge zone.

Methods

Prior to the On-Site Assessment, a background review of the proposed project area was conducted including an aerial photograph review and review of government databases pertaining to potential fish species, watercourses and wetlands/waterbodies (AEP 2017, 2018).

A Ghostpine Qualified Aquatic Environmental Specialist (QAES) conducted an On-Site Assessment of the proposed project area on June 21, 2019.

Results

The Stavely lagoon is partially surrounded by a man-made drainage ditch meant to allow natural runoff around the lagoon. The drainage ditch around the lagoon was dry at the time of the site visit. The lagoon drains into this man-made drainage ditch which then flows in an east by northeast direction and connects to a man-made bar ditch alongside Range Road (RR) 273 (Appendix A: Figure 1; Appendix B: Plate 1). The man-made runoff ditch is approximately 1.0 m wide, slightly incised, roughly 0.3 m deep at the discharge location and heavily choked with tall grass vegetation.

The bar ditch that runs north along RR273 is roughly 2.0 m wide and 0.3 m deep, with decaying vegetation, turbid water and barely detectable flow (Appendix B: Plate 2). Shallow turbid water would likely be high in temperature and decaying vegetation indicates low dissolved oxygen (DO), typical of drainage ditches. It is unlikely the drainage ditch or the bar ditch provide fish habitat as it is likely dry most of the year.

The bar ditch flows east along the south side of Township Road (TWP RD) 142 (Appendix B: Plate 3). The bar ditch was densely vegetated with tall grass and some aquatic vegetation. Wetted width where visible was approximately 1.0 to 1.5 m wide with water depths averaging 0.4 m. Flow was visible.

The bar ditch crosses TWP RD 142 in 3-15-14-27 W4M. The culvert is undersized and has caused back flooding along the south side of the road and into an adjacent field, creating a temporary wetland (Appendix B: Plate 4).

The bar ditch continues to flow east along the north side of TWP RD 142 before entering an unnamed tributary to Clear Brook in 1-15-14-27 W4M (Appendix B: Plate 5). Water from the bar ditch could be observed flowing into Clear Brook but it is unclear how much of the water is from the lagoon discharge, as opposed to from runoff from recent rain events. The unnamed tributary is approximately 400 m long with what appears to be a gradient of 3 to 5%, with a shallow, narrow channel. It is unlikely fish would move up the unnamed tributary.

The confluence to Clear Brook was heavily impacted by cattle standing in, and next to, both watercourses (Appendix B: Plate 6).

Clear Brook is a large permanent mapped Class D watercourse with no Restricted Activity Period (indicating poor fish habitat). Clear Brook flows for approximately 20 km before entering Clear Lake (Appendix B: Plates 7, 8, 9).

Clear Brook has multiple sections with densely growing aquatic grasses thereby losing defined bed and banks and creating isolated pools. Based on indications of eroded banks, the watercourse experiences large volumes of spring runoff over a short period of time. Otherwise, the watercourse appears to have isolated pools interconnected with wet vegetated areas. According to Alberta Environment and Parks Fish and Wildlife Internet Mapping Tool (FWIMT; AEP 2018), fish species have not been documented in Clear Brook.

Recommendations

Considering the low volume of lagoon release in combination with densely vegetated ditches and isolated pockets of water within Clear Brook, it is likely that the discharge from the lagoon does not reach Clear Lake. Clear Brook contains poor fish habitat so effluent discharge from the lagoon is not likely to affect fisheries resources.

A fish and fish habitat assessment on Clear Brook at the effluent confluence is not considered necessary therefore is not recommended.

Limitation of Liability

Methods and results in this report are based on Ghostpine's adherence to municipal, provincial and federal regulations in place on the date issued. Inter and intra-regulatory agency interpretation of rules and regulations have been accounted for as much as reasonably possible.

During the preparation of this report and associated services, Ghostpine relied upon the full disclosure and accuracy of all applicable information by the client on the past, present and proposed conditions of this site. This report is based upon the information provided by MPE, information collected during desktop and/or field investigations, information gathered from regulatory bodies and agencies. The information provided by parties other than Ghostpine is believed to be accurate but cannot be guaranteed. The work was conducted by Ghostpine in accordance with the scope of work prepared for this project, including verbal or written requests from MPE. No other warranty, expressed or implied, is made.

All spatial data presented in this report (text or figures) was collected by a hand-held GPS unit, which typically has a 5 to 7 m margin of error. This known margin of error may be subject to further variance or discrepancy under certain field conditions or the time of day. A verified survey is recommended where any distances are required for regulatory compliance or conformance.

Ghostpine has exercised reasonable care and due diligence in the preparation of this report and the services have been performed in a manner consistent with other professionals currently practicing under similar conditions in the jurisdiction in which the services were provided.

It must be noted that the environmental assessment, as per the established scope of work of any site, is based on observations made at a specific moment in time; therefore, the conclusions and recommendations set out in this report are time sensitive. The report is based solely on the conditions that existed at the time of the investigation. The conclusions and recommendations set out in this report are based on the specific observations and testing at the subject site. Conditions across the site may vary which would affect the conclusions and recommendations made in the report. No detailed assessment on a given property or site can wholly eliminate the uncertainty regarding the potential for unrecognized conditions in connection with that particular property or site.

This report and the assessments and recommendations described within are intended for the sole use of MPE and their agents. Other representations or warranties regarding surface, subsurface, biotic, abiotic, and documentation of said condition in the form of report, or regulatory submission not referenced, are not provided. Any unauthorized use of this report is at the sole risk of the user. The document may not be manipulated, edited or amended without the expressed written consent and understanding of Ghostpine.

MPE may rely on this completed report for specific application to this project, based on project area discussed and conditions present at the time of the field assessment.

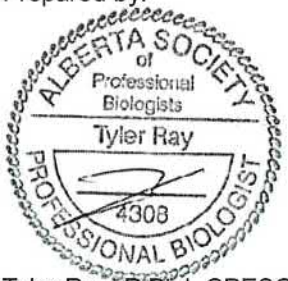
Closure

We appreciate the opportunity to work with MPE. Please contact the undersigned for additional information or with any questions or comments.

Yours truly,

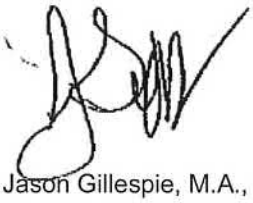
GHOSTPINE ENVIRONMENTAL SERVICES LTD.

Prepared by:



Tyler Ray, P.Biol.,CPESC-IT., QAES.
Lead, Aquatic Resources

Reviewed by:



Jason Gillespie, M.A., E.P.
Senior Regulatory Specialist

References

Literature Cited

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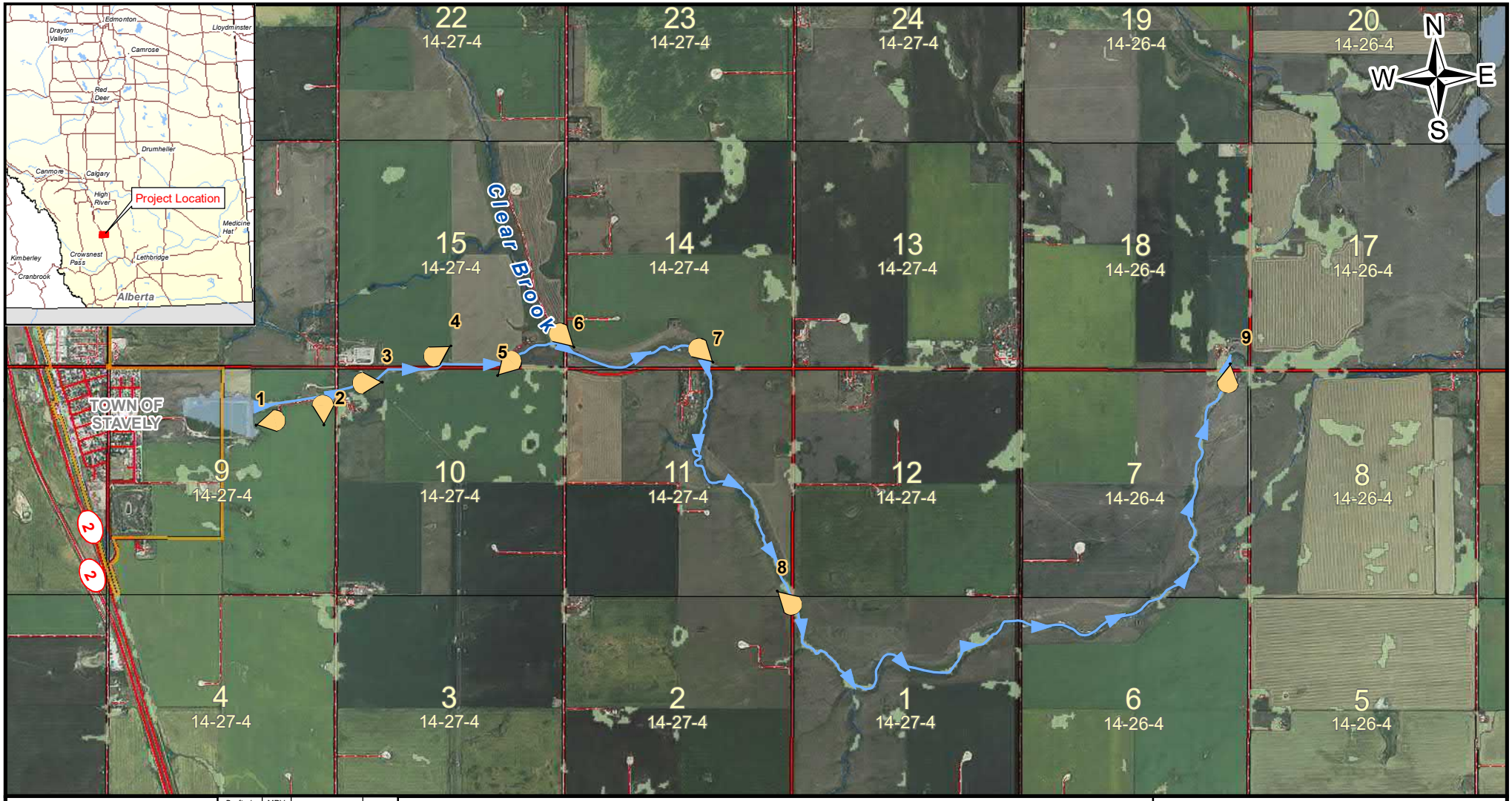
AEP. 2017. *Alberta Merged Wetland Inventory*. Ducks Unlimited Canada and Ducks Unlimited Inc., Government of Alberta (Environment and Sustainable Resource Development), United States Forest Service, United States Fish and Wildlife Service, North American Wetlands Conservation Act, The PEW Charitable Trusts, Canadian Boreal Initiative, Alberta-Pacific Forest Industries Inc., Environment Canada, Canadian Space Agency, Lakeland Industry and Community Association, Imperial Oil Resources, Shell Canada, Suncor Energy Foundation, Weyerhaeuser Company Limited, EnCana Corporation. April 2017.

APPENDIX A

FIGURE



SCALE: 1:40,000

0.25 0 0.25 0.5 0.75 km

Drafted:	MRV	Date:	Revision:
QA/QC:	MGW		
Approved:	CN	Dec. 10, 2019	0
Development Source:		Date:	Revision:
Sketch		Dec. 10, 2019	N/A

Data Sources:
Imagery: ESRI 2015
ATS Grid: AltaLIS 2007.
Please contact Ghostpine Environmental Services Ltd. for all other sources.

Although we have no reason to doubt the accuracy and completeness of the data used to generate this product, users should be aware that errors in the data may be present.

Ghostpine Environmental Services Ltd.

Proudly Serving Western Canada 20 Years

Legend

Routing:

- Photograph Location (showing direction of photo)
- Drainage Ditch

Alberta Merged Wetland Inventory:

- Marsh
- Open Water

Base Layers:

- Town Boundary
- Paved Road
- Unpaved Road
- AltaLIS Watercourses

MPE Engineering Ltd.

Photo Locations of the Proposed Stavely Lagoon Discharge

December 2019

REF.: 5204-06-200 (FIELD)

Figure 1

APPENDIX B

PHOTO PLATES

Plate 1
Date: June 21, 2019
Location of Photo: 15-9-14-27 W4M
Photo Direction: East-northeast.
Description: A man-made drainage ditch flows east-northeast from the Stavely lagoon to the Range Road 273 bar ditch.

Plate 2
Date: June 21, 2019
Location of Photo: 16-9-14-27 W4M
Photo Direction: North
Description: Bar ditch along west side of Range Road 273, south of Township Road 142.

Plate 3
Date: June 21, 2019
Location of Photo: 13-10-14-27 W4M
Photo Direction: West
Description: Bar ditch along the south side of Township Road 142, east of Range Road 273.

Plate 4
Date: June 21, 2019
Location of Photo: 3-15-14-27 W4M
Photo Direction: Southwest
Description: Temporary marsh wetland created by undersized culvert south of Township Road 142.

Plate 5
Date: June 21, 2019
Location of Photo: 2-15-14-27 W4M
Photo Direction: Northeast
Description: Culvert crossing of bar ditch to north of Township road 142. Ditch then enters an unnamed tributary of Clear Brook.

Plate 6
Date: June 21, 2019
Location of Photo: 1-15-14-27 W4M
Photo Direction: Northwest.
Description: Cattle trampling of Clear Brook on the west side of Range Road 272 and north of Township Road 142.

Plate 7
Date: June 21, 2019
Location of Photo: Northwest.
Photo Direction: 2-14-14-27 W4M
Description: Culvert crossing of Clear Brook to north of Township Road 142.

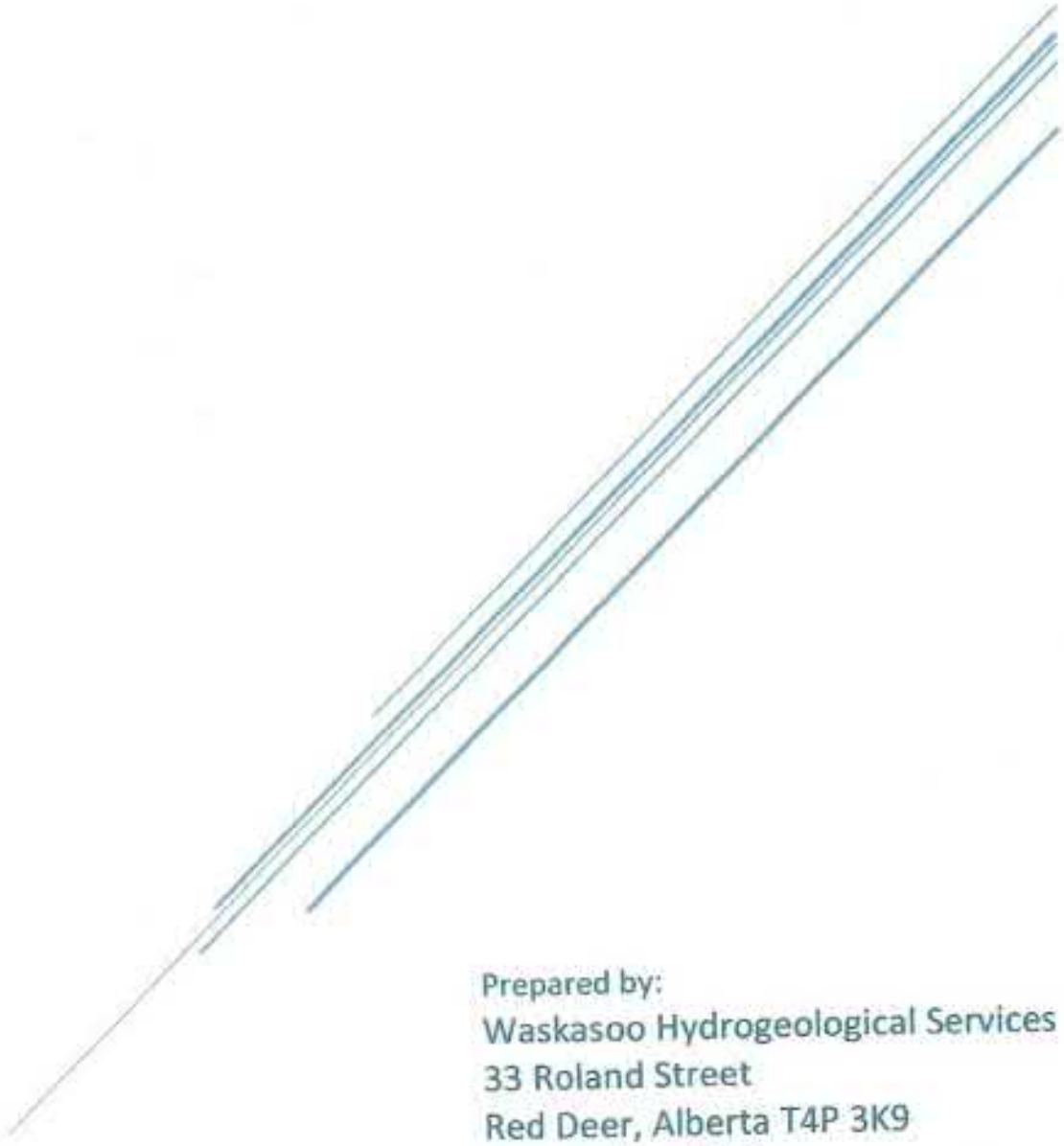
Plate 8
Date: June 21, 2019
Location of Photo: 13-11-14-27 W4M
Photo Direction: South.
Description: Culvert crossing of Clear Brook to the east side of Range Road 271.

Plate 9
Date: June 21, 2019
Location of Photo: 16-7-14-26 W4M
Photo Direction: Southeast
Description: Culverts crossing on south side of Township Road 142, west of Range Road 265

Appendix B
WASKASOO HYDROGEOLOGICAL SERVICES REPORT

GROUNDWATER EVALUATION, STAVELY AND NANTON, ALBERTA

FOR: MPE ENGINEERING LTD., LETHBRIDGE, AB



Prepared by:
Waskasoo Hydrogeological Services
33 Roland Street
Red Deer, Alberta T4P 3K9
September, 2019

TABLE OF CONTENTS

FIGURES

TABLES

1.0 Stavely water supply

1.1 Introduction

The terms of reference for the groundwater evaluations for both Stavely and Nanton were examined to review the existing files available from Alberta Environment and Parks and other sources for the two respective towns, as well as other files and published reports. Just these two towns have been the object of an investigation for their groundwater needs as the other towns have not identified such needs. The region included in the project is shown in Figure 1.1

Two types of aquifers are present in this region. The bedrock aquifers of the Cretaceous Willow Creek Formation consist of sandstone, generally within a silty to argillaceous matrix. Except in rare situations where the sandstone is highly fractured, these aquifers have low potential even to not meeting domestic needs in some locations.

There are also valley aquifers, gravel and sand which fill the ancient valleys, or paleovalleys of pre-glacial river beds These pre-glacial channels do not necessarily correspond to the modern river valleys. Where present and where they contain sufficient saturated sand and gravel, they often constitute prolific aquifers, and hence have been investigated in detail in Alberta Those shown in the study area are located as shown in Figure 1.2. The Stavely valley passes in a west-to-east direction about 2 km south of Stavely town (see Figure 1.3), based on a detailed interpretation of all water well records available for this area.

Alberta Environment's files for the two towns are stored in Environment's Lethbridge office, but were sent to Red Deer and made available to the author. These files included not only the normal correspondence between the towns and Environment, but also their valid licenses for diversion of groundwater and two consulting reports whose references are listed at the end of this brief report. In addition, the author purchased 1:50,000 scale topographic maps for the two town areas to better evaluate details of topography and elevations.

At present, the Town of Stavely owns two municipal wells, with all their water production currently coming from their Well #2, located as shown in Figure 1.4 (courtesy of UMA).

There is also a privately-owned water co-op, Big Sky Rural Water Co-op, whose water source is a deep well just east of Highway 2. This supply has also been reviewed.

In the case of Stavely town, three separate options have been identified, in no particular order of preference. The final decision will depend on several factors: technical, economic and security.

MPE Engineering Ltd. has determined the present and future projected demand for water to year 2044 for Stavely. Population growth is expected to be modest, to about 821 people, with an annual water demand of 132 422 cubic metres, or 363 cubic metres average per day at that time.

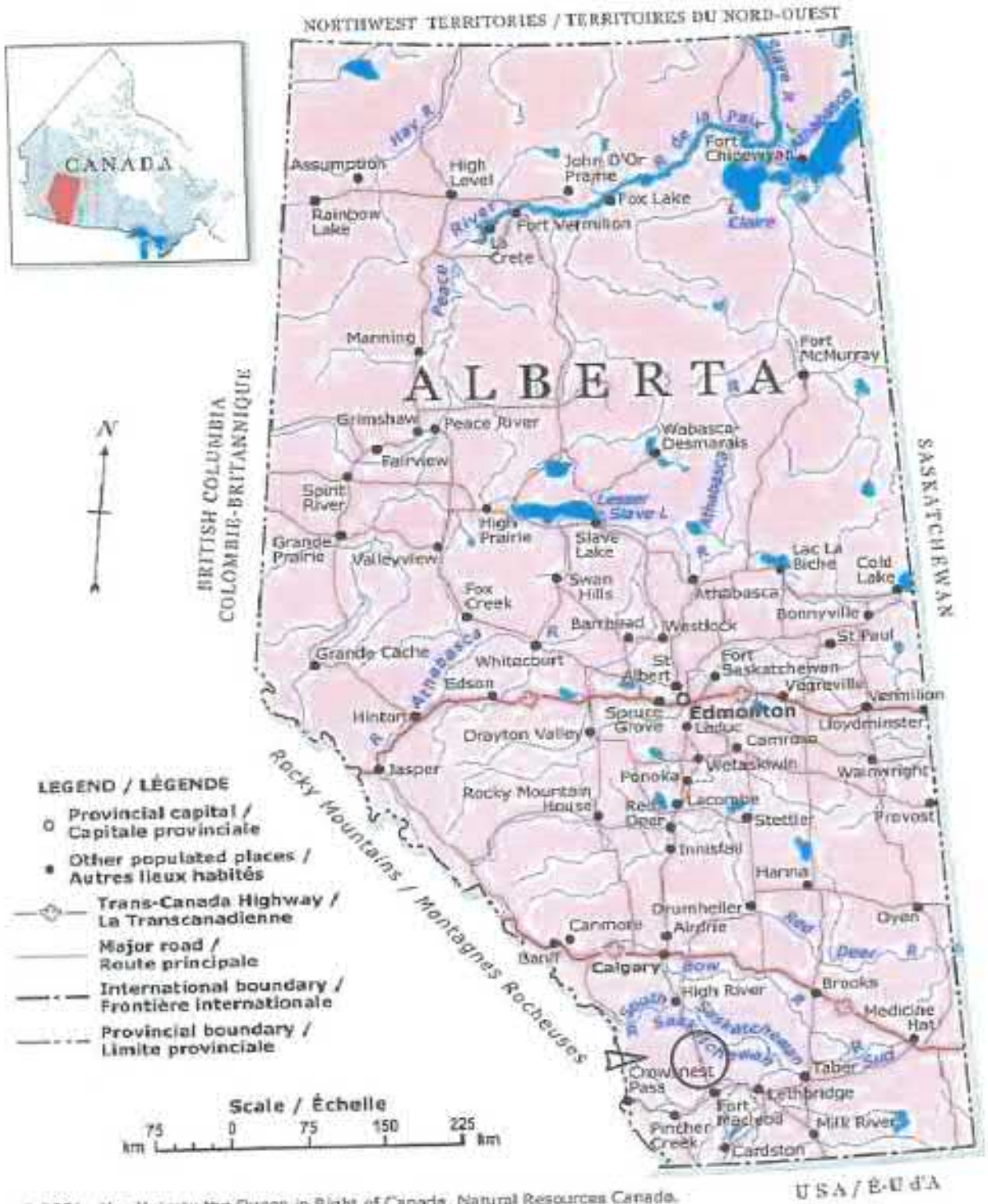


FIGURE 1.1. STUDY AREA

http://2.bp.blogspot.com/-tMmXTaB7KXA/T5IsX9oTYdI/AAAAAAAABR4/6nh8PVoD6VM/s1600/alberta_regions_...

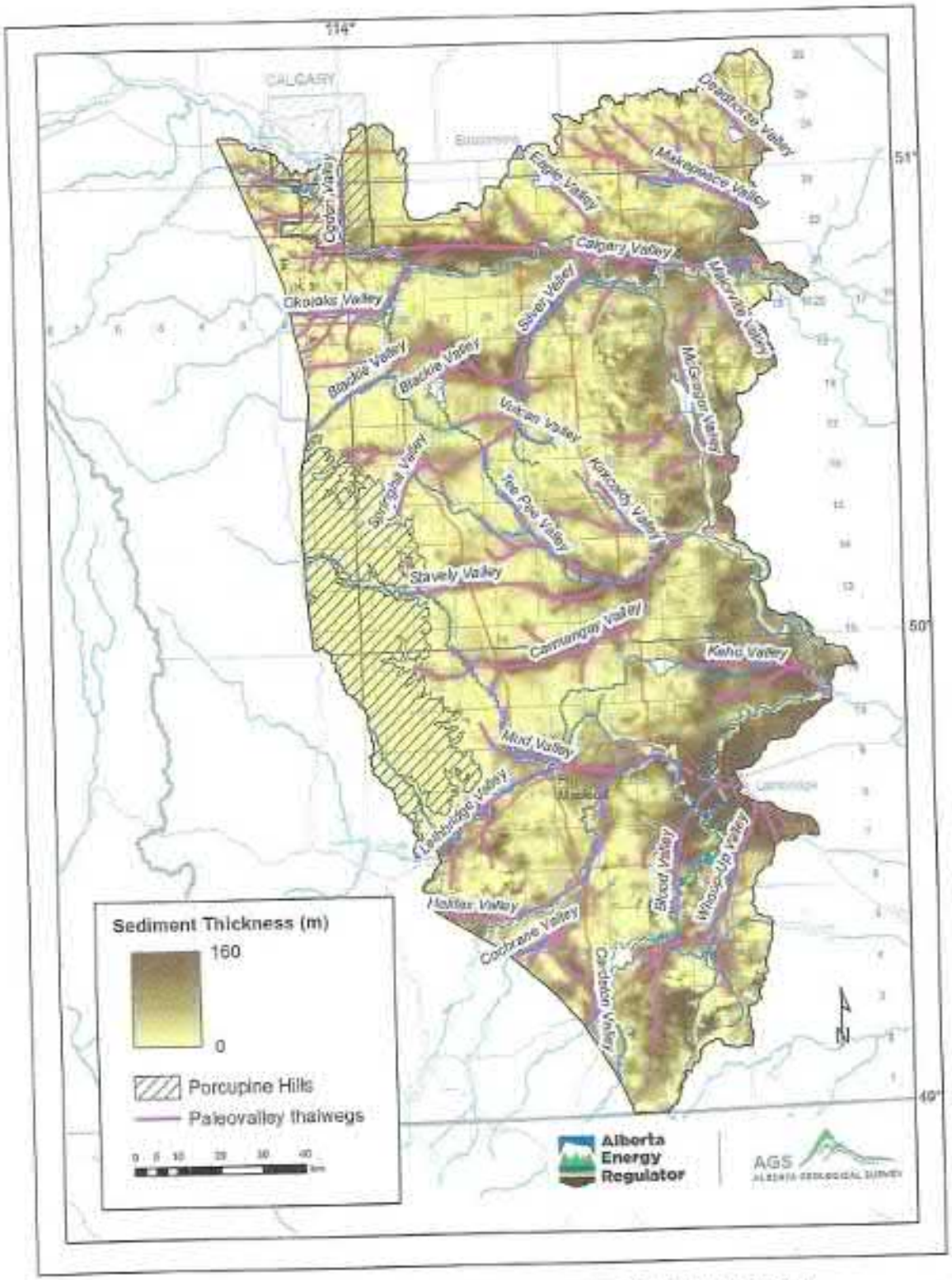


FIGURE 1.2. PALEOVALLEYS OF SOUTHWEST ALBERTA

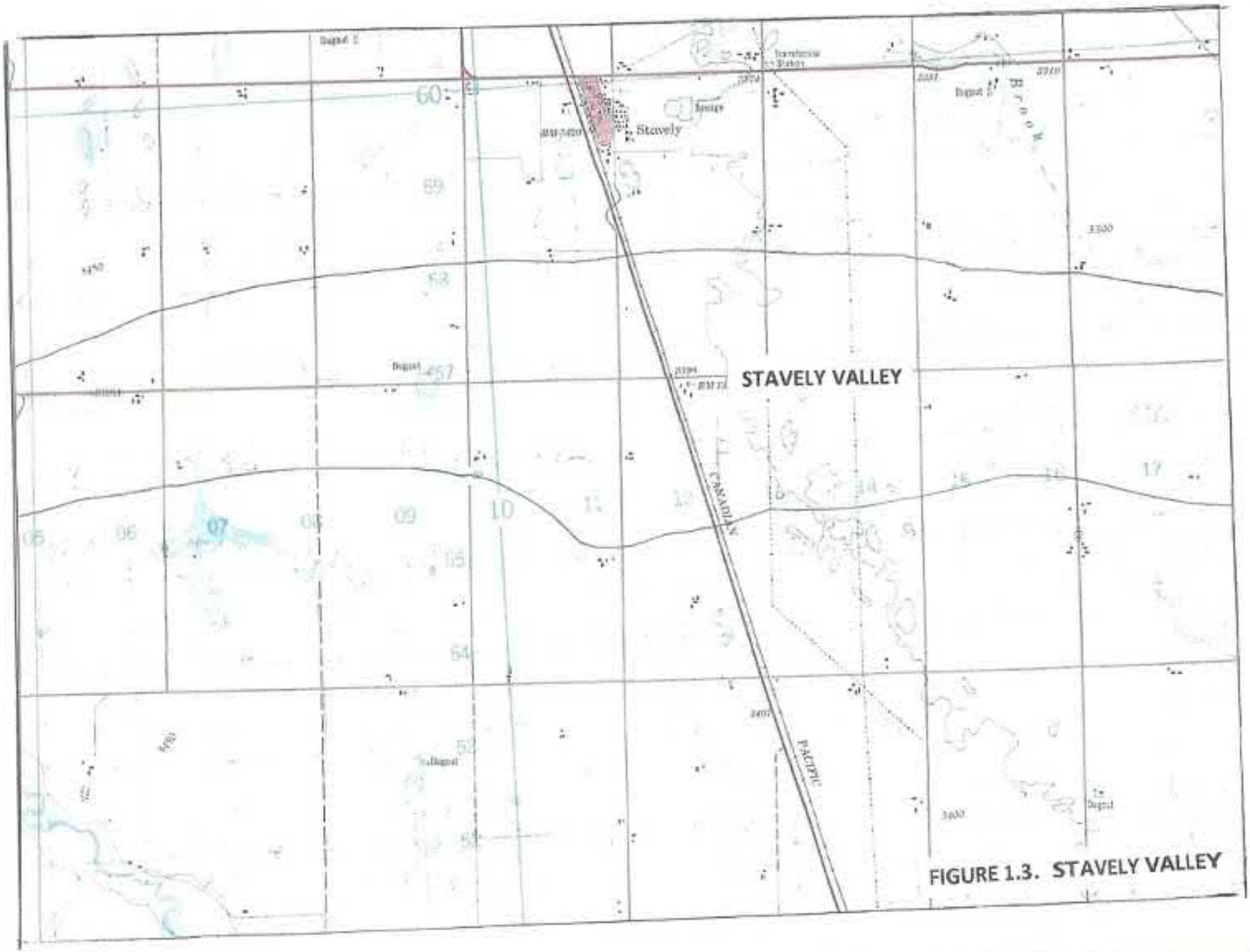


FIGURE 1.3. STAVELY VALLEY

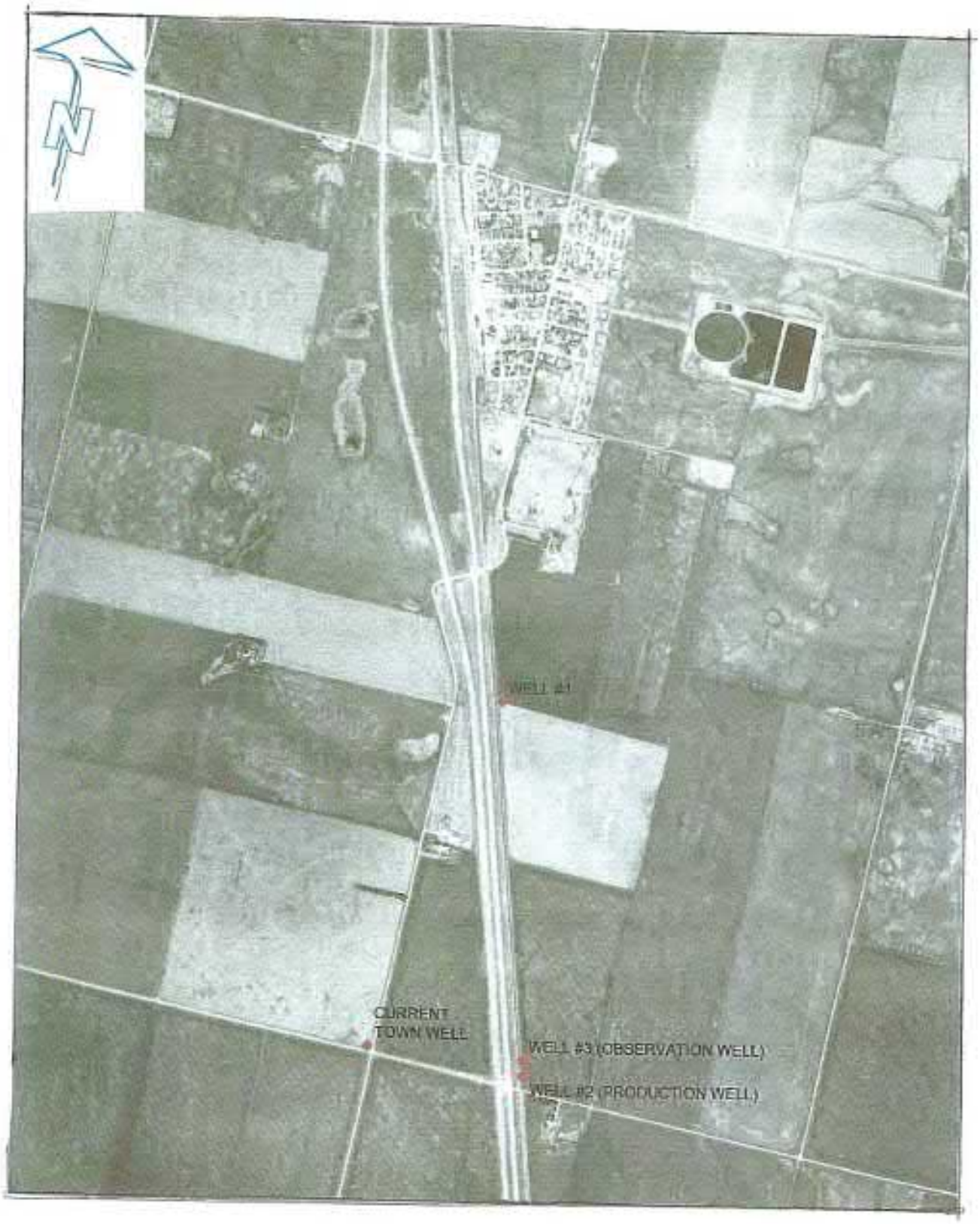


FIGURE 1.4. LOCATION OF STAVELY MUNICIPAL WELLS

1.2 Pine Coulee Reservoir

A consulting report prepared by UMA in 2005 describes in some detail a set of three relief wells which were constructed about 2.5 km east of the Pine Coulee Reservoir (see Figure 1.5). Their purpose is to reduce excess pore pressure in the aquifer just east of the reservoir. In fact, other wells were also constructed, but just three are in current use. They are pumped intermittently in order to maintain the groundwater level within a certain range adjacent to the reservoir, and thus avoid piping of the soils in the area. Attached is a verbatim summary by UMA of the operations of this facility, as described in 2005 (Figure 1.6). The water so pumped is then directed back into the reservoir. This water, if it could be utilized in part by the Town, would have a number of important advantages. These would include:

- This water source already exists and has been fully evaluated. Hence there would be no cost for exploration, drilling, and evaluation of well capacity.
- Pumping, maintenance and operational costs are already being borne by Alberta Environment, and would not be at the expense of the Town
- The three wells are located at about 20 m higher land elevation than Stavely's existing wells at Lsd. 1-5 and SW-4, adjacent to Highway 2. This would facilitate pumping to and connection with the existing pipeline to the Town's treatment plant.
- Because of the depth of the wells and their distance from the reservoir, the water would not be considered as GWUDI (groundwater under direct connection with surface water), thus facilitating its treatment at the Town's treatment planet.
- These wells were constructed to very high standards and would meet all Environment standards for use as municipal supply wells.

Disadvantages of developing this supply might include the following:

- The distance from these relief wells to the existing connection to the Town's supply is about 5.5 km, necessitating a costly pipeline for access.
- A guaranteed supply may not be available at all times, as the goal of these wells is to be pumped to maintain the aquifer level within a certain range.
- Alberta Environment may be unwilling to allow the secondary use of the relief wells for this purpose.

The excerpt from the UMA report, which follows, discusses these wells and their use. This supply, if available, would provide all the water needed for present and foreseeable population and commercial/industrial growth of the Town. If this appears to be an attractive alternative, it is recommended to initiate discussions with the managers of this system with respect to this option.

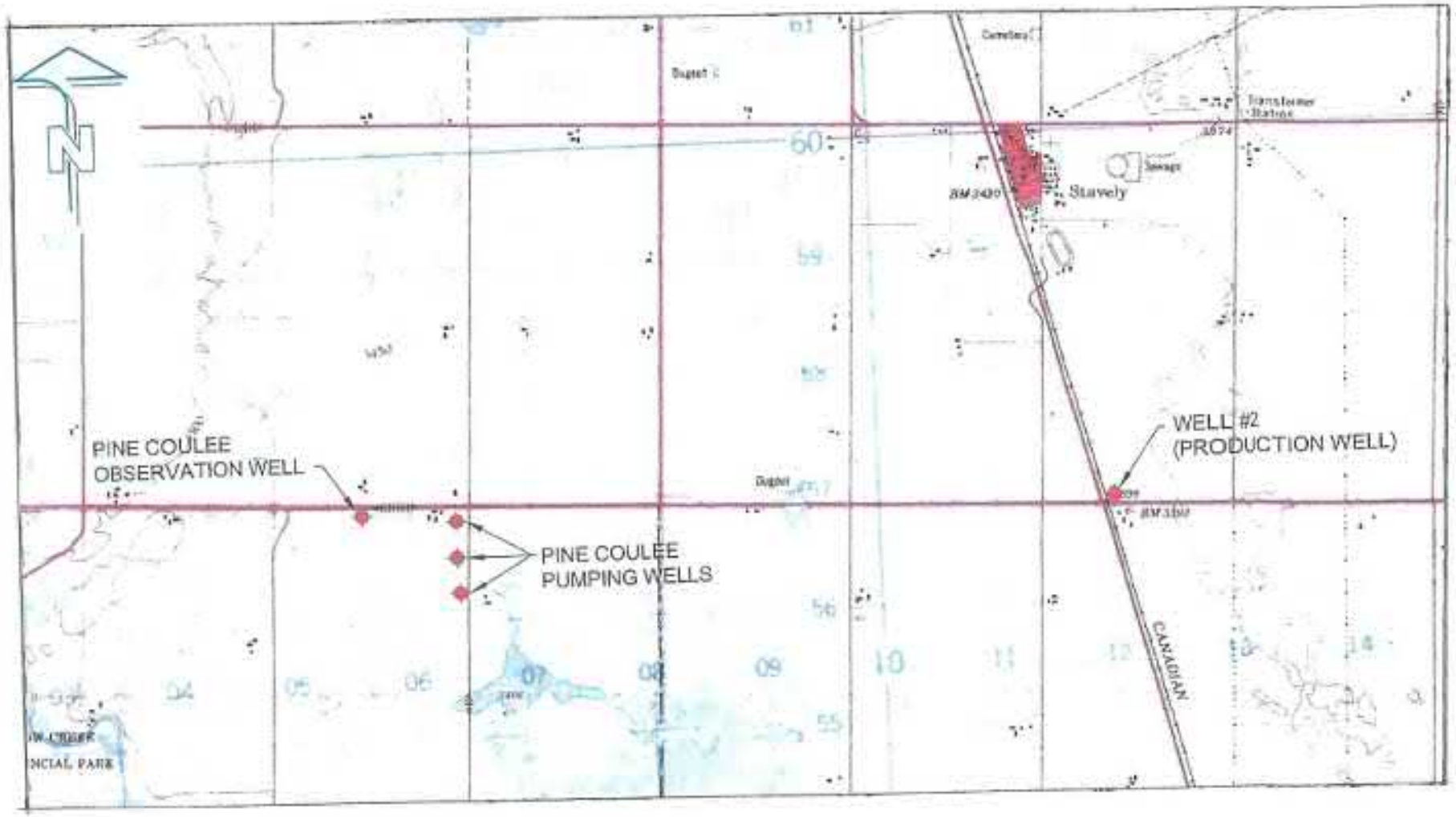


FIGURE 1.5. LOCATION OF PINE COULEE RELIEF WELLS

FIGURE 1.6. SUMMARY DESCRIPTION OF PINE COULEE WELLS

Alberta Environment (AENV) has three wells approximately 5.5 km west of Well #2. These wells are hydraulically connected to Well #2 and the other wells completed in the same aquifer. The wells are on the east side of the Pine Coulee Reservoir. The pumped groundwater is directed into the reservoir. A representative of AENV's Lethbridge office indicated that the purpose of the wells is to maintain a consistent groundwater level of 1,034.8 meters above sea level (mASL). Each well is able to pump at about 1,728 m^3/day (264 lgpm). The AENV representative indicated that usually only one well is pumping at a time and that there is a monitoring well about three quarters of a kilometre west of the wells that is used to measure the groundwater elevation.

Normally the pumps are automatically turned on when the level in the monitoring well rises above 1,034.8 mASL, but during the period that Well #2 was being pump tested, there was a problem with the pumps and they had to be turned on manually. They were turned on during the day and then turned off at the end of the day. The AENV representative provided the daily measurements of the groundwater level around the Pine Coulee Reservoir during the four days of the pump test and recovery test. They were:

- September 21, 2004 – 1034.5 mASL
- September 22, 2004 – 1034.02 mASL
- September 23, 2004 – 1035.51 mASL
- September 24, 2004 – 1035.75 mASL

These measurements indicate that the two days that Well #2 was being pumped, the groundwater level was below the level of 1,034.8 mASL that AENV usually keeps it at and that the groundwater levels were above normal levels the two days during the recovery test. These results could indicate that pumping Well #2 effects the ~~Spring~~ Pine Coulee wells.

As previously discussed in Section 5.1 of this report, there were bumps in the time-drawdown graphs. The consistent timing of these events every day during the testing indicates an unnatural source of the drawdown. The drawdown could correspond to a delayed response to the Pine Coulee wells being pumped during the day. Because of the distance away from the Reservoir, the drawdown wouldn't be seen in Well #2 until some time after the Pine Coulee well or wells were turned on. The same would be true for when the Pine Coulee wells were turned off. The drawdown would continue to be seen in Well #2 past the time that the Pine Coulee wells were turned off. This would explain why Well #2 shows a drawdown between 4 p.m. and midnight when the Pine Coulee wells were likely turned on at 8 or 9 a.m. and turned off in the afternoon.

The Pine Coulee well system will also help in preventing drawdown from Well #2 affecting other wells in the area. The Pine Coulee monitoring well measures the groundwater level, when the level rises above 1,034.8 mASL, the wells are turned on until the groundwater is drawn down to 1,034.8 mASL. This monitoring well is approximately 6.25 km away from Well #2. As Well #2 pumps, the drawdown effect would eventually reach the monitoring well and draw the water level below 1,034.8 mASL. The Pine Coulee wells would compensate for this drawdown by not pumping. This would allow the water level to rise back up to 1034.8 mASL. Allowing this extra water to be in the system would in effect stop any other drawdown from occurring beyond 6.25 km away from Well #2.

1.3 Increase pumping from existing well

UMA (2005, p. 4-3 to 4-4) describes the construction and testing of the well currently in use, located in SW-4-14-27-W.4, called Well #2 in their report (their Figure 2). It was tested at 126 igpm for 48 hours with recovery measured thereafter. Non-pumping water level was just 5.45 feet below top of casing. Further east of Highway 2, the non-pumping water level in the same aquifer under natural conditions is high enough that wells commonly flow, or at least used to flow.

The top of perforations in the casing was 190 feet, hence there are 184.55 feet of available drawdown for active pumping of this well. All of this suggests that this same well could be pumped at a much greater rate than is currently the case. Although the well is completed within a sandstone stratum just below the gravel mentioned previously, this sandstone is highly fractured and is hydraulically connected directly with the gravel.

UMA (2005, p. 6-3) calculated that sustainable yield of this well would be 491 igpm (3211 cubic metres per day). The well itself is not necessarily capable of producing this discharge because of the limitations of the size of pump and casing diameter required. However, Groundwater and Wells, 1989, p. 417, states that an appropriate pump inside a 6 inch diameter casing is capable of producing up to 450 US gpm (350 igpm). Thus, the existing well, with a larger pump could meet the needs of the target year of 2044.

To do so would require a new testing program and new engineering study, with a recommended 72 hour pumping and up to 72 hour recovery test of the well, plus use of two observation wells. There are already two wells in close proximity which could meet this need. It is suggested to carry out the test at about 200 igpm.

The driller's log of this well is attached following this section.

1.4 Construction of a new production well

The third option would be the construction of a new well. Because of the detailed knowledge now available on the aquifer in this immediate area, it is suggested to locate the new well about 50 m north of the existing well in Lsd. 1-5. It could be constructed with a larger diameter casing than is present in the current production well. The current well casing diameter is barely adequate, so increasing to 8 inch diameter increases the ability to carry out maintenance of any kind. The same comments regarding the testing program in section 1.3 above also apply here.

With the existence of two operational wells, the two could be operated simultaneously or in tandem, that is, pump one well for one week, then the other for the following week. The advantage of this option is mainly one of security. Should any power failure, pump failure,

transformer problems, etc. occur with one well, it would be an easy matter to switch to the other during maintenance or repairs.

1.5 General and conclusions

The current well which supplies the Town's water is now 15 years old, having been constructed in 2004. Files made available from Environment do not mention any attempts at maintenance or repairs to this well. It is strongly recommended therefore that as soon as practical, a competent drilling contractor be retained to carry out the following works:

- Remove the pump and inspect it for any damage to bearings, bowls, etc.
- Verify the condition of the riser pipe and electrical wiring from the pump to the land surface. Repair or replace as needed.
- Verify the current total depth of the well to determine if sediment has accumulated in the bottom since original construction.
- Acidize, flush and redevelop the well if and as needed, depending on the conditions encountered at that time. This will restore productivity to its original level.

Such works are best done in winter, when water demand is at a minimum. In conclusion, the Town of Stavely has several options for improving and guaranteeing a municipal water supply to meet current and future water needs. The selection of the final option will depend not only on the technical merits of each, but also on questions of security and comparative costs of each one. MPE Engineering Ltd. will aid the Town in the complete comparative evaluation of each and help them select the option which best meets their current and future needs. The solution selected must be part of the regional strategy, such that the solution for Stavely does not negatively impact the solution for other municipal organizations.

2.0 Nanton groundwater supply

2.1 Introduction

MPE Engineering Ltd. estimates that annual water demand for Nanton in 2044 will be 489,519 cubic metres per year, or 1341.1 cubic metres per day. They have indicated that ideally this supply should be sourced entirely from either a surface water body or from groundwater, but without mixing the two types of water. Treatment of the two radically different water qualities is considered to be problematic.

The discussion that follows therefore is oriented solely on the possibilities of developing groundwater as the sole source. Surface water supply is the object of a separate study.

2.2 Spring

The Town of Nanton has had a license since Aug. 28, 1969 to divert annually up to 100 acre-feet (123 457 cubic metres) of water from a spring, located west of the town in W1/2-3-16-29-W.4. (see Figure 2.1). However, on Mar. 7, 2014, their license was amended in order to divert 27 acre-feet (33 334 cubic metres) from the spring to the Rural Springhill Water Users Society. This now leaves 73 acre-feet, or 90 123 cubic metres annually available to the Town.

Table 2.1, *Town of Nanton Water Use Summary* (supplied by the Town), is a water use summary for the Town of Nanton during several years. (Note that the three columns entitled **m^3/s** should read **m^3/year**.) The table shows that the Town has used in excess of their authorized diversion in three of the five years of record. Additional information not shown indicates that in 2004, use was 137,377.3 acre-feet, but in 2005 it dropped to just 52,573 acre-feet.

In year 2004, total municipal water use was documented as shown below:

Mosquito Creek	500 acre-feet
Spring	100 acre-feet (less 27 acre-feet)
Water well	15 acre-feet
TOTAL	**615 acre-feet (less 27 acre-feet)**

The Town has requested Environment to increase the allocation from 100 to 200 acre-feet annually, but this has been rejected. There is concern with meeting the needs of other downstream users. Thus, for the foreseeable future, the realistic water supply available from the spring likely will remain at 73 acre-feet, or 90 123 cubic metres annually.

Town of Nanton Water Use Summary

	Spring (F00440)			Well (F18213)			Mosquito Creek (F20325)			Total All Sources
Year	Gallons	m^3/s	Acre-feet	Gallons	m^3/s	Acre-feet	Gallons	m^3/s	Acre-feet	Acre-feet
2003*	54,582,770	248,103.5	198.5	14,647,300	66,578.6	53.3	27,006,000	122,754.5	98.2	349.9
2002	38,436,620	174,721.0	139.8	8,151,800	37,053.6	29.6	32,505,000	147,750.0	118.2	287.6
2001	22,113,234	100,514.7	80.4	6,400,300	29,092.3	23.3	54,657,000	248,440.9	198.8	302.4
2000	24,266,440	110,302.0	88.2	10,257,200	46,623.6	37.3	52,227,000	237,395.5	189.9	315.5
1999	34,763,960	158,018.0	126.4	9,966,600	45,302.7	36.2	0	0.0	0.0	162.7
1998			N/A			N/A			N/A	N/A
1997			N/A			N/A			N/A	N/A
1996			N/A			N/A			N/A	N/A
1995			N/A	0	0.0	0			N/A	N/A
1994			N/A	1,058,380	4,810.8	3.8			N/A	N/A
1993	4,292,800	19,512.7	15.6	1,389,200	6,314.5	5.1	66,357,500	301,625.0	241.3	262.0
1992			N/A	3,603,200	16,378.2	13.1	67,578,500	307,175.0	245.7	258.8
1991			N/A	3,000,600	13,639.1	10.9	38,623,750	175,562.5	140.5	151.4
1990			N/A	3,426,400	15,574.5	12.5			N/A	12.5
Average			126.7			22.5			176.1	261.3
Licences Allocations			100.0			15.0			500.0	615.0

* Note for 2003, the reported water use is only up to November 24, 2003.

TABLE 2.1. TOWN OF NANTON WATER USE SUMMARY

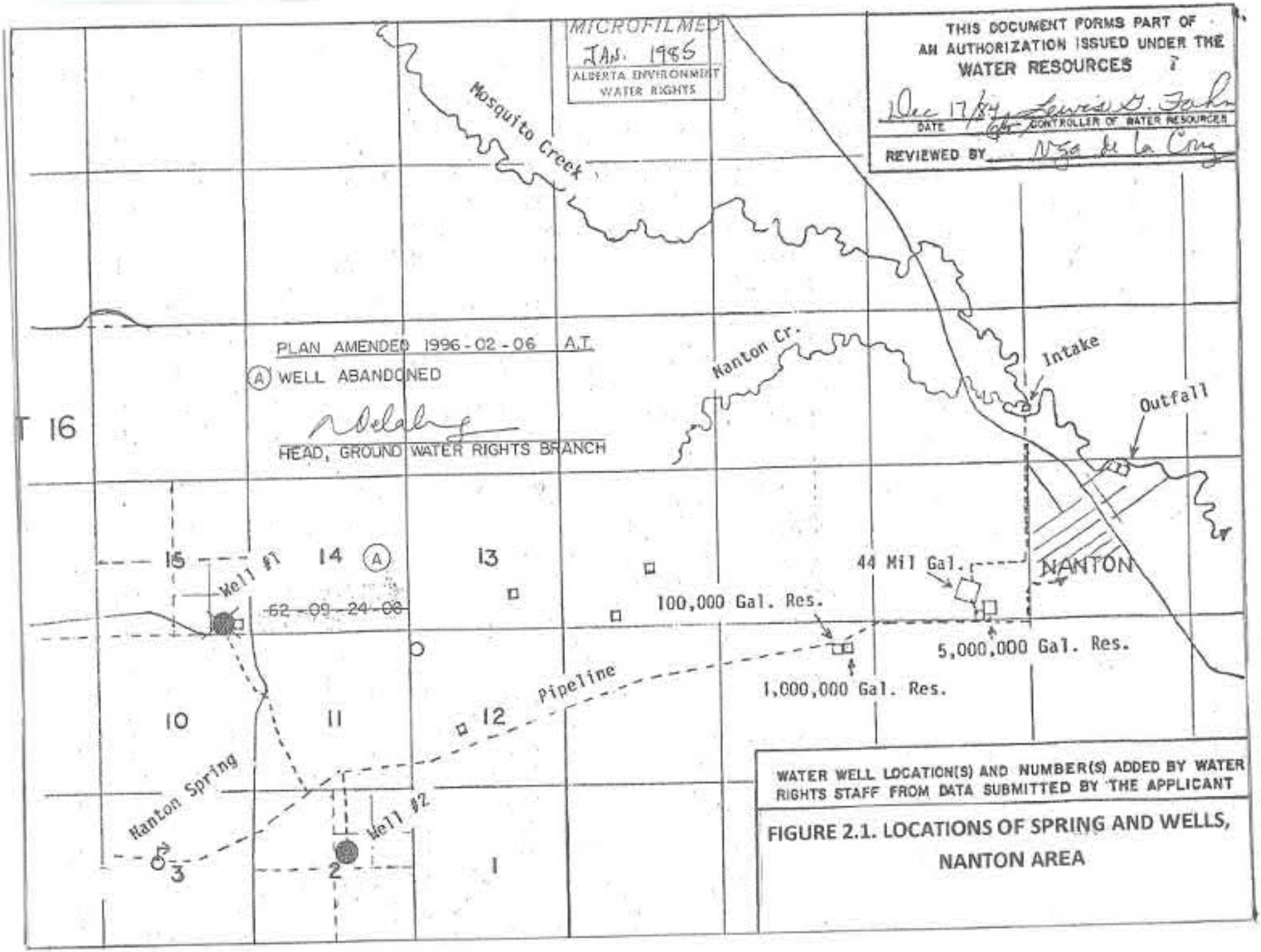


FIGURE 2.1. LOCATIONS OF SPRING AND WELLS, NANTON AREA

2.3 Well supply

A well, not currently used but still licensed, was drilled and used sporadically for municipal supply, starting in 1977. It is located in Lsd. 10-2-16-29-W.4, about 2 km east of the spring described above (See Figure 2.1 for locations). This plan refers to it as Well # 2. The driller indicated at that time that the well could pump an estimated 150 igpm. However, it was licensed for just 43 igpm, with a diversion not to exceed 34 acre-feet per year, later reduced to 15.0 acre-feet. The reasons for this significant reduction are unclear.

Two chemical analyses exist for this well, but are 42 and 28 years old, respectively (Tables 2.2 and 2.3). They are far from complete by modern standards, and show similar but not identical results. They suggest nothing of great concern, but do indicate that the water was rather hard.

This well was tested by All's Well of High River on Nov. 30, 2018 at 45 igpm for 607 minutes. This pumping rate was used because the pump in the well could not produce more. After 607 minutes, the electric power failed and the test was terminated. At this time, total drawdown was just 0.3 feet. At this discharge, it was impossible to determine the true productive capacity of the well. The information available, although incomplete, strongly suggests that this is a viable water source for about 125 to 150 igpm. The non-pumping water level was 31.5 feet when drilled in 1977, rising to 29.8 feet when tested in 2018, that is, a rise of 1.7 feet during 41 years, so there is no evidence of depletion during that time. If we optimistically assume a sustainable capacity of 125 igpm, or 819 cubic metres per day, this well could produce 298,939 cubic metres per year.

The well was completed within a pit, which Environment has pointed out to the Town is not legal. Moreover, the data are somewhat incomplete for other aspects of the well construction, and the casing does not appear to be properly sealed. Nor is the completion depth indicated. For these reasons (and perhaps others), this well cannot be licensed in its current condition today, should any increase in discharge be contemplated.

There is however enough evidence of a viable water source that it is recommended to construct and test a new well at this location. The drilling and completion details must meet all applicable standards of the *Water (Ministerial) Regulation* and *the Water Well* and *Ground Heat Exchange System Directive*, in order for the well to be licensed. If this aquifer is to be utilized, it will probably contribute a significant addition to the Town's water needs, but may not fully satisfy them. The ultimate capacity of a well at this location cannot be known until it is fully tested as indicated above.

Another well, shown as Well #1 in Figure 2.1, was licensed to produce 43 igpm, from a zone between 68 feet and 129 feet depth. Water was first produced from this source in 1966, but the license was cancelled by. Environment in 1996, for reasons unknown. Nothing further is known about this water source.

Alberta

CHEMICAL ANALYSIS REPORT

WELL NAME	NANTON, TOWN OF	GIC WELL ID	103760
LOCATION	LSD NE SEC 2 TWP 16 RG 29 M 4	SAMPLE NO.	8830-W
WELL DEPTH	61.00 ft	WATER LEVEL	37.00 ft
AQUIFER		LABORATORY	AE
SAMPLING DATE	1977-09-01		

FIELD	MG/L
BICARBONATE	
CHLORIDE	
DISSOLVED OXYGEN	
IRON	
PH	
S2	
TOTAL ALKALINITY	
LABORATORY	
COD	
DIC	
ION BALANCE	1.0530
SAR	
TOTAL ALKALINITY	354.0000
TDS	389
DOC	
AMMONIUM-N	
CALCIUM	55.9996
CHLORIDE	2.0022
NITRATE-N	
PHOSPHATE	
SODIUM	49.9997
NO2 + NO3	0.2996
ALUMINUM	
BARIUM	
CADMIUM	
COBALT	
IRON	-0.0500
MANGANESE	
MOLYBDENUM	
SELENIUM	
VANADIUM	
HYDROCARBONS	
PHENOLICS	

FIELD	MG/L
CARBONATE	
CONDUCTIVITY	
EH	
MANGANESE	
SULPHATE	
TEMPERATURE(C)	0
TOTAL HARDNESS	
Analysis Date	1977-09-12
CONDUCTIVITY	680
FLUORIDE	0.3200
PH	8.20
SIO2	7.8000
TC	
TN	
BICARBONATE	431.0449
CARBONATE	
MAGNESIUM	36.0301
NITRITE-N	-0.0994
POTASSIUM	4.5000
SULPHATE	27.0370
TOTAL HARDNESS	288.0000
ARSENIC	
BERYLLIUM	
CHROMIUM	
COPPER	
LEAD	
MERCURY	
NICKEL	
STRONTIUM	
ZINC	
PESTICIDES	

Remarks:

SAMPLED FROM WELL

Temperature reported in Degree Centigrade. Conductivity reported in microsiemens/cm, pH in pH units. Alkalinity and Hardness expressed as Calcium Carbonate. FE, VA, PB, AL, AG expressed as extractable, FE in field measurements and all remaining metals expressed as total. '-' indicates concentrations less than.

EH - Oxidation-Reduction Potential
SAR - Sodium Adsorption Ratio
DIC - Dissolved Inorganic Carbon
COD - Chemical Oxygen Demand
DOC - Dissolved Organic Carbon
TN - Total Particulate Nitrogen
TDS - Total Dissolved Solids
TC - Total Particulate Carbon

Note: this data may not be fully checked. The Province disclaims all responsibility for its accuracy

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TABLE 2.2. CHEMICAL ANALYSIS OF WELL WATER, 1977

Alberta

CHEMICAL ANALYSIS REPORT

WELL NAME	NANTON, TOWN OF	GIC WELL ID	103760
LOCATION	LSD NE SEC 2 TWP 16 RG 29 M 4	SAMPLE NO.	2904
WELL DEPTH	61.00 ft	WATER LEVEL	31.50 ft
AQUIFER		LABORATORY	LB
SAMPLING DATE	1981-01-14		

FIELD	MG/L
BICARBONATE	
CHLORIDE	
DISSOLVED OXYGEN	
IRON	
PH	
S2	
TOTAL ALKALINITY	
LABORATORY	
COD	
DIC	
ION BALANCE	
SAR	1.4000
TOTAL ALKALINITY	380.0000
TDS	652
DOC	
AMMONIUM-N	
CALCIUM	60.9996
CHLORIDE	3.0033
NITRATE-N	
PHOSPHATE	
SODIUM	54.9999
NO2 + NO3	0.2002
ALUMINUM	
BARIUM	
CADMIUM	
COBALT	
IRON	0.1000
MANGANESE	
MOLYBDENUM	
SELENIUM	
VANADIUM	
HYDROCARBONS	
PHENOLICS	

FIELD	MG/L
CARBONATE	
CONDUCTIVITY	
EH	
MANGANESE	
SULPHATE	
TEMPERATURE(C)	0
TOTAL HARDNESS	
Analysis Date	1981-01-21
CONDUCTIVITY	700
FLUORIDE	0.3000
PH	8.10
SIO2	
TC	
TN	
BICARBONATE	463.0470
CARBONATE	0.0000
MAGNESIUM	37.0308
NITRITE-N	
POTASSIUM	4.0920
SULPHATE	29.0428
TOTAL HARDNESS	305.0000
ARSENIC	
BERYLLIUM	
CHROMIUM	
COPPER	
LEAD	
MERCURY	
NICKEL	
STRONTIUM	
ZINC	
PESTICIDES	

Remarks:

SAMPLED FROM WELL #2

Temperature reported in Degree Centigrade. Conductivity reported in microsiemens/cm, pH in pH units. Alkalinity and Hardness expressed as Calcium Carbonate. FE, VA, PB, AL, AG expressed as extractable. FE in field measurements and all remaining metals expressed as total. '<' indicates concentrations less than.

EH - Oxidation-Reduction Potential
SAR - Sodium Adsorption Ratio
DIC - Dissolved Inorganic Carbon
COD - Chemical Oxygen Demand
DOC - Dissolved Organic Carbon
TN - Total Particulate Nitrogen
TDS - Total Dissolved Solids
TC - Total Particulate Carbon

TABLE 2.3. CHEMICAL ANALYSIS OF WELL WATER, 1981

Nevertheless, this may be a favorable area for an exploration program to develop additional groundwater supplies.

The theoretical (and admittedly optimistic) availability of groundwater identified for the Nanton area is summarized as follows:

Total demand for 2044	**489,519 m^3/year**
Spring	90,123
Well #2 125 igpm	298,939
Well #1 area, 43 igpm	102,834
Total groundwater	**491,896m^3/year**

Extensive testing of the two potential wells mentioned previously would be required if this option is to be evaluated, and it would be recommended that testing go beyond the minimal requirements of *Alberta Environment's Guide to Groundwater Authorization.* Considering the implications of a possible later failure of the wells, it is recommended that the aquifer test be of one-week duration, not just the normal 3 days. In addition, Well # 2 is about 2 km distant from the spring. It is essential to monitor spring discharge during and after the test of Well #2, to determine any impact on the discharge of the spring resulting from pumping Well #2.

Various other sources of information have been investigated in the hope of identifying another prolific buried valley aquifer, similar to the one south of Stavely. Although published documents (Figure 1.2) mention such channels (Springhill Valley, Blackie Valley, Vulcan Valley), none contain a significant thickness of sand/gravel aquifer which could justify the cost of development nor would they meet the needs of the Town. There are several highly productive wells in the Silver Valley, in township 19 range 26. This is however some 25 km northeast of town in a straight line.

The Alberta Research Council prepared a set of hydrogeological maps for most of Alberta at a scale of 1:250,000 in the 1970's based on data available over 40 years ago. The Gleichen sheet, published in 1974 (their report 74-9) shows a limited area of highly productive aquifer just southeast of Nanton Town. An examination of the original water well drilling information of the area suggests that this interpretation is based on the data from a single point. No other reports show any justification to support this interpretation. This option is therefore not considered realistic.

The relief wells near Pine Coulee Reservoir west of Stavely could produce up to 1728 cubic metres per day each. However, UMA indicates (Figure 1.6) that the owners typically pump just one at a time. Total demand of Nanton in 2044 will be 1341 cubic metes per day or 489,519 cubic metres per year. If it were considered feasible financially and if Alberta Environment were agreeable, these relief wells could provide much if not all the water needed by the Town of Nanton in year 2044. The biggest cost would be the construction of a pipeline of some 26 km length. Obviously,

choosing this option for Nanton would preclude its choice as an option for Stavely. For this reason, it is essential to keep in mind a regional approach to municipal water supply.

Another option would be the construction of one or two wells in the Stavely Valley, but at least 5 km east of the Stavely supply in order to avoid well interference. The piezometric surface of this aquifer is vey high east of Highway 2 and flowing wells are the norm in this area. Sufficient recharge is not a problem, as the Pine Coulee relief wells were constructed in order to lower the pressure in the aquifer. The main problem again is distance, about 30 km.

Other similar buried valley aquifers such as the Blackie and Okotoks valleys are at similar distances or more from Nanton, but north of the town.

3.0 Other authorized diversions

Only one other licensed groundwater diversion has been documented within the study area. This is the Big Sky Rural Water Co-op, whose source is a water well located 2.5 km east of the Stavely municipal well, situated in the road allowance between Sections 33/34-13-27-W.4M. This well was constructed and tested in 2003, for the purpose of supplying water to a network of rural users to the south and east It is completed in the same valley aquifer as is the Stavely municipal well and was licensed to divert up to 214,185 cubic metres per year. Actual current production rates are unknown, except for the first full year, in which production was just 43,912 cubic metres. At the anticipated full discharge rate, the interference to the nearest private well 600 m away would be less than 5 m after 20 years nonstop pumping, ignoring recharge.

4.0 Moratorium on water diversions

Because of over-allocation or nearly complete allocation of the available water resources within the Oldman – Bow River Basins, Alberta Environment has imposed a moratorium on additional diversions of water, both surface water and groundwater. This took effect on August 1, 2006. Thee are certain exceptions, such as household use, indigenous traditional rights, etc. However, in general, in order to obtain a right to divert water, it is now necessary to purchase that right from somebody else who already holds the right. That is, there now exists a market to buy and sell water rights, with market forces determining their price. Environment reserves the right to approve or veto such sales in the public interest, but in general, market forces determine their value. In addition, Environment has discretionary power to withhold for environmental purposes10 per cent of the amount of any right transferred in the case of surface water.

Having stated the above general policy, this does not apply to "true" groundwater which may be shown not to be connected directly to surface water. True groundwater diversion will not impact the discharge of streams, and Environment issues a number of such diversion licenses every year. It is up to the applicants and their consultants to make the case that a proposed diversion is indeed true groundwater not under the influence of surface water. Applications are approved on a case by case basis, depending on the merits of each application.

Regardless of which of the several options discussed in this report may be selected for detailed evaluation, an important aspect of that evaluation will be the determination of the extent to which the groundwater is or is not connected to nearby surface water bodies.

5.0 References

Alberta Environment, 2013, Guide to groundwater authorization; Government of Alberta, March, 2013

Alberta Geological Survey, 2017, Reginal geological and hydrogeological characterization of the Calgary-Lethbridge corridor in the South Saskatchewan reginal planning area; AGS/AER report 91.

Alberta Research Council, 1974, Hydrogeology of the Gleichen area, Alberta; Earth Sci. Rept. 1974-09, by G.F. Ozoray and A.T.Lytviak

Driscoll, Fletcher G., 1989, Groundwater and wells; Johnson Filtration Systems St. Paul,, inn., 3rd edition.

Files of Alberta Environment and Parks, Lethbridge, Alberta

Files supplied by the Town of Stavely

Reid Crowther and Partners, 1974, Exploration, drilling, testing and production water supply well, Town of Stavely, Stavely, Alberta; July 2, 1974

UMA, 2005, Town of Stavely, replacement well, Stavely, Alberta; Jan. 7, 2005

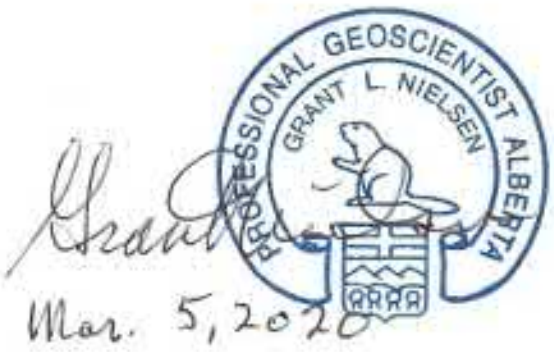
Western Watertech Inc. , 2003, Report to Stantec Inc. and Camfield Drilling Services Ltd., on community of Stavely groundwater evaluation 33/34-13-27-W.4M; dated Sep. 10, 2003

6.0 Closure

This document, entitled "**Groundwater Evaluation, Stavely and Nanton, Alberta**" was prepared at the request of and on behalf of **MPE Engineering Ltd.** by Waskasoo Hydrogeological Services. The material in it reflects Waskasoo Hydrogeological Services' best judgement in light of the information available to the firm at the time of its preparation. MPE Engineering Ltd. and Waskasoo Hydrogeological Services make no representation or warranty to any other person with regard to this report and the work referred to in this report and they accept no duty of care to any other person nor any liability or responsibility whatsoever for any losses, expenses, damages, fines, penalties or other harm what may be suffered or incurred by any other person as a result of the use of, reliance on, any decision made, or any action taken based on this report or the work referred to in this report. Any use, reliance on or decisions made which any third party makes of this report based on it, are the full responsibility of such third parties.

The report has been prepared for specific application to the sites described in the report and is based mainly upon the documents provided to Waskasoo by MPE Engineering and by Alberta Environment and Parks.

Nothing in this report is intended to constitute or provide a legal opinion.



Mar. 5, 2020

Grant L. Nielsen, Ph.D., P.Geo.

APPENDIX
Relevant water well records

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 140576
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1979/07/31

GOWN ID

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STAVELY, TOWN OF	P.O. BOX 249 STAVELY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	1	5	14	27	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.137638 Longitude -113.643675
How Location Obtained
Map

Elevation 1038.15 m
How Elevation Obtained
Survey-Transit

Drilling Information

Method of Drilling
Drilled

Type of Work
New Well

Proposed Well Use
Municipal

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.10		Clayey Topsoil
15.24		Gray Gravelly Clay & Shale
18.29		Shale
24.38		Shale & Sandstone
30.48		Silty Shale & Sandstone
36.58		Shale & Sandy Stringers
39.62		Pea Shale & Gravel
44.20		Quicksand
45.72		Shale
48.77		Wet Sand & Shale
51.21		Shale
51.82		Sandstone
56.39		Sandstone & Gravel
57.61		Gray Silt

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1973/05/21	318.23	7.62

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
57.61 m		1973/04/10	1973/05/11

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	57.61

Surface Casing (if applicable)
Steel
Size OD : 21.92 cm
Wall Thickness : 0.000 cm
Bottom at : 51.82 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Cement/Grout
Placed from 0.00 m to 50.60 m
Amount

Other Seals

Type	At (m)

Screen Type Stainless Steel
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)
51.82	56.39	0.000

Attachment Telescoped
Top Fittings Packer
Bottom Fittings Washdown

Pack
Type
Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
CULVERS FARM&RANCH

Copy of Well report provided to owner | Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 140576
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1979/07/31

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
STAVELY, TOWN OF	P.O. BOX 249 STAVELY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	1	8	14	27	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.137638 Longitude -113.643875
How Location Obtained
Map

Elevation 1038.15 m
How Elevation Obtained
Survey-Transit

Measurement in Metric

Additional Information

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 42.67 m
Pump Installed Yes Depth m
Type SUB Make JACUZZI H.P. 5
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken Electric
Submitted to ESRD Electric
Sample Collected for Potability Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level
Depth to water level

Measurement in Metric

Test Date	Start Time	Static Water Level	Pumping (m)	Elapsed Time Minutes:Sec	Recovery (m)
1973/05/21	12:00 AM	7.62 m			

Method of Water Removal
Type Air
Removal Rate 318.23 L/min
Depth Withdrawn From 42.67 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source
Amount Taken L
Diversion Date & Time

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER
Company Name
CULVERS FARM&RANCH
Certification No
1
Copy of Well report provided to owner
Date approval holder signed

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Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 167501
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1992/07/28

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
STAVELY	STAVELY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	5	14	27	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.139446 Longitude -113.646690
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Municipal

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
0.00 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	0.00

Surface Casing (if applicable)

Size OD: 0.00 cm
Wall Thickness: 0.000 cm
Bottom at: 0.00 m

Well Casing/Liner

Size OD: 0.00 cm
Wall Thickness: 0.000 cm
Top at: 0.00 m
Bottom at: 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type

Size OD: 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack

Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner
Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 167501
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1992/07/28

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
STAVELY	STAVELY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	5	14	27	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.139446 Longitude -113.646890
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Measurement in Metric

Additional Information

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Type
Depth m
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Taken From Ground Level Measurement in Metric

Yield Test

Test Date	Start Time	Static Water Level
		m

Method of Water Removal
Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 140572
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name: ALTA ENV #0636E
Address | Town | Province | Country | Postal Code

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	5	4	14	27	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.141269 Longitude -113.637981
How Location Obtained: Not Verified

Elevation 1035.41 m
How Elevation Obtained: Estimated

Drilling Information

Method of Drilling: Rotary
Proposed Well Use: Unknown
Type of Work: Test Hole

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.10		Light Green Silty Clay
10.67		Light Green Sandy Clay
13.72		Light Green Fine Grained Clay & Sand
24.38		Greenish Gray Clay
38.71		Greenish Gray Gravelly Clay
40.84		Gravel
42.67		Greenish Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
42.67 m		1972/11/27	1972/11/28

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	42.67

Surface Casing (if applicable)
Size OD: 0.00 cm
Wall Thickness: 0.000 cm
Bottom at: 0.00 m

Well Casing/Liner
Size OD: 0.00 cm
Wall Thickness: 0.000 cm
Top at: 0.00 m
Bottom at: 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal: Cement/Grout
Placed from 0.00 m To 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD: 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings | Bottom Fittings

Pack
Type | Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER
Company Name
ALBERTA ENVIRONMENT

Certification No
1
Copy of Well report provided to owner | Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 140572
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name: ALTA ENV #0935E | Address | Town | Province | Country | Postal Code

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	S	4	14	27	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.141269 Longitude -113.637961
How Location Obtained: Not Verified

Elevation 1035.41 m
How Elevation Obtained: Estimated

Measurement in Metric

Additional Information

Distance From Top of Casing to Ground Level: cm
Is Artesian Flow:
Rate: L/min
Is Flow Control Installed:
Describe:

Recommended Pump Rate: L/min
Recommended Pump Intake Depth (From TOC): m
Pump Installed:
Depth: m
Type:
Make:
H.P.:
Model (Output Rating):

Did you Encounter Saline Water (>4000 ppm TDS):
Depth: m
Gas:
Depth: m
Well Disinfected Upon Completion:
Geophysical Log Taken: Electric
Submitted to ESRD: Electric
Samples Collected for Potability:
Submitted to ESRD:

Additional Comments on Well

Taken From Ground Level | Measurement in Metric

Yield Test

Test Date	Start Time	Static Water Level
		m

Method of Water Removal
Type:
Removal Rate: L/min
Depth Withdrawn From: m

If water removal period was < 2 hours, explain why:

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well: UNKNOWN NA DRILLER
Company Name: ALBERTA ENVIRONMENT
Certification No: 1
Copy of Well report provided to owner:
Date approval holder signed:

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 1555031
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received:

GOWN ID:

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
TOWN OF STAVELY	17007-17 AVE	EDMONTON	AB	CA	T5S 1G3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	4	14	27	4				UMA ENGINEERING

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude: 50.139300 Longitude: -113.635000
How Location Obtained: Not Verified

Elevation: m
How Elevation Obtained: Not Obtained

Drilling Information

Method of Drilling: Rotary
Proposed Well Use: Municipal
Type of Work: New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
3.66		Brown Sandy Clay
12.80		Brown Clay & Rocks
42.67		Brown Sandy Clay & Rocks
50.29		Sand
55.47		Pea Sand & Gravel
62.79		Blue Gray Sandstone
70.10		Gray Shaly Shale & Sandstone Ledges

Yield Test Summary

Measurement in Metric

Recommended Pump Rate: 681.91 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2004/08/21	659.18	1.66

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
67.06 m		2004/08/18	2004/08/26

Borehole

Diameter (cm)	From (m)	To (m)
15.24	0.00	67.06

Surface Casing (if applicable)
Steel
Size OD: 16.83 cm
Wall Thickness: 0.480 cm
Bottom at: 56.39 m

Well Casing/Liner
Plastic
Size OD: 12.70 cm
Wall Thickness: 0.630 cm
Top at: 48.77 m
Bottom at: 67.06 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)
57.91	65.53	0.320		20.32

Perforated by: Saw

Annular Seal: Driven & Bentonite
Placed from: 0.00 m to: 55.78 m
Amount:

Other Seals

Type	At (m)

Screen Type
Size OD: cm

From (m)	To (m)	Slot Size (cm)

Attachment:
Top Fittings: Bottom Fittings:

Pack
Type: Unknown Grain Size:
Amount: Unknown

Contractor Certification

Name of journeyman responsible for drilling/construction of well: TODD NIEMANS
Company Name: NIEMANS DRILLING (1980) LTD.
Certification No: 23199A
Copy of Well report provided to owner: Date approval holder signed:

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 1655031
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
TOWN OF STAVELY	17607-17 AVE	EDMONTON	AB	CA	T5S 1G3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	4	14	27	4				UMA ENGINEERING

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.139300 Longitude -113.635000
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Measurement in Metric

Additional Information

Distance From Top of Casing to Ground Level 60.96 cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 681.91 L/min
Recommended Pump Intake Depth (From TOC) 39.62 m
Pump Installed
Type
Depth m
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Measurement in Metric

Yield Test

Test Date	Start Time	Static Water Level
2004/09/21	12:00 AM	1.66 m

Method of Water Removal
Type Pump
Removal Rate 659.18 L/min
Depth Withdrawn From 44.20 m

If water removal period was < 2 hours, explain why:

Taken From Ground Level
Depth to water level

Pumping (m)	Elapsed Time Minutes:Sec	Recovery (m)
1.66	0:00	
4.60	1:00	3.16
4.69	2:00	3.10
4.70	3:00	3.07
4.57	4:00	3.06
4.54	5:00	3.05
4.49	6:00	3.04
4.54	7:00	3.03
4.56	8:00	3.01
4.57	9:00	3.01
4.56	10:00	3.00
4.74	12:00	2.98
4.81	14:00	2.97
4.80	16:00	2.96
4.78	20:00	2.93
4.81	25:00	2.91
4.87	30:00	2.89
4.85	35:00	2.87
4.92	40:00	2.86
4.97	50:00	2.83
4.97	60:00	2.80
4.95	75:00	2.77
5.04	90:00	2.74
5.01	105:00	2.71
5.10	120:00	2.70
6.13	2880:00	1.83

Water Diverted for Drilling

Water Source
Amount Taken L
Diversion Date & Time

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
TODD NIEMANS
Company Name
NIEMANS DRILLING (1980) LTD.
Certification No
23199A
Copy of Well report provided to owner
Date approval holder signed

Printed on 3/5/2020 5:15:32 PM

Water Well Drilling Report

View in Metric | Export to Excel

The data supplied the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 1555102
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

GOWN ID

Measurement in Imperial

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
STAVELY, TOWN OF	17007 - 107 AVE	EDMONTON	AB	CA	T5S 1G3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	4	14	27	4				ATT: UMA ENGINEERING LTD ATT" MICHAEL

Measured from Boundary of
ft from
ft from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.139300 Longitude -113.635000
How Location Obtained
Not Verified

Elevation ft
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Observation

Type of Work
Piezometer

Formation Log

Measurement in Imperial

Depth from ground level (ft)	Water Bearing	Lithology Description
1.00		Topsoil
13.00		Sandy Clay
43.00		Brown Sticky See Comments
141.00		Sandy Clay & Rocks
166.00		Sand
181.00		Pea Sand & Gravel
186.00		Blue Shale
195.00		Gray Fine Grained Sandstone
202.00		Gray Sandstone
220.00		Brownish Gray Shale

Yield Test Summary

Measurement in Imperial

Recommended Pump Rate igpm

Test Date	Water Removal Rate (igpm)	Static Water Level (ft)
2004/09/21	0.00	6.66

Well Completion

Measurement in Imperial

Total Depth Drilled / Finished Well Depth	Start Date	End Date
220.00 ft	2004/09/13	2004/09/18

Borehole

Diameter (in)	From (ft)	To (ft)
6.00	0.00	220.00

Surface Casing (if applicable)
Unknown
Size OD : in
Wall Thickness : in
Bottom at : ft

Well Casing/Liner
Plastic
Size OD : 2.00 in
Wall Thickness : 0.015 in
Top at : 0.00 ft
Bottom at : 220.00 ft

Perforations

From (ft)	To (ft)	Diameter or Slot Width(in)	Slot Length (in)	Hole or Slot Interval(in)
195.00	215.00	0.020		2.00

Perforated by Machine

Annular Seal Bentonite Chips/Tablets
Placed from 0.00 ft to 194.00 ft
Amount
Other Seals

Type	At (ft)

Screen Type Plastic
Size OD : 2.00 in

From (ft)	To (ft)	Slot Size (in)
195.00	215.00	0.020

Attachment Unknown
Top Fittings Unknown Bottom Fittings Unknown

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Company Name
NIEMANS DRILLING (1980) LTD.

Certification No
46340A

Copy of Well report provided to owner Date approval holder signed

Water Well Drilling Report

View in Metric | Export to Excel

The data supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 1555102
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

GOWN ID

Measurement in Imperial

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
STAVELY, TOWN OF	17007 - 107 AVE	EDMONTON	AB	CA	T5S 1G3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	4	14	27	4				ATT: UMA ENGINEERING LTD ATT" MICHAEL

Measured from Boundary of
ft from
ft from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.139300 Longitude -113.635000
How Location Obtained
Not Verified

Elevation ft
How Elevation Obtained
Not Obtained

Measurement in Imperial

Additional Information

Distance From Top of Casing to Ground Level 24.00 in
Is Artesian Flow
Rate igpm
Is Flow Control Installed
Describe

Recommended Pump Rate igpm
Recommended Pump Intake Depth (From TOC) ft
Pump Installed Depth ft
Type Make H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth ft
Gas Depth ft
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability Submitted to ESRD

Additional Comments on Well
13' - 43' STICKY SDY BRN CLAY & ROCKS, OBS WELL FOR TOWN SUPPLY

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS
Company Name
NIEMANS DRILLING (1960) LTD.

Certification No
46340A
Copy of Well report provided to owner Date approval holder signed

Printed on 3/5/2020 5:16:13 PM

Water Well Drilling Report

View in Metric | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 1555102
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received:

GOWN ID:

Measurement in Imperial

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
STAVELY, TOWN OF	17007 - 107 AVE	EDMONTON	AB	CA	T5S 1G3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	4	14	27	4				ATT: UMA ENGINEERING LTD ATT" MICHAEL

Measured from Boundary of:
ft from
ft from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude: 50.139300 Longitude: -113.635000
How Location Obtained: Not Verified

Elevation: ft
How Elevation Obtained: Not Obtained

Yield Test

Taken From Ground Level
Depth to water level

Measurement in Imperial

Test Date: 2004/09/21
Start Time: 12:00 AM
Static Water Level: 6.66 ft

Method of Water Removal
Type: Unknown
Removal Rate: 0.00 igpm
Depth Withdrawn From: ft

If water removal period was < 2 hours, explain why

Pumping (ft)	Elapsed Time Minutes:Sec	Recovery (ft)
7.01	1:00	10.22
7.18	2:00	10.06
7.27	3:00	9.97
7.31	4:00	9.91
7.35	5:00	9.87
7.38	6:00	9.83
7.41	7:00	9.80
7.44	8:00	9.76
7.46	9:00	9.73
7.49	10:00	9.71
7.55	12:00	9.67
7.61	14:00	9.62
7.64	16:00	9.58
7.72	20:00	9.51
7.79	25:00	9.44
7.86	30:00	9.37
7.92	35:00	9.31
7.98	40:00	9.27
8.07	50:00	9.16
8.16	60:00	9.08
8.27	75:00	8.97
8.37	90:00	8.87
8.45	105:00	8.79
8.53	120:00	8.70
8.67	150:00	8.56
8.80	180:00	8.43
8.89	210:00	8.30
8.98	240:00	8.19
9.11	300:00	7.98
9.24	360:00	7.81
9.48	480:00	7.57
10.03	600:00	7.73
10.42	720:00	7.77
10.68	840:00	7.69
10.94	960:00	7.61
10.67	1080:00	7.19
10.62	1200:00	6.86
10.63	1320:00	6.62
10.72	1440:00	6.46

Water Diverted for Drilling

Water Source:
Amount Taken: kg
Diversion Date & Time:

Contractor Certification

Name of Journeyman responsible for drilling/construction of well:
CHAD NIEMANS

Company Name:
NIEMANS DRILLING (1980) LTD.

Certification No:
46340A

Copy of Well report provided to owner:
Date approval holder signed:

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 288163
GoA Well Tag No.:
Drilling Company Well ID: PINE COULEE ABANDONMENT
Date Report Received: 2012/10/22

GOWN ID:

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA ENVIRONMENT&WATER	P.O. BOX 903 1002 - 2 AVENUE	VULCAN	ALBERTA	CANADA	T0L 2B0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	35	13	28	4				

Measured from Boundary of: m from / m from

GPS Coordinates in Decimal Degrees (NAD 83): Latitude 50.131968 Longitude -113.726208

How Location Obtained:

Elevation: m

How Elevation Obtained:

Drilling Information

Method of Drilling: Unknown

Proposed Well Use: Unknown

Type of Work: Existing Well-Decommissioned

Plugged: 2012/10/17

Plugged with: Cement

Amount: 100.00 Gallons

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
45.42		Old Well

Yield Test Summary

Measurement in Metric

Recommended Pump Rate: L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)

Size OD: cm
Wall Thickness: cm
Bottom at: m

Well Casing/Liner

Size OD: cm
Wall Thickness: cm
Top at: m
Bottom at: m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by:

Annular Seal

Placed from: m to m
Amount:

Other Seals

Type	At (m)

Screen Type

Size OD: cm

From (m)	To (m)	Slot Size (cm)

Attachment:
Top Fittings: Bottom Fittings:

Pack

Type: Grain Size:
Amount:

Contractor Certification

Name of Journeyman responsible for drilling/construction of well: KEVIN BLAND

Company Name: CAMFIELD DRILLING SERVICES LTD.

Certification No: VC3171

Copy of Well report provided to owner: Yes

Date approval holder signed: 2012/10/22

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 288163
GoA Well Tag No.:
Drilling Company Well ID: PINE COULEE ABANDONMENT
Date Report Received: 2012/10/22

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA ENVIRONMENT&WATER	P.O. BOX 903 1002 - 2 AVENUE	VULCAN	ALBERTA	CANADA	T0L 2B0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	35	13	28	4				

Measured from Boundary of
_____ m from
_____ m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude: 50.131988 Longitude: -113.726208
How Location Obtained:

Elevation: _____ m
How Elevation Obtained:

Measurement in Metric

Additional Information

Distance From Top of Casing to Ground Level: _____ cm
Is Artesian Flow: _____
Rate: _____ L/min
Is Flow Control Installed: _____
Describe: _____

Recommended Pump Rate: _____ L/min
Recommended Pump Intake Depth (From TOC): _____ m
Pump Installed: _____ Depth: _____ m
Type: _____ Make: _____ H.P.: _____
Model (Output Rating): _____

Did you Encounter Saline Water (>4000 ppm TDS): _____ Depth: _____ m
Gas: _____ Depth: _____ m
Well Disinfected Upon Completion: _____
Geophysical Log Taken: _____
Submitted to ESRD:
Sample Collected for Potability: _____ Submitted to ESRD: _____

Additional Comments on Well:
CASING CUT OFF 6 FEET BELOW GROUND

Taken From Ground Level | Measurement in Metric

Yield Test

Test Date	Start Time	Static Water Level
		m

Method of Water Removal
Type: _____
Removal Rate: _____ L/min
Depth Withdrawn From: _____ m

If water removal period was < 2 hours, explain why:

Water Diverted for Drilling

Water Source	Amount Taken		Diversion Date & Time
TOWN OF CLARESHOLM	1136.52	L	2012/10/16 10:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well:
KEVIN SLAND

Company Name:
CAMFIELD DRILLING SERVICES LTD.

Certification No:
VC3171

Copy of Well report provided to owner:
Yes

Date approval holder signed:
2012/10/22

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 288164
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1997/09/09

GOWN ID:

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PUBLIC WORKS	3 FLOOR, 6950 113 ST, EDMONTON				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	35	13	28	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude: 50.131968 Longitude: -113.726208
How Location Obtained: Not Verified

Elevation: m
How Elevation Obtained: Not Obtained

Drilling Information

Method of Drilling: Rotary
Proposed Well Use: Observation
Type of Work: New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
10.97		Brown Till
36.58		Gray Till
38.10		Gray Sandy Till
39.62		Brown Sand
42.06		Gray Sandy Till
45.72		Gravel
46.94		Red Shale
48.16		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate: 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1996/11/14	200.03	29.26

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
48.16 m		1996/11/13	1996/11/14

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	48.16

Surface Casing (if applicable)
Steel
Size OD: 14.12 cm
Wall Thickness: 0.478 cm
Bottom at: 42.37 m

Well Casing/Liner
Size OD: 0.00 cm
Wall Thickness: 0.000 cm
Top at: 0.00 m
Bottom at: 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by:

Annular Seal Bentonite Chips/Tablets
Placed from: 0.00 m to: 38.58 m
Amount:
Other Seals:

Type	At (m)

Screen Type: Stainless Steel
Size OD: 10.16 cm

From (m)	To (m)	Slot Size (cm)
42.37	43.59	0.051

Attachment: Telescoped
Top Fittings: Packer
Bottom Fittings: Plug

Pack
Type: Natural
Grain Size:
Amount:

Contractor Certification

Name of Journeyman responsible for drilling/construction of well: UNKNOWN NA DRILLER
Company Name: MCALLISTER HOLDINGS LTD.
Certification No.: 1
Copy of Well report provided to owner:
Date approval holder signed:

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 288164
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1997/09/09

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
ALTA PUBLIC WORKS	3 FLOOR, 6950 113 ST, EDMONTON				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	35	13	28	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.131988 Longitude -113.726208
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Measurement in Metric

Additional Information

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken Electric
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: .54 M. SEE OMNI MCCANN REPORT.

Measurement in Metric

Yield Test

Test Date 1996/11/14
Start Time 12:00 AM
Static Water Level 29.26 m

Taken From Ground Level
Depth to water level

Pumping (m)	Elapsed Time Minutes:Sec	Recovery (m)
	2:00	29.28
	3:00	29.29
	4:00	29.30
	6:00	29.30
	8:00	29.30

Method of Water Removal
Type Air
Removal Rate 200.03 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why:

Water Diverted for Drilling

Water Source
Amount Taken L
Diversion Date & Time

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER
Company Name
MCALLISTER HOLDINGS LTD.

Certification No
1
Copy of Well report provided to owner
Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 1170540
GoA Well Tag No.
Drilling Company Well ID PINE COULEE
Date Report Received 2012/10/22

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA ENVIRONMENT&WATER	P.O. BOX 903 1002 - 2 AVENUE	VULCAN	ALBERTA	CANADA	T0L 2B0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	12	35	13	26	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.130444 Longitude -113.729978
How Location Obtained
Differential corrected handheld GPS 5-10m

Elevation 1063.69 m
How Elevation Obtained
Differential corrected handheld GPS 5-10m

Drilling Information

Method of Drilling
Rotary - Air

Proposed Well Use
Dewatering

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
9.75		Brown Oxidized Clay
42.06		Gray Unoxidized Clay
43.28		Gray Lacustrine Silt
43.89		Gray Alluvial Sand
47.55	Yes	Clayey Gravel
47.85		Light Gray Soft Shale & Siltstone

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 1932.09 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2012/10/17		16.29

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
47.85 m	47.55 m	2012/09/03	2012/09/14

Borehole

Diameter (cm)	From (m)	To (m)
20.32	0.00	47.85

Surface Casing (if applicable)
Size OD cm
Wall Thickness cm
Bottom at m

Well Casing/Liner
Steel
Size OD 21.77 cm
Wall Thickness 0.864 cm
Top at -0.45 m
Bottom at 45.11 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Puddled Clay
Placed from 0.00 m to 45.11 m
Amount 45.00 Gallons

Other Seals

Type	At (m)
Driven	45.11

Screen Type Stainless Steel
Size OD 17.78 cm

From (m)	To (m)	Slot Size (cm)
45.11	47.55	0.356

Attachment Telescoped
Top Fittings Packer
Bottom Fittings Ball

Pack
Type Natural
Grain Size
Amount

Contractor Certification

Name of journeyman responsible for drilling/construction of well
KEVIN BLAND

Company Name
CAMFIELD DRILLING SERVICES LTD

Certification No
VC3171

Copy of Well report provided to owner
Yes

Date approval holder signed
2012/10/22

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 1170540
GoA Well Tag No.
Drilling Company Well ID PINE COULEE
Date Report Received 2012/10/22

GOWN ID

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA ENVIRONMENT&WATER	P.O. BOX 903 1002 - 2 AVENUE	VULCAN	ALBERTA	CANADA	T0L 2B0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	12	35	13	28	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.130444 Longitude -113.729978
How Location Obtained
Differential corrected handheld GPS 5-10m

Elevation 1063.69 m
How Elevation Obtained
Differential corrected handheld GPS 5-10m

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 46.26 cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 1932.09 L/min
Recommended Pump Intake Depth (From TOC) 35.05 m
Pump Installed Yes
Type Submersible
Depth 35.05 m
Make GOULDS
H.P. Unknown
Model (Output Rating) 500

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion Yes
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
OVRBURDEN IS BOULDERY CORDILLERAN TILL: GRAVEL IS PRE-GLACIAL; BEDROCK IS LIKELY WILLOW CREEK

Yield Test

Measurement in Metric

Test Date 2012/10/17
Start Time 3:00 PM
Static Water Level 18.29 m

Method of Water Removal
Type Pump
Removal Rate L/min
Depth Withdrawn From 35.05 m

Taken From Ground Level
Depth to water level

Pumping (m)	Elapsed Time Minutes:Sec	Recovery (m)
18.29	0:00	19.51
18.90	1:00	
19.05	2:00	
19.20	10:00	
19.35	60:00	
19.51	120:00	

If water removal period was < 2 hours, explain why:

Water Diverted for Drilling

Water Source TOWN OF CLARESHOLM
Amount Taken 4546.09 L
Diversion Date & Time 2012/09/03 9:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
KEVIN BLAND
Company Name
CAMFIELD DRILLING SERVICES LTD.

Certification No
VC3171
Copy of Well report provided to owner Yes
Date approval holder signed 2012/10/22

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 1501449
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

GOWN ID

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA INFRASTRUCTURE	6950 - 113 STREET	EDMONTON	AB	CA	T6H 5V7

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	11	35	13	28	4				00-43-D

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.130190 Longitude -113.724190
How Location Obtained
Map

Elevation 1045.16 m
How Elevation Obtained
Hand held autonomous GPS 20-30m

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Observation

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
16.46		Brown Till
32.92		Gray Till
37.19		Gravel

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2000/02/04	409.15	8.59

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
37.19 m		2000/01/22	2000/02/04

Borehole

Diameter (cm)	From (m)	To (m)
20.00	0.00	37.19

Surface Casing (if applicable)
Steel
Size OD : 14.13 cm
Wall Thickness : 0.480 cm
Bottom at : 33.83 m

Well Casing/Liner
Unknown
Size OD : cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by Unknown

Annular Seal Cement/Grout
Placed from 0.00 m to 33.83 m
Amount

Other Seals

Type	At (m)

Screen Type Stainless Steel
Size OD : 12.70 cm

From (m)	To (m)	Slot Size (cm)
35.66	37.19	0.051

Attachment Telescoped
Top Fittings Packer
Bottom Fittings Plug

Pack
Type Unknown
Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
VINCE FRAZER

Company Name
MCALLISTER DRILLING INC.

Certification No
31215A

Copy of Well report provided to owner
Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 1501449
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
ALBERTA INFRASTRUCTURE	6950 - 113 STREET	EDMONTON	AB	CA	T6H 5V7

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	11	35	13	28	4				00-43-D

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.130190 Longitude -113.724190
How Location Obtained
Map

Elevation 1045.16 m
How Elevation Obtained
Hand held autonomous GPS 20-30m

Measurement in Metric

Additional Information

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Type
Depth m
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken Electric
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
LEGAL CHANGED FROM LSD 13 TO LSD 11 AS PER OMNI-MCCANN NOV 2009. RISER PIPE FROM 107' - 117'

Measurement in Metric

Yield Test

Test Date	Start Time	Static Water Level	Taken From Ground Level Depth to water level		
			Pumping (m)	Elapsed Time Minutes:Sec	Recovery (m)
2000/02/04	12:00 AM	8.59 m			

Method of Water Removal
Type Air
Removal Rate 409.15 L/min
Depth Withdrawn From 33.22 m

If water removal period was < 2 hours, explain why
MEASUREMENTS FROM GROUND.

Water Diverted for Drilling

Water Source
Amount Taken L
Diversion Date & Time

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
VINCE FRAZER
Company Name
MCALLISTER DRILLING INC.
Certification No
31215A
Copy of Well report provided to owner
Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 103764
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1988/01/29

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
NANTON, TOWN OF	NANTON				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	3	16	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.320852 Longitude -113.902409
How Location Obtained
Not Verified

Elevation 1106.42 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Not Applicable

Proposed Well Use
Domestic

Type of Work
Spring

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
0.00 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	0.00

Surface Casing (if applicable)

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack

Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Printed on 3/6/2020 5:54:53 PM

Water Well Drilling Report

View in Imperial | Export to Excel

The order supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID: 103764
GoA Well Tag No.:
Drilling Company Well ID:
Date Report Received: 1966/01/29

GOWN ID:

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
NANTON, TOWN OF	NANTON				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	3	16	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude: 50.320852 Longitude: -113.902409
How Location Obtained: Not Verified

Elevation: 1106.42 m
How Elevation Obtained: Estimated

Measurement in Metric

Additional Information

Distance From Top of Casing to Ground Level: cm
Is Artesian Flow:
Rate: L/min
Is Flow Control Installed:
Describe:

Recommended Pump Rate: L/min
Recommended Pump Intake Depth (From TOC): m
Pump Installed:
Type:
Depth: m
Make:
H.P.:
Model (Output Rating):

Did you Encounter Saline Water (>4000 ppm TDS):
Depth: m
Gas:
Depth: m
Well Disinfected Upon Completion:
Geophysical Log Taken:
Submitted to ESRD:
Sample Collected for Potability:
Submitted to ESRD: Yes

Additional Comments on Well:

Taken From Ground Level | Measurement in Metric

Yield Test

Test Date	Start Time	Static Water Level
		m

Method of Water Removal
Type:
Removal Rate: L/min
Depth Withdrawn From: m

If water removal period was < 2 hours, explain why:

Water Diverted for Drilling

Water Source:
Amount Taken: L
Diversion Date & Time:

Contractor Certification

Name of Journeyman responsible for drilling/construction of well:
UNKNOWN NA DRILLER
Company Name:
UNKNOWN DRILLER
Certification No:
1
Copy of Well report provided to owner:
Date approval holder signed:

Printed on 3/5/2020 5:54:53 PM

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 169321
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1976/08/23

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	County	Postal Code
NANTON, TOWN OF	NANTON				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	3	16	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.320852 Longitude -113.913710
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Not Applicable

Proposed Well Use
Municipal

Type of Work
Spring

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
0.00 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	0.00

Surface Casing (if applicable)

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount
Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack

Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner | Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 189321
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1978/08/23

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
NANTON, TOWN OF	NANTON				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	3	16	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.320852 Longitude -113.913710
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Measurement in Metric

Additional Information

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Taken From Ground Level | Measurement in Metric

Yield Test

Test Date	Start Time	Static Water Level
		m

Method of Water Removal
Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER
Company Name
UNKNOWN DRILLER

Certification No.
1
Copy of Well report provided to owner
Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 169322
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1980/01/31

GOWN ID

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
NANTON, TOWN OF	NANTON				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	6	3	16	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.315428 Longitude -113.910883
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Not Applicable

Proposed Well Use
Municipal

Type of Work
Spring

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
0.00 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	0.00

Surface Casing (if applicable)

Size OD: 0.00 cm
Wall Thickness: 0.000 cm
Bottom at: 0.00 m

Well Casing/Liner

Size OD: 0.00 cm
Wall Thickness: 0.000 cm
Top at: 0.00 m
Bottom at: 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width (cm)	Slot Length (cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m
Amount
Other Seals

Type	At (m)

Screen Type

Size OD 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack

Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
UNKNOWN DRILLER

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Water Well Drilling Report

View in Imperial | Export to Excel

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

GIC Well ID 169322
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1980/01/01

GOWN ID

Measurement in Metric

Well Identification and Location

Owner Name	Address	Town	Province	Country	Postal Code
NANTON, TOWN OF	NANTON				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	6	3	16	29	4				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 50.315428 Longitude -113.910893
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Measurement in Metric

Additional Information

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Type
Depth m
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Possibility
Submitted to ESRD Yes

Additional Comments on Well

Taken From Ground Level Measurement in Metric

Yield Test

Test Date	Start Time	Static Water Level
		m

Method of Water Removal
Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER
Company Name
UNKNOWN DRILLER

Certification No
1
Copy of Well report provided to owner
Date approval holder signed

Appendix C
DETAILED CAPITAL COST ESTIMATES

Shared Water Distribution Study
Alternative 1
Pine Coulee Raw Water Supply

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
Schedule A					
1	Mobilization / Demobilization / Bonding & Insurance / Profit	1	L.S.	$ 1,023,000.00	$ 1,023,000
2	Raw Water Intake and Booster Station	1	L.S.	$ 2,500,000.00	$ 2,500,000
3	Connection to Nanton Reservoir	1	L.S.	$ 20,000.00	$ 20,000
4	Raw Water Storage Upgrades	1	L.S.	$ 3,000,000.00	$ 3,000,000
5	Flushing, Pressure Testing and Disinfection	1	L.S.	$ 50,000.00	$ 50,000
6	Allowance for Easements in Private Lands				
	Land Acquisition (20 m Permanent)	122	ac	$ 3,000.00	$ 364,726
	Easement Preparation and Execution	1	LS	$ 50,000.00	$ 50,000
	Landman Requirements	1	LS	$ 50,000.00	$ 50,000
7	Legal Survey	24,600	m	$ 3.00	$ 73,800
8	Hydro Excavation	120	hours	$ 450.00	$ 54,000
9	Supply and Install 250mm DR-11 HDPE PE3408 water pipe and fittings	24,600	m	$ 150.00	$ 3,690,000
10	Supply and Install 250 mm water main isolation valves, complete	16	each	$ 3,500.00	$ 56,000
11	Utility Crossings	25	each	$ 3,000.00	$ 75,000
12	Automatic Air Relief Valves	12	each	$ 15,000.00	$ 180,000
13	Flushing Hydrants	4	each	$ 7,500.00	$ 30,000
14	Pipeline Markers	50	each	$ 300.00	$ 15,000
15	Grass Seeding	5	ha	$ 3,000.00	$ 14,760
				SUBTOTAL	$ 11,246,286
				EXTRA WORK ALLOWANCE (15%)	$ 1,687,000
				ENGINEERING SERVICES (12%)	$ 1,350,000
				GEOTECHNICAL SERVICES (2.5%)	$ 282,000
				GRAND TOTAL	**$ 14,565,000**

Shared Water Distribution Study
Alternative 2
Raw Water Storage Upgrades

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
General Items					
1	Mobilization / Demobilization / Bonding & Insurance / Profit	1	L.S.	$ 303,000.00	$ 303,000
				SUBTOTAL	$ 303,000
Structures and Piping					
1	Extend Mosquito Creek Intake Pipe to New Reservoir	200	m	$ 200.00	$ 40,000
2	Extend Spring Line Intake from WTP to Both Reservoirs	700	m	$ 200.00	$ 140,000
3	Intake/Outlet Piping	100	m	$ 125.00	$ 12,500
4	Relocate Existing Reservoir Outlet Pipe to WTP	300	m	$ 125.00	$ 37,500
5	Relocate Existing Backwash Line	400	m	$ 125.00	$ 50,000
6	Relocate Existing Reservoir Aeration Pipe	350	m	$ 75.00	$ 26,250
7	New Reservoir Aeration System (Supplier Package, c/w building)	1	L.S.	$ 300,000.00	$ 300,000
8	Misc. Piping Connections and Appurtenaces	1	L.S.	$ 50,000.00	$ 50,000
				SUBTOTAL	$ 656,250
Site Excavation and Restoration					
1	Topsoil Stripping	50,000	m^2	$ 1.00	$ 50,000
2	Common Excavation	80,000	m^3	$ 8.00	$ 640,000
3	Topsoil Restoration	30,000	m^2	$ 2.00	$ 60,000
4	New Reservoir Gravel Driving Bank Restoration	2,500	m^2	$ 7.50	$ 18,750
5	New Reservoir Bank Armour	9,000	m^2	$ 55.00	$ 495,000
6	Relocate Drainage Ditch	350	m	$ 85.00	$ 29,750
7	Chain Link Fencing	750	m	$ 85.00	$ 63,750
				SUBTOTAL	$ 1,357,250
Water Treatment Plant Upgrades					
1	Water Treatment Plant Upgrades:				
	- Building Addition, Complete (Slab on grade, steel construction, HVAC, Elec)	1	LS	$ 100,000.00	$ 100,000
	- Civil site works to accommodate building expansion	1	LS	$ 20,000.00	$ 20,000
	- Powdered Activated Carbon Feed System, complete	1	LS	$ 500,000.00	$ 500,000
	- Coagulant Sidestream Injection System, complete	1	LS	$ 50,000.00	$ 50,000
	- Process piping, valving, instrumentation	1	LS	$ 80,000.00	$ 80,000
	- Electrical upgrades	1	LS	$ 75,000.00	$ 75,000
	- Programming and Commissioning	1	LS	$ 30,000.00	$ 30,000
				SUBTOTAL	$ 855,000
				GRAND SUBTOTAL	**$ 3,172,000**
				EXTRA WORK ALLOWANCE (15%)	$ 476,000
				ENGINEERING SERVICES (12%)	$ 381,000
				GEOTECHNICAL SERVICES (2.5%)	$ 80,000
				GRAND TOTAL	**$ 4,109,000**

Shared Water Distribution Study
Alternative 3
Claresholm Regional Water Supply

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
Schedule A					
1	Mobilization / Demobilization / Bonding & Insurance / Profit	1	L.S.	$ 980,000.00	$ 980,000
2	Connection to High River and Pump Station Upgrades	1	L.S.	$ 750,000.00	$ 750,000
3	Connection to Nanton Potable Water Storage	1	L.S.	$ 50,000.00	$ 50,000
4	Water Treatment Plant Decommissioning	1	L.S.	$ 100,000.00	$ 100,000
5	Flushing, Pressure Testing and Disinfection	1	L.S.	$ 50,000.00	$ 50,000
6	Allowance for Easements in Private Lands				
	Land Acquisition (20 m Permanent)	233	ac	$ 3,000.00	$ 699,800
	Easement Preparation and Execution	1	LS	$ 50,000.00	$ 50,000
	Landman Requirements	1	LS	$ 50,000.00	$ 50,000
7	Legal Survey	47,200	m	$ 3.00	$ 141,600
8	Hydro Excavation	160	hours	$ 450.00	$ 72,000
9	Supply and Install 250mm DR-11 HDPE PE3408 water pipe and fittings	47,200	m	$ 150.00	$ 7,080,000
10	Supply and Install 250 mm water main isolation valves, complete	30	each	$ 3,500.00	$ 105,000
11	Utility Crossings	50	each	$ 3,000.00	$ 150,000
12	Automatic Air Relief Valves	25	each	$ 15,000.00	$ 375,000
13	Flushing Hydrants	8	each	$ 7,500.00	$ 60,000
14	Pipeline Markers	100	each	$ 300.00	$ 30,000
15	Grass Seeding	9	ha	$ 3,000.00	$ 28,320
				SUBTOTAL	$ 10,771,720
				EXTRA WORK ALLOWANCE (15%)	$ 1,616,000
				ENGINEERING SERVICES (12%)	$ 1,293,000
				GEOTECHNICAL SERVICES (2.5%)	$ 270,000
				GRAND TOTAL	**$ 13,951,000**

Shared Water Distribution Study
Alternative 4
High River Regional Water Supply

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
Schedule A					
1	Mobilization / Demobilization / Bonding & Insurance / Profit	1	L.S.	$ 611,000.00	$ 611,000
2	Booster Station Upgrades:				
	- Building Addition, complete (slab on grade, Steel construction, HVAC and Elec)	1	LS	$ 150,000.00	$ 150,000
	- Civil site works, including piping connections	1	LS	$ 75,000.00	$ 75,000
	- Booster Pumps (Vertical Multistage Inline 20HP)	2	each	$ 20,000.00	$ 40,000
	- Process piping, instrumentation and valves	1	LS	$ 80,000.00	$ 80,000
	- Backup power generation	1	LS	$ 100,000.00	$ 100,000
	- Electrical (including pump VFDs)	1	LS	$ 100,000.00	$ 100,000
	- Controls and Instrumentation, Communication, Programming and Commissioning	1	LS	$ 75,000.00	$ 75,000
3	Connection to Nanton Potable Water Storage	1	LS	$ 50,000.00	$ 50,000
4	Water Treatment Plant Decomissioning	1	LS	$ 100,000.00	$ 100,000
5	Flushing, Pressure Testing and Disinfection	1	L.S.	$ 20,000.00	$ 20,000
6	Allowance for Easements in Private Lands				
	Land Acquisition (20 m Permanent)	141	ac	$ 3,000.00	$ 422,549
	Easement Preparation and Execution	1	LS	$ 20,000.00	$ 20,000
	Landman Requirements	1	LS	$ 20,000.00	$ 20,000
7	Legal Survey	28,500	m	$ 3.00	$ 85,500
8	Hydro Excavation	80	hours	$ 450.00	$ 36,000
9	Supply and Install 250mm DR-11 HDPE PE3408 water pipe and fittings	28,500	m	$ 150.00	$ 4,275,000
10	Supply and Install 250 mm water main isolation valves, complete	20	each	$ 3,500.00	$ 70,000
11	Utility Crossings	30	each	$ 3,000.00	$ 90,000
12	Automatic Air Relief Valves	15	each	$ 15,000.00	$ 225,000
13	Flushing Hydrants	5	each	$ 7,500.00	$ 37,500
14	Pipeline Markers	60	each	$ 300.00	$ 18,000
15	Grass Seeding	6	ha	$ 3,000.00	$ 17,100
				SUBTOTAL	$ 6,717,649
				EXTRA WORK ALLOWANCE (15%)	$ 1,008,000
				ENGINEERING SERVICES (12%)	$ 807,000
				GEOTECHNICAL SERVICES (2.5%)	$ 168,000
				GRAND TOTAL	**$ 8,701,000**

Shared Water Distribution Study
Alternative 5
Pine Coulee Regional Water Supply

ORDER OF MAGNITUDE COST ESTIMATE

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
Schedule A					
1	Mobilization / Demobilization / Bonding & Insurance / Profit	1	L.S.	$ 606,000.00	$ 606,000
2	New Water Treatment Plant	1	L.S.	$20,000,000.00	$ 20,000,000
3	Flushing, Pressure Testing and Disinfection	1	L.S.	$ 20,000.00	$ 20,000
4	Allowance for Easements in Private Lands				
	Land Acquisition (20 m Permanent)	167	ac	$ 3,000.00	$ 501,869
	Easement Preparation and Execution	1	LS	$ 20,000.00	$ 20,000
	Landman Requirements	1	LS	$ 20,000.00	$ 20,000
5	Legal Survey	33,850	m	$ 3.00	$ 101,550
6	Hydro Excavation	140	hours	$ 450.00	$ 63,000
7	Supply and Install 250mm DR-11 HDPE PE3408 water pipe and fittings	28,100	m	$ 150.00	$ 4,215,000
8	Supply and Install 150mm DR-11 HDPE PE3408 water pipe and fittings	5,750	m	$ 100.00	$ 575,000
8	Supply and Install water main isolation valves, complete	25	each	$ 3,500.00	$ 87,500
9	Utility Crossings	35	each	$ 3,000.00	$ 105,000
10	Automatic Air Relief Valves	17	each	$ 15,000.00	$ 255,000
11	Flushing Hydrants	6	each	$ 7,500.00	$ 45,000
12	Pipeline Markers	70	each	$ 300.00	$ 21,000
13	Grass Seeding	7	ha	$ 3,000.00	$ 20,310
				SUBTOTAL	$ 26,656,229
				EXTRA WORK ALLOWANCE (15%)	$ 3,999,000
				ENGINEERING SERVICES (12%)	$ 3,199,000
				GEOTECHNICAL SERVICES (2.5%)	$ 667,000
				GRAND TOTAL	**$ 34,521,000**

Appendix D
PRESENT WORTH ANALYSIS

Shared Water Distribution Study

O&M Costs - Alternative 2 Nanton RW Storage and WTP Upgrade

Engineer Input

To Be Determined

Not Applicable

Assumptions

General:

Power Cost:	0.12	$/kW hr
Gas Cost:	5.60	$/GJ
Inflation:	2	%
Operations Annual Cost:		
Labour Annual Cost:	175000	
Administration Annual Cost:	30000	
Raw Water Conveyance:		$/m3
UV Lamp Replacement:	0	No. of Lamps per year
UV Lamp Replacement Cost:	500	$/Lamp
Filter Media Life Expectancy:	10	years
Filter Media Volume:		Per Filter Train
Sand:	1.512	m3 (Calculated from PDF inserted into spreadsheet)
Anthracite:	2.268	m3 (Calculated from PDF inserted into spreadsheet)
Filter Media Replacement Cost:		$/m3
Membrane:		$
Sand:	900	$/m3
Anthracite:	3500	$/m3
Maintenance Allowance Unit Cost:	0.1	$/m3
Annual Building Electricity Consumption (lighting, HVAC)	100000	kWh
Annual Gas Consumption	3000	GJ

WTP General:

Number of Filtration Trains:	3	
Number of Expansion Filtration Trains:		
Number of Membrane Modules per Train:		
Net Potable Water Production:	3.8	MLD (Summation of flows from DAF Upgrade dwgs AE)
Minimum Plant Flow:	20	l/sec (Guess)
WTP Efficiency:	80	%
Filtration System Downtime (Clean):	5	hr/day
XR Recirc Rate:		%
Max Filtrate Instantaneous Flow:	56	l/sec
Max Membrane Feed Instantaneous Flow:	56	l/sec

Raw Water Pumping (Mosquito Creek):

Pump Head Required:	61	m (From MPE Record Drawings 2630-002-03)
Pump & Motor Combined Efficiency:	75	%

Raw Water Pumping (In-Plant):

Pump Head Required:	16	m (From DAF Upgrade dwgs AE)
Pump & Motor Combined Efficiency:	75	%

RW Aeration Air Compressor:

No. of Compressors:	2	
Motor:	3.72	kW (Assumed)
% Runtime during production:	100	%

Rapid Mixer/Sidestream Injection Booster Pump:

Motor:		kW

Flocculators

No. of Motors:	4	
Motor:	3.72	kW (Assumed)
% Runtime during production:	100	%

Coagulation / Maturation Mixers:

No. of Coagulation Mixers):		
1st Stage Motor:		kW
No. of Maturation Mixer(s):		
2nd Stage Motor:		kW

DAF Recycle Pumps

No. of Motors:	2	
Motor:	3.72	kW (Assumed)
% Runtime during production:	50	%

Process Chemical Consumption:

$KMnO_4$ Dosage Rate:		mg/L	
$KMnO_4$ Cost:		$/kg	
Clarifier Microsand Usage Rate:		mg/L	
Clarifier Microsand Cost:		$/kg	
CO_2 Dosage Rate:	25	mg/L	
CO_2 Cost:	0.4	$/kg	
CO_2 Lease & Fees:	33.21	$/day	
Coagulant Dosage Rate:	25	mg/L	
Coagulant Cost:	1.20	$/kg	
PAC Dosage Rate:	5	mg/L	
PAC Cost:	9.20	$/kg	
Chlorine Dosage Rate:	3.5	mg/L	
Chlorine Cost:	2.11	$/kg	
Flocculant Dosage Rate:	10	mg/L	Guess
Flocculant Cost:	1.25	$/kg	Guess
Polymer Dosage Rate:		mg/L	
Polymer Cost:		$/kg	
NaCl Consumption Rate:		kg/day	
NaCl Cost:		$/kg	

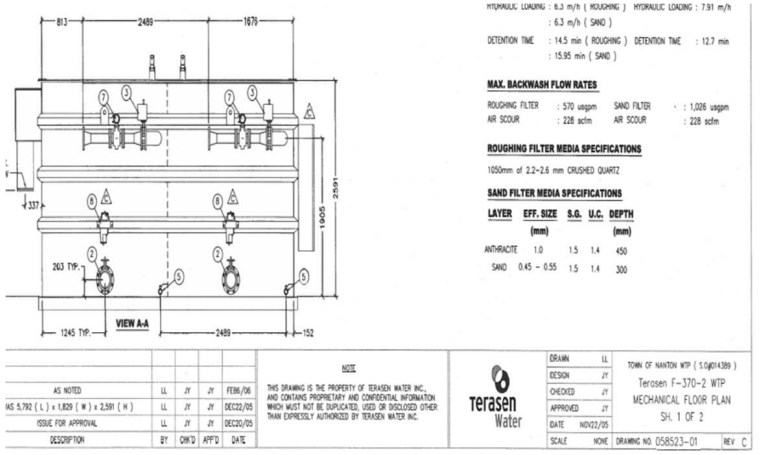
Cleaning Chemical Consumption:

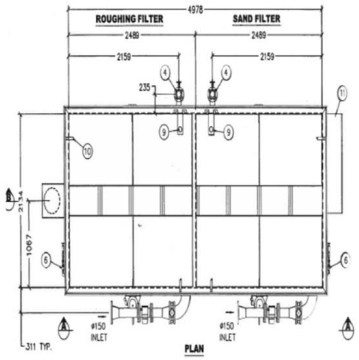
EFM

NaOCl per EFM:		L
EFM Frequency:		m^3 Produced Water/EFM

CIP

Caustic per CIP:		L
NaOCl per CIP:		L
Citric Acid per CIP:		L





DAF Scraper Motor

No. of Motors:	2	
Motor:	1.49	kW (Assumed)
% Runtime during production:	10	%

Mixer :

No. of Mixers:		
Motor:		kW

Filtrate Pumping:

Pump Head Required:	14	m
Pump & Motor Combined Efficiency:	75	%

Air Blower (For Sand Filter System):

No. of Blowers:	2	
Motor:	3.72	kW
% Runtime during production:	5	%

Filter Backwash Pumping:

Pump Head Required:	18	m (From DAF Upgrade dwgs AE)
Flow:	88	l/sec
Pump & Motor Combined Efficiency:	75	%
% Runtime during production:	5	%

Air Compressor(s):

No. of Compressors:	1	
Motor:	3.72	kW
% Runtime During Production:	100	%

PAC System Operation:

Motor:	0.15	kW

Polymer Pumping:

Motor:		kW

Coagulant Pumping:

Motor:	0.15	kW

Flucculant Pumping:

Motor:	0.15	kW

UV Disinfection System :

No. of Reactors:		
Motor:		kW
% Runtime During Production:		%

CIP Recirc Pumping:

Motor:		kW
% Runtime During Production:		%

CIP Drain Pumping:

Motor:		kW
% Runtime During Production:		%

Distribution Pumping:

Pump Head Required:	64	m
Pump & Motor Combined Efficiency:	75	%

CIP Frequency: m^2 Produced Water/CIP

Cleaning Chemical Cost

Caustic Cost:	0.00	$/kg
NaOCl Cost:		$/kg
Citirc Acid Cost:		$/kg

Projected Operational Costs

Year		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
Town of Nanton Projected Water Usage	**Unit**																										
Total	Avg Day (m^3/day)	924	938	952	967	981	996	1,011	1,026	1,041	1,057	1,073	1,089	1,105	1,122	1,139	1,156	1,173	1,191	1,208	1,227	1,245	1,264	1,283	1,302	1,321	1,341
	Max Day (m^3/day)	1,979	2,009	2,039	2,069	2,100	2,132	2,164	2,196	2,229	2,263	2,297	2,331	2,366	2,401	2,438	2,474	2,511	2,549	2,587	2,626	2,665	2,705	2,746	2,787	2,829	2,871
Water Treatment System Power Consumption																											
Raw Water Pump (Creek) Operation Projected Run Time	(hr)	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.5	14.7	14.9	15.1	15.3	15.6	15.8	16.1	16.3	16.5	16.8	17.0	17.3	17.6	17.8	18.1	18.4	18.6
Raw Water Pump Operation Projected Flow Rate	(l/sec)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Raw Water Pump Operation Power Consumption	(kW hr)	205	208	211	214	217	221	224	227	231	234	238	241	245	249	252	256	260	264	268	272	276	280	284	288	293	297
Raw Water Pump Operation Cost	($)	13.52	13.99	14.49	15.00	15.53	16.08	16.64	17.23	17.84	18.47	19.12	19.80	20.50	21.22	21.97	22.74	23.55	24.38	25.24	26.13	27.05	28.01	29.00	30.02	31.08	32.18
Raw Water Pump (In-Plant) Operation Projected Run Time	(hr)	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.5	14.7	14.9	15.1	15.3	15.6	15.8	16.1	16.3	16.5	16.8	17.0	17.3	17.6	17.8	18.1	18.4	18.6
Raw Water Pump Operation Projected Flow Rate	(l/sec)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Raw Water Pump Operation Power Consumption	(kW hr)	54	55	55	56	57	58	59	60	61	61	62	63	64	65	66	67	68	69	70	71	72	73	75	76	77	78
Raw Water Pump Operation Cost	($)	6.45	6.67	6.91	7.15	7.41	7.67	7.94	8.22	8.51	8.81	9.12	9.44	9.77	10.12	10.48	10.85	11.23	11.63	12.04	12.46	12.90	13.36	13.83	14.32	14.82	15.34
RW Aeration Air Compressor Operation Projected Run Time	(hr)	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.5	14.7	14.9	15.1	15.3	15.6	15.8	16.1	16.3	16.5	16.8	17.0	17.3	17.6	17.8	18.1	18.4	18.6
RWPS Air Compressor Operation Power Consumption	(kW hr)	95.5	96.9	98.4	99.9	101.4	102.9	104.4	106.0	107.6	109.2	110.8	112.5	114.2	115.9	117.6	119.4	121.2	123.0	124.9	126.7	128.6	130.6	132.5	134.5	136.5	138.6
RWPS Air Compressor Operation Avg Day Cost	($)	11.46	11.87	12.29	12.72	13.17	13.63	14.11	14.61	15.13	15.66	16.21	16.79	17.38	17.99	18.63	19.29	19.97	20.67	21.40	22.16	22.94	23.75	24.59	25.45	26.35	27.28
Flocculator Operation Projected Run Time	(hr)	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.5	14.7	14.9	15.1	15.3	15.6	15.8	16.1	16.3	16.5	16.8	17.0	17.3	17.6	17.8	18.1	18.4	18.6
Flocculator Operation Power Consumption	(kW hr)	191.0	193.9	196.8	199.8	202.7	205.8	208.9	212.0	215.2	218.4	221.7	225.0	228.4	231.8	235.3	238.8	242.4	246.0	249.7	253.5	257.3	261.1	265.1	269.0	273.1	277.2
Flocculator Operation Avg Day Cost	($)	22.92	23.73	24.57	25.44	26.34	27.27	28.23	29.22	30.26	31.32	32.43	33.57	34.76	35.99	37.26	38.57	39.93	41.34	42.80	44.31	45.88	47.50	49.17	50.91	52.71	54.57
DAF Recycle Pump Projected Run Time	(hr)	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.6	7.7	7.8	7.9	8.0	8.1	8.3	8.4	8.5	8.6	8.8	8.9	9.0	9.2	9.3
DAF Recycle Pump Power Consumption	(kW hr)	47.8	48.5	49.2	49.9	50.7	51.4	52.2	53.0	53.8	54.6	55.4	56.3	57.1	58.0	58.8	59.7	60.6	61.5	62.4	63.4	64.3	65.3	66.3	67.3	68.3	69.3
DAF Recycle Pump Avg Day Cost	($)	5.73	5.93	6.14	6.36	6.58	6.82	7.06	7.31	7.56	7.83	8.11	8.39	8.69	9.00	9.31	9.64	9.98	10.34	10.70	11.08	11.47	11.87	12.29	12.73	13.18	13.64
DAF Scraper Motor Projected Run Time	(hr)	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.9
DAF Scraper Motor Power Consumption	(kW hr)	3.8	3.9	3.9	4.0	4.1	4.1	4.2	4.2	4.3	4.4	4.4	4.5	4.6	4.6	4.7	4.8	4.9	4.9	5.0	5.1	5.2	5.2	5.3	5.4	5.5	5.6
DAF Scraper Motor Avg Day Cost	($)	0.46	0.48	0.49	0.51	0.53	0.55	0.57	0.59	0.61	0.63	0.65	0.67	0.70	0.72	0.75	0.77	0.80	0.83	0.86	0.89	0.92	0.95	0.98	1.02	1.06	1.09
Blower Operation Projected Run Time	(hr)	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Blower Operation Power Consumption	(kW hr)	4.8	4.8	4.9	5.0	5.1	5.1	5.2	5.3	5.4	5.5	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9
Blower Operation Avg Day Cost	($)	0.57	0.59	0.61	0.64	0.66	0.68	0.71	0.73	0.76	0.78	0.81	0.84	0.87	0.90	0.93	0.96	1.00	1.03	1.07	1.11	1.15	1.19	1.23	1.27	1.32	1.36
Filter Back Pulse Pump Operation Projected Run Time	(hr)	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Filter Back Pulse Pump Operation Projected Flow Rate	(l/sec)	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88
Filter Back Pulse Pump Operation Power Consumption	(kW hr)	13	13	14	14	14	14	15	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19
Filter Back Pulse Pump Operation Cost	($)	1.60	1.65	1.71	1.77	1.83	1.90	1.96	2.03	2.11	2.18	2.26	2.34	2.42	2.50	2.59	2.68	2.78	2.88	2.98	3.08	3.19	3.31	3.42	3.54	3.67	3.80
Compressor Operation Projected Run Time	(hr)	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.5	14.7	14.9	15.1	15.3	15.6	15.8	16.1	16.3	16.5	16.8	17.0	17.3	17.6	17.8	18.1	18.4	18.6
Compressor Operation Power Consumption	(kW hr)	47.8	48.5	49.2	49.9	50.7	51.4	52.2	53.0	53.8	54.6	55.4	56.3	57.1	58.0	58.8	59.7	60.6	61.5	62.4	63.4	64.3	65.3	66.3	67.3	68.3	69.3
Compressor Operation Avg Day Cost	($)	5.73	5.93	6.14	6.36	6.58	6.82	7.06	7.31	7.56	7.83	8.11	8.39	8.69	9.00	9.31	9.64	9.98	10.34	10.70	11.08	11.47	11.87	12.29	12.73	13.18	13.64
PAC System Operation Projected Run Time	(hr)	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.5	14.7	14.9	15.1	15.3	15.6	15.8	16.1	16.3	16.5	16.8	17.0	17.3	17.6	17.8	18.1	18.4	18.6
PAC System Operation Power Consumption	(kW hr)	1.9	2.0	2.0	2.0	2.0	2.1	2.1	2.1	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.6	2.7	2.7	2.8	2.8
PAC System Operation Avg Day Cost	($)	0.23	0.24	0.25	0.26	0.27	0.27	0.28	0.29	0.30	0.32	0.33	0.34	0.35	0.36	0.38	0.39	0.40	0.42	0.43	0.45	0.46	0.48	0.50	0.51	0.53	0.55
Coagulant Pump Operation Projected Run Time	(hr)	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.5	14.7	14.9	15.1	15.3	15.6	15.8	16.1	16.3	16.5	16.8	17.0	17.3	17.6	17.8	18.1	18.4	18.6
Coagulant Pump Operation Power Consumption	(kW hr)	1.9	2.0	2.0	2.0	2.0	2.1	2.1	2.1	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.6	2.7	2.7	2.8	2.8
Coagulant Pump Operation Avg Day Cost	($)	0.23	0.24	0.25	0.26	0.27	0.27	0.28	0.29	0.30	0.32	0.33	0.34	0.35	0.36	0.38	0.39	0.40	0.42	0.43	0.45	0.46	0.48	0.50	0.51	0.53	0.55
Flocculant Pump Operation Projected Run Time	(hr)	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.5	14.7	14.9	15.1	15.3	15.6	15.8	16.1	16.3	16.5	16.8	17.0	17.3	17.6	17.8	18.1	18.4	18.6
Flocculant Pump Operation Power Consumption	(kW hr)	1.9	2.0	2.0	2.0	2.0	2.1	2.1	2.1	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.6	2.7	2.7	2.8	2.8
Flocculant Pump Operation Avg Day Cost	($)	0.23	0.24	0.25	0.26	0.27	0.27	0.28	0.29	0.30	0.32	0.33	0.34	0.35	0.36	0.38	0.39	0.40	0.42	0.43	0.45	0.46	0.48	0.50	0.51	0.53	0.55
Total Avg Day Cost	($)	122.04	125.26	128.57	131.99	135.51	139.14	142.87	146.72	150.69	154.78	159.00	163.35	167.83	172.45	177.21	182.13	187.19	192.42	197.80	203.36	209.09	215.00	221.10	227.39	233.89	240.58
Avg Day Unit Cost	($/$m^3$)	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.17	0.17	0.17	0.18	0.18

Distribution Pumping Power Consumption																												
Distribution Pump Projected Run Time	(hr)	24	24	24	24	24	24	25	26	27	28	24	25	26	27	28	24	25	26	27	28	24	25	26	27	28	24
Distribution Pump Operation Projected Flow Rate	(l/sec)	11	11	11	11	11	12	12	12	12	12	12	13	13	13	13	13	14	14	14	14	14	15	15	15	15	16
Distribution Pump Operation Power Consumption	(kW hr)	215	218	221	225	228	231	245	258	272	287	249	264	278	293	309	269	284	300	316	333	289	306	323	340	358	312
Distribution Pump Operation Avg Day Cost	($)	25.78	26.69	27.64	28.61	29.62	30.67	33.07	35.61	38.29	41.11	36.48	39.34	42.36	45.54	48.89	43.39	46.79	50.38	54.16	58.15	51.60	55.65	59.92	64.42	69.17	61.38
Total Avg Day Cost	($)	25.78	26.69	27.64	28.61	29.62	30.67	33.07	35.61	38.29	41.11	36.48	39.34	42.36	45.54	48.89	43.39	46.79	50.38	54.16	58.15	51.60	55.65	59.92	64.42	69.17	61.38
Avg Day Unit Cost	($/m^3)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.05	0.05	0.05	0.05
Building Electricity Consumption																												
WTP & RWPS Building Avg Day Electricity Consumption	($/day)	32.88	33.53	34.20	34.89	35.59	36.30	37.02	37.77	38.52	39.29	40.08	40.88	41.70	42.53	43.38	44.25	45.13	46.04	46.96	47.90	48.85	49.83	50.83	51.84	52.88	53.94
Total Avg Day Cost	($)	32.88	33.53	34.20	34.89	35.59	36.30	37.02	37.77	38.52	39.29	40.08	40.88	41.70	42.53	43.38	44.25	45.13	46.04	46.96	47.90	48.85	49.83	50.83	51.84	52.88	53.94
Avg Day Unit Cost	($/m^3)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Building Energy Consumption																												
WTP & RWPS Building Avg Day Gas Consumption	($/day)	46.03	46.95	47.89	48.84	49.82	50.82	51.83	52.87	53.93	55.01	56.11	57.23	58.37	59.54	60.73	61.95	63.19	64.45	65.74	67.05	68.39	69.76	71.16	72.58	74.03	75.51
Total Avg Day Cost	($)	46.03	46.95	47.89	48.84	49.82	50.82	51.83	52.87	53.93	55.01	56.11	57.23	58.37	59.54	60.73	61.95	63.19	64.45	65.74	67.05	68.39	69.76	71.16	72.58	74.03	75.51
Avg Day Unit Cost	($/m^3)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
Process Chemical Consumption																												
CO2 Avg Day Consumption	(kg)	23	23	24	24	25	25	25	26	26	26	27	27	28	28	28	29	29	30	30	31	31	32	32	33	33	34
CO2 Avg Day Cost	($)	42.45	43.44	44.45	45.50	46.56	47.66	48.78	49.93	51.11	52.31	53.55	54.82	56.13	57.47	58.84	60.24	61.69	63.17	64.68	66.24	67.84	69.48	71.16	72.89	74.66	76.48
Coagulant Avg Day Consumption	(kg)	23	23	24	24	25	25	25	26	26	26	27	27	28	28	28	29	29	30	30	31	31	32	32	33	33	34
Coagulant Avg Day Cost	($)	27.73	28.71	29.72	30.77	31.86	32.98	34.15	35.35	36.60	37.89	39.23	40.61	42.05	43.53	45.07	46.66	48.31	50.01	51.78	53.60	55.50	57.46	59.48	61.58	63.76	66.01
PAC Avg Day Consumption	(kg)	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	7	7	7
PAC Avg Day Cost	($)	42.52	44.02	45.57	47.18	48.85	50.57	52.36	54.21	56.12	58.10	60.15	62.27	64.47	66.75	69.11	71.54	74.07	76.68	79.39	82.19	85.10	88.10	91.21	94.43	97.76	101.21
CL2 Avg Day Consumption	(kg)	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5
CL2 Avg Day Cost	($)	6.83	7.07	7.32	7.57	7.84	8.12	8.41	8.70	9.01	9.33	9.66	10.00	10.35	10.72	11.09	11.49	11.89	12.31	12.75	13.20	13.66	14.14	14.64	15.16	15.70	16.25
Caustic Avg Day Consumption	(kg)	9	9	10	10	10	10	10	10	10	11	11	11	11	11	11	12	12	12	12	12	12	13	13	13	13	13
Caustic Avg Day Cost	($)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Avg Day Cost	($)	119.52	123.23	127.07	131.02	135.11	139.33	143.69	148.19	152.83	157.63	162.59	167.71	173.00	178.46	184.10	189.93	195.95	202.17	208.60	215.24	222.10	229.18	236.50	244.06	251.88	259.95
Avg Day Unit Cost	($/m^3)	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.18	0.19	0.19	0.19
Operations Cost																												
Labour Unit Cost	($/m^3)	0.52	0.52	0.52	0.53	0.53	0.53	0.53	0.54	0.54	0.54	0.54	0.55	0.55	0.55	0.56	0.56	0.56	0.56	0.57	0.57	0.57	0.58	0.58	0.58	0.58	0.59
Labour Avg Day Cost	($/day)	479.45	489.04	498.82	508.80	518.97	529.35	539.94	550.74	561.75	572.99	584.45	596.14	608.06	620.22	632.63	645.28	658.18	671.35	684.78	698.47	712.44	726.69	741.22	756.05	771.17	786.59
Total Avg Day Cost	($)	479.45	489.04	498.82	508.80	518.97	529.35	539.94	550.74	561.75	572.99	584.45	596.14	608.06	620.22	632.63	645.28	658.18	671.35	684.78	698.47	712.44	726.69	741.22	756.05	771.17	786.59
Avg Day Unit Cost	($/m^3)	0.52	0.52	0.52	0.53	0.53	0.53	0.53	0.54	0.54	0.54	0.54	0.55	0.55	0.55	0.56	0.56	0.56	0.56	0.57	0.57	0.57	0.58	0.58	0.58	0.58	0.59
Administration Cost																												
Administration Unit Cost	($/m^3)	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Administration Avg Day Cost	($/day)	82.19	83.84	85.51	87.22	88.97	90.75	92.56	94.41	96.30	98.23	100.19	102.20	104.24	106.32	108.45	110.62	112.83	115.09	117.39	119.74	122.13	124.58	127.07	129.61	132.20	134.84
Total Avg Day Cost	($)	82.19	83.84	85.51	87.22	88.97	90.75	92.56	94.41	96.30	98.23	100.19	102.20	104.24	106.32	108.45	110.62	112.83	115.09	117.39	119.74	122.13	124.58	127.07	129.61	132.20	134.84
Avg Day Unit Cost	($/m^3)	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Maintenance																												
Filter Media Replacement	($/day)	7.64	7.80	7.95	8.11	8.27	8.44	8.61	8.78	8.95	9.13	9.32	9.50	9.69	9.89	10.08	10.29	10.49	10.70	10.92	11.13	11.36	11.58	11.82	12.05	12.29	12.54
General Maintenance Allowance	($/day)	92.43	95.70	99.07	102.57	106.19	109.94	113.82	117.84	122.00	126.31	130.76	135.38	140.16	145.11	150.23	155.53	161.02	166.71	172.59	178.68	184.99	191.52	198.28	205.28	212.53	220.03
Total Avg Day Cost	($)	100.08	103.49	107.03	110.68	114.46	118.38	122.43	126.62	130.95	135.44	140.08	144.88	149.85	154.99	160.31	165.82	171.51	177.41	183.51	189.82	196.35	203.10	210.10	217.33	224.82	232.57
Avg Day Unit Cost	($/m^3)	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.17
Total Operation & Maintenance Costs																												
Total Avg Day Cost	($)	1007.97	1032.04	1056.73	1082.06	1108.06	1134.73	1163.42	1192.93	1223.27	1254.48	1278.97	1311.72	1345.41	1380.06	1415.71	1443.36	1480.78	1519.30	1558.93	1599.72	1630.96	1673.80	1717.90	1763.29	1810.03	1845.37
Avg Day Unit Cost	($/m^3)	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.19	1.19	1.20	1.22	1.23	1.24	1.25	1.26	1.28	1.29	1.30	1.31	1.32	1.34	1.35	1.37	1.38

Shared Water Distribution Study

O&M Costs - High River Regional Water Supply

Engineer Input

To Be Determined

Not Applicable

Assumptions

General:

Power Cost:	0.12	$/kW hr	**Process Chemical Consumption:**	
Gas Cost:	5.60	$/GJ		
Inflation:	2	%		
Operations Annual Cost:				
Labour Annual Cost:	70000			
Administration Annual Cost:	20000			
Potable Water Purchase:	0.93	$/m3 (From Reilley @ Town of High River)		
Potable Water Connection Fee:	1500	$/month (From Reilley @ Town of High River)		
Maintenance Allowance Unit Cost:	0.015	$/m3		
Annual Building Electricity Consumption (lighting, HVAC)	50000	kWh		
Annual Gas Consumption	2000	GJ		
			Process Chemical Consumption:	
Regional Booster Pumping:				
Pump Head Required:	46	m		
Pump & Motor Combined Efficiency:	75	%	Chlorine Dosage Rate:	1.5 mg/L
			Chlorine Cost:	2.11 $/kg
Distribution Pumping:				
Pump Head Required:	64	m		
Pump & Motor Combined Efficiency:	76	%		

Projected Operational Costs

Year		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
Town of Nanton Projected Water Usage	**Unit**																										
Total	Avg Day (m^3/day)	924	938	952	967	981	996	1,011	1,026	1,041	1,057	1,073	1,089	1,105	1,122	1,139	1,156	1,173	1,191	1,208	1,227	1,245	1,264	1,283	1,302	1,321	1,341
	Max Day (m^3/day)	1,979	2,009	2,039	2,069	2,100	2,132	2,164	2,196	2,229	2,263	2,297	2,331	2,366	2,401	2,438	2,474	2,511	2,549	2,587	2,626	2,665	2,705	2,746	2,787	2,829	2,871
Water Treatment System Power Consumption																											
Regional Booster Pump Operation Projected Run Time	(hr)	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Regional Booster Pump Operation Projected Flow Rate	(l/sec)	11	11	11	11	11	12	12	12	12	12	12	13	13	13	13	13	14	14	14	14	14	15	15	15	15	16
Regional Booster Pump Operation Power Consumption	(kW hr)	154	157	159	161	164	166	169	171	174	177	179	182	185	187	190	193	196	199	202	205	208	211	214	218	221	224
Total Avg Day Cost	($)	18.53	19.19	19.86	20.57	21.29	22.04	22.82	23.63	24.46	25.32	26.22	27.14	28.10	29.09	30.12	31.18	32.28	33.42	34.60	35.83	37.09	38.40	39.76	41.16	42.61	44.12
Avg Day Unit Cost	($/$m^3$)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Distribution Pumping Power Consumption																											
Distribution Pump Projected Run Time	(hr)	24	24	24	24	24	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
Distribution Pump Operation Projected Flow Rate	(l/sec)	11	11	11	11	11	12	12	12	12	12	12	13	13	13	13	13	14	14	14	14	14	15	15	15	15	16
Distribution Pump Operation Power Consumption	(kW hr)	212	215	218	222	225	228	242	255	269	283	297	312	327	343	359	376	392	410	427	446	464	483	503	523	543	564
Distribution Pump Operation Avg Day Cost	($)	25.45	26.34	27.27	28.24	29.23	30.26	32.64	35.14	37.78	40.56	43.50	46.58	49.84	53.26	56.86	60.66	64.64	68.84	73.25	77.88	82.75	87.87	93.25	98.89	104.82	111.05
Total Avg Day Cost	($)	25.45	26.34	27.27	28.24	29.23	30.26	32.64	35.14	37.78	40.56	43.50	46.58	49.84	53.26	56.86	60.66	64.64	68.84	73.25	77.88	82.75	87.87	93.25	98.89	104.82	111.05
Avg Day Unit Cost	($/$m^3$)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08
Building Electricity Consumption																											
WTP & RWPS Building Avg Day Electricity Consumption	($/day)	16.44	16.77	17.10	17.44	17.79	18.15	18.51	18.88	19.26	19.65	20.04	20.44	20.85	21.26	21.69	22.12	22.57	23.02	23.48	23.95	24.43	24.92	25.41	25.92	26.44	26.97
Total Avg Day Cost	($)	16.44	16.77	17.10	17.44	17.79	18.15	18.51	18.88	19.26	19.65	20.04	20.44	20.85	21.26	21.69	22.12	22.57	23.02	23.48	23.95	24.43	24.92	25.41	25.92	26.44	26.97
Avg Day Unit Cost	($/$m^3$)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Building Energy Consumption																												
WTP & RWPS Building Avg Day Gas Consumption	($/day)	30.68	31.30	31.92	32.56	33.21	33.88	34.56	35.25	35.95	36.67	37.40	38.15	38.92	39.69	40.49	41.30	42.12	42.97	43.83	44.70	45.60	46.51	47.44	48.39	49.35	50.34
Total Avg Day Cost	($)	30.68	31.30	31.92	32.56	33.21	33.88	34.56	35.25	35.95	36.67	37.40	38.15	38.92	39.69	40.49	41.30	42.12	42.97	43.83	44.70	45.60	46.51	47.44	48.39	49.35	50.34
Avg Day Unit Cost	($/m^3)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Potable Water Conyenace																												
Potable Water Conveyance Charge	($/day)	859.62	889.97	903.32	916.87	930.62	944.58	958.75	973.13	987.73	1002.54	1017.58	1032.85	1048.34	1064.06	1080.02	1096.22	1112.67	1129.36	1146.30	1163.49	1180.95	1198.66	1216.64	1234.89	1253.41	1272.21
Potable Water Connection Fee		50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Total Avg Day Cost	($)	845.95	891.65	922.40	954.23	987.15	1021.23	1056.49	1092.99	1130.75	1169.84	1210.28	1252.14	1295.45	1340.28	1386.67	1434.68	1484.37	1535.79	1589.01	1644.08	1701.08	1760.07	1821.12	1884.31	1949.70	2017.39
Avg Day Unit Cost	($/m^3)	0.92	0.95	0.97	0.99	1.01	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.19	1.22	1.24	1.27	1.29	1.31	1.34	1.37	1.39	1.42	1.45	1.48	1.50
Process Chemical Consumption																												
CL2 Avg Day Consumption	(kg)	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CL2 Avg Day Cost	($)	2.93	3.03	3.14	3.25	3.36	3.48	3.60	3.73	3.86	4.00	4.14	4.28	4.44	4.59	4.75	4.92	5.10	5.28	5.46	5.66	5.85	6.06	6.28	6.50	6.73	6.96
Total Avg Day Cost	($)	2.93	3.03	3.14	3.25	3.36	3.48	3.60	3.73	3.86	4.00	4.14	4.28	4.44	4.59	4.75	4.92	5.10	5.28	5.46	5.66	5.85	6.06	6.28	6.50	6.73	6.96
Avg Day Unit Cost	($/m^3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Operations Cost																												
Labour Unit Cost	($/m^3)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Labour Avg Day Cost	($/day)	191.78	195.62	199.53	203.52	207.59	211.74	215.98	220.30	224.70	229.20	233.78	238.46	243.22	248.09	253.05	258.11	263.27	268.54	273.91	279.39	284.98	290.68	296.49	302.42	308.47	314.64
Total Avg Day Cost	($)	191.78	195.62	199.53	203.52	207.59	211.74	215.98	220.30	224.70	229.20	233.78	238.46	243.22	248.09	253.05	258.11	263.27	268.54	273.91	279.39	284.98	290.68	296.49	302.42	308.47	314.64
Avg Day Unit Cost	($/m^3)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Administration Cost																												
Administration Unit Cost	($/m^3)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Administration Avg Day Cost	($/day)	54.79	55.89	57.01	58.15	59.31	60.50	61.71	62.94	64.20	65.48	66.79	68.13	69.49	70.88	72.30	73.75	75.22	76.73	78.26	79.83	81.42	83.05	84.71	86.41	88.13	89.90
Total Avg Day Cost	($)	54.79	55.89	57.01	58.15	59.31	60.50	61.71	62.94	64.20	65.48	66.79	68.13	69.49	70.88	72.30	73.75	75.22	76.73	78.26	79.83	81.42	83.05	84.71	86.41	88.13	89.90
Avg Day Unit Cost	($/m^3)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Maintenance																												
General Maintenance Allowance	($/day)	13.86	14.35	14.86	15.39	15.93	16.49	17.07	17.68	18.30	18.95	19.61	20.31	21.02	21.77	22.53	23.33	24.15	25.01	25.89	26.80	27.75	28.73	29.74	30.79	31.88	33.00
Total Avg Day Cost	($)	13.86	14.35	14.86	15.39	15.93	16.49	17.07	17.68	18.30	18.95	19.61	20.31	21.02	21.77	22.53	23.33	24.15	25.01	25.89	26.80	27.75	28.73	29.74	30.79	31.88	33.00
Avg Day Unit Cost	($/m^3)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Total Operation & Maintenance Costs																												
Total Avg Day Cost	($)	1200.42	1254.14	1293.10	1333.33	1374.88	1417.78	1463.38	1510.53	1559.27	1609.66	1661.76	1715.63	1771.33	1828.92	1888.47	1950.05	2013.73	2079.58	2147.68	2218.11	2290.95	2366.28	2444.20	2524.79	2608.14	2694.36
Avg Day Unit Cost	($/m^3)	1.30	1.34	1.36	1.38	1.40	1.42	1.45	1.47	1.50	1.52	1.55	1.58	1.60	1.63	1.66	1.69	1.72	1.75	1.78	1.81	1.84	1.87	1.91	1.94	1.97	2.01

Shared Water Distribution Study - Town of Nanton Upgrade Alternative #2 - RW Storage Upgrade and Treatment Plant Improvements
Present Worth Analysis

Alternative 1B Capital Cost: $4,109,000
AMWWP Funding: **61.70%**
Eligible Funding: **$2,535,253**
Discount Rate: 4.00%
Inflation Rate: 2.00%
Interest Rate: 2.651%

COST COMPONENTS		PRESENT WORTH	YEAR 0	1	2	3	8	13	18	23	25	25 Year Total
			2019	2020	2021	2022	2027	2032	2037	2042	2044	
1 Alternative 2: Actiflo Clarification, Sand Filtration, UV Disinfection												
PROJECT PAYBACK PERIOD:												
Term: 25 years												
CAPITAL COSTS ($):												
Total Project Captial Cost	$4,109,000											
Eligible Grants	$2,535,253											
Total	$1,573,747	$1,389,000	**$86,899**	**$86,899**	**$86,899**	**$86,899**	**$86,899**	**$86,899**	**$86,899**	**$86,899**	**$86,899**	$2,259,368
ANNUAL OPERATION & MAINTENANCE COSTS ($/yr):												
Operation, Maintenance, and Labour		$7,666,000	$367,911	$376,695	$385,707	$394,953	$446,493	$503,722	$569,011	$643,602	$673,560	$13,151,316
Total		$7,666,000	**$367,911**	**$376,695**	**$385,707**	**$394,953**	**$446,493**	**$503,722**	**$569,011**	**$643,602**	**$673,560**	$13,151,316
NET PRESENT WORTH:												
(Capital Cost + Annual Operation & Maintenance Costs):		**$9,055,000**	**$454,809**	**$463,593**	**$472,605**	**$481,852**	**$533,392**	**$590,621**	**$655,909**	**$730,501**	**$760,458**	$15,410,684
UNIT COST:												
Annual Production (m3)			337,380	342,440	347,577	352,790	380,056	409,428	441,070	475,158	489,519	
Capital Cost ($/m3)			$0.26	$0.25	$0.25	$0.25	$0.23	$0.21	$0.20	$0.18	$0.18	
O&M Cost ($/m3)			$1.09	$1.10	$1.11	$1.12	$1.17	$1.23	$1.29	$1.35	$1.38	
Total Cost ($/m3)			**$1.35**	**$1.35**	**$1.36**	**$1.37**	**$1.40**	**$1.44**	**$1.49**	**$1.54**	**$1.55**	

Alternative 2 Capital Cost: $4,109,000
AMWWP Funding: **0.00%**
Eligible Funding: **$0**
Discount Rate: 4.00%
Inflation Rate: 2.00%
Interest Rate: 2.651%

COST COMPONENTS		PRESENT WORTH	YEAR 0	1	2	3	8	13	18	23	25	25 Year Total
			2019	2020	2021	2022	2027	2032	2037	2042	2044	
1 Alternative 2: Actiflo Clarification, Sand Filtration, UV Disinfection WITH: RW Pipeline, GC Supply, Dist. Pumping, TW Storage												
PROJECT PAYBACK PERIOD:												
Term: 25 years												
CAPITAL COSTS ($):												
Total Project Captial Cost	$4,109,000											
Eligible Grants	$0											
Total	$4,109,000	$3,626,000	**$226,890**	**$226,890**	**$226,890**	**$226,890**	**$226,890**	**$226,890**	**$226,890**	**$226,890**	**$226,890**	$5,899,132
ANNUAL OPERATION & MAINTENANCE COSTS ($/yr):												
Operation, Maintenance, and Labour		$7,666,000	$367,911	$376,695	$385,707	$394,953	$446,493	$503,722	$569,011	$643,602	$673,560	$13,151,316
Total		$7,666,000	**$367,911**	**$376,695**	**$385,707**	**$394,953**	**$446,493**	**$503,722**	**$569,011**	**$643,602**	**$673,560**	$13,151,316
NET PRESENT WORTH:												
(Capital Cost + Annual Operation & Maintenance Costs):		**$11,292,000**	**$594,800**	**$603,584**	**$612,596**	**$621,843**	**$673,383**	**$730,612**	**$795,900**	**$870,492**	**$900,449**	$19,050,448
UNIT COST:												
Annual Production (m3)			337,380	342,440	347,577	352,790	380,056	409,428	441,070	475,158	489,519	
Capital Cost ($/m3)			$0.67	$0.66	$0.65	$0.64	$0.60	$0.55	$0.51	$0.48	$0.46	
O&M Cost ($/m3)			$1.09	$1.10	$1.11	$1.12	$1.17	$1.23	$1.29	$1.35	$1.38	
Total Cost ($/m3)			**$1.76**	**$1.76**	**$1.76**	**$1.76**	**$1.77**	**$1.78**	**$1.80**	**$1.83**	**$1.84**	

Shared Water Distribution Study - Town of Nanton Upgrade Alternative #5 - PW Supply from High River
Present Worth Analysis

Alternative 3 Capital Cost: $8,701,000
W4L Funding: **90.00%**
Eligible Funding: $7,830,900
Discount Rate: 4.00%
Inflation Rate: 2.00%
Interest Rate: 2.651%

COST COMPONENTS		PRESENT WORTH	YEAR 0	1	2	3	8	13	18	23	25	25 Year Total
			2019	2020	2021	2022	2027	2032	2037	2042	2044	
1 Alternative 1: Conventional Clarification and Membrane Filtration												
PROJECT PAYBACK PERIOD:												
Term: 25 years												
CAPITAL COSTS ($):												
Total Project Captial Cost	$8,701,000											
Eligible Grants	$7,830,900											
Total	$870,100	$768,000	**$48,045**	**$48,045**	**$48,045**	**$48,045**	**$48,045**	**$48,045**	**$48,045**	**$48,045**	**$48,045**	$1,249,169
ANNUAL OPERATION & MAINTENANCE COSTS ($/yr):												
Operation, Maintenance, and Labour		$10,087,000	$438,152	$457,761	$471,983	$486,667	$569,134	$667,557	$783,904	$921,547	$983,441	$17,600,480
Total		$10,087,000	**$438,152**	**$457,761**	**$471,983**	**$486,667**	**$569,134**	**$667,557**	**$783,904**	**$921,547**	**$983,441**	$13,851,389
NET PRESENT WORTH:												
(Capital Cost + Annual Operation & Maintenance Costs):		**$10,855,000**	**$486,197**	**$505,806**	**$520,028**	**$534,712**	**$617,179**	**$715,601**	**$831,949**	**$969,592**	**$1,031,486**	$18,849,649
UNIT COST:												
Annual Production (m3)			337,380	342,440	347,577	352,790	380,056	409,428	441,070	475,158	489,519	
Capital Cost ($/m3)			$0.14	$0.14	$0.14	$0.14	$0.13	$0.12	$0.11	$0.10	$0.10	
O&M Cost ($/m3)			$1.30	$1.34	$1.36	$1.38	$1.50	$1.63	$1.78	$1.94	$2.01	
Total Cost ($/m3)			**$1.44**	**$1.48**	**$1.50**	**$1.52**	**$1.62**	**$1.75**	**$1.89**	**$2.04**	**$2.11**	

Alternative 3 Capital Cost: $8,701,000

W4L Funding: **0.00%**

Eligible Funding: $0
Discount Rate: 4.00%
Inflation Rate: 2.00%
Interest Rate: 2.651%

COST COMPONENTS		PRESENT WORTH	YEAR 0	1	2	3	8	13	18	23	25	25 Year Total
			2019	2020	2021	2022	2027	2032	2037	2042	2044	
1 Alternative 1: Conventional Clarification and Membrane Filtration												
PROJECT PAYBACK PERIOD:												
Term: 25 years												
CAPITAL COSTS ($):												
Total Project Captial Cost	$8,701,000											
Eligible Grants	$0											
Total	$8,701,000	$7,679,000	**$480,450**	**$480,450**	**$480,450**	**$480,450**	**$480,450**	**$480,450**	**$480,450**	**$480,450**	**$480,450**	$12,491,689
ANNUAL OPERATION & MAINTENANCE COSTS ($/yr):												
Operation, Maintenance, and Labour		$10,087,000	$438,152	$457,761	$471,983	$486,667	$569,134	$667,557	$783,904	$921,547	$983,441	$17,600,480
Total		$10,087,000	**$438,152**	**$457,761**	**$471,983**	**$486,667**	**$569,134**	**$667,557**	**$783,904**	**$921,547**	**$983,441**	$13,851,389
NET PRESENT WORTH:												
(Capital Cost + Annual Operation & Maintenance Costs):		**$17,766,000**	**$918,602**	**$938,211**	**$952,432**	**$967,117**	**$1,049,584**	**$1,148,006**	**$1,264,354**	**$1,401,996**	**$1,463,891**	$30,092,169
UNIT COST:												
Annual Production (m3)			337,380	342,440	347,577	352,790	380,056	409,428	441,070	475,158	489,519	
Capital Cost ($/m3)			$1.42	$1.40	$1.38	$1.36	$1.26	$1.17	$1.09	$1.01	$0.98	
O&M Cost ($/m3)			$1.30	$1.34	$1.36	$1.38	$1.50	$1.63	$1.78	$1.94	$2.01	
Total Cost ($/m3)			**$2.72**	**$2.74**	**$2.74**	**$2.74**	**$2.76**	**$2.80**	**$2.87**	**$2.95**	**$2.99**	