Little Bow Resort
Water Treatment Plant Upgrade
Evaluation

Evaluation Report
Prepared For:
The Owners Condominium Plan No. 9311680 o/a Little Bow Resort

September 2009

Table of Contents

1.0 INTRODUCTION 1
1.1 OVERVIEW / PROJECT BACKGROUND 1
1.2 OBJECTIVES AND SCOPE OF WORK 1
1.3 CONSTRAINTS 2
1.4 ACKNOWLEDGEMENTS 2

2.0 INFORMATION REVIEW 3
2.1 PREVIOUS STUDIES 3
2.2 DATA COLLECTION 3
2.3 FACILITY APPROVAL 4
2.4 WATER RESOURCES ACT LICENSES 6

3.0 EXISTING WATER TREATMENT PLANT 8
3.1 GENERAL DESCRIPTION 8
3.2 EXISTING SYSTEM ASSESSMENT 8
3.2.1 Raw Water Supply System 8
3.2.2 Raw Water Diversion 10
3.2.3 Raw Water Intake 11
3.2.4 Raw Water Pumps and Transmission Main 11
3.2.5 Water Treatment Plant 12
3.2.5.1 Rapid Gravity Sand Filters 12
3.2.5.2 Chemical Feed Systems 12
3.2.5.3 Wastewater Disposal 12
3.2.5.4 Electrical 12
3.2.5.5 Distribution Pumps 13
3.2.5.6 Fire Protection 13
3.2.5.7 Treated Water Storage 13
3.3 EXISTING RAW WATER QUALITY 14
3.3.1 Turbidity 14
3.3.2 Particle Counts 14
3.3.3 Giardia, Cryptosporidium and Viruses Log Reduction 15
3.3.4 Historical Log Reduction 15

4.0 PROJECTED POPULATION AND WATER DEMANDS 17
4.1 POPULATION AND DEVELOPMENT PROJECTIONS 17
4.2 WATER DEMAND DESIGN FLOWS 17
4.3 TREATED WATER STORAGE REQUIREMENTS 19
4.3.1 Fire Storage 20
4.3.2 Total Storage Requirements 20

5.0 FUTURE TREATED WATER QUALITY GOALS 21
5.1 FUTURE TREATED WATER QUALITY GOALS 21

Table of Contents

6.0 UPGRADE RECOMMENDATIONS 22
6.1 OVERVIEW 22
6.2 WATER SUPPLY UPGRADES 22
6.2.1 Raw Water Diversion License 22
6.2.2 Raw Water Pumping 22
6.3 TREATMENT PROCESS UPGRADE OPTIONS 22
6.3.1 Existing Treatment Plant Process 22
6.3.2 Treatment Process Improvements 23
6.3.2.1 Ultraviolet Disinfection 23
6.3.2.2 Sodium Hypochlorite Feed System 23
6.3.2.3 Instrumentation 23
6.3.2.4 Electrical 23
6.3.2.5 Supervisory Control and Data Acquisition (SCADA) 24
6.3.2.6 Communication 24
6.3.2.7 Process Upgrades 24

7.0 OPINION OF PROBABLE COSTS 28

8.0 REFERENCES 29

9.0 CONCLUSIONS AND RECOMMENDATIONS 30
9.1 CONCLUSIONS 30
9.2 RECOMMENDATIONS 30

10.0CORPORATE AUTHORIZATION 31

APPENDIX A – ALBERTA ENVIRONMENT APPROVAL AND WATER ACT LICENSES 32

APPENDIX B – OPINION OF PROBABLE COST DETAILS 33

APPENDIX C – RAW WATER ANALYSIS 34

FIGURES

Appendix A – Alberta Environment Approval and Water Act Licenses
Appendix B – Opinion of Probable Cost Details
Appendix C – Raw Water Analysis

1.0 Introduction

1.1 OVERVIEW / PROJECT BACKGROUND

Condominium Corporation No. 9311680 o/a Little Bow Resort is a bare land condominium development approximately 100 km north of Lethbridge, Alberta. The resort is managed by an elected Board of Directors of the Condominium Corporation. The Corporation retains Braemore Management as managers of the resort. The resort operates its own water treatment plant which provides potable water to resort residents and tot the nearby Southern Alberta Bible Camp with raw water obtained from the Travers Reservoir.

The water treatment plant was originally constructed in 1993 and has not received any upgrades. The current Alberta Environment Approval No. 16260-01-00 expires March 1, 2010.

1.2 OBJECTIVES AND SCOPE OF WORK

The objectives of this evaluation is to conduct a preliminary evaluation of the existing water treatment plant to determine the extent of necessary upgrades to the plant in order to meet current Alberta Environment standards.

The scope of work covered in this preliminary evaluation is as follows:

- Collect and review available data including historical water demand and treatment records, water treatment plant drawings and operation manuals, previous engineering reports and evaluations, licenses and approvals.
- Meet with Alberta Environment representatives to discuss upgrading requirements and options to the water treatment plant.
- Conduct an on-site investigation and assessment of all existing system components.
- Conduct a detailed review of existing Approval to operate.
- Comparison of the existing Approval to the current Alberta Environment Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems.
- Determine ultimate build-out population projections.
- Develop a design basis for average, maximum day and peak water consumption.
- An assessment of recommended fire flow rates and fire storage volume will be made to determine the sizing of water storage facilities.

- Evaluate upgrade alternatives as outlined in the information and investigation phases.
- A reasonable and financially viable strategy for staged upgrades to the system will be developed.
- Order of Magnitude cost estimates for upgrade alternatives for the purposes of long term budget planning will be developed.
- Present to the Association the findings of the preliminary evaluation including recommended upgrades and associated capital and operational costs.
- Final incorporation of comments, report production to the Association.

1.3 CONSTRAINTS

The constraints in this study are set out by the objectives listed above. Detailed engineering is required to act upon each recommendation.

1.4 ACKNOWLEDGEMENTS

Stantec wishes to thank Warren Lyckman at Braemore Management Ltd. and Ray Kienlan, water treatment plant operator for their cooperation and prompt response to queries made and information requests.

2.0 Information Review

2.1 PREVIOUS STUDIES

The report entitled *"Little Bow Resort Raw Water Supply Study"*, MPE Engineering Ltd., February 2008 was reviewed to determine the capacity of the existing raw water intake and pumping intake.

The objective of this study included the following:

- Review current and projected turf irrigation requirements.
- Review capacity of existing intake and pumping system.
- Upgrade strategy to maximize potential of existing intake/pumping capabilities.
- Review the need for construction of a second permanent raw water intake.
- Review the concept of temporary raw water storage near the water treatment plant for turf irrigation use.

The conclusions of this study, relevant to the Little Bow Resort Water Treatment Plant Upgrade Evaluation, are as per the following excerpts:

- *A pump with a capacity of 300 USgpm or 1635 m^3/day would provide sufficient capacity to meet current and future treated water and irrigation demands. Detailed design of the raw water pump upgrading should incorporate Variable Frequency Drives in order to limit pump flow to match intake capacity based on reservoir level.*
- *The current intake is sufficient unless the water level is regularly around the LWL in which case a second intake should be considered.*
- *No temporary storage is required as long as the water level stays above the Normal LWL.*

2.2 DATA COLLECTION

The following reports and data have been provided by Little Bow Resort and Braemore Management Ltd. for use in this evaluation.

- Alberta Environment EPEA Approval to Operate No. 16260-01-00.
- Alberta Environment Water Resources Act Interim License to Divert Water.

- Water treatment plant monthly and annual reports (2006-2008).
- 1993 For Construction Drawings – Lift Station and Water Intake and Plant, Cicon Engineering.
- Little Bow Resort Raw Water Supply Study, MPE Engineering Ltd., 2008.

2.3 FACILITY APPROVAL

The Environmental Protection and Enhancement Act (EPEA) defines the requirements of water treatment and distribution systems in Alberta. This act requires that all municipal water treatment and distribution systems operate under the terms and conditions of an approval for each system. Table 2.1 summarizes the current approval for the resort. A Copy of the approval is attached in **Appendix A**.

Table 2.1 Facility Approval

Approval Holder	Approval No.	Effective Date	Expiry Date	Facility Classification	
				Treatment	Distribution
"The Owners" Condominium Corporation 9311680 (Little Bow Resort)	16260-01-00	March 3, 2000	March 1, 2010	I	I

The Approval sets forth performance limits on the treatment system. The approval outlines treatment objectives, record keeping requirements and operational requirements. The minimum treatment targets are summarized in Table 2.2.

Table 2.2 Little Bow Resort Waterworks Limits

Parameter	Designated Sampling Location	Limit
Volume of Raw Water	Entering the Treatment Plant	3.8 L/s per filter
Volume of Treated Water	Entering the treated water reservoir	Average of 1310 m^3/day
Turbidity of Treated Water	Prior to entering the treated water reservoir	≤ 1 NTU if raw water turbidity is > 2.5 NTU
		≤ 0.8 NTU if raw water turbidity is 1.6 – 2.5 NTU
		≤ 50% of raw water turbidity if raw water turbidity is < 1.6 NTU
Turbidity of Treated Water	Random locations in the water distribution system	≤ 5 NTU
pH of Treated Water	Entering the water distribution system	6.5 – 8.5
Free Chlorine Residual of Treated Water	In the water distribution system	≥ 0.1 mg/L
Free Chlorine Residual of Treated Water	After a minimum of 20 minutes of contact	≥ 0.5 mg/L

Table 2.3 summarizes the sampling frequency, test requirements and reporting frequency required by the operations staff at the plant.

Table 2.3 Monitoring and Reporting Requirements

Parameters	Frequency	Sample Type	Sampling Location	Reporting Frequency	Report To
Raw Water Turbidity	Once per day	Grab	Prior to chemical addition	Annually	Director
Raw Water pH	Once per day	Grab	Prior to chemical addition	Annually	Director
Treated Water Volume	Once per day	Continuous	Entering the treated water reservoir	Annually	Director
Raw Water Volume	Once per day	Continuous	Entering treatment plant	Annually	Director
Treated Water Turbidity	Once per day	Continuous	Prior to entering treated water reservoirs	Annually	Director
Turbidity of Water Within the Distribution System	Once per week	Grab	Random location in the water distribution system	Annually	Director
pH of Treated Water	Once per day	Grab	Entering the water distribution system	Annually	Director
CT Value	Daily	Calculation	Prior to entering the water distribution system	Annually	Director
Free Chlorine Residual of Treated Water	Once per day	Grab	Entering the water distribution system	Annually	Director
Free Chlorine Residual of Treated Water	Once per week	Grab	Random location in the water distribution system	Annually	Director
Name, concentration and dosage of the chemicals added	Once per day	N/A	To the water treatment process	Annually	Director
Bacteria in Treated Water (Bacteriological examination)	As required by the GCDWQ	Grab	Random location in the water distribution system	Annually	Director

2.4 WATER RESOURCES ACT LICENSES

As noted in section 2.3 the EPEA defines treatment storage and distribution requirements. The licenses for the right withdrawal water from a source rate and total annual volume allowed to be withdrawn are provided under the Water Act. The licenses under the Water Act grants each approval holder the right to divert and use water from its source subject to the terms and conditions stated in the license. Table 2.4 provides details of the license for the resort and the Southern Alberta Bible Camp. The Water Act License to Divert is included in **Appendix A**.

Table 2.4 Water Resources Act Licenses

Approval Holder	License No.	Priority No.	Point of Use	Annual Gross Diversion (m^3)	Rate of Diversion (L/s)
Little Bow Resort	00254596-00-00	1992-09-22-01	Travers Reservoir	49,360	1.6
Southern Alberta Bible Camp	11682	1981-12-29-01	Travers Reservoir	4,933	0.57
TOTAL ANNUAL GROSS DIVERSION				**54,293**	

3.0 Existing Water Treatment Plant

3.1 GENERAL DESCRIPTION

The Little Bow Resort water treatment plant draws water from the Travers Reservoir via the Bow River through the Carseland – Bow River Headworks. Raw water from the reservoir flows through a screened intake located in the reservoir and into the pump manhole. Raw water is then pumped up to the flash mixer located in the water treatment plant. Raw water is mixed with a coagulant, Polyaluminum Chloride (PAC). The raw water is then treated by rapid gravity sand filtration and chlorine disinfection prior to being stored in the treated water reservoir. Treated water is pumped into the distribution via three distribution pumps.

The treatment plant consists of the following main components:

- Raw water pump
- Chemical coagulation
- Rapid gravity sand filtration
- Disinfection
- Potable water reservoir
- Distribution pumps

The plant currently uses the following chemical treatment systems:

- Polyaluminum Chloride (PAC) feed system
- Post chlorination system, consisting of calcium hypochlorite tabs

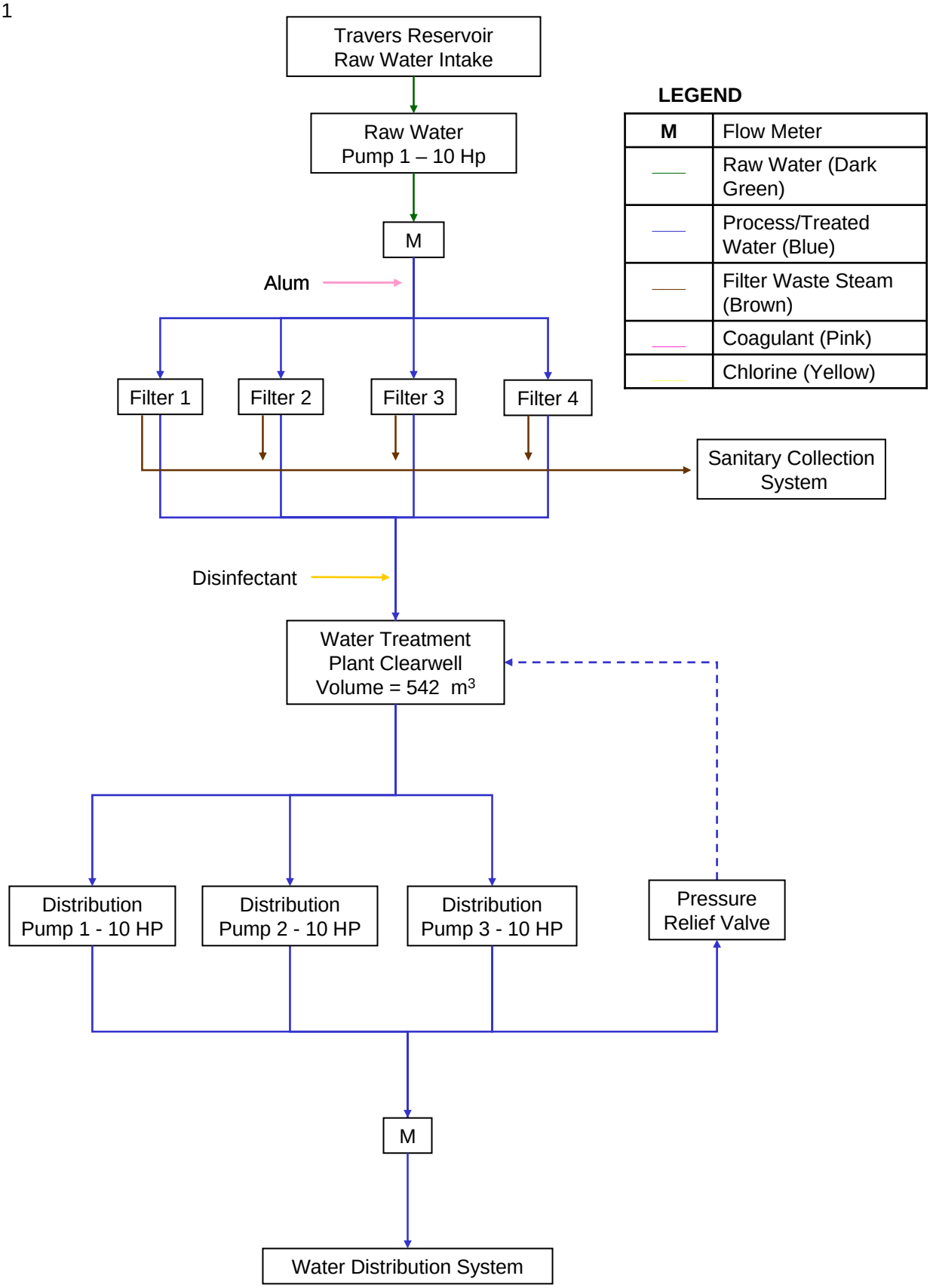
Figure 3.1 provides generalized process flow diagram of the existing system. The following sections describe the most critical system components in detail.

3.2 EXISTING SYSTEM ASSESSMENT

3.2.1 Raw Water Supply System

The raw water supply for the Little Bow Resort is taken from the Travers Reservoir. The raw water supply system consists of a submerged stainless steel well screen intake, a 200mm transmission pipeline and a raw water intake pump manhole that pumps raw water through a 150 mm main to the Water Treatment Plant.

Little Bow Resort – Existing Process Flow Diagram
Figure 3.1



3.2.2 Raw Water Diversion

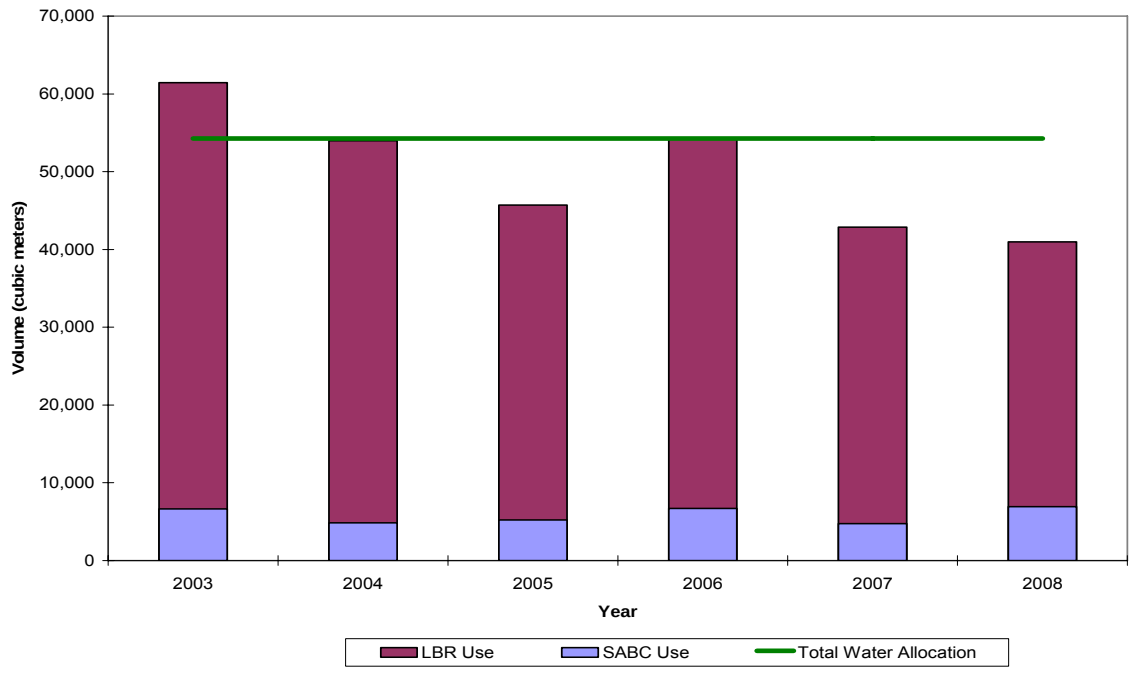
Currently under the Alberta Water Resources Act, the Little Bow Resort and the Southern Alberta Bible Camp hold a license to divert and use water from Alberta Environment under Water Act Legislation.

The current resort diversion was reviewed based on the state of its licensing relative to its long-term water needs. In the past six years the resort along with the Southern Alberta Bible Camp are diverting an average of 49,873 m^3 of water annually for their use. The total diversion volume was exceeded in 2003 and has met the total license amount twice in the previous six years.

In the case of low river flows that results in less senior licenses being limited, the resort would be required to put restrictions in place in order to reduce demand. Figure 3.2 shows total diversion over the past six year period in relation to the total licensed withdrawal.

The resort has implemented water conservation methods including installing residential water meters in 2006/07 and has stopped irrigating common property areas along lakefront properties. The results of these measures have resulted in lower annual usage as can be seen in 2007 and 2008.

Figure 3.2 Little Bow Resort Water Resources Act Diversion Volumes



3.2.3 Raw Water Intake

The capacity of the existing raw water intake is sufficient to meet the projected demands of the resort as stated in the MPE study (2008).

3.2.4 Raw Water Pumps and Transmission Main

A single 10 horsepower (hp) submersible pump is located in the intake pump manhole. Raw water is pumped approximately xxx meters through a 150mm supply line to the water treatment plant. The material of the supply line is not known but is assumed to be high density polyethylene (HDPE).

Typically, raw water pumps are sized to accommodate maximum day demand. This allows the treatment facilities to have a continuous supply for the summer maximum day demand.

Based on Construction Drawings by Cicon Engineering, the capacity of the existing raw water pump is 1,305 m^3/day (239 USgpm). The maximum day demand over the past six years is shown in Table 3.1

Table 3.1 Historical Maximum Day Demand

Year	MDD (m^3/day)
2003	515
2004	461
2005	450
2006	719
2007	534
2008	489

The current pumping capacity has been able to meet the maximum day demand in each of the previous six years.

A replacement raw water pump is on hand should the installed pump fail, however the anticipated time to remove and replace the pump could be upwards of a day or more as a crane is required for pump removal and installation as was experienced by the operator.

3.2.5 Water Treatment Plant

3.2.5.1 Rapid Gravity Sand Filters

The water treatment plant has four rectangular rapid gravity sand filters. Each filter has a surface of approximately 2.1 m^2. Based on the Alberta Environment recommended filter loading rate of 3.8 L/s, the total design capacity of the four filters is 1,310 m^3/day. The filters have an automatic backwash cycle with treated water and do not require backwash pumps. The filters can also be manually backwashed as required

Operation staff report backwashes are restricted during peak sanitary lift station demands in order to limit the inflow to the lift station.

3.2.5.2 Chemical Feed Systems

The existing water treatment process Polyaluminum Chloride (PAC) is used to chemically enhance the filtration process. The liquid Stern PAC is stored in a 205 L drum and fed by a chemical feed pump into the raw water stream at the rapid mixer upstream of the filters.

Calcium Hypochlorite tabs are used to provide disinfection after filtration. The chlorine solution is added to the filter water stream prior to the treated water reservoir.

3.2.5.3 Wastewater Disposal

The water treatment plant produces wastes such as filter backwash and sanitary waste. The filter backwash and sanitary waste is discharged into the sewage collection system.

3.2.5.4 Electrical

A 50kVA, 480 volt, single phase electrical service is provided above ground to the Water Reservoir building from a Fortis Alberta owned pole mounted transformer. The single phase service is fed to a Dynaphase 50kVA, 480 volt, 3 phase rotary converter and is distributed through loose motor starters to the mechanical pumps at the water treatment plant and lift station. The motors are electrically interlocked to prevent any two pumps from starting at the same time.

A wall mounted PLC control panel performs control functions for the pumps and filters. Visual display lights on the exterior of the panel alert the operator as to which pumps are running, filter operations, and system alarms.

A 480-120/208 volt, 3 phase transformer located at the water treatment plant provides power to the remainder of the equipment and lighting in building, while a 480-120 volt single phase transformer provides the same service for the lift station.

The existing electrical service to the facility has a very small capacity for future electrical loads, with a max meter reading of approximately 47kVA being shown. A utility supplied 3 phase overhead electrical service, while planned for in the original electrical design for the facility, has not been realized to this point.

3.2.5.5 Distribution Pumps

There are three submersible distribution pumps located in the water treatment plant. All pumps and associated valves and piping appear to be in good condition. The distribution pumps are summarized in Table 3.2.

Table 3.2 Distribution Pumps

Pump	Motor Size	Capacity
1	10 hp	17 L/s (270 USgpm)
2	10 hp	17 L/s (270 USgpm)
3	10 hp	17 L/s (270 USgpm)
Firm Capacity		**34 L/s (540 USgpm)**

3.2.5.6 Fire Protection

The fire storage and fire flow requirements have been calculated as per the Fire Underwriters Survey (1999) and are explained in further detail in the following sections. The required fire flow is 67 L/s (1,057 USgpm) for 1.5 hours which equates to a storage requirement of 360 m^3. According to the Fire Underwriters Survey (1999), a water supply system is considered to be adequate for fire protection when it can supply the required fire flows with consumption at the maximum daily rate. The resort currently does not have the capacity to deliver the combined fire flow and MDD of 73 L/s.

3.2.5.7 Treated Water Storage

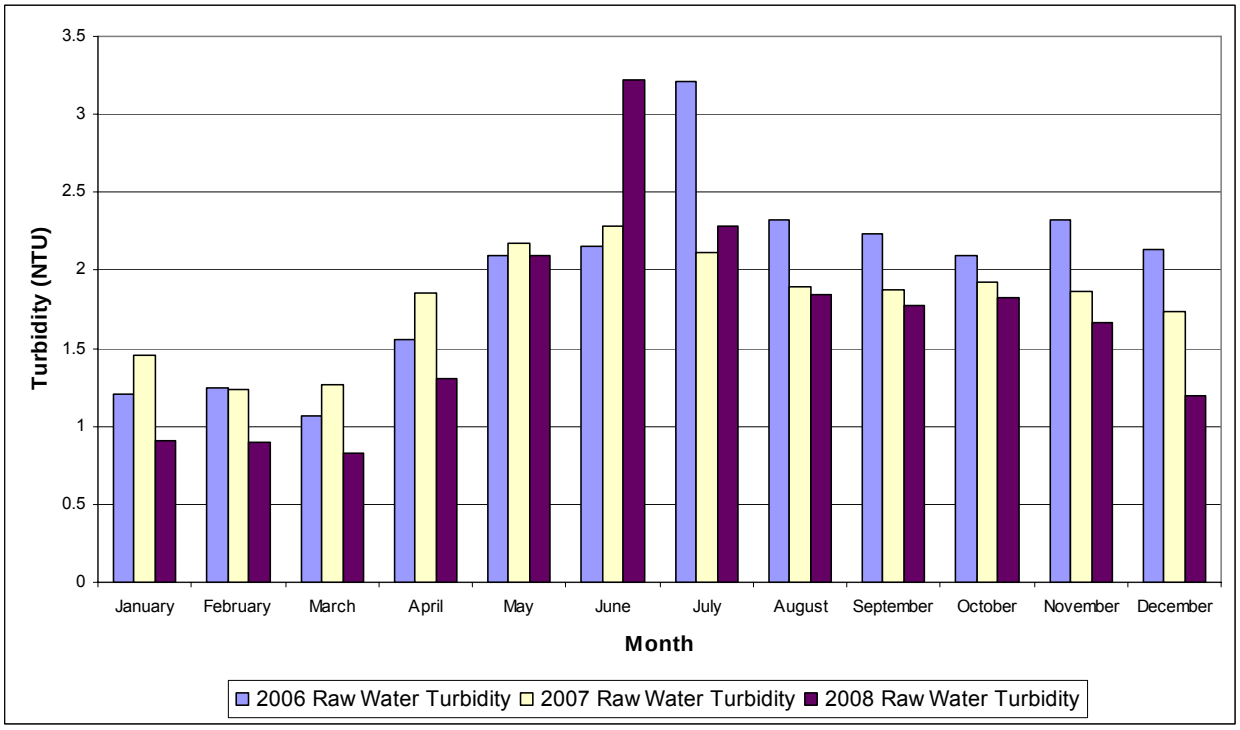
Treated water is stored in a cast-in-place concrete reservoir located directly below the treatment plant. The reservoir was constructed with a wall which divides the reservoir in two equal halves. There is no ability to isolate either half of the reservoir. The total available treated water storage is approximately 542 m^3. The reservoir was emptied and cleaned in month of 2008.

3.3 EXISTING RAW WATER QUALITY

3.3.1 Turbidity

Raw water turbidity is measured manually prior to treatment. The raw water turbidity does not vary significantly during the year. Monthly average raw water turbidity ranges are shown in Figure 3.3

Figure 3.3 Historical Monthly Average Turbidity Levels



The current water treatment plant consistently meets the turbidity guidelines and normally the treated water turbidity is in the range of 0.15 to 0.2 NTU.

3.3.2 Particle Counts

Particle reduction standards may be used in addition to the turbidity requirements, at the discretion of the system owner. Particle reduction is not a part of the current approval. The Little Bow Resort treatment plant does not currently measure particle counts.

3.3.3 Giardia, Cryptosporidium and Viruses Log Reduction

According to AE, all waterworks systems shall achieve a minimum 3.0 log (99.9%) reduction or removal of Giardia and Cryptosporidium and 4.0 log (99.99%) reduction or removal of viruses through filtration and disinfection together. However, based on the raw water cysts and oocysts levels, systems shall achieve a reduction of Giardia and Cryptosporidium in accordance with the requirements shown in Table 3.3.

Table 3.3 Log Reduction Required for Filtered Systems

Raw Water Giardia Levels (cysts / 100 L)[1]	Raw Water Cryptosporidium Level (oocysts / 100 L)[1]	Log Reduction
< 1	< 7.5	3.0 log
> 1 and < 10	> 7.5 and < 100	4.0 log
> 10 and < 100	> 100 and < 300	5.0 log
> 100	> 300	5.5 log

1 – For communities with population less than 10,000, that are triggered based on E.coli sampling the levels are based on running annual average of bi-weekly samples over a one year period.

A recent raw water analysis, conducted July 16, 2009, indicated Giardia level of <1.7 cysts/100L and Cryptosporidium level of <1.7 oocysts/100L. A copy of the complete analysis is included in Appendix C. It is expected that Alberta Environment will require source water monitoring for E.Coli at least every two weeks for a one-year period. Although it is dependant on E.Coli results, it is recommended to sample and test for Giardia and Cryptosporidium in order to help define required log reduction of Giardia and Cryptosporidium.

3.3.4 Historical Log Reduction

Log reductions values for Giardia and Viruses for have been calculated using values for temperature, pH and chlorine residuals as follows:

- Minimum clearwell volume = 273 m^3 (half of maximum clearwell volume)
- Reservoir baffling coefficient = 0.3 (poor)
- Chlorine Residual in clearwell = 0.9 mg/L (average of daily residual level in 2008)
- Temperature = 11 °C (lowest recorded value in 2008)
- pH = 7.72 (average of daily pH in 2008)

- Projected Peak Hour Flow = 1,500 L/min

Table 3.4 summarizes the total estimated log removal credits for Giardia, Cryptosporidium and Viruses based on the raw water analysis results of July 16, 2009. As chlorine is ineffective in Cryptosporidium removal, the log removal achieved is less than the requirement listed in the current Alberta Environment standards. In order to achieve the required minimum 3.0 log removal for Cryptosporidium, an Ultraviolet light disinfection system will be required.

Table 3.4 Total Log Removal Credits for Giardia, Cryptosporidium and Viruses

Water Treatment Process	Log Reduction Credit		
	Giardia	Cryptosporidium	Viruses
Direct Filtration Process	2.5	2.5	1.0
Chlorine Disinfection Process	0.92	0.0	30.0
Log Removal Achieved	3.42	2.5	31.0
Total Log Removal Required	**4.0**	**3.0**	**4.0**

4.0 Projected Population and Water Demands

4.1 POPULATION AND DEVELOPMENT PROJECTIONS

Little Bow Resort currently has approximately 140 developed lots in the resort. The total resort build-out is 252 lots. There is no population data available for the resort.

For the purposes of this evaluation, we have assumed a linear lot development projected over a 20 year period and an average of 3.5 people lot. Table 4.1 summarizes projected population data.

Table 4.1 Projected Population

	Historical Population[1]	Projected Population[1]			
Year	2008	2014	2019	2024	2029
Developed Lots	140	168	196	224	252
Pop.	490	588	686	784	882

1 - Populations assume 3.5 people per lot

4.2 WATER DEMAND DESIGN FLOWS

Water demands from the previous six years were reviewed to determine the historical water demands for the Little Bow Resort. Table 4.2 summarizes the historical water demands from 2003 through 2008.

Table 4.2 Historical Water Demands

Year	Annual Volume[1] (m3)	Average Day Demand (m3)	Population	Average Day Demand (Lpcd)	Maximum Day Demand (m3)	Ave to Max Ratio
2003	61,439	168	414	407	515	3.06
2004	53,991	148	429	345	461	3.12
2005	45,705	125	445	281	450	3.59
2006	54,272	149	460	323	719	4.84
2007	42,861	117	475	247	534	4.55
2008	40,969	112	490	229	489	4.36
Average	49,873	137	-	305	528	3.92

1 – Annual Volume includes Little Bow Resort and Southern Alberta Bible Camp

The ratio of average day demand and maximum day demand is shown. The ratio ranges form 3.06 to 4.84, which is slightly more than typical municipalities in southern Alberta, however, the values are in line with the resort as it can experience a large increase in demand during the summer months. For the purpose of demand projections, the average value over the previous six years, 4.46, has been used.

Table 4.3 summarizes projected design demand flows at the ultimate build-out of the resort.

Table 4.3 Projected Design Flows

Scenario	Design Flow (m^3/day)	Design Flow (l/s)
Distribution Design Flows		
Average Day Demand (ADD)	269	3.1
Maximum Day Demand (MDD)	1,055	12.2
Peak Hour Demand	2,110	24.4
Raw Water Design Flows		
Raw Water Design Flow*	1,161	13.4

* The design basis for the raw water design flow is 110% of the projected MDD

4.3 TREATED WATER STORAGE REQUIREMENTS

According to Alberta Environment's Standards and Guidelines for Municipal Waterworks, Wastewater, and Storm Drainage Systems, treated water storage required for any licensed community where the water treatment plant is only capable of satisfying the maximum daily design flow is determined by the following formula:

S = A + B + (the greater of C or D)

Where:

S = Total storage requirement, m^3

A = Fire storage, m^3

B = Equalization storage (25% of projected maximum day design flow), m^3. Equalization storage allows a buffer of storage for the distribution system to operate off of. This storage allows for the minimization of equipment cycling.

C = Emergency storage (minimum of 15% of projected average day design flow), m^3. Emergency storage allows additional storage in the case of emergency.

D = Disinfection contact time (T10) storage to meet CT requirements, m^3

It has been assumed that the disinfection contact time storage is less than the emergency storage requirement.

4.3.1 Fire Storage

Fire storage and fire flow requirements were calculated using the recommendations in the *Water Supply for Public Fire Protection* 1999 Fire Underwriters Survey. Calculations were based on the short method as per Note J. An exposure distance of 3 – 10 metres has been assumed. The required fire flow is 4,000 L/min (1,057 USgpm) for a duration of 1.5 hours.

4.3.2 Total Storage Requirements

The total storage requirements are summarized in Table 4.5. The projected storage requirements exceed the current clearwell capacity by approximately 20%. It may be possible for the resort to utilize the reservoir as an additional source of water in a fire fighting scenario. In discussions with the operator the fire department at Lomond is aware of this and has the proper equipment should the situation arise.

Table 4.5 Potable Water Storage Requirements

	ADD (m^3)	MDD (m^3)	Fire Storage (A) (m^3)	Equalization Storage (B) (m^3)	Emergency Storage (C) (m^3)	Total Storage Required (m^3)	Current Available Storage (m^3)
Little Bow Resort	269	1,055	360	265	36	661	542

5.0 Future Treated Water Quality Goals

5.1 FUTURE TREATED WATER QUALITY GOALS

Presently, the Little Bow Resort waterworks system performs well within its operating approval limits as presented in Table 2.2.

The current license to operate does not have the requirement of disinfection for Giardia cysts inactivation/removal. However, the current (2006) Alberta Environment standard requires that all surface water treatment plants, which have rapid gravity sand filtration and disinfection, achieve a minimum 3-log reduction of Giardia and Cryptosporidium and 4-log reduction of viruses.

In conjunction with this evaluation, an application has been submitted to Alberta Environment to renew the Resort's current License to Operate. The new license will contain the future treatment parameters that must be met. As stated in Section 3, it is expected that Alberta Environment will require source water monitoring for E.Coli at least every two weeks for a one-year period.

Table 5.1 presents a comparison of the existing water treatment plant performance limits and the anticipated limits in the forthcoming approval. It should be noted that required Giardia and Cryptosporidium log reduction will be based on source water monitoring results.

Table 5.1 Anticipated Treated Water Quality Goals

Parameter	Existing Plant Performance	Anticipated Treatment Limits
Giardia reduction	N/A	minimum 4.0 log[1]
Cryptosporidium reduction	N/A	minimum 3.0 log[1]
Virus reduction	N/A	minimum 4.0 log
Turbidity	≤ 0.8 NTU	≤ 0.3 NTU
pH	6.5 to 8.5	6.5 to 8.5
Treated water free chlorine residual (entering the distribution system)	N/A	≥ 0.5 mg/L
Treated water free chlorine residual (random locations in water distribution system)	> 0.1 mg/L	≥ 0.1 mg/L

1 – Treatment Limits based on raw water analysis obtained July 16, 2009

6.0 Upgrade Recommendations

6.1 OVERVIEW

The Little Bow Resort water treatment plant is presently producing and supplying adequate quantity and is providing treatment to conform to its license requirements and the water quality meets the Canadian Drinking Water Guidelines. However, the plant will be required to meet the current Alberta Environment standards when the License to Operate is renewed.

The following sections summarize the recommended upgrades for the water supply and treatment process upgrading options. Opinions of probable costs are included in Section 7.

6.2 WATER SUPPLY UPGRADES

6.2.1 Raw Water Diversion License

The current license for the Little Bow Resort and the Southern Alberta Bible Camp allows a combined gross annual diversion of up to 54,300 m^3 (45 acre-feet). The raw water demand projections indicate additional diversion license will be required. The resort should initiate the process of obtaining additional license allocations to accommodate growth to the anticipated build-out of the resort.

6.2.2 Raw Water Pumping

The existing raw water pump should be replaced in addition to installing a second raw water pump in order to meet Alberta Environment standards which states that pump capacities should be such that with the largest pump out of service, the remaining pump(s) will be able to supply the treatment plant capacity. The pumps should also be installed with variable frequency drives. This will allow the speed of the pumps to increase or decrease depending on the level in the reservoir. The second raw water pump should in a similar precast concrete manhole similar to the existing pump manhole.

6.3 TREATMENT PROCESS UPGRADE OPTIONS

6.3.1 Existing Treatment Plant Process

The existing water treatment process consists of an inline filtration process which is chemical coagulation followed by rapid gravity sand filters. In order for the plant to receive Giardia and Cryptosporidium reduction credits, the plant would require flocculation after chemical coagulation and prior to the filters, known as direct filtration. Alberta Environment has indicated through preliminary discussions that they may consider the option of allowing the plant to continue as an inline filtration plant as historical treatment records indicate the current treated

water quality is meeting the projected treatment requirements. Continued water quality monitoring would be required to document the plant performance for this option to be considered and further discussion would be required. In this instance, UV disinfection would still be required to meet log reduction requirements of Giardia and Cryptosporidium.

6.3.2 Treatment Process Improvements

6.3.2.1 Ultraviolet Disinfection

Ultraviolet disinfection (UV) is effective for inactivation of Giardia and Cryptosporidium. Based on the evaluation of the plant UV Disinfection will be required to achieve the required log removal for cryptosporidium removal.

6.3.2.2 Sodium Hypochlorite Feed System

The existing system of Calcium Hypochlorite tabs should be replaced with a sodium hypochlorite (chlorine) feed system. The feed pump will supply a constant flow of chlorine solution to the filtered water after UV disinfection and prior to entering the clearwell.

6.3.2.3 Instrumentation

The following instrumentation will be required to continuously monitor and record various parameters in the plant in order to meet current Alberta Environment Standards:

- Turbidimeters: turbidimeters will be installed to monitoring raw water turbidity prior to treatment and downstream of each filter.
- Chlorine Analyzer: the free chlorine residual will be continuously monitored prior the treated water entering the distribution system. The analyzer will also record pH and temperature to assist in the calculation of CT values.
- Magnetic Flow Meters: flow meters will display flow and total flow for raw water entering the treatment plant and treated water flows exiting the plant.
- Level Transmitter: the water level in the clearwell will be monitored to assist in the calculation of CT values.

6.3.2.4 Electrical

The following electrical system upgrades should be considered to improve the reliability of the services provided by the water treatment plant:

- A 50kW, diesel fuel emergency generator complete with automatic transfer switch should be installed to allow all plant processes to continue in the event of a power failure. Space exists to install the generator in the portion of the water treatment plant

currently being used as a storage area. The generator would be walled off for safety reasons and outfitted with a 50 gallon, double walled, above ground diesel tank.

6.3.2.5 Supervisory Control and Data Acquisition (SCADA)

A full SCADA system will be required to allow for remote monitoring and operation of the water treatment plant. The SCADA system would replace the existing on-site PLC based control panel. Monitoring and operation functions would be performed either on-site or remotely via a web-based browser or Local Area Network connection. The SCADA system would be complete with an auto-dialer to communicate alarm notifications to the water treatment plant operator.

6.3.2.6 Communication

Due to the lack of cellular communications coverage in the area, the water treatment plant operator should be provided with a pager to receive alarm notifications.

6.3.2.7 Process Upgrades

Two upgrading alternatives have been identified to meet current Alberta Environment standards, while optimizing the use of the existing infrastructure where possible. The alternatives are as follows:

- Alternative 1: Existing Inline Filtration and UV Disinfection
- Alternative 2: Direct filtration process and UV Disinfection

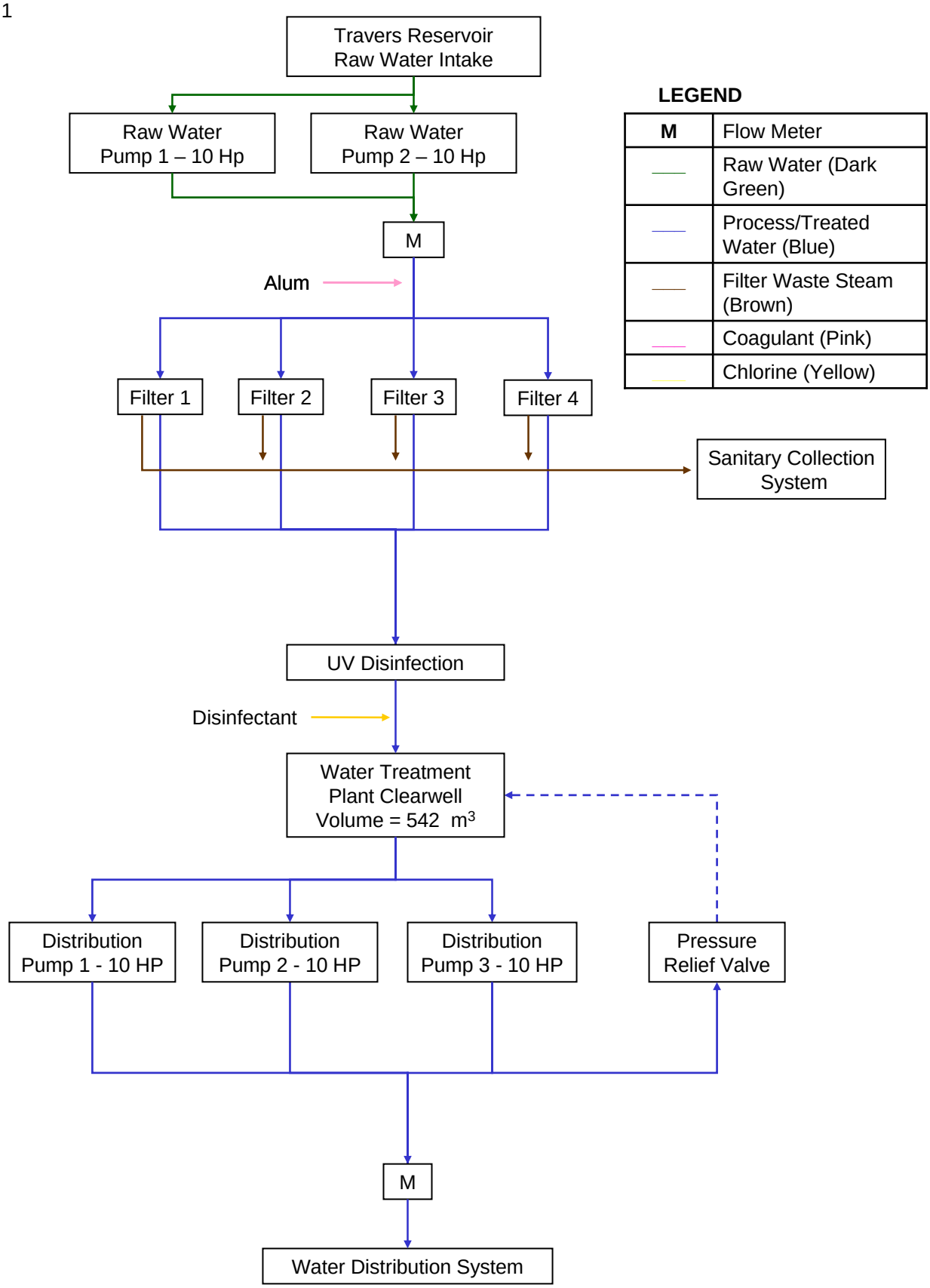
6.3.2.7.1 Alternative 1 – Existing Inline Filtration and UV Disinfection

As stated above, this alternative would require approval of Alberta Environment as it would require maintaining the current inline filtration process, without flocculation.

This alternative includes the addition of air scour to the backwash process in order to improve the efficiency of the filters, resulting in a decrease of the frequency of backwashes and in use of treated water for the process. One positive displacement blower with a sound enclosure will deliver the required volume of air to each filter during the air scour cycle. The existing filter media would be removed and replaced with an optimized angular sand and filter anthracite. Filter media replacement is recommended due to the age and expected condition of the existing media. UV disinfection will be incorporated with the upgraded chlorination system to provide the required log reductions.

Figure 6.1 provides a simple process flow diagram of this alternative.

Little Bow Resort – Alternative 1 Process Flow Diagram
Figure 6.1



6.3.2.7.2 Alternative 2 – Direct Filtration and UV Disinfection

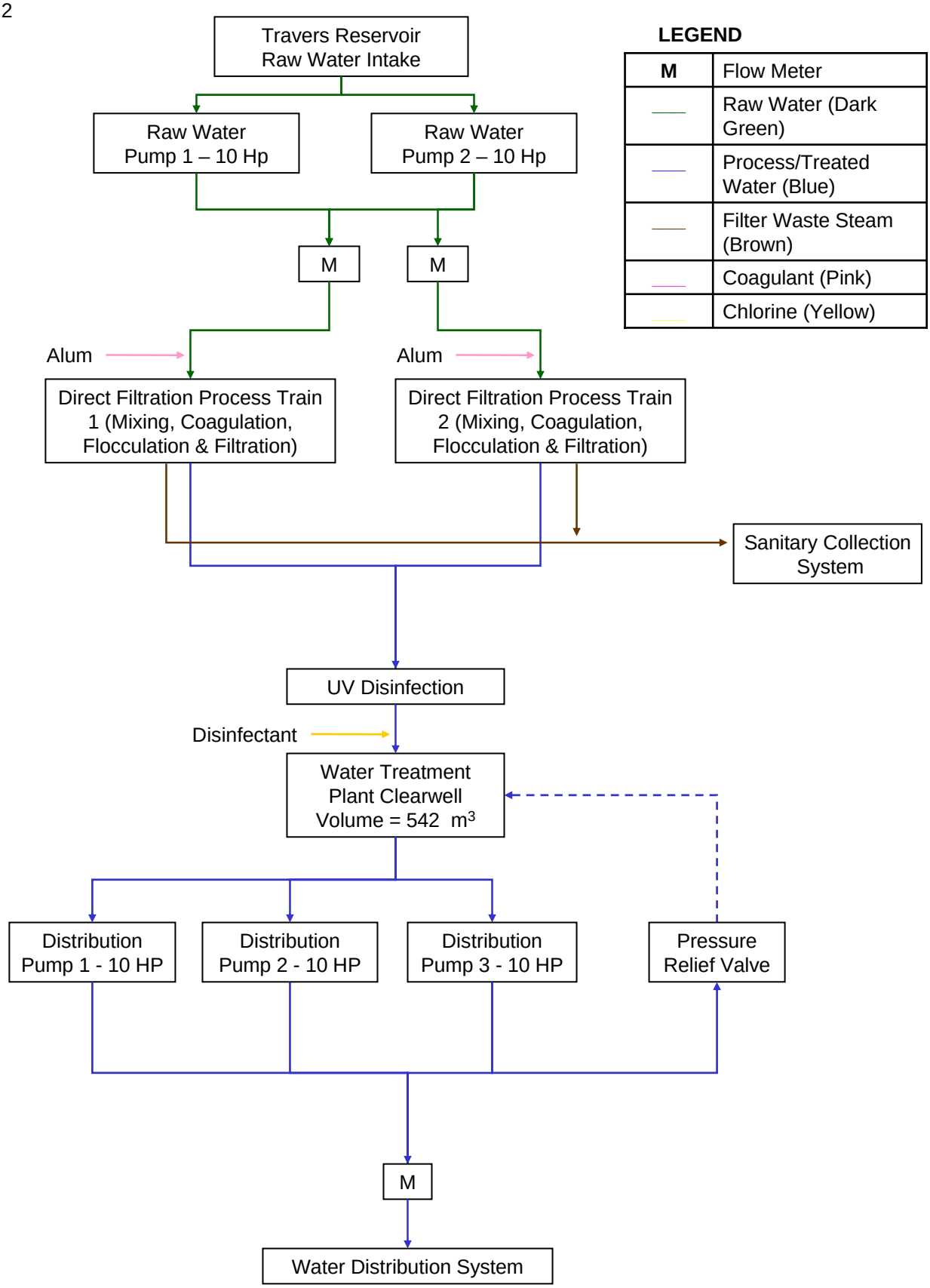
This alternative would require the replacement of the current inline filtration system with a pre-packaged direct filtration system. The package will include two process trains with the following items:

- Inlet flow control valve
- Raw water magnetic flow meter
- Static mixer for addition of coagulant
- Two stage mechanical flocculation
- One dual media, rapid gravity filter
- Backwash pump
- One air scour blower
- Chemical systems
    - PAC as primary coagulant
    - Polymer flocculation aid

UV disinfection will be incorporated with the upgraded chlorination system to provide the required log reductions. The piping arrangement leading to the plant as well as interior process piping changes will be required to accommodate the direct filtration system and associated components.

Figure 6.2 provides a simple process flow diagram of this alternative.

Little Bow Resort – Alternative 2 Process Flow Diagram
Figure 6.2



7.0 Opinion of Probable Costs

This section presents **conceptual** cost estimates (± 50%) for capital costs associated with the construction of recommended treatment plant upgrades as described in the previous sections for each alternative.

Due to the conceptual nature of this study and understanding that unknown variables exist beyond the scope of this study, the cost estimates presented include a contingency allowance of 15% and an engineering allowance of 12% of the total estimated capital costs. These factored level capital cost estimates should be considered realistic, but preliminary and are intended to give an order of magnitude opinion of estimated costs for planning and feasibility purposes only.

No detailed specifications, process flow diagrams or construction drawings have been developed or assessed to obtain "preliminary design level" cost estimates. *Stantec Consulting Ltd. does not guarantee the accuracy of this opinion of probable cost. The actual cost of the project will be determined through the bidding and construction process.* Costs were based on recent material pricing information received from suppliers and estimates of installation and construction costs from similar projects, updated based on information received from Contractors regarding the 2008 construction season.

Table 7.1 provides a summary of the probable cost analysis. Details for each cost estimate are provided in **Appendix B.**

Table 7.1 Opinion of Probable Cost Summary

Alternative	Capital Cost[1]
1 – Inline Filtration with UV Disinfection	$744,500
2 – Direct Filtration with UV Disinfection	$1,168,500

1 – Costs includes Contingency Allowance and Engineering Fees

8.0 References

"*Little Bow Resort Raw Water Supply Study*", MPE Engineering Ltd., February 2008

"*Standards and Guideline for Municipal Waterworks, Wastewater and Storm Drainage Systems*", Alberta Environment, January 2006.

"*Water Supply for Public Fire Protection*", Fire Underwriters Survey, 1999

"*Little Bow Resort Inc. Lift Station and Water Intake and Plant*", Issued For Construction, 1993

9.0 Conclusions and Recommendations

9.1 CONCLUSIONS

9.2 RECOMMENDATIONS

10.0 Corporate Authorization

Appendix A – Alberta Environment Approval and Water Act Licenses

Appendix B – Opinion of Probable Cost Details

OPINION OF PROBABLE COST

ALTERNATIVE 1 - INLINE FILTRATION WITH UV DISINFECTION

Stantec

PROJECT : Little Bow Resort Water Treatment Plant Upgrade Evaluation

CLIENT : Condominium Corporation No. 9311680 o/a Little Bow Resort

JOB No : 112944875

DATE : September 17, 2009

File Number : V:\1129\active\112944875\design\estimate\[prelim design estimate_draft_20090917.xls]Alternative 1

	ITEM	UNIT	TOTAL QUANTITY	UNIT RATE	AMOUNT
A. WATER SUPPLY AND TREATMENT PROCESS UPGRADES					
A1	Mobilization / Demobilization / Contractor Profit	LS	1	75,000.00	75,000.00
A2	Raw Water Pump w/ VFD's	ea	2	25,000.00	50,000.00
A3	Raw Water Pump Chamber	LS	1	25,000.00	25,000.00
A4	Air Scour Addition w/ Filter Media Replacement	LS	1	100,000.00	100,000.00
A5	UV Disinfection System	LS	1	125,000.00	125,000.00
A6	Online Instrumentation				
	a) Turbidimeter	ea	5	6,000.00	30,000.00
	b) Chlorine, pH, Temperature Analyzer	ea	1	7,500.00	7,500.00
	c) Magnetic Flow Meter	ea	2	5,000.00	10,000.00
	d) Level Transmitter	ea	1	5,000.00	5,000.00
A7	Sodium Hypochlorite Feed System	LS	1	15,000.00	15,000.00
A8	Process Piping Modifications	LS	1	25,000.00	25,000.00
A9	Back-up Generator	LS	1	50,000.00	50,000.00
A10	Building Modifications	LS	1	20,000.00	20,000.00
A11	SCADA	LS	1	20,000.00	20,000.00
A12	PLC Programming	LS	1	20,000.00	20,000.00

SUB-TOTAL	577,500.00
CONTINGENCY (15%)	87,000.00
ENGINEERING (12%)	80,000.00
TOTAL A - WATER SUPPLY AND TREATMENT PROCESS UPGRADES	**$744,500.00**

OPINION OF PROBABLE COST

ALTERNATIVE 2 - DIRECT FILTRATION WITH UV DISINFECTION

Stantec

PROJECT : Little Bow Resort Water Treatment Plant Upgrade Evaluation

CLIENT : Condominium Corporation No. 9311680 o/a Little Bow Resort

JOB No : 112944875

DATE : September 17, 2009

File Number : V:\1129\active\112944875\design\estimate\[prelim design estimate_draft_20090917.xls]Alternative 2

	ITEM	UNIT	TOTAL QUANTITY	UNIT RATE	AMOUNT
A. WATER SUPPLY AND TREATMENT PROCESS UPGRADES					
A1	Mobilization / Demobilization / Contractor Profit	LS	1	100,000.00	100,000.00
A2	Raw Water Pump w/ VFD's	ea	2	25,000.00	50,000.00
A3	Raw Water Pump Chamber	LS	1	25,000.00	25,000.00
A4	Pre-Packaged Direct Filtration Plant	LS	1	400,000.00	400,000.00
A5	UV Disinfection System	LS	1	125,000.00	125,000.00
A6	Online Instrumentation				
	a) Chlorine, pH, Temperature Analyzer	ea	1	7,500.00	7,500.00
	b) Magnetic Flow Meter	ea	1	5,000.00	5,000.00
	c) Level Transmitter	ea	1	5,000.00	5,000.00
A7	Process Piping Modifications	LS	1	50,000.00	50,000.00
A8	Back-up Generator	LS	1	50,000.00	50,000.00
A9	Building Modifications	LS	1	30,000.00	30,000.00
A10	SCADA	LS	1	30,000.00	30,000.00
A11	PLC Programming	LS	1	30,000.00	30,000.00

SUB-TOTAL	907,500.00
CONTINGENCY (15%)	136,000.00
ENGINEERING (12%)	125,000.00
TOTAL A - WATER SUPPLY AND TREATMENT PROCESS UPGRADES	**$1,168,500.00**

Appendix C – Raw Water Analysis