4. WASTEWATER TREATMENT SYSTEM

4.1 Capacity of Existing Lagoons

The Capacity of existing lagoon system is evaluated for future demand based on the following requirements.

Existing Lagoons

- Anaerobic cells - Four Cells, Capacity of each cell 2680 m3
- Facultative cells - One cell 78,800 m3 Capacity
- Storage cells - One cell 462,700 m3 Capacity

Retention time required at Average day flow[12]

- Anaerobic cell 2 days each cell
- Facultative cell 60 days
- Storage cell 365 days

The Capacity of lagoon required for future flows is provided in the following table

Table 4.1 Lagoon Capacity

Retention time for anaerobic cell 2 days @ Average day demand (2 days WWF)
Retention time for Facultative cell 60 days @ Average day demand (60 days WWF)
Retention time for Storage cell 365 days @ Average day demand (305 days DWF and 60 days WWF)

Year	DWF	WWF	Anaerobic Cell		Facultative Cell		Storage Cell	
			Capacity reqd.	Surplus/ (Deficient)	Capacity reqd.	Surplus/ (Deficient)	Capacity reqd.	Surplus/ (Deficient)
	m3/day		m3	m3	m3	m3	m3	m3
2007	542	1,215	2,431	249	72,925	5,875	238,083	224,617
2012	1108	1,938	3,875	-1,195	116,262	-37,462	454,125	8,575
2017	1384	2,346	4,692	-2,012	140,748	-61,948	562,807	-100,107
2027	2084	3,378	6,755	-4,075	202,650	-123,850	838,331	-375,631
Ultimate	20312	30,479	60,958	-58,278	1,828,736	-1,749,936	8,023,934	-7,561,234

[12] Alberta Environment Standards and Guidelines for municipal works

As shown in the above table, the Anaerobic cells, the Facultative cell and the Storage cell may reach their capacity before 2012 and need to be upgraded to provide the additional volume to satisfy the retention time requirements of Alberta Environment.

Four basic options to expand the Town's sewage treatment capabilities were examined as noted in the following sections. Each has its own advantages and disadvantages.

4.2 Option 1 Expand Existing Lagoon System

Option 1 involves expanding existing lagoons to provide the required retention time as per the Alberta Standards and Guidelines for Municipal Works. A summary of footprint (area) required for a conventional lagoon expansion is provided in Table 4.2

Table 4.2 Area Required for Lagoon expansion (ha)

Year	Population	Area Required
2007	2,178	0
2012	2,650	12
2017	3,072	19
2027	4,128	37
Ultimate	43,575	516

Expanding the existing lagoons requires an additional area of approximately 37 ha for the 20 year planning horizon (2027) and approximately 516 ha for the ultimate full build scenario. Lagoon expansion is not a feasible solution in the Ultimate scenario as the land requirement is too large. Lagoon expansion is possible in the 20-year horizon however issues such as land acquisition, set back requirements, environmental impact etc. need to be considered.

4.3 Option 2 Aerated Lagoon System

Various technology options were evaluated for converting the existing lagoon system to an aerated system. There have been a number of successful Aerated Lagoon conversions in similar small sized communities across Alberta. We looked at various aeration technologies and received a specific proposal from Nelson Environment for conversion of the existing lagoon system (Appendix E).

The advantages of using the proposed aeration system are as follows:

- Alberta Environment has already given approval at Clairmont for this system and they are familiar with the technology and performance.

- The operators at Aquatera are also familiar with this system and it is beneficial from operations and maintenance point of view to have similar systems replicated. It is economical from the point of view of maintaining critical spares for emergency.

- It requires no major upgrade or capital work on the existing lagoon. The aeration system however requires additional operational and maintenance expenses compared to the conventional systems but they are minimal compared to a typical mechanical treatment plant.

Converting the existing system into an aerated system requires increasing the frequency of discharge. A discharge frequency of twice a year would be required as a minimum under this scenario and this needs to be agreed with the Alberta Environment. We discussed this issue with Alberta Environment and it appears that a twice a year discharge with six months storage capacity could be an acceptable solution.

Currently the lagoons are discharged once in a year. The storage cell has six months storage capacity for the 2017 projected population. However, additional storage capacity is required as the population grows towards the 2027 level as shown in the following table:

Table 4.3 Six months storage capacity - Aerated Lagoon (m3)

WWF Days	60
DWF Days	123

Year	DWF	WWF	Capacity reqd.	Surplus/ (Deficient)
	m3/day		m3	m3
2007	542	1,215	139,530	323,170
2012	1108	1,938	252,515	210,185
2017	1384	2,346	310,955	151,745
2027	2084	3,378	459,007	3,693
Ultimate	20312	30,479	4,327,127	-3,864,427

4.4 Option 3 Mechanical Treatment Plant

There are a variety of mechanical treatment systems that would suit a community the size of Sexsmith. Mechanical treatment can be an ideal solution where land is limited or where there is a continuously flowing stream to receive the treated effluent. Such systems could be built in a modular fashion so that the initial mechanical plant will be designed to suit demand until 2012 and subsequent modules added to meet the next 10 year demand. There are several technology options available. Some popular technology options are listed here:

- Conventional Activated Sludge plant. These are generally suited for larger plants and normally used on schemes where nutrient removal is required. They have high capital and operating and maintenance cost.

- Solar Aquatics technology. This treatment system uses aquatic plants housed in a green house to treat the sewage flow. There are examples of such project implementation on Eastern Canada. They can also serve as a tourist attraction and provide an Eco friendly environment. However the technology has not been proven in Alberta and the performance of the treatment plant in the harsh winter conditions of Alberta is unknown. In the Grande Prairie region, there are green houses but they generally are not operational during the winter due to the high energy cost associated with maintaining the temperature for the plants to survive. The operational cost of this plant may outweigh the environmental benefits provided by the natural system.

- Membrane Bio Reactor. An MBR is a system that utilizes a single complete mix reactor in which all the steps of the activated sludge and biological nutrient removal process occur with a membrane filter system submerged in the reactor. The quality of effluent produced by the MBR system is very good and this technology is generally accepted as a preferred option for effluent recycle/ re-use.

- Sequencing Batch Reactor. An SBR cell is a fill-and-draw reactor system that utilizes a single complete mix reactor in which all the steps of the activated sludge process occur. The SBR plant produces a good quality effluent suitable for smaller communities.

The main disadvantage with a mechanical system is the high operating cost and the requirement for a continuous discharge. Alberta Environment Standards and Guidelines for Municipal works -Section 3.1.4 states the following in relation to discharge of final effluent:

> *Continuous discharge of effluent from treatment plants to a receiving watercourse shall be permitted if the recorded minimum mean monthly watercourse flow is ten times the total average daily discharge of treated effluent, and receiving water assessment indicates that there are no appreciable water quality impacts. However, if it can be demonstrated with a high level of certainty that no appreciable water quality impacts are projected to occur at 10:1 dilution, then discharge may be permitted at less than 10:1 dilution*

The current lagoon discharges in to a small creek which has no flow in the winter and hence it does not offer any dilution. In order to obtain continuous discharge consent with a less than 10:1 dilution, advanced treatment systems will be necessary to polish effluent quality. Such treatment plants would have high capital and operating costs. The treatment plant also requires continuous monitoring of the final effluent. It is also possible that Alberta Environment would impose “Water quality based Effluent limits” as opposed to the current effluent standards based on “Best Practicable Technology Standards”. In this case, a detailed study of the hydrology and water quality of the water bodies in the surrounding area would be required to satisfy Alberta Environment. Without a detailed study of the watercourses for suitability of discharge, an approval from Alberta Environment is unlikely.

For the purpose of costing the mechanical treatment plant option, an MBR plant was selected since the quality of effluent produced by an MBR plant is very good and continuous discharge at Sexsmith has some possibility of being acceptable. If continuous discharge is possible at Sexsmith then the mechanical treatment plant option is the most viable solution. It is recommended that Aquatera carry out a pilot study of a mechanical treatment plant (preferably an MBR plant with UV disinfection) to evaluate the impact of the final effluent on the receiving watercourse.

4.5 Option 4 Pipeline to Grande Prairie

If continuous discharge at Sexsmith is not feasible then the final effluent need to be discharged to a suitable water course where 1in 10 dilution is possible. The nearest major water body is the Wapiti River at Grande Prairie. This would involve constructing approximately 30Km of pipeline to Grande Prairie and pumping raw sewage to the Grande Prairie Sewage Treatment plant. The cost of upgrading the Sewage Treatment Plant at Grande Prairie also needs to be considered but this cost has not been included in this report. In a regional system the existing lagoons could be used as a balancing tank to stabilise the inflow to the pumping station and to reduce the diameter of the force main to Grande Prairie.

4.6 Discussion & Conclusion

The existing lagoon system is inadequate to service the projected Wastewater flows to the end of the 5-year development phase (2012). There is a need to start planning to upgrade the existing lagoon facilities.

Conventional Lagoon expansion is not feasible in the long run as it requires a large land area for expansion. This creates constraints such as availability of additional land for procurements, set back requirements, environmental constraints and buy-in from the local community.

Conversion of the existing lagoon to an aerated lagoon appears to be the most cost-effective option up to 2027. Around 2022 planning should be started on how best to handle the next expansion. If aerated lagoons continue to be the selected sewage treatment process then additional storage capacity will be required in order to continue to provide six months storage. This will create the same constraints as with the conventional lagoon system, such as: land availability, set back requirements, environmental constraints, etc.

The mechanical treatment option requires continuous discharge, and the lack of a watercourse in the immediate vicinity to offer sufficient dilution poses severe constraint in obtaining approval for a mechanical treatment plant proposal.

A regional approach may prove to be the most cost effective and viable option for the Ultimate Phase development. This would involve construction of a pipeline from Sexsmith to Grande Prairie. Such a regional system should not be looked at in isolation and it should also include Clairmont. It would be unrealistic to plan for the ultimate (full build out) scenario at the present time and the Town should adopt a staged approach of option evaluation.

In conclusion it appears that upgrading to an aerated lagoon system with discharge twice a year is the best way to go to provide the short to medium term sewage treatment solution. As the aerated lagoon reaches capacity as confirmed by actual measured flows, Aquatera and the Town can determine the best way forward at that time. Currently the regional approach appears to be the best long-term option but this should re-examined again in 10 years time.