EarthTech
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Final Report

Town of Edson Lagoon Assessment

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INTRODUCTION

The Town of Edson, located approximately 200 km west of Edmonton along the Yellowhead highway, operates a continuous discharge lagoon system that discharges into the McLeod River. Since January 2007, the Town has reported nine discharge contraventions to Alberta Environment as the result of exceeding their effluent CBOD limit of 25 mg/L. There is no limit for TSS. In June 2007, the Town of Edson retained Earth Tech to undertake a capacity assessment of the existing system. In particular, the goals of this study were to:

- Confirm the current treatment capacity of the existing system;
- Investigate the possible reasons for effluent CBOD limit exceedances experiences recently;
- Determine what upgrades would be required to meet a future design population of 15,000;
- Provide a cost estimate for any recommended upgrades.

This report addresses these issues with the aim of providing the Town of Edson sufficient information so that they may discuss with Alberta Environment the timing and extent of works to upgrade or expand the existing lagoon system, if required, as the current Approval will expire in October 2007.

CAPACITY ASSESSMENT

The existing lagoon system is comprised of anaerobic cells and storage ponds from the original plant and aerated cells from the 1983 upgrade. The 1983 upgrade was reportedly designed for flows of 4863 m^3/d. Typically, lagoon systems do not have both anaerobic and aerobic treatment for municipal sewage.

In general, the Town has indicated that the lagoon system works well. The blowers are refurbished regularly and only some of the valves on the aeration header or sections of header need upgrades or replacement.

Existing System Capacity

The capacity of the existing system was undertaken using a model calibrated with historical data and ensuring the sizing of the various cells met Alberta Environment Guidelines. The findings of the capacity assessment can be summarized as follows:

- The existing anaerobic cells do not provide sufficient hydraulic retention time and are not deep enough to ensure anaerobic conditions. Their current greatest benefit to the system is flow equalization.
- The aerobic cells can theoretically treat up to 4000 m^3/day winter max month flow and 6500 m^3/day summer maximum month flow and meet the effluent CBOD concentration of 25 mg/L. These flows would represent equivalent populations of 9500 and 11000 and based on the current population projections, these populations should be reached in 2009 and 2014 respectively. At this flow rate, the hydraulic retention time (HRT) falls within typical ranges, 5-30 days per cell. However, the BOD loading rate during summer maximum month (814 kg/ha/d) exceeds the typical range of 100-600 kg/ha/d. If the BOD loading rate were reduced to within the typical range, then the flow capacity of the system would be reduced to 4900 m^3/d in the summer months. Based on current flows, this means that the existing lagoon system is very close to or at capacity now.
- The existing Storage Pond 3, originally used as part of a yearly discharge lagoon system, provides well over the required 5-day HRT required for an aerobic system. Based on current flows, the HRT ranges from 43 to 64 days for winter and summer flows.
- The existing lagoon system, as it is currently configured, would not be able to treat flows equivalent to a population of 15,000.
- The capacity of the existing 400 mm PVC pipe to the aeration cells pipe is approximately 11,000 m^3/d, based on a minimum slope of 0.3%. The capacity of the existing effluent line to the river consisting of a 400 mm section and a 450 mm section is approximately 9,500 m^3/d. Consequently, these lines will either have to be twinned or upgraded once these flows are reached. However, the flows will likely not be reached until the population is approximately 15,000 to 16,000 people, projected to be around 2023

Contraventions

In reviewing the historical data provided by the Town and in particular the contraventions which exceeded the CBOD effluent limit of 25 mg/L, the following observations were made:

- The contraventions occurred from mid-January to mid-April 2007.
- Between January and April 2007, TSS concentrations and loading rates were between three and five times greater than during the same period in 2006 whereas BOD influent concentrations remained stable and the BOD loading rates actually decreased.
- In January 2006 the collection system was flushed. At that time, the TSS loading did not reach the levels noted in the winter the following year. In addition, the impact on the CBOD effluent was minimal.

- Of the three parameters, flow, influent BOD and influent TSS, the effluent CBOD concentrations seems to follow the TSS pattern the most closely during the winter of 2007.
- During all other periods of time, the system seems to be able to react well to short term spikes in flow, TSS and influent BOD and combinations thereof.

In summary, it is suspected that something was being discharged into the collection system which caused the extremely high TSS but which did not impact BOD loading. These suspended solids likely also had an impact on the biological activity and consequently treatment capacity of the lagoons as this occurred during the coldest month of the year. This could be the result of a short-term construction project or other short-term activity. As the TSS fell to within normal levels in April 2007, the final effluent CBOD was quickly re-established to below the limit of 25 mg/L.

Based on the above, it is believed that the existing lagoon system does work well and that the recent contraventions were due to a specific discharge into the collection system.

System Expansion Requirements

Based on the modeling results, the existing lagoon system capacity would not be able to treat flows for an equivalent of 15,000 people. Consequently, more significant upgrades will be required to meet these flows.

It is proposed to reconfigure existing Storage Pond 3 using baffle curtains into a completely mixed zone, a partially aerated zone and a polishing zone that would be common for both aerated trains. Thus, one common discharge location would be maintained and the current short-circuiting from the aerobic effluent to the final discharge minimized. The two aerated trains would be of equal size to facilitate flow splitting.

In addition to dividing the existing Storage Pond 3, the aeration system capacity would have to be increased in size and additional structures would likely be required for flow splitting.

COST ESTIMATE

The cost estimate for the required upgrades to double the existing capacity to approximately 9, 600 m^3/d maximum summer flow, or an equivalent population of 16,500, is in the order of \$2 million including engineering fees and a fifty percent construction contingency due to the current market conditions.

TOWN OF EDSON
LAGOON ASSESSMENT
DETAILED REPORT

1.0 INTRODUCTION

1.1 Purpose of the Study

The Town of Edson, located approximately 200 km west of Edmonton along the Yellowhead highway, operates a continuous discharge lagoon system that discharges into the McLeod River. Since January 2007, the Town has reported nine discharge contraventions to Alberta Environment as the result of exceeding their effluent CBOD limit of 25 mg/L. There is no limit for TSS. In June 2007, the Town of Edson retained Earth Tech to undertake a capacity assessment of the existing system. In particular, the goals of this study are to:

- Investigate the possible reasons for effluent CBOD limit exceedances experiences recently;
- Confirm the current treatment capacity of the existing system;
- Determine what upgrades would be required to meet a future design population of 15,000;
- Provide a cost estimate for any recommended upgrades.

This report addresses these issues with the aim of providing the Town of Edson sufficient information so that they may discuss with Alberta Environment the timing and extent of works to upgrade or expand the existing lagoon system, if required, as the current Approval will expire in October 2007.

2.0 BACKGROUND

2.1 Plant Layout

The original lagoon system (pre-1983) consisted of four treatment cells (anaerobic and facultative cells); and three storage cells, Ponds 1, 2 and 3. Wastewater flowed sequentially through treatment Cells Nos. 1 to 4 located in the north west corner of the property and then sequentially through Storage Ponds 1 to 3, located west to east, along the south end of the property. Provisions were provided in the treatment cells to by-pass Cell 1, Cell 2 and Cell 4, if required. Final discharge to the McLeod River was located in the south east corner of Storage Cell No. 3. Refer to **Figure 2.1** for a plan view of the lagoon system – which also depicts the 1983 upgrades described below.

In 1983, the lagoon system was upgraded to accommodate the growing population as follows:

- The existing treatment cells were designated as anaerobic cells, Cells No. 1 to 4.

- Two aerobic cells, Aerobic Cell No. 1 and 2, were added in the north east corner of the property along with a blower house housing two duty and one standby blower which provide air to the submerged aeration system.

- The gravity discharge to the McLeod River was relocated from the south east corner of Storage Pond No. 3 to the north east corner of Storage Pond No. 3, in close proximity to the discharge from Aerobic Cell No. 2 into Storage Pond No. 3.

- Various connecting structures were added to allow for redirection of flow and by-pass of cells for maintenance purposes.

- The wastewater was to be directed from the anaerobic cells to the aerated cells to Storage Pond 3 before being discharged to the river.

2.2 Current Operation

Currently, the system is operated as described in the following paragraphs. Flow enters the facility at the west end of the property were flow is measured using a Parshall Flume. Influent samples are also taken at this location, Sample Location No. 1. Flow is then directed to Anaerobic Cells 1 and 2, connected in parallel. These cells both discharge into Anaerobic Cell 3. From Structure No. 1 at the end of Anaerobic Cell No. 3, wastewater is directed to the aerobic lagoon cells via a 400 mm diameter steel pipe.

Wastewater enters the south end of the Aerobic Cell No. 1 and discharges at the north end of the cell into a 450 mm diameter pipe which has several outlet structures into Aerobic Cell No. 2. Under normal operating conditions, discharge into Aerobic Cell No. 2 is via Structures No. 4, 5 and 6. The submerged aeration system was designed such that Aerobic Cell No. 1 receives approximately seventy percent (70%) of the air flow and Aerobic Cell No. 2 receives approximately thirty percent (30%) of the air flow; these cells are considered completely mixed and partially mixed, respectively. Two duty blowers and one standby blower located in a blower house at the south west corner of Aerobic Cell 1 provide the required air for the aerobic cells.

Aerated Cell No. 2 discharges into Storage Pond No. 3 via Structure No. 8. Structure No. 8 is located along the north east portion of the Storage Pond berm. The new discharge into the McLeod River is located in the north east corner of Storage Pond No. 3, likely allowing for short-circuiting of the pond. The river outfall line is a 400 mm diameter line. Refer to **Figure 2.1**.

2.3 Plant Design Capacity

According to the excerpts of the design manual provided to Earth Tech by the Town of Edson, the upgraded plant was designed to treat 4863 m^3/d (1.07 MIGD), equivalently approximate to a population of 10,500, and provide a final effluent capable of meeting the 25 mg/L CBOD effluent requirement. At this design population, it was intended that two blowers run continuously with a third blower on standby. The hydraulic retention time (HRT) in the various cells was provided in the design manual. However, since Anaerobic Cells No. 1 and 2 are run in parallel and Anaerobic Cell No.3 appeared to be larger than the other cells, the hydraulic time was recalculated based on current operation and cell sizes. The cell volumes along with design and calculated hydraulic retention times are summarized in **Table 2.1** below.

Table 2.1 Hydraulic Retention Time at a Design Flow of 4863 m3/d

	Anaerobic Cell No. 1	Anaerobic Cell No. 2	Anaerobic Cell No. 3	Aerobic Cell No. 1	Aerobic Cell No. 2	Storage Pond No. 3
Volume, m^3	1,735	2,360	3,700	43,830	79,140	223,490
HRT, days original report	1.2	1.2	1.2	9.5	17.0	27.0
HRT, days calculated	0.36	0.49	0.76	9.0	16.3	46.0

Based on the calculated HRT, the total retention time in the lagoons is 73 days at a flow of 4863 m^3/d (1.07 MIGD) which is more than sufficient.

2.4 Current Maintenance Program

The Town provided information on the historical and current maintenance requirements for the lagoons system which is summarized below.

2.4.1 Lagoons

According to the Town, since the 1983 upgrade to the lagoon system, the lagoons have been desludged as follows:

- The anaerobic cells have been desludged two or three times since 1983, most recently in September 2006; the sludge was relocated to one of the two original ponds for drying
- Aerobic Cell No. 1 and 2 have not been desludged since being built in 1983
- Storage Pond No. 3 has not been desludged since at least 1983

2.4.2 Blowers

The three existing blowers are Gardner Denver blowers, Model 7CDL17, which operate in a two duty and one standby configuration. During the site visit, it was noted that the discharge pressure on the blowers is approximately 40-42 kPa and they run at 3600 rpm. There was no discernable information regarding blower size on the name plate. The blower capacity was estimated to be 4080 m^3/hour per blower, (2400 cfm) based on typical blower curves provided by WestRon and the power requirements is approximately 56 kW per blower.

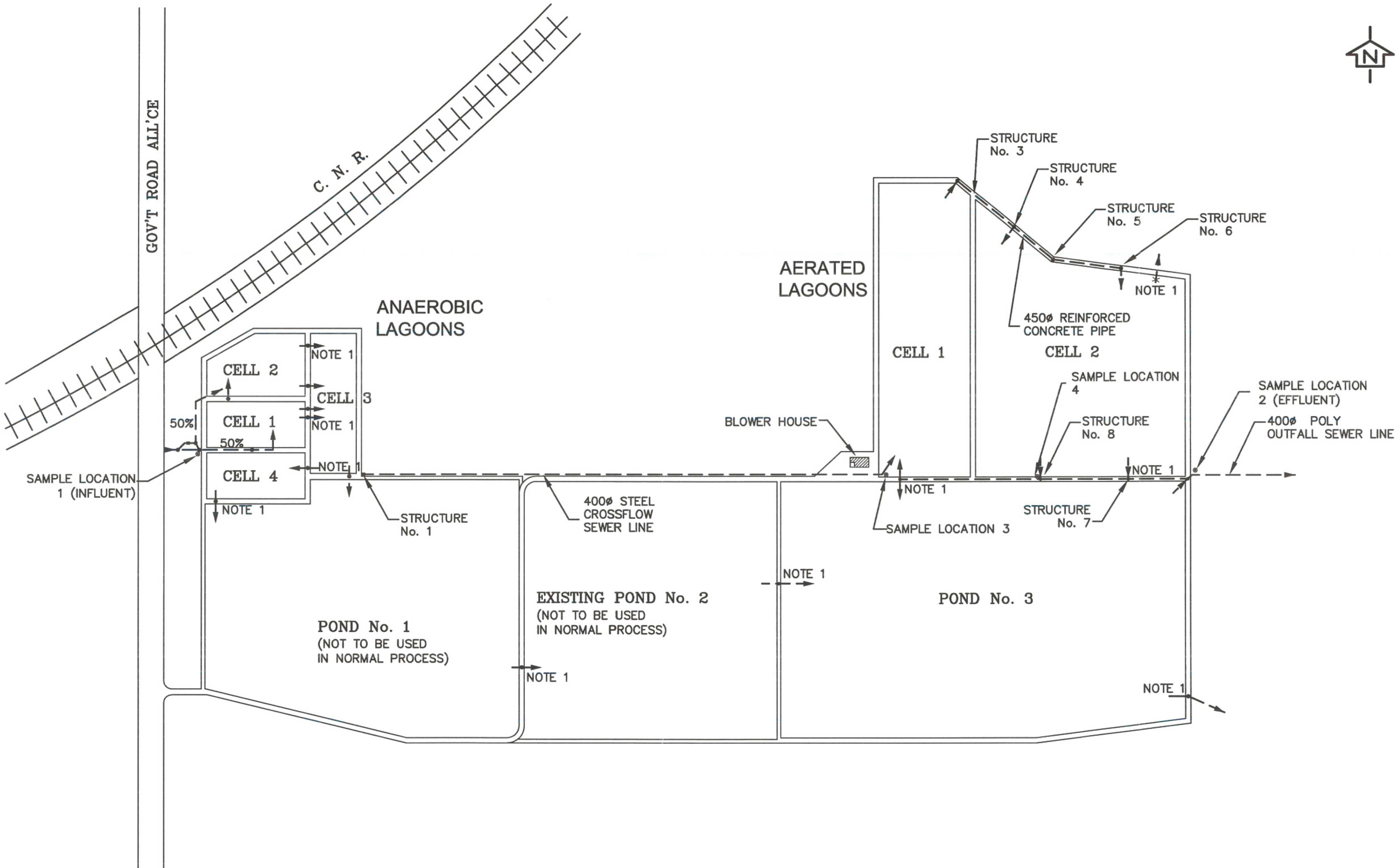
According to the Town of Edson, the blowers have been regularly sent out for overhauling over the years to WestRon, in Edmonton Alberta. Staff indicated that the blowers operate well without any notable problems. A copy of a typical blower curve for this model along with additional information obtained from the website has been included in **Appendix A** for reference.

2.4.2 Aeration System

The only notable concern expressed by the Town regarding the lagoon system was regarding the aeration system. During the initial site visit, the Town has indicated that several valves on the aeration system or will be replaced. The Town completed replacement of the valves and broken lines in early September 2007 at which time they noted one area in the south-east corner of aeration pond 1 which still seemed to be fed by a separate line and which still leaked. This last leak will require further investigation. In addition, the aerated cells froze over last winter, however ice cover is not uncommon for submerged aeration systems.

Surface aerators can also be used for lagoon aeration, and although there tends to be less freezing associated with these aeration systems, one of the downfalls is that surface aerators actually result in colder lagoon temperatures, thereby extending the "winter" treatment season, which in Canadian climates is not ideal.

In summary, at this time there do not seem to be any serious concerns with the equipment and lagoons per se; only the capacity of the system must be confirmed.



NOTE:

1. EXISTING STRUCTURE NOT USED IN NORMAL PROCESS.

TOWN OF EDSON		TOWN OF EDSON LAGOONS	Dwg. No.
EarthTech — A Tyco International Ltd. Company		EXISTING SITE PLAN FIGURE 2.1	
Drawn: YTT	Checked:	Scale: N.T.S.	Sheet
Date: AUG. 1, 2007	Approved:		
Designed: KAS	Project No.: 100870		

3.0 DESIGN CRITERIA

In order to determine the capacity of the existing system along with any upgrades required to treat an equivalent population of 15,000, the design criteria must first be established.

3.1 Design Population

The Town of Edson provided Earth Tech with historical population statistics from 2001 and 2005. The population had increased approximately 13% over that four year period. Consequently, the Town is currently using an average growth rate of 3.25% per annum for planning purposes. The current 2007 population is estimated at 8,916. The historical and projected population up to a design population of 15,000 is presented in **Table 3.1** below. As noted previously, Earth Tech is to assess the existing system's capacity to treat the flows and loads for a population of 15,000 which, according to projections, is likely to occur some time around 2023.

Table 3.1 Historic and Projected Population Based on 3.25% Growth per Annum

Year	Population	
2001	7,385	Census
2005	8,365	Census
2006	8,636	
2007	8,916	
2008	9,205	
2009	9,504	
2010	9,814	
2011	10,133	
2012	10,463	
2013	10,802	
2014	11,153	
2015	11,516	
2016	11,890	
2017	12,276	
2018	12,676	
2019	13,088	
2020	13,513	
2021	13,952	
2022	14,406	
2023	14,874	
2024	15,358	

3.2 Flows and Loads

Normally, as much historical data as is available is reviewed and analyzed to ensure a good understanding of seasonal patterns, allow for the rejection of outlier data and to project flows and loads based on a per capita basis. Unfortunately, due to a clerical error, data earlier than January 2006 was not available from the Town. Thus, in the interest of advancing this study as quickly as possible, Alberta Environment was not contacted for historical data and analysis of the system was done based on one and a half years of data. Although not ideal, this data can still be compared to similar systems. (Note that completely new facilities must often be designed based on typical textbook wastewater characteristics.)

Flows are measured continuously at the plant influent using a Parshall Flume. There is also a chart recorder at this location. Data collected includes minimum, average and maximum hourly and daily flows along with the total monthly flow.

Influent pH, BOD and TSS are measured at the lagoon influent (Sample Location 1) and effluent pH, BOD, TSS and CBOD are measured at the lagoon effluent (Sample Location 2) on a weekly basis. Refer to **Figure 2.1** for Sample Locations. A summary of the 2006 and 2007 influent and effluent flows and wastewater characteristics are presented in **Appendix B**.

Based on the available data, the 2006 and 2007 average and maximum month summer and winter flows, typically used for lagoon design, were established for the current capacity assessment. The per capita flows and loads were then used to project future flows and loads for a design population of 15,000.

Due to the limited data available, average and maximum summer and winter values for both 2006 and 2007, for only 2006 and for only 2007 were calculated to determine variability. Since only eighteen months of data was used, it was more difficult to establish a trend or determine which of the two years would present atypical values. Consequently, to be conservative, the higher values from the three calculations were typically chosen as the design basis. This was essentially the 2007 data. Refer to **Table 3.2** for the current and future design flows projected to a population of 15,000.

Table 3.2 Current and Future Design Flows

	2006/2007 (m^3/d)	**2006 (m^3/d)**	**2007 (m^3/d)**	**Current Design Flows (m^3/d)**	**Current per Capita Flow (l/d/cap)**	**Future Flows @ 15,000 p. (m^3/d)**
Average day:	3773	3536	**4246**	**4300**	482	7234
Avg Winter (Dec-March)	3319	3220	**3518**	**3500**	393	5888
Avg Summer (May-Aug)	4003	3605	**4534**	**4600**	516	7739
Max Winter	3720	3314	**3720**	**3750**	421	6309
Max Summer	5161	4090	**5161**	**5200**	583	8748

Similarly, the BOD and TSS data from 2006 and 2007 was reviewed. As the influent BOD values were similar for both years, the average of the two years was taken. The TSS data was based on 2006 for reasons described in Section 5.0. The design values are presented in **Table 3.3** below.

According to Town staff, the lagoon temperature varies from 4°C in the winter to somewhere between 14 and 18°C in the summer. 14°C was used as a more conservative design value for the summer temperatures.

3.3 Alberta Environment Guidelines

The current Alberta Environment license stipulates that the effluent must meet a CBOD limit of 25 mg/L based on monthly average of weekly grab samples which is standard for municipalities with a current population of less than 20,000 people.

In recent discussions between the Town and Alberta Environment, there has reportedly been no mention of modifying the effluent treatment limits or requirements when the license is renewed this fall. However, since the Town's population will not reach 20,000 before the next license renewal or likely the following license renewal, the 25 mg/L effluent CBOD limit will continue to be used as the effluent design criteria.

3.4 Design Criteria Summary

A summary of the design criteria that will be used for analysis of the existing system and capacity to treat a future design population of 15,000 is presented in **Table 3.3**.

Table 3.3 Design Criteria

	Current Design Criteria		Future Design Criteria	
	Winter 2007	**Summer 2007**	**Winter 2023**	**Summer 2023**
Population	8,916	8,916	15,000	15,000
Flows, m^3/d				
Average Day	3500	4600	5890	7740
Max Month	3750	5200	6310	8750
BOD, influent, mg/L	125	150	125	150
TSS, influent, mg/L	200	250	200	250
Wastewater Temp., °C	4	14	4	14
CBOD, effluent, mg/L	25	25	25	25

4.0 THEORETICAL LAGOON CAPACITY

4.1 Current Design Capacity

The Edson lagoon system was upgraded almost thirty years ago, in 1983, and since then no significant upgrades to the system have been made aside from the replacement of a few valves on the aeration system. A confirmation of the existing treatment capacity is one of the main goals for this assignment, particularly as knowledge of lagoon system design and performance has improved since the last upgrade. In addition, Alberta Environment provides guidelines[1] regarding lagoon system designs. These guidelines will be used as a basis for determining lagoon capacity as any upgrades to the existing system would likely require that the latest Alberta Environment guidelines also be met.

Of particular note is that Alberta Environment allows for several types of lagoons systems, all of which meet the guidelines. For smaller systems with a design capacity ranging from 0 to greater than 500 m^3/d, lagoon systems are comprised of anaerobic cells, facultative cell(s) and a 12-month storage cell. These systems typically discharge on an annual basis. For larger continuous discharge systems such as Edson's lagoon system, treatment typically consists of an aerobic lagoon system consisting of one or more complete mix cells and one or more aerobic cells. A final cell is provided for polishing which allows the suspended solids to settle before final discharge to a river. Alberta Environment does differentiate slightly between lagoon systems for populations less than or greater than 20,000. The Town of Edson falls within the former category, with a current population of just over 8,000 people and particularly as there are no known industrial discharges into the collection system which are adding a significant load to the system.

Because the current Edson lagoon system is the result of upgrades from a smaller capacity lagoon system to a larger aerated system, there are both anaerobic and aerobic cells along with a final storage or polishing pond. Theoretically, only the aerobic cells and storage pond would be needed. However the analysis will take into account the current layout.

One of the most basic design criteria is the hydraulic retention time (HRT) in each cell. Since this is an existing lagoon system, the first step in the capacity assessment was to determine if each cell provides an adequate HRT. The next step is to determine the theoretical treatment capacity of the cells and thirdly, to ensure that there is sufficient air for the system. As the latter factor is the most easily remedied by the addition of blowers if there is not enough air, the blower capacity was not seen as a major constraining factor in the assessment.

[1] Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, Alberta Environment, January 2006.

4.2 Cell Sizing Requirements

4.2.1 Anaerobic Cells

Alberta Environment's requirements for designing anaerobic-facultative-storage cell lagoon systems dictate that each anaerobic cell provide for two days of retention time. For a system the size of Edson's, with a flow of greater than 500 $m^{3/}d$, Alberta Environment would require four anaerobic cells with a total retention time of 8 days based on average design flows and a minimum cell depth of 3.0 m. These criteria will be used to determine if the Edson anaerobic cells provide treatment, since, as mentioned previously, typical designs do not include both anaerobic and aerobic cells and the aerobic cells alone may be sufficient for adequate treatment.

Since Anaerobic Cell 4 is typically only used for by-pass purposes, this cell has not been included in the capacity assessment calculations.

The individual and total HRT for each cell at the current and future flows equivalent to a population of 15,000 people is presented in **Table 4.1** below.

Table 4.1 Hydraulic Retention Time at Average Day Flows

	Volume m^3	Winter 2007 HRT, d	Summer 2007 HRT, d	Winter 2023 HRT, d	Summer 2023 HRT, d
Anaerobic Cell 1	1,735	0.99	0.93	0.59	0.55
Anaerobic Cell 2	2,360	1.35	1.26	0.80	0.75
Anaerobic Cell 3	3,700	1.06	0.99	0.63	0.59
Total HRT		**3.40**	**3.18**	**2.02**	**1.89**
Required HRT		***8***	***8***	***8***	***8***

As can be seen from the above table, none of the cells provide the required 2 day HRT and do not come close to providing a total required HRT of 8 days for anaerobic treatment. In addition, the cells currently being called anaerobic cells in Edson were designed for an operating depth of 1.05 m, 2.0 m and 1.72 m for Anaerobic Cells 1, 2 and 3, respectively, which based on the Alberta Environment Guidelines are not deep enough to ensure anaerobic conditions at all times. Consequently, there appear to be too many inadequacies related to the anaerobic cells sizing to meet Alberta Environment guidelines for these cells to be considered capable of providing reliable anaerobic treatment.

Although these cells may provide some treatment, the greatest benefit of these cells would be the flow equalization that is provided.

Consequently, for the purposes of this report, the anaerobic cells will no longer be considered as providing any treatment in the system and the assessments focus will be centered on the capacity of the aerobic and storage cells.

4.2.2 Aerobic Cells

The aerated system consists of two types of cells:

1. The complete mix cell is designed to provide enough oxygen to satisfy the applied CBOD loading and to maintain a uniform solids concentration. This is Aerobic Cell No. 1's purpose within the Edson system.

2. The partial mix or aerobic cell is designed to satisfy the applied CBOD loading while maintaining an adequate uniform dissolved oxygen level in the cell. As the solids concentration is not uniform, solids are allowed to settle in the bottom of the cell and undergo anaerobic decomposition. This is Aerobic Cell No. 2's purpose within the Edson system.

In addition to sizing the aerated cells to ensure proper treatment based on the model described in Section 4.3 below, the HRT and BOD loading rate are often used as a cross-check to ensure that the design values fall within typical ranges. On a design basis for aerated cells the typical HRT ranges between 5 and 30 days whereas typical BOD loading rates ranges have been documented between 100 and 600 BOD/ha/d[2]. Typical design depth for the aerobic cells ranges from 2 to 5 m.

4.2.3 Polishing Cell

Alberta Environment requires that systems with continuous discharge to a receiving stream have a polishing cell with a minimum hydraulic retention time (HRT) of five days based on summer average daily design flows.

4.2.4 HRT for Current and Future Flows

In order to determine if the cells meet the most basic design criteria of HRT, the HRT for current and future design flows at a population of 15,000 people were calculated and are presented in **Table 4.2**

[2] Wastewater Engineering Treatment and Re-use, Metcalfe and Eddy, Fourth Edition, 2003.

Table 4.2 Hydraulic Retention Time in Lagoon Cells for Current and Future Flows

		Winter 2007		**Summer 2007**		**Winter 2023 15,000 p.e.**		**Summer 2023 15,000 p.e.**	
	Volume m^3	**HRT,d @ Avg Day**	**HRT,d @ Max Month**	**HRT,d @ Avg Day**	**HRT,d @ Max Month**	**HRT,d @ Avg Day**	**HRT,d @ Max Month**	**HRT,d @ Avg Day**	**HRT,d @ Max Month**
Anaerobic Cells									
Anaerobic Cells, Total		3.40		3.17		2.02		1.89	
Required		*8*		*8*		*8*		*8*	
Aerobic Cells									
Aerobic Cell 1	43,830	12.5	9.5	11.7	8.4	7.4	5.7	6.9	5.0
Aerobic Cell 2	79,140	22.6	17.2	21.1	15.2	13.4	10.2	12.5	9.0
Typical Range, Each Cell		***5-30***	***5-30***	***5-30***	***5-30***	***5-30***	***5-30***	***5-30***	***5-30***
Storage Cell									
Storage Pond 3	223,490	63.9	48.6	59.6	43.0	38.0	28.9	35.4	25.5
Required				***5***				***5***	
Total Storage, d		**102**	**75**	**96**	**67**	**61**	**44**	**57**	**40**

As can be seen from the above Table, aside from an insufficient HRT in the anaerobic cells, the HRT is acceptable in both the aerobic cells and more than adequate for the Storage Pond to meet current and future flow equivalent to a population of 15,000.

4.3 Treatment Capacity Requirements

In addition to providing sufficient HRT, the lagoon system has to be able to treat the influent load. For complete mix cells, estimates of CBOD and effluent characteristics are calculated using the following model:

$$\frac{BODeff}{BOD\inf} = \frac{1}{(1+K_{t/n}T)^n}$$

Where	BOD eff	= Cell Effluent BOD, mg/L
	BOD inf	= Cell Influent BOD, mg/L
	K_t	= Reaction rate coefficient at t °C, day $^{-1}$
	T	= Total hydraulic retention time in lagoon system, days
	n	= number of equal volume Cells in series

According to Alberta Environment, the reaction rate coefficient K_{20} may vary from 1.5 day $^{-1}$ for completely mixed cells to 0.37 day $^{-1}$ for partially mixed cells. Several other sources such as the WEF Manual of Practice (4th Edition) use a range of 0.1 to 0.3 day^{-1} for these same reaction rate coefficients; these ranges are more conservative than the ranges suggested by Alberta Environment. .

As temperature has an important effect on biological activity, it is important to take temperature into account and review the sizing of the system based on both winter and summer design criteria using the worst case scenario for sizing the system. The influence of temperature on the reaction rate is expressed by the following equation:

$$K_t = K_{20} * \theta^{(t-20)}$$

Where	K_t	= Reaction rate coefficient at t °C, day $^{-1}$
	K_{20}	= Reaction rate coefficient at 20 °C, day $^{-1}$
	t	= Wastewater temperature , °C
	θ	= Temperature activity coefficient, typically 1.065, based on AENV guidelines

If bench scale or pilot tests are not feasible to determine the reaction rate value, experience at other similar facilities are often used when selecting the reaction rate coefficient. However in this case, historical data was used to better approximate the K_{20} values. Using both summer and winter months in which the influent flows and influent and effluent BOD concentrations were relatively stable, the model was calibrated and the resulting K_{20} values for the completely mix and partially mix cells were established as 0.2 and 0.14 respectively. These constants along with some of the additional aerobic cell design values are presented in **Table 4.3** below.

Table 4.3 Design Criteria

	Alberta Environment (Max. Values)	WEF Manual of Practice (Typical Range)	Winter 2007	Summer 2007
Temperature, °C			4	14
θ			1.065	1.065
K_{20}, day $^{-1}$				
Complete Mix:	1.5	0.1 – 0.3	0.2	0.2
Partial Mix:	0.37	0.1 – 0.3	0.14	0.14
K_t, day $^{-1}$				
Complete Mix:			0.08	0.14
Partial Mix:			0.06	0.10

Once the model was calibrated based on existing data, the model was used to assess the theoretical treatment capacity, disregarding blower capacity, for both winter and summer conditions based on the following design goals set out at the start of this study:

1. Existing Capacity – current population in 2007

2. Capacity of existing system to treat flows for a population of 15,000 (year 2023 approximately)

3. Maximum lagoon capacity of existing system

However, in working through the calculations, it was quickly determined that the existing lagoon configuration and system would not be able to treat flows for a population of 15,000. Consequently, the following scenarios were developed:

1. Scenario 1: Capacity of existing system to treat current population in 2007

2. Scenario 2a: Maximum capacity of existing system – using calibrated model

3. Scenario 2b: Maximum capacity of existing system – using Alberta Environment reaction rate coefficient. This was done for comparison purposes to emphasize the impact on selecting appropriate rate coefficients.

4. Scenario 3: Maximum capacity using converted Storage Pond 3 to treat flows for a population of at least 15,000, excluding blower requirements.

The calculations for each scenario are presented in **Appendix C**. The modeling results for Scenarios, 1, 2a and 2b are based on the existing lagoon system and are presented in **Table 4.4**. These results will be compared with actual treatment results recorded during 2006 and 2007. The results of Scenario 3 which pertain to upgrades required to meet an equivalent population of 15,000 or greater, will be discussed in **Section 6.0** in more detail.

Table 4.4 Design Criteria

	Scenario 1 Current Flows Existing 1 Train Calibrated Model		Scenario 2a Max. Capacity Existing 1 Train, Calibrated Model		Scenario 2b Max Capacity Existing 1 Train AB Env. Coeff.	
	Winter 2007	**Summer 2007**	**Winter 2009**	**Summer 2014**	**Winter 2023**	**Summer 2023**
Population	8,916	8,916	**9500**	**11,000**	15,000	15,000
Flows, m³/d per train Average Day Max Month	 3500 3750	 4600 5200	 4000	 6500	 5890 6310	 7740 8750
BOD, influent, mg/L	125	150	125	150	150	150
TSS, influent, mg/L	200	250	200	250	250	250
Lagoon Temperature, t, °C	4	14	4	14	14	14
K_{20}, day $^{-1}$ Complete Mix: Partial Mix:	 0.2 0.14	 0.2 0.14	 0.2 0.14	 0.2 0.14	 **0.6** **0.37**	 **0.6** **0.37**
Final Effluent CBOD, theoretical, mg/L	20	15	23	23	8	4.55
HRT, d Aerobic 1 Cell Aerobic 2 Cell Storage Cell *Typical Range: 5-30*	 11.7 21.1	 8.4 15.2	 11 19.8	 6.7 12.2	 6.9 12.5	 5.0 9.0
BOD Loading, kg/ha/d Aerobic 1 Cell Aerobic 2 Cell Storage Cell *Typical Range: 100-600*	 391 113	 **651** (1) 165	 418 124	 **814** (1) 231	 **659** (1) 138	 **1096** (1) 195

Note (1): These BOD loading rates exceed the typical ranges of between 100-600 kg/ha/d used for lagoon design values

Scenario 1: Capacity of Existing Treatment System to Treat Current Flows - 2007

As can be seen from the above table, theoretically, the existing lagoon system should not have any problems treating the existing flows and loads. According to the model predictions, the final effluent CBOD should be less than 25 mg/L, the HRT of the cells falls within the acceptable range and only the BOD loading rate on Aerobic Cell 1 is slightly above the normal range. These effluent results are comparable to final effluent CBOD concentrations currently analyzed at the Edson lagoons.

However, since the BOD loading rate is slightly greater than the typical range of 100-600 kg BOD/ha/d, the existing facility can be considered close capacity. As noted in the original operations manual, the plant was designed for a flow of 4863 m^3/d. Although it was not stipulated if this value was for the maximum summer flow or what influent BOD concentration was used in the design, the current summer design flow rate of 5200 m^3/d and influent BOD of 150 mg/L are likely close to the original design flows and loads, if not higher.

Scenario 2: Maximum Treatment Capacity Using Existing Configuration

The maximum capacity of the existing lagoon system was determined based on using the rate coefficient established by calibrating the model using historical data (Scenario 2a) and the rate coefficients suggested in the Alberta Environment guidelines (Scenario 2b). The results are described in further detail in the following paragraphs.

Scenario 2a – Maximum Capacity Using the Calibrated Model

Assuming the typical BOD loading range of 100-600 kg BOD/ha/d can be pushed to 800 kg BOD/ha/d in the summer, based on the model, the maximum capacity for the existing system would be in the range of 6500 m^3/d with an influent BOD concentration of 150 mg/L; the effluent concentration would be 23 mg/L. In the winter, the maximum capacity would be 4000 m^3/d with an influent concentration of 125 mg/L; the effluent concentration would be 23 mg/L.

These maximum winter and summer month flows would equate to populations of approximately 11,000 people in the summer and 9500 people in the winter, based on current trends. These populations will be reached sometime between 2009 and 2014, according to the population projections presented in **Table 2.1**. As such, in order to treat flows for a population of 15,000 people, significant system upgrades would be required.

Using these design values would allow for very little buffering capacity in the system and effluent CBOD excursions would likely result. Consequently, although the system could likely operate at these flows and loads most of the time, it is recommended that the Town weigh the risk of adopting these maximum capacity design values.

The excursions noted by the Town of Edson since the start of the year will be analyzed in further detail in **Section 5.0** below, as many of the excursion occurred during the colder winter months, when abnormally high influent TSS concentrations were being sampled.

Scenario 2b – Maximum Capacity Using Alberta Environment Rate Coefficients

The theoretical capacity was also calculated using the rate coefficients closer to those suggested in the Alberta Environment Guidelines for comparison purposes. From **Table 4.4** above, it can be seen that these rate coefficients, 0.6 for a complete mix cell and 0.37 for a partially mixed cell, are not as conservative as those used to calibrate the model. Using these coefficients, the model predicted that the existing system could treat the projected flows and loads for a population of 15,000 people with effluent CBOD concentrations of less than 10 mg/L for both winter and summer conditions. However, the BOD loading rate would be almost double the normal typical range during summer flows. Considering the historical data, it would be difficult to believe that the existing system could handle almost double the population.

These calculations were made to emphasize the impact of choosing the appropriate coefficients. As noted earlier, several months of historical data were used to calibrate the model which is more conservative than the suggested Alberta Environment guidelines.

4.4 Blower Sizing

Blower Sizing

In addition to cell size, HRT, and BOD loading rate, providing sufficient air is also critical for aerated systems. Since the existing blowers seem to work well and there are potentially only some valve or line upgrades required, keeping the existing blower system was considered more cost effective than considering major upgrades to the existing aeration system. Air and blower requirements to meet the existing capacity requirements are outlined below.

Aerobic Cell No. 1 – Complete Mix Cell

Typically for complete mix cells, when comparing blower power requirements for oxygen transfer versus maintaining solids in suspension, the mixing requirements dictate the blower power requirements of the system. Alberta Environment suggests that the power requirements are approximated using 6-10 w/m^3 of cell volume, as rule of thumb. Power requirements as low as 1.5 to 4 w/m^3 have been suggested in other reports[3, 4].

[3] Wastewater Engineering Treatment and Re-use, Metcalfe and Eddy, Fourth Edition, 2003.

Since the existing blower system appears to supply sufficient air to meet the current aeration demands, and each blower is rated at approximately 56 kW, the estimated mixing energy was based on 2 W/m^3. Thus, the Aerobic 1 Cell would require a mixing energy of 88 kW.

Aerobic 1 Volume	Required Mixing Energy	Power Required
m^3	(W/m^3)	kW
43,830	2	88

As this mixing energy is not a function of influent characteristics, the required blower power would not change with increasing flows.

Aerobic Cell No. 2 – Partial Mix Cell

In partial mix cells, oxygen requirements dictate blower power requirements. As a rule of thumb, approximately 1.5 to 2.0 kg of oxygen is required per 1.0 kg of CBOD to be removed.

In general, dissolved oxygen should be controlled such that a minimum concentration of 2.0 mg/L is maintained during peak loading conditions. Odour problems are typically the result of insufficient dissolved oxygen in a lagoon system.

Detailed calculations resulted in an equivalent mixing energy of approximately 0.15 to 0.25 W/m^3 during winter and summer months, respectively. Theoretically, minimal additional power would be required to supply sufficient air to meet the maximum capacity of the existing system.

Summary of Blower Requirements

Alberta Environment provides a detailed aeration system design summary table in the guidelines which we have duplicated in order to facilitate further discussion between the Town of Edson and Alberta Environment. Refer to **Appendix D** for this table.

The required blower size for the existing flows and loading rates are summarized in **Table 4.5.** The total power required for the existing flows is 106 kW whereas the total power required if the existing system were operating at maximum capacity is marginally higher, at 108 kW. Considering the available blowers are approximately 56 kW each, for a total of 112 kW, there is very little spare capacity when two blowers are in operation. In the event that the Town considers using the full capacity of the lagoons, consideration should be given to allowing for the third blower to run until the system has been further expanded, including the aeration system.

[4] Cold Climate Sewage Lagoons, Proceedings of the June 1985 Workshop, Winnipeg, Manitoba, Report EPS 3/NR/1, April 1987.

Table 4.5 Lagoon Cell Mixing Requirements

Cell	Volume (m^3)	Required Mixing Energy (W/m^3)	Current Total Power Requirement (1 train) (kW)	Total Power Requirement (1 train) Maximum Capacity (kW)
Aerobic Cell 1	43,830	2	**88**	**88**
Aerobic Cell 2 Winter	79,140	0.15	11	12
Aerobic Cell 2 Summer		0.25	**19**	**20**
Total Required			**106**	**108**
Total Available (2 Blowers)			**112**	**112**

5.0 LAGOON CAPACITY TO TREAT EXISTING FLOWS

As stated in the introduction, one of the goals of this study is to determine the capacity of the existing lagoon system to treat current flows due to the contraventions which have occurred in the last few years. In Section 4.0, the theoretical capacity of the existing lagoons and blowers was determined. Based on those calculations, the lagoons should be able to treat the current flows and loads. However, as several contraventions were noted in 2007, the historical data will be reviewed and analyzed and the specific time frames in question will be discussed below.

5.1 General Assessment

First, the historical data and treatment results will be compared with the theoretical treatment capacity outlined in Section 4.0. Numerous graphs were produced using the existing data in order to provide a visual summary. These graphs are presented in **Appendix E**. The most noteworthy graphs are discussed in greater detail below.

Figure 5.1 depicts total monthly flows along with the effluent CBOD for 2006 and 2007. From this graph, it would appear the flows have increased slightly, from seven to twelve percent per month, between 2006 and 2007, with a more significant increase in the range of twenty percent in the spring of 2007. This is significantly higher than the projected increases of 3.25% based on population increases.

Figure 5.1 Town Of Edson - Lagoon Capacity Assessment
Lagoon Monthly Influent Flow and Effluent CBOD (Jan06-Jul07)

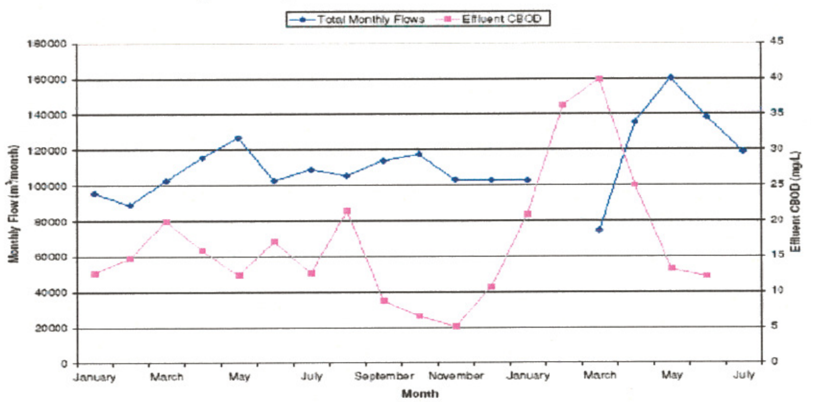


Figure 5.2 depicts the influent TSS along with the effluent CBOD for 2006 and 2007. As can be seen from the graph below, although the influent TSS fluctuates significantly, the effluent TSS remains relatively constant, typically below 25 mg/L with occasional increases up to 50 mg/L. However, there seems to be a more direct correlation between the influent TSS and effluent CBOD increases in the winter/spring of 2007.

Figure 5.2 Town of Edson Lagoon Capacity Assessment
Lagoon Monthly Influent & Effluent TSS and Effluent CBOD (Jan06-Jul07)

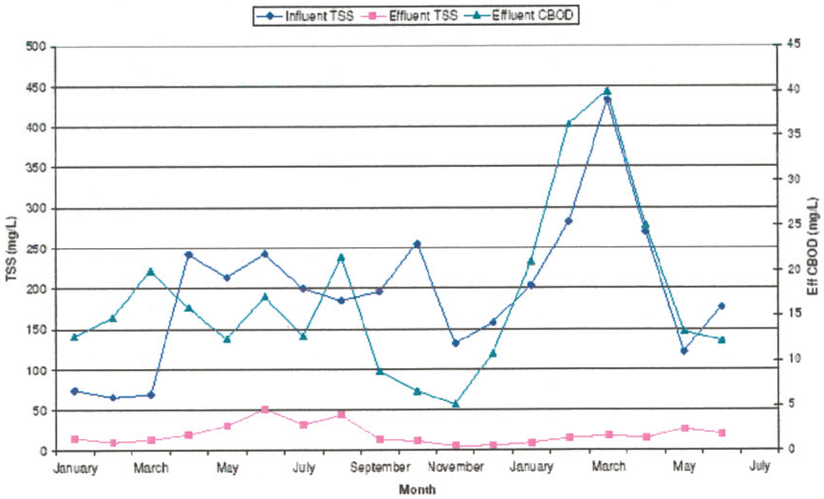
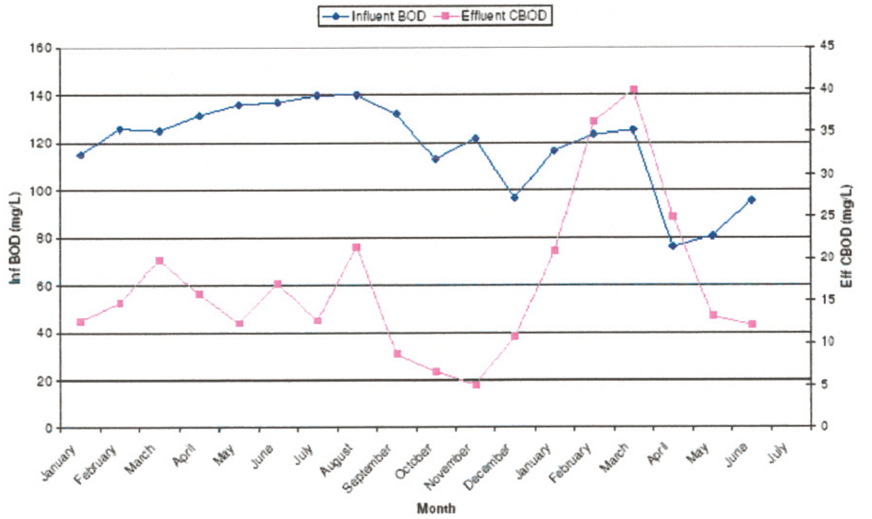


Figure 5.3 depicts the influent BOD and effluent CBOD for 2006 and 2007. Although the influent BOD appears to decrease during the winter of 2007, the effluent CBOD increases significantly.

Figure 5.3 Town of Edson Lagoon Capacity Assessment
Monthly Influent BOD and Effluent CBOD (Jan06-Jul07)



Of the three parameters, flow, influent BOD and influent TSS, the effluent CBOD concentrations seems to follow the TSS pattern the most closely. The next step was to determine if there was an actual increase in BOD and TSS loading to the system or if the fluctuations in concentrations could be attributed to an event such as system flushing.

Figure 5.4 depicts total monthly flows for 2006 and 2007 along with BOD loading (kg/month) for the same time period. The BOD loading appears to fluctuate over the course of the year, with the loading increasing in the spring of both years. However, from 2006 to 2007, the BOD loading has decreased significantly. Thus, based on the loading, the lagoon system should be able to treat the current flows.

Figure 5.4 Town of Edson - Lagoon Capacity Assessment
Lagoon Monthly Flow and BOD Loading

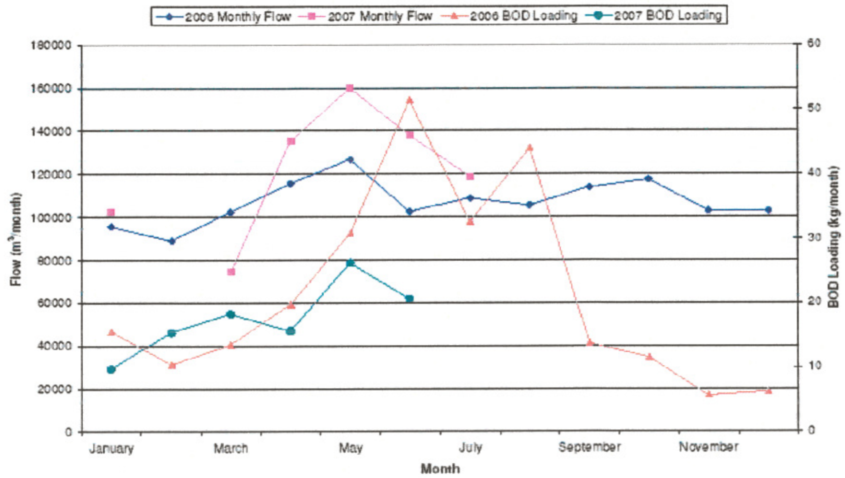


Figure 5.5 depicts total monthly flows for 2006 and 2007 along with TSS loading (kg/month) for the same time period. From this graph, it would appear that the TSS fluctuates significantly over the course of the year. The TSS loading is relatively low in the winter and increases in the spring, typical of many plants were the spring melt and infiltration into the sewer collection systems results in high sewer flows and solids deposited in the collections system being swept to the treatment plants. The Town has indicated that the water table is high and there is a lot of groundwater infiltration into the collection system, which confirms these observations. The TSS was at least three to five times as high from January to March 2007 compared to the previous year and still significantly higher in April 2007.

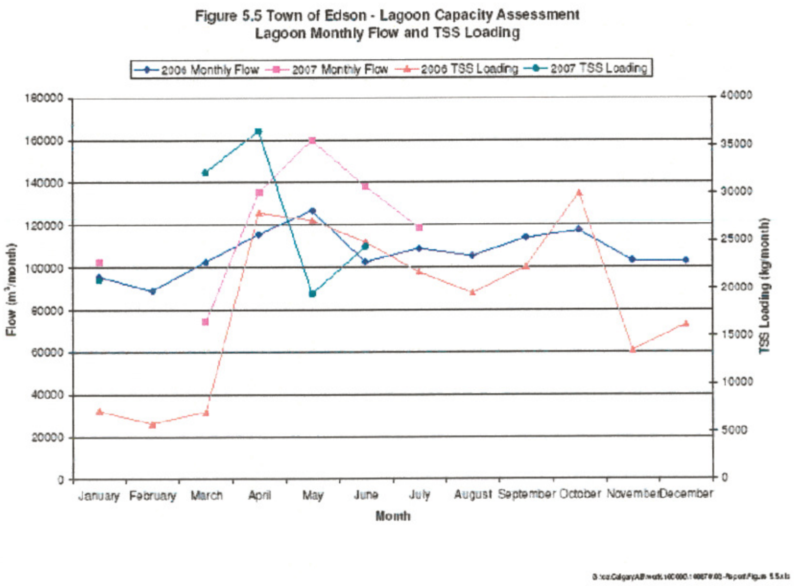
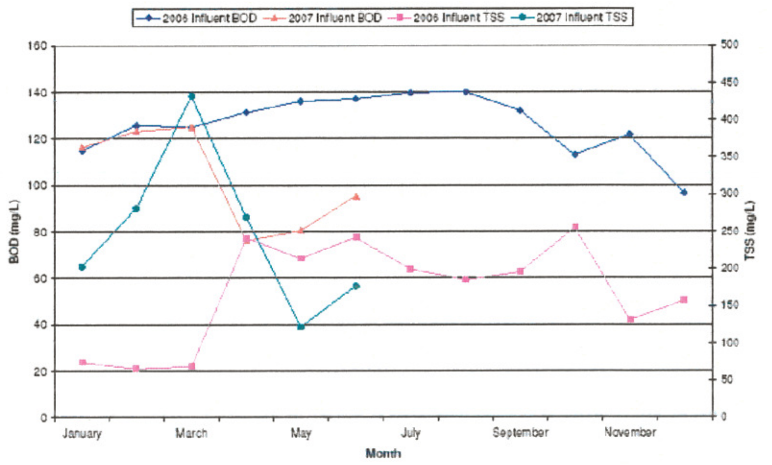


Figure 5.6, depicts the influent BOD and TSS and the effluent CBOD for 2006 and 2007. From these graphs, it should be noted that although the average influent BOD concentrations from January to April were almost identical in 2006 and 2007, the average influent TSS concentrations were between three to five times higher from January to March 2007 compared with 2006. Considering the approximate hydraulic retention time in the lagoons is 30 days, the impact of what enters the lagoons at the start of one month would typically be seen at the end of the system at the end of the month. Consequently, the impact of the high TSS at the end of March could still be seen well into April.

Figure 5.6 Town of Edson - Lagoon Capacity Assessment
Monthly Lagoon Influent BOD and TSS Comparison



Overall, the lagoon system seems capable of meeting the current CBOD limit of 25 mg/L at the current flows and BOD loading rates, with the exception of January to April 2007. Specific incidences are reviewed in more detail in the paragraphs that follow.

5.2 Specific Incident Reports

Town staff has included notes regarding equipment failures, high flow events and contraventions on the raw data spreadsheets. These occurrences have been summarized below.

5.2.1 Equipment Failures

There were several events related to the equipment which either explains a lack of data or sudden variations in treatment results. These events include:

- Cleaning of the anaerobic ponds the first week of June 2006: this resulted in an increase in effluent CBOD to 26 mg/L for one week in June.
- A power failure which shut down the aerators the first week of August 2006: this resulted in a two week increase in effluent CBOD ranging from 32 to 44 mg/L in early August 2006. Note that this increase does not appear on the graph as the graphs are based on monthly averages.
- A chart recorder failure in January 2006 which did not allow recording of the hourly flows.
- An influent flow meter failure in February 2007.

Although the first two equipment failures resulted in weekly exceedences of the CBOD limit, they could easily be explained. In addition, the monthly average was still below the CBOD limit of 25 mg/L.

5.2.2 High Flows

As noted in the raw data spreadsheets, **Appendix B**, the maximum daily flow to the lagoon exceeded the 1983 design flow of 4863 m^3/d during the time frames listed below. It should be noted that the effluent CBOD limit during these same periods was not exceeded.

- April 1-3rd 2006. The maximum daily flow recorded during this month was 5210 m^3/d and the average daily flow was 3851 m^3/d. Although there was no rainfall recorded during this period, in reviewing the historical temperatures at this time of the year, the high flow was likely due to spring run-off and infiltration into the system. There was no obvious impact on effluent CBOD as the lagoons continued to meet the effluent limits, with a noticeable downward trend over the course of the month as lagoon temperature likely increased.
- May 25th – June 1st 2006. The maximum daily flow recorded during this month was 6582 m^3/d and the average daily flow was 4090 m^3/d. The Town noted that 28 mm of rain was recorded during this period. Although the influent flows were high and the influent TSS peaked at 340 mg/l, there was only a slight increase in effluent CBOD, from 6.4 mg/L to 17. 2 mg/L, between the last two weeks of May. The higher CBOD effluent the following week of 26 mg/L could in part be attributed to the higher flows however cleaning of the anaerobic ponds is a more likely cause.
- September 15-22, 2006. The maximum daily flow recorded during this month was 6479 m^3/d and the average daily flow was 4061 m^3/d. The Town noted that a 57 mm rainfall was recorded during this time period. Again, although the influent flows were high and the influent TSS peaked at 403 mg/l, there was no obvious increase in effluent CBOD as concentrations remained below 10 mg/L well into November after this rain event.

In summary, it would appear that the lagoon system is able to handle short term higher flows with minimal increases in effluent CBOD when the influent BOD remains relatively constant. Furthermore, the short term increases in TSS, particularly during the warmer weather, as the biological activity increases, do not seem to impact lagoon performance.

5.2.3 Permit Contraventions

Several contraventions, when the lagoons exceeded the CBOD limit of 25 mg/L, were noted all occurring between mid-January to mid-April 2007, as detailed below.

- January 2007 Week 4 and 5

- February 2007 Week 2
- March 2007 Weeks 1, 2, 3 and 4: During which time the maximum daily flow was 4996 m^3/d; at these flows, it is possible that there were not enough blowers in operation
- April Weeks 1 and 2: During which time the maximum daily flow was 7302 m^3/d and the average daily flow was 4834 m^3/d, which is close to the summer design capacity of 4863 m^3/d at 14 deg C. (Note that if the lagoon temperatures are estimated at 4 deg C, the effluent CBOD is theoretically estimated to be 30 mg/L, exceeding the lagoon treatment capacity; at these flows, it is possible that there were not enough blowers in operation

For the most part, these contraventions occurred during the coldest wastewater temperatures of the year when biological activity is at its slowest. The influent flows, along with influent and effluent TSS for this time frame, are presented in **Table 5.1** below. Certain cells are highlighted for a quick colour reference regarding values to be compared.

Of notable interest when reviewing the data were the following facts:

- The flows were slightly higher during 2007 compared to the previous year, although unfortunately there was no data for the month of February. A slight increase of 3.0 to 3.5 percent would be expected due to the increase in population. However, the calculated increase was in the range of seven, eleven and twenty percent for January, March and April respectively. Refer to **Table 5.1**.

In order to better understand what may have been occurring during this time frame, temperature and precipitation records were graphed for the time periods in questions. Refer to **Figures 5.7 and 5.8.** During the January-April 2007 time frame, the average daily temperature fluctuated between -10°C and 0°C but the daily maximums often climbed above 0°C, allowing for melting of any accumulated snow. Consequently, although some portion of this increase in flow could potentially be attributed to snow melt during the winter of 2007, this would not explain the extremely high TSS noted below.

Figure 5.7 Town of Edson - Lagoon Capacity Assessment
Temperature Trends From Jan 1 - Apr 21, 2007

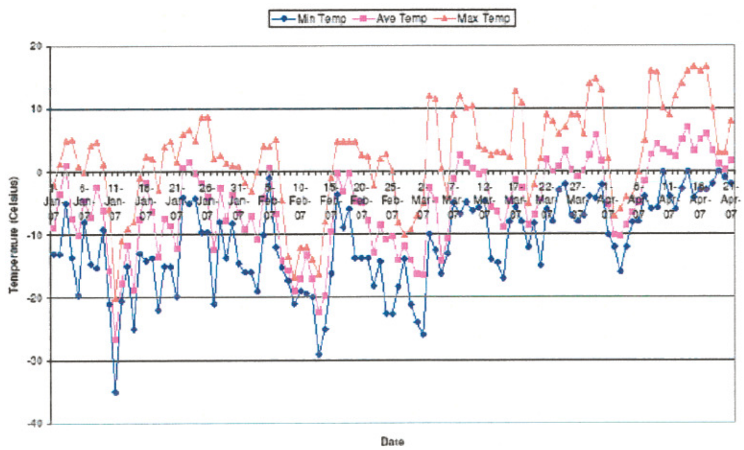
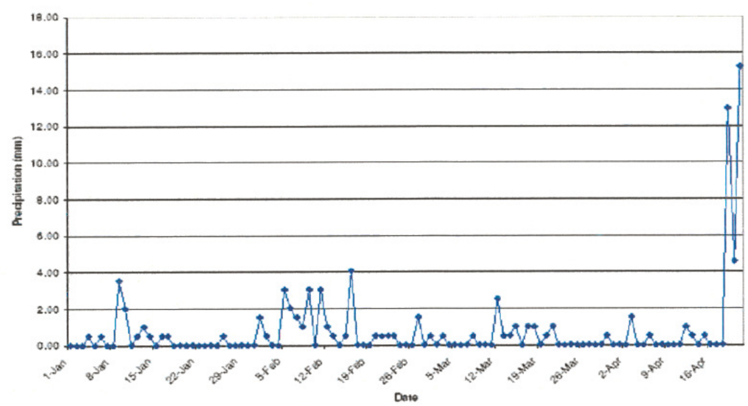


Figure 5.8 Town of Edson - Lagoon Capacity Assessment
Precipitation From Jan 1 - Apr 21, 2007



- The BOD influent concentration remained extremely stable over the first three month of each year, ranging from 115 to 126 mg/L for both years. There was a slight increase in April 2006 up to 131 mg/L and a noticeable decrease in April 2007 down to 76 mg/L. Refer to **Table 5.1** below. The BOD actually decreased from 2006 to 2007. Consequently, there would be no expected need to increase the number of blower in operation. However, the Town did note that they were having some problems with the aeration distribution system such as system leaks and the need for replacing some valves. This may explain, in part, the higher effluent CBOD.

Table 5.1 Influent and Effluent Flow, BOD and TSS in 2006 and 2007

	2006						2007					
Month	Avg Daily Flow m3/d	Inf B.O.D.	Inf T.S.S.	Eff B.O.D.	Eff T.S.S.	Eff C.B.O.D	Avg Daily Flow m3/d	Inf B.O.D.	Inf T.S.S.	Eff B.O.D.	Eff T.S.S.	Eff C.B.O.D
January		107.76	138.67	19	18.16	11.72		109.78	158.67	23.50	7.57	15.75
Week2		112.6	44.55	29.08	16.43	16.27		124.67	199.17	20.05	8.16	14.68
Week3		118.27	61.11	23.97	13.62	11.47		103.75	147.90	27.60	7.20	20.15
Week4		120.97	55.55	28.19	14.44	11.30		117.60	222.43	35.05	10.94	26.21
Week5								126.60	287.60	3.10	14.80	27.90
Average	**3087**	**114.90**	**74.97**	**25.05**	**15.66**	**12.69**	**3316**	**116.48**	**203.15**	**21.86**	**9.73**	**20.94**
February		122	78.66	44.64	10.67	14.80		126.15	319.33	41.54	10.89	36.18
Week 2		122.65	68.06	25.17	10.48	15.98		124.58	402.40	40.29	16.77	35.33
Week 3		122.55	65.61	26.56	8.90	14.60		128.35	250.67	40.64	17.8	35.13
Week4		135.97	51.50	25.09	11.68	13.50	**Not available**	113.95	154.06	40.72	15.97	38.24
Week 5												
Average	**3177**	**125.79**	**65.96**	**30.37**	**10.43**	**14.72**		**123.26**	**281.62**	**40.80**	**15.36**	**36.22**
March		141.13	98.50	33.97	12.90	19.22		129.87	331.80	41.70	17.97	39.10
Week2		117.28	41.05	32.49	13.70	20.61		132.85	407.80	35.20	18.37	39.72
Week 3		130.98	55.17	27.79	13.20	20.89		131.80	563.50	41.70	19.70	41.30
Week 4		122.20	87.90	34.34	11.57	20.73		105.87	426.11	37.41	17.00	39.50
Week5		112.65	64.11	31.56	16.21	18.31						
Average	**3302**	**124.85**	**69.35**	**32.03**	**13.52**	**19.95**	**3720**	**125.10**	**432.30**	**39.00**	**18.26**	**39.91**
April		109.10	71.39	32.82	17.86	15.36		101.10	423.50	40.50	12.6	39.00
Week 2		135.03	328.22	29.28	16.22	18.52		80.30	428.60	38.20	17.80	28.90
Week3		141.46	279.33	38.43	24.15	15.23		64.90	89.30	24.60	14.90	18.40
Week4		139.70	289.10	25.60	20.91	14.33		58.30	136.60	17.69	17.20	13.76
Week 5												
Average	**3851**	**131.32**	**242.01**	**31.53**	**19.79**	**15.86**	**4834**	**76.15**	**269.50**	**30.25**	**15.63**	**25.02**

- The TSS concentration increased at least three-fold from 2006 to 2007. In 2006, the influent TSS ranged from 41 to 139 mg/L from January to March for an average of 70 mg/L, and from 71 to 289 mg/L in April, likely when the spring melt began. In 2007, the influent TSS ranged from 147 mg/L to 566 mg/L from January to March for an average of 306 mg/L and from 89 to 423 mg/L in April. The average TSS over the first four months of 2006 was 113 mg/L whereas the average TSS over the first four months of 2007 was 297 mg/L. This data is summarized in **Table 5.2.** As noted earlier, the TSS loading also increased at least three-fold during the winter months from 2006 to 2007.

Table 5.2. Average Monthly TSS during the first quarter of 2006 and 2007

	2006	**2007**
Average TSS, mg/L (January to March)	70	306
Average TSS, mg/L (January – April)	113	297

In this type of collection system, with little industrial component, the average TSS should typically range between 200-250 mg/L, with slightly lower values expected in the winter and higher concentrations expected particularly during spring run-off. Consequently, the sustained high TSS values in the winter of 2007 are highly suspect and may be the cause of dumping something into the collection system that is harmful to the biological activity in the lagoon system.

Of particular importance is the fact that although the sewer flushing which was undertaken in January 2006 resulted in an increase in influent TSS up to 140 mg/L compared to following weeks at 55-75 mg/L, this concentration was much less than the almost to 300 mg/L observed in the first four months of 2007. In addition, the 2006 sewer flushing exercise seemed to have minimal impact on the effluent CBOD, which remained below the effluent limit.

5.3 Conclusions

Based on the theoretical calculations, the lagoons should have been able to treat the wastewater in the winter of 2007 without exceeding the effluent CBOD limit of 25 mg/L. However, the combination of the following factors may explain why limits were exceeded:

1. The Town did note some operational difficulties with the aeration system, potentially resulting in some difficulty providing sufficient air to the system.

2. The maximum daily temperatures were often above 0°C, possibly resulting in earlier snow melt and slightly higher influent flows along with some TSS entrainment due to pre-mature flushing of the system. This would also explain in part why the TSS is higher in the spring of 2006 (214 mg/L in May and 242 mg/L in June) compared to 2007 which was 121 mg/L and 176 mg/L respectively.

3. Although the BOD influent concentration remained relatively constant, the sustained higher flows simply did not allow for sufficient retention time in the system for treatment to occur. Using the calibrated model, the model predicts that at a flow of 4834 m^3/d, equal to the average daily flow in April 2007, the effluent CBOD would be approximately 30 mg/L, assuming a wastewater temperature of 4 deg C. The actual recorded effluent CBOD was 40 mg/L.

However, since the flows were lower at the start of 2007 and the effluent CBOD climbed up to 40 mg/L for almost 6 weeks straight between the end of February and the starting of April, the increased flows alone would not explain the high effluent. The biological activity would have to have been impaired during the same time period in conjunction with reduced aeration efficiency.

Consequently, it is suspected that something was being discharged into the collection system resulting in high TSS which did not impact the BOD loading or significantly impact the flows. However, the suspended solids may have had an impact on the biological activity. As long as TSS loads remain within typical ranges, the existing lagoon system should be able to treat the projected flows and loads for the next couple of years.

Although the Town had previously indicated that there is no major industrial component in their collection system, after presenting the draft report to the Town staff, the Town staff recalls construction of a new big store which coincides with the period in question and in particular the use of chemicals to clean or wash the floor which were causing some plugging in the sewer collection system. It is thus likely that the construction and resulting disposal of concentrated or chemical waste may have occurred during this time period which impacted the Town's lagoon system. As noted previously, once the TSS concentrations re-established themselves to near "normal levels" starting mid-April, the lagoons seem to have quickly re-established themselves and effluent CBOD values dropped below the 25 mg/L limit. This improved treatment would also coincide with the warming of the wastewater and increased biological activity.

6.0 CAPACITY EXPANSION

6.1 Timing of upgrades

As indicated in the previous sections, the existing system should not have any problems treating the existing flows and loads for the next couple of years. However, as early as the winter of 2009, the Town will likely experience an increase in the number of short-term CBOD effluent limit exceedences based on predicted flows and loads. When measures are taken to address this issue, the limiting capacity of the blower system should also be reviewed and addressed. Consequently, a significant expansion is likely required in the following years in addition to some short term aeration system upgrades.

The current and maximum capacity of the existing lagoon system are re-iterated in **Table 6.1** below along with the modeling results based on one option proposed to expand the capacity – described as Scenario 3 below.

Scenario 3 – Maximum Treatment Capacity Using Converted Storage Pond 3

As outlined in Section 4 above, using the calibrated model, it appears that the existing lagoon system would not have sufficient capacity to treat the projected flows and loads for a population of 15,000 people. The model predicts a CBOD concentration of 35 - 40 mg/L for both winter and summer conditions at the effluent end of Aerobic Cell No. 2, based on the existing configuration and a population of 15,000. In addition, although the HRT in the aerobic and storage cells falls within the acceptable ranges, the BOD loading rate on the aerobic cell (1099 mg BOD/ha/d) is almost double the typical range (100-600 mg BOD/ha/d) in the summer months.

Since the existing HRT is excessive for Storage Pond 3, it seems reasonable to work on the basis of expanding the aerated lagoons to treat flows for a population of 15,000 people, hence consideration was given to modifying the existing lagoons rather than constructing additional cells.

Considering the number of storage ponds currently not in use and the land availability, there are numerous options available to increase the treatment capacity of the system. More options could be developed by a more detailed investigation, which would determine which option is best in the long term. However, due to the proximity of Storage Pond 3 to the existing blower house, conversion of this pond to aeration cells seems obvious. In addition, the excess storage in Storage Pond 3 would be put to use and piping modifications to split the influent flow would be minimal.

On the basis that Storage Pond 3 could be reconfigured such that a volume equivalent to the existing aerated cells was available for treatment, two equalized aerated trains could be created. Approximately 45,000 m^3 could be converted to a completely mixed cell and 80,000 m^3 could be converted to a partially mixed cell. The remaining 100,000 m^3 would be used as a common storage or polishing pond for both trains. This presumes that curtains can be installed to divide the cell as constructing berms would take up too much of the cell volume. Refer to **Figure 6.1** for the proposed layout. **Figures 6.2 and 6.3** are sample of other lagoons with baffle curtains similar to those being considered.

Figure 6.2 Floating Baffle Curtain with Serpentine Flow Formation

Figure 6.3 Floating Baffle Curtain and Surface Mount Aerators.

The calibrated model was used to predict the maximum capacity of a modified Storage Pond 3. Based on the modeling results, reconfiguring Storage Pond 3 would provide a total treatment for 11,000 m^3/d at maximum monthly flow during summer (**Summer (A)**) with a resulting effluent CBOD concentration of approximately 18 mg/L. This assumes that the BOD loading rate can be pushed to 700 kg/ha/d. The equivalent population would be approximately 19,000 people.

However, to design the system such that the BOD loading rate remains within the typical range of 100-600 mg/ha/d, the influent summer design flow would have to be reduced to 9600 m^3/d which would be equivalent to a population of 16,500 people (**Summer (B)**). Effluent CBOD would also be reduced to 13 mg/L which would allow more buffering capacity in the event of an abnormal operating condition, such as those experienced this winter.

In the winter, the reconfigured Storage Pond 3 would be able to treat a maximum winter month flow of 8,000 m^3/d, with a resulting final effluent of 23 mg/L CBOD based on predicted flows and loads. All other parameters fall within typical ranges. This flow would also be equivalent to a population of approximately 19,000 people.

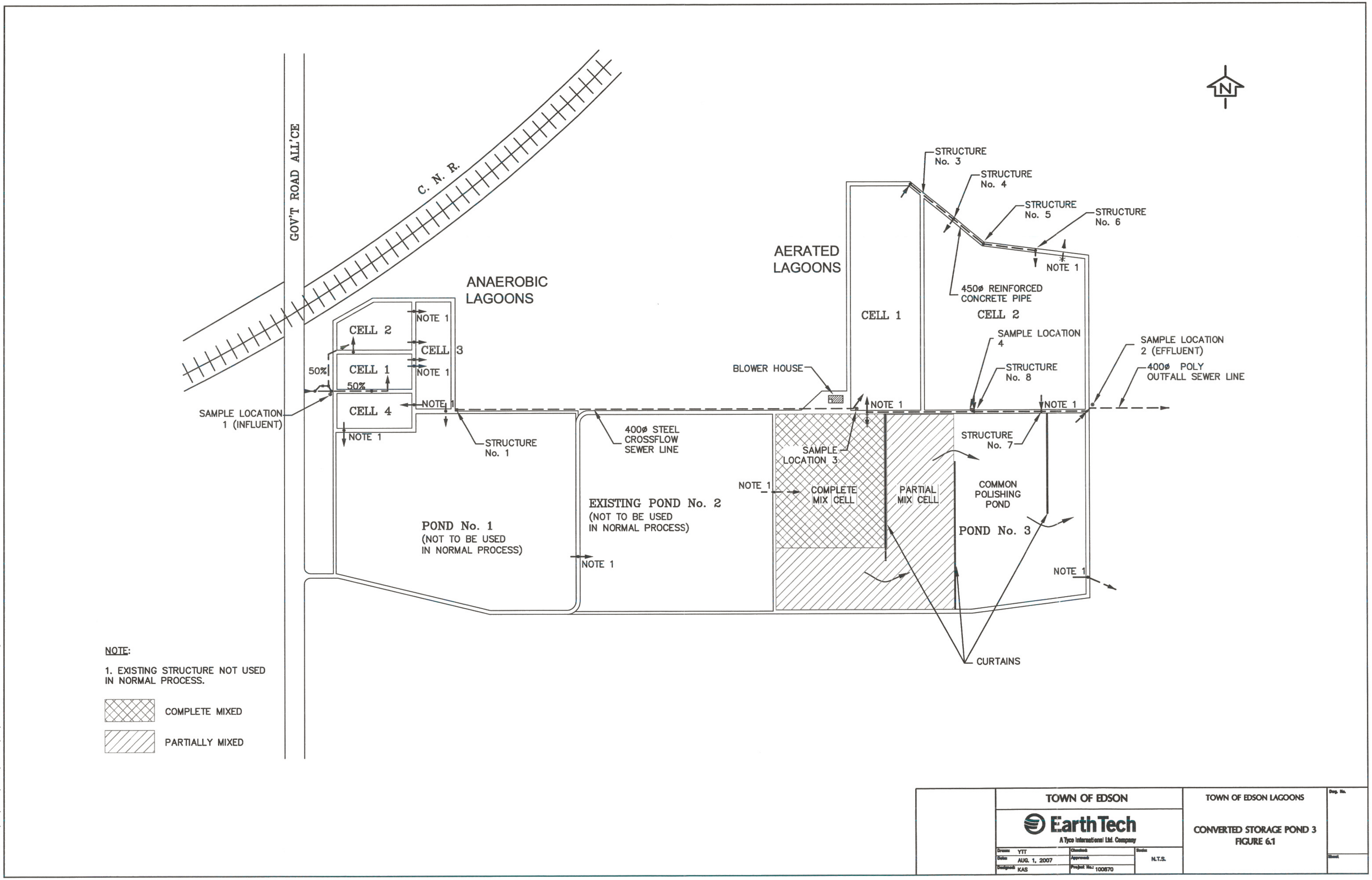
Table 6.1 – Capacity of Existing and Proposed Future Lagoon System

	Scenario 1 Current Flows 1 Train		Scenario 2a Max. Capacity Existing 1 Train, Calibrated Model		Scenario 3 Maximum Capacity 2 Identical Trains Calibrated Model		
	Winter 2007	**Summer 2007**	**Winter 2009**	**Summer 2014**	**Winter**	**Summer (A)**	**Summer (B)**
Population	8,916	8,916	**9500**	**11,000**	19,020	18,860	16,460
Flows, m^3/d per train Average Day Max Month	 3500 3750	 4600 5200	 4000	 6500	 8000	 11000	 9600
BOD, influent, mg/L	125	150	125	150	125	150	150
TSS, influent, mg/L	200	250	200	250	200	250	250
Lagoon Temperature, t, °C	4	14	4	14	4	14	14
K_{20}, day^{-1} Complete Mix: Partial Mix:	 0.2 0.14	 0.2 0.14	 0.2 0.14	 0.2 0.14	 0.2 0.14	 0.2 0.14	 0.2 0.14
Final Effluent CBOD, theoretical, mg/L	20	15	23	23	23	18	13
HRT, d Aerobic 1 Cell Aerobic 2 Cell Storage Cell *Typical Range: 5-30*	 11.7 21.1	 8.4 15.2	 11 19.8	 6.7 12.2	 10.6 19.7 12.8	 7.9 13.9 9.4	 9.1 16.4 10.5
BOD Loading, kg/ha/d Aerobic 1 Cell Aerobic 2 Cell *Typical Range: 100-600*	 391 113	 **651**(1) 165	 418 124	 **814**(1) 231	 430 127	 **696**(1) 187	 600 146

Note (1): These BOD loading rates exceed the typical ranges of between 100-600 kg/ha/d used for lagoon design values

The capacity of the existing 400 mm PVC pipe to the aeration cells pipe is approximately 11,000 m^3/d, based on a minimum slope of 0.3%. The capacity of the existing effluent line to the river consisting of a 400 mm section and a 450 mm section is approximately 9,500 m^3/d, based on a slope of 0.2%. Consequently, these lines will either have to be twinned or upgraded once the flows stated above are reached. However, the flows will likely not be reached until the population is approximately 15,000 to 16,000 people, projected to be around 2023

It is suggested that once additional capacity has been added to the system, the existing aerated lagoons be taken out of service for maintenance and desludging of Aeration Cell 2. Storage Pond 3 will also have to be desludged at some point, particularly if a portion of the cell is to be reconverted into an aerated system.


C. N. R.
GOV'T ROAD ALL'CE
ANAEROBIC LAGOONS
CELL 2
CELL 3
CELL 1
CELL 4
50%
50%
NOTE 1
SAMPLE LOCATION 1 (INFLUENT)
STRUCTURE No. 1
400ø STEEL CROSSFLOW SEWER LINE
POND No. 1 (NOT TO BE USED IN NORMAL PROCESS)
EXISTING POND No. 2 (NOT TO BE USED IN NORMAL PROCESS)
AERATED LAGOONS
BLOWER HOUSE
CELL 1
CELL 2
STRUCTURE No. 3
STRUCTURE No. 4
STRUCTURE No. 5
STRUCTURE No. 6
450ø REINFORCED CONCRETE PIPE
SAMPLE LOCATION 4
STRUCTURE No. 8
SAMPLE LOCATION 2 (EFFLUENT)
400ø POLY OUTFALL SEWER LINE
SAMPLE LOCATION 3
COMPLETE MIX CELL
PARTIAL MIX CELL
STRUCTURE No. 7
COMMON POLISHING POND
POND No. 3
CURTAINS
N
NOTE:
1. EXISTING STRUCTURE NOT USED IN NORMAL PROCESS.
COMPLETE MIXED
PARTIALLY MIXED
TOWN OF EDSON
EarthTech
A Tyco International Ltd. Company
Drawn: YTT
Date: AUG. 1, 2007
Designed: KAS
Project No.: 100870
Scale: N.T.S.
TOWN OF EDSON LAGOONS
CONVERTED STORAGE POND 3
FIGURE 6.1
2007-08-14 L:\work\100000\100870\02-CAD\WAT\CONVERTED STORAGE POND.dwg

7.0 COST ESTIMATE FOR UPGRADES

7.1 Timing of Upgrades

Based on the capacity assessment of the existing system, the existing lagoon configuration should be able to treat summer flows in the range of 6500 m^3/d with an influent BOD concentration of 150 mg/L. In the winter, the maximum capacity would be 4000 m^3/d with an influent BOD concentration of 125 mg/L. These maximum month winter and summer flows would equate to populations of approximately 11,000 people in the summer and 9500 people in the winter, based on current trends. These populations will be reached sometime between 2009 and 2014, according to the population projections presented in **Table 2.1**

In order to ensure the Town of Edson agrees with any modifications to their system, the next steps in the project of this nature would be to undertake a functional design which could likely be completed in two months to undertake some preliminary surveying and potentially geotechnical investigations, if no other information is available; to confirm which lagoon cell should be used to expand the existing facility; and to select what type of aeration system should be used for the additional aeration cells. Once this phase is complete, the timeline to complete the detailed design would be in the order of three to four months; two to three months to pre-purchase equipment, and construction which ideally would be undertaken in the summer, would require approximately 6 months, depending labour availability.

According to one possible baffle curtain supplier, the lagoons do not need to be drained and can be installed using a boat. However, depending on the type of aeration system used, submerged or surface mounting, the lagoon may or may not have to be drained to install the aeration system.

7.2 Preliminary Capital Costs

Recommended upgrades to the existing lagoon system which would allow for doubling of the lagoon capacity to an equivalent population of approximately 16,500 to 19,000 people would include the following basic changes:

- Repair of the existing aeration system in the existing aerated cells – more detailed analysis of exact upgrades is required.
- Installation of one additional blower and purchase of a shelf-spare; alternatively, one or two of the additional lagoons zones could be provided with surface aerators.
- Reconfiguration of Storage Pond 3 including addition of curtains and a new aeration system.
- Addition of a new structure to divert one half of the flows to the reconfigured Storage Pond 3
- Upgrade the electrical service

- Upgrade the control system

For the purposes of this report, very preliminary estimates for the disciplines including Process, Civil, and Electrical, in addition to the General Requirements which include site costs, insurance, bonding, contractor overhead and profit margins have been compiled to generate the total upgrade project estimate. The Civil estimate includes for dewatering and desludging, survey and geotechnical work, and some additional in-ground structures. The process equipment estimate includes for baffle curtains, blowers and the aeration system. In addition, due to current market conditions, a fifty percent construction contingency has been included as the timing of the upgrades will greatly influence the cost.

Table 7.1. Preliminary Capital Cost Estimate

Item	Description	Cost ($)
1	General Requirements	200,000
2	Process Equipment	700,000
3	Civil	270,000
4	Electrical & Instrumentation	50,000
	Subtotal	1,020,000
	Construction Contingency (50%)	610,000
	Total	**1,830,000**
	Engineering Fees (15% of Subtotal)	180,000
	Total, excl. GST	**2,010,000**

8.0 CONCLUSIONS

Based on the theoretical calculations and historical data, it appears that the existing lagoon system would have sufficient capacity to treat the existing flows. However, as early as the winter of 2009, the Town will likely experience an increase in the number of short-term CBOD effluent limit exceedences based on predicted flows and loads. Any measures taken to address this issue, the limiting capacity of the blower system should also be reviewed and addressed. Consequently, a significant expansion is likely required in the following years in addition to some short term aeration system upgrades.

The contraventions experienced in the first four months of 2007 were likely due to a discharge into the collection system which inhibited the micro-organisms within the treatment process, particularly during the cold winter months. During this time frame, extremely high influent TSS (upwards of 500 mg/L) was noted although neither the influent BOD nor the effluent TSS seemed to be affected. The effluent CBOD recovered quickly to meet effluent CBOD requirements, once the TSS fell to normal levels (200-250 mg/L).

In order to provide sufficient capacity to treat flows for a population of 15,000 people, significant upgrades to the existing lagoon system are required. It is proposed that existing Storage Pond 3 be divided into zones using curtain baffles such that two parallel aerobic trains of equal size are created. The effluent from both aerobic trains would combine at the current discharge location from Aerobic Cell 2 into Storage Pond 3. An additional baffle curtain would be provided at the east end of the Storage Pond to minimize short circuiting to the final discharge. Additional flow splitting boxes and aeration systems would also be required.

An approximate time frame to complete a project of this nature is in the order of thirteen to fifteen month, assuming there are no delays, with the following phases:

- Functional Design: two months
- Detailed Design: three to four months
- Equipment Pre-Purchase: two months
- Construction: six months.

The cost estimate for the required upgrades to double the existing capacity to approximately 9, 600 m^3/d maximum summer flow, or an equivalent population of 16,500, is in the order of $2 million including engineering fees and a fifty percent construction contingency due to the current market conditions.

APPENDIX A

ORIGINAL BLOWER CURVE

Date: 8/31/2007 PROJECT:

GD CycloBlower

Application:
Customer Name:
Comments:

Application Engineer:
Sales Order Number:

GAS MIXTURE: Air(100%)
MACHINE SELECTION: Model 7CDL17
SERVICE: Pressure

CORRECTED VALUES	**ORIGINAL UNITS**
Inlet Set #1	
Barometer	14.696 PSIA
Inlet Pres.	0.000 PSIG
Inlet Temp.	68.00 F
Blower Speed	1,800 RPM
% of Max. Speed	45. %
Dis. Pres.	6.100 PSIG
Rel. Humid.	36.0 %
Delta Pressure	6.100 PSIG

MEASURED VALUES	**PLOT UNITS**
Inlet Set #1	
Inlet Flow	927.63 SCFM
Blower Power **	29.4 HP
Efficiency	73.8 %
Discharge Temp.	136.1 F
Estimated Noise	82.5 dBA

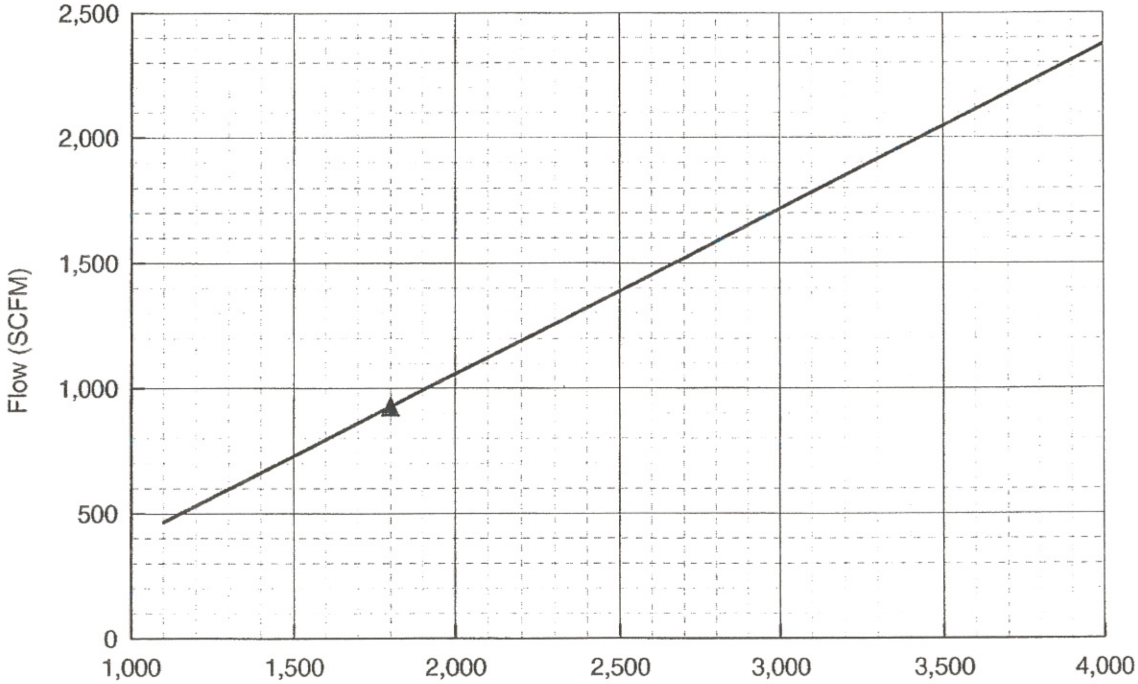
** Drive losses not included

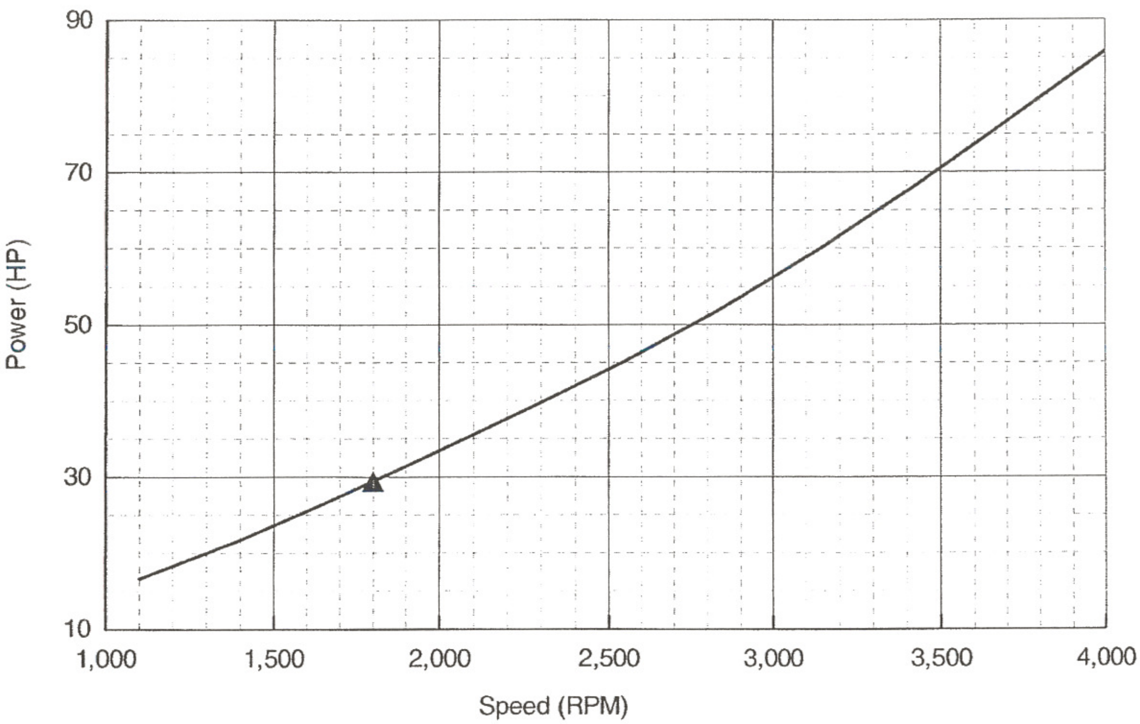
GAS PARAMETERS	**ENGLISH UNITS**	**METRIC UNITS**
Inlet Set #1		
Molecular Weight	28.91 lbm/lbmol	28.91 kg/kgmol
R Value	53.46 ft.lbf/lbm.R	0.29 kJ/kg.K
Density	0.075 lbm/ft^3	1.200 kg/m^3
Sp. Heat @ Const. P	0.241 BTU/lbm.R	1.007 kJ/kg.K
Ratio of Sp. Heats	1.40	1.40
Saturated Vapor Pres.	2.6104 PSIA	0.1800 Bars(A)
Partial Pres. of Gas	14.5740 PSIA	1.0048 Bars(A)
Partial Pres. of Vapor	0.1220 PSIA	0.0084 Bars(A)

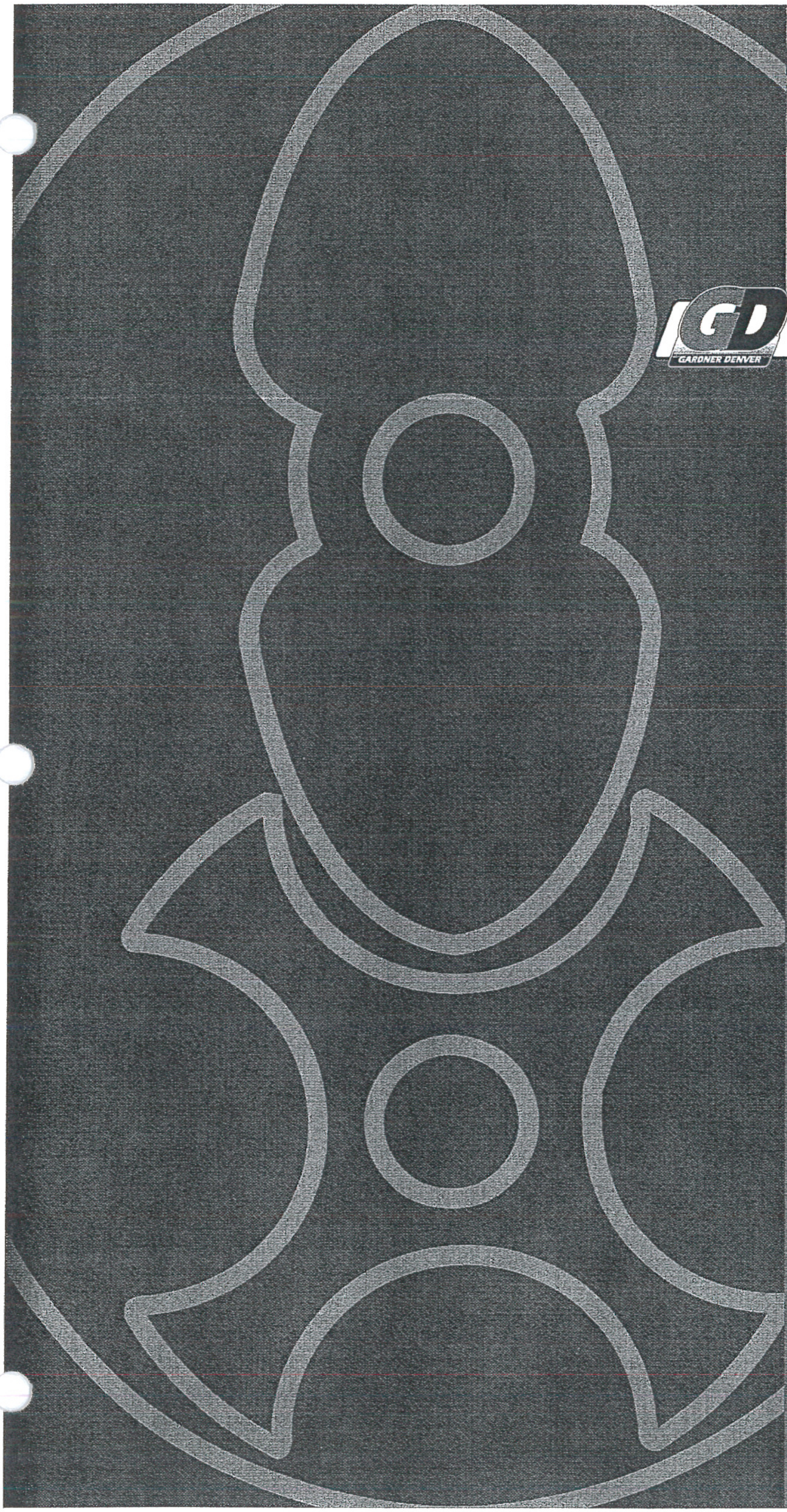
Date: 8/31/2007 PROJECT:

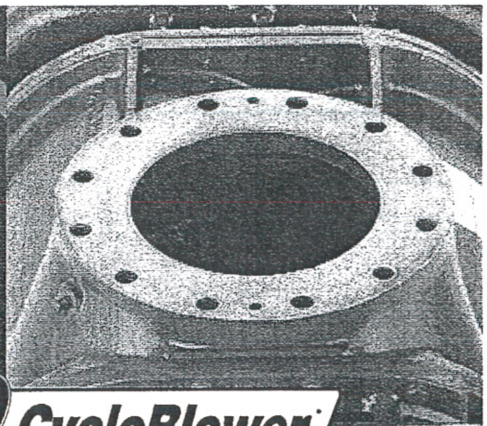
GD CycloBlower

GAS MIXTURE: Air(100%)
MACHINE SELECTION: Model 7CDL17





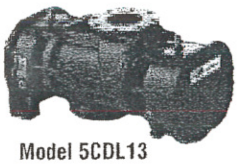




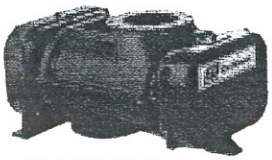
GARDNER DENVER CycloBlower®

Helical Screw Blowers/Vacuum Pumps

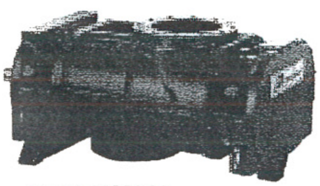
INDUSTRIAL
XP SERIES



Model 5CDL13



Model 7CDL17



Model 11CDL31

Clean Air/Gas Delivery – Since the rotors do not touch each other or the housing, lubrication is not required within the compression chamber. The outboard position of rotor bearings allows atmospheric venting between the compression chamber and the bearings and gears. This prevents gear and bearing lubricants from contaminating the compression chamber and the air or gas.

Efficient, Shock-Free Compression – The screw-type, cycloidal rotors generate a balanced compression cycle, providing a smooth and steady discharge, eliminating the sudden release of trapped pockets of air into the line. Contoured inlet and discharge ports minimize turbulence.

High Capacity-Low Weight – Compact design, selection of optimum performance parts and materials and accurately maintained tolerances allow the CycloBlower XP to be operated at high speeds, increasing capacity for relatively low unit weight. Direct or step-up drive permits the use of less expensive standard motors.

Installation Flexibility – Units may be driven by any normal source of power that provides adequate speed and horsepower. The capacity of each model covers a broad range of pressure and air delivery. CycloBlower XP models can be powered by various types of drives including electric motors, constant or variable, gasoline and diesel engines or steam turbine and may be connected through a speed regulating mechanism, V-belt or direct drive.

CycloBlower® XP Series offers 20 psig continuous pressure and 17 "Hg continuous vacuum.

Dependable, Long-Life Service – With two rotating parts that do not touch, wear within the compression chamber is eliminated. The CycloBlower XP design does not require valves and other reciprocating parts that are subject to wear.

Low Installation Cost – A special foundation is not required; simple base mounting is adequate and CycloBlower XP units require a minimum of floor space.

Model 9CDL23

CycloBlower XP Overview

- 75 to 6700 cfm
- Pressures to 20 psig
- Dry vacuum to 17 "Hg

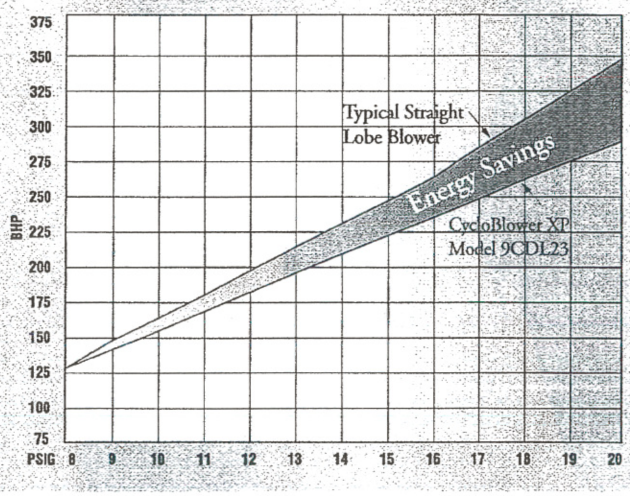
CycloBlower® XP Industrial Applications

INDUSTRIAL PROCESSING
- Recovery Air of Gas
- Combustion Air
- Air Drying
- Air Flotation and Sliding
- Blow-off Systems/ Drying/Can Drying
- Carbon Black
- Coal Gasification
- Coke Oven Gas
- Gas Boosting
- Vacuum Systems
- Air Knife Stripping
- Numerous OEM Applications

WATER TREATMENT
- Pond Aeration, Municipal or Industrial
- Wastewater Treatment
- Aeration
- Air Scouring
- Digester Gas Boosters
- Filter Backwashing

PARTICULATE HANDLING
- Clean Rooms
- Clean-Up
- Pneumatic Conveying Dry Bulk Fly Ash
- Source Capture

BRAKE HORSEPOWER REQUIREMENT COMPARISON



CycloBlower Performance Specifications

BLOWER	SPEED	PRESSURE												VACUUM								DIMENSIONS-BARE BLOWER				
		5 PSIG		9 PSIG		12 PSIG		15 PSIG		18 PSIG		20 PSIG		8 "Hg		12 "Hg		16 "Hg		17 "Hg		(INCHES)			SIZE AND	WT.
MODEL	RPM	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	L	W	H	TYPE PORTS	LBS.
	1500	97	3.5	80	6.4	66	7.7							107	3.0	92	4.2			114	6.8	28 3/4	15	15 1/4	3" Flange	372
	2000	144	4.8	126	8.5	113	10.6	100	13.1					158	3.9	143	5.4	127	7.3	162	9.1				7.5" O.D.	
	2500	190	6.4	173	10.8	159	13.6	146	16.6					209	4.9	194	6.8	178	8.7	210	11.2				Both Ports	
5CDL5	3000	237	8.2	219	13.4	206	16.8	193	20.5	179	23.7			260	6.1	245	8.3	229	10.4	258	13.2					
	3500	283	10.3	266	16.1	252	20.1	239	24.7	226	28.5			311	7.5	296	10.0	280	12.3	306	15.3					
	4000	330	12.5	312	19.2	299	23.7	286	29.1	272	33.3			363	9.2	347	11.8	331	14.2	354	17.4					
	4500	376	14.9	359	22.5	345	27.6	332	33.5	319	38.2	310	42.7	414	11.0	398	13.7	382	16.3	402	19.7					
	5000	423	17.7	405	26.2	392	31.5	379	38.0	365	43.2	356	48.5	465	13.0	449	15.8	433	18.4	450	22.2					
	1500	178	6.1	153	11.8	135	15.9							164	4.6	123	6.5			209	9.5	32 3/4	15	15 1/4	5" Flange	441
	2000	266	8.0	241	14.5	222	19.3	204	23.6					259	6.1	219	8.8			287	12.5				10" O.D.	
	2500	354	10.2	329	17.7	310	23.2	292	28.3	273	33.5			354	7.7	314	11.1	273	15.6	365	15.6				Both Ports	
5CDL9	3000	442	12.6	417	21.3	398	27.8	379	33.7	361	39.8	348	44.9	450	9.2	409	13.3	369	18.7	443	18.8					
	3500	529	15.3	504	25.4	486	32.9	467	39.9	448	46.9	436	52.5	545	10.7	505	15.6	464	21.7	521	21.9					
	4000	617	18.2	592	29.7	573	38.3	555	46.8	536	54.8	524	60.6	640	12.2	600	17.9	559	24.8	599	24.8					
	4500	705	21.1	680	34.3	661	44.2	643	54.4	624	63.4	611	69.4	736	13.8	695	20.2	655	27.9	677	27.2					
	5000	793	24.2	768	39.3	749	50.5	730	62.6	712	72.8	699	78.7	831	15.3	791	22.5	750	30.9	756	28.9					
	1500	247	8.4	218	14.7	195	18.8							230	5.9	179	8.7			265	12.7	36 3/4	15	15 1/4	5" Flange	500
	2000	372	11.1	342	19.5	320	25.3	298	31.7					352	8.8	301	12.2			386	16.9				10" O.D.	
	2500	497	14.3	467	24.7	445	32.1	423	40.1	400	47.2			474	11.6	423	15.7	373	20.0	507	20.8				Both Ports	
5CDL13	3000	622	18.2	592	30.6	570	39.1	547	48.0	525	55.9	510	62.5	596	14.4	545	19.3	495	24.0	629	24.6					
	3500	746	22.6	717	36.8	695	46.3	672	55.6	650	64.7	635	72.5	718	17.3	667	22.7	617	28.0	759	28.4					
	4000	871	27.5	842	43.2	819	54.0	797	63.5	775	73.6	760	82.2	840	20.2	789	26.3	739	32.1	871	32.2					
	4500	996	33.1	966	49.6	944	62.0	922	71.2	900	82.8	885	91.7	962	23.0	911	29.9	861	36.3	992	36.2					
	5000	1121	39.3	1091	56.4	1069	70.2	1047	78.2	1024	92.4	1009	101.4	1084	25.9	1033	33.5	982	40.5	1113	40.2					
	1100	329	11.1	281	19.0	245	26.3	209	26.0					334	8.4	268	11.9			357	20.4	36 1/2	20 1/2	19 3/4	8" Flange	867
	1600	547	16.3	499	28.0	463	36.8	426	42.9	390	52.8			558	12.3	492	17.4	426	23.6	579	29.7				13.5" O.D.	
	2100	764	22.1	716	37.9	680	48.7	644	58.8	608	70.6	584	78.5	782	16.7	716	23.4	650	31.5	801	38.7				Both Ports	
7CDL11	2600	982	28.6	934	48.7	898	62.1	862	75.1	826	89.4	801	97.9	1006	21.4	940	30.0	874	40.3	1024	47.9					
	3100	1200	35.5	1151	59.7	1115	75.8	1079	91.8	1043	109.0	1019	119.0	1230	26.3	1164	36.7	1098	49.2	1246	57.2					
	3600	1417	42.6	1369	70.3	1333	89.2	1297	108.2	1261	129.0	1237	141.8	1454	31.2	1388	43.2	1322	57.3	1469	66.5					
	4000	1591	48.5	1543	78.7	1507	100.0	1471	121.0	1435	145.0	1411	160.4	1633	35.2	1567	48.3	1501	63.8	1647	73.4					
	1100	431	15.0	384	23.2	349	29.9	314	36.1					440	10.0	380	14.5	320	18.5	480	23.3	39 1/2	20 1/2	19 3/4	8" Flange	911
	1600	705	20.1	658	33.3	623	43.1	588	53.8	553	64.9	530	69.1	734	15.5	674	22.0	614	27.8	753	32.7				13.5" O.D.	
	2100	980	26.3	933	44.6	898	58.0	863	72.2	828	86.4	804	94.0	1028	21.2	968	29.7	908	37.4	1025	41.8				Both Ports	
7CDL14	2600	1254	33.6	1207	57.0	1172	74.2	1137	90.8	1102	107.7	1079	119.9	1322	26.8	1262	37.3	1202	47.0	1298	51.2					
	3100	1529	42.4	1482	70.1	1447	90.3	1411	109.0	1376	129.5	1353	144.3	1616	32.4	1556	44.8	1496	56.4	1570	60.8					
	3600	1803	52.9	1756	84.2	1721	106.6	1686	127.0	1651	152.3	1627	167.2	1910	37.9	1850	52.4	1790	65.9	1843	70.2					
	4000	2023	61.9	1976	96.3	1941	120.9	1905	141.6	1870	170.9	1847	186.0	2145	42.4	2085	58.4	2025	73.4	2061	77.2					
	1100	484	13.8	424	24.6	379	30.7	335	39.0					509	12.4	446	17.4	382	23.0	523	24.2	42 1/2	20 1/2	19 3/4	8" Flange	1016
	1600	812	21.2	753	37.7	708	48.7	664	60.0	619	72.6			865	17.9	801	24.7	738	32.6	851	36.3				13.5" O.D.	
	2100	1141	29.9	1082	51.3	1037	67.4	993	82.0	948	96.7	918	112.5	1220	24.5	1157	32.9	1094	42.7	1179	47.5				Both Ports	
7CDL17	2600	1470	39.5	1411	64.7	1366	85.4	1321	104.5	1277	121.9	1247	138.6	1576	32.1	1513	41.7	1449	52.9	1508	58.4					
	3100	1799	50.7	1739	79.4	1695	103.4	1650	126.7	1606	147.2	1576	163.1	1932	40.4	1869	51.1	1805	63.8	1836	69.4					
	3600	2128	64.0	1476	67.5	2024	122.0	1979	148.6	1934	173.1	1905	190.2	2288	49.5	2224	61.2	2161	75.6	2165	80.6					
	4000	2391	75.4	2331	109.3	2287	136.6	2242	166.2	2198	194.7	2168	212.8	2572	57.5	2509	69.8	2446	85.0	2427	89.7					

High Efficiency for Improved Energy Savings

In many comparable applications, the CycloBlower XP operates more efficiently than other straight lobe blowers. By requiring less brake horsepower, BHP, energy operating costs can be reduced.

LEFT CHART shows a comparison of the BHP for a typical straight-lobe blower versus a CycloBlower XP 9CDL23. The CycloBlower requires less BHP to produce 3,000 CFM at pressures from 8 to 20 PSIG.

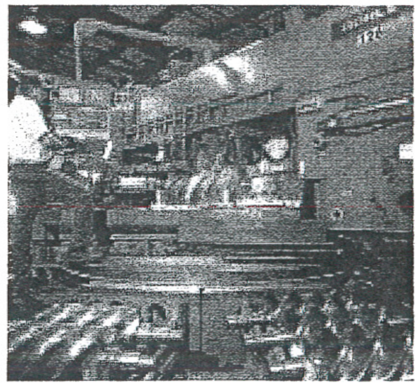
RIGHT CHART translates the resulting BHP comparison reduction into annual energy cost savings. Calculations are based on the cost of providing 3,000 CFM of air for 8,736 hours, approximately 1 year of operation assuming motor efficiency = .90 and energy cost per kilowatt-hour = $0.07.

ANNUAL ENERGY COST SAVINGS

	BHP REQUIREMENT FOR 3,000 CFM		ASSUMING MOTOR EFFICIENCY = .90 COST/KWH = $.07	
PSI	TYPICAL STRAIGHT LOBE	CYCLOBLOWER XP MODEL 9CDL23	PERCENT BHP REDUCTION	ANNUAL ESTIMATED SAVINGS
8	130	125	3.8%	$ 0
9	145	143	1.4%	$ 1,013
10	162	157	3.1%	$ 2,533
11	180	170	5.6%	$ 5,067
12	196	182	7.1%	$ 7,094
13	212	194	8.5%	$ 9,120
14	232	206	11.2%	$ 13,174
15	248	218	12.1%	$ 15,201
16	265	233	12.1%	$ 16,214
17	286	249	12.9%	$ 18,747
18	310	265	14.5%	$ 22,801
19	328	278	15.2%	$ 25,334
20	347	291	16.1%	$ 28,374

		PRESSURE												VACUUM								DIMENSIONS-BARE BLOWER				
BLOWER	SPEED	5 PSIG		9 PSIG		12 PSIG		15 PSIG		18 PSIG		20 PSIG		8 "Hg		12 "Hg		16 "Hg		17 "Hg		(INCHES)			SIZE AND	WT.
MODEL	RPM	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	L	W	H	TYPE PORTS	LBS.
	1200	810	20.2	749	40.0	703	52.3	657	72.4					805	19.5	716	26.2	628	33.0	919	40.7	40 3/8	25 3/4	23	8" Flange	1500
	1500	1069	27.4	1008	50.9	962	65.0	916	84.1	870	98.3			1069	24.0	980	32.1	892	40.6	1112	52.5				13.5" O.D.	
	1800	1328	36.5	1267	63.2	1221	80.0	1175	98.9	1129	113.7	1099	132.5	1333	29.6	1244	39.1	1155	49.4	1305	63.4				Both Ports	
9CDL13	2100	1587	47.7	1526	77.1	1480	97.3	1434	116.6	1388	132.7	1358	155.8	1597	36.4	1508	47.3	1419	59.4	1499	73.3					
	2400	1845	60.5	1784	92.6	1739	116.5	1693	137.4	1647	155.4	1617	180.7	1861	44.6	1772	56.9	1683	70.8	1692	83.3					
	2700	2104	74.5	2043	109.6	1998	137.3	1952	161.2	1906	181.8	1875	206.7	2125	53.9	2036	67.9	1947	83.2	1886	94.8					
	3000	2363	89.5	2302	128.0	2256	159.5	2211	187.9	2165	212.2	2134	234.4	2389	64.5	2300	80.0	2211	96.6	2079	110.7					
	1200	1119	31.1	1045	54.1	988	71.1	932	86.9	876	100.1			1171	24.9	1107	35.5	1043	48.1	1144	51.7	44 1/2	25 3/4	23	Inlet	1673
	1500	1478	40.4	1404	68.9	1347	88.8	1291	105.9	1235	124.7	1198	142.6	1533	31.4	1469	43.5	1405	57.3	1518	66.4				10" Flange	
	1800	1837	51.3	1763	85.3	1706	108.4	1650	128.5	1594	152.0	1557	175.4	1894	39.6	1830	53.1	1766	68.2	1892	80.7				16" O.D.	
9CDL18	2100	2196	64.0	2122	102.9	2065	129.9	2009	154.6	1953	181.6	1916	208.5	2256	49.3	2192	64.2	2128	80.7	2266	94.6				Discharge	
	2400	2555	78.3	2481	121.6	2424	152.8	2368	183.9	2312	214.8	2275	241.8	2617	61.1	2553	77.5	2489	95.3	2640	108.4				8" Flange	
	2700	2914	94.0	2840	140.8	2783	176.3	2727	215.8	2671	252.6	2634	277.3	2979	76.1	2915	94.0	2851	112.4	3014	122.4				13.5" O.D.	
	3000	3273	110.9	3199	160.5	3142	200.5	3086	250.0	3030	293.8	2993	317.7	3340	95.9	3276	114.9	3212	132.7	3387	136.8					
	1200	1337	41.3	1236	68.1	1160	82.4	1084	96.6	1009	116.2			1380	32.5	1255	41.8	1129	52.1	1424	60.4	49 1/2	25 3/4	23	Inlet	1843
	1500	1799	55.0	1698	87.7	1622	107.2	1546	126.1	1471	150.1	1420	169.1	1846	42.1	1720	54.0	1594	68.9	1886	76.0				10" Flange	
	1800	2261	68.8	2160	107.5	2084	132.5	2009	155.3	1933	185.1	1883	203.7	2311	51.4	2186	66.5	2060	85.6	2349	92.0				16" O.D.	
9CDL23	2100	2723	82.7	2622	127.1	2547	157.8	2471	184.1	2395	219.9	2345	238.8	2776	60.6	2651	79.2	2525	102.3	2812	108.1				Discharge	
	2400	3185	96.7	3084	146.8	3009	182.8	2933	213.3	2857	254.1	2807	275.3	3242	69.9	3116	91.8	2991	118.9	3275	124.2				8" Flange	
	2700	3647	110.6	3547	166.6	3471	207.7	3395	243.0	3320	288.5	3269	313.3	3707	79.5	3582	104.0	3456	135.5	3738	139.0				13.5" O.D.	
	3000	4110	124.6	4009	186.5	3933	232.9	3857	271.9	3782	323.6	3731	350.6	4173	89.5	4047	116.0	3922	152.2	4200	151.2					
	800	1628	44.8	1483	78.2	1374	98.5	1265	117.2	1156	136.1			1491	32.4	1304	47.7	1117	61.4	1466	70.5	53	33	29	Inlet	3364
	1100	2348	63.1	2203	109.2	2094	136.8	1985	163.4	1876	192.4	1803	213.7	2238	49.4	2051	68.2	1863	84.3	2272	98.9				14" Flange	
	1400	3068	86.8	2923	141.4	2814	179.3	2705	214.2	2596	252.7	2523	279.7	2984	70.0	2797	92.1	2609	110.8	3078	128.0				21" O.D.	
11CDL23	1700	3788	115.8	3643	176.3	3534	224.9	3425	268.8	3316	316.7	3243	348.9	3730	94.4	3543	119.5	3356	140.7	3884	158.6				Discharge	
	2000	4508	148.5	4363	214.1	4254	271.8	4145	324.9	4036	381.9	3963	416.4	4477	121.4	4290	149.2	4102	172.4	4690	189.5				12" Flange	
	2200	4988	171.6	4843	240.7	4734	303.2	4625	362.7	4516	425.6	4443	461.4	4974	139.8	4787	169.3	4599	194.0	5227	208.6				19" O.D	
	800	1760	51.9	1587	87.8	1458	114.7	1328	138.6					1713	41.3	1509	57.0	1305	74.5	1778	73.9	57	33	29	Inlet	3475
	1100	2599	73.5	2426	120.5	2297	157.7	2167	190.9	2038	226.1	1952	249.8	2581	58.9	2377	80.1	2172	101.5	2713	109.2				14" Flange	
	1400	3438	100.6	3266	158.9	3136	206.4	3007	248.7	2877	292.5	2791	322.8	3448	81.1	3244	106.4	3040	131.5	3647	140.1				21" O.D.	
11CDL27	1700	4278	133.0	4105	202.5	3976	260.4	3846	311.7	3717	366.2	3630	402.5	4316	108.3	4112	135.7	3907	163.8	4582	168.2				Discharge	
	2000	5117	170.0	4944	250.7	4815	317.8	4685	376.7	4556	443.9	4470	484.4	5184	139.4	4980	166.8	4775	196.6	5516	196.7				12" Flange	
	2200	5677	197.2	5504	285.6	5374	357.3	5245	420.7	5115	497.1	5029	539.6	5762	161.5	5558	188.0	5353	218.3	6139	218.1				19" O.D	
	800	2013	56.6	1838	97.5	1707	125.9	1576	154.9	1444	185.8			2077	43.6	1900	62.3	1722	79.5	1856	80.1	61	33	29	Inlet	3672
	1100	2999	80.4	2824	132.4	2692	170.0	2561	207.7	2430	245.9	2342	272.9	2989	63.2	2812	86.5	2634	106.7	2902	113.5				14" Flange	
	1400	3984	108.4	3809	174.9	3677	222.8	3546	271.0	3415	318.0	3327	352.5	3901	87.1	3724	115.1	3545	138.7	3948	146.6				21" O.D.	
11CDL31	1700	4969	140.8	4794	225.0	4663	284.7	4531	344.8	4400	401.7	4312	445.3	4813	115.2	4636	147.8	4457	175.4	4995	180.8				Discharge	
	2000	5954	176.5	5779	280.9	5648	353.9	5516	426.6	5385	494.1	5298	547.5	5725	146.7	5548	183.6	5369	215.7	6041	215.3				12" Flange	
	2200	6611	201.9	6436	320.7	6305	403.4	6173	484.6	6042	559.5	5954	619.7	6333	169.2	6156	208.8	5977	244.2	6739	237.3				19" O.D	

Performance data for air at standard conditions: sea level, 14.7 PSIA. 68ºF inlet temperature, 36% relative humidity. Contact Gardner Denver Blower Division for wet vacuum applications to 24 "Hg.



CycloBlower XP rotors are precision ground using state of the art milling technology.

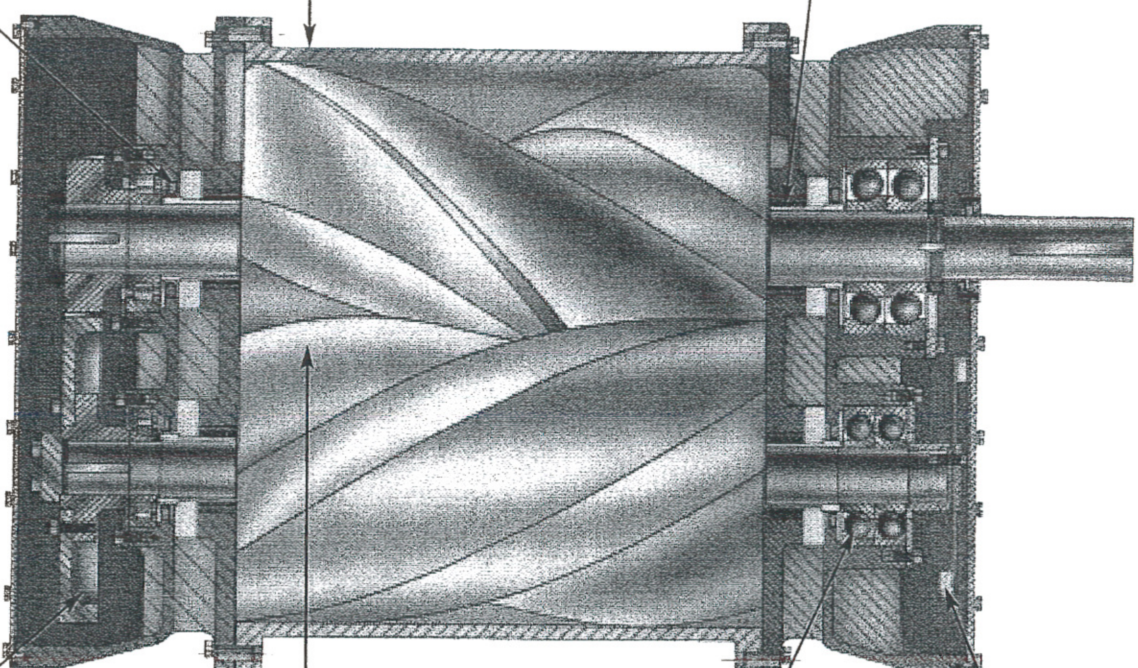
The new CycloBlower® XP is a compact, helical lobe, axial flow, positive displacement blower/vacuum pump capable of up to 20 psig continuous pressure and 17" Hg dry continuous vacuum. The CycloBlower XP combines the most efficient rotor techniques with other features that provide benefits not found in other blower designs. The meshing of two screw-type rotors synchronized by timing gears provides controlled compression of air for maximum efficiency and shock-free discharge. As a result of improved manufacturing systems, assembly methods and internal clearances, the new CycloBlower XP series allows higher operating speeds for increased flow capacities from a compact design. Blower performance efficiency is improved as a result of the higher operating speed capabilities of these blowers. The CycloBlower XP's simple design assures clean air or gas delivery, efficient shock-free compression and dependable operation.

Unique CycloBlower® Design Features

OIL SEALS — Hydrodynamic oil seals automatically push lubricant back towards reservoir for superior sealing

HOUSING — One piece, high strength housing resists deflection to retain accurate running tolerances between rotors. Properly contoured porting provides smooth air flow.

AIR/GAS SEALS — Labyrinth-type shaft seals provide a minimum of controlled leakage of air or gas. Purged labyrinth seals or mechanical seals are available with units handling gas, where leakage cannot be tolerated.



TIMING GEARS — Synchronization of rotors is through a pair of helical timing gears. Precision alloy steel gears provide quiet, accurate operation.

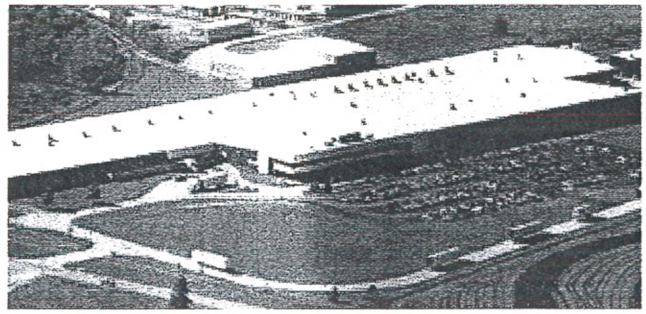
ROTORS — Helical four-flute gate rotor and two-lobe main rotor are milled from high tensile strength ductile iron, stress relieved and dynamically balanced.

BEARINGS — Anti-friction bearings carry the shaft loads in all models. All models use pairs of angular-contact ball bearings on the discharge end and cylindrical roller bearings or single-row ball bearings on the gear end.

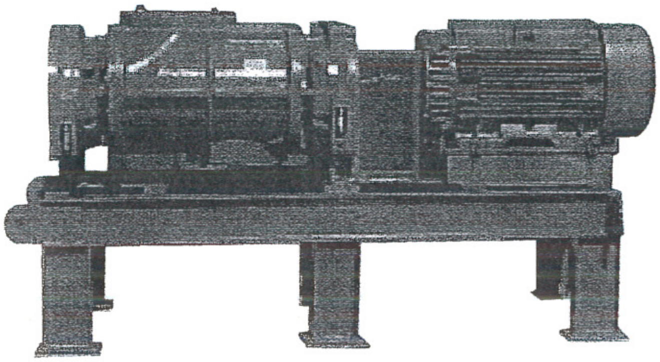
LUBRICATION — Basic design requires no lubrication of rotors. Gears and bearings are lubricated by a splash oil system. An oil pump is not required.

Gardner Denver Engineered Packaging Center

If you need a complete packaged system using a CycloBlower, our Engineered Packaging Center located in Houston, Texas, can custom design a complete pressure or vacuum system to match your air or gas applications. All components are carefully matched and assembled and packaged according to your specification guidelines and application requirements.



All CycloBlowers are manufactured to ISO 9001 standards in our Sedalia, MO plant.



CycloBlower® XP Service & Parts

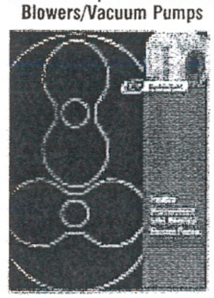
- Factory Trained Service Professionals
- On-site, On-Demand Service
- System Optimization
- Re-manufacturing
- Training, Troubleshooting and Consulting
- Preventative Maintenance Agreements
- Warranty Renewal Programs
- Genuine GD Quality Replacement Parts
- Highest Quality Lubricants and Accessories

Warranty – CycloBlower Industrial XP Series Blowers/ Vacuum Pumps carry one of the industry's strongest warranties. Gardner Denver warrants products manufactured by it to be free of defects in materials and workmanship for a period of one (1) year from date of shipment.

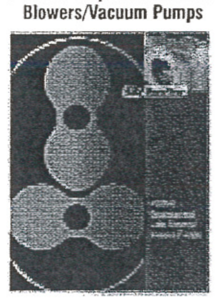
Contact Your CycloBlower Representative

Other Gardner Denver Brochures Available

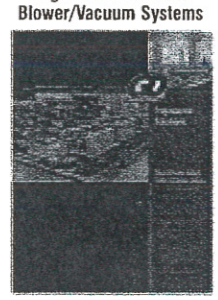
Sutorbilt Legend Positive Displacement Lobe Blowers/Vacuum Pumps



DuroFlow Industrial Positive Displacement Lobe Blowers/Vacuum Pumps



Engineered Solutions Blower/Vacuum Systems



Gardner Denver

For additional information, contact your local representative or

Gardner Denver Blower Division
100 Gardner Park, Peachtree City, GA 30269
Toll Free 800-543-7736 ext. 466
Phone 770-632-5000 • Fax 770-486-5629
E-mail: blowersmktg@gardnerdenver.com
Visit our web site: www.gardnerdenver.com
For Parts Information, Contact:
Gardner Denver Blower Division Customer Service
Phone 770-632-5000 • Fax 770-486-5629

Bulletin 37-2-255 08015M Specifications subject to change without notice. Litho in U.S.A.

APPENDIX B

2006 AND 2007 INFLUENT AND EFFLUENT FLOWS AND WASTEWATER CHARACTERISTICS

Town of Edson - Lagoon Capacity Assessment
Lagoon 2006-2007 Flow Summary

Lagoon Influent flow yearly summary 2006 (M^3)

	Total Monthly	Ave Hourly	Max Hourly	Min Hourly	Min Daily	Max Daily	Ave Daily
January	95713.00				2626.00	3774.00	3087.52
February	88953.60	132.40	205.80	45.30	2893.10	3403.80	3176.90
March	102371.80	137.70	255.60	39.70	2905.50	4349.00	3302.30
April	115537.20	160.50	305.50	56.30	3232.60	5210.40	3851.20
May	126785.40	170.50	394.00	56.30	2967.80	6581.90	4089.90
June	102607.70	142.20	283.30	1.00	23.50	4976.50	3420.30
July	108809.50	146.20	305.50	67.40	3126.00	4040.90	3510.00
August	105414.50	142.00	283.30	61.90	2881.10	4103.10	3400.50
September	113726.10	168.90	349.80	56.30	2997.30	6479.10	4061.60
October	117370.30	157.80	288.90	67.40	3437.90	4482.40	3786.10
November	103076.90	142.40	222.40	56.30	3149.60	4021.00	3435.90
December	102728.60	138.10	211.40	56.30	2813.20	3565.20	3313.80
Total	1283094.6						
Min	88953.6			39.70	23.5		3087.52
Max	126785.4		394			6581.9	4089.9
Ave	106924.55	148.9727					3536.34

January hourly flows cannot be determined, new chart recorder on order at the time.

Exceeded Design Capabilities of lagoon (Approx 4863M^3/D) for 3 distinct periods in 2006

April 1st - 3rd	>>no rainfall
May 25th - June 1st	>>28mm of rain in this period
Sept 15-22nd	>>57mm of rain in this period

Lagoon Influent flow yearly summary 2007 (M^3)

	Total Monthly	Ave Hourly	Max Hourly	Min Hourly	Min Daily	Max Daily	Ave Daily
January	102803.30	138.20	216.90	50.80	3047.60	3508.50	3316.20
February							
March	74403.60	155.00	283.30	45.30	3027.30	4996.10	3720.20
April	135359.90	201.40	449.40	39.70	3204.50	7302.10	4834.30
May	159992.10	215.00	776.00	67.40	3874.30	8713.80	5161.00
June	138190.40	191.90	427.30	95.10	3962.90	6977.30	4606.30
July	118906.60	159.80	255.60	67.40	3193.40	4616.20	3835.70
August							
September							
October							
November							
December							
Total	729655.90						
Min	74403.60			39.70	3027.30		3316.20
Max	159992.10		776.00			8713.80	5161.00
Ave	121609.32	176.88					4245.62

Data Logger failed February, unable to get readings

Town of Edson
Lagoon Capacity Assessment

2006 Waste Water Treatment Annual Report

Month	Inf PH	Inf B.O.D.	Inf T.S.S.	Eff PH	Eff B.O.D.	Eff T.S.S.	Eff C.B.O.D	Note:
January	8.20	107.76	138.67	8.12	19	18.16	11.72	Sewer Flushing
Week2	8.31	112.6	44.55	8.18	29.08	16.43	16.27	
Week3	8.24	118.27	61.11	8.15	23.97	13.62	11.47	
Week4	8.26	120.97	55.55	8.17	28.19	14.44	11.30	
Week5								
Average	**8.25**	**114.90**	**74.97**	**8.16**	**25.05**	**15.66**	**12.69**	
February	8.04	122	78.66	8.01	44.64	10.67	14.80	
Week 2	*	122.65	68.06	*	25.17	10.48	15.98	PH meter away for repairs
Week 3	*	122.55	65.61	*	26.56	8.90	14.60	
Week4	*	135.97	51.50	*	25.09	11.68	13.50	
Week 5								
Average	**8.04**	**125.79**	**65.96**	**8.01**	**30.37**	**10.43**	**14.72**	
March	*	141.13	98.50	*	33.97	12.90	19.22	
Week2	*	117.28	41.05	*	32.49	13.70	20.61	
Week 3	*	130.98	55.17	*	27.79	13.20	20.89	
Week 4	7.90	122.20	87.90	7.69	34.34	11.57	20.73	PH meter repaired
Week5	7.75	112.65	64.11	7.69	31.56	16.21	18.31	
Average	**7.83**	**124.85**	**69.35**	**7.69**	**32.03**	**13.52**	**19.95**	
April	7.51	109.10	71.39	7.87	32.82	17.86	15.36	
Week 2	7.93	135.03	328.22	7.89	29.28	16.22	18.52	
Week3	7.84	141.46	279.33	8.06	38.43	24.15	15.23	
Week4	7.99	139.70	289.10	8.66	25.60	20.91	14.33	
Week 5								
Average	**7.82**	**131.32**	**242.01**	**8.12**	**31.53**	**19.79**	**15.86**	
May	7.92	121.17	118.39	8.40	20.76	28.55	8.36	
Week 2	8.02	143.30	266.20	8.50	23.48	34.30	19.44	
Week 3	8.84	124.18	152.72	7.98	28.96	27.66	10.58	
Week4	8.03	148.60	195.56	8.74	36.68	34.83	6.37	
Week 5	8.07	142.78	338.39	8.65	34.99	28.93	17.19	
Average	**8.18**	**136.01**	**214.25**	**8.45**	**28.97**	**30.85**	**12.39**	
June	7.87	132.22	242.50	8.86	37.07	48.01	25.96	Anaerobic ponds being cleaned
Week2	7.81	130.12	255.89	8.21	45.64	45.41	13.79	
Week3	7.90	139.25	261.39	8.47	46.03	59.98	15.45	
Week 4	7.93	146.53	209.94	8.97	28.34	52.42	13.18	
Week 5								
Average	**7.88**	**137.03**	**242.43**	**8.63**	**39.27**	**51.46**	**17.10**	
July	7.66	145.75	226.61	8.54	19.47	18.67	8.12	
Week2	7.77	138.53	246.55	8.62	35.20	21.81	5.59	
Week3	7.79	134.36	197.17	9.06	26.14	53.18	17.88	
Week 4	8.02	140.03	129.33	9.38	38.47	36.64	19.23	
Week 5								
Average	**7.81**	**139.67**	**199.92**	**8.90**	**29.82**	**32.58**	**12.71**	
August	7.93	131.05	195.89	8.88	53.34	105.60	43.34	Bruce Lange Notified, Power failures in aeraters.
Week2	7.85	138.00	140.89	9.28	49.92	59.33	32.26	
Week 3	7.86	145.15	256.06	9.05	20.77	28.54	15.91	
Week4	7.88	147.52	184.43	8.53	20.98	19.32	11.96	
Week 5	7.57	138.17	148.77	8.16	14.67	7.07	3.68	
Average	**7.82**	**139.98**	**185.21**	**8.78**	**31.94**	**43.97**	**21.43**	
September	7.71	146.95	208.00	8.27	11.59	12.10	7.04	
Week2	7.78	149.15	152.20	8.03	28.30	32.80	17.30	
Week3	7.86	104.15	20.20	8.35	19.87	1.49	6.08	
Week4	7.76	127.90	403.00	8.31	12.57	8.50	4.49	
Week 5								
Average	**7.78**	**132.04**	**195.85**	**8.24**	**18.08**	**13.72**	**8.73**	
October	7.65	112.32	137.40	8.39	13.91	15.00	7.07	
Week2	7.57	114.30	153.90	8.32	10.69	12.80	6.69	
Week 3	7.85	114.30	457.70	8.28	7.90	9.60	5.67	
Week4	7.87	110.82	272.00	8.12	7.20	8.90	7.02	
Week 5								
Average	**7.74**	**112.94**	**255.25**	**8.28**	**9.93**	**11.58**	**6.61**	
November	7.99	115.57	184.06	7.77	5.68	6.00	2.92	
Week2	7.86	128.45	184.40	8.03	9.23	6.40	9.23	
Week3	8.01	119.37	94.56	8.14	9.37	5.71	4.49	
Week 4	7.81	129.92	58.40	8.16	8.83	4.90	5.77	
Week5	8.37	115.27	134.93	7.89	4.35	5.37	3.14	
Average	**8.01**	**121.72**	**131.27**	**8.00**	**7.49**	**5.68**	**5.11**	
December	7.94	117.60	128.80	7.75	12.30	3.70	9.80	
Week2	8.01	100.17	158.10	7.91	14.73	4.40	9.80	
Week 3	8.45	94.25	150.10	8.09	14.35	10.40	12.04	
Week4	8.68	73.90	192.70	7.98	32.87	6.50	11.38	
Week 5								
Average	**8.27**	**96.48**	**157.43**	**7.93**	**18.56**	**6.25**	**10.76**	
Min	**7.51**	**73.90**	**20.20**	**7.69**	**4.35**	**1.49**	**2.92**	
Max	**8.84**	**149.15**	**457.70**	**9.38**	**53.34**	**105.60**	**43.34**	
Average	**7.95**	**126.06**	**169.49**	**8.27**	**25.25**	**21.29**	**13.17**	

Town of Edson
Lagoon Capacity Assessment

2007 Waste Water Treatment Annual Report

Month	Inf PH	Inf B.O.D.	Inf T.S.S.	Eff PH	Eff B.O.D.	Eff T.S.S.	Eff C.B.O.D	Note:
January	8.17	109.78	158.67	7.91	23.50	7.57	15.75	
Week 2	8.14	124.67	199.17	7.98	20.05	8.16	14.68	
Week 3	8.37	103.75	147.90	8.04	27.60	7.20	20.15	
Week4	8.16	117.60	222.43	7.85	35.05	10.94	26.21	Contravention #182259
Week 5	8.14	126.60	287.60	7.88	3.10	14.80	27.90	Contravention #182259
Average	**8.20**	**116.48**	**203.15**	**7.93**	**21.86**	**9.73**	**20.94**	
February	8.28	126.15	319.33	7.82	41.54	10.89	36.18	
Week 2	8.40	124.58	402.40	7.87	40.29	16.77	35.33	Contravention #182669
Week 3	8.14	128.35	250.67	8.10	40.64	17.8	35.13	
Week 4	8.23	113.95	154.06	7.94	40.72	15.97	38.24	
Week 5								
Average	**8.26**	**123.26**	**281.62**	**7.93**	**40.80**	**15.36**	**36.22**	
March	8.27	129.87	331.80	8.03	41.70	17.97	39.10	Contravention #183581
Week2	8.16	132.85	407.80	7.89	35.20	18.37	39.72	Contravention #183581
Week 3	8.27	131.80	563.50	7.98	41.70	19.70	41.30	Contravention #183581
Week4	8.15	105.87	426.11	7.89	37.41	17.00	39.50	Contravention #183581
Week 5								
Average	**8.21**	**125.10**	**432.30**	**7.95**	**39.00**	**18.26**	**39.91**	
April	8.34	101.10	423.50	7.96	40.50	12.6	39.00	Contravention #183581
Week 2	8.34	80.30	428.60	7.89	38.20	17.80	28.90	Contravention #183581
Week 3	7.83	64.90	89.30	7.90	24.60	14.90	18.40	
Week 4	7.85	58.30	136.60	8.02	17.69	17.20	13.76	
Week 5								
Average	**8.09**	**76.15**	**269.50**	**7.94**	**30.25**	**15.63**	**25.02**	
May	7.86	82.17	136.50	8.15	17.38	27.30	15.93	
Week2	7.86	58.97	143.90	8.16	18.20	30.80	10.80	
Week 3	8.01	63.32	105.28	8.89	23.52	33.32	14.64	
Week 4	7.72	98.80	147.10	8.81	29.50	28.70	16.10	
Week 5	7.55	99.50	74.30	8.58	14.70	10.90	8.50	
Average	**7.80**	**80.55**	**121.42**	**8.52**	**20.66**	**26.20**	**13.19**	
June	8.14	95.10	114.20	8.85	16.90	17.30	11.30	
Week 2	7.75	98.70	249.80	8.30	14.50	23.60	12.50	
Week3	7.66	93.00	119.40	8.31	11.50	20.50	8.65	
Week4	7.85	94.42	222.00	8.48	27.05	21.00	16.28	
Week 5								
Average	**7.85**	**95.31**	**176.35**	**8.49**	**17.49**	**20.60**	**12.18**	

APPENDIX C

SCENARIO CALCULATIONS

Town of Edson
Lagoon Capacity Assessment
Summer - Coefficient Cross-Check

#1 Cell - Completely Mixed Aerated Lagoon

Data Based on July 2007

INPUT VALUES			
flow, max month	m^3/day	3835	
influent BOD	mg/L	112	Aerobic Inf. Sample
k20	day^{-1}	0.20	AB Env: up to 1.5 (0.14-0.3)
θ		1.06	range (1.06 to 1.12)
T	C	12	estimate
depth	m	3.66	
number of cells		1	
V (total)	m^3	43825	
CALCULATED VALUES			
T corrected k	day^{-1}	0.13	
V (per cell)	m^3	43825	
A (total)	ha	1.197	
effluent BOD	mg/L	46	
CHECKS			
HRT	day	11.4	range (5 to 30)
BOD loading rate	kg/ha d	359	range (100 to 400)

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	3835	
influent BOD	mg/L	46	
k20	day^{-1}	0.14	AB Env: 0.37 (0.14-0.3)
θ		1.06	range (1.06 to 1.12)
T	C	12	
depth	m	3.66	
number of cells		1	
V (total)	m^3	79135	
CALCULATED VALUES			
T corrected k	day^{-1}	0.09	
V (per cell)	m^3	79135	
A (total)	ha	2.162	
effluent BOD	mg/L	7.5	
CHECKS			
HRT	day	20.6	range (5 to 30)
BOD loading rate	kg/ha d	82	range (100 to 400)
effluent BOD - calc	mg/L	8	25 to meet permit
effluent BOD -sample	mg/L		

Figure C.1

Town of Edson
Lagoon Capacity Assessment
Spring 2007 - High Flows

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow, max month	m^3/day	4834	April 2007 Avg Daily
influent BOD	mg/L	125	
k20	day^{-1}	0.20	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
V (total)	m^3	43825	
CALCULATED VALUES			
T corrected k	day^{-1}	0.08	
V (per cell)	m^3	43825	
A (total)	ha	1.197	
effluent BOD	mg/L	73	
CHECKS			
HRT	day	9.1	range (5 to 30)
BOD loading rate	kg/ha d	505	range (100 to 600)

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	4834	
influent BOD	mg/L	73	
k20	day^{-1}	0.14	AB Env
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
V (total)	m^3	79135	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (per cell)	m^3	79135	
A (total)	ha	2.162	
effluent BOD	mg/L	30	
CHECKS			
HRT	day	16.4	range (5 to 30)
BOD loading rate	kg/ha d	163	range (100 to 400)
effluent BOD	mg/L	30	25 to meet permit

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

Figure C.2

Town of Edson
Lagoon Capacity Assessment
Summer - Current Flows

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow, max month	m^3/day	5200	
influent BOD	mg/L	150	
k20	day^{-1}	0.20	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
V (total)	m^3	43828	
CALCULATED VALUES			
T corrected k	day^{-1}	0.14	
V (per cell)	m^3	43828	
A (total)	ha	1.197	
effluent BOD	mg/L	69	
CHECKS			
HRT	day	8.4	range (5 to 30)
BOD loading rate	kg/ha d	651	range (100 to 600)

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	5200	
influent BOD	mg/L	69	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
V (total)	m^3	79138	
CALCULATED VALUES			
T corrected k	day^{-1}	0.10	
V (per cell)	m^3	79138	
A (total)	ha	2.162	
effluent BOD	mg/L	15.26	
CHECKS			
HRT	day	15.2	range (5 to 30)
BOD loading rate	kg/ha d	165	range (100 to 400)
effluent BOD	mg/L	15	25 to meet permit

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

Figure C.3 G:\ca\CalgaryAB\work\100000\100870\02-Design\WAT\Edson - cold climate sizing rev 2.xlsSummer Design- actual

Town of Edson
Lagoon Capacity Assessment
Summer - Maximum Capacity - Existing Train

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow, max month	m^3/day	6500	
influent BOD	mg/L	150	
k20	day^{-1}	0.20	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
V (total)	m^3	43828	
CALCULATED VALUES			
T corrected k	day^{-1}	0.14	
V (per cell)	m^3	43828	
A (total)	ha	1.197	
effluent BOD	mg/L	77	
CHECKS			
HRT	day	6.7	range (5 to 30)
BOD loading rate	kg/ha d	814	range (100 to 600)

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	6500	
influent BOD	mg/L	77	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
V (total)	m^3	79138	
CALCULATED VALUES			
T corrected k	day^{-1}	0.10	
V (per cell)	m^3	79138	
A (total)	ha	2.162	
effluent BOD	mg/L	23.12	
CHECKS			
HRT	day	12.2	range (5 to 30)
BOD loading rate	kg/ha d	231	range (100 to 400)
effluent BOD	mg/L	23	25 to meet permit

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

Figure C.4 G:\ca\CalgaryAB\work\100000\100870\02-Design\WAT\Edson - cold climate sizing rev 2.xlsSummer Design- actual max

Town of Edson
Lagoon Capacity Assessment
Winter - Current Flows

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow, max month	m^3/day	3750	
influent BOD	mg/L	125	
k20	day^{-1}	0.20	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
V (total)	m^3	43825	
CALCULATED VALUES			
T corrected k	day^{-1}	0.08	
V (per cell)	m^3	43825	
A (total)	ha	1.197	
effluent BOD	mg/L	65	
CHECKS			
HRT	day	11.7	range (5 to 30)
BOD loading rate	kg/ha d	391	range (100 to 600)

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	3750	
influent BOD	mg/L	65	
k20	day^{-1}	0.14	AB Env
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
V (total)	m^3	79135	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (per cell)	m^3	79135	
A (total)	ha	2.162	
effluent BOD	mg/L	20	
CHECKS			
HRT	day	21.1	range (5 to 30)
BOD loading rate	kg/ha d	113	range (100 to 400)
effluent BOD	mg/L	20	25 to meet permit

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

Figure C.5

Town of Edson
Lagoon Capacity Assessment
Winter - Maximum Capacity - Existing Train

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow, max month	m^3/day	4000	
influent BOD	mg/L	125	
k20	day^{-1}	0.20	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
V (total)	m^3	43825	
CALCULATED VALUES			
T corrected k	day^{-1}	0.08	
V (per cell)	m^3	43825	
A (total)	ha	1.197	
effluent BOD	mg/L	67	
CHECKS			
HRT	day	11.0	range (5 to 30)
BOD loading rate	kg/ha d	418	range (100 to 600)

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	4000	
influent BOD	mg/L	67	
k20	day^{-1}	0.14	AB Env
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
V (total)	m^3	79135	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (per cell)	m^3	79135	
A (total)	ha	2.162	
effluent BOD	mg/L	23	
CHECKS			
HRT	day	19.8	range (5 to 30)
BOD loading rate	kg/ha d	124	range (100 to 400)
effluent BOD	mg/L	23	25 to meet permit

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

Figure C.6 G:\ca\CalgaryAB\work\100000\100870\02-Design\WAT\Edson - cold climate sizing rev 2.xlsWinter Design- actual max

Town of Edson
Lagoon Capacity Assessment
Summer - 15000 People - 1 Train - AB Env. Coefficients

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow, max month	m^3/day	8750	
influent BOD	mg/L	150	
k20	day^{-1}	0.60	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
V (total)	m^3	43828	
CALCULATED VALUES			
T corrected k	day^{-1}	0.42	
V (per cell)	m^3	43828	
A (total)	ha	1.197	
effluent BOD	mg/L	48	
CHECKS			
HRT	day	5.0	range (5 to 30)
BOD loading rate	kg/ha d	1096	range (100 to 600)

Reference - AB Env. Guidelines 2006

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	8750	
influent BOD	mg/L	48	
k20	day^{-1}	0.37	AB Env: 0.37
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
V (total)	m^3	79138	
CALCULATED VALUES			
T corrected k	day^{-1}	0.26	
V (per cell)	m^3	79138	
A (total)	ha	2.162	
effluent BOD	mg/L	4.55	
CHECKS			
HRT	day	9.0	range (5 to 30)
BOD loading rate	kg/ha d	195	range (100 to 400)
effluent BOD	mg/L	5	25 to meet permit

Reference - AB Env. Guidelines 2006

Figure C.7 G:\ca\CalgaryAB\work\100000\100870\02-Design\WAT\Edson - cold climate sizing rev 2.xlsSummer Design- 15000 AB

Town of Edson
Lagoon Capacity Assessment
Winter - 15000 People - 1 Train - AB Env Coefficients

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow, max month	m^3/day	6310	
influent BOD	mg/L	125	
k20	day^{-1}	0.60	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
V (total)	m^3	43825	
CALCULATED VALUES			
T corrected k	day^{-1}	0.24	
V (per cell)	m^3	43825	
A (total)	ha	1.197	
effluent BOD	mg/L	47	
CHECKS			
HRT	day	6.9	range (5 to 30)
BOD loading rate	kg/ha d	659	range (100 to 600)

Reference - AB Env. Guidelines 2006

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	6310	
influent BOD	mg/L	47	
k20	day^{-1}	0.37	AB Env
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
V (total)	m^3	79135	
CALCULATED VALUES			
T corrected k	day^{-1}	0.15	
V (per cell)	m^3	79135	
A (total)	ha	2.162	
effluent BOD	mg/L	8	
CHECKS			
HRT	day	12.5	range (5 to 30)
BOD loading rate	kg/ha d	138	range (100 to 400)
effluent BOD	mg/L	8	25 to meet permit

Reference - AB Env. Guidelines 2006

Figure C.8 G:\ca\CalgaryAB\work\100000\100870\02-Design\WAT\Edson - cold climate sizing rev 2.xlsWinter Design- 15000 AB

Town of Edson
Lagoon Capacity Assessment
Summer - 15000 People - 1 Train - Converted Storage Pond 3

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow	m^3/day	8750	
influent BOD	mg/L	150	
effluent BOD	mg/L	88	
k20	day^{-1}	0.20	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.14	
V (total)	m^3	43724	
V (per cell)	m^3	43724	
A (total)	ha	1.195	
CHECKS			
HRT	day	5.0	range (5 to 30)
BOD loading rate	kg/ha d	1099	range (100 to 600)
V total	m3	43724	43830 Existing

Reference - WEF Manual of Practice (4th Edition)

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	8750	
influent BOD	mg/L	88	
effluent BOD	mg/L	35	
k20	day^{-1}	0.14	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.10	
V (total)	m^3	81741	
V (per cell)	m^3	81741	
A (total)	ha	2.233	
CHECKS			
HRT	day	9.3	range (5 to 30)
BOD loading rate	kg/ha d	345	range (100 to 400)
V total	m3	81741	79140 Existing

Reference - WEF Manual of Practice (4th Edition)

#3 Cell - Partially Mixed Aerated Lagoon (Plug Flow) (Converted Portion of Storage Pond #3)

INPUT VALUES			
flow	m^3/day	8750	
influent BOD	mg/L	35	
effluent BOD	mg/L	20	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.10	
V (total)	m^3	49614	
V (per cell)	m^3	49614	
A (total)	ha	1.356	
CHECKS			
HRT	day	5.7	range (5 to 30)
BOD loading rate	kg/ha d	226	range (100 to 400)
V converted, total	m3	49614	
			223,488 m3 available less converted
Storage Pond HRT	day	20	V; need 5 days

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

Figure C.9

G:\ca\CalgaryAB\work\100000\10087002-Design\WAT\Edson - cold climate sizing rev 2.xlsSummer Design-15000-WEF

Town of Edson
Lagoon Capacity Assessment
Summer - 15000 People - 2 Trains - Converted Storage Pond 3

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow	m^3/day	4375	2 trains @ 15,000
influent BOD	mg/L	150	
effluent BOD	mg/L	63	
k20	day^{-1}	0.20	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	

CALCULATED VALUES			
T corrected k	day^{-1}	0.14	
V (total)	m^3	42851	
V (per cell)	m^3	42851	
A (total)	ha	1.171	

CHECKS			
HRT	day	9.8	range (5 to 30)
BOD loading rate	kg/ha d	561	range (100 to 600)
V total	m3	42851	43830 Existing

Reference - WEF Manual of Practice (4th Edition)

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	4375	2 trains @ 15,000
influent BOD	mg/L	63	
effluent BOD	mg/L	11	
k20	day^{-1}	0.14	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	

CALCULATED VALUES			
T corrected k	day^{-1}	0.10	
V (total)	m^3	77364	
V (per cell)	m^3	77364	
A (total)	ha	2.114	

CHECKS			
HRT	day	17.7	range (5 to 30)
BOD loading rate	kg/ha d	130	range (100 to 400)
V total	m3	77364	79140 Existing

Reference - WEF Manual of Practice (4th Edition)

#3 Cell - Storage Cell (Converted Portion of Storage Pond #3)

INPUT VALUES			
flow	m^3/day	8750	all the flow
influent BOD	mg/L	11	
effluent BOD	mg/L	5	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	

CALCULATED VALUES			
T corrected k	day^{-1}	0.10	
V (total)	m^3	103273	Remaining Storage Pond
V (per cell)	m^3	103273	
A (total)	ha	2.822	

CHECKS			
			223,488 m3 available less converted
Storage Pond HRT	day	11.8	V; need 5 days
V converted, total	m3	120215	To Aerobic Cells

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

Figure C.10

Town of Edson
Lagoon Capacity Assessment
Summer - Maximum Capacity - Trains - Converted Storage Pond 3

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow	m^3/day	4800	2 trains
influent BOD	mg/L	150	
effluent BOD	mg/L	65.5	
k20	day^{-1}	0.20	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.14	
V (total)	m^3	43920	
V (per cell)	m^3	43920	
A (total)	ha	1.200	
CHECKS			
HRT	day	9.1	range (5 to 30)
BOD loading rate	kg/ha d	600	range (100 to 600)
V total	m3	43920	43830 Existing

Reference - WEF Manual of Practice (4th Edition)

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	4800	2 trains @ 15,000
influent BOD	mg/L	65.5	
effluent BOD	mg/L	13	
k20	day^{-1}	0.14	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.10	
V (total)	m^3	78648	
V (per cell)	m^3	78648	
A (total)	ha	2.149	
CHECKS			
HRT	day	16.4	range (5 to 30)
BOD loading rate	kg/ha d	146	range (100 to 400)
V total	m3	78648	79140 Existing

Reference - WEF Manual of Practice (4th Edition)

#3 Cell - Storage Cell (Converted Portion of Storage Pond #3)

INPUT VALUES			
flow	m^3/day	9600	all the flow
influent BOD	mg/L	13	
effluent BOD	mg/L	5	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.10	
V (total)	m^3	100920	Remaining Storage Pond
V (per cell)	m^3	100920	
A (total)	ha	2.757	
CHECKS			
			223,488 m3 available less converted
Storage Pond HRT	day	10.5	V; need 5 days
V converted, total	m3	122568	To Aerobic Cells

Reference - WEF Manual of Practice (4th Edition)
Reference - AB Env. Guidelines 2006

Figure C.11

Town of Edson
Lagoon Capacity Assessment
Winter - 15000 People - 1 Train - Converted Storage Pond 3

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow	m^3/day	6310	"@ 15,000 people
influent BOD	mg/L	125	
effluent BOD	mg/L	80	
k20	day^{-1}	0.20	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.08	
V (total)	m^3	45083	required
V (per cell)	m^3	45083	
A (total)	ha	1.232	
CHECKS			
HRT	day	7.1	range (5 to 30)
BOD loading rate	kg/ha d	640	range (100 to 600)
V total	m3	45083	43830 Existing

Reference - WEF Manual of Practice (4th Edition)

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	6310	
influent BOD	mg/L	80	
effluent BOD	mg/L	40	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (total)	m^3	79363	
V (per cell)	m^3	79363	
A (total)	ha	2.168	
CHECKS			
HRT	day	12.6	range (5 to 30)
BOD loading rate	kg/ha d	233	range (100 to 400)
V total	m3	79363	79140 Existing

Reference - WEF Manual of Practice (4th Edition)

#3 Cell - Partially Mixed Aerated Lagoon (Plug Flow) (Converted Portion of Storage Pond #3)

INPUT VALUES			
flow	m^3/day	6310	
influent BOD	mg/L	40	
effluent BOD	mg/L	20	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (total)	m^3	79363	
V (per cell)	m^3	79363	
A (total)	ha	2.168	
CHECKS			
HRT	day	12.6	range (5 to 30)
BOD loading rate	kg/ha d	116	range (100 to 400)
V converted, total	m3	79363	
			223,488 m3 available less
Storage Pond HRT	day	23	converted V; need 5 days

Reference - WEF Manual of Practice (4th Edition)

Figure C.12

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow	m^3/day	3155	"2 trains @ 15,000 people
influent BOD	mg/L	125	
effluent BOD	mg/L	60	
k20	day^{-1}	0.20	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.08	
V (total)	m^3	43414	required
V (per cell)	m^3	43414	
A (total)	ha	1.186	
CHECKS			
HRT	day	13.8	range (5 to 30)
BOD loading rate	kg/ha d	332	range (100 to 600)
V total	m3	43414	43830 Existing

Reference - WEF Manual of Practice (4th Edition)

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	3155	
influent BOD	mg/L	60	
effluent BOD	mg/L	16	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (total)	m^3	75669	
V (per cell)	m^3	75669	
A (total)	ha	2.067	
CHECKS			
HRT	day	24.0	range (5 to 30)
BOD loading rate	kg/ha d	92	range (100 to 400)
V total	m3	75669	79140 Existing

Reference - WEF Manual of Practice (4th Edition)

#3 Cell - Partially Mixed Aerated Lagoon (Plug Flow) (Converted Portion of Storage Pond #3)

INPUT VALUES			
flow	m^3/day	6310	
influent BOD	mg/L	16	
effluent BOD	mg/L	8	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (total)	m^3	104406	Remaining Storage Cell
V (per cell)	m^3	104406	
A (total)	ha	2.853	
CHECKS			
Storage Pond HRT	day	16.5	223,488 m3 available less converted V; need 5 days
V converted, total	m3	119082	Converted to Aerobic

Reference - WEF Manual of Practice (4th Edition)

Figure C.13

Town of Edson
Lagoon Capacity Assessment
Winter - Maximum Capacity - 2 Trains - Converted Storage Pond 3

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow	m^3/day	4000	"2 trains
influent BOD	mg/L	125	
effluent BOD	mg/L	68	
k20	day^{-1}	0.20	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.08	
V (total)	m^3	42588	required
V (per cell)	m^3	42588	
A (total)	ha	1.164	
CHECKS			
HRT	day	10.6	range (5 to 30)
BOD loading rate	kg/ha d	430	range (100 to 600)
V total	m3	42588	43830 Existing

Reference - WEF Manual of Practice (4th Edition)

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	4000	
influent BOD	mg/L	68	
effluent BOD	mg/L	23	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (total)	m^3	78679	
V (per cell)	m^3	78679	
A (total)	ha	2.150	
CHECKS			
HRT	day	19.7	range (5 to 30)
BOD loading rate	kg/ha d	127	range (100 to 400)
V total	m3	78679	79140 Existing

Reference - WEF Manual of Practice (4th Edition)

#3 Cell - Partially Mixed Aerated Lagoon (Plug Flow) (Converted Portion of Storage Pond #3)

INPUT VALUES			
flow	m^3/day	8000	
influent BOD	mg/L	23	
effluent BOD	mg/L	8	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (total)	m^3	102220	Remaining Storage Cell
V (per cell)	m^3	102220	
A (total)	ha	2.793	
CHECKS			
			223,488 m3 available less
Storage Pond HRT	day	12.8	converted V; need 5 days
V converted, total	m3	121268	Converted to Aerobic

Reference - WEF Manual of Practice (4th Edition)

Figure C.14

G:\ca\Calgary\AB\work\100000\10087002-Design\WAT\Edson - cold climate sizing rev 2.xls Winter Design-15000-WEF 2max

Town of Edson
Lagoon Capacity Assessment
Summer - Maximum Capacity - 1 Train - Converted Storage Pond 3

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow	m^3/day	12000	
influent BOD	mg/L	150	
effluent BOD	mg/L	100	
k20	day^{-1}	0.20	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.14	
V (total)	m^3	42556	
V (per cell)	m^3	42556	
A (total)	ha	1.163	
CHECKS			
HRT	day	3.5	range (5 to 30)
BOD loading rate	kg/ha d	1548	range (100 to 600)
V total	m3	42556	43830 Existing

Reference - AB Env. Guidelines 2006

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	12000	
influent BOD	mg/L	100	
effluent BOD	mg/L	52	
k20	day^{-1}	0.14	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.10	
V (total)	m^3	79509	
V (per cell)	m^3	79509	
A (total)	ha	2.172	
CHECKS			
HRT	day	6.6	range (5 to 30)
BOD loading rate	kg/ha d	552	range (100 to 400)
V total	m3	79509	79140 Existing

Reference - AB Env. Guidelines 2006

#3 Cell - Partially Mixed Aerated Lagoon (Plug Flow) (Converted Portion of Storage Pond #3)

INPUT VALUES			
flow	m^3/day	12000	
influent BOD	mg/L	52	
effluent BOD	mg/L	20	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	14	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.10	
V (total)	m^3	116178	
V (per cell)	m^3	116178	
A (total)	ha	3.174	
CHECKS			
HRT	day	9.7	range (5 to 30)
BOD loading rate	kg/ha d	197	range (100 to 400)
V converted, total	m3	116178	
			223,488 m3 available less converted
Storage Pond HRT	day	9	V; need 5 days

Reference - AB Env. Guidelines 2006

Figure C.15

Town of Edson
Lagoon Capacity Assessment
Winter - Maximum Capacity - 1 Train - Converted Storage Pond 3

#1 Cell - Completely Mixed Aerated Lagoon

INPUT VALUES			
flow	m^3/day	8250	
influent BOD	mg/L	125	
effluent BOD	mg/L	89	
k20	day^{-1}	0.20	AB Env: up to 1.5
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.08	
V (total)	m^3	42387	required
V (per cell)	m^3	42387	
A (total)	ha	1.158	
CHECKS			
HRT	day	5.1	range (5 to 30)
BOD loading rate	kg/ha d	890	range (100 to 400)
V total	m3	42387	43830 Existing

Reference - WEF Manual of Practice (4th Edition)

#2 Cell - Partially Mixed Aerated Lagoon (Plug Flow)

INPUT VALUES			
flow	m^3/day	8250	
influent BOD	mg/L	89	
effluent BOD	mg/L	53	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (total)	m^3	77596	
V (per cell)	m^3	77596	
A (total)	ha	2.120	
CHECKS			
HRT	day	9.4	range (5 to 30)
BOD loading rate	kg/ha d	346	range (100 to 400)
V total	m3	77596	79140 Existing

Reference - WEF Manual of Practice (4th Edition)

#3 Cell - Partially Mixed Aerated Lagoon (Plug Flow) (Converted Portion of Storage Pond #3)

INPUT VALUES			
flow	m^3/day	8250	
influent BOD	mg/L	53	
effluent BOD	mg/L	20	
k20	day^{-1}	0.14	range (0.14 to 0.3)
θ		1.06	range (1.06 to 1.12)
T	C	4	
depth	m	3.66	
number of cells		1	
CALCULATED VALUES			
T corrected k	day^{-1}	0.06	
V (total)	m^3	145891	
V (per cell)	m^3	145891	
A (total)	ha	3.986	
CHECKS			
HRT	day	17.7	range (5 to 30)
BOD loading rate	kg/ha d	110	range (100 to 400)
V converted, total	m3	145891	
Storage Pond HRT	day	9	223,488 m3 available less converted V; need 5 days

Reference - WEF Manual of Practice (4th Edition)

Figure C.16

APPENDIX D

ALBERTA ENVIRONMENT DETAILED AERATION SYSTEM DESIGN SUMMARY TABLE

Appendix D
Aeration System Design Summary per Alberta Environment Guidelines

Table D.1 Current Aeration System Design Summary Table

	Winter			Summer		
Criteria	**Aerob 1**	**Aerob 2**	**Total**	**Aerob 1**	**Aerob 2**	**Total**
1. CBOD reduction as % of average daily design BOD loading, %	49.6	27.5	77.2	57.3	36.1	93.4
2. CBOD removed, kg/d	217.2	120.5	337.7	395.6	249.0	644.6
3. CBOD removed, kg/hr	9.0	5.0	14.1	16.5	10.4	26.9
4. AOR, kg/hr	13.6	7.5	21.1	24.7	15.6	40.3
5. Oxygen transfer correction ratio	0.36	0.36	0.36	0.46	0.46	0.46
6. SOR Kg/hr	37.8	21.0	58.8	53.9	33.9	87.5

The highest total oxygen transfer rate is used to size the aeration system for the applied CBOD loading.

APPENDIX E

AVAILABLE RAW DATA

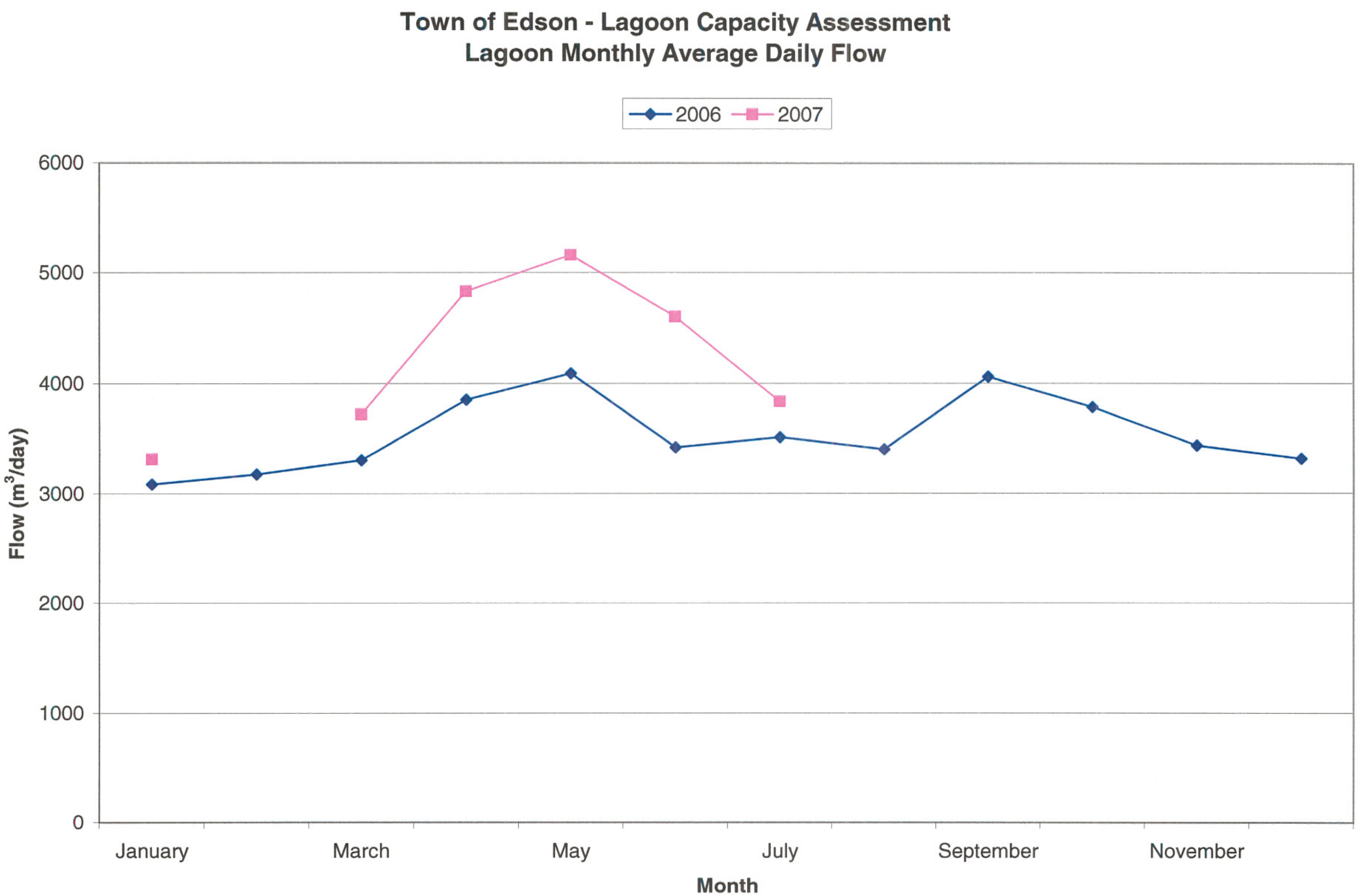


Figure E-1

L:\work\100000\100870\03-Report\Appendices\Appendix E - Wastewater Graphs\Figure E-1Ave Daily.xls

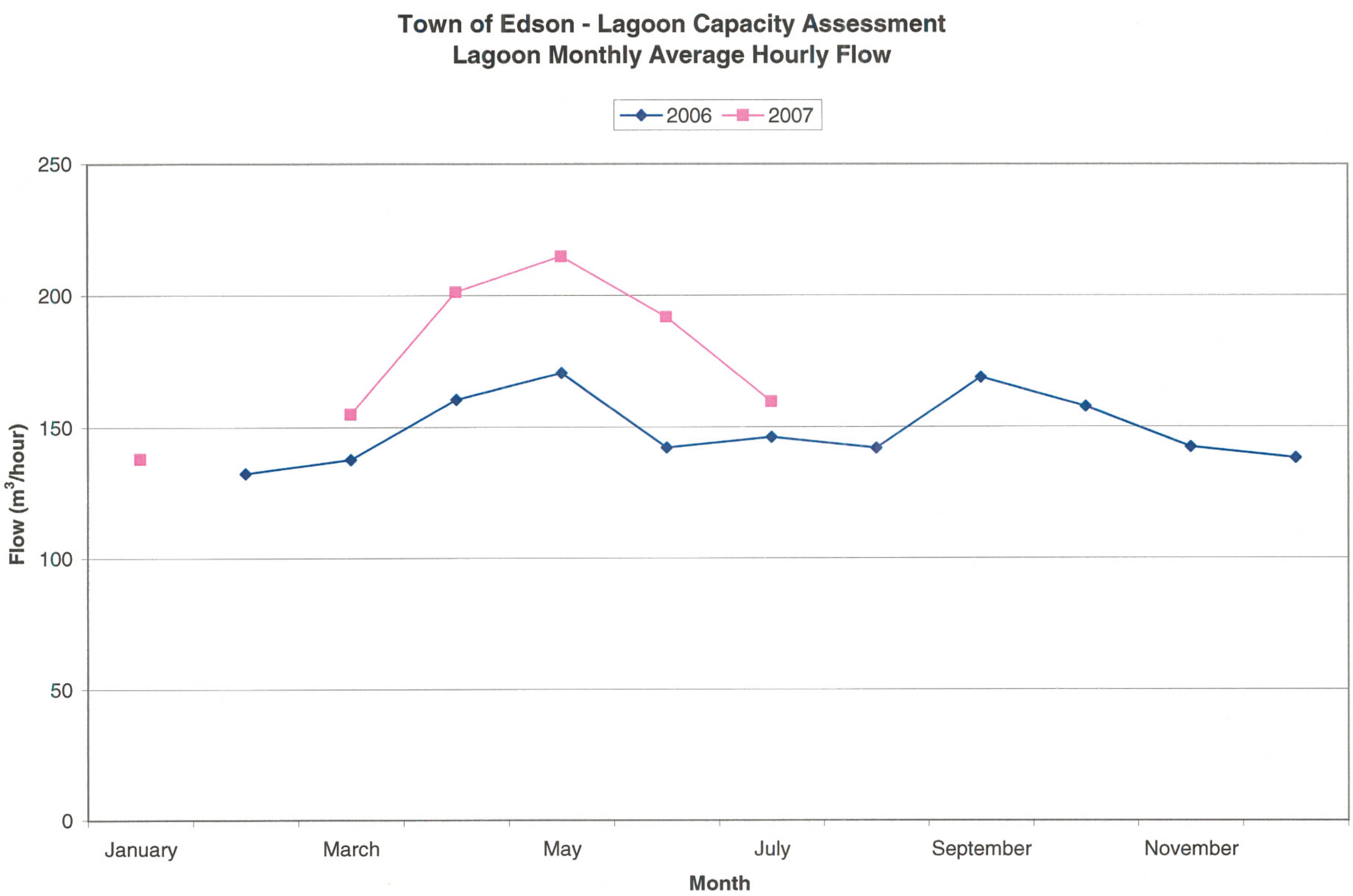


Figure E-2

L:\work\100000\100870\03-Report\Appendices\Appendix E - Wastewater Graphs\Figure E-2 Ave hourly.xls

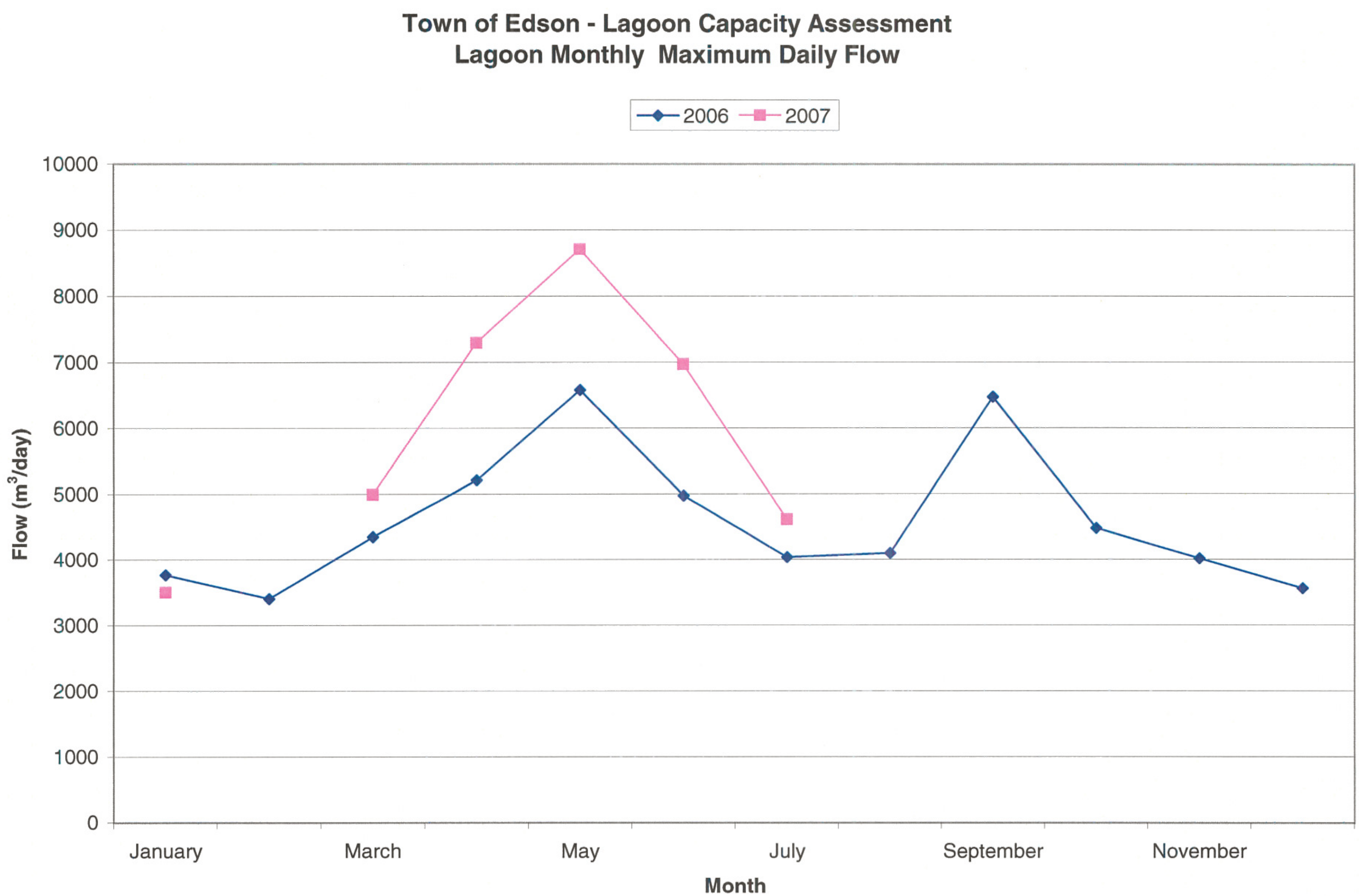


Figure E-3

L:\work\100000\100870\03-Report\Appendices\Appendix E - Wastewater Graphs\Figure E-3 Max Daily.xls

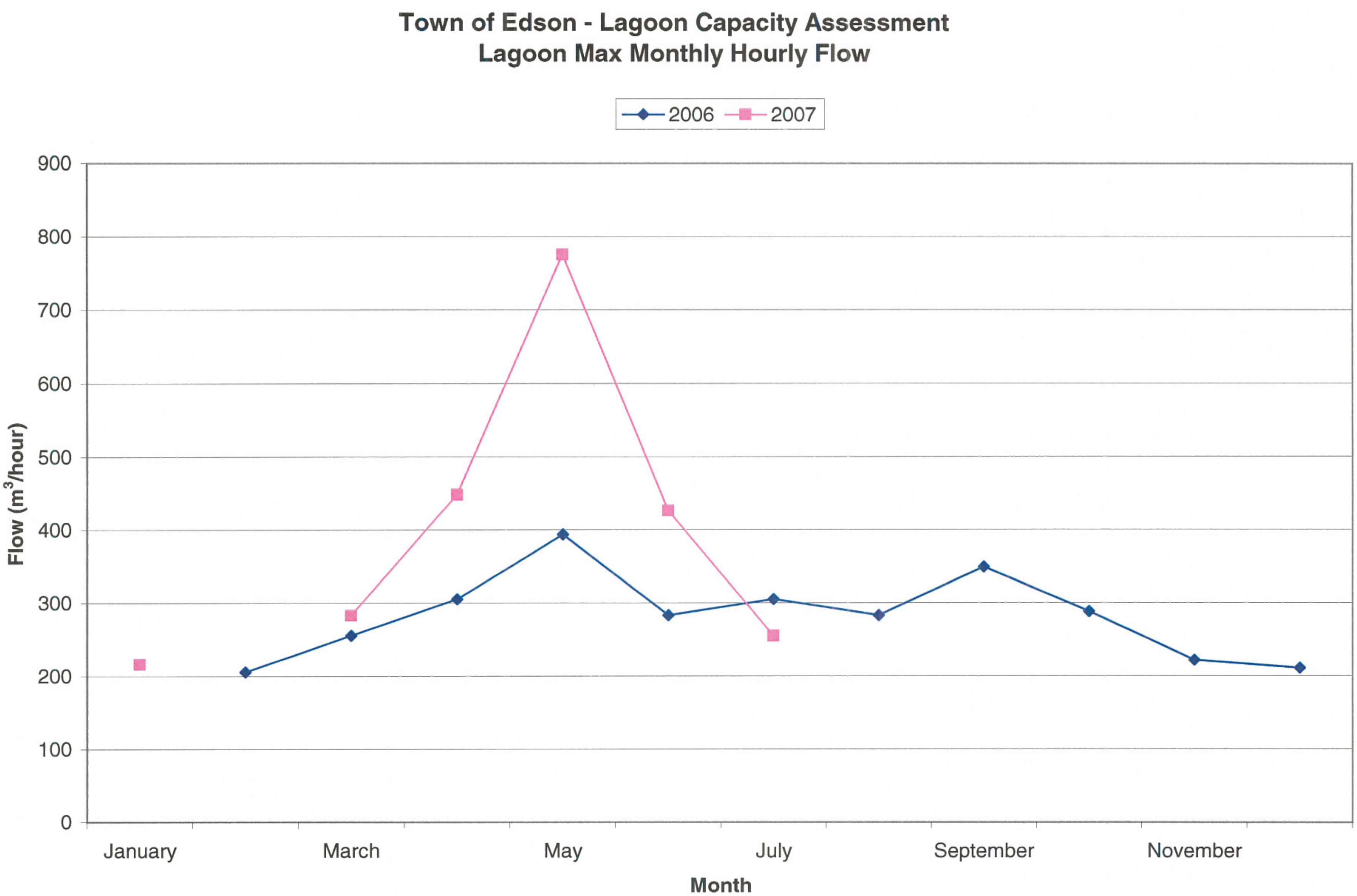


Figure E-4

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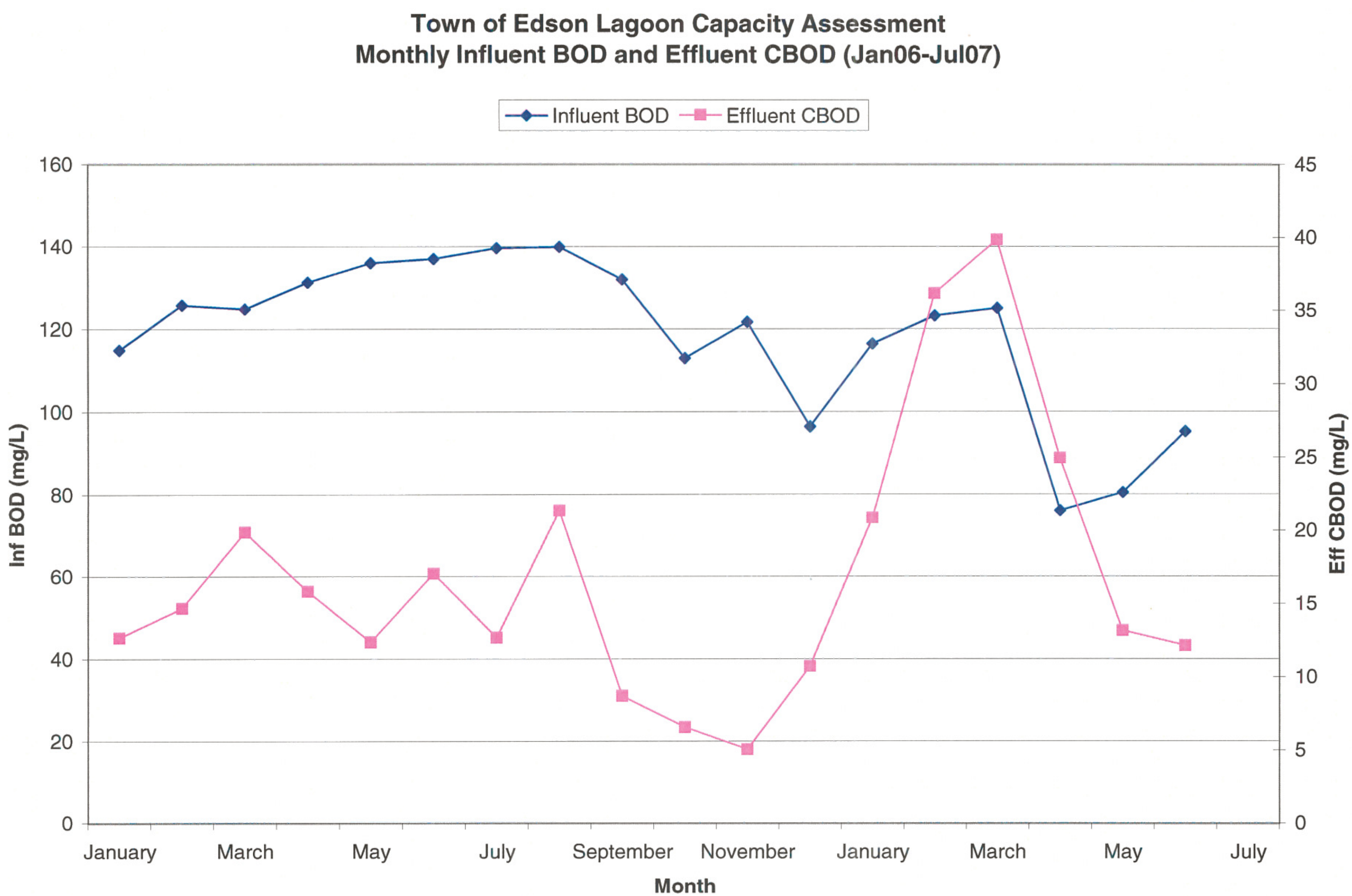

Figure E-5

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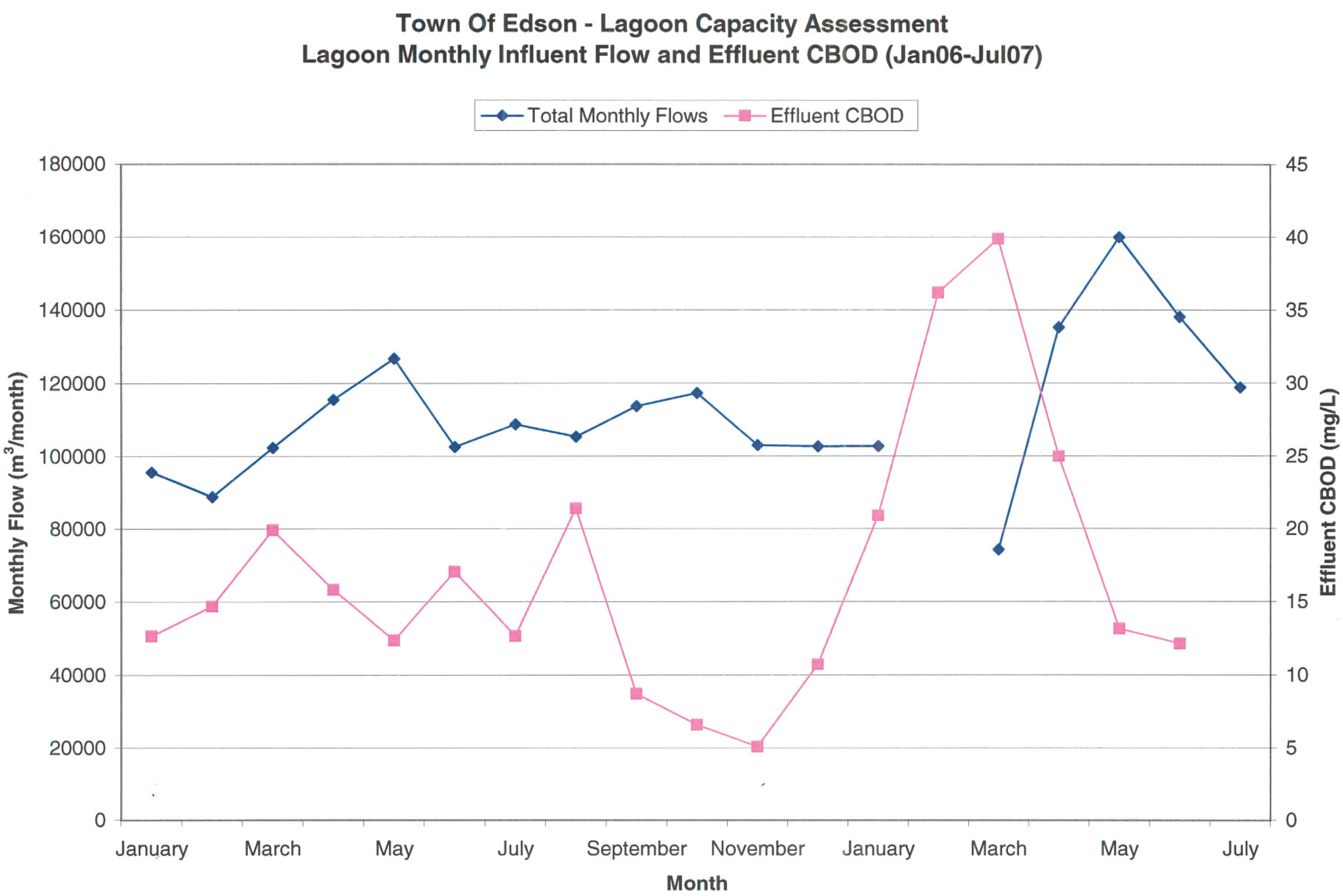

Figure E-6

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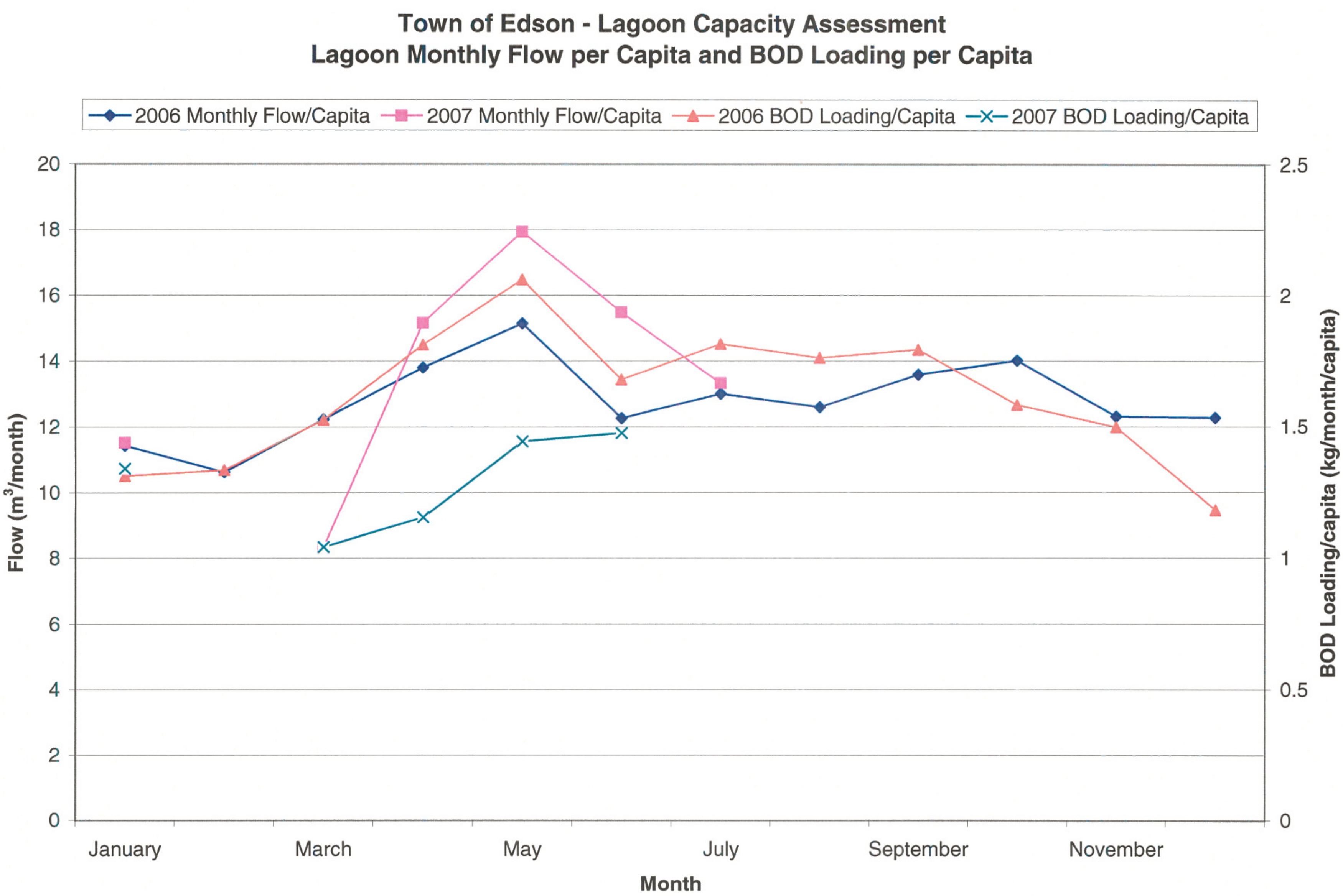

Figure E-7

L:\work\100000\100870\03-Report\Appendices\Appendix E - Wastewater Graphs\Figure E-7 flow&bodpc.xlsFlow&BOD Loading per Cap

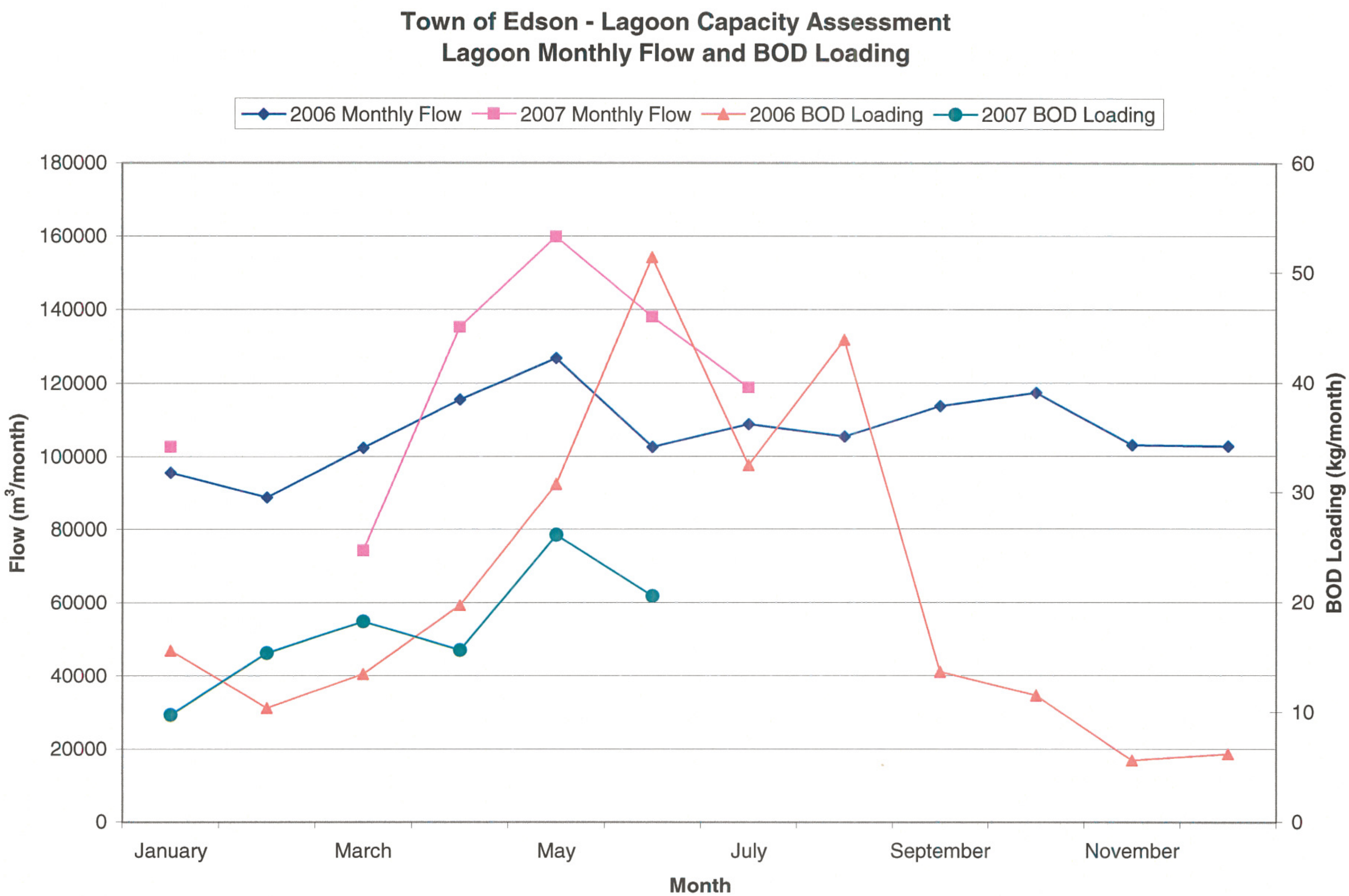

Figure E-8

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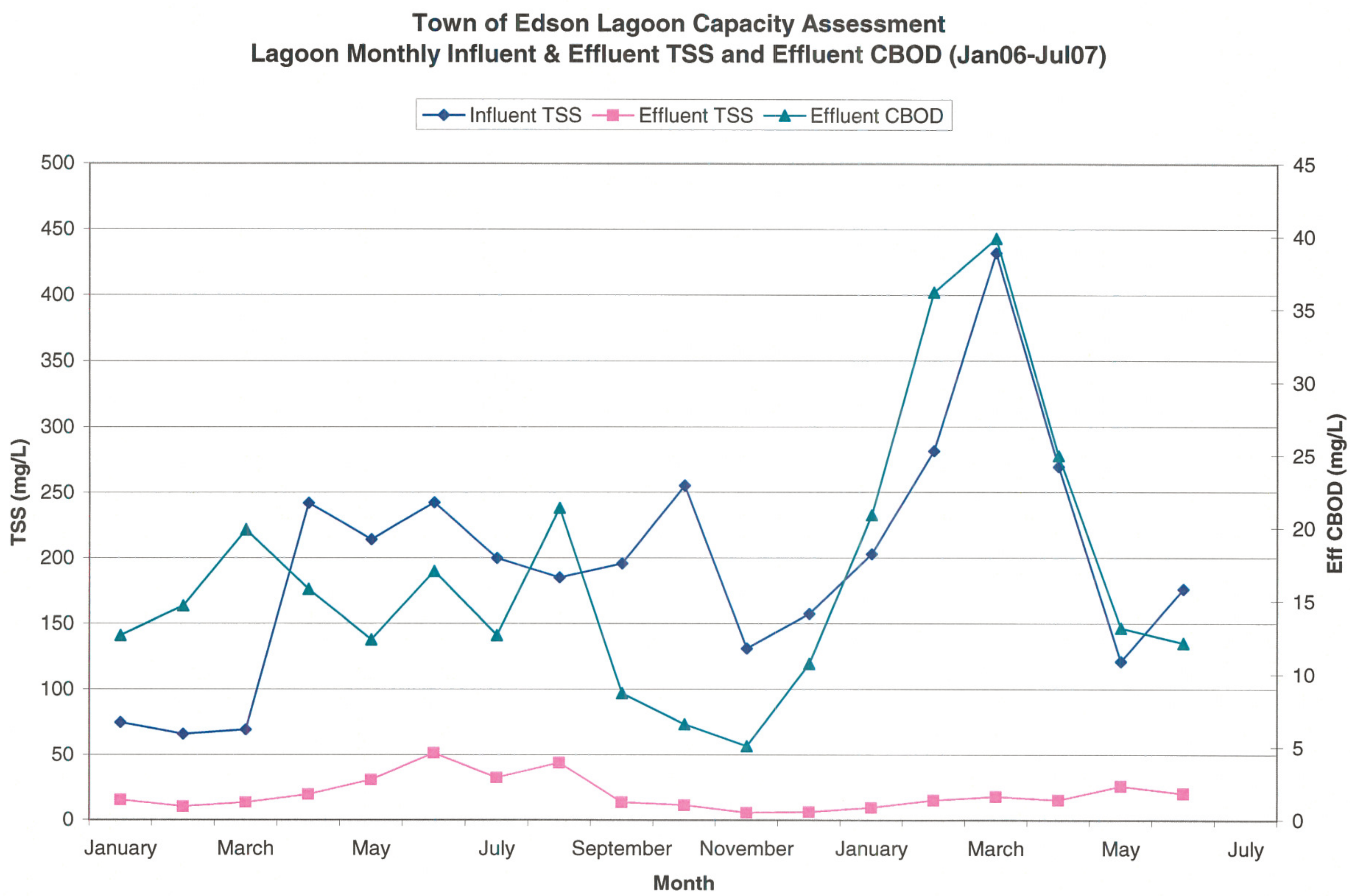

Figure E-9

L:\work\100000\100870\03-Report\Appendices\Appendix E - Wastewater Graphs\Figure E-9 TSS BOD.xls

Town of Edson - Lagoon Capacity Assessment
Lagoon Monthly Flow and TSS Loading

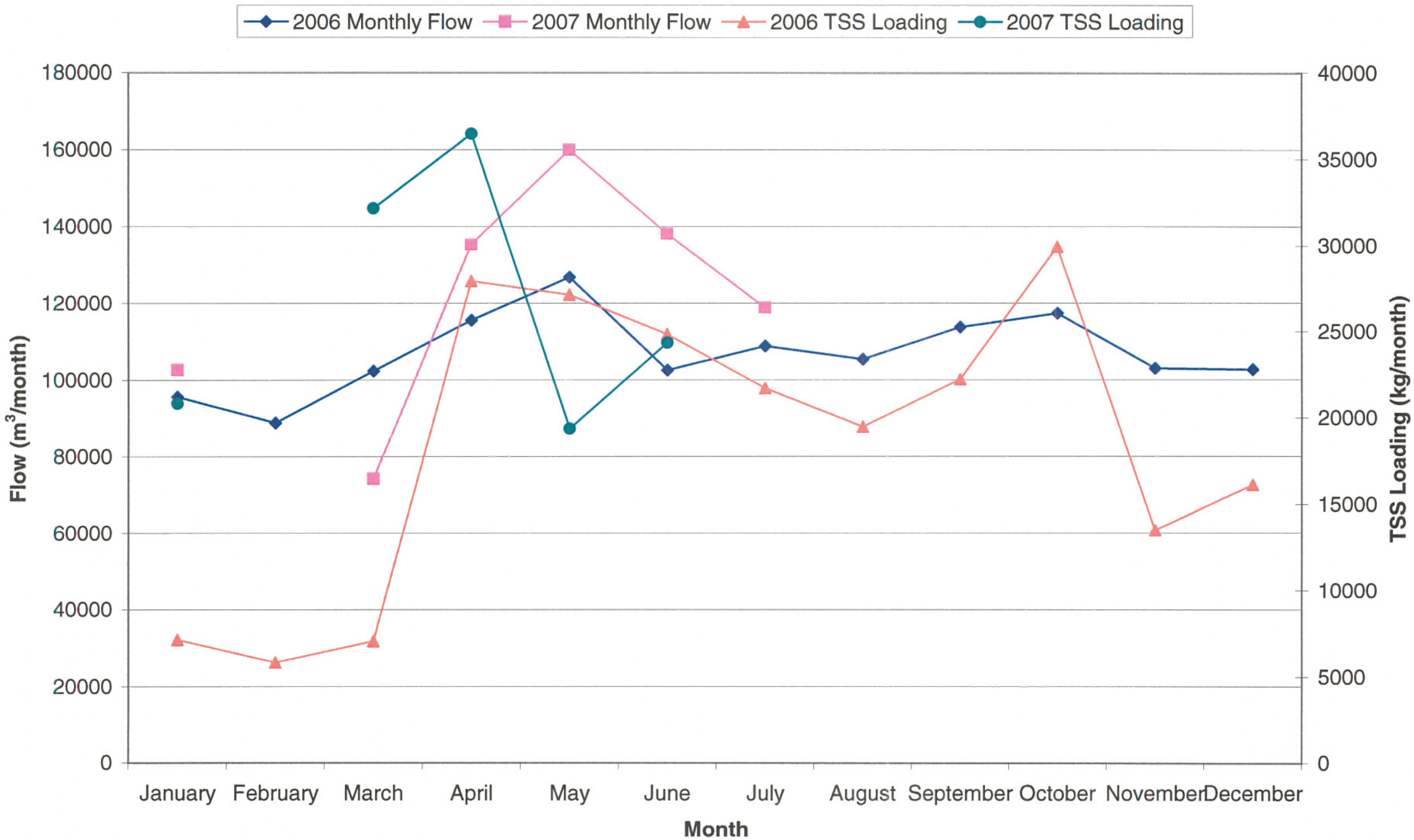

Figure E-10

L:\work\100000\100870\03-Report\Appendices\Appendix E - Wastewater Graphs\Figure E-10 flow tss load.xls

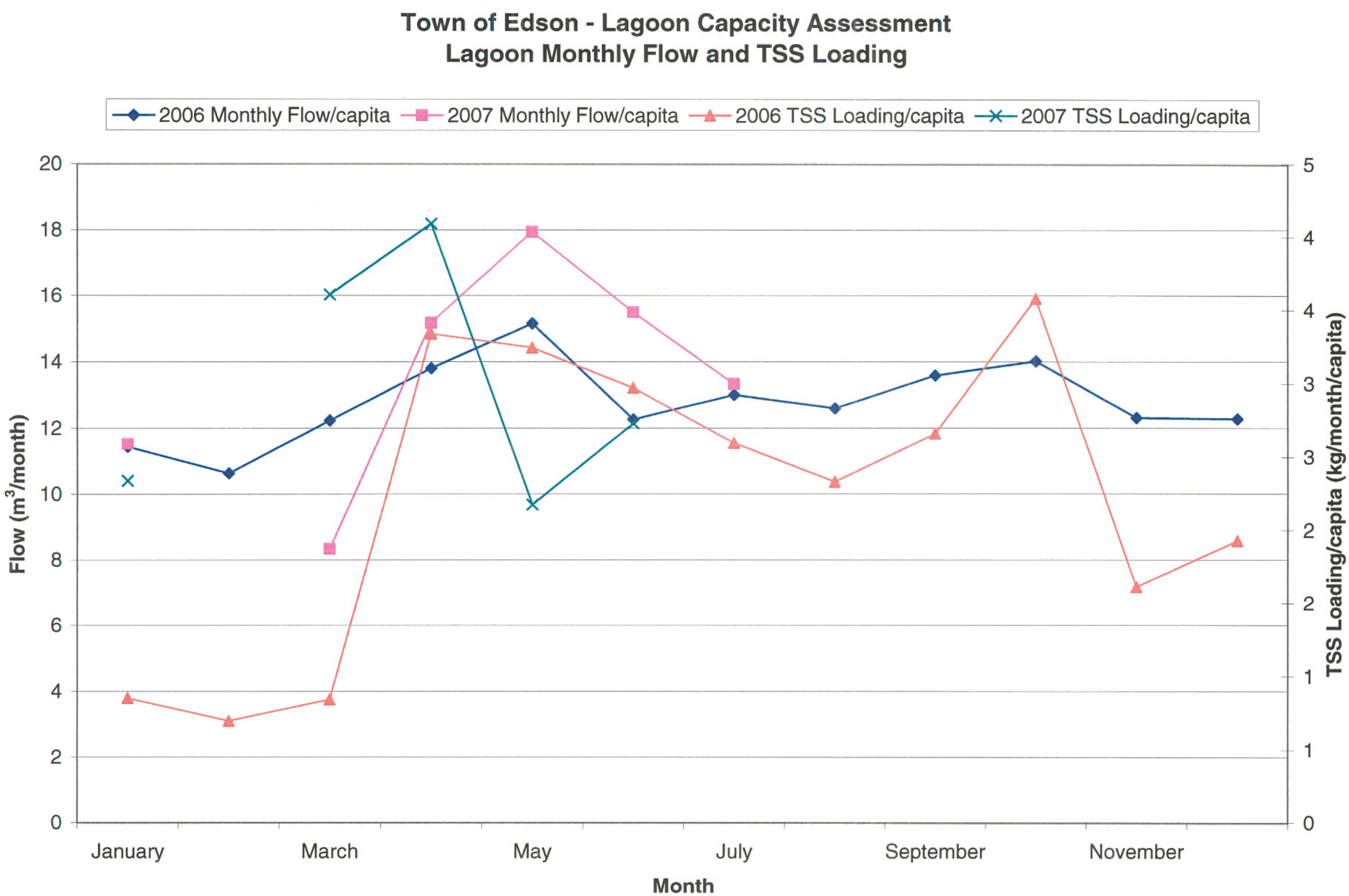

Figure E-11

L:\work\100000\100870\03-Report\Appendices\Appendix E - Wastewater Graphs\Figure E-11 Flow&TSSpc.xlsFlow&TSS Loading per capita

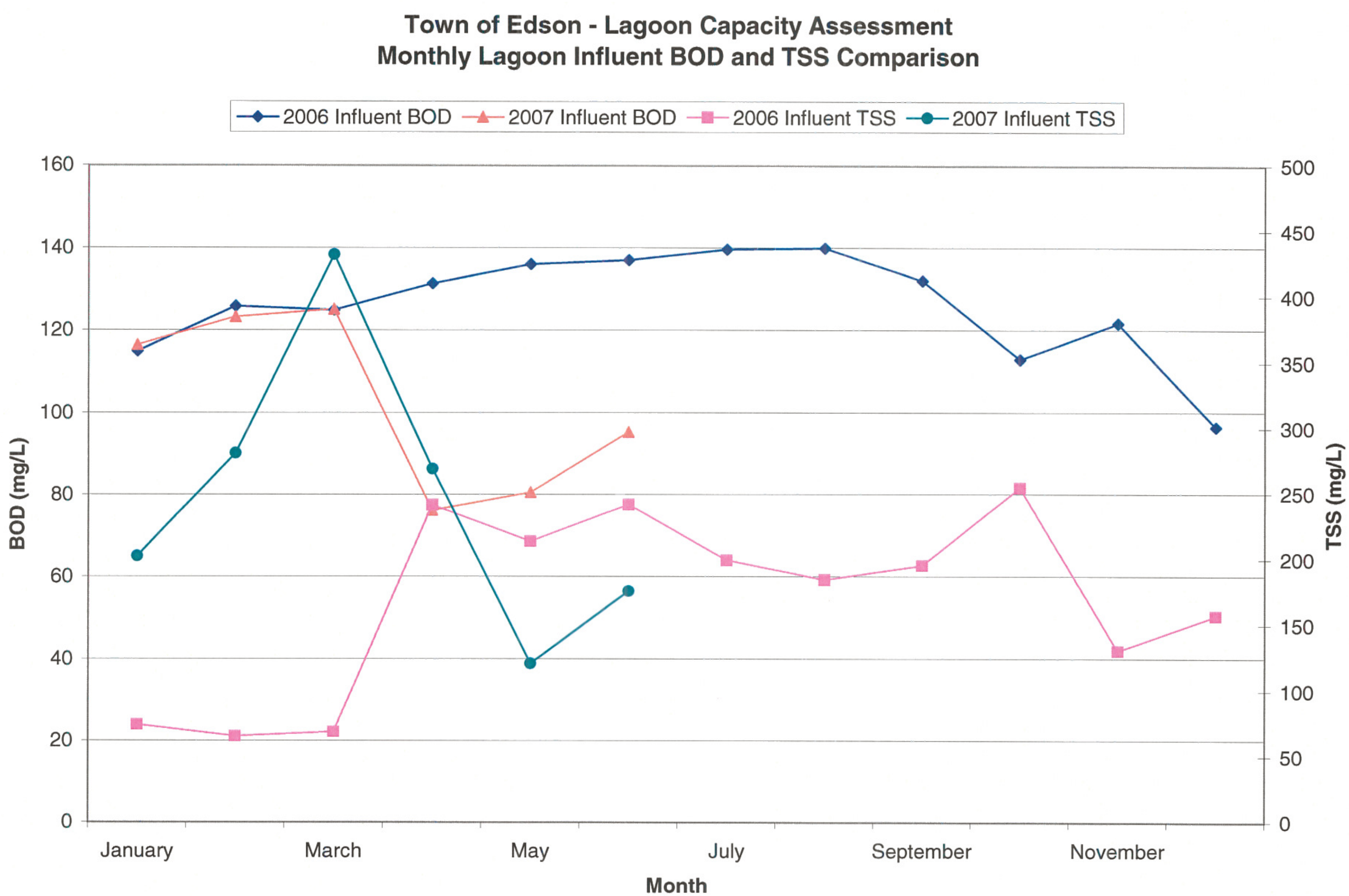

Figure E-12

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