HAMLET OF ARVIAT

P.O. BOX 150
ARVIAT, NUNAVUT
X0C-0E0

General Office: 867-857-2841 -- e-mail: hamletav@attcanada.ca -- Facsimile: 867-857-2519

INTERNAL	
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Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU
X0E 1J0

August 26, 2003

Re: Arviat Water Licence Application

Attention: Phyllis,

Please find enclosed Arviat's Water Licence Application and copies of the sewage lagoon drawings.

If you require additional information please feel free to contact the undersigned.

Sincerely,

Rick Van Horne, SAO
Hamlet of Arviat

Spare set mailed to Jim Wall

P.O. Box 119
Gjoa Haven, NU X0E 1J0
Tel: (867) 360-6338
Fax: (867) 360-6369
KATIMAYINGI

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NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN

WATER LICENCE
(DRAFT) APPLICATION FROM (ARVIAT, NUNAVUT)

Application for: (check one)

_____ **X New** _____ Amendment _____ Renewal _____ Assignment

LICENCE NO.:
(for NWB use only)

1. NAME AND MAILING ADDRESS OF APPLICANT/LICENSEE
Hamlet of ARVIAT

2. ADDRESS OF CORPORATE OFFICE IN CANADA (if applicable)
N/A

3. LOCATION OF UNDERTAKING (describe and attach a topographical map, indicating the main components of the Undertaking)

Approximate location of hamlet are:

Latitude:	Longitude	NTS Maps No.: 55 E/1	Scale: **N/A**
N61degrees07minutes	W94degrees 04minutes		

4. DESCRIPTION OF UNDERTAKING (attach plans and drawings)

There is no "undertaking" at the moment. The Hamlet simply wishes to conform to regulations and obtain its water license.

5. TYPE OF UNDERTAKING (A supplementary questionnaire must be submitted with the application for undertakings listed in **"bold"**)

_____ _____ Industrial
_____ _____ **Mine Development**
_____ _____ **Advanced Exploration**
_____ _____ **Exploratory Drilling**
_____ _____ **Remote/Tourism Camp**
Water services , Solid waste, sewage disposal Municipal
_____ _____ _____ Power
_____ _____ Other (describe)
_____ _____ _____

6. WATER USE

____ ____ **To obtain water**	____ ____ To divert a watercourse
____ To modify the bed or bank of a watercourse	____ ____ Flood Control
____ To alter the flow of, or store, water	**Provision of Public water service Other (describe)**
____ ____ To cross a watercourse	

7. QUANTITY OF WATER INVOLVED (liters per second, liters per day or cubic meters per year, including both quantity to be used and quality to be returned to source) 62268.993 cubic meters per year

8. WASTE (for each type of waste describe: composition, quantity, methods of treatment and disposal, etc.)

LAGOON (55,000cu m) ONE CELL FLOWPATH (200m)	____ Sewage	____ ____	Waste Oil
BURN AND LANDFILL (34400sq m)	Solid Waste	LAGOON (55,000cu m) ONE CELL FLOWPATH (200m)	Grey Water
____ ____	_ Hazardous	____ ____	____ Sludges
BULKY WASTE SITE (20000sq m) Items/Scrap Metal	Bulky	____ ____	Other (describe)
		____ ____	____

9. PERSONS OR PROPERTIES AFFECTED BY THIS UNDERTAKING (give name, mailing address and location; attach if necessary) N/A

Land Use Permit

INAC	_ xYes	____No	If no, date expected ____
Regional Inuit Association	xYes	____No	If no, date expected ____
Commissioner	_ xYes	____No	If no, date expected ____

10. PREDICTED ENVIRONMENTAL IMPACTS OF UNDERTAKING AND PROPOSED MITIGATION MEASURES (direct, indirect, cumulative impacts, etc.)

NIRB Screening ____ xYes ____No If no, date expected ____

11. INUIT WATER RIGHTS

Will the project or activity substantially affect the quality, quantity, or flow of water flowing through Inuit Owned Lands and the rights of Inuit under Article 20 of the Nunavut Land Claims Agreement?

If yes, has the applicant entered into an agreement with the Designated Inuit organization to pay compensation for any loss or damage that may be caused by the alteration? If no compensation agreement has been made, how will compensation be determined?

12. CONTRACTORS AND SUB-CONTRACTORS (name, address and functions)

13. STUDIES UNDERTAKEN TO DATE (list and attach copies of studies, reports, research, etc.)

14. THE FOLLOWING DOCUMENTS MUST BE INCLUDED WITH THE APPLICATION FOR THE REGULATORY PROCESS TO BEGIN

Supplementary Questionnaire (where applicable: see section 5) _Yes ___No If no, date expected ____

Inuktitut/English Summary of Project

Application fee $30.00 (c/o of Receiver General for Canada) _Yes No If no, date expected _____

15. PROPOSED TIME SCHEDULE

_____ _____Annual (or) _____ _____ Multi Year

Start Date: _____ Completion Date: _____

Name (Print)	Title (Print)	Signature	Date
	S.A.O.	OS B. Richard VanHerme	

For Nunavut Water Board Use Only

APPLICATION FEE	Amount: $ _____	Receipt No.: _____
WATER USE DEPOSIT	Amount: $ _____	Receipt No.: _____

FSC
ARCHITECTS
& ENGINEERS

Design Concept for Arviat Sewage Lagoon Design

prepared for:

Department of Community Government & Transportation
Government of Nunavut
2nd Floor, Oomolik Building
P. O. Box 490
Rankin Inlet, Nunavut
X0C 0G0

INTERNAL	
PC	DP
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TA2	
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ED	
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BRD	
EXT.	

prepared by:

FSC Architects & Engineers
4910 53rd Street
Yellowknife, NT
X1A 2P4

FSC Project No: 2003-0440

Date: May 23, 2003

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& ENGINEERS

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1.0 INTRODUCTION

FSC was contracted by the GN on behalf of the Hamlet of Arviat to complete a design and non-resident supervision services for a new sewage lagoon.

FSC completed a growth study to predict the 20-year (2023) population, sewage volume and sewage quality or sewage strength.

Predictions concluded from the growth study, along with information from the Hamlet and mapping provided by CG&T, were used to develop the design concept.

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Table 1.1 Projected Sewage Generation, Arviat NU

Census Population	1,899
Census Year	2001
% Population Increase	2.86
Residential Water Use	60.5 lpcd
Sludge Generation Rate	50 grams/cd
BOD	45 grams/cd
SS	48 grams/cd
T-PO4	2.3 grams/cd
TKN	12 grams/cd
FC	9.50E+10 #/cd

Planning Year	Calendar Year	Total Population	Projected Water Use	Projected Volume	Projected Sludge Volume	Accumulated Sludge Volume	BOD	TSS	T-PO4	TKN	FC
			(lpcd)	(litres/year)	(m3/yr)	(m3)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(#/dl)
	2001	1,899	86.9	60,250,472	35	35	518	552	26	138	1.1E+08
	2002	1,953	87.7	62,513,086	36	70	513	547	26	137	1.1E+08
0	2003	2,009	88.5	64,871,706	37	107	509	543	26	136	1.1E+08
	2004	2,067	89.3	67,330,896	38	145	504	538	26	134	1.1E+08
	2005	2,126	90.1	69,895,454	39	183	500	533	26	133	1.1E+08
	2006	2,187	90.9	72,570,424	40	223	495	528	25	132	1.0E+08
	2007	2,249	91.8	75,361,117	41	264	490	523	25	131	1.0E+08
5	2008	2,314	92.7	78,273,117	42	307	485	518	25	129	1.0E+08
	2009	2,380	93.6	81,312,302	43	350	481	513	25	128	1.0E+08
	2010	2,448	94.6	84,484,856	45	395	476	508	24	127	1.0E+08
	2011	2,518	95.5	87,797,289	46	441	471	502	24	126	9.9E+07
	2012	2,590	96.5	91,256,453	47	488	466	497	24	124	9.8E+07
10	2013	2,664	97.6	94,869,563	49	537	461	492	24	123	9.7E+07
	2014	2,740	98.6	98,644,213	50	587	456	487	23	122	9.6E+07
	2015	2,819	99.7	102,588,400	51	638	451	481	23	120	9.5E+07
	2016	2,899	100.8	106,710,548	53	691	446	476	23	119	9.4E+07
	2017	2,982	102.0	111,019,526	54	745	441	471	23	118	9.3E+07
15	2018	3,067	103.2	115,524,678	56	801	436	465	22	116	9.2E+07
	2019	3,155	104.4	120,235,847	58	859	431	460	22	115	9.1E+07
	2020	3,245	105.7	125,163,404	59	918	426	454	22	114	9.0E+07
	2021	3,338	107.0	130,318,275	61	979	421	449	22	112	8.9E+07
	2022	3,434	108.3	135,711,974	63	1,042	416	443	21	111	8.8E+07
20	2023	3,532	109.6	141,356,636	64	1,106	410	438	21	109	8.7E+07

2.0 DESIGN CONCEPT

2.1 GENERAL

The proposed design will involve, seasonal retention lagoons followed by overland flow treatment.

Currently there are two lagoons operating in parallel, with a discharge to the foreshore of Hudson's Bay. FSC proposes that a third lagoon be constructed to accommodate the 20-year volume and that the foreshore area be developed so that it naturally evolves into an overland flow treatment area.

At commissioning, we expect the effluent from the lagoons prior to discharge to the overland flow area to potentially meet the Nunavut Water Board Guidelines for discharges to marine environments. The effluent will trigger the development of the overland flow area.

The lagoons will be discharged at a slow continuous rate during the growing season, approximately July and August. At the end, there will be sufficient volume in the lagoons to accept the next years sewage volume.

2.2 VOLUME

The 20-year volume is estimated to be 141,000 m^3. The current lagoon volume is estimated to be 49,600 m^3, based on a 2 metre working depth.

To gain a more accurate scope of the natural hydrologic processes occurring in the area, evaporation rates must be considered. Evaporation maps showing the 10-year mean annual monthly lake evaporation data. This is the most current information available from Environment Canada.

It is assumed that water evaporates from a sewage lagoon at the same rate as from a lake. Sublimation rates are not included in the mapping and therefore shall not be included in the calculations. The evaporation map can be found in Appendix A.

The annual evaporation for Arviat is 203 mm. The annual evaporation was then compared to the annual precipitation. There is no climate normal data from the Environment Canada website for Arviat, therefore information was collected from the Rankin Inlet Climate Normals. The average annual precipitation for Rankin Inlet is 297 mm. Climate Normals can be found in Appendix A

Therefore, if the Rankin rainfall data is comparable to Arviat, the lagoons will incur a net gain of 297 mm 203 mm = 94 mm of precipitation over the area of the lagoons.

Runoff was not considered in the analysis as the lagoon berms are raised and no runoff should enter the lagoons.

Therefore, the required lagoon volume for the 20-year period is 98,353 m^3.

With the incorporation of overland flow into the treatment process, a 12-month storage lagoon is not required at this time. The recommend storage period is 7 months. The corresponding total lagoon volume required for the 20-year horizon is 86,306 m^3. The additional lagoon volume is therefore, 36,706 m^3.

2.3 LOCATION

FSC proposes an adjacent lagoon north of the existing lagoons, as shown on the sketch EN-2, in Appendix B.

2.4 OPERATION

Sewage will be discharged to the lagoons year round from the trucked system. As one lagoon becomes full the truck will then discharge to the next empty lagoon.

The lagoons will be discharged annually beginning approximately July 1st and continuously until approximately August 31st, at which time all the lagoons will be at their lowest level.

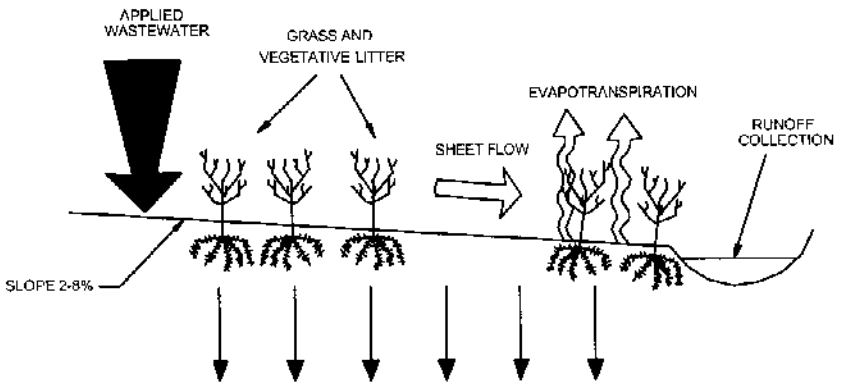
Lagoons can be discharged in a number of ways, either through pumps or siphons. FSC recommends consideration of windmills to perform the pumping operations. Windmills are low cost, low maintenance, sustainable technology.

2.5 OVERLAND FLOW CONCEPT

The proposed overland flow area is shown on EN-2, Appendix B. Effluent from the lagoons is proposed to be discharged at a slow, continuous rate at the head of the overland flow area. Irrigation techniques and flow attenuation berms will be used to ensure liquid is spread evenly across the area.

The land between the lagoons and Hudson's Bay will be used as a microenvironment to further treat sewage, and provide for evaporation of the liquid and disinfection of the effluent. The following sketch shows an overland flow concept.

OVERLAND FLOW



2.6 PREDICTED EFFLUENT QUALITY

2.6.1 LAGOON EFFLUENT QUALITY

It is expected that upon commissioning and with all three lagoons in use, the water will be relatively shallow and retention period will exceed 12 months. Treatment efficiencies for carbon-based parameters should exceed 80% removal. Therefore, we expect an effluent from the lagoons that meet Nunavut Water Board Guidelines as shown in Table 2.1.

Table 2.1 Estimated Effluent Quality Compared to Nunavut Water Board Guidelines (2004)

Parameter	Raw Sewage (2004)	Expected Lagoon Effluent Quality	Nunavut Water Board Requirements
BOD	504 mg/l	less than 100 mg/l	120 mg/l
TSS	538 mg/l	less than 120 mg/l	180 mg/l
T-PO_4	26 mg/l	less than 16 mg/l	N/A
TKN	134 mg/l	less than 20 mg/l	N/A
Fecal Coliform	1.0 E08 CFU/dl	less than 1.0 E06 CFU/dl	N/A*

*Depending on local fisheries

However, as volumes increase, so will the depths in the lagoons, as will the amount of sludge accumulation. Treatment efficiencies will reduce and although unlikely, for the purposes of the design concept, could be as low as 40% removal for carbon based

parameters. These factors will combine to reduce the effluent quality to concentrations shown in Table 2.2.

Table 2.2 Estimated Effluent Quality Compared to Nunavut Water Board Guidelines (2023)

Parameter	Raw Sewage (2023)	Expected Lagoon Effluent Quality	Nunavut Water Board Requirements
BOD	410 mg/l	246 mg/l	120 mg/l
TSS	438 mg/l	263mg/l	180 mg/l
T-PO_4	21 mg/l	13 mg/l	N/A
TKN	109 mg/l	66 mg/l	N/A
Fecal Coliform	8.7 E07 CFU/dl	5.20E+07 CFU/dl	N/A*

*Depending on local fisheries

During the period between 2004 and 2023, the overland flow area will have evolved into a functioning microenvironment estimated to be capable of providing treatment to concentrations shown in Table 2.3. The model for this estimation is shown in Appendix C.

Table 2.3 Estimated Effluent Quality Compared to Nunavut Water Board Guidelines (2023)

Parameter	Lagoon Effluent (2023)	Expected Overland Flow Area Effluent Quality	Nunavut Water Board Requirements
BOD	246 mg/l	90 mg/l	120 mg/l
TSS	263mg/l	23 mg/l	180 mg/l
T-PO_4	13 mg/l	8 mg/l	N/A
TKN	66 mg/l	31 mg/l	N/A
Fecal Coliform	5.20E+07 CFU/dl	3E+06 CFU/dl	N/A*

*Depending on local fisheries

Therefore, the design concept and modeling illustrates that the facility will be in compliance with the Nunavut Water Board requirements beginning at commissioning and throughout the design life.

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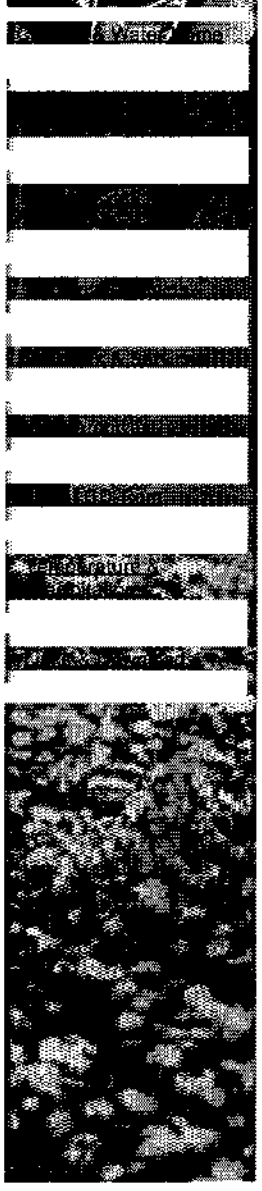
APPENDIX A
CLIMATE DATA

Canadian Climate Normals 1971-2000



NOTE!! Data used in the calculation of these Normals may be subject to further quality assurance checks. This may result in minor changes to some values presented here.

Canadian Climate Normals 1971-2000 for

RANKIN INLET A
Nunavut

Latitude: 62° 49' N **Longitude:** 92° 07' W **Elevation:** 28.7 m

The minimum number of years used to calculate these Normals is indicated by a code for each element. A "+" beside an extreme date indicates that this date is the first occurrence of the extreme value.

Normals from January to Year View

January-June | January-December+Year | July-December

Back to station list | Another location

Temperature:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Cod
Daily Mean (°C)	-31.9	-30.1	-25.2	-16.3	-5.9	4.2	10.4	9.5	3.4	-5.3	-17.8	-26.7	-11.0	
Standard Deviation	2.8	3.2	2.8	2.6	2.1	1.9	1.7	1.1	1.5	1.9	3.3	3.5	1.3	
Daily Maximum (°C)	-28.3	-26.2	-20.9	-11.7	-2.4	7.9	14.9	13.0	5.8	-2.4	-13.9	-22.9	-7.3	
Daily Minimum (°C)	-35.5	-33.9	-29.5	-20.8	-9.2	0.4	5.9	5.9	0.9	-8.2	-21.6	-30.4	-14.7	
Extreme Maximum (°C)	23.4	-4.4	1.3	3.4	14.1	26.1	28.9	30.5	20.6	9.3	0.9	-2.4	30.5	
Date (yyy/dd)	997/05	998/18	999/26	984/17	984/29	993/29+	996/31	991/10	996/18	988/08	983/04+	999/01	991/10	
Extreme Minimum (°C)	-46.1	-49.8	-43.4	-35.7	-23.8	-9.4	-1.9	-1.4	-9.0	-27.4	-36.5	-43.6	-49.8	
Date (yyy/dd)	982/07	990/15	984/11	984/06	991/02	992/02	992/04	986/31	989/30	986/31	982/24	996/30	990/15	
Precipitation:														
Rainfall (mm)	0.0	0.1	0.0	1.0	7.4	25.0	39.5	57.3	39.2	11.9	0.1	0.0	181.5	
Snowfall (cm)	6.7	9.3	12.9	13.6	11.5	4.9	0.0	0.3	4.6	23.1	20.9	11.9	119.7	
Precipitation (mm)	6.6	8.9	12.6	14.3	18.4	29.8	39.5	57.6	43.8	34.6	19.8	11.3	297.1	
Mean Snow Depth (cm)	27	30	36	38	20	1	0	0	0	3	14	23	16	
Median Snow Depth (cm)	27	30	36	38	20	0	0	0	0	3	14	23	16	
Snow Depth at Month-end (cm)	28	34	38	33	5	0	0	0	0	8	20	25	16	
Extreme Daily Rainfall (mm)	0.0	1.0	0.0	6.8	30.8	45.8	41.4	41.2	45.0	24.1	0.6	0.2	45.8	

Extreme Daily Rainfall (mm)	0.0	1.0	0.0	0.0	30.0	45.0	41.4	41.2	45.0	24.1	0.0	0.2	45.0
Date (yyy/dd)	981/15+	998/17	981/19+	000/24	998/15	999/23	990/28	984/14	991/15	982/29	988/24+	991/30	999/23
Extreme Daily Snowfall (cm)	6.4	17.4	12.2	14.0	13.6	21.5	2.4	2.6	10.4	18.2	23.6	8.6	23.6
Date (yyy/dd)	992/03	996/23+	991/24	994/13	001/07	990/06	001/03	985/28	982/11	997/13	985/06	999/01	985/06
Extreme Daily Precipitation (mm)	6.4	17.4	11.6	14.0	31.2	45.8	41.4	41.2	45.0	33.0	23.2	8.6	45.8
Date (yyy/dd)	992/03	996/23+	991/24	994/13	999/06	999/23	990/28	984/14	991/15	997/13	985/06	999/01	999/23
Extreme Snow Depth (cm)	50.0	64.0	73.0	86.0	68.0	20.0	1.0	0.0	4.0	22.0	57.0	59.0	86.0
Date (yyy/dd)	991/17+	996/28+	996/22+	991/22+	993/02+	987/02+	001/03	981/01+	985/25	985/31	985/30	985/11+	991/22+
Days With:													
Freezing Rain or Freezing Drizzle	0.2	0.2	0.7	1.8	3.9	1.3	0.1	0.0	0.3	3.0	1.6	0.5	13.4
Thunderstorms	0.0	0.0	0.0	0.0	0.1	0.4	1.0	0.8	0.6	0.0	0.0	0.0	2.8
Hail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Fog, Ice Fog, or Freezing Fog	2.4	2.2	3.3	3.3	5.0	4.7	5.1	4.7	4.0	4.8	2.2	2.7	44.1
Smoke or Haze	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.4	0.2	0.0	0.0	0.0	1.0
Blowing Dust	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blowing Snow	15.4	12.9	13.5	8.1	3.3	0.4	0.0	0.1	0.7	5.6	12.6	14.1	86.4
Days with Maximum Temperature:													
<= 0 °C	31.0	28.3	30.9	29.0	19.9	1.4	0.0	0.0	1.6	20.1	29.8	31.0	222.8
> 0 °C	0.1	0.0	0.1	1.0	11.2	28.6	31.0	31.0	28.4	11.0	0.3	0.0	142.5
> 10 °C	0.1	0.0	0.0	0.0	0.1	10.0	25.8	22.2	4.0	0.0	0.0	0.0	62.1
> 20 °C	0.1	0.0	0.0	0.0	0.0	0.7	5.4	2.2	0.1	0.0	0.0	0.0	8.3
> 30 °C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
> 35 °C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Days with Minimum Temperature:													
> 0 °C	0.0	0.0	0.0	0.0	0.5	17.0	30.5	30.7	18.8	2.6	0.0	0.0	100.1
<= 2 °C	31.0	28.3	31.0	30.0	31.0	21.8	2.3	1.5	18.2	30.4	30.0	31.0	286.4
<= 0 °C	31.0	28.3	31.0	30.0	30.5	13.1	0.5	0.3	11.2	28.4	30.0	31.0	265.1
<= -2 °C	31.0	28.3	31.0	29.8	27.1	4.7	0.0	0.0	5.3	25.5	29.8	31.0	243.4
<= -10 °C	31.0	28.3	30.5	27.1	12.7	0.0	0.0	0.0	0.0	10.9	26.9	30.8	198.1
<= -20 °C	30.5	27.2	27.8	17.2	1.7	0.0	0.0	0.0	0.0	1.3	18.8	27.7	152.0
<= - 30 °C	26.1	21.6	17.4	3.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	19.6	91.4
Days with Rainfall:													
>= 0.2 mm	0.0	0.1	0.0	0.7	2.4	6.2	10.2	13.2	10.2	3.8	0.3	0.1	46.9
>= 5 mm	0.0	0.0	0.0	0.1	0.4	1.4	2.0	3.3	2.6	0.9	0.0	0.0	10.4
>= 10 mm	0.0	0.0	0.0	0.0	0.2	0.5	1.1	1.6	1.3	0.3	0.0	0.0	4.9
>= 25 mm	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.4	0.1	0.0	0.0	0.0	1.1
Days With Snowfall:													
>= 0.2 cm	6.9	7.2	9.1	8.0	7.1	1.9	0.1	0.2	3.9	12.1	12.0	9.5	77.8
>= 5 cm	0.2	0.2	0.5	0.6	0.7	0.3	0.0	0.0	0.2	1.1	0.9	0.4	4.9
>= 10 cm	0.0	0.1	0.1	0.2	0.1	0.2	0.0	0.0	0.1	0.2	0.2	0.0	1.1
>= 25 cm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Days with Precipitation:													
>= 0.2 mm	6.8	7.1	9.0	8.4	8.8	7.4	10.2	13.2	12.8	14.3	11.9	9.5	119.1
>= 5 mm	0.2	0.2	0.5	0.7	1.1	1.6	2.0	3.3	2.8	2.0	0.8	0.4	15.3

>= 10 mm	0.0	0.1	0.1	0.2	0.2	0.7	1.1	1.6	1.4	0.5	0.1	0.0	5.8
>= 25 mm	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.4	0.1	0.1	0.0	0.0	1.2
Days with Snow Depth:													
>= 1 cm	31.0	28.3	31.0	30.0	29.8	7.8	0.0	0.0	0.5	18.1	30.0	31.0	237.3
>= 5 cm	31.0	28.3	31.0	29.8	24.7	1.9	0.0	0.0	0.0	8.2	27.9	31.0	213.7
>= 10	29.4	28.1	31.0	29.2	21.7	0.6	0.0	0.0	0.0	3.7	19.5	29.5	192.6
>= 20	23.7	22.8	28.7	26.0	14.3	0.1	0.0	0.0	0.0	0.1	4.8	16.1	136.4
Days with Wind:													
Wind Speed >= 52 km/hr	5.5	5.4	4.7	2.6	2.8	1.2	1.6	2.8	3.7	5.4	5.0	5.2	45.6
Wind Speed >= 63 km/hr	2.3	1.8	1.7	0.7	0.5	0.5	0.5	1.2	1.5	2.0	1.9	1.8	16.2
Maximum Wind Gust	132.0	113.0	111.0	111.0	117.0	111.0	106.0	124.0	109.0	137.0	124.0	124.0	137.0
Date (yyy/dd)	999/06	999/02	986/05	999/25	986/29	999/23	990/29	984/03	989/20+	997/14	985/06	985/27	997/14
Direction of Extreme Wind Gust	NW	NE	NW	NW	NW	E	NW	NW	W	W	N	NW	W
Degree Days:													
Above 24 °C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above 18 °C	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.2	0.0	0.0	0.0	0.0	1.4
Above 15 °C	0.0	0.0	0.0	0.0	0.0	0.3	7.9	2.5	0.0	0.0	0.0	0.0	10.7
Above 10 °C	0.0	0.0	0.0	0.0	0.0	4.2	52.7	30.1	1.6	0.0	0.0	0.0	88.7
Above 5 °C	0.0	0.0	0.0	0.0	0.1	34.5	172.7	139.0	21.0	0.1	0.0	0.0	367.4
Above 0 °C	0.0	0.0	0.0	0.0	5.0	131.9	325.4	292.0	111.5	8.4	0.0	0.0	874.2
Below 0 °C	989.5	849.5	784.0	488.7	186.3	7.0	0.0	0.0	9.5	171.1	532.7	829.5	4847.7
Below 5 °C	1144.5	990.7	939.0	638.7	336.4	59.5	2.4	2.0	69.0	317.8	682.7	984.5	6167.1
Below 10 °C	1299.5	1132.0	1094.0	788.7	491.3	179.3	37.4	48.1	199.6	472.7	832.7	1139.5	7714.6
Below 15 °C	1454.5	1273.2	1249.0	938.7	646.3	325.4	147.6	175.4	348.0	627.7	982.7	1294.5	9462.9
Below 18 °C	1547.5	1358.0	1342.0	1028.7	739.3	415.1	233.9	266.1	438.0	720.7	1072.7	1387.5	10549.4

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APPENDIX B
SKETCHES

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APPENDIX C
WETLAND MODELING

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GROUP

Alberta Environment Wetlands Calculations

Surface Flow Wetland Treatment

Design Flow m3/d Q = 1341

		TSS	BOD	TP	TN	NH4-N	FC
Wastewater Characterization	Ci	246	263	13	66	80	5.20E+07
Target Effluent Quality	Ce	120	100	2	4	2	10000
Wetland Background Input	C* =	23	17	0.05	2	0	100

for TSS, C* = 7.8 + 0.063Ci
for BOD, C* = 3.5 + 0.053Ci

Area Rate Constant @20oC	k =	1000	34	12	22	18	77
Required Wetland Area	A =	0.04	1.567	7.591	7.700	10.032	5.446

Models $A = \frac{0.0365*Q}{k} * \ln\left[\frac{Ci - C^*}{Ce - C^*}\right]$ Available Area: 7

Projected Effluent Quality	**Co**	**23**	**19**	**2.30**	**4.74**	**6.10**	**9.59E+02**

$Co = C^* + [Ci - C^*] \exp\left[\frac{-kAmax}{0.0365*Q}\right]$

Overall % removal	90.53	92.65	81.69	92.78	92.38	100.00

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Alberta Environment Wetlands Calculations

10C
Area rate constant, k, has been divided by 2 from 20C value

Alberta Environment Wetlands Calculations

Surface Flow Wetland Treatment

Design Flow m3/d Q = 1341

		TSS	BOD	TP	TN	NH4-N	FC
Wastewater Characterization	Ci	246	263	13	66	80	5.20E+07
Target Effluent Quality mg/l	Ce	120	100	2	4	2	10000
Wetland Background Input	C* =	23	17	0.05	2	0	100
Area Rate Constant @10oC	k =	500	17	6	11	9	38.5
Required Wetland Area, ha	A =	0.08	3.135	15.182	15.400	20.064	10.892
Projected Effluent Quality	**Co**	**23**	**39**	**5.37**	**15.21**	**22.09**	**2.11E+05**
Overall % removal		90.53	85.16	57.37	76.84	72.39	99.59

for TSS, C* = 7.8 + 0.063Ci
for BOD, C* = 3.5 + 0.053Ci

Models $A = \frac{0.0365*Q}{k} * \ln\left[\frac{Ci - C^*}{Ce - C^*}\right]$ Available Area: 7

Co = C* + [Ci - C*] exp $\left[\frac{-kAmax}{0.0365*Q}\right]$

FSC
GROUP

Alberta Environment Wetlands Calculations

5C
Area rate constant, k, has been divided by 2 from 10C value

Alberta Environment Wetlands Calculations

Surface Flow Wetland Treatment

Design Flow m3/d Q = 1341

		TSS	BOD	TP	TN	NH4-N	FC
Wastewater Characterization	Ci	246	263	13	66	80	5.20E+07
Target Effluent Quality mg/l	Ce	120	100	2	4	2	10000
Wetland Background Input	C* =	23	17	0.05	2	0	100
Area Rate Constant @5oC	k =	250	8.5	3	5.5	4.5	19.25
Required Wetland Area, ha	A =	0.16	6.269	30.364	30.801	40.129	21.784
Projected Effluent Quality	**Co**	**23**	**90**	**8.21**	**31.00**	**42.04**	**3.31E+06**
Overall % removal		90.53	65.68	34.74	52.80	47.45	93.62

for TSS, C* = 7.8 + 0.063Ci
for BOD, C* = 3.5 + 0.053Ci

Models $A = \frac{0.0365*Q}{k} * \ln\left[\frac{Ci - C^*}{Ce - C^*}\right]$ Available Area: 7

Co = C* + [Ci - C*] exp $\left[\frac{-kAmax}{0.0365*Q}\right]$