BROCKVILLE
CITY OF THE 1000 ISLANDS

BROCKVILLE WATER POLLUTION CONTROL CENTRE UPGRADE

CLASS ENVIRONMENTAL
ASSESSMENT REPORT

Technical Memorandum No. 1
Planning and Design Basis Information

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1. Introduction

The City of Brockville is proceeding to complete a Class Environmental Assessment to assess alternative solutions for a proposed Brockville Water Pollution Control Plant (WPCC) Upgrade.

The upgrade works, as a minimum, are to provide the current "normal" level of treatment prescribed by the Ministry of Environment (MOE), which is considered as being secondary treatment or equal and consistent with the Provincial Guideline F-5.

This Technical Memorandum (TM#1) has been prepared to consider design populations, flows, influent characteristics, and forecasted effluent quality requirements. TM#1 provides summarized planning and design basis information for the proposed Brockville WPCC Upgrade.

2. Current and Projected Future Population

The City of Brockville's current population is estimated at 21,475[1].

The existing Brockville WPCC facility design parameters developed in 1988, included for a future service population of 24,295 in the year 2008. This service population used previous Brockville Planning Department projections to 2001, and was further projected using an annual growth rate of 0.76% per annum.

Over the last decade, the City of Brockville has experienced very low growth, and both the Ontario Ministry of Finance and City have significantly lowered projected residential population growth to reflect a contemplated continuation of this trend. The City's recent population and household projections (Development Charges Background Study, 1999 and 2004) for year 2018 used a projected average annual growth rate of approximately 0.5% in 1999, and 0.2% in 2004.

Of the varying growth rate projections, an average growth rate of 0.5% per annum appears to represent a medium growth projection scenario. Based on the current estimated population, the design population of 24,295 will be attained in approximately 25 years with a population growth of 0.5% per year. The following projections are based on the current estimated population and an average increase of 0.5% per annum:

[1] City of Brockville Development Charges Background Study – Draft, 2004

Period	Population
Current	21,475
10 year	22,573
+/- 25 year	24,295 (design population)

A population of 24,295 represents a design period of approximately 25 years with an annual average growth rate of 0.5%. Twenty to twenty-five years is a preferred longer term planning horizon for wastewater treatment facilities.

3. Historical and Projected Future Flows

The plant is currently treating an average flow of 17,753 m^3/d (2003 daily average), which is a per capita flow contribution (inclusive of all sectors/contributors) of 825 L/cap/day. This is a relatively high per capita flow; likely factors contributing to the high value are infiltration and inflow, and industrial/commercial sectors. The maximum peak daily flow in 2003 was 40,178 m^3/d, and this was the maximum peak daily instantaneous flow recorded at the plant between January 2001 and June 2004. Accordingly, the historical yearly peak flow factor is 2.3 for the period 2001 to 2004.

Considering collection system infrastructure, water conservation, and other on-going and contemplated future initiatives, it is anticipated that per capita sewage flows will decline in the future. The following projected future flows conservatively apply the existing 820 L/cap/d flow contribution to future population projections, to yield projected average day future flows:

Period / Population	Projected Future Flow
10 year / 22,573	18,660 m^3/d
25 year / 24,295	20,050 m^3/d

The existing Brockville WPCC design flows and rated capacity are:

- Average Day Flow 21,800 m^3/d
- Peak Flow 54,500 m^3/d
- Peak Flow Factor 2.5

The existing and projected future hydraulic flows, as indicated above, are accommodated by the existing Brockville WPCC hydraulic design flows and rated capacities. **Table 1** summarizes the current and projected average day and maximum daily peak flow.

TABLE 1:
Current and Projected Average Day and Maximum Daily Peak Flow

Period / Item	Average Day Flow (m^3/d)	Peak Factor	Maximum Daily Peak Flow (m^3/d)
Current	17,800	2.3	40,180
10 Year Period (2014)	18,660	2.5	46,625
25 Year Period (2029)	20,500	2.5	50,125
Existing Design & Rated Capacity	21,800	2.5	54,500

4. Historical and Projected Future Influent Characteristics

Table 2 summarizes historical average annual influent concentrations, typical domestic wastewater concentrations (MOE Guideline, 1984), and suggested design concentrations at average day flow and peak day flow.

TABLE 2:
Historical, Typical, and Suggested Design Influent Concentrations

	BOD_5 mg/L	TSS mg/L	TP mg/L	TKN mg/L
Historical Average (Period 2001-3)[1]	112	143	3	12.4
Typical Domestic Wastewater (MOE)	170	200	7	
Suggested Design Values @ Average Day Flow (21,800 m^3/day)	120	160	4	15
Suggested Maximum Month Design Values	160	200	4	18

Notes:
1) No septage receiving during this period.
2) BOD – biochemical oxygen demand (5-day), TSS – total suspended solids, TP – total phosphorus, TKN – total Kjeldahl nitrogen

Historical average influent loadings, and current and projected influent loadings calculated with the above average day flow and associated suggested design concentrations are shown in **Table 3**.

TABLE 3: Average Historical, Current and Projected Influent Loadings				
	BOD_5 (kg/d)	TSS (kg/d)	TP (kg/d)	TKN (kg/d)
Historical Average (Period 2001-3)	1,870	2,405	52	
Current (17,800 m^3/d) at Suggested ADF Design Values	2,136	2,848	71	267
10 Year Period (2014)	2,239	2,986	75	280
25 Year Period (2029)	2,407	3,209	80	300

Recent historical 75th percentile per capita influent (raw wastewater) loadings, and MOE Guideline values are presented in **Table 4**.

TABLE 4: Historical 75th Percentile per Capita Influent (Raw Wastewater) Loadings				
	BOD_5 (g/cap/d)	TSS (g/cap/d)	TP (g/cap/d)	TKN (g/cap/d)
Historical Per Capita Loading (Period Aug 03 to Jun 04)	90	115	2.6	14
Per Capita Loading – MOE Guideline	75	90	3	15

Other influent wastewater characteristics based on historical plant data:

- Alkalinity range: 150 to 220 mg/L (as $CaCO_3$)
- Influent wastewater temperature range: 10 to 25 deg. Celsius
- Minimum temperatures experienced in late winter and early spring

5. Forecasted Effluent Quality Requirements

The MOE has adopted the approach that all sewage treatment works should provide secondary or equivalent as the “normal” level of treatment, unless individual receiving water assessment studies indicate the need for higher levels of treatment.

An analysis of the assimilative capacity of the St. Lawrence River has been undertaken to consider appropriate effluent parameters limits for the Brockville WPCC Upgrade. This study[2] and others, have shown the St. Lawrence River to have significant assimilative capacity for water quality parameters of concern in all months of the year.

[2] Brockville Water Pollution Control Centre Assimilative Capacity Analysis, XCG, May 2004

In terms of normal treatment effluent parameters, the assimilative capacity study illustrated that after mixing the following effluent values have minimal impact, and meet Provincial Water Quality Objectives (PWQO):

- BOD_5 25 mg/L
- Total Suspended Solids 25 mg/L
- Total Phosphorus 1.0 mg/L

Un-ionized ammonia is often a critical water quality parameter and is considered relative to several criterion. The PWQO and Canadian Water Quality Guideline for un-ionized ammonia are currently 0.02 mg/L and 0.019 mg/L respectively. The assimilative capacity study findings indicate that un-ionized ammonia levels at the point of complete mixing are significantly below the 0.019 mg/L requirement.

Ammonia has been classified as “toxic” under the Canadian Environmental Protection Act (CEPA), and it is listed on the Priority Substance List. If effluent total ammonia exceeds 20 mg/L during the summer months (June to September), and pH exceeds 7.5, the CEPA requires preparation of a corresponding pollution control prevention plan. Based on current conditions, the assimilative capacity study suggests effluent total ammonia concentrations would likely not require the preparation of a pollution control plan.

With respect to un-ionized ammonia, another consideration is effluent toxicity. A conservative non-toxic limit for un-ionized ammonia is 0.1 mg/L, and a typical value is 0.2 mg/L. The calculation of un-ionized ammonia levels are very much dependant on effluent temperature and pH. Because of the significant influence of temperature and pH, it is important to consider data as representative as possible. The Brockville WPCC has continuous on-line temperature and pH monitoring data for the plant influent (raw sewage). Note: the previously referenced plant monthly effluent temperatures in the assimilative capacity study appear based on the 75^{th} percentile of daily maximum raw sewage temperature readings. Monthly temperature values have been updated using the 75^{th} percentile of daily average raw sewage temperature and pH readings. Using available raw sewage temperature records data is considered a conservative indicator of effluent temperature, as spot readings taken during summer conditions consistently found the effluent temperature being less than the recorded raw sewage temperature.

The following tables present: 1) calculated effluent un-ionized ammonia under current conditions; 2) maximum effluent ammonia for non-toxic effluent based on updated temperature and pH source data; and 3) non-toxic limits for un-ionized ammonia of 0.1 mg/L and 0.2 mg/L using updated temperature and pH source data.

Calculated effluent un-ionized ammonia using current condition historical data is shown in **Table 5**.

TABLE 5:
Current Condition Un-Ionized Ammonia
(Updated Temperature and pH Source Data)

Month	Effluent TAN (mg/L)	Effluent Temp. (^{o}C)	Effluent pH	Eff. Un-Ionized NH3-N (mg/L)
Jan	17.50	14.5	7.50	0.144
Feb	15.25	13.4	7.70	0.183
Mar	15.28	12.2	7.50	0.106
Apr	11.25	14.0	7.40	0.071
May	18.84	16.2	7.30	0.112
Jun	19.81	19.4	7.20	0.118
Jul	17.56	22.8	7.10	0.107
Aug	18.16	25.6	7.00	0.107
Sep	18.53	25.7	7.10	0.138
Oct	22.56	23.2	7.20	0.177
Nov	16.66	19.5	7.30	0.126
Dec	17.00	16.5	7.40	0.130

Notes:
1) TAN - total ammonia nitrogen ($NH_3 + NH_4^+$)
2) Effluent temperature and pH taken as 75th percentile of daily average influent readings for the period Jan 02 to July 04

Maximum effluent total ammonia nitrogen required for a non-toxic un-ionized ammonia limit of 0.10 mg/L is shown in **Table 6**.

TABLE 6:
Maximum Effluent Total Ammonia
for Non-Toxic Un-Ionized Ammonia Limit of 0.10 mg/L

Month	Effluent TAN (mg/L)	Effluent Temp. (^{o}C)	Effluent pH	Eff. Un-Ionized NH3-N (mg/L)
Jan	12.1	14.5	7.50	0.10
Feb	8.4	13.4	7.70	0.10
Mar	14.5	12.2	7.50	0.10
Apr	15.9	14.0	7.40	0.10
May	16.8	16.2	7.30	0.10
Jun	16.8	19.4	7.20	0.10
Jul	16.5	22.8	7.10	0.10
Aug	17.0	25.6	7.00	0.10
Sep	13.4	25.7	7.10	0.10
Oct	12.8	23.2	7.20	0.10
Nov	13.2	19.5	7.30	0.10
Dec	13.1	16.5	7.40	0.10

Notes:
1) TAN - total ammonia nitrogen ($NH_3 + NH_4^+$)
2) Effluent temperature and pH taken as 75th percentile of daily average influent readings for the period Jan 02 to July 04.

Maximum effluent total ammonia nitrogen required for a non-toxic un-ionized ammonia limit of 0.20 mg/L is shown in **Table 7**.

TABLE 7:
Maximum Effluent Total Ammonia
for Non-Toxic Un-Ionized Ammonia Limit of 0.20 mg/L

Month	Effluent TAN (mg/L)	Effluent Temp. (^{o}C)	Effluent pH	Eff. Un-Ionized NH3-N (mg/L)
Jan	24.2	14.5	7.50	0.20
Feb	16.7	13.4	7.70	0.20
Mar	28.9	12.2	7.50	0.20
Apr	31.7	14.0	7.40	0.20
May	33.7	16.2	7.30	0.20
Jun	33.5	19.4	7.20	0.20
Jul	33.0	22.8	7.10	0.20
Aug	34.0	25.6	7.00	0.20
Sep	26.8	25.7	7.10	0.20
Oct	25.5	23.2	7.20	0.20
Nov	26.4	19.5	7.30	0.20
Dec	26.2	16.5	7.40	0.20

Notes:
1) TAN - total ammonia nitrogen (NH_3 + NH_4^+)
2) Effluent temperature and pH taken as 75th percentile of daily average influent readings for the period Jan 02 to July 04.

Based on the above considerations of ammonia and un-ionized ammonia concentrations, appropriate seasonal total ammonia objectives and limits are proposed as shown in **Table 8**.

TABLE 8:
Effluent Total Ammonia Concentration

Season	Design Objective	Compliance Limit[1]
Summer (May 1 to Oct. 30)	12 mg/L	(18 mg/L)
Winter (Nov. 1 to Apr. 30)	8 mg/L	(16 mg/L)

Notes:
1) The MOE has indicated they are recently including the requirement of effluent lethality testing to be performed on a periodic basis as a condition on Certificates of Approval. This condition requirement will effectively eliminate the need for ammonia compliance limits.

It is observed that although the trends of relatively elevated pH values in the winter, and relatively warm wastewater temperatures during the winter season are considered representative based on available data records and likely reflect the influence of local industries, they are also atypical. If future additional effluent temperature and pH monitoring data warrant, the seasonal total ammonia concentration objectives and limits may require further review and adjustment.

Forecasted effluent quality requirements for the Brockville WPCC Upgrade consider the assimilative capacity study findings, requirements recently instituted at other wastewater treatment facilities, recognized treatment level objectives for secondary treatment or equivalent, and effluent ammonia objectives for non-toxic effluent. A summary of forecasted effluent requirements in terms of parameter design objectives and compliance criteria follows:

TABLE 9:
Forecasted Effluent Requirements

Parameter	Design Objective (mg/L)	Compliance Limit (mg/L)
$CBOD_5$	15	25
Total Suspended Solids (TSS)	15	25
Total Phosphorus (TP)	0.8	1.0
Total Ammonia (as N) Summer (May 1 to Oct 30)	12	(see note 3)
Total Ammonia (as N) Winter (Nov 1 to Apr 30)	8	(see note 3)
Total Residual Chlorine	0.02	0.05
Escherichia Coli (E- Coli)	200 org/100 mL	100 org/100 mL

Notes:
1) $CBOD_5$ – carbonaceous biochemical oxygen demand (5-day)
2) Compliance limits based on monthly average concentration. It is suggested compliance limits be based on concentration limits only, and not parameter loadings since based on monthly averages.
3) The MOE has indicated they are recently including the requirement of effluent lethality testing to be performed on a periodic basis as a condition on Certificates of Approval. This condition requirement will effectively eliminate the need for ammonia compliance limits.

6. Summary

Information presented in the preceding sections, is summarized and consolidated in **Tables 10**, **11, 12** and **13**.

6.1 Current and Projected Future Population

TABLE 10: Current and Projected Future Population				
Period	Current	2014	2029	
Population	21,475	22,573	24,295	
Design Population				**24,295**

6.2 Current and Projected Future Flows

TABLE 11: Current and Projected Future Flows		
	Average Day Flow (m^3/d)	Maximum Daily Peak Flow (m^3/d)
Current	17,800	40,180
10 Year Period (2014)	18,660	46,625
25 Year Period (2029)	20,050	50,125
Existing Design & Rated Capacity	**21,800**	**54,500**
Notes: 1) Design Peak Factor (PF) = 2.5		

6.3 Historical and Projected Future Influent Characteristics and Loadings

TABLE 12: Historical and Projected Future Influent Characteristics and Loadings				
	BOD_5 mg/L	TSS mg/L	TP mg/L	TKN mg/L
Period 2001-3 Average	112	143	3	12.4(1)
Suggested Design Values @ Average Day Flow (21,800 m^3/day)	120	160	4	15
Suggested Maximum Month Design Values	160	200	4	18
Notes: 1) No septage receiving during this period. 2) BOD – biochemical oxygen demand (5-day), TSS – total suspended solids, TP – total phosphorus, TKN – total Kjeldahl nitrogen				

Projected future influent characteristics at an Average Day Flow of 21,800 m3/d are:

- Biochemical Oxygen Demand (5 day) 120 mg/L
- Total Suspended Solids 160 mg/L

- Total Phosphorus 4 mg/L
- Total Kjeldhal Nitrogen 15 mg/L

6.4 Forecasted Effluent Quality Requirements

TABLE 13:
Forecasted Effluent Requirements

Parameter	Design Objective (mg/L)	Compliance Limit (mg/L)
$CBOD_5$	15	25
Total Suspended Solids (TSS)	15	25
Total Phosphorus (TP)	0.8	1.0
Total Ammonia (as N) Summer (May 1 to Oct 30)	12	(see note 3)
Total Ammonia (as N) Winter (Nov 1 to Apr 30)	8	(see note 3)
Total Residual Chlorine	0.02	0.05
Escherichia Coli (E- Coli)	200 org/100 mL	100 org/100 mL

Notes:
1) $CBOD_5$ – carbonaceous biochemical oxygen demand (5-day)
2) Compliance limits based on monthly average concentration.
3) The MOE has indicated they are recently including the requirement of effluent lethality testing to be performed on a periodic basis as a condition on Certificates of Approval. This condition requirement will effectively eliminate the need for ammonia compliance limits.

TM1_DesignBasis