National Survey of Wastewater Treatment Plants

Final Report
June 14, 2001

Submitted to: Environment Canada, National Pollutant Release Inventory (NPRI)

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Requirements of the Contract

The terms of the contract required the following actions and mile-posts:

1. The terms of reference for the Ad Hoc Advisory Committee be established,
2. A listing of the municipalities to be contacted be provided by Environment Canada,
3. The membership of the Ad Hoc Advisory Committee be supplied along with the biographies of the project staff,
4. The draft Survey 1 and 2 forms be prepared along with the covering messages,
5. The final Survey 1 form and covering letter be approved and the translation made (January 29, 2001),
6. Survey 1 be distributed (February 5),
7. Survey 1 be completed and a data base prepared (February 26),
8. An Interim Report submitted (February 26),
9. The final Survey 2 form and covering letter be approved and the translation made (March 5),
10. Survey 2 to be distributed (March 12, 2001),
11. Survey 2 be completed and a data base prepared (March 30),
12. Interim Report submitted (March 30),
13. Draft Report and Final Survey Results and Data Base submitted (May 7), and
14. Final Report Submitted (June 14).

Summary of Achievements

All items from 1 to 12 were all achieved within the mileposts. The Draft Report and Final Survey Results and Data Base were submitted late on May 7th, and late returns continued to be received even at that date and beyond. As these were received, the data base was modified until the cut-off date which was set at June 5th. The Tables in the Final Report were modified and checked for consistency in the days following.

The Final Report, dated June 14, provides a summary of the findings. Tables 1 and 2 provide the Final Results of the Surveys to June 5th. Other tables (Tables 1.1., 1.2. etc) provide some analysis based on the extraction of data received. During the extraction process, a number of inconsistencies were found in some of the data that had been entered that resulted in further follow-up contacts with the data provider to clarify the information submitted. In looking at the data, based on averaging, a number of anomalous situations were found which would provide extreme results, for example, some communities have extremely high population changes across the seasons, or communities with small resident populations may be affected by regional industrial or institutional centres located in the community that contribute to higher than normal effluent generation. In reviewing this per capita or per day data, it might well be best to exclude the upper and lower deciles as being atypical.

Should any further reports be received, the data bases will be modified and forwarded to Environment Canada, but the analytical Tables will not be changed.

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FINAL REPORT

RESPONSE TO THE SURVEYS

The response to the survey can only be interpreted as providing some indication of the nature of the wastewater facilities in the country. It was not possible to achieve a 100% response. Overall, the response to the surveys has been good compared to standard survey results. This can be attributed to the repeated follow-up contacts to encourage responses.

Despite fairly extensive notes and an attempt to use what was considered to be commonly understood terminology, there was still a degree of confusion in the responses, particularly in some aspects of the characterization of the facility's components, and in the units used to respond to the quantitative components - "mg/L" and "ppm", "gallons/day" and "m^3/day", and whether the biosolids were to be measured "wet" or "dry". In addition some reports showed aberrant results when per capita or per day figures were calculated largely due to unusual conditions - e.g., high seasonal populations, large industrial or institutional centres serving non-resident populations. As a result, additional efforts had to be made to contact and clarify, or to establish conversion tables for the information received.

SPECIFIC TABULAR RESULTS FROM SURVEY 1

Notes on the interpretation of these information shown in the Tables to this section are included at the end of the Report.

The overall responses show that it had been planned to obtain data on 400 facilities, but that data was received on 738, of which 509 were from facilities serving populations greater than 1,000 persons. The actual distribution of the facilities by population served was different from the anticipated (i.e., "originally planned") due to the fact that municipalities often have more than one facility to serve their entire population and even the larger municipalities have a number of small facilities (serving less than 5000 persons) probably as a result of decentralized systems either being built or acquired after a municipal amalgamation. Responses from 86 facilities serving populations greater than 25,000 persons, including 29 facilities serving populations greater than 100,000 were received.

TABLE 1 - REVISED SUMMARY OF RESPONSES TO SURVEY 1 TO JUNE 5TH, 2001

Population Groups	Municipalities in Database	Municipalities Responding	Facilities Surveyed		Percent Achieved (%)
			Originally Planned	Received	
[1]	[2]	[3]	[4]	[5]	[6]
> 100,000	32	27	25	30	120
25,001 to 100,000	73	47	75	55	73
5,001 to 25,000	296	148	200	136	68
1,000 to 5,000	438	223	100	289	289
Subtotal > 1,000	**839**	**445**	**400**	**510**	**128**
less than 1,000	226	78	0	193	N/A
Population not supplied	-	-	0	35	N/A
Total all groups	**1065**	**523**	**400**	**738**	**185**

For reference purposes, the following table (Table 1.1) shows the distribution of responses received by province and territory and by the size of the population served. This is not considered representative of the actual distribution of facilities by size across the country.

TABLE 1.1 FACILITIES RESPONDING BY PROVINCE/TERRITORY BY POPULATION GROUPS SERVED

Prov/Terr	> 100,000	>25,000	> 5,000	> 1,000	< 1,000	Not Given	Total
BC	4	10	12	33	17	6	82
AB	4	3	14	21	50	3	95
SK	2	2	7	28	18	2	59
MB			6	17	12	1	36
ON	12	22	53	76	40	11	214
QC	7	12	27	74	13	1	134
NB		2	8	19	8	1	38
PE		1	2	1	1		5
NS		3	3	13	20	9	48
NF	1		2	1	8		12
YT			1	2	2	1	6
NT			1	3	4		8
NU				1			1
TOTAL	30	55	136	289	193	35	738

The following table (Table 1.2) provides a categorization of the facilities as to whether they are of: a **preliminary treatment** nature (i.e. removal of grit and screenings only, with no other treatment of any kind prior to discharge); **primary treatment** (ie. *preliminary treatment* followed by primary sedimentation and/or skimming and/or some form of disinfection); **secondary treatment** (ie. *preliminary treatment* followed by *primary treatment* and some form of a biological or physical chemical process on the liquid effluents. Biological processes available include activated sludge employing conventional activated sludge, contact stabilization, extended aeration, or the oxidation ditch process and attached biological growth processes such as rotating biological contactors. Physical chemical treatment involved processes such as chemical flocculation and sedimentation); or of an **enhancedsecondary treatment** (ie. *secondary treatment* plus nitrogen or phosphorous removal). Further information on these alternatives are shown in additional data extractions below. In some cases facilities having no, preliminary or primary treatment also had phosphorous and/or nitrogen removal, these facilities are indicated in parenthesis.

TABLE 1.2 - PERCENT OF FACILITIES IN TREATMENT GROUPINGS

Features	> 100,000	> 25,000	> 5,000	> 1,000	< 1,000	Not Given	Total
All facilities	30	55	136	289	178	50	738
No Treatment	1	1	27 (7)	124	101 (8)	9 (1)	263
Preliminary	1	2 (2)	17 (3)	21	1	2	44
Primary	2	3 (1)	6 (1)	15	8	8	42
Secondary	10	25	45	81	60	17	238
Enhanced Secondary	16	24	41	48	8	14	151

The following table (Table 1.3) shows the number of facilities applying various forms of disinfection and, for those using chlorine as a disinfectant, the percentage that-dechlorinate prior to discharge.

TABLE 1.3 - DISINFECTION METHODS

Features	> 100,000	> 25,000	> 5,000	> 1,000	< 1,000	Not Given	Total
All facilities	30	55	136	289	178	50	738
UV	9	12	25	26	9	9	90
Other		1	1	3	1		6
Chlorine	14	29	42	55	30	14	184
Percentage who de-chlorinate	10%	16%	3%	3%	0%	2%	3.5%

The following table (Table 1.4) indicates the number of facilities who have lagoons of various types; note some facilities have more than one type of lagoon within the facility so the rows cannot be simply added.

TABLE 1.4 - USE OF LAGOONS

Features	> 100,000	> 25,000	> 5,000	> 1,000	< 1,000	Not Given	Total
All facilities	30	55	136	289	178	50	738
1 or more lagoon types	2	11	66	190	116	25	410
% with 1 or more lagoons	6.7	23.0	48.5	65.7	65.2	50.0	55.6
No. with Aerobic lagoons	1	5	44	117	31	12	210
No. with Anaerobic lagoons		1	9	50	46	11	117
No. with Facultative lagoons	1	6	30	52	59	5	153

The table below (Table 1.5) indicates the number of facilities with different types of biological liquid effluent processes, some facilities will have more than one type of process.

TABLE 1.5 - LIQUID EFFLUENT PROCESSES

Features	> 100,000	> 25,000	> 5,000	> 1,000	< 1,000	Not Given	Total
All facilities	30	55	136	289	178	50	738
Primary sedimentation	26	44	39	37	27	6	179
Chemical flocculation	12	17	26	31	13	5	104
Activated sludge	16	30	53	59	13	15	186
Oxidation ditch		3	2	10	1	3	19
Rotating biological contactor	2	2	8	5	13	1	31
Trickling filter	2	6	3	3	3	1	18
Extended aeration	1	3	26	62	21	6	119
Sequencing batch reactor		2	6	5	1	4	18

The following table (Table 1.6) indicates the number of facilities with different types of sludge handling processes. Some facilities have more than one type of process.

TABLE 1.6 - SLUDGE HANDLING PROCESSES

Features	> 100,000	> 25,000	> 5,000	> 1,000	< 1,000	Not Given	Total
All facilities	30	55	136	289	178	50	738
Gravity settling	9	15	33	66	36	11	170
Dissolved air flotation	9	6	4	7	1	3	30
Belt thickening	4	16	19	8	0	3	50
Co-thickening	6	9	7	2	1	4	29
Centrifuge thickening	9	3	5	2	0	0	19

The table below (Table 1.7) indicates the numbers of facilities who report having nitrogen and phosphorous removal processes. Phosphorous removal is more common than nitrogen removal, but many facilities have neither.

TABLE 1.7 - FACILITIES IN TREATMENT GROUPINGS

Features	> 100,000	> 25,000	> 5,000	> 1,000	< 1,000	Not Given	Total
All facilities	30	55	136	289	178	50	738
Nitrogen removal	5	11	11	7	3	2	39
Phosphorous removal	15	25	50	77	16	8	191

The following table (Table 1.8) indicates the range of monitoring data reported. The maximum shown is the highest value reported of all the maxima, the minimum is the lowest figure reported of all the minima. The average is the numerical average of the averages reported.

TABLE 1.8 - MONITORING DATA

Para-meter	Influent				Effluent			
	#	Max	Ave	Min	#	Max	Ave	Min
TSS	478	1800	192.19	3	599	2000	29.94	0.98
BOD	493	938	165.07	2	602	363.6	17.58	0.8
3 Nit.	232	524	25.52	0.04	358	192	9.38	0.005
3 Phos.	340	41.6	6.34	0.6	406	310	2.7	0.01
TKN					253	112	10.19	0.086
Ecoli					292	72400000	8938	0
3 Cl res.					150	547	16.64	0

The table below (Table 1.9) indicates the range of successes in reducing parameters between influents and effluents. In some cases negative removal efficiencies were found, these were not included in the calculations, as they likely reflect errors on the data received on the survey forms:

TABLE 1.9 - REMOVAL EFFICIENCY DATA

Para-meter	Removal Efficiencies - % Reductions		
	Max	Ave	Min
TSS	99.71	87.84	0
BOD	99.69	88.17	0
3 Nit.	99.92	60.42	0
3 Phos.	99.77	77.6	0

The following table (Table 1.10) indicates average flows per capita for systems which are separated and for combined sewer systems. For those responding positively as combined systems, the question was also asked what is the % sanitary and the % stormwater. The data shown is for the maximum of the maxima, arithmetical average of the average, and the minium of the minima as reported. Clearly the maximum and minimum as reported represent extreme situations that are atypical.

TABLE 1.10 - PER CAPITA FLOW DATA

	Influent			Effluent		
	Max	Ave	Min	Max	Ave	Min
Separated	1.94	0.509	0.02	1.943	0.495	0.003
Combined	8.9	0.771	0.077	9.04	0.776	0.081
% Sanitary	100%	76%	30%			
% Storm	70%	23%	1%			

SPECIFIC TABULAR RESULTS FROM SURVEY 2

Notes on the interpretation of these information shown in the Tables to this section are included at the end of the Report.

Survey 2 was sent to all municipalities who indicated in their Survey 1 response that in addition to the monitoring data reported, they performed other monitoring. A few of these misunderstood the question and sent back in Survey 2 only the information already received through Survey 1.

Table 2 shows that Survey 2 was sent to 202 facilities, and responses have been received to date for 101 facilities.

TABLE 2 - SUMMARY OF RESPONSES TO SURVEY 2 TO JUNE 5TH, 2001

Population Groups	Municipality Surveys		Facility Surveys		Percent Received (%)
	Sent	Received	Sent	Received	
[1]	[2]	[3]	[5]	[6]	[7]
> 100,000	20	13	20	18	90
25,001 to 100,000	17	10	24	14	58
5,001 to 25,000	41	16	46	23	50
1,000 to 5,000	43	17	80	32	40
less than 1,000	6	2	28	11	39
Population not supplied	-	-	4	3	75
Total	**127**	**58**	**202**	**101**	**50**

The following table (Table 2.1) provides information reported on the pH and temperatures of the influent and effluent flows.

TABLE 2.1 - QUALITY DATA

	Influent			Effluent		
	Max	Ave	Min	Max	Ave	Min
pH	7.956	7.34	6.85	7.89	7.41	6.99
Temp °C	19.9	15.024	9.55	20.68	13.64	8.27

The following table (Table 2.2) shows for those plants which produce biosolids, information on the total biosolids production and the nature of the biosolids produced. Under the Total Reported column, the figures shown are the sum of the individual facility data reported, and the % figures are the % by type of the total shown in the final row. The Facility Data columns show the amounts reported by facility with the maximum being the maximum of the maxima, etc. Several municipalities reported values on a volumetric basis (m^3), a conversion factor was applied which was thought to be accurate, but may not be in all cases.

TABLE 2.2 - BIOSOLIDS PRODUCTION (000s tonnes)

	# of plants reporting	Total reported	Facility Data		
			Max	Ave	Min
tons pelletized	1	3.1	3.1	3.1	3.1
% pelletized	1	0.5	79.0	79.0	79.0
composted	4	23.9	11.7	5.9	0.8
% composted	2	4.3	70.3	48.9	27.0
incinerated	12	82.1	22.9	6.8	0.0
% incinerated	10	14.8	100.0	60.3	47.0
land filled	17	155.8	68.9	9.2	0.0
% land filled	17	28.0	100.0	66.0	20.0
land applied	27	230.1	75.2	9.7	0.0
% land applied	26	41.4	100.0	81.0	5.0
Total biosolids	49	554.8			

Influent, Effluent and Biosolid Quality Monitoring

The table below (Table 2.3) indicates reported levels of the principal chemical contaminants monitored by the majority of responding facilities in influents, effluents and biosolids. This data was reported in mg/L. The figures shown under the Max columns are: in the upper row, the maximum of the maxima, and in the lower rows are the average of the maxima. A similar relationship holds for the data in the Min columns. In the Ave column, the figure is the arithmetical average of the averages shown. Some maximum and some minimum data appears to be extreme, but are as reported.

TABLE 2.3 - MONITORING DATA

	Influent			Effluent			Biosolids		
	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min
	true/ave		true/ave	true/ave		true/ave	true/ave		true/ave
Aluminum	5.1	1.8	0.6	3.8	0.3	0.0	41,322.0	7,318.6	51.0
	2.6		1.2	0.6		0.1	8,858.0		7,614.0
Ammonia	44.1	26.2	14.8	16.9	5.2	0.0	14,100.0	3,740.0	12.1
				15.0		0.2	4,815.0		3,080.0
Antimony	0.2	0.0	0.0	0.0	0.0	0.2	2.0	1.2	2.0
	0.0		0.0						
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	6.9	2.2	0.0
	0.0		0.0	0.0		0.0	1.7		0.9
Barium	0.2	0.1	0.0	0.1	0.0	0.0	1,160.0	462.2	360.0
	0.1		0.1	0.0		0.0	790.0		490.0
Berylium	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
				0.0		0.0			
Boron	0.5	0.2	0.0	0.4	0.2	0.0	40.0	40.3	7.4
	0.3		0.1	0.2		0.1	64.0		13.2
Cadmium	0.1	0.0	0.0	0.0	0.0	0.0	14.0	1.1	0.0
	0.0		0.0	0.0		0.0	1.8		0.8
Calcium	91.7	72.1	30.6	154.0	72.4	25.2	64,600.0	29,357.0	15,500.0
	86.7		42.2	78.0		62.5	52,800.0		25,750.0
Chloride	710.0	104.5	55.9	536.0	290.1	68.4			
	431.5		80.0	296.6		252.8			
Chloroform				0.6	0.3	0.6			
Chromium	0.3	0.0	0.0	0.2	0.0	0.0	642.0	25.7	0.0
	0.0		0.0	0.0		0.0	69.8		11.4

	Influent			Effluent			Biosolids		
	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min
	true/ave		true/ave	true/ave		true/ave	true/ave		true/ave
Cobalt	0.1	0.0	0.0	0.1	0.0	0.0	31.0	1.9	0.0
	0.0		0.0	0.0		0.0	2.7		1.1
Copper	0.3	0.1	0.0	0.4	0.0	0.0	2,680.0	343.7	0.1
	0.2		0.1	0.1		0.0	462.0		247.0
Cyanide	0.0	0.0	0.0	0.0	0.0	0.0	2.2	2.0	1.8
	0.0		0.0	0.0		0.0			
Ethylbenzene	0.4	0.4	0.4	0.4	0.4	0.4	0.0	0.0	0.0
Iron	5.5	1.8	0.2	3.1	0.9	0.0	71,000.0	13,074.0	123.0
	2.7		1.0	1.3		0.4	22,195.0		17,038.0
Lead	0.1	0.0	0.0	0.1	0.0	0.0	120.0	22.5	0.0
	0.0		0.0	0.0		0.0	29.9		14.9
Magnesium	27.3	17.8	10.8	110.0	32.0	7.4	6,800.0	6,619.0	6,200.0
	22.9		14.9	42.0		34.7			
Manganese	0.3	0.1	0.0	0.2	0.1	0.0	280.0	414.8	130.0
	0.1		0.1	0.1		0.0	275.0		185.0
Mercury	3.1	0.1	0.0	0.3	0.0	0.0	110.0	3.7	0.0
	0.4		0.0	0.1		0.0	12.5		0.7
Molybdenum	0.2	0.0	0.0	0.0	0.0	0.0	42.0	4.1	0.0
	0.1		0.0	0.0		0.0	5.6		1.7
Nickel	0.6	0.0	0.0	0.8	0.0	0.0	118.0	11.8	0.0
	0.1		0.0	0.1		0.0	21.7		7.0
Oils & Grease	356.0	34.9	2.0	20.0	8.5	2.0		15.0	
	91.5		15.0	9.0		5.8			
Phenolics	39.0	4.2	0.0	5.0	0.4	0.0			
	5.7		3.3	0.9		0.2			
Potassium	18.2	12.4	7.9	17.4	11.0	7.2	3,348.0	1,345.3	45.6
	15.3		10.4	12.7		10.1	1,212.9		1,010.2
Selenium	0.1	0.0	0.0	0.1	0.0	0.0	5.8	1.3	0.0
	0.0		0.0	0.0		0.0	1.3		0.7
Silica				8.7	2.1	1.0		7,000.5	
				5.9		4.5			
Silver	0.1	0.0	0.0	0.0	0.0	0.0	11.0	7.1	10.0

	Influent			Effluent			Biosolids		
	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min
	true/ave		true/ave	true/ave		true/ave	true/ave		true/ave
	0.0		0.0	0.0		0.0			
Sodium	125.0	91.9	51.6	423.0	142.9	51.3	700.0	4,657.2	550.0
	118.5		73.8	200.3		168.9			
Strontium	1.0	0.6	0.4	1.0	0.5	0.3	630.0	361.7	260.0
	0.9		0.5	0.6		0.3	560.0		405.0
Sulphide	0.5	0.1	0.0	0.1	0.1	0.0		13,300.0	
	0.2		0.1	0.1		0.1			
Thallium	0.1	0.1	0.1	0.3	0.0	0.0	10.0	4.8	8.0
				0.1		0.0			
Toluene	2.3	0.7	0.4	0.9	0.4	0.4	0.0	0.0	0.0
				0.7		0.7			
Uranium								0.0	
Vanadium	0.1	0.0	0.0	0.1	0.0	0.0	11.0	6.0	2.0
	0.0		0.0	0.0		0.0			
Zinc	0.4	0.1	0.0	2.0	0.1	0.0	3,340.0	227.3	0.5
	0.2		0.1	0.2		0.0	434.6		164.7

No responders reported any atmospheric information.

In addition to these contaminants already named and reported on, additional contaminant monitoring has been reported by more than one facility. This is shown in Table 2.4.

TABLE 2.4 - ADDITIONAL MONITORING DATA

	Influent			Effluent			Biosolids		
	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min
	true/ave		true/ave	true/ave		true/ave	true/ave		true/ave
Alkalinity	356	228	116	284	144	56			
	289.142		161.571	213.909		93.181			
Tin	0.2	.125	0.02	0.2	0.125	0.1	60	50	50
	.125		.08	0.125		0.125			

NOTES TO TABLES

Table 1.1 Notes:

The Population Groups shown *(Column 1)* apply equally to the Municipalities in the Contact Database and Municipalities Responding (*Columns 2 & 3)* and to the Facilities to be Surveyed columns - Originally Planned to be surveyed and from which we actually Received a survey *(Columns 4 & 5)*.

The number of municipalities originally shown in *Column 2* included (due to an initial oversight) both independent municipalities and municipalities that are or were within Regional Municipalities, as well as the regional municipalities themselves. For example, Hamilton and Burlington were both counted as being separate municipalities within the original total of 40 municipalities having populations > 100,000, but the response when received came from the new City of Hamilton (the former Region of Hamilton-Wentworth). This resulted in the need for some adjustments to be made to the figures in *Column 2* to eliminate this double counting. Many adjustments have been made to reconcile this but since there were close to 100 amalgamations in Ontario alone, there may still be some municipalities new names not reflected. However, *Columns 2* and *3* are not really relevant, since the survey is of wastewater treatment plants not municipalities, and there is no consistent correlation between municipalities and the number of facilities located in them or the populations served by the plants. For example, GVRD and CUM are two regional municipalities having roughly similar populations served, yet GVRD has 5 plants, CUM only 1 and both regions serve about the same number of independent municipalities (20+). A similar situation occurs in respect to municipalities - Toronto with a population served of 2,500,000 has 4 plants, Prince George with a population of 80,000 has 7 plants, and Saint John with a population of 72,494 has 5. The extreme is that the Sunshine Coast Regional District with a population of 13,075 has 11 plants, none of which serve more than 2000 persons and the smallest, just 20 persons.

In respect to *columns 4* and *5*, it was planned that all wastewater treatment plants serving populations over 25,000 persons would be surveyed, and that a representative number of plants serving 1,000 to 5,000 persons and 5,001 to 25,000 persons would be surveyed. As mentioned, the correlation between municipal population and plants and populations served is extremely variable, thus the original expectations (*Column 4*) cannot be met as it turned out to be quite inaccurate of the real situation, nor should it be considered a benchmark for the number of plants to be surveyed. Overall, there is a considerable number of smaller facilities than expected.

Table 2.1 Notes:

Please note, there is no correlation between facilities and municipalities by population groups (*Columns 2* and *5*). Municipalities having a population greater than 100,000 may have combinations of plants serving 100,000 or more and 100,000 and less.

The number of facilities to whom this survey was sent (*Column 5*) is less than the number of facilities shown in *Column 5* of Table 1, since not all of those in Table 1 indicated other monitoring beyond the 5 substances or characteristics in Survey 1.

For some of the smaller plants responding, the additional monitoring reported in Survey 1 turned out to be only one or two substances, or perhaps the pH. In some cases, no additional data was received, indicating they had misread the form, or decided not to respond.For the four surveys sent out to facilities where the population served was not supplied, the plants have been contacted and the population figures were indertiminable. Generally, the bigger the plant, the more contaminants are monitored and reported.