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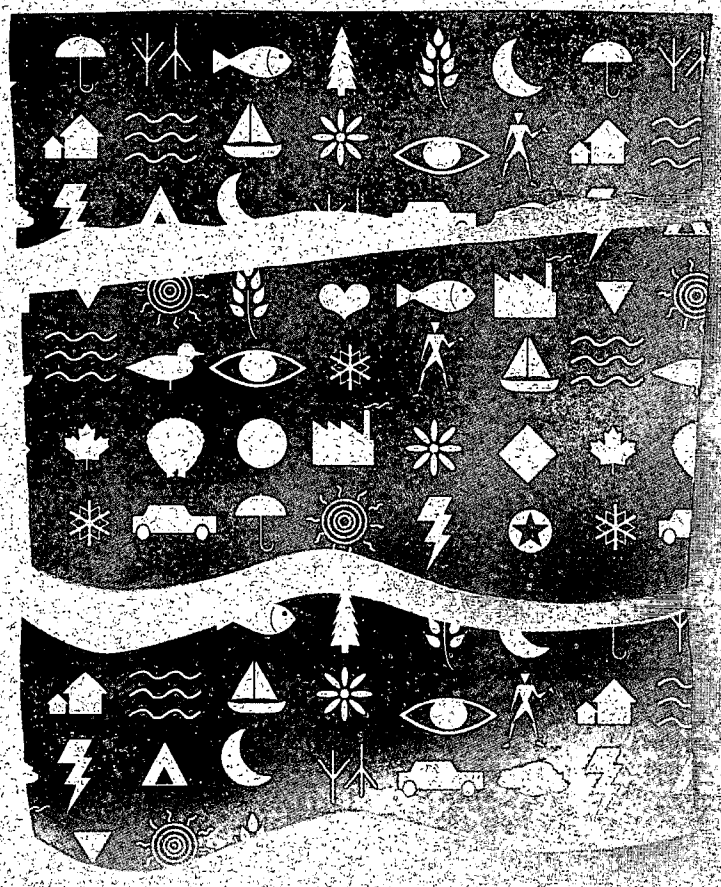
Water Use in Canadian Industry, 1986

Donald M. Tate and David N. Scharf



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Ecosystem Sciences and Evaluation Directorate
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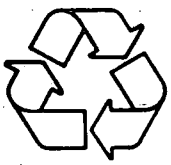

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Abstract

This report summarizes the results of the 1986 survey of industrial water use. It is the fourth such report since 1977; previous reports dealt with industrial water use in 1972, 1976, and 1981.

As in past reports, this report presents data and discussion on five physical parameters of industrial water use (intake, recirculation, gross use, consumption, and discharge), as well as some basic economic parameters such as output value and water cost, by sector (manufacturing, mineral extraction, and thermal power) and by province for the manufacturing sector. Two departures from past reports are a more detailed discussion of water use in the mineral extraction and thermal power sectors, and a discussion of the time trends observed in industrial water use.

Environment Canada, with the cooperation of Statistics Canada, conducts these surveys at five-year intervals, with the next being planned for 1991.

Résumé

Ce rapport résume les résultats de l'étude faite en 1986 sur l'utilisation industrielle de l'eau. Il s'agit de la quatrième édition de ce genre de rapport depuis 1977; les rapports précédents portaient sur l'utilisation industrielle de l'eau en 1972, 1976 et 1981.

À l'instar de ces rapports, on y présente des données et on y analyse cinq paramètres relatifs à l'utilisation industrielle de l'eau (alimentation, recirculation, utilisation brute, consommation et rejet), ainsi que certains paramètres économiques de base comme la valeur de production et le coût de l'eau, par secteur (fabrication, extraction des minéraux et énergie thermique) et par province dans le cas du secteur de la fabrication. Cette année, le rapport compte deux changements importants: une analyse plus détaillée de l'utilisation de l'eau dans les secteurs de l'extraction des minéraux et de l'énergie thermique, et une analyse des tendances temporelles observées dans l'utilisation industrielle de l'eau.

Cette étude fait partie d'une série d'enquêtes entreprises tous les cinq ans par Environnement Canada, avec la participation de Statistique Canada, la prochaine étant prévue pour 1991.

Water Use in Canadian Industry, 1986

Donald M. Tate and David N. Scharf

INTRODUCTION

This report describes the results of an industrial water use survey for 1986. Similar surveys were completed in 1972, 1976, and 1981, and were reported on by Tate (1977), Tate (1983), and Tate and Scharf (1985), respectively. Data collected during the survey have been used in a variety of federal, provincial, and private-sector studies.

Background

Periodic inventories are a vital and basic step in studying any aspect of resource management. In the water resource field, Environment Canada, in cooperation with the provinces, is entering its ninth decade of collecting water supply data; it also holds substantial amounts of water quality data. As important as water quantity and water quality, however, is water use. For this reason, industrial water use data have been collected since 1972.

Researchers in the past 25 years have built a rich literature on industrial water use (see, for example, Bower 1966; de Rooy 1970; Kindler and Russell 1984; Tate 1984; Renzetti 1987). Several general observations have been made. First, water use is varied in nature, with physical, technological, economic, and policy factors all contributing to the level of water usage. Second, the economic component shows that water use is actually a "demand" in the economists' sense in that as the price rises, usage or demand falls in a definable fashion. Third, the level of water use is influenced heavily by action to control water pollution. Fourth, industries adapt their water use to availability, thus regional patterns are discernable. These factors have influenced the design of the Canadian industrial water use surveys.

Purpose and Scope of the Survey

The 1986 survey consisted of a questionnaire mailed to some 6000 industrial establishments in four industrial sectors: manufacturing, mineral extraction, thermal power, and hydro power. Telephone consultations with respondents clarified and verified the responses.

First, the survey inventoried the volume of water being used for intake, recirculation, and discharge, allowing gross use and consumption to be calculated (see the section Basic Survey Parameters). Second, it examined the basic end uses to which the water is put (e.g., cooling and processing). Third, it documented a few basic economic parameters (e.g., employment and value of shipments) in order to relate water use to measures of economic activity. Fourth, it assembled sufficient information to allow the computation of an approximate price for water to the plants surveyed. Finally, it collected basic data on industrial waste treatment.

The survey was limited in a number of ways. Because of resource constraints, it did not survey all industrial operations in Canada, which number between 35 000 and 40 000. Sampling procedures were not used. Instead, the survey was sent to a selected universe, and results were estimated for nonrespondents. No data on physical output were collected because output from large operations can vary widely in type, and there is no satisfactory method of handling this diversity in a mailed survey. Finally, no data were compiled on the quality of effluent streams, because of the survey method and the complexity of the effluent sampling process.

Survey Concepts and Methods

Basic Survey Parameters

In describing industrial water use, five basic parameters are of interest: intake, recirculation, gross use, consumption, and discharge. Figure 1 shows the relationships between these parameters, which are discussed in detail in this section. These parameters have been used in all of the Canadian industrial water use surveys and are consistent with those used in other countries.

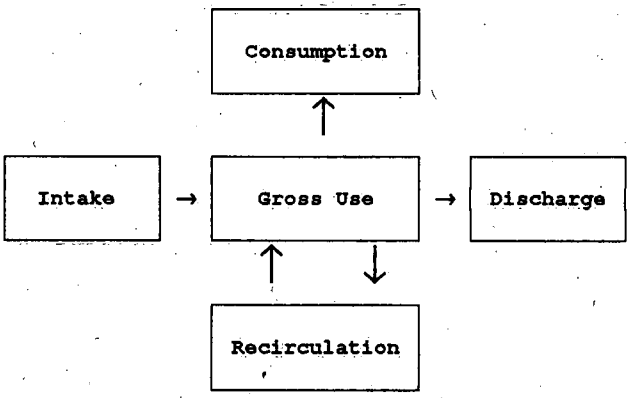

Figure 1. An industrial plant water system.

Intake is the water added to the water system of a plant to replace water discharged or consumed during production. It may be considered in terms of its source (e.g., surface water and groundwater) or its purpose or end use—processing; cooling, condensing, and steam; sanitary services; and other purposes. Processing water includes all water that comes in direct contact with products and/or materials. Cooling, condensing, and steam generation use water does not come in direct contact with the products, materials, or by-products of the processing operation. Examples include pass-through water used in the operation of cooling or process equipment (including air conditioning) and water introduced into boilers for the production of steam for either process operations or electric power.

Recirculation is the use of water at least twice in the manufacturing process. It is not the use of water a number of times within a particular process subsystem of a plant, but water that leaves a particular process subsystem and re-enters it or is used in another process. Recirculated water and intake combine to form the gross use.

Gross use refers to the total amount of water used in the production of a product. Because it is the sum of intake and recirculated water, this parameter was calculated from surveyed data on intake and recirculation.

Consumption refers to water that is lost in the production process. In other words, consumed water is not returned to its original source. Water is consumed primarily through escaped steam and incorporation into a product, as in the production of soft drinks. Consumption was not surveyed but was calculated by subtracting discharge (see below) from intake.

Discharge is water that is returned to the environment in the form of water, usually close to the plant. Discharged water may be treated or untreated. Together, discharge and consumption form the effluent subsystem of the plant. The sum of these two parameters is approximately equal to the total water intake of the plant.

Questionnaire Design

The questionnaires for each of the four industrial sectors were similar (see Appendix), although some variations were made in the questionnaires for the two power generation sectors to collect data peculiar to them. The general description that follows is based on the manufacturing and mineral extraction sectors.

Section 1 requested basic information on employment, plant operations, and products. Section 2 was devoted to information on the monthly pattern of intake and discharge and their annual totals. The sources and kinds of intake were covered in section 3, while section 4 requested details on the various treatments given to the intake water. Both volume and cost information were requested in sections 3 and 4. Section 5 was concerned with intake by purpose, and section 6, with data on the purpose and cost of recirculation. Section 7 was devoted to the various types of treatment to discharge and their cost. Finally, section 8 concerned data on the discharge by discharge point and the cost.

Respondent Selection

The 1986 survey was based on a mailing to selected categories of the manufacturing and mineral extraction sectors of the Canadian economy and to all thermal and hydroelectric power plants across the country.

Within the manufacturing sector, respondents were selected on the basis of past survey results and the type of questionnaire sent by Statistics Canada during its annual census of manufacturing. During the first survey in 1972, questionnaires had been sent to a relatively large number of industries that used very little water. To exclude these, the 1976 survey was sent only to those industries in the ten two-digit SIC

groups[1] within the manufacturing sector that used the most water. Only those establishments in these ten groups that received the long-form questionnaires[2] during the 1976 census of manufacturing were selected.

For the 1981 survey, the 1976 survey of these industries in the manufacturing sector was refined by eliminating some of the minor water users. For example, only sawmills were surveyed in the wood products industry. Although the resultant changes in water use data were small, the number of employees or plants was noticeably reduced in some industries. A new industry group—fabricated metals—was added to the 1981 survey. As well, a reporting cut-off of less than 4500 cubic metres of annual water use was provided for the convenience of the smaller operations in the manufacturing, mineral extraction, and thermal power sectors.

The 1986 survey of the manufacturing sector included 14 major two-digit SIC industry groups, three more than the 1981 survey. This increase resulted from the adoption of the Statistics Canada 1980 SIC system, which increased the number of major industrial groups. For example, the food and beverage groups, which were combined in 1981, were now two separate groups. Some industry groups were also expanded at the four-digit level to improve coverage of establishments involved in the same kind of economic activity. For example, the industry class Motor Vehicle Parts and Accessories was expanded to seven separate four-digit SICs.

An attempt was made to include all significant operating establishments in the mineral extraction industry. The industries from the 1981 survey using the most water, as well as establishments in the peat extraction industry, were included. All Canadian thermal power plants and hydroelectric power generating plants were included.

Response Rates

The response rates obtained varied among the four sectors surveyed (Table 1). In the manufacturing sector, the largest in the survey, 5235 questionnaires were distributed to industrial firms. Of this number, 3535 were returned, for a response rate of 68%. The response rate for the mineral extraction sector was much higher at 90%. Both the thermal and hydro sectors had a 100% response.

Table 1. Summary of Survey Returns

Sector	Question-naires	Respondents	Non-respondents	Response rate (%)
Manufacturing	5235	3535	1700	68
Mineral extraction	277	248	29	90
Thermal power	77	77	–	100
Hydro power	358	358	–	100
Total	5947	4218	1729	71

Estimation Procedures for Nonrespondent Data

Water use data for nonrespondents in the manufacturing and mineral extraction sectors were estimated using coefficients of water use per employee developed from the respondent data for each industry at the four-digit SIC industry level and on a provincial basis. Each water use coefficient was multiplied by the employment for the nonrespondent plants. Where the provincial universe for a particular industry was small, the coefficients from the national level were used to provide the estimates.

In estimating results for nonrespondents, it was assumed that plants in the same industry in the same province would use essentially the same processes. This assumption is not wholly acceptable (Whitington 1978), but was used as a convenient way to provide data for the entire survey universe, since estimation was usually required only for smaller plants.

Survey Responsibilities

The 1986 survey was a collaborative effort by a number of federal and provincial agencies, principally Environment Canada and Statistics Canada. Statistics Canada selected the potential respondents from the

[1]Standard Industrial Classification (SIC), as defined by Statistics Canada. The two-digit level is the coarsest division of the SIC and includes major industrial groups such as the food industry and the paper and allied products industry. The four-digit level is the finest division and includes subcategories of industrial groups such as sugar refineries and pulp mills. (See Statistics Canada 1980).

[2]Long-form questionnaires are those that request detailed input and output data from "large" industrial establishments. The definition of "large" varies from industry to industry, but, in general, includes all those establishments of a specified size which together account for a significant proportion (usually 90% or more) of total industrial shipments of goods of own manufacture. Remaining establishments in the industrial group receive a short-form questionnaire, requiring minimum information. This procedure reduces the response burden on small firms and, at the same time, provides essential operation-related statistics for the industry.

censuses of manufacturing, mining, and energy and received the completed questionnaires, using its system for tracking questionnaire surveys. Environment Canada selected the industry (SIC) groups to be surveyed, designed the questionnaire, edited and processed the data, and published the results.

The Planning Division, Alberta Environment, performed its own survey and data tabulation for that province using the same set of questionnaires as the federal survey. The Alberta results have been incorporated into this publication. The Water Resources branches of both the Manitoba Department of Natural Resources and the Ontario Ministry of the Environment assisted by reviewing the questionnaire design.

Report Outline

This report presents the basic survey results, which can be used for many types of analyses by a wide variety of researchers. While it describes water use patterns in the various subcomponent industries, it does not attempt an analysis.

The report focuses on the main parameters of water use, as outlined above. It discusses the sources of industrial water, the treatment of this water prior to use, the basic end uses to which water is put, the gross amount of water used by industry, and various aspects of waste disposal. In addition, it outlines the basic economic data collected, including the cost of intake (e.g., pumping and licences), intake treatment, recirculation, and discharge treatment. The sum of these four cost parameters, averaged over the plant intake, can be substituted for the price of water (de Rooy 1970).

The body of the report deals with water use in the manufacturing, mineral extraction, and thermal power sectors. The hydroelectric power generation sector is not included in this report because it is a nonwithdrawal user. Most of the discussion focuses on the manufacturing sector because it is the most diverse user of water and contains the most subsectors. Only the most important details of water use in the mineral extraction and thermal power sectors are discussed.

The complete survey results have been published in the 1986 Industrial Water Use Survey Tables: Volume I—Water Use in Manufacturing; Volume II—Water Use in Mineral Extraction, Thermal Power, and Hydro Power, and are available from the authors. Data in the tables in this report are derived from the complete survey tables. Figures have been rounded for simplification and consequently may appear not to total correctly.

WATER USE IN MANUFACTURING INDUSTRIES

Industry-by-Industry Water Use Patterns

General Characteristics

Just over 830 000 persons worked in the 5235 manufacturing plants surveyed (Table 2). These plants represented the majority of industries in Canada that used large amounts of water and employed about 43% of the workers in all manufacturing industries. The intake of the surveyed plants totalled 7984 million cubic metres (MCM) from ambient water bodies in 1986 (Table 3). Gross use totalled 15 796 MCM; recirculated water, 7813 MCM (Table 3). In other words, recirculation effectively doubled industrial water supplies. The use rate (an index of water recirculation) for the manufacturing sector was 198% (Table 4), down slightly from 210% in 1981. Water consumption totalled 405 MCM, or 5.1% of the intake, whereas 7579 MCM were discharged to the ambient water bodies (Table 3). The consumption rate of 5.1% (Table 4) was up slightly from 5.0% in 1981.

The five manufacturing groups in the survey using the most water were the paper and allied products, primary metal, chemical and chemical products, food, and refined petroleum and coal products industries. Together these five major water users accounted for about 94% of both intake and discharge and 89% of consumption.

Use rates varied substantially among industry groups (Table 4), ranging between 110% for the wood industry and 550% for the fabricated metal products industry. Two of the industries using the largest amounts of water, the primary metals and the chemical and chemical products industries, had use rates slightly below the national average (180% and 190%, respectively).

The use rates for most of the surveyed industries rose between 1972 and 1976, indicating a short-term trend toward increasing the use of recirculation technology. In the 1981 survey, the rubber products, plastic products, nonmetallic mineral products, refined petroleum and coal products, and wood industries showed large increases in use rates. In 1986, all these industries revealed noticeable declines in recirculation.

Table 2. Employment by Industry Group and Province, Manufacturing (Persons)

Industry group	Newfoundland	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Northern Territories	Total
Foods	16 584	2 507	9 764	12 897	31 661	51 502	7 228	3 012	8 276	11 915	25	155 371
Beverages	528	45	713	963	6 575	8 583	975	874	1 519	2 363	0	23 138
Rubber products	0	0	3 900	15	4 690	12 138	44	0	215	199	0	21 201
Plastic products	55	0	631	248	7 971	17 868	1 245	143	1 778	1 806	0	31 745
Primary textiles	0	17	731	121	10 126	8 893	26	0	0	153	0	20 067
Textile products	15	0	415	0	3 037	2 632	0	10	200	20	0	6 329
Wood	106	2	482	1 690	11 436	5 812	532	536	1 974	26 481	0	49 051
Paper and allied products	3 270	0	2 584	5 867	33 565	28 718	1 001	472	2 648	15 684	0	93 809
Primary metals	0	0	1 920	606	24 921	62 645	4 353	436	2 840	5 974	0	103 695
Fabricated metal products	148	140	595	980	11 029	27 345	1 336	422	3 075	2 641	0	47 711
Transportation equipment	600	124	2 952	1 781	29 873	130 189	3 758	44	685	3 365	0	173 371
Nonmetallic mineral products	361	34	684	712	9 508	19 298	887	658	2 974	3 804	10	38 930
Refined petroleum and coal products	0	0	493	450	1 323	4 590	0	291	1 545	1 049	15	9 756
Chemicals and chemical products	411	47	454	155	16 015	32 480	383	226	4 049	2 052	4	56 279
Total	22 078	2 916	26 318	26 485	201 730	412 693	21 768	7 124	31 778	77 506	54	830 450

Table 3. Number of Plants and Water Use (MCM) by Industry Group, Manufacturing

Industry group	Number of plants	Intake	Recirculation	Gross use*	Consumption†	Discharge
Foods	1 288	564	148	712	24	540
Beverages	217	63	107	169	12	51
Rubber products	86	23	67	90	2	21
Plastic products	438	30	66	96	3	27
Primary textiles	123	95	30	125	2	93
Textile products	72	13	12	25	2	11
Wood	341	56	8	64	2	54
Paper and allied products	291	3 029	2 979	6 008	200	2 829
Primary metals	221	1 718	1 350	3 068	43	1 675
Fabricated metal products	537	25	114	139	1	24
Transportation equipment	435	117	237	354	4	114
Nonmetallic mineral products	588	90	70	160	18	72
Refined petroleum and coal products	32	487	1 068	1 555	33	454
Chemicals and chemical products	566	1 674	1 558	3 232	59	1 615
Total	5 235	7 984	7 813	15 796	405	7 579

*Gross use = intake + recirculation
†Consumption = intake - discharge

In fact, the use rates in 1986 declined in all industries, except for the chemical and chemical products, transportation equipment, and fabricated metal products industries. The decline in the paper and allied products industry alone offset the effect of increased recirculation in these three. This caused the national aggregate use rate to decline slightly from 1981.

The consumption rate is an index of the amount of water lost during production, most commonly through evaporation or incorporation of water into products. As noted earlier, the national average rate of consumption was 5.1% of intake. The rate varied between 20.0% for the nonmetallic mineral products industry and 2.1% for the primary textile industry.

Sources

The manufacturing industries surveyed obtained most (83%) of their water supply from self-supplied, freshwater, surface sources (Table 5). Eight percent derived their water from public utilities (an increase of about 1% from 1981), 4% from fresh groundwater sources, and 4% from brackish sources. The last two sources constituted a small but significant portion of total intake, showing a marked increase from 4% in 1981.

Industries dominated by large establishments differed from those dominated by relatively small establishments with regard to water source. This difference was apparent from both the examination of individual

Table 4. Use and Consumption Rates by Industry Group, Manufacturing (%)

Industry group	Use rate*	Consumption rate†
Foods	130	4.3
Beverages	270	19.0
Rubber products	390	8.7
Plastic products	320	10.0
Primary textiles	130	2.1
Textile products	190	15.4
Wood	110	3.6
Paper and allied products	200	6.6
Primary metals	180	2.5
Fabricated metal products	550	4.0
Transportation equipment	300	3.4
Nonmetallic mineral products	180	20.0
Refined petroleum and coal products	320	6.8
Chemicals and chemical products	190	3.5
Average	198	5.1

*Use rate = (gross use ÷ intake) × 100%
†Consumption rate = (consumption ÷ intake) × 100%

plant returns and the inspection of the aggregate data of Table 5. For example, the beverage industry, which was composed generally of many relatively small plants, withdrew 63% of its intake from public sources. This industry was characterized not only by small plants but by a requirement for high quality intake water. Thus, it relied upon public supplies for much of its water. Fabricated metal products, an industry dominated by small and mid-size establishments, also revealed a great dependency on public water supply (84%). In contrast, four of the five major water users—paper and allied products, primary metals, refined petroleum and coal products, and chemicals and chemical products—withdrew 3%, 5%, 4%, and 4%, respectively, from public supplies. These industries had fewer and generally larger plants than the beverage and fabricated metals industries.

Intake Treatment

Manufacturers treat large volumes of intake water prior to use (Table 6). Since many plants employ two or more treatment processes prior to use, the total amount of water reported in this table substantially exceeded the total water intake reported in Table 3. On the other hand, many plants reported little treatment prior to the initial use of water. The volume of water treated by the manufacturing firms surveyed totalled 9445 MCM. Screening, chlorination and disinfection, and filtration were the most frequently used pretreatment methods, together accounting for about 84% of the total amount treated. The "other" category included processes such as dechlorination and distillation, which were not easily classified in other groups. The substantial amounts of intake water treated prior to use reflected a need in many industries for water of high quality.

Purposes

Data on the inital use of water in manufacturing (Table 7) indicate that 50% of total intake was used for cooling, condensing, and steam. Process water accounted for 47% of intake, with sanitary and other uses accounting for the remaining 3%.

Table 5. Intake by Source and Industry Group, Manufacturing (MCM)

Industry group	Fresh water				Brackish water			Total intake
		Self-supplied			Self-supplied			
	Public	Surface	Ground	Other	Ground	Tide	Other	
Foods	158	82	263	1	-	59	-	564
Beverages	40	19	3	1	-	-	-	63
Rubber products	12	4	5	-	3	-	-	23
Plastic products	11	14	2	3	-	-	-	30
Primary textiles	11	84	-	-	-	-	-	95
Textile products	11	2	-	-	-	-	-	13
Wood	8	37	2	5	-	4	-	56
Paper and allied products	99	2891	32	5	-	3	-	3029
Primary metals	94	1525	2	12	-	85	-	1718
Fabricated metal products	21	3	1	-	-	-	-	25
Transportation equipment	60	57	-	-	-	-	-	117
Nonmetallic mineral products	23	55	3	9	-	-	-	90
Refined petroleum and coal products	22	412	1	2	1	49	-	487
Chemicals and chemical products	72	1469	6	7	2	119	-	1674
Total	642	6654	319	44	6	319	-	7984

Table 6. Treatment of Intake by Type and Industry Group, Manufacturing (MCM)

Industry group	Filtration	Chlorination and disinfection	Corrosion and slime control	Hardness and alkalinity Screening	Hardness and alkalinity Control	Other	Total treatment	Total intake
Foods	27	88	6	41	16	4	182	564
Beverages	24	23	2	15	12	7	84	63
Rubber products	1	1	2	3	2	-	8	23
Plastic products	3	-	1	3	2	1	10	30
Primary textiles	12	30	-	47	7	-	97	95
Textile products	3	-	1	-	3	-	8	13
Wood	3	-	1	16	1	1	22	56
Paper and allied products	1273	911	107	1370	174	131	3966	3029
Primary metals	40	938	354	582	31	15	1960	1718
Fabricated metal products	4	-	-	1	1	-	7	25
Transportation equipment	1	10	1	48	3	1	64	117
Nonmetallic mineral products	8	2	6	31	1	1	50	90
Refined petroleum and coal products	20	75	25	242	35	43	440	487
Chemicals and chemical products	92	582	376	1415	39	44	2548	1674
Total	1510	2662	883	3815	328	248	9445	7984
Totals as a percentage of total manufacturing water intake	19	33	11	48	4	3	-	-

Table 7. Intake by Purpose and Industry Group, Manufacturing, (MCM)

Industry group	Processing	Cooling, condensing, and steam	Sanitary services	Other	Total intake
Foods	352	161	47	4	564
Beverages	15	35	11	2	63
Rubber products	5	16	2	-	23
Plastic products	7	22	1	-	30
Primary textiles	16	77	3	-	95
Textile products	9	3	-	-	13
Wood	13	41	2	-	56
Paper and allied products	2286	677	44	22	3029
Primary metals	746	931	31	11	1718
Fabricated metal products	14	9	2	-	25
Transportation equipment	49	58	9	1	117
Nonmetallic mineral products	24	61	3	1	90
Refined petroleum and coal products	33	449	5	-	487
Chemicals and chemical products	208	1438	15	13	1674
Total	3778	2976	175	54	7984

Cooling, condensing, and steam accounted for the largest proportion of initial use in 11 of the 14 industries surveyed. The paper and allied products industry, however, which used the most water, used most of its new water intake for processing, thereby having a significant impact on the total amount of process water reported in Table 7. The other four major water users reported that most of their intakes were used in cooling, condensing, and steam rather than in processing.

Monthly Water Use Patterns

The monthly distribution of annual water intake was found to be consistent with that of water discharge. Thus, only the intake pattern has been tabulated (Table 8). The data were converted to percentage terms for the purposes of this table to facilitate comparisons between industries without respect to size. An even monthly distribution of the data would be 8.3% of the annual intake. Table 8 shows that some seasonality was experienced, with total intake tending to be higher in the summer and fall. This pattern was expected in view of higher cooling requirements in the summer and the effects of fall processing in the food industry.

Monthly patterns varied from industry to industry. Of the five major users, the food and the refined petroleum and coal products industries exhibited the most

Table 8. Monthly Distribution of Intake by Industry Group, Manufacturing (% of annual total)

Industry group	J	F	M	A	M	J	J	A	S	O	N	D
Foods	6.7	7.6	7.6	7.7	8.4	8.8	9.1	9.9	9.4	8.9	8.0	7.8
Beverages	9.2	8.8	9.4	8.2	8.7	8.9	8.1	7.6	8.0	8.2	7.8	7.2
Rubber products	8.2	8.3	8.5	8.8	8.3	8.7	7.9	9.0	8.8	8.4	7.9	7.3
Plastic products	8.3	8.3	8.6	8.9	8.1	8.2	8.1	8.2	8.2	8.1	8.8	8.4
Primary textiles	6.9	6.3	7.1	7.4	9.2	8.6	7.7	9.9	10.5	10.2	8.6	7.6
Textile products	8.3	8.2	8.2	9.0	8.5	8.4	6.4	8.2	8.4	8.9	9.3	8.2
Wood	11.3	10.9	12.0	12.2	12.5	12.2	10.4	3.6	1.8	2.0	1.3	9.8
Paper and allied products	8.2	7.8	8.2	8.1	8.8	8.6	9.0	8.8	8.0	8.6	8.0	8.0
Primary metals	8.5	8.0	8.5	8.4	8.6	8.4	8.2	7.9	8.2	8.5	8.4	8.4
Fabricated metal products	7.9	8.1	8.0	8.4	8.6	8.5	8.7	8.2	8.7	8.7	8.2	8.1
Transportation equipment	8.1	7.9	8.2	8.6	8.8	8.9	8.6	7.0	8.5	8.9	8.1	8.4
Nonmetallic mineral products	7.9	7.5	7.9	8.2	9.2	9.7	9.1	9.7	9.5	8.7	8.1	8.2
Refined petroleum and coal products	7.6	7.3	8.0	6.9	7.9	8.4	9.0	9.7	9.3	9.1	8.2	8.6
Chemicals and chemical products	8.3	7.5	8.2	8.0	8.4	8.3	8.7	8.9	8.9	8.4	8.2	8.3
Total	8.1	7.7	8.2	8.1	8.6	8.5	8.7	8.7	8.4	8.5	8.1	8.2

significant trends toward summer peaking, with differences of over 2% between the lowest and highest pumpage months. The greatest variation was shown by the wood industry.

Discharge Points

Wastewater totalling 7579 MCM (Table 9) was discharged to the following points: public sewers, 9%; freshwater bodies, 74%; tidewater bodies, 16%; groundwater and other uses, <1%. The beverage industry discharged 78% of its effluent to public sewers, a proportion larger than its intake from the public water supply system. The food industry discharged 64% to the public sewers. In contrast, the remaining four major water users discharged relatively small amounts of water to public sewers (i.e., paper and allied products, 3%; primary metal, 3%; refined petroleum and coal products, 2%; and chemicals and chemical products, 4%).

The choice of various discharge points was related directly to the amount of the wastewater discharged, the location of the plant, and the characteristics of the pollutants in the wastewater. The food and beverage industries, which usually have small plants, do not have sufficient discharges to justify building and operating individual waste treatment facilities. Also, because wastes from food and beverage plants have a high biochemical oxygen demand (BOD) and contain suspended solids, they tend to be compatible with municipal waste treatment processes.

On the other hand, the larger plants of other industrial groups generate large volumes of waste, which are often too large to be handled in municipal treatment plants. Most of this wastewater must be handled internally and discharged directly to surface waters. Also, because some of the pollutants generated by large industries are incompatible with municipal waste treatment processes, wastewater must be treated internally and discharged directly to receiving waters.

Discharge Treatment

Many of the firms surveyed treated their wastewater prior to discharge. The quantities of discharge are classified by the generic type of treatment in Table 10. Primary treatment is the use of mechanical methods of treating wastes, such as screening, coagulation, and filtration. Secondary treatment is the use of processes depending upon some form of biological treatment to reduce the biochemical oxygen demand of the effluent. Activated sludge and trickling filter methods are common forms of secondary treatment. Tertiary treatment refers to methods that "polish" the effluent subsequent to secondary treatment. One common form of tertiary treatment is phosphorus removal.

As in intake treatment, the same volume of water may be processed by more than one level of treatment. Thus, the amounts recorded in the "total treatment" column of Table 10 will contain a substantial degree of double counting. The brief discussion below focuses on the data within each column in an attempt to avoid the double counting as much as possible.

About 50% of all discharge was treated by some form of waste treatment. The amounts of water treated under each catetgory were distributed among the

Table 9. Discharge by Discharge Point and Industry Group, Manufacturing (MCM)

Industry group	Public sewer	Freshwater body	Tidewater body	Ground-water	Transferred to other uses	Total
Foods	346	104	84	4	3	540
Beverages	40	10	-	1	-	51
Rubber products	10	11	-	-	-	21
Plastic products	21	5	-	-	-	27
Primary textiles	13	80	-	-	-	93
Textile products	11	-	-	-	-	11
Wood	3	40	10	2	-	54
Paper and allied products	86	1911	811	16	5	2829
Primary metals	51	1477	126	17	4	1675
Fabricated metal products	19	4	-	1	-	24
Transportation equipment	38	73	1	1	-	114
Nonmetallic mineral products	13	56	-	2	-	72
Refined petroleum and coal products	9	391	52	2	-	454
Chemicals and chemical products	65	1417	129	3	-	1615
Total	724	5579	1214	49	13	7579

Table 10. Discharge Treatment by Type and Industry Group, Manufacturing (MCM)

Industry group	Primary	Secondary	Tertiary	Total treatment	Total discharge
Foods	63	18	1	82	540
Beverages	5	2	-	7	51
Rubber products	-	-	1	1	21
Plastic products	3	-	-	3	27
Primary textiles	4	9	-	13	93
Textile products	3	1	-	4	11
Wood	6	-	-	6	54
Paper and allied products	1530	608	48	2186	2829
Primary metals	582	10	12	604	1675
Fabricated metal products	9	1	2	12	24
Transportation equipment	35	7	2	44	114
Nonmetallic mineral products	19	2	-	21	72
Refined petroleum and coal products	706	41	5	752	454
Chemicals and chemical products	117	17	8	142	1615
Total	3082	716	79	3877	7579
Total as a percentage of total manufacturing discharge	41	9	1	-	-

industrial groups in roughly the same way as other characteristics of water use. The paper and allied products industry treated the largest amounts in all categories: 50% of the total amount treated by primary methods, 85% by secondary, and 61% by tertiary. This dominance reflects the concerted efforts made by plants in the industry during the 1970s to install pollution control devices. The refined petroleum and coal products, primary metal, and chemical and chemical products industries were the next to treat significant quantities of wastewater.

Recirculation

The data on water recirculation (Table 11) highlight the importance of recycling or reuse for the five major water users. These industries accounted for 91% of the total recirculation reported of 7813 MCM. The paper and allied products industry alone recycled 38% of the total, most of it for processing purposes. Recycled water was used primarily for cooling, condensing, and steam by the chemical and chemical products, refined petroleum and coal products, primary metal, food, and beverage industries.

Costs

The 1986 survey collected data on the cost of water acquisition (Table 12) and on the cost of intake and discharge treatment and water recirculation (Table 13). The water acquisition costs consisted of the costs of in-house treatment facility operation and mainte-

Table 11. Recirculation by Purpose and Industry Group, Manufacturing (MCM)

Industry group	Processing	Cooling, condensing, and steam	Other	Total
Foods	37	102	10	148
Beverages	3	102	1	107
Rubber products	8	59	-	67
Plastic products	14	52	-	66
Primary textiles	1	29	-	30
Textile products	-	12	-	12
Wood	1	4	3	8
Paper and allied products	2613	258	108	2979
Primary metals	348	983	20	1350
Fabricated metal products	105	8	1	114
Transportation equipment	84	107	45	237
Nonmetallic mineral products	9	60	2	70
Refined petroleum and coal products	39	1024	5	1068
Chemicals and chemical products	311	1238	9	1558
Total	3572	4038	203	7813

Table 12. Acquisition Costs by Industry Group, Manufacturing ($000's)

Industry group	Payment to public public utility	In-house operation/ maintenance	Plant intake licence	Acquisition total
Foods	22 356	7 748	103	30 208
Beverages	8 586	1 236	15	9 836
Rubber products	1 507	312	-	1 819
Plastic products	2 056	453	6	2 516
Primary textiles	1 689	1 318	-	3 007
Textile products	1 883	228	2	2 113
Wood	672	1 924	8	2 603
Paper and allied products	6 996	15 571	133	22 700
Primary metals	14 532	86 145	80	100 757
Fabricated metal products	3 332	615	2	3 949
Transportation equipment	13 059	812	37	13 908
Nonmetallic mineral products	4 554	1 203	4	5 761
Refined petroleum and coal products	1 313	5 024	10	6 347
Chemicals and chemical products	10 187	12 702	10	22 899
Total	92 723	135 291	410	228 424

Table 13. Costs by Cost Component and Industry Group, Manufacturing ($000's)

Industry group	Intake treatment	Recirculation	Discharge treatment	Total
Foods	4 375	4 811	6 516	15 702
Beverages	2 449	759	504	3 712
Rubber products	766	748	121	1 636
Plastic products	515	1 162	261	1 938
Primary textiles	1 355	441	777	2 573
Textile products	350	226	77	653
Wood	309	265	81	655
Paper and allied products	20 338	8 400	38 058	66 796
Primary metals	9 857	26 960	33 746	70 563
Fabricated metal products	583	625	3 125	4 333
Transportation equipment	2 650	2 503	12 106	17 259
Nonmetallic mineral products	825	1 685	490	3 000
Refined petroleum and coal products	6 157	3 685	8 744	18 586
Chemicals and chemical products	18 429	14 892	12 067	45 388
Total	68 958	67 160	116 673	252 794

nance, the amounts paid by firms to water suppliers, normally local public utilities, for water services, and, in some cases, the cost of the plant intake licence. It should be noted that these data constitute only part of the total cost of water to the industries surveyed. Not included in Table 12, for example, were data on the capital costs of self-supplied water acquisition. The cost of discharge treatment consists mainly of annual operation and maintenance costs, but may also include sewer surcharges levied by municipalities. No attempt was made to estimate costs for nonrespondents for any of the cost categories.

The cost of water acquisition totalled just over $228 million in 1986. The primary metal industry was the most significant contributor to this cost (44%), with the food industry (13%) the second contributor, followed by the chemical and chemical products and the paper and allied products industries (10% each). Data in Table 12 reveal that 59% of acquisition costs were reported for in-house operation and maintenance costs, substantially more than payments to public utilities at 40%. The food, primary metal, transportation equipment, chemical and chemical products, and beverage industries paid the most to public utilities, indicating their reliance on potable water supplied largely by municipalities.

The data on intake treatment costs also reflect the dominance of the five major water users (Table 13). These five, plus the beverage industry, spent approximately 89% of the total cost reported for intake treatment, over $61 million.

The cost of discharge treatment was reported at just over $116.5 million. Of this total, the paper and allied products industry spent just over $38 million, or 33%. Costs to the other four major water users, the primary metal, chemical and chemical products, refined petroleum and coal products, and food industries followed the paper and allied products industry in that order. The other significant costs for discharge treatment were incurred by the transportation equipment and fabricated metal products industries.

The costs for water recirculation reflect the importance of recirculation to the five major water users, which account for 87% of the total cost. The primary metal industry alone spent almost $27 million, or about 40%, of these costs. Other significant contributors to recirculation costs were the transportation equipment and plastic products industries.

Through the extensive telephone follow-up undertaken to complete returns for some of the survey respondents, additional information was obtained on the costs of water acquisition and treatment. Hence the values obtained for the 1986 survey are more accurate than those of the 1981 survey, where only a minimum amount of time was available for the follow-up inquiries. The response to these cost items also reflects several interesting points about current water management practices. First, there has been an increasing use of meters by both the municipalities and the larger industries, resulting in improved records of the amount of money spent on water use. Second, because of the greater concentration of effort in the area of treatment, especially waste treatment, companies are monitoring the costs of each treatment method and its efficiency in terms of dollars as well as water quality. The data also reflect the greater emphasis all manufacturing industries are placing on the recirculation and reuse of the water used in their plant processes.

Provincial Water Use Patterns

General Characteristics

Tables 14 through 18 show the patterns of water use in the provinces and territories. (Data in these tables for the Yukon and Northwest Territories have been combined under the heading Northern Territories.) Ontario accounted for 47% of the total manufacturing water intake, followed by Quebec with 19%, and British Columbia with 17% (Table 14). In contrast, Prince Edward Island and the Northern Territories accounted for an insignificant proportion of the total. This distribution of water intake reflects provincial/territorial industrial structures.

Table 15 gives the use and consumption rates by province/territories. In general, the use rates in the Atlantic region were among the lowest in Canada. These low use rates resulted from several factors. First, because water is readily available in the Atlantic region, the need for recirculation is reduced. Also, because of the industrial mix of the region, industry groups with high use rates, such as the refined petroleum and coal products and the chemical and chemical products industries, were not predominant. Finally, because the industrial base of the Atlantic region tended to be older than that of the rest of Canada, it employed older technological methods, which did not recirculate large amounts of water.

Table 14. Water Use by Province/Territories, Manufacturing (MCM)

Province/Territories	Intake	Recir-culation	Gross use*	Consump-tion†	Discharge
Newfoundland	123	49	172	2	121
Prince Edward Island	5	1	5	-	5
Nova Scotia	575	244	818	27	548
New Brunswick	255	354	610	12	243
Quebec	1 521	2 125	3 646	80	1 441
Ontario	3 763	3 305	7 069	137	3 626
Manitoba	108	144	252	5	103
Saskatchewan	43	38	81	2	41
Alberta	206	671	876	51	155
British Columbia	1 383	881	2 265	88	1 295
Northern Territories	1	2	2	-	1
Total	7 984	7 813	15 796	405	7 579

*Gross use = intake + recirculation
†Consumption = intake - discharge

Table 15. Use and Consumption Rates by Province/Territories, Manufacturing (%)

Province/Territories	Use rate*	Consumption rate†
Newfoundland	140	1.6
Prince Edward Island	100	-
Nova Scotia	140	4.5
New Brunswick	240	4.7
Quebec	240	5.3
Ontario	190	3.6
Manitoba	230	4.6
Saskatchewan	190	4.6
Alberta	430	24.8
British Columbia	160	6.4
Northern Territories	300	-
Average	200	5.1

*Use rate = (gross use ÷ intake) × 100%
†Consumption rate = (consumption ÷ intake) × 100%

The use rate for New Brunswick was the same as Quebec's, but higher than Ontario's. The low use rate for Ontario was probably due to a generally plentiful water supply from the Great Lakes. The use rate for Alberta was substantially higher than the use rates in the rest of Canada because of the need for greater recirculation by plants in the Prairie region, due in part to a semiarid climate that requires enhanced water conservation efforts. The use rate for British Columbia was lower than that for any of the Prairie provinces, and also below the national average, reflecting the industrial mix and location patterns of industry in this province.

The consumption rates varied substantially among the provinces, ranging from 1.6% in Newfoundland to 24.8% in Alberta. The consumption rate for Alberta was the only rate substantially above the national average. This higher rate may have resulted from relatively high evaporation rates during the summer. However, Manitoba and Saskatchewan, the other two Prairie provinces, actually had lower consumption rates than two other provinces. Provincial industrial mixes and the ages of the plants account for this.

Sources

The distribution of the total water intake by source among the various provinces/territories (Table 16) shows some interesting geographical patterns. In the Atlantic provinces, about 12% of manufacturing water derived from public systems, as opposed to a national average of 8% and a low of 4% in British Columbia. Atlantic firms withdrew less water from all their freshwater sources (68%) than the national average of 88%, and much less than Ontario (92%), Quebec (90%), and British Columbia (87%). These findings illustrate that the smaller plants in the Atlantic region relied less heavily upon freshwater sources than do the larger plants in Ontario, Quebec, and British Columbia. Although the national average for intake from fresh groundwater sources was 4% of the total intake, the groundwater withdrawals in Prince Edward Island and Nova Scotia were above this average, with a high of 39% in Nova Scotia. The coastal provinces combined to provide a national average of 4% from tidewater sources.

Discharge Points

The four Atlantic provinces and British Columbia relied heavily upon discharge to tidewater (50% of their total discharge) (Table 17). The plants in the inland provinces principally used freshwater bodies (90% of their total discharge). In all provinces, a small proportion of wastewater (9%) was discharged to public systems, usually by the smaller plants. As in the intake distribution, the distribution of discharge to groundwater and other sources was small (<1%).

Table 18 shows the monthly distribution of water intake for each province. No breakdown was provided for the Yukon or Northwest Territories because of their small intake requirements. The distribution patterns for the provinces were similar for both intake and discharge. Hence, only the monthly intake distribution is covered here. Eight provinces withdrew the largest portions of their intake during the summer. The annual distribution range is the lowest in Alberta (1%) and the highest in Saskatchewan (5%).

Table 16. Intake by Source and Province/Territories, Manufacturing (MCM)

Province/Territories	Fresh water				Brackish water			Total
		Self-supplied			Self-supplied			
	Public	Surface	Ground	Other	Ground	Tide	Other	
Newfoundland	36	57	10	-	-	20	-	123
Prince Edward Island	2	-	1	-	-	2	-	5
Nova Scotia	34	179	222	-	1	139	-	575
New Brunswick	45	179	3	2	-	26	-	255
Quebec	151	1337	14	13	2	4	-	1521
Ontario	281	3444	18	18	2	-	-	3763
Manitoba	11	92	5	-	-	-	-	108
Saskatchewan	6	36	1	-	1	-	-	43
Alberta	24	173	4	4	-	-	-	206
British Columbia	52	1157	41	6	-	127	-	1383
Territories	-	1	-	-	-	-	-	1
Total	642	6654	319	44	6	319	-	7984

Table 17. Discharge by Discharge Point and Province/Territories, Manufacturing (MCM)

Province/Territories	Public sewer	Freshwater body	Tidewater body	Ground	Transferred other	Total
Newfoundland	21	2	98	-	-	121
Prince Edward Island	2	-	3	-	-	5
Nova Scotia	230	100	218	1	-	548
New Brunswick	5	162	76	-	-	243
Quebec	225	1099	113	2	2	1441
Ontario	172	3441	-	4	10	3626
Manitoba	10	75	-	17	-	103
Saskatchewan	5	36	-	-	-	41
Albera	16	133	-	5	1	155
British Columbia	37	531	708	20	-	1295
Northern Territories	-	1	-	-	-	1
Total	724	5579	1215	49	12	7579

Table 18. Monthly Distribution of Intake by Province, Manufacturing (% of annual total)

Province	J	F	M	A	M	J	J	A	S	O	N	D
Newfoundland	6.9	7.6	7.7	7.4	7.9	8.9	9.8	10.5	9.8	9.5	7.3	6.7
Prince Edward Island	6.5	6.8	7.3	7.2	9.3	10.1	10.5	10.8	10.1	8.6	6.7	6.1
Nova Scotia	7.6	7.9	8.3	7.2	8.3	8.6	8.8	9.1	8.6	8.8	8.3	8.4
New Brunswick	7.7	8.1	8.7	7.9	9.0	8.7	8.2	8.9	7.7	9.1	8.0	7.9
Quebec	8.2	7.8	8.1	8.3	8.6	8.4	8.8	8.9	8.4	8.5	8.2	7.9
Ontario	8.1	7.6	8.2	8.1	8.4	8.4	8.6	8.9	8.8	8.6	8.1	8.2
Manitoba	8.9	8.5	8.8	8.3	8.8	8.7	7.6	8.7	8.1	7.9	7.7	8.1
Saskatchewan	8.1	7.2	7.9	5.1	8.9	9.2	9.5	10.1	8.8	9.0	8.3	7.9
Alberta	8.5	7.7	8.4	8.1	8.7	8.4	8.7	8.6	7.9	8.5	8.2	8.3
British Columbia	8.5	8.1	8.3	8.3	9.0	8.9	9.0	7.8	7.4	8.2	8.1	8.5
Total	8.1	7.7	8.2	8.1	8.6	8.5	8.7	8.7	8.4	8.6	8.1	8.2

Costs

The cost data on water acquistion, intake and discharge treatment, and recirculation for the provinces reveal that Ontario paid more than any other province in all but one category (Tables 19 and 20). Its largest acquistion cost was in-house operation and maintenance, but its second largest, payment to public utility, was still greater than that spent by any province.

Ontario's intake treatment costs were 39% of the national total; recirculation costs were 62%; and discharge treatment costs were 59%. Quebec, Alberta, and British Columbia were the other major contributors in all categories.

Table 19. Acquisition Cost by Province/Territories, Manufacturing ($000's)

Province/Territories	Payment to public utility	In-house operation/ maintenance	Plant intake licence	Acquisition total
Newfoundland	1 020	52	0	1 072
Prince Edward Island	14	78	1	92
Nova Scotia	1 198	413	1	1 612
New Brunswick	1 723	3 792	-	5 515
Quebec	13 748	8 953	170	22 872
Ontario	57 438	103 598	62	161 098
Manitoba	3 338	1 337	5	4 681
Saskatchewan	2 286	390	6	2 682
Alberta	8 663	5 799	12	14 474
British Columbia	3 291	10 880	152	14 322
Northern Territories	5	-	-	5
Total	92 723	135 291	410	228 424

Table 20. Costs by Cost Component and Province/Territories, Manufacturing ($000's)

Province/Territories	Intake treatment	Recir-culation	Discharge treatment	Total
Newfoundland	358	273	273	903
Prince Edward Island	55	7	15	77
Nova Scotia	1 471	239	1 011	2 720
New Brunswick	1 734	811	4 382	6 927
Quebec	14 515	8 940	17 981	41 436
Ontario	26 826	41 400	68 371	136 597
Manitoba	1 112	1 843	2 608	5 564
Saskatchewan	2 739	778	896	4 413
Alberta	13 727	9 910	5 923	29 559
British Columbia	6 416	2 959	15 215	24 590
Northern Territories	6	-	-	6
Total	68 958	67 160	116 673	252 791

Table 21. Number of Employees and Mines, Mineral Extraction

Industry group	Employees	Mines
Metal mines	44 998	117
Nonmetal mines	11 800	82
Coal mines	8 936	28
Crude petroleum and natural gas	8 372	49
Total	74 106	277

WATER USE IN THE MINERAL EXTRACTION INDUSTRY

Major revisions made by Statistics Canada to the mining census in the 1980 Standard Industrial Classification (SIC) Manual divided the mineral extraction industry into two groups: mining industries and crude petroleum and natural gas industries. Mining industries include three major categories: metal mines, nonmetal mines (except coal), and coal mines. The second group, the crude petroleum and natural gas industries, consists of establishments engaged in exploration and/or production of crude oil and natural gas whether by conventional or nonconventional methods. The data presented for this second group (also referred to as mineral fuels) pertain only to firms in Alberta. (See Table 21 for number of employees and mines.)

The mineral extraction industries surveyed had a total intake of 593 MCM in 1986, which, combined with recirculation of 2037 MCM, gives a gross water use of 2631 MCM (Table 22). The metal mines, the largest group surveyed, were the largest water users in all parameters. The use rate for the mineral extraction sector was calculated at 440%, much higher than that for the manufacturing sector. Because mine water was included in the discharge totals, discharge exceeded intake, creating a negative figure for water consumption. Since this is an impossibility, water consumption figures are not reported here.

The metal mines category reported the largest volume of recirculation. However, the highest degree of recirculation, indicated through calculating use rates, occurred in the mineral fuels group, particularly by the nonconventional crude oil operations, the oil sands extraction plants, and natural gas processing plants.

The mineral extraction industries withdrew most of their intake (Table 23) from surface water bodies (84%), with the second source of supply being groundwater sources (8%). Processing (77%) accounted for the largest amount of intake water in this sector, followed by cooling, condensing, and steam (18%), and sanitary services and other purposes (5%) (Table 24). Chlorination and disinfection dominated the methods of intake treatment (Table 25), followed by screening, filtration, and hardness and alkalinity control.

Table 22. Water Use by Industry Group, Mineral Extraction (MCM)

Industry group	Intake	Recirculation	Gross use*	Discharge
Metal mines	431	958	1389	584
Nonmetal mines	64	175	239	88
Coal mines	12	31	43	19
Crude petroleum and natural gas	86	873	959	43
Total	593	2037	2631	734

*Gross use = intake + circulaiton

Table 23. Intake by Source and Industry Group, Mineral Extraction (CMC)

	Fresh water				Brackish water			
		Self-supplied			Self-supplied			
Industry group	Public	Surface	Ground	Other	Ground	Tide	Total	Total
Metal mines	14	370	28	15	3	-	2	431
Nonmetal mines	4	42	9	-	1	6	2	64
Coal mines	-	4	6	2	-	-	-	12
Crude petroleum and natural gas	-	80	5	-	-	-	-	86
Total	18	496	48	18	4	6	4	593

Table 24. Intake by Purpose and Industry Group, Mineral Extraction (MCM)

Industry group	Processing	Cooling, condensing, and steam	Sanitary services	Other	Total
Metal mines	373	41	12	6	431
Nonmetal mines	47	14	3	-	64
Coal mines	11	-	1	-	12
Crude petroleum and natural gas	24	52	2	8	86
Total	455	108	17	14	593

Table 25. Treatment of Intake by Type and Industry Group, Mineral Extraction (MCM)

Industry group	Filtration	Chlorination and disinfection	Corrosion and slime control	Screening	Hardness and alkalinity control	Other	Total
Metal mines	23	92	16	82	14	17	244
Nonmetal mines	2	4	2	8	2	1	19
Coal mines	-	-	-	-	-	-	-
Crude petroleum and natural gas	38	39	17	37	34	5	170
Total	64	136	35	127	50	23	434

The discharge from plants in the mineral extraction sector exceeded intake because mine water (or mine dewatering) was included only in the discharge totals. The distribution of discharge to various discharge points is an accurate reflection of industry practice (Table 26). Freshwater bodies received the largest share of discharge. The amounts of water transferred to tailings ponds reflect the importance of tailings recovery processes in the metal mines and reinjection schemes in the oil and gas operations. Tailings ponds are used to a lesser degree in potash mining, with Saskatchewan plants injecting salty wastes to disposal wells for permanent ground storage.

Much of the effluent from all four mining categories received at least primary treatment (Table 27). Metal mines provided all three levels of treatment to cleanse their effluent before discharge.

The reliance on self-supplied intake sources in three of the four categories is reflected in the water acquistion costs. The in-house operation and main-

Table 26. Discharge by Discharge Point and Industry Group, Mineral Extraction (MCM)

Industry group	Public sewer	Freshwater body	Tidewater body	Groundwater	Tailings pond transfer	Transferred	Total
Metal mines	3	442	26	12	94	8	584
Nonmetal mines	-	42	15	22	5	4	88
Coal mines	5	5	1	-	8	-	19
Crude petroleum and natural gas	-	30	-	7	6	-	43
Total	8	519	42	41	113	11	734

Table 27. Discharge Treatment by Type and Industry Group, Mineral Extraction (MCM)

Industry group	Primary	Secondary	Tertiary	Total treatment	Total discharge
Metal mines	307	7	45	360	584
Nonmetal mines	22	1	-	23	88
Coal mines	8	-	-	8	19
Crude petroleum and natural gas	23	1	-	24	43
Total	359	10	46	414	734

tenance costs accounted for almost 83% of these expenditures (Table 28). Only the nonmetal mines paid more to the public utilities for their intake than on in-house operation and maintenance costs. As in all other parameters, the metal mines incurred the largest costs.

The costs of discharge treatment are shown in Table 29. Treatment costs for the discharge and recirculation streams in the metal mines and mineral fuels industries reflect the importance of recirculation from tailings ponds. The mineral fuels group spend a significant amount on intake treatment because of the high quality of water required for some processes in the oil sands and gas processing plants.

WATER USE BY THERMAL POWER PLANTS

Thermal power plants (Table 30) were the largest users of water of the industrial sectors surveyed. Electric power plants accounted for approximately 98% of intake in the thermal power sector. Other industrial establishments (e.g., manufacturing) that produced electricity and steam for their own processes accounted for the rest. Of these industries, the three major water users accounted for almost the entire remainder of intake, primary metals being largest (Table 31). (There is no overlap in statistics with the manufacturing and mineral extraction sectors.)

Surface water bodies were the principal sources of water for thermal power generators (Table 32). The secondary source was tidewater, especially for the

Table 28. Acquisition Costs by Industry Group, Mineral Extraction ($000's)

Industry group	Payment to public utility	In-house operation/ maintenace	Plant intake licence	Total
Metal mines	1 016	13 424	280	14 720
Nonmetal mines	2 137	1 296	4	3 437
Coal mines	73	803	-	876
Crude petroleum and natural gas	401	3 515	-	3 916
Total	3 628	19 037	283	22 948

Table 29. Costs by Cost Component, Mineral Extraction ($000's)

Industry group	Intake treatment	Recirculation	Discharge treatment	Total
Metal mines	2 160	8 571	28 075	38 806
Nonmetal mines	332	1 429	471	2 232
Coal mines	46	462	443	951
Crude petroleum and natural gas	13 050	6 181	1 401	20 632
Total	15 588	16 644	30 389	62 621

electrical utilities. The discharge data show that the largest part of the effluent (about 99%) was discharged to freshwater and tidewater bodies, with only a small amount being held in artificial bodies (Table 33).

The most frequently used processes to treat intake water were screening, chlorination and disinfection, and corrosion and slime control (Table 34). These three treatments accounted for about 99% of

Table 30. Number of Employees and Plants, Thermal Power

Industries	Employees	Plants
Mining - Generation	5	1
Foods - Generation	9	2
Primary textiles - Generation	16	1
Wood - Generation	59	4
Pulp and paper - Generation	546	20
Primary metals - Generation	6	2
Chemicals and chemical products - Generation	144	4
Electric power - Generation	8177	43
Total	8962	77

Table 31. Water Use by Industry Group, Thermal Power (MCM)

	Intake	Recir-culation	Gross use*	Discharge
Mining - Generation	-	-	-	-
Food - Generation	-	2	3	-
Primary textiles - Generation	-	-	-	-
Wood - Generation	15	8	23	15
Pulp and paper - Generation	51	32	83	44
Primary metals - Generation	331	662	993	331
Chemicals and chemical products - Generation	4	-	4	1
Electric power - Generation	24 963	3 776	28 739	24 702
Total	25 364	4 480	29 844	25 093

*Gross use = intake + recirculation

treatment. The electric power companies dominated all categories.

The survey data on costs for water acquisition and intake treatment showed the same dominance by the electric power companies (Table 35). Among the manufacturing industries, however, the pulp and paper industry spent the most on intake treatment. This table also shows that the primary metals group, the largest manufacturing water user reporting thermal use, spent considerably less than either of these other major water users.

Although the recirculation data received were not sufficient for analysis, it appears that almost all of the water was used for condenser cooling purposes. This use accounted for about 99% of the water recirculated by the electric power utilities, the predominant thermal power water user.

SUMMARY AND TRENDS IN INDUSTRIAL WATER USE

Four industrial water use surveys were conducted between 1972 and 1986, and some significant trends can be seen in the accumulated data. Intake for the three sectors increased both nationally and regionally, with national intake growing from 18 045 MCM in 1972 to 33 941 MCM in 1986. Regionally, the major users, Ontario and Quebec, followed this same trend. British Columbia intake increased from 1972 to 1981, but declined in 1986. The Prairie region intake increased between 1972 and 1976, but declined slightly between 1976 and 1986. Intake in the Atlantic region has fluctuated, increasing from 1972 to 1976, declining in 1981, and increasing again in 1986.

Ontario was the major user, accounting for 54% of all intake in 1972 and more than 70% in 1986. The second largest regional user has changed in each survey: the Prairie region ranked second in 1972, the Atlantic region in 1976, British Columbia in 1981, and the Atlantic region in 1986. The use of water as a portion of the national use decreased between 1972 and 1986 in the Atlantic and Quebec regions, though both showed an increase in use. This phenomenon was attributed to the major growth in water intake for thermal generation in Ontario, which overshadowed the increases in all other uses.

Trends in water use in the three surveyed sectors are included in the following discussion.

Manufacturing

Manufacturing was the second largest water user among the sectors surveyed. Intake grew from 8362 MCM in 1972 to 9936 MCM in 1981. In 1986, however, the intake decreased significantly to 7984 MCM. This decrease was due in part to increased water conservation efforts by industry and to the depressed economic conditions in some regions. All of the parameters—intake, recirculation, gross use, discharge, and consumption—showed a general upward trend in the 1972–1981 period. In 1986, all but one of the parameters showed a significant decrease from 1981. The exception was consumption, which remained at approximately 5% of intake in all four survey years (494 MCM in 1981 and 404 MCM in 1986).

In each of the four survey years, the paper and allied products subsector reported the largest water intake and the largest level of recirculation and gross use as well. The primary metal and the chemical and chemical products subsectors were the other major water users during the 1972–1986 period. Ontario was the province with the greatest use in manufacturing during the 15-year period, followed by Quebec and British Columbia.

Table 32. Intake by Source and Industry Group, Thermal Power (MCM)

Industry group	Fresh water				Brackish water		Total
		Self-supplied			Self-supplied		
	Public	Surface	Ground	Other	Ground	Tide	
Mining - Generation	-	-	-	-	-	-	-
Foods - Generation	-	-	-	-	-	-	-
Primary textiles - Generation	-	-	-	-	-	-	-
Wood - Generation	1	9	1	-	-	4	15
Pulp and paper - Generation	13	37	1	-	-	-	51
Primary metals - Generation	4	327	-	-	-	-	331
Chemicals and chemical products - Generation	2	2	-	-	-	-	4
Electric power - Generation	13	22 510	-	-	-	2 441	24 963
Total	32	22 886	2	-	-	2 445	25 364

Table 33. Discharge by Discharge Point and Industry Group, Thermal Power (MCM)

Industry group	Public sewer	Freshwater body	Tidewater body	Groundwater	Artificial body	Transferred other	Total
Mining - Generation	-	-	-	-	-	-	-
Foods - Generation	-	-	-	-	-	-	-
Primary textiles - Generation	-	-	-	-	-	-	-
Wood - Generation	1	9	4	-	1	-	15
Pulp and paper - Generation	-	29	4	12	-	-	44
Primary metals - Generation	4	327	-	-	-	-	331
Chemicals and chemical products - Generation	-	-	-	-	-	1	1
Electric power - Generation	-	22 247	2 421	-	7	28	24 702
Total	5	22 612	2 429	12	7	28	25 093

Table 34. Treatment of Intake by Type and Industry Group, Thermal Power (MCM)

Industry group	Filtration	Chlorination and disinfection	Corrosion and slime control	Screening	Hardness and alkalinity control	Other	Total
Mining - Generation	-	-	-	-	-	-	-
Foods - Generation	-	-	-	-	-	-	-
Primary textiles - Generation	-	-	-	-	-	-	-
Wood - Generation	-	-	-	9	-	-	9
Pulp and paper - Generation	11	3	19	177	10	6	225
Primary metals - Generation	-	-	-	327	3	-	331
Chemicals and chemical products - Generation	2	3	-	-	1	-	7
Electric power - Generation	25	889	480	23 806	77	6	25 283
Total	37	896	499	24 320	92	12	25 855

Table 35. Acquisition and Intake Treatment Costs by Industry Group, Thermal Power ($000's)

Industry group	Acquisition Cost				Intake treatment
	Payment to public utility	In-house operation/ maintenance	Plant intake licence	Total	
Mining - Generation	2	-	-	2	-
Foods - Generation	46	15	-	61	28
Primary textiles - Generation	-	-	-	-	2
Wood - Generation	85	40	3	128	-
Pulp and paper - Generation	348	396	30	774	1 584
Primary metals - Generation	50	-	-	50	300
Chemicals and chemical products - Generation	5	2 461	-	2 466	89
Electric power - Generation	655	5 686	27	6 368	6 797
Total	1 191	8 600	59	9 850	8 800

Mineral Extraction

The mineral extraction industry ranks last in terms of total intake in all four surveys. Its intake fluctuated over the study period, increasing from 362 MCM in 1972 to 667 MCM in 1976, but declining slightly to 648 MCM in 1981 and decreasing even more to 593 MCM in 1986. This sector has employed recirculation to a greater extent than the other sectors, with the 1986 intake being reused more than four times to create a gross use of 2631 MCM in 1986, down slightly from 1981 when the intake was reused over five times to create a gross use of 3440 MCM. The consumptive use in this sector has slowly increased over the 15-year study period, with the mineral fuels subsector having the highest consumptive rate and metal mines, the lowest in 1981.

Thermal Power

The thermal power sector was responsible for the largest intake in all years surveyed. This industrial sector, which includes both conventional and nuclear power generation plants, increased its portion of water used nationally from 51.6% in 1972 to 74.7% in 1986. This large growth is the result of rapid growth in demand for electricity and a gradual increase in the amount of generating capacity from nuclear power plants, which use relatively more cooling water than conventional thermal plants.

Recirculation has increased considerably in recent years, from 1868 MCM in 1981 to 4480 MCM in 1986. Compared to the large intake, this sector's water consumption remains relatively low because most older plants used a once-through system of cooling and the highly consumptive cooling towers or cooling ponds were used only in the newer, larger conventional and nuclear power plants. In fact, the consumption has increased steadily from 102 MCM in 1972 to 271 MCM in 1986.

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We received cooperation and coordination from J. Barlishen and J. Erxleben of the Planning Division, Alberta Environment, who conducted the survey in Alberta. D. Donachuk and A. Maslowski of the Water Resources Branch, Manitoba Department of Natural Resources, provided assistance and information in the survey of firms in that province.

The assistance of all these persons is appreciated.

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Appendix
Survey Questionnaires

Statistics Canada
Environment Canada

Statistique Canada
Environnement Canada

WATER USE IN MANUFACTURING INDUSTRIES 1986

In all correspondence concerning the questionnaire please refer to the first seven digits in the top line of the mailing address below.

Si vous désirez un questionnaire en français, veuillez cocher ☐ et retourner à la Division de l'industrie, Statistique Canada, Ottawa, K1A 0T6.

Mailing Address (Please correct if necessary)

Physical Location of Establishment (Please correct if necessary)

(Form EC-5-3309-2.1)

SECTION 1 : GENERAL INFORMATION

1.1 AUTHORITY

This survey is conducted under the authority of the Statistics Act, Statutes of Canada, 1970-71-72, Chapter 15. To reduce response burden and to ensure more uniform statistics, Statistics Canada has entered into an agreement with the Department of the Environment under Section 11 of the Canada Statistics Act for sharing of data herein. This Section 11 agreement shall not apply if an authorized officer or person of your Company **objects in writing to the Chief Statistician and mails that letter to the Industry Division of Statistics Canada** together with the completed questionnaire.

The Department of the Environment may in turn share data if requested by the provincial agencies (as listed below) with the province in which this establishment is located **if you so consent in writing**. These agencies are: Newfoundland Department of the Environment, Prince Edward Island Department of Community Affairs, Nova Scotia Department of the Environment, New Brunswick Department of the Environment, Quebec Department of the Environment, Ontario Ministry of the Environment, Manitoba Department of Natural Resources, Saskatchewan Water Corporation, Alberta Department of the Environment and the British Columbia Ministry of the Environment or their successor or equivalent provincial agencies.

I consent to the sharing of the data by the Department of the Environment with the provincial agencies (if requested) within the province in which this establishment is located, for statistical, research and planning purposes.

Signature of authorized official: _____

1.2 COMPLETION AND RETURN

The data included in this report must relate to the **calendar year 1986**. Please complete this questionnaire **within 30 days of receipt**, retain one copy for your files and return one copy to Statistics Canada utilizing the return envelope provided.

NOTE

(i) Shaded areas are for office use only.

(ii) Water volumes are to be reported in the units in use at the plant. Some of the more common units are:

Code
0.1
0.2
0.3
0.4

☐ thousand Imperial gallons
☐ cubic feet
☐ cubic metres

If one of these units has been used, please check the appropriate box.
If another unit has been used, please specify: _____

Please confirm that your water is not measured in tens (10's) or hundreds (100's) of units reported.
Please report all monthly or annual water volumes in the units indicated above.

(iii) Please report all cost items in Canadian dollars (omitting cents).

(iv) Where exact values are not available, please estimate.

	DETAILS OF OPERATION	Code	Number
1a	Indicate the average number of employees :	1.1	
1b	Indicate the number of days of operation during the reporting period:	1.2	
1c	Indicate the number of hours worked in an average day:	1.3	

1d Indicate the major products produced by your plant:

PRODUCTS

SECTION 2 : MONTHLY AND ANNUAL TOTAL WATER INTAKE AND DISCHARGE

INSTRUCTIONS

(i) In this section, under intake, please report by month the quantity of "new water" brought into your operation and under discharge the quantity of water routed to its ultimate point of discharge. For the purpose of this questionnaire "new water" is defined as water introduced for the first time into this establishment regardless of source or quality.

(ii) Report in units specified in section 1.2 (ii).

(iii) Under discharge **do not report** the volume of water released to ponds, lagoons or basins and **intended for recirculation or reuse** until such water is actually discharged to a location beyond the control of the plant.

(iv) Under discharge **do not include** any water lost in production through evaporation, permanently held in open or closed storage, or otherwise consumed (e.g. included in a final product).

(v) Annual total intake should be greater than or equal to annual total discharge.

(vi) Where you supply water to adjacent industry(ies) or municipality(ies), please report estimated water intake for your plant only.

Month	Code	Volume per month		Month	Code	Volume per month	
		Intake	Discharge			Intake	Discharge
January	2.1			July	2.7		
February	2.2			August	2.8		
March	2.3			September	2.9		
April	2.4			October	2.10		
May	2.5			November	2.11		
June	2.6			December	2.12		
				ANNUAL TOTAL	2.13		

2a Estimated annual cost of water acquisition

2.39	COST	Payment to public utility:	$
2.40	COST	In-house operating and maintenance costs (excluding water treatment costs):	$
2.41	COST	Cost of your plant's intake licence (if applicable):	$

If the annual total amount indicated in box 2.13 above is less than: 1,000,000 gallons, or 160,000 cubic feet, or 4,500 cubic metres, then please ignore the remaining questions, sign the back page, and return the questionnaire as instructed on page 1. Thank you.

SECTION 3 : WATER INTAKE BY SOURCE AND KIND

INSTRUCTIONS

(i) In this section, please break down your new water intake by source and kind.

(ii) Report in units specified in section 1.2 (ii), OR as a percentage of the annual total as reported in section 2.13 above. Where percentages are used, please indicate with a percent sign (%).

(iii) "Brackish water" is defined as water containing more than 1,000 parts per million of dissolved solids.

SOURCE	3.0	%	Code	Volume per year	
				Fresh	Brackish
3a Public water utility system (name)			3.1		XXXXX
3b Self-supplied surface water system (lake, river, etc.) (name)			3.2		XXXXX
3c Self-supplied groundwater system (well, spring, etc.) (specify)			3.3		
3d Self-supplied tide water (salt water) body (estuary, bay, ocean etc.) (name)			3.4	XXXXX	
3e Other sources (specify)			3.5		
3f Total water intake (sum of 3a to 3e). (Quantity should equal the amount reported in box 2.13 or 100%)			3.6		

SECTION 4 : TREATMENT OF INTAKE WATER

INSTRUCTIONS (i) Indicate the amount of intake water treated within your plant prior to use.

(ii) Report in units specified in section 1.2 (ii).

	CATEGORY OF TREATMENT	Code	Volume per year
4a	Filtration	4.1	
4b	Chlorination & disinfection	4.2	
4c	Corrosion and slime control	4.3	
4d	Screening	4.4	
4e	Hardness and alkalinity control	4.5	
4f	Other (specify)	4.6	

4g	Estimated annual operating and maintenance cost of water treatment	4.8	COST	$

SECTION 5 : WATER INTAKE BY PURPOSE

INSTRUCTIONS (i) Report the amount of water within your plant by initial use. This section should not include recirculated water except as stated in section 5a. (For a definition of "recirculated water", see section 6)

(ii) In 5d "Other uses" should not include water pumped by the plant, and intended for initial use outside the plant.

(iii) Report in units specified in section 1.2 (ii) OR as a percentage of annual total as reported in section 2.13. Where percentages are used please indicate with a percent sign (%).

	PURPOSE	5.0	%	Code	Volume per year
5a	Process water - includes all water **which comes in direct contact** with products and/or materials. It is further defined to include water which is consumed in milling and special processes, water which is included in final output or water which has been used for another purpose, and is undergoing its final use as process water.			5.1	
5b	Cooling, condensing and steam - defined as water **which does not come in direct contact** with the products, materials or by-products of the processing operation. Includes pass-through water used in the operation of cooling or process equipment (including air conditioning) and water introduced into boilers for the production of steam for either process operations or electric power.			5.2	
5c	Sanitary service (including cleanup) (The average toilet uses 4 gallons, 18 litres, 0.018 cubic metres or 0.64 cubic feet per flush.)			5.3	
5d	Other uses (specify)			5.4	
5e	Total (5a to 5d should equal sum of figures reported in box 2.13 or 100%)			5.5	

SECTION 6 : WATER RECIRCULATED OR REUSED BY PURPOSE

INSTRUCTIONS (i) For water recirculated or reused within your plant, please indicate the additional quantity of water that would have been required by purpose had no water been recirculated or reused. For the purpose of this questionnaire, **"water recirculated or reused"** is defined as water which is discharged from the plant or from a particular process within the plant, and which is subsequently recycled into the same process or into a different process within the plant.

(ii) Report in units specified in section 1.2 (ii).

	PURPOSE	Code	Volume per year
6a	Process	6.1	
6b	Cooling, condensing, and steam	6.2	
6c	Other uses (specify)	6.3	
6d	Total (items 6a to 6c)	6.4	

6e	Estimated annual operating and maintenance cost of water recirculation	6.5	COST	$

SECTION 7 : TREATMENT OF WATER PRIOR TO DISCHARGE

INSTRUCTIONS (i) In items 7a to 7c, specify treatment process used in each of the treatment methods.
(ii) Include only on-site treatment.
(iii) Report in units specified in section 1.2 (ii).

	TREATMENT METHOD	Code	Volume per year
7a	Primary or mechanical (specify process) (i)	7.2	
	(ii)	7.3	
7b	Secondary or biological (specify process) (i)	7.4	
	(ii)	7.5	
7c	Tertiary or advanced treatment (specify process) (i) (include toxics removal)	7.6	
	(ii)	7.7	

7d	Estimated annual operating and maintenance cost of treatment prior to discharge	7.9	COST	$

7e	Please indicate if your final plant effluent is monitored (by any agency) for (check the appropriate items ☒) : ☐ B.O.D. ☐ S.S. ☐ Phenols ☐ Toxics ☐ pH ☐ Other	7.10	
7f	If so, how often?	7.11	

SECTION 8 : WATER DISCHARGE

INSTRUCTIONS (i) In this section, please report the volume of all water routed to its ultimate point of discharge.
(ii) Report in units specified in section 1.2 (ii), OR as a percentage of the annual total discharge reported in section 2.13. Where percentages are used, please indicate with a percent sign (%).
(iii) **Do not report** the volume of water released to ponds, lagoons or basins and **intended for recirculation or reuse** until such water is actually discharged to a location beyond the control of the plant.
(iv) **Do not include** the volume of water lost in production through evaporation, permanently held in open or closed storage or otherwise consumed and not brought to the ultimate point of discharge.
(v) In item 8e, please identify the use intended.
(vi) If discharge is not metered, please provide your best estimate.

	DISCHARGE POINT	8.0	%	Code	Volume per year
8a	Public utility sewer (municipality, etc.) (name)			8.1	
8b	Fresh water body (lake, river, etc.) (name)			8.2	
8c	Tide water (salt water) body (estuary, bay, ocean, etc.)(name)			8.3	
8d	Ground (specify) (including well disposal)			8.4	
8e	Transferred to other uses outside your plant (specify)			8.7	
8f	Total water discharge (Quantity should equal discharge values as reported in box 2.13 or 100%)			8.8	

8g	Gross value of shipments for your plant in 1986 (or fiscal year 1985-86)	8.14	VALUE	$
8h	Total capital expenditures made at this plant on water related facilities in 1986 (or fiscal year 1985-86)	8.15	EXPENDITURES	$

CERTIFICATION *I certify that the information herein is complete and correct to the best of my knowledge and belief and covers the calendar year 1986.*

Signature of authorized person		Title	Date
Name of contact regarding this report	Area code	Telephone number	Ext.
Comments			
			Thank You

Statistics Canada
Environment Canada

Statistique Canada
Environnement Canada

WATER USE IN THE MINERAL EXTRACTION INDUSTRY 1986

In all correspondence concerning the questionnaire please refer to the first seven digits in the top line of the mailing address below.

Si vous désirez un questionnaire en français, veuillez cocher ☐ et retourner à la Division de l'industrie, Statistique Canada, Ottawa, K1A 0T6.

Mailing Address (Please correct if necessary)

Physical Location of Establishment (Please correct if necessary)

(Form EC-5-3309-1.1)

SECTION 1 : GENERAL INFORMATION

1.1 AUTHORITY

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The Department of the Environment may in turn share data if requested by the provincial agencies (as listed below) with the province in which this establishment is located **if you so consent in writing**. These agencies are: Newfoundland Department of the Environment, Prince Edward Island Department of Community Affairs, Nova Scotia Department of the Environment, New Brunswick Department of the Environment, Quebec Department of the Environment, Ontario Ministry of the Environment, Manitoba Department of Natural Resources, Saskatchewan Water Corporation, Alberta Department of the Environment and the British Columbia Ministry of the Environment or their successor or equivalent provincial agencies.

I consent to the sharing of the data by the Department of the Environment with the provincial agencies (if requested) within the province in which this establishment is located, for statistical, research and planning purposes.

Signature of the authorized official _____

1.2 COMPLETION AND RETURN

The data included in this report must relate to the **calendar year 1986**. Please complete this questionnaire **within 30 days of receipt**, retain one copy for your files and return one copy to Statistics Canada utilizing the return envelope provided.

NOTE

(i) Shaded areas are for office use only.

(ii) Water volumes are to be reported in the units in use at the plant. Some of the more common units are:

Code
0.1
0.2
0.3

☐ thousand Imperial gallons
☐ cubic feet
☐ cubic meters

If one of these units has been used, please check the appropriate box.
If another unit has been used, please specify: _____ 0.4

Please confirm that your water is not measured in tens (10's) or hundreds (100's) of units reported.
Please report all monthly or annual water volumes in terms of the units indicated above.

(iii) Please report all cost items in Canadian dollars (omitting cents)
(iv) Where exact values are not available, please estimate.

	DETAILS OF OPERATION	Code	Number
1a	Indicate the average number of employees:	1.1	
1b	Indicate the number of days of operation during the reporting period:	1.2	
1c	Indicate the number of hours worked in an average day:	1.3	
1d	Indicate the principal output and the type of operation carried on by this unit (i.e. underground mine, stripmine, gas plant,oil extraction plant, etc.)	1.12	
1e	Has there been an addition to or a change of technology in the mine or plant since the 1981 survey or in the last five (5) years? If yes, please explain	1.11	1 ☐ Yes 2 ☐ No

SECTION 2 : MONTHLY AND ANNUAL TOTAL WATER INTAKE AND DISCHARGE

INSTRUCTIONS

(i) In this section, under intake, please report by month the quantity of "new water" brought into your operation and under discharge the quantity of water routed to its ultimate point of discharge. For the purpose of this questionnaire "new water" is defined as water introduced for the first time into this establishment regardless of source or quality.

(ii) Report in units specified in section 1.2 (ii).

(iii) In mining operations please include waste water pumped from the mine, and not used for any other purpose **as discharge water only**.

(iv) In oil and gas operations please include produced water not reused for any other purpose (or for reinjection) **as discharge water only**. "Produced water" is defined as water which is removed from the original oil-water mixture.

(v) Under discharge **do not include** any water lost in production through evaporation, permanently held in open or closed storage or otherwise consumed (e.g. included in a final product or slurry). Include such water only as intake.

(vi) Under discharge **do not report the volume of water** released to ponds, lagoons, or basins and **intended for recirculation or reuse**, until such water is actually discharged to a location beyond the control of the mine or plant.

(vii) Annual total discharge may be greater than annual total intake as explained above in items 2(iii) and 2(iv).

(viii) Where you supply water to adjacent industry(ies) or municipality(ies), please report estimated water intake for your operation only.

Month	Code	Volume per month		Month	Code	Volume per month	
		Intake	Discharge			Intake	Discharge
January	2.1			July	2.7		
February	2.2			August	2.8		
March	2.3			September	2.9		
April	2.4			October	2.10		
May	2.5			November	2.11		
June	2.6			December	2.12		
				ANNUAL TOTAL	2.13		

2a Of the reported annual volumes of discharge water (2.13) what volume of water originated as mine water or waste water pumped from the mine? **2.26**

2b Estimated annual cost of water acquisition

2.39	COST	Payment to public utility:	$
2.40	COST	Operating and maintenance costs (excluding water treatment costs):	$
2.41	COST	Cost of your mine's or plant's intake licence (if applicable):	$

If the annual total amount indicated in box 2.13 above is less than: 1,000,000 gallons, or 160,000 cubic feet, or 4,500 cubic metres, then please ignore the remaining questions, sign the back page, and return the questionnaire as instructed on page 1. Thank you.

SECTION 3 : WATER INTAKE BY SOURCE AND KIND

INSTRUCTIONS

(i) In this section, please break down your new water intake by source and kind.

(ii) Report in units specified in section 1.2 (ii), OR as a percentage of the annual total as reported in section 2.13 above. Where percentages are used, please indicate with a percent sign (%).

(iii) "Brackish water" is defined as water containing more than 1,000 parts per million of dissolved solids.

SOURCE	3.0	%	Code	Volume per year	
				Fresh	Brackish
3a Public water utility system (name).....			3.1		XXXXX
3b Self-supplied surface water system (lake, river, etc.) (name).....			3.2		XXXXX
3c Self-supplied groundwater system (well, spring, etc.) (specify).....			3.3		
3d Self-supplied tide water (salt water) body (estuary, bay, ocean etc.) (name).....			3.4	XXXXX	
3e Other sources (specify).....			3.5		
3f Total water intake (sum of 3a to 3e). (Quantity should equal the amount reported in box 2.13 or 100%)			3.6		

SECTION 4 : TREATMENT OF INTAKE WATER

INSTRUCTIONS (i) Indicate the amount of intake water treated within your operation prior to use.
(ii) Report in units specified in section 1.2 (ii).

	CATEGORY OF TREATMENT	Code	Volume per year
4a	Filtration	4.1	
4b	Chlorination & disinfection	4.2	
4c	Corrosion and slime control	4.3	
4d	Screening	4.4	
4e	Hardness and alkalinity control	4.5	
4f	Other (specify)	4.6	

4g	Estimated annual operating and maintenance cost of water treatment	4.8	COST	$

SECTION 5 : WATER INTAKE BY PURPOSE

INSTRUCTIONS (i) Report the amount of water within your establishment by initial use. This section should not include recirculated water except as stated in section 5a. (For a definition of "recirculated water", see section 6)
(ii) In 5d "Other uses" should not include water pumped by mine or plant facility, and intended for initial use outside the operation.
(iii) Report in units specified in section 1.2 (ii) OR as a percentage of annual total as reported in section 2.13. Where percentages are used please indicate with a percent sign (%).

	PURPOSE	5.0	%	Code	Volume per year
5a	Process water - includes all water **which comes in direct contact** with products and/or materials. It is further defined to include water which is consumed in milling and special processes, water which is included in final output or water which has been used for another purpose, and is undergoing its final use as process water.			5.1	
5b	Cooling, condensing and steam - defined as water **which does not come in direct contact** with the products, materials or by-products of the processing operation. Includes pass-through water used in the operation of cooling or process equipment (including air conditioning) and water introduced into boilers for the production of steam for either process operations or electric power.			5.2	
5c	Sanitary service (including cleanup) (The average toilet uses 4 gallons, 18 litres, 0.018 cubic metres or 0.64 cubic feet per flush)			5.3	
5d	Other uses (specify)			5.4	
5e	Total (5a to 5d should equal sum of figures reported in box 2.13 or 100%)			5.5	

5f	What volume of intake water was used as injected water or steam in the secondary recovery of oil or natural gas?	5.22	
5g	Of the annual volume of intake water for process reported in 5a, what volume of water was consumed or lost?	5.23	
5h	Of the volume of intake water for cooling, condensing, or steam production reported in 5b, what volume of water was consumed or lost?	5.24	

SECTION 6 : WATER RECIRCULATED OR REUSED BY PURPOSE

INSTRUCTIONS (i) For water recirculated or reused within your plant, please indicate the additional quantity of water that would have been required by purpose had no water been recirculated or reused. For the purpose of this questionnaire **"water recirculated or reused"** is defined as water which is discharged from the plant or from a particular process within the plant, and which is subsequently recycled into the same process or into a different process within the plant.
(ii) Report in units specified in section 1.2 (ii).

	PURPOSE	Code	Volume per year
6a	Process	6.1	
6b	Cooling, condensing, and steam	6.2	
6c	Other uses (specify)	6.3	
6d	Total (items 6a to 6c)	6.4	

6e	Does this operation have a tailings pond?	6.6	1 ☐ Yes 2 ☐ No
	If yes, indicate the volume of water recirculated or reused from the tailings pond	6.7	
6f	Does this operation inject water into an oil bearing formation?	6.11	1 ☐ Yes 2 ☐ No
	If yes, indicate the volume of water injected	6.12	

6g	Estimated annual operating and maintenance cost of water recirculation	6.5	COST	$

SECTION 7 : TREATMENT OF WATER PRIOR TO DISCHARGE

INSTRUCTIONS (i) In items 7a to 7c, specify treatment process used in each of the treatment methods.
(ii) Include only on-site treatment.
(iii) Report in units specified in section 1.2 (ii).

	TREATMENT METHOD	Code	Volume per year
7a	Primary or mechanical (specify process) (i)	7.2	
	(ii)	7.3	
7b	Secondary or biological (specify process) (i)	7.4	
	(ii)	7.5	
7c	Tertiary or advanced treatment (specify process) (i) (include toxics removal)	7.6	
	(ii)	7.7	

7d	Estimated annual operating and maintenance cost of treatment prior to discharge	7.9	COST	$

7e	Please indicate if your final plant effluent is monitored (by any agency) for (check the appropriate items ☒): ☐ B.O.D. ☐ S.S. ☐ Phenols ☐ Toxics ☐ pH ☐ Other	7.10	
7f	If so, how often?	7.11	

SECTION 8 : WATER DISCHARGE

INSTRUCTIONS (i) In this section please report the volume of all water routed to its ultimate point of discharge.
(ii) Report in units specified in section 1.2 (ii), OR as a percentage of the annual total discharge reported in section 2.13. Where percentages are used, please indicate with a percent sign (%).
(iii) **Do not report** the volume of water released to ponds, lagoons or basins and **intended for recirculation or reuse** until such water is actually discharged to a location beyond the control of the mine or plant.
(iv) **Do not include** the volume of water lost in production through evaporation, permanently held in open or closed storage or otherwise consumed and not brought to the ultimate point of discharge.
(v) In item 8e, please identify the use intended.
(vi) If discharge is not metered, please provide your best estimate.

	DISCHARGE POINT	8.0 %	Code	Volume per year
8a	Public utility sewer (municipality, etc.) (name)		8.1	
8b	Fresh water body (lake, river, etc.) (name)		8.2	
8c	Tide water (salt water) body (estuary, bay, ocean, etc.)(name)		8.3	
8d	Ground (specify) (including well disposal)		8.4	
8e	Discharged from tailings pond or injected to producing formation (specify)		8.5	
8f	Transferred to other uses outside your operation (specify)		8.7	
8g	Total water discharge (Quantity should equal discharge values as reported in box 2.13 or 100%)		8.8	

8h	Gross value of shipments for your plant in 1986 (or fiscal year 1985-86)	8.14	VALUE	$
8i	Total capital expenditures made at this plant on water related facilities in 1986 (or fiscal year 1985-86)	8.15	EXPENDITURES	$

CERTIFICATION *I certify that the information herein is complete and correct to the best of my knowledge and belief and covers the calendar year 1986.*

Signature of authorized person		Title	Date
Name of contact regarding this report	Area code	Telephone number	Ext.
Comments			
			Thank You

Statistics Canada
Environment Canada

Statistique Canada
Environnement Canada

WATER USE BY THERMAL POWER PLANTS 1986

In all correspondence concerning the questionnaire please refer to the first seven digits in the top line of the mailing address below.

Si vous désirez un questionnaire en français, veuillez cocher ☐ et retourner à la Division de l'industrie, Statistique Canada, Ottawa, K1A 0T6.

Mailing Address (Please correct if necessary)

Physical Location of Establishment (Please correct if necessary)

(Form EC-5-3309-3.1)

SECTION 1 : GENERAL INFORMATION

1.1 AUTHORITY

This survey is conducted under the authority of the Statistics Act, Statutes of Canada, 1970-71-72, Chapter 15. To reduce response burden and to ensure more uniform statistics, Statistics Canada has entered into an agreement with the Department of the Environment under Section 11 of the Canada Statistics Act for sharing of data herein. This Section 11 agreement shall not apply if an authorized officer or person of your Company **objects in writing to the Chief Statistician and mails that letter to the Industry Division of Statistics Canada** together with the completed questionnaire.

The Department of the Environment may in turn share data if requested by the provincial agencies (as listed below) with the province in which this establishment is **located if you so consent in writing**. These agencies are: Newfoundland Department of the Environment, Prince Edward Island Department of Community Affairs, Nova Scotia Department of the Environment, New Brunswick Department of the Environment, Quebec Department of the Environment, Ontario Ministry of the Environment, Manitoba Department of Natural Resources, Saskatchewan Water Corporation, Alberta Department of the Environment and the British Columbia Ministry of the Environment or their successor or equivalent provincial agencies.

I consent to the sharing of the data by the Department of the Environment with the provincial agencies (if requested) within the province in which this establishment is located, for statistical, research and planning purposes.

Signature of the authorized official _____

1.2 COMPLETION AND RETURN

The data included in this report must relate to the **calendar year 1986**. Please complete this questionnaire **within 30 days of receipt**, retain one copy for your files and return one copy to Statistics Canada utilizing the return envelope provided.

NOTE

(i) Shaded areas are for office use only.

(ii) Water volumes are to be reported in the units in use at the plant. Some of the more common units are:

	Code
☐ thousand Imperial gallons	0.1
☐ cubic feet	0.2
☐ cubic metres	0.3

If one of these units has been used, please check the appropriate box.
If another unit has been used, please specify: _____ | 0.4 |

Please confirm that your water is not measured in tens (10's) or hundreds (100's) of units reported.
Please report all monthly or annual water volumes in the units indicated above.
(iii) Please report all cost items in Canadian dollars (omitting cents)
(iv) Where exact values are not available, please estimate.

	DETAILS OF OPERATION		Code	Number
1a	Indicate the average number of employees required to operate the power plant in 1986:		1.1	employees
1b	Indicate the number of days of operation during 1986:		1.2	days
1c	Indicate the number of hours worked in an average day:		1.3	hours
1d	Indicate the amount of power produced at this plant in 1986:	(i) net generation	1.4	Mwh
		(ii) station service	1.5	Mwh
1e	Indicate the average heat rate of the plant:		1.6	BTU / hr.
1f	Indicate the capacity of water intake pumps (specify units):		1.7	
1g	Indicate the generation capacity of this plant in 1986:		1.8	MW
1h	Does your facility provide water for uses other than in the power plant? (specify use)		1.9	1 ☐ yes 2 ☐ no

SECTION 2 : MONTHLY AND ANNUAL TOTAL WATER INTAKE AND DISCHARGE

INSTRUCTIONS (i) In this section, under intake, please report by month the quantity of "new water" brought into your operation for power plant use and under discharge the quantity of water routed to its ultimate point of discharge. For the purpose of this questionnaire "new water" is defined as water introduced for the first time into this establishment regardless of source or quality. "New water" also includes water diverted from a natural source into storage ponds or outside holding facilities for later use.

(ii) Report in units specified in section 1.2 (ii).

(iii) Under discharge **do not report** the volume of water released to ponds, lagoons or basins and **intended for recirculation or reuse,** until such water is actually discharged to a location beyond the control of the plant.

(iv) Under discharge **do not include** any water lost in production through evaporation, permanently held in open or closed storage, or otherwise consumed.

(v) Annual intake should be greater than or equal to annual total discharge.

(vi) Where you supply water to adjacent industry(ies) or municipality(ies), please report estimated water intake for your plant only.

Month	Code	Volume per month		Month	Code	Volume per month	
		Intake	Discharge			Intake	Discharge
January	2.1			July	2.7		
February	2.2			August	2.8		
March	2.3			September	2.9		
April	2.4			October	2.10		
May	2.5			November	2.11		
June	2.6			December	2.12		
				ANNUAL TOTAL	2.13		

2a	Estimated annual cost of water acquisition	2.39	COST	Payment to public utility:	$
		2.40	COST	Operating and maintenance costs (excluding water treatment costs):	$
		2.41	COST	Cost of your plant's intake licence (if applicable):	$

SECTION 3 : WATER INTAKE BY SOURCE AND KIND

INSTRUCTIONS (i) In this section please break down your new water intake by source and kind.

(ii) Report in units specified in section 1.2 (ii), OR as a percentage of the annual total as reported in section 2.13 above. Where percentages are used, please indicate with a percent sign (%).

(iii) "Brackish water" is defined as water containing more than 1,000 parts per million of dissolved solids.

SOURCE		3.0	%	Code	Volume per year	
					Fresh	Brackish
3a	Public water utility system (name)			3.1		XXXXX
3b	Self-supplied surface water system (lake, river, etc.) (name)			3.2		XXXXX
3c	Self-supplied groundwater system (well, spring, etc.) (specify)			3.3		
3d	Self-supplied tide water (salt water) body (estuary, bay, ocean etc.) (name)			3.4	XXXXX	
3e	Other sources (specify)			3.5		
3f	Total water intake (sum of 3a to 3e). (Quantity should equal the amount reported in box 2.13 or 100%)			3.6		

SECTION 4 : TREATMENT OF INTAKE WATER

INSTRUCTIONS (i) Indicate the amount of intake water treated within your plant prior to use.

(ii) Report in units specified in section 1.2 (ii).

	CATEGORY OF TREATMENT	Code	Volume per year
4a	Filtration	4.1	
4b	Chlorination & disinfection	4.2	
4c	Corrosion and slime control	4.3	
4d	Screening	4.4	
4e	Hardness and alkalinity control	4.5	
4f	Other (specify)	4.6	

4g	Estimated annual operating and maintenance cost of water treatment	4.8	COST	$

SECTION 5 : WATER USAGE

INSTRUCTIONS (i) Report the amount of water used within the thermal plant by initial use. This section should not include recirculated water.

(ii) Report in units specified in section 1.2 (ii) OR as a percentage of annual total as reported in section 2.13. Where percentages are used please indicate with a percent sign (%).

			Code	
5a	Is there a water-cooled condenser in your plant?		5.6	1 ☐ Yes 2 ☐ No
	If yes, what is the design temperature for the cooling water in your condenser cooling cycle?		5.7	____ °C (ex.25°C)
5b	What kind of cooling system is employed in your plant?	(i) once-through	5.25	1 ☐ Yes 2 ☐ No
		(ii) cooling pond	5.26	1 ☐ Yes 2 ☐ No
		(a) on stream	5.27	1 ☐ Yes 2 ☐ No
		(b) off stream	5.28	1 ☐ Yes 2 ☐ No
		(iii) other methods (e.g. tower) (explain)	5.29	1 ☐ Yes 2 ☐ No
5c	Did this plant produce steam for purposes other than power generation (i.e. process, for sale)?		5.8	1 ☐ Yes 2 ☐ No

			5.0	%	Code	Volume per year
5d	What was the amount of boiler make-up water required for power generation purpose (excluding production for steam sales or transfer)?				5.9	
5e	Of the total water intake reported in box 2.13 what was the amount required for:	(i) condenser cooling for power generation purpose only?			5.10	
		(ii) sanitary, fire protection or other (i.e. service water)?			5.11	
5f	What were the estimated water losses (including evaporation and seepage):	(i) in cooling cycle?			5.13	
		(ii) in ash control system (include evaporation losses from ponds)?			5.21	

SECTION 6 : WATER RECIRCULATED OR REUSED

INSTRUCTIONS (i) In this section **"water recirculated or reused"** is defined as water which is discharged from the plant or from a particular process within the plant, and which is subsequently recycled into the same process or into a different process within the plant.

(ii) Report in units specified in section 1.2 (ii).

			Code	Volume per year
6a	If this plant recirculated water in the cooling and condensing system (open or closed) estimate the amount of additional intake water that would have been required WITHOUT such recirculation having taken place (i.e. the amount of water recirculated).	(i) fresh	6.9	
		(ii) brackish	6.10	

SECTION 7 : WATER DISCHARGE

INSTRUCTIONS
(i) In this section please report the volume of all water routed to its ultimate point of discharge from the plant (and /or the cooling pond if applicable).
(ii) Report in units specified in section 1.2 (ii) OR as a percentage of the annual total discharge reported in section 2.13. Where percentages are used, please indicate with a percent sign (%).
(iii) **Do not report** the volume of water released to ponds, lagoons or basins and **intended for recirculation or reuse** until such water is actually discharged.
(iv) **Do not include** the volume of water lost in production through evaporation, permanently held in open or closed storage, or otherwise consumed and not brought to the ultimate point of discharge.
(v) In item 7f please identify the use intended.
(vi) If discharge is not metered, please provide your best estimate.

	DISCHARGE POINT	8.0	%	Code	Volume per year
7a	Public utility sewer (municipality, etc.) (name)			8.1	
7b	Fresh water body (lake, river, reservoir, etc.) (name)			8.2	
7c	Tide water (salt water) body (estuary, bay, ocean, etc.) (name)			8.3	
7d	Ground (specify) (including well disposal)			8.4	
7e	Final discharge from plant to artificial surface body (specify)			8.6	
7f	Transferred to other uses outside your plant(specify)			8.7	
7g	Total water discharge (sum of 7a to 7f)			8.8	
7h	Was the discharge water reported in 7g treated so as not to exceed a certain given temperature? If yes, please specify the methods of heat dissipation employed			8.9	1 ☐ Yes 2 ☐ No

7i Indicate the highest and lowest temperatures of water permanently discharged from the plant during 1986 along with the corresponding months of occurence (ex. 45°C).

	Code	Temperature	Code	Month
High	8.10	°C	8.11	
Low	8.12	°C	8.13	

7j Total capital expenditures made at this plant on water related facilities in 1986 (or fiscal year 1985-86).

Code		
8.15	EXPENDITURES	$

SECTION 8 : MONTHLY AND ANNUAL POWER GENERATION

INSTRUCTIONS (i) In this section please break down, as accurately as possible, for the calendar year 1986 the electrical net power generation as specified in 1d (i). Please report below in net Mwh (megawatt hours) per month.

Month	Code	Mwh per month	Month	Code	Mwh per month
January	9.14		July	9.20	
February	9.15		August	9.21	
March	9.16		September	9.22	
April	9.17		October	9.23	
May	9.18		November	9.24	
June	9.19		December	9.25	

CERTIFICATION *I certify that the information herein is complete and correct to the best of my knowledge and belief and covers the calendar year 1986.*

ANNUAL TOTAL	9.26	

Signature of authorized person		Title	Date
Name of contact regarding this report	Area code	Telephone number	ext.
Comments			
			Thank You

Statistics Canada
Environment Canada

Statistique Canada
Environnement Canada

HYDRO GENERATION WATER USE 1986

In all correspondence concerning the questionnaire please refer to the first seven digits in the top line of the mailing address below.

Si vous désirez un questionnaire en français, veuillez cocher ☐ et retourner à la Division de l'industrie, Statistique Canada, Ottawa, K1A 0T6.

Mailing Address (Please correct if necessary)

Physical Location of Establishment (Please correct if necessary)

(Form EC-5-3309-4.1)

SECTION 1 : GENERAL INFORMATION

1.1 AUTHORITY

This survey is conducted under the authority of the Statistics Act, Statutes of Canada, 1970-71-72, Chapter 15. To reduce response burden and to ensure more uniform statistics, Statistics Canada has entered into an agreement with the Department of the Environment under Section 11 of the Canada Statistics Act for sharing of data herein. This Section 11 agreement shall not apply if an authorized officer or person of your Company **objects in writing to the Chief Statistician and mails that letter to the Industry Division of Statistics Canada** together with the completed questionnaire.

The Department of the Environment may in turn share data if requested by the provincial agencies (as listed below) with the province in which this establishment is located **if you so consent in writing**. These agencies are: Newfoundland Department of the Environment, Prince Edward Island Department of Community Affairs, Nova Scotia Department of the Environment, New Brunswick Department of the Environment, Quebec Department of the Environment, Ontario Ministry of the Environment, Manitoba Department of Natural Resources, Saskatchewan Water Corporation, Alberta Department of the Environment and the British Columbia Ministry of the Environment or their successor or equivalent provincial agencies.

I consent to the sharing of the data by the Department of the Environment with the provincial agencies (if requested) within the province in which this establishment is located, for statistical, research and planning purposes.

Signature of authorized official: _____

1.2 COMPLETION AND RETURN

The data included in this report must relate to the **calendar year 1986**. Please complete this questionnaire **within 30 days of receipt**, retain one copy for your files and return one copy to Statistics Canada utilizing the return envelope provided.

NOTE

(i) Shaded areas are for office use only.

1.3 LOCATION

(i) In the spaces below, please indicate:

	Code
1a. Plant Name: _____	0.5
1b. River: _____	0.6

SECTION 2 : MONTHLY FLOWS

INSTRUCTIONS (i) For the calendar year 1986, please provide the monthly average flow through turbines in cubic metres/second (m^3/s).

Month	Code	Flow in m^3/s	Month	Code	Flow in m^3/s
January	2.14		July	2.20	
February	2.15		August	2.21	
March	2.16		September	2.22	
April	2.17		October	2.23	
May	2.18		November	2.24	
June	2.19		December	2.25	

SECTION 3 : MONTHLY SPILL

INSTRUCTIONS (i) For the calendar year 1986, please provide the monthly average spill in cubic metres/second (m^3/s) at this plant.

Month	Code	Spill in m^3/s	Month	Code	Spill in m^3/s
January	2.27		July	2.33	
February	2.28		August	2.34	
March	2.29		September	2.35	
April	2.30		October	2.36	
May	2.31		November	2.37	
June	2.32		December	2.38	

SECTION 4 : WATER USE DETAILS

INSTRUCTIONS (i) Please answer the following questions in the units specified.

4a In relation to long run averages at this plant, was calendar year 1986 (please check ☒):

(1) a high water year? ☐ (2) an average level year? ☐ (3) a low water year? ☐ 5.14

4b What was the maximum (1 hour) output of this plant in calendar year 1986? 5.15 MW

4c What flow (in m^3/s) was associated with the maximum output given in question 4b above? 5.16 m^3/s

4d In 1986, the capacity of this plant was used for: (check either or both items as appropriate).

(1) Peaking ☐ (2) Baseload ☐ 5.17

4e In 1986, what was the capacity factor of the plant? 5.18 %

4f In 1986, the total usable storage (including pondage) available to this plant in thousands of cubic metres (000m^3) was: 5.19 000 m^3

SECTION 5 : MONTHLY AND ANNUAL POWER GENERATION

INSTRUCTIONS (i) In this section please break down, as accurately as possible, for the calendar year 1986, the total gross electrical power generation. Please report below in Mwh (megawatt hours) per month.

Month	Code	Mwh per month	Month	Code	Mwh per month
January	9.1		July	9.7	
February	9.2		August	9.8	
March	9.3		September	9.9	
April	9.4		October	9.10	
May	9.5		November	9.11	
June	9.6		December	9.12	

ANNUAL TOTAL	9.13	

CERTIFICATION *I certify that the information herein is complete and correct to the best of my knowledge and belief and covers the calendar year 1986.*

Signature of authorized person		Title	Date
Name of contact regarding this report	Area code	Telephone number	ext.
Comments			
			Thank You