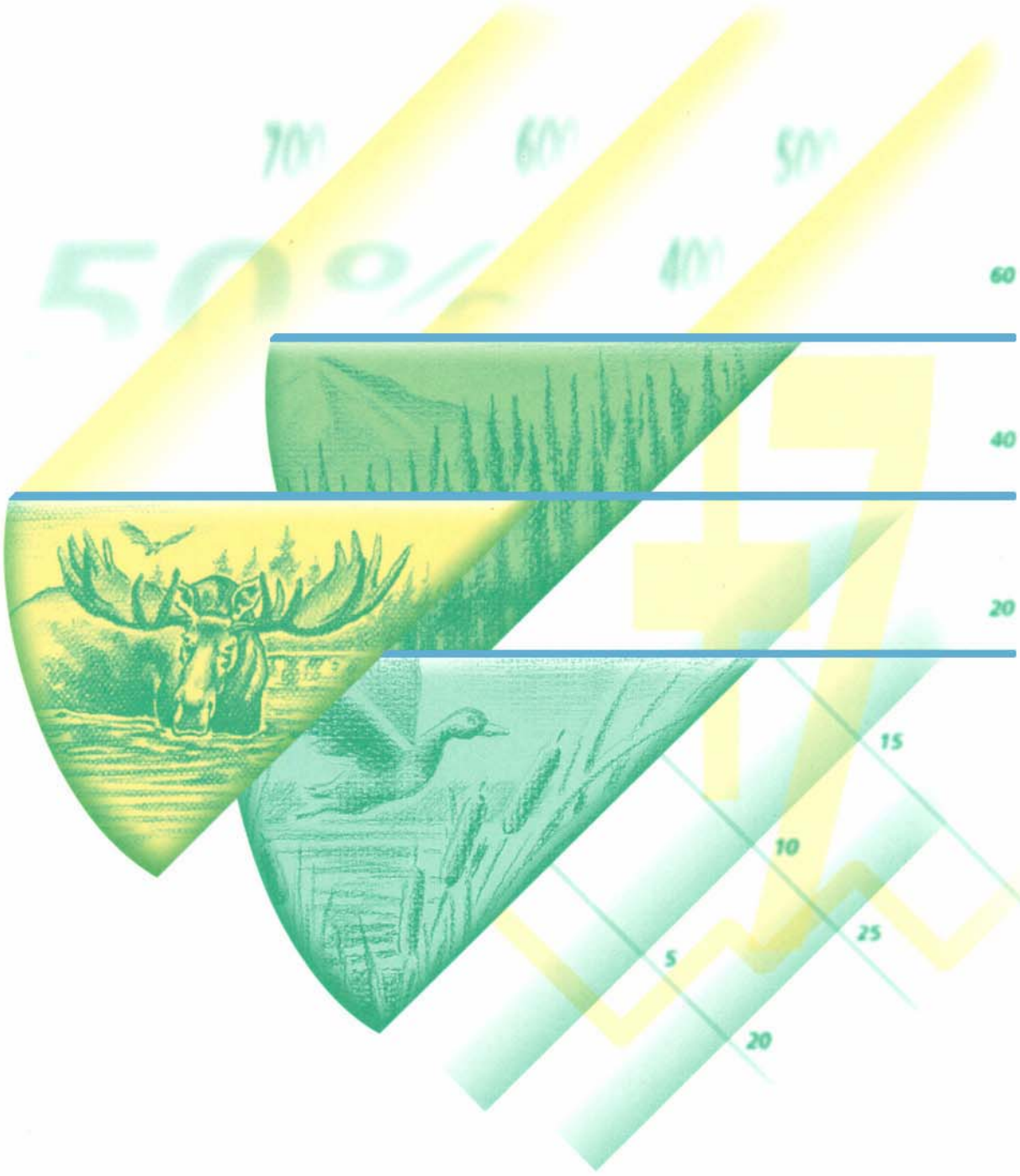
Industrial Water Use 1996



Industrial Water Use, 1996

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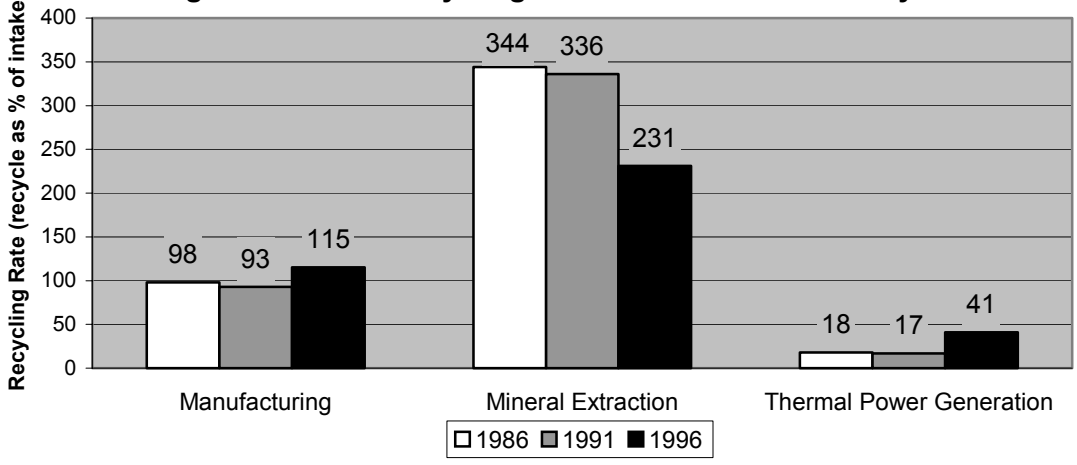
Executive Summary

The Industrial Water Use Survey has been conducted every five years. This report provides the results of the 1996 survey, and makes very general comparisons with the results of the previous two surveys – that conducted in 1991 and to a lesser extent that conducted in 1986.

- Manufacturing establishments reduced overall gross water use by 8% from 1991 to 1996. The water recycling rate in the sector increased from 93% to 115%. This increased efficiency in water use resulted in a reduction of 17% in total water intake (Figure 1).
- Despite these positive developments, consumption rates have gone up from 7% of water withdrawn in 1991 to 9% in 1996 – a continuation of the trend since 1986, when it was just 5%.
- Also of note is that, despite the greater water use efficiencies achieved in manufacturing, at least 42% of the discharges of the sector continue to be released untreated. On the positive side, this is down from an estimated 50% in 1991.
- In contrast to the reductions in the Manufacturing establishments, the Mineral Extraction sector increased their gross water use by 8% from 1991 to 1996. The water recycling rate in the sector declined from 336% to 231%. This reduced efficiency in water use explains the increase of 42% in total water intake (Figure 1).
- The mineral extraction sector also continues to discharge waste (78% to freshwater bodies) with little treatment beyond primary levels.
- In the Thermal Power Generation sector, water recirculation took a notable jump from 17% of intake in 1991 to 41% of intake in 1996 (Figure 1).

Figure 1. Water Recycling Rates in Canadian Industry



Sources: Tate, 92, Tate, 95, 1996 Industrial Water Survey

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1. Introduction

1.1 Background

This report highlights the findings of the 1996 Industrial Water Use Survey. Data for some 4,560 of 6,118 establishments surveyed in the manufacturing, mineral extraction and thermal power sectors are included in this report, with the remaining non-respondents imputed for, as detailed in the methodology section of this report (Table 1). A survey of this type has been conducted every five years since 1972 by Environment Canada and Statistics Canada, although the sample has varied for each survey. The main purpose of the report is to provide information regarding the volume of water use, end uses, water treatment and cost of water in Canada for industrial users. In order to expedite comparisons, percentages and numbers from the 1991 report are often indicated in brackets following the equivalent 1996 values.

1.2 Report Outline

This first chapter outlines the layout of the report, and gives definitions of some basic terminology used in the report, including explanations of the terms "water consumption' and 'gross water use'.

The second chapter of the report deals with the manufacturing sector and reports results at both national and provincial levels for the 14 industry groups which comprise the manufacturing sector. Information related to the water intake, discharge, recirculation is presented along with calculated gross use and consumption of the sector. Water acquisition and total costs are also presented. A similar breakdown by province is also provided. All findings are compared to those of the 1991 Industrial Water Use Survey and significant changes are noted.

The third and fourth chapters follow the structure of the second, but give the findings for the Mineral Extraction and Thermal Power Sectors. Also, data is further aggregated at the regional rather than the provincial level in order to maintain the confidentiality of individual establishment questionnaire responses.

The fifth chapter details the methodologies used in survey design, distribution, and tabulation of the data received. Finally, Annex 1 contains the detailed tables which are referred to at various points in the report.

1.3 Basic Definitions

In documenting industrial water use, five basic parameters are of interest: water intake, recirculation, gross water use, water consumption, and wastewater discharge. Figure 2 shows the relationships between these parameters. The same parameters have been used in all of the Canadian industrial water use surveys, and are consistent with those used in other nations.

Total water intake refers to the total amount of water added to the water system of the establishment to replace water discharged or consumed during production. It may be broken down into the amounts withdrawn from various sources (e.g. surface water, groundwater, etc.) and the amounts used for various purposes, or end uses. The latter refers to the initial use of water in these purposes – cooling, processing, condensing, and steam generation, and sanitary and other purposes. Cooling and condensing water refers to that water used for the production of steam or the dissipation of waste heat. Processing water refers to water that comes in contact with an intermediate or final product of the manufacturing operation. Sanitary water use serves basic human sanitary requirements at industrial establishments.

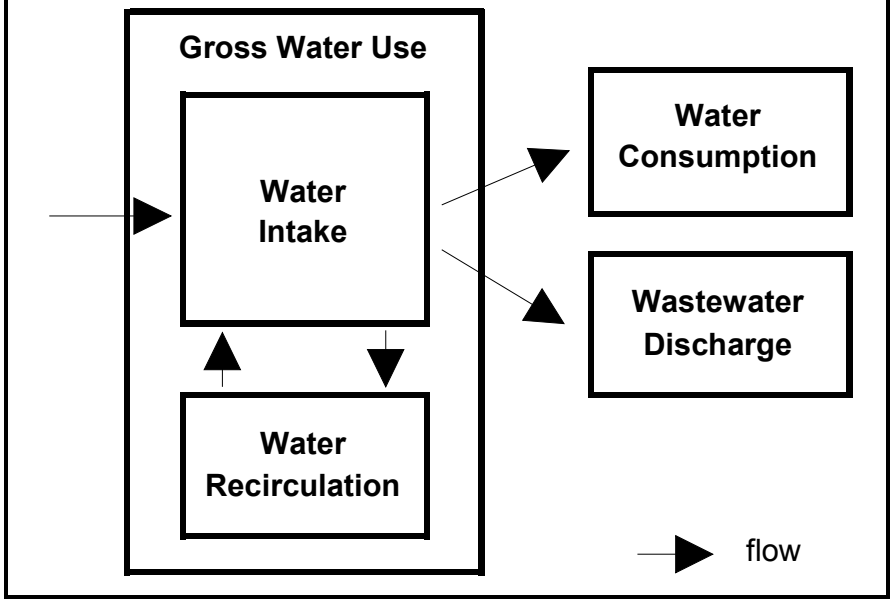
Recirculated water (recirculation or recycling) refers to water used more than once in an industrial establishment, and in Canada applies mainly to cooling and processing activities. Recirculation does not refer to water used a number of times within a particular process subsystem of an establishment but only to water that leaves a particular process subsystem and re-enters it or is used in another process. Recirculation and water intake combine to form the water input system of an establishment.

Gross water use refers to the total amount of water used in the production of the product. It is the sum of total water intake and water recirculation.

Water consumption refers to water that is lost in the production process. In other words, consumed water is not returned to its original source. The two major portions of consumed water are escaped steam and the incorporation of water into a product, as for example in the production of soft drinks. Water consumption is a strictly "local" concept for the purposes of this report, and refers to water not returned to the source of abstraction *in the vicinity of the establishment in question*. In the broader context, because of the earth's water cycle, water is never really "consumed." For example, evaporated water falls back to the earth in the form of precipitation, and is not "lost" to the environment as a whole. In this report, "consumption" is an accounting concept used to describe the water balances at single establishments only.

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

Figure 2 A Generalized View of an Industrial Establishment Water System



On the basis of the preceding section, two identities can be used to quantify industrial water use.

(1) On the intake side,

$$I + R = G$$

Where:
I = the quantity of water intake
R = the quantity of recirculated water
G = the quantity of gross water use

and

(2) On the discharge side,

$$I - C = D$$

Where:
I = the quantity of water intake
C = the quantity of water consumed
D = the quantity of water discharged

The survey on which this report is based collected data on intake, recirculation, and discharge. This allows the other two parameters to be calculated.

2. MANUFACTURING WATER USE AND COSTS

2.1 National Sectoral Characteristics

Water forms an essential requirement and input to the manufacturing process, regardless of the industrial sector. Industry would not be able to function without water to serve cooling and processing purposes and to act as a catalyst and to convey waste materials. The availability of water supplies in sufficient quantity and quality is one of several important considerations in the locations of most industrial establishments. Therefore, it comes as no surprise that the overwhelming majority of Canadian manufacturing establishments are located adjacent to large sources of water.

Given the huge volume, and for the most part the adequate quality of these sources, it is also no surprise that Canadian manufacturing establishments have tended to use water extensively, with few considerations for conservation, recycling and reuse. By 1996, however, this has begun to change, as indicated by increasing recycling rates.

2.1.1 Intake – Sources, Purpose and Treatment

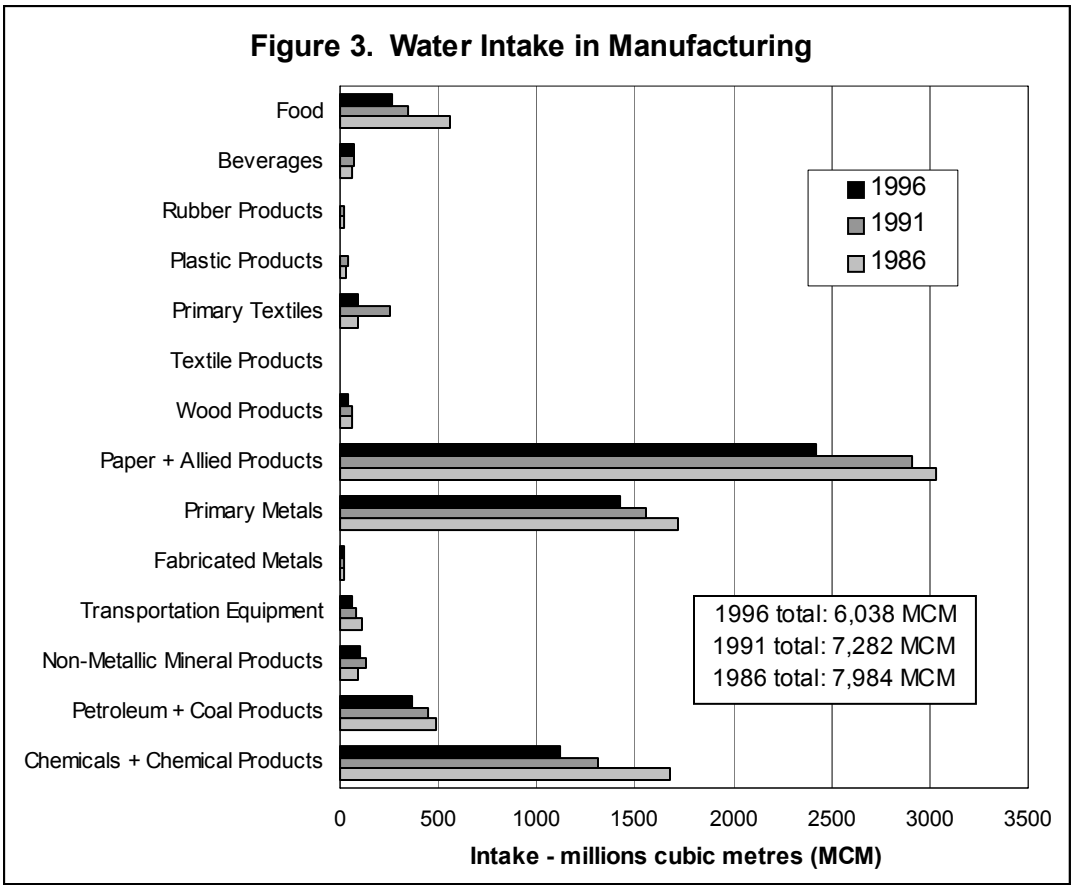
Total reported water intake in 1996 was 6,038 million cubic meters (MCM) (Table 3). This is down 17% from the total reported 7,282 MCM in 1991, which continues the trend from 1986, when it was 7,984 MCM (Figure 3).

The manufacturers surveyed obtained 4,943 MCM or 82% (6,100 or 83% in 1991) of their water supply from self-supplied freshwater surface sources (Table 4), down slightly from 1991 results (which were similar to 1986). An additional 9% derived from public utilities, a decrease of about 1% from 1991 (but up from 1986 at 8%). Approximately 3% of the total came from fresh groundwater sources and 3% from other freshwater sources. The remainder, at 3%, came from brackish sources (mainly tidewater).

A notable, but expected, difference emerged with regard to water source between industries dominated by large establishments and those dominated by relatively small establishments. The latter tend to draw a much larger proportion of their water supplies from public utilities, largely for two reasons: the fact that public supplies are cheaper than the cost of self supplied water systems, and the need for potable water for many of the smaller establishments.

For example, the beverage industry, composed generally of many relatively small water users, withdrew 67% of its total responding intake from public sources (57% in 1991). This industry was characterized not only by small establishments but by a requirement for high quality intake water. Thus, it relied upon public supplies for much of its water. Another industry, fabricated metal products, was dominated by small and mid-sized establishments and revealed a similar dependency of 62% on public water supply (58% in 1991). In contrast, the four largest water withdrawing industries – paper and allied products, primary metals, chemicals and chemical products, and petroleum and coal products – withdrew relatively small quantities from public sources. These industries were characterized by fewer and generally larger establishments than those of the beverage and fabricated metal products industries. In 1996, the transportation equipment industry revealed the largest dependency on public sources, 92%, down slightly from 95% in 1991.

Data on the initial use of water in manufacturing (Table 6) are surrogates for the end uses of water in the sector. Processing water accounted for 49% of intake in 1996, a reversal of 1991 when cooling, condensing, and steam generation was the largest initial use of new water taken into establishments, accounting for 49% of total intake declining to 47 % in 1996. The remaining uses, sanitary and other uses, accounted for the remaining 4% in 1996, as in 1991. Cooling, condensing and steam generation accounted for the largest



Sources: Tate, 92, Tate, 95, 1996 Industrial Water Survey

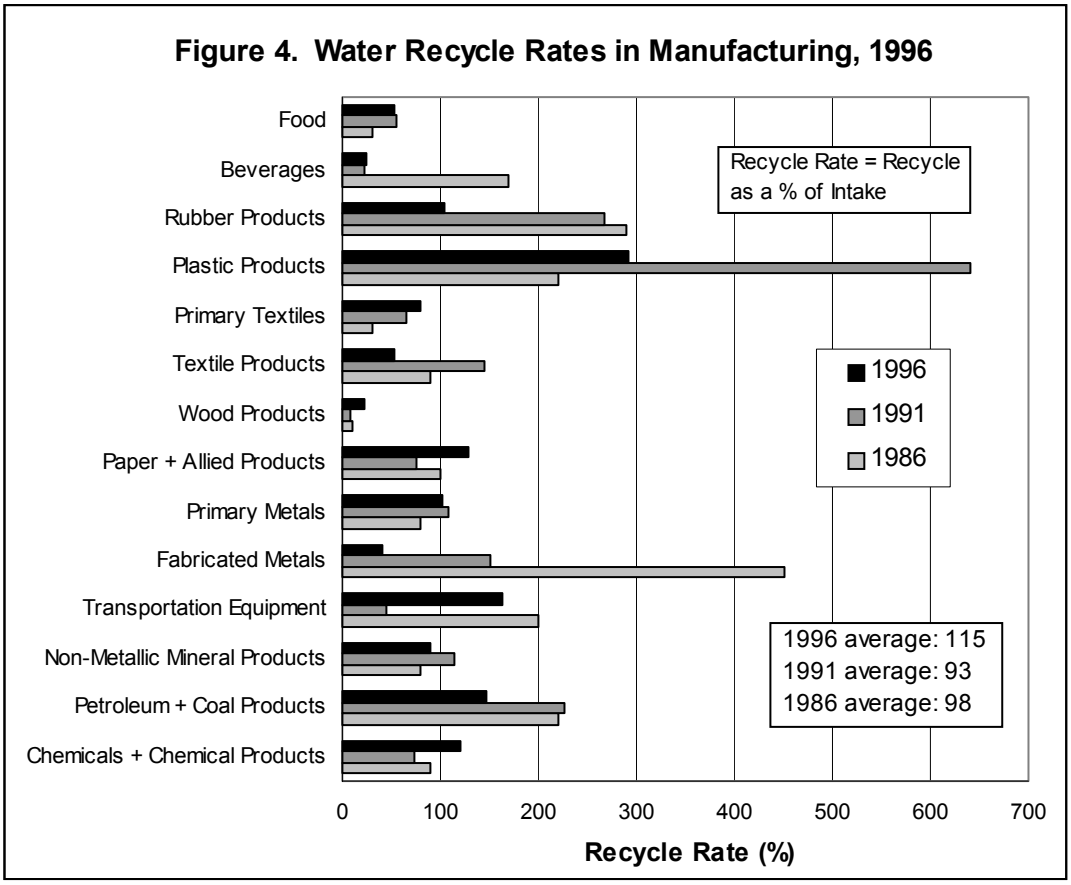
proportion of initial use in 11 of the 14 industries surveyed. However, the largest water-using industry, paper and allied products, used most of its new water for processing, specifically 76% in 1996 (which is similar to 1991), thereby having a significant impact on the total amount of processing water reported in Table 6. The other three major water users reported that more of their intake used in cooling and condensing than in processing.

Manufacturers treat large volumes of intake water prior to use (Table 5). Many establishments employ two or more treatment processes prior to use, which would mean that the total amount of treatment would substantially exceed the total water intake reported in Table 4.

Screening, followed by filtration, and chlorination and disinfection comprised the most frequently used pre-treatment types, used by industries. The "other" category included processes like dechlorination and distillation, which were not easily classified to other groups. Treatment of intake water is tailored to the quality needs at the respective establishments.

2.1.2 Water Recycling

The recycling rate is the ratio of recycled water over water intake and represents the efficiency with which water is used. The manufacturing establishments increased recycling rates from 93% of intake in 1991 to 115% in 1996, a notable improvement (Figure 4). This increased efficiency of use allowed the manufacturers to reduce water intake by 17% while reducing gross water use by only 8%.



Sources: Tate, 92, Tate, 95, 1996 Industrial Water Survey

The recycling rates varied substantially among all industry groups, ranging from a low of 22% in the wood products industry (9% in 1991) to a high of 292% in the plastic products industry (641%). The three largest water-using industries, paper and allied products industry at 128% (75%), primary metals at 102% (108%), and chemicals and chemical products 121% (74%) reflect the national average. The other two major users – petroleum and coal products, and food industries – had recycling rates of 146% (227%) and 54% (56%) respectively.

2.1.3 Discharge – Discharge Points and Treatment

Wastewater from responding manufacturing establishments totalled 5,486 MCM, down from 6,762 MCM in 1991 (Figure 5), and discharged to the following points: public sewers 14% (10% in 1991), private surface water disposal 70% (74%), tidewater 16% (14%), and less than 1% to ground water and other uses (slightly over 1% in 1991).

In 1996, the textile products industry group reported discharging 100% of its effluent to public sewers. The plastic products industry discharged 82% of its effluent to the public sewers, with beverages next at 81%. The chemicals and chemical products group discharged about 93% to fresh water bodies, followed by non-metallic mineral products at 86%, and primary textiles at 84%. The petroleum and coal products group and the paper and allied products group also reported significant discharges to tidewater at 31% and 28% respectively. Of all industries, the food industry distributed its effluent more evenly with over 39% to public sewers, 30% to fresh water bodies and about 27% to tidewater sources (Table 9).

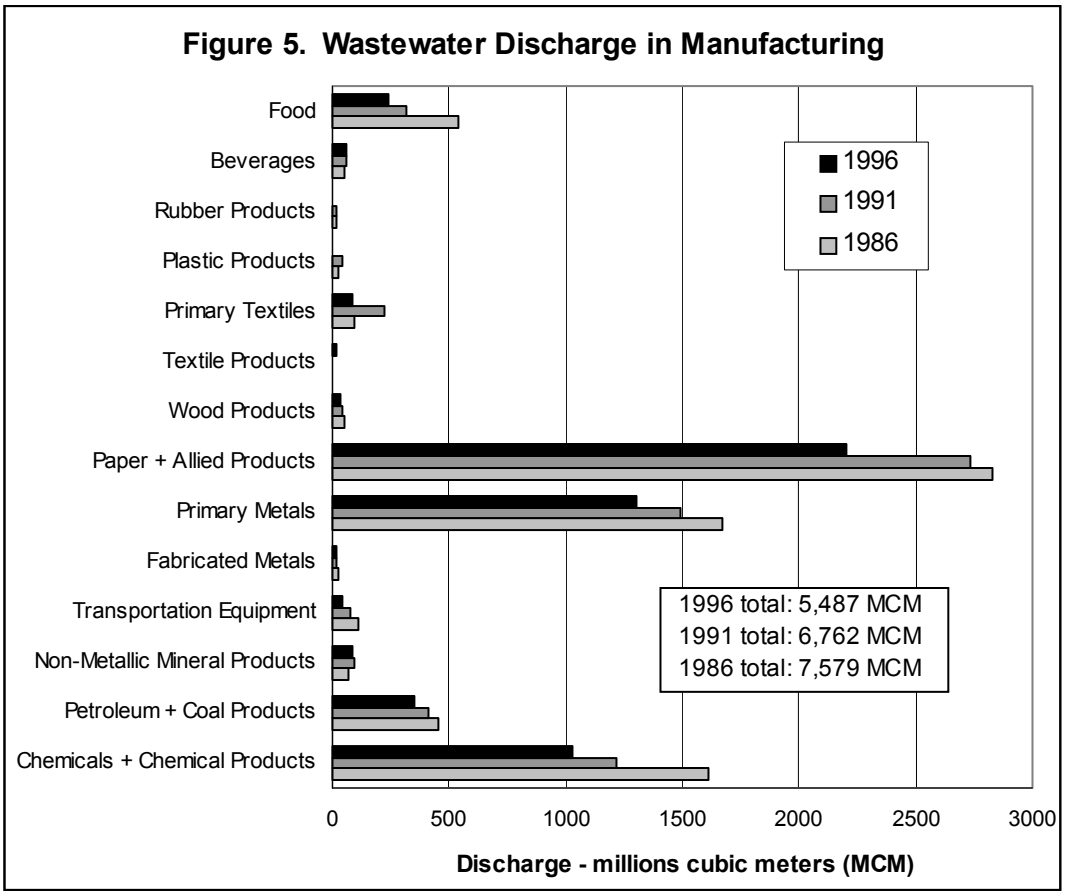
The use of various discharge points was related directly to the magnitude of the wastewater discharged, the location of the establishment, and also the characteristics of the pollutants in the wastewater. The food and beverage industries, being composed of relatively small water users, usually do not have sufficient water discharges to justify building and operating individual waste treatment facilities. There were, of course, exceptions to this general point, and many establishments in the industry pre-treated their waste before discharging it to public sewers. Also, wastes from food and beverage establishments, being composed mainly of biochemical oxygen demand (BOD) and suspended solids (SS), tend to be compatible with municipal waste treatment processes. On the other hand, the larger establishments of other industrial groups generate large volumes of waste. Often, these volumes are too large to be treated by municipal treatment establishments, or some of the pollutants generated by large industries are incompatible with municipal waste treatment processes, resulting in the need for internal treatment and subsequent direct discharge to receiving waters.

Many of the establishments surveyed provided some type of treatment to their wastewater prior to discharge. The quantities of waste involved (Table 10) are classified by the generic type of treatment. Primary treatment refers to the use of mechanical methods of treating wastes, such as screening, coagulation, and filtration. Secondary treatment refers to 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 the use of methods to "polish" the effluent subsequent to secondary treatment. One common form of tertiary treatment is phosphorus removal.

The same physical volume of water may be processed by more than one level of treatment. For example, it is common for an establishment to treat its wastes by primary methods initially and then by secondary methods prior to final discharge. Thus, a "total treatment" column in Table 10 has been omitted. The brief discussion below examines the data within each column.

A sum of treatment levels gives a total of 5,509 MCM of effluent that was treated by responding Canadian manufacturers in 1996, of 5,486 MCM of effluent. However, there was substantial double counting in compiling these treatment data, meaning that the proportion of waste treated was almost certainly much smaller than this. One could assume that wastes treated at the two "advanced" levels underwent primary treatment initially. Because the figures for secondary and tertiary treatment were significantly under the primary treatment volume, it is likely that the former volumes are "cascaded" through the "advanced" levels of treatment, where multiple such treatment levels were indicated. Thus, on that assumption we can state that just under 3,200 MCM of discharge (i.e. about 58% of manufacturing discharge) was treated at some level. Therefore, the best estimate is that just over 2,300 MCM (42%) of discharge from manufacturing establishments was given no discharge treatment of any kind. This is an improvement over the 1991 estimate of 50% with no treatment. The amounts of water treated under each category of treatment were distributed among the industrial groups in roughly the same way as other characteristics of water use.

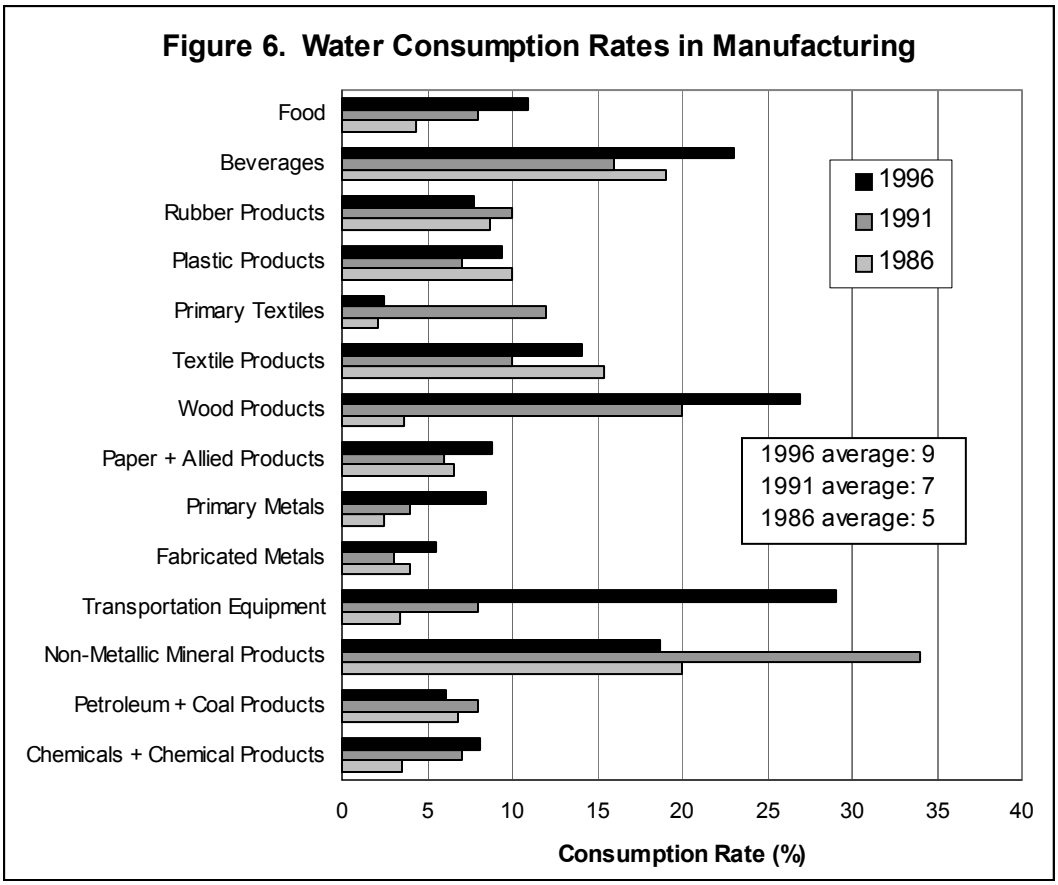
The largest amount treated in all categories was accounted for by the paper and allied products industry, with 76% (1,671 MCM) of the total amount (2,207 MCM total discharge, Table 9) treated by primary methods, 83% (1,825 MCM) of the total treated by secondary methods, and 5.9% (131 MCM) of the total treated by tertiary treatment (Table 10). This assumes multiple treatments of a level, in one facility, are treating the same water. This dominance by the paper and allied products industry reflects efforts made by this industry during the 1970s and the 1980s to install pollution control devices, though specifics through the early 1990s are not known. The primary metals, petroleum and coal products, and chemicals and chemical products groups accounted for the next most significant amounts in terms of the quantities of wastes treated.



Sources: Tate, 92, Tate, 95, 1996 Industrial Water Survey

2.1.4 Consumption Rates

Consumption rates provide a percentage value of the amount of water lost during production at the individual establishment level; most commonly through evaporation or incorporation of water into products (e.g. beverages). Approximately 5,487 MCM was discharged to ambient water bodies adjacent to the establishments or to municipal sewer systems. Water consumption was estimated to be 552 MCM or approximately 9 % of the total withdrawal (Table 3). This is a small increase in consumption from the 520 MCM, or 7% of total withdrawal reported in 1991, which continues the trend from 1986, when the rate was just 5% (Figure 6).



Sources: Tate, 92, Tate, 95, 1996 Industrial Water Survey

The five largest water-using industries covered by the survey – paper and allied products, primary metals, chemicals and chemical products, petroleum and coal products, and food products industries – accounted for 86% of the total sector water consumption in 1996, versus 78% in 1991.

Sector-wide, the rate varied from a low of 2% (12% in 1991) for the primary textiles industry to a high of 29% (8% in 1991) in the transportation equipment industry. Employment changes in this survey group may be evidence of structural changes in these industry groups, in that primary textiles employment was down by over 9% since 1991, despite more establishments being surveyed for 1996. In transportation equipment it was up by almost 40% in that time with the number of establishments surveyed up by 45% (Tables 2 and 3). In these same industries, water intake was down 66% and 20% respectively, over the same time period, even though significantly more establishments were surveyed in 1996 in both industries. Other industries also reported substantial changes in their consumption rates, with rates of 19% (34% in 1991) in the non-metallic mineral products, and a doubling in the primary metals (8% from 4%) and fabricated metals (6% from 3%) sectors.

2.1.5 Water Acquisition Sources and Costs

As in the previous surveys, such as 1991, the 1996 survey collected data on the costs of water acquisition, intake treatment, waste treatment, and water recirculation (Tables 11 to 14). The costs of water acquisition consisted mainly of the amounts paid by establishments to water suppliers, normally the local public utilities for water services or in many cases, the cost of the establishment intake licence usually paid to provincial water agencies. These data constitute only part of the total cost of water acquisition to the industries surveyed. Not included in Tables 11 to 14 were data on the capital costs or depreciation of self-supplied water acquisition facilities, although most of these establishments did include their operation and maintenance costs incurred. The cost of waste treatment usually referred to the annual operation and maintenance costs of in-house treatment, but may also have included sewer surcharges levied by municipalities. No attempt was made to estimate costs for non-respondents for any of the cost categories, nor to adjust values for inflation – all dollar values given in this report are for the individual survey years in question.

The cost of water acquisition reported totalled almost $338 million in 1996, down considerably from the $812 million in 1991. This relative decline was due to large at-establishment water development costs in the primary metals and paper and allied products industries in 1991. In 1996, the primary metals industry and the food products industry accounted for the largest portions of this $338 million acquisition cost, at 21% and 20% respectively. The remainder ranged from 15% for the paper and allied products industry, to 11% for chemicals and chemical products down to 1% for rubber products. The payment to pubic utilities category comprised the largest amount at 58% of the total, with 41% of the total attributed to the at-establishment operation and maintenance costs category and about 1% in the provincial licence fees category. Of the amount paid to the public utilities, the food products industry was the largest contributor at 28%, followed by the chemicals and chemical products industry at 13%, and transport equipment industry at 12%. In the case of the food products industry, this finding denotes the reliance of the small to middle-size establishments of these industries on potable water supplied by municipalities. This same dependency is also illustrated by the beverage industry.

2.1.6 Costs of Water Recirculation and Water Treatment

Tables 13 and 14 provides the data for the other cost questions asked on the questionnaire. These costs are discussed under the following three components: costs associated with intake treatment, water recirculation and discharge treatment. As mentioned above, all dollar values given in this report are for the individual survey years in question, with no attempts to adjust values for inflation.

Intake treatment costs totalled $140 million in 1996, up from $122 million in 1991 (Tables 13 and 14). The data on intake treatment costs reflected the dominance of the four major water-using industries: paper and allied products, primary metals, chemicals and chemical products and petroleum and coal products. These four water users plus the food and beverage industries spent over 90% of the total cost reported for intake treatment. The paper and allied products industry alone spent about $46 million or 33% of the total.

The total recirculation costs for 1996, was $145 million, up from $97 million in 1991 (Tables 13 and 14). The costs of water recirculation reflected the relative importance of recirculation to the same four major water-using industries, which account for over 72% of the total cost. The paper and allied products industry again spent almost $46 million, or about 32% of these costs. The primary metals industry contributed $36 million, or 25%, chemicals and chemical products spent $13 million, or 9%, and petroleum and coal products spent $9.1 million, or 6%. In addition to these big four, the textile products group also spent over $22 million in 1996, or about 15% of the total recirculation costs.

The total 1996 cost of discharge or waste treatment was reported at $402 million, up significantly from the $222 million in 1991 (Tables 13 and 14). Of this total, the paper and allied products industry alone spent $228 million, or 57% of this total. The combined costs of the other three large water users – the primary

metals, chemicals and chemical products, and petroleum and coal products groups – followed the paper and allied products industry at about $110 million, or 27%. The other significant costs for waste treatment were incurred by the food and the transportation equipment industries, at $28 million and $15 million, respectively.

2.2 Provincial Sectoral Characteristics

Table 16 summarizes the characteristics and patterns of water use found in the provinces and regions in 1996. Data for the Yukon and Northwest Territories have been combined under the heading "Territories." Ontario accounted for 50% (47%) of the total Canadian manufacturing water intake reported, followed by Quebec with 19% (22%) of the total, and British Columbia with 17 % (16%). In contrast, Prince Edward Island and the territories accounted for an insignificant proportion of the total. This distribution of water intake among the provinces reflected provincial industrial structures.

Recycling and consumption rates by province are also given in Table 16. In general, the recycling rates in the Atlantic provinces (the four eastern provinces) were among the lowest in Canada. These lower recycling rates resulted from several factors. First, water is more readily available in the Atlantic provinces than in many other areas, reducing the need for recirculation. Also, the industrial mix of the region was such that industry groups with higher recycling rates, such as petroleum and coal products and chemicals and chemical products, were not predominant. Finally, the industrial base of the Atlantic provinces may still be older than that of the rest of Canada and thus employ older technological methods that do not recirculate large amounts of water.

2.3 Conclusions

Water use efficiency has increased markedly in the manufacturing sector. The recycling rate increased to 115% in 1996 from 93% in 1991, and 98% in 1986. This signifies a notable turnaround of the trend between 1986 and 1991 (Figure 7). There are two manufacturing industries that should be highlighted: the paper and allied products industry and the chemicals and chemical products industry. Both of these account in large part for the reduction in water intake and increases in water recirculation in the Manufacturing sector.

Withdrawals by industries characterized by large establishments such as paper and allied products were mainly from private freshwater sources, while industries dominated by smaller establishments such as the beverage industry tended to draw from public utilities. The industries making the largest withdrawals from water sources in Canada were paper and allied products, primary metals, petroleum and coal products, and chemical and chemical products.

There was also a reversal in the purpose of water use from the 1991 survey. In 1996 more water was used as process water than for cooling, compared to 1991 when it was mainly meant for cooling, condensation and steam generation. This perhaps accounts for the increase in water consumption to 9% in 1996, up from 7% in 1991, and 5% in 1986.

Wastewater discharge figures indicated that an estimated 42% of manufacturers' discharges received no treatment at all – and the bulk of these discharges were directly to surface waters. Overall, however, wastewater discharge volumes were down from 1991 levels, and the percentage not treated was also down from an estimated 50% in 1991.

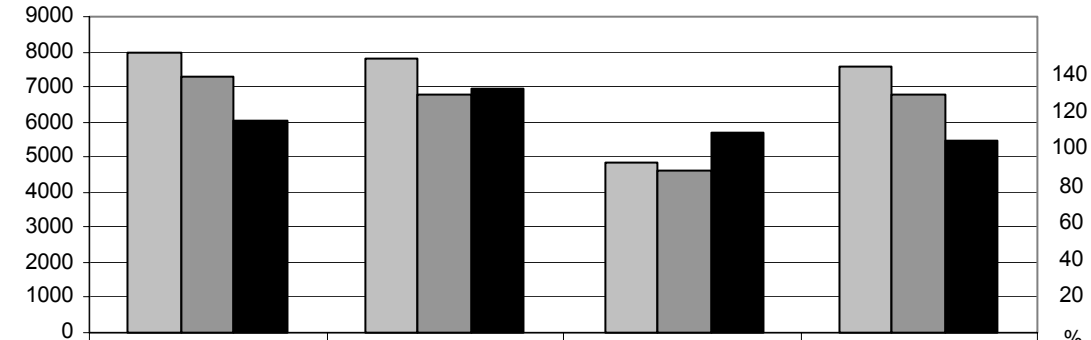
It should be noted that no qualitative measurement of pollutant loads or dispersion rates were included as part of this survey. Thus no assumptions can thus be made regarding any change in total pollutants released resulting from the reported increased recirculation of water in the manufacturing industry combined with the increased proportions being used in manufacturing processes (as opposed to cooling) and the high

percentage of the discharges being untreated. As a result of these factors, the decrease in discharge volumes may or may not have been accompanied by an actual decrease in pollutants released into the environment.

Water acquisition, recirculation and treatment costs totalled over $1 billion in 1996 for all of Canadian manufacturing compare to almost $1.3 billion in 1991. The cost of water acquisition decrease significantly from 1991 to 1996, whereas discharge treatment costs increase considerably. Payments to public utilities accounted for 58% of the $338 million acquisition costs, paid mainly by smaller establishments. Of the $402 million in discharge treatment costs, paper and allied products industries paid for 57% of the total.

Provincially, of survey respondents, Ontario accounted for 50% of the water intake for manufacturing purposes in Canada, followed by Quebec at 19% and BC at 17%. This reflects the heavier concentration of manufacturing industries in these provinces.

Figure 7. Water Flow Characteristics in Manufacturing



	Intake (MCM)	Recycle (MCM)	Recycle Rate (%)	Discharge (MCM)
1986	7,984	7,813	98	7,579
1991	7,282	6,807	93	6,762
1996	6,038	6,958	115	5,487

Sources: Tate, 92, Tate, 95, 1996 Industrial Water Survey

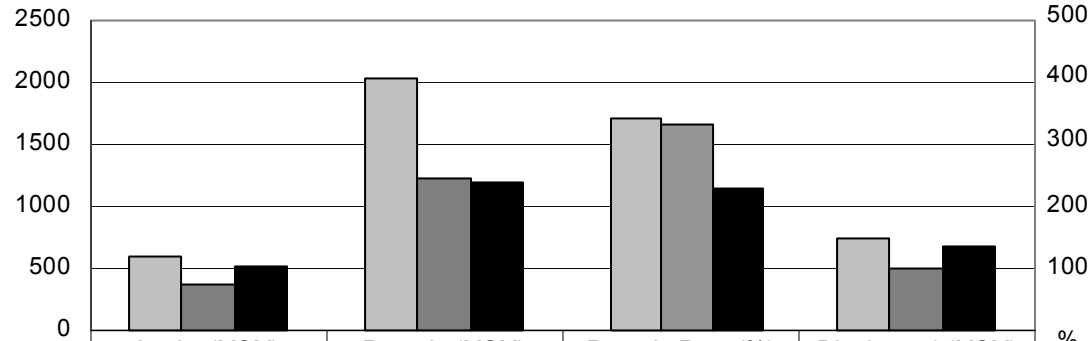
3. MINERAL EXTRACTION WATER USE AND COSTS

3.1 National Sectoral Characteristics

For the purposes of this survey, the mineral extraction industry consisted of three mining industry groups - metal mining, non-metal mining, and coal mining. Technical difficulties prevented the inclusion of crude petroleum and natural gas establishments, which had been surveyed in previous years. Due to confidentiality restrictions under the federal Statistics Act, the summary results contained in this paper are reported at the regional level, as opposed to the more detailed provincial level provided for the manufacturing sector. Also, the discussion is much shorter, because the basic concepts used are similar to those employed in the manufacturing sector.

In 1996, the mineral extraction establishments surveyed had a combined water intake totalling 518 MCM (364 MCM in 1991), an increase of 42%, which when combined with the recirculation of 1,197 MCM (1,224 MCM) yielded a gross water use of 1,715 MCM (1,587 MCM) (Table 17, Figure 8). The recycling rate for the three mining sectors decreased from 336% in 1991 to 231% in 1996, a decreased efficiency of water use. The sector had an 8% increase in their gross water use. The recycling rate for the mineral extraction sector is much higher than that for manufacturing, primarily because of the water recirculation from tailings ponds (Table 17).

Figure 8. Water Flow Characteristics in Mineral Extraction



	Intake (MCM)	Recycle (MCM)	Recycle Rate (%)	Discharge* (MCM)
1986	593	2,037	344	734
1991	364	1,224	336	499
1996	518	1,197	231	672

* Discharge values are estimates only. See Table 17 or Table 26 in Annex 1.

Sources: Tate, 92, Tate, 95, 1996 Industrial Water Survey

Because the question pertaining to wastewater discharge included the mine water, namely the drainage of groundwater from many of the mines, discharge totals often exceeded intake, causing consumption to be mathematically negative.

The metal mines, the largest mineral extraction group surveyed, were the largest water users in all parameters in 1996 as in 1991. The mineral extraction industries withdrew most of their water (Table 18) from self-supplied surface freshwater bodies 82% (78%), with the second source of supply being self-supplied fresh groundwater sources at slightly under 8% (8%). Processing uses, at 72% (75%) accounted for the largest amount of intake water in this sector (Table 19).

Chlorination and disinfection dominated the methods of intake treatment employed (Table 20) followed by screening, other treatment methods, filtration, and hardness and alkalinity control categories. Total water recirculation in mineral extraction industries in 1996 was reported as 1,197 MCM, with 93% of that used for processing. Much of this was recycled from tailing ponds.

Freshwater bodies accounted for the largest proportion 78% (59%) of responding water discharge from mines in this sector (Table 22). The amounts of water transferred to tailings ponds was estimated at 15% (20%) which reflected the importance of the tailings recovery processes in the metal mines. As noted above, much of the water recirculated by the metal mines was derived from tailings ponds for process reuse.

Much of the effluent from all three mining sectors received at least primary treatment (Table 23). Metal mines provided all three levels of treatment to cleanse their effluent before discharge. As is common with the manufacturing sector, the primary (mechanical) waste treatment type predominated in the mining sector. Much of the settlable waste from ore processing remains in tailings ponds adjacent to most mine sites. However, settling methods will not remove substances requiring more advanced forms of treatment, especially for toxic removal and by-product recovery. Thus, mining may generate a wide variety of pollutants that can damage the quality of streams and lakes. The offsetting factor to this point is that mines are generally in remote locations, away from major concentrations of population. However, this fails to take account of harm done to the environment, and to the fish and wildlife dependent on it. Therefore, the lack of advanced waste treatment is an unsustainable practice that needs to be addressed further in future.

The reliance on self-supplied intake sources in all three groups is reflected in the water acquisition costs. The in-house operating and maintenance costs reported by the metal mines accounted for approximately 74% (93%) of these expenditures (Table 24). Only the non-metals group paid more to the public utilities for their withdrawals 71% (53%) than on in-house operating and maintenance costs. As in all other parameters, the metals group incurred the largest costs overall at about 60% of the total acquisition costs.

3.2 Regional Sectoral Characteristics

Table 26 examines the mineral extraction water use data on a regional basis. The spatial distributions indicated reflect the regional distribution of mining activity in Canada. Establishments in the Atlantic provinces and Quebec tended to have higher recycling rates than the national average for the sector. This is consistent with previous surveys. The reasons for these higher levels of recirculation are not being delved into here, but the industry composition would play a significant role.

3.3 Conclusions

The mineral extraction sector show a decrease in recycling rates, from 336% in 1991 to 231% in 1996, resulting from an increased of intake of 42%, as recirculation decreased only marginally. Metal mines were the largest water users in this sector.

Surface water was the main source of intake, and process uses the dominant purpose for water use at 72% of all uses, although this was down slightly from 1991. Discharges continued to receive little treatment beyond primary and were sent mainly to freshwater bodies.

In-house operating and maintenance costs were the largest part of water acquisition costs, at 74%, reflecting the reliance on self-supply of water and the costs of water reuse from mining operations. Discharge treatment was the single largest cost component overall, at 47% of the total.

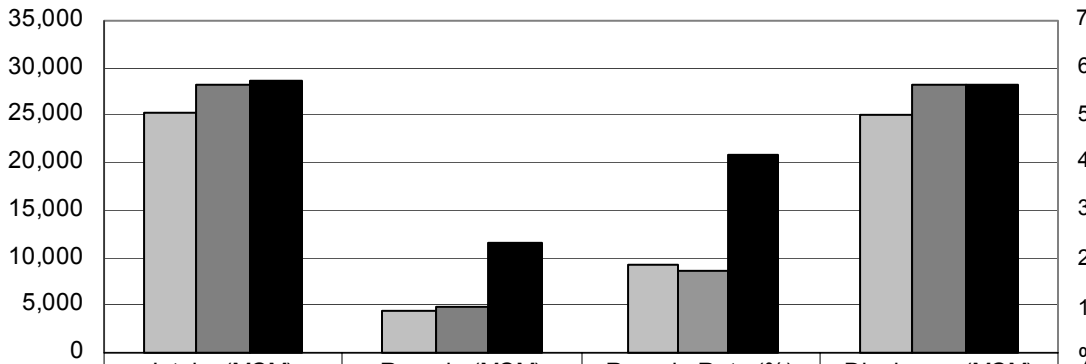
4. THERMAL POWER WATER USE AND COSTS

4.1 National Sectoral Characteristics

Water use for thermal power generation was the largest of the industrial sectors surveyed. In 1996, electric power establishments accounted for over 99% of intake in the sector, at 28,664 million cubic meters (MCM) (28,358 MCM in 1991), of a total reported 28,750 MCM (Table 27, Figure 9). The industrial manufacturing establishments producing electricity and steam for their processes accounted for the remainder. Of these industries, paper and allied products dominated, followed by chemicals and chemical products and primary metals. This is a change from 1991, when the primary metals groups was the largest water user, followed by paper and allied products, and chemicals and chemical products. Although, in 1996 there were establishments in both the manufacturing and mineral extraction sectors that practise co-generation of power and steam for their processes, they have been included only in their sectoral results. Therefore, there is no statistical overlap with the thermal establishments.

Surface freshwater bodies made up the principal sources of water for thermal power generators at approximately 91%, (92% in 1991), with the secondary source being tidewater at 6% (8%), with the later applying solely to the electrical utilities (Table 28). The discharge data show that 92% (as in 1991) of the effluent was discharged to surface freshwater bodies, with tidewater being the only other significant destination at 7% (Table 31).

Figure 9. Water Flow Characteristics in Thermal Power Generation



	Intake (MCM)	Recycle (MCM)	Recycle Rate (%)	Discharge (MCM)
1986	25,364	4,480	18	25,093
1991	28,358	4,810	17	28,225
1996	28,750	11,655	41	28,242

Sources: Tate, 92, Tate, 95, 1996 Industrial Water Survey

Because of the volumes of water involved, most of the discharge from thermal power establishments flowed to independent surface water sinks, principally freshwater lakes. Very small portions of the water (mainly that from sanitary uses) went to public sewers. Several establishments, especially in the Prairie region, used surface water basins as part of their recycling systems. In fact, two establishments reported zero-discharge systems. The thermal power industry, which in the past had a dismal record of water recycling (at about 17% of 1991 intake), reported a significant increase in recycling by 1996, to 11,655 MCM of the reported intake of 28,750 MCM, giving a recycling rate of 41%. Although these changes reflect the greater recycling methods employed by the newer establishments, the older establishments still generally use their cooling water only once before discharging it back to its source.

The most frequently used process to treat intake water was screening, at 24,168 MCM, followed distantly by hardness and alkalinity control at 1,836 MCM, chlorination and disinfection, filtration, and corrosion and slime control (Table 29). The electrical utilities dominated all categories, with paper and allied products following, in total treated volume.

The survey data on costs for water acquisition (Table 32) reveal that the paper and allied products industry contributed $7.4 million to the total costs of over $13 million. This is greater than the $5.5 million spent by the electric power utilities group – a much larger user. The electrical power industry dominated the intake treatment costs category – by far the largest expenditure category – spending $7.14 billion, which amounted to 99.7% of all reported water costs in the sector.

4.2 Regional Sectoral Characteristics

Water use in the thermal power sector was concentrated in the regions with the highest recirculation rates, the largest number of establishments, and the largest establishments. It is therefore dominated by Ontario and the Prairie provinces respectively, as Ontario had much larger withdrawals of water as well as more recirculation in 1996, even though the Prairie provinces had more establishments, and high levels of water recirculation. The Atlantic provinces were the third largest gross water using region in this sector. These regions rely more heavily on the electricity generated by thermal establishments as revealed in the generation totals (Table 33). Separate water intake tables have been created for the annual and monthly totals on both an industry group and a regional basis, which show Ontario electrical power generators as being responsible for the intake of 81% of all reported water in the sector, in 1996 (Table 35).

4.3 Conclusions

Electric power establishments account for over 99% of water intake in the thermal power generation sector, with the paper and allied products industry being the largest non-electrical power establishment user. This represents a change from the 1991 survey when the primary metals groups occupied the second position.

The largest change from the 1991 survey was the substantial increase in water recirculation, which increased from 17% of intake to over 40% of intake in 1996.

Acquisition costs for water in the thermal power sector were paid mainly by the paper and allied products industry and electrical power generation industries. The vast majority of the intake treatment costs in the thermal power sector were paid by the electrical power generation industry, at 99.9%. Intake treatment costs accounted for 99.8% of all the water-related costs in the sector.

Regionally, the largest users were in Ontario, the Prairie provinces, and the Atlanitic provinces, respectively. Ontario was where the establishments with the highest total reported intake and total reported recirculation were located, and the Prairie provinces were where the largest number of such establishments were located. Ontario had, by far, the largest withdrawals and recirculation of water, by volume, while at least some establishments in the Prairies provinces had very high levels of recirculation.

5. SURVEY METHODOLOGY

Sample Size

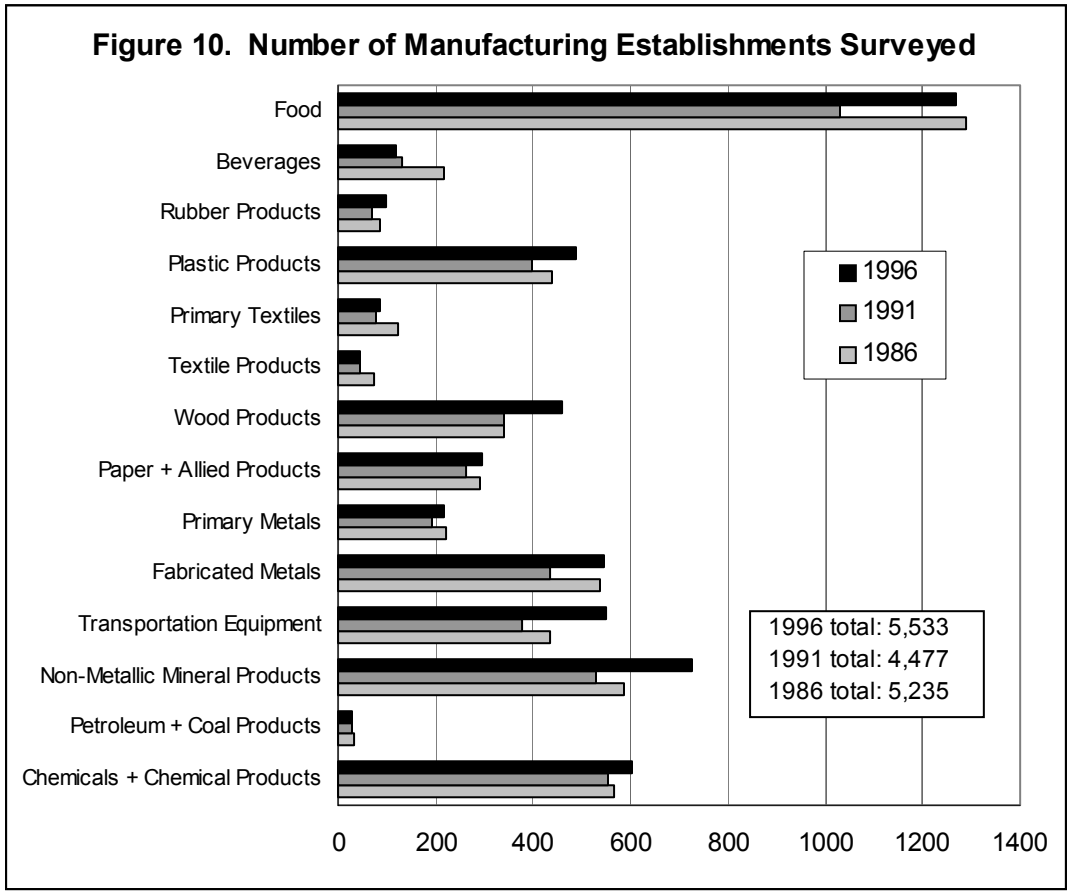
The 1996 Industrial Water Use Survey comprised a mailed survey to just over 6,100 industrial establishments conducted under the federal Statistics Act, and administered by Environment Canada. It did not survey all Canadian industrial operations, which numbered between 35,000 and 40,000 establishments in 1991. Resource constraints dictated this limitation. Sampling procedures were not used. Instead, the survey was sent to a pre-selected universe, and results imputed for non-respondents on the basis of results received.

Selection of Respondents

The survey included establishments in selected categories of the manufacturing, mineral extraction, and electric power sectors of the Canadian economy. The mailing list used has evolved over time, particularly with regard to the manufacturing sector, and, to add perspective, the development of this list is summarized here. During the first survey in 1972, questionnaires had been sent to a relatively large number of respondents who used very little water. To omit these smaller users, the 1976 survey was sent only to members of those industries classified as belonging to the 10 largest water-using two-digit SIC groups within the manufacturing sector. For these 10 groups, only those establishments that had received the long-form questionnaires during the annual Census of Manufacturing were selected. In 1981, the metal fabrication sector was added, because of its potentially high water use. Further revisions occurred for the 1986 survey, due largely to Statistics Canada's revision to the SIC system. For example, the food and beverage industry was split into two components, foods and beverages. Similar revisions lead to the survey of 14 manufacturing groups, again using a "universal" selection of long form respondents. The mailing list for 1991 was compiled on the same basis as that for 1986. In order to maintain continuity of the data, the same 14 industrial groups in the manufacturing sector were surveyed in the 1996 Survey.

The selection of establishments to be surveyed in the mineral extraction industry was based on the selection used in 1991. Basically, an attempt was made to include all significant operating mining establishments. All thermal power establishments in operation were included in the 1996 survey. As in 1991, a sub-section of the 1996 survey was devoted to the hydroelectric power generating establishments.

Relating to trend analyses – as given in the various figures in this report – the number of manufacturing establishments surveyed in the 1986, 1991 and 1996 surveys (Figure 10) do show some notable variation (Tate, 92, Tate, 95). This should be at least considered as a possible cause of some variation when comparing absolute numbers, though the size of the plants included or excluded from survey to survey is not specified. Comparison of recycling rates and consumption rates is less affected by this variation. This variation is not a significant factor in the other industrial sectors, which were more fully represented and had higher response rates.



Sources: Tate, 92, Tate, 95, 1996 Industrial Water Survey

Response Rates

The number of establishments and the response rates obtained varied among the four sectors surveyed (Table 1). The manufacturing sector, with 5,533 questionnaires, comprised the largest sector surveyed. Of these questionnaires, 3,992 were returned, for an overall response rate of 72%. The remaining 1,541 establishments surveyed either (1) sent back returns that contained basic information such as employment, operating days, and product descriptions but little or no water use information, or (2) refused to respond. For both types of returns, water use information was estimated from the respondent data to obtain survey totals. For the mineral extraction sector, the response rate was much higher at 90%. In the two electric power sectors, completed questionnaires were received for all establishments. The aggregate response rate for the entire survey was 75% (Table 1).

Table 1
Responses for the 1996 Survey, by Sector and Rate (%)

Sector	Total Number of Questionnaires			Number of Respondents			Number of Non-respondents			Response Rate (%)		
year	1986	1991	1996	1986	1991	1996	1986	1991	1996	1986	1991	1996
Manufacturing	5,235	4,477	5,533	3,535	3,060	3,992	1,700	1,417	1,541	68	68	72
Mineral Extraction	277	203	173	248	180	156	29	23	17	90	89	90
Thermal Power	77	66	60	77	66	60	0	0	0	100	100	100
Hydro Power	358	358	352	358	358	352	0	0	0	100	100	100
Total	5,947	5,104	6,118	4,218	3,664	4,560	1,729	1,440	1,558	71	72	75

Sources: Tate, 92, Tate, 95, 1996 Industrial Water Survey

Estimation Procedures for Non-Respondents

As in the previous surveys, estimation procedures provided water use data for non-respondents in the manufacturing and mineral extraction sectors. These estimations used coefficients of water use per employee developed from the respondent data, for each industry at the four-digit SIC industry level on a provincial basis, multiplying each water use coefficient by the employment for the non-respondent establishments. The estimates were then added to the respondent data to provide aggregated results for each parameter. Where the provincial set of responses for a particular industry were too small to form reliable coefficients of water use per employee (judged to be fewer than three observations), coefficients from the national level were used to provide the estimates. No estimations were required for the electric power sectors, because the survey in these sectors was complete.

The assumption underlying the non-respondent estimates was that establishments in the same industry in the same province use essentially the same processes. Theoretically, this assumption is not wholly acceptable (Whittington, 1978; Tate, 1984), but was used here as an approximate means of obtaining complete estimates of water use by sector and spatial unit. In general, estimations were required only for the smaller establishments.

Survey Concepts and Methods

The 1996 survey was a collaborative effort by Environment Canada and Statistics Canada. Statistics Canada personnel guided the selection of potential respondents from the Censuses of Manufacturing, Mining and Energy, and undertook to receive the completed questionnaires using their system for "tracking" questionnaire surveys as they progress. Environment Canada staff undertook all other tasks, such as selection of industry (SIC) groups to be surveyed, questionnaire design, editing, data processing, and publication of the survey results.

ACKNOWLEDGEMENTS

The assistance of several persons was required to conduct this project. During the survey phase, Dave Scharf, of the Environmental Economics Branch, lead the project, answered respondent enquiries and assisted in the follow-up and estimation phases of the project. Fraser Brown, a summer student, was largely responsible for the data entry and also provided some assistance in the follow-up phase. Special thanks to Martin Lemire and François Soulard, both of Statistics Canada, who assisted in editing the manuscript for publication, and to Valerie Sexton, of the Environmental Economics Branch, Environment Canada, who assisted in the development of this report. The assistance of all these persons is appreciated.

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ANNEX 1

Detailed Tables

All values in these detailed tables are derived
from the 1996 Industrial Water Survey results databases

In order to save space in the following detailed tables,
the term ‘plant’ will be used in place of the term ‘establishment’.
The title ‘Number of Plants’ refers to the number of establishments
responding and imputed for, in the survey database, for that variable.

The term ‘recycle’ will be used in place of the term ‘recycling’.

In these tables, the term ‘Prairies’ refers to the Prairie provinces
(Manitoba, Saskatchewan, and Alberta), and the term ‘Atlantic’
refers to the Atlantic provinces (Newfoundland,
Prince Edward Island, Nova Scotia, and New Brunswick)

Table 2
Employment (number of persons) in Surveyed Manufacturing Plants, by Industry Group and Province, 1996

Industry Group	NF	PE	NS	NB	QU	ON	MB	SK	AB	BC	Terr.	Total
Food	10,813	3,456	10,456	12,399	30,230	49,303	5,818	3,587	11,408	12,308	0	149,778
Beverages	447	90	415	540	3,679	6,368	780	258	1,191	1,550	0	15,318
Rubber Products	0	0	3,400	19	3,197	10,493	214	0	317	275	0	17,915
Plastic Products	98	8	711	491	10,833	23,647	1,496	284	2,019	2,764	20	42,371
Primary Textiles	0	11	100	237	7,755	5,787	0	0	685	158	0	14,733
Textile Products	0	8	375	28	3,958	2,767	0	0	0	0	0	7,136
Wood Products	354	43	875	3,520	14,882	6,888	144	353	2,913	25,269	0	55,241
Paper + Allied Products	1,562	0	2,486	3,506	27,747	21,752	1,294	1,091	3,620	14,683	0	77,741
Primary Metals	0	0	730	549	19,782	44,469	640	839	3,815	2,746	0	73,570
Fabricated Metals	54	173	462	1,170	11,366	19,556	1,333	606	3,852	2,163	16	40,751
Transportation Equipment	767	351	4,266	3,600	28,886	148,280	3,424	124	1,518	5,352	0	196,568
Non-Metallic Mineral Products	343	79	902	862	9,354	14,691	912	415	3,262	2,931	28	33,779
Petroleum + Coal Products	345	0	241	262	1,368	2,585	0	420	1,500	622	10	7,353
Chemicals + Chemical Products	83	121	298	267	17,991	30,774	883	436	5,022	1,947	0	57,822
Total	14,866	4,340	25,717	27,450	191,028	387,360	16,938	8,413	41,122	72,768	74	790,076
%	1.9	0.5	3.3	3.5	24.2	49.0	2.1	1.1	5.2	9.2	0.0	100.0

Table 3
Selected Characteristics of Manufacturing Water Use (MCM water/year), by Parameter and Industry Group, 1996

Industry Group	Number of Plants	Employees (000's)	Intake	Recycle	Gross Water Use	Discharge	Consumption
Food	1270	149.8	269.5	145.3	414.9	240.0	29.5
Beverages	121	15.3	73.1	18.3	91.4	56.2	16.9
Rubber Products	97	17.9	12.3	12.9	25.2	11.3	1.0
Plastic Products	489	42.4	13.3	38.7	52.0	12.0	1.3
Primary Textiles	87	14.7	86.7	68.2	154.9	84.6	2.1
Textile Products	47	7.1	15.0	7.9	23.0	12.9	2.1
Wood Products	458	55.2	45.1	10.2	55.3	33.0	12.1
Paper + Allied Products	294	77.7	2,421.3	3,105.9	5,527.3	2,207.0	214.3
Primary Metals	217	73.6	1,423.0	1,447.9	2,870.9	1,303.0	120.0
Fabricated Metals	545	40.8	19.4	8.1	27.5	18.4	1.1
Transportation Equipment	549	196.6	65.4	107.3	172.7	46.4	19.0
Non-Metallic Mineral Products	727	33.8	102.3	91.8	194.1	83.1	19.2
Petroleum + Coal Products	27	7.4	370.5	541.4	911.9	348.0	22.5
Chemicals + Chemical Products	605	57.8	1,121.3	1,353.7	2,475.0	1,030.6	90.7
Total	5533	790.1	6,038.3	6,957.7	12,996.0	5,486.7	551.6

Note: See tables 15 and 16 for percentages and rates

Table 4
Water Intake in Manufacturing (MCM/year), by Source and Industry Group, 1996

Industry Group	Number of Plants	Fresh Water				Brackish Water			Total Intake
		Public Supplied	Self-Supplied			Self-Supplied			
		Municipal	Surface	Ground	Other	Ground	Tidewater	Other	
Food	1254	118.7	61.8	44.6	3.4	1.9	38.7	0.2	269.3
Beverages	121	49.0	16.1	8.1	0.0	0.0	0.0	0.0	73.1
Rubber Products	96	8.2	1.3	2.4	0.5	0.0	0.0	0.0	12.3
Plastic Products	482	7.0	4.8	1.2	0.1	0.1	0.0	0.0	13.2
Primary Textiles	87	34.6	51.4	0.1	0.0	0.1	0.0	0.5	86.7
Textile Products	47	13.1	0.0	2.0	0.0	0.0	0.0	0.0	15.0
Wood Products	454	18.8	16.4	9.5	0.2	0.1	0.1	0.0	45.1
Paper + Allied Products	292	70.4	2240.0	65.8	45.3	0.0	0.0	0.0	2421.3
Primary Metals	217	61.2	1314.0	22.9	12.8	0.0	12.1	0.0	1423.0
Fabricated Metals	543	12.1	6.8	0.5	0.0	0.0	0.0	0.0	19.4
Transportation Equipment	547	59.5	4.7	0.7	0.0	0.0	0.0	0.0	65.0
Non-Metallic Mineral Products	725	19.5	36.3	9.9	36.0	0.0	0.4	0.0	102.1
Petroleum + Coal Products	27	11.4	249.0	2.5	1.3	0.0	102.1	4.2	370.5
Chemicals + Chemical Products	599	66.1	940.1	7.2	67.2	0.1	40.5	0.1	1121.3
Total	5491	549.6	4942.5	177.3	166.8	2.3	193.9	5.0	6037.4
%		9.1	81.9	2.9	2.8	0.0	3.2	0.1	100.0

Table 5
Water Intake Treatment in Manufacturing (MCM/year), by Type of Treatment and Industry Group, 1996

Industry Group	Filtration	Chlorination and Disinfection	Corrosion and Slime Control	Screening	Hardness and Alkalinity Control	Other
Food	28.9	102.0	5.3	55.7	10.9	3.5
Beverages	30.3	17.8	2.8	15.5	11.8	1.5
Rubber Products	1.9	2.0	0.5	0.0	1.3	0.0
Plastic Products	0.6	0.2	1.5	4.5	1.2	0.2
Primary Textiles	31.3	22.2	0.3	29.1	2.9	24.6
Textile Products	0.0	0.0	0.3	0.0	3.5	0.0
Wood Products	0.2	0.2	6.3	12.6	1.0	5.9
Paper + Allied Products	1,003.2	751.4	109.3	1,092.2	238.9	246.1
Primary Metals	238.6	141.8	162.7	402.6	26.8	19.2
Fabricated Metals	2.9	0.1	0.3	0.0	0.7	0.1
Transportation Equipment	1.5	1.2	0.8	1.5	4.9	0.3
Non-Metallic Mineral Products	4.4	0.6	0.5	23.2	1.5	0.5
Petroleum + Coal Products	21.8	266.5	69.3	226.5	62.1	12.2
Chemicals + Chemical Products	319.0	165.6	42.1	851.4	53.3	7.0
Total	1,684.7	1,471.6	401.9	2,715.0	420.8	321.1

Table 6
Water Intake in Manufacturing (MCM/year), by Purpose of Initial Use and Industry Group, 1996

Industry Group	Number of Plants	Processing	Cooling, Condensing and Steam	Sanitary Services	Other	Total Intake	%
Food	1,264	128.6	107.3	27.8	5.9	269.5	4.5
Beverages	121	38.4	29.0	4.6	1.1	73.1	1.2
Rubber Products	96	3.6	7.7	0.9	0.1	12.3	0.2
Plastic Products	486	5.9	5.9	1.3	0.2	13.3	0.2
Primary Textiles	87	15.5	64.6	6.5	0.0	86.7	1.4
Textile Products	47	12.8	1.8	0.4	0.1	15.0	0.2
Wood Products	454	9.7	24.4	2.2	8.8	45.1	0.7
Paper + Allied Products	292	1,847.5	508.3	49.1	16.4	2,421.3	40.1
Primary Metals	217	557.6	830.1	21.5	13.8	1,423.0	23.6
Fabricated Metals	543	11.3	6.4	1.6	0.1	19.4	0.3
Transportation Equipment	547	28.5	25.0	11.1	0.4	65.0	1.1
Non-Metallic Mineral Products	726	21.6	44.9	3.5	32.1	102.1	1.7
Petroleum + Coal Products	27	34.4	324.6	4.9	6.6	370.5	6.1
Chemicals + Chemical Products	599	220.9	879.8	10.9	9.7	1,121.3	18.6
Total	5,506	2,936.3	2,859.6	146.3	95.3	6,037.5	100.0
%		48.6	47.4	2.4	1.6	100.0	

Table 7
Monthly Distribution of Water Intake in Manufacturing (%), by Industry Group, 1996

Industry Group	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Food	6.8	7.0	7.0	7.1	8.6	9.7	9.5	10.2	10.6	8.9	7.8	6.9
Beverages	7.4	6.8	8.8	8.6	9.5	9.8	8.2	8.2	7.9	8.2	8.7	7.8
Rubber Products	8.1	7.9	8.2	8.1	8.4	8.4	8.3	9.4	9.2	8.6	8.0	7.5
Plastic Products	10.0	10.1	10.1	10.6	6.0	6.2	6.5	6.6	6.3	6.7	11.0	9.8
Primary Textiles	6.0	5.3	5.8	6.0	7.3	9.8	9.7	10.2	12.1	12.0	8.0	7.8
Textile Products	7.4	7.6	7.8	7.9	8.9	8.9	7.5	8.6	9.1	9.1	9.1	8.3
Wood Products	10.0	9.8	9.6	7.4	8.4	10.0	8.6	7.0	7.4	7.9	6.4	7.6
Paper + Allied Products	8.3	7.6	8.1	7.7	8.1	8.4	9.3	9.4	8.7	8.5	8.1	7.9
Primary Metals	8.0	7.9	8.2	8.1	8.3	7.9	8.4	8.7	8.8	8.9	8.4	8.4
Fabricated Metals	8.5	8.2	8.1	7.8	8.3	8.6	8.5	8.4	8.8	8.5	8.5	7.7
Transportation Equipment	8.4	8.3	7.8	8.2	8.5	8.4	8.1	9.0	8.7	8.1	8.8	7.6
Non-Metallic Mineral Products	7.6	7.1	7.9	7.9	8.4	8.7	9.4	9.0	9.1	8.9	8.3	7.6
Petroleum + Coal Products	8.2	7.6	8.3	7.8	8.5	8.6	9.3	9.2	8.9	8.0	7.9	7.8
Chemicals + Chemical Products	9.4	8.8	9.3	9.3	9.3	7.0	6.4	6.3	7.6	8.4	8.7	9.5
Total	8.3	7.8	8.3	8.1	8.4	8.2	8.5	8.7	8.6	8.6	8.3	8.3

Table 8
Water Recirculation in Manufacturing (MCM/year), by Purpose and Industry Group, 1996

Industry Group	Number of Plants	Processing	Cooling, Condensing and Steam	Other	Total	%
Food	732	72.0	68.7	4.6	145.3	2.1
Beverages	89	5.4	12.0	1.0	18.3	0.3
Rubber Products	57	5.9	5.7	1.4	12.9	0.2
Plastic Products	289	7.7	31.1	0.0	38.7	0.6
Primary Textiles	56	21.6	46.6	0.0	68.2	1.0
Textile Products	35	0.2	7.6	0.1	7.9	0.1
Wood Products	172	1.7	8.5	0.0	10.2	0.1
Paper + Allied Products	195	2,710.5	391.4	4.0	3,105.9	44.6
Primary Metals	134	603.8	842.5	1.6	1,447.9	20.8
Fabricated Metals	235	3.8	4.2	0.0	8.1	0.1
Transportation Equipment	303	54.9	52.4	0.0	107.3	1.5
Non-Metallic Mineral Products	425	9.3	78.8	3.6	91.8	1.3
Petroleum + Coal Products	19	1.1	538.4	1.9	541.4	7.8
Chemicals + Chemical Products	376	63.9	1,285.5	4.3	1,353.7	19.5
Total	3,117	3,561.8	3,373.3	22.7	6,957.7	100.0
%		51.2	48.5	0.3	100.0	

Table 9
Water Discharge in Manufacturing (MCM/year), by Point of Discharge and Industry Group, 1996

Industry Group	Public Sewer	Freshwater Body	Tidewater	Groundwater	Transferred to Other Uses	Total Discharge	%
Food	94.2	72.3	64.5	6.2	2.7	239.9	4.4
Beverages	45.7	10.4	0.0	0.0	0.0	56.2	1.0
Rubber Products	6.0	5.3	0.0	0.0	0.0	11.3	0.2
Plastic Products	9.8	1.5	0.0	0.7	0.0	12.0	0.2
Primary Textiles	13.1	71.2	0.1	0.2	0.0	84.6	1.5
Textile Products	12.9	0.0	0.0	0.0	0.0	12.9	0.2
Wood Products	4.3	25.1	2.2	1.4	0.1	33.0	0.6
Paper + Allied Products	119.5	1,466.3	618.2	1.5	1.5	2,207.0	40.2
Primary Metals	361.2	919.3	20.2	1.3	1.0	1,303.0	23.8
Fabricated Metals	13.3	4.5	0.0	0.5	0.0	18.3	0.3
Transportation Equipment	35.1	6.4	4.6	0.3	0.0	46.4	0.8
Non-Metallic Mineral Products	9.2	71.0	1.4	1.3	0.1	83.0	1.5
Petroleum + Coal Products	6.3	233.5	106.9	0.4	0.9	348.0	6.3
Chemicals + Chemical Products	27.3	957.8	36.5	4.2	4.7	1,030.5	18.8
Total	757.9	3,844.7	854.6	18.0	11.1	5,486.3	100.0
%	13.8	70.1	15.6	0.3	0.2	100.0	

Table 10
Treatment of Manufacturing Water Discharge (MCM/year), by Treatment Type and Industry Group, 1996

Industry Group	Primary Method	Two Primary Methods	Secondary Method	Two Secondary Methods	Tertiary Method	Two Tertiary Methods
Food	65.8	4.3	72.8	1.6	7.0	0.3
Beverages	21.8	1.8	2.1	1.9	0.9	2.6
Rubber Products	1.2	0.5	0.1	0.0	0.0	0.0
Plastic Products	0.4	0.0	0.1	0.0	0.0	0.0
Primary Textiles	3.2	0.4	1.5	0.2	0.0	0.0
Textile Products	11.9	2.1	3.1	0.0	0.0	0.0
Wood Products	11.2	0.2	8.8	0.0	0.0	0.0
Paper + Allied Products	1,670.6	155.0	1,824.9	97.9	130.9	0.0
Primary Metals	260.8	62.4	79.0	4.2	208.0	4.5
Fabricated Metals	5.8	0.2	3.1	0.0	1.6	0.0
Transportation Equipment	8.4	1.8	5.0	0.4	0.9	0.1
Non-Metallic Mineral Products	44.5	3.2	0.8	0.0	2.6	0.0
Petroleum + Coal Products	258.7	83.5	121.8	18.5	5.6	1.9
Chemicals + Chemical Products	179.3	3.2	21.6	3.2	5.9	1.1
Total	2,543.6	318.6	2,144.8	127.9	363.4	10.5

Table 11
Water Acquisition Costs in Manufacturing ($ Millions), by Cost Component and Industry Group, 1996

Industry Group	Paid to Public Utilities	At Plant Operation and Maintenance	Provincial Licence Fees	Total	%
Food	54.0	14.0	0.1	68.1	20.2
Beverages	16.8	7.3	0.0	24.1	7.1
Rubber Products	3.2	0.6	0.0	3.8	1.1
Plastic Products	4.5	1.1	2.3	7.9	2.3
Primary Textiles	2.8	1.8	0.0	4.7	1.4
Textile Products	4.3	0.2	0.0	4.5	1.3
Wood Products	2.8	9.2	0.0	12.1	3.6
Paper + Allied Products	17.5	33.9	0.6	52.0	15.4
Primary Metals	22.0	48.3	0.1	70.4	20.8
Fabricated Metals	6.4	1.1	0.0	7.5	2.2
Transportation Equipment	24.4	5.0	0.0	29.4	8.7
Non-Metallic Mineral Products	8.9	3.1	0.0	12.1	3.6
Petroleum + Coal Products	3.0	1.7	0.0	4.7	1.4
Chemicals + Chemical Products	25.5	10.9	0.0	36.4	10.8
Total	196.2	138.2	3.2	337.7	100.0
%	58.1	40.9	1.0	100.0	

Table 12
Water Acquisition Costs in Manufacturing ($ Thousands) by Cost Component and Province, 1996

Province	Paid to Public Utilities	At Plant Operation and Maintenance	Provincial Licence Fees	Total	%
Newfoundland	1,283.3	619.2	14.5	1,917.0	0.6
Prince Edward Island	456.7	227.7	3.5	687.9	0.2
Nova Scotia	3,026.2	1,598.8	39.1	4,664.1	1.4
New Brunswick	2,795.0	2,448.2	10.1	5,253.2	1.6
Quebec	30,504.9	17,001.5	2,368.9	49,875.3	14.8
Ontario	119,646.0	76,615.0	117.7	196,378.7	58.2
Manitoba	5,166.6	1,550.0	36.3	6,752.9	2.0
Saskatchewan	3,425.9	1,389.3	97.7	4,912.9	1.5
Alberta	15,998.5	6,055.6	17.5	22,071.6	6.5
British Columbia	13,861.0	30,720.9	527.4	45,109.3	13.4
Territories*	24.0	20.3	5.0	49.3	0.0
Total	196,188.0	138,246.6	3,237.7	337,672.3	100.0
%	58.1	40.9	1.0	100.0	

* Territories are combined due to privacy concerns

Table 13
Total Water Costs in Manufacturing ($ Millions), by Cost Component and Industry Group, 1996

Industry Group	Acquisition	Intake Treatment	Recirculation	Discharge Treatment	Total	%
Food	68.1	8.4	5.2	27.8	109.6	10.7
Beverages	24.1	4.9	1.3	2.8	33.2	3.2
Rubber Products	3.8	0.7	0.8	0.3	5.6	0.5
Plastic Products	7.9	1.3	3.4	0.2	12.8	1.2
Primary Textiles	4.7	1.4	0.7	1.4	8.1	0.8
Textile Products	4.5	0.7	22.4	0.8	28.4	2.8
Wood Products	12.1	1.4	0.3	6.2	19.8	1.9
Paper + Allied Products	52.0	45.8	46.4	227.8	371.9	36.3
Primary Metals	70.4	29.2	36.0	56.7	192.2	18.8
Fabricated Metals	7.5	0.8	0.7	8.1	17.1	1.7
Transportation Equipment	29.4	6.0	4.2	15.4	55.0	5.4
Non-Metallic Mineral Products	12.1	1.3	1.6	0.6	15.6	1.5
Petroleum + Coal Products	4.7	14.1	9.1	23.1	51.0	5.0
Chemicals + Chemical Products	36.4	23.7	13.0	30.6	103.8	10.1
Total	337.7	139.7	145.0	401.8	1,024.2	100.0
%	33.0	13.6	14.2	39.2	100.0	

Table 14
Total Water Costs in Manufacturing ($ Millions), by Cost Component and Province, 1996

Province	Acquisition	Intake Treatment	Recirculation	Discharge Treatment	Total	%
Newfoundland	1.9	1.0	1.1	13.7	17.7	1.7
Prince Edward Island	0.7	0.1	0.0	0.2	1.1	0.1
Nova Scotia	4.7	1.3	2.8	11.5	20.2	2.0
New Brunswick	5.3	5.7	3.2	12.1	26.2	2.6
Quebec	49.9	33.4	51.9	108.1	243.3	23.8
Ontario	196.4	45.4	49.2	164.6	455.6	44.5
Manitoba	6.8	3.7	1.0	2.2	13.7	1.3
Saskatchewan	4.9	5.2	10.1	1.7	22.0	0.0
Alberta	22.1	32.7	11.5	19.5	85.8	8.4
British Columbia	45.1	11.0	14.3	68.2	138.5	13.5
Territories*	0.0	0.1	0.0	0.0	0.1	0.0
Total	337.7	139.7	145.0	401.8	1,024.2	100.0
%	33.0	13.6	14.2	39.2	100.0	

* Territories are combined due to privacy concerns

Table 15
Characteristics of Manufacturing Water Use (MCM/year), by Water Use Parameter and Industry Group, 1996

Industry Group	Intake	%	Recycle	%	Recycle Rate*	Gross Water Use	%	Discharge	%	Consumption Total	%	Rate**
Food	269.5	4.5	145.3	2.1	54	414.9	3.2	240.0	4.4	29.5	5.3	10.9
Beverages	73.1	1.2	18.3	0.3	25	91.4	0.7	56.2	1.0	16.9	3.1	23.1
Rubber Products	12.3	0.2	12.9	0.2	105	25.2	0.2	11.3	0.2	1.0	0.2	7.8
Plastic Products	13.3	0.2	38.7	0.6	292	52.0	0.4	12.0	0.2	1.3	0.2	9.4
Primary Textiles	86.7	1.4	68.2	1.0	79	154.9	1.2	84.6	1.5	2.1	0.4	2.4
Textile Products	15.0	0.2	7.9	0.1	53	23.0	0.2	12.9	0.2	2.1	0.4	14.1
Wood Products	45.1	0.7	10.2	0.1	22	55.3	0.4	33.0	0.6	12.1	2.2	26.9
Paper + Allied Products	2,421.3	40.1	3,105.9	44.6	128	5,527.3	42.5	2,207.0	40.2	214.3	38.9	8.9
Primary Metals	1,423.0	23.6	1,447.9	20.8	102	2,870.9	22.1	1,303.0	23.7	120.0	21.7	8.4
Fabricated Metals	19.4	0.3	8.1	0.1	42	27.5	0.2	18.4	0.3	1.1	0.2	5.6
Transportation Equipment	65.4	1.1	107.3	1.5	164	172.7	1.3	46.4	0.8	19.0	3.4	29.0
Non-Metallic Mineral Products	102.3	1.7	91.8	1.3	90	194.1	1.5	83.1	1.5	19.2	3.5	18.7
Petroleum + Coal Products	370.5	6.1	541.4	7.8	146	911.9	7.0	348.0	6.3	22.5	4.1	6.1
Chemicals + Chemical Products	1,121.3	18.6	1,353.7	19.5	121	2,475.0	19.0	1,030.6	18.8	90.7	16.4	8.1
Sum Total	6,038.3	100.0	6,957.7	100.0	115	12,996.0	100.0	5,486.7	100.0	551.6	100.0	9.1

* Recycle Rate = Recycle as % of Water Intake

** Consumption Rate = Water Consumption as % of Water Intake

Table 16
Characteristics of Manufacturing Water Use (MCM/year), by Water Use Parameter and Province or Region, 1996

Province	Intake	%	Recycle	%	Recycle Rate*	Gross Water Use	%	Discharge	%	Consumption		
										Total	%	Rate**
Newfoundland & Lab.	106.6	1.8	75.1	1.1	70	181.7	1.4	90.2	1.6	16.4	3.0	15.4
Prince Edward Island	10.4	0.2	1.7	0.0	16	12.1	0.1	9.8	0.2	0.7	0.1	6.3
Nova Scotia	194.9	3.2	66.0	0.9	34	260.8	2.0	183.1	3.3	11.8	2.1	6.1
New Brunswick	167.9	2.8	161.1	2.3	96	329.0	2.5	153.6	2.8	14.4	2.6	8.6
Quebec	1,172.5	19.4	1,066.3	15.3	91	2,238.8	17.2	1,046.3	19.1	126.2	22.9	10.8
Ontario	3,010.6	49.9	3,077.7	44.2	102	6,088.3	46.8	2,812.1	51.3	198.5	36.0	6.6
Manitoba	38.3	0.6	10.3	0.1	27	48.6	0.4	31.4	0.6	7.0	1.3	18.1
Saskatchewan	47.1	0.8	129.9	1.9	276	177.1	1.4	43.3	0.8	3.9	0.7	8.2
Alberta	282.1	4.7	896.6	12.9	318	1,178.7	9.1	205.1	3.7	76.9	13.9	27.3
British Columbia	1,007.5	16.7	1,473.0	21.2	146	2,480.5	19.1	911.6	16.6	95.8	17.4	9.5
Territories***	0.4	0.0	0.0	0.0	4	0.4	0.0	0.3	0.0	0.0	0.0	8.4
Region												
Atlantic	479.8	7.9	303.8	4.4	63	783.7	6.0	436.6	8.0	43.2	7.8	9.0
Quebec	1,172.5	19.4	1,066.3	15.3	91	2,238.8	17.2	1,046.3	19.1	126.2	22.9	10.8
Ontario	3,010.6	49.9	3,077.7	44.2	102	6,088.3	46.8	2,812.1	51.3	198.5	36.0	6.6
Prairies	367.5	6.1	1,036.9	14.9	282	1,404.4	10.8	279.7	5.1	87.8	15.9	23.9
British Columbia	1,007.5	16.7	1,473.0	21.2	146	2,480.5	19.1	911.6	16.6	95.8	17.4	9.5
Territories***	0.4	0.0	0.0	0.0	4	0.4	0.0	0.3	0.0	0.0	0.0	8.4
Sum Total	6,038.3	100.0	6,957.7	100.0	115	12,996.0	100.0	5,486.7	100.0	551.6	100.0	9.1

* Recycle Rate = Recycle as % of Water Intake

** Consumption Rate = Water Consumption as % of Water Intake

*** Territories are combined due to privacy concerns

Table 17
Selected Characteristics of Mineral Extraction Water Use (MCM/year), by Water Use Parameter and Industry Group, 1996

Industry Group	Number of Plants	Employees (000's)	Intake	%	Recycle	%	Recycle Rate*	Gross Water Use	%	Discharge	%	Mine Water	Plants Resp.** to Mine Water
Metal Mines	96	35.8	427.8	82.5	1,114	93.1	260	1,542	89.9	573.6	85.4	72.6	57
Non-metal Mines	48	7.5	56.3	10.9	40	3.4	72	97	5.6	72.4	10.8	17.8	16
Coal Mines	29	8.7	34.2	6.6	42	3.6	124	77	4.5	25.9	3.9	17.4	15
Total	173	52.0	518.2	100.0	1,197	100.0	231	1,715	100.0	671.9	100.0	107.8	88

* Recycle Rate = recycle as a % of Intake

** No reliable mining water consumption values can be estimated due to a high level of Mine Water non-response, as well as large intake and discharge discrepancies. The later are likely due to unaccounted for Tailing Pond volume changes. Note that mining consumption values for previous Industrial Water Surveys have had the same problem, and therefore any consumption numbers therein should be used only with caution.

Table 18
Water Intake in Mineral Extraction (MCM/year), by Source and Industry Group, 1996

Industry Group	Responding Plants	Fresh Water				Brackish Water			Total Intake
		Public Supplied	Self-Supplied			Self-Supplied			
		Municipal	Surface	Ground	Other	Ground	Tidewater	Other	
Metal Mines	96	3.8	388.3	23.5	8.3	0.9	0.0	3.0	427.8
Non-metal Mines	48	6.8	31.2	6.5	0.5	3.1	8.1	0.0	56.3
Coal Mines	29	0.3	5.8	10.3	2.5	0.0	0.0	15.3	34.2
Total	173	11.0	425.2	40.4	11.3	4.0	8.1	18.3	518.2
Percent of Total Intake		2.1	82.1	7.8	2.2	0.8	1.6	3.5	100.0

Table 19
Water Intake in Mineral Extraction (MCM/year), by Purpose of Initial Use and Industry Group, 1996

Industry Group	Number of Plants	Processing	Cooling, Condensing and Steam	Sanitary Services	Other	Total Intake
Metal Mines	96	301.4	30.7	12.8	82.9	427.8
Non-metal Mines	48	38.1	14.2	2.0	1.9	56.3
Coal Mines	29	31.5	1.1	1.0	0.7	34.2
Total	173	370.9	46.0	15.9	85.4	518.2
Percent of Total Intake		71.6	8.9	3.1	16.5	100.0

Table 20
Water Intake Treatment in Mineral Extraction (MCM/year), by Type of Treatment and Industry Group, 1996

Industry Group	Filtration	Chlorination and Disinfection	Corrosion and Slime Control	Screening	Hardness and Alkalinity Control	Other
Metal Mines	18.9	77.4	4.2	59.5	3.4	8.3
Non-metal Mines	2.9	4.6	0.4	7.9	1.9	4.2
Coal Mines	0.1	0.2	0.5	0.0	5.2	15.2
Total	21.9	82.3	5.1	67.4	10.6	27.7

Table 21
Water Recirculation in Mineral Extraction (MCM/year), by Purpose and Industry Group, 1996

Industry Group	Number of Plants	Processing	Cooling, Condensing and Steam	Other	Total Recirculation
Metal Mines	96	1,043.7	56.7	13.7	1,114.1
Non-metal Mines	47	25.2	14.3	0.8	40.3
Coal Mines	29	42.3	0.2	0.0	42.5
Total	172	1,111.2	71.2	14.5	1,196.9
Percent of Total Recirculation		92.8	6.0	1.2	100.0

Table 22
Wastewater Discharge in Mineral Extraction (MCM/year), by Point of Discharge and Industry Group, 1996

Industry Group	Public Sewer	Freshwater Body	Tidewater	Groundwater	Tailings Discharge	Transferred to Other Uses	Total Discharge
Metal Mines	2.4	473.0	1.5	11.5	82.5	2.7	573.6
Non-metal Mines	0.1	34.0	11.3	13.3	9.3	4.3	72.4
Coal Mines	0.3	15.7	2.1	1.7	6.0	0.1	25.9
Total	2.8	522.7	15.0	26.5	97.9	7.0	671.9
Percent of Total Discharge	0.4	77.8	2.2	3.9	14.6	1.0	100.0

Table 23
Wastewater Treatment in Mineral Extraction (MCM/year), by Treatment Type and Industry Group, 1996

Industry Group	Primary Methods	Two Primary Methods	Secondary Methods	Two Secondary Methods	Tertiary Methods	Two Tertiary Methods
Metal Mines	239.9	12.7	23.1	7.7	262.2	32.4
Non-metal Mines	10.7	0.0	0.1	0.0	0.0	0.0
Coal Mines	15.4	0.0	0.6	0.0	0.7	0.0
Total	266.0	12.7	23.8	7.7	262.8	32.4

Table 24
Water Acquisition Costs in Mineral Extraction ($000), by Cost Component, Industry Group, and Region, 1996

Industry	Paid to Public Utilities	At Plant Operation and Maintenance	Provincial Licence Fees	Total
Metal Mines	1,315.4	9,134.5	302.5	10,752.4
Non-metal Mines	2,961.7	1,211.7	10.1	4,183.6
Coal Mines	56.0	3,016.0	2.9	3,074.9
Region				
Atlantic	188.7	269.0	3.0	460.8
Quebec	265.5	891.1	0.0	1,156.6
Ontario	403.2	3,316.0	0.1	3,719.3
Prairies	2,866.7	5,730.9	20.9	8,618.5
British Columbia	602.9	2,688.3	159.5	3,450.8
Territories	6.0	466.9	132.0	604.9
Total	4,333.1	13,362.2	315.5	18,010.8
Percent of Total Acquisition Costs	24.1	74.2	1.8	100.0

Table 25
Total Water Costs in Mineral Extraction ($000,000), by Cost Component and Industry Group, 1996

Industry	Acquisition	Intake Treatment	Recirculation	Discharge Treatment	Total
Metal Mines	10.8	2.8	13.4	34.3	61.2
Non-metal Mines	4.2	1.4	3.0	0.1	8.7
Coal Mines	3.1	0.6	0.7	1.1	5.4
Region					
Atlantic	0.5	1.5	0.5	4.0	6.5
Quebec	1.2	0.2	0.9	9.6	11.8
Ontario	3.7	1.2	2.9	6.9	14.7
Prairies	8.6	1.4	3.6	10.2	23.8
British Columbia	3.5	0.5	7.5	2.7	14.1
Territories	0.6	0.0	1.7	2.1	4.4
Total	18.0	4.8	17.0	35.4	75.3
Percent of Total Water Costs	23.9	6.4	22.6	47.0	100.0

Table 26
Selected Characteristics of Mineral Extraction Water Use (MCM/year), by Water Use Parameter and Region, 1996

Region	Number of Plants	Employees	Intake	%	Recycle	%	Recycle Rate*	Gross Water Use	%	Discharge	%	Mine Water	Resp. to Mine Water*
Atlantic	20	9,017	205.5	39.7	759.1	63.4	369	964.7	56.2	250.7	37.3	40.7	13
Quebec	35	8,756	38.2	7.4	139.6	11.7	365	177.9	10.4	122.6	18.3	19.3	20
Ontario	40	11,900	55.5	10.7	70.5	5.9	127	126.0	7.3	79.1	11.8	12.7	25
Prairies	46	12,573	61.2	11.8	72.5	6.1	119	133.6	7.8	81.8	12.2	24.4	21
British Columbia	24	7,440	142.5	27.5	146.6	12.3	103	289.1	16.9	125.8	18.7	9.8	6
Territories	8	2,264	15.3	3.0	8.6	0.7	56	23.9	1.4	11.8	1.8	0.8	3
Total	173	51,950	518.2	100.0	1,196.9	100.0	231	1,715	100.0	671.9	100.0	107.8	88

* Recycle Rate = Recycle as a % of Intake

** No reliable mining water consumption values can be estimated due to a high level of Mine Water non-response, as well as large intake and discharge discrepancies. The later are likely due to unaccounted for Tailing Pond volume changes. Note that mining consumption values for previous Industrial Water Surveys have had the same problem, and therefore any consumption numbers therein should be used only with caution.

Table 27
Selected Characteristics of Water Use (MCM/year), in Thermal Power Generation, by Parameter and Industry Group, 1996

Industry Group	Plants	Employees (000's)	Intake	%	Recycle	%	Recycle Rate**	Gross Water Use	%	Discharge	%	Consumption	%	Cons. Rate***	Power Generation (M,Mwh)
Paper and Allied	12	0.8	79.7	0.3	35.2	0.3	44	114.9	0.3	66.4	0.2	13.3	2.6	16.7	1.7
Electrical Power	45	13.6	28,664.2	99.7	11,617.1	99.7	41	40,281.3	99.7	28,173.0	99.8	491.2	96.7	1.7	180.6
Other Thermal*	3	0.1	5.7	0.0	2.7	0.0	48	8.5	0.0	2.4	0.0	3.3	0.7	58.2	0.7
Total	60	14.5	28,749.7	100.0	11,655.0	100.0	41	40,404.7	100.0	28,241.8	100.0	507.9	100.0	1.8	183.0

* Other Thermal Industries include Primary Metal Industries and Chemical and Chemical Products. These have been combined due to privacy concerns.

** Recycle Rate = Recycle as a % of Intake

*** Cons. Rate = Consumption Rate = Consumption as a % of Intake

Table 28
Water Intake (MCM/year) in Thermal Power Generation, by Source and Industry Group, 1996

Industry Group	Fresh Water				Brackish Water			Total
	Public/Municipal	Surface	Ground	Other	Ground	Tidewater	Other	
Paper and Allied Industries	31.5	14.1	7.9	26.3	0.0	0.0	0.0	79.7
Electrical Power Industries	570.3	26,104.8	129.7	12.0	0.0	1,847.4	0.0	28,664.2
Other Thermal Industries*	0.0	5.7	0.0	0.0	0.0	0.0	0.0	5.7
Total	601.8	26,124.6	137.6	38.3	0.0	1,847.4	0.0	28,749.7
Percent of Total Intake	2.1	90.9	0.5	0.1	0.0	6.4	0.0	100.0

* Other Thermal Industries include Primary Metal Industries and Chemical and Chemical Products. These have been combined due to privacy concerns.

Table 29
Intake Water Treatment (MCM/year) in Thermal Power Generation, by Type of Treatment and Industry Group, 1996

Industry Group	Filtration	Chlorination and Disinfection	Corrosion and Slime Control	Screening	Hardness and Alkalinity Control	Other
Paper and Allied Industries	9.5	4.4	0.0	34.2	8.7	7.6
Electrical Power Industries	1,287.9	1,536.0	881.0	24,128.1	1,823.9	515.7
Other Thermal Industries*	3.3	0.0	0.0	5.7	3.3	0.0
Total	1,300.7	1,540.4	881.0	24,168.1	1,836.0	523.3

* Other Thermal Industries include Primary Metal Industries, and Chemical and Chemical Products. These have been combined due to privacy concerns.

Table 30
Water Intake (MCM) in Thermal Power Generation, by Month, by Industry Grouping, 1996

Month	Electrical Power	%	Paper and Allied	%	Other*	%	Total	%
January	2,158.1	7.5	7.0	8.7	0.5	7.9	2,198.3	7.2
February	2,266.3	7.9	6.5	8.1	0.4	7.4	2,301.8	7.6
March	2,542.9	8.8	6.5	8.1	0.4	7.5	3,900.7	12.8
April	2,274.2	7.9	6.1	7.6	0.4	7.6	2,322.0	7.6
May	2,340.7	8.1	6.2	7.8	0.5	8.5	2,371.9	7.8
June	2,423.1	8.4	6.5	8.2	0.5	8.4	2,455.2	8.1
July	2,420.4	8.4	7.3	9.1	0.6	9.9	2,433.3	8.0
August	2,622.0	9.1	7.6	9.6	0.8	13.2	2,635.5	8.6
September	2,543.1	8.8	6.5	8.1	0.3	4.8	2,568.0	8.4
October	2,450.9	8.5	7.6	9.5	0.5	9.2	2,492.4	8.2
November	2,348.1	8.2	6.1	7.7	0.4	7.7	2,389.7	7.8
December	2,359.9	8.2	6.0	7.5	0.4	7.8	2,400.1	7.9
Total	28,749.7	100.0	79.7	100.0	5.7	100.0	30,468.8	100.0

* Other includes Primary Metal Industries as well as Chemical and Chemical Products industries. These were grouped due to the small number of plants, thus limiting releasability of the industries separately.

Table 31
Water Discharge (MCM/year) in Thermal Power Generation, by Discharge Point and Industry Group, 1996

Industry Group	Public Sewer	Freshwater Body	Tidewater	Groundwater	Artificial Surface Basin	Transferred to Other Uses	Total
Paper and Allied Industries	0.0	40.0	26.1	0.0	0.3	0.0	66.4
Electrical Power Industries	60.9	26,051.3	2,029.0	0.1	2.6	29.1	28,173.0
Other Thermal Industries*	0.0	2.4	0.0	0.0	0.0	0.0	2.4
Total	60.9	26,093.7	2,055.2	0.1	2.8	29.1	28,241.8
Percent of Total Discharge	0.2	92.4	7.3	0.0	0.0	0.1	100.0

* Other Thermal Industries include Primary Metal Industries, and Chemical and Chemical Products. These have been combined due to privacy concerns.

Table 32
Water Aquisition and Intake Treatment Costs ($000,000) in Thermal Power Generation, by Cost Component, Industry Group, and Region, 1996

Industry Group	Water Aquisition			Intake Treatment	Total
	Public Utilities	Operation and Maintenance	Provincial Licence Fees		
Paper and allied products Industries	1.1	6.1	0.2	6.3	13.7
Electrical Power Industries	1.5	4.0	0.0	7,144.9	7,150.4
Other Thermal Industries*	0.2	0.1	0.0	1.8	2.1
Region					
Atlantic and Quebec**	2.0	2.5	0.0	6.7	11.3
Ontario	0.3	1.8	0.0	7,138.3	7,140.4
Prairies and British Columbia**	0.5	5.9	0.2	8.0	14.5
Total	2.8	10.2	0.2	7,153.0	7,166.2
Percent of Total Water Costs	0.04	0.14	0.003	99.8	100.0

* Other Thermal Industries include Primary Metal Industries, and Chemical and Chemical Products. These have been combined due to privacy concerns.

** Some regions have been combined for the same reason.

Table 33
Selected Characteristics of Water Use (MCM) and Economic Activity in Thermal Power Generation, by Characteristic and Region, 1996

Industry Group	Number of Plants	Employees (000's)	Intake	%	Recycle	%	Recycle Rate*	Gross Water Use	%	Discharge	%	Consumption	%	Cons. Rate**	Power Generation (M,Mwh)
Atlantic	19	2.4	2,372	8.2	201	1.7	8	2,572	6.4	2,298	8.1	74	14.5	3.1	21.9
Quebec	3	0.8	809	2.8	0.01	0.0	0	809	2.0	809	2.9	0.0	0.0	0.0	5.2
Ontario	15	9.4	23,228	80.8	7,816	67.1	34	31,044	76.8	23,224	82.2	4	0.8	0.0	97.9
Prairies	20	1.8	2,337	8.1	3,639	31.2	156	5,975	14.8	1,907	6.8	430	84.6	18.4	57.5
British Columbia	3	0.1	4.2	0.0	0.1	0.0	1	4.3	0.0	4.2	0.0	0.1	0.0	2.0	0.4
Total	60	14.5	28,750	100.0	11,655	100.0	41	40,405	100.0	28,242	100.0	508	100.0	1.8	183.0

* Recycle Rate = Recycle as a % of Intake

** Cons. Rate = Consumption Rate = Comsumption as a % of Intake

Table 34
Water Intake (MCM) in Thermal Power Generation, by Month, by Region, 1996

Month	Atlantic	%	Quebec	%	Ontario	%	Prairies	%	British Columbia	%	Total	%
January	162.6	6.9	64.4	8.0	1,733.2	7.5	197.4	8.4	0.4	10.0	2,158.1	7.5
February	152.5	6.4	59.0	7.3	1,893.4	8.2	161.0	6.9	0.4	9.2	2,266.3	7.9
March	173.4	7.3	62.1	7.7	2,112.2	9.1	194.8	8.3	0.4	8.9	2,542.9	8.8
April	182.5	7.7	60.0	7.4	1,858.8	8.0	172.6	7.4	0.2	5.3	2,274.2	7.9
May	192.4	8.1	51.9	6.4	1,943.4	8.4	152.6	6.5	0.4	8.3	2,340.7	8.1
June	194.3	8.2	66.5	8.2	2,004.7	8.6	157.3	6.7	0.3	7.7	2,423.1	8.4
July	204.0	8.6	82.2	10.2	1,932.3	8.3	201.5	8.6	0.4	8.7	2,420.4	8.4
August	220.1	9.3	85.7	10.6	2,089.1	9.0	226.8	9.7	0.3	7.4	2,622.0	9.1
September	199.1	8.4	81.4	10.1	2,034.6	8.8	227.8	9.7	0.3	7.7	2,543.1	8.8
October	229.6	9.7	77.0	9.5	1,913.7	8.2	230.3	9.9	0.4	9.1	2,450.9	8.5
November	233.3	9.8	59.0	7.3	1,853.4	8.0	202.0	8.6	0.4	8.7	2,348.1	8.2
December	228.0	9.6	59.8	7.4	1,859.2	8.0	212.6	9.1	0.4	8.9	2,359.9	8.2
Total	2,371.7		808.9		23,228.2		2,336.6		4.2		28,749.7	
% of Total	8.25		2.81		80.79		8.13		0.01		100.00	

Table 35
Water Intake (MCM/year) in Thermal Power Generation, by Industry Group and Region, 1996

Region	Paper and Allied	Other*	Electrical Power	Total	%
Atlantic	63.3	0.0	2,308.4	2,371.7	8.2
Quebec	0.0	0.0	808.9	808.9	2.8
Ontario	7.9	5.7	23,214.6	23,228.2	80.8
Prairies	4.3	0.0	2,332.3	2,336.6	8.1
British Columbia	4.2	0.0	0.0	4.2	0.01
Total	79.7	5.7	28,664.2	28,749.7	100.0

* Other Thermal Industries include Primary Metal Industries, and Chemical and Chemical Products. These have been combined due to privacy concerns.

Table 36
Monthly Distribution of Hydro Power Generation, by Industry Group, 1996

Industry Group	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Paper & Allied Industries	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.5
Primary Metal Industries	2.6	2.3	2.5	2.2	2.3	2.1	2.2	2.3	2.1	2.3	2.3	2.3	27.6
Service to Transportation Industries*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Electric Power Industries	31.6	27.8	27.9	25.6	23.2	21.4	22.6	23.8	22.3	25.4	26.8	29.0	307.3
Total	34.4	30.4	30.6	28.0	25.7	23.8	25.1	26.2	24.6	27.9	29.4	31.5	337.5
Percent of Total Generation	10.2	9.0	9.1	8.3	7.6	7.0	7.4	7.8	7.3	8.3	8.7	9.3	100.0

* Not available/ releasable due to small number of plants and privacy concerns.

Table 37
Provincial Distribution of Hydro Power Generation (millions Mwh), 1996

Province	Total Generation	%
Newfoundland	35.4	10.5
Prince Edward Island	0.0	0.0
Nova Scotia	1.4	0.4
New Brunswick	3.5	1.0
Quebec	162.9	48.3
Ontario	37.4	11.1
Manitoba	31.0	9.2
Saskatchewan	4.4	1.3
Alberta	1.8	0.5
British Columbia	59.2	17.6
Territories	0.6	0.2
Total	337.5	100.0