WATER RESOURCES STUDY

of the

PROVINCE OF NEWFOUNDLAND AND LABRADOR

for

ATLANTIC DEVELOPMENT BOARD

Volume THREE B

WITHDRAWAL WATER DEMAND

THE SHAWINIGAN ENGINEERING COMPANY LIMITED
JAMES F.MacLAREN LIMITED

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The Shawinigan Engineering Company Limited
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VOLUME THREE B

WITHDRAWAL WATER DEMAND

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11.1 General Economic Framework

In 1965 the mining sector contributed one-third of the net value of commodity production. Despite the fact that mining is the major primary resource, no smelting and refining activity takes place and concentrates of copper, lead, zinc, and iron are shipped to smelters outside the Province.

The possibilities for metallic smelting and refining operations are confined to the base metals, copper, lead, zinc, and iron ore. The rare metals, gold and silver, are by-products of the base metals production, and are drawn off at the smelting and refining stage.

11.1.1 Copper, Lead, and Zinc

There are two main reasons why smelting and refining operations have not been established in the Province - the scale necessary to support an economic operation, and the diversity of mining operations. As long as these two factors preclude the establishment of such operations, an analysis of the other factors on which their economic viability depends is academic.

Current annual levels of concentrate production on the Island are: copper - 20,000 short tons; lead - 25,000 short tons; zinc - 40,000 short tons, which fall considerably short of the smelting and refining capacities of establishments in other parts of Canada[1].

The minimum annual capacity for copper in tons of ore and concentrate for blast furnaces in Canada is 650,000 tons and for reverberators 300,000 tons. The smallest annual capacity of an electrolytic copper refinery is 170,000 short tons. The annual capacity of the only lead smelter in Canada is 600,000 tons of charge. The smallest electrolytic zinc plant has an estimated annual capacity for cathode zinc of 80,000 tons. Although the minimum economic size of a smelting and refining complex is not constant over time, the fact remains that the level of base-metal mining on the Island is not sufficient to support operations of the smallest size operation noted above.

The capacity figures at which a smelting and refining complex can operate profitably depends on a great many interrelated factors; such as, the process used; the levels of automation; wages and skills; transportation costs; market proximity; stage of development; and financial conditions. For example, the lead-zinc smelter planned by Japanese interests[2] in Peru calls for a lead capacity of 33,000 short tons per year and a zinc capacity of 55,000 short tons per year. The new smelting and refining complex using the Imperial process, which went on stream in late 1966 at Belledune, New Brunswick, has an annual capacity in the range of 50,000 short tons of zinc and 50,000 short tons of lead. Although these capacity levels are closer to the combined annual production of the mining companies on the Island, they still exceed it.

The largest operation and the only producer of all three base metals on the Island is the American Smelting and Refining Company. The output of its mines is sent to the company's smelter in Tacoma, Washington. If, however, its mining activities could support a smelter on the Island, the establishment of such a unit would not depend solely on the economics of building such an installation in Newfoundland, it would have to be weighed against the effect on the profits of the integrated operation and the effect of the withdrawal of the Buchans infeed on the Tacoma smelter. This oversimplification is used merely to stress the fact that integrated corporations operating in a number of locations measure the economic viability of operating units within the framework of their total operation. What may be critical factors or an economic scale to a company operation in a single location change when measured against a different set of criteria.

11.1.2 Iron Ore

There is a small steel company and iron foundry on the Island which is discussed in the following section.

For purposes of this report, it has been assumed that no refinement of iron ore past the concentrating and pelletizing stage will be carried out in Labrador during the forecast period.

11.1.3 Aluminum

No aluminum production is presently carried out on the Island.

The primary aluminum industry has been one of the major growth industries of the century, and Figures 5-8A and 5-8B show that the trend has not diminished in recent years. Between 1955 and 1966, North American consumption of primary aluminum increased 90 percent, while consumption in the rest of the world for which data are available increased 150 percent.

Although the consumption growth rate for the world, excluding North America, was considerably higher than that of North America, the per capita consumption was considerably lower. Given rising income levels and expanding economies, per capita consumption is an indication of market potential.

PER CAPITA CONSUMPTION OF ALUMINUM
IN SELECTED COUNTRIES - 1961[3]

	Kilograms	US Per Capita Consumption = 100
South Africa	0.6	6
Brazil	0.5	5
Canada	5.6	57
United States	9.8	100
Norway	5.0	51
France	4.4	45
Germany (West)	5.4	55
United Kingdom	5.4	55
Italy	2.1	21
Japan	2.0	20

The market for aluminum is developing around the world. Major North American producers, who have dominated the aluminum market, continue to expand their production capacities both in North America and abroad.

The aluminum industry may be divided into four distinct stages: mining, beneficiation, smelting, and semi-fabricating or fabricating. The following comments deal with the smelting stage, the transformation of alumina (AC_2O_3) to aluminum.

In the production of aluminum from alumina, the major input, other than alumina, is a large amount of electrical energy. Historically at least, low cost electricity was a powerful inducement in the location of a smelter, as the development of the industry in Canada verifies. Because of the large volumes of raw material required and the relatively high cost of moving the final produce, in addition to easy access, transportation costs must be competitive in terms of final costs.

The location of an aluminum plant on the Island could fulfill these two key requirements. Government policy could make potentially large blocks of low cost energy available. As far as transportation is concerned, Newfoundland's geographical position on the major North Atlantic shipping lanes provides relatively easy physical access to both the raw material and to the major European markets. Whether this offers an economic advantage with respect to transportation would require a detailed analysis.

If government expenditures, direct or indirect, are required to establish an industrial complex, they should be weighed against the industry's effective contribution to the economy. For example, according to Girvan[5] the contribution of an aluminum smelter to a regional economy is limited in the following sense. Because of the nature of the inputs with their high import level, the industry's demand which can be filled by the provincial economy is minimized. The industry's demand for goods, and services, tends to be confined to the labour content of value added which, in such a highly capitalized industry, does not contribute the major portion of value added. Furthermore, the "profit" portion of value added will be payable outside the Province.

11.2 Present Day Conditions

In 1968 the only metallic smelting and refining taking place in the Province was a scrap iron smelting operation in St. John's. The annual rated capacity of the plant was 60,000 tons per year. The plant came into production in September 1966, but unforeseen start-up difficulties have resulted in low levels of production which are not expected to improve much before 1969.

In 1966 the plant employed 120 men. However, production in that year was only a little over 13 percent of capacity. No data on salaries and wages, value of shipments, or value added are available. The Board provided only the value of shipments at capacity operation.

Because this is a small operation in comparison to the Hamilton or even the Sydney iron and steel complex, the application of industry average ratios can be dangerous. This is particularly true when mix of skills can alter average wages per employee. However, an assumption must be made and it is assumed that salaries and wages follow the national ratio and account for 44 percent of value added, and that value added represents 50 percent of the value of shipments.

According to the Board, the value of shipments when the plant is operating at capacity is $7.8 million in terms of 1965 dollars. At a 50 percent value added to value of shipments ratio, the value added at capacity operations would be $3.9 million. The salaries and wages bill would be $1.7 million. Taking the 1965 average wages and salaries of $6,000 per employee, employment at the plant would be 283 people.

11.3 Potential and Planned Development

11.3.1 Iron and Steel

The forecasts of activity at the existing steel plant were based on the assumption that there would be no major change in the existing rated capacity. Employment forecasts were based on a productivity increase of 2.5 percent per year from 1965 to 1981. This productivity was assumed to be reflected in salaries and wages which in 1965 were estimated to be $6,000 per employee. On this assumption, the average salary and wage in 1971 in 1965 dollars was $6,954, in 1976 - $7,872, and in 1981 - $8,904.

Employment was assumed to remain constant over the forecast period with increased productivity coming from increasing utilization of operating capacity. It was assumed that operations would be at 76 percent of capacity in 1971 and 86 percent in 1976, giving the following series in 1965 dollars:

STEEL PLANT FORECASTS 1971 TO 1981

	1971	1976	1981
Value of Shipments	$ 6.0 M	$ 6.8 M	$ 7.8 M
Value Added	$ 3.0 M	$ 3.4 M	$ 3.9 M
Wages and Salaries	$ 1.3 M	$ 1.5 M	$ 1.7 M
Employment	193	193	193

11.3.2 Aluminum Smelter

The major potential development in this sector of the economy results from the assumption that an aluminum reduction plant will be built in Newfoundland. Two possible sites are being considered for this plant, Stephenville and Bay D'Espoir.

Realization of this potential depends primarily, if not exclusively, on government policy with respect to power, its supply and cost. Power supply must be reliable as downtime caused by power outages is very expensive and it must be relatively cheap. If costs are equal, the plant location could be decided by the site offering the greatest assurance of reliable power supply.

Data on the aluminum industry are not published separately because of confidentiality. Production figures are included under the standard industries classification, smelting and refining. Because of this lack of data, statistics and general information were based on a literature search.

The input requirements of a specific plant depend on plant design and operating efficiencies. In the absence of specific details, it has been necessary to use average ratios to describe the operating characteristics which in turn may be used to calculate direct or indirect water demand.

Energy consumption depends on a number of factors: cell design, bus-bar design, and operating practices. Energy requirements can be altered by design; however, a decrease in energy requirements from the operating norm usually entails increased capital costs. The estimates of energy requirement used in the United Nations' study are based on an average demand of 20,000 kwh per ton of output. It is stressed that the 20,000 kwh ratio is an average; and that, of ten reduction plants used to illustrate energy demand, the range per ton of output was 16,800 kwh to 23,800 kwh.

The difference between the energy requirements quoted per ton of output is usually explained by the age of the plants surveyed. According to Bloch and Moment[4], improvements in the technology of aluminum metal production (rectification, cell, electrodes, and electrolyte) have reduced overall plant use of electricity per pound from the formerly quoted 10 kwh to about 7 kwh for newer plants.

The ultimate capacity of the proposed plant was rated at 225,000 tons per year. Based on information supplied by the Board, two potlines of 75,000 tons per year each were assumed to be operating by 1970 and the third potline, also of 75,000 tons annual capacity, was assumed to be on stream by 1972.

Production levels during the forecast period were based on the assumption that the two potlines would operate at 80 percent of capacity in 1970 and 100 percent of capacity in 1972. The third potline was to come on stream in 1973, at which time production would be at 80 percent of capacity rising at 2.5 percent per year to 88 percent of capacity in 1976 and 100 percent in 1981.

Energy requirements were estimated on the ratio of 20,000 kwh per ton of output. This ratio appears to be reasonable for making first estimates of energy requirements. They were also estimated at 15,000 kwh per ton of output because this ratio appeared to reflect the requirements of recently designed plants.

The value of shipments was estimated at $500 per short ton and the value added, based on the ratio provided by the Board, was calculated at 52 percent of the value of shipments.

Total employment at the complex was based on an average labour requirement of 13 manhours per ton of output at full capacity and a working year of 2000 hours. The labour input varies with the type and size of process, and it was felt that these ratios allow for total employment rather than labour input only. The labour requirement was held constant with rising production rather than decreasing employment, providing the productivity increase.

Wages and salaries were estimated at $7000 per employee in 1965, and an allowance of 2.5 percent per year was made for rising wages and salaries. The annual wages and salaries bill was based on estimated employment times average wages and salaries per employee.

The assumptions outlined above are summarized in the following table and in Figure 11-1:

ALUMINUM INDUSTRY 1970 - 1981

	1970	1971	1972	1976	1981
Production (short tons)	120 M*	150 M	180 M	200M	225 M
Energy (billion kwh)					
at 20,000 kwh (ton)	2.4	3.0	3.6	4.0	4.5
at 15,000 kwh (ton)	1.8	2.3	2.7	3.0	3.4
Value of Shipments (1965 dollars)	$65.0 M	$75.0 M	$90.0 M	$100.0 M	$112.5 M
Value Added (1965)	33.8 M	$39.0 M	$46.8 M	$ 52.0 M	$ 58.5 M
Employment	780	975	1170	1170	1170
Wages and Salaries (1965 dollars)	$ 6.2 M	$ 8.0 M	$ 9.7 M	$ 10.7 M	$ 12.2 M

* Thousands

It is noted that the energy requirements shown above are inconsistent with the given power assumptions summarized as follows:

	1971	1976	1981
Megawatts	--	480	600
Billions of kwh	--	3.32	4.26

The primary inconsistency is in the given timing of the smelter start-up and energy availability. A secondary problem is the demand level and supply deficiency. These two inconsistencies are illustrated in Figure 11-2. The Board have stated that for the time being "the discrepancy between the output and the schedule of energy demand must be reconciled by the assumption that thermal power will be provided".

Without further diversification into some forms of secondary manufacturing, the major contribution to the economy of the Province will be expressed in the employment generated directly and indirectly by the industry and through the wages and salaries it provides. The other major contribution would be through the energy sector.

11.4 Specific Water Demand and Wastewater Releases

The analysis in Section 11.3 has indicated that the new developments in smelting and refining which could occur in the Province are in the field of aluminum and, less probably, in steel production. As production of aluminum may begin within the study period (1968-1981), attention was paid to such a possibility. Large scale steel production is unlikely to start before 1981. Some indications on specific water demand in the steel production industry under present conditions in the Island are given in Section 11.5.1.

11.4.1 Water Demand for Production of Aluminum from Alumina

The specific water demand for this industry as well as the wastewater characteristics could be estimated in a general way only since the data available were insufficient for meaningful statistical processing or other interpretation.

11.4.1.1 Intake Water Demand

As the literature survey summarized in Volume Eight, Appendix B, Part V, indicates, specific intake water demand of fresh water for the production of aluminum from alumina varies between 1 and 30 gallons per pound of aluminum. However, when a plant is located near the ocean, it may use up to 90 gallons of sea water and 10 gallons of fresh water per pound of aluminum. From this it may be assumed that the optimum intake demand might be higher than 30 gallons per pound.

Since scale formation and corrosion can increase investment, operation, and maintenance costs, it appears that the use of good quality fresh water in excess of the 30 gallons per pound limit indicated above could be a definite advantage. Furthermore, the survey has indicated that, in conditions of ample water availability, an amount of 24 gallons per pound of aluminum is used for gas scrubbing and 8 gallons for transformer and rectifier cooling (second largest use) per pound of aluminum.

Since literature indicates that these two uses together represent in average 84 percent of the total use, it may be concluded that a water intake of 40 gallons per pound would represent a value close to the optimum demand. Other important water uses, apart from potable water, is for boiler feed (one gallon per pound of aluminum) and for the electrode plant (about 0.5 gallons per pound of aluminum). When water availability decreases, the optimum restricted demand also decreases. The optimum restricted water intake demand has to be determined according to the specific condition, by comparing possible alternatives of re-use and recycling.

The literature survey has not produced sufficient data to estimate by statistical analysis how water intake varies with cost of water or other factors.

11.4.1.2 Quality of Intake Water

The literature survey did not indicate the existence of norms or standards for the water used in this industry.

The quality problems related to the water used for gas scrubbing and cooling are the turbidity, the scale forming, and corrosive properties.

The portion of the water intake used for special purposes (potable water, boiler feed, electrode plant) has to satisfy specific requirements and is generally treated before use.

11.4.2 Quantity and Quality of Wastewater from the Production of Aluminum from Alumina

The quantity of wastewater is approximately equal to that of intake water minus water lost by evaporation which is significant only when recycling of cooling water is used, and the losses by evaporation can be very high. For example, a survey by Conklin[1] indicated that in some cases the amount of wastewater represented only 20 percent of the intake water. Presumably this is achieved by extensive recycling which increases the evaporation losses.

The main quality changes in the characteristics of the wastewater compared to those of the intake water are:

a) Increased temperature.

b) Increased fluorine content (0.03 lb of fluoride per pound of aluminum is used and between 0.01 and 0.02 lb of fluorine per pound of aluminum is found in the effluent as HF);

c) Increased chlorine content (when chlorine is used in casting operations for purging).

There are no readily available data which defines the temperature changes numerically or the amounts of chemicals other than fluorine. Mention should also be made here that, when corrosive water is used for cooling, chemical additives such as polyphosphates may be used to reduce corrosion. Nitrates and tannins are also added occasionally to the cooling water for metallurgical reasons (to prevent caustic embrittlement). These additives may have a polluting effect since they may eutrophy the receiver.

Since there are no complete data on the amount of chemicals included in the wastewaters, it is difficult to assess treatment requirements. If the amount of fluorine in the water is considered a criterion, and Klein[7] indicates that a concentration of over 300 ppm is toxic for fish (rainbow trout), it may be presumed that 15 ppm would be harmless. In this case the treatment required would be a 95 percent removal of fluorine which could only be accomplished with both primary and biological treatment. Further effluent polishing would be necessary to reduce the effluent concentration of fluorine to a level satisfactory for drinking water purposes.

11.5 Present and Forecast Water Demand and Wastes

Present day water demand and use for smelting and refining is confined to that for the St. John's Steel Company Limited, and as such has only local significance. Future development of this industry could be influenced to some extent by the availability of a good quality water supply.

11.5.1 Present Day Water Demand and Waste Releases

The St. John's steel mill is a scrap operation with a 25-ton electric furnace, a two-strand rolling mill, a 30-ton per hour reheat furnace, a 10-ton per hour ball mill, and a forging furnace and quench tank. The production assumption supplied by the Board is that this operation will produce 60,000 tons of steel a year.

According to the Shawinigan-MacLaren questionnaire submitted to the company, the present capacity of the water system is 6000 gpm, or 8.6 million gpd on a 24-hour operating basis. It is noted that the water is used for cooling and is recirculated, but no information was available on recirculation practices.

The plant has its own water system and the supply is drawn from Octagon Pond near the upstream end of the Topsail River basin immediately to the west of Donovans. The cooling water is returned to the pond via Rock Pond. Domestic water requirements are drawn from an artesian well with a capacity of 15 gallons per minute and is chlorinated.

If it is assumed that the plant operates 350 days of the year, the daily production would be in the order of 170 tons per day. The water usage per ton of output, with the water system operating at capacity, would be 51,000 gallons. This figure is within the limits suggested by the literature which indicated a wide range of use depending on the types of processes used, on the level of integration, the level of technology, and the recirculation practices. This range is 1000 to 55,000 gallons per ton. The cooling water has increased temperature and other quality changes, but data are not available on the actual extent of these changes. Since the plant has a quench tank which probably involves the use of oil, this may be considered as an additional source of pollution. An indication of the wastewater characteristics of such mills is found in Reference 8.

According to Reference 8, a rolling mill producing 1915 ingot tons per day and using old technology releases a wastewater flow of 7.08 million gpd containing 90,300 pounds of suspended solids and 5890 pounds of lubricating oils. While the Newfoundland mill began production in September 1966, its size and the information available on its equipment indicate that it would be classified as old technology in the reference study.

11.5.2 Future Water Demand and Waste Releases

At the time of writing, no expansion was planned for the existing steel mill. Therefore, the only problems which could occur over the study period would be confined to those resulting from changes in operating practices.

The only significant development to be considered within the study period is an aluminum smelter having an ultimate capacity of 225,000 tons per year. The optimum demand for the smelter, according to the considerations included in Section 11.3, would be about 50 million gpd (92 cfs) at this capacity. For the initial capacity of 150,000 tons per year, the corresponding demand would amount to 34 million gpd.

This high rate of water intake assumed no cooling water recirculation. In this case, the wastewater flow will almost be of the same magnitude as the intake water. If no wastewater treatment is used, the wastewater will include when the plant is working at full capacity:

About 26,000 pounds of fluorine per day.

A certain amount of chlorine and other chemicals.

If the fluorine toxicity to fish (rainbow trout) is taken as a criterion for dilution requirements as stated in Section 11.4.2, expensive wastewater treatment will be required.

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NEWFOUNDLAND
ENERGY DEMAND AND SUPPLY FOR ALUMINUM COMPLEX
1970 - 1981

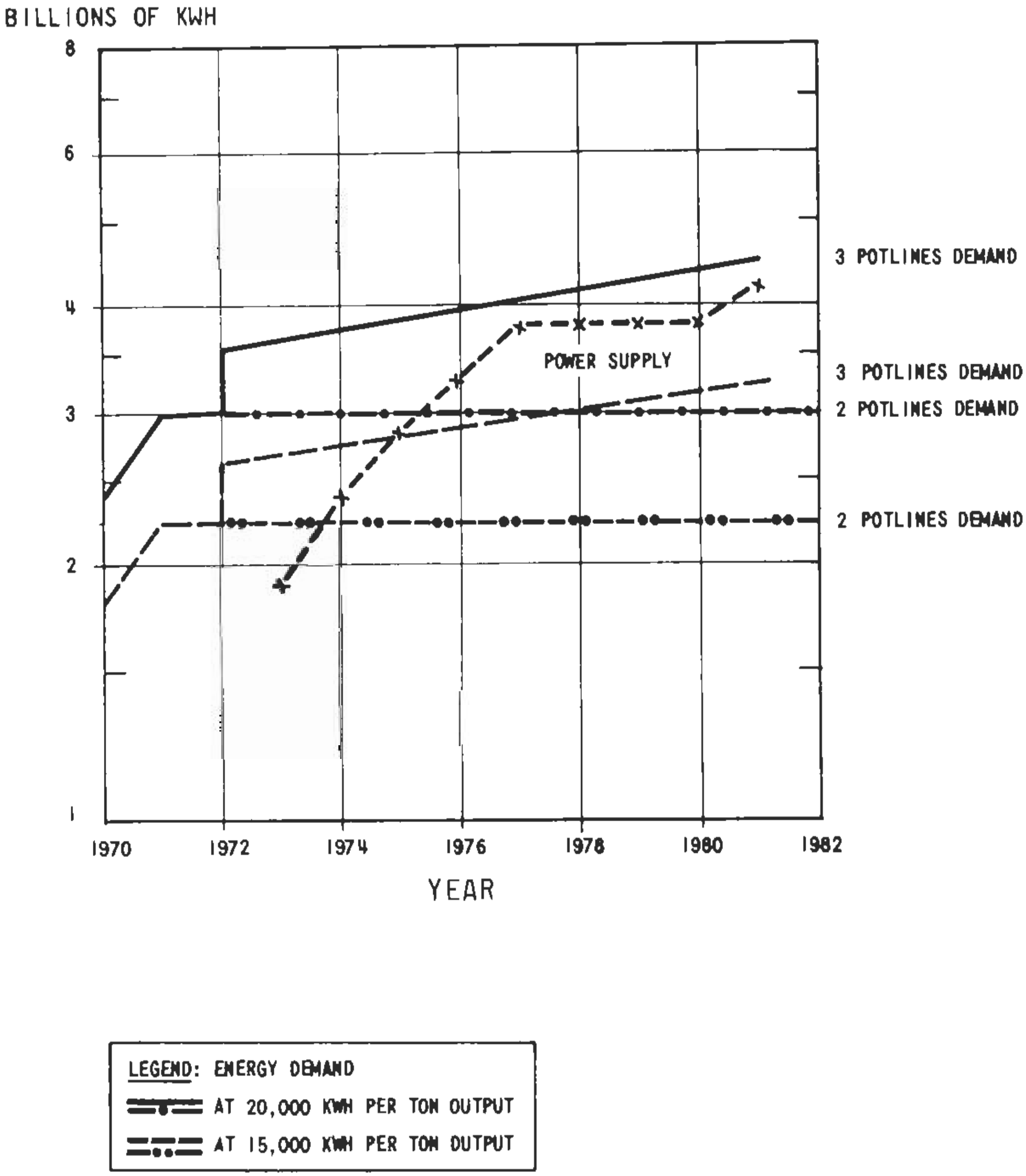
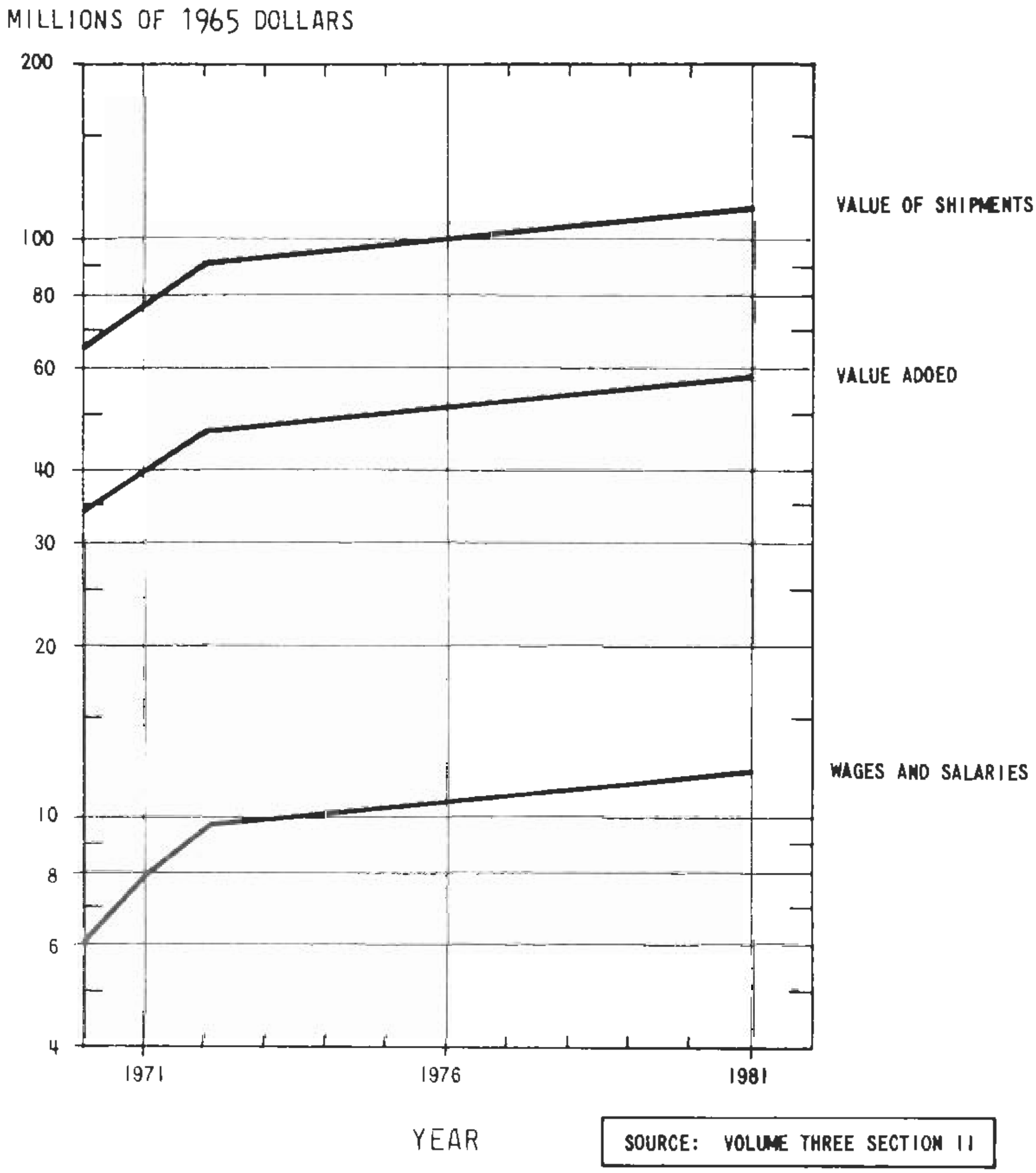


FIGURE 11-1A

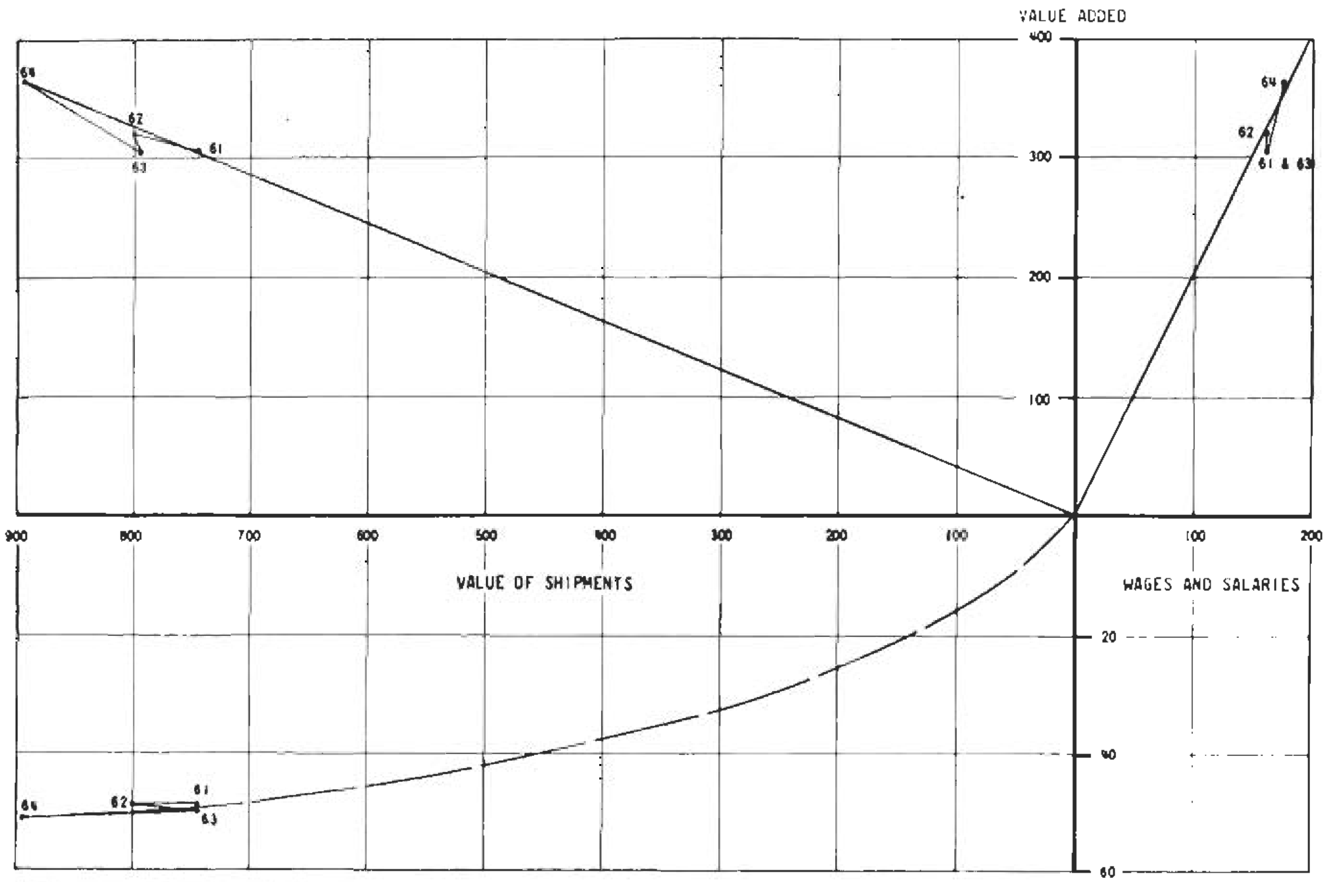
NEWFOUNDLAND
ESTIMATED FUTURE DEVELOPMENT IN PRIMARY ALUMINUM PRODUCTION



SOURCE: VOLUME THREE SECTION II

FIGURE II-1B

RELATIONSHIP BETWEEN ECONOMIC FACTORS IN SMELTING AND REFINING OF METALS (TOTAL ACTIVITY) CANADA



SOURCE: DBS CAT. 31 - 203
NOTE: ALL UNITS IN MILLIONS OF DOLLARS

FIGURE 11-2

NEWFOUNDLAND
PRESENT AND ESTIMATED FUTURE WATER DEMAND BY RECENTLY ESTABLISHED AND PROPOSED MAJOR NEW INDUSTRIES EXCLUDING PULP AND PAPER AND MINING

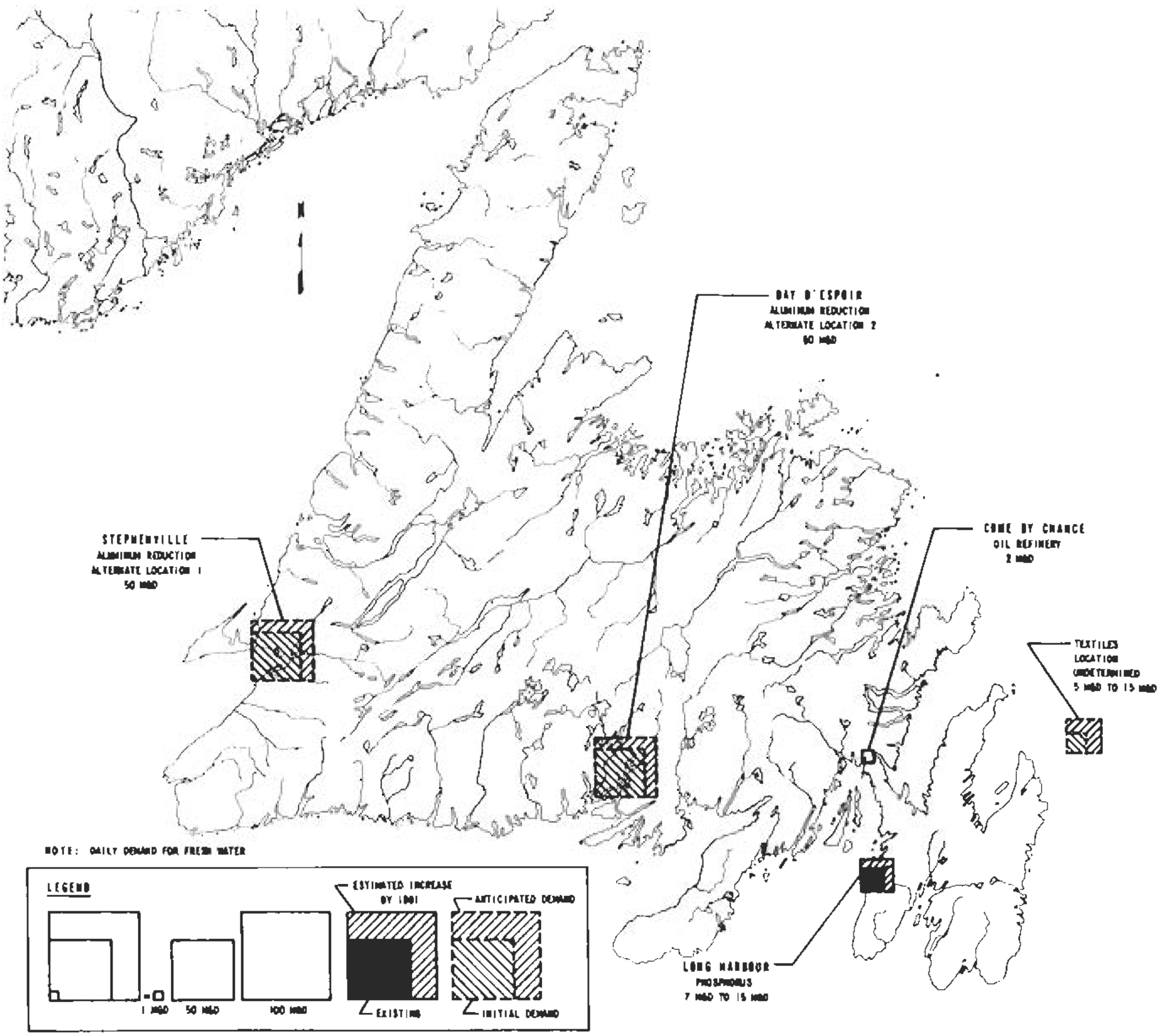


FIGURE 11-3

12 SMELTING AND REFINING (Non-Metals)

12.1 General Economic Framework

Discussion in this section is confined to the construction at Long Harbour of a phosphorus plant which is designed to use an electric reduction process. In provincial terms this will be an import/export industry. The major inputs for this industry are phosphate rock, quartz, coke, and electricity, and of these inputs the phosphate rock and coke will be imported. At the present time it is planned that all production will be shipped to markets outside the Province.

The main reason for this industry locating on the Island is the availability of relatively cheap electric power. A secondary inducement was the potential harbour facilities adjacent to the site which would provide an all-weather port. The availability of quartz appears to be a tertiary incentive and this alone would not be a location inducement. Such facilities are important because of the import/export nature of the industry.

12.2 Present Day Conditions

The phosphorus complex being constructed at Long Harbour is expected to be on stream by October 1968. Because very little operating data are available a brief description is given of the process to be used[1].

The phosphate rock will be brought in from Florida in 30,000-ton vessels capable of self-unloading at the rate of 2000 tons an hour. The ore will be kept in storage until required, when it will be fed to the ball mill where it will be pulverized. From the ball mill the powder will move to large rotating pans where the addition of water will form it into pellets about half an inch in diameter. The pellets are then fed, together with coke and quartz, into the top of the electric furnace whose design capacity is 75,000 kw. The coke, acting as a chemical reducing agent, releases the phosphorus. The quartz, acting as a fluxing agent, combines with the balance of the phosphate ore and produces a fluid slag which will be tapped from the furnace.

Phosphorus distills as a vapour which is cooled to give liquid phosphorus. Because it burns in air, it must be kept under water at all times. The liquid phosphorus will be pumped from storage to tankers capable of carrying 5000 tons of phosphorus.

Although the phosphate and coke infeeds will be imported, the quartz requirements will come from the quartz quarry at Villa Maria, near Placentia. It will be trucked to the plant where a small storage facility will be constructed. The annual requirement is estimated to be 200, 000 tons.

12. 3 Potential Development and Known Expansion

The potential development of this industry depends not only on industry trends and the evolution of world markets, but also on the availability of additional low-cost power. Supported by both industrial and agricultural world markets, the outlook for the operation appears strong during the forecast period.

Operating details and estimates of operating levels during the forecast period are not available in detail. However, both furnaces are expected to be on stream by the end of 1968. Provision has been made for a third furnace which, according to the power assumptions, may be in operation by 1972. Only nominal annual growth is anticipated between 1972 and 1981.

Forecasts provided by the Board (Table 5-1) estimated that the annual output will be 70, 000 tons of phosphorus and 800, 000 to 1 million tons of phosphate pellets, and that the plant will employ between 250 and 300 persons with an annual wages and salaries bill of $2 million.

12. 4 Specific Water Demand and Wastewater Releases

There are no readily available data on the unrestricted specific water demand for the phosphorus electric reduction operation. The probable specific water demand for this industry was determined from the ERCO plant questionnaire data, the study for the water supply for the same plant[2], and data from a similar industry in Quebec.

The data obtained from a plant in Quebec producing phosphorus from the same type of phosphate rock as that used at the Long Harbour plant indicates a specific use of 5 gallons of water per pound of phosphorus produced, with a loss by evaporation of about 20 percent. However, these data refer to a plant which has no pelletizing facilities, and where the cooling and scrubbing takes place as a once-through operation.

In the new Long Harbour plant, according to the information available, the water used for scrubbing and condensing the phosphorus will be recirculated and cooled with heat exchangers, through which the cooling water circulates. In addition, pelletizing will be carried out not only for the supply of the plant, but also for export. It can therefore be presumed that the specific water demand will be higher by some 50 percent than that used at the Quebec plant.

The indirect cooling system permits the alternate use of sea water provided that adequate measures to avoid corrosion, slime, and organic growth are taken.

Specific water demand for pelletizing is not known, but the plant expects to use an average total of 8 million gpd of fresh water for the operation of two furnaces, with occasional peaking up to 12 million gpd.

Wastewater from the phosphorus production would probably represent considerably more than 80 percent of the intake water, as was the case for the direct once-through cooling since the lower cooling efficiency is probably related to lower evaporation. Comparisons with other cooling systems would indicate that the wastewater would represent 90 to 95 percent of the intake water.

Little is known about the quality of the wastewater. However, it may be inferred that, in addition to the temperature changes, the water used for cooling also includes additives required to reduce corrosion (polyphosphates or ammonia). No data are available on the amount of heat, the temperature differential, or the real amount and chemical characteristics of additives to check corrosion and growth.

While the wastewaters from the phosphorus plant are expected to be conventionally clean because of the indirect cooling system used, the wastewaters used in the pelletizing process probably include a fair amount of suspended solids, and the phosphates included may generate eutrophication problems. Because the plant was not in production data on the characteristics of these wastewaters were not available. The lack of data on wastewater makes any kind of estimate of wastewater dilution demand impossible, but from information obtained at the plant an amount of about 6 million gpd of sea water will be introduced into the effluent before it is discharged into Long Harbour. Under present plans no fresh water will be used for effluent dilution.

12.5 Present and Forecast Water Demand and Wastewater

The ERCO phosphorus plant at Long Harbour has an intake capacity of about 12 million gpd of fresh water, plus a pumping capacity in the order of 10 million gpd of sea water.

Information regarding the pelletizing demand is lacking, and the whole matter of water demand at this plant requires considerable information before any definite figures can be given. According to the design studies available, the plant would ultimately require a fresh water supply of about 12 million gpd and roughly the same amount of sea water. In view of the water usage at the Varennes, Quebec, plant this demand appears to be rather high.

Little is known about the actual composition of the waste-waters. If the by-products (ferro-phosphorus and slag) are recovered and there is no direct contact between the circulating, condensing, and scrubbing water, little pollution can be expected from the phosphorus production process. However, the pelletizing process may produce some pollution due to some inert and phosphate rocks, but the amount of these wastes is not known.

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13 OIL REFINING

13.1 General Economic Framework

The only oil refinery in the Province, at Holyrood, serves the domestic market and a proposed refinery at Come By Chance will operate primarily in the world markets.

The existing refinery appears to supply approximately 40 percent of the total provincial market. This estimate is based on a comparison of domestic disappearance and inter-provincial movements into the Province[1]. Although production figures are not available, the refinery would appear to supply the major portion of heavy and light fuels consumed; and the demand for other petroleum products, such as kerosene and diesel fuel, appears to be supplied by an inward provincial movement.

13.2 Present Day Conditions

The oil refinery at Holyrood has a crude capacity of 11,000 barrels a day[2]. Because this is the only provincial establishment in the oil refining industry, no data on its operations are published by DBS. The information given below was obtained from a questionnaire circulated by the consultants.

In 1966 the firm employed 87 people on its permanent staff.

Of the daily production of 10,000 barrels (35 imperial gallons per barrel), the product mix is 56 percent bunker oil, 18 percent gasoline, and 26 percent stove and furnace oil. In 1966 the actual production in thousands of barrels was: gasoline - 657, bunker oil - 2040, and stove and furnace oil - 949.

13.3 Potential and Planned Development

A 100,000 barrel per day refinery is proposed for the Come By Chance area and will include a 10,000 barrel per day cat reformer and a 52,000 barrel per day hydrocracker[3]. The $40 million grassroots refinery is part of a $97 million petrochemical complex[3]. Details concerning this complex are not finalized.

At the end of June 1968, the Provincial Government announced that a ten-year contract has been negotiated with the British Petroleum Company of London for the supply of 100,000 barrels of crude oil a day.

The refining route has not been finalized, although a possible route would produce 65 percent jet fuel plus motor and distillate fuels. It is assumed that much of the heavier residual fuel will be used on site. The possible uses would be either as fuel for the paper mill power plant, or as feed-stock and fuel for a hydrogen plant. The hydrogen plant would serve both the "all-hydrogen" refinery and the proposed ammonia plant[4]. The new thermal power plant at Holyrood is another possible market for residual fuel.

The viability of this refinery depends on the ability of the firm to establish itself in the highly competitive American and European markets. The production capacity is far in excess of any domestic provincial demand. The establishment of the oil refinery is a possible inducement for the location of chemical industries using potential by-products such as the possible ammonia complex.

No chemical firm has yet announced intentions of locating at Come By Chance, although such a development would also influence the economics of the refining operation by providing a captive market for benzene or some other aromatic which could be extracted from a naphtha distillate[5].

The forecasts shown below and in Figure 13-1 are calculated from the forecasts of value of shipments and value added provided by the Board which assume operations at 100,000 barrels per day capacity in 1981. The growth between 1971 and 1981 in terms of 1965 dollars was estimated for both series to be at the rate of 2.5 percent a year. Wages and salaries are estimated to be 25 percent of value added during the forecast period. Employment is estimated on the basis of average wages and salaries in 1971 per employee of $10,700 in 1965 dollars. Employment is assumed to be constant over the forecast period at a level of 500 employees.

Potential Oil Refinery Forecast in 1965 Dollars

	1971	1976	1981
Value of Shipments	$100.0 M	$114.0 M	$127.0 M
Value Added	$ 21.5 M	$ 24.2 M	$ 27.4 M
Wages & Salaries	$ 5.3 M	$ 6.0 M	$ 6.8 M
Employment	500	500	500

The forecast growth of the existing oil refinery was provided by the Board for value of shipments and value added. Employment for the base year 1965 was provided. Future employment levels were calculated on the basis of a 2.5 percent productivity increase. These forecasts are summarized in Figure 13-1.

The decrease in employment between that reported in Section 13.2 and that shown on the following table reflects increasing productivity between 1966 and 1971.

Existing Refinery Forecast in 1965 Dollars

	1971	1976	1981
Value of Shipments	$14.3 M	$18.3 M	$23.2 M
Value Added	$ 2.8 M	$ 3.5 M	$ 4.5 M
Wages & Salaries	$ 0.7 M	$ 0.9 M	$ 1.2 M
Employment	69	78	88

No details were available on the relationship between the value of shipments and existing levels of production. However, using a ratio of annual value of shipments to a per barrel day capacity, an estimate can be made of the capacity implications of the forecast.

The 1981 forecast, in 1965 dollars, indicates an increase in capacity in the order of 5,000 barrels a day over the existing capacity. This is not a precise measurement, but an indication that additional demands for water will probably materialize.

13.4 Specific Water Demand and Wastewater

Because of its large share in water usage in several countries, especially in the United States, the water demand for oil refineries has been the subject of considerable study. Most studies are regional in character and water demand estimates for a specific refinery made on such a basis should be considered as representing only a first approximation. Defining specific wastes released by a refinery (for example, wastes per barrel of crude oil) is an even more difficult task since the specific design of the refinery, the type of crude oil, the by-product recovery, and the relationship with nearby chemical plants are factors which decisively influence the amount and chemical composition of the wastes. Therefore, the indications on specific waste releases included in the study should be considered as a rough estimate only.

13.4.1 Specific Water Demand

Statistical analysis of the regional average data available in the US has yielded a significant relationship between process water usage, refinery size, and water availability. However, because the data were very restricted (only nine regions reporting water usage for refineries), the results of this statistical analysis are not reported in this study. Further and more detailed investigation is recommended on this subject.

The literature survey reported in Volume Eight, Appendix B, Part VI, has indicated that the water usage in refineries varies between 85 and 850 gallons per barrel, with an average of 330 gallons; most of the variation results from water availability, process used, type of cooling, re-use and recycling, and the quality of water. The figure for the existing refinery in Newfoundland is close to the average (300 gallons per barrel).

Average water usage is 91 percent for cooling, 5 percent for boiler feed, and 4 percent for plant sanitation and other miscellaneous uses. According to one survey, the refineries would use 6.6 times as much fresh water if it were available as they actually do at present. Assuming that no recycling is done, the average amount of water used would be about 1000 gallons per barrel, which indicates the size of the unrestricted demand.

The cooling water can be of low quality (salt or brackish), whereas the remaining requirement for boiler feed and other uses is for fresh water of good quality and should be treated accordingly. For details on water quality requirements, see Volume Eight, Appendix B, Part VI.

A more specific indication on water demand can be obtained from Bower[7], who gives a relationship between refinery complexity (the number of times more complex a refinery is than one which has only a simple crude distillation unit) and clean water demand per barrel (cooling plus process water) and this is reproduced in Figure 13-2. The probable relationship between complexity and size of refinery obtained from the same reference are also included in this figure.

Average gross cooling water requirements by type of process used are given by Mohring and Boyd[8].

13.4.2 Specific Wastewater

Recent literature[9] indicates that advances in technology will reduce cooling requirements which include the use of finned tube coolers and the use of computers in the product flow. A decrease by 50 percent of process water used in newer technology refineries is also indicated by this study. A detailed discussion on wastewater sources, quantity and quality, and treatment techniques is given in Volume Eight, Appendix B, Part VI.

The wastewater from cooling, unmixed at any stage with the remaining water, will be subject only to losses by evaporation and to increased temperature. For once-through cooling, changes in water quantity are minor since the losses are of the order of 5 to 20 percent of the total amount. Increases in temperature are a function of the process and recirculation pattern. However, if water is recirculated (this is frequently done when fresh water is used for cooling), losses may go to over 95 percent of the intake water and the quality of the water released would be very low in the sense that the dissolved solids content would have been considerably increased. The finned tube coolers which transfer heat from the water to the air by convection and radiation may reduce much of this problem.

The process wastewaters include different amounts of various chemicals, depending on the nature of the crude oil, technological process use, and other factors (Volume Eight, Appendix B, Part VI). The main pollutants are oil, sulphides, and phenols. The specific amount of these pollutants (pound per gallon of wastewater) varies widely. However, from data available at refineries in the United States and Canada, given by Mohring and Boyd[8], it was possible to estimate graphically a relationship between the amount of sulphides, oil, and BOD (Figure 13-3)* after in-plant primary treatment, and total wastewater flow. This could be used for preliminary estimates of these pollutants in refinery wastewaters in the mentioned conditions.

For phenols, it was not possible to estimate such a relationship because of the large scatter of points. From the data available[8], it appears that the content varies between about 60 pounds per million gallons of water and over 2600 pounds per million gallons. According to Mohring and Boyd[8]: "These data should be interpreted cautiously. Waste generation rates of a given refinery are subject to variation, for example, as the output mix is altered and as the crude characteristics change. The authors did not always clearly specify the sources of the water to be treated, the degree of in-plant, primary treatment performed, or the operating conditions yielding the waste flows cited. The data for the different refineries may not, for these reasons, be directly comparable. Nevertheless, these are the only data of this kind that have been published.

"It should be noted that waste flows "in" to the biological treatment units are not the untreated flows from process units, but represent wastes after primary, in-plant treatment. Sour condensates containing high sulfur concentrations have thus been stripped of a large part of these acids, along with some phenols and, thus, BOD. Oily waters have been routed through an oil separator, removing some phenols, sulfides and BOD along with oil. This primary treatment is necessary before any degree of biological treatment is undertaken. Furthermore, conversation with refinery engineers indicate that the

* The authors point out that the table used summarizes the data on refinery waste load characteristics found in their references. The flow refers to process water only, and the physical units of waste recorded there were calculated in most cases by multiplying this flow by the reported concentrations. Where reported by the original source, data on oil, BOD, phenols and sulfides are recorded, both before and after biological treatment. Whenever more than one figure was reported for waste concentration or flow, the average was used. If only a range of figures was reported, the midpoint was used.

optimal level of at least sulfide stripping is very inelastic with respect to the level of biological treatment, because of the bactericidal properties of any but the smallest concentrations of sulfur compounds.

"It should not be inferred that these refineries are typical with respect to degree of treatment. On the contrary, given the political sensitivity of the subject, it is likely that only those refineries with exceptionally below-average pollution discharges would publicize their records. It should be kept in mind also that the articles in question were addressed to the engineering profession with the aim of reporting advances in waste treatment techniques, not the average of current practice. For these reasons, it is likely that the post-primary treatment waste load generation would be more representative of future refinery opeartions than of a past era subject to a far lesser degree of pollution regulation."

A detailed breakdown of the waste loadings and wastewater volumes associated with fundamental processes in older, typical and newer refineries is given by Bower[7] and reproduced in Table 13-2.

13.5 Present and Forecast Water Demand and Wastewater

13.5.1 Present Water Demand and Wastewater

The existing refinery at Holyrood is using on average 3 million gpd of water, of which about 0.4 million gpd is fresh water and the remaining 2.6 million gpd is sea water. The fresh water is treated to correct the pH to the 6 to 7 range, and is used as process water and for sanitary purposes. Sea water is used for cooling.

The wastewaters have a temperature of about 70 deg F, and are lagooned before disposal. There are no further indications available about the quality of wastewaters. From Figure 13-3 and the discussion included in Section 13.4.2, it may be estimated that these wastewaters contain about 100 pounds of oil per day, 400 pounds of BOD per day, and 20 pounds of sulphides per day.

13.5.2 Forecast Water Demand and Wastewater

By 1981 the existing Holyrood refinery is assumed to expand to about 230 percent of its present capacity. In addition, a propane plant is planned in the near future. Since increased capacity will probably also mean increased complexity, it can be assumed that this expansion will require a proportional increase in the fresh and sea water demand. (The propane plant alone requires an additional 0.15 million gpd of fresh water.) There will be no problem in obtaining the additional amount of sea water.

A proportional increase in wastewater and pollutants can also be expected if no additional treatment is introduced. According to the graph mentioned in Section 13.4, the expanded refinery might release in the wastewaters, after primary treatment, at least about 200 pounds per day of oil, 40 pounds per day of sulphides, about 800 pounds per day of BOD, and between 30 and 1300 pounds per day of phenols.

The new refinery to be located at Come By Chance can be expected to require between 13 and 33 million gpd (total demand). The higher figure would correspond to the indication given by Bower [7]: assuming the highest complexity recorded for this size of refinery, the other would correspond to the average demand and to slightly more than the specific demand of the existing Holyrood refinery. Since fresh water demand represents about 10 percent of the total demand, this would indicate a fresh water demand of 1.3 to 3.3 million gpd. In the light of these considerations, the design data included in the ShawMont Report SM-2-68[10] of 2.0 million gallons per day appears reasonable.

The amount of wastes, after in-plant treatment and assuming process (fresh water) usage of about two million gpd, would represent per day at least about 1300 pounds of oil, 170 pounds of sulphides, 2200 pounds of BOD, and between 100 and 4400 pounds of phenols. Oil recovery and biologic treatment could probably reduce these wastes by more than 95 percent.

Of course, in estimating the wastewater flow and the main characteristics of the planned oil refinery, its technologic process input and output are basic factors, and these were not available at the time of writing this report. Therefore, in Table 13-1, which is reproduced from Reference 9, detailed data on wastewater flow and main characteristics for a refinery of 100,000 barrels per day are given for each fundamental process. This could be used later, when the refinery plans become more definite, to estimate the probable flow and main characteristics of the refinery wastewaters.

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NEWFOUNDLAND
ESTIMATED FUTURE DEVELOPMENT OF THE OIL REFINING INDUSTRY

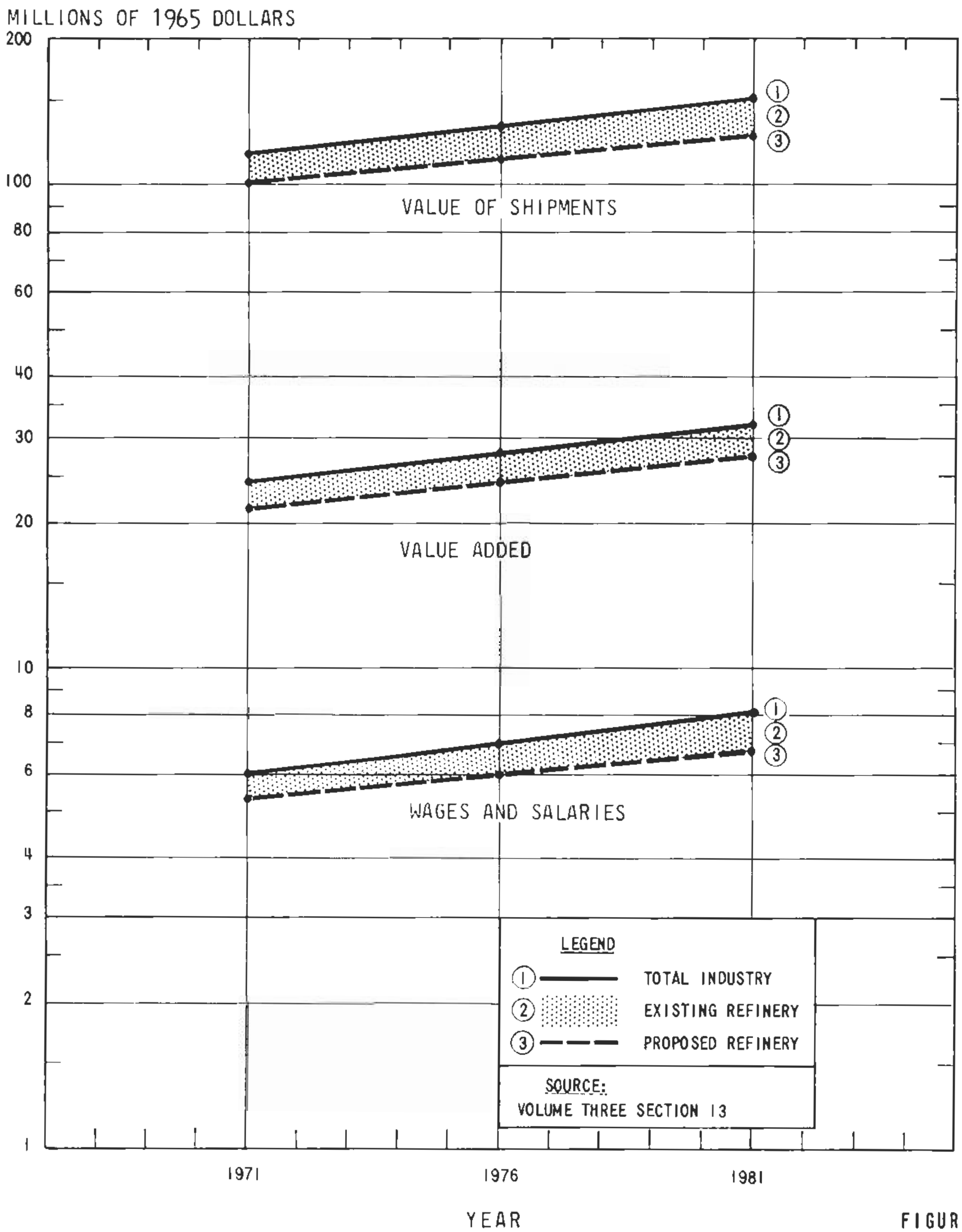
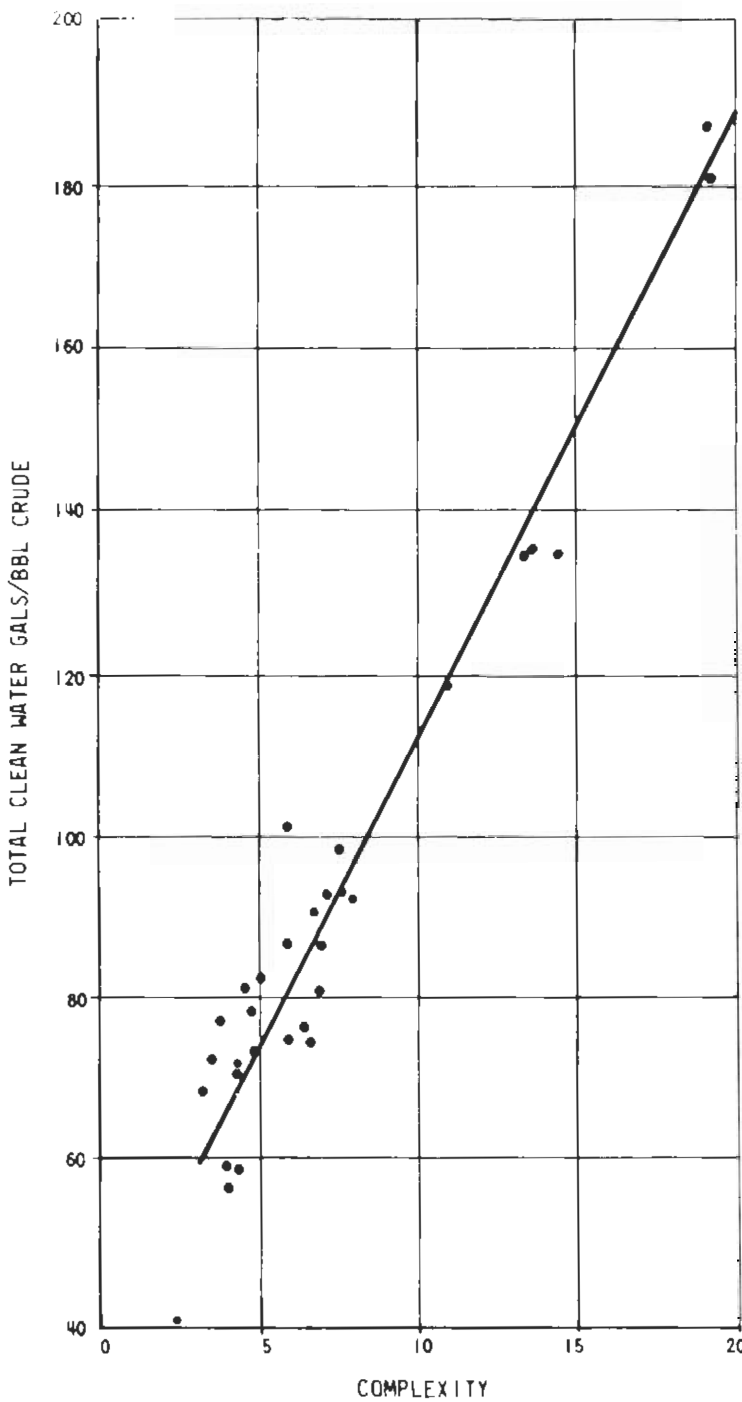


FIGURE 13-1

RELATIONSHIP BETWEEN REFINERY COMPLEXITY AND CLEAN WATER REQUIREMENTS



REFINERY COMPLEXITY IN RELATION TO CRUDE CAPACITY		
CRUDE CAPACITY	REFINERY COMPLEXITY 1	
	MEAN	RANGE
20,000 (PRODUCING LUBES AND SIMILAR PRODUCTS)		
AS OF 1/1/60	22.9	6.9 - 39.9
AS OF 1/1/65	21.2	3.2 - 49.0
20,000 (NOT PRODUCING LUBES AND SIMILAR PRODUCTS)		
AS OF 1/1/60	3.3	1.0 - 17.5
AS OF 1/1/65	3.5	1.0 - 13.4
20,000 - 50,000		
AS OF 1/1/60	6.2	1.0 - 12.2
AS OF 1/1/65	6.6	1.7 - 11.1
50,001 - 80,000		
AS OF 1/1/60	7.1	1.5 - 12.3
AS OF 1/1/65	7.5	4.4 - 11.3
80,001 - 120,000		
AS OF 1/1/60	7.2	5.0 - 12.3
AS OF 1/1/65	8.0	4.9 - 13.0
120,001 - 200,000		
AS OF 1/1/60	7.5	4.3 - 11.9
AS OF 1/1/65	8.5	5.2 - 13.7
200,000		
AS OF 1/1/60	8.5	6.0 - 10.4
AS OF 1/1/65	9.8	9.0 - 11.7

1. BASED ON NELSON, W.L., 1961, HOW TO COMPUTE REFINERY "COMPLEXITY", OGJ, 59, 25, P. 109

SOURCE OF DATA: ANNUAL SURVEYS OF REFINERY CAPACITY

SOURCE: NELSON, W.L., 1963 CLEAN WATER NEEDS OF REFINERIES OGJ VOL. 61 NO. 3

FIGURE 13-2

TABLE 13-1

OIL REFINERIES
WASTE LOADINGS AND WASTEWATER VOLUMES ASSOCIATED WITH FUNDAMENTAL PROCESSES IN OLDER, TYPICAL, AND NEWER 100,000 bpsd REFINERIES.

Fundamental Process	Older Technology					Typical Technology					Newer Technology				
	Process Capacity 1000 bpsd	Flow mgd	BOD lb/day	Phenol lb/day	Sulfides lb/day	Process Capacity 1000 bpsd	Flow mgd	BOD lb/day	Phenol lb/day	Sulfides lb/day	Process Capacity 1000 bpsd	Flow mgd	BOD lb/day	Phenol lb/day	Sulfides lb/day
Crude Oil Product Storage	100	0.04	100	*	*	100	0.04	100	*	*	100	0.04	100	*	*
Crude Desalting	100	0.02	200	20	200	100	0.02	200	10	200	100	0.02	200	5	200
Crude Fractionation	100	10.00	2000	300	100	100	5.00	20	100	100	100	1.00	20	100	100
Thermal Cracking	20	1.32	20	140	40	15	0.03	15	3	15	10	0.02	10	2	10
Catalytic Cracking	50	4.25	3100	2500	1500	50	1.50	500	1000	150	50	0.25	500	250	150
Hydrocracking		not in this technology					not in this technology				14	0.07	*	*	*
Reforming	15	0.14	t	10	t	20	0.12	t	14	20	23	0.14	t	16	23
Polymerization	1.3	0.39	4	2	286	1	0.14	3	t	10		not in this technology			
Alkylation	2	0.35	2	t	10	6	0.36	6	1	60	6	0.12	6	1	120
Isomerization		not in this technology					not in this technology				1	*	*	*	*
Solvent Refining	6	0.05	*	18	t	6	0.05	*	18	t	6	0.05	*	18	t
Dewaxing	4	0.99	2080	8	t	4	0.09	2000	6	t	4	0.08	1000	6	t
Hydrotreating	10	0.01	20	6	70	35	0.04	70	t	70	40	0.32	80	t	80
Deasphalting	3	*	*	*	*	3	*	*	*	*	3	*	*	*	*
Drying and Sweetening	50	5.00	5000	500	*	50	2.00	2500	500	*	45	1.80	2250	450	*
Wax Finishing	0.5	*	*	*	*	0.5	*	*	*	*	0.5	*	*	*	*
Grease Manufacture	0.2	*	*	*	*	0.2	*	*	*	*	0.2	*	*	*	*
Lube Oil Finishing	4	*	*	*	*	4	*	*	*	*	4	*	*	*	*
Hydrogen Manufacture	--	not in this technology				--	not in this technology				--	*	*	*	*
Blending and Packaging	100					100					100				
Summation		23.10	12,526	3,504	2,205		9.93	5,414	1,652	625		4.45	4,166	848	683
Unaccounted		(1.9)	(27,474)	--	--		(.07)	(4,586)	--	--		(.55)	(834)	--	--
Total Plant Effluent (after API Separator)		25.0	40,000	3,000	1,000		10.0	10,000	1,000	500		5.00	5,000	500	300

* data not available for reasonable estimate
t - trace

TABLE 13-2

OIL REFINERIES
WASTE LOADINGS AND VOLUMES PER UNIT OF FUNDAMENTAL PROCESS THROUGHPUT IN OLDER, TYPICAL, AND NEWER TECHNOLOGIES

Fundamental Process	Older Technology				Typical Technology				Newer Technology			
	Flow gal/bbl	BOD lbs/bbl	Phenol lbs/bbl	Sulfides lbs/bbl	Flow gal/bbl	BOD lbs/bbl	Phenol lbs/bbl	Sulfides lbs/bbl	Flow gal/bbl	BOD lbs/bbl	Phenol lbs/bbl	Sulfides lbs/bbl
Crude Oil and Product Storage	4	0.001	*	*	4	0.001	*	*	4	0.001	*	*
Crude Desalting	2	0.002	0.20	0.002	2	0.002	0.10	0.002	2	0.002	0.05	0.002
Crude Fractionation	100	0.020	3.0	0.001	50	0.0002	1.0	0.001	10	0.0002	1.0	0.001
Thermal Cracking	66	0.001	7.0	0.002	2	0.001	0.2	0.001	1.5	0.001	0.2	0.001
Catalytic Cracking	85	0.060	50.0	0.03	30	0.010	20	0.003	5	0.010	5	0.003
Hydrocracking		not in this technology				not in this technology			5	*	*	*
Reforming	9	t	0.7	t	6	t	0.7	0.001	6	t	0.7	0.001
Polymerization	300	0.003	1.4	0.22	140	0.003	0.4	0.010		not in this technology		
Alkylation	173	0.001	0.1	0.005	60	0.001	0.1	0.010	20	0.001	0.1	0.020
Isomerization		not in this technology				not in this technology			*	*	*	*
Solvent Refining	8	*	3	t	8	*	3	t	8	*	3	t
Dewaxing	247	0.52	2	t	23	0.50	1.5	t	20	0.25	1.5	t
Hydrotreating	1	0.002	0.6	0.007	1	0.002	0.01	0.002	8	0.002	0.01	0.002
Deasphalting	*	*	*	*	*	*	*	*	*	*	*	*
Drying and Sweetening	100	0.10	10	*	40	0.05	10	*	40	0.05	10	*
Wax Finishing	*	*	*	*	*	*	*	*	*	*	*	*
Grease Manufacture	*	*	*	*	*	*	*	*	*	*	*	*
Lube Oil Finishing	*	*	*	*	*	*	*	*	*	*	*	*
Hydrogen Manufacture		not in this technology				not in this technology			*	*	*	*
Blending and Packaging	*	*	*	*	*	*	*	*	*	*	*	*

* Data not available for reasonable estimate.
t - Trace.

Source: U. S. Department of the Interior, Cost of Clean Water, Vol. III, Industrial Waste Profiles No. 5, Petroleum Refining.

OIL REFINING INDUSTRY
RELATIONSHIP BETWEEN POLLUTANT AMOUNTS AND WASTE WATER FLOW

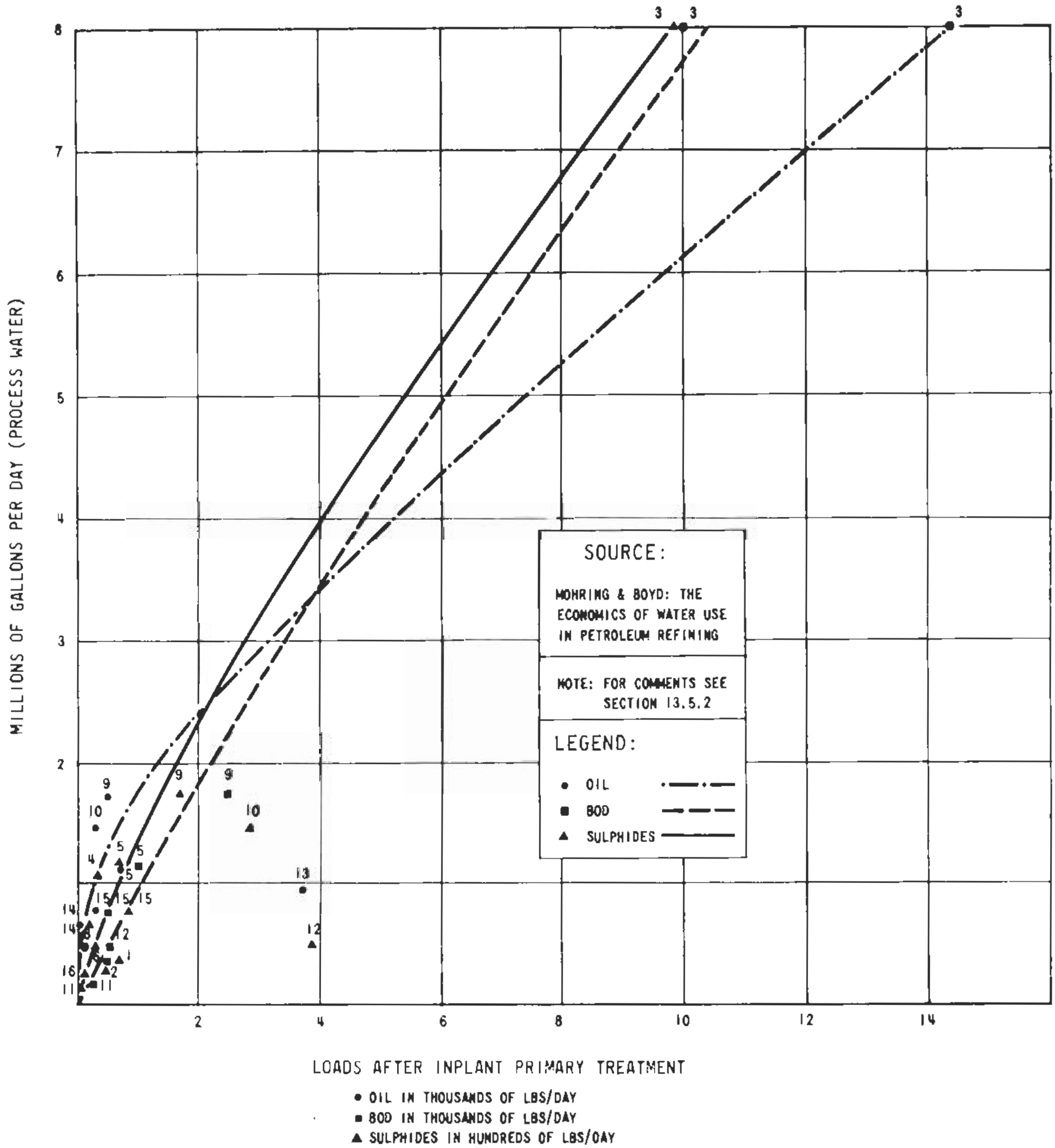


FIGURE 13-3

PART V - COMMODITY PRODUCING SECTORS CONSUMER ORIENTED AND OTHER MANUFACTURING

14 FOOD PROCESSING (exclusive of fish processing and beverages)

14.1 General Economic Framework

The development of food processing industries is defined in this section as exclusive of fish processing and the beverage industry. It is influenced on the one hand by the size, location, and income levels of potential markets and on the other by the location and nature of the industry inputs.

Consumer demand in the Province is affected by the relatively low income levels and by the sparse and scattered population distribution.

14.2 Present Day Conditions

Both demand and supply have limited and shaped the development of the food processing industries in the Province. In 1965 the food industry contributed $16.3 million or approximately one percent of the value of production of the commodity producing sectors.

Canadian averages of per capita expenditure for food cannot be applied to the Province. The income levels and living patterns are not comparable. However if, as a rough estimate, one third of the Canadian per capita expenditure on food was used to estimate the size of the Provincial market, it would be about $60 million annually. Using one half of the Canadian average, the market would be about $90 million. These figures indicate that a considerable market potential exists to support the development and diversification of a competitive food processing industry in the Province.

Table 5-2 estimates the existing size of the food processing industries for which the total value of shipments in 1965 was $6 million. The difference between this figure and the total potential expenditure on food is made up by imports and by food obtained without a direct cash expenditure. The industry falls into three categories; semi-perishable fruit and vegetables; high bulk low value products - bread and biscuits; and meat and poultry processing and dairy products. Although cost statistics are not available for the agricultural sector, it is safe to assume that most of the imported food could not be produced competitively in the Province.

14.3 Potential and Planned Development

Development in this sector is limited not so much by market demand as by the limited potential for agricultural development and by the costs of import substitution. However, the agricultural sector does have some development potential (Section 9.3) and if this potential is realized, the forecasts provided by the ADB for the food processing sector would require an upward revision.

The food processing industries which would be most affected by the potential changes in the agricultural sector are dairy and meat processing establishments. Existing information indicates that the present limited size of these operations is the result of locally restricted inputs rather than limited demand. Changes in farming practices could see substantial growth in both hog and beef production. Possibilities also exist for an expansion of poultry production and new poultry processing facilities on the Island were included in the forecasts provided by the Board.

Another possible expansion to the food processing sector would result from the development of market garden activities mentioned in Volume Three A, Part III, Section 9. Such developments would support canning and freezing activities for which a growing domestic market exists.

The growth of the domestic market for food products will stem both from the anticipated growth in population and from the assumption that there will be a continuing improvement in the level of personal income. The vigorous efforts being made to reduce the proportion of the population which subsists at the lower levels of the income scale will result in a significant reduction in the dependence of the population on home grown produce, including fish, and their conversely greater dependence on domestic or imported processed foods.

The following forecasts provided by the Board may be conservative if the agricultural sector realizes even some of its apparent potential:

FOOD PROCESSING
(excluding beverages and fish processing)

	1965	1971	1976	1981
	millions of dollars			
Value of shipments	16.3	23.2	29.9	37.5
Value added	4.9	7.4	9.6	11.9
Employment (number of people)	653	849	953	1067

14.4 Specific Water Demand and Wastewater Releases

The separate discussion of fish processing and beverage industries reduced the number of food processing establishments of economic significance to be analyzed in this section. Because of this, the literature search conducted for data on specific water demand and wastewater releases was less extensive than for other industries.

From the questionnaires circulated, some indications of water usage were obtained for bakeries, smoked meat, and a margarine establishment. It appears from this information that bakeries use between 1.4 and 2.8 gallons per dollar of gross value of production. The use of smoked meat and margarine industries seems to be of the same order of magnitude.

Several sources available indicate that the water demand for slaughter houses, dairies, and fruit and vegetables has a significant variation.

From US census data* for meat and slaughtering plants, a good relationship between process water intake per establishment and value added per establishment (Figure 14-4) was obtained. Since there is little quantitative difference between process water and intake water in this industry, Figure 14-4 can be used for rough estimates of specific intake water demand for planning purposes. Similarly, Figure 14-3 may be used to estimate the relationship between specific process and demand per value added in food and kindred products, productivity (expressed as value added per worker) and water availability (expressed as runoff units per population). The regionally averaged values obtained from US Census* for the food industry indicate a specific intake water demand variation between 23 and 250 gallons per dollar value added. An attempt to obtain a similar result for fluid milk was unsuccessful. It is worthwhile, however, to mention that the regionally averaged specific intake water demand in the fluid milk industry varies between 22 and 83 gallons per dollar value added.

The quality of water used in the food industry has to correspond generally to the requirements for drinking water. For special types of products, the requirements may be more specific as indicated in Table 14-5.

The amount and characteristics of wastewater from the food industry varies with the type of industry. The main pollutant in most food processing plants is organic matter, but other substances can

*U. S. Census of Manufacturing, Chapter 10, "Water Use, 1964", Government Printing Office, Washington, D. C.

3B

also be present. In some cases, bacteriological pollution is also possible. Special characteristics of the organic substances included make it difficult sometimes to treat them together with the municipal wastes. Data on wastewater characteristics from the food processing industry are shown in Tables 14-1 to 14-4.

Treatment requirements are very similar to those applied to municipal wastes and the extent of treatment will vary with waste strengths and the character of the receiving water.

14.5 Present and Forecast Water Demand and Wastewater Releases

Data on actual water usage are limited both in the number of respondents and the information available. Water information from the ten food processors is summarized in the following table. With the exception of the bakery in Catalina which draws its supply from a well, all other establishments draw their supply from municipal systems.

Industry	Location	Annual Gross Value of Production	Daily Water Usage (Gallons) Peak	Average
Bakery	Catalina			200
	St. John's	$ 2.4 M		10,000
	St. John's	$ 1.1 M		9,700
	St. John's		5,000	
Margarine	St. John's		60,000	
Ice Cream	Grand Falls			23,000
	St. John's			80,000
	Corner Brook			46,000
Reconstituted Milk	Gander			1,200
Smoked Meat	St. John's	$ 3.6 M		50,000
Slaughter House	St. John's			110,000 (intermittent use only)

The scale and complexity of the American food processing industry, discussed in Section 14. 4, makes a comparison with the existing provincial industry questionable. The two bakeries for which production values were supplied suggest the order of magnitude difference. To translate this data into a ratio of specific water usage per dollar value added it was assumed that both bakeries reflected the Provincial average. For the Provincial bakeries it is estimated that the value added averages 47 percent of the gross value of production. On the basis of this assumption the specific water usage of the two bakeries was 3 gallons and 6 gallons per dollar value added.

However, the total amount of water demand is generally low, and even accepting a highly improbable average of 40 gallons per dollar of value added, the total present day demand would amount to less than 2 million gpd for the whole Province. Approximately 30 food processing plants are located in the Province today which indicates an average demand per plant of, at the most, 70, 000 gpd. The maximum daily consumption estimated for the St. John's slaughterhouse is of the order of 110, 000 gpd.

It is estimated, on the basis of the relationships discussed, that the water demand of the existing processing industries may be between 4 and 5 million gallons a year by 1981. On a provincial basis this represents a doubling of demand in a little more than a decade. However, considering the fairly limited demand of the individual establishments, the implications for the municipalities to which they are connected, while important, are not critical.

The exception to this general statement could arise from a major expansion of the agricultural sector, resulting in the development of considerably larger scale processing establishments for milk, meat, and vegetables. If these were comparable in size and complexity to the American industries discussed in Section 14. 4, a combined additional activity generating 5 million dollars value added a year could result in an annual additional water demand of 100 million to a billion gallons a year of 3 to 30 million gpd. This demand placed on municipal systems would have quite different implications than those suggested by the combined expansion of the existing food manufacturers. Waste disposal problems could become significant if a major expansion takes place in the food processing industries.

FORECASTS IN THE FOOD PROCESSING INDUSTRY (EXCLUDING FISH PROCESSING AND THE BEVERAGE INDUSTRIES) 1965-1981

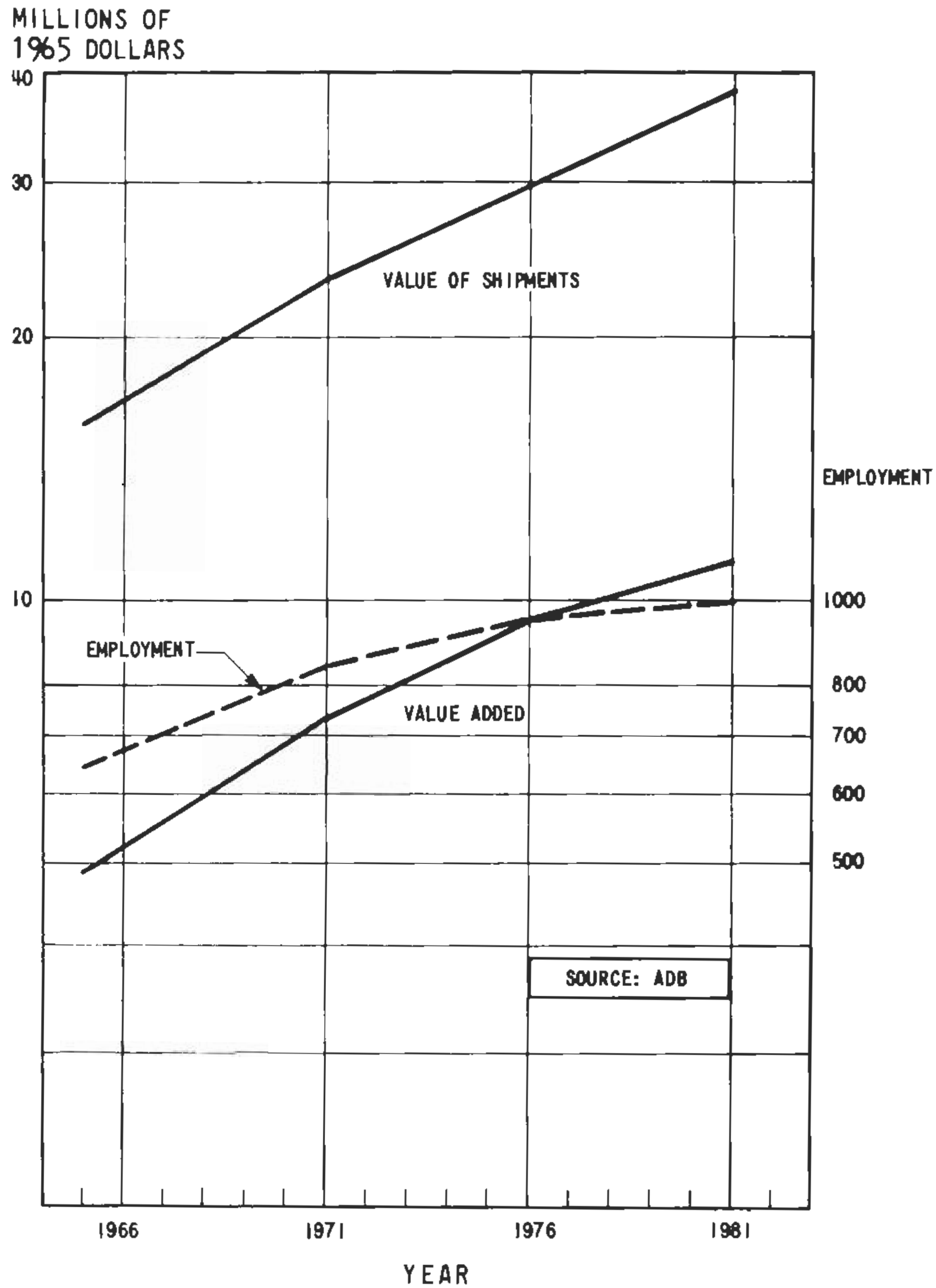
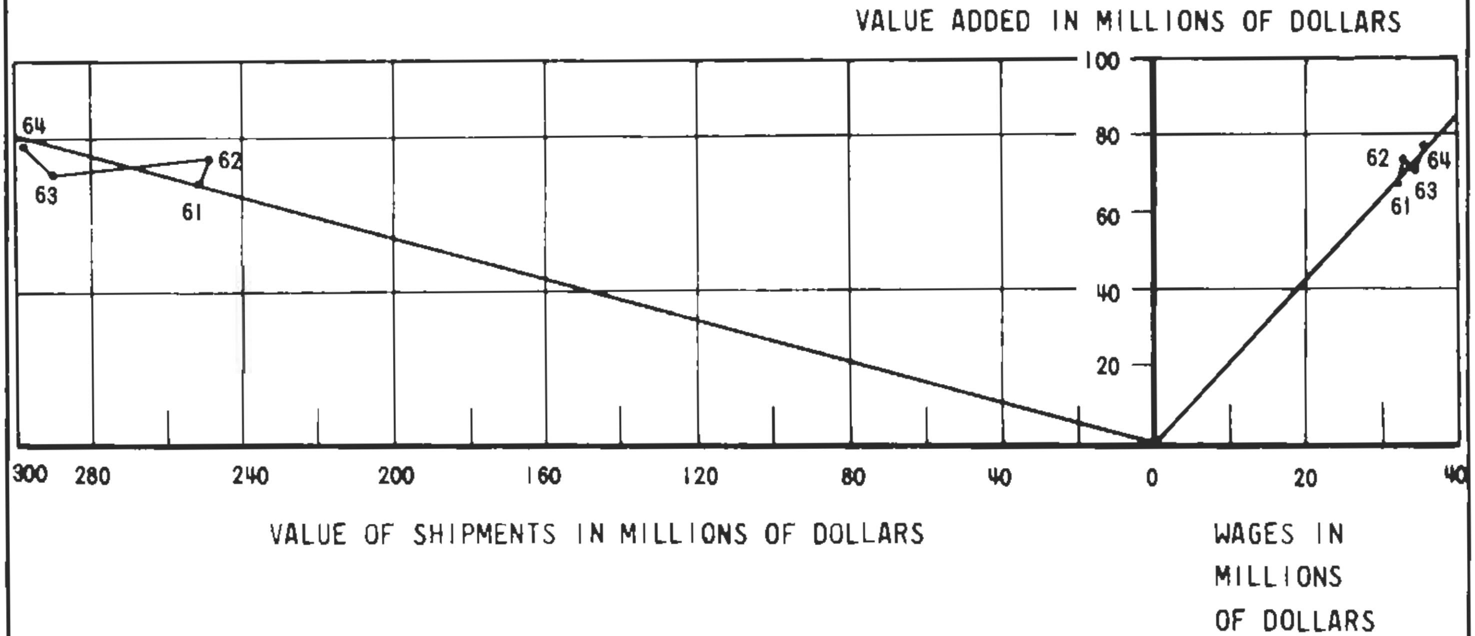


FIGURE 14-1

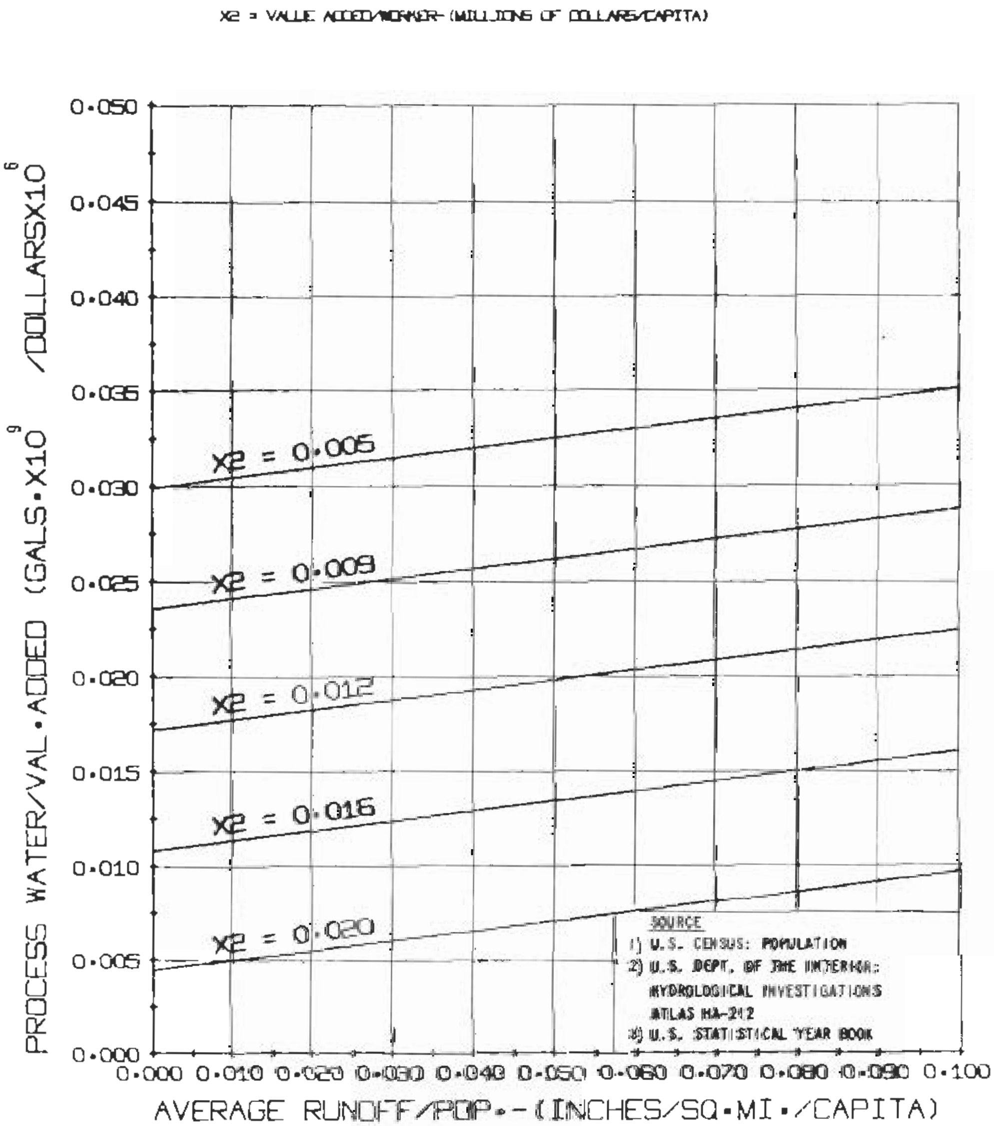
RELATIONSHIP BETWEEN ECONOMIC FACTORS IN THE FOOD PROCESSING INDUSTRY (TOTAL ACTIVITY) EXCLUDING FISH PROCESSING, BREWERIES AND SOFT DRINKS ATLANTIC PROVINCES



NOTE:	ALL SCALES IN MILLIONS OF DOLLARS
SOURCE:	DBS CAT. 31-204

FIGURE 14-2

APPROXIMATE RELATIONSHIP FOR ESTIMATING PROCESS WATER DEMAND BY THE FOOD PROCESSING INDUSTRY



U.S. FOOD & KINDRED PRODUCTS INCLUDES:

FLUID MILK
FROZEN FRUITS AND VEGETABLES
MALT LIQUORS
FOOD PREPARATIONS
MEAT SLAUGHTERING PLANTS
MEAT PROCESSING PLANTS
POULTRY DRESSING PLANTS
CANNED FRUITS AND VEGETABLES
CANE SUGAR REFINING
CONFECTIONERY PRODUCTS
BOTTLED AND CANNED SOFT DRINKS
FLAVOURINGS
CONDENSED AND EVAPORATED MILK
CANNED SPECIALTIES
ANIMAL AND MARINE FATS AND OILS
PICKLES, SAUCES, SALAD DRESSING
DISTILLED LIQUOR, EXCEPT BRANDY
SHORTENING AND COOKING OILS
SOYBEAN OIL MILLS
MANUFACTURED ICE
CREAMERY BUTTER
NATURAL PROCESS CHEESE
CEREAL PREPARATIONS
MALT
WET CORN MILLING
RAW CANE SUGAR
COTTONSEED OIL MILLS
BEET SUGAR
DEHYDRATED FOODS PRODUCTS
WINES AND BRANDY

SOURCE: U.S. CENSUS: WATER USE

FIGURE 14-3

APPROXIMATE RELATIONSHIP
FOR ESTIMATING PROCESS WATER DEMAND
OF MEAT PROCESSING AND SLAUGHTERING PLANTS

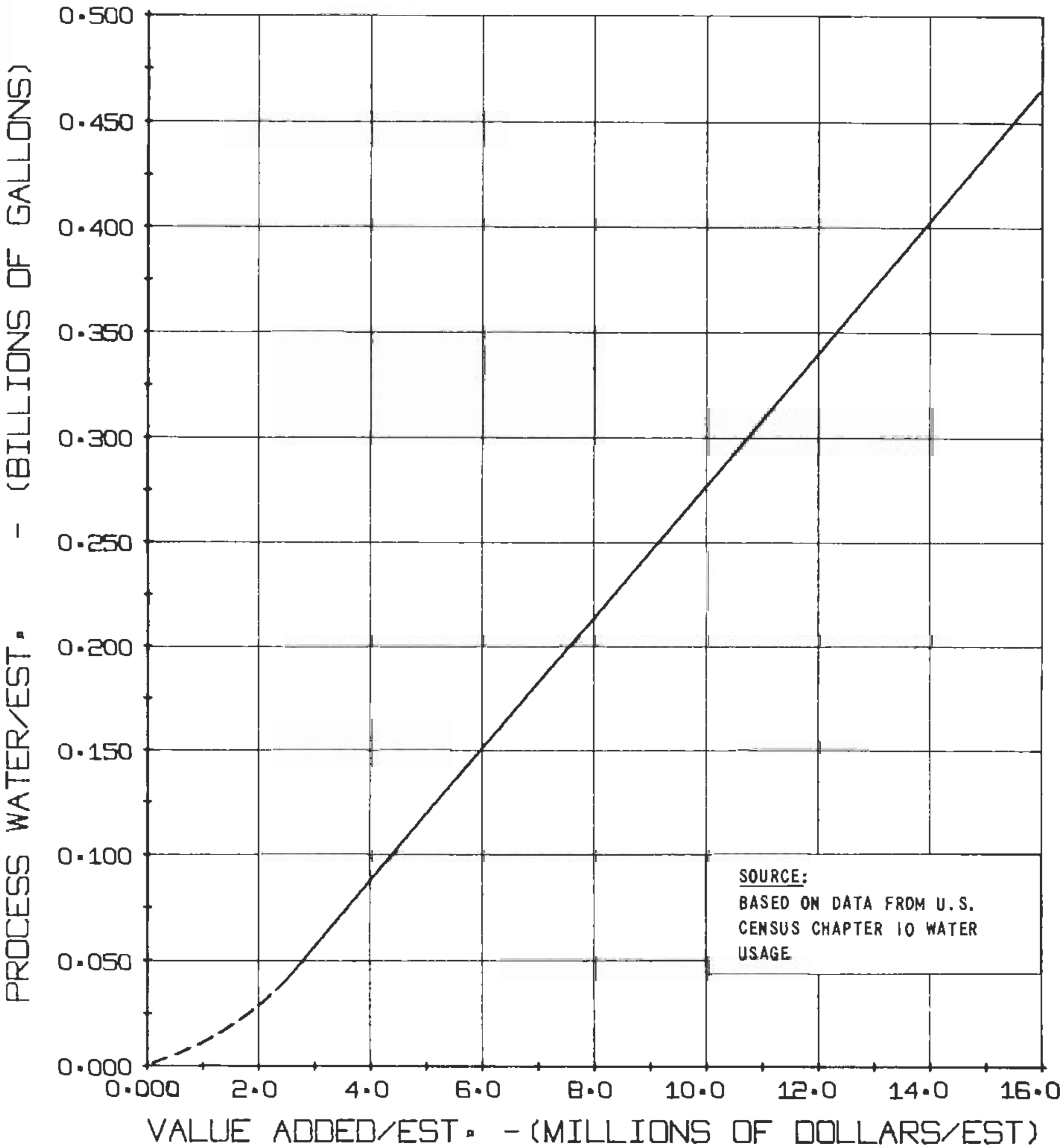


FIGURE 14-4

TYPICAL CANNING WASTES

PRODUCT	WASTE VOLUME (imp. gallon/case)	5-DAY BOD* (milligrams/litre)	5-DAY BOD* (pounds/case)	SUSPENDED SOLIDS* (milligrams/litre)	SUSPENDED SOLIDS* (pounds/case)
Apples	24 to 38	1680 to 5530	0. 64 to 1. 31	300 to 600	0. 10 to 0. 20
Cherries	12 to 38	700 to 2100	0. 16 to 0. 50	200 to 600	0. 05 to 0. 14
Cranberries	9 to 19	500 to 2250	0. 10 to 0. 21	100 to 250	0. 02 to 0. 05
Asparagus	67	16 to 100	0. 01 to 0. 07	30 to 180	0. 02 to 0. 12
Beans, baked	33	925 to 1440	0. 31 to 0. 48	225	0. 07
Beans, green/wax	25 to 41	160 to 600	0. 15 to 0. 67	60 to 150	0. 02 to 0. 04
Beans, kidney	17 to 19	1030 to 2500	0. 19 to 0. 45	140	0. 02
Beans, lima, dried	17 to 27	1740 to 2880	0. 30 to 0. 60	160 to 600	0. 05 to 0. 10
Beans, lima, fresh	47 to 250	190 to 450	0. 21 to 0. 47	420	0. 20 to 1. 02
Beets	26 to 67	1580 to 7600	1. 00 to 2. 00	740 to 2220	0. 50 to 1. 00
Carrots	30	520 to 3030	0. 11 to 0. 67	1830	0. 40
Corn, cream style	23 to 27	620 to 2900	0. 17 to 0. 66	300 to 675	0. 07 to 0. 17
Corn, whole kernel	24 to 67	1120 to 6300	0. 74 to 1. 50	300 to 4000	0. 20 to 0. 95
Mushrooms (per ton)		76 to 850	4. 77 to 55. 58	50 to 240	3. 14 to 15. 07
Peas	13 to 72	380 to 4700	0. 27 to 0. 63	270 to 400	0. 06 to 0. 20
Potatoes, sweet	75	1500 to 5600	1. 10 to 4. 40	400 to 2500	0. 31 to 1. 95
Potatoes, white	-	200 to 2900	-	990 to 1800	-
Pumpkin	19 to 47	1500 to 6880	0. 72 to 1. 31	785 to 1960	0. 38
Sauerkraut	3 to 17	1400 to 6300	0. 10 to 0. 30	60 to 630	0. 01 to 0. 10
Spinach	150	280 to 730	0. 42 to 1. 11	90 to 580	0. 14 to 0. 88
Squash	19	4000 to 11000	0. 76 to 2. 09	3000	0. 57
Tomatoes	3 to 95	180 to 4000	0. 11 to 0. 17	140 to 2000	0. 06 to 0. 13

* It should be noted that the normal engineering technology describes the wasteload in milligrams per litre or parts per million. In most parts of this report, the wasteloads were described on the basis normally used by industry - pounds per equivalent case. To convert milligrams per litre to pounds per case, multiply the mg/l loading by 8.33×10^{-6} lb/gal, and multiply by the waste volume discharged in gallons per case.

All gallons are imperial measure and all cases contain 24 sixteen-ounce cans or the equivalent.

Source: Cost of Clean Water, Volume III,
Industrial Waste Profile No. 6,
Canned and Frozen Fruits and Vegetables.

TABLE 14-1

SLAUGHTERING PLANT

WASTELOAD AND WASTEWATER PER THOUSAND POUNDS LIVEWEIGHT KILLED BY TYPE OF TECHNOLOGY, 1966*
(PRE-CATCH BASIN WASTELOADS)

Type of Technology	No. of Plants	Size of Plant in Annual Liveweight Killed (millions of pounds)		Wasteload Pounds BOD per 1000 Pounds Liveweight Killed			Wastewater Gallons per 1000 Pounds Liveweight Killed		
		Range	Average	Range	Average	Weight** Average	Range	Average	Weight Average
Typical	22	12 to 300	235	2.9 to 32.8	18.5	19.2	512 to 3054	1126	1294
Old	14	8 to 500	164	11.4 to 48.5	25.9	26.9	780 to 2245	1632	2112
Advanced	17	8 to 700	194	2.5 to 35.6	11.9	13.1	104 to 2088	769	1116

* Technology is defined by the subprocess mix as indicated in Table 10 of the source.

** Weighted by annual liveweight killed.

Source: US Department of the Interior,
Federal Water Pollution Control Administration,
Volume III, Industrial Waste Profile No. 8,
Meat Products.

TABLE 14-2

TABLE 14-3

POULTRY PLANT
WASTE INDEX BY TECHNOLOGY, 1966

Type of Technology *	Waste Characteristics Per 1000 Birds Killed: BOD in Pounds	Wastewater in gallons	Index of Waste BOD	Index of Wastewater
Old	31.7	3330	100	100
Typical	26.2	8700	83	260
Advanced	26.0	6100	82	190

* Definition - Table 6 of source document.

Source: Cost of Clean Water, Volume III,
Industrial Waste Profile No. 8
Meat Products

TABLE 14-4

FLUID MILK

WASTE AND WASTEWATER QUANTITIES PER POUND OF FINISHED PRODUCT

	Whey Pounds BOD	Product Pounds BOD	Soap and Chemicals Pounds BOD	Wastewater Gallons
Fluid Milk:				
Older technology		0.0026	0.0003	5.0
Typical technology		0.0010	0.0001	3.5
Advanced technology		0.0005	0.0001	2.0
Cottage Cheese:				
Older technology	0.128	0.012	0.0012	53.2
Typical technology	0.128	0.008	0.0008	48.4
Advanced Technology	0.128	0.002	0.0002	35.1

This data represents industry operating experience. Whey is similar for all levels of technology because the basic process is similar for all levels; however, the other wastes are affected by plant size and technology.

NOTE: For technology classification see source table No. 9-137.

Source: Cost of Clean Water, Volume III, Industrial Waste Profiles No. 9 - Dairies

FOOD PROCESSING INDUSTRY - QUALITY OF WATER USED

	----Range of Recommended Threshold Values in ppm---			
	Food Processing		------Canning-------	
Constituent	General	Bakery	Vegetables	General
Turbidity	1 - 10	10	10	10
Colour	5 - 10	10		
Taste and Colour	low (barely noticeable)	low	low	low
Iron	0. 2*	0. 2*	0. 2*	0. 2*
Manganese	0. 2*	0. 2*	0. 2*	0. 2*
Alkalinity, as $CaCO_3$	30 - 250			
Hardness, as $CaCO_3$	10 - 250		25 - 75	
Total Dissolved Solids	850			
Fluoride	1. 0			
H_2S		0. 2	1	1

* Limits apply both to the individual constituents and to their sum.

Note: Potability of water is a general requirement

Source: Goudreau, J. P., Asselin, R, "Industrial Use of Water", Background Paper A4-1-6, prepared for the National Conference on Pollution and our Environment, Edited by CCRM, Volume I, Montreal, 1966.

TABLE 14-5

15 BEVERAGE INDUSTRIES

15.1 General Economic Framework

The beverage industry in this section is confined to the brewery and soft drink industries. The contribution of these two industries to the national, regional, and provincial economy is considerable. For example, on the basis of the Canadian 1964 census of manufacturers, breweries ranked as 29th in the value of shipment and as 19th in the value added. While soft drinks did not appear in the top 40 industries ranked by value of shipments, it ranked as the 31st largest industry on the basis of value added.

On the Atlantic provinces regional basis, in the 1963 census of manufacturers, breweries ranked 8th in value of shipments and as the 7th largest industry by value added. For the same year soft drinks ranked as 11th in value of shipments and as 8th in value added.

In the Province, breweries were not shown among the six largest industries, but soft drinks ranked third both in value of shipments and value added behind pulp and paper and fish processing.

These industries respond to certain parallel market characteristics, although the response is not identical.

The demand for both products depends, in common with most consumer products, on the size of the population. In the Province the number of isolated communities has a considerable influence on consumer buying patterns. The age structure of the population is of greater obvious significance to the brewing industry because of the legal drinking age laws. However, age structure is also a marketing factor for the soft drink industry. The sex structure of the population would again be of greater significance to the brewing industry.

Income levels are another factor affecting demand. However, the relationship between demand and the level of income varies in time and space. For example, while it might be generally true to say that per capita beer consumption rises with rising incomes and population concentrations, local preferences for hard liquor or non-alcoholic beverages would negate the potential market expansion. Again local drinking laws have a direct affect on beer consumption.

In very broad terms considering population distribution and existing income levels, the market potential for both industries is considerable.

15.2 Present Day Conditions

15.2.1 Breweries

No data on the brewing industry in Newfoundland and Labrador are published by the Dominion Bureau of Statistics. This manufacturing industry in the Province is grouped with statistical data for the Atlantic provinces.

In 1965, 16.4 million gallons of beer, ale, stout, and porter were sold in the Atlantic region. The industry employed 736 people with a salaries and wages bill of $3.6 million, of whom 507 were production workers receiving $2.4 million in wages. The industry contributed $22.4 million "value of shipments of goods of own manufacture" and $12.5 million of total activity value added. There were eight establishments in the region of which three were located in Newfoundland.

The Board provided the following information on the brewery industry in Newfoundland in 1965. The three establishments operating in the Province were located in St. John's. They employed 96 people who produced a value of shipments of $2.9 million and a value added of $1.8 million. No information was provided on wages and salaries. On the assumption that the provincial level is similar to that of the Atlantic Provinces, the average wage and salary per employee in 1965 was $5,000, giving a total wage bill of $480,000.

In 1965 the Canadian brewing industry contributed $216 million value added to the economy. In the same year the total volume of production in Canada was 299 million gallons. Each dollar of value added represented 1.4 gallons of production. Assuming that the national ratio applies to the Province, the volume of production, for a value added of $1.75 million, is 2.45 million gallons. The value of manufacturing shipments for the total activity in 1965 was $299 million, giving a value added ratio of 72 percent.

All three Newfoundland breweries replied to questionnaires circulated by the Consultant in connection with industrial water demand. Only one firm supplied both manufacturing and water demand information, although all three gave indications of water requirements.

	Annual Production		Annual Water Demand
	Value	Imperial Gallons	Imperial Gallons
Company A	$3.8 M	1.1 M gal. Actual	34 M Actual
Company B	-	0.7 M estimated	21 M Actual
Company C	-	0.7 M estimated	21 M Actual
Total		2.5 M	

On the assumption that the three breweries use the same basic process, and therefore the same water input to produce output, the estimated annual production of the three breweries suggests that the volume estimated by using the gallons per value added is a reasonable indication of production levels.

15.2.2 Soft Drinks

According to the latest census of manufacturers available for the soft drink industry, there were nine soft drink establishments in the Province in 1965. The value of shipments of goods of own manufacture was $4.5 million and the value added for the total activity was $2.6 million. The total activity employed 186 people with a wages and salaries bill of $662,000. On the questionnaires circulated to the soft drink industry, in connection with their water usage, three of the firms reported a combined employment of 150 permanent staff and 33 seasonal workers in the 1966 - 1967 period.

The quantity of carbonated beverages, reported in imperial gallons, in DBS Catalogue 32-208, "Soft-Drink Manufacturers", excludes a number of products such as syrups and natural mineral water. The major value is in the syrup concentrates sold to bottlers which represents about 10 percent of total value of shipments. Additionally, syrup sold to the fountain trade represents about 3 percent of the total value of shipments.

In order to approximate the quantity of soft drinks produced in the Province, it was assumed that the link between value added and quantity is similar to the Canadian pattern. It was also assumed that the sales of other products, discussed above, has held the same relative position in recent years.

In 1965, each dollar of value added, total activity, represented a production of 1.3 gallons of soft drinks. Applying this ratio to the provincial value added, the volume of soft drink production was estimated to be 3.4 million gallons which represents a per capita consumption of seven gallons a year. This compares with the estimated Canadian per capita average of 9.5 gallons a year.

The Designated Industry questionnaires circulated to the bottling industry do not provide sufficient information to make estimates of establishment and industry operations possible. From all indications, the existing market was estimated to be 3.4 million imperial gallons annually. If per capita consumption had been equivalent to the Canadian average, the indicated potential market is 4.6 million imperial gallons annually.

15.3 Potential and Planned Development

It would appear, given a growing population and rising average incomes, that the soft drink and brewery markets will continue to expand.

There are nine carbonated beverage bottling establishments in Newfoundland, five located in St. John's, two in Corner Brook, one in Bishops Falls, and one in Stephenville. In 1965 there were three breweries in Newfoundland, all located in St. John's. In 1968 a new brewery was opened in Stephenville.

The location of these production facilities in terms of population centres and growth areas is good in terms of market coverage. Any expansion in production facilities required to meet the given manufacturing forecasts for the two industries will probably occur in areas where plants are already located. Should growth exceed the given forecasts, then new production locations would probably be considered.

15.3.1 Breweries

The potential development for the brewery industry in the Province is dependent on a number of market factors discussed in Section 15.1 and in the soft drink section above. There are certain consumer differences as well as age structure and legislation differences. However, population growth and level of income are the basic factors in market potential.

Figure 15-1a shows the estimated per capita consumption of beer for Canada and the Atlantic region. The position of the two series illustrates the difference in relative market positions, and the faster growth rates possible in areas which are markedly below the national market.

On the assumption that the annual per capita consumption in the Province will rise to 15 gallons by 1981, it is possible to estimate the total consumption would be 9.5 million gallons a year. Using the 1965 value added per gallon, the 1981 value added would be in the range of $6.6 million. This is considerably higher than the value added provided in the brewery industry forecasts.

The Board provided forecasts of the value of shipments and value added for 1965, 1971, 1976 and 1981 and the level of employment for 1965. The forecasts incorporate the addition of the new Stephenville brewery.

Employment was estimated from the base year on the productivity assumption of 2.5 percent increase per year in the same way as for soft drinks. The jump in employment in 1971 is explained by the new brewery. The decreasing employment between 1971 and 1981 results from the forecasted rates of growth for value of shipment and value added being one percent per year lower than the assumed productivity growth rate. The forecasts of industry activity were based on the anticipated average annual growth rate of population of 1.5 percent.

The following table shows a marked increase in activity between 1965 and 1971. This is explained by the new brewery which was opened in Stephenville in 1968. The stated capacity of the new brewery is 50,000 barrels a year. In the Canadian brewery industry, a barrel is equivalent to 25 imperial gallons, thus the brewery has an annual capacity of 1,250,000 gallons. This represents approximately 30 percent of the industry forecast for 1971.

Volume forecasts were based on the 1965 national average of 1.4 gallons per dollar value added, as discussed in Section 15.2.

The forecasts are summarized in the following table and on Figure 15-1b.

	1965	1971	1976	1981
Value of Shipments	$2.9 M	$5.2 M	$5.6 M	$6.0 M
Value Added	$1.8 M	$2.9 M	$3.1 M	$3.3 M
Employment	96	144	137	130
Volume in Gallons	2.5 M	4.0 M	4.3 M	4.7 M
Salaries & Wages ('000)	$490	$850	$915	$985

15.3.2 Soft Drinks

The potential market for soft drinks in the Province is considerable. First there is the potential offered by an increasing population and a rising income level. The rising income levels are of greater significance to the soft drink market in the Province than they would be in areas where incomes are significantly higher.

Figure 15-5a shows the evolution of Canadian per capita consumption of soft drinks, excluding fountain sales. Projecting the trend from 1958 to 1965, a consumption of about 11 gallons per capita will be reached by 1981.

On the assumption that the provincial population will be about 630,000 by 1981, the consumption of soft drinks would be in the order of eight million gallons a year. By applying the 1965 ratio of value added per gallon of product, the value added ratio would be in the order of $6.2 million

This is considerably higher than the forecast of $4.1 million provided by the Board and used in the following section. It would appear, at least on this basis, that the potential market for soft drinks is considerable.

The Board provided forecasts of value of shipments and value added for 1965, 1971, 1976 and 1981. They also provided the level of employment for 1965.

On the basis of this information, employment levels were calculated using an annual productivity increase per employee of 2.5 percent. Salaries and wages per man, from information available from DBS, were calculated at an average annual increase of 2.5 percent and the result applied to employment forecasts to determine total salaries and wages.

This information is summarized in the following table and in Figure 15-5b. All forecasts are in terms of 1965 dollars.

SOFT DRINK INDUSTRY FORECASTS 1965 - 1981

	1965	1971	1976	1981
Value of Shipments	$4.5 M	$5.0 M	$5.8 M	$6.7 M
Value Added	$2.6 M	$2.8 M	$3.5 M	$4.1 M
Employment	184	172	183	196
Salaries & Wages ('000)	$660	$720	$890	$1040

15.4 Specific Water Demand and Wastes

Water is used in many ways in the production of beer and soft drinks. It is obviously a raw material incorporated in the produce and it is also used extensively for bottle washing and other purposes (see Volume Eight, Appendix B, Parts III and IV). Since bottle washing represents a very significant portion (40 to 75 percent) of the use, both for beer and soft drink manufacturing, changes in technology related to increased use of canning instead of bottling could substantially reduce water demand.

15.4.1 Breweries

According to the literature survey data (Volume Eight, Appendix B, Part III), the specific water use in the brewing industry varies between 5 and 35 gallons per gallon of beer. The only data available in Newfoundland at one establishment indicates a demand of 30 gallons per gallon of beer. Statistical processing of the data available from the US Census of Water Use in Industry[1] has yielded a relationship between water per value added, the level of productivity and/or capital (value added per worker), water availability (runoff per population per square mile), and climatic conditions (potential evaporation), which is shown in Figure 15-4. Although the data are restricted and represent averages, it seems that the results obtained from this relationship when applied to Newfoundland's conditions are reasonably close to actual data which would indicate that its use can be recommended as a first approximation in estimating probable water demand for new breweries in the planning stage. This is acceptable since process water for this industry closely approximates the water intake in the case of Newfoundland's conditions. If cost of water or effluent charges should impose a reduction in water usage, re-use or recycling in the washing process would represent a substantial reduction in intake water.

The water quality requirements are discussed in Volume Eight, Appendix B, Part III. Because water fulfilling all the requirements is difficult to find in nature, some manufacturers demineralize the water and add the minerals required in a controlled way. The questionnaire circulated for the purpose of this study and filled in by Bavarian Brewing Company of St. John's reports using carbon filters for water treatment. Possibly this is done to dechlorinate the water or to remove some taste or odour.

The amount of wastewater is probably equal to 80 to 90 percent of the intake water, the depletion being the water incorporated in the product and by-products and lost by evaporation. The lower percentage obviously corresponds to the lower limit of water demand.

The sources and characteristics of wastewaters released by the brewery industry are discussed in detail in Volume Eight, Appendix B, Part III. The following main characteristics of the composite wastewaters are more significant: 5-day BOD, 420 to 1200 ppm; suspended solids, 200 to 500 ppm; and pH, 5.5 to 7.4. Variation in the wastewater mix results in corresponding variation in the quality of wastewater.

Studies by O'Rourke and Tomlinson[2] revealed that the pH of brewhouse wastes varied between 3. 64 and 7. 14 and were usually in the 4. 0 to 6. 0 acid range. The low pH was believed to be caused by excess yeast which entered the wastewater during washing of the fermentation cellars and storage tanks. The pH of the bottling plant, on the other hand, varied between 2. 4 and 12. 1 with the high value being caused by a batch of spent caustic soda solution.

15. 4. 2 Soft Drink Plants

The literature survey, summarized in Volume Eight, Appendix B, Part I V, has indicated a variation of 4 to 10 gallons per gallon of soft drink produced. Data for a statistical estimate of the demand, as a function of plant technical economical characteristics and water availability conditions, were not available. The actual data included in the answers to the questionnaires circulated to the Newfoundland soft drink manufacturing plants indicate the same range and are summarized in the table included in Section 15. 5. 2.

It may be assumed that the upper limit is close to the unrestricted optimum, whereas the lower represents restricted water demand resulting from a higher cost of water. Since 65 to 70 percent of the total plant intake is used for bottle washing, it is obvious that recirculation of the cleaning water or the use of tin cans, which require little washing, could substantially reduce the water demand. However, recirculation would probably be economically beneficial only under conditions of very high cost of water and effluent charges.

The quality of water has to conform to the general requirements for water used in food preparation. Additional requirements are indicated in Volume Eight, Appendix B, Part I V. The plants generally use package treatment plants.

The amount of wastewater is generally equal to the amount of water intake minus the water incorporated in the product. Consequently, it represents between 3 and 9 gallons per gallon of product.

The quality of wastewater is discussed in more detail in Volume Eight, Appendix B, Part I V. The main characteristics are, according to Porges[3], as follows: pH - 10. 0 to 11. 4; BOD - 250 to 660 ppm (average 430 ppm); suspended solids - 160 to 340 ppm (average 220 ppm); and total alkalinity - 220 ppm as $CaCO_3$ (average value).

Again this waste can be readily treated when combined with municipal sewage.

15.5 Present and Forecast Water Demand and Wastewaters

Most breweries and soft drink manufacturing plants obtain their waters from the municipal water system and release their wastes (with or without preliminary treatment, depending on local conditions) in the municipal sewer systems. This pattern is also observed in Newfoundland. Nevertheless, since a big brewery and sometimes even a big soft drink plant can represent concentrated water use of some importance, disturbing the average conditions in the area, some attention has to be paid to these industries in the frame of the present study. Moreover, a new brewery in the Stephenville area represents an exception to the above described pattern; its water is obtained from former US base distribution system.

15.5.1 Breweries

According to the available information the three existing breweries, all located in the St. John's area, have a water consumption of 34, 21, and 21 million gallons per year for production of 1.1, 0.7, and 0.7 million gallons of beer; the production figures for the two smaller breweries are estimated (Section 15.2.1). All the breweries obtain their water from the municipal water system and treat it to some extent (one treats all the water by chlorination, another by filtration through carbon filters).

The plants apparently work five days a week and between 8 and 12 hours a day. The monthly consumption in July, at one of the plants, indicates an almost two-fold increase above the average monthly consumption. A minor water re-use is reported by one of the plants.

No data are available on the actual quantity and quality of wastewaters but, considering the discussion in Section 15.4.1, it may be presumed that these represent 80 to 95 percent of the intake water. Further, it may be presumed that the polluting substances are closer to the lower limits indicated in the above-mentioned section, because of the large water consumption.

Extension of the existing breweries will probably occur at a lower rate than the 5 percent per year assumed for other industries, because of the additional capacity of the new brewery at Stephenville. If a significant shift from bottling to canning occurs in the next few years, it is probable that the production increase could be obtained without significant increase in the water demand. However, if this change does not take place, consumption at the existing plants might be expected to increase by 1 to 2 percent, unless deterrent water and effluent charges should be introduced.

The new brewery at Stephenville is expected to produce 1,250,000 gallons per year which would require, at the average present day use, some 37 million gallons of water per year, with a probable monthly peak of 6 million gallons, or close to 0.3 million gpd if the brewery is working only five days a week.

If the specific water demand for the Stephenville brewery is estimated using the statistical relationship discussed in Section 15.5.1 and shown graphically in Figure 15-4, the demand of the brewery will coincide with that estimated in the preceding paragraph. Figure 15-4 shows an upper limit of 30 gallons of water per gallon of beer produced. When the statistical relationship is used for the Stephenville brewery conditions, the upper limit is applicable.

Wastewaters released from the new Stephenville brewery are assumed to average 90 percent of the intake or about 0.27 million gpd at peak demand and 0.13 million gpd on the average with corresponding amounts of BOD of about 1300 pounds per day at the peak and 650 on the average, and a comparable amount of suspended solids and a determined amount of causticsoda and other chemicals.

15.5.2 Soft Drink Plants

From the questionnaires circulated at four plants by the consultant for the purpose of this study, some data are available on actual production and water usage. These data, obtained from four plants in St. John's, and one in Bishops Falls, are summarized in the following table:

Type of Plant	Annual Production*	Water Usage	Water Usage/Gallon of Soft Drink
	(millions of gallons)		
Soft Drink	-	4.0	-
Soft Drink	1.4	8.5	6
Soft Drink	1.5	19.0	12
Soft Drink**	.55	7.5	13
Soft Drink & Bakery	.25	3.75	15 (assumed)

* 1966/67
**Bishops Falls

There are nine soft drink establishments on the Island, four in St. John's; two in Corner Brook; and one each in Bishops Falls, Grand Falls, and Stephenville. It was assumed that the production of soft drinks at the four plants for which no data were available was within the ranges shown in the above illustration.

These data suggest that the specific water demand of soft drink plants falls within a range of 6 to 15 gallons per gallon of output. On the basis of the estimated 1965 production of 3.4 million gallons of soft drinks, the average plant size was 380,000 gallons a year. The annual average water demand estimated on the basis of 15 gallons of water per gallon of output would be 5.5 million gallons. On a per day basis, assuming a 260 day operation, the average water demand would be 21,000 gallons with a peak demand of about 42,000 gallons.

These figures are slightly lower than the average obtained from the examples quoted in the foregoing table. However, these figures represent water usage in 1965, while the figures available for individual plants are for 1966, and a very high growth rate was recorded in this sector in the Province during this period. From data included in the questionnaires it appears that the daily maximum represents some 0.6 percent of the annual demand.

The wastewater representing 80 to 90 percent of the water intake (lower figure for lower intake amount) contains, for an average plant in the peak days, an estimated amount of about 150 pounds per day of five days BOD, some 75 pounds per day of suspended solids, and an undetermined amount of caustic soda and other chemicals. On the basis of the BOD content, the treatment requirements for an average plant would not be significant, especially where the waste is combined with municipal sewage.

The forecast for soft drinks calls for an increase of over 50 percent of the present day production over the interval 1965 to 1981. This forecast, which seems to be conservative, assumes that the increase in production will take place mostly at the existing plants. However, this will represent less than an increase by 50 percent of the water consumption, since shifting to canning instead of bottling may drastically reduce the specific water consumption.

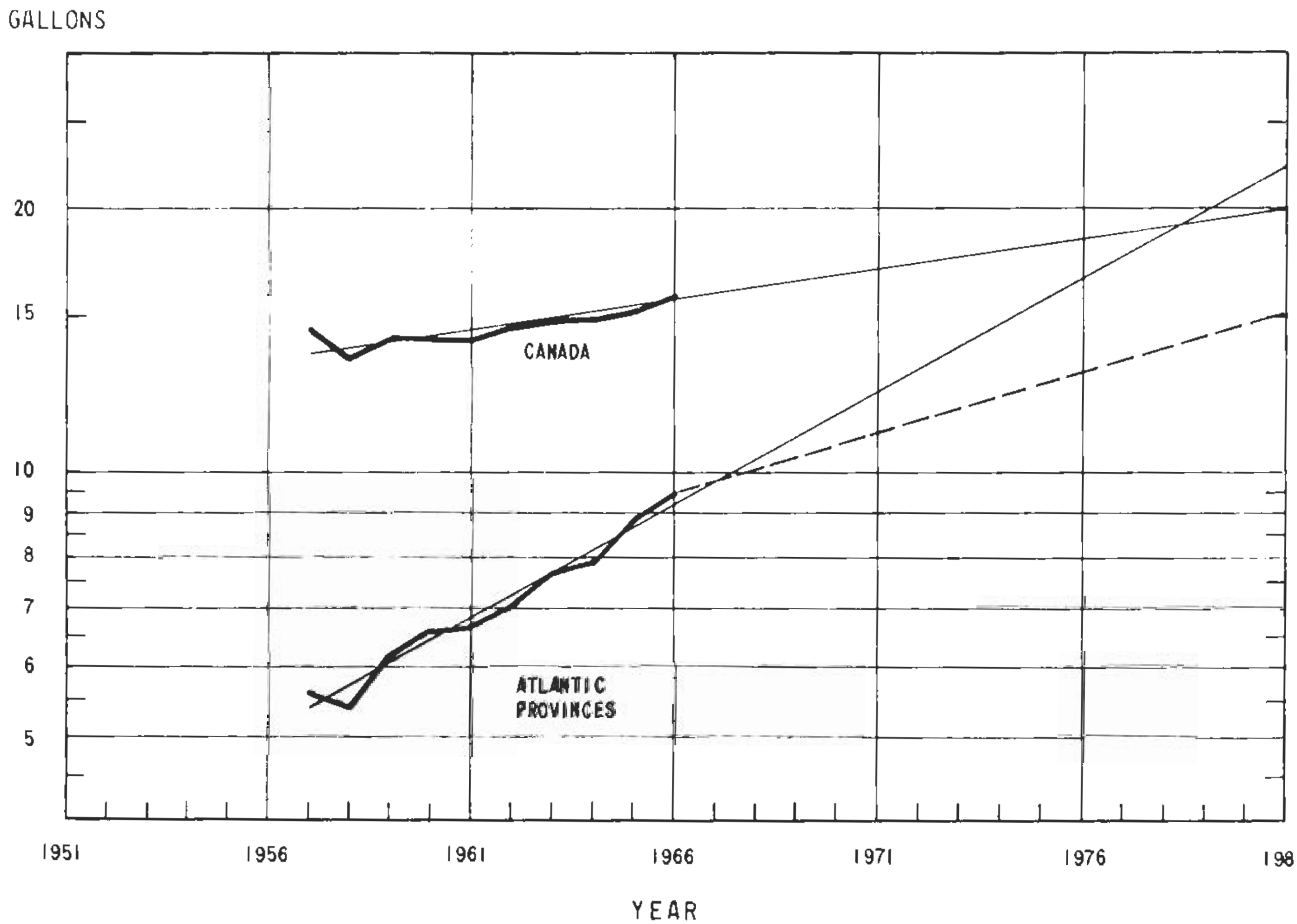
REFERENCES

1 U. S. Bureau of the Census. Census of Manufacturers. Water Intake by Purpose 1964, Gross Water Used and Discharged, 1964 and 1959. Washington, GPO.

2 O'Rourke, J. T., and Tomlinson, H. D. Extreme Variations in Brewery Waste Characteristics and Their Effect on Treatment. In Proceedings of the Seventeenth Industrial Waste Conference, Purdue University, 1962.

3 Porges, T., et al. Wastes from the Soft Drink Bottling Industry. In Proceedings of the Fifteenth Industrial Waste Conference, Purdue University, 1960.

ESTIMATED PER CAPITA "CONSUMPTION" OF BEER, CANADA AND ATLANTIC PROVINCES 1956 - 1981

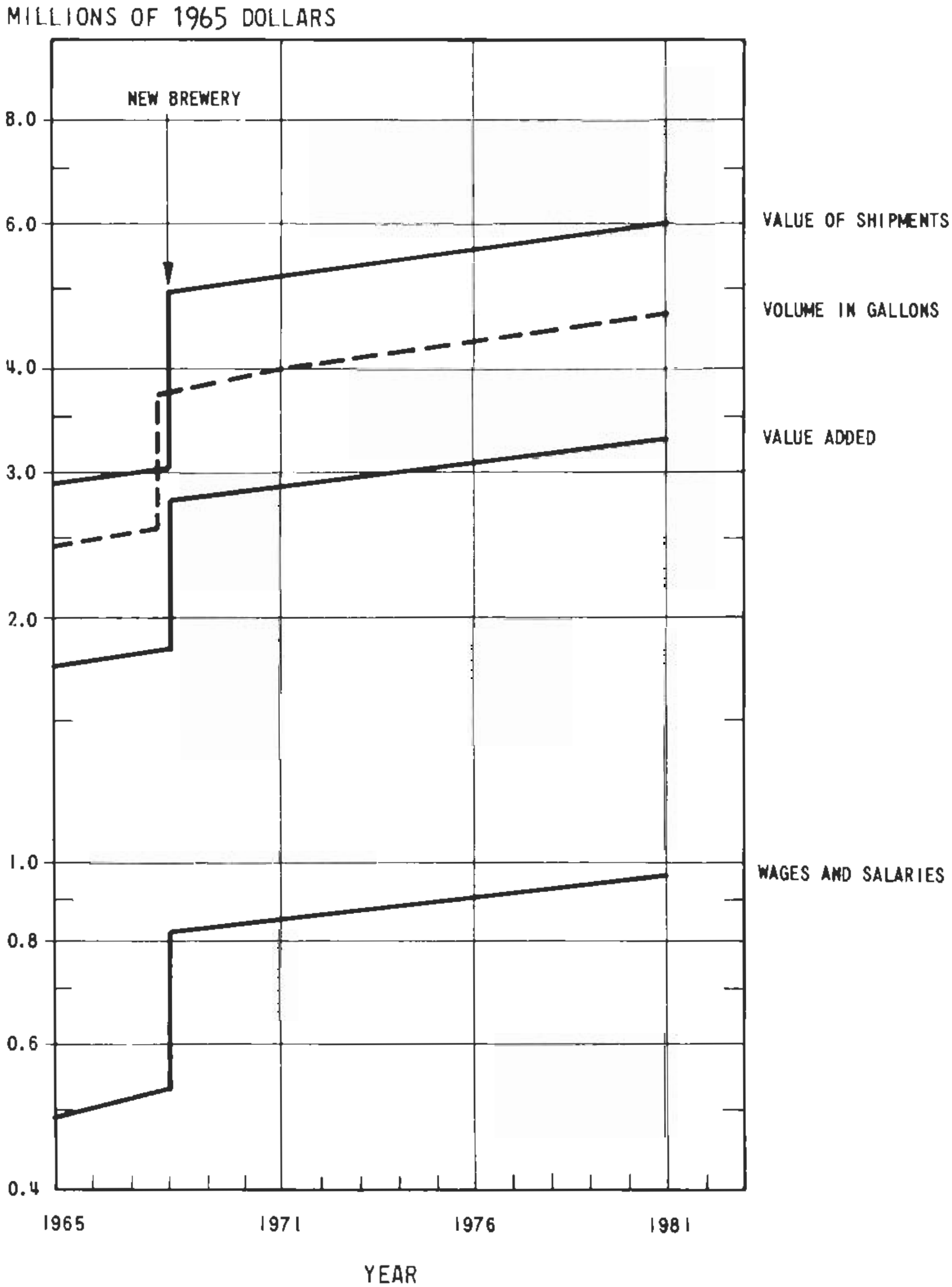


SOURCE: DBS CAT 32-205

NOTE: "CONSUMPTION" BASED ON DOMESTIC PRODUCTION OF BEER

FIGURE 15-1A

NEWFOUNDLAND
FORECASTS OF THE BREWERY INDUSTRY
1965 - 1981



SOURCE: ADB

FIGURE 15-1B

RELATIONSHIP BETWEEN ECONOMIC FACTORS IN THE BREWERY INDUSTRY (TOTAL ACTIVITY) CANADA

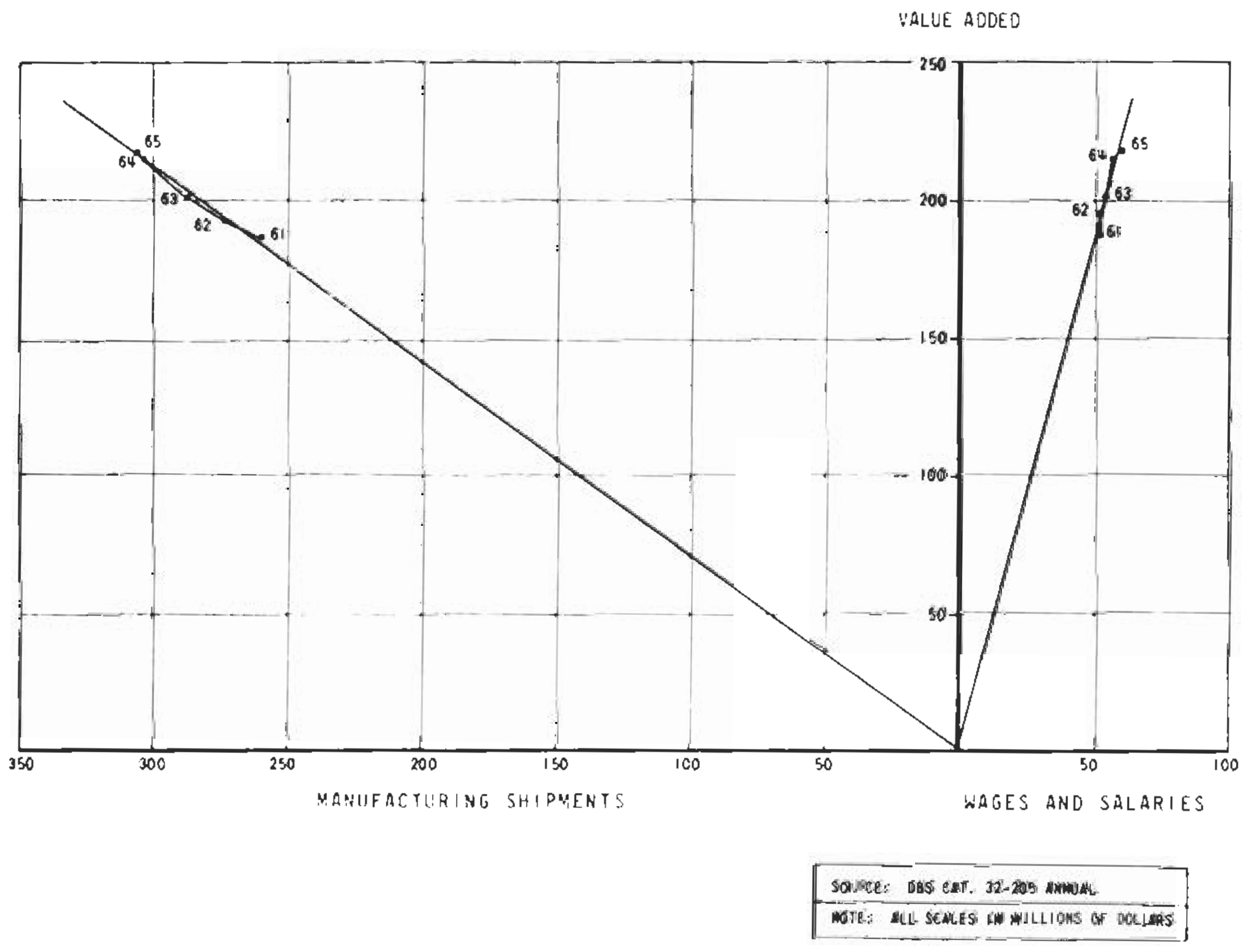


FIGURE 15-2

APPROXIMATE RELATIONSHIP FOR PROBABLE WATER DEMAND IN THE BREWERY INDUSTRY

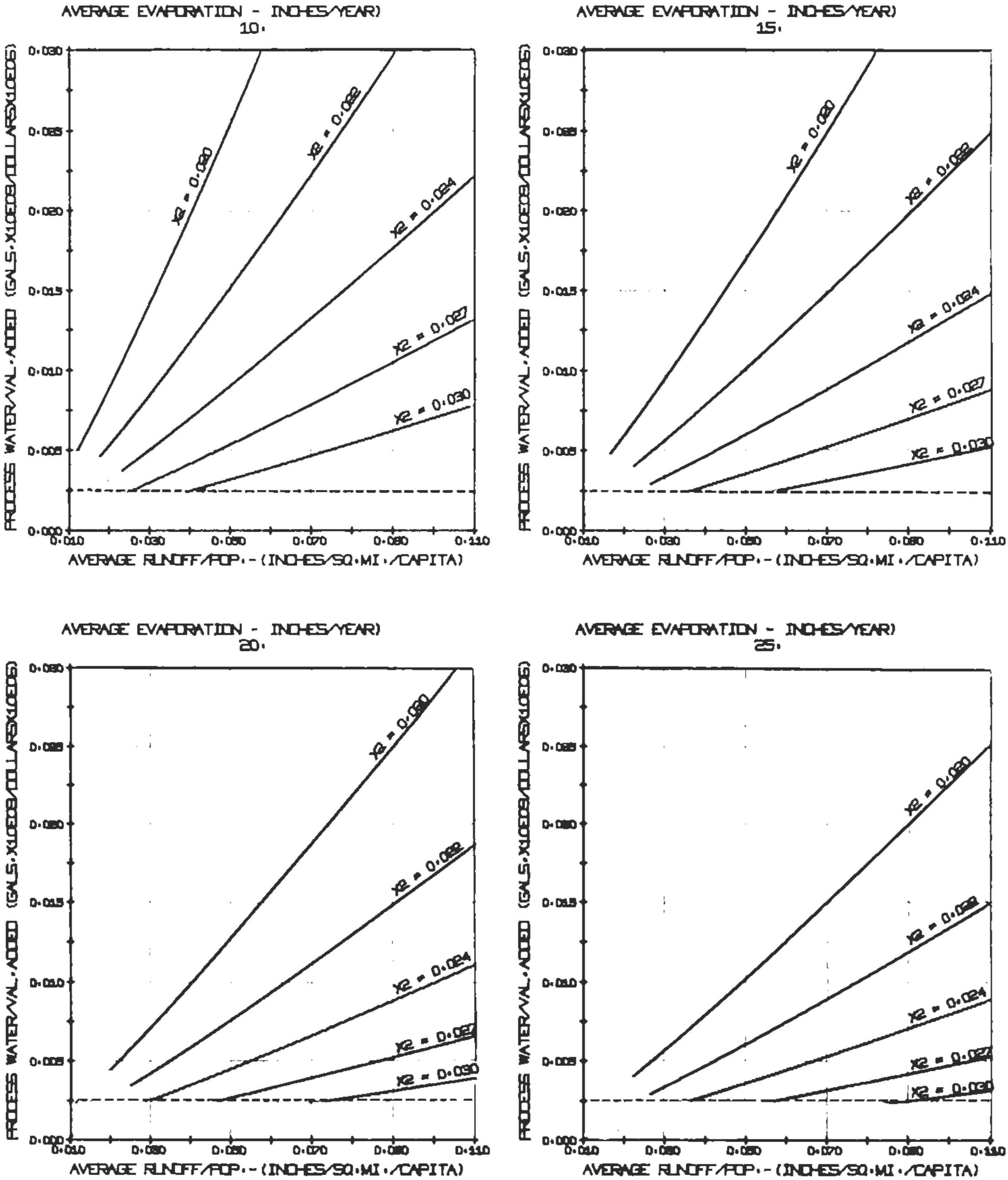


FIGURE 15-3

NOTE: DO NOT EXTRAPOLATE BELOW DOTTED LINE

NEWFOUNDLAND PRESENT AND ESTIMATED FUTURE WATER DEMAND BY THE BREWERY AND SOFT DRINK INDUSTRIES

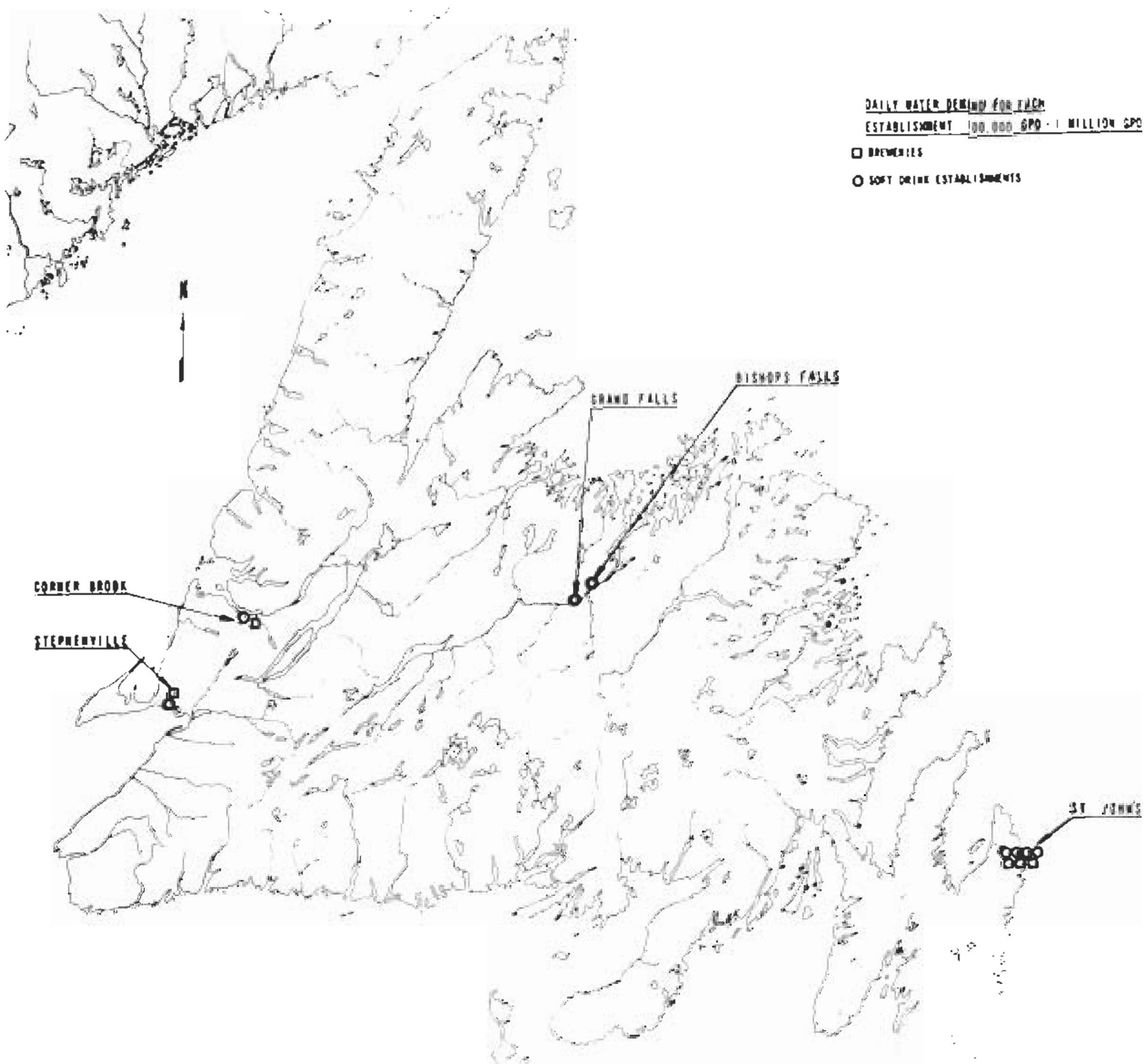
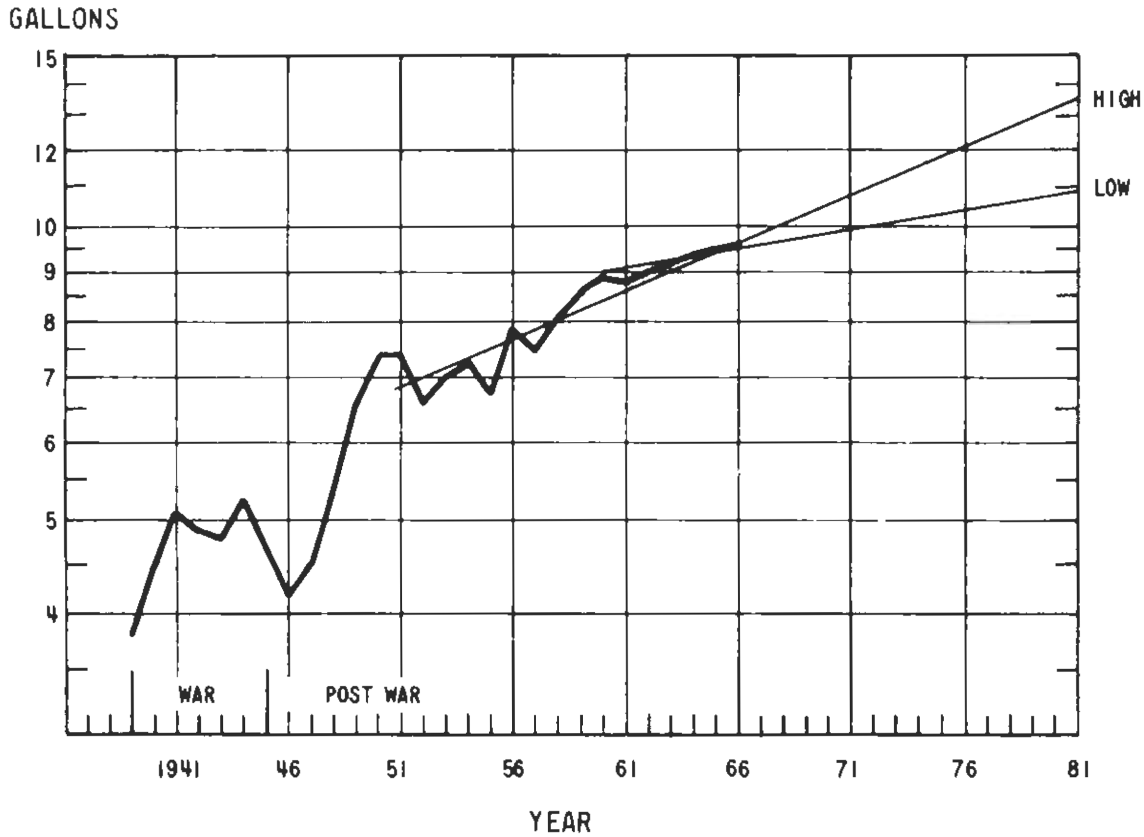


FIGURE 15-4

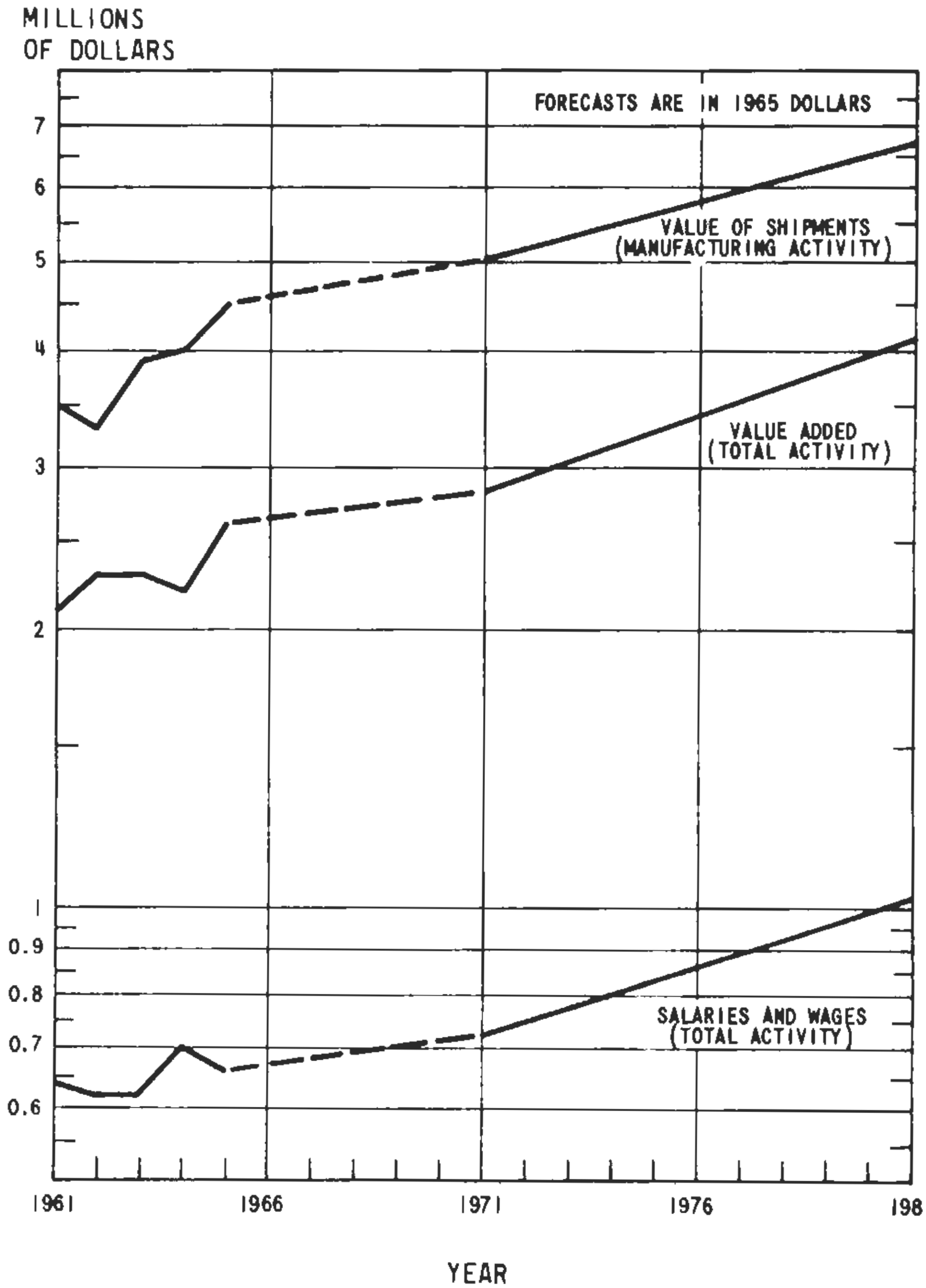
PER CAPITA CONSUMPTION OF SOFT DRINKS - CANADA *



SOURCE: DBS CAT.32-208
* ESTIMATED ON BASIS OF PRODUCTION DATA

FIGURE 15-5A

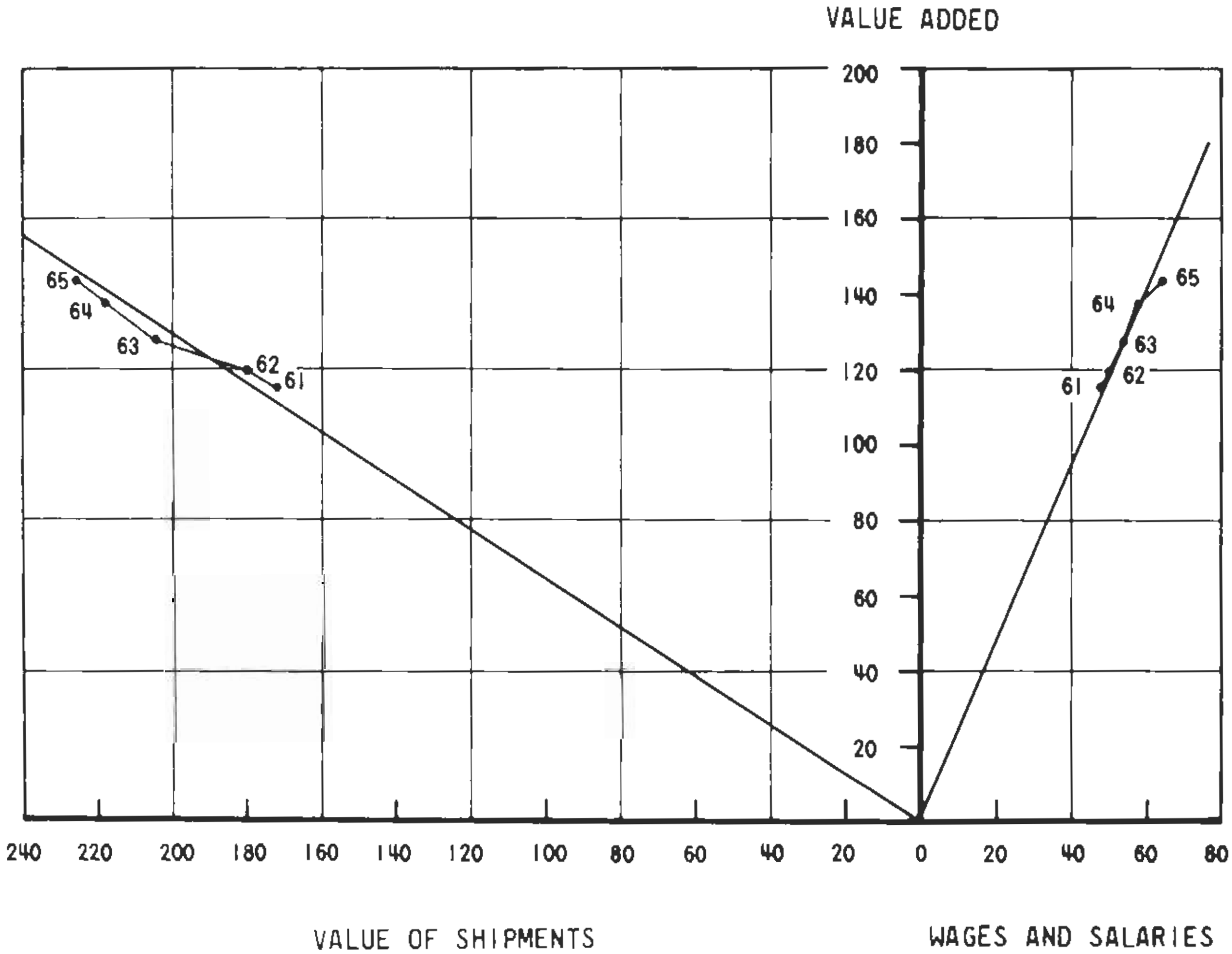
NEWFOUNDLAND
TRENDS AND FUTURE DEVELOPMENTS
SOFT DRINK INDUSTRY
1961 - 1981



SOURCE: 1961-65 DBS CAT.32-208
1971-81 ADB

FIGURE 15-5B

RELATIONSHIP BETWEEN ECONOMIC FACTORS SOFT DRINK INDUSTRY (TOTAL ACTIVITY) CANADA



SOURCE:	DBS CAT. 32-208
NOTE:	ALL UNITS IN MILLIONS OF DOLLARS.

FIGURE 15-6

16 TEXTILE, CHEMICAL, AND OTHER MANUFACTURING INDUSTRIES

16.1 General Economic Framework

Other than those discussed individually in the preceding sections, the manufacturing industries in the Province are small. They are designed to serve domestic markets which places a restriction on size because of the small population and relatively low levels of personal disposable income. Market conditions for these "existing manufacturing industries" are not expected to change greatly over the forecast period.

However, there are some interesting possibilities for the expansion of the manufacturing sector that lie outside the existing manufacturing base. For clarity these possibilities are divided into two groups, those termed "chemical industries possibilities" which stem primarily from developments taking place in other industries on the Island, and those termed "market oriented industries" which could develop if provincial conditions are turned to advantage in the competition for national markets.

16.2 Present Day Conditions

The existing manufacturing industries included in this section are shown on Table 5-2 where they are identified by an asterisk (*). Many of these industries are represented by only one or two firms, and no statistics on industry operations are published by DBS. Under the circumstances the figures for most of the industries included on Table 5-2 are approximations. (This applies to the iron foundry whose water usage is discussed in Section 16.5.)

The establishments within each industry, with the exception of commercial printing and printing and publishing, are small with values of shipments of less than a million dollars a year and fewer than 100 employees. These establishments are not major industrial water users and their water demand is included under municipal demand.

16.3 Potential and Planned Development

16.3.1 Existing Manufacturing Industries

The forecasts for the existing manufacturing industries were provided by the Board in the frame of the general economic assumptions and are shown for 1971, 1976, and 1981 on Table 5-2. The assumptions underlying these forecasts may be summarized very briefly as follows: the first basic assumption was that the value of shipments and value added would grow, in real terms expressed as 1965 dollars, at five percent a year; secondly, it was assumed that productivity, or value added per employee, would increase at two and one-half percent a year. It is recognized that these assumptions are global and that individual industries will probably have variable growth patterns.

The aggregate employment of the 26 industries included in this sector is estimated to be 2600 by 1981 which represents about two percent of total employment forecast for the Province by 1981. At the provincial level these industries are not significant employers, but at the local level some industries may have considerable impact. However, within the provincial framework their size does not warrant detailed analysis and their water demand generally is included in the municipal demand.

16.3.2 Chemical Industries Possibilities

The developments anticipated in the pulp and paper industry and the oil refining industry may offer diversification opportunities to the secondary manufacturing sector. The realization of such opportunities would be of significance both economically and in terms of water demand and supply. Unfortunately, no estimates of their potential size either in terms of employment or in terms of value of shipment and value added were available; therefore, any figures used in this section are order of magnitude estimates only.

The following comments are intended to underline the fact that if and when tangible information becomes available, a review must be made not only of the economic implications, but also of the water implications in the location area.

Generally speaking, major expansions in the secondary manufacturing sector will locate in the larger established urban areas. This is the natural consequence of the more developed infrastructure and of the quantity and quality of the labour force available.

The Board provided a list of the type of industries that may locate in the Province. While no information was available at the time of writing, the possibility of a chlorine and caustic soda establishment deserves mention because such an establishment appears to be quite sensitive to electric energy costs.

However, while a low cost of electricity could be a location inducement, the costs of transportation of the product are extremely high and tend to restrict location in terms of potential regional markets (Schramm 1968)[1]. Therefore, the size of the potential market for chlorine and caustic soda offered by the expanding pulp and paper industry would be of critical importance to the establishment of such a plant.

Further diversification possibilities are offered by the 100,000 barrel a day oil refinery proposed for Holyrood. This refinery could support a number of related industries such as a plastics and an ammonia industry. The establishment of a plastics industry would depend not only on the economics of the industry itself, but also on the source of crude oil and the production process of the oil refinery. Plans for the oil refinery complex include provision for the establishment of a 1000 ton per day ammonia plant. However, because of the existing market conditions, it was announced in mid-1968 that plans for this ammonia plant had been postponed for an indefinite period. While development potentials of some importance exist, it would appear fairly reasonable to assume that any development which does materialize will not occur until the last few years of the forecast period.

In Section 16.4 the impact upon water resources of the establishment of a major chemical industry on the Island is considered. It would employ 300 to 500 people and contribute a value added of $5 to $8 million annually.

16.3.3 Market Oriented Industries

Within the framework of national supply and demand statistical indications are that the market could support additional domestic textile capacity.

Certain industry and provincial characteristics indicate that the establishment of a textile industry may be feasible and could be beneficial. The industry is included here because its establishment on the Island would place specific demands upon the water resources in terms of quantity and quality.

The specific characteristics of the textile industry are important when placed in the provincial reference. The industry tends to locate in small urban settings. For example, while Montreal is a major textile centre, the textile manufacturing industry is located and continues to locate in the smaller communities around Montreal.

The age of the labour force employed in the textile industry is considerably higher than the average age found in any manufacturing sector. At the present time, the average age of textile workers is 45. The industry does not require a highly skilled labour force which is reflected by the fact that the average textile worker has a grade eight education. Although the education level is comparatively low, the wages and salaries paid in the primary textile industry average 80 percent of the national average manufacturing sector wages and salaries.

The prospects for the establishment of a textile industry increase when it is recognized that one of the Island's established industries offers a potential base for the development of a synthetic material made from cellulose fibre has a rapidly growing market in disposable products. Hospitals and other institutions are using an increasing amount of these disposable products which are considered a growth market by some pulp and paper manufacturers. Further processing of the cellulose fibres results in the synthetic materials used for clothing and such things as carpeting for which expanding potential markets also exist.

In order to measure the impact of the establishment of a textile industry on the water resources of the location area, a major development should be considered. In Section 16.4 the water implications are measured in terms of a textile industry being established with the assumption that the industry would employ 600 to 800 people and contribute a value added in the range of $3 to $4 million.

16.4 Specific Water Demand and Wastes

The industries which were not considered in the preceding sections and would represent significant water resources problems are the chemical, textile, plastics, and fabricated metal industries.

Processing of the US census data has resulted in acceptable relationships for the gross water applied per value added in the chemical industry (Figure 16-2). With the caution required for using relationships established on the basis of very little data, this relationship could be used for preliminary estimates of water demand for planning purposes in this industry, if such development is contemplated in the Province.

The data available from the US census indicate that, for the chemical industry, the ratio between gross water applied and the intake water varies in most cases between 1.5 and 3.0. The water intake data in the US census show regional variation of water intake per dollar of value added to be between 80 and 650 gallons.

For fabricated metal products the ratio between process water, which does not include cooling, and intake water varies between 0.5 and 1. The amount of water intake per dollar of value added for this industry varies in terms of regional averages in the United States between 8 and 40 gallons.

For the textile industry the average requirements per pound processed are indicated in Table 16-1. Because of the possibilities mentioned in Section 16.3, it is interesting to note that the largest water use is for rayon which is produced from cellulose.

For the plastics industry, indications from the US census on use of water in the rubber and plastics industries have been used. The regional average data indicate a water intake per million dollars of value added of between 11 and 92 gallons with one exception (Tennessee) where the figure is 844 gallons.

The quality requirements for the water used in the textile, plastics, and chemical industries, to the extent these data were readily available, are shown in Table 16-2. The amount of wastewater is generally close to the intake water.

The quality of wastewater for all these industries varies widely according to the type of produce and process used; Table 16-3 gives an indication of the extent to which data were readily available.

16.5 Present and Forecast Water Demand and Wastes

The existing small industries covered in this section have their water supply and wastewater sewage connected to municipal systems and, even where exceptions exist, they are not of significance. It may be assumed that these industries do not present significant water resources implications except possibly for localized pollution problems. An example of such an establishment is the only iron foundry on the Island in St. John's. According to the information contained in the Shawinigan-MacLaren questionnaire, the company employs 100 regular employees and operates 250 days a year. Their annual water demand has averaged around 6.4 million gallons or about 25,600 gpd, which is drawn from the St. John's municipal system. The water is used primarily for cooling, with a small amount being used for acid cleaning and domestic purposes. The discharge quantity reported was the same as the intake, although this is probably an approximation because of losses in the cooling use. The company reported no expansion plans over the forecast period.

If in the future similar industries develop in different centres, the water demand will probably be only of local significance. Except for an investigation of the nature and amount of wastes to assess in-plant treatment requirements, it is unlikely that these industries would create problems outside the municipal systems to which they will be connected.

If a large textile or chemical industry should be established on the Island, however, it could involve a significant demand for water and possibly a waste disposal problem. For a textile industry making rayon or a similar product based on cellulose and employing 600 to 800 people, a large chemical industry associated with pulp and paper, or oil refining employing 300 to 400 people, daily requirements would be in the order of 5 to 15 million gallons, according to the data included in Section 16.4.

The amount of wastewaters would be of the same order; their characteristics cannot be indicated because of the difficulty of assessing the type of industry involved. However, Table 16-3 together with Figures 16-1A, 16-1C and 16-6A, B, C and D can be helpful in assessing the possible amounts of wastes.

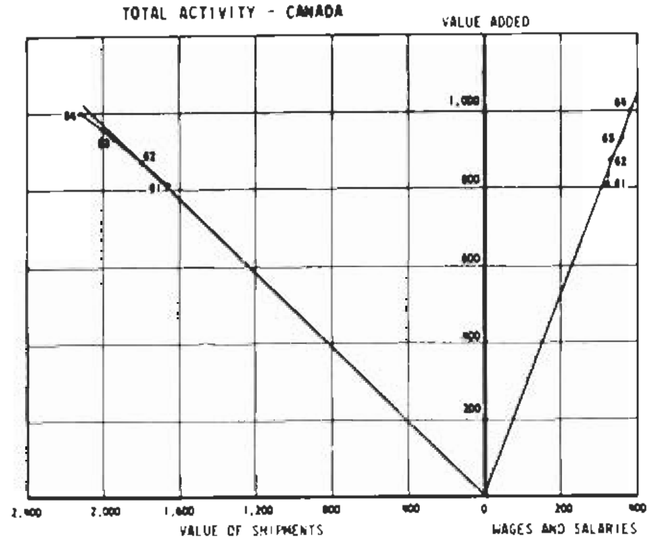
REFERENCES

1 Schramm, G. The Effect of Low-Cost Hydro Power on Industrial Location. Canadian Economic Association. Annual Meeting. Calgary, 1968.

RELATIONSHIP BETWEEN ECONOMIC FACTORS IN THE CHEMICAL INDUSTRIES

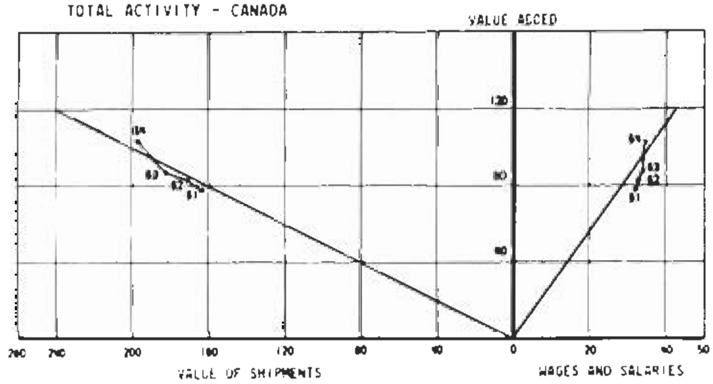
CHEMICAL AND CHEMICAL PRODUCTS INDUSTRIES - TOTAL ACTIVITY - CANADA

FIGURE 16-1A



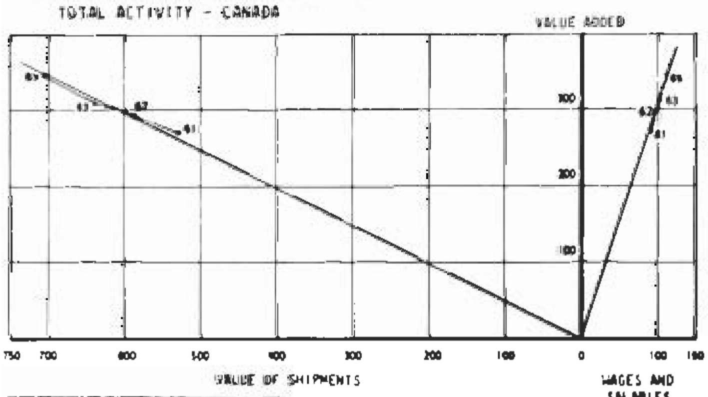
PAINT AND VARNISH MANUFACTURERS- TOTAL ACTIVITY - CANADA

FIGURE 16-1B



MANUFACTURERS OF INDUSTRIAL CHEMICALS- TOTAL ACTIVITY - CANADA

FIGURE 16-1C

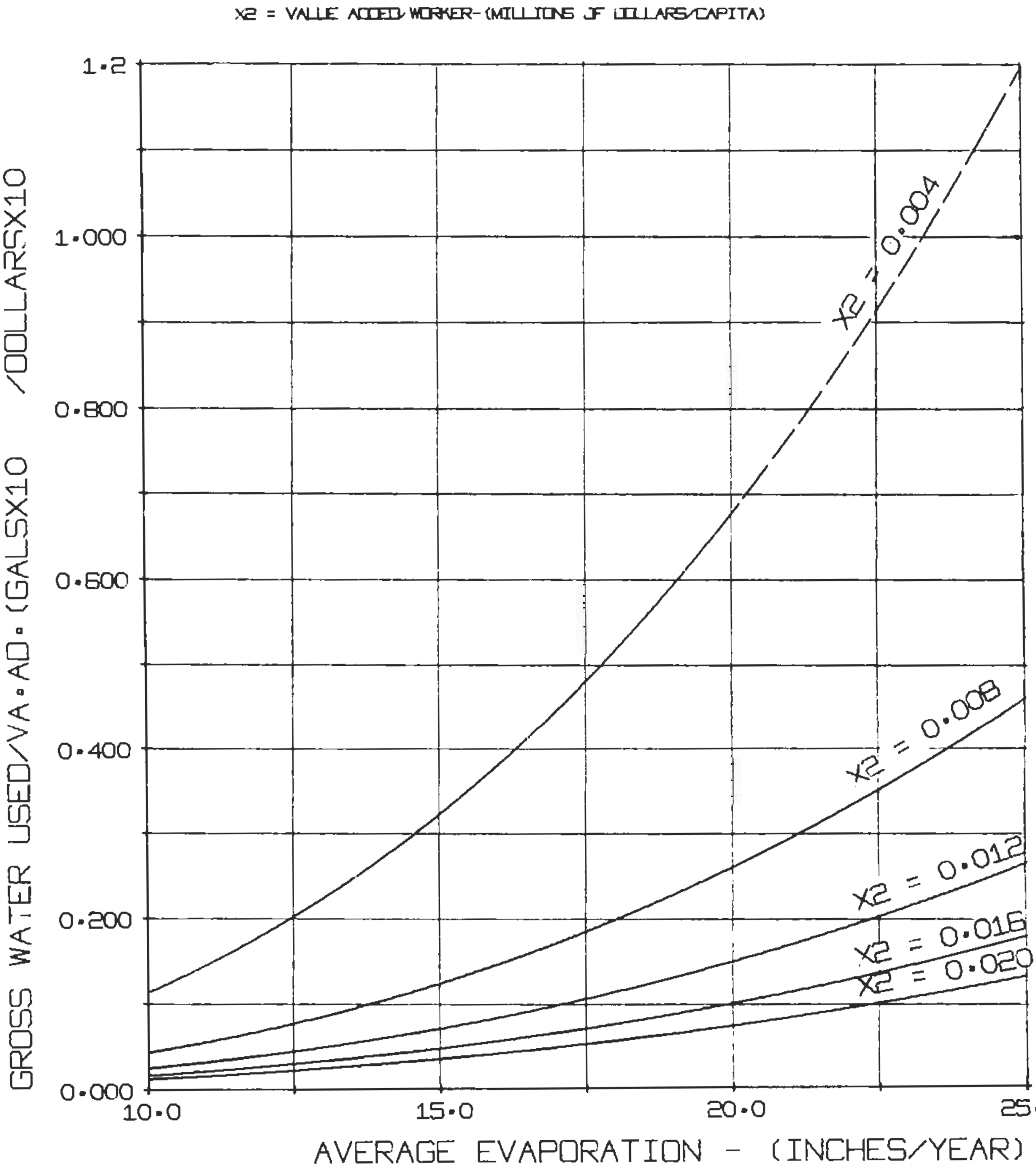


SOURCE: DBS [illegible]

NOTE: ALL SCALES IN THOUSANDS OF DOLLARS

FIGURE 16-1

APPROXIMATE RELATIONSHIP FOR ESTIMATING GROSS WATER USED IN THE CHEMICALS AND ALLIED PRODUCTS INDUSTRY



SOURCE U.S. CENSUS: WATER USE
U.S. WEATHER BUREAU

FIGURE 16-2

RELATIONSHIP BETWEEN ECONOMIC FACTORS IN THE METAL PROCESSING INDUSTRIES

FIGURE 16-3A

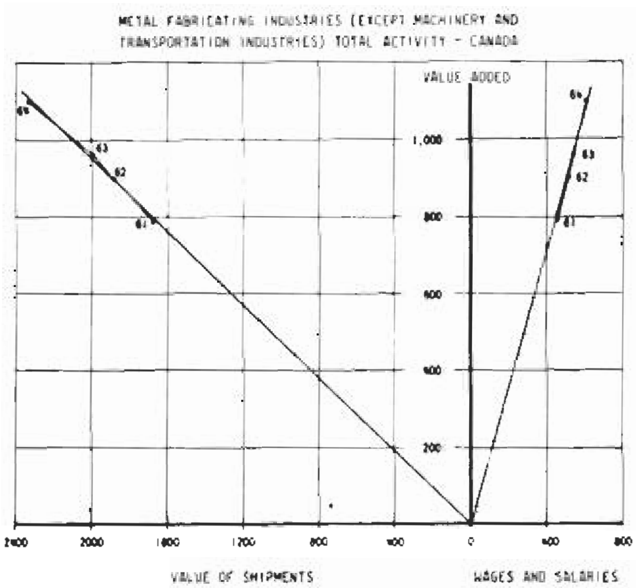
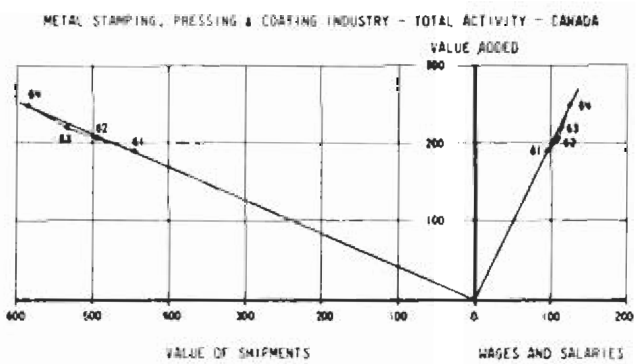


FIGURE 16-3B



SOURCE: DBS CAT. 31-203
NOTE: ALL SCALES IN MILLIONS OF DOLLARS

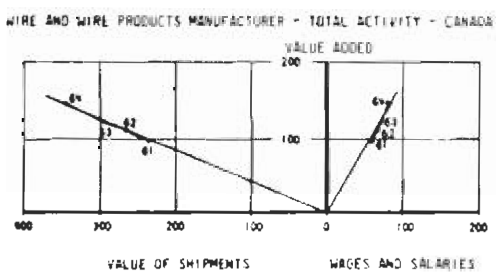


FIGURE 16-3C

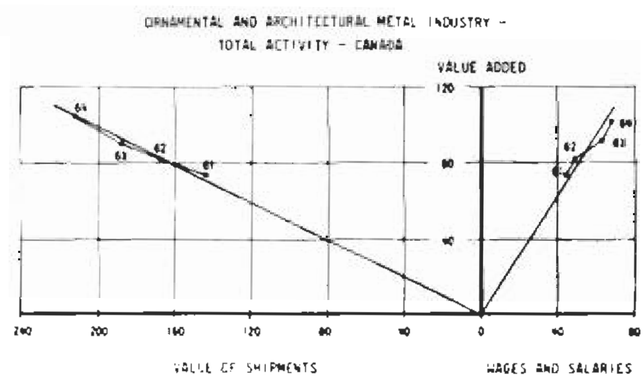


FIGURE 16-3D

RELATIONSHIP BETWEEN ECONOMIC FACTORS IN THE TEXTILE INDUSTRIES

FIGURE 16-4A

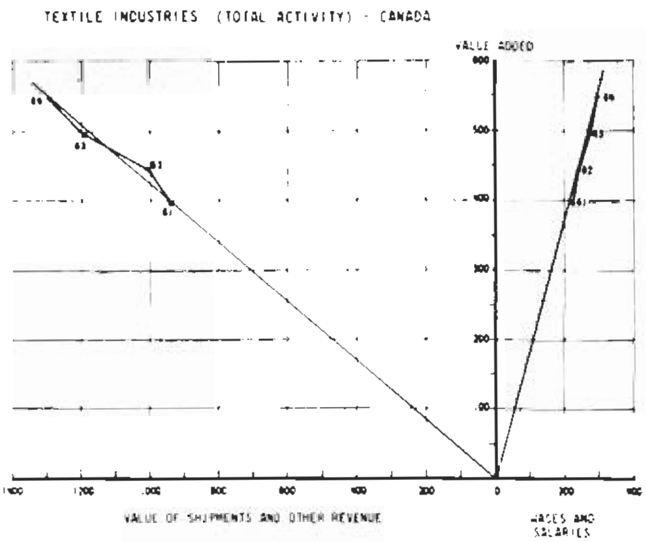
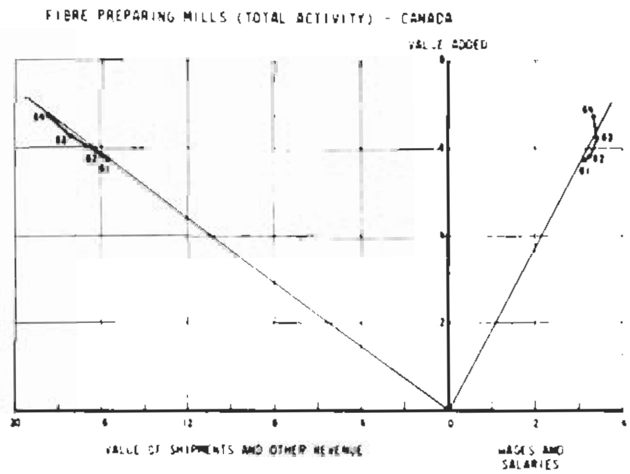


FIGURE 16-4B



SOURCE: DBS 31-203
NOTE: ALL SCALES IN MILLIONS OF DOLLARS

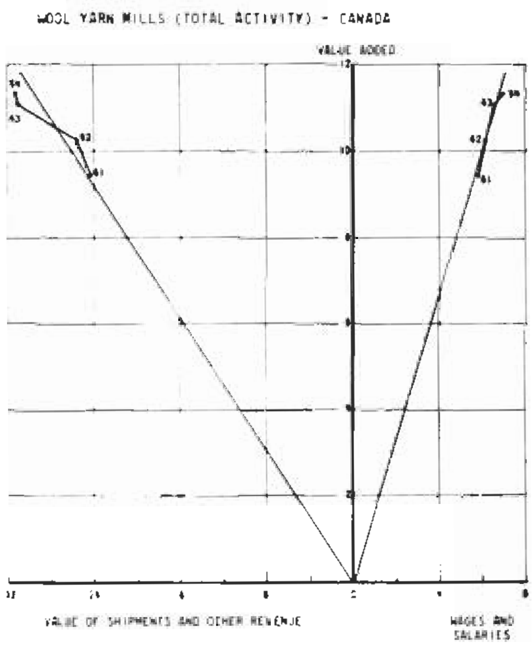


FIGURE 16-4C

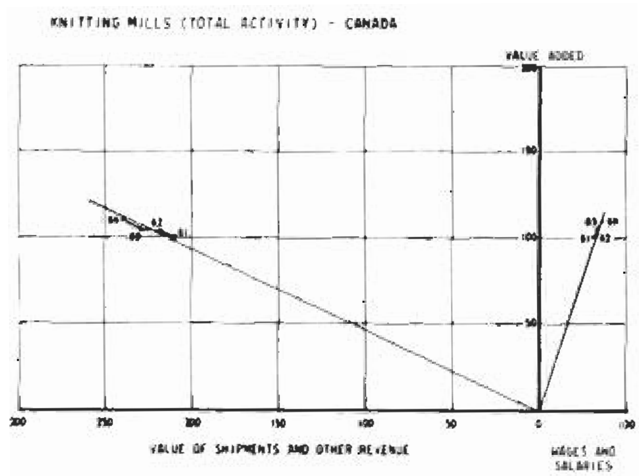


FIGURE 16-4D

FIGURE 16-4

TEXTILE AND PLASTICS INDUSTRY

MAXIMUM ALLOWABLE CONCENTRATIONS

	Textiles General	Dyeing	Wool Scouring	Cotton Bandage	Rayon - Viscose	Clear Plastics
Turbidity JTU	25	5.0	-	5.0	5.0	2.0
Colour units	70	20.0	70	5.0	5.0	2.0
Iron and Manganese	1	0.25	1	-	0.1	0.02
Iron	1	0.25	1	0.2	0.1	0.02
Manganese	1	0.25		0.2	0.05	0.02
Hardness as $CaCO_3$	50				50.0	
COD	8					
Calcium	10					
Magnesium	5					
Sulphate	100					
Chloride	100					
Bicarbonate as CO_3	200					
Total solids		200			100	200
Other requirements	constant composition			no slime formation		

Source: Goudreau, J. P., and Asselin, R., "Industrial Use of Waters", Background Paper A4-1-6, prepared for the National Conference on Pollution and our Environment, Montreal, 1966.

TABLE 16-1

TABLE 16-2

WOOL PROCESSING WASTE CHARACTERISTICS
(Based on Annual Production at a Typical Mill)

	Weight of cloth processed		BOD		Alkalinity		Acidity		Volume	
	1000 lb per year	% of total plant production	lb per 1000 lb	% of total	lb per 1000 lb	% of total	lb per 1000 lb	% of total	imp gal per 1000 lb	% of total
Scouring for grease removal	473	59	104.5	42	109.3	58	0	0	3,071	7
Stock dyeing	700	88	34.3	14	12.8	7	0	0	1,562	3
Washing after fulling	800	100	94.0	37	38.2	20	0	0	27,313	59
Return fulling	176	22	15.0	6	13.9	8	0	0	3,800	8
Neutralization after carbonizing	800	100	1.7	0.7	12.7	7	40.5	100	10,432	22
Optical bleach	100	13	1.4	0.5	1.1	0.6	0	0	223	0.5
Total	800	-	250.9	-	188.0	-	40.5	-	46,401	-

A composite of all wastes would contain 432 mg/litre BOD and 237 mg/litre alkalinity

Source: Gurnham, C. F., Editor, Industrial Wastewater Control, Academic Press.

TABLE 16-3

COTTON PROCESSING WASTE CHARACTERISTICS

	Concentrations			Total Quantities			
Process	pH	BOD mg/litre	Total solids, mg/litre	Flow imp gal/1000 lb	BOD lb/1000 lb	Total solids lb/1000 lb	Population equivalents per 1000 lb
Slashing and sizing	7.0 - 9.5	620 - 2500	8,500 - 22,600	50 - 783	0.5 - 5.0	47 - 67	2 - 30
Desizing	-	1700 - 5200	16,000 - 32,000	250 - 916	14.8 - 16.1	66 - 70	90 - 100
Kiering	10 - 13	680 - 2900	7,600 - 17,400	258 - 1,416	1.5 - 17.5	19 - 47	10 - 105
Scouring	-	50 - 110	-	1,915 - 4,247	1.36 - 3.02	-	8 - 18
Bleaching	8.5 - 9.6	90 - 1700	2,300 - 14,400	250 - 12,407	5.0 - 14.8	38 - 290	30 - 90
Mercerizing	5.5 - 9.5	45 - 65	600 - 1,900	23,232 - 30,768	10.5 - 13.5	185 - 450	60 - 80
Dyeing:							
Aniline Black	-	40 - 55	600 - 1,200	12,490 - 19,152	5 - 10	100 - 200	40 - 60
Basic	6 - 715	100 - 200	500 - 800	14,989 - 29,977	15 - 50	150 - 250	100 - 400
Developed colours	5 - 10	75 - 200	2,900 - 8,200	7,411 - 20,818	15 - 50	325 - 650	90 - 120
Direct	6.5 - 7.6	220 - 600	2,200 - 14,000	258 - 5,329	1.3 - 11.7	25 - 250	25 - 75
Indigo	5 - 10	90 - 1700	1,100 - 9,500	500 - 4,996	0.8 - 9.5	20 - 63	10 - 60
Naphthol	5 - 10	15 - 675	4,500 - 10,700	1,915 - 13,989	2 - 15	200 - 650	13 - 80
Sulphur	8 - 10	10 - 1800	4,200 - 14,800	2,415 - 21,217	2 - 250	300 - 1200	14 - 1500
Vats	5 - 10	125 - 1500	1,700 - 7,400	833 - 16,654	12 - 30	150 - 250	75 - 175

Source: Gurnham, C. F., Editor, Industrial Wastewater Control, Academic Press

SYNTHETIC FIBRE PRODUCTION - WASTEWATER CHARACTERISTICS

AVERAGE WASTELOAD PRODUCTION RATES
PER THOUSAND POUNDS OF CLOTH PRODUCED

SUBPROCESS	FIBRE	VOLUME (Imp. Gal)	BOD (lb)	SUSPENDED SOLIDS (lb)	TOTAL DISSOLVED SOLIDS (lb)
Scour	Nylon	4,996 - 6,662	[illegible] - 40	20 - 40	30 - 50
	Acrylic	4,996 - 6,662	15 - 30	25 - [illegible]	12 - 20
	Polyester	2,498 - [illegible]	15 - 25	- 15	25 - 35
Scour and Dye	Rayon	1,665 - 3,330	50 - 70	0 - [illegible]	25 - [illegible]
	Acetate	3,330 4,996	40 - 60	-	-
Dye	Nylon	1,665 - 3,330	5 - 20	1 - 20	20 - [illegible]
	Acrylic	1,665 - 3,330	2 - 40	2 - 42	6 - 9
	Polyester	1,665 - 3,330	15 - 600	5 - 20	50 - 200
Salt Bath	Rayon	416 - 1,250	0 - 3	-	20 - 200
Final Scour	Acrylic	6,662 - 8,327	10 - 25	2 - 6	5 - 12
	Polyester	1,665 - 3,330	15 - 25	3 - 7	10 - 50
Special	Rayon	416 - 1,250	20	5 - 50	3 - 100
	Acetate	2,498 - 4,164	40	3 - 50	5 - 100
	Nylon	3,330 - 4,996	10	3 - 50	3 - 100
	Acrylic	4,164 - 5,829	60	3 - 50	3 - 100
	Polyester	833 - 2,498	2 - 80	3 - 50	3 - 100
Total	Rayon	2,498 - 5,829	20 - 40	20 - 90	20 - 500
	Acetate	5,829 - 9,160	40 - 50	20 - 60	20 - 300
	Nylon	9,992 - 14,989	35 - 55	20 - 40	20 - 300
	Acrylic	17,482 - 24,148	100 - 150	25 - 150	25 - 400
	Polyester	6,662 - 15,323	120 - 250	30 - 160	30 - 600

Source: Cost of Clean Water, Volume III,
Industrial Waste Profile No. 4,
Textile Mill Products

PART VI - COMMODITY PRODUCING SECTORS - ENERGY AND CONSTRUCTION

17 ENERGY PRODUCTION - THERMAL

17.1 General Economic Framework

This section deals only with the Island of Newfoundland as it is expected that energy requirements in Labrador will be supplied largely by hydro power.

Generation of electricity on the Island developed in isolated centres across the Island. In the centre and west, the pulp and paper industry were located close to potential hydro-electric sites, while in the east, the light industrial and domestic load around St. John's was serviced by several small hydro plants. These hydro installations, plus other smaller plants in the outports, all developed separately with their own local transmission and distribution systems serving limited areas. These systems developed as industry and population expanded, and in the St. John's area in the 1950's, thermal stations were constructed as economical hydro power sites were no longer available nearby.

This pattern of individual development has recently changed with the commissioning of the large hydro power station at Bay D'Espoir in 1967 and a 230 kv transmission network connecting the three main load centres in the east, the centre, and the west to the development. Bay D'Espoir is probably the last large economic site for production of hydro power on the Island, although it is possible that one or two medium-sized plants may be developed as discussed in Volume Four.

For the purpose of this study, it has been assumed that future supplies of power and energy for the Island will come from the Upper and Lower Churchill River Development, the first block to be imported in 1972. In the meantime, the load growth will be supplied by the Stage II development at Bay D'Espoir supplemented by a 300 Mw oil-fired thermal plant to be built at Holyrood which is scheduled to be on line in 1971. This plant will be the first large thermal power station to be built in the Province.

17.2 Present Development

At the present time, the installed power capacity connected to the Island grid consists of the following:

Island of Newfoundland
Installed Power Capacity Connected to Transmission Grid
December 31, 1967

Hydro		
Newfoundland and Labrador Power Commission	229,500 kw	
Newfoundland Light and Power Company	77,800 kw	
Bowater Power Company Limited	128,151 kw	
Price (Nfld.) Pulp & Paper Limited	47,675 kw	
Others	1,760 kw	
		484,886 kw
Thermal - Steam		
Newfoundland Light and Power Company	30,000 kw	
Bowater Power Company Limited	6,600 kw	
Price (Nfld.) Pulp & Paper Limited	10,000 kw	
Others	5,000 kw	
		51,600 kw
Thermal - Gas Turbine		
Newfoundland and Labrador Power Commission	14,150 kw	
		14,150 kw
Thermal - Diesel		
Newfoundland Light and Power Commission	6,539 kw	
		6,539 kw
TOTAL		557,175 kw

Excludes plants smaller than 1500 kw.

All thermal units are small and water supply is not a problem.

17.3 Potential Development and Planned Expansion

The forecast requirements for electrical energy can be met by the construction of thermal plants on the Island or by the infeed via DC transmission line of power generated by hydro-electric plants in Labrador. Economic studies comparing the two alternatives are under way and for the purposes of this report, the Board has provided the following assumptions regarding power supply:

Island of Newfoundland
Installed Power Capacity Connected to Transmission Grid
as of December 31, 1967

	Megawatts		
	1967	1976	1981
Hydro			
Newfoundland and Labrador Power Commission	230	459	684
Newfoundland Light and Power Company	78	78	78
Bowater Power Company Limited	128	128	128
Price (Nfld.) Pulp & Paper Limited	48	48	48
Others	2	2	2
	486	715	940
Thermal - Steam			
Newfoundland and Labrador Power Commission	-	300	300
Newfoundland Light and Power Company	30	30	30
Bowater Power Company Limited	7	7	7
Price (Nfld.) Pulp & Paper Limited	10	10	10
Others	5	5	5
	52	352	352
Thermal - Gas Turbine			
Newfoundland and Labrador Power Commission	14	14	14
Newfoundland Light and Power Company	-	14	14
	14	28	28

Thermal - Diesel	Megawatts 1967	1976	1981
Newfoundland Light and Power Company	7	7	7
HVDC From Labrador			
Newfoundland and Labrador Power Commission	-	1080	1440
TOTAL	559	2182	2767

The increase in thermal power shown between 1967 and 1976 is mainly the 2 x 150 Mw thermal plant now under construction at Holyrood near St. John's. This plant has been located at Holyrood because of system load conditions and available fuel and cooling water. Fuel is available from the oil refinery now located at Holyrood and from overseas tanker. Cooling water is available from the sea.

17.4 Specific Water Demand and Wastes

Water uses for a steam generating station include condenser cooling, boiler make-up, bearing and process water cooling, screen washing, fire protection, sanitary, and drinking water. Each one demands water with certain characteristics, but generally the purer and cooler the water the better. The availability of water for condenser cooling which comprises about 95 percent of the water requirements of a thermal generation station is a large factor in determining the location of the plant. The remaining 5 percent of the water required is service water and a small portion of this may require treatment of various kinds to correct any undesirable characteristics.

Water for condenser cooling may be obtained by direct circulation from a river or the sea; this system requires between 1 and 2 cfs per megawatt of capacity. An alternative system is water re-circulation in which cooling towers or ponds reduce the temperature of the recycled effluent by evaporation. For cooling towers a small quantity of make-up water is required amounting to approximately 12 gpm per megawatt of capacity. For a cooling pond the surface area required varies from 2 to 3 acres per megawatt of capacity. Similarly a small quantity of water is required for make-up purposes.

When using sea water, special attention has to be paid to corrosion, slime formation, and other problems related to water quality in the condensers and water conduits, etc. The use of anti-growth chemicals may induce some local pollution in the area where the wastewater is returned. Station service water requirements for fresh water are low and would not exceed 35 gpm per megawatt of capacity plus provision for a stand-by supply of about 2000 gpm for fire protection. However, only about 12 gpm of this quantity would need to be of high quality for bearing cooling, and boiler make-up water.

The changes in the natural environment brought about by using the nearest water source as a heat sink must also be considered. The thermal sink to a station receives about two million Btu of heat every hour for each megawatt of station capacity. Possible effects of thermal pollution include a reduction in oxygen content of the receiving body of water, an increase in numbers of marine borers of timber piles below the high water mark, and destruction of diatoms or microscopic plant content of plankton. Increases in evaporation, humidity, and fog occurrence may also be experienced in the immediate area of the power station. None of these factors is expected to create a problem under conditions which prevail in Newfoundland.

17.5 Forecast of Water Demand and Wastes

Design and construction of the 300 Mw thermal plant at Holyrood is proceeding with commissioning expected in late 1971. It is proposed to use sea water cooling on a once-through basis with the sea receiving the heated effluent. Sea water for condenser cooling will require about 400 cfs with a temperature rise of about 10 deg F. Service water demand would not exceed 28 cfs but, as already indicated, only about 2 cfs need be good quality water for bearing cooling, boiler make-up, and drinking purposes.

With power from Churchill satisfying future energy requirements until after 1981, no requirement is seen for other thermal generation except for peaking capacity. This could be provided by gas-type turbines which generally are air-cooled.

Should there be a delay in the importation of power from the Churchill River in Labrador, the load can be met by conventional thermal plants. Power system configuration, forecast load distribution, capability of unloading large tankers and the requirement for process and cooling water would most likely limit the sites for construction of large thermal plant to near St. John's on the east and near Stephenville on the west.

18 CONSTRUCTION AND CONSTRUCTION MATERIAL PRODUCTION (other than Quarrying)

18.1 General Economic Framework

The construction industry has experienced considerable expansion since 1949 and now ranks second in net value of commodity production amongst the commodity producers in the Province. By 1966 the total annual value of construction had reached $219 million from a base of $15.2 million in 1949, an increase of over thirteen times.

Although this increase reflects the general economic growth of the Province in this period, the construction industry has increased its proportion of net value of commodity production from 16 percent to 28 percent of the whole from 1949 to 1965. This compares with a national average for the construction sector of about 17 percent in 1965.

Construction material production does not appear to have kept in step with the large growth in construction in this period. Many materials, including lumber for framing and concrete formwork, are imported, usually because local products are not available or because imported material is cheaper.

18.2 Present Day Conditions

The distribution of construction activity by value of work performed and type of structure in the Province in 1966 as given by DBS[1] was as follows:

	(Millions of Dollars)	
Building Construction		
Residential	43.8	
Industrial	11.8	
Commercial	14.5	
Institutional	36.4	
Other	8.7	115.2
Engineering Construction		
Marine	13	
Highways and Aerodromes	44.8	
Waterwork and Sewage Systems	1.1	
Electric Power	32.9	
Other	12.2	104.0
Total Value of Construction		219.2

In building construction, residential building is the largest single component with institutional building second. These latter comprise buildings, such as schools, hospitals, and churches. National percentages of total building construction in 1966 for these two elements are slightly higher for residential building and much lower for institutional building.

In engineering construction, highways rank highest in value of construction in 1966, closely followed by electric power; these consume more than two-thirds of the total value of engineering construction. The national picture is very different, although the ranking is identical, with the value of these two sectors comprising less than half of the total value of engineering construction.

The present day producers of construction materials in the Province are listed in the following table together with the latest production figures available from Department of Mines and Technical Surveys[2].

Company	Product	Annual Production
Atlantic Gypsum Limited	Wallboard Lath	29,000 tons (1967) 8,700 tons (1967)
North Star Cement	Portland Cement	105,000 tons (1965)
Pelley-Shaw Newfoundland Ltd.	Bricks	2.7 million (1962)

18.3 Potential and Planned Development

A recent study of the construction sector by Peat, Marwick, Mitchell & Company[3] forecast a growth rate of 8.7 percent annually for the period 1966 to 1971. Assuming this same rate applies to 1981, the total value of construction in that year will increase to about $600 million current or $500 million constant (1965) as shown in Figure 18-2B.

A forecast of individual elements in the construction sector to 1981 may be of doubtful validity as individual elements are more volatile than the group.

The 8.7 percent annual growth rate makes no allowance for the construction work at Churchill Falls which is estimated to be over $400 million during the period 1966 to 1974. Annual estimates were not available at the time the Peat, Marwick & Mitchell Report was issued, but they note that when these are available they should be added to their estimates over this period.

The producers of construction material listed above have the capacity or plans for increased production, and these are as follows:

Company	Product	Annual Production
Atlantic Gypsum Limited	Wallboard and Lath	68,000 tons (present plant capability)
North Star Cement	Portland Cement	150,000 tons (present expansion) 175,000 tons (1975)
Pelley-Shaw Newfoundland Ltd.	Bricks	4 million (present expansion) 8 million (1970)

18.4 Specific Water Demand and Wastewater

The construction industry uses water either to cement materials together; for example, concrete, bricks, and plasterboard; or to wash or wet materials before use and to continue to wet them for a short period after placing. The quantities are generally small and only reach significant amounts on large sites where central batching of concrete occurs. If aggregate preparation is also carried out at the site, the washing of materials may consume significant volumes of water.

Aggregate washing requirements can be taken as 10 gallons per minute per cubic yard per hour of aggregate produced. The water required per cubic yard of concrete depends upon the structure being built, but may roughly be taken to be 25 gallons per cubic yard of concrete.

The water used for mixing concrete should be reasonably clean and free from objectionable quantities of silt, organic matter, alkali, salts, and other impurities. Water containing sulphate impurities may be used although an SO_4 concentration of 1 percent reduces final strengths by 10 percent. Sea water may be used for mixing as long as it is recognized that the finished product will have reduced strength; 5 percent sodium chloride will reduce strengths by 30 percent according to the United States Department of the Interior[4].

The residues from aggregate washings are the major source of wastes from the construction industry and these would normally be returned to the nearest water body. A wastewater system which includes a retention basin would enable most of the washed material to settle out.

Details of water usage for the small amount of construction material production on the Island are limited, and the following figures are taken from the United States Census of Industrial Water Usage. For the cement industry, gross water use per dollar of value added varied from 462 gallons to 53 gallons. This variation may be due to the two main differences in manufacture known as the wet and dry processes. For the stone, clay, and glass industries, gross water usage per dollar of value added varied from 248 gallons to 31 gallons.

18.5 Present and Forecast Water Demand and Wastewater

As noted above, the water requirements of the construction industry are small. For the largest single construction project on the Island in recent years at Bay D'Espoir, about 46,000 cubic yards of concrete were placed for the powerhouse, spillway, and intake. The materials for this concrete were batched at one location and mixed in transit-mixers on the way to the various sites. This concrete production took place over a period of 18 months and, assuming a uniform rate of production, the annual water requirements for mixing were about 770,000 gallons. To derive an estimate of peak water consumption, it may be assumed that double the average monthly production of concrete was placed in a 15-day period; this reduces to 8,000 gallons per day which is still a relatively small demand.

Large construction sites in the future will have similar water demands which have been shown to be small and, since construction may generally be assumed to be dispersed throughout the Province, there will be little concentration of demand.

REFERENCES

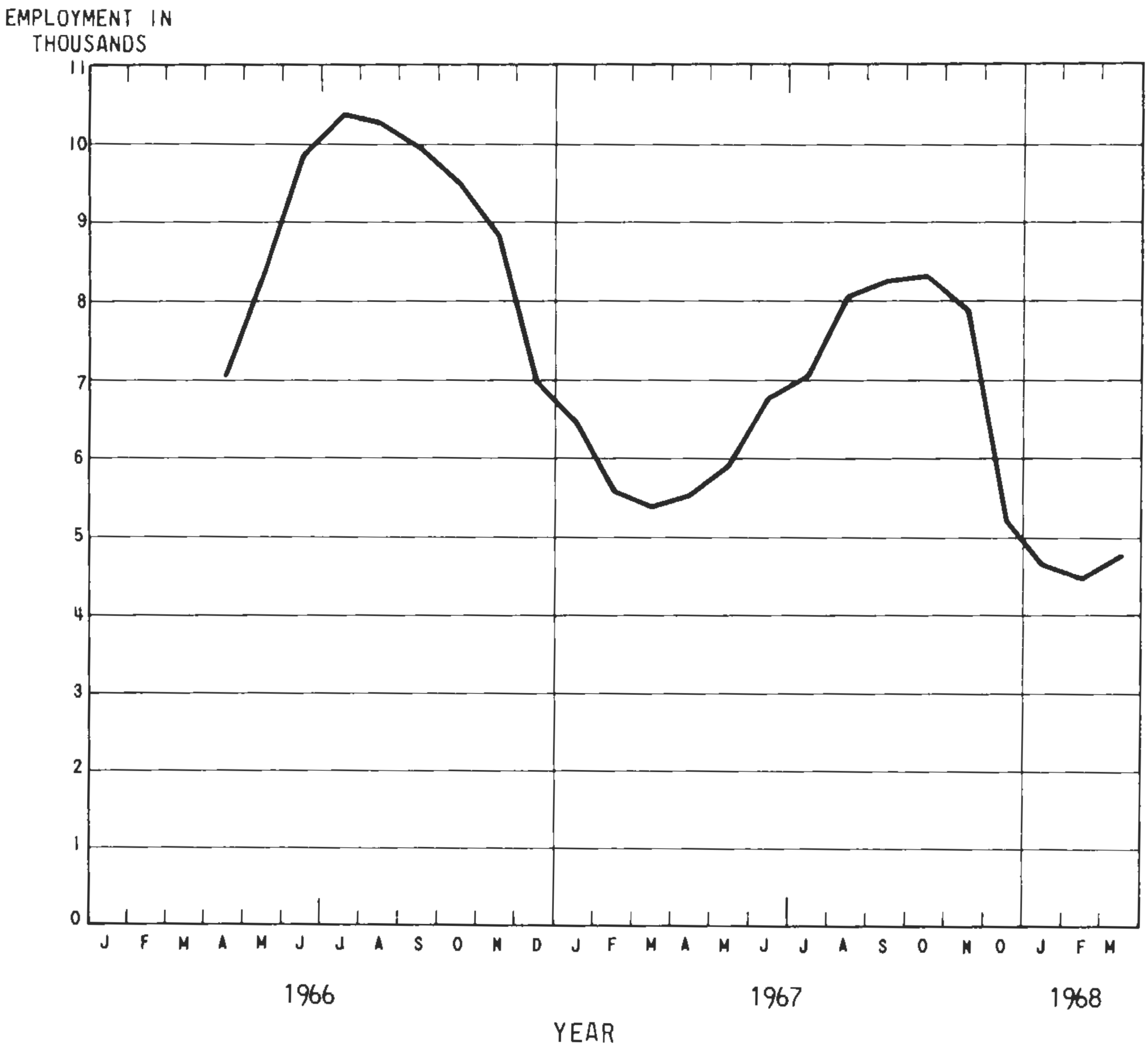
1 Canada. Dominion Bureau of Statistics. Construction in Canada. Annual. Ottawa, Queen's Printer.

2 Canada. Department of Mines and Technical Surveys. Mineral Resources Division. Mineral Resources Development Province of Newfoundland and Labrador. (Internal Report MRI 288/66). 1966.

3 Report of the Royal Commission on the Economic State and Prospects of Newfoundland and Labrador. Sector Study on the Construction Industry. Peat, Marwick, Mitchell and Co. January 1967.

4 United States. Bureau of Reclamation. Concrete Manual. Sixth Edition. Washington, GPO, 1955.

NEWFOUNDLAND AND LABRADOR
SEASONAL PATTERN OF EMPLOYMENT
IN THE CONSTRUCTION INDUSTRY



SOURCE: DBS CAT. 72-002

NEWFOUNDLAND AND LABRADOR
LEVEL OF ACTIVITY IN THE CONSTRUCTION INDUSTRY BY INDUSTRY OR BY SPENDING SECTOR 1951 - 1964

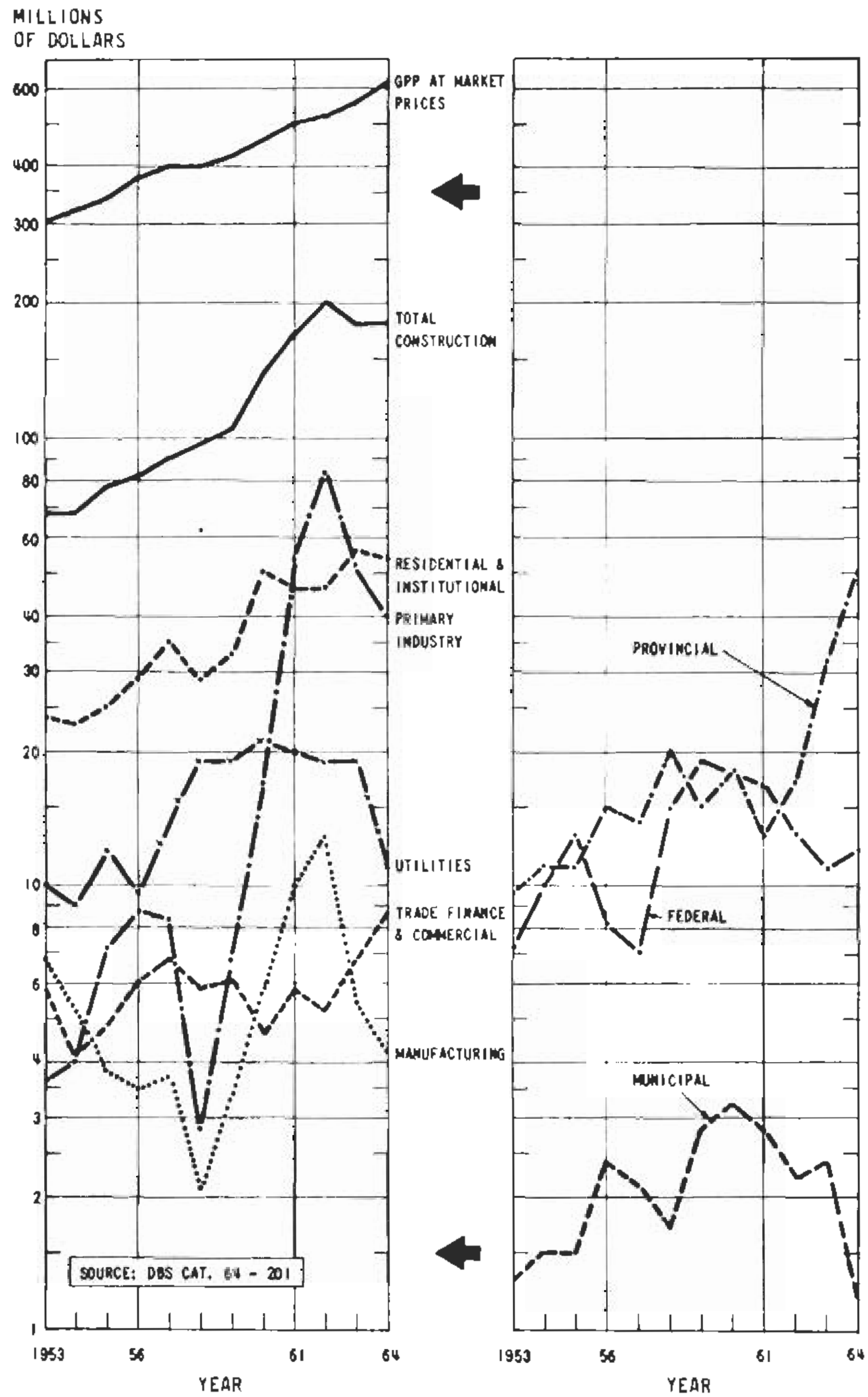


FIGURE 18-2A

NEWFOUNDLAND AND LABRADOR
TRENDS AND FORECASTS OF CONSTRUCTION ACTIVITY
1951 - 1981

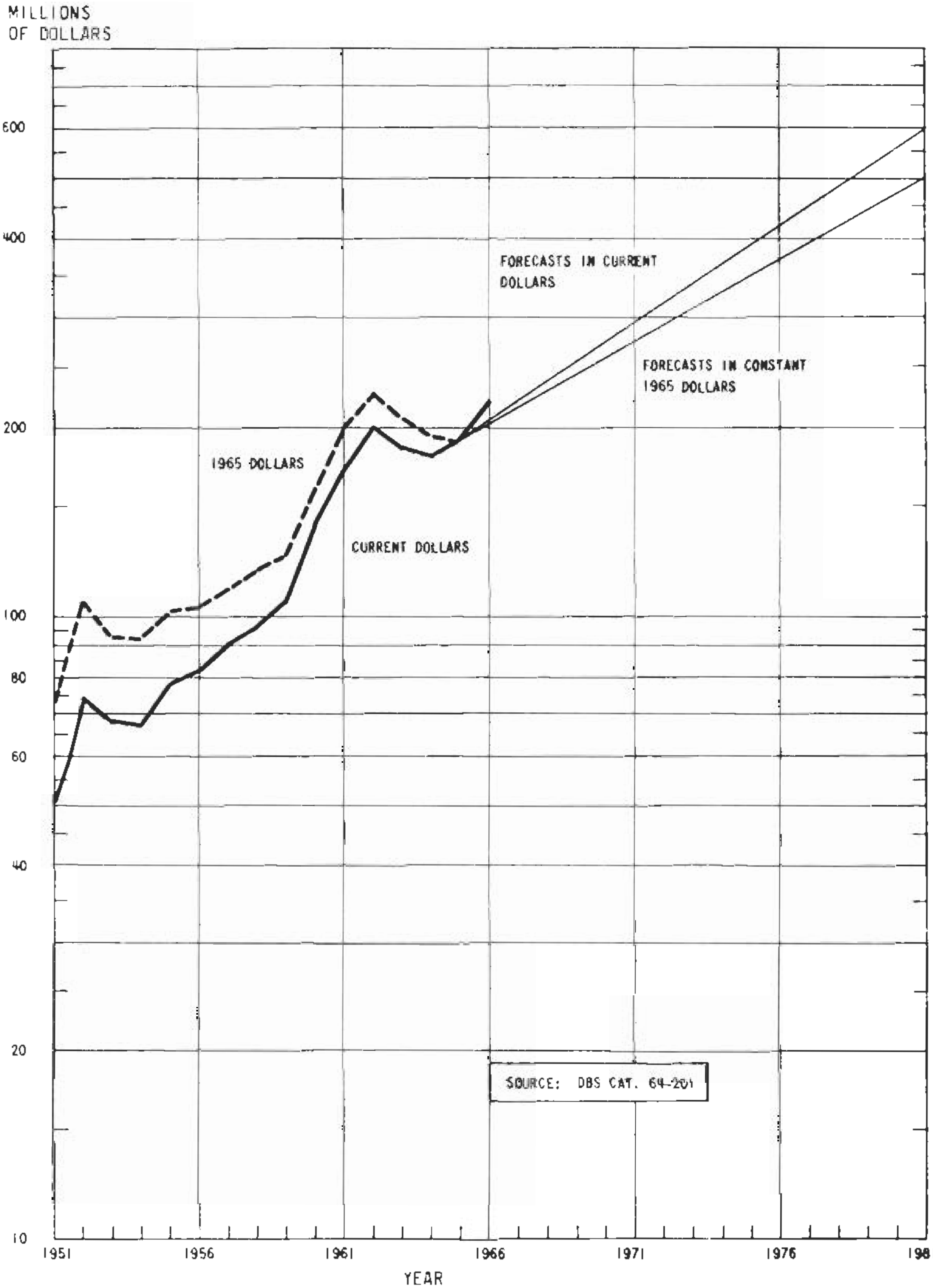
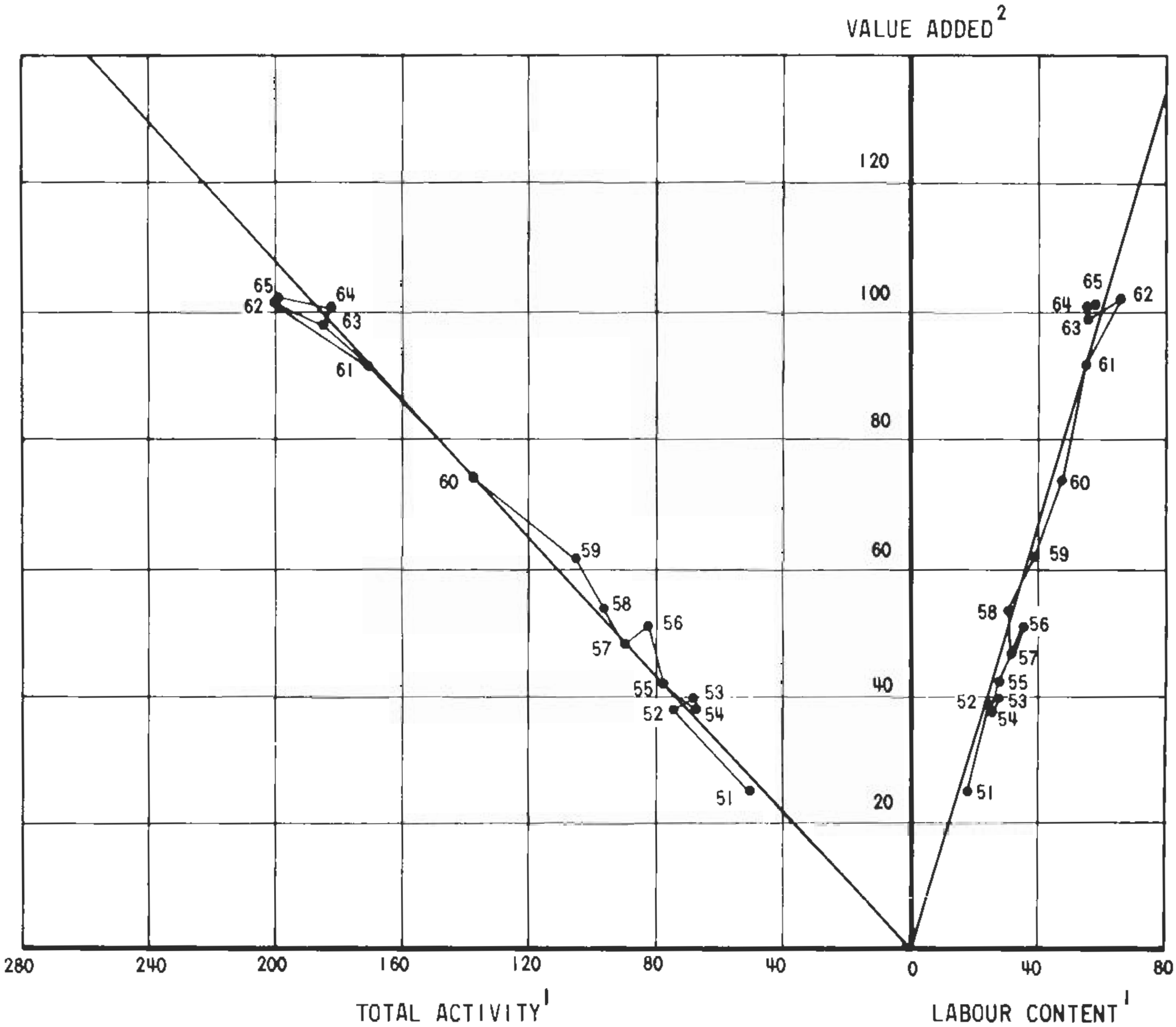


FIGURE 18-2B

NEWFOUNDLAND AND LABRADOR
RELATIONSHIP BETWEEN ECONOMIC FACTORS
IN THE CONSTRUCTION INDUSTRY



ALL SCALES IN MILLIONS OF DOLLARS
SOURCE: (1) DBS CAT. 64-201
(2) DBS CAT. 61-202

FIGURE 18-3

PART VII - TERTIARY SECTOR AND POPULATION CHARACTERISTICS

19 TRANSPORTATION

19.1 General Economic Framework

The geographical position of the Province, its predominantly littoral population distribution, and the location of the natural resources on which the economy is based make efficient transportation essential to economic development.

This report assumes that potential development will not be restricted by either the lack of physical transportation facilities or prohibitive costs, and that, wherever the use of the facilities would incur prohibitive costs, some form of subsidy will provide the necessary adjustment.

19.2 Present Conditions

The Province imports the bulk of its consumer and capital goods. Most of its products are shipped in bulk to markets outside the Province.

In 1963, 2.3 million tons of goods entered the Province, and 11.4 million tons were exported, of which iron ore shipments from Labrador contributed 8.5 million tons[1].

19.2.1 Island of Newfoundland

The narrow gauge railway, completed in 1898, runs from Port aux Basques on a northerly loop to St. John's. With the completion of the Trans-Canada Highway in 1965, passenger traffic has fallen off. Freight shipments continue to be substantial but this may be due to the lack of a competitively priced and efficient alternate means of transportation. Road transportation has increased in importance since the completion of the Trans-Canada Highway, but the trucking industry is still in an embryonic stage. Two factors have contributed to this limited and slow development:

a) The roads leading off the Trans-Canada Highway are few and those existing are not in good condition by mainland standards.

b) The ferry service and loading facilities at both Port aux Basques and on the mainland impose physical limitations on goods moving by truck[3].

Ferry, coastal, and ocean shipping continue to play an important transportation role. The coastal services exist partly for historical reasons and partly because of the lack of alternative services to the small communities.

About 55 percent of the passenger movement to and from Newfoundland is by air and 45 percent by the Port aux Basques ferries.

19.2.2 Labrador

Excluding air traffic, Labrador has two distinct transportation areas, the rail link from the iron ore mines to the St. Lawrence River at Sept Iles, Quebec, in the western area, and shipping services in the eastern area. There is no ground transportation link between these two areas.

The railway was built for the development of the vast mineral resources of Labrador, and will continue to provide the transportation of iron ore concentrates and pellets from the interior to the port at Sept Iles. Passenger movement in the western area served by the railway is primarily by air.

In the eastern area, the population concentration is at Goose Bay and Happy Valley. There are few local road connections in this area. The rest of the population is scattered in small villages along the seacoast, and water transportation continues to play an important role. The coastal services link the Labrador population and provide transportation to the Island. Passenger movement is also facilitated by the airport at Goose Bay.

19.3 Potential and Planned Development

Two developments in the transportation industry could be of economic significance to the Province. Although only a detailed analysis could establish their viability, their possible implications merit their mention.

The first development would be the establishment of deep water harbours to handle the super tankers and bulk carriers now being constructed. Such ships will be unable to navigate the St. Lawrence Seaway or use many of the existing ports along the eastern seaboard, and cargos will therefore have to be transshipped. The Island offers a possible location for bulk transshipment.

The second potential arises from the introduction of jumbo jets. Current studies appear to indicate that most established eastern seaboard airports are now taxed to capacity. Gander is being promoted as a transshipment airport because it does not require excessive expenditures for the present facilities to be used. Such a development could create 200 or more new jobs.

In the transportation sector, at the present time, only the air transportation services in the Province are considered adequate[1]. It follows that if the economic development of the Province is not to be hampered, the transportation sector must continue to expand and improve.

19.3.1 Island of Newfoundland

It is assumed that the air transportation sector will continue to grow but, with the exception of possible transshipment developments, no major development will occur to change the established structure of the industry.

Before 1971, if current plans materialize, the rail passenger services will be replaced by a trans-island bus service. About 80 percent of railway freight traffic is intraprovincial and this aspect of the service seems adequate[3]. It is assumed that the railway will continue to handle freight shipments but increased utilization of the rail service will be limited by the narrow gauge line and its route across the Island.

Gulf shipping services are linked to some extent with the railroad system. According to the findings of the Economist Intelligence Unit[3], the service leaves much to be desired. With changes in subsidy structures, traffic would be diverted from the railway/ferry system to side-loading vessels capable of handling road trailers and containers. The implementation of such a change would require additional port facilities at Corner Brook, and Port aux Basques; and would probably have potential in other areas such as Stephenville, Come By Chance, Long Harbour, and Bay D'Espoir.

With the changing structure of land and other water transportation industries the importance of coastal services will probably decline.

Undoubtedly, if Newfoundland is to continue on its path of economic development, the road transportation industry must assume a role of increasing importance. The Royal Commission on transportation detailed a program of road construction in excess of $100 million dollars for the Island. It is assumed that a soundly planned highway development policy will form the basis for rapidly developing trucking industry.

19.3.2 Labrador

The Royal Commission on Transportation[2] recommended the construction of a road from the Labrador City - Wabush area to Goose Bay and the Straits of Belle Isle.

Another significant development will be the construction of harbour facilities to accommodate the wood-chip ships which will supply both the proposed Stephenville linerboard plant and the Come By Chance paper mill. Because the shipping season is limited by ice conditions facilities will have to include provision for bulk storage.

19.3.3 Newfoundland and Labrador

Some indication of activity would be employment, but unfortunately the only figures available include communications and utilities. However, transportation is the major employer in the sector, and the present and forecast figures of employment are therefore an indicator of the expected growth. The average employment from 1963 to 1965 was 13,900, and it is forecast to rise to 16,000 by 1971, and 28,000 by 1981.

The industry is not a water consuming one, and the main demand generated by this increasing activity will occur in the various municipal water demands.

REFERENCES

1 Report of the Royal Commission on the Economic State and Prospects of Newfoundland and Labrador. St. John's, Queen's Printer, 1967.

2 Royal Commission on Transportation, Newfoundland 1966. St. John's, Queen's Printer.

3 Atlantic Provinces Transportation Study. Volume IV, Transportation in Newfoundland. London, The Economist Intelligence Unit, 1967.

20 TERTIARY INDUSTRY (OTHER THAN TRANSPORTATION)

20.1 General Economic Framework

Generally speaking, a service sectors' size, structure, and growth depends upon the size, structure, and activity of the commodity producing sectors. However, the relationship is circular and developments in the tertiary sector can have a direct influence on the primary and secondary sectors. For example, the quality and policies in the field of education have a very direct influence on the structure of the primary and secondary labour force and their productivity. Other groups such as the tourist industry may be the cause, rather than a reflection, of economic growth.

Although the service sector is not a water consuming one, in the direct way that primary and secondary industry are, its size, composition, and distribution have considerable water implications. These implications are reflected in what is termed municipal demand, or in the case of tourism non-withdrawal demand. It is for this reason that they must be considered separately.

20.2 Present Day Conditions

The range of activities considered as service industries is wide and includes such industries as trade, finance, government, and community services, through personal and domestic to miscellaneous. Although this sector has both a direct and indirect impact on the economy through the employment and incomes it generates, and the support it offers to the commodity producing sectors, complete, regular, and detailed statistics are not available to describe its activities. Complete employment series are not available and income statistics can only be estimated.

There are indications that, because of the generally low entrance requirements of some, if not all, of the service industries, the sector acts as a sponge for surplus labour. Although this may be preferable to unemployment, such a function depresses both productivity and incomes and it may also hide the vitality of the industries with the result that their basic contribution to economic development is underestimated.

The most recent comprehensive figures available on employment in the service industries of the Province are contained in the 1961 Census of Canada. Comparison to the 1951 census may give some indication of the changes which have undoubtedly taken place in the past seven years.

The service industries employed 50,700 people in 1961, an increase of slightly more than three percent a year from 1951. This increase coupled with slight decrease in employment reported by the commodity producing sectors resulted in a shift for the service sectors from 35 percent of the labour force to 42 percent. It is readily apparent that the service sector as an employer is of vital importance to the Newfoundland economy.

Data on wages and salaries are only available for certain industries within the service sector; and, because of the varying skill-content, the variation is probably just as marked as that within the commodity producing sector.

20.3 Potential Development

With the lack of precise data, quantitative description of future activity in the tertiary sector is limited to estimates of the levels of employment. These are shown, by industry, in Section 5.

The assumption is that the service industries will grow relatively faster than the commodity producing sectors. This assumption is based on the trend towards greater urbanization and rising incomes.

It is quite apparent, from even the most cursory analysis of specific areas within the Province, that the proportion of the labour force engaged in service industries varies in both size and structure from area to area. In areas dependent on the fishing industry, particularly the inshore fisheries, the service sector is limited to what could be termed corner store operations. In the more concentrated areas, activity expands to include more developed activities. The larger urban areas become even more diversified because they service not only the immediate population but also regional population by providing educational and medical facilities, and financial, wholesale, and other services. St. John's is probably unique in the Provincial experience because in many ways it acts as the regional centre for the whole Province.

In some areas then, the ratio of commodity producing employment to the service sector will be one to less than one. In other areas the ratio will probably be one to three or more.

Particular attention has been paid to the tourist industry and this is discussed in Volume Four. This is because of the special nature of the tourist industry and its potential to generate economic activity in an area rather than playing the passive role of reflecting economic development.

In summary, employment in the service sector is anticipated to rise from its estimated 1961 level of 50,700 to 61,000 by 1971. This reflects a drop in the average annual growth rate from just over three percent experienced between 1951 and 1961 to just under two percent a year. By 1981 employment in the service sector is anticipated to reach the 92,500 level reflecting an annual growth rate of approximately four percent. It is in this last decade of the forecast period that increasing urbanization and rising incomes resulting from the rationalization of primary industry and expansion of secondary industry will have a marked effect on the service sector.

21 POPULATION AND MUNICIPAL DEMAND

21.1 Population, Distribution, and Characteristics - Present

The size and distribution of population and its descriptive characteristics, including levels in standards of living, are key factors in estimating water demand for domestic and commercial use. The size and distribution of population shifts over time as do the reasons behind the changes.

This section does not attempt a detailed analysis of the cause and effect of population dynamics. It does attempt to measure certain broad general trends because the size and distribution of the population must be estimated at future points in time, specifically 1971, 1976, and 1981, in order to determine the water resources implications.

The basic assumption is that historic trends in total population movement can be projected into the future to derive total future population levels at given points in time. This assumption is based on the premise that there will be no major or abrupt change in the evolution of the factors which affect population increases (or decreases), other than those implicit in aggregate projections. The premise is open to question, but only detailed demographic analysis could measure the degree to which the final figures are affected by relative changes in underlying movements.

The main purpose of gathering detailed population statistics was the need to prepare an areal distribution of population growth. It is noted that the total aggregate population projections used in this study are almost identical to those supplied later by the Board which were based on detailed demographic analysis.

The areal projections were based on data compiled for the census years 1951, 1956, 1961, and 1966 for the Island only. Each settlement, hereafter referred to as "town" with a population of more than 50 persons,was located on a map of 1:250,000 scale. Each town so located was given a grid reference (Appendix A), and its census subdivision and reported population were gathered from census records. In some cases there was a change in subdivision between census periods. Where this occurred, towns were assigned to the census subdivision in which they last occurred, and previous records were adjusted to provide uniformity over time.

Census figures are collected on the basis of enumeration areas, which vary in size. In cities they may cover a number of blocks, in rural areas they may cover a number of square miles. The boundaries of enumeration areas frequently change with each census, reflecting shifts of population and problems of data gathering. However, the assignment of population to a specific geographic location provides some degree of uniformity, and is the most consistent indication of population which could be used.

Changes in town boundaries between census periods also affected the comparison of population data over time. In the majority of cases it was possible to adjust records to allow for these changes.

Not all the population of the Island lives in towns with populations of more than 50, as shown below:

	Total Population	Population in Towns of 50 Persons or More
1951	353,539	310,180
1956	404,260	355,772
1961	444,319	431,180
1966	472,239	460,034

People living in communities of less than 50 were incorporated into the study by distributing the difference in each census subdivision proportionally to populations of larger communities with grid references.

Between 1925 and 1941 the average annual growth rate was just under one percent. From 1941 to 1964 the growth rate has averaged 2.25 percent. The accuracy of intercensus figures is open to question, but it would appear that there has been a levelling off in growth of the various indications of outward migration.

21.1.1 Net Out-Migration

The growth or decrease of total population depends on many factors which are beyond the scope of this study. There is, however, an "external" factor which deserves consideration and that is the one of net out-migration. Net out-migration is the number of people who left the Province to take up permanent residence elsewhere, in excess of the number of people who took up residence in the Province over the same period of time.

This outward movement of population has been a characteristic of the Atlantic region over a relatively long period. The tempo of the movement has increased in recent intercensus periods.

Atlantic Provinces and Newfoundland, 1951-1966[1]

	Net Migration			Percentage of Base Year Population		
	1951-56	1956-61	1961-66	1951-56	1956-61	1961-66
Atlantic Provinces	-37,772	-58,925	-103,076	2.3	3.3	5.4
Newfoundland	+ 1,733	-16,366	- 23,613	0.5	3.9	5.2
Newfoundland/ Atlantic Provinces	4.4%	27.8%	22.8%			

It is dangerous to draw conclusions from data which do not detail such factors as age structure, education, or income levels. However, the size of the net out-migration, 38,246 in a 15-year period, has already affected population growth in the immediate future even if this movement were checked in 1966.

21.1.2 Urbanization

When population growth is estimated in terms of both size and geographic location, it may become a relevant indication of levels of water demand. There are two main trends, in the Canadian context, which are exerting pressure on historical patterns of population distribution. One is the increasing level of urbanization and the other is the movement off the farms. The terms urban and farm in this section are used in the context of their census definition. An urban area is a community with a population of 1,000 or more, and a census farm is a holding of one acre or more with sales of agricultural products in the year preceding the census of $50 or more.

Two facts are immediately apparent from the statistics for the Province, DBS[2].

First, the farm population is small and even if it completely disappeared between 1966 and 1981, the effect would not be significant in terms of total population, In 1961, 2.0 percent of the provincial population lived on farms against the Canadian average of 11.4 percent. The Province's farm population represented less than one-half of one percent of the total Canadian farm population. In 1966 the farm populations of the Province and Canada represented 1.7 percent and 9.6 percent of their respective total populations.

The second fact which becomes apparent is that the Province is still essentially a rural, if not a farm, population. In 1966 only 54 percent of the Province's population lived in urban centres compared to the Canadian figure of 74 percent. Forty-four percent of the population were classified as rural non-farm compared to only 17 percent for Canada as a whole.

This difference in the level of urbanization between the Province and Canada as a whole is even more striking when the populations living in urban areas of 10,000 and over are compared. For Canada as a whole, 62.8 percent of the population were living in the larger urban centres; in Newfoundland only 24.3 percent of the population were living in similar size cities.

21.1.3 Age Structure and Labour Force

The age-sex structure of the population is of considerable importance in the potential development of the economy particularly with respect to the labour force.

In Canada the labour force is usually defined as the non-institutional population over 14 years of age who are working or are actively seeking work. In this study, because of the statistical grouping of the population age structure available, the labour force age group are those 15 years and over. The labour force is those in this age group who are working or seeking work.

The labour force participation rate is the ratio of the labour force to the labour force age group. The Provincial rate is lower than the Canadian rate or that of the Maritime Provinces (Figure 5-3) and the trend is common to both the male and female sectors.

Since 1961 there has been a decrease, in the 15 to 19 year old age group, in both the male and female participation rates which could be attributed to the extension of the education period; without a detailed analysis of the structure of unemployment the inability of the economy to absorb the younger age group is not discounted.

There was a similar, though not so pronounced, decrease in the male participation rate in the 20 to 24 year old age group and the 55 and over age group.

Female participation rates in the over 20 age group have diverged from the male participation rate patterns in that there has been increasing female participation. This trend, common to the Canadian experience though at a lower level, reflects a characteristic of urbanization and increasing service sector activity.

The distribution of the labour force was discussed briefly in Section 5 and will not be repeated here.

21.1.4 Education and Mobility

Education is a basic factor in labour force mobility; and mobility, both occupational and spacial, is one key to economic development. This report has assumed that mobility will be sufficient to meet the demands placed upon the labour force by the developing economy. Within the framework of this report such a sweeping assumption is not an inconsistency although experiences in Newfoundland and elsewhere[3] indicate the dangers of such an assumption in an economic development program.

21.1.5 Income Levels and Regional Disparity

The Provincial income disparity is not unique in the Canadian experience, and it is interesting to note that over the past forty years the interregional structure of income has hardly changed[4]. The causes of this disparity are the key to regional analysis and their solution is fundamental to regional development. This study includes only a simplified review of the problem. For example, per capita income levels are one indicator of domestic and municipal water demand, and for this reason simplified forecasts of wage and salary levels were included in Sections 7 to 20, although more comprehensive studies of the economy have not included such data.

With the lack of comprehensive provincial output data, personal income and earned income per employed person act as indicators of economic activity. The trend in personal income per capita gives some indication of the relationship between rates of growth in total income and in population. Personal income per capita is also an indication of economic participation in the national economy, the narrower the dispersion, the more uniform the participation[5].

Figure 21-5 shows personal income and its major components from 1949 to 1965. Despite the steady growth of personal income per capita in current dollars since 1949, by 1965 personal income per capita for the Province was still only 70 percent of the average for all provinces; and since 1961, the Province has experienced little or no change in relation to other regions[5].

Considerable disparities in income also exist within the Province and comments made by Buckley and Tihanyi[7] on rural poverty deserve mention, as 43,600 families or about 225,000 people are involved in their Study, which was based on 1961 data.

Rural Farm and Non-Farm
Family Income Classification

Total Rural Families	43,614
Poor - Farm	808
- Non-Farm	28,900
Total Poor	29,708

On this basis 68 percent of the rural families in Newfoundland were poor compared to 44 percent of all families residing in rural areas of Canada. The spacial dimensions of the rural income problems have important policy implications because it is more difficult to alleviate spacially diffused poverty such as exists in the Province. This is a complex problem for which there is no easy or quick solution.

It was fully recognized that relatively high level and diffused nature of rural poverty in the Province would have a direct effect on per capita incomes and an indirect effect on municipal water demand. However, the forecasts of income levels were maintained at an optimistic level in order to highlight any demand-supply conflicts which might occur at the municipal level.

21.2 Population Forecasts and Characteristics

21.2.1 Forecasts

It was essential, for purposes of this study, to make an areal distribution of the aggregate population forecasts supplied by the Board for 1971, 1976, and 1980, and to extend the 1980 data to 1981.

The method of projection used in this report to obtain an areal population distribution was built from the detail level and may be considered "mechanical". There was only a slight difference at the aggregate level between the population forecasts provided by the Board and the projection of areal distribution of population used in this report. The difference was not considered significant and approval was given for the use of the projections made for this study. Because these "mechanical" projections vary so little from the Board's forecasts, which were based on detailed demographic analysis, it may be assumed that at the aggregate level of the areal projections, the demographic considerations are implicit.

The projections of population size and distribution are based, in a first approximation, on recorded population patterns. This was mentioned in Section 21.1 in terms of the assessment of population by grid square for the census periods 1951, 1956, 1961 and 1966.

There are over a thousand communities in the Province and to make valid forecasts of each individual population concentration would be impractical. Therefore, the projections based on the population distribution of the last four census years were done mechanically using the technique described below.

The projections represent a straight-line trend fitted by the least-squares method, weighted to give more importance to the size and movement of populations in recent years.

Several series of weighting factors were tested and one was selected as the best reflection of the following restrictions:

a) Obtaining a forecast as close as possible to that supplied by the Board.

b) Obtaining from the 1951, 1956, and 1961 data a projection for 1966 populations which were most representative of the actual 1966 census data.

The actual weights used were 1951 equal to 1; 1956 equal to 10; 1961 equal to 100; and 1966 equal to 100.

Use of the grid square technique resulted in "negative population" in some squares showing rapid decreases. These were later distributed into adjoining squares, and the squares in which they occurred were considered as having no population. This technique was necessary because of the distribution of population in grid square rather than communities. The grid square population projection techniques were only used for the Island. The size of the population and the state of historical data did not warrant its application in Labrador.

A simplified ratio technique was used to estimate the population of Labrador over the forecast period.

The percent of the Provincial population living in Labrador has increased over the last four census periods. Considering the resource potential and the development plans for the area, it is assumed that this trend will continue. Over the last four census periods the Labrador content of provincial population was 2. 2, 2. 6, 3. 0, and 4. 3 percent. This trend has been projected, with upper and lower limits as follows:

	1971	1976	1981
		(percent)	
Upper Limit	6.2	8.1	10.0
Lower Limit	5.4	6.4	7.0

Using the upper limit Labrador ratio and the Island population projection, the provincial population projections used in this study may be compared to the provincial population forecast provided by the Board and to those used in the Royal Commission Report[6]. It is noted that the 1981 figure is an extrapolation from the data provided by the Board which terminated in 1980.

	1971	1976	1981
	(population in thousands)		
The Island	505.1	536.4	567.8
Labrador (upper limit)	33.4	57.3	63.1
	538.5	593.7	630.9
ADB Province	547.3	590.0	635.0
Royal Commission[6]			
High	556.7		665.6
Medium	550.1		650.4
Low	543.5		635.3

The Royal Commission[6] forecasts were prepared before the 1966 census data were available, and a 1966 base estimated at 505.6 thousand was used rather than the actual population level of 493.4 thousand. The Royal Commission[6] only revised their medium projection for 1971 which was 550.1 thousand and is now 535.0 thousand. On the basis of these comparisons the projection built up by grid square seemed reasonable.

This first approximation was based on past trends and did not provide for population movements resulting from major new developments planned to take place over the forecast period. The population distributions shown on Figures 21-2 and 21-3 reflect the impact of new developments on population locations for the benchmark years 1971, 1976, and 1981. Discussions of net population movements are contained in Volume Seven. The two series of illustrations provide for an alternate location of the proposed aluminum smelter either at Stephenville (Figure 21-2) or at Bay D'Espoir (Figure 21-3).

21.2.2 Net Migration Patterns

No separate study has been prepared on the net out-migration patterns discussed in Section 21.1.1. The assumption is that these population movements are implicit in the projections.

21.2.3 Urbanization

In Section 21.1.2 it was apparent that the existing level of urbanization in the Province is considerably below the Canadian average. Empirical evidence indicates a causal relationship between the degree of urbanization and relative income levels. This relationship, in general, appears to hold true for the Census Divisions of the Province, as indicated on Figure 21-4.

Labrador has been excluded from the ranking of urbanization, per capita disposable income and average male earnings. The three census divisions with the highest degree of urbanization also have the highest income levels. Conversely, the three census divisions with the lowest degree of urbanization have the lowest income levels.

This relationship has special implication for the Province because of its relatively low degree of urbanization and the plans for population centralization. It does not follow that incomes will rise simply by concentrating populations; incomes will only rise if the economic base of an area to which population moves is expanding at a sufficient rate to support the expanded population.

Because the areal distribution of population over the forecast period uses the square grid unit and not communities proper, the degree of urbanization over the forecast period can only be estimated as an order of magnitude.

For 1966 the grid squares with over a thousand people accounted for 76 percent of the population compared to the 54 percent who actually lived in urban areas. Assuming the percentage point spread between the two indicators remains constant over the forecast period, the following degree of urbanization is indicated for the Province. In 1971, 57 percent of the people will live in urban areas, rising to 60 percent by 1976, and 63 percent by 1981. These figures are probably conservative when the structural changes resulting from economic development plans are considered.

21.2.4 Age Structure and Labour Force Participation Rates

The structure of the population forecasts by sex and age groups is shown on Table 21-1. This information was calculated from population statistics provided by the Board. The percentage distribution between age groups does not change significantly over the forecast period.

The labour force participation rate of the Province has been consistently below the Canadian and Maritime provinces rate; so that any improvement in the Province's participation in the national economy will be reflected in an increased labour force participation rate. As national and provincial economic objectives are predicated on an improvement in the relative position of the provincial economy in the national activity, an increased participation rate must be assumed.

The participation rates over the forecast period have been assumed to rise from the existing rate for 1966 and 1967 of 44.3 percent to 46 percent in 1971, 48 percent in 1976, and 50 percent by 1981. In view of the existing participation rates in the Maritime Provinces and Canada (Figure 5-3), this assumption appears reasonable.

On the basis of estimates of the size of the labour force age group for the forecast period, the participation rate assumptions, the size of the labour force may be estimated.

	Labour Force Age Group and Labour Force		
	1971	1976	1981
Labour Force Age Group	338,200	378,200	414,500
Labour Force	155,600	181,500	207,300

21.2.5 Employment

Estimates of employment over the forecast period are given in Section 5.

21.2.6 Income Levels and Regional Disparity

Personal per capita income shown on Figure 5-10 was obtained by dividing forecasts of personal income by projected population levels. The level of personal income over the forecast period was based on an extrapolation of personal income stated in terms of 1965 dollars.

The average annual increase in per capita personal income over the forecast period, in 1965 dollars, is approximately 4.3 percent. The forecast annual increase when compared to past experience does not appear unreasonable. The past rates were based on estimated per capita income in terms of 1965 dollars. Between 1951 and 1965 the average rate was 3.7 percent a year, and between 1958 and 1965 it was 4.3 percent. The maintenance of this rate of increase will come from a combination of factors: the assumption that there will be no major change in the proportion of transfer payments or other income accruing to the personal income sector.

The underlying factors which support this estimated increase in personal income are as follows:

a) An increasing proportion of the population will be actively engaged in the labour force. The labour force as a percent of total population will increase from approximately 28 percent in 1966 to 35 percent in 1981.

b) There will be shifts in the structure of the labour force from lower income sectors to higher income sectors. For example, proportionately fewer people will be engaged in the generally low income fisheries sector and proportionately more people will be employed in the higher income manufacturing sector.

c) Within the industry groups themselves there will be structural changes with a shift from unskilled and semi-skilled jobs. The proportionately higher skill content will increase the average incomes even if no changes in pay structures should take place.

These structural shifts, in various combinations, will occur in a period of rising salary and wage rates. No attempt has been made to measure the degree to which income disparities will be reduced, although some reduction is implicit in the assumptions of high economic activity and structural changes.

Figure 21-6 gives an indication of the level of per capita disposable income by census divisions over the forecast period. The estimates are not precise and are intended only as an indication of the relationship between the census divisions.

21.3 Specific Total Municipal Water Demand and Wastewater

Municipal water demand is defined as the amount of water provided by a municipal system for residential, commercial, industrial, and public use such as street cleaning. By definition the total use must also include all unaccounted for water.

Water demand by the various categories of users is a function of a large number of economic and physical variables whose influence on use varies in time and place. Of those, the following were considered in this study as being the most significant for the Province and, because some data were available, as being useful for estimating their possible influence.

Physical Variables:

Size of community
Geographical conditions
Nature of physical supply

Socio-Economic Variables:

Income and standard and style of living
Price and type of billing (including metering)

The following table provides an indication of the proportion between the demand by various categories of municipal users. Column A was based on a survey of 29 municipalities in the United States, all with populations in excess of 25,000. These figures are almost identical to those in column B which were based on a survey conducted in 1955 by US Public Health Department of 206 cities with the same population criterion. The table is used only as an illustration and is not meant to be applied to the provincial communities whose populations are very much smaller.

Municipal Water Demand by Type of User

Category	A (percent)	Category	B (percent)	Gal/capita/day
Residential	42	Domestic	41	59
Industrial	20	Industrial	24	36
Commercial	21	Commercial	18	26
Public and Other	17	Public and Other	17	24
		Average Daily Output		145

These percentages indicate very general relationships and are obviously subject to considerable variations when specific examples are examined. This is particularly true for the Province where only two communities, Corner Brook and St. John's, have population concentrations comparable in size to the communities studied.

Furthermore, very few communities in the Province are metered and as yet sufficient historical data are not available to support a profile of water demand by type of user. Finally, it should be pointed out that in small communities, one or two water-using industries may completely change these percentages.

21.3.1 Domestic and Residential Water Demand

In current literature a distinction is frequently made between domestic and residential water demand and this distinction should be borne in mind when comparing specific Provincial data with statistics available on experience elsewhere. Domestic water demand normally refers to water used within the home. Residential water demand is expanded to include such outdoor water usage as lawn sprinkling, automobile washing, and swimming pool requirements.

21.3.1.1 Domestic Water Demand

A recent study by Linaweaver, et al[8], discussed two characteristics of domestic water demand which may have implications for the Province. First it was found that domestic use did not appear sensitive to price insofar as use did not vary appreciably between metered and flat rate areas. Second, domestic demand in areas using septic tanks appeared to be significantly less than areas serviced by municipal sewage systems. The study suggests that domestic use when areas change from septic tanks to public sewers may be expected to increase by 25 percent.

Location and climate do not appear to have very much influence on domestic water demand, but, although no statistical relationships were found, it does not seem unreasonable to assume that domestic usage would be influenced by climates of extreme temperature variations if water cooled air conditions were used in the summer and humidifiers were used in the winter. An influence of climatic conditions on water demand is that of running taps to prevent pipes from freezing; this is not unique to the Province but is extensively practiced.

21.3.1.2 Residential Water Demand

Residential water demand varies more than domestic demand in terms of a series of variables. The influence of the size of a community is directly related to the structure of that community in terms of municipal demand, but it is difficult to establish a direct relationship between residential demand and the community size.

Geographic location, particularly with respect to climate, has a considerable influence on outdoor usage which in turn affects what has been defined as residential demand. Further discussion of American findings are found in Porges[13] who illustrates the decrease in per capita residential demand with the increase in rainfall, and the inverse relationship between lawn sprinkling and precipitation.

Generally speaking, the socio-economic conditions in the Province are different from those of the mainland and of the United States on whose experience theories of water demand are being developed. There is a considerable disparity of income between the Province and the rest of Canada and this lower income is reflected in such things as market value of residences and the standard of living, including the ownership of water-using appliances. Under the circumstances, it appears reasonable to assume that any incremental increase in per capita residential water usage will be more pronounced than those suggested by most current studies of Canadian and American experience. As personal income increases, changes in demand patterns will probably parallel experiences in areas of similar climatic and economic conditions.

Current literature indicates per capita residential demand varies with the type of dwelling, but the per capita domestic demand does not. This suggests that the difference in residential demand is confined to the outdoor uses by single or multiple dwelling units which are not required by apartment dwellers.

Information from various sources on the market value of residences on the Island indicates a wide disparity between them and the market value of residences used in American studies. While the general statement that a relationship exists between the market value of residence and water demand may be true, it would be misleading to apply generalized relationships to provincial conditions. It was therefore decided that, for this stage of the study, a detailed literature search in this respect would not be justified. However, it would be interesting in the next stage of the study to attempt to gather some data on residential market values and their relationship to water demand for use in more specific area studies.

Discussions by Linaweaver, et al[8], and Hanson and Hudson[11] suggest that a relationship exists between income and water demand. This relationship would appear to exist because of the relationship between income and what may be referred to as the style of living as an extension of a standard of living. In effect, a rise in income may, and often does, result in greater outdoor demand through the purchase of houses with larger grounds, and greater domestic demand through the addition of water-using appliances.

In Section 21.3.1.1, it was stated that there appeared to be very little difference in domestic water use between metered and flat rate areas. On the other hand, considerable difference in residential water demand exists between metered and flat rate areas. The reason for the variation in domestic and residential use appears to be due primarily to sprinkling practices. In areas where lawn sprinkling is not likely to occur, water demand patterns will not be influenced to a significant degree by the type of rate system used. This condition could have considerable implications when the decision to install meters is being considered.

However, one benefit of a metered system is the detection of leakages. This benefit is particularly important in older systems where leakage assumes greater significance. The practice of running taps to prevent pipe freezing could be considered a domestic leakage. It is estimated that in areas where this practice exists, annual water demand could be 10 to 15 percent higher than in residences with properly insulated piping. For the customer, the rate structure of a metered system would discourage such practices when it became cheaper to properly insulate the piping. For the municipality, the cost of installing meters would have to be weighed against the savings generated by the lower per capita residential usage, plus additional income related to the charge structure. A study by Fourt[9] based on 44 fully metered cities in the United States determined an elasticity for the price of water of -0.4: a 10 percent increase in price will result in a 4 percent decrease in consumption.

21.3.2 Industrial and Commercial

In the United States, almost 80 percent of the water used in industry is for cooling requirements, although in Newfoundland it probably does not represent as large a proportion. Conley[10] has concluded that industries which derive water from municipal supplies are generally paying relatively high prices for water and therefore have already initiated water saving methods. For such industries the price elasticity is quite low, around -0.2, indicating a highly inelastic condition. Industrial demand in Newfoundland's municipalities at the present time, exclusive of the water-using industries discussed in Sections 7 to 16, probably does not exceed an average of 4000 gallons per acre per day of industrial land, although insufficient data were available to confirm this estimate.

Commercial consumption is that part of the total municipal consumption required by stores, offices, service shops, etc, and is normally considered on a per acre basis. It is unlikely that commercial consumption during the study period will exceed 4000 gallons per acre per day of commercial land.

21.3.3 Public and Other Uses

This category includes water used for street flushing, fire fighting, as well as system leakage and water otherwise not accounted for. System leakages are normal; however, numerous system studies suggest that many municipal systems are losing excessive amounts of water. This is particularly true of unmetered systems where losses are not readily detected. When the unaccounted for water is less than 15 percent of the total water produced, the system is generally considered to be well maintained. It has been found that a correlation exists between the size of the losses and the age of the system[14].

Because the Province's water systems are not metered, the amount of losses cannot be accurately determined but they are probably in excess of 20 percent. Undetected losses have been known to exceed 40 percent in some mainland municipalities. Although this figure may appear high, recognition of losses in an unmetered system depends to a great extent on the availability of supply.

21.3.4 Municipal Water Demand

A general indication of the relationship between the various components of municipal demand has been given in the preceding sections. The following table highlights the distribution of demand for the 29 cities in column A of the table in Section 21.3:

Percent Total Demand Showing Frequency of Occurrence

Class Interval Percent	Frequency of Occurrence			
	Residential	Commercial	Industrial	Public Use
0-10	0	5	7	11
11-20	2	15	13	11
21-30	4	8	3	3
31-40	6	0	4	2
41-50	4	0	2	1
51-60	5	0	0	0
61-70	5	1	0	0
71+	3	0	0	0
	29	29	29	28 (+one no data)

This table illustrates the different distribution patterns when each category of municipal demand is examined for its percentage of total demand. As can be readily seen the range for commercial demand is concentrated, with 15 of the 29 cities accounting for between 11 and 20 percent of total municipal demand. The average figure of

42 percent is used for residential demand, but for the 29 cities in this sample with a fairly uniform distribution was 11 to 71 plus percent. The information contained in this table is shown graphically in Figure 21-8. This illustration gives some indication of the error of estimation which may occur if average figures are used for individual estimates. Therefore, the general cautionary remark, that the indications included in this study cannot be considered dependable for individual localized problems, is repeated in connection with the estimation of municipal demand.

The specific total municipal water use of the Island's municipalities have not been precisely established, mainly because there is little historical data and few of the municipal systems are metered. Therefore, the average usages based on the limited data available must be reviewed as additional information becomes available.

Gallons per capita day (gpcd) is the basic unit used when discussing water demands. In reviewing literature on water demand it was noted that the gpcd figures could be misleading as the distinction between domestic, residential, and municipal demand was not always evident.

The highest municipal gpcd recorded for the Province was at Carbonear where demand was estimated to be 290 municipal gpcd. The explanation of this high figure is the fact that two fish processing plants are connected to the municipal system. On the basis of their reported 1966 output of 16.5 million pounds and allowing for a 250-day operating year, the fish plants' water demand was equivalent to 190 gpcd. Excluding this demand from the municipal usage, the adjusted demand is 100 municipal gpcd.

The highest known demand, 160 municipal gpcd, is in St. John's which does not meter residential consumption although a program to install such meters commenced in 1968. It is known that considerable leakage was occurring in the St. John's municipal system which is reflected in the high usage figure.

The following table gives an indication of the range in municipal per capita actual usage:

Municipality	Connected Population	Consumption (gal/capita/day)
St. John's	79,844	160
Corner Brook	25,000	149
Lewisport	2,892	120
Gander	5,725	105
St. Lawrence	2,130	80
Burin	1,116	70
Harbour Grace	2,650	68
Windsor	6,692	65
Carbonear	3,500	290*

The average municipal demand reflected by this table is 149 gpcd, a figure heavily weighted by St. John's and Corner Brook. When these two cities are excluded, the average municipal demand drops to 108 gpcd.

21.3.5 Specific Water Demand Estimated

Analysis of municipal water demand in the Province was severely restricted by the lack of data. To estimate municipal water demand over the forecast period two paths were open. Either assumptions, based on impressions gained during the data gathering phase, could be made concerning future requirements or an attempt could be made to use data from more documented areas and adapt them to Provincial conditions. The second approach was chosen in the full realization that, at this stage, only readily available data and generalized relationships could be used. Despite these limitations it was felt that the development of the technique was of primary importance and that in the course of time input data could be improved and refined.

* This consumption includes water used by two fish plants, but the amounts are not known.

Personal disposable income was the only indicator related to water usage for which provincial data was available and which had been used in water usage studies of other areas. A study by R. Hanson and H. E. Hudson Jr. [11] which related disposable income per household to residential water usage was used to prepare Figure 21-7.

There are a number of weaknesses to this graph which assumes a linear relationship between disposable income and residential water usage. It is extremely doubtful that the relationship is linear. Because of climatic and geographic variations between areas it is doubtful that a common level curve exists. Nevertheless this figure illustrates the type of relationship required for the development of the technique and it was felt that while estimates based on it would be subject to error the degree of absolute error did not preclude its use.

The advantage of relating municipal water demand to disposable income was that on an area distribution the variations in requirements would be more indicative of real conditions then estimates based on an average demand.

The most comprehensive and readily available information on municipal water demand was for Ontario. From information contained in the 1967 Annual Report of the Ontario Department of Municipal Affairs[15] it was possible to prepare the following summary table for communities of less than 10,000 people.

Summary of Municipal Water Works Statistics
for Typical Group of Smaller Ontario Municipalities

	POPULATION RANGE							
	0 - 1000		1000-2000		2000-5000		5000-10,000	
	UNM*	MET*	UNM	MET	UNM	MET	UNM	MET
Number Reporting	12	3	12	3	8	8	-	11
Average Consumption - gpcd	60	66	66	54	66	71	-	91
Extreme Variations in Consumption - gpcd	100-23	98-41	116-25	66-29	76-53	93-48	-	107-42
Average Number Persons per Consumer	3.6	3.5	3.5	3.0	4.2	3.0	-	3.7
Mileage of main per 1000 persons served	5.4	5.7	3.8	6.5	2.5	3.9	-	3.1
Number of hydrants per 1000 persons served	26.5	30	32	40	18	27.5	-	22.8

* UNM - unmetered
MET - metered

From an examination of the detailed data on which this table was based a mean per capita consumption of 64 gpcd was established. This figure is representative of the metered and unmetered per capita consumption patterns for communities of less than 10,000. The patterns were examined individually for communities of 0 to 1000, 1000 to 2000, 2000 to 5000, and 5000 to 10,000.

A study of municipal consumption in the United States carried out by Porges[13] provided data from which the following table was prepared:

Percent Metered	Municipal Water Consumption gpcd — Population (1000's) 5 - 10	10-25	25-50	50-100	100 +	Total Population
0-50	152	158	174	162	142	145
50-95	103	108	109	114	129	121
95-99	102	100	102	102	124	116
99+	99	107	107	100	114	109
Total Population*	108	112	111	108	125	110

*Weighted Average

This table indicates the per capita water usage of larger municipalities. It also provides data for communities in the 5000 to 10,000 interval. The difference in per capita usage between the Ontario data for communities in the 5000 to 10,000 interval, and this table is only 8 gpcd.

The Ontario municipal water demand of 64 gpcd is used to convert residential water demand, estimated from the relationship between disposable income and residential demand, to municipal demand in the following manner.

$$\text{Newfoundland Municipal} = \frac{\text{Newfoundland Residential}}{\text{Ontario Residential}} \times \text{Ontario Municipality}$$

In 1967 per capita disposable income in Newfoundland was approximately $1320 or $5280 per household following the assumption used in this report of four people per household. The Ontario disposable income per capita for 1967 was then examined to estimate disposable income for communities of less than 10,000.

Two approaches were used to establish this figure. An average figure was determined by subtracting from the Ontario provincial totals of population and disposable income those figures for communities of greater than 10,000. The information on disposable income was not readily available for communities of less than 10,000. Disposable income was also plotted against population for communities of greater than 10,000. The examination of this data gave an estimation of average disposable income per capita for the smaller Ontario communities of \$1600. Disposable income per household was established by determining the average household size for the smaller communities. This was established at 3.4 people per household which resulted in a per household disposable income of \$5440. From Figure 21-7 the comparative residential water demand per household was determined and plugged into the municipal equation:

$$\frac{22 \text{ gpcd}}{24 \text{ gpcd}} \times 64 \text{ gpcd} = 58 \text{ gpcd}$$

The estimated residential demand for Newfoundland is approximately 38 percent of total estimated municipal demand which is not unreasonable. However, since a comparison of this figure with the few data available for Newfoundland (Table 4-2 of Volume Five) and a series of data for the Maritime Provinces made available in the latter stages of this study indicate larger per capita demand, which may be related to various local factors and require further investigation. One possible reason is the satellite type of residential towns encountered in Ontario, reduces the demand from municipal systems for local small commercial and industrial users. Therefore the results obtained from the comparison with Ontario were increased by 33% to allow for larger local demand for small commercial and industrial enterprises. Municipal per capita demand with this adjustment becomes 77 gpcd.

A second adjustment factor was used to include unaccounted system leakage and losses. An allowance factor of 1.2 is made for this and results in a total average municipal demand of 93 gpcd. To obtain regional values the average demand was increased or decreased according to the average regional disposable income.

In Volume Five, the two adjustment factors were combined in one single coefficient (1.6) which multiplies the basic regional per capita residential demand to give total regional per capita demand.

Over the study period, significant capital investments will be made in water distribution and sewerage disposal systems for the communities now without such systems or whose existing systems are inadequate. Dependent on the size, design, and operating characteristics of these systems, substantial sums will be paid for the operation and maintenance of these systems. For both design and financial planning purposes, estimates of total municipal per capita water demand and its various components, for various-sized communities, would be extremely useful.

Investigations made in this study indicate that domestic and residential demand do not differ appreciably in the Province. This is contrary to demand patterns in most mainland communities. If planning estimates were based on per capita demand, without an allowance made for this factor, the estimates would be erroneous. The same erroneous estimates would result for small communities if the average per capita demand was heavily weighted by consumption patterns of larger communities.

It is therefore recommended that an investigation be made to establish reasonable estimates of per capita municipal water demand, and its various components, for different sized communities which could be used for planning purposes for Newfoundland conditions.

21.3.6 Municipal Wastewater

The quantity of municipal wastewater generated equals the municipal water use less that amount of water not reaching the sewers plus water which infiltrates into the sewers. Water not reaching the sewers includes part of the leakage losses in the water distribution system, some of the publicly used water, part of the water used for lawn sprinkling, and water depleted in various industrial processes. Infiltration into the sewers varies with the nature of the soil in which the sewers are installed, the height of the groundwater table relative to the sewer, as well as the standard of construction of the sewer system. The groundwater table in turn is influenced by the amount of leakage and lawn sprinkling. When data are available a rational approach can be made to determine the quantity of wastewater to be conveyed or treated; when data are not available estimates must be made. For Newfoundland municipalities, it is reasonable to assume that infiltration approximates the amount of water supplied to the system but not reaching the sewer and thus the quantity of municipal wastewater may be assumed to equal the municipal water use.

Although no data are available on the strength of municipal wastewater in Newfoundland, there is no reason to believe that this wastewater will vary significantly in strength from normal municipal wastewater. Accordingly, BOD's (5-day) of 200 ppm and suspended solids of 300 ppm can be anticipated.

21.4 Forecast

21.4.1 Non-urban Demand

One important distinction must be made when using average water demand figures expressed as gallons per capita day. This is the distinction between urban and non-urban demand. In this context the definition of urban and non-urban is not the census definition; urban is defined here as communities with municipal systems and non-urban is defined as communities where households are served by individual water supply systems.

Unfortunately no data was available on the non-urban requirements in the Province. This is the usual problem experienced on the mainland; individual householders have no reason to measure their water usage. Their only concern is whether or not their requirements are being met.

The reason for stressing this point is the fact that such a large proportion of the Provincial population is classified as non-urban users.

In studies of metered water consumption by non-urban consumers, Hanson and Hudson[11] and Csallany[12] have concluded that the average per capita municipal demand in communities of less than 1000 will lie between 25 and 40 gpcd, inclusive of commercial and public usage and losses. It has been concluded, on the basis of these findings and the conditions prevailing in the Island communities of less than 1000 persons, that their municipal demand will not exceed 50 gpcd prior to 1981. This figure does not include any allowance for industrial water usage for industries whose needs were exceeding nominal sanitary requirements.

21.4.2 Future Municipal Water Demand

This section considers the probable trend of basic municipal per capita demand of communities of more than 1000, excluding the demands of major water using industries which are considered separately.

Table 21-2 shows, for each grid square with a 1966 population of 700 or more, 1966 and 1981 data on population, estimated municipal per capita water demand and total daily water demand. The population data are those used throughout this study. The basic municipal per capita demand was based on the considerations discussed in Section 21.3.5, and the total daily demand is the product of population and estimated gpcd. The areal demand patterns are shown on Figures 21-10A and B and 21-11A and B.

The 1966 minimum grid square population of 700 was chosen for two reasons. First, because at this stage the concern is with areas of 1000 minimum population and by choosing 700 for 1966, a level of 1000 by 1981 was provided for. Second, the relationships used to estimate per capita water demand were not considered applicable to populations of less than 700.

The estimates of family disposable income for 1966 and 1981 used in the calculation of municipal per capita demand was based on the information contained in Figure 21-6. The figures in Table 21-2 are only approximations but as more precise data become available, recalculation of the water demand figures is a simple procedure.

The following comments concern selected levels of municipal consumption shown on Table 21-2. The figure of 36 gpcd basic municipal demand is effectively residential demand since no municipal systems exist in these communities. In appreciating the figure it should also be kept in mind that most of the small communities have no sewer systems, which is a significant restraint for water usage[14]. It will be seen that with few exceptions this level of income and water demand is confined to communities of about 1000 persons. The demand for water by other categories of municipal demand would be very limited. Furthermore, while the term municipal demand is used, most of the communities of this size on the Island are supplied by individual wells. Considering these factors, the estimated per capita municipal demand appears acceptable.

The higher levels of municipal demand occur in areas of higher average income and generally larger population centres. These factors will usually result in higher demand by the other municipal users, particularly the service sector which will be more developed.

The 1966 estimates are in line with the range of municipal per capita water demand included in the Montreal Engineering Company, Limited's Per Capita Demand Study of the Maritime Provinces. For example, the 1966 municipal water demand was 85 gpcd for Halifax, 43 gpcd for Chatham, 89 gpcd for Fredericton, and 70 gpcd for Charlottetown. Income levels were indicated by average male income 1961 rather than by per capita disposable income 1966. However, the per capita disposable income for each of the other three Maritime Provinces was slightly higher than that of Newfoundland and Labrador.

21.4.3 Wastewater

In spite of the fact that no data on present municipal wastewater quantities are available for Newfoundland municipalities, it is reasonable to expect that they will approximate municipal water demand throughout the study period. From municipalities of less than 1000 persons wastewater quantities, exclusive of industrial wastewater, will probably average 50 gpcd. From municipalities having populations of between 1000 and 10,000, municipal wastewater inclusive of normal industrial and commercial consumers will average about 110 gpcd for municipalities in excess of 10,000 persons, total municipal wastewater quantities are estimated to be 120 gpcd. It should be noted that wastewater quantities from large water consuming industries located in small municipalities could markedly affect the above-noted average quantities.

No data exist with respect to the composition of Newfoundland municipal wastewater to indicate that its strength will vary from typical municipal wastewater. Where a large percentage of the total wastewater flow is composed of wastewater from food processing plants, the strength will be greater than that of most municipal wastewater; wastewater from metal plating plants, chemical plants, as well as breweries, as discussed in other sections of this volume, can be expected to affect the character of the wastewater particularly if they are to be subjected to biological treatment.

The present trend of the discharge of municipal wastewaters untreated to the receiving water is creating a substantial consumptive use in the quality of the resource. If the cost of correcting this use through waste treatment is not recognized, a substantial loss to other users of the resource will occur quite probably disclosing a most uneconomic resource demand.

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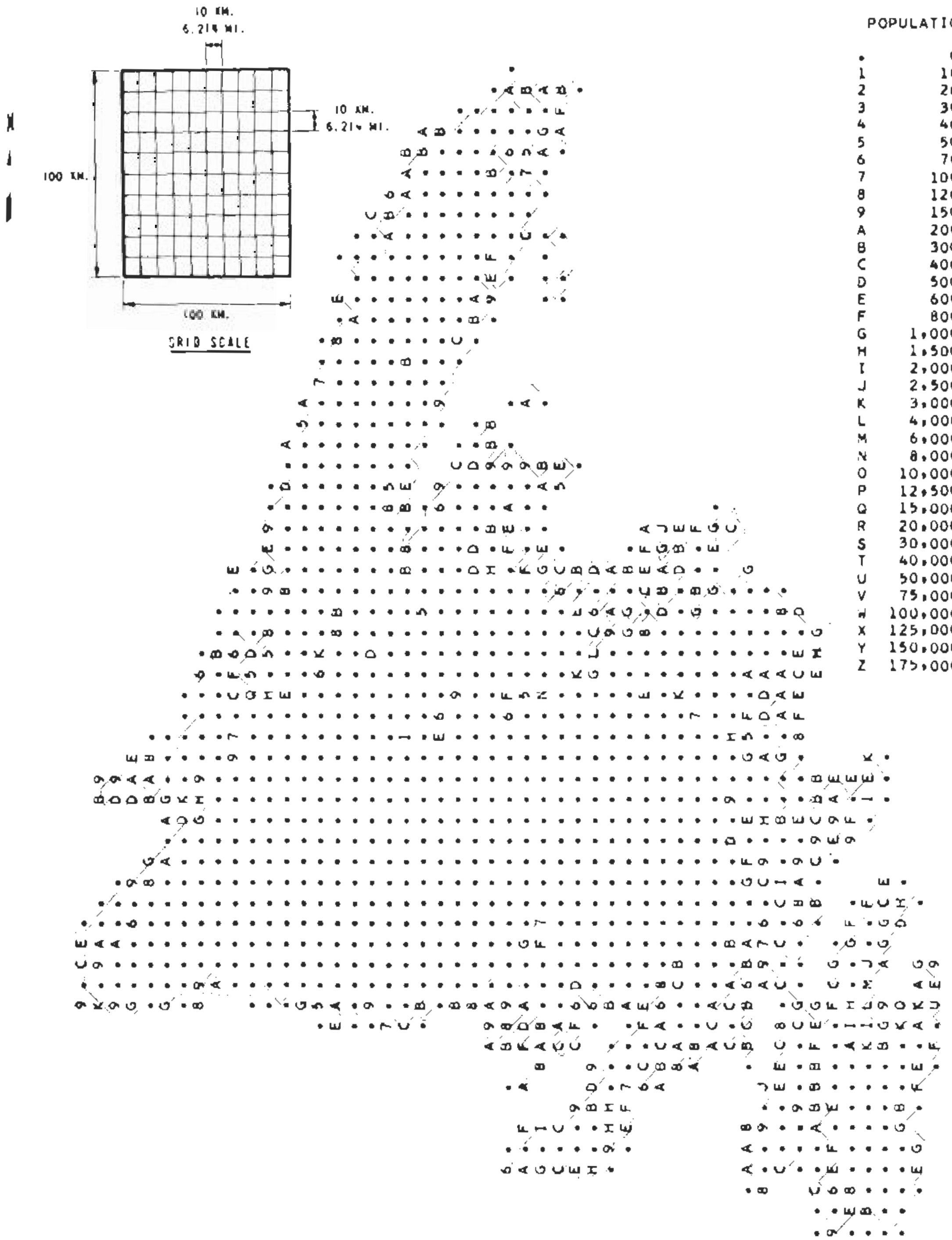
NEWFOUNDLAND
POPULATION DISTRIBUTION BY SQUARE GRID
1951

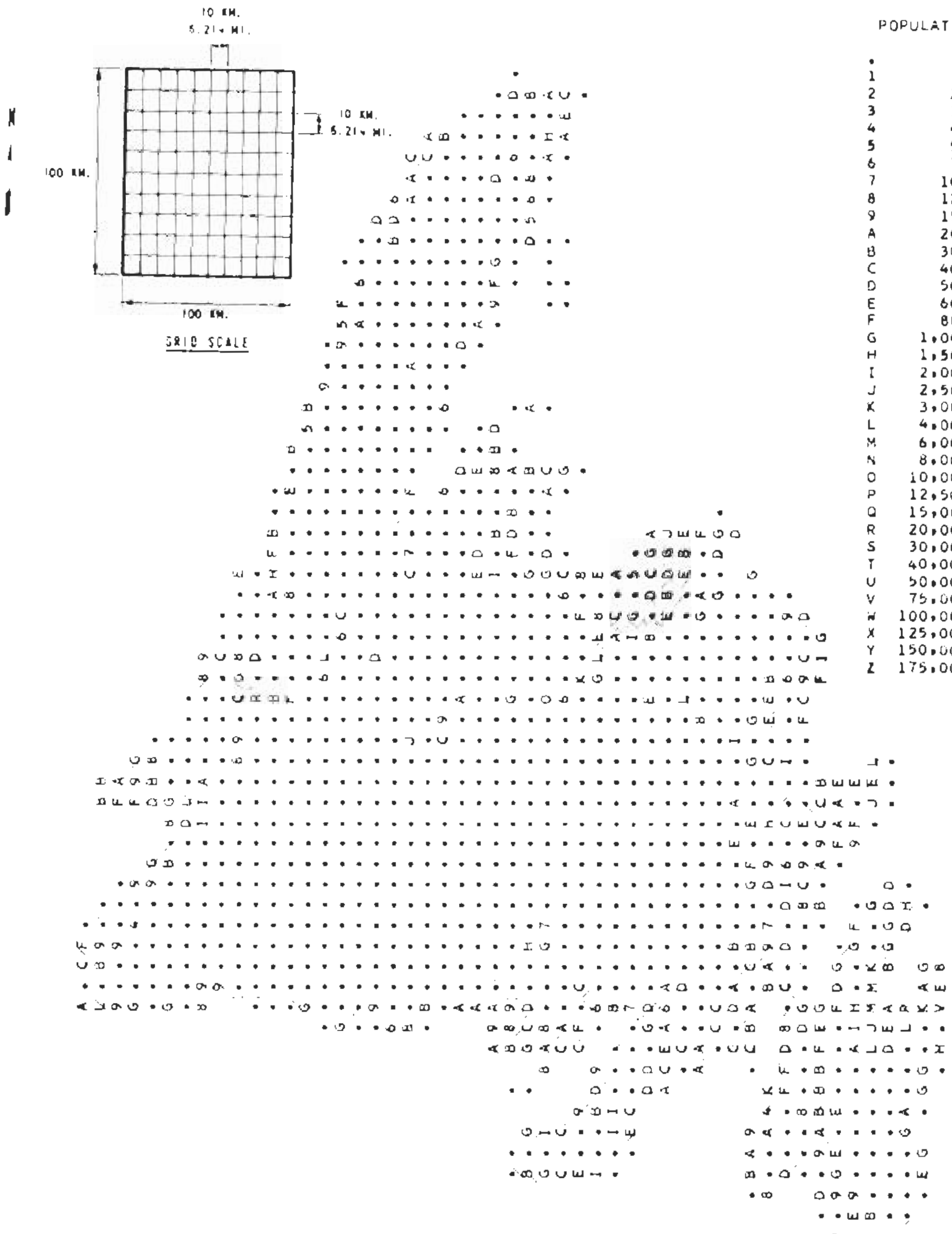


POPULATION IN 1951

•	0	–	9
1	10	–	19
2	20	–	29
3	30	–	39
4	40	–	49
5	50	–	69
6	70	–	99
7	100	–	119
8	120	–	149
9	150	–	199
A	200	–	299
B	300	–	399
C	400	–	499
D	500	–	599
E	600	–	799
F	800	–	999
G	1,000	–	1,499
H	1,500	–	1,999
I	2,000	–	2,499
J	2,500	–	2,999
K	3,000	–	3,999
L	4,000	–	5,999
M	6,000	–	7,999
N	8,000	–	9,999
O	10,000	–	12,499
P	12,500	–	14,999
Q	15,000	–	19,999
R	20,000	–	29,999
S	30,000	–	39,999
T	40,000	–	49,999
U	50,000	–	74,999
V	75,000	–	99,999
W	100,000	–	124,999
X	125,000	–	149,999
Y	150,000	–	174,999
Z	175,000	–	199,999

FIGURE 21-1A

NEWFOUNDLAND
POPULATION DISTRIBUTION BY SQUARE GRID
1956

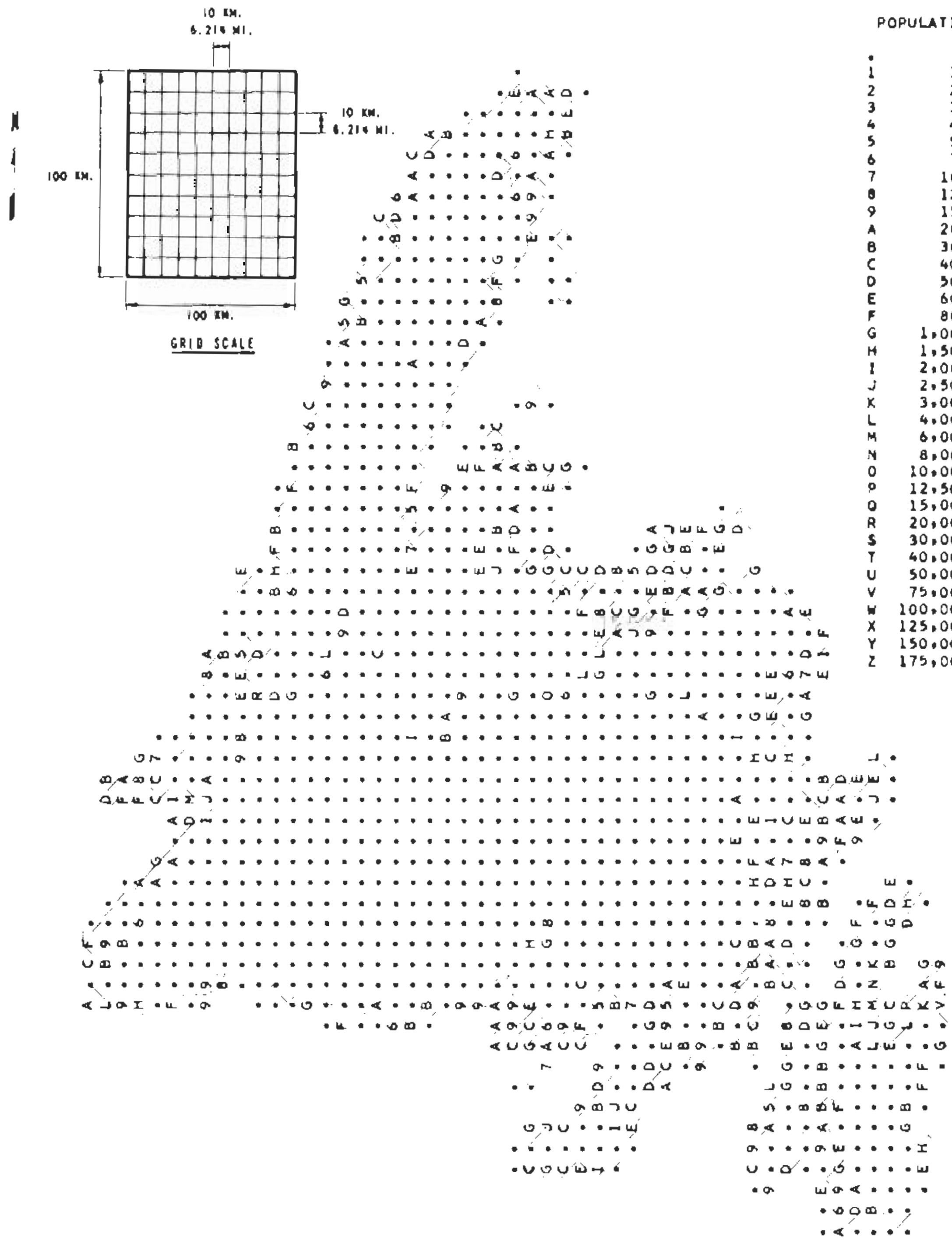


POPULATION IN 1956

•	0 -	9
1	10 -	19
2	20 -	29
3	30 -	39
4	40 -	49
5	50 -	69
6	70 -	99
7	100 -	119
8	120 -	149
9	150 -	199
A	200 -	299
B	300 -	399
C	400 -	499
D	500 -	599
E	600 -	799
F	800 -	999
G	1,000 -	1,499
H	1,500 -	1,999
I	2,000 -	2,499
J	2,500 -	2,999
K	3,000 -	3,999
L	4,000 -	5,999
M	6,000 -	7,999
N	8,000 -	9,999
O	10,000 -	12,499
P	12,500 -	14,999
Q	15,000 -	19,999
R	20,000 -	29,999
S	30,000 -	39,999
T	40,000 -	49,999
U	50,000 -	74,999
V	75,000 -	99,999
W	100,000 -	124,999
X	125,000 -	149,999
Y	150,000 -	174,999
Z	175,000 -	199,999

FIGURE 21-1B

NEWFOUNDLAND
POPULATION DISTRIBUTION BY SQUARE GRID
1961

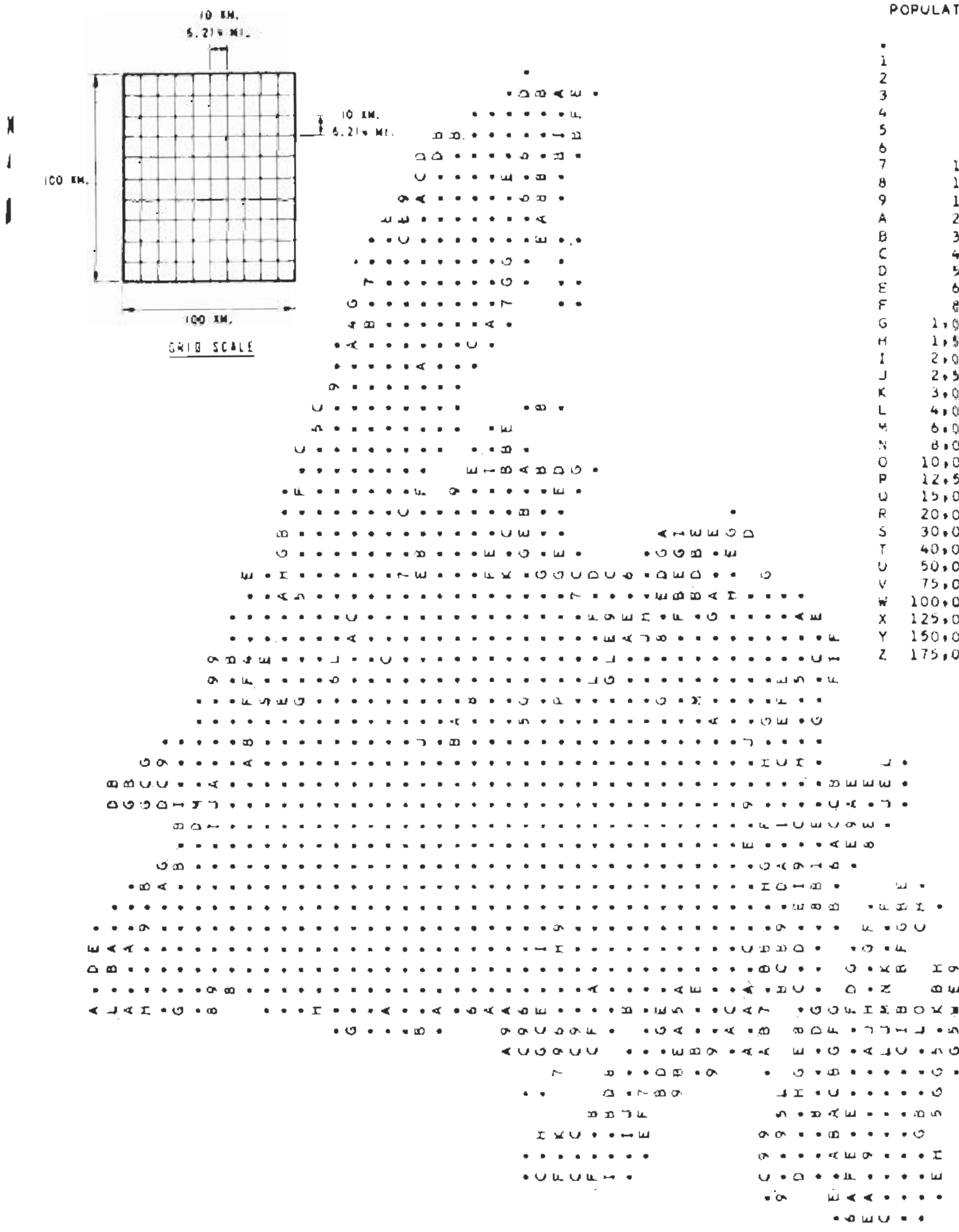


POPULATION IN 1961

Symbol	Population
•	0 - 9
1	10 - 19
2	20 - 29
3	30 - 39
4	40 - 49
5	50 - 69
6	70 - 99
7	100 - 119
8	120 - 149
9	150 - 199
A	200 - 299
B	300 - 399
C	400 - 499
D	500 - 599
E	600 - 799
F	800 - 999
G	1,000 - 1,499
H	1,500 - 1,999
I	2,000 - 2,499
J	2,500 - 2,999
K	3,000 - 3,999
L	4,000 - 5,999
M	6,000 - 7,999
N	8,000 - 9,999
O	10,000 - 12,499
P	12,500 - 14,999
Q	15,000 - 19,999
R	20,000 - 29,999
S	30,000 - 39,999
T	40,000 - 49,999
U	50,000 - 74,999
V	75,000 - 99,999
W	100,000 - 124,999
X	125,000 - 149,999
Y	150,000 - 174,999
Z	175,000 - 199,999

FIGURE 21-1C

NEWFOUNDLAND
POPULATION DISTRIBUTION BY SQUARE GRID
1966

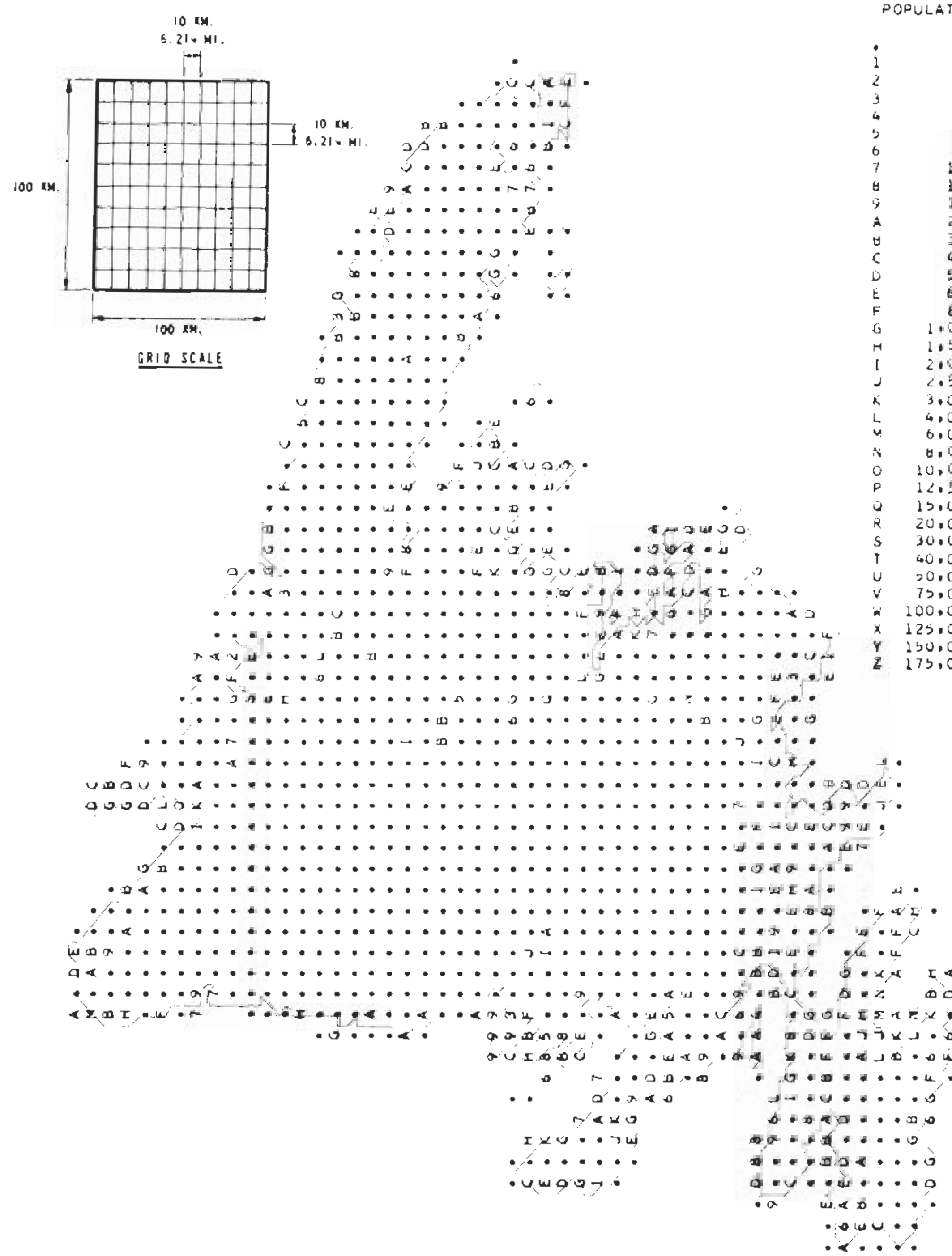


POPULATION IN 1966

•	0 –	9
1	10 –	19
2	20 –	29
3	30 –	39
4	40 –	49
5	50 –	69
6	70 –	99
7	100 –	119
8	120 –	149
9	150 –	199
A	200 –	299
B	300 –	399
C	400 –	499
D	500 –	599
E	600 –	799
F	800 –	999
G	1,000 –	1,499
H	1,500 –	1,999
I	2,000 –	2,499
J	2,500 –	2,999
K	3,000 –	3,999
L	4,000 –	5,999
M	6,000 –	7,999
N	8,000 –	9,999
O	10,000 –	12,499
P	12,500 –	14,999
Q	15,000 –	19,999
R	20,000 –	29,999
S	30,000 –	39,999
T	40,000 –	49,999
U	50,000 –	74,999
V	75,000 –	99,999
W	100,000 –	124,999
X	125,000 –	149,999
Y	150,000 –	174,999
Z	175,000 –	199,999

FIGURE 21-1D

NEWFOUNDLAND
POPULATION DISTRIBUTION BY SQUARE GRID
1971 ALTERNATIVE 1
ALUMINUM SMELTER AT STEPHENVILLE



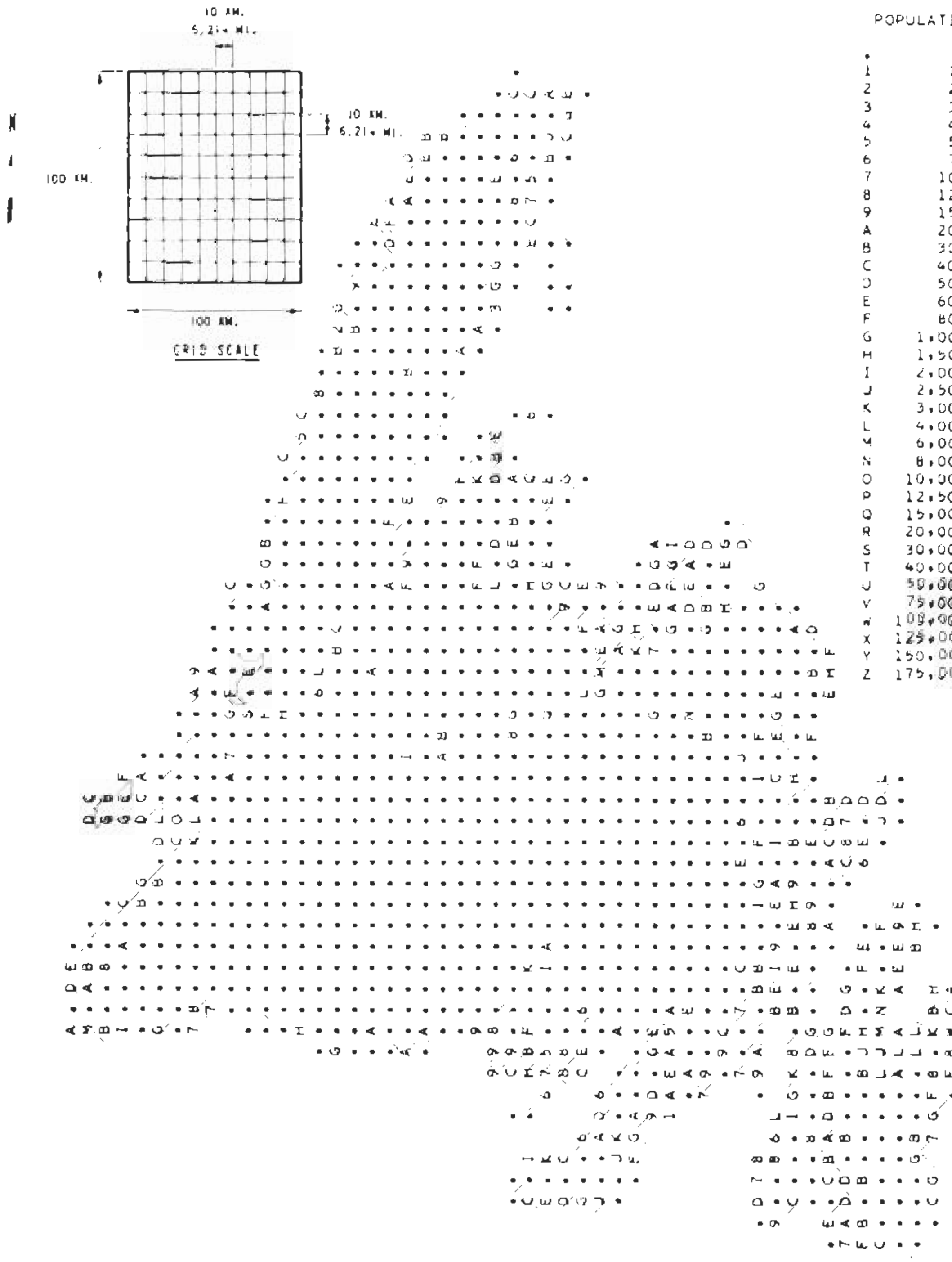
GRID SCALE

POPULATION IN 1971

•	0 -	9
1	10 -	19
2	20 -	29
3	30 -	39
4	40 -	49
5	50 -	59
6	70 -	99
7	100 -	119
8	120 -	149
9	150 -	199
A	200 -	299
B	300 -	399
C	400 -	499
D	500 -	599
E	600 -	799
F	800 -	999
G	1,000 -	1,499
H	1,500 -	1,999
I	2,000 -	2,499
J	2,500 -	2,999
K	3,000 -	3,999
L	4,000 -	5,999
M	6,000 -	7,999
N	8,000 -	9,999
O	10,000 -	12,499
P	12,500 -	14,999
Q	15,000 -	19,999
R	20,000 -	29,999
S	30,000 -	39,999
T	40,000 -	49,999
U	50,000 -	74,999
V	75,000 -	99,999
W	100,000 -	124,999
X	125,000 -	149,999
Y	150,000 -	174,999
Z	175,000 -	199,999

FIGURE 21-2A

NEWFOUNDLAND
POPULATION DISTRIBUTION BY SQUARE GRID
1976 ALTERNATIVE 1
ALUMINUM SMELTER AT STEPHENVILLE

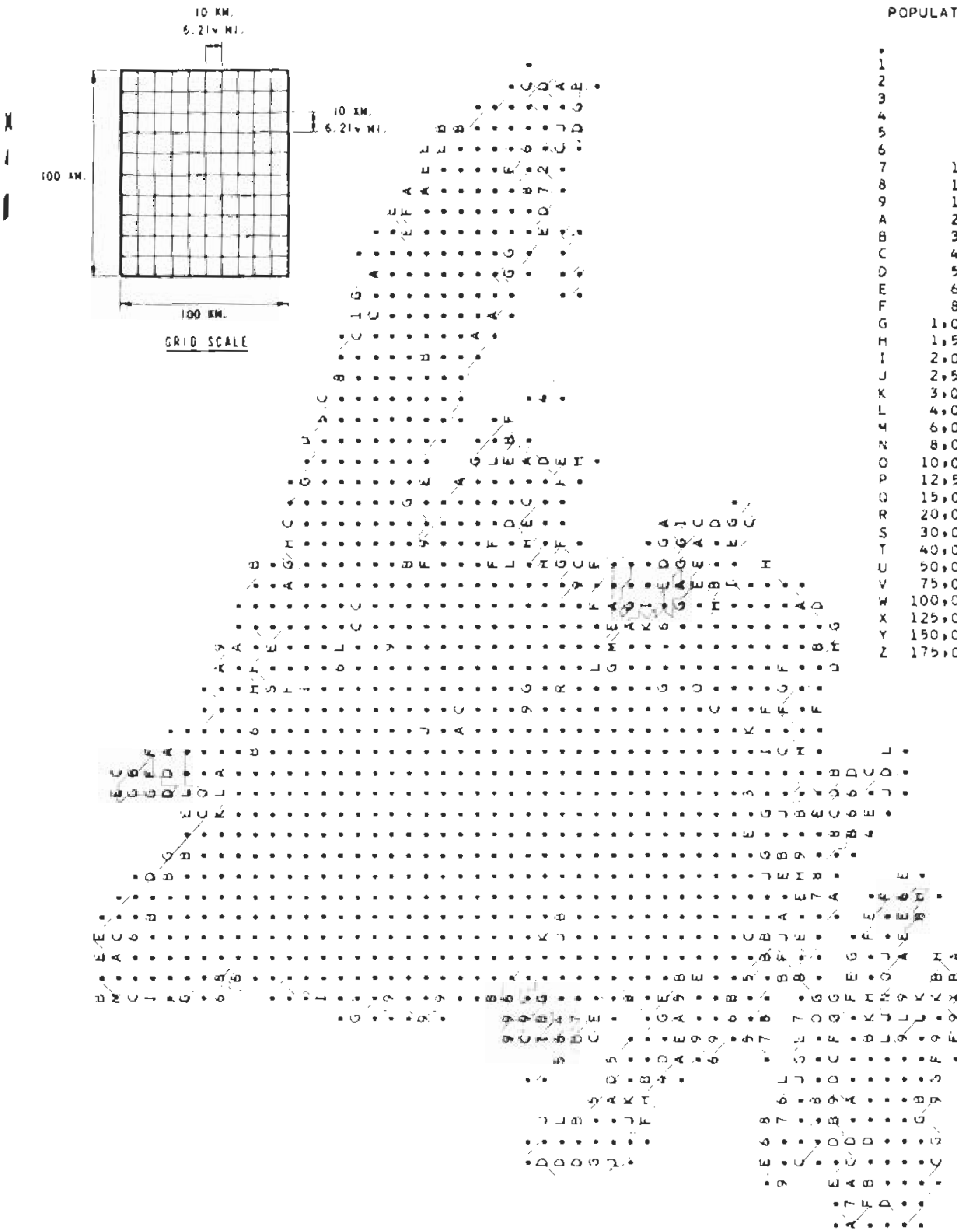


POPULATION IN 1976

•	0 -	9
1	10 -	19
2	20 -	29
3	30 -	39
4	40 -	49
5	50 -	69
6	70 -	99
7	100 -	119
8	120 -	149
9	150 -	199
A	200 -	299
B	300 -	399
C	400 -	499
D	500 -	599
E	600 -	799
F	800 -	999
G	1,000 -	1,499
H	1,500 -	1,999
I	2,000 -	2,499
J	2,500 -	2,999
K	3,000 -	3,999
L	4,000 -	5,999
M	6,000 -	7,999
N	8,000 -	9,999
O	10,000 -	12,499
P	12,500 -	14,999
Q	15,000 -	19,999
R	20,000 -	29,999
S	30,000 -	39,999
T	40,000 -	49,999
U	50,000 -	74,999
V	75,000 -	99,999
W	100,000 -	124,999
X	125,000 -	149,999
Y	150,000 -	174,999
Z	175,000 -	199,999

FIGURE 21-2B

NEWFOUNDLAND
POPULATION DISTRIBUTION BY SQUARE GRID
1981 ALTERNATIVE 1
ALUMINUM SMELTER AT STEPHENVILLE

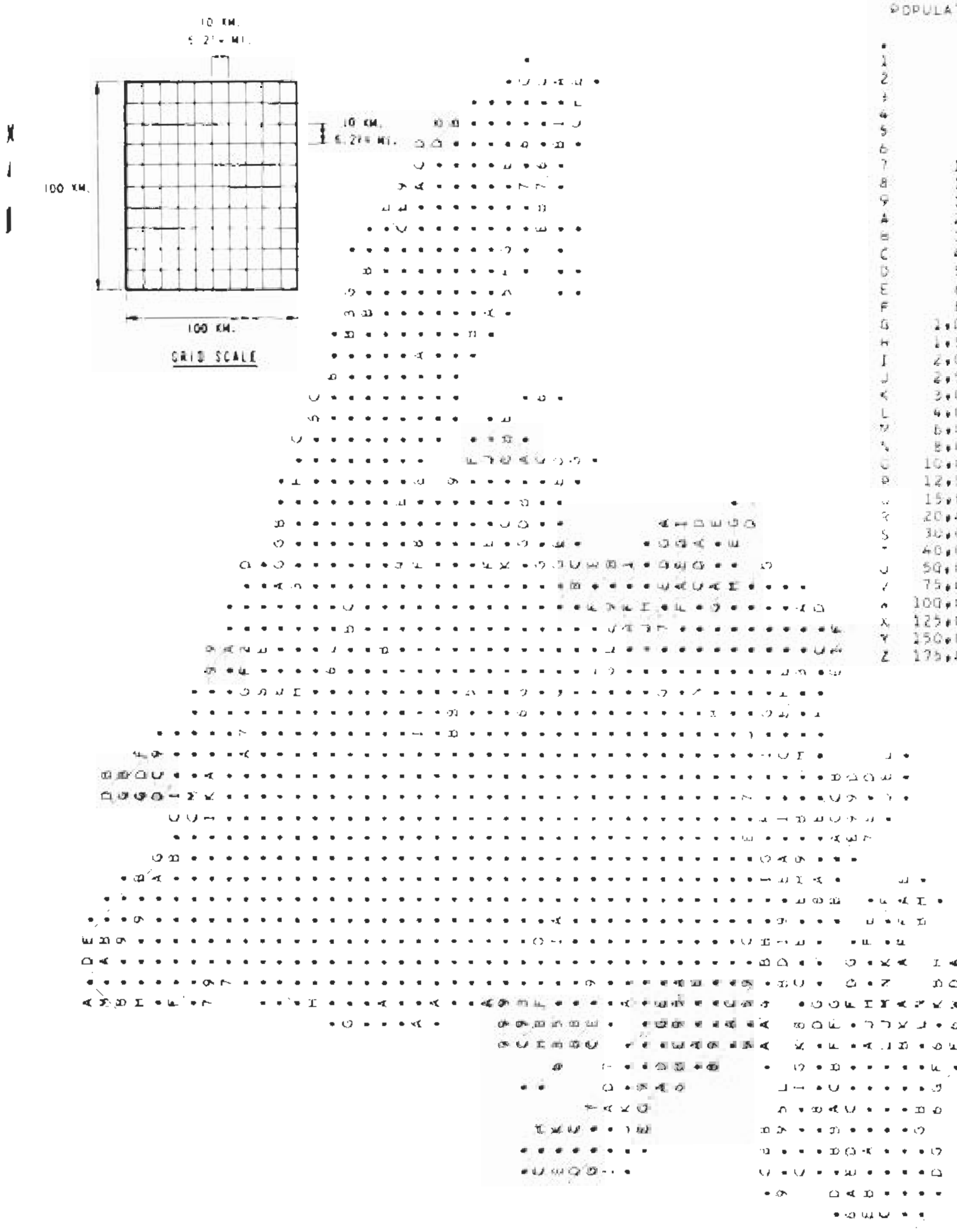


POPULATION IN 1981

•	0 -	9
1	10 -	19
2	20 -	29
3	30 -	39
4	40 -	49
5	50 -	69
6	70 -	99
7	100 -	119
8	120 -	149
9	150 -	199
A	200 -	299
B	300 -	399
C	400 -	499
D	500 -	599
E	600 -	799
F	800 -	999
G	1,000 -	1,499
H	1,500 -	1,999
I	2,000 -	2,499
J	2,500 -	2,999
K	3,000 -	3,999
L	4,000 -	5,999
M	6,000 -	7,999
N	8,000 -	9,999
O	10,000 -	12,499
P	12,500 -	14,999
Q	15,000 -	19,999
R	20,000 -	29,999
S	30,000 -	39,999
T	40,000 -	49,999
U	50,000 -	74,999
V	75,000 -	99,999
W	100,000 -	124,999
X	125,000 -	149,999
Y	150,000 -	174,999
Z	175,000 -	199,999

FIGURE 21-2C

NEWFOUNDLAND
POPULATION DISTRIBUTION BY SQUARE GRID
1971 ALTERNATIVE 2
ALUMINUM SMELTER AT BAY D'ESPOIR

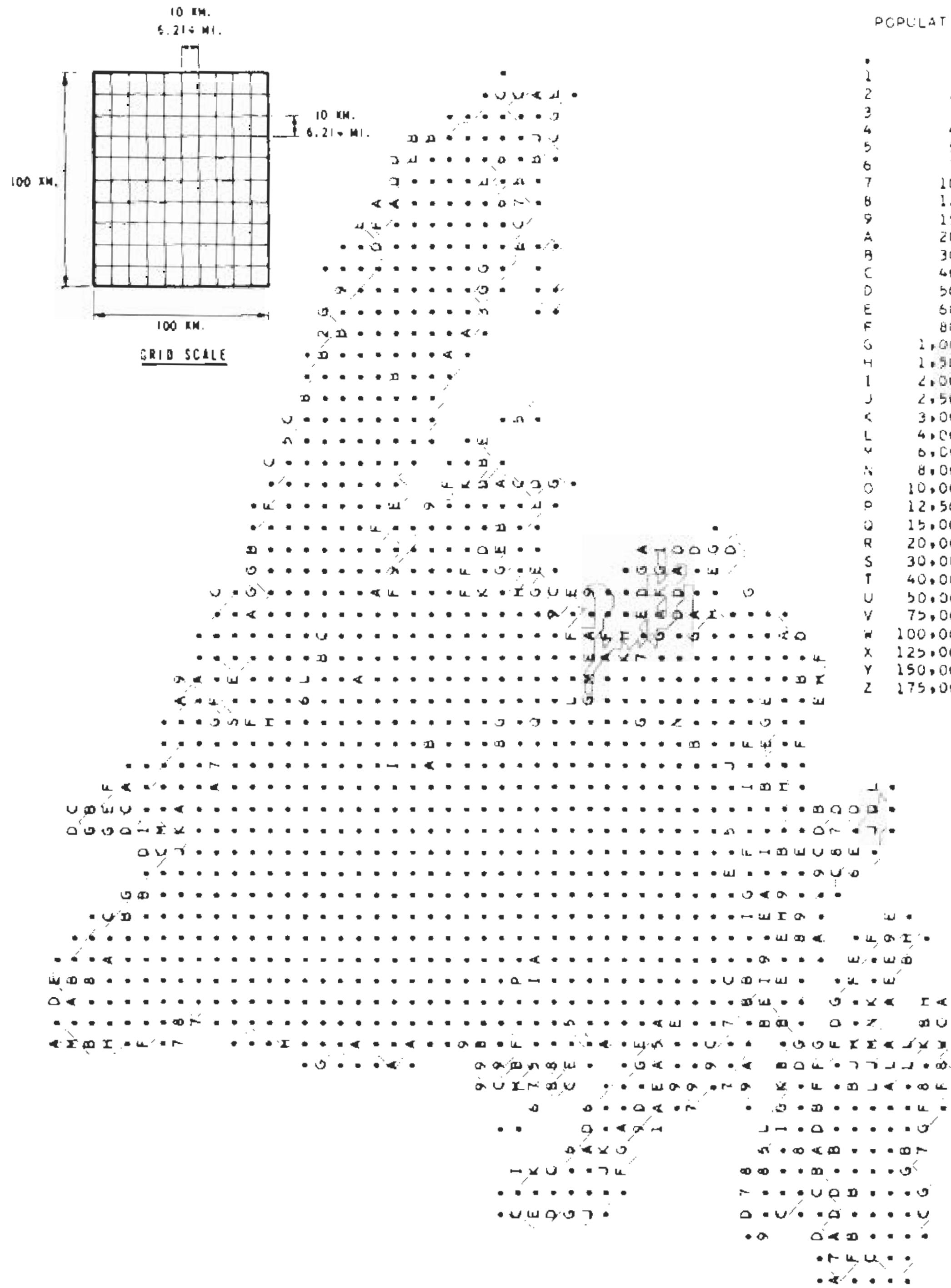


POPULATION IN 1971

.	0	–	9
1	10	–	19
2	20	–	29
3	30	–	39
4	40	–	49
5	50	–	69
6	70	–	99
7	100	–	119
8	120	–	149
9	150	–	199
A	200	–	299
B	300	–	399
C	400	–	499
D	500	–	599
E	600	–	799
F	800	–	999
G	1,000	–	1,499
H	1,500	–	1,999
I	2,000	–	2,499
J	2,500	–	2,999
K	3,000	–	3,999
L	4,000	–	5,999
M	6,000	–	7,999
N	8,000	–	9,999
O	10,000	–	12,499
P	12,500	–	14,999
Q	15,000	–	19,999
R	20,000	–	29,999
S	30,000	–	39,999
T	40,000	–	49,999
U	50,000	–	74,999
V	75,000	–	99,999
W	100,000	–	124,999
X	125,000	–	149,999
Y	150,000	–	174,999
Z	175,000	–	199,999

FIGURE 21-3A

NEWFOUNDLAND
POPULATION DISTRIBUTION BY SQUARE GRID
1976 ALTERNATIVE 2
ALUMINUM SMELTER AT BAY D'ESPOIR



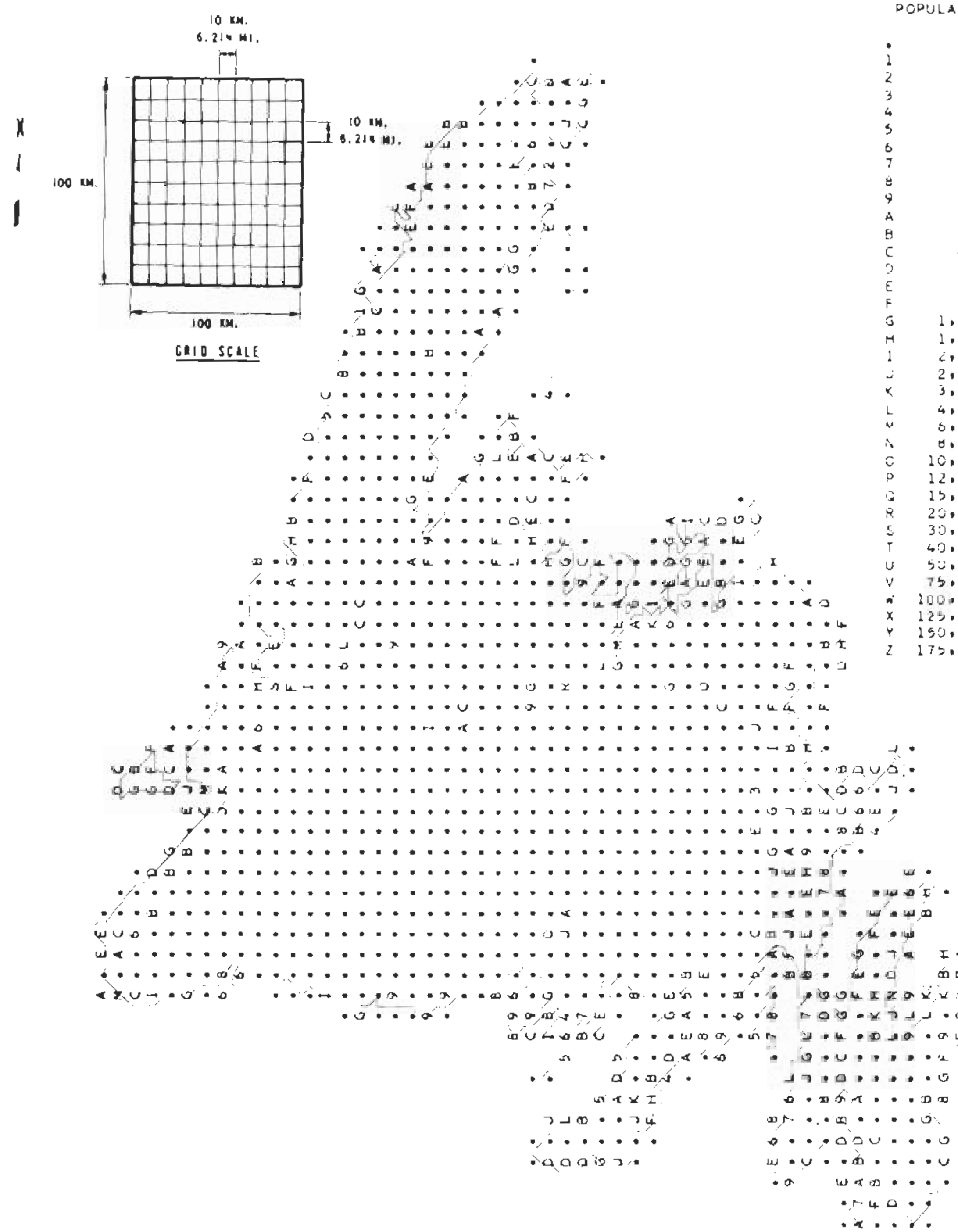
GRID SCALE

POPULATION IN 1976

•	0	-	9
1	10	-	19
2	20	-	29
3	30	-	39
4	40	-	49
5	50	-	69
6	70	-	99
7	100	-	119
8	120	-	149
9	150	-	199
A	200	-	299
B	300	-	399
C	400	-	499
D	500	-	599
E	600	-	799
F	800	-	999
G	1,000	-	1,499
H	1,500	-	1,999
I	2,000	-	2,499
J	2,500	-	2,999
K	3,000	-	3,999
L	4,000	-	5,999
M	6,000	-	7,999
N	8,000	-	9,999
O	10,000	-	12,499
P	12,500	-	14,999
Q	15,000	-	19,999
R	20,000	-	29,999
S	30,000	-	39,999
T	40,000	-	49,999
U	50,000	-	74,999
V	75,000	-	99,999
W	100,000	-	124,999
X	125,000	-	149,999
Y	150,000	-	174,999
Z	175,000	-	199,999

FIGURE 21-3B

NEWFOUNDLAND
POPULATION DISTRIBUTION BY SQUARE GRID
1981 ALTERNATIVE 2
ALUMINUM SMELTER AT BAY D'ESPOIR



POPULATION IN 1981

•	0 -	9
1	10 -	19
2	20 -	29
3	30 -	39
4	40 -	49
5	50 -	69
6	70 -	99
7	100 -	119
8	120 -	149
9	150 -	199
A	200 -	299
B	300 -	399
C	400 -	499
D	500 -	599
E	600 -	799
F	800 -	999
G	1,000 -	1,499
H	1,500 -	1,999
I	2,000 -	2,499
J	2,500 -	2,999
K	3,000 -	3,999
L	4,000 -	5,999
M	6,000 -	7,999
N	8,000 -	9,999
O	10,000 -	12,499
P	12,500 -	14,999
Q	15,000 -	19,999
R	20,000 -	29,999
S	30,000 -	39,999
T	40,000 -	49,999
U	50,000 -	74,999
V	75,000 -	99,999
W	100,000 -	124,999
X	125,000 -	149,999
Y	150,000 -	174,999
Z	175,000 -	199,999

FIGURE 21-3C

NEWFOUNDLAND AND LABRADOR
POPULATION CHARACTERISTICS BY CENSUS DIVISION
1966

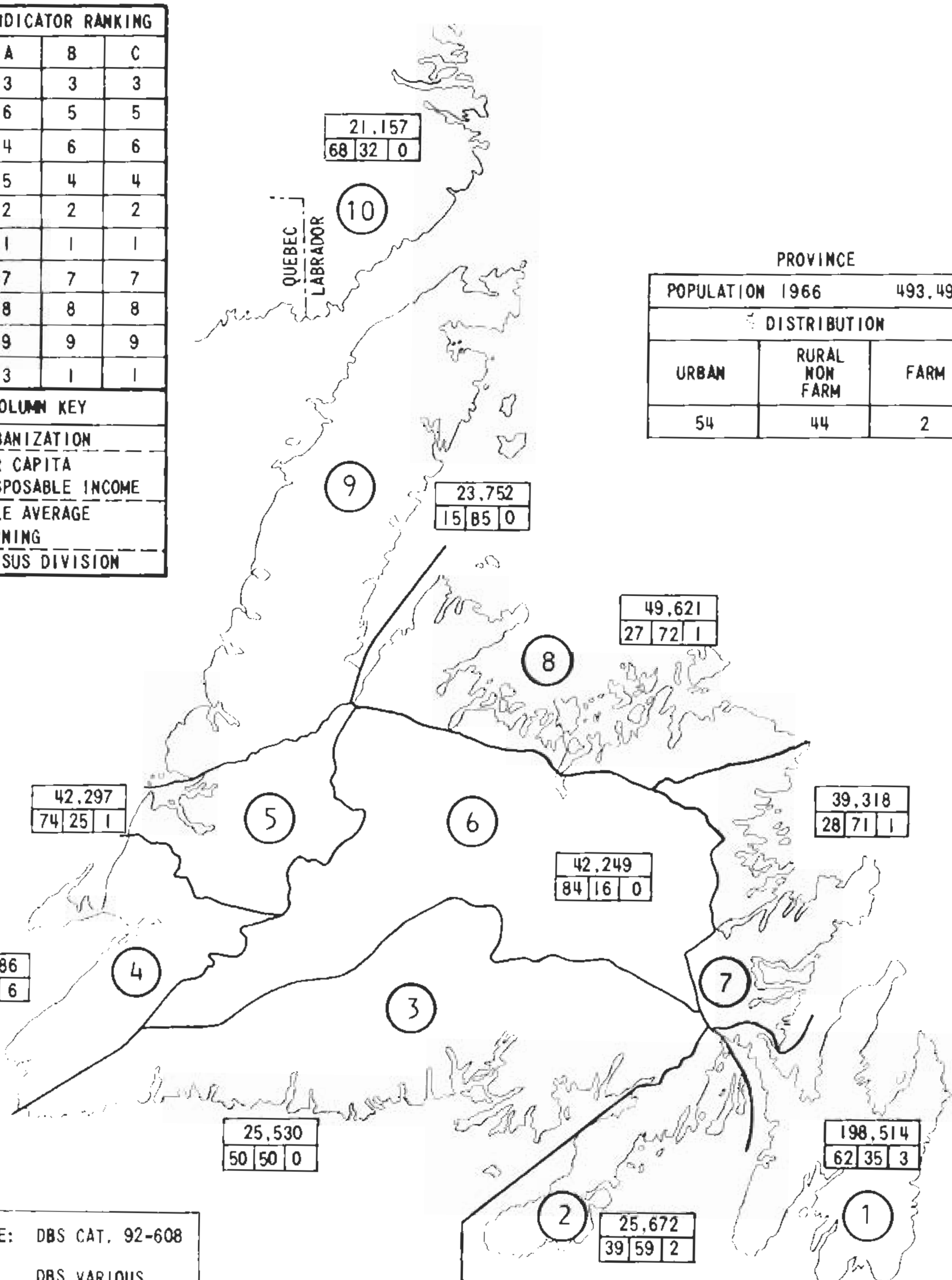
C.D	INDICATOR RANKING A	B	C
1	3	3	3
2	6	5	5
3	4	6	6
4	5	4	4
5	2	2	2
6	1	1	1
7	7	7	7
8	8	8	8
9	9	9	9
10	3	1	1

COLUMN KEY

A = URBANIZATION
B = PER CAPITA DISPOSABLE INCOME
C = MALE AVERAGE EARNING
C.D = CENSUS DIVISION

PROVINCE

POPULATION 1966		493,496
% DISTRIBUTION		
URBAN	RURAL NON FARM	FARM
54	44	2



SOURCE: DBS CAT. 92-608
DBS VARIOUS

NEWFOUNDLAND AND LABRADOR
PERSONAL INCOME AND ITS MAIN COMPONENTS
1949 - 1966

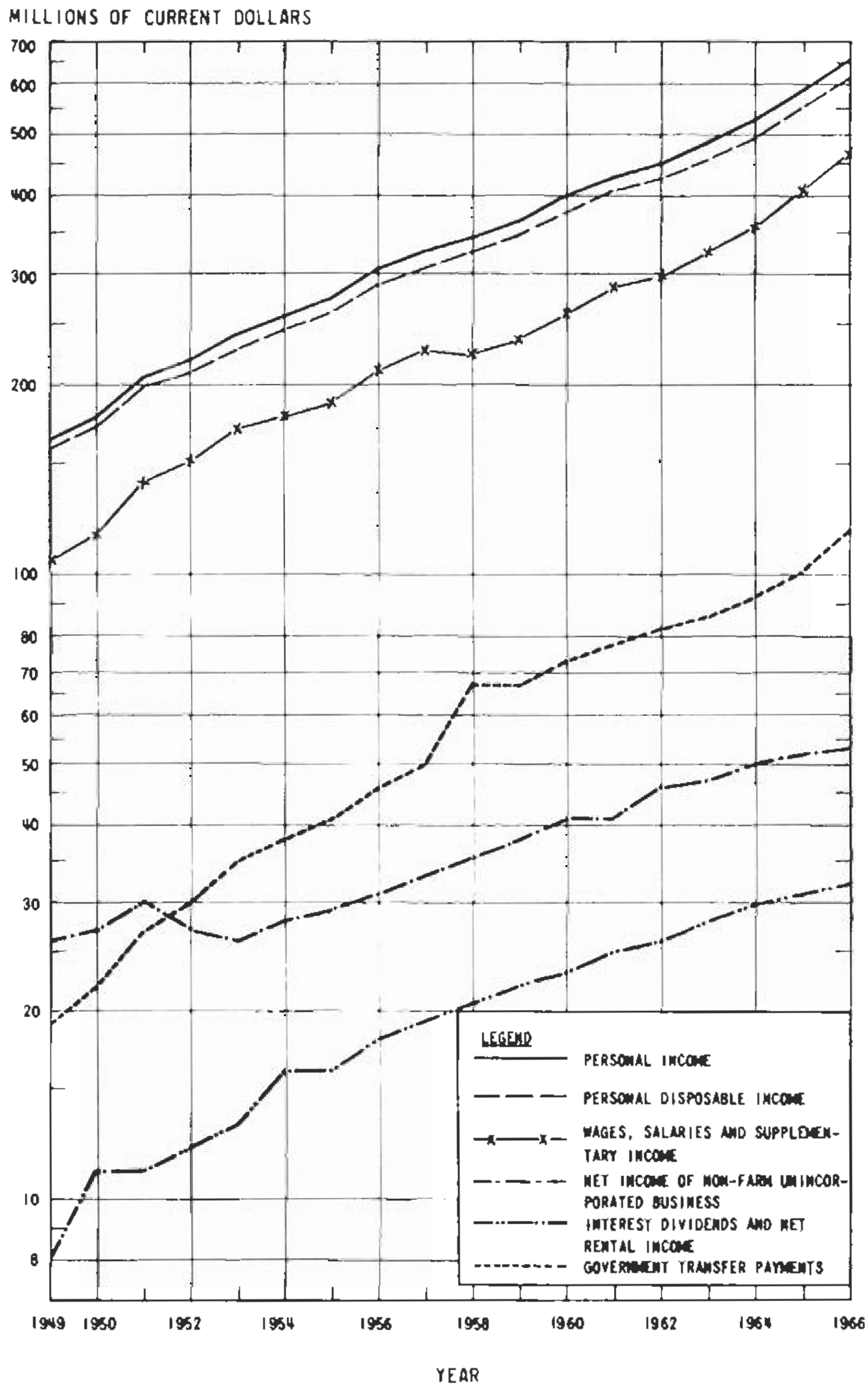
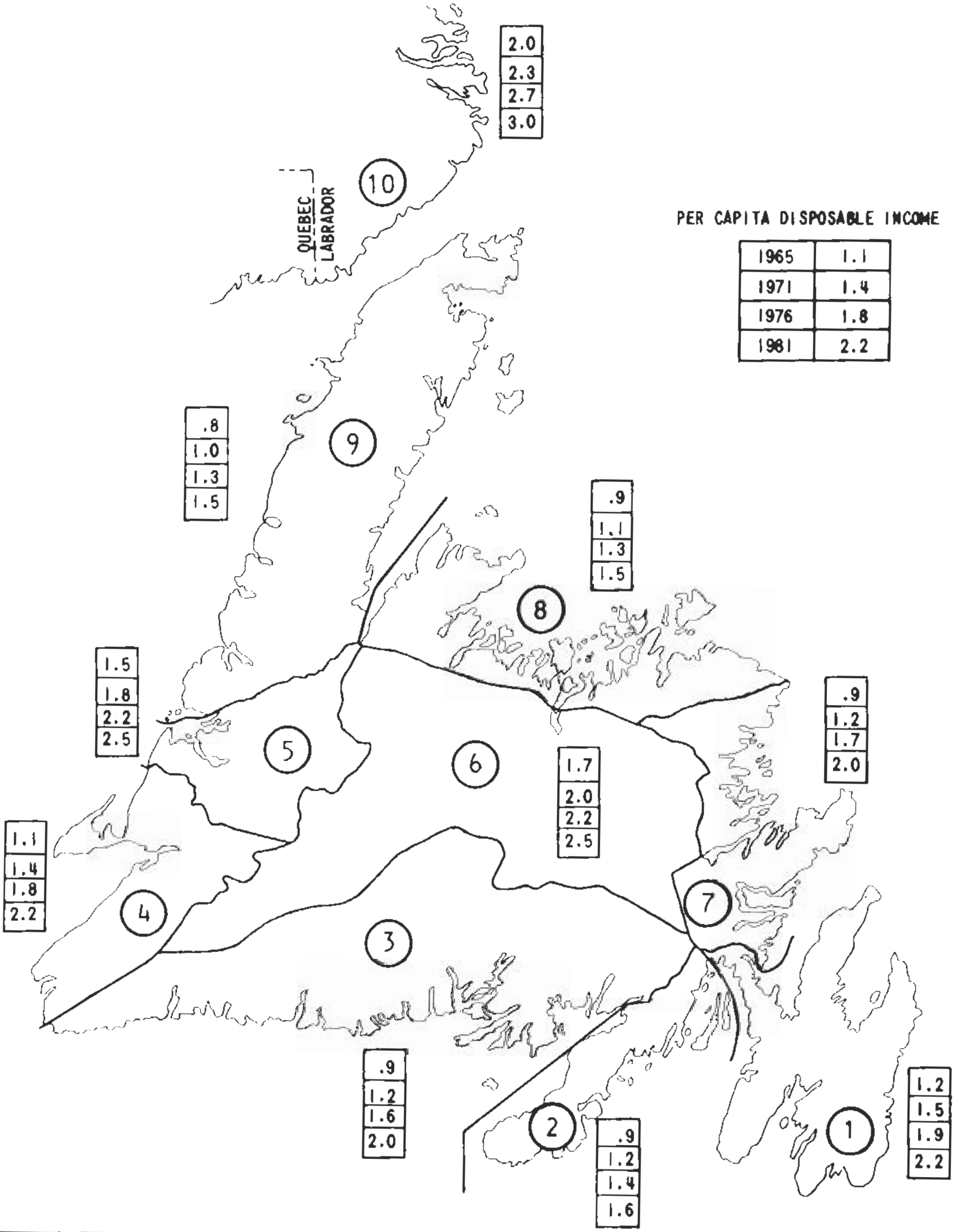


FIGURE 21-5

NEWFOUNDLAND AND LABRADOR PER CAPITA DISPOSABLE INCOME BY CENSUS DIVISION 1965,1971,1976,1981



PER CAPITA DISPOSABLE INCOME

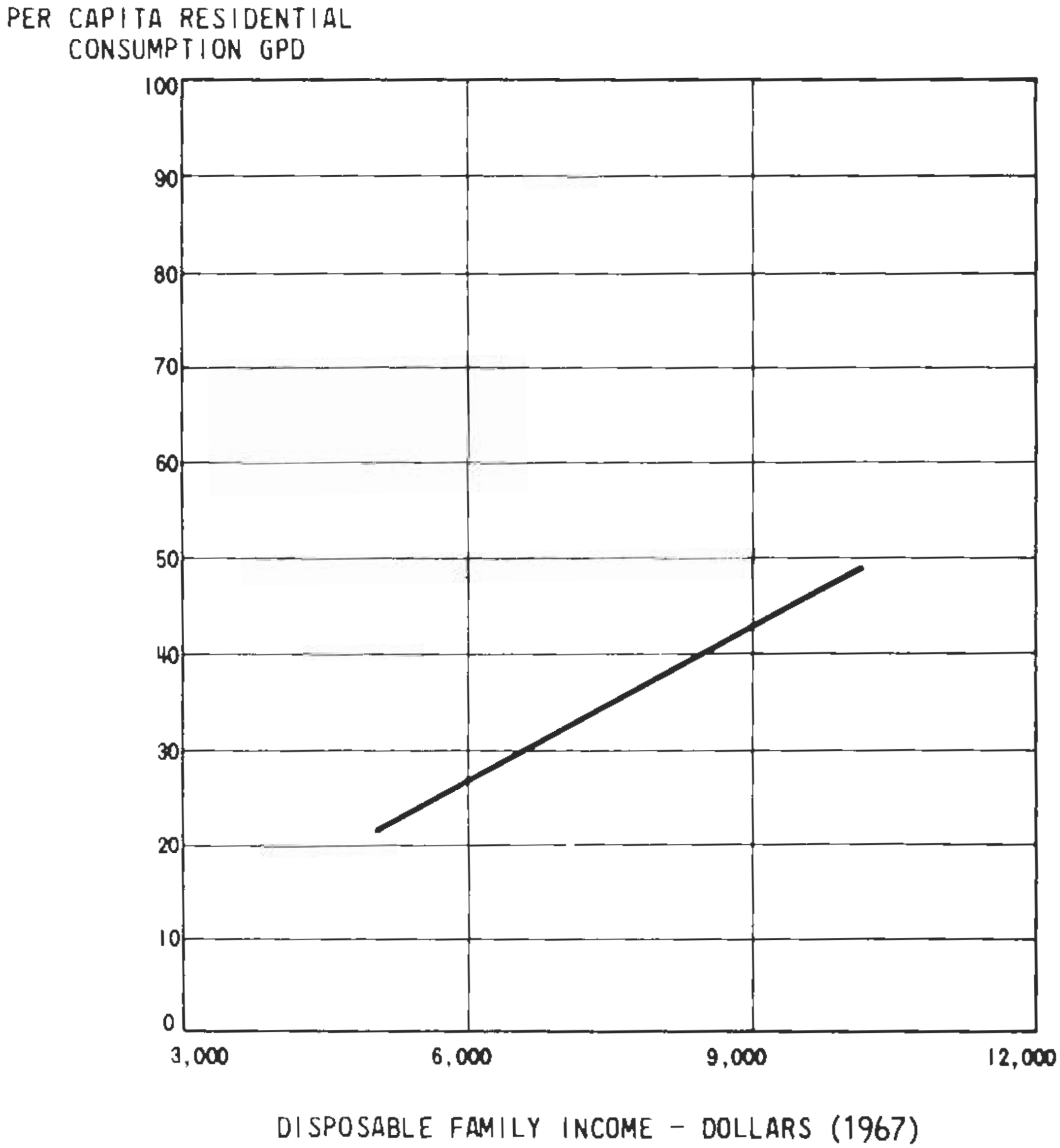
1965	1.1
1971	1.4
1976	1.8
1981	2.2

NOTE: (1) ASSUMES ALUMINUM COMPLEX IN BOTH SUB-DIVISION 3 AND 4.

(2) ALL FIGURES ARE SHOWN IN THOUSANDS OF 1965 DOLLARS.

FIGURE 21-6

RELATIONSHIP BETWEEN RESIDENTIAL WATER CONSUMPTION AND DISPOSABLE FAMILY INCOME



NOTE: BASED ON DATA PRESENTED BY R. HANSON & H.E. HUDSON JR. IN AWWA NOV. 1956

FIGURE 21-7

MUNICIPAL WATER USE: FREQUENCY DISTRIBUTION
PERCENT OF TOTAL DEMAND BY TYPE OF USER

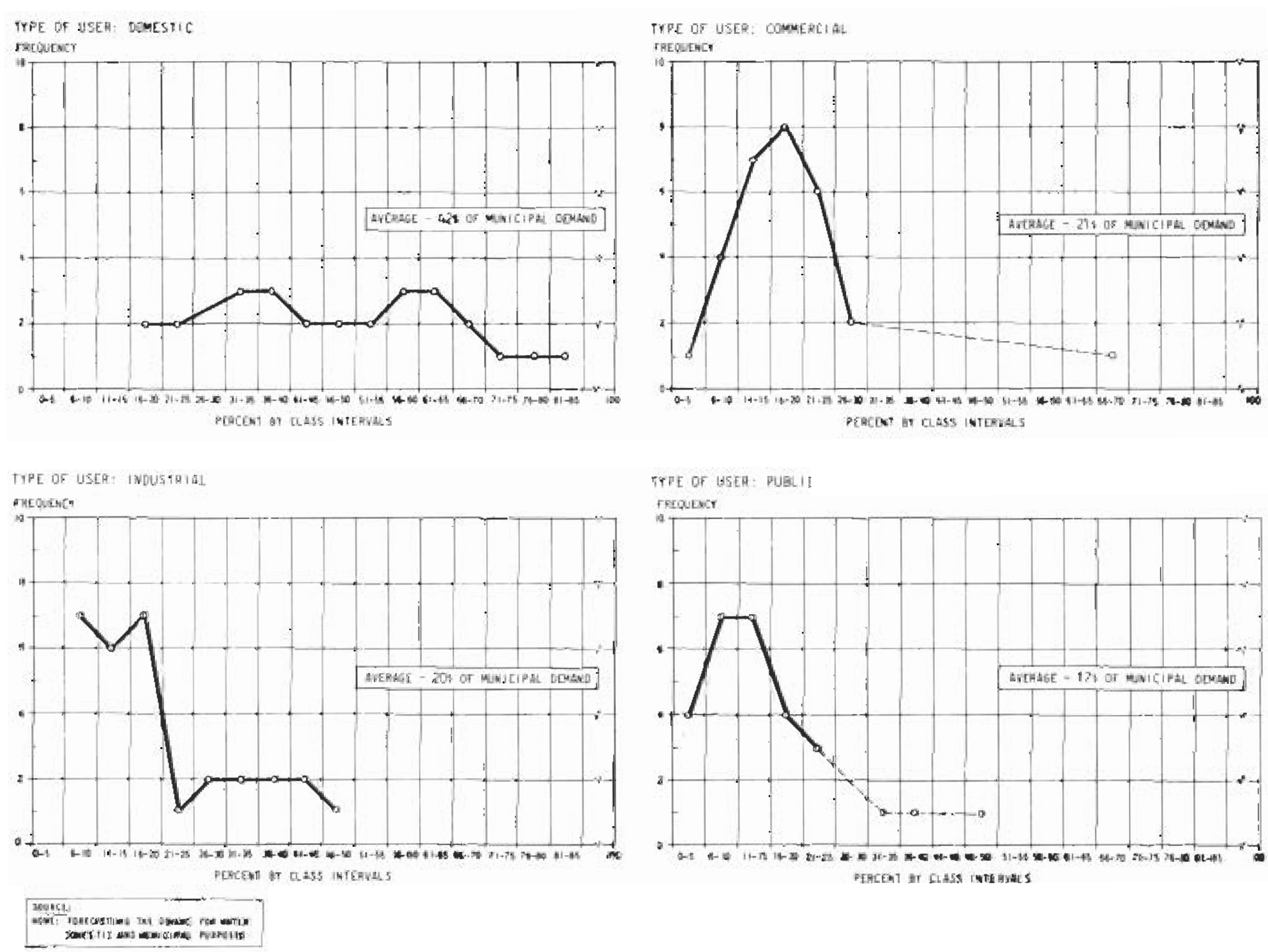
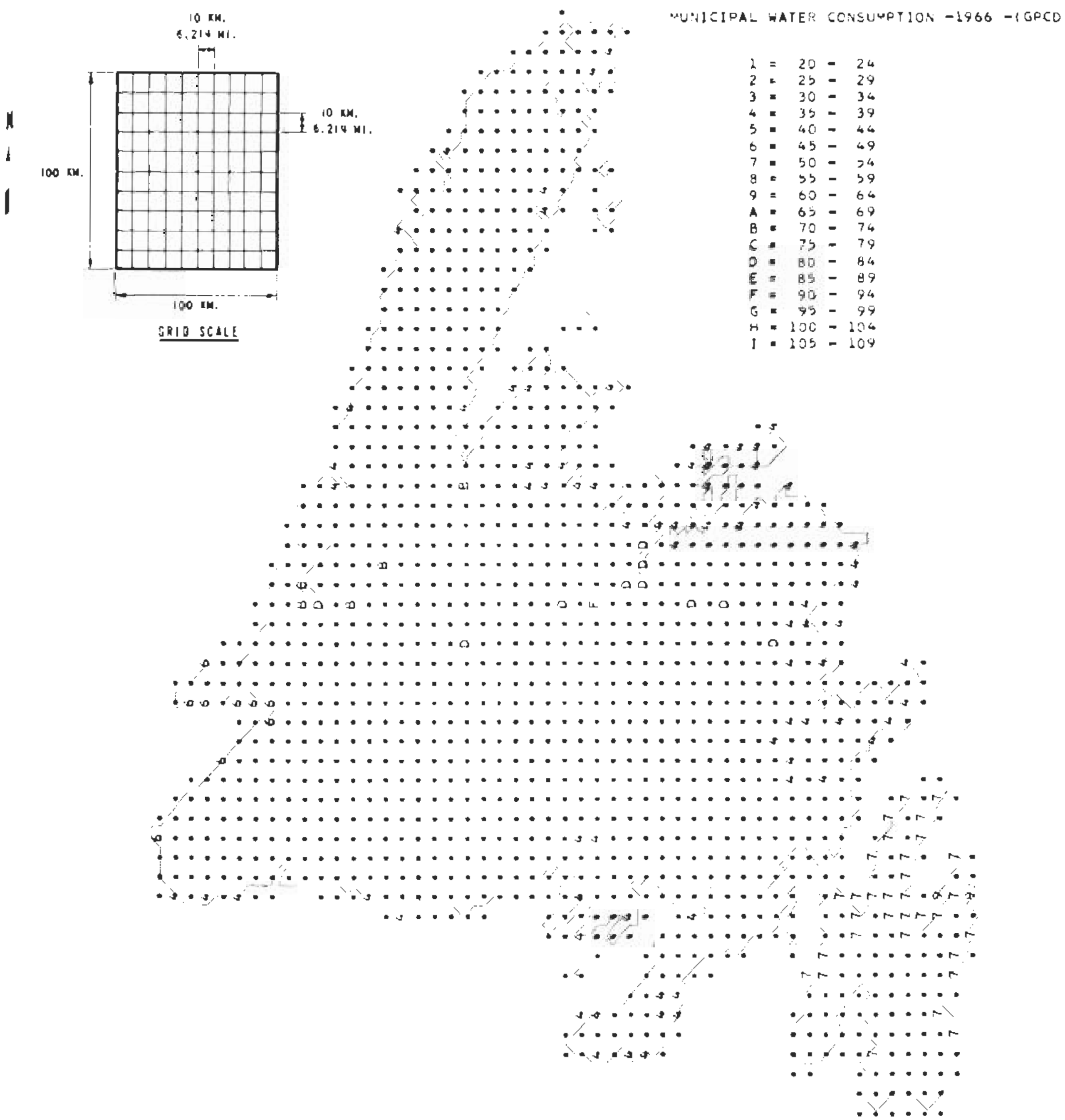


FIGURE 21-8

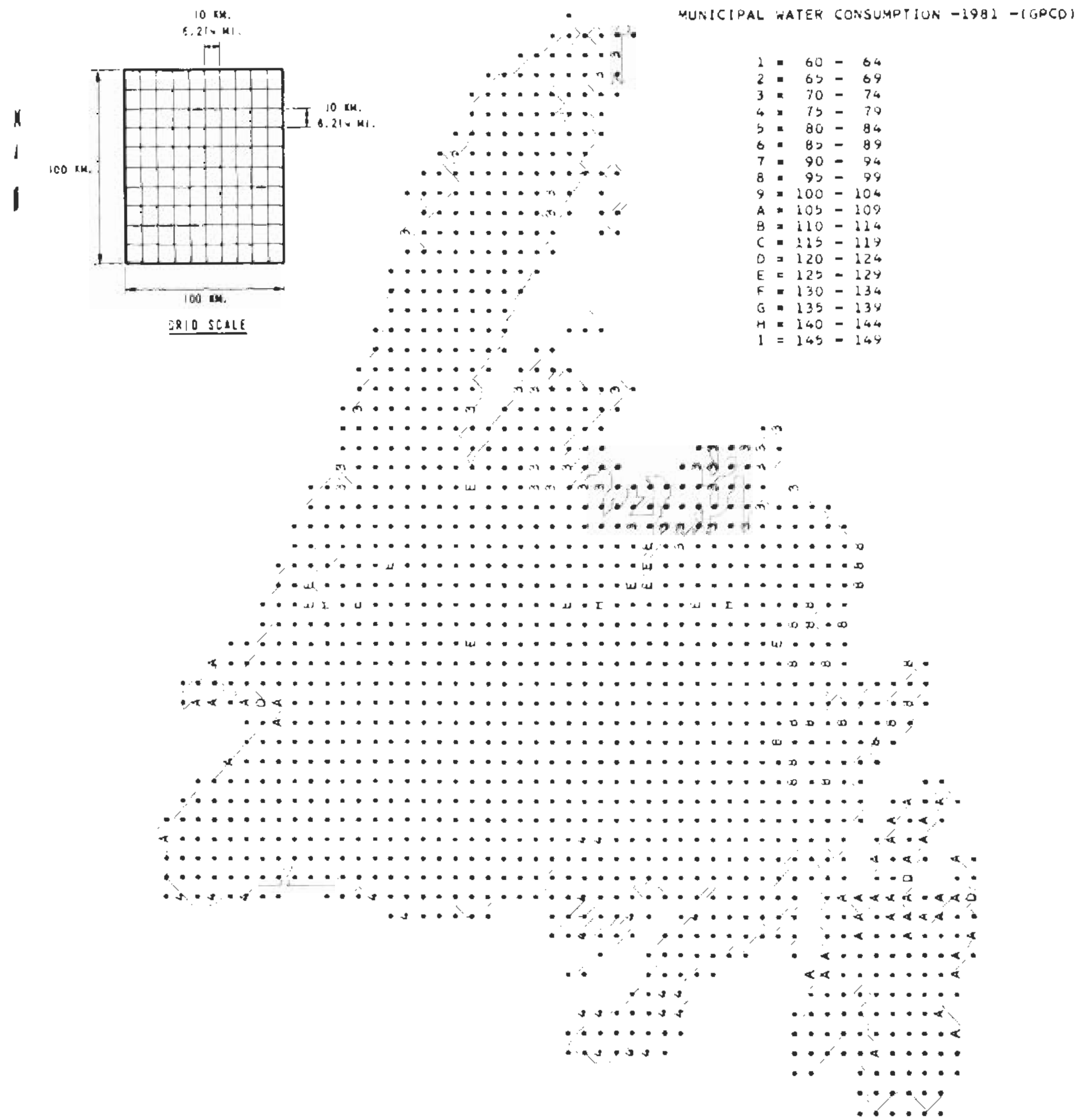
NEWFOUNDLAND
ESTIMATED MUNICIPAL WATER DEMAND PER CAPITA 1966



NOTE: ONLY FOR SQUARES WITH POPULATION OF 700 AND MORE.

FIGURE 21-9A

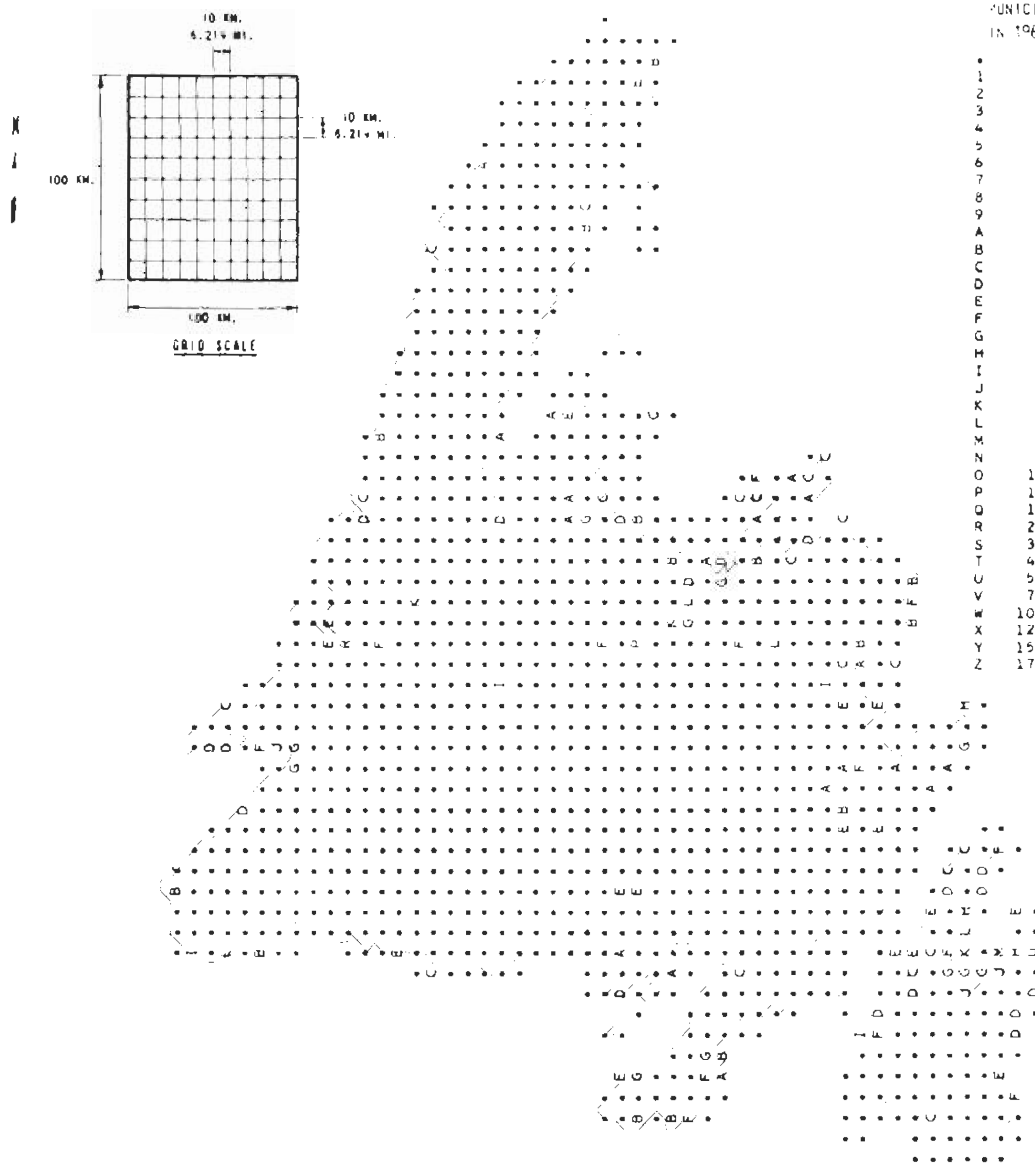
NEWFOUNDLAND
ESTIMATED MUNICIPAL WATER DEMAND PER CAPITA 1981



NOTE: ONLY FOR SQUARES WITH POPULATION OF 700 AND MORE.

FIGURE 21-9B

NEWFOUNDLAND
TOTAL WATER DEMAND
BY SELECTED AREA 1966



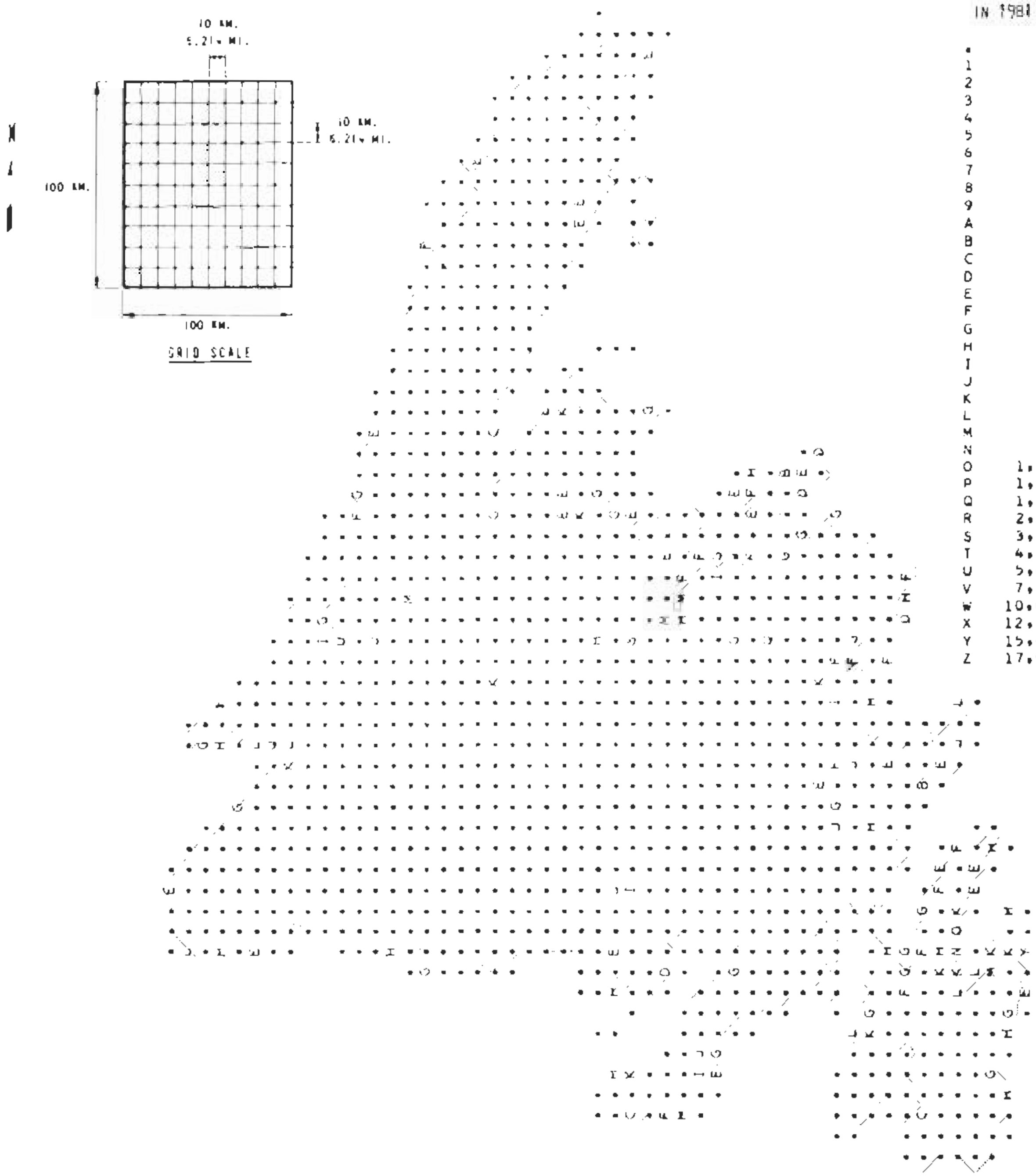
MUNICIPAL WATER DEMAND IN 1966 (G.P.D. × 1000)

•	0 –	
1	1 –	1
2	2 –	2
3	3 –	3
4	4 –	4
5	5 –	6
6	7 –	9
7	10 –	11
8	12 –	14
9	15 –	19
A	20 –	29
B	30 –	39
C	40 –	49
D	50 –	59
E	60 –	79
F	80 –	99
G	100 –	149
H	150 –	199
I	200 –	249
J	250 –	299
K	300 –	399
L	400 –	599
M	600 –	799
N	800 –	999
O	1,000 –	1,249
P	1,250 –	1,499
Q	1,500 –	1,999
R	2,000 –	2,999
S	3,000 –	3,999
T	4,000 –	4,999
U	5,000 –	7,499
V	7,500 –	9,999
W	10,000 –	12,499
X	12,500 –	14,999
Y	15,000 –	17,499
Z	17,500 –	19,999

NOTE: ONLY FOR SQUARES WITH POPULATION OF 700 AND MORE.

FIGURE 21-10A

NEWFOUNDLAND TOTAL WATER DEMAND BY SELECTED AREA 1981



MUNICIPAL WATER DEMAND IN 1981 (G.P.D. ×1000)

•	0 –	
1	1 –	1
2	2 –	2
3	3 –	3
4	4 –	4
5	5 –	6
6	7 –	9
7	10 –	11
8	12 –	14
9	15 –	19
A	20 –	29
B	30 –	39
C	40 –	49
D	50 –	59
E	60 –	79
F	80 –	99
G	100 –	149
H	150 –	199
I	200 –	249
J	250 –	299
K	300 –	399
L	400 –	599
M	600 –	799
N	800 –	999
O	1,000 –	1,249
P	1,250 –	1,499
Q	1,500 –	1,999
R	2,000 –	2,999
S	3,000 –	3,999
T	4,000 –	4,999
U	5,000 –	7,499
V	7,500 –	9,999
W	10,000 –	12,499
X	12,500 –	14,999
Y	15,000 –	17,499
Z	17,500 –	19,999

NOTE: ONLY FOR SQUARES WITH POPULATION OF 700 AND MORE.

FIGURE 21-10B

NEWFOUNDLAND AND LABRADOR

POPULATION BY AGE GROUP AND SEX
1971, 1976, 1981

	1971			1976			1981		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
	in thousands			in thousands			in thousands		
TOTAL POPULATION	538.5	275.0	263.5	583.7	298.0	285.7	630.9	324.0	306.9
under 15 years	200.3	101.5	98.8	205.5	104.0	101.5	216.4	111.0	105.4
over 15 years	338.2	173.5	164.7	378.2	194.0	184.2	414.5	213.0	201.5
LABOUR FORCE AGE GROUPS									
15 - 19 years	66.3	34.0	32.3	73.7	37.8	35.9	77.1	39.4	37.7
20 - 24 years	55.5	28.1	27.4	63.2	32.2	31.0	70.5	36.0	34.5
25 - 64 years	185.7	96.5	89.2	203.5	107.5	96.0	227.6	119.3	108.3
65 - 69 years	11.2	5.5	5.7	12.9	6.4	6.5	14.9	7.0	7.9
70 and over	19.5	9.4	10.1	24.9	10.1	14.8	22.4	11.3	11.1

TABLE 21-1

NEWFOUNDLAND

1966 AND 1981 ESTIMATED BASIC MUNICIPAL WATER USES BY COMMUNITIES WITH A 1966 POPULATION GREATER THAN 700

SQUARE IDENTIFICATION	POPULATION (PERS.) 1966	POPULATION (PERS.) 1981	MUNICIPAL WATER CONSUMPTION PER CAPITA (GPCD) 1966	PER CAPITA (GPCD) 1981	TOTAL (GPDx1000) 1966	TOTAL (GPDx1000) 1981
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

COMMERCIAL AND INSTITUTIONAL WATER USE BY SELECTED PARAMETERS

Type of Establishment or Institution	Selected Parameter	Annual Water Use (gpd/unit) Expected	Design	Maximum Day Water Use (gpd/unit) Expected	Design	Peak Hour Water Use (gpd/unit) Expected	Design	Hours of Peak Occurrence
Primary and Secondary Schools								
Public Elementary	gpd/student	5.38	8.67	9.68	13.0	49.1	52.4	1 p.m. - 2 p.m.
Public Junior High	"	5.64	9.75					
Public Senior High	"	6.63	12.2	19.6	25.2	121	127	4 p.m. - 5 p.m.
Private Elementary	"	2.27	6.09	3.10	6.92	25.7	29.5	10 a.m. - 11 a.m.
Private Senior High	"	10.4	18.6	15.7	23.9	38.7	46.9	4 p.m. - 5 p.m.
Combined (grades 1-12)	"	8.49	18.7	16.8	27.0	51.3	61.5	5 p.m. - 6 p.m.
Colleges								
Students in residence	gpd/student	106	179	114	187	250	323	1 p.m. - 2 p.m.
Non-Resident students	"	15.2		27.0		57.8		8 a.m. - 9 a.m.
Hospitals	gpd/bed	346	559	551	764	912	1120	11 a.m. - 12 noon
Nursing Homes and Institutions	gpd/bed	133	209	146	222	424	500	4 p.m. - 5 p.m.
Apartments								
High Rise	gpd/occupied unit	218	322	426	530	745	849	11 a.m. - 12 noon
Garden Type	"	213	315	272	374	671	773	8 a.m. & 6 p.m.
Hotels	gpd/sq.ft.	0.256		0.294		0.433		6 p.m. - 7 p.m.
Motels	gpd/sq.ft.	0.224	0.326	0.461	0.563	1.55	1.65	10 a.m. - 11 a.m.
Office Buildings								
General offices less than 10 yrs. old	gpd/sq.ft.	0.093	0.164	0.173	0.244	0.521	0.592	12 noon - 1 p.m.
General offices more than 10 yrs. old	"	0.142	0.273					
Medical offices	"	0.618		1.66		4.97		11 a.m. & 4 p.m.
Department Stores	gpd/sq.ft. of total sales area	0.216	0.483	0.388	0.655	0.958	1.23	12 noon - 1 p.m.
Shopping Centers	gpd/sq.ft. of total sales area	0.160		0.232		0.412		2 p.m. - 3 p.m.
Car Washes	gpd/sq.ft.	4.78		10.3		31.5		12 p.m. - 2 p.m.
Service Stations	gpd/sq.ft. of garage and office space	0.251	0.485	0.590	0.824	4.89	5.12	12 a.m. - 1 p.m.
Laundries								
Commercial Laundries & Dry Cleaners	gpd/sq.ft.	0.253	0.639	0.326	0.712	1.57	1.96	2 p.m. - 3 p.m.
Laundromats	"	2.17	6.39					
Restaurants								
Drive-Ins (parking only)	gpd/car space	109						
Drive-Ins (seating and parking)	gpd/seat	40.6						
Conventional Restaurants	gpd/seat	24.2	55.2	83.4	114	167	198	2 p.m. - 3 p.m.
Clubs								
Golf Clubs	gpd/membership	66.1						
Swimming Clubs	"	16.5						
Boating Clubs	"	10.5						
Churches	gpd/member	0.138		0.862		4.70		8 p.m. - 9 p.m.
Barber Shops	gpd/chair	54.6	97.5	80.3	123	389	432	2 p.m. - 3 p.m.
Beauty Salons	gpd/station	269	532	328	591	1,070	1,330	2 p.m. - 3 p.m.

Note: The water use figures are quoted in U.S. gallons.

Source: Johns Hopkins University,
Report on the Commercial Water Use Research Project.

TABLE 21-3