WATER RESOURCES STUDY

of the

PROVINCE OF NEWFOUNDLAND AND LABRADOR

for

ATLANTIC DEVELOPMENT BOARD

Volume THREE A

WITHDRAWAL WATER DEMAND

THE SHAWINIGAN ENGINEERING COMPANY LIMITED
JAMES F.MacLAREN LIMITED

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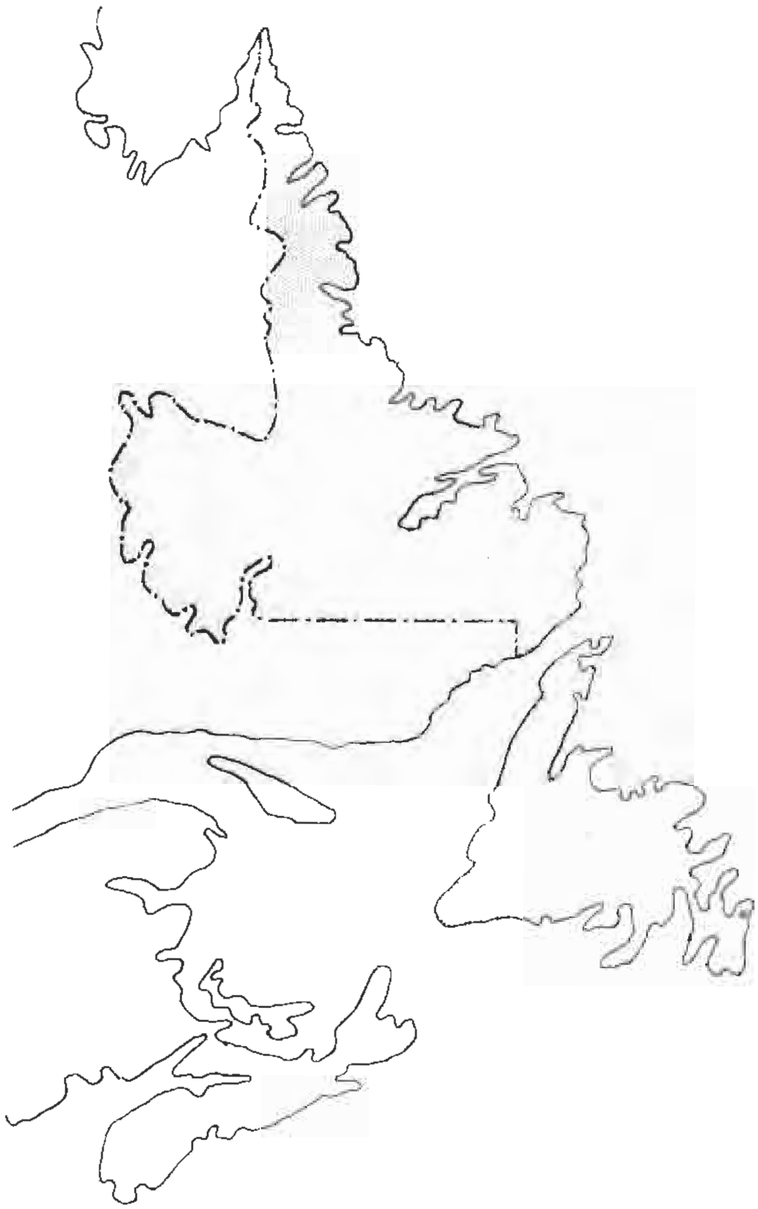

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GENERAL METHODOLOGY OF WATER DEMAND

PART I - WATER DEMAND METHODOLOGY

Water demand is a controversial and frequently ill-defined concept, and the methodologic discussion of this subject is very much related to the problem of defining and classifying it. A general discussion of this subject is included in Volume One. However, these concepts deserve further elucidation as an introduction to the methodologic analysis contained in this volume.

Although this is basically a methodologic discussion, it also includes discussion of the practical aspects which had to be considered in the water demand analysis. The specific circumstances under which this report was prepared necessitated the use of approaches other than those which would have been more desirable from the methodologic viewpoint.

The following discussions deal with a total concept although it was never intended that attempts would be made to cover all aspects of the water resources of the Province in this study. However, by preparing a comprehensive outline it was felt that secondary problems which might have been overlooked would be thrown into relief thereby ensuring their consideration in the continuation of the work of developing a Water Management Program.

The methodologic discussion included in this section relates to Volumes Three and Four, and covers the various aspects of water demand analyzed in these two volumes.

1 DEFINITION, INTERRELATIONSHIPS, AND CLASSIFICATIONS OF NATURAL, ECONOMIC, AND SOCIAL CONDITIONS

The methodologic discussion requires the definition of the water demand concept and its relationship to the other concepts used. Further it is considered very helpful to define the different categories of water demand which, although contained within the same broad concept, play quite different roles in the development of water resources.

1.1 Definition and Interrelationship with Natural and Social Conditions

Water demand is defined in this report as the totality of water requirements (quantity and quality) in their time variation and space distribution that a given society is trying to satisfy, according to certain regulations and economic objectives, by means of the water resources available and accessible to that society.

The interdependence between the social structure and the environmental conditions (including water resources) determines the demand in its historical evolution. The different social activities (economic, administrative, legislative) interact among themselves and with the water resources, to adjust the demand to the means of the society and to the availability of the resource. In most societies this process is one of continuous interaction. When the demand exceeds the water resources availability or when demands are mutually exclusive, conflicts of interest arise which must be resolved. Generally, this does not occur spontaneously, and the lag between the advent of the conflict and its solution results in inefficiencies.

1.2 Water Demand Conflicts of Interest and Water Resources Management

The solution of the conflicts of interest is reached through the inherent elasticity which exists in any type of water demand, by the re-arrangement of water related operations to accommodate multiple uses, by the substitution of water using activities with others which do not require water (or require less water), by the arrangement of uses in series (consecutive use by several water users, with or without treatment), by recycling (use of water in closed circuit), and other possible technologic changes.

Because of the complex interrelationship uses, an uncontrolled water demand requirement on the resources can unleash conflicts of interest which become progressively more difficult and ofter more costly to resolve. The criteria for resolving such conflicts of interest must incorporate considerations of public health and aesthetics, for example, which are not precisely measurable in economic terms.

On this basis it is evident that long range planning is an essential and integral part of water resources management. The object of this planning is to reduce or avoid conflicts of interest before they occur. To do this the program must include not only forecasts of demand by the various sectors of an economy, but it must also include, in the broadest sense, the social implications to the public well being. The problem examined in this section, from the methodologic viewpoint, is the assessment of demand, required to set up the water resources management planning.

1.3 Water Demand Categories

In this analysis the water demand requirements which society tends to impose on the water resources available are discussed under three main categories.

1.3.1 Withdrawal or "Public Utility" Demand

The first group is that usually identified in technical literature as "withdrawal demand" and which tends to be considered more and more a "public utility" water demand category. The term water withdrawal demand is used in this report to identify the total physical quantity of water withdrawn from a source.

Although part of the withdrawal demand-supply developments may be entirely in private hands, the interrelation between public and private interests, where withdrawal uses are involved, leads to the thought that use of the public utility water demand concept probably contributes to a better understanding of the responsibility of the private sector to the society as a whole, from the water intake to the waste-water disposal. This category comprises the demand exerted by population for household and municipal uses, and by the primary, secondary, and tertiary industries.

The primary industry is considered to include agriculture and other farm and crop production activities (irrigation). This demand is closely related to and determined by economic conditions. It involves withdrawal from the source, storage, changes in regime and quality, and depletion. For this type of demand the general economic conditions are the determinant factors. The water demand in this category can be satisfied by modern technology (desalination, recycling, etc); and the so-called intake demand may be reduced when natural availability is restricted. The provision of adequate and abundant sources of low cost water supply for public utility demand (including the possibility of waste disposal with modest or no effluent charges) may facilitate economic expansion.

It should be noted here that, although the process of releasing wastewater cannot be considered a withdrawal use from the physical viewpoint, it can represent a net loss to the water resources due to its effect on the receiver's water quality. Since settleable solids may tend to accumulate in the lakes, estuaries, or embayments and create pollution problems in spite of the dilution obtained, it is considered that all wastes should be treated before disposal at least to retain the settleable solids.

Because of the significance of the fisheries to the Province, the dilution requirements for this use have been considered in assessing dilution demand. Although other uses requiring high quality water may impose different requirements, it may be considered that, if the water meets the quality requirements for fisheries, it can meet the quality requirements for other uses after relatively simple treatment such as chlorination. The use of water for contact recreation activities which may also be a criterion for dilution demand is not a problem in the conditions prevailing in the Province.

1. 3. 2 Non-Withdrawal or Non-Consumptive Demand

This includes the demand which does not generally require an abstraction of water from the source and especially does not involve depletion. It comprises the use of water for fisheries, recreation, log driving, navigation, and hydro-electric power. However, these uses sometimes involve storage, resulting in flow, velocity, and level regime changes, and in some cases, quality changes related to the above or induced by the use (bark and sunken logs in log driving; oil and gasoline from boats).

Sometimes the term non-consumptive demand may be more appropriate than non-withdrawal. Non-consumptive demand includes cases such as the diversion of water from one watershed to another. However, the main characteristic of this category of demand is that, in the water management analysis, development takes place primarily because of the availability of the resource.

There is an analogy in this case between the water resources and other natural resources such as forests and mineral, and the obviously represent an asset for the region where they can be developed. The resource is developed when it becomes economically advantageous to do so. However, resources in an area may not be developed if there are substitutes for the resource. For example, if hydro-electric power potential development is too expensive, alternative sources of energy (thermal, nuclear) can be used. Again the existence of rivers in an area does not mean water transportation will be used if alternate tran transportation (railways, highways, air transportation) are more economical. The possibilities of substitution apply to water as well as to other natural resources.

Essentially, the water resources of a region will develop according to the potential available, the availability of alternate resources, and the possibility of multiple use or of conflicts of interest with other water resources users. The actual scheduling, taking into account the multiple use or conflicts of interest problems, belongs to those stages of the continuing study of the Province's water resources which will consider water demand and availability in the framework of a regional or river basin water management program.

1.3.3 Deleterious or "Negative" Water Demand

This category of demand deals with the problems in which, because of excessive water flow, water level, and water velocity, or changes in water quality may have a deleterious effect on the economy (flooding, bank and soil erosion, excessive rise in groundwater, leaching, swamp formation, ice jams and other ice obstructions, and silting of reservoirs, land, or estuaries). The "negative" demand may arise because of natural conditions or man-induced conditions (planned or inadvertent). The related problems can be considered as a "negative" demand only to the extent to which they interfere with present and future economic activity, land use, etc. The "negative" demand analysis will have to delineate such problems where they already exist and indicate possible new cases generated by new development (water resources development or other general economic activity). Further discussion of this subject matter is included in Section 4.

2 METHODOLOGY - WITHDRAWAL WATER DEMAND

In this study, withdrawal water demand will be divided into two principal groups:

a) Demand by primary, secondary, and - in special cases - by tertiary industry which requires relatively large quantities of water in concentrated areas.

b) Demand by population (for household related uses), municipal uses (fire protection, street cleaning, public area sprinkling, etc), and "diffuse" water demand by commercial and small tertiary industries which is closely related to population density and level of living.

The methodology in the first group requires the clarification of two main issues: the specific withdrawal industrial demand and the industries to be considered over the study period.

The methodology in the second group involves the approach of predicting population distribution and the level of living and of establishing relationships between population density and levels of living, natural and social conditions, and the specific consumption per capita.

2.1 Industrial Water Demand

In this section an analysis is made of the various methodologic aspects of the water demand for industries.

2.1.1 Specific Industrial Withdrawal Demand

This was the object of more detailed studies (of so-called designated industries) and the basic methodologic problems encountered in this study are discussed in Section 2.1.1.1.

2.1.1.1 Definitions

The concept of withdrawal industrial demand is difficult to define because water demand will be differently considered according to the viewpoint of the person or institution defining it.

From the viewpoint of the water user, water demand can be defined as the assembly of physical, chemical, and biological requirements for water at the lowest possible cost which satisfies at an optimum level the needs of a water-related activity. These requirements may vary in time (in the sense that the amount of water and its quality may vary either because of the differing requirements or because of the interrelationship between quantity and quality) and/or in space (in the sense that one and the same user might require the water at different points, each with its own time variation). Therefore, although it is a widespread practice in literature to consider the water demand for a certain use as being defined by the average and peak flow, as well as recommended quality and the acceptable limits, more accurate information on water demand is actually required in order to assess the water demand from the viewpoint of the user. This should be provided in the form of flow demand hydrographs, and related time variation of water quality, with indications as to location where the water is needed at different times.

Water demand is characterized not only by quantity-quality regime requirements, but also, in some cases, by requirements regarding the water velocity and cross-sectional characteristics of flow as in the case of water transportation, drainage, or irrigation. Besides variation of the water demand quality regime which is due to the technologic characteristics of the user (variation in output regime for example), the water demand can also be characterized by a series of regime curves indicating the limits of flow and quality tolerance within which the user can still function, but with some reduction in over-all efficiency, or output. Finally, although not all water users include this aspect in their definition of water demand, the dilution requirement for wastewater disposal is also an aspect of the water demand*. Although this usually receives attention in relation to the use of water downstream of the respective waste disposal area, public opinion pressures and legislation are bringing closer the realization that the waste disposal problem is the responsibility of the users.

2.1.1.2 Factors Reducing Industrial Water Demand

Lack of water, cost of water, or cost of conveying it to the place of use, conflicts of interest, public opinion, legislation, administrative measures, and other circumstances may apply mitigating pressure against the desire of the user to obtain water which would correspond to his unrestricted requirements. Faced with this, the user may resort to a series of measures which can reduce the amount of water extracted from the source (without necessarily reducing the water applied to the technologic process), or change the technologic process to obtain a reduction in water demand. This trend may apply to both water intake and waste disposal.

* See comments on this subject in Section 1.3.1

2.1.1.3 Unrestricted (Optimum) and Restricted Industrial Water Demand

The analysis of the technologic process of an industrial user under the assumption of no quantity or quality constraints can indicate a series of data which, for the given characteristics of the user, represent the unrestricted (optimum) water demand.

The reduction in water intake can be obtained by re-use (the use of the same volume of water successively to different sections of the technologic process, with or without prior treatment) or recycling (the re-use of the same volume of water in the same process). Where the restraint applies to the waste disposal, besides re-use, recycling, and changes in technology, wastewater treatment with or without by-products recovery may be added. In practical cases, all or part of these processes may be used in various combinations and to different degrees.

When the requirement to reduce the water demand is generated by the cost of water or effluent charges (which is similar to conditions of reduced water availability), economic analysis can show the point where, given a cost per unit of water, a set of data indicating restricted optimum demand under the conditions of the cost of water can be obtained. A similar analysis for effluent charges will indicate optimum conditions of waste reduction, recirculation, re-use, and water treatment. Because of increased complexity of the problem, the estimation of the restricted optimum demand requires a systems analysis study of a plant model to consider different combinations of reductions in water demand and waste water, which is outside the scope of the present study.

If considerations other than cost of water are involved, which can be translated into economic terms such as losses in electric energy production, or restriction in irrigation, navigation draft, etc., the restricted optimum demand can also be determined; but the computation becomes more complicated and also requires - when more than one condition is involved - the application of systems analysis techniques to determine the restricted optimum demand.

This type of computation, however, has to be left to the further stage of the water management study when the assembly of demands are optimized in the frame of the available supply. The multitude of combinations which can be imagined for obtaining the restricted optimum demand would otherwise make such a computation impracticable.

The same considerations apply to the case where restrictions which cannot be expressed in terms of economic values are considered (such as aesthetic requirements). In this case the problem can be solved only by reversing the procedure in the sense that the cost to the user to meet the aesthetic requirements could be estimated. However, this also implies a detailed water demand-availability analysis, and cannot be included in a study of a general character such as the present one.

2.1.1.4 Intake and Internal Industrial Water Demand

The demand analysis also requires distinguishing between intake and internal industrial demand. The external water demand, or intake demand, is defined as:

a) The water quantity and quality required at the intake, and

b) The water quantity and quality required to abate the pollution of the effluent water (wastewater dilution demand)*

The internal water demand is defined as:

i) The gross water applied, that is the total flow of fresh, re-used, and recirculated water which is taking part in the technologic process during a certain period in different sections of the production process.

ii) The water depletion, that is the water lost by evaporation or included in the industrial product.

In the general case, the difference between the intake water and the effluent water represents the depletion.

From the viewpoint of water resources management, the most important data are those on external water demand, but it is clear that a strong interrelationship exists between the internal and external water demand, and these are actually determined by a complex interaction which will embrace a different aspect in each particular case.

* See comments on this subject in Section 1.3.1.

Finally, it should also be mentioned that industrial demand may be divided into different subdivisions, each having its own quantity and quality requirements. The most common subdivisions are process water, cooling water, and drinking-sanitary water. In industries such as food processing, process water quality must meet much higher quality requirements than those generally associated with process water. Effluents can also be subdivided into similar categories although, in many cases, the effluents of several internal uses are mixed in the same sewer for convenience and economy.

2.1.1.5 Example Discussion of Industrial Water Demand Problems

To illustrate the above analysis, a brief commentary is given on the water demand for a thermal power plant. This example was selected, not because it is of great significance for the industrial water demand of the Province, but because it is simple to follow and representative of the different concepts discussed above.

From the characteristics of a given steam thermal power plant, one can determine the regime of once through cooling water demand producing the highest efficiency and also the water quality required to avoid corrosion, scale, sludge deposits, biological growth on condensers, and sediment deposits. The demand for steam process water and for drinking-sanitary water can also be established. Furthermore, the regime of the effluents, their characaeristics (increased temperature for cooling water, concentrated chemical content of the blow down water) can also be determined. As costs of water are taken into account (including costs related to quality requirements), a reduction in the amount of cooling water used can be considered with corresponding decreases in efficiency, and water re-use and recirculation introduced (cooling ponds, towers, etc.). This will increase the cost of the investment and operation (pumping), but decrease the amount of intake water required, as well as the amount of waste heat which might contribute to the pollution of the receiving water body. Comparison of the cost of water, the plant efficiency losses, and operation and maintenance cost will then determine the optimum amount of intake water under the given conditions. Changes to cheaper sources of poor quality water can be examined (brackish and sea water), again taking into account the costs involved in treating water and protecting the concrete and metal parts against corrosion, scale formation, etc. Similar considerations would apply if restrictions were imposed on the allowable temperature of the cooling system effluent or if a BOD limit in the domestic sanitary effluent was imposed. Tables could then be developed indicating the

the optimal demand as a function of the cost of water (of different qualities) or of different effluent charges. Finally, indications could be obtained on the level of effluent treatment required, considering different types of restrictions imposed.

When cooling water restrictions are imposed, changes in technology can also be considered. In the example chosen, it is possible to reduce water requirements by accepting some residual steam pressure at the turbine outlet and utilizing the low pressure steam for other purposes (back-pressure turbines). In appropriate cases, losses in efficiency can be compensated by the steam-use benefit. However, this cannot be ascertained without considering a more comprehensive industrial complex. Furthermore, complications arising from the introduction of cooling towers (smog formation, aesthetic considerations) or the use of waste heat for greenhouses, etc., can add to the complications of the problem, but this obviously cannot be considered outside the environmental conditions and has to be left to the section of the study dealing with water demand and availability analyses.

In concluding the discussion of the example, it must be pointed out that, whereas the main external demand (cooling water intake) may vary in the order of 20 to 1, from once through cooling to complete recirculation, the demand for drinking-sanitary uses might show only a very slight variation. On the other hand, whereas for once through cooling the depletion could represent no more than two to four percent of the intake water demand, the complete recirculation use would represent close to 100 percent depletion of the intake water demand which, however, in absolute figures, would be only two to three times larger than the depletion correponding to once through cooling. On the other hand, evaporation losses in the wastewater receiver, when added to the depletion inside the plant, may well result in equal total figures for both type of cooling.

This example for an industry which is relatively simple to analyze shows that it is very difficult to speak of water demand as an established figure or relationship since the complexity of its determination for each case requires a special analysis.

2.1.1.6 Methods of Establishing Industrial Water Demand

Theoretically at least a water resources study should be based on data of unrestricted water requirements considering both intake and effluents and on restricted intake and effluent water demand for different water costs, water availability, and effluent charges. This work proved to be beyond the scope of the present study. In general, the study of available data has yielded indications on the variation of intake and process water demand and indications of effluent polluting strength which, as expected, vary widely; but the background information which could be used in assessing the unrestricted and restricted water demands for different types of industry, technologies, and conditions, was not available. In general, the upper intake water demand figures should give some indication of the unrestricted demand, and the lower figures of the restricted demand.

In addition to the data on intake demand and effluent polluting strength limits, it was concluded that some processing of the limited statistical information for some of the industries would be of use in assessing as a first estimate the water demand in different conditions. The main sources of statistical data used were the US Department of Commerce, Bureau of the Census, 1963 Census of Manufacturers, Chapter 10, Water Use in Manufacturing, and the questionnaires on water usage by industries circulated in the Province by the consultant during this study.

The statistical analysis has attempted to relate water demand (intake, process, depletion, gross water applied) to a series of factors for which data were obtained from the above or other sources (water availability, expressed as runoff divided by population density in the area; climatic conditions, expressed in terms of evapotranspiration; size of the industry, expressed in terms of value added and number of workers; level of productivity, expressed as value added per worker). Because the US census data represent average regional figures, the results of the correlations are of limited value. However, it was necessary to assume that the industries of a region had more or less similar characteristics, and also that the individual values were not very different from their mean, thus making the use of averages more acceptable. These assumptions were necessary because the form in which the data were available made impossible the use of more sophisticated analyses to estimate separately the influence of the various factors.

The correlations were developed primarily from data contained in the US Department of Commerce, Bureau of the Census, 1963 Census of Manufacturers, Chapter 10, Water Use in Manufacturing. However, in the case of the pulp and paper industry, the correlation was based on 13 US data and data from 2 Newfoundland establishments. Data made available by 8 Maritime Province establishments were used as a consistency check. Correlations for the fish processing industry were based on data from 11 establishments in the Atlantic Provinces. The application of the correlations to Provincial conditions should be made with due caution. This is particularly true where the size of the production unit and the level of technological development are not comparable.

However, the development of the correlations was pursued to show that possibilities exist for obtaining statistical relationships for water demand and their use was confined only to a cross check of the results of the questionnaires and the literature survey. The latter were used in most cases for preliminary estimations of industrial demand for this stage of the study. The estimates obtained on this basis can be accepted for general planning purposes.

The actual water demand for any industrial development for design purposes of the individual industry has to be determined on the basis of the analysis of its technologic design and conditions in the water basin or study area from the viewpoint of the cost of water, competition for the water resource, conflicts with other users, and environmental and legal-administrative conditions. Each case will require its own special analysis within the framework of the basin or region in which the industry is located.

2.1.2 Individual Industrial Establishments

From the methodologic viewpoint the individual industrial establishments to be considered are those which would require either a separate water supply or effluent treatment or special provisions in the municipal distribution and/or sewage system. Since each municipal system has its own characteristics for classifying these types of establishments, the actual demand limit had to be varied according to local conditions for each study area. The analysis of industrial water demand for individual industries had to investigate the following groups of industries:

a) Existing industries (taking into account future expansion).

b) Planned and forecast industries based on natural resources and economic policy decisions.

c) Possible new industries induced by the planned and forecast industries.

The original intention was to use input/output tables as the basis for discussion of the Province's economy in relation to its water resources. Unfortunately, input/output tables for the Province were not available in time to be used. As a result it was necessary to construct a very simple model of the economy on the basis of assumptions provided by the Board. The lack of economic data and the resulting change in emphasis in the Consultant's work precluded detailed analysis. It is stressed that in this volume the economic information is descriptive and is included as a background for the sections on water usage by the various sectors of the economy.

On the basis of these economic assumptions, the categories of industries which were considered individually in the study are discussed in Section 5. 5.

2. 1. 2. 1 Existing Industries

In the river basin and study area, all existing industries having individual supply or effluent disposal which might introduce significant changes in water quality. Data have been collected through the questionnaires sent out to all these industries, considering initially that such industries would have at least 10 employees and/or a water consumption of at least 5000 gpd. These limits were set up in a conservative way, since a large portion of these industries are supplied from the municipal system and do not need to be considered individually. A minimum expansion of existing industries of 5 percent per year* was considered, unless otherwise specifically stated in the industry's questionnaire or economic assumptions.

2. 1. 2. 2 Planned and Forecast Developments

These were considered in the study according to the economic assumptions, with nominal changes required for overall consistency. The scheduling, rate of expansion, output and employment data, as well as some indications on water demand, were also included in the economic assumptions. Nevertheless, for all new developments, estimates of probable water demand (and where possible of unrestricted optimum water demand) and of probable effluent content were made on the basis of data obtained from various sources.

The locations of the new, planned, and forecast developments were also indicated in the economic assumptions, in some cases with possible alternatives. These alternatives were studied at the same level of detail.

* This increase does not imply changes in the basic plant characteristics. It is assumed that this increase can be obtained by improved utilization of the existing installations, including the water supply system, and higher labour productivity.

2.1.2.3 Possible New Industries

Existing and new industries, available resources, and especially manpower might induce the development of new industries. The new industries selected were those whose manufacturing activities could stimulate growth either through their input requirements or by further processing of their manufacturing output. Consequently, consideration was given mainly to the chemical industries which provide important inputs to the pulp and paper industry; the petrochemical industry, related to oil refining; and aluminum processing. Since no data on the capacity, output, employment, and rate of growth of these industries were included in the economic assumptions, these were indirectly estimated. It was understood that the assessment of these possible new industries does not represent an attempt to forecast the economy, but to assess the implications on water resources of a rapidly growing economy. For this purpose, relationships between the economic indices were developed using data available for Canada and the Atlantic Provinces. Employment assumptions then formed the basis of estimating the other economic indices.

Possible new industries were located either in areas of existing population concentration, with their relatively developed infrastructure, or adjacent to major developments as in the case of the aluminum smelter.

2.2 Specific Water Demand for Domestic, Municipal, Service, and Small Industry

Because of the difficulty of separately assessing domestic and municipal demand on one hand and service and small industry demand on the other in the conditions prevailing in the Province, these two items were treated as a combined municipal demand. An analysis of the probable combined municipal demand as related to the population size, cost of water, percentage of metered water usage, level of income, and climatic conditions (expressed as evaporation) was made using the available information for Newfoundland and Labrador, the other Atlantic Provinces, and other areas in Canada and the USA. For the assessment of future demand, the characteristics of the population from the view viewpoint of size, number of workers, and level of income were estimated as shown in the next section. Water availability per capita and evaporation were obtained from the studies included in Volume Two A, Part IV.

2. 2. 1 Population Growth and Characteristics

The water demand for domestic, municipal, service, and small industry being considered in this study is essentially related to the population size and level of income. These two characteristics had to be estimated in their areal distribution in order to assess the corresponding water demand.

2. 2. 1. 1. Population, Size, and Distribution

The population geographical distribution and its historical variation were established on the basis of the square grid and from the DBS 1951, 1956, 1961, and 1966 census data. Straight line population variation trends fitted by the method of least squares were used to extrapolate population growth or depletion in each square for the years 1971, 1976, and 1981. The method was checked by comparing the results to the total population forecasts resulting from the studies done by the Board using other methods. This was considered as a first approximation of population distribution.

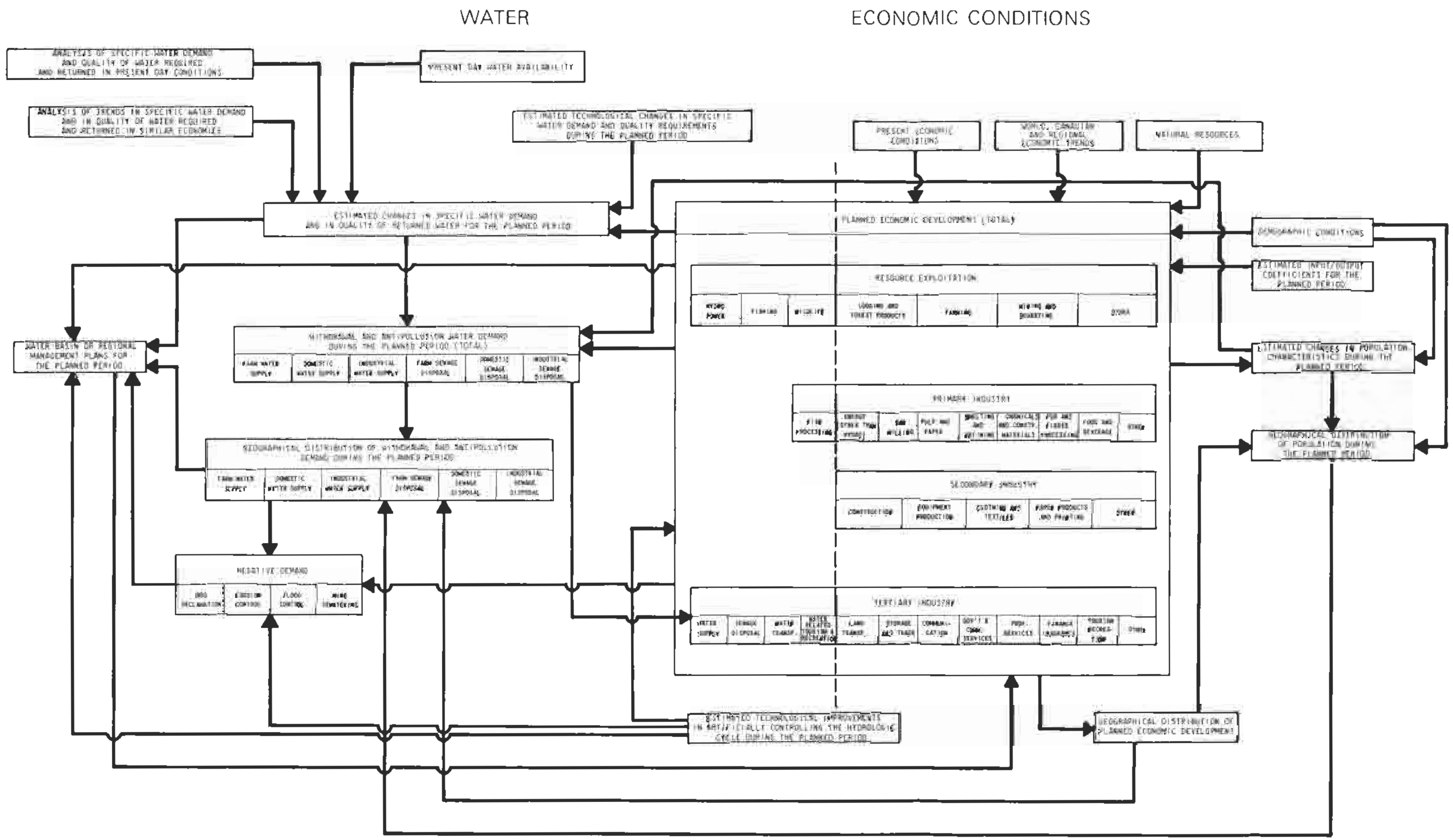
A second approximation was obtained by adding to the population in localities where new primary and secondary industrial development is assumed to occur. The additional population was estimated on the assumption that each new industrial job will create one and a half new service jobs in 1971, and two new service jobs in 1981, and that each employee will have an average of three dependents.

2. 2. 1. 2 Level of Income

Indications of the relative levels of income of the Province's ten census divisions were based on 1965 and 1966 estimates of per capita disposable income by census division. Estimates of 1981 per capita disposable income in terms of 1965 dollars are extrapolations of provincial disposable and per capita disposable income, taking into consideration the developments planned or forecast for various areas.

2. 2. 1. 3 Estimates of Combined Municipal Demand

The grid population densities and regional level of income were used with the results of the analysis of the variation of probable combined municipal demand with the factors indicated in Section 2. 2 to assess the probable demand for different communities. Whenever possible, comparisons were made of the forecast of total municipal demand obtained by this approach with demand in localities situated in similar regions and having populations of comparable sizes and levels of income.



NOTE: FOR SIMPLIFICATION THE CHART IS PRESENTED FOR THE PLANNED DEVELOPMENT PERIOD.

WATER DEMAND METHODOLOGICAL PRECEDENCE CHART

FIGURE 2-1

3 METHODOLOGY - NON-WITHDRAWAL OR NON-CONSUMPTIVE DEMAND

This type of demand, as shown in Section 1. 3. 2, is characterized by the availability of the resource in relation to society's needs. In this case the water resources potential is generally utilized only if alternative sources of satisfying the corresponding requirements are less competitive. However, as already mentioned in Section 1, single purpose use of the resources due to direct economic requirements may lead to conflicts of interest, with significant losses to the society as a whole.

The final assessment of the demand can therefore be achieved only in the framework of water management river basin studies. Consequently, prior to an examination of conflicts of interest, competition for the resource, and other water resources problems, the non-withdrawal uses will be regarded only as possibilities to be considered, and therefore the related water demand is qualified in this report as possible demand.

Possible water demand has been defined as the demand which would become actual if, in the framework of the given water resources and economic conditions, the considered non-withdrawal use proves to be competitive compared with other alternative resources, compatible with other accepted water uses, and is included as a part of the water resources management plan.

In preparation of the water resources management studies, the possible water demand has to be determined and this can be done by using the following general steps:

a) Estimation of gross potential.

b) Assessment of present day uses.

c) Selection of potential developments ranked according to cost estimating criteria.

d) Preliminary examination of possible water resource implications and changes in priorities according to these implications.

e) Tentative scheduling of developments in conjunction with the forecast of the economy's requirements and availability of competitive resources.

The water management study will determine the optimum development plan considering all water resources implications.

The following sections outline the methodology of assessing possible demand for different non-withdrawal uses which, although similar in principle, vary in their application mainly because of the variation in available data and particular conditions in the Province.

3.1 Hydro Electric Power

This use has been extensively examined for the whole area of the Island, but only in the preliminary stages for Labrador on account of the scarcity of the available data and of the area involved which creates almost limitless development possibilities.

3.1.1 Estimation of Gross Hydro Power Potential

The gross hydro power potential was estimated in two stages:

a) The estimation of gross surface potential which is expressed as the product between the volume of annual runoff per square mile and the average head differential of the square (which can be computed using the square elevations stored for the square grid system). This gives a preliminary indication of areas where significant concentrations of hydro-electric power can be expected.

b) The estimation of river gross potential which is obtained by integrating the product of mean flow and slope along the rivers. From the examination of the river gross potential diagrams, indications of the most interesting development sites were obtained.

3.1.2 Existing Hydro Power Developments

An inventory of existing hydro power developments and an examination of the operating regime and conditions prevailing upstream and downstream of the sites showed:

a) Those sections of the potential development which have already been harnessed.

b) The validity of the gross river potential method to indicate potential development sites.

c) Changes in water regime and quality and their effects on other uses such as fisheries and log driving.

3.1.3 Preliminary Selection of Most Promising Hydro Power Development Sites

Following the first two steps, the areas where there are indications of undeveloped concentrated hydro power have been investigated and development sites selected for further investigations. The review considered different types of power plants, with varying storage volumes and diversion. Preliminary cost estimates for different capacity factors were made (including estimates for access roads where applicable for potential sites on the Island). Priority lists were then established on the basis of the cost per kilowatt installed and kilowatt-hour produced.

In addition some of the more topographically interesting sites for pumped storage hydro power developments were identified.

3.1.4 Preliminary Examination of Hydro Power Development Effects on Other Users

Hydro power development may affect other users, especially water supply, fisheries, log driving, recreation, and wildlife. The effects may be favourable or deleterious according to circumstances; these effects were examined. The ranking of the sites analyzed in Section 3.1.3 was therefore reconsidered, taking into account these effects where they were significant.

3.1.5 Preliminary Scheduling of Hydro Power Development

Electric energy and capacity demand forecasts included in the economic assumptions were combined with data on costs of competitive sources of energy to produce a preliminary scheduling of the hydro-power developments.

Attention was paid to the possibility of varying the capacity factors of the hydro power developments to meet both energy and capacity requirements in the most economic way. The influence of the capacity factor variation on the flow required was estimated and, when necessary, the effects of this variation on other users was considered in the more detailed studies included in Volumes Six and Seven. Consideration was also given in the detailed studies to increasing the capacity and/or storage of existing developments and the effects thereof on other users (Humber River).

Existing electric energy development plans were then used with the results of the other demand investigation in the analysis of water demand-availability by river basin for the preliminary selection of the sites for hydro power plants most likely to be developed.

3.2 Fisheries for Fresh Water Dependent Species*

Information on potential, existing developments, policy, objectives, conflicts of interest, and development projects was provided by the Canada Department of Fisheries. In analyzing this information for investigation in the study and as preparatory work for the analysis of water demand and availability carried out in Volumes Six and Seven, the following investigations were attempted:

3.2.1 Fresh Water Fisheries Potential

The potential as indicated by the actual catch data for the selected river basins was analyzed in relation to the water quality and quantity, as well as with other conditions.

A comparison between actual and potential catch, (taking into account the number of rod days in sports fishing), and analysis of the natural conditions, and the fishery and other water resources developments, as well as the sources of pollution, was used as background information to assess the possible influence of these factors on fisheries and of fishery development projects. Whenever possible, the effect of different types of pollution or developments acting independently or in various combinations, was identified.

3.2.2 Future Developments

These were analyzed mainly in the frame of the more detailed studies included in Volumes Six and Seven. The priorities and scheduling of future developments were basically accepted as indicated by the Canada Department of Fisheries. Analysis of these developments was undertaken to indicate.

a) The related requirements for recreation which may arise from the population redistribution studies and other considerations.

b) The pollution problems resulting from planned, forecast, and possible new industrial developments.

* Throughout this volume the term 'fresh water fisheries' is used as an abbreviation of 'fisheries for fresh water dependent species'.

c) Conflicts or community of interests with the hydro power developments, log driving, industrial, and municipal water supply.

The possibility of artificially increasing the existing fish population and/or of developing game fish in the new reservoirs and of domestic pollution abatement by exotic fish such as carp was considered.

It was assumed that problems related to commercial fisheries have been accounted for in the priorities established by the Canada Department of Fisheries.

The demand of fresh water fisheries determined from this analysis was expressed in terms of minimal water quantity and quality. Required structures were indicated in the more detailed studies where velocities or structures introduced in the river were considered to be insurmountable barriers to anadromous fish migration. Prescribed limitations by log driving activities were considered as a possible requirement for fisheries. The implications and possibilities of migratory fish requirements were mentioned within the water demand-availability analysis by river basins.

3. 3 Log Driving

Although at the present time water transportation of logs is a declining activity in some areas on the Island, it still represents a significant non-withdrawal use. Moreover it may become significant in Labrador as forest operations develop there.

3. 3. 1 Log Driving Potential

Flow regime analysis of the rivers in areas containing merchantable forest stands or of rivers flowing to pulp and paper mills were used to delineate areas where log driving could be carried out:

- during the whole ice-free season, without storage.
- during spring only.
- during the whole ice-free season, by means of storage regulation.

3.3.2 Analysis of Present Day Log Driving Operations

Data on volume, costs, storage developments for log driving, and resulting changes in flow regime and water quality in their historical sequence were analyzed to obtain indications.

a) Trends and their causes.

b) Conflicts or community of interests with other users, especially related to water water supply, fisheries, and hydro power.

c) Comparisons with competitive transportation systems, especially trucking and piping of chips.

3.3.3 Possible Log Driving Trends and Developments

The analysis of the forest industry and its expansion, the potential for log driving, and the analysis of present conditions were used to indicate:

a) Areas where log driving will decline.

b) Areas where log driving will remain constant or increase.

c) Developments required for log driving, changes in water regime , and effects on quality in areas where log driving will increase, which will actually represent the possible water demand for log driving.

3.3.4 Effect of Log Driving on Other Water Resources Users

This was analyzed mainly in the framework of the more detailed studies included in Volume Six. In addition to, and on the basis of, the analysis of the effect of present day log driving on other water users, a preliminary examination of the possible implications of declining or increasing log driving on other water users (and vice versa) was carried out. Special attention was paid to water supply, fisheries, hydro power, and recreation uses, taking into account both changes in water flow regime and quality (due mainly to natural debarking and sunken logs).

Following this examination a review of the development required for log driving was made and, where necessary, alternative means of transportation indicated. Special attention was paid to possible piping of chips since this would also affect the water resources.

3.3.5 Indications of New Log Driving Developments

These indications were obtained from the examination of the development of forest operations and were used in the river basins water demand-availability studies.

3.4 Navigation

Navigation in the Province's fresh waters is and will continue to be restricted to log driving and pleasure craft.

The problem of sedimentation in actual or potential harbours was examined if related to sediment carried by rivers, and the corresponding remedial requirements considered as possible "negative" water demand for navigation with regard to the corresponding rivers.

3.5 Wildlife

The management of the wildlife resource has considerable economic implications. However, this volume is concerned primarily with the physical relationship between this resource and the water resource. At this stage of the water resources study, the following approach was used in connection with possible water demand for wildlife:

a) Investigation of existing wildlife and, whenever possible, analysis of past data to estimate the result of man's activity, and forest activity including forest fires on the population of various wildlife species.

b) Assessment of required pollution abatement measures for the preservation of existing wildlife under present day and future development conditions.

c) Assessment of favourable and/or deleterious effects (other than pollution) which can result from future developments including recreation and tourism and possible water resources projects and related activities (such as flooding of reservoirs and draining of bogs).

On the basis of the above analysis and wildlife objectives derived from the policy formulation, possible water demand for wildlife was indicated. This was expressed mainly in the form of water quality which would be required to preserve or expand existing wildlife.

These indications of desirable quality were taken into account in the water demand-availability studies included in Volumes Six and Seven, and the consequences of various other requirements and developments on wildlife preservation conditions assessed.

3.6 Recreation and Tourism

Although recreation and tourism are not greatly developed at the present time, the resources of the area in this field will, in time, play a more and more important role as leisure time increases, travel costs and time decrease, and areas with scanty population and relative low level of air and water pollution become more and more difficult to find on this continent. For these reasons, preservation and development of recreation areas should be based on long term rather than short term considerations.

3.6.1 Potential for Recreation and Tourism

The more favourable areas for development of recreation and tourism were assessed taking into account natural conditions (scenery, water availability, climate, fresh water fishing, sand beaches, and wildlife potential), accessibility, distances to populated centers, forestry conditions, present, planned, and forecast developments (including water resources). The selected areas were ranked according to the above criteria.

3.6.2 Present Day Development

The areas where tourism and recreation are already developed were investigated to assess the importance of different factors considered in the selection of potential development areas. In the more detailed studies included in Volumes Six and Seven, deficiencies in the currently developed areas due to water resources related causes (poor water quality, large variation of levels and/or flows, fouling of beaches, and poor wildlife and fisher development) were noted and the remedial requirements included as part of the possible water demand for recreation and tourism.

3.6.3 Selection of Areas for Development and Preservation for Recreation and Tourism

On the basis of the analysis included in the preceding sections, recommendations for the development and preservation of specific areas for recreation and tourism were made on the more detailed studies included in Volumes Six and Seven.

4 DELETERIOUS EFFECTS OF WATER OR "NEGATIVE" DEMAND

When water exceeds certain flow, velocity, or level limits (without mentioning quality or pollution limits which were included in the preceding two sections), its effects can be harmful and a reduction of the excess water become desirable. In this case, water can be considered a "negative" benefit and its reduction, accordingly, a "negative" demand.

Two main groups of "negative" demand have to be considered:

a) Basin distributed "negative" demand.

b) Local "negative" demand.

4.1 Basin Distributed "Negative" Demand

In the case of Newfoundland and Labrador, this is mostly limited to soil erosion problems resulting from rapidly concentrated runoff on deforested slopes caused by forest fires and careless clear cutting. This results in the silting of lakes, reservoirs, and estuaries. The "negative" demand in this case would consist of the requirement to reduce the rate of runoff concentration on such slopes.

4.2 Local "Negative" Demand

There are several types of local "negative" demand, the most important being:

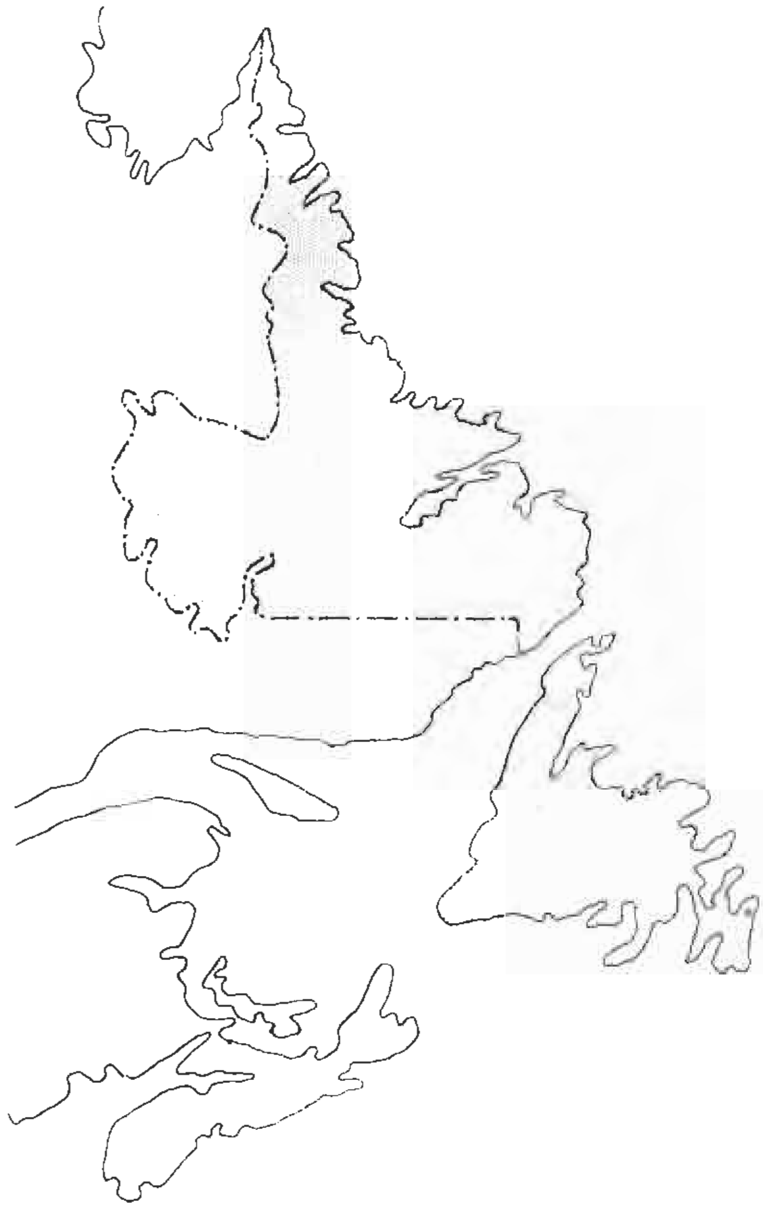
a) Reduction of level in bogland (drainage) allowing the use of land for farming or forestry purposes, and with consequent increase in stream flow variability and possible increase in water acidity. This demand is limited by the agricultural and forestry requirements which, according to the economic assumptions, are negligible over the study period.

b) Reduction of natural floods threatening developed areas or those designated for development. Such cases are rare in the Province, and represent the demand for reducing flow variability, avoiding structures which favour the formation of ice jams or, a less probable demand in the Province's conditions, the construction of dikes.

c) Reduction of water levels and areas flooded by new storage developments which might destroy productive forest stands, inundate construction, cottages, highways, etc. These problems represent a demand to reduce the storage, or confine flooded areas by diking them. Obviously, each problem has to be treated individually, according to the circumstances at hand.

d) Reduction of flows and velocities where these might produce bank erosion. Such problems are of very limited importance and outside the scope of the Stage I study.

e) De-watering of existing and developing mines, with implications on surface water quality and groundwater levels and flows. This demand represents generally a requirement to maintain the groundwater levels below a certain limit in the mine areas where the problem appears to be significant. It has been discussed where appropriate in the first place in the analyses of the water demand for mining establishments.



VOLUME THREE-A - PART II — SECTIONS 5 & 6

ECONOMIC CONSIDERATIONS AND CHANGES IN SPECIFIC DEMAND

PART II - ECONOMIC CONSIDERATIONS AND CHANGES IN SPECIFIC DEMAND

5 GENERAL ECONOMIC CONSIDERATIONS AND CHANGES IN SPECIFIC DEMAND

5.1 General Review of Present-Day Economic Conditions

The level of withdrawal water demand is determined, to a considerable extent, by population characteristics; such as size, concentration, and levels of income, and by the level of economic activity. The following sections take a sectoral approach to the review of economic activity. The purpose of this section is to give a general framework against which the sectoral discussions may be measured.

Economic conditions within the various sectors of the provincial economy are not uniform and conditions in areas of population concentrations are not the same as those in the hundreds of small communities scattered along the coastline of Newfoundland and Labrador.

The provincial economy is resource rather than market oriented and sells in highly competitive export markets. The location of economic activity has been dictated by the location of resources and the flexibility of location has been restricted by the level of technological innovation and modified by the financial resources available.

The following table indicates the extent to which the economy of the Province is dependent on its natural resources.

Percentage Distribution of Net Value of Commodity Producing Industries - 1963

	Canada %	Atlantic %	N & L %
Agriculture	11.6	5.5	not available
Forestry - Primary	3.2	6.2	6.2
Fisheries - Primary	0.6	6.3	6.6
Mining	8.1	12.0	25.8
Electric Power	4.0	4.1	5.0
Manufacturing	54.9	39.0	24.4
Construction	17.4	26.9	32.0
Total	100.0	100.0	100.0

The primary activity generated by the natural resources, excluding electric power, accounts for approximately 39 percent of the total net value of commodity production. The full impact of the natural resources on the economy is not understood until it is realized that 63 percent of the manufacturing activity in the Province comes from secondary forestry and fisheries activity. When these two industries are removed from the manufacturing sector, the manufacturing contribution to total net value of commodity production drops to 9.1 percent compared to the national figure of 48 percent. Furthermore, considerable construction activity is directly and indirectly influenced by the activity generated by natural resource exploitation.

Excluding agriculture and electric power, the employment in these sectors is:

		Employment Order of Magnitude - %
Fisheries - Primary		45
Forestry - Primary		8
Mining		12
Construction		17
Manufacturing	- Forestry	6
	- Fisheries	7
	- Other	5
		100

At the present time, primary and secondary fisheries, primary forestry, and construction are characterized by pronounced seasonal employment patterns. In effect, close to 80 percent of the employment in these sectors is seasonal.

According to the 1961 census, 43 percent of the labour force was employed in the commodity producing sectors and 57 percent were employed in the tertiary sectors[2].

5.2 Economic Policy and the Basis of Economic Forecasts

5.2.1 Economic Policy

This study assumes that the water resources must be considered within the framework of the economic policy discussed in the Report of the Royal Commission on the Economic State and Prospects of Newfoundland and Labrador .

In general the goals expressed parallel those proposed for Canada by the Economic Council of Canada[2], in their annual reviews, and may be summarized as: full employment, a high rate of economic growth, reasonable price stability, a viable balance of payments, and an equitable distribution of rising incomes. It should be noted that the specific terms of these goals at the national level are not applicable without modification at the regional level. In terms of this study, a number of these goals are peripheral and therefore are not considered in themselves. Further modification had to be made where existing conditions made the achievement of national goals appear unrealistic.

The basic economic objectives for the region may be summarized as follows:

A rising level of labour force participation.

The highest possible level of employment - modified in certain sectors where conditions, other than economic, exert a strong influence.

A reasonable level of increasing productivity.

Increasing levels of economic activity within the various sectors.

Rising per capita income in real terms.

5.2.2 Basis of Economic Forecasts

The forecasts used in the following sections were based on the general considerations itemized above wherever specific forecasts were not provided by the Board. These forecasts assume implicitly that the level of domestic and foreign market demand will not be a limiting factor on the pace of economic expansion. They also assume that the labour force, including the employment generated by new developments, will be drawn from provincial sources.

In some instances initial forecasts provided by the Board were modified in order to maintain consistency between the sectors within the framework of the basic policy assumptions. Where inconsistencies could not be reconciled at the time of writing, they have been noted.

A major difficulty of implementing any policy measures will be the reconciliation of the goals of high employment with the objectives of an equitable distribution of rising incomes and the achievement of a high rate of economic growth.

In order to remain, or become, competitive existing labour intensive industries will have to increase their productivity levels substantially. This will require a considerable shift towards capital intensive production methods. In some cases, particularly the fisheries sector, this will mean a decrease in existing levels of employment. As a result, if will be necessary to find alternate employment opportunities.

This will not be an easy task. Most of the new developments included in the assumptions are of a capital intensive nature; but it is primarily these new developments which must, directly or indirectly, generate sufficient employment to absorb both the growing labour force as well as those presently employed in marginal occupations.

This study is based on the assumption that a relatively high level of employment should be maintained. The specific assumption used to describe an acceptable level of unemployment was the rate of 10 percent which in Provincial terms appears to be a realistic target over the forecast period.

In the final analysis, productivity in individual sectors may be higher or lower than those assumed. However, in areas of existing population concentrations, any implied changes arising therefrom in terms of specific employment will not result in any significant net change in terms of water resources. The study also recognized that changes in assumptions relating to undeveloped areas would have major water resource implications, and has been so arranged that water resource implications resulting from major changes to assumptions may be readily assessed.

5.3 Economic Assumptions

The economic assumptions used in this report were provided to the Consultant by the Board. Whenever the Consultants found implied inconsistencies between the assumptions for various sectors or within an individual sector, the problem was reviewed with representatives of the Board and approval was given for any changes made, as illustrated in Table 5-1. While these assumptions form the basis of a model of the Provincial economy for the purposes of this study, they should not be interpreted as a model of the economy as such.

The assumptions are purposely biased towards an optimistic forecast. This was done in order to allow for the examination of conditions which could occur if economic developments exert a higher demand on water resources than are generally expected.

5.3.1 Population Forecasts

Forecasts of population and distribution were based on data provided by the Board and the method of forecasting the areal distribution of the population over the forecast period is discussed in Volume Three B, Part VII, Section 21.2. The population forecast provided by the Board includes the age and sex distributions on a provincial basis. Where age and sex distributions were required on an areal basis; they were based on information provided by the Board. Regional (study area, basin, or town) forecasts were adjusted to reflect the impact of anticipated developments.

5.3.2 Labour Force and Employment Assumptions

The size of the labour force has been estimated by applying the following labour force participation rates to the labour force age group (15 years and over).

1971	46%
1976	48%
1981	50%

It was assumed that education levels would be sufficient to meet employment demands and to ensure the job mobility required by the employment distribution by sector indicated as follows:

Employment Assumptions by Sector

	1971	1981
Agriculture	2,000	2,000
Primary Fishing	19,400	12,500
Primary Forestry	2,850	5,000
Mining	8,000	10,000
Fish Processing	6,000	7,000
Pulp and Paper	2,850	3,650
Manufacturing	4,000	4,850
Construction	11,200	15,000
Subtotal	56,300	60,500
New Developments - Planned		3,000
- Proposed		2,500
Total Commodity		66,000
Transportation, Communication, Utility	16,000	27,000
Trade - Wholesale	5,800	7,200
- Retail	17,500	27,200
Finance	1,800	2,600
Public Administration and Defense	10,600	13,500
Community Services	25,300	41,000
Total Tertiary	77,000	118,500
TOTAL EMPLOYMENT	133,300	184,500

Assumption of the ratio of employment between the service industries and the commodity producing sectors was given as 2 to 1 in 1981, except for primary fishing which is a 1 to 1 ratio.

For the assessment of population changes resulting from planned and potential industries, it was assumed that a household of four people would result from the creation of each job (employee plus three dependents).

5.3.3 Seasonal Patterns of Employment

Where pronounced seasonal patterns exist, they are noted. Seasonal peaks occur in summer months and lows in winter months. For purposes of this report, it was assumed that no new developments would have seasonal patterns such as to offer employment during periods of low activity in fishing, fish processing, and forestry. The only improvement will come from changes in industry structures which by their nature will modify the seasonal pattern.

5.3.4 Productivity

Wherever possible, changes in productivity were measured in real terms, either physical units of production or constant dollars. It was assumed that manufacturing productivity would increase at 2.5 percent per year; recognizing that this is a global figure. Productivity changes were used as a consistency check for wages and salaries and output only. No separate analysis of productivity was made.

5.3.5 Secondary Manufacturing Other Than Fish Processing, Pulp and Paper, and Potential Major New Developments

This sector includes all manufacturing except fish processing, pulp and paper, and potential major new developments. The basic assumptions were provided, or agreed to, by the Board for 1965, 1971, 1976, and 1981 for value of shipments and value added as shown in Table 5-2. Value of shipments and value added were assumed to increase at 5 percent per year, except for specially adjusted series (breweries and construction related industries). Productivity, in this case value added per employee, was assumed to increase at 2.5 percent per year. Employment in the forecast years was estimated on the basis of the forecasts of value added and estimates of productivity taking 1965 as the base year.

5.3.6 Major New Developments

The locations, capacities, and employment for new developments were provided by the Board as shown in Table 5-1. It was assumed that the projected aluminum smelter would be located either in Stephenville or Bay D'Espoir.

Unless otherwise specified, new industries such as chemical industries which supply the pulp and paper manufacturers, or petrochemical and aluminum processing industries were assumed to locate at St. John's, Corner Brook, or Stephenville.

5.3.7 Electric Power

Electric energy demand and electric power development were based on the forecasts provided by the Board and shown in Tables 5-3 and 5-4.

5.3.8 Income Levels, and Wages and Salaries

Estimates of income levels over the forecast period were based on extrapolations of aggregate data. No attempt was made to analyze the wages and salary component. As an approximation, wages and salaries were assumed to parallel the increase in value added which, unless otherwise specified, was projected to increase at 2.5 percent a year.

5.4 Relationship Between Economic Factors: Cross Section Graphs

Volume Three A and B contains a number of graphs which describe the "Relationship Between Economic Factors" in various industries. The first of these is Figure 7-6. Generally these graphs show the relationship over time between three industry characteristics, gross value of production (or value of manufacturing shipments), net value of production (or value added) and wages and salaries (or earnings).

Using Figure 7-6 as the example, it will be seen that the gross value of production was plotted against the net value of production in the left hand "quadrant" and that the net value of production was plotted against earnings (on other figures, salaries and wages) in the right hand "quadrant". The number shown against each plot identifies the year of the data. For example; 49 would read 1949.

The straight line, from the origin through the scatter, represents a graphically estimated relationship between the two variables which, in these graphs, is assumed to be generally linear.

The graphs served a three-fold purpose. First, they were used as a consistency check between given economic assumptions; secondly, they were used to estimate economic characteristics where only one variable was known; and finally, they were used to make Provincial estimates when no Provincial data were available.

As an example of their use, referring to Figure 7-6, suppose an estimate of the Province's gross value of production in the mining industry was given as $100 million and no data on net value and earnings were available. By reading off the graph, it is seen that the $100 million gross value of production would result in an estimated net value of production of $50 million and earnings of $25 million.

It should be noted when using these graphs that the "Relationship Between Economic Factors" may be either for the industry's "manufacturing activity" or for its "total activity".

There is a distinction in the DBS Annual Census of Manufacturers series, the source data, between "total activity" and "manufacturing activity". Detailed definitions are contained in the annual catalogues of the series. A simplified distinction is that manufacturing activity reports data on goods of own manufacture while total activity includes, in addition to the manufacturing statistics, data on sales offices, administrative offices, and resale of goods not of own manufacture.

Data used on some graphs of this type have a very short time base because changes in data grouping procedures made earlier data inconsistent with the current series and because there is a three to four year time lag in the publication of some series. Despite these limitations these graphs were useful particularly because they enabled the estimation of numerous missing data.

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. Economic Council of Canada. Fourth Annual Review: The Canadian Economy from the 1960's to the 1970's. (EC21-1). Ottawa, Queen's Printer, 1967.

GROSS INCOME AT MARKET PRICES NET INCOME AT FACTOR COST, AND PERSONAL INCOME CANADA, ATLANTIC PROVINCES, NEWFOUNDLAND AND LABRADOR 1949 - 1965

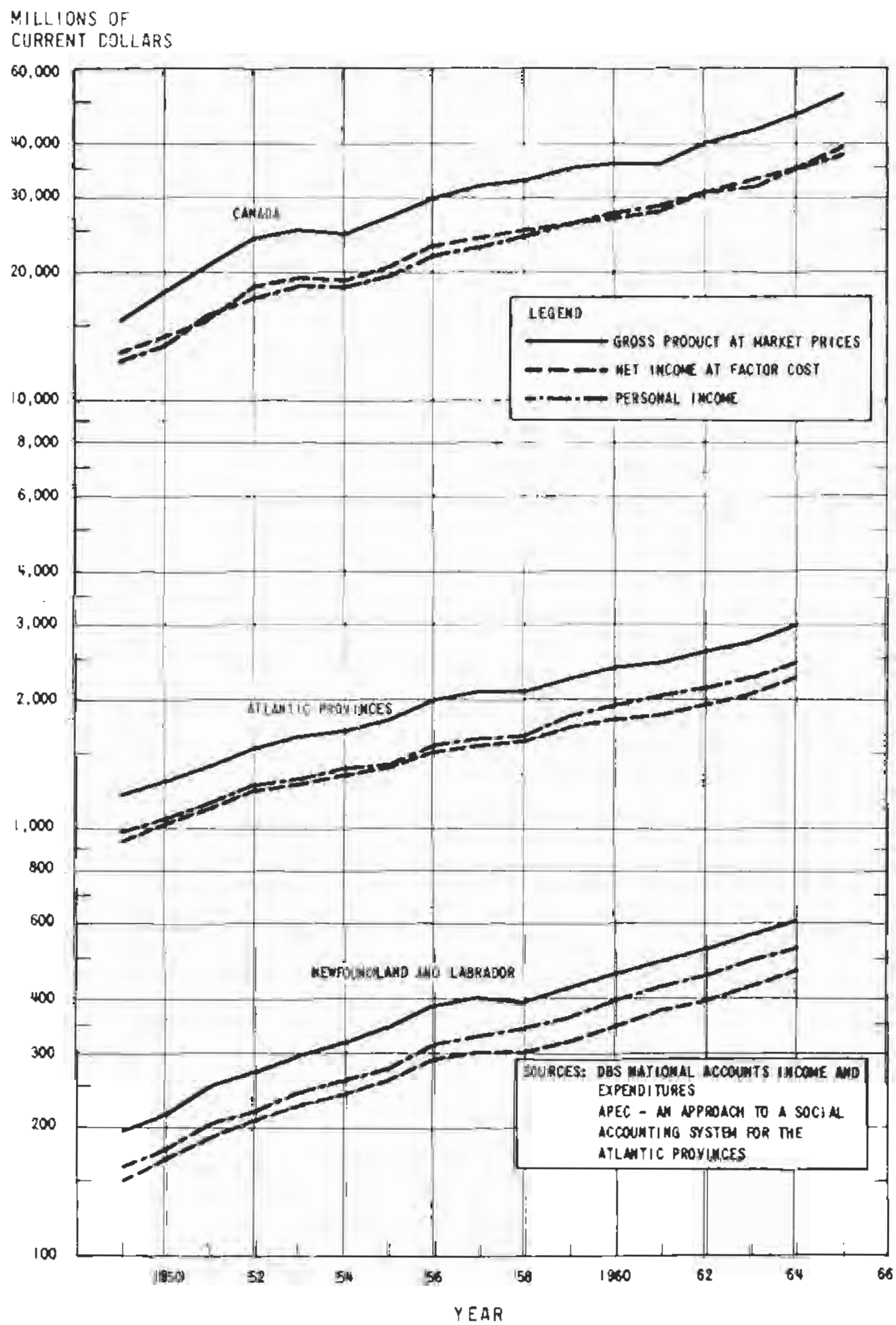


FIGURE 5-1

POPULATION BY CENSUS PERIOD 1951-1966
CANADA, ATLANTIC PROVINCES, NEWFOUNDLAND & LABRADOR

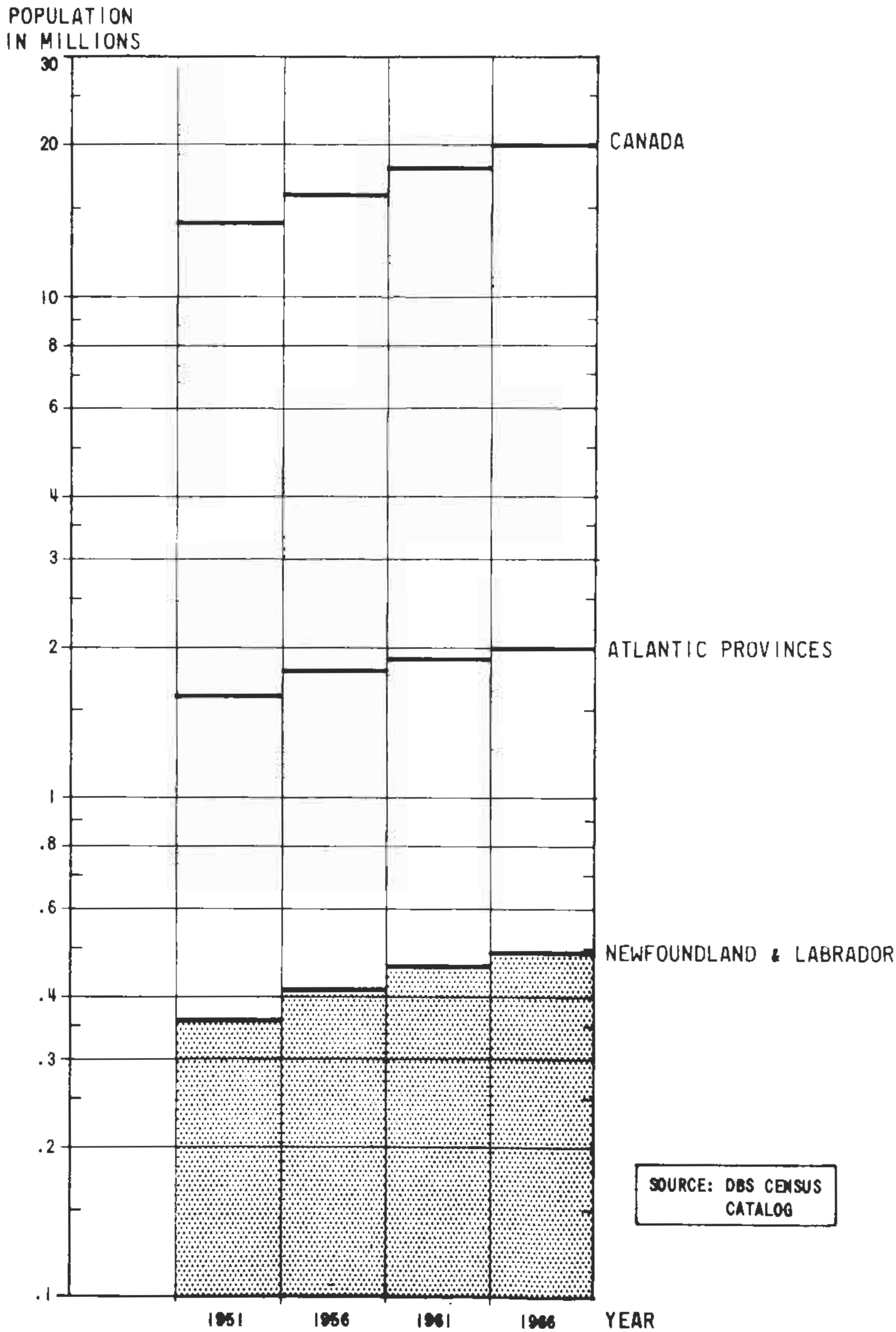


FIGURE 5-2

LABOUR FORCE PARTICIPATION RATES 1950 - 1966
CANADA, MARITIME PROVINCES, NEWFOUNDLAND & LABRADOR

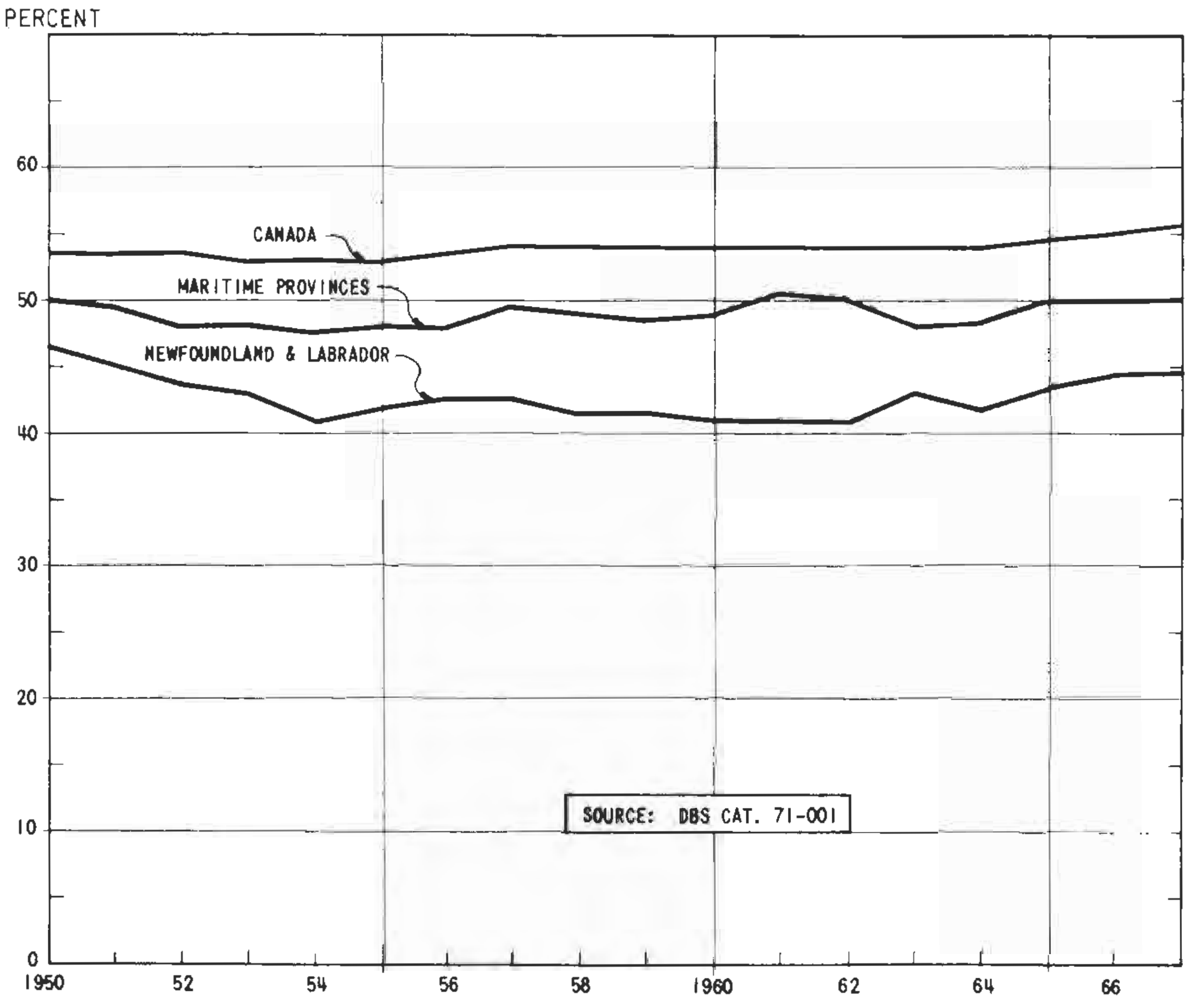
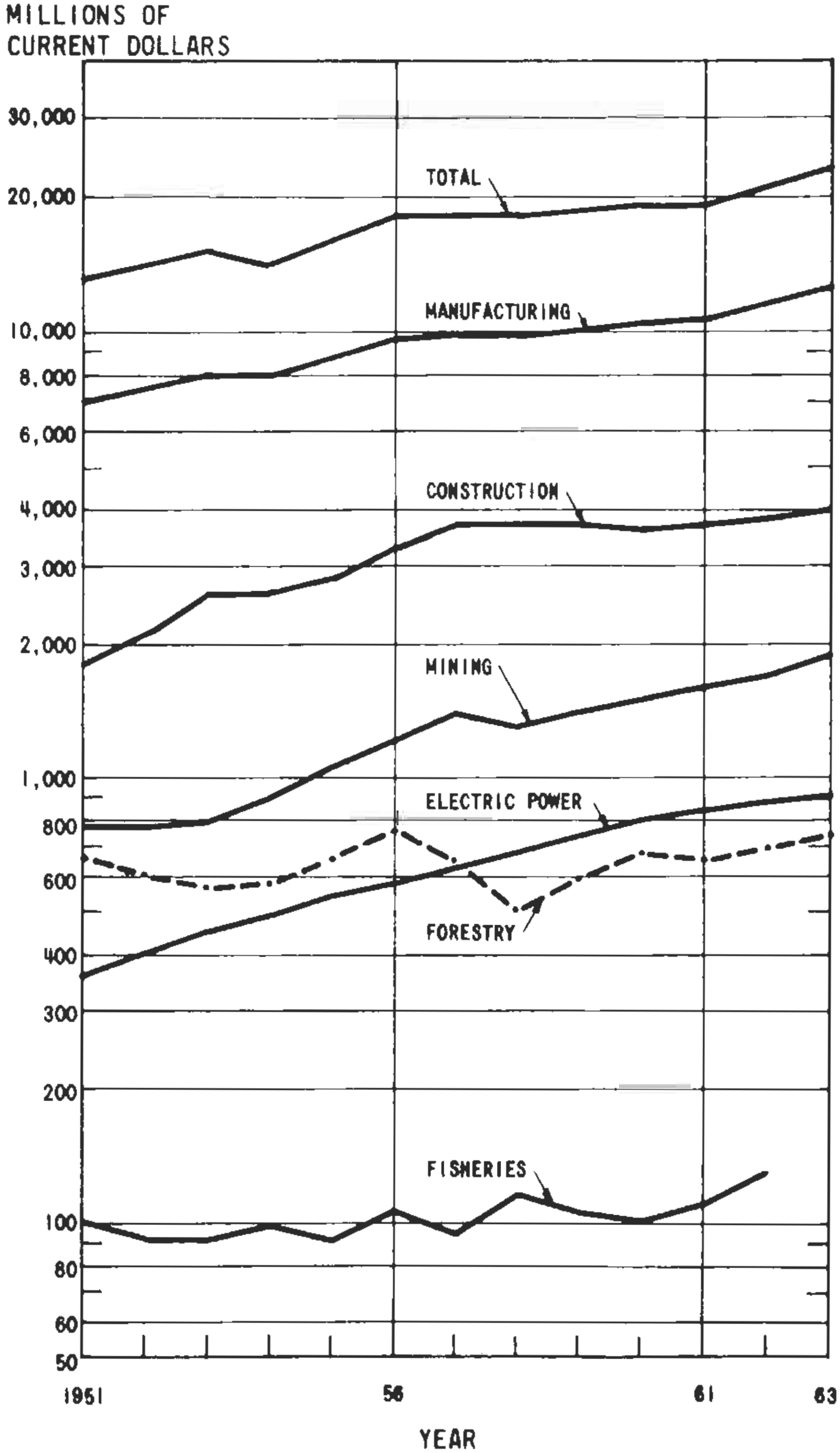


FIGURE 5-3

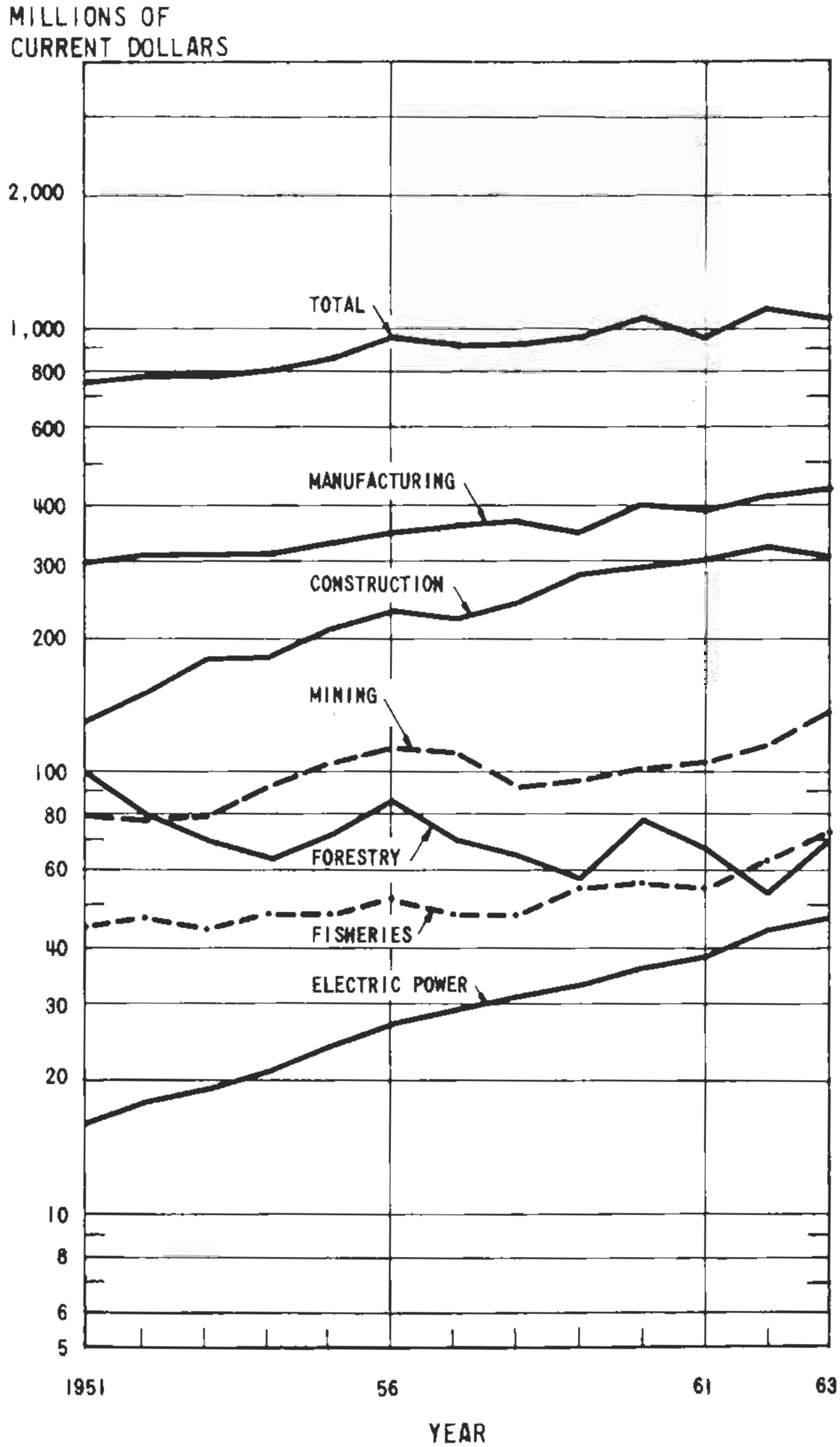
NET VALUE OF PRODUCTION BY COMMODITY PRODUCING SECTOR
CANADA 1951-1963



SOURCE: DBS CAT. 61-202

FIGURE 5-4A

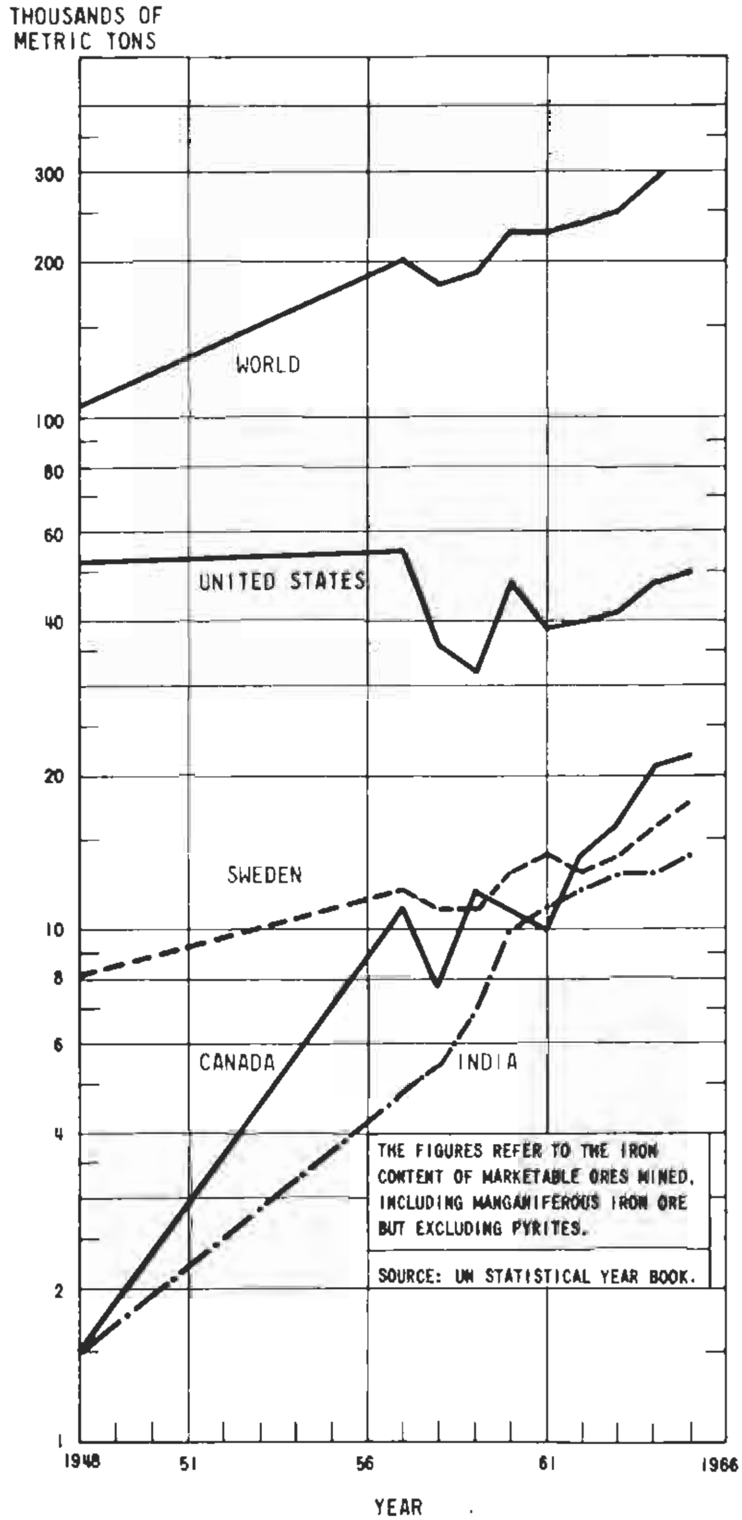
NET VALUE OF PRODUCTION BY COMMODITY PRODUCING SECTOR ATLANTIC PROVINCES 1951 - 1963



SOURCE: DBS CAT. 61-202

FIGURE 5-4B

INDUSTRY TRENDS
MINING OF IRON ORE, WORLD AND SELECTED COUNTRIES
1948 - 1965



INDUSTRY TRENDS
MINING OF COPPER ORE, WORLD AND SELECTED COUNTRIES
1948 - 1965

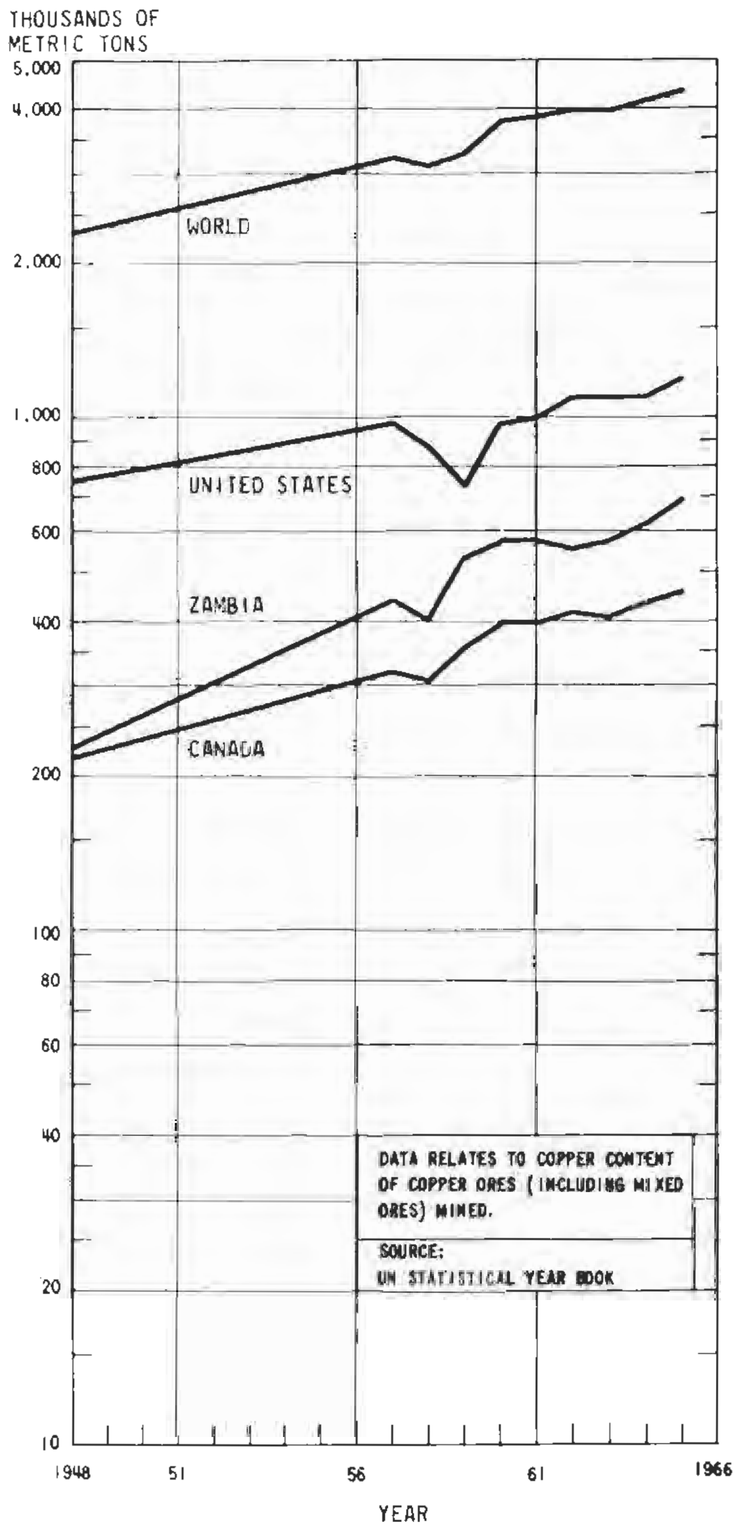


FIGURE 5-5B

INDUSTRY TRENDS
MINING OF LEAD ORE, WORLD AND SELECTED COUNTRIES
1948 - 1965

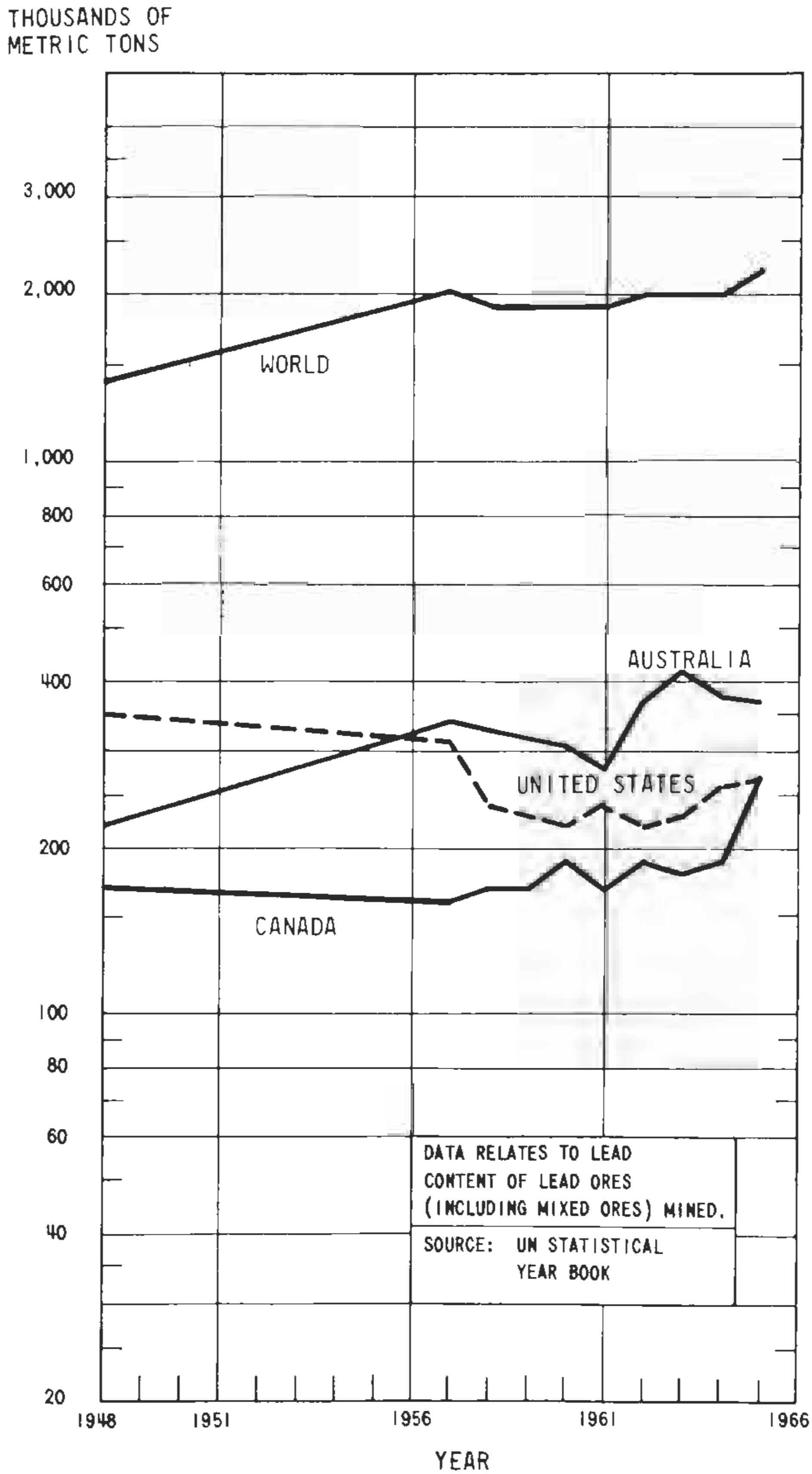


FIGURE 5-5C

INDUSTRY TRENDS
MINING OF ZINC ORE, WORLD AND SELECTED COUNTRIES,
1948 - 1965

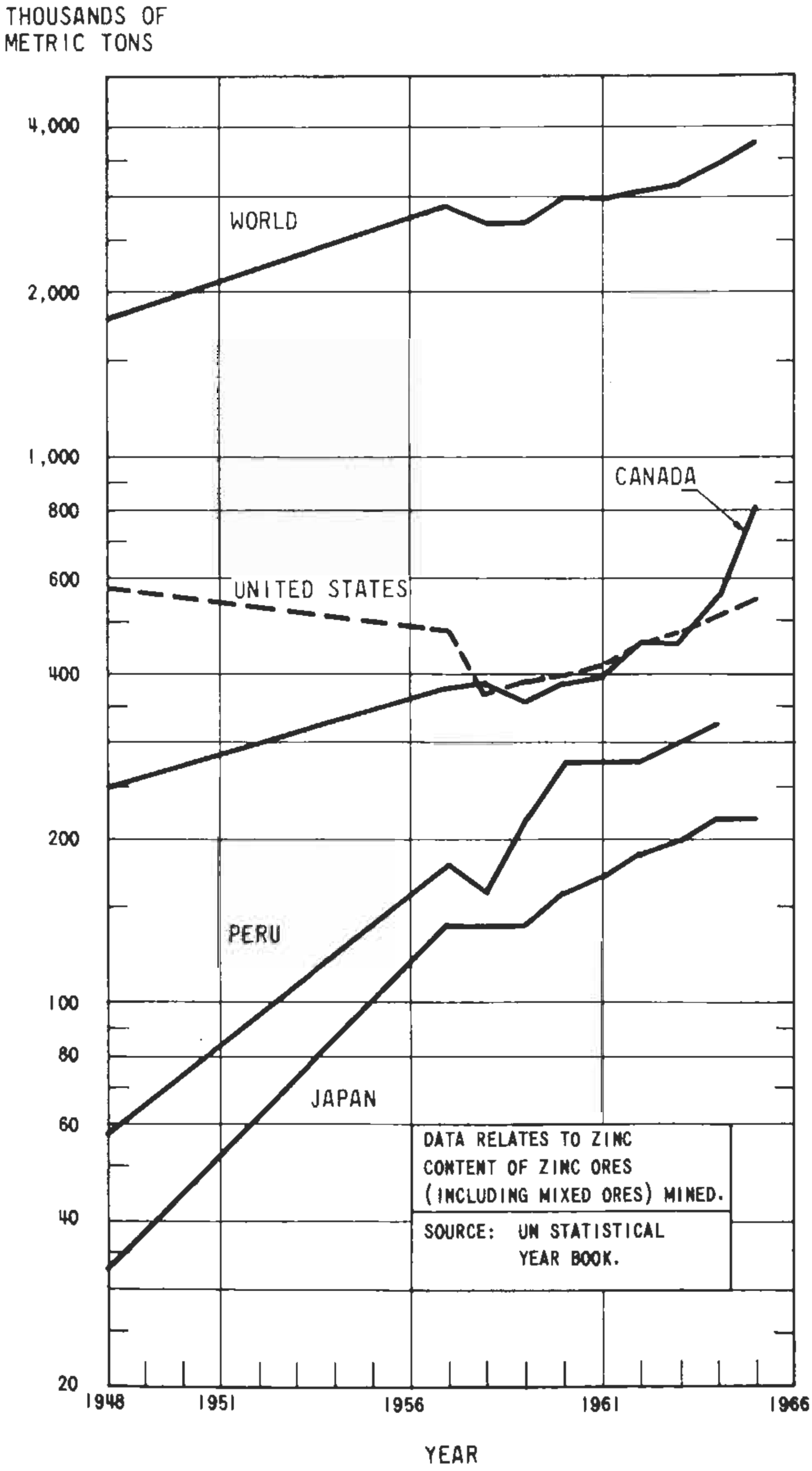


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FIGURE 5-5D

INDUSTRY TRENDS
WOOD PULP WORLD PRODUCTION AND CONSUMPTION
1937 - 1965

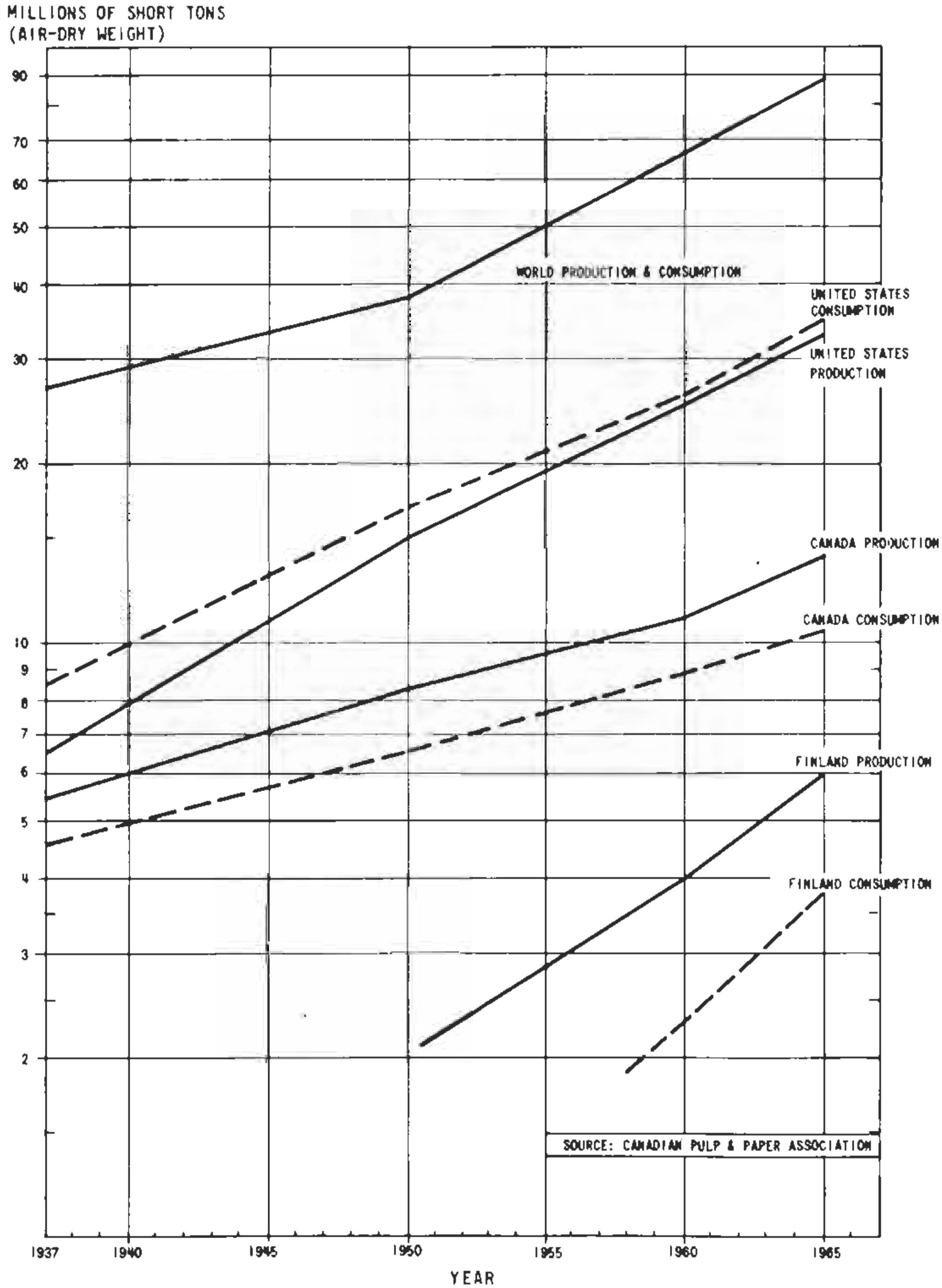


FIGURE 5-6A

INDUSTRY TRENDS
CANADIAN CONSUMPTION OF WOOD PULP IN PAPER PAPER BOARD AND OTHER BOARD PRODUCTS, BY KINDS 1946 - 1966

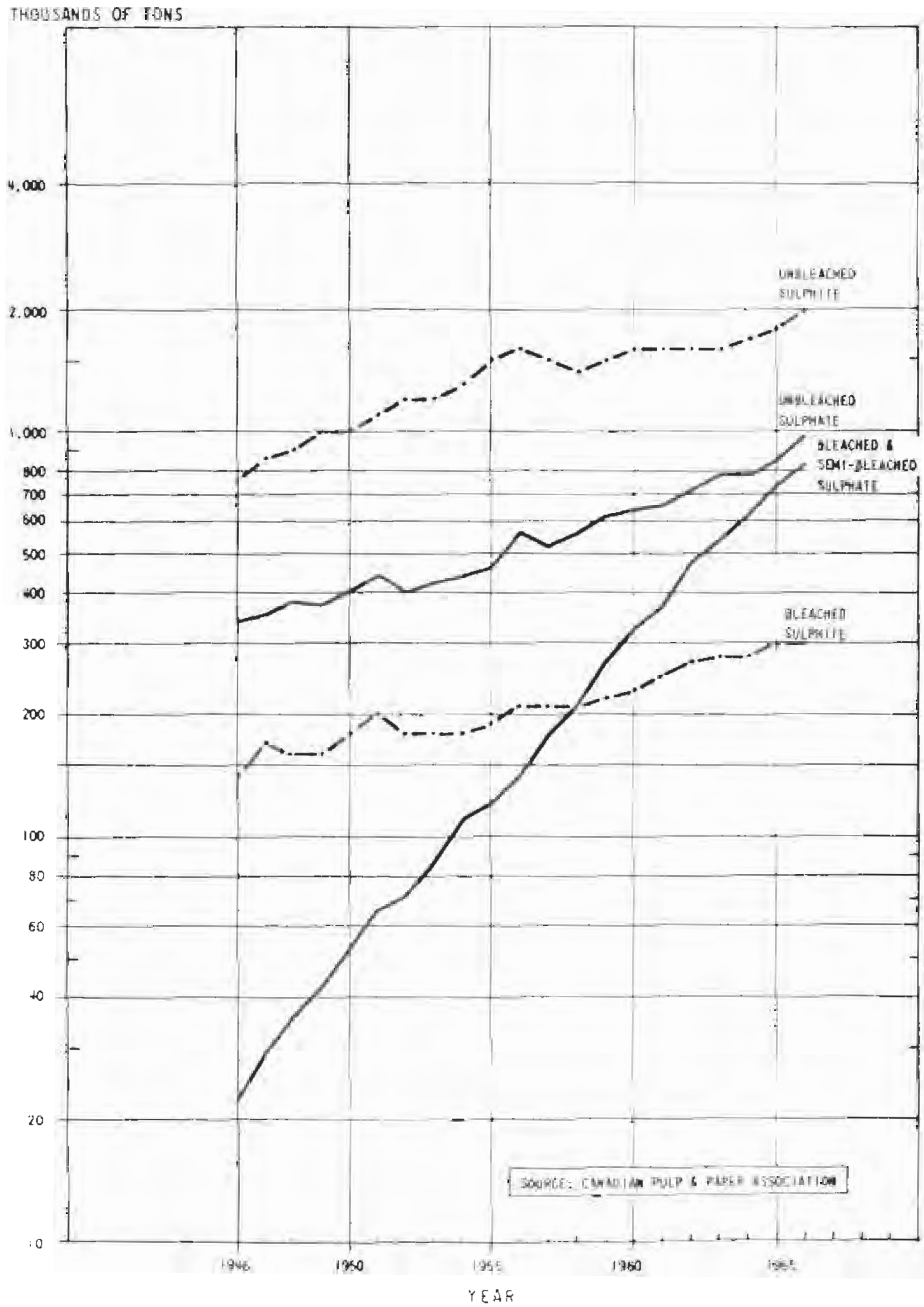


FIGURE 5-6B

CANADIAN NEWSPRINT ANNUAL CAPACITY AND PRODUCTION
1940-1966

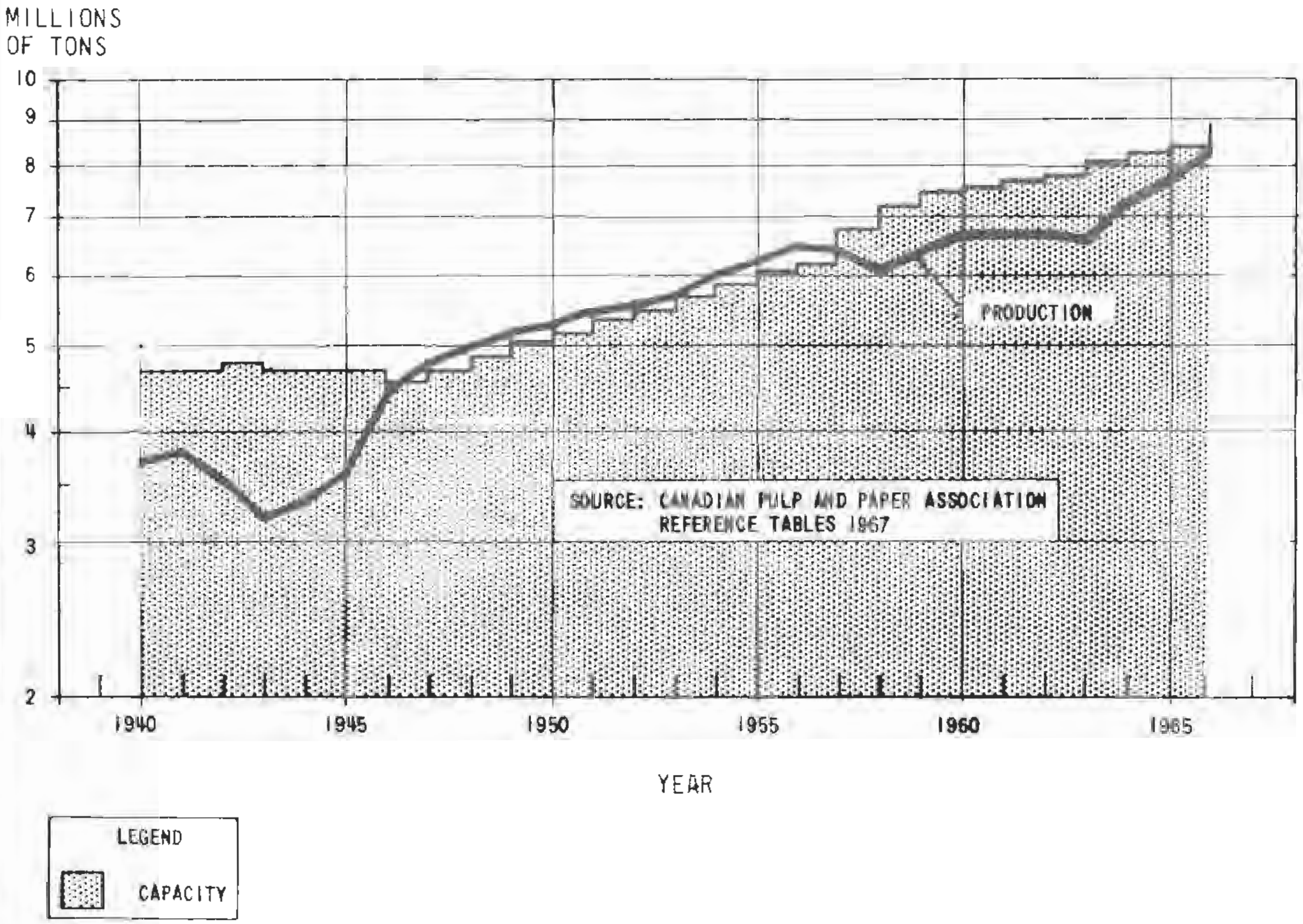
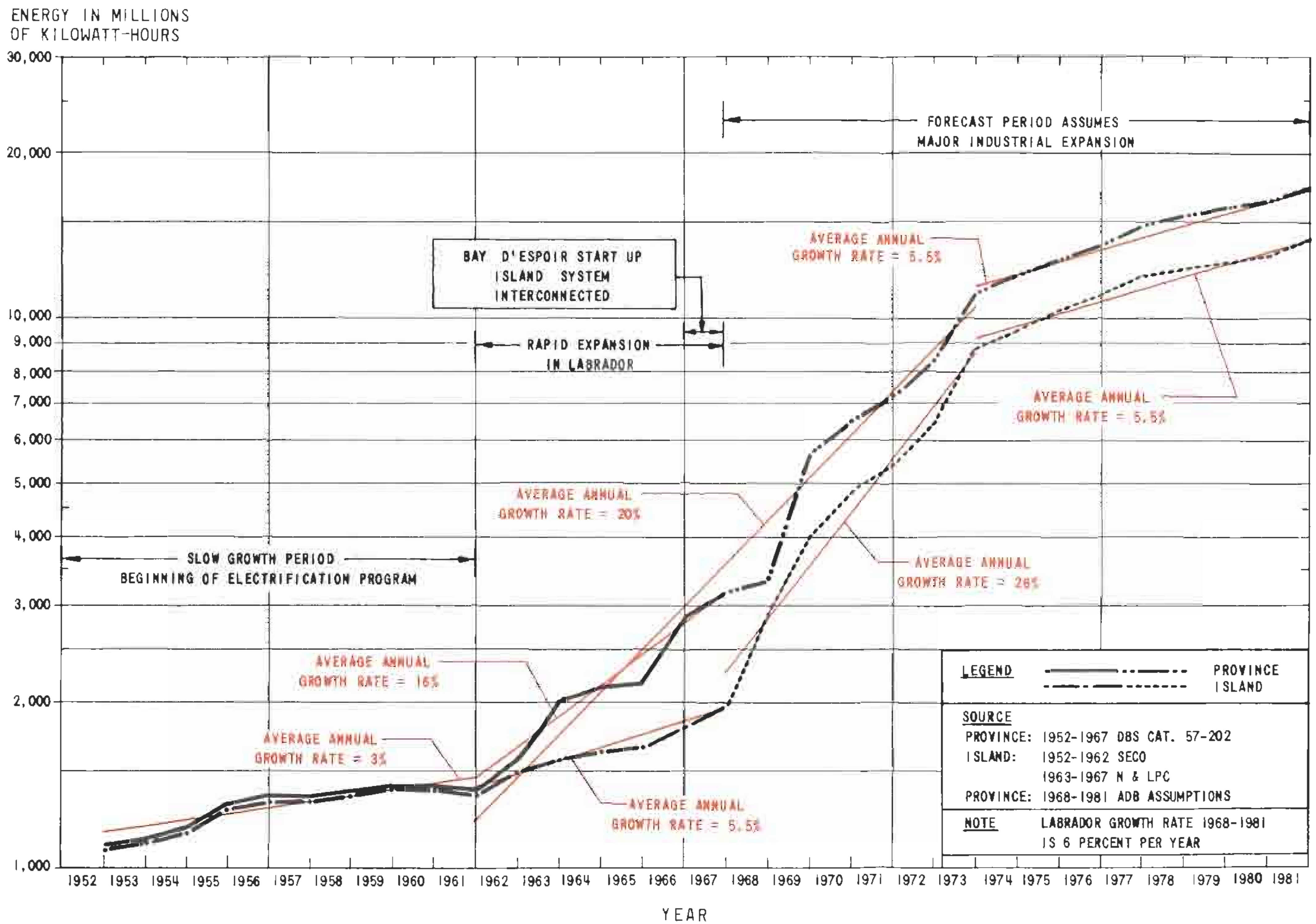


FIGURE 5-6C



NEWFOUNDLAND AND LABRADOR
ENERGY DEMAND 1952-1981

FIGURE 5-7

INDUSTRY TRENDS: ALUMINUM - PRIMARY AND SECONDARY PRODUCTION WORLD AND SELECTED COUNTRIES 1948-1965

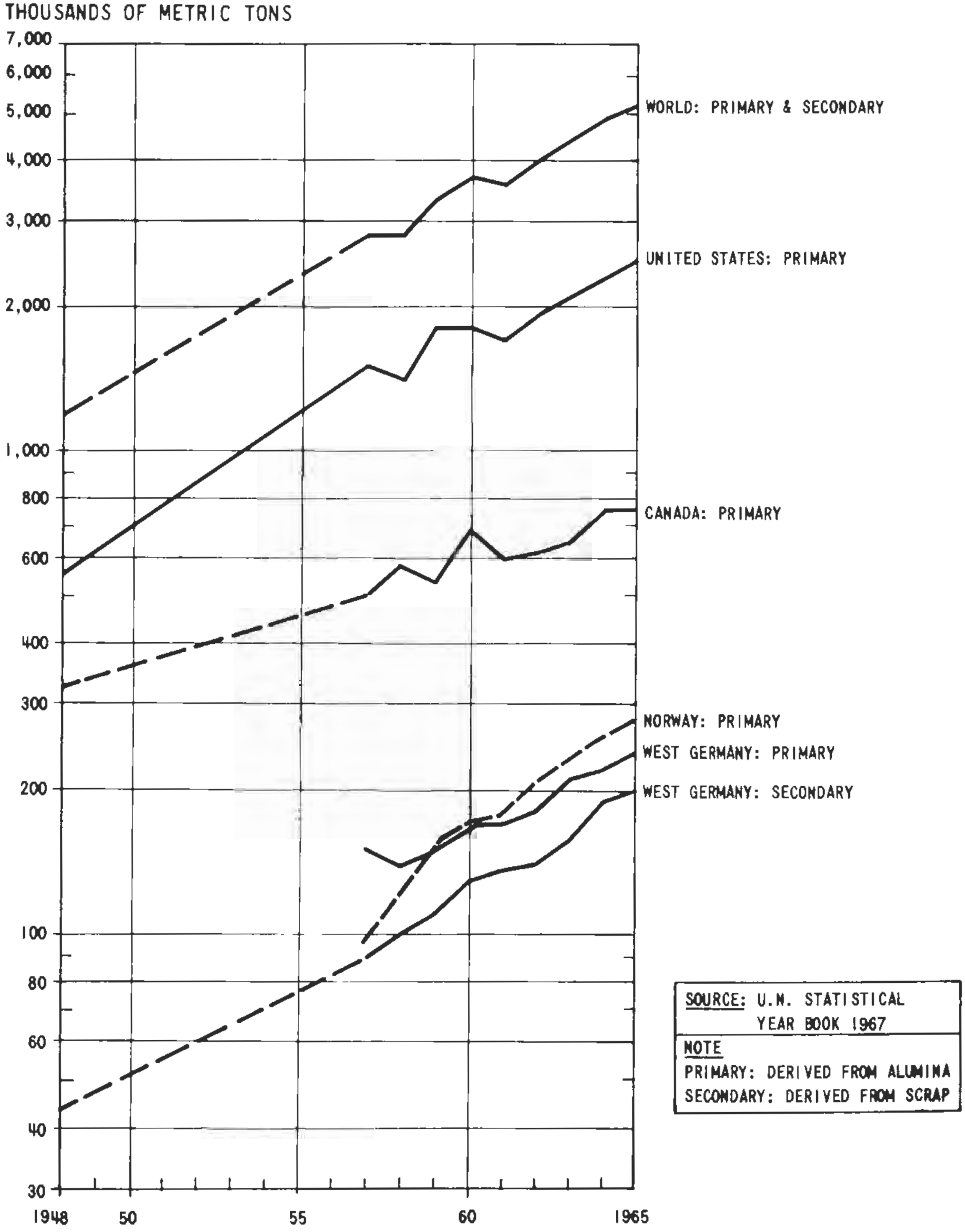
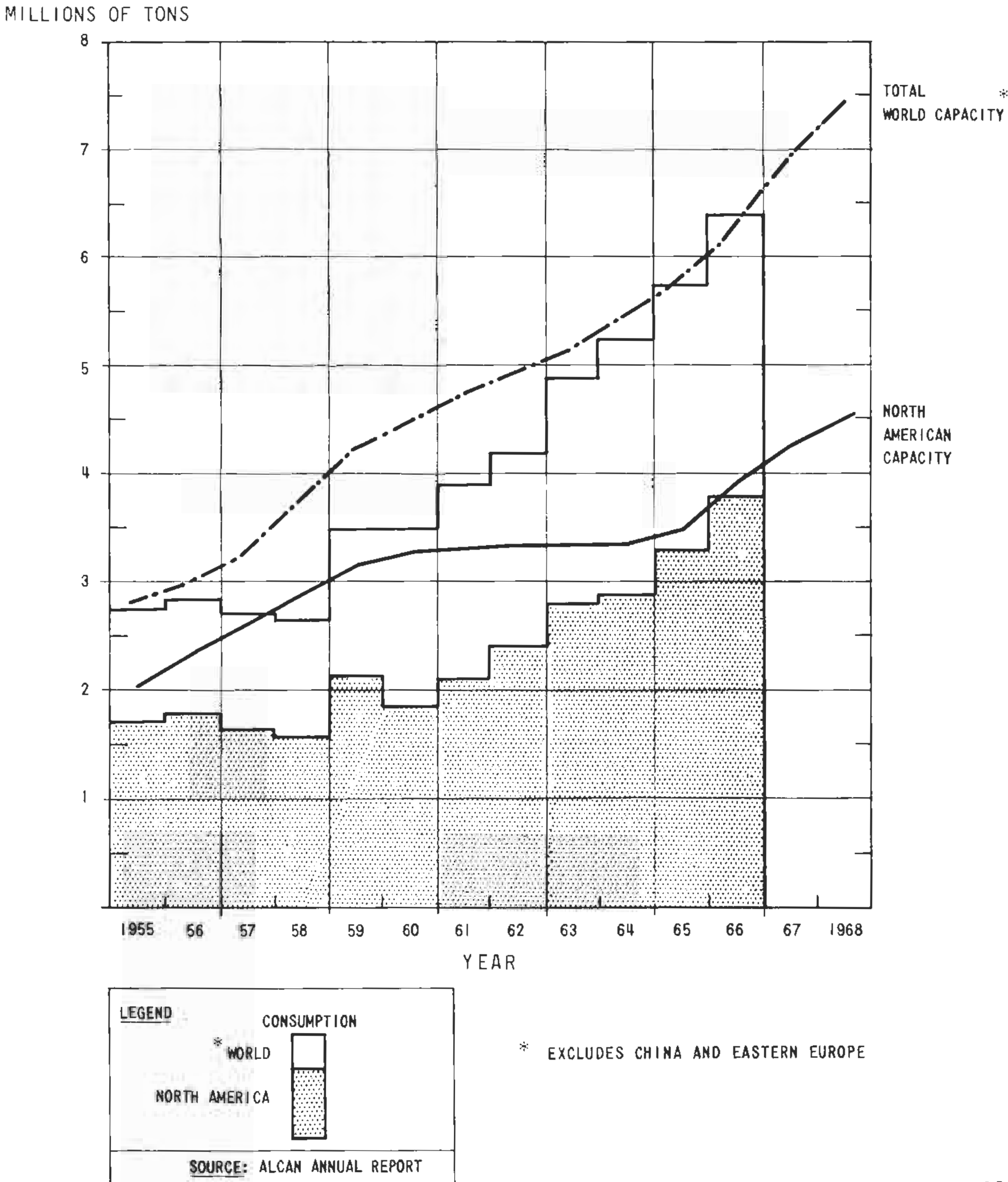


FIGURE 5-8A

INDUSTRY TRENDS: WORLD PRIMARY ALUMINUM CONSUMPTION AND CAPACITY



* EXCLUDES CHINA AND EASTERN EUROPE

FIGURE 5-8B

INDUSTRY TRENDS
SMELTER PRODUCTION COPPER
WORLD AND SELECTED COUNTRIES

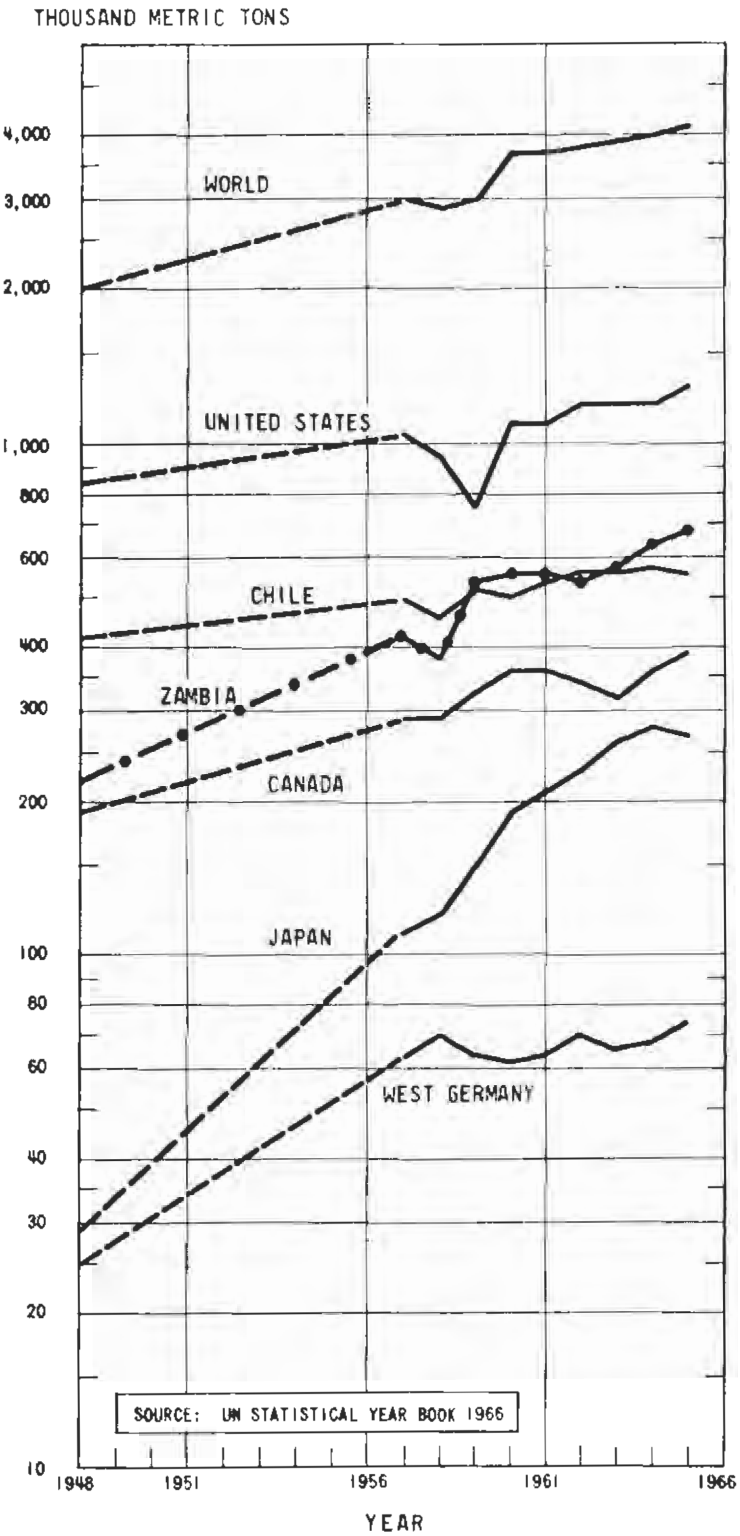
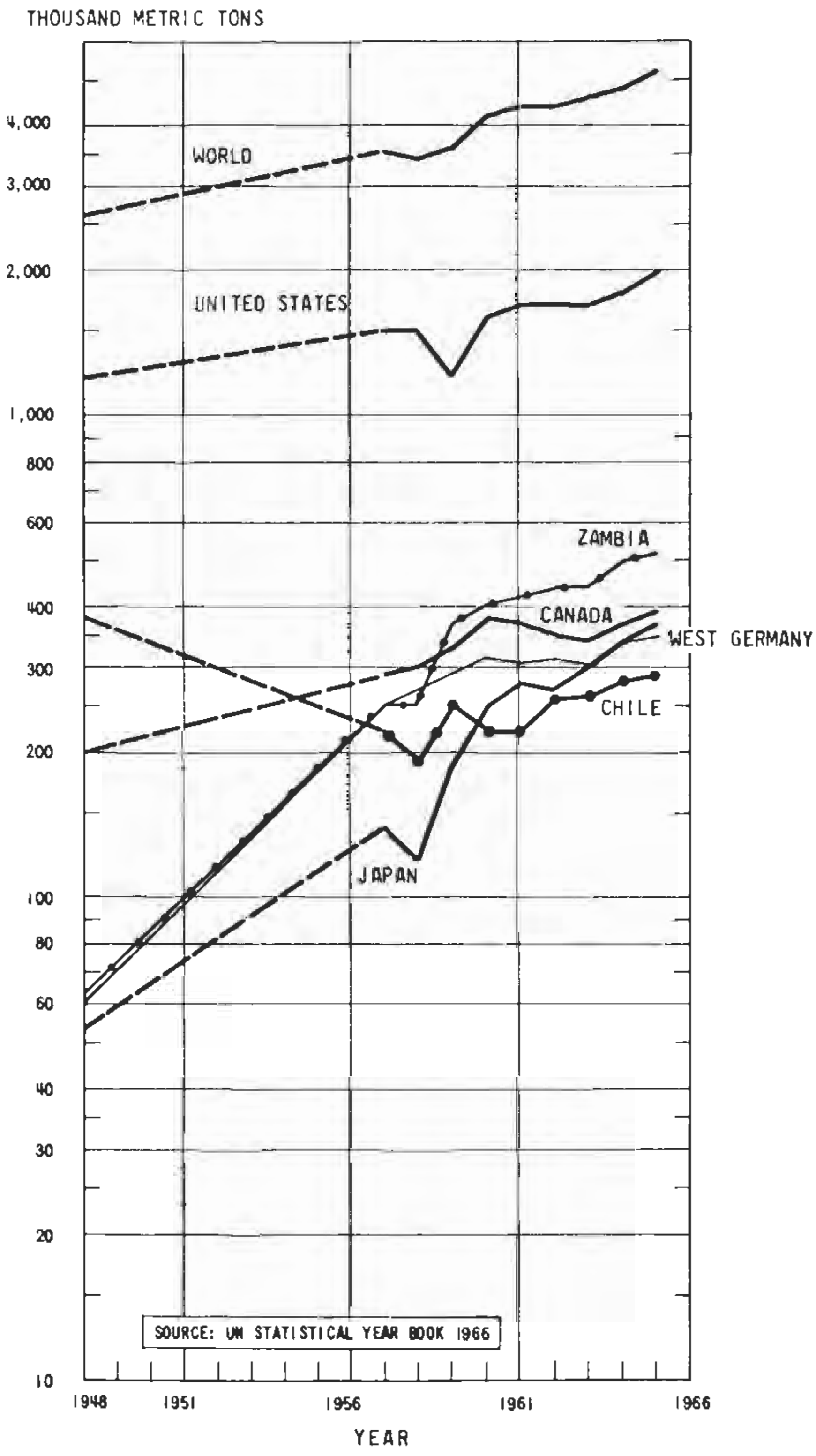


FIGURE 5-9A

INDUSTRY TRENDS
PRIMARY AND SECONDARY COPPER REFINED PRODUCTION
WORLD AND SELECTED COUNTRIES



INDUSTRY TRENDS LEAD PRODUCTION
PRIMARY, SECONDARY, REMELT AND RECOVERED IN ALLOYS,
WORLD AND SELECTED COUNTRIES
1948 - 1965

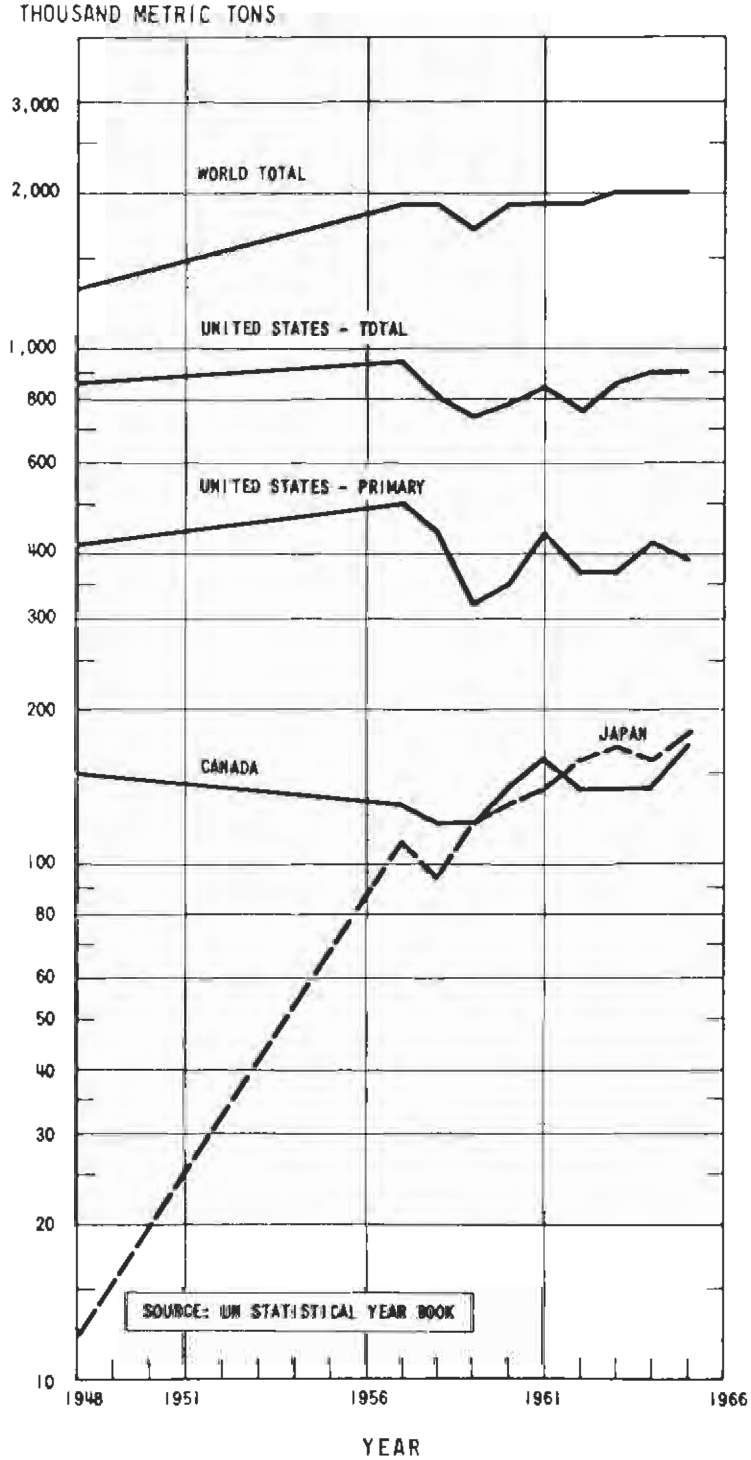


FIGURE 5-9C

INDUSTRY TRENDS - ZINC PRODUCTION
INCLUDING PRIMARY, SECONDARY, REMELT AND RECOVERED IN ALLOYS
WORLD AND SELECTED COUNTRIES
1948 - 1965

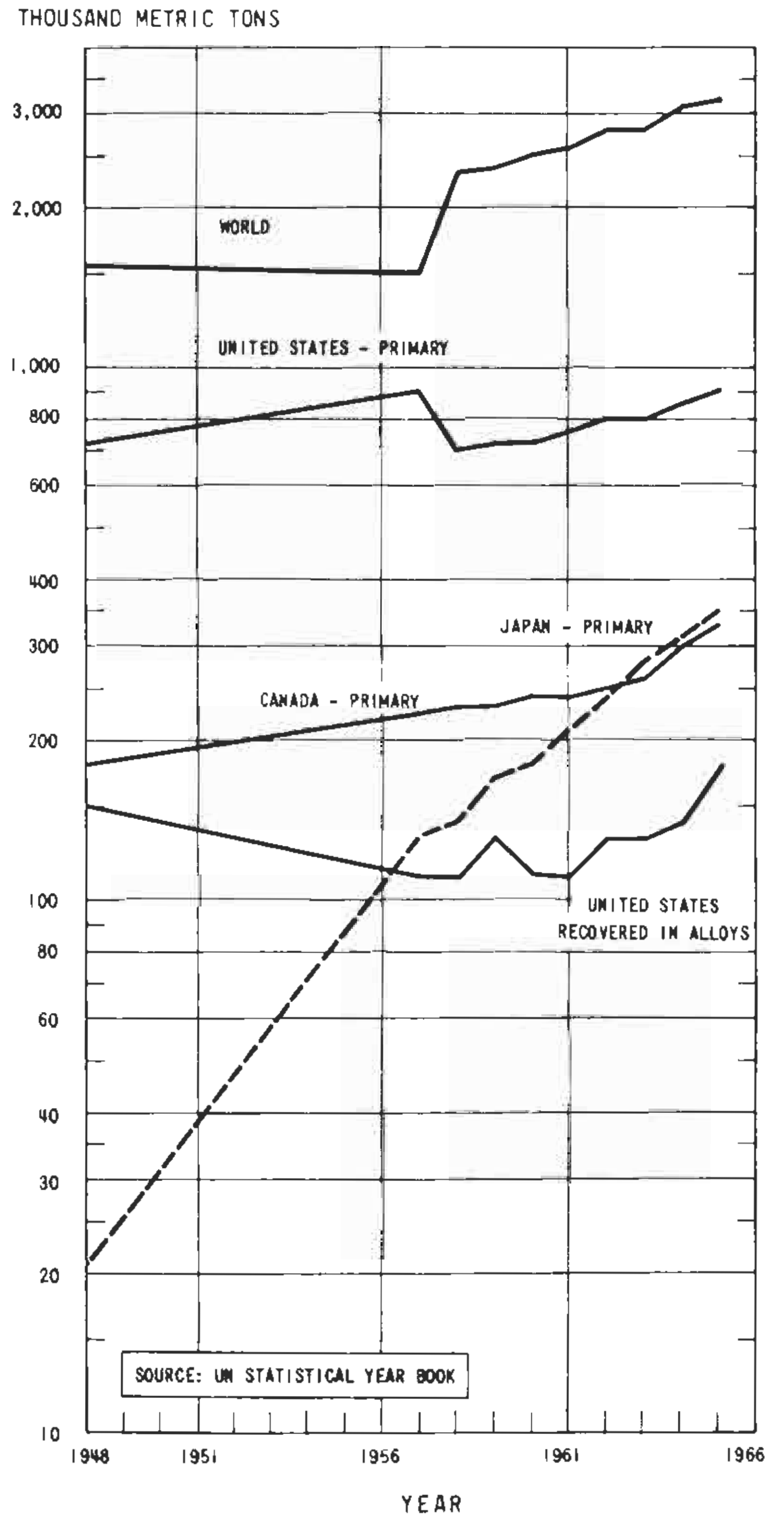


FIGURE 5-9D

NEWFOUNDLAND AND LABRADOR GROSS PROVINCIAL PRODUCT, PERSONAL INCOME AND PERSONAL INCOME PER CAPITA 1951 - 1981

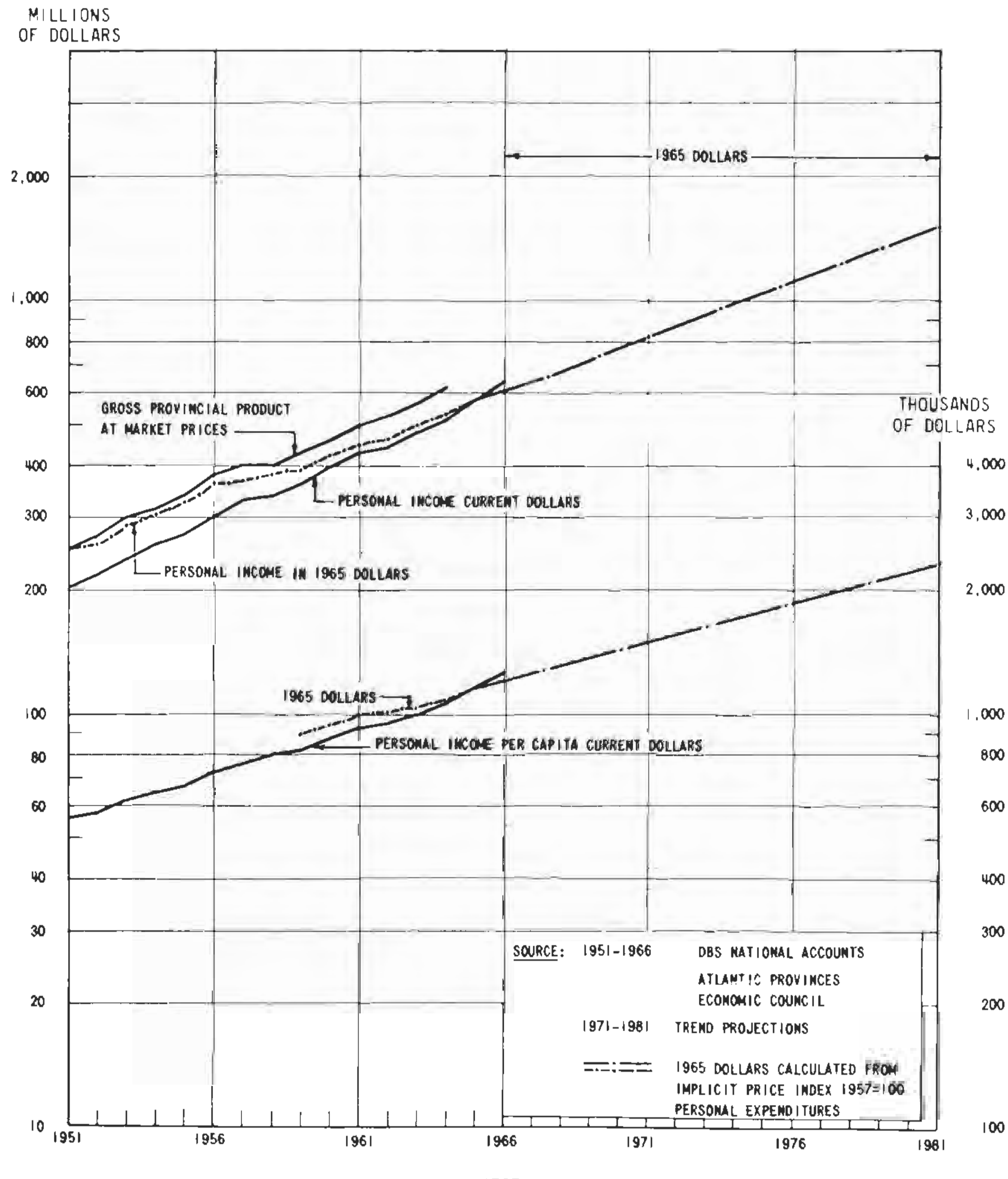


FIGURE 5-10

NEWFOUNDLAND AND LABRADOR NET VALUE OF PRODUCTION COMMODITY PRODUCING INDUSTRIES 1949-1965

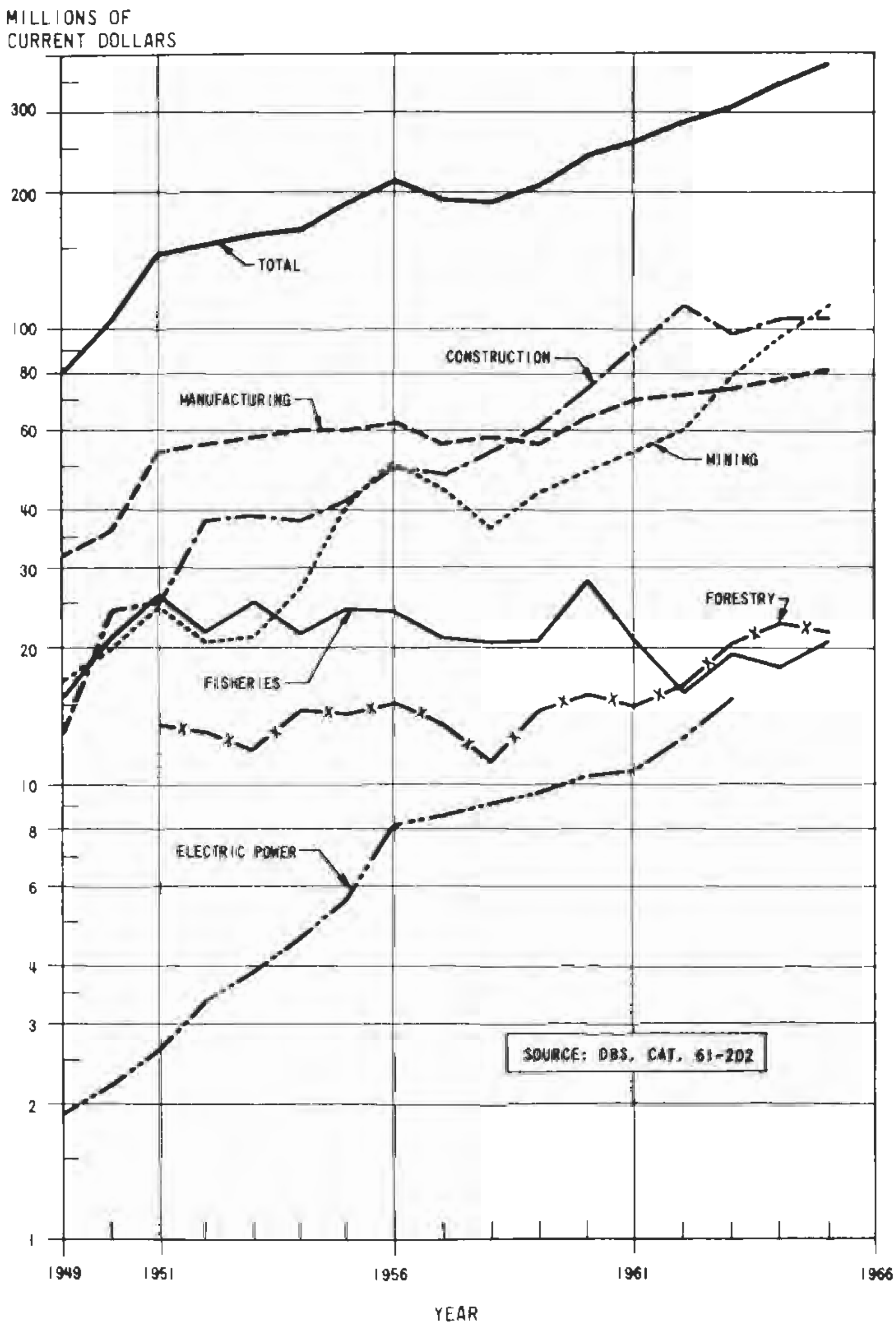


FIGURE 5-11

NEWFOUNDLAND AND LABRADOR:
POPULATION BY CENSUS YEAR 1951 - 1966
AND PROJECTIONS 1971, 1976 AND 1981

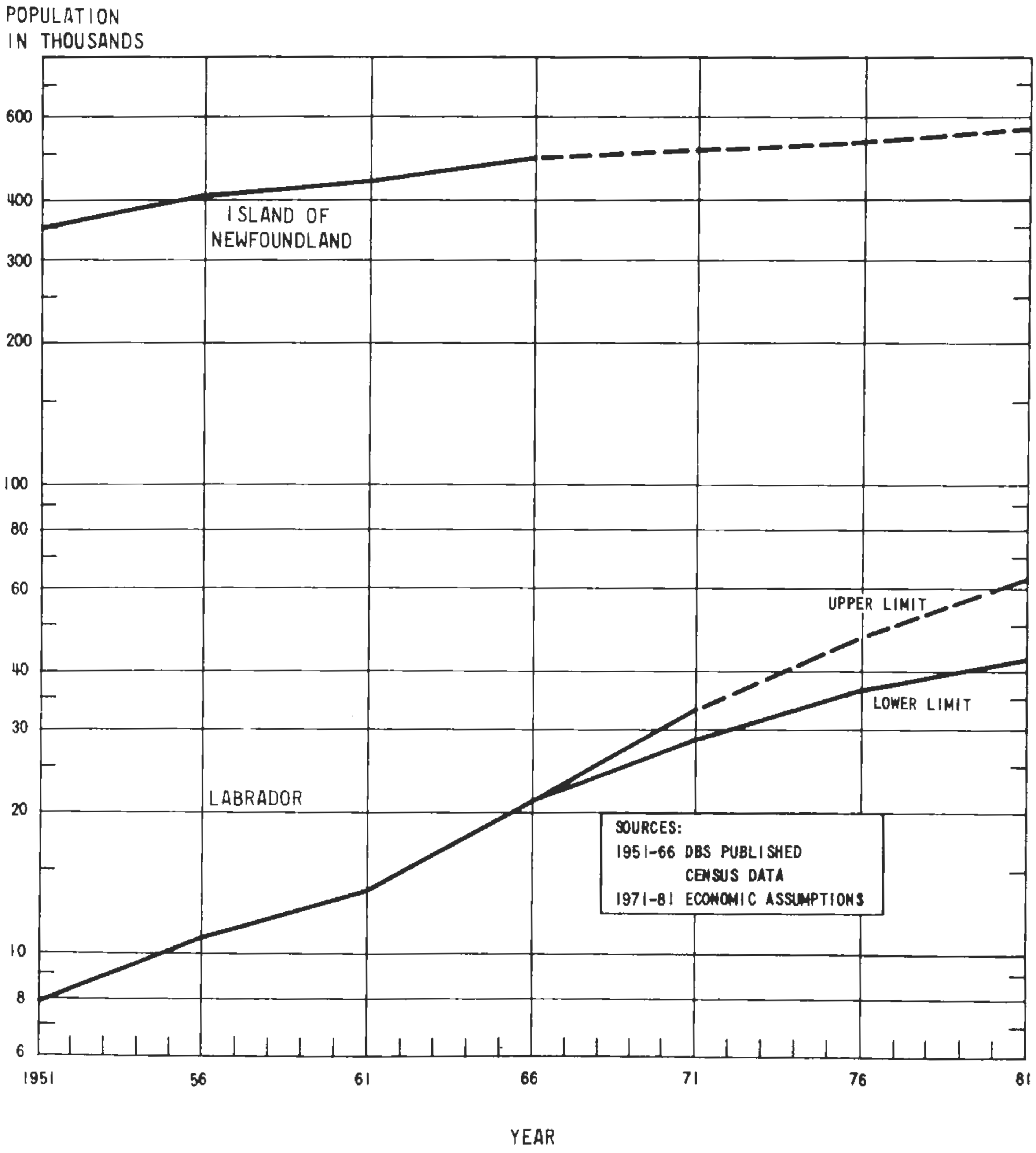


FIGURE 5-12

NEWFOUNDLAND AND LABRADOR
1966 CENSUS - DIVISIONS AND SUBDIVISIONS

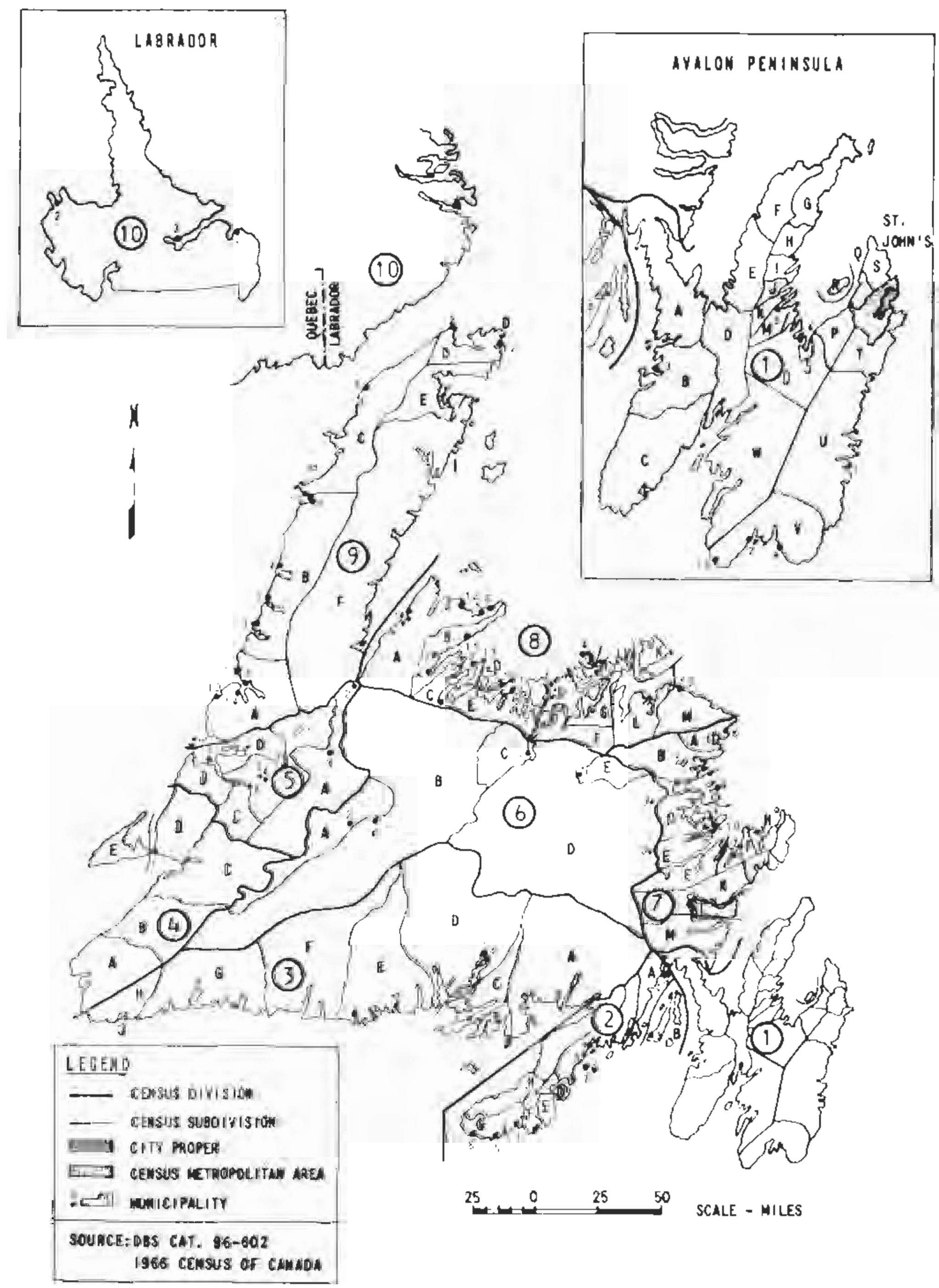


FIGURE 5-13

NEWFOUNDLAND CHARACTERISTICS OF MAJOR PLANNED DEVELOPMENTS 1971, 1976, 1981

COMPANY - LOCATION		INVESTMENT	EMPLOYMENT 1971	EMPLOYMENT 1976	EMPLOYMENT 1981	VALUE ADDED ($ million) 1971	VALUE ADDED ($ million) 1976	VALUE ADDED ($ million) 1981	VALUE OF SHIPMENTS ($ million) 1971	VALUE OF SHIPMENTS ($ million) 1976	VALUE OF SHIPMENTS ($ million) 1981	CAPACITY
Newfoundland Pulp and	(A)	$ 65.0	350-400	350-400	350-400	11.6	18.8	18.8	26.2	43.7	43.7	600 tons per day newsprint
Chemical Company	(B)	65.0	400	400	400	11.6	16.5	18.8	26.2	38.5	43.7	
Come By Chance												
Oil Refinery	(A)	95.0	500	500	500	8.8		27.4	50.0		127.0	100,000 barrels per day.
Come By Chance	(B)	95.0	250	250	250	21.5	24.2	27.4	100.0	114.0	127.0	
Ammonia Plant	(A)	35.0	170	170	170	5.1	5.1	5.1	9.7	9.7	9.7	1000 tons per day.
Come By Chance												
An aluminum smelter	(A)	150.0	800	800	800	19.2	19.2	19.2	37.2	37.2	37.2	3 potlines at 75,000 tons per year. aluminum.
Stephenville and Bay D'Espoir	(B)		975	1170	1170	39.0	52.0	58.5	75.0	100.0	112.5	2 in 1970, 1 in 1971
Alcan	(A)	1.5	50									
Stephenville												
Melville Pulp and Paper	(A)	250.0	400	400	400	25.5	25.5	25.5	51.0	51.0	51.0	1000 tons per day linerboard
Stephenville	(B)	250.0	400	400	400	19.9	22.4	25.5	39.8	44.9	51.0	
Electric Reduction Company	(A)	52.0	300									70,000 tons net phosphorous
Long Harbour												800,000 to 1,000,000 tons phosphate pellets, annually
Price (expansion)	(A)					1.9	4.7	4.7	4.4	11.0	11.0	+ 100 tons per day newsprint
Grand Falls												
Bowaters (expansion)	(A)						3.5	7.1		8.2	16.5	+ 350 tons per day newsprint
Corner Brook												

(A) = Basic assumption provided by Atlantic Development Board.
(B) = Working assumption approved for use by Atlantic Development Board.

PROVINCIAL MANUFACTURING PROJECTIONS OTHER THAN FISH PROCESSING AND PULP AND PAPER 1965, 1971, 1976, 1981

NOTE

Value of shipment and value added shown in thousands of dollars.
1965 data provided by Atlantic Development Board for value of shipments, value added, and employment.
Except where specified, value of shipments and value added are projected at 5 percent compounded.
All productivity growth is at 2.5 percent compounded.

LEGEND

- V of S - value of shipment
- VA - value added
- Emp - employment
- Prod - productivity = value added / employment

			1965	1971	1976	1981
1	Bakeries	V of S	4,529	7,400	9,800	11,800
		VA	2,144	3,700	4,900	5,900
		Emp	260	387	453	482
		Prod	8,240	9,550	10,810	12,230
2	Soft Drinks	V of S	4,475	5,000	5,800	6,700
		VA	2,592	2,800	3,500	4,100
		Emp	184	172	182	196
		Prod	14,087	16,326	18,480	20,905
3	Slaughtering and Meat Packing	V of S	3,971	5,320	6,790	8,660
		VA	738	990	1,260	1,610
		Emp	108	125	140	160
		Prod	6,833	7,920	8,960	10,140
4	Sausage and Sausage Casing	V of S	796	1,070	1,360	1,740
		VA	198	265	340	430
		Emp	26	30	34	38
		Prod	7,615	8,825	9,990	11,300
5	Dairy Factories	V of S	2,688	3,600	4,600	5,870
		VA	672	900	1,150	1,470
		Emp	95	109	124	140
		Prod	7,073	8,200	9,280	10,500
6	Fruits and Vegetables	V of S	85	170	170	170
		VA	40	80	80	80
		Emp	10	20	20	20
		Prod				
7	*Feed Manufacturing	V of S	338	450	580	740
		VA	76	100	130	170
		Emp	10	11	13	15
		Prod	7,600	8,810	9,970	11,280

* Refers to industries considered in Volume Three B, Part 5, Section 16.

TABLE 5-2

			1965	1971	1976	1981
8	Biscuits	V of S	1,150	1,540	1,970	2,510
		VA	535	715	915	1,170
		Emp	101	116	132	149
		Prod	5,297	6,140	6,950	7,860
9	Breweries	V of S	2,900	5,171	5,571	6,001
		VA	1,750	2,873	3,095	3,334
		Emp	96	144	137	130
		Prod	17,187	19,920	22,550	25,505
10	*Shoes	V of S	520	695	890	1,135
		VA	280	375	480	610
		Emp	68	79	89	100
		Prod	4,118	4,770	5,400	6,110
11	*Miscellaneous Leather Products	V of S	292	390	500	640
		VA	159	215	270	345
		Emp	40	47	52	58
		Prod	3,975	4,610	5,215	5,900
12	*Canvas Products	V of S	44	260	430	590
		VA	22	120	190	240
		Emp	4	19	26	29
		Prod	5,500	6,375	7,215	8,160
13	Sash and Door	V of S	855	1,145	1,460	1,865
		VA	420	560	720	915
		Emp	65	75	85	95
		Prod	6,460	7,490	8,475	9,585
14	Coffin and Casket	V of S	133	180	230	290
		VA	66	90	115	145
		Emp	18	21	24	27
		Prod	3,666	4,250	4,810	5,440
15	Miscellaneous Wood Products	V of S	650	870	1,110	1,420
		VA	290	390	495	630
		Emp	36	42	47	53
		Prod	8,055	9,335	10,570	11,950
16	Household Furniture	V of S	217	290	370	475
		VA	151	200	260	300
		Emp	31	35	41	46
		Prod	4,870	5,645	6,390	7,230
17	"Other" Furniture	V of S	229	305	390	500
		VA	178	240	305	390
		Emp	17	20	22	25
		Prod	10,470	12,135	13,735	15,540
18	*Commercial Printing	V of S	1,169	1,565	2,000	2,550
		VA	814	1,090	1,390	1,775
		Emp	148	171	193	218
		Prod	5,500	6,375	7,215	8,160
19	*Printing and Publishing	V of S	2,730	3,660	4,670	5,960
		VA	2,241	3,005	3,835	4,895
		Emp	300	347	391	441
		Prod	7,476	8,665	9,810	11,095

			1965	1971	1976	1981
20	Iron Foundries	V of S	153	205	260	335
		VA	83	110	140	180
		Emp	29	33	37	42
		Prod	2,862	3,315	3,755	4,250
21	Ornamental and Architectural Metal	V of S	514	690	880	1,120
		VA	303	405	520	660
		Emp	47	54	62	69
		Prod	6,446	7,470	8,455	9,565
22	Metal Stamping and Pressing	V of S	232	310	395	505
		VA	116	155	200	255
		Emp	11	13	14	16
		Prod	10,545	12,220	13,835	15,650
23	Wire and Wire Rod	V of S	390	520	665	850
		VA	123	165	210	270
		Emp	22	25	29	33
		Prod	5,590	6,480	7,335	8,295
24	Machine Shops	V of S	440	590	750	960
		VA	182	245	310	395
		Emp	32	37	42	47
		Prod	5,688	6,541	7,451	8,418
25	Miscellaneous Metal Fabrication	V of S	2,140	2,865	3,660	4,670
		VA	1,060	1,420	1,810	2,310
		Emp	349	406	455	514
		Prod	3,037	3,492	3,978	4,494
26	Miscellaneous Machinery and Equipment	V of S	510	685	870	1,110
		VA	350	470	600	765
		Emp	54	63	70	80
		Prod	6,481	7,453	8,490	9,590
27	Shipbuilding and Repair	V of S	4,600	6,165	7,865	10,040
		VA	2,500	3,350	4,275	5,455
		Emp	432	503	563	636
		Prod	5,787	6,655	7,580	8,565
28	Boatbuilding and Repair	V of S	80	107	135	175
		VA	43	58	75	95
		Emp	6	7	8	10
		Prod	7,166	8,240	9,387	10,606
29	Cement	V of S	2,000	2,680	3,420	4,360
		VA	1,500	2,010	2,565	3,270
		Emp	120	138	156	176
		Prod	12,500	14,500	16,400	18,500
30	Concrete Products	V of S	1,170	1,568	2,000	2,550
		VA	650	862	1,100	1,409
		Emp	80	92	103	116
		Prod	8,125	9,400	10,650	12,000
31	Ready Mix Concrete	V of S	1,578	2,115	2,698	3,440
		VA	455	592	753	963
		Emp	72	80	91	103
		Prod	6,320	7,350	8,300	9,350

			1965	1971	1976	1981
32	Clay Products	V of S	556	745	950	1,212
		VA	380	506	646	824
		Emp	48	55	62	70
		Prod	7,916	9,166	10,375	11,710
33	Stone Products	V of S	78	105	133	170
		VA	48	64	81	103
		Emp	22	25	28	32
		Prod	2,181	2,500	2,863	3,227
34	*Paint and Varnish	V of S	745	1,000	1,275	1,625
		VA	370	495	630	810
		Emp	35	40	45	52
		Prod	10,570	12,250	13,870	15,685
35	*Industrial Chemicals	V of S	576	770	986	1,255
		VA	360	480	615	785
		Emp	21	25	27	31
		Prod	17,143	19,870	22,490	25,440
36	*Scientific and Process Equipment	V of S	219	295	375	480
		VA	129	170	220	280
		Emp	19	22	25	28
		Prod	6,790	7,870	8,910	10,075
37	Miscellaneous Food	V of S	570	765	975	1,245
		VA	187	250	320	410
		Emp	23	27	30	34
		Prod	8,130	9,420	10,665	12,065
38	*Corrugated Boxes	V of S	250	335	430	545
		VA	100	134	170	210
		Emp	13	15	17	19
		Prod	7,692	8,915	10,090	11,415
39	*Signs and Displays	V of S	243	325	415	530
		VA	151	200	260	330
		Emp	24	27	32	35
		Prod	6,292	7,290	8,255	8,340
40	*Miscellaneous Manufacturing	V of S	159	215	270	349
		VA	100	134	170	218
		Emp	19	22	25	28
		Prod	5,263	6,100	6,905	7,810
41	Poultry Processing	V of S	2,500	3,350	4,275	5,455
		VA	385	515	660	840
		Emp	30	35	40	44
		Prod	12,833	14,875	16,835	19,045
42	Petroleum Refinery	V of S	10,642	14,260	18,200	23,220
		VA	2,071	2,775	3,540	4,520
		Emp	60	69	78	88
		Prod	34,517	40,005	45,285	51,225
43	Gypsum Products	V of S	2,000	2,680	3,420	4,360
		VA	1,200	1,608	2,050	2,616
		Emp	67	77	88	99
		Prod	17,910	20,800	23,400	26,500

1965

MANUFACTURING INDUSTRIES: NEWFOUNDLAND - LOCATIONS

Bakeries	Corner Brook, Catalina, Botwood, Curling, Dildo, Fortune Grand Falls, Lewisporte, Placentia Bay, Stephenville, St. John's - 6, St. John's East, Springdale.
Soft Drinks	St. John's - 5, Corner Brook - 2, Bishops Falls - 1, Stephenville - 1.
Slaughtering and Meat Packing	St. John's, Grand Falls
Sausage and Sauge Casing	St. John's - 2.
Dairy Factories	St. John's 2, Corner Brook, Grand Falls, Lewisporte, Little Rapids.
Fruit and Vegetable Canning	St. John's, Green Bay.
Feed Manufacturing	Dildo, Donovans.
Biscuits	St. John's
Shoes	Harbour Grace
Miscellaneous Leather Products	St. John's, Harbour Grace.
Canvas Products	St. John's.
Sash and Door	St. John's - 2, Corner Brook - 3, New Chelsea, Bishops Falls, Hare Bay, Channel, Glovertown, Bonavista South District, Coleys Point, Donovans, Spaniard's Bay, Rochy Harbour, Springdale.
Coffin and Casket	Freshwater
Miscellaneous Wood Products	Trinity North District, St. John's, Port de Grave District, Carbonear.
Household Furnishing	St. John's - 2, Stephenville - 2, Corner Brook, Goose Bay.
"Other" Furniture	St. John's.
Commercial Printing	St. John's - 10, Corner Brook, Bishops Falls, Harbour Grace, Tor's Cove, Bay Roberts, Twillingate.
Printing and Publishing	St. John's - 3, Corner Brook, Mount Pearl, Grand Falls, Port Union.
Iron Foundries	St. John's.

1965

MANUFACTURING INDUSTRIES: NEWFOUNDLAND - LOCATIONS

Ornamental and Architectural Metal	St. John's - 3, Conception Bay.
Metal Stamping and Pressing	Bishops Falls.
Wire and Wire Products	Bay Roberts.
Machine Shops	St. John's - 2.
Miscellaneous Metal Fabrication	St. John's - 2.
Miscellaneous Machinery and Equipment	St. John's.
Shipbuilding and Repair	Marystown, Clarenville.
Boatbuilding and Repair	Fortune.
Cement	Corner Brook
Concrete Products	Corner Brook, Stephenville, Shoal Harbour.
Ready-Mix Concrete	St. John's, Bay Roberts, Stephenville.
Clay Products	Milton.
Stone Products	St. John's - 3.
Paint and Varnish	St. John's
Industrial Chemicals	St. John's
Scientific and Professional Equipment	St. John's - 3.
Miscellaneous Foods	St. John's.
Corrugated Boxes	St. John's.
Signs and Displays	St. John's - 3.
Miscellaneous Manufacturing (excluding signs, displays, and scientific equipment)	St. John's.
Poultry Processing	None
Petroleum Refineries	Holyrood.
Gypsum Products	Corner Brook.

NEWFOUNDLAND
ELECTRICAL LOAD FORECAST
1968 - 1981, 1991

		1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1991
Megawatts																
Growth Rate																
6%/72/2%	Bowater Mill	116	122	128	134	141	144	147	150	153	156	159	162	165	168	208
2%	Price Mill	70	93	103	105	107	109	111	113	115	117	119	121	123	126	153
7.5%	Steel Plant	5	6	16	16	18	20	21	23	25	27	29	31	33	36	74
2% to 220	Electric Reduction	130	130	130	130	200	200	200	200	200	204	208	212	216	220	220
2%	Third Paper Mill	-	-	45	46	47	48	49	50	51	52	53	54	55	56	67
2%	Oil Refinery	-	-	20	20	20	21	21	21	22	22	23	23	24	24	30
2%	Chemical Complex	-	-	20	20	20	21	21	21	22	22	23	23	24	24	30
2%	Liner Board Mill	-	-	-	-	40	40	41	42	43	44	45	46	47	48	58
-	Aluminum Plant	-	-	-	-	-	240	360	360	480	480	480	480	480	600	600
11%/77/8%	General Utility	231	257	282	310	341	377	415	454	500	550	594	641	691	747	1612
		557	610	744	781	932	1220	1384	1434	1611	1674	1733	1793	1858	2049	3052
	Loss at 7%	39	43	52	55	65	85	97	100	113	117	121	125	130	143	214
	Total Load	596	653	796	836	997	1305	1481	1534	1724	1791	1854	1918	1988	2192	3266
Billions KWH																
Load Factor																
93%	Bowater Mill	0.95	0.99	1.04	1.09	1.15	1.17	1.20	1.22	1.25	1.25	1.30	1.32	1.34	1.37	1.69
90%	Price Mill	0.48	0.57	0.77	0.81	0.84	0.86	0.88	0.89	0.91	0.92	0.94	0.95	0.97	0.99	1.20
50%	Steel Plant	0.02	0.03	0.04	0.06	0.08	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.14	0.16	0.32
90%	Electric Reduction	0.28	1.02	1.02	1.02	1.58	1.58	1.58	1.58	1.58	1.61	1.64	1.67	1.70	1.73	1.73
90%	Third Paper Mill	-	-	0.17	0.35	0.36	0.37	0.38	0.39	0.40	0.41	0.42	0.43	0.44	0.44	0.53
90%	Oil Refinery	-	-	0.08	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.19	0.19	0.19	0.20	0.24
90%	Chemical Complex	-	-	0.08	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.19	0.19	0.19	0.20	0.24
90%	Liner Board Mill	-	-	-	-	0.19	0.31	0.32	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.46
90%	Aluminum Plant	-	-	-	-	-	1.88	2.36	2.84	3.32	3.78	3.78	3.78	3.78	4.26	4.73
50%	General Utility	1.02	1.13	1.24	1.36	1.49	1.65	1.81	1.99	2.19	2.41	2.60	2.81	3.03	3.27	7.06
		2.76	3.74	4.37	5.03	5.95	8.25	8.76	9.68	10.46	11.21	11.54	11.75	12.15	13.00	18.21
	Losses at 7%	0.20	0.26	0.31	0.35	0.42	0.58	0.61	0.68	0.73	0.79	0.81	0.83	0.85	0.91	1.27
	Total Load	2.96	4.00	4.68	5.38	6.38	8.83	9.37	10.36	11.19	12.00	12.35	12.58	13.00	13.91	19.48
	Load Factor	0.567	0.699	0.671	0.735	0.763	0.772	0.739	0.771	0.741	0.766	0.760	0.754	0.746	0.724	0.681

3A

TABLE 5-3

LABRADOR

ELECTRICAL LOAD FORECAST

Year	Megawatts	Millions** Kilowatthours
1968	210	1288
1969	260	1594
1970	281*	1723
1971	298	1827
1972	318	1950
1973	335	2054
1974	355	2177
1975	376	2306
1976	398	2441
1977	422	2588
1978	475	2913
1979	503	3084
1980	533	3268
1981	565	3465
1991	1013	6212

* 6% growth rate
** 70% load factor

Source: Atlantic Development Board

 TABLE 5-4

NEWFOUNDLAND AND LABRADOR

ELECTRIC SYSTEM GROWTH FORECAST

December	1971	-	Two 150 Mw oil-fired thermal units located at Holyrood.	
May	1972	-	First Churchill Power Block	- 360 Mw
September	1974	-	Second Churchill Power Block	- 360 Mw
November	1976	-	Third Churchill Power Block	- 360 Mw
November	1979	-	Units 7 and 8 at Bay D'Espoir	- 225 Mw
November	1981	-	Fourth Churchill Power Block	- 360 Mw
November	1984	-	Units 9 and 10 at Bay D'Espoir	- 225 Mw
November	1987	-	Fifth Churchill Power Block	- 360 Mw
November	1991	-	Sixth Churchill Power Block	- 360 Mw

Source: Atlantic Development Board

TABLE 5-5

6 GENERAL CONSIDERATIONS OF POSSIBLE CHANGES IN SPECIFIC DEMAND AND WASTEWATER

At the present time some of the larger industries in Newfoundland use higher than average volumes of water, and the scattered population in rural areas uses considerably less than the Provincial average. Between these extremes, the use of water for industrial, municipal, and domestic purposes seems to be related to the amount available from the existing supply.

The misconception which has prevailed that water is an unlimited natural resource inevitably results in its indiscriminate use for waste releases to the inland waters or the sea, and to increasing pollution. Only in a few places has this reached serious levels, such as the St. John's area where the general public is becoming concerned, and the Exploits River where a conflict exists between use by industries and the fishery (Volume Six A, Part I).

A general discussion on the possible future changes in the withdrawal water demand and wastewater disposal pattern is given in this section, as a starting point for the discussion on future water demand included in Sections 7 to 16, and 21.

6.1 Approach

The methodology of assessing industrial water demand was already discussed in Section 2.1. It has been shown that assessment of possible changes in specific water demand can be obtained either by the use of models or by statistical analysis of data from areas with a more advanced technology and/or with greater competition for the use of the available water. As indicated, model construction was considered outside the scope of this study. Only statistical analyses based on the 1963 US Census data could be used to any extent for such purposes; some of the results obtained are discussed in the sections on water demand by various industries (Sections 7 to 16). The discussion included in this section is mainly centered around the presentation of a few general indications on specific water demand variation as shown by the above-mentioned statistical analysis and also by the water usage data for the Island and other areas for which data were available. Since the data available for the statistical analyses represented regionally averaged figures, and since the restricted number of data did not permit a more sophisticated analysis to permit the assessment of the separate influence of each factor, the comments included in the following sections must be considered as preliminary.

It is also obvious that the results obtained for the United States cannot be applied to the Province's conditions without further investigation. In this section a few areas where changes in technology may significantly decrease or increase the water demand are also pointed out. Indications of the significance of technological changes in the variation of water demand can be found in the US Department of the Interior publication - The Cost of Clean Water, Volume III[1], some of which are included in this section. It should be kept in mind that the numerical data included in the discussion are intended to indicate the order of magnitude of the possible changes only, and should not be used for actually computing such changes for specific conditions except as rough estimates for preliminary planning purposes of a regional nature.

6.2 Effect of Water Availability

Almost invariably the statistical analysis has indicated an increase of water usage in the United States with the increase in water availability measured as volume of runoff per capita, although there are some exceptions. The magnitude of the reduction is dependent on the industry. For example, in the case of the food industry, other conditions being equal for a reduction to a half of the water available, the specific process water usage decreased by 2.5 gallons per dollar of value added at an average process water demand of 21 gallons per dollar of value added. In the pulp and paper industry the statistical analysis indicates a reduction in the process water per establishment of about 1.4 million gpd at a plant using 20 to 50 million gpd for each reduction by a tenth of a unit in the water availability expressed as runoff in inches per year per person per square mile, other conditions being similar. In actual fact, the new pulp and paper mill at Come By Chance, which is located in an area where fresh water resources are limited, is designed to work with a specific water intake only about 20 percent of that of the pulp and paper mill at Grand Falls*, where there is no shortage of water at the scale of the pulp and paper mill needs.

In some cases, total water usage can be decreased by reducing excess demand, water wastage, leakage, and evaporation. Other reductions can be obtained by recirculation and re-use, and especially by changes in technology.

* This is valid for the specific usage at Grand Falls which includes water usage for wood handling. If this usage is excluded, the specific water demand at Come By Chance represents 60 percent of the usage at Grand Falls.

6.3 Scale Effect

In some industries the statistical analysis has revealed trends of decreasing specific usage that is usage per unit of output, measured as value added. However, the scale of output measured by value added hides differences in technology and degree of integration. It was found that operations of apparently the same scale experienced considerable variation in specific water usage. A good example is the oil refining industry. On closer examination newer plants were discovered to have higher specific water demand as a result of this increased complexity.

Moreover, in the chemicals and allied products, meat and slaughtering, primary metals, and machinery industries, the statistical analysis has indicated that specific water usage is increasing. Consequently, generalized assumptions as to the relationship between specific water usage and scale of production may be misleading. Detailed analysis of specific water usage data and the technologic process involved should be made before any conclusions are drawn as to changes in specific water usage resulting from changes in the scale of output.

6.4 Costs and Other Restrictions

Cost figures for water are not included in the US Department of Commerce Census of Water Use in Manufacturing[5]. The only case for which some statistical data on costs and water usage were available was for a limited sample of fish processing plants in the Atlantic Provinces. The analysis of this sample indicates, as shown on Figure 10-9, that cost is a significant factor in water usage in this industry. A plant paying 30 cents per 1000 gallons will use 0.25 gallons per pound of fish less than a plant paying 20 cents per 1000 gallons, and one gallon per pound less than a plant paying 10 cents per 1000 gallons. The average usage per pound of fish (input) is 2.5 gallons.

6.5 Changes in Technology

These can account for important changes in water use and waste releases (both increases and decreases). Important technologic changes which may affect water usage include those related to cooling and transportation. Changes from fresh water cooling to salt water cooling can significantly affect the fresh water demand for an industry, and could provide more flexibility in locating the industry. Further changes from water cooling to air cooling (considered for example in the oil refinery industry) can drastically reduce the overall water usage[1]. Volume III of the US Department of the Interior series on the Cost of Clean Water[1] includes a series of details on variation of wastewater amounts and, by implication, of intake water demand for different types of industries, some of which are summarized in Table 6-1. As indicated by the data included in the table, while new technology is generally associated with reduction in water usage, some processes and industries (especially the steel making processes) use increasing amounts of water in the newer technology.

6.5.1 Use of Seawater

In recent years changes in technology have enabled increased use of seawater especially for cooling and transporting materials such as fluming.

The use of seawater for cooling is widespread in many industries. Future possible uses of seawater for cooling in the Province are in thermal power production, oil refining, and aluminum production industries. In using seawater the advantages of conserving fresh water and avoiding river pollution (especially thermal pollution) have to be weighted against the following disadvantages.

a) The need for using special alloys and linings for the surfaces coming in contact with seawater, to avoid corrosion and other undesirable effects due to the chemistry of seawater.

b) The need for using special additives to the water to avoid chemical, bacteriological, and biological degradation of water tracts. This can be expensive and may also pollute the seawater, a possible problem when the wastes are released in an estuary or embayment (Volume Two B, Part VI).

c) The need for using two series of intakes and separate distribution, and sometimes separate wastewater treatment systems when both fresh and seawater are used.

Seawater has been used primarily for fluming in the fish processing industry in Newfoundland. Apart from the problems mentioned above, in this case the problem of bacteriologic quality is paramount since in many cases the fish processing plants are located on estuaries or embayments which present advantages as harbours. Possibilities of bacteriologic pollution from the fish processing plant wastes, the wastes of the adjacent community, ships, or other sources are always present, therefore the treatment of the seawater seems to be a necessary measure in such cases. Keeping in mind that the nature of the pollutants for which treatment needs are difficult to establish and which may change rapidly, the advantages of using seawater for fluming in the fish processing industry appear questionable.

6.5.2 Changes in Hydraulic Transportation

The average volume of water used by an establishment or industry depends on whether dry or hydraulic transportation practices are used. For example, wood transportation from the forest to the mill, which is basically a non-withdrawal water use activity, can become a user of withdrawal water if transportation by means of wood chip piping is introduced. This in turn can affect the water quality. Log driving may have some effect on water quality for which there is no satisfactory treatment. On the other hand, water used for chip piping can easily be treated if necessary. Water demand for chip transportation can easily be estimated, knowing that the ratio of chips to water is of the order of 1:1.5.

Changes in technology which could affect the water demand in the Province in a significant way are those related to the increased use of hydraulic transportation in mining. Such transportation is already extensively used in the flotation and tailings disposal operation, but may expand into the mining operation proper (dredging). Although this was not included in the basic assumption for the study period, some data on water demand related to this problem may be useful. Table 6-2 presents data given by Brebner and Kostiuk[4] on water flow, concentration of solid matter, delivered solid tonnage, and other data regarding hydraulic transportation in the Canadian mining industry.

6.5.3 Wastes and By-Products Recovery

Technology changes in the general process, such as switching from a calcium sulphite process to a sodium sulphite process at the two pulp and paper mills in Newfoundland, may entail changes in the waste-water chemistry, and open up the possibility of a reduction in pollution by recovery of chemicals. Both plants have introduced bark recovery thus obtaining fuel for steam production at a cost much below that of conventional fuel.

In general, changes in technology related to the recovery of by-products in the wastewaters can be extremely helpful in reducing wastewater problems. It is already an accepted technique in Newfoundland to use wastes from fish processing plants to produce fish meal. This already reduces the amount of wastes from some of the fish processing plants to about 10 to 20 percent from 60 percent of the landed fish. Further by-product recovery could further improve the situation but is related to the problem of scale, since efficient operation of by-product lines can be obtained more easily in large plants.

By-products recovery and waste utilization can be considered in many other industries, as for example the use of spent sulphite liquor in the production of feed yeast, used of oil wastes for production of steam, use of warm wastewaters for heating (including greenhouse heating when a nearby market for agricultural products exists). In examining the economic efficiency of by-product recovery, consideration has to be given to water management problems in the manner discussed in Section 6. 7.

6. 6 Increase in Productivity

The analysis of the US Census data has indicated that, in many cases, increased productivity (expressed as valued added per worker) is related to some reduction in specific water usage. Thus, in the fishing industry, other conditions being equal, an increase of 50 percent in productivity is related to a decrease of about 10 percent in specific water usage. Similar trends are observed in the food processing, breweries, and primary and fabricated metal products industries. However, the opposite trend can be detected in the machinery and electrical machinery industry indicating that no generalized conclusions about the relationship between productivity and water usage can be obtained, and that some industries have their particular trends in this respect, related mainly to the complexity level of the given industry.

6. 7 Water Management Policy

Water management exercised in a reasonable way can induce significant adjustments in the water usage and the amount and nature of wastewaters and pollutants. The implications of water management in this area are extremely complex and full examination of the subject would require a separate study. At the present time there is no comprehensive water management as such in Newfoundland, the water resources being used generally as the needs appear and with little or no concern for other uses. This section is therefore limited to discussion of a few basic principles to be applied in water management problems in relation to withdrawal water demand, should water management be started in the Province in the future.

One of the basic principles of water management in relation to withdrawal water demand and wastewater disposal is that the assessment of the effects of the possible changes in demand and wastewater releases has to be made from the viewpoint of the water users directly affected by such changes. In the Provinc's conditions this applies in the first place to the economics of wastewater disposal. For example, if a by-product can be obtained from wastes, the economics of the process should not be considered only from the viewpoint of the industry involved, but also of the interests of the downstream users who may get cleaner water due to the by-product recovery.

A second basic principle, significant in the Province's conditions in searching for more reasonable adjustment of water usage and wastewater releases, is related to the fact that wastes can best be handled before they have reached the receiver. This is because of the large and variable amount of water generally involved when trying to treat the receiving waters, and because of the infinite chain of reactions which the wastewaters trigger once they reach the receiver. Since wastewater treatment costs are closely related to the amount of wastewater to be treated, this also leads to the conclusion that, between two processes of almost equal economic efficiency and releasing similar amounts of wastes, the one using less water (and wastewater) should be preferred. Because of relatively abundant water availability in Newfoundland, this almost obvious principle is often overlooked. Use of separate wastewater streams, one with high concentration of wastes, the other with relatively unpolluted water (cooling water usually), should be preferred to those involving the combining of wastewaters, although the latter solution may appear more economical to the user unconcerned with pollution problems, as is often the case in the Province.

A third principle to be considered in the analysis of industrial water demand is that, from the viewpoint of the industry itself, there is a point where the amount of water made available reaches an optimum and that further increases may even be detrimental to the interests of the plant itself.

For a better understanding of this argument, it is sufficient to consider a plant which uses water for fluming. After achieving the correct amount to ensure the proper water-product mix and the required velocity, further increases of water volume leads to increased costs. The tendency of many plants to overstate their needs is related to their desire to have water in critical drought periods and to ensure the possibility of expansion. If these problems are clarified in the context of a water resources management plan, it is probable that most industries would be ready to consider a more reasonable water supply.

A fourth principle to be considered in Newfoundland is related to the fact that search for better water utilization should not always be oriented towards the use of less water and lower quality of water. Since, in spite of some problem areas, water is available in sizeable amounts throughout the Province, when increased use of available water can contribute to a more efficient industrial process, it should be encouraged. Examples would be the use of water for wood chip transportation in pipes, or hydraulic mining.

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VARIATION OF INDUSTRIAL WASTEWATERS WITH CHANGES IN TECHNOLOGY (Average Figures)

Industry	Type of Operation	Unit of Product	TECHNOLOGY LEVEL: Older (gallons per unit of product)	Today's Typical	Newer
Pulp	Wood handling	ton	19,000	3,400	1,700
	Pulping - groundwood		7,000	-	2,000
and	Sulphate		20,300	5,600	4,600
	Sulphite		14,600	10,900	6,300
Paper	Semi-chemical		12,000	7,000	-
	Pulp screening		9,000	5,000	0
	Pulp washing		9,000)	6,900)	2,700
	Pulp thickening		14,000)	)	
	Bleaching		44,000	-	9,000
	Paper making		32,000	-	7,500
Oil	Crude oil and product storage	barrel	4	4	4
Refining	Crude desalting		2	2	2
	Crude fractionation		100	50	10
	Thermal cracking		66	2	1.5
	Catalytic cracking		85	30	5
	Reforming		9	6	6
	Polymerization		300	140	not used
	Alkylation		173	60	20
	Dewaxing		247	23	20
	Hydro-treating		1	1	8
	Drying and sweetening		100	40	40
Textiles	Wool scouring and finishing	pound	78	65	62
	Cotton finishing		50	38	35
Steel	Blast furnace	ton	2,560	2,000	2,500
	Rolling mills (hot)		3,700	4,200	5,700
Mills	Coke plant		3,260	3,000	3,100
	Integrated mills		9,850	9,900	13,750

Source: "The Cost of Clean Water", Volume III.

TABLE 6-1

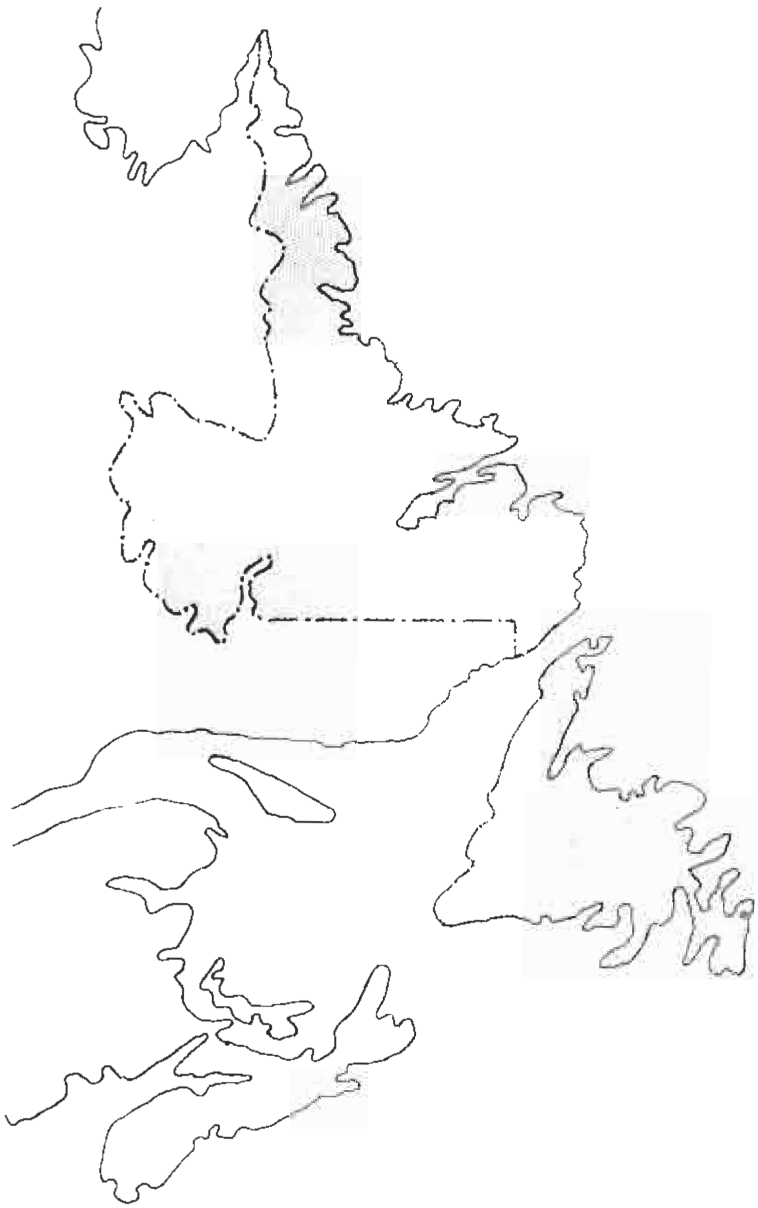
EXAMPLE	SYMBOL	UNITS	BUCHANS 1	BUCHANS 2	BUCHANS 3	CHIBOUG 1	CHIBOUG 2	CHIBOUG 3	NORANDA 1	NORANDA 2	NORANDA 3	STANROCK 1	STANROCK 2	DENISON	GUNNAR	FARADAY
			American Smelting & Refining Company, Buchans			Campbell Chibougamau Mines Ltd. Chibougamau			Noranda Mines Ltd. Noranda			Stanrock Uranium Mines Ltd. Elliot Lake		Denison Mines Ltd. Elliot Lake	Gunnar Mining Ltd. Gunnar	Faraday Uranium Mines Ltd. Bancroft
Size distribution – cumulative % +10 mesh		%	22·8						1·0							
% +65 mesh		%	50·0			14·2	34·2	0·2	38·0			10·30	10·30	3·3	19·0	5·4
% +100 mesh		%	78·1			33·2	40·9	1·7	48·0	3·0	0·7	26·08	26·08	14·6		18·6
% +200 mesh		%	88·5	7·4	6·4	69·3	47·6	11·6	65·0	28·0	9·0	49·50	49·50	30·9	55·0	45·4
% +325 mesh		%	100·0	10·8	11·9									100·0		
Specific gravity of solids	S_s		2·80	4·20	4·30	2·80	3·0	4·20	3·80	3·80	3·80	2·70	2·70	2·80	2·70	2·68
Specific gravity of mixture	S_m		1·15	1·16	2·16	1·54	2·0	1·216	1·86	1·26	1·42	1·233	1·941	1·25	1·35	1·23
Volumetric pulp concentration	C_v	%	8·5	5·0	35·0	30·0	50·0	6·75	30·5	9·3	15·0	13·7	55·4	13·9	20·6	13·8
Estimated critical velocity of mixture	u_c'	fps	14·0			5·1	8·6	5·5								6·0
Operating temperature	T	°F	32 – 70	seasonal	seasonal	48	54	48	50 – 70	50 – 70	50 – 70	70	75	70	70 – 76	80
Type of pipe			steel	steel	steel	rubber	rubber	rubber	rubber	steel	rubber	steel	steel	woodstave	rubber	B.I. tubing
Length of pipe	L	ft	13000	77	55	70	74	34	40	31	32	467·5	128	3200	90	60
Nominal pipe diameter (V, vertical ; H, horiz.)	D	in.	8	4	6	5	4	4	4	8	6	$7\frac{5}{8}$ V ; 8 H	$7\frac{5}{8}$	10	4·5	6
Static discharge head	h_s	ft of water	256	20	37	20	22·5	23·3	12·5	22·75	20	263·5	51	201	60	50
Estimated friction gradient	i_m	ft of water/ft	0·09	0·025	0·030	0·034	0·115	0·051				0·041	0·08	0·014		
Total dynamic head (static + friction)	H_t	ft of water	1306	22	39	22·4	30·0	24	18·0	23·0	21	269·5	61	241	60·5	60
Number of pumps (series (S) or parallel (P))			10 S	1	1	1	1	1	1	1	1	2 S	1	2 S	1	1
Impeller type			closed	open	open	closed	closed	closed	standard	standard	standard	closed	closed		open	closed
Mean flow velocity	u_m	fps	15·7	3·5	1·8	5·05	8·8	5·45	7·92	8·9	8·75	4·35 V ; 4·5 H	2·46	5·09	12·3	5·0
Type of drive			"D" belts						Texrope	Texrope	Texrope	belts	belts	"D" belts	belts	belts
Actual flow rate	Q	cfs	5·46	0·305	0·365	0·702	0·78	0·48	0·70	3·1	1·75	1·56	0·78	2·78	1·4	1·0
Operating speed of pump	S	rpm	975	1180	1100	737	971	1275	850	850	600	1150	1300	945	1060	990
Total H.P. input at operating speed	HP	H.P.	#1200	#7·5	#20	*13	*28	*6·5	#20	#50	*18·5	*113·3	*61·1	#220	*17	*17
Delivered solid tonnage		tph	146	7·2	61·6	66·2	122	15·3	91·5	123	112	65·5	131	121	87·5	43·2

#Motor rating H.P
*Actual measured H.P. input

Source: Dr. A. Brebner and P. Kostuik,
The Hydraulic Hoisting of a Magnetite Slurry

DATA ON TRANSPORTATION OF SOLIDS BY PIPELINE IN CANADA

TABLE 6-2



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COMMODITY PRODUCING SECTORS - RESOURCE BASED

PART III

PART III - COMMODITY PRODUCING SECTORS - RESOURCE BASED

7 MINING, QUARRYING, AND BENEFICIATION

7.1 The Resource

7.1.1 Island of Newfoundland

Mineral occurrences on the Island, as shown on Figure 7-1 and Table 7-1, are abundant, but only a few have known commercial or potentially commercial value. With the closure of the Wabana Mines on Bell Island in 1966, it is not expected that any further iron mining will take place on the Island during the study period. All iron ore mining is now concentrated in Labrador, and all other forms of mining, at the present time, take place on the Island.

7.1.1.1 Metallic Minerals

Ore deposits in a number of areas support a number of mines producing copper, lead, and zinc. These three metals form the basis of commercial mining operations in Newfoundland.

Copper has been mined on the Island since the mid-nineteenth century. All the copper produced comes from sulphide deposits, the occurrences of native copper not being of commercial value. With the possible exception of the Buchans deposits, the sulphide ores are in Ordovician volcanic rocks. In some ways, they are geologically similar to the rich Bathurst, New Brunswick area.

This similarity is important because many Bathurst deposits were discovered by intensive geochemical, geophysical, and geological exploration. Those ore bodies on the Island were discovered by investigations of the surface exposures of mineralized rocks. The intensive application of modern prospecting techniques could very well result in the discovery of new ore bodies of commercial value.

The following comments pertain only to producing deposits or to deposits with known commercial value. Exhausted deposits are omitted.

Avalon Peninsula

There are numerous occurrences of copper sulphides but none are of known commercial value.

Notre Dame Bay

More than half the known copper deposits are found in this area. The Little Bay Mine, which operated in the late eighteen hundreds, was reopened by the Atlantic Coast Copper Corporation Limited in 1961. The Gull Pond deposit was discovered in 1905 but did not come into production until 1967. The deposit is controlled by Gullbridge Mines Limited and indicated reserves are substantial. The Whalesback Mine of British Newfoundland Exploration came into production in 1965, and reserves are sufficient to maintain a twenty-year production life.

North Coast - White Bay Area

A number of mines operated in this area at the turn of the century. The Rambler deposit, discovered in 1905, was brought into production by Consolidated Rambler Mines in 1964 and is anticipated to support production for a ten-year period.

The Buchans Area

Known mineral deposits are concentrated in the Red Indian Lake area. This area includes the American Smelting and Refining Company's zinc-lead-copper deposits being mined at Buchans, with a life expectancy of about ten more years. The new potential at Tulk's Pond is covered under the zinc section.

West Coast Area

The occurrences known in this area have no known commercial value.

Lead and zinc deposits are widely scattered across the Island; and while only a few are of commercial value, the ones which are mined are of considerable importance to the provincial economy.

Avalon Peninsula

Mining has taken place at various times in the past but deposits are not considered to be of commercial value today.

South Coast and Interior

Deposits of varying size occur in this area but most are not known to have commercial value. The known lead-zinc vein deposits in the Bay D'Espoir area are not considered commercial; however, they occur in a belt of Ordovician and Silurian sedimentary rocks which have not been extensively prospected.

The Tulk's Pond's zinc-lead-copper-silver deposit, although small, has important implications. This deposit, optioned by ASARCo, lies south of Red Indian Lake and was discovered in 1963 through geochemical investigations. Because it lies in Ordovician rock geologically similar to the rich Bathurst area discoveries, its discovery cannot be over-emphasized.

West Coast

A number of minor deposits are found in the area. Newfoundland Zinc Mines Limited has a potential zinc deposit near Daniel's Harbour. Of the four occurrences, three have an estimated combined tonnage in excess of 500,000 tons averaging between 5 percent and 10 percent zinc content.

Northeast Coast

A number of deposits occur in the area but none are of known commercial value.

A deposit of tungston (wolframite) has been discovered in the Grey River area controlled by ASARCo. Depending on the market price, the deposit is considered sufficient to support a small but profitable operation.

The gold and silver produced from Newfoundland deposits are by-products of copper, lead, and zinc refining. While some natural deposits of these metals exists, they are not of commercial value.

The following metals are those with known deposits but with no known commercial value:

Antimony Arsenic Beryllium Bismuth Nickel

Some metals occur in considerable quantity but their commercial value is either undetermined (molybdenum and titanium) or their development is restricted by reason of not being competitive (chromium and manganese).

7.1.1.2 Non-Metallic Minerals

Magnesite is the only non-metal occurring in considerable quantities in the Gander River area, but is considered unlikely to be developed commercially.

There are a number of areas on the Island which are considered favourable commercial occurrences of asbestos. Small asbestos deposits are found in most of the ultrabasic rocks of the Island. These ultrabasic rocks trending north-northeast are an extension of the Appalachian serpentine belt which contains the principal asbestos deposits of Quebec and Vermont.

Deposits exist in the Hare Bay area; between Bluff Head and Bay of Islands; in the Burnt Hill area of the interior; in the Gander Basin; and in the area between White Bay and Notre Dame Bay. It is in the latter occurrence, at Baie Verte that Advocate Mines operates the only commercially developed asbestos deposit.

Fluorspar (fluorite) is found in several localities on the Island, but only the deposits at St. Lawrence on the Burin Peninsula are considered to be of commercial significance.

Gypsum and Anhydrite deposits are all in the St. Georges Bay area and are estimated to have a combined reserve in excess of one billion tons. Only one deposit, at Flat Bay, has been commercially developed.

Pyrophyllite occurs in several places on the Island, but only the Conception Bay deposits are considered to have commercial value.

7.1.1.3 Structural Materials

Three main groups of structural materials occur on the Island.

Various grades of shale and clay are found throughout the Island. Many of the deposits contain pebbles which make the material unsuitable for manufacturing purposes. The Lower Ordovician shale beds on Random Island have been the primary source for the past twenty years. The reserves are adequate for the foreseeable future.

Limestone deposits occur in many parts of the Island. At the present time, only the deposits on the west coast, Corner Brook area, have been developed on a large commercial scale.

Widespread deposits of good quality sand and gravel occur on the Island. The most extensive deposits are in the Humber Valley.

7.1.2 Labrador

The richest and most significant known mineral deposits are the iron ore occurrences in Labrador. Iron formations occur extensively in the Pre-Cambrian sedimentary, volcanic, and metamorphic rocks of the Labrador trough. One hundred and fifty miles of this north trending, 40-mile-wide belt, lies in Labrador.

There are two major iron ore mining developments in Labrador, one in the Schefferville area and one in the Wabush area. In the first area, over forty ore bodies have been outlined, varying in size from one million to over fifty million tons each. In the latter area, it is estimated that over 20 billion tons of ore exist that are suitable for open pit mining, of which about one-third lies in Labrador.

In the early 1950's, uranium in pitchblende was discovered about 10 miles south-southwest of Makkovik. Uranium was also discovered at nearby Kitts Pond, about one mile from tidewater which is considered of sufficient grade to support a small mining operation. It is generally believed that uranium deposits in the area are of commercial importance.

No information is presently available on non-metallic deposits of commercial value in Labrador.

For a description of the geology of Labrador and the known mineral deposits, see Volume Two A, Section 4.

7.2 Present Day Conditions

The primary mining sector includes mining activities to the first level of beneficiation, that is to the concentrating and/or pelletizing stages. Separation of activities which are essentially mining from those which are the first steps of refining is impossible because of the integrated nature of the operations.

Table 7-2 shows the location and type of mining activity which occurs in the Province.

It is interesting to note that between 1951 and 1965, the position of Labrador and the Island, in terms of value of production, has completely reversed. In 1951, Labrador accounted for less than 25 percent of the value of production; by 1965, Labrador accounted for 78 percent of the value of mineral production. Furthermore, in this period the value of mineral production rose from $32 million to $208 million.

In terms of the net value of commodity production in the Province, the net value of mineral production has risen from about 17 percent of the total net value in 1951 to just over 25 percent in 1963 the last year for which figures are available. This growth has been concentrated in iron ore production and iron ore growth which has taken place in Labrador.

The following table summarizes the change which has taken place since 1951:

	VALUE OF PRODUCTION			
	1951		1965	
	$M	Percent	$M	Percent
Iron Ore	9.1	28	156.9	82
Metals other than iron	19.9	61	31.3	9
Total metals	29.0	89	188.2	91
Non-metals	2.0	6	13.0	6
Structural materials	1.5	5	6.3	3
Mining Sector	32.5	100	207.5	100

7.2.1 Metals

7.2.1.1 Island of Newfoundland

Copper, lead, and zinc form the basis of the metal mining industry on the Island. The structure of the industry is such that only a few companies are involved in the operation of a relatively small number of mines. As a result, the simplest review of the present position of the industry is to highlight the operations of the companies operating the mines.

American Smelting and Refining Company - Buchans

The American Smelting and Refining Company's (ASARCo) mine is located at Buchans, approximately 5 miles north of Red Indian Lake in central Newfoundland. The property covers some 1389 square miles.

The Buchans site is connected to the Trans-Canada Highway at Badger by an all-weather road and by a privately-owned railroad which connects with the CNR's Trans-Island line at Millertown Junction. Concentrates are shipped by rail from Buchans 92 miles to tidewater at Botwood for ocean shipment. Concentrates must be stockpiled at Botwood because the port is open only seven months of the year.

The Buchans ore bodies were discovered in 1905, but efforts to establish the mining operation were not successful because of metallurgical difficulties. In 1925, ASARCo developed a method of treating the fine-grained aggregate of sulphides and the mine came into production in 1928.

The ore bodies at the site which are estimated to be over four million tons have been fairly uniform and the average grades obtained have been 15.5 percent zinc, 7.85 percent lead, 1.45 percent copper, and 0.05 oz. of gold and 3.52 oz. of silver to the ton.

The ore milled at Buchans is very complex, and the mill uses a flotation process. The first stage is to produce a bulk copper-lead concentrate from the basically copper-lead-zinc infeed, then to float the copper minerals away from the lead minerals. Tailings from the bulk flotation become the feed for the zinc flotation circuit.

The mill capacity is 1250 short tons of ore a day. The tailings are discharged into the Buchans River which empties into Red Indian Lake.

All concentrates are exported.

The company employs approximately 650 men.

Atlantic Coast Copper Corporation

The mine site is at Little Bay on Indian Bight in Notre Dame Bay. The 640 acres covering the peninsula between Little Bay and Indian Bight are the company's property. Land access to the mine is by road, 13 miles from Springdale the nearest town, and 58 miles from Badger, the nearest railway station. Concentrates are shipped by sea from the company's loading dock at Little Bay.

The deposit was discovered in 1878 but it was not until the present company assumed control in 1956 that an extensive diamond drilling program was carried out. The company has not reported its reserves since 1961 when they were 1.5 million tons, averaging 2.1 percent copper.

The copper content per ton of concentrate has ranged between 24.0 percent and 28.1 percent. The gold content is about 0.065 oz. per ton.

They use a standard flotation circuit to produce the copper concentrate. The mill is designed for a capacity of 1000 tons of ore per day. Production difficulties were encountered because of excessive dilution which reduced daily throughput to between 800 and 900 tons per day. However, with ore being developed below the 1350-foot level, it is expected that dilution will be less.

The concentrates are trucked to storage sheds at the loading dock at Little Bay for shipment to the smelter at Gaspe, Quebec.

The company employs approximately 160 men.

British Newfoundland Corporation Limited (BRINCo), Whalesback

The Whalesback mine is located on Halls Bay, 6 miles by road from Atlantic Coast Copper Corporation's Little Bay Mine. The property is part of a 754-square-mile concession held by BRINCo.

The site was first explored at the turn of the century but the deposit was not considered to have commercial value. It was not until BRINCo's subsidiary, British Newfoundland Exploration Limited (BRINEX) carried out detailed geological mapping of the area in 1957 that the commercial potential of the site was established.

As yet no results have been released on mill performance. However, the ore appears to have about a 1.75 percent copper content in an indicated reserve of three million tons.

The mill, located at the site, uses a standard flotation circuit and has a design capacity of 2000 tons of ore per day.

The concentrate is trucked to a storage shed at the Atlantic Coast Copper Limited's dock at Little Bay.

All concentrates are shipped to the Gaspé Copper Mines Limited's smelter at Murdockville, Quebec.

The company employs approximately 150 men.

Consolidated Rambler Mines Limited

The 3775-acre mine site is located near Baie Verte. A mile long private road connects the mine site, which is 13 miles by road from Baie Verte, to the La Scie - Baie Verte highway.

Sulphides were first discovered on the property in 1905 and exploration activity continued at intervals, but it was not until the early 1960's that active development was undertaken. Shafts were sunk on the Rambler zone in 1960 which came into production in 1963. In 1964, a production shaft was begun on what is known as the East Zone ore body.

The Rambler ore body with estimated reserves of 575 thousand short tons averages 1.44 percent copper, 2.03 percent zinc, and 0.21 oz. of gold per ton. The East Zone ore body with estimated reserves of two million short tons averages 1.65 percent copper.

There are two concentrators on the property - a 500-ton per day mill at the Rambler Zone site which went into production in late 1964, and a 1000-ton per day mill at the East Zone site which went into production in 1966. The mills use a flotation process.

The tails from the cleaner cells, from which the copper concentrate is obtained, form the feed for the zinc flotation circuit.

The concentrates are transported to Tilt Cove for shipment to the Murdockville smelter in Gaspé, Quebec.

The company employs approximately 250 men.

First Maritime Mining Corporation Limited, Gullbridge Mine

The 6300-acre property is located on the west shore of Gull Pond. A 20-mile road links the site with the railway station at Badger. There is a deep water harbour site 17 miles north of the property at South Brook on Halls Bay.

The Gullbridge deposit was discovered in 1905. In the 1950's, an extensive surface geology and diamond drilling program was carried out by Falconbridge Nickel Mines Limited, who had an option on the property at the time. Active development of the property was started in 1963 by the First Maritime Mining Corporation Limited.

The ore body is estimated to be in excess of four million tons with an average 1.43 percent copper.

The mill uses a flotation process and has a daily capacity of 1500 tons.

The company employs approximately 250 men.

7.2.1.2 Labrador

The iron ore mining is concentrated in Labrador and is covered by reviewing the activities of the two mining companies operating in the area.

Iron Ore Company of Canada, Carol Lake Operation

The Carol Lake deposits are 192 miles north of Seven Islands, Quebec, and are joined to the Quebec North Shore and Labrador Railway at Ross Bay Junction by a 40-mile spur line. The company's town site at Labrador City is serviced by an air strip built jointly with Wabush Mines.

Exploration of the 250-square-mile lease began in 1949, but it was not until 1956 that extensive exploration and development started. In 1959 major construction was undertaken; this included mining, milling, concentrating, service, and housing facilities at Labrador City. Construction of the pelletizing plant was started in 1961. The Carol Lake operation began in mid-1962 with the first concentrate shipment. The shipment of pellets began in the spring of 1963.

The mine site is at the Smallwood deposit which is roughly five miles north of the concentrator. A second site known as Carol East supplements production from the main deposit. Ore is moved from the mine sites to the concentrator by an automated railroad 7.5 miles to the crusher and beneficiating complex.

The Carol Lake concentrator is designed to produce 7 million long tons of high grade concentrate (62-63 percent iron) annually. According to the questionnaires circulated during the data collection program in the autumn of 1967, the annual capacity of the concentrator was expanded to ten million long tons in January 1968. The pelletizing plant had a capacity of 5.5 million long tons which was expanded to 10 million long tons in January 1968.

The concentrating is a highly automated gravity separation process, and the entire installation is operated from three control rooms: crushing, grinding, and concentrating. The pelletizing plant, which receives its infeed from the concentrator, produces 3/8 inch pellets which are hardened at temperatures of up to 2,400 deg. F.

All concentrates and pellets are shipped by rail to Seven Islands for water shipment.

Employment in 1965 and 1966 was over 1000 men.

<u>Iron Ore Company of Canada (Schefferville Operations)</u>

The Knob Lake deposits of IOCo lie within a 40-mile radius of Schefferville, Quebec, and part of this deposit is located in Labrador. The company's town at Schefferville is connected to Seven Islands by a 356-mile line operated by IOCo's subsidiary, the Quebec North Shore and Labrador Railway. An airstrip near the town provides scheduled flights to Seven Islands and Montreal.

There are forty-three separate deposits in the area which were estimated in 1964 to exceed 360 million tons of which approximately 114 million tons are in Labrador.

The first shipment from Schefferville was from the Ruth Mine Labrador deposit in mid-1954. The other Labrador deposit is known as Wishart No. 1 and came into production in 1960. The ore mined is a direct-shipping ore and requires only sizing on grizzlies and crushing.

The normal shipping season for the direct shipping operations is mid-April to mid-November. Shipments from 1961 to 1965 were 4.4, 5.1, 3.4, 3.7, and 2.9 millions of long tons. Sixty to seventy percent of the ore shipped from Schefferville goes to the United States. The balance is consumed in Canada and Western Europe.

The company employs over 1800 men in its Labrador operations.

Wabush Mines, Labrador

Wabush Mines lease three properties in Labrador: the 5.6-square-mile Wabush deposit, the 3.9-square-mile Wabush Mountain area, and the 5.9-square-mile Knoll Lake area. The deposits lie approximately 37 miles west of the Quebec North Shore and Labrador Railway to which they are connected by a spur line. Regular scheduled flights connect Wabush with Montreal and Seven Islands.

Wabush Mines' firm reserve estimates are not available but government geologists estimate the deposits to contain over one billion long tons of crude ore. Proven reserves are sufficient to support a 5-million long ton concentrating operation for the next forty years.

Construction at the Wabush deposits began in 1962 and included mining, milling, concentrating, service, and housing facilities at Wabush Lake. The Wabush concentrates are pelletized at Pointe Noire, Quebec. The operations came into production in 1965.

The mill capacity is 5.3-million long tons of high grade (66 percent iron) concentrate annually. The operation is highly automated and is operated from a single control room.

The concentrate is shipped to Pointe Noire by rail.

The company employs approximately 1000 men.

7.2.2 Non-Metals

Advocate Mines Limited

This company holds a 207-acre mining lease in the north-eastern part of the Burlington Peninsula between White Bay and Notre Dame Bay, and the asbestos deposits four miles from Baie Verte. The mine is linked by a 50-mile secondary road to the Trans-Canada Highway. A dock at the mine site provides water transportation facilities. The concentrate is shipped by sea. The shipping season is limited because of ice conditions.

The asbestos mine came into production in mid-1963 and by 1966 accounted for 72 percent of the value of non-metallic production in the province. The deposit contains proven reserves estimated to be in excess of 38.5-million tons. The mining is an open pit operation.

There is a 5000-ton per day mill on site capable of producing 60,000 tons of product annually. Nearly all the output is exported.

The company employs approximately 400 men.

Newfoundland Fluorspar Limited

Newfoundland Fluorspar Limited is a wholly owned subsidiary of Aluminum Company of Canada. The mine is located one and a half miles west of St. Lawrence on the Burin Peninsula. Access to the mine is by water or by a 120-mile secondary highway which links up with the Trans-Canada Highway. No accurate reserve figures are available, but estimates place the area's reserves in excess of 20 million tons or about one-third the known world reserves.

Initial concentration is done on site at the heavy-media separation plant which has a rated capacity of 100,000 short tons of output a year. All production is shipped to Arvida for further concentration.

Newfoundland Minerals Limited

All mining of pyrophyllite is carried out by Newfoundland Minerals Limited, a subsidiary of American Olean Tile Company. The total production of crude pyrophyllite is shipped in bulk to the United States.

The property is near Long Pond, on Conception Bay, and is commonly referred to as the Manuel's deposit. No details concerning the reserves are available other than that they are termed adequate.

A crushing mill capable of handling 200 tons of pyrophyllite a day is located adjacent to the mine.

The company employs about 55 men.

7.2.3 Structural Materials

In 1965, the structural materials, clay products, cement, sand and gravel, and stone contributed just under three percent of the total value of mineral production of the Province.

1965 Value of Structural Materials

Clay products	$ 72,717	
Cement	1,987,220	
Sand and gravel	3,785,071	
Stone	496,590	
Total	$6,341,598	100 percent

Since 1951, one company, C.M. Pelly Limited has accounted for the entire production of clay products, and operates a brick plant at Milton, about six miles north of Clarenville. Until 1954, the plant used a soft mud process in the production of brick, and the clay was obtained from a pit adjacent to the plant. Since 1954, the plant has used a dry-press process which uses shale rather than clay. The shale is quarried on Random Island, and the reserves are considered sufficient for many years. The operations are seasonal, with the plant operating from March to November.

Cement production is concentrated in the Corner Brook area at the Humbermouth plant of North Star Cement Limited, who supply all provincial demands and also ship to the Maritime markets.

The company operates three stone quarries, two for the production of limestone (actually marble) and one produces shale, all within a mile of the mill. Reserves of both limestone and shale for the production of cement are considered adequate for many years.

The plant now uses a wet process and plant capacity has been expanded to 860,000 barrels or 226,000 short tons a year.

The plant employs about 80 men, and the quarries about 20.

The demand for sand and gravel, and for crushed stone, stems primarily from road construction and repair activities. Information on individual operations are not available. The location of active pits varies from year to year, depending on where major construction projects are centred.

In 1965, the total mineral production of the Province was valued at $207.6 million: metals contributed $188.2 million, of which iron ore was $156.9 million; non-metals contributed $13 million; and structural materials contributed $6.3 million. The net value of production for the mining sector in 1965 was $122.8 million or 62 percent of the gross value.

7.3 Potential and Planned Developments

Development of the mining sector depends on the level of international demand, expansion policies of mining companies, the rate of resource depletion, exploration programs, and government policies in areas such as mineral rights and depletion allowances. For mines supplying captive or open markets, industry costs in terms of capital, labour, and transportation must be competitive within the international framework.

At the same time, rapid technological developments, in terms of new uses for metals and the substitution of synthetic materials in certain traditional markets make it difficult to estimate in qualitative terms the size and composition of potential markets ten and twenty years from now.

Some indication of the problem is illustrated in Figures 5-5A, B, C, and D, which shows copper, lead, and zinc production for the world and selected countries. While most countries have tended to reflect the trends of total world production, Japan's growth has been much steeper than one would expect on examination of the world trends, which reflect aggregate evolution.

The forecasts for individual metals, contained in this section are based on the Canada Department of Mines study[1]. Special considerations in terms of markets or production limitations noted in the study are included under the discussion of the individual metal concerned.

The forecasts contained in this section are stated in terms of 1965 dollars. Wherever possible, historical data are shown in terms of both current and 1965 dollars. For the historical period the 1965 dollars were obtained by applying the average 1965 price per ton to the reported volumes of production.

The outlook for the mining sector during the forecast period is somewhat mixed. On the aggregate basis the mining sector outlook is extremely strong, but on examination it is apparent that the growth is concentrated in iron ore production which will occur in Labrador, with only an indirect effect on the Island.

All other mining activity is located on the Island where the forecasts for non-ferrous output are relatively static. (Figure 7-4)

Forecasts for copper, lead, and zinc rest on the fundamental assumption that, as reserves of producing mines are exhausted, new mines on adjacent sites will be brought into production at a rate sufficient to maintain past levels of production.

Although increasingly scientific exploration is being undertaken on the Island, no major new developments of copper, lead, and zinc bodies have been considered.

7.3.1 Metals

Copper mining activity in Newfoundland from 1951 to 1965 and the forecasted level of production to 1981 for both volumes and values are contained in Figure 7-4a.

The pronounced jump in the level of production between 1957 and 1958 is explained by the First Maritime Mining Corporation Limited's mine at Tilt Cove being brought into production. The Tilt Cove mine ceased production in 1966, but this loss was offset by two new mines, Atlantic Coast Copper Corporation Limited's Little Bay mine, and Consolidated Rambler Mines Limited's Baie Verte mine. First Maritime Mining Corporation Limited's Gull Pond mine came into production in 1967.

The Canada Department of Mines' forecast [1] of copper concentrate production, on the basis of the British Newfoundland Exploration Limited's new mine at Whalesback, expected an increase in production from just under 20,000 short tons to over 25,000 short tons in 1966. However, preliminary estimates indicate that such an increase did not take place which could mean an extension of the life of the Whalesback mine beyond 1975.

The American Smelting and Refining Company's mine at Buchans was the only copper producer on the Island until 1957, and in the Canada Department of Mines' forecast [1], it is the only existing mine which will be producing after 1975. Between 1970 and 1975, a number of producing mines are scheduled to close unless further reserves are discovered. As a result, no forecasts were made for the following mines for 1975:

Atlantic Coast Copper Corporation, Little Bay
Consolidated Rambler Mines Limited, Baie Verte
BRINCo, Whalesback
First Maritime Mining Corporation Limited, Gull Pond

It is expect ed that some new reserves will come into production to replace the depleted reserves, but they will not be sufficient to maintain the peak reached in 1970. The high and low forecasts for 1970 are 40,000 and 30,000 short tons, and for 1975 are 19,000 and 11,000 short tons. On Figure 7-4a the high and low forecasts are shown and the two points, 1970 and 1975, have been joined. The joining of the two points is merely to highlight their relative position and does not represent the volume of activity in the intervening years. On this consideration the level volume of production of 25,000 short tons between 1971 and 1981 is not unreasonable.

Lead mining activity in Newfoundland from 1951 to 1966 and the forecasts to 1981 in both volumes and values are contained in Figure 7-4c. The forecast is for a level volume of production of 23,000 short tons over the forecast period.

At the present time only the American Smelting and Refining Company produces lead with the production concentrates at Buchans.

Zinc mining activity in Newfoundland from 1951 to 1966 and forecasts to 1981 in both volumes and values are contained in Figure 7-4b.

All zinc production came from the American Smelting and Refining Company's Buchans operation until 1964 when the initial production from Consolidated Rambler began. It is expected that Rambler's zinc bearing reserves will be exhausted by 1968 or 1969, and that the mine will become a copper operation leaving ASARCo the only zinc producer.

Because of the good potential for copper-zinc occurrences in the Notre Dame Bay area, on the west coast and in parts of the interior, the forecasts for 1976 and 1981 of 37,000 and 40,000 short tons assume that mines other than Buchans will be in operation.

In 1965, the other metallics mined on the Island accounted for just over nine percent of the non-ferrous metal production.

Cadmium is derived entirely as a by-product of zinc-lead production; and, in line with the level of zinc-lead forecasts, is expected to yield 100 short tons a year over the forecast period.

The gold production in Newfoundland is a by-product operation which depends on the level of copper production. It is not foreseen that lode gold will be mined in Newfoundland during the forecast period. On the basis of the relationship between gold and copper, gold production is forecast at 40,000 ounces a year.

Silver production is forecast at a level of 1.2 million ounces valued at $1.7 million in 1970 and 1975. This level is assumed for the study forecast period of 1971, 1976, and 1981.

Figure 7-3 shows the volume and value of iron ore production from 1951 to 1966 preliminary estimates and provides forecasts for 1971, 1976, and 1981.

The very steep growth of iron ore production reflects both demand and new productive capacities. It is assumed that major expansion programs will not continue past 1970, and that between 1970 and 1975 the trend will reflect nominal increased demand.

The cyclical movement around the trend will probably be more pronounced once the major expansion period is over and the supply capabilities change position in relation to demand. The forecasted level of production in millions of long tons for 1971, 1976, and 1981 is 26, 28, and 30.

There is a possibility that before 1981 uranium may be produced in Labrador, but there is no production at the present time and no forecasts are available.

7.3.2 Non-Metals

Forecasts for the four non-metallic minerals produced in Newfoundland (asbestos, gypsum, pyrophyllite, and fluorspar) are shown on Figure 7-5.

The rated output capacity of the asbestos mine is 60,000 short tons a year. However, in both 1965 and 1966 shipments were 65,000 short tons. The forecast from 1971 to 1981 is assumed to be 65,000 short tons of fibre a year or $11 million in 1965 dollars.

Fluorspar production is forecast to remain constant between 1971 and 1981 at a level of 100,000 short tons annually. The value of production in 1965 dollars is estimated at $2.5 million. Although deposits exist at Long Harbour (Fortune Bay), they are considered of doubtful commercial value. Under the circumstances no allowance has been made for their development. All production from the existing mine is shipped to the parent company's aluminum smelter. The introduction of an aluminum smelter on the Island is mentioned because the possibility of expanded production should not be dismissed.

Gypsum production forecasts from 1971 to 1981 were based on known expansion plans of the Flintlock Company of Canada. In 1965 dollars, the forecast for 1971, 1976 and 1981 is $2.3 million, $2.8 million, and $3.4 million. Most of the mine production is shipped from St. George's to processing plants in central Canada and the United States. However, a small portion of the output is shipped by rail to the Atlantic Gypsum Limited's plant at Humbermouth. Because only a small portion of the production is processed on the Island, it is assumed that any increase in the Island's demands resulting from an accelerated construction process will not be sufficient to alter the basic production forecasts, although it may increase the Island's consumption.

Only one deposit of pyrophyllite has commercial value. At the present time, the Province accounts for the total Canadian production of pyrophyllite. Total future production is dependent on the requirements of American Olean. The value of production in 1965 dollars is forecast for 1971, 1976, and 1981 at $740,000, $980,000, and $1,300,000.

In 1964 the Sundew Peat Moss Company began exploiting the Cochrane Pond peat bog on the Avalon Peninsula. No production figures have been reported and no operating details are available.

7.3.3 Structural Materials

In 1965 the production of structural materials accounted for just under three percent of the total provincial value of mineral production and was estimated to be $6.3 million. If all the construction developments planned for the Province, and more specifically the Island, actually take place, the forecasts quoted below may be conservative. However, sufficient specific information on construction intentions is not available to warrant upward revisions to existing forecasts.

The forecast for clay and clay products is essentially a forecast of the expansion plans of the Island's existing brick plant and shale quarry. In terms of 1965 dollars the forecast for 1971 is $300,000 and for 1976 and 1981, it is $500,000.

The forecast for cement is based on the expansion production capacity of the Corner Brook plant to 800,000 barrels in 1971 and to 1,000,000 barrels in 1976 and 1981. In 1965 dollars this would represent about $3.0 million in 1971 and $3.8 million in 1976 and 1981.

Sand and gravel production depends to a great extent on the amount of road construction undertaken. In terms of 1965 dollars the forecast for 1971 is $6 million rising to $8.4 million by 1976 and to $11 million in 1981.

Because of the closing of the Aguathuna quarry in 1964, past production of limestone is not indicative of future trends. Production of limestone will reflect the increased demands of the pulp and paper industry. The following forecasts, in terms of 1965 dollars, reflect the anticipated demand of the pulp and paper industry. In 1971 the value of production is estimated at $200,000 rising to $400,000 by 1976 and to $500,000 by 1981.

The forecasts for the mining sector are summarized in Figure 7-2. Forecasts of employment were made at the aggregate level as were the forecasts of average wages and salaries. The dollars used in the following table are 1965 dollars.

Mining Industry Forecasts

	1971	1976	1981
Value of production	$385.3 M	$412.0 M	$435.6 M
Value added	$219.0 M	$250.0 M	$287.0 M
Employment	8000	9100	10,500
Wages and salaries	$ 46.4 M	$ 59.2 M	$ 77.7 M

7.4 Specific Water Demand and Wastewater

In the mining industry, the most important specific water demand and most difficult to handle wastewaters are those related to metallic mineral mining.

As indicated in Section 7.3, future activity in metallic minerals mining will expand substantially for iron, and will probably remain fairly constant for non-ferrous minerals. Nevertheless changes in the location of non-ferrous mineral mines are expected, and this may raise new water supply and wastewater disposal problems.

The mining and quarrying operations related to non-metallic minerals and to structural materials is generally an activity which does not require significant amounts of water and is related to water resources mostly by the erosion-sedimentation problems it generates and, in some cases, by the changes it induces in a river bed when quarrying is taking place there. One notable exception is the fluorspar mining near St. Lawrence (Burin Peninsula) where the mine dewatering brings to the surface some radioactive water. However, it is possible that in the future the exploitation of non-metallic minerals will require increasing amounts of water.

The estimates of water demand for metallic mineral mining are based on the literature survey summarized in Volume Eight, Appendix B, Part VII, since the available data were not sufficient to establish statistical relationships between water demand, water availability, cost, and other factors which may influence the demand. It is assumed in the following analysis that no hydraulic mining is contemplated. As mentioned in Section 6. 5, such a change in technology could greatly modify the water demand and wastewater release conditions.

7. 4. 1 Iron Ore Mining and Concentrating - Water Demand and Wastewater Release

7. 4. 1. 1 Intake Water Demand

The literature survey (Volume Eight, Appendix B, Part VII) indicates that the water demand for mining varies between nil and 62 gallons per ton of raw ore with an average of 10 gallons per ton. Since other information is lacking, it may be assumed that the maximum limit approximates an optimum water intake demand and the average a probable water intake demand.

When the demand is for both mining and concentrating the survey indicates a range of 60 to 3820 gallons per ton of raw ore, with an average of 795 gallons per ton. Data available on the water use in the iron ore mining and concentration in Labrador indicate that the intake water is very close to the above-mentioned average, but the gross water applied is about five times larger than the intake water[2], thus approaching the upper limit of demand indicated above. It may therefore be assumed that the optimum water intake for iron ore mining and concentrating is of the order of 3500 gallons per ton of raw ore, and the probable water intake of the order of 700 gallons per ton.

When pelletizing is the next beneficiation step, the above data indicate an intake water demand of 600 gallons per ton of pellets and gross water applied of the order of 1500 gallons per ton of pellets. Since no other data were available on the water demand for this type of operation, it will be presumed in the following that the probable intake water demand for pelletizing is of the order of 600 gallons per ton of pellets.

The quality of water is not an important factor except for water required for drinking and sanitary use and boiler feed, which have to fulfill the standard requirements.

7.4.1.2 Wastewater Releases

The quantity of wastewater may be assumed equal to 96 percent of the intake water, but the mixture of water and tailings may have a significantly larger volume than the intake water.

The quality characteristics of the wastewater are hard to define, as they depend on the concentration and nature of ore and tailings, type of mining, concentrating, and pelletizing process, water quantity, and many other factors. The most important quality changes in the receiving water body are related to:

Increase in colour;
Increased turbidity;
Increase in dissolved iron and manganese;
Increased hardness;
Decrease in dissolved oxygen.

Although some chemical analyses of receiving water bodies upstream and downstream of an area of tailings disposal from a mine are available[4], these cannot be used to determine the chemical substances and sediments introduced by the wastewater, since the flows of the receiving water bodies upstream and downstream of the waste releases at the moment of the sampling are not known.

Impoundment of tailings does not normally provide adequate treatment to mine wastes to prevent serious degradation of the receiving waters. Primary treatment with chemical flocculation would appear to be a minimum level of treatment required*.

The pellet plant wastewater presents special problems since installations designed to retain as much as possible of the iron compound from the ore required further grinding of the concentrate, and this results in the increase of colloidal material discharged with the wastewaters[4]. This would indicate that, if such colloidal materials must not be released in the receiver, some form of treatment for colloid precipitation (chemical coagulation) has to be included in the tailing pond and reuse of water practised to the largest possible extent to avoid troublesome pollution.

* See comments on this subject matter in Section 1.3.1.

7.4.2 Copper, Lead, and Zinc Ore, and By-Product Mining and Concentrating - Water Demand and Wastewater Releases

7.4.2.1 Intake Water Demand

The principal water use in base metal mining and concentration is in the concentration phase which, in Newfoundland is and will presumably continue to be, a flotation process.

For considerations similar to those discussed in Section 7.4.1, it was concluded from the literature survey (Volume Eight, Appendix B, Part VII) that for each of the main base metal ores (copper, lead, and zinc), the probable intake water demand for mining and concentrating is of the order of 400 to 500 gallons per ton of ore. Unrestricted optimum intake water demand is difficult to estimate from literature data, but is apparently of the order of 1200 gallons per ton of ore for copper and probably lower for lead and zinc. Apart from other conditions which may influence the intake water demand, the ore grade is of significant importance. Lower grade ores generally require higher amounts of water for concentration, and optimum unrestricted intake demand for low grade ores probably reaches values of 4500 gallons per ton.

When several metals are found in the same ore, the intake water demand is less than the sum of the individual intake water demand for each ore. A reduction of the sum of individual demands by about 10 percent for two metals and by about 20 percent for three metals mined simultaneously in the same ore seems to be reasonable.

The questionnaires circulated to the mines have yielded only partial information on specific water demand. Thus, the Buchans mine which produces concentrates of copper, lead, and zinc, and also small quantities of gold, silver, and cadmium has a water intake corresponding to 1800 gallons per ton of ore[2]. If a water demand of some 250 gallons per ton of ore is allocated for each of the by-product metals (gold, silver, cadmium), and the reduction mentioned above is applied to the sum of individual intake demand, it appears that the indications for probable water intake demand apply well in the case of this mine.

The other two questionnaires (the mine-concentrators of Whalesback and Gull Pond) give only data on the capacity of their water supply systems and no data on their actual intake and output.

However, if the design capacities are considered, a specific water demand of 500 gallons per ton of ore is obtained for Whalesback and 1500 gallons per ton of ore at Gull Pond. The ore grade of Gull Pond is lower (1.4 percent copper) than at Whalesback, (1.7 percent copper), and this can account partially for the large difference.

The literature survey has indicated[5] some average water intake demand for the primary metals industry in a region with ample water supply (Michigan) related to the number of workers (2.7 million gallons per year per worker) and to the value added (200 gallons per dollar of value added). Comparisons with data obtained from the questionnaires indicate that these figures could be used as a first approximation of the water demand for the Province of Newfoundland and Labrador.

Water used for drinking and sanitary uses and boiler feed has to meet the required standards, and be treated whenever necessary. It should be mentioned that all the water used by the Gull Pond mine is treated by chlorination; at Buchans 18 percent of the water (used mainly for domestic purposes) is treated by filtration and chlorination, whereas the Whalesback mine uses completely untreated water.

Water polluted by "petroleum-like" substances are unfit for concentration purposes and must be treated if used. However, this type of pollution is very unlikely to occur in the waters used in the Newfoundland concentrating operations.

7.4.2.2 Wastewater Releases

The quantity of wastewater is roughly equal to that of the water intake. While depletions of the order of 4 percent or even more (evaporated water or concentrate humidity) may be experienced, wastewater resulting from mine dewatering may occasionally increase the total wastewater to an amount equal to or higher than the intake water. In addition, the tailings volume increases siginificantly the volume of wastewaters.

The polluting effects of the wastewater from mining and concentrating operations are mainly due to:

Acidity of mine dewatering water.

Turbidity resulting from the grinding and concentration processes, and also from dust control and wash out by local runoff.

Chemical re-agents used in the froth flotation.

Since sedimentation is a relatively inexpensive wastewater treatment technique, and may also result in the storage of tailings containing significant concentration of metals, it may be considered as general practice today to use a natural or artificial tailings pond for clarifying wastewaters from mining and concentrating. Besides clarification by sedimentation, pH correction and chemical coagulation can also be carried out in such ponds. In these conditions it may be assumed that most of the sediments are retained in the tailings pond, thereby protecting the receiving waters.

The base metal ion concentration is a much more difficult problem. Minute concentrations of copper, zinc, and lead have not only an adverse effect on fish, but on the whole life of the river. At a concentration of 1 to 2 ppm of copper in the River Churnet (England), life was completely exterminated and even sewage fungus was absent or very rare[8]. Similar conditions had developed in Buchans Brook[7] before corrective measures were taken.

Although the incipient lethal level of different ion concentrations of copper, lead, and zinc for different species of fish has formed the subject of numerous interesting laboratory studies[6], it is difficult to assess the long range effects of base metal concentration on fish and aquatic life, especially when several base metals are present. In addition, the concentration of base metal ions in the wastewater may differ very widely from one mine to another according to local circumstances (amount of specific wastewater, water chemistry, process used, type of ore, etc). Therefore it is extremely difficult to estimate the level of dilution required to obtain a concentration of base metal ions harmless for fish and supporting life. Nevertheless, taking into account data obtained at the Buchans mine[7] and further in the Exploits River, it may be assumed that a (five hundred fold) dilution of base metals, mine, and concentration wastewaters (after treatment in a tailings pond) would still be necessary when the intake water used is close to the average (400 to 500 gallons per each metal and ton of ore). Evidence therefore indicates the necessity for treatment beyond normal tailings separation before discharge of the wastewater.

The chemical re-agents used in the froth flotation may have significant polluting effects, but the literature survey has not yielded specific information on this subject. However, attention must be paid to the chemicals used in the concentration and extraction of gold which may contain sodium cyanides. Minute concentrations of cyanides (0.04 ppm as CN) can be fatal to fish[8].

7.4.3 Non-Metallic Minerals Specific Water Demand and Wastewater Release

Literature on water demand and waste releases for non-metallic mining and beneficiation is very scarce. Interesting comments were found in Lund[3] and these are quoted at some length:

"Water performs a large number of functions in non-metal mining and beneficiation. In mining, water may be used in large quantities to perform major functions that include floating a dredge, hydraulicking, dissolving underground material in solution mining of salt and potash, or melting underground material as in the Frasch method of sulfur production. Water may be used in smaller amounts in rock drilling, in allaying dust after blasting, and in cooling engines and other machinery used in mining, loading, and transporting ore.

"In beneficiation, water finds its greatest use. Although dry preparation methods are common in beneficiation of non-metallic minerals, as in crushing stone, dry grinding of cement, feldspar, talc, and pyrophyllite, and screening of sand and gravel, most beneficiation processes utilize water to meet product specifications for markets or for further processing. The major function performed by water is to provide a medium that allows for separation of products into grades of purity by various types of gravity methods (simple sprays for washing, spiral cones, screws, log washers, jigs, various types of classifiers, scrubbers, cones, etc), flotation methods, wet magnetic methods, and many other processes. Water also provides the medium for chemical processing of some non-metallics - as in purifying and separating saline brines and in solution and selective crystallization purification of potash. In all wet preparation methods, moreover, water serves a vital function in transporting the product through the equipment, by means of pipes and launders, with flow maintained by gravity or pumps.

"Including wet preparation methods applied to all types of metallic and non-metallic ores, gravity treatment uses 10 to 20 tons of water per ton of ore treated, and flotation methods use 3 to 5 tons.

"Another important function of water in preparation plants is dust suppression. Although methods are available for controlling dust in dry processing, water is a most effective means of minimizing this troublesome problem. It is most useful in handling dusts high in free silica, where dangers of employees' contracting silicosis are encountered.

"Finally, water serves such conventional uses in treatment plants as coolant in processing operations and for engines powering various equipment, steam generation, fire prevention, and domestic needs of the community of workers and families.

WASTE CHARACTERISTICS

Types and Sources

"Contaminants in water that is used in or results from mining and beneficiating non-metallic minerals vary over tremendous ranges - both in type and in quantity. Considering the entire industry, it can be said that the types of contaminants that are most commonly encountered and are most abundant are suspended particles of fine sand, silt, and clay, and lesser amounts of fine particles of limestone and dolomite. These result from the washing of sand and gravel, and crushed limestone - the two most widely distributed and largest water users in non-metal mining. Fines or slimes also result from the crushing and grinding of rock to produce grades and sizes of produce that meet market specifications. Quantities of solids in the water as it leaves the washing or preparation plant may vary from a few percent up to perhaps 10 or 20 percent. In sand and gravel dredging operations, waste returned to the stream may amount to as much as two-thirds of the product recovered, as indicated by a survey of 47 dredge operations in the lower Missouri River basin. A total of 6 million tons of waste was returned to rivers or streams in producing 9.5 million tons of sand and gravel."

7.4.3.1 Asbestos

The information obtained from the questionnaires[2] indicates that the only asbestos mine active in Newfoundland has a water intake demand of about 700 gallons per ton of asbestos produced.

The water is used in the proportion of 50 percent for cooling, 23 percent for general dust control, cleaning, truck washing, and 24 percent for drinking and sanitary uses, but this includes the use for a nearby residential area servicing the mine; the remaining 3 percent is used for atomizing heavy oil for dryers and boiler feed, and most of it represents a consumptive use. If the probable losses in the cooling process are considered, it may be presumed that the wastewater represents some 96 percent of the intake water. No data are given for mine dewatering in this particular case, but these may increase the wastewater amount by a few percent.

The quality of intake water must satisfy that required for the above-mentioned uses. In the specific case analysed, 28 percent of the water used for drinking and sanitary purposes and other special purposes is treated by chlorination, the boiler feed water being further treated chemically.

The wastewater can produce thermal and sediment pollution. In Newfoundland's conditions thermal pollution is probably not signigicant in this case if the water used for cooling is mixed with the other wastewaters. Sedimentation pollution can be avoided by using a tailing pond.

7.4.3.2 Fluorspar

According to the data obtained from the fluorspar mine operating at St. Lawrence, the specific demand (including process water, cooling, and sanitary uses) amounts to 1500 gallons per short ton. This specific demand appears to be high.

7.4.3.3 Gypsum

At the present time in Newfoundland, gypsum production is basically a dry process and water is used, apart from the usual drinking-sanitary purposes, only for dust control. However, it may in the future also be used for washing the ore when this has large percentages of impurities. According to the information obtained from a questionnaire, the total intake water demand, including drinking-sanitary demand, amounts to 40 gallons per short ton of gypsum produced.

7.4.3.4 Pyrophyllite Mining

This is a quarry process which does not use water, except for the drinking-sanitary requirements of the workers.

7.4.4 Structural Materials

Of all the structural materials the highest and stablest water user is cement. Other structural materials require less water in their production, but may interfere in the runoff-erosion process and create indirectly water resources problems.

7.4.4.1 Cement

According to Wixom [5], in a region with ample water availability, the amount of intake water used for producing a short ton of cement is 600 gallons and a similar amount for beneficiation of a short ton of rock used in cement of the wastewaters. No data were readily available in the case of the wet process on the amount of water depleted or on the quality of wastewater, but it may be presumed that the main pollutant effect due to the wastewaters of this industry is related to suspended sediments, and measures are necessary to retain these sediments before reaching the receiving water body.

7.4.4.2 Clay, Sand, and Gravel Quarrying

Water demand for clay quarrying is negligible. For sand and gravel quarrying water is often used for washing the products and the specific amount used varies with the quality of the deposit, the use given to the sand and gravel, and the water availability. A rough indication would be a specific intake water demand varying between 300 and 3000 gallons per ton, according to Kaufman and Nadler [9]. It can be estimated that the wastewater represents roughly 90 to 95 percent of the intake water, and its main characteristic is the increased content of suspended and colloidal substances, and organic matter. The concentration of these substances is obviously very variable, according to local circumstances. An idea of the order of magnitude of the suspended solids and organic matter which may be found in water used to wash sand may be obtained from Klein [8]. This author indicates that in experiments for treating such water, the crude waste presented a suspended solid content of 160 ppm and that normal sedimentation would reduce this concentration by 50 percent over a two-hour period.

7.5 Present and Forecast Water Demand and Wastewater

This section analyzes the present known water uses in the mining industries; and rough estimates are made, based on specific water demand and production levels, of the water demand for those cases where data on the water demand are missing. Because of lack of data (even at the statistical level) on the influence of different factors such as scale of production, cost of water, water quality, etc, on water demand, these estimates are affected by errors. In estimating future water demand still bigger errors are involved, related on the one hand to the economic forecast errors and on the other to the errors included in assuming future specific water demand to be equal to the present levels. These rough estimates are only accepted because of lack of more accurate techniques, and the forecast data are considered as a starting point for the exploration of possible problem areas. Detailed investigations in problem areas will require the application of other more sophisticated techniques to assess possible variation of water demand under various circumstances.

7.5.1 Iron Ore Mining and Beneficiation

a) The Iron Ore Company of Canada mine at Wabush Lake takes its water supply from Wabush Lake. In 1966 the intake water capacity was 47.5 million gpd (4 pumps of 8200 gpm), but the actual water intake was only 24.0 million gpd. The plant capacities were at that time 8 million long tons per year of iron ore concentrates from which 5.5 million long tons per year of pellets were produced. Since the concentrator and pellet plants were expanded to a capacity of 10 million tons in 1968, the intake capacity has been increased to 58 million gpd by the addition of one pump.

Total process water in the concentrating operation in 1966 was 63.0 million gpd (at a production of 21,600 tons of concentrates per day) with a recirculation of 48.0 million gpd. Total process water in the pellet mill was 22.5 million gpd (at a production of 14,600 tons of pellets per day), with a recirculation of 13.5 million gpd. It may be presumed that the corresponding usage has increased in 1968 proportionately to the capacity increases, but data are not available to confirm this. This is roughly estimated to be 35 million gpd.

The volume of tailings represents about 150 percent of the volume of concentrates, which means that at its new capacity the concentrator and pellet mill will release about 15 million tons of tailings per year in the lake. Screen analyses of the concentrator tailings are discussed by Horn[4]. The tailings concentration in the wastewater is 20 percent by volume with iron content of the tailings at 17 percent by weight. Screen analyses from the pellet plant are not available, but it is known that the amount of fine and colloidal particles is larger than in the concentrator tailings. The tailings volume from the concentrating operation is estimated at the present time at 41,000 long tons per day. There are no data to estimate the volume of tailings from the pelletizing operations.

b) The Wabush mine has its water supply from Little Wabush Lake. The intake water capacity is rated at 15.7 million gpd (3 pumps), but the actual intake is 10.0 million gpd, one of the pumps being on standby. The process water used in the concentrating process is 60.0 million gpd out of which 50.0 million gpd are recirculated (at a production of 15,000 tons ore concentrates per day).

Wastewaters are released at a rate of 8.4 million gpd and are discharged into Flora Lake. This means that the intake water demand represents a consumptive use for Little Wabush Lake. The wastewaters have a tailings concentration of about 21 percent in volume and the iron content of the tailings is about 19 percent in weight.

There are plans to expand the operation up to 100 percent, but no definite deadlines are known. When this occurs, the estimated intake water will be 20 million gpd and the volume of tailings 46,000 long tons per day.

c) The Iron Ore Company of Canada mine at Carol Lake does not exert a demand nor does it relase wastewater in Labrador.

d) Wabana Mines - Although the mine is closed, the following comments indicate the level of intake demand which would occur should the mine be re-opened. At a production of between 5 and 10 million long tons of ore per year, it may be assumed that the intake demand would be of the order of 8 to 15 million gpd. It is possible that some demand would develop for the production of phosphorus.

"Negative" demand in the iron ore mining in Labrador is restricted to the runoff and groundwater collected in the open pit mines which is usually pumped into the nearest drainage system, and may represent a pollution source for the receiver. Due to local topography and the short time of operation, these mine waters have not yet been a problem.

As indicated in Section 7.3, it is expected that the iron ore concentrates production will double during the study period, reaching a level of 30 million long tons per year in 1981. If the level of pellet production is assumed to increase at the same rate (up to 11 million long tons of pellets per year in 1981), this would imply an increase in intake water demand to about 66 million gpd. The increase of the tailings volume to some 45 million long tons per year in 1981 may represent a pollution problem. The dewatering of the open pit mines may also become a problem as the operations advance in depth in the existing mines.

7.5.2 Copper, Zinc, Lead, and By-Products

The present level of production at the existing mines will probably be maintained over the study period, or in some cases the operations will be discontinued and replaced with new similar mines. The location of the new mines cannot be determined at this stage; however, the data on water demand and wastewater characteristics given in this section could be used as indications of the water demand for the future new mines.

a) The American Smelting and Refining Company mine at Buchans is supplied with water from Sandy Lake. The rated capacity of the intake is 3.2 million gpd. However, only 2.2 million gpd are pumped when the mill is working at its rated capacity of 1250 short tons per day. A small recirculation at the rate of about 0.3 million gpd is used, and of the 2.2 million gpd, 0.4 million gpd are used for domestic-sanitary purposes. This water is treated by filtration and chlorination. In addition, the mine has another intake from the same lake having a rated capacity of 2.6 million gpd, working at a rate of about 1 million gpd for sand filling of abandoned sections of the mine.

Pumping from mine dewatering results in a flow of 60 thousand gallons per day. The wastewater flow from the concentration operations represents about 1.6 million gpd and contains about 10 percent tailings.

Since 1967, the wastewaters have been impounded before being released into Buchans Brook and thence into Red Indian Lake.

b) The Brinco mine at Whalesback has its intake from Little Bear Pond. The rated capacity of the system is 1 million gpd. No data of the actual water intake used are available, but judging from the concentrator's capacity (2000 short tons per day), it may be presumed that the intake is working close to full capacity 24 hours per day. The water used is untreated. Some recirculation and/or re-use is practiced, but data on amounts involved are not available.

The wastewaters represent a flow of 1.5 million gpd, the increase probably being related to the volume of tailings carried in suspension. Data on tailings concentration in wastewater are not available, but if the volumes of water assumed are correct, a concentration of 30 percent may be expected. In addition, the wastewater flow is increased by the discharge resulting from mine dewatering pumping which represents about 150 thousand gpd.

The wastewaters are clarified in a lake (the questionnaire mentions an "old lake bed") and thence discharged through a tunnel and a small stream leading into the ocean.

c) The Consolidated Rambler Mines Limited mine is near Baie Verte. No data are available on the water usage and wastewaters at this mine. Since production represents about 75 percent of that at Whalesback, it may be assumed that the water intake and wastewater flow is about 75 percent of the corresponding figures at Whalesback.

It is interesting to note that the only data available on this mine are on the mine dewatering flow which is 110 thousand gpd or very close to 75 percent of the corresponding flow at Whalesback.

d) The First Maritime Mining Corporation Limited mine at Gullbridge has its intake from Gull Pond. The rated capacity of the system is 2.4 million gpd. No information on actual use is available since the mine only started operation in 1967. However, for the rated capacity of 1500 tons per day, it may be presumed that the flow used will represent only about 50 percent of the rated intake capacity. All the water used is treated by chlorination. The water supply system provides water for domestic use and fire protection to the whole complex including the small townsite nearby.

The mine dewatering flow is about 150 thousand gallons per day. The wastewater flow, which probably amounts to about 1.5 million gpd, with an estimated concentration of suspended solids of 30 percent, is returned to Gull Pond after being clarified in a tailings pond, which was constructed by isolating a portion of Gull Pond. The wastewater dilution demand may be estimated at 750 million gpd.

e) The Atlantic Coast Copper mine is at Little Bay. There are no data available on the water usage and wastewaters at this mine. Since the production of this mine represents about 50 percent of that at Whalesback, it may be assumed that the water intake demand and wastewater flow is about 50 percent of the corresponding figures at Whalesback.

The mine dewatering flow varies between 50,000 gpd in dry periods to 100,000 gpd in spring and fall, which is about 50 percent of the mine dewatering flow at Whalesback.

7.5.3 Non-Metallic Minerals

The water demand in the non-metallic minerals mining and beneficiation is less than that for the metallic mining. However, as mentioned in Section 7.4.3, this demand is on the increase, and may be a factor in future selection of non-metallic mining developments.

a) The Advocate Mines Limited at White Bay South, which is producing asbestos, has its water intake from the Upper Duck Island Cove Pond, with a rated capacity of 0.6 million gpd under normal conditions, and 1.8 million gpd under emergency conditions.

Water is used only in auxiliary activities, the mining and beneficiation process being essentially dry. The average daily use is about 216,000 gpd, of which 55,000 gpd is used for drinking, sanitary purposes, and boiler feed; 106,000 gpd for cooling; 5000 gpd for atomizing heavy oil for dryers; and 50,000 gpd for cleaning and truck washing. The average daily output of the mine is about 200 short tons of asbestos fibre. The water used for drinking and sanitary purposes and for boiler feed is treated. The treatment plant includes a chlorinator, a deaerator, and a chemical feeder.

The wastewater flow is equal to the intake water minus the 5000 gpd used for atomizing which represents depletion. The wastewater is discharged into Upper Duck Island Cove Brook.

The forecast is that the asbestos production will increase over the study period by 50 percent, and it can be assumed that water demand will increase accordingly.

b) Newfoundland Fluorspar Limited mine at St. Lawrence - The industrial water requirements of the mine and beneficiation mill are supplied from the groundwater resulting from mine dewatering. The total dewatering flow is about 3.0 million gpd, of which about 0.5 million gpd are used in the ore processing, powerhouse cooling, mine showers, and fire protection.

The mine water brings in radon gas, a disintegration product of the uranium oxide which appears in small amounts in the granite in which the mine is located. This water cannot be used for drinking-sanitary purposes, hence, water for these uses is obtained from the Hay Pook Pond and is treated by charcoal filtration and chlorination in a treatment plant having a capacity of 20,000 gpd.

Disposal of mine wastewater is to the Seal Cove Brook at a rate of about 2.5 million gpd and thence to the sea after being passed through a series of small settling ponds. Disposal of the sanitary and domestic wastes is by septic tank. The problems related to the disposal of mine water in this particular case require further investigation. Conditions in the mine are under study by a Royal Commission.

The production of the mine will probably increase by 50 percent during the study period, with a corresponding increase in water demand.

c) The Flintkote Company of Canada mine at Flat Bay has a water supply from two wells. The water is used mainly for drinking-sanitary purposes and for dust control. The capacity of the system is 36,000 gpd. Surface water could be used for washing the ore if required.

The forecast indicates a 200 percent increase in production to one million tons per year by 1981. If washing of the ore is introduced, this may represent a demand of about 2 million gpd.

d) The Newfoundland Minerals Limited mine near Long Pond produces pyrophillite by an essentially dry quarry process, and the water used is limited to drinking-sanitary purposes. There are no data on the actual water demand at this quarry.

7.5.4 Construction Materials

Data on the actual use of water in the construction material quarrying and processing industry are not available. As indicated in Section 7.3.3, a significant increase in this sector may be expected. Although in some cases part of the water used in this activity is depleted by evaporation or is incorporated in the products, in most cases a very large percentage of water is returned to the source from which it was withdrawn. Therefore, in the Province's conditions, the supply of water for this activity is not and will not be a problem, although the cost and availability of water may play some role in the selection of one or another quarry. The main water resources problems generated by this type of activity are related to the disposal of tailings and other wastes and by changes induced in runoff and erosion patterns, or disturbances induced directly in the river beds by quarrying. These problems are not expected to be at all serious during the study period.

7.5.4.1 North Star Cement

In 1966 this plant was using an approximately constant amount of water of 300,000 gpd. The waste water represented some 285,000 gpd. No data are available on the quality characteristics of the wastewaters. This usage of water has probably increased since, as mentioned in the Department of Mines Report[1], the present process was to be changed to a wet one. It may be presumed that the forecast expansion to 1,000,000 barrels per year from the 600,000 reported in 1966, together with the change in the technologic process, will raise the water use to about 700,000 gpd, and that evaporation losses (consumptive demand) will increase significantly with the change to the wet process, but data were not readily available to estimate this consumptive demand.

Although data on the quality of wastewaters are not available, it may be presumed that a certain quantity of suspended mineral solids is carried by the wastewaters of this plant.

7. 5. 4. 2 C. M. Pelley

This establishment is producing bricks and there are no data on the water demand or waste releases. Since the value of production is small (100, 000) and the specific demand per dollar value of production is low, it may be concluded that the water demand for this industry is not significant. Wastewater from this plant may include suspended solids and possibly some organic matter.

7. 5. 4. 3 Limestone and Sand and Gravel

The location of quarries for limestone and sand and gravel is not known.

From the limestone production forecast indicated in Section 7. 3. 3, and the existing general indications of water usage in this quarrying activity, it may be inferred that the water usage is not significant.

The forecasts for the sand and gravel industry indicate substantial increase, the corresponding total water demand being estimated at 1. 5 billion gallons per year in 1971; 2. 1 billion gallons per year in 1976; and 2. 7 billion gallons per year in 1981. Because of the seasonal character in this type of operation, this water demand has some significance. However, it should be borne in mind that most of the water used in this activity is generally returned to the source. Because no data are available on the actual sites and characteristics of the pits and quarries, it is not possible to estimate the wastewater characteristics.

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* Reference 1 was the designated data source for Sections 7.1 to 7.3.

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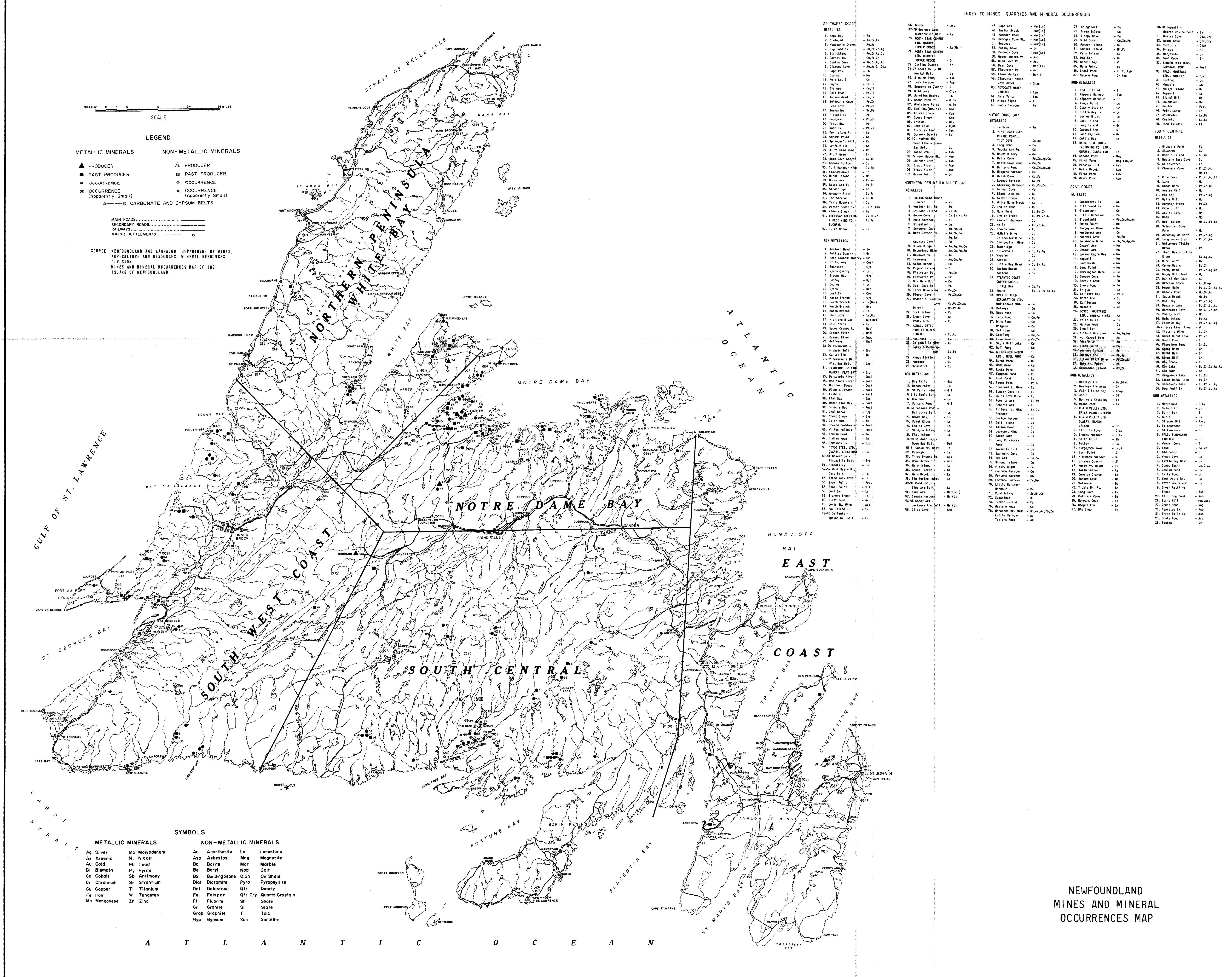


FIGURE 7-1

NEWFOUNDLAND AND LABRADOR
TRENDS AND FORECASTS IN THE MINING INDUSTRY
1951 - 1981

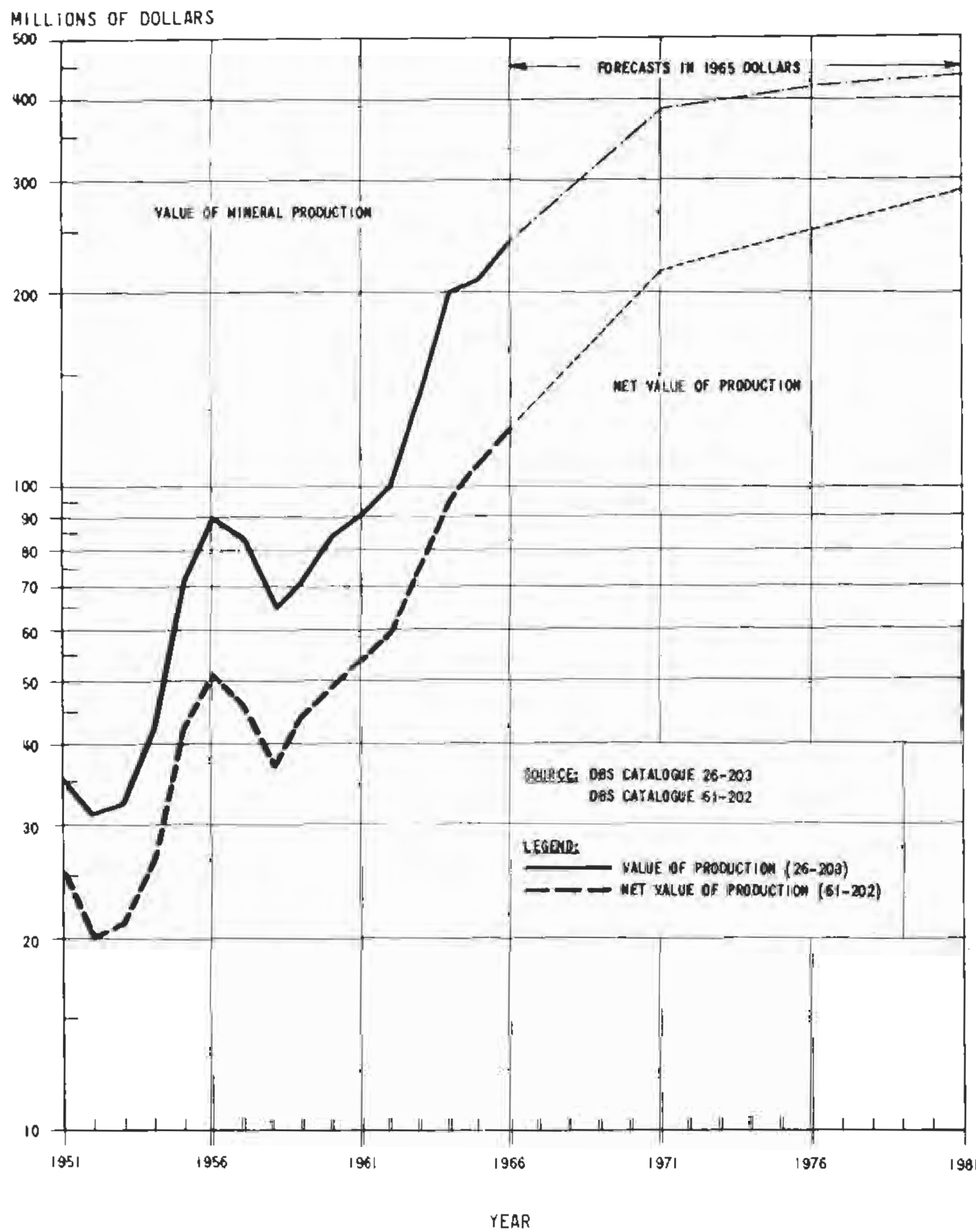


FIGURE 7-2

NEWFOUNDLAND AND LABRADOR
TRENDS AND ESTIMATED DEVELOPMENT IN THE IRON MINING INDUSTRY

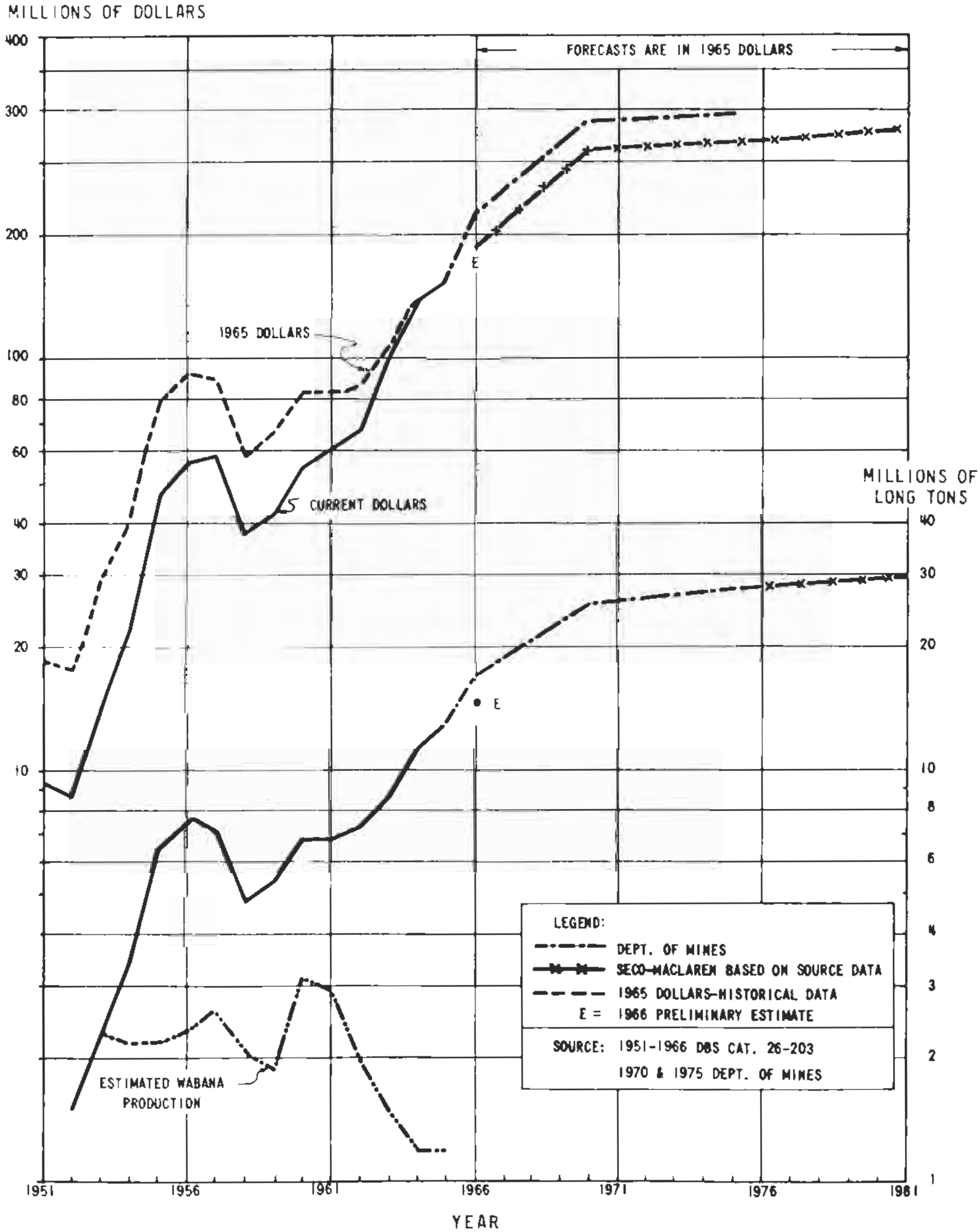


FIGURE 7-3

NEWFOUNDLAND AND LABRADOR
TRENDS AND ESTIMATED DEVELOPMENT IN THE NON-FERROUS MINING INDUSTRY

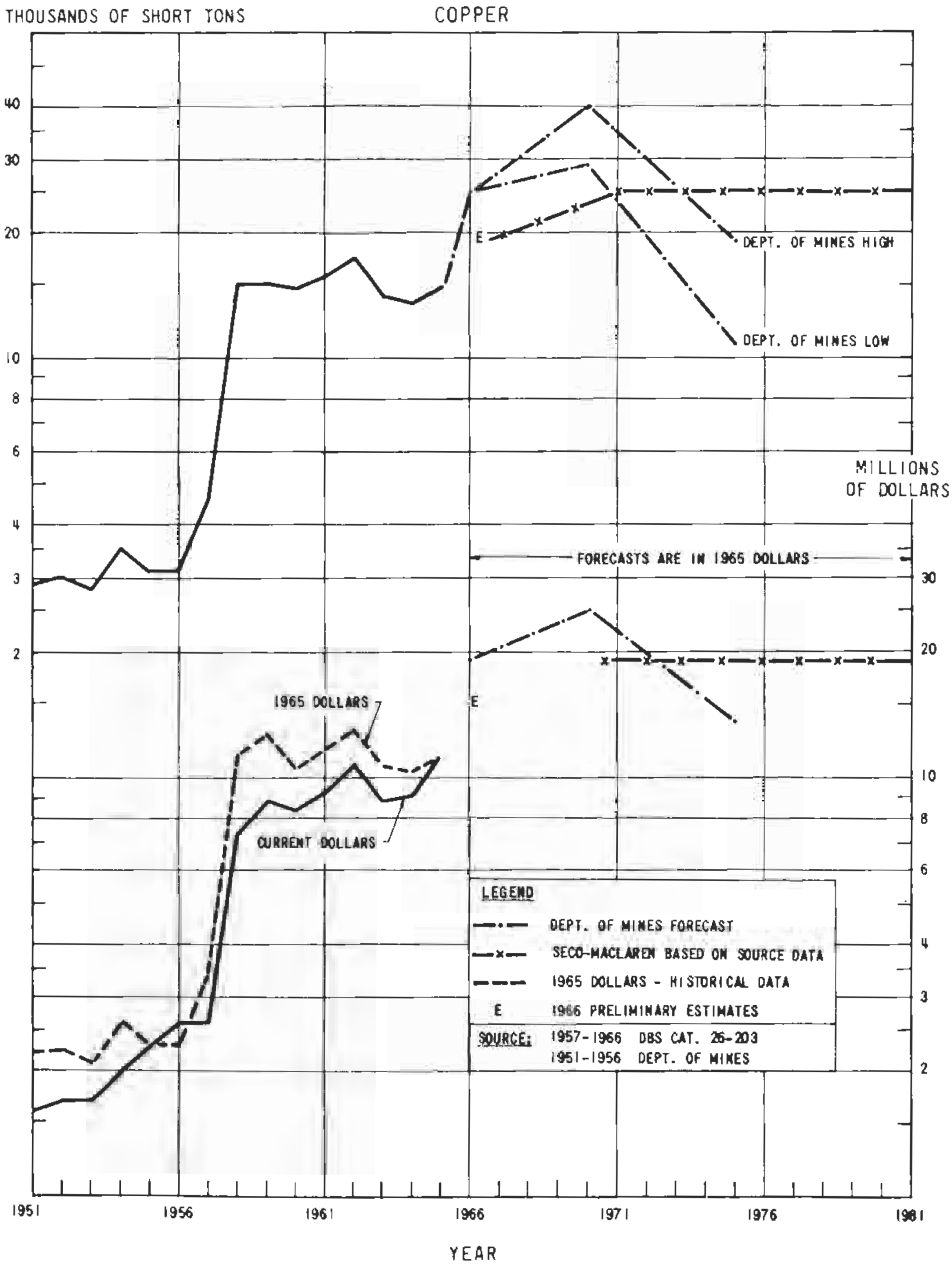
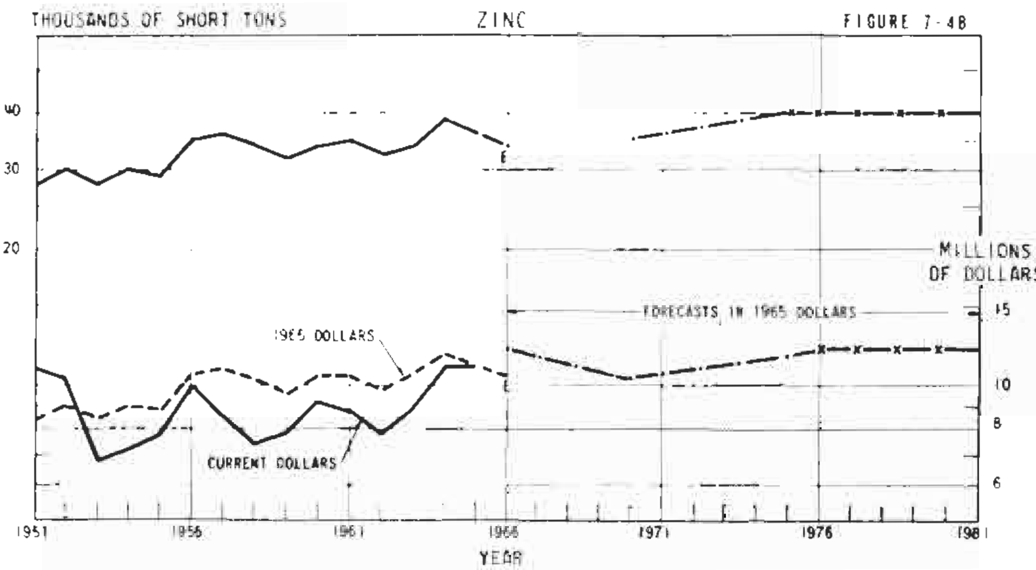


FIGURE 7-4A

NEWFOUNDLAND AND LABRADOR
TRENDS AND ESTIMATED DEVELOPMENT IN THE NON-FERROUS MINING INDUSTRY



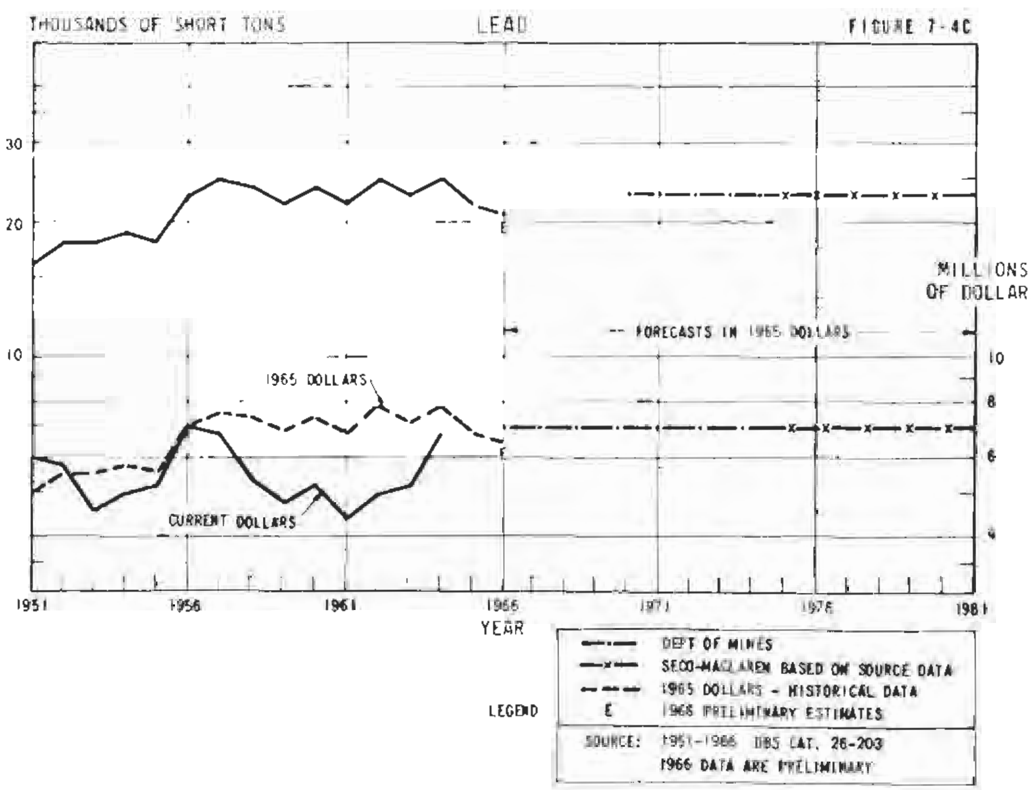


FIGURE 7-4 B/C

The Shawinigan Engineering Company Limited
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NEWFOUNDLAND AND LABRADOR
TRENDS AND ESTIMATED FUTURE PROBABLE DEVELOPMENT IN THE NON-METALLIC MINING INDUSTRY

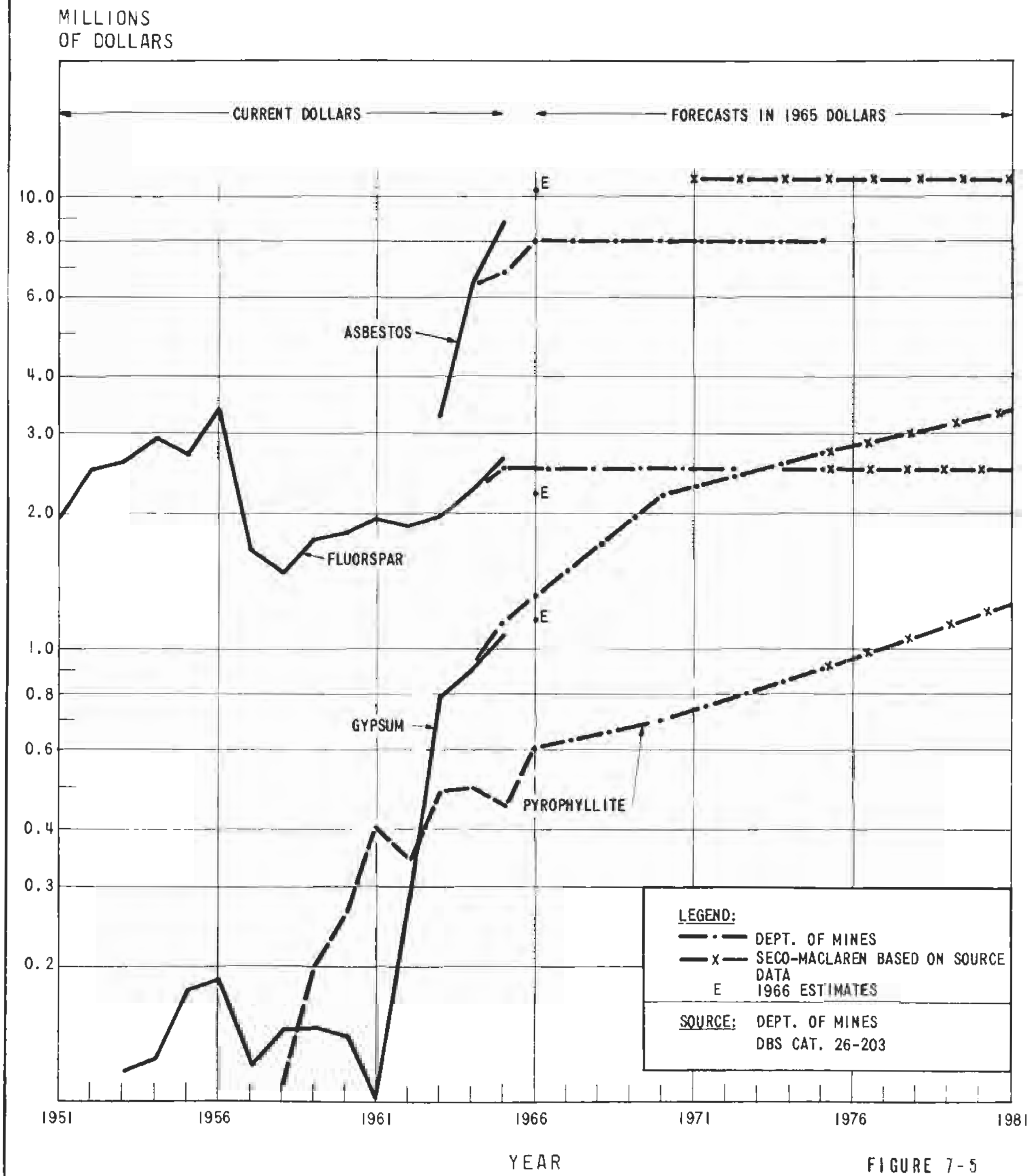

FIGURE 7-5

RELATIONSHIP BETWEEN ECONOMIC FACTORS IN THE MINING INDUSTRY

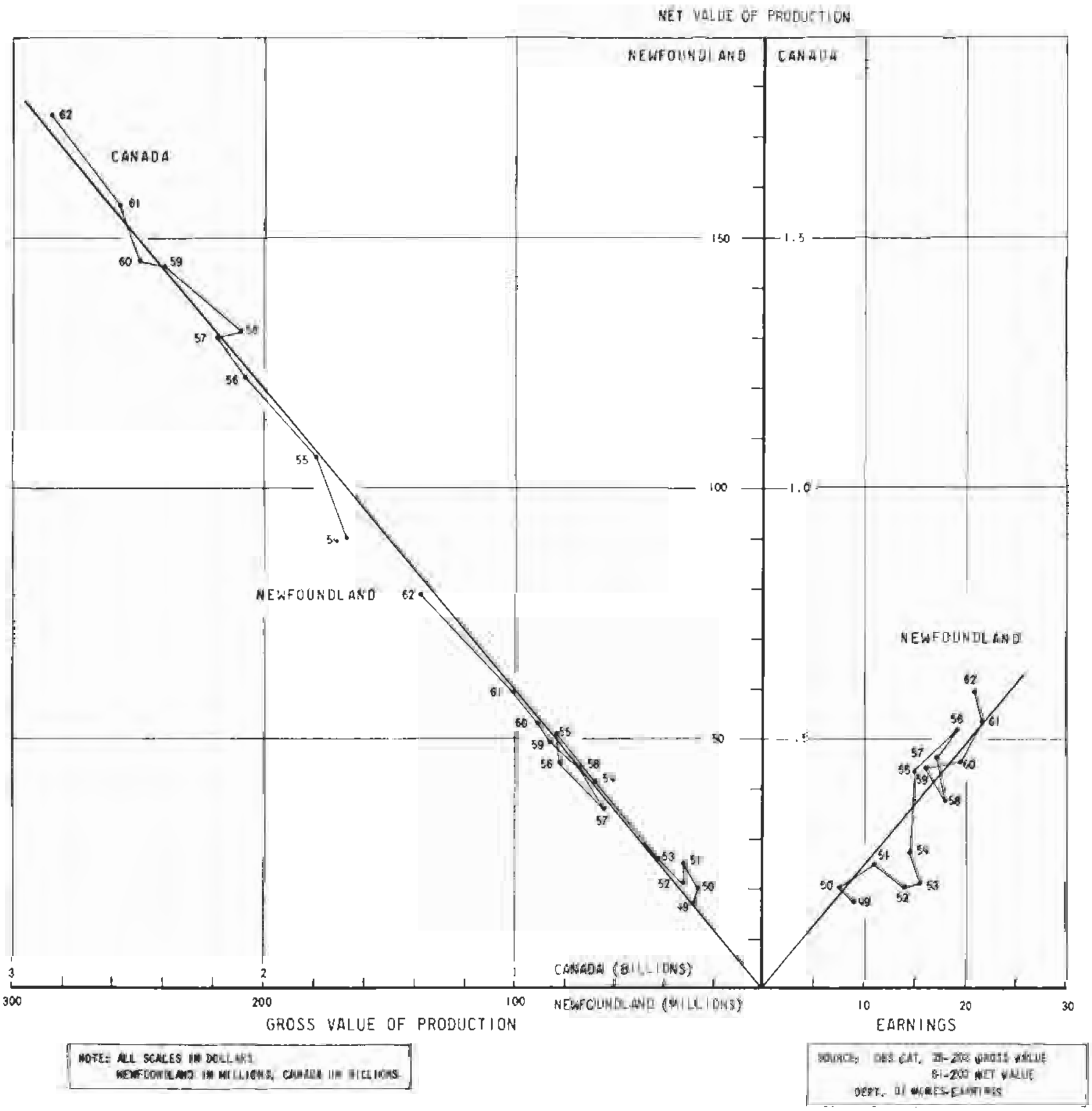

FIGURE 7-6

NEWFOUNDLAND AND LABRADOR
PRESENT AND ESTIMATED FUTURE WATER USES
BY THE MINING INDUSTRY

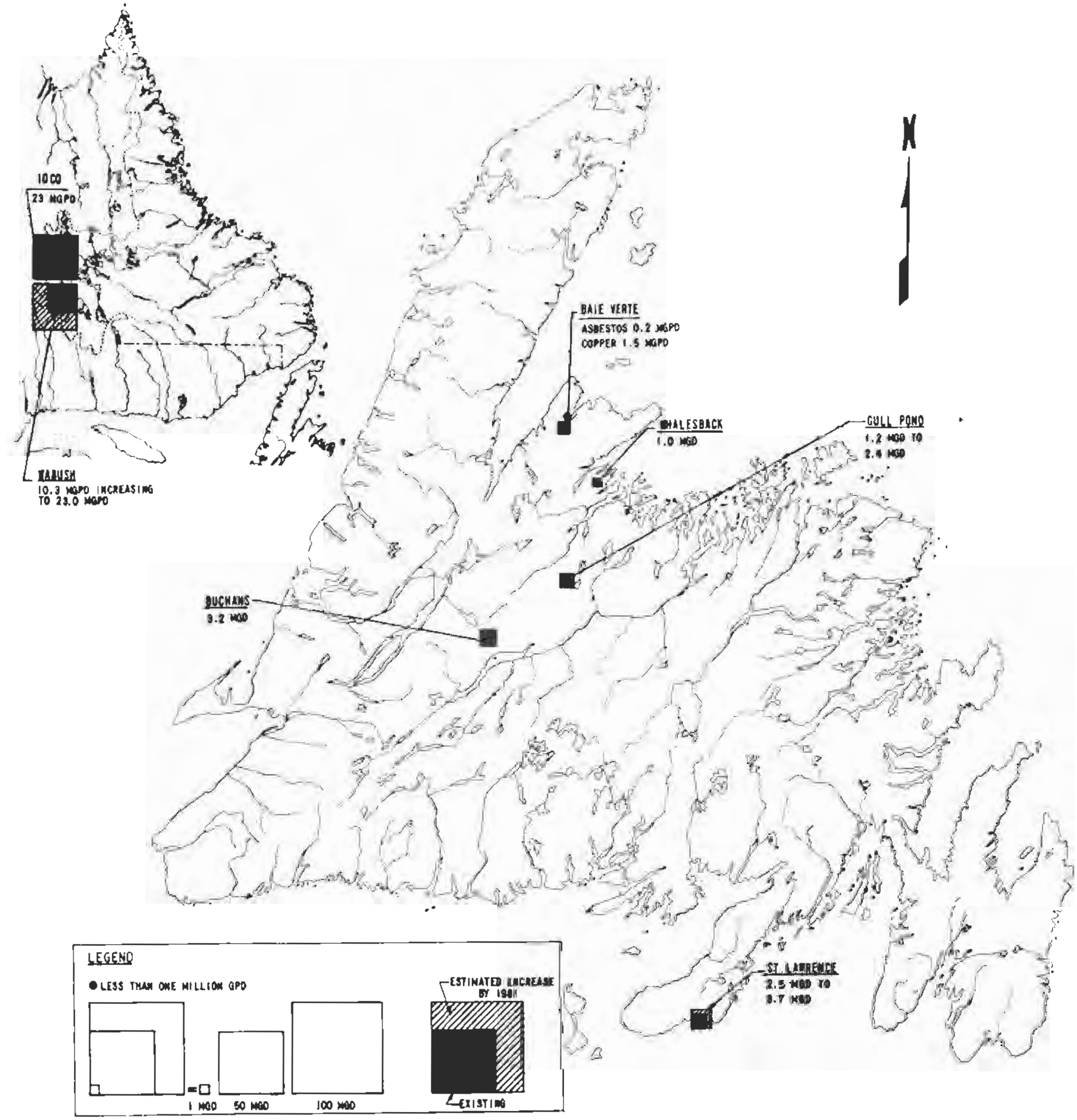

FIGURE 7-7

MINERAL OCCURRENCES AND REGIONAL GEOLOGY

Metallic and non-metallic minerals and structural materials are recovered in ten widely scattered areas of the Province.

NEWFOUNDLAND

Notre Dame Bay area	copper and gold at Tilt Cove,* Little Bay, and Whalesback limestone at Cobbs Arm
White Bay area	asbestos at Baie Verte copper, zinc, and gold at Rambler
Island Interior	zinc, lead, copper, cadmium, gold, and silver at Buchans
Bay of Islands area	limestone, marble, and shale near Corner Brook
St. George's Bay area	gypsum at Flat Bay
Burin Peninsula	fluorspar near St. Lawrence
Trinity Bay area	shale and clay at Random Island
Conception Bay (St. John's area)	iron ore on Bell Island* peat at Cochrane Pond pyrophyllite at Manuels

LABRADOR

Schefferville area	direct shipping iron ore
Wabush area	iron ore (concentrates, pellets)

In addition, deposits that may be developed for production include copper at Deer Pond (second deposit near the Whalesback mine); copper and zinc at York Harbour; iron ore at Julian Lake north of Wabush Lake and another operation at Carol Lake, both in Labrador.

Source: Department of Mines and Technical Surveys,
Mineral Resources Division,
Mineral Resource Development Newfoundland and Labrador, 1967.

* Mines now closed

3

TABLE 7-1

PRODUCING MINES

DEPOSIT	LOCATION	COMPANY	PRODUCT	CAPACITY
		NEWFOUNDLAND		Short tons per day concentrates
Metallic				
Buchans	Buchans	American Smelting & Refining Co.	zinc, lead, copper, cadmium, gold, silver	1250
Rambler	Baie Verte	Consolidated Rambler Mines Ltd.	copper, zinc, gold	1500
Gull Pond	Gull Pond	First Maritime Mining Corporation Ltd.	copper, gold	1500
Little Bay	Notre Dame Bay	Atlantic Newfoundland Copper Corp. Ltd.	copper, gold	1000
Whalesback	Notre Dame Bay	British Newfoundland Explorations Ltd.	copper	2000
Wabana	Bell Island	Dosco Industries Ltd.	iron ore (closed 1966)	
Non-metallic				Short tons
Flat Bay Quarry	St. George's Bay	The Flintkote Company of Canada Ltd	gypsum	1,250,000/year
Corner Brook Quarries	Corner Brook	North Star Cement Ltd.	limestone (marble), shale, cement	226,000/year
Baie Verte Mine	Baie Verte	Advocate Mines Ltd.	asbestos	65,000/year
Cobbs Arm Quarry	Cobbs Arm	The Newfoundland Lime Manufacturing Co.	limestone	
Random Island Quarry	Clarenville	C & M Petty Ltd.	shale (for brick)	
Cochrane Pond	St. John's	Sundew Peat Moss	peat	
Oval Mine	Manuels	Newfoundland Minerals Ltd	pyrophyllite	200/day
Director Mine	Burin Peninsula	Newfoundland Fluorspar Ltd	fluorite	100,000/year
		LABRADOR		Long tons/year
Metallic				
Ruth Lake and Wishart	Schefferville	Iron Ore Company of Canada	iron ore	Direct shipment
Carol Lake	Labrador City	Iron Ore Company of Canada	iron ore	(Concentrator - 10 million (Pelletizer - 10 million
Wabush	Wabush	Wabush Mines Ltd.	iron ore	Concentrator - 5.5 million

Source: Department of Mines and Technical Surveys,
Mineral Resources Division,
Mineral Resource Development Newfoundland and Labrador, 1967

TABLE 7-2

8 FOREST EXPLOITATION, WOOD PROCESSING, AND PULP AND PAPER INDUSTRY

8.1 Forest Resources

The forest resources of the Island have been of great importance to the Province's economic development and at this time the vast forest resources of Labrador are virtually untapped.

Approximately 30 percent of the Island and 19 percent of Labrador is covered with productive forests. Productive forest land is defined as that bearing, or capable of bearing, five or more merchantable cords per acre. Merchantable forest are stands supporting five cords or more of pulpwood per acre which are more than 40 years old.

It is beyond the scope of this report to go into the complexities of forest utilization. However, an understanding of the different inter-relationships involved in forest resources exploitation and management is essential to constructing a consistent model of the Province's economy. Moreover, since the size and characteristics of the forested area of a basin are significant to the hydrologic regime, these characteristics deserve attention in a water resources study.

The principal natural conditions which affect the utilization of the forest are:

The extent, composition and location of the forests,
Terrain (topography, geology and soils),
Climate,
Rates of growth,
Disease,
Flooding, and Fire.

The influence of these conditions on the forest-based industries is discussed briefly in the following paragraphs.

8.1.1 Extent and Composition of the Forests

The distribution of the forest areas in Newfoundland and Labrador, according to the 1:250,000 scale maps produced by the Canada Department of Mines and Technical Surveys (now the Department of Energy, Mines, and Resources), is shown schematically in Figures 8-1 and 8-3. The aerial photographs which form the basis of these maps were taken around 1950, and since then forest fires have been recorded as indicated on the figures.

The Provincial Forest Service is now preparing a Forest Capability Study, which is one section of the Canada Land Inventory - a joint Federal-Provincial project. The final report will cover the whole Island and 20,000 square miles of Labrador. In addition to the Forest Capability Study, a Forest Inventory is also being prepared to indicate growth and yield factors. This section is only in preliminary stages of preparation. Accurate estimates of land capability must await the completion of these studies (approximately 1970). Until then, it is necessary to use estimates of doubtful accuracy.

8.1.1.1 Island of Newfoundland

Estimates of the extent of the Island's forested areas vary. Calculations based on the Department of Mines and Technical Surveys' 1:250,000 scale maps, issued over a period of years, indicate a forested area of 13.5 million acres. For purposes of this section, the 1962 estimates are used as shown in Table 14-1 A, which show a total forested area of 14.5 million acres out of a total land area of 26.3 million acres.

Of the forest land, 8.3 million acres are considered productive, and 54 percent of that area constitutes merchantable forests.

The following table summarizes the percentage distribution by types of the Island's productive forest land of 8.3 million acres:

	Softwood	Mixed Wood	Hardwood	Total
	%	%	%	%
Merchantable	51	3	-	54
Young Growth	39	2	2	43
Unclassified	-	-	-	3
				100 %

The distribution by species of merchantable standing volumes is shown in Table 8-1 B; this varies slightly from the percentages indicated in Table 8-1 A. However, the differences are minor and are largely because the estimates were based on different years (1962 for Table 8-1 A and 1967 for Table 8-1 B).

At the present time, only two of the five main species found on the Island are of economic significance; balsam fir and black spruce, both of which are used in the production of pulp and paper. The Island forests are made up predominantly of balsam fir, although the stands are frequently mixed with other species. The normal regeneration pattern in an area following a clearcutting pulpwood operation produces balsam fir, a factor which may be used in estimating the future distribution of the species. Black spruce stands, the most valuable pulpwood species, are scattered across the Island and this is the dominant species in burnt-over areas.

While accurate estimates are not yet available, the following comments indicate the general distribution of the species found on the Island.

Balsam fir is the dominant softwood species on the west coast and the Great Northern Peninsula.

Black spruce predominates in the central and eastern regions, where considerable fire damage has occurred. However, because of the widespread burning and reburning, the Avalon Peninsula has become predominantly a heath barren. Black spruce is also found in scattered stands across the Island.

Eastern white pine, once the most valuable softwood for lumber, is gradually disappearing because of blister rust. It is no longer a significant species.

Red pine is found in small stands near Terra Nova, Gambo, Alexander Bay, and Howley. It is not an economically significant species.

White birch is the main hardwood found on the Island. There are also small quantities of yellow birch.

8.1.1.2 Labrador

Estimates of the forested area of Labrador are probably less accurate than those for the Island; however, they indicate the possible extent of this barely touched resource. Out of the total land area of Labrador of 65.2 million acres, the total forest land is estimated to cover 41.6 million acres, of which 13.4 million acres are considered productive. Eighty-five percent of the 13.4 million acres are classified as merchantable softwood, 4 percent young growth, and the remaining 11 percent are unclassified.

Estimates of the merchantable standing volumes of wood by species are shown in Table 8-1 B. A distribution of the forested area in Labrador according to quality is indicated in Table 8-1 C.

Black spruce occupy about 70 to 80 percent of the forested area of Labrador lying south of 58 degrees North Latitude. White spruce, comprising less than five percent of the forested area, is found in the same areas as the black spruce.

Balsam fir accounts for about 25 percent of the Labrador forest but is very scarce north of latitude 54 degrees. White birch comprises less than 1 percent of the total forest cover.

The essentially unexploited merchantable softwood stands of Labrador are almost three times greater than those of the Island. However, this is not intended to imply that the growth potential of Labrador is three times greater than that of the Island.

8.1.2 Terrain

The topography of the land is a natural condition which dictates not only the area and type of forests but also their exploitation. Slope is an important factor in the regeneration of the forest after clear cutting and especially after fire. In some cases, potentially productive areas may be inaccessible because of the terrain. In others, the terrain may prohibit the mechanization of woods operations or impose prohibitive costs in terms of transportation. The timber volumes in the more accessible watersheds in Labrador are indicated in Table 8-3 B.

8.1.3 Climate

Climatic conditions are another key factor in the growth and exploitation of the forests. The relatively short growing season, and cool temperatures, and accompanying low evapo-transpiration (about 15 inches in Newfoundland, about 10 inches in Labrador) are limiting factors to tree growth in the Province. In some areas wind intensity inhibits growth despite favourable soil conditions.

8.1.4 Natural Destructive Forces

Historical evidence indicates that large blocks of forest land have deteriorated because of forest fires. In some areas, forest fires and subsequent soil erosion may have rendered the land unproductive, and special and expensive measures would have to be taken to reforest them. Table 8-2 A summarizes the acreage damaged by forest fires between 1947 and 1965. During this period 515,700 acres or 25 percent of the total area burnt was classified as merchantable timber.

Figures 8-1 and 8-3 show the main areas affected by destructive forest fires in the Province. The date of burn is shown for each area.

A detailed discussion on the influence of extensive deforestation, from forest fires on the hydrologic regime of the river basins is given in Volume Six B, Part IV.

Forest management can be helpful in preventing forest fires and forest fire consequences, and it can also have a beneficial effect on river flow variation. Furthermore, if cloud seeding operations are included in the water management programs designed to increase runoff, they may also be used for forest fire containment.

Insects can have a serious destructive impact on forests. The use of insecticides to combat this type of destruction has water resource implications and problems related to the use of insecticides are discussed in Section 8.4.2.

8.1.5 Forest Management

Accurate estimates of the present growth rate of the Provincial forests are not available, but the existing growth rate is undoubtedly below what could be achieved with intensive forest management. Ker[1] states, "Because of the lack of comprehensive growth data, it becomes necessary to accept the growth rate, assumed by the Kennedy Commission[2] for the entire Island, of 0.18 cords per acre per year." It should be stressed that this average applies to disturbed areas of merchantable softwood volumes, assuming a rotation age of 80 years. This estimate of mean annual increment is the best available for the Island, and is used for policy-making decision by the Provincial Government.

"There is no doubt, however, that intensive forest management could double the growth rate to 0.36 cords per acre per year for all of the merchantable forests. Estimates of growth potential as high as 0.5 cords per acre per year have been made for the entire productive forest area of the Island."

The appendix to the Ker Report[1] outlines in considerable detail the potential resource of the Island and, because of the lack of information, in summary form the potential of Labrador.

Forest potential depends on both natural and man-made conditions and therefore is not an absolute index. For example, the forest industries on the Island have practised extensive rather than intensive forest management. Extensive management resulted from an evolutionary process and changing conditions indicate that shift to intensive management must be expected. However, the impact of the change to intensive management will not be felt immediately, and for purposes of this study, the potential of the forest is assumed to be allowable annual cut, recognizing that in all probability the actual potential is considerably greater than this indicator.

The allowable annual cut for the Island is estimated at 1.5 million cords, and for Labrador 1.6 million cords, making a total provincial allowable annual cut, according to Ker [1], of 3.1 million cords.

The use of the total allowable annual cut is an over-simplification of the studies necessary to truly measure forest potential. However, its use as a consistency check indicated that the provincial forests could support the planned and anticipated expansion of the pulp and paper industry.

8.2 Forest Exploitation, Wood Processing, and Pulp and Paper

8.2.1 Present-Day Conditions

8.2.1.1 Forestry

The exploitation of the forests played an important role in the settlement of the Island and in shaping its economic development. However, it was only with the establishment of the pulp and paper manufacturing industry that the resource became economically significant.

The two existing pulp and paper companies, Bowaters (Nfld) Limited in Corner Brook and Price (Nfld) Pulp and Paper Limited in Grand Falls, own or control about 60 percent, or five million acres, of the Island's productive forest land. A breakdown of the productive forest areas by owner or lease holder is given in the 1965 annual report of the Provincial Department of Mines, Agriculture, and Resources [3] and may be summarized as follows:

Limit Holder	Productive Forest in Thousand of Acres	
	Island	Labrador
Unoccupied Crown (Provincial)	3,030	851
Crown (Federal)	61	-
Price (Nfld)	2,109	-
Bowaters	3,105	-
Reid Lots	39	-
Private	37	-
Newfoundland & Labrador Corp.	-	2,680
Brinco	-	852
Newfoundland Pulp and Chemical Co.	-	6,327
Total	8,381	10,710

The discrepancy in total productive forest area between this table and the information quoted previously is due to the different sources used.

In 1965 the wood cut on crown lands was estimated by Ker[1] to be 273,880 cords classified as follows:

200,000 cords - fuel wood
1,453 cords - local industries
46,592 cords - equivalent for lumber production
25,835 cords - pulpwood export

Fuel wood cutting reflects the local conditions and the guarantee under Section 89, Crown Land Act, that people in fisheries, agriculture, or similar occupations, may cut a maximum 2000 cubic feet for their own use. Fuel wood cutting is not considered an industrial activity because most of this cutting is for personal consumption of the cutter, and as such does not represent employment in terms of labour force participation.

In 1965 the estimated cutting of the two existing pulp and paper companies was 916,500 cords. It would appear that pulp and paper operations account for over 90 percent of wood cutting operations if fuel wood cutting is excluded. In view of this domination and the fact that data on other forms of wood operations are not available the economic analysis of this sector is based mainly on data of the wood cutting operations of the two pulp and paper companies. Data on other woods activity can be estimated roughly by taking a ratio between total production, as given above, and the total production of the two paper companies.

Accurate and comprehensive historical data on woods employment are not available, so trends in forestry employment reflect only estimated levels based on the interpretation of the partial and somewhat contradictory information available from various sources. The primary forestry employment at the time of the 1951 census was reported to be 9, 146. At the time of the 1961 census, employment in this sector had decreased to 5, 746. This pronounced decrease has been attributed to the partial mechanization of woods operations, particularly the introduction of the chain saw. It should be borne in mind that the present level of mechanization in the Province is still low compared to other areas of Canada.

One difficulty in discussions of primary forestry employment is the seasonal characteristic of employment in this sector. This contributes to the difficulty of determining the real employment. For example, according to the Ker Report[1] woods employment at the two existing mills is 3, 000 men each. This estimate was substantiated by the questionnaires compiled for the present study. However, when compared to employment series published by DBS[6], it would appear that these data represent the seasonal peak in primary forestry employment.

When annual employment figures are used in this section, they reflect an average employment. Figure 8-5 shows the monthly forestry employment from 1964 to 1967. It will be noted that the average of 3, 900 for 1965 is identical to the figure used by the Board in their various working documents.

In 1965 the total value added by the primary forestry sector was $21, 260, 000.

8. 2. 1. 2 The Pulp and Paper Industry

Two companies constitute the Province's pulp and paper industry and both are located on the Island. The industry has grown in importance since its establishment in 1909, and today it is second only to the mining industry in its contribution to the gross provincial product. In value of factory shipments, it accounts for well over 90 percent of manufacturing based on the forest resource. However, closer examination by Ker[1] and Kennedy[2] indicates that the contribution of the industry to the provincial economy does not parallel the position its gross provincial product rating would imply.

Although the two companies are the lifeblood of Corner Brook and Grand Falls - Windsor, as well as a number of peripheral communities such as Deer Lake and Botwood, they have not induced any significant local industry other than primary forestry and electric energy. The communities supported by the pulp and paper industry have developed mainly as service centres.

The primary output of both Bowaters and Price is newsprint; but, because of economies of scale of the sulphite-groundwood processes both companies have excess chemical pulp capacities.

The rated capacity of the existing mills is as follows:

	Newsprint	Sulphite Pulp
Bowaters	1,260 tons/day	375 tons/day
Price	990 tons/day	250 tons/day

Table 8-2C shows that the pulp and paper industry has witnessed a slow but steady reduction in plant employment in the last 15 years. Total employment in the two mills is now (1966-1967) running just over 3,000. While minor fluctuations in employment occur monthly, there is no apparent seasonal pattern. According to DBS[4] in 1965 the pulp and paper industry employed 3,301 with a value added of $39,815,000.

8.2.1.3 Other Forest Products

In the previous section, it was noted that the pulp and paper industry accounted for more than 90 percent of the manufacturing activity, based on the forest resource. Sawmill activities on the Island are primarily family operations. Most of these establishments are operated seasonally by fishermen, who take their lumber from the three-mile Crown shoreline reserve. In 1964, 75 percent of the lumber produced on the Island came from Crown lands. According to the Provincial Department of Mines, Agriculture and Resources[3,5] in the same year, 1465 mills were licensed to operate in the Province, but by 1966 only 1100 sawmills were licensed. Production in 1964 and 1966 was as follows:

Sawmill Production in 1964 and 1966

Region	Crown Land 1964	Crown Land 1966	Private Land 1964	Private Land 1966	Total 1964	Total 1966
	Thousand feet board measure					
Eastern	7,047	7,357	746	751	7,793	8,108
Central	10,332	6,614	5,751	4,341	16,083	10,955
Western	5,450	5,313	2,294	1,686	7,744	6,999
Labrador	192	230	0	0	192	230
TOTAL	23,021	19,514	8,791	6,778	31,812	26,292

Note: Approximately three-quarters of the licensed mills actually operate in any given year.

The dependence of the sawmills on Crown lands is one of a number of reasons for the limited operations of this undustry. The "three-mile" crown land has been cut over and much of the remaining timber is not of a usable quality.

In 1966, it was estimated by Ker[1] that 50 percent of the lumber used on the Island was imported. The imported lumber is available at prices which are lower than those of lumber produced on the Island.

In addition to sawmilling operations, there is some small-scale manufacturing based on the forest resource. Information is limited, but some indication of the small scale of the operations can be drawn from the timber input. The spoolwood operation at Loon Bay used a total of 1,800 cords of white birch in their manufacturing operations. Production was exported to Europe. The pressboard operation at Donovans processed 7,500 cords of softwood. Another plant at Donovans, which manufactures veneer, plywood, and furniture, consumed 463 mfbm of white birch. A plant at Clarenville, producing chemically treated railway ties, poles, and construction timbers, used 930 mfbm of hardwood and 5.4 mfbm of softwood.

8.3 Potential and Planned Development

8.3.1 Forestry

While physical conditions place limits on both the type and level of exploitation, the potential economic activity which can be based on the forest resource rests, to a large extent on management practices. This report assumes that the forests of the Island can support additional activity, and that the forests of Labrador will have entered into the first stage of their potential development during the forecast period.

The distribution of cutting activity for the pulp and paper industry between Newfoundland and Labrador is based on the assumption, provided by the Board, that the two existing pulp and paper mills on the Island will derive all their wood from the Island; the proposed Stephenville linerboard mill will receive all its wood from Labrador, and the new mill to be built at Come By Chance will obtain its wood as follows:

	1971	1976	1981
	%	%	%
From Newfoundland	80	50	20
From Labrador	20	50	80

These figures allow for the possible increase in demand on the Island's resources resulting from increases in production at the existing mills and the limitations implicit in present allowable cuts. Although forest management would certainly increase the allowable cut in time, it is doubtful whether this will occur to a significant extent before the end of the study period in 1981.

Another assumption provided by the Board is that productivity will increase from the current relatively low level of 1.25 cords per man-day to 3.2 cords per man-day by 1981.

All employment figures concerning woods operations are computed on the basis of annual average employment. It may be assumed that employment in forest management and changes in technology (production of chips to be piped to the mill) will reduce the present seasonal variation of employment.

The total cut was estimated on the basis of the ratio between output at the various mills and the specific input of wood. This resulted in the following figures for 1981:

	Capacity in Tons	Cords of Input
Bowaters	563,500	845,250
Price	381,500	572,250
Come By Chance	210,000	315,000
Stephenville	350,000	507,500
		2,240,000

Note: 1981 capacity for 350 days per year.

This table together with the productivity assumptions result in woods employment estimates for 1981 of 2435 on the Island and 1250 in Labrador, for a total provincial employment of approximately 3700.

The ratio of value added between the primary and secondary forestry sectors was 45 percent for the period 1961 to 1965; a ratio assumed to remain constant over the forecast period resulting in the following estimates in 1965 dollars:

	1971	1976	1981
	(millions of dollars)		
Value added primary forestry	37.9	44.3	50.1

8.3.2 Pulp and Paper Industry

The potential development of the pulp and paper industry depends on many factors, from the potential of the forest resource to the demand conditions prevailing in international markets.

The existing mills and the proposed new mills are treated separately to allow for the assessment, on a regional basis, of industrial demand and the municipal demand generated by the corresponding employment in related service sectors.

Basic data for this sector to 1971 were obtained from various unplublished working documents supplied by the Board. Data for 1976 and 1981 are based on the economic assumptions described in Section 5.3. The report assumes no major change in the basic process now being used by the two existing mills, an assumption that is of particular importance with respect to problems of possible pollution and effluent treatment.

Nominal capacity expansion is anticipated at the two existing mills before 1971. By 1971, their rated daily capacity is assumed to be:

Bowaters - 1,610 tons per day newsprint

Price - 1,090 tons per day newsprint

An employment level of 2850 for the two existing mills is assumed to reflect the anticipated increase in productivity up to 1971. Thereafter, until 1981, employment is assumed to remain constant with productivity increasing at the rate indicated by the increase in plant output, that is, from 78 percent capacity in 1971 to 88 percent in 1976, and 100 percent in 1981. Newsprint production from these two mills was estimated as follows:

	1971 - 78%	1976 - 88%	1981 - 100%
	(in thousands of tons)		
Bowaters	439.5	495.9	563.5
Price	297.6	335.7	381.5
	737.1	831.6	945.0

The following forecasts, stated in terms of 1965 dollars, assume that the existing mills will continue to produce a number of sundry items such as those itemized in the Department of Mines, Agriculture and Resources Annual Reports[3, 5].

FORECAST OF PRODUCTION AT EXISTING MILLS

	1971	1976	1981
	(in millions of dollars)		
Value of Shipments	105.4	118.9	134.2
Value Added	52.7	59.5	67.1
Wages and Salaries	23.7	26.8	30.2

Two new mills are proposed for the Island and both are expected to be in production by 1971.

According to the basic economic assumptions (Table 5-1), the first is to be a newsprint mill, using a sodium base sulphite process and conventional mechanical pulp, at Come By Chance. The rated capacity of the plant is 600 tons per day with an employment of 400 over the forecast period.

The other new mill, to be built at Stephenville, will be a sulphate (kraft) process to produce linerboard. The rated capacity will be 1000 tons per day with an employment of 400 over the forecast period.

Based on the assumptions provided by the Board, the following table summarizes the activity forecast for the two new mills over the forecast period:

Come By Chance	1971	1976	1981
Employment	400	400	400
Value of Shipments*	26.2	38.5	43.7
Value Added*	11.6	16.5	18.8
Wages and Salaries*	3.6	4.1	4.5
Stephenville			
Employment	400	400	400
Value of Shipments*	39.8	44.9	51.0
Value Added*	19.9	22.4	25.5
Wages and Salaries*	3.6	4.1	4.5

It is assumed that average wages and salaries per employee will be higher at the two new mills, reflecting the higher productivity implicit in the employment data.

Although the employment generated by the two new mills appears low in comparison to the existing mills, the levels are not unreasonable when compared to new mills in other parts of the country.

* In millions of 1965 dollars.

The Provincial forecasts in 1965 dollars based on the assumptions provided by the Board are as follows:

	1971	1976	1981
Employment	3,650	3,650	3,650
Value of Shipment*	171.4	202.3	228.9
Value Added*	84.2	98.4	111.4
Wages and Salaries*	30.9	35.0	39.2

* In millions of dollars.

8.3.3 Forest Management and Forest Products Other than Pulpwood

At the present time according to Ker[1], "companies freely admit that forest management is not now being practiced." With the addition of the two proposed mills and the changing cost structures in the industry it is assumed that during the study period some form of intensive forest management practices will be introduced.

It is interesting to note that recently the pulp and paper mills have initiated some action in this direction. The Price (Nfld) Company has started the first major scale tree nursery on the Island just west of Grand Falls, at Rushy Pond. The initial stage will see 18 acres seeded with black spruce. After a four year period, it is expected that five million young trees will be ready for transplanting.

The first planting, in 1971, will be made in the area south of the Grand Falls Mill where, because of repeated fire damage, there is no hope of growing a merchantable tree crop without artificial regeneration.

By 1971, when the first seedlings are transplanted, the Rushy Pond Nursery will have been enlarged from 18 to 100 acres.

For a number of years, the Provincial Forest Service has operated a small nursery at Mount Pearl.

Seed collection for the nursery has employed up to 40 men at a time. Another pilot project was the seeding by Helicopter of 4000 acres of burned areas around Carmanville and Trinity Bay.

The move towards intensive forest management practices in the Province would not only influence the level and nature of primary and secondary industrial activity, but it would also influence the water resources of the Province. The implementation of such a policy would be a fundamental change in existing practices, and as such would have far reaching effects, although the full effects would probably not be realized during the forecast period. The effects would be seen in a change in the direct physical relationships between the forest resource and the water resources, and in the indirect relationships. These indirect changes would result from the shifts in the employment structure in the industry itself and in the supporting services.

8.4 Water Demand Generated by the Primary Forest Industry

There is a complex interrelationship between the primary forestry industry and water resources. This section will analyze this interrelationship in broad terms, for the whole of the Province, to determine the direct water demand, or the changes in water availability (which may be considered an indirect water demand). More details will be given in Volume Six on water demand and availability in selected river basins.

The main areas of interrelationship are:

- influence of forestry operations on hydrologic cycle and runoff variations;
- influence on water quality due to forest exploitation;
- use of water for transportation of logs;
- "negative" demand (soil erosion, drainage requirements, flooding problems).

8.4.1 Influence of Forestry Operations on Hydrologic Cycle and Runoff Variation

The proportion of forested area in a region has an obvious influence on the hydrologic regime. The influence on the average runoff does not seem to be very significant. However, the influence on the flow variation is more marked.

8.4.1.1 Influence of Proportion of Forested Area on Average Runoff

This subject is controversial since on one hand forest increases evapo-transpiration and on the other it appears that forest is able to produce condensation nuclei, and thus increase the precipitation. However, if there is a pattern of forested and deforested areas, the latter influence would certainly be less significant, and the additional transpiration a d interception by forest might play some role in the hydrologic cycle.

The runoff studies discussed in Volume Two A, Section 16 indicate that, in the western portion of the Island, the proportion of forested area does not play a statistically significant role, whereas in the eastern portion a completely forested area might yield up to 1.4 inches of runoff per year less than a completely deforested area. For the average conditions of the Island, this would represent a decrease of about 3 percent. For Labrador the corresponding figure is 0.4 inches of runoff. The variation in the physiographical characteristics of the three areas might explain this difference, at least partially. These indications are only the result of a multiple regression analysis, hence they should be regarded with caution. More evidence discussed in the next section shows that, on the average, there appears to be little difference between a forested area and a deforested area in the Province's conditions. As a preliminary conclusion it may be assumed that deforestation does not decrease or increase the average runoff significantly.

8.4.1.2 Influence of Proportion of Forested Area on Flow Variation

The proportion of forest in a basin can significantly influence the flow variation, because forests retard runoff concentration and snow melt.

Statistical analysis of the unit hydrograph characteristics of the Island discussed in Volume Two A, Section 18.1, has shown that the most significant physiographic factor with regard to the peak of the unit hydrograph is the area of forest in the basin. According to the statistical relationship, the peak unit hydrograph flow decreases by about 1.3 cfs for each square mile of forested area in the basin (when compared to a completely deforested but otherwise similar basin). Thus, a thousand square mile river basin which is completely deforested would have in the Province's conditions a peak unit hydrograph flow of about 9000 cfs. whereas if the same basin is completely covered by forests, the corresponding value would be 7700 cfs.

Interesting evidence of influence of forests on flow regime was obtained by comparing the daily flow regime curve of the Pipers Hole River before and after a forest fire had destroyed (late in 1961) the forest cover of the basin (Figure 8 - 11). As can be readily seen from the figure, the variation of flow is remarkably different from that before the forest fire. Comparison with the flow regime of the nearby Bay du Nord River with similar physiographic conditions, but much less affected by forest fires, indicates that there is a high probability that the factor responsible for this regime change is deforestation.

Correlations of the monthly flows cf the two rivers carried out separately for the two periods, before and after the forest fire, indicate little change between the two periods. However, when shorter time intervals are considered; for example, 10 days, the two correlations tend to differ. At larger flows the Pipers Hole discharges were larger after the forest fires than one would expect from the correlation established before the forest fires. The reverse relationship applies for low flow, although at very low flow the differences tend to disappear.

The increase in large flows and decrease in low flows, which is equivalent to a reduction of natural storage, represent indirectly a demand on the water resources. This emphasizes the importa. ce of forest management to water resources management.

Some changes in the flow regime of the river might also occur as a consequence of draining of bogs for reforestation. This problem is discussed in Section 8. 4. 5.

8. 4. 2 Effect of Forestry on Water Quality

The forest and the primary forest industry influences the quality of surface water (and partially of ground water) in several ways. This section discusses the direct influence of forests and forest exploitation on water quality. The effects of log transportation are discussed in Section 8. 4. 3.

8. 4. 2. 1 Effect of Forests on Water Chemistry

Numerical relationships between the proportion of forest area in the basin and water chemical characteristics of the river draining the forest area have not been attempted because of lack of adequate data. However, it is assumed that the acidity of some of the Province's waters is related to a certain extent to the nature of forest cover, and to the distribution of swamps and bogs.

8.4.2.2 Effects of Deforestation

The most significant effect of deforestation following improper cutting or forest fires on water quality is due to soil erosion and consequent increase in the sediment concentration of the rivers. Although in many cases soil erosion after forest cutting may have occurred unnoticed, at least two instances have been reported; one in the Birch Ridge area which drains into Indian River near Birchy Lake, the other on a slope above the north side of Victoria Lake, near the southeast end of the lake.

Similarly two cases of soil erosion after burning were observed, Miguel Hill near the Great Rattling Brook south of Grand Falls, and in the Bonavista North Peninsula where some complete wash-outs of top soil occurred after the severe 1961 fire. For the Pipers Hole River basin, turbidity measurements in 1956 and 1966 appear to indicate some increase in turbidity for the latter period. This is presumably related to the forest fire in 1961. However, these measurements are not conclusive, since the measurements before the forest fire are too few[5], and those in 1966 were carried out five years after the forest fire when the rate of soil erosion had probably decreased.

Soil erosion may be also related to poor practices in opening roads and trails and other wood operations.

Although forest exploitation or forest fires are not the sole sources of soil erosion and sediments, the troubles experienced with water intake ponds in some cases such as those supplying Corner Brook may possibly be due to the forest cutting practices in the area as discussed in Volume Six A, Part II. Proper forest management in the cutting systems used and proper distribution of brush as well as reforestation should be considered for preserving water supply reservoirs, especially shallow ones, from rapid sedimentation due to soil erosion.

8.4.2.3 Effects of Sawdust from Sawmills

Another source of water quality changes due to forest is waste disposal at sawmills, which may adversely affect river water quality by bark and sawdust pollution and consequent smothering of bottom fauna, as indicated by Larkin[8]. Although the reduced saw milling activity in the Province might imply that this is not a significant problem, checking for proper bark and sawdust disposal facilities at larger mills is recommended, especially if lumbering activity should increase. The possibility of using the wood wastes for producing heat and steam should always be considered as a means of disposing of these wastes.

8.4.2.4 Effects of Insecticides

An important source of water pollution related to forestry activity is the spraying of insecticides. The existence and spread of hemlock looper and woolly aphid led the Provincial authorities to carry out, after extensive discussions, a spraying program to control the hemlock looper in 1968. Certain pesticides have been known in the past to cause serious pollution and although recently developed pesticides are not resistant to degradation and can be detected only in streams and lakes directly adjacent to the sprayed areas (Bailey and Hannum[9]), nevertheless not all of their effects have been fully investigated and it is therefore recommended that action in this field be fully co-ordinated with all interested parties, including public health and fisheries representatives.

8.4.3 Wood Transportation

Wood transportation by log-driving, trucking and, as recently proposed, by pipelines, have all a certain influence on water quality and river flow regime, and might impose withdrawal demand.

8.4.3.1 Log Driving

Log driving activities result in changes of water quality and river flow regime (Figure 8-10), as discussed in Volume Four, Section 3. As a conclusion of the Section it was indicated that, although log driving is considered a non-withdrawal use, by impairing the river water quality and by mechanical degradation of river channels it induces losses equivalent to withdrawal uses, because of reduced suitability of the affected rivers and lakes for fisheries, recreation and possibly for domestic water supply unless it is treated to remove excessive fibre content. However, the data so far available are not sufficient to indicate what this loss represents in terms of monetary value. Nevertheless, wherever comparisons between alternatives of log transportation are examined, these aspects should be carefully considered.

8.4.3.2 Trucking

Generally trucking is related to mechanization and, if it results in debarking directly in the forest, may represent significant economies of water at the mill, and may eliminate the problems of bark disposal.

Trucking may induce local erosion if roads are improperly designed, particularly insofar as drainage is concerned. However, trucking is preferred to log driving from the viewpoint of water resources management when other criteria are not decisive, and should be encouraged in further developments.

8.4.3.3 Piping

In 1953 the Pulp and Paper Research Institute of Canada initiated an investigation on the technical and economical feasibility of shipping chips by pipelines[7]. This would result in by-passing some of the steps in the handling and rehandling of individual pieces of wood on their way from the forest to the mill. Indications are that convenient pipes would be made of aluminum, although other materials are not excluded. Such a method of transportation could have important technological and economical benefits for the pulp and paper mill, which have not yet been fully investigated, including the possibility of some processing of the material toward pulp during transport.

Since the chip water mixture would represent a ratio of about 1:1.5, water requirements to transport up to 2000 cords per day would be of the order of 5 cfs. This would require the fully regulated runoff from an area of about 2 square miles, or of a larger area if full regulation is not possible. Such sources of supply would be easy to find in the forested areas. This water might be reused at the mill in further operations, and the effect of such a withdrawal use can be considered for all practical purposes as negligible.

This transportation method would have some interesting advantages from the viewpoint of water resources, in that it would:

a) Avoid the water quality deterioration and other inconveniences produced by log driving.

b) Remove the debarking process from the pulp and paper mill, thus reducing the water demand and waste disposal problems.

c) Provide the possibility of using pipelines for fire fighting under emergency conditions.

d) Increase the overall efficiency by more complete usage of the trees.

Disadvantages in the Province's conditions would be problems related to freezing in the pipe and consequently difficulty of operation during the winter, the high investment involved, and the reduction in labour input in the primary forestry industry.

8.4.4 Use of Water for Domestic and Wastewater Requirements by Workers in the Woods

Permanent logging camps were used to a lesser extent in recent years, because improved transportation facilities permit commuting in most cases. Domestic use for these camps and the related problems of waste disposal are not significant, and could be neglected in the framework of the present study.

8.4.5 "Negative" Demand

This arises from the need to reduce runoff concentration for the purpose of avoiding soil erosion: bog and swamp reclamation to enable aforestation or normal forest growth: and protection against flooding, especially by man-made reservoirs.

8.4.5.1 Soil Conservation Measures

These pertain mostly to forest management, and consist of proper cutting and distribution of brush, preservation of forest strips, cutting of fire breaks and expansion of fire-fighting facilities, seedling planting, etc. Each situation should be considered on its own merits, as conditions will vary considerably.

8.4.5.2 Bog and Marsh Reclamation

In this report, bog is considered a vegetal soil formation consisting mainly of sphagnum with other vegetation occurring occasionally; whereas a marsh is considered a soil with excessive humidity because of poor drainage covered by underdeveloped vegetation.

So far bog reclamation has apparently been carried out only for agricultural purposes (crops and pasture). Nevertheless bog reclamation for aforestation might also be one of the objects of forest management and deserves further investigation. Although this might, to some degree, initially increase the acidity of the rivers and lakes into which they are drained, it is believed that this would not involve any significant change in their water regime. The runoff correlations do not indicate conclusively the changes in average runoff which might occur with decrease in bog area, and compensation for any such changes would probably arise by reason of the increase in forest area.

Marsh reclamation is not of significance for the Province, since marsh areas are not extensive. In any case, each problem will have to be considered in the framework of local conditions.

8.4.5.3 Flooding

Natural flooding is not significant for forests and forest exploitation, apart from occasional and local difficulties in logging operations. However, it should be mentioned that Stage I of the Bay D'Espoir power development resulted in the flooding of about 20,000 acres of productive forest land, with a net initial loss of 28,000 cords and corresponding productivity losses. In addition to this net loss, it is anticipated that another 100,000 cords will be made economically less accessible. Stage II is expected to flood an additional 32,000 acres including a considerable area of productive forest land.

8.4.6 Water Resources Implications

The complex interrelationship discussed in the preceding sections results in the following water resources implications.

8.4.6.1 Effects of Primary Forest Industry on Other Water Resources Developments

Due to log driving and soil erosion, the primary forestry industry can impair to some extent the river and lake water quality with possible deleterious effects for fish (Exploits River, and to a lesser extent Humber River), industrial and domestic water supply (Corner Brook River), siltation of reservoirs (Corner Brook area), and some difficulties in operating hydro-electric and other intakes. Careless deforestation and especially forest fires may result in increased flow variability, and consequent increase in storage requirements for water supply or hydro-electric power regulation, and larger spillway capacities. Lack of clearing of areas flooded by new reservoirs can reduce their usefulness by impairing their water quality and possible use for recreation. Examples are the Bay D'Espoir development and the Terra Nova development which has been studied by the Newfoundland and Labrador Power Commission. By disturbing the wildlife habitat, the forestry industry may occasionally add to the negative impact on recreation activities. However with careful forest management this can be avoided and conditions can even be improved.

8.4.6.2 Influence of Other Water Resources Developments On Primary Forestry Industry

Direct or indirect effects of different water resources developments on forest and logging operations can be expected in most cases. For example, some existing and future reservoirs related to hydro-electric developments result in flooding of forested area (Grey and White Bear reservoirs, the Terra Nova Scheme), thus reducing the timber reserves. It should be noted that in the Province's condition such losses can be significant. This again points out the necessity of careful forest management which, through increased yield, could compensate for these losses. Efforts to salvage some of the commercial stands through cutting before flooding should always be considered. Furthermore, the extension of road networks which generally accompanies the hydro-electric development of a basin may, in some cases, open up new areas which were previously inaccessible for logging. Such is the case with the Bay D'Espoir development, and would be the case if the Cat Arm basin is developed.

8.4.7 Forestry Industry and Weather Modification

Successful increase of precipitation during dry periods could be helpful for forests by ensuring a normal growth rate and fire protection. As shown in Volume Two A, Section 13, in other parts of the world, cloud seeding can probably increase the runoff by 6 to 8 percent and probably increase the precipitation and actual evaporation. The evidence available for Newfoundland is not conclusive, but topographical and meteorological conditions indicate that such operations could be successful both in Newfoundland and Labrador. At least further experimental investigations in this area are recommended.

8.5 Pulp and Paper Industry - Specific Water Demand and Wastes

From the viewpoint of water resources, data on water demand arising from two distinct requirements of the pulp and paper industry are most significant:

a) The water intake demand.

b) The degree of its degradation by industry prior to return to the receiving body.

The water depletion (difference between intake and effluent water) is not an important factor in the province's conditions.

The type of pulp and paper mills to be considered, as shown in Section 8.3, are the groundwood plus sulphite newsprint and the kraft linerboard.

8.5.1 Intake Water Demand

The optimum water intake cannot be determined unless all the characteristics of the plant, including its environmental conditions, and the water cost are known. Furthermore, each particular case requires the establishment of a model for the assessment of different technologic alternatives, involving different amounts of intake water. An extensive analysis of the problems of such a model was done by Eliassen[10]. However, since such an analysis was outside the scope of the present study, the intake water demand for the pulp and paper industry was estimated from literature data and a statistical analysis based on the limited information available.

8.5.1.1 Literature Data

As shown in Volume Eight, Appendix B, Part I, the literature survey has resulted in ranges of water intake for different types of pulp mills, as well as for integrated pulp and paper mills.

It can be assumed that the upper limits of these ranges represent approximately the optimum unrestricted water intake demand. It might further be assumed that the lower limits would be close to the restricted water demand in difficult conditions. Since available data did not provide ranges for a kraft unbleached linerboard mill, the water demand was computed by adding to the demand for unbleached kraft pulp that for a board mill using imported pulp. This leads to a range of 17,000 to 48,000 gallons per ton of product.

For newsprint mills using sulphite pulp, the accepted range is that indicated for mills producing pulp and newsprint, namely, 20,000 to 50,000 gallons per ton of product.

8.5.1.2 Specific Water Usage in the Province

The existing pulp and paper mills have the following approximate specific water demand:

Price - 42,000 gallons per ton of product

Bowaters - 32,000 gallons per ton of product

Actually, the total water intake of the Price paper mill has a capacity more than double that corresponding to the specific water usage indicated above, but almost all this additional water is used for wood handling and it is not known for what length of time this additional intake is operated. If the water used for wood handling is considered, the specific water demand at this mill reaches about 117,000 gallons per ton of product.

8.5.1.3 Statistical Approach

As shown in Volume Eight, Appendix B, Part I, Section 6, statistical processing of the U.S. Census data based on regional averages has resulted in correlations which enable approximate estimates of probable intake and process water demand. It is realized that the data processed for this purpose was regional and macroscopic, and therefore the results have limited application in Newfoundland. Nevertheless, they are considered useful for this study as indications of water demand for preliminary planning. In the United States a significant part of the intake water is used for cooling, whereas in the Province's conditions the process water is almost equal to the water intake demand. Hence, for the present study, it may be presumed that the process water represents a better approximation of the probable water intake demand. If, as recommended in Volume Eight, Appendix B, Equation 5 (Figure 8-12) is used, the following specific demand is obtained:

a) For the kraft linerboard mill at Stephenville - 19,000 gallons per ton of product.

b) For the sulphite-groundwood newsprint mill at Come By Chance - 25,000 gallons per ton of product.

The computations for estimating the intake (process) water for the two new mills were done taking into account the planned development in the areas and the corresponding 1981 populations. Both values are within the ranges indicated under 8.5.1.1 and very close to the lower limit.

If Equation 6 discussed in Volume Eight, Appendix B, Part I is used, and which includes Newfoundland data in the statistical analysis, values approximately twice as large as those indicated above are obtained. This would correspond to the average values of the literature ranges and would be very close to the specific water demand at existing mills in the province. Nevertheless, it is considered that in the given conditions, the probable water intake demand will be closer to that obtained from Equation 5, because of lower demand for wood handling and competitive demand for the water resources in the areas concerned. In any case, it might be stated that the probable water intake demand by the new pulp and paper mills could vary within the limits indicated by the two equations. This narrows the range to about half that obtained from the literature survey.

The Cost of Clean Water, Volume III, No. 3, Paper Mills[11] in discussing amounts of wastewater, which do not differ substantially from the intake water amounts, indicates that while today's typical pulp and paper mills release 33,000 gallons per ton of product, mills using newer technology have wastewater releases only of 20,000 gallons per ton of product.

8.5.1.4 Quality of Intake Water

The quality of intake water for different types of pulp and paper mills is indicated in Volume Eight, Appendix B, Part I. It should be noted that since the pulp and paper mill at Come By Chance will produce both sulphite and groundwood pulp, the higher requirements will have to be satisfied for the total water intake unless water used for one or both processes is treated.

8.5.2 Wastewater Characteristics

Accurate estimates of the wastewater characteristics for a new mill would require an analysis based on a model similar to that for the intake water demand[10]. These characteristics will depend on the technologic process used and degree and method of treatment, which in turn depend on economic conditions (including the uses of the receiving body of water), legislation, and many other factors. Since such a model is outside the scope of this study, the following discussion is based on literature data which mainly reflects the methods of wastewater disposal which are particular to each process used, rather than the restrictive conditions imposed by other users of the affected water resource.

8.5.2.1 Quantity of Wastewater

Gebrun[12], the TAPPI Monograph No. 18[13], as well as data from Newfoundland paper mills, indicate that the amount of wastewater represents about 90 to 95 percent of the amount of intake water (Volume Eight, Appendix B, Part I).

8.5.2.2 Quality of Wastewater

The normal ranges of strength of various pulp and paper mill effluents from the viewpoint of suspended solids and 5-day BOD are indicated in Volume Eight Appendix B, Part I. According to the data shown there, it might be expected that the kraft mill will release suspended solids within the range of 20 to 30 pounds per ton of product. For the groundwood-sulphite newsprint mill, if one assumes that the ratio of sulphite pulp to groundwood pulp will be 1:4, then the suspended solids would represent some 40 to 75 pounds per ton and the BOD about 100 to 150 pounds per ton of product. These figures do not appear to include debarking effluents, although this is not clear. Debarking effluents from drum debarkers can contain up to 50 percent of the bark in the form of fine solids. Large solids are normally removed by screening for burial or burning as is done at the Newfoundland mills.

The literature does not indicate the amount of sulphite waste liquor, but the waste liquor quantities would be highly variable depending on the volume of water used in the blow tank and, in the case of kraft pulp, the volume of water used in the washers and the number of washing stages that follows the blow tank. Sulphite waste liquor (SWL) from Price is about 1200 gallons per ton of pulp.

The chemical composition of SWL and KWL (kraft waste liquor) depends on the species of wood being pulped and the cooking chemicals being used (for example, sulphite cooking may be carried out using $Ca(OH)_2$, $Mg(OH)_2$, NaOH, NH_3OH).

SWL contains in dissolved or finely divided suspension approximately half of the weight of the wood used for pulping and comprises fibre-binding substances, such as lignin and pectin, hemicelluloses, sulphur dioxide, sulphites, polythionates, organic acids and numerous other organic and inorganic substances. Most SWL's contain 10 to 14 percent total solids with 5-day BOD values of about 30,000 mg/l.

Since the kraft process includes recovery there is little waste liquor associated with it.

Because of the many unknowns regarding the chemical compositon and concentration of the SWL, it is extremely difficult to indicate treatment required. Both primary and biological processes are readily adaptable to the treatment of these wastes. Since the sulphate process includes chemical recovery from the spent liquor, its polluting effects are less significant than those due to the sulphite process. The kraft process generally uses only chemical pulp and it may be assumed that the treatment requirements for this process will be substantially less extensive and costly than for either the sulphite or sulphate process.

More detailed discussions of the water quality and quantity characteristics of the pulp and paper manufacturing industry are contained in Volume Eight, Appendix B, Part I.

8.6 Pulp and Paper Industry - Present and Forecast Water Demand and Wastes

As noted in the previous section, the water intake of the existing pulp and paper mills correspond more or less to the average of the demand range indicated in literature. Future expansion of the existing mills may require a reduction of the specific water demand in order to avoid excessive capital expenditure on the supply system. This problem, however, would have to be analyzed on an individual plant basis. So far wastes have been released by the industry without treatment, taking advantage of the relatively large flows available for dilution in one case (Exploits River) and of the possibility of discharging the effluent in tide water in the other (Humber Arm). Nevertheless, cumulative effects of settleable wastes are potentially harmful, and this must be kept in mind when disposal systems of new mills are being planned.

The new pulp and paper mills might have to include water conservation measures from the beginning, since the water availability in the areas in which they will be located is relatively low. However, these mills may benefit from their location near tide water for their wastewater disposal. Nevertheless, the problems related to settleable solids observed at the existing mills should be kept in mind when designing wastewater disposal systems of the new mills.

8.6.1 Present Day Intake Water Demand and Wastewater Releases

The following data for the water demand and usage by the existing mills in Newfoundland have been obtained from the questionnaires completed in connection with the present study, supplemented by direct information obtained during trips to the mills.

8.6.1.1 The Price (Nfld) Pulp and Paper Mill

Two water systems are in use; the first with a capacity of 41,000 gpm is used for wood handling and debarking and is probably not operating continuously; the second system, having a capacity of 23,000 gpm, is the main supply system of the mill and is used for the process involved in producing groundwood pulp, sulphite pulp, and newsprint, as well as for sanitary use around the mill and for municipal use in the town of Grand Falls. All of the water in this second system is screened to remove solid matter, and the portion used for sanitary purposes, including that for the town of Grand Falls, is chlorinated and filtered. It is estimated that Grand Falls uses about 1,000,000 gpd.

Considerable re-use of the process water takes place, but this is largely for the purpose of avoiding excessive waste of wood fibre and heat, rather than to save water.

Loss by evaporation, water content in the paper, and exhaust steam are of negligible proportions.

Wastewater is discharged untreated to the Exploits River below the mill. It includes sulphite waste liquor amounting to 0.5 million gpd. There are no other data on the wastewater characteristics. It is estimated that they include about 32,000 pounds of suspended solids, 450,000 pounds of dissolved solids, and 70,000 pounds of BOD_5 per day. The wastewater pH is estimated to be between 5 and 6.

The bark removed from the logs was dumped into the river until about 1956. It is now reclaimed and used for the production of steam for the mill at an estimated 50 percent saving, compared to other fuel sources.

8.6.1.2 The Bowaters Newfoundland Limited

The Bowaters mill obtains its 40 million gpd requirements from three intakes. Two of these draw their water from the Corner Brook River; the larger, amounting to an average daily intake of 33 million gallons, is used as process water in the mill; the second, of 5 million gpd, is used for wood barking and handling. The third intake of 2 million gpd is from the municipal system and is used for boiler feed water after being treated by means of a sodium zeolite system, and for drinking-sanitary purposes.

The wastewaters from the mill represent about 37 million gpd. The amount of sulphite waste liquor is estimated at approximately 0.6 million gpd. One analysis available from the mill wastewater indicates a content of 30,000 pounds of suspended solids and 990,000 pounds of dissolved solids per day. These figures may be representative of the average conditions, and are in line with the ranges indicated by the literature survey summarized in Volume Eight, Appendix B, Part I. The estimated BOD_5 content of the wastewater is approximately 90,000 pounds per day. The pH is probably in the 5.0 to 6.0 range. Following debarking, the water is pressed from the bark which is used for fuel.

8.6.2 Future Intake Water Demand and Wastewater Releases

Studies on the water supply for the new pulp and paper mills at Come By Chance and Stephenville are well advanced. However, the problems of wastewater disposal apparently are still under investigation. Therefore, the discussion included in this section on wastewater releases is based on literature data and assumptions rather than on actual information on the new mills.

8.6.2.1 The Come By Chance Newsprint Mill

Since the capacity of the mill will be about 600 tons per day, and assuming that the mill uses a mixture of 80 percent groundwood to 20 percent sulphite, the optimum unrestricted water demand would amount to about 30 million gpd, while the probable water demand, determined on the basis of statistical relationships and considering forecast conditions for the year 1981, would represent 15 million gpd. In the early stages of the mill design, the water demand was set at high levels (25 million gpd). However, reconsideration of requirements, based on newer technology and the availability of supply, have resulted in reducing the demand to 15 million gpd. The amount of sulphite waste liquor is estimated to be about 0.35 million gpd.

It is estimated from the average figures available that the suspended solids content of the wastewaters will be about 24,000 pounds per day, the total solids 300,000 pounds per day, and the BOD_5 about 50,000 pounds per day.

8.6.2.2 The Stephenville Linerboard Mill

This mill will use a kraft (unbleached) process at a capacity of 1000 tons per day, according to the literature data quoted in the previous section. The optimum unrestricted demand could be as high as 60 million gpd. The statistical relationships indicate a range of between 19 and 35 million gpd. Actually, preliminary water supply plans have been developed[14] for a demand of 40 million gpd (to be increased to 60 million gpd if the mill is expanded to a capacity of 1450 tons per day). It is to be noted that the 40 and 60 million gpd demand included in this study is based on the assumption that the mill will produce not only linerboard, but also corrugated medium and white bleached kraft paper. It should be kept in mind that the 35 million gpd was obtained by statistical analysis using Equation 6 (Section 8.5.1.3). As the mill will use chips imported from Labrador, it may be expected that its water demand will be lower than that of a mill processing logs, and further analysis of the water demand is required. However, for the purpose of this study, the figure of 40 million gpd was accepted, although it is considered as higher than expected under the given circumstances.

The amount of wastewater is estimated to be about 37 million gpd. Assuming that the plant will use the newer technology, the estimated BOD_5 content of the waste effluent will be about 20,000 pounds per day, and their probable suspended solids 3000 pounds, and dissolved solids about 78,000 pounds per day for a rated capacity of 1000 tons per day.

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NEWFOUNDLAND
FOREST AREAS, (PERCENT OF FOREST COVER BY SQUARE GRID) AND MAJOR BURNED AREAS

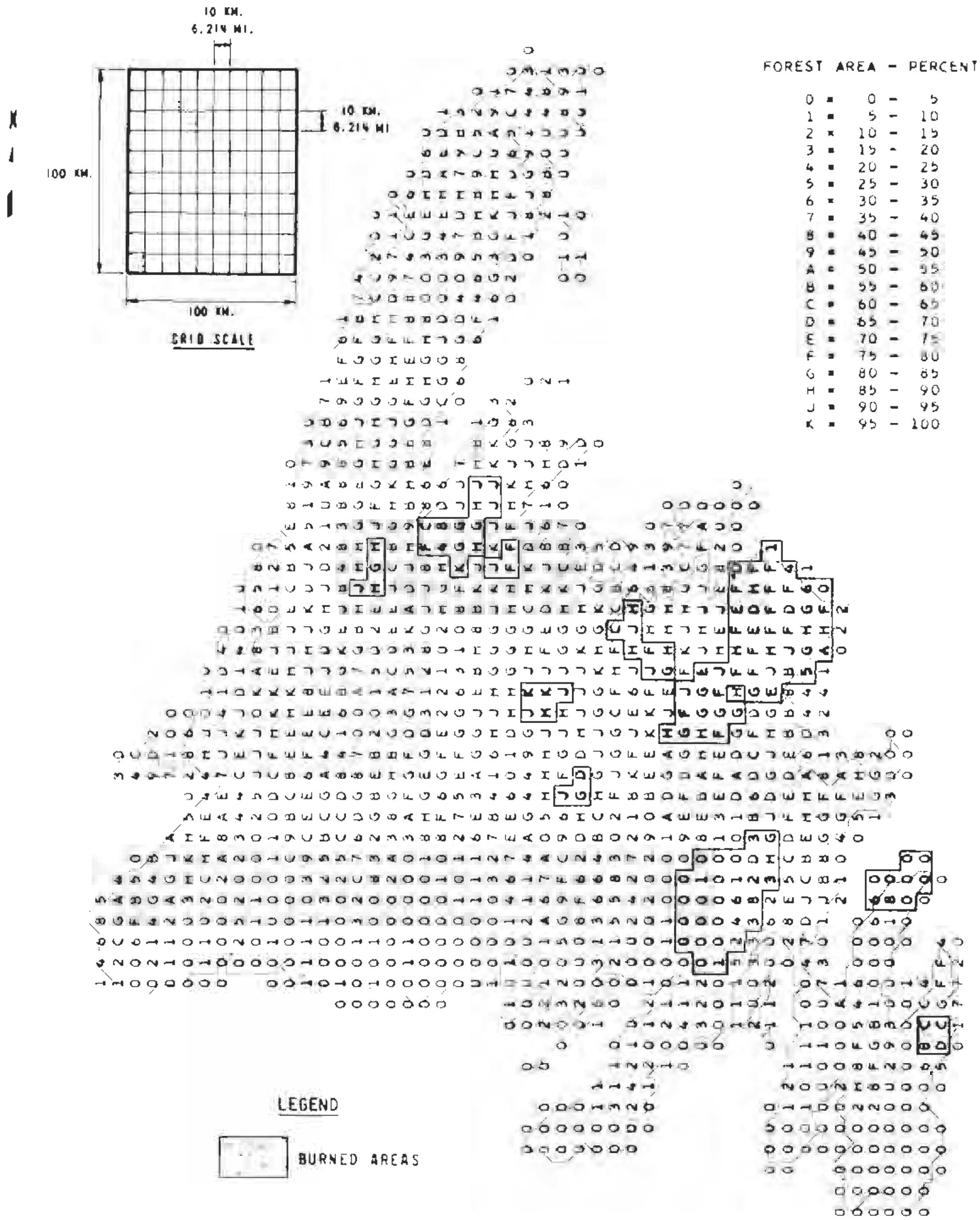
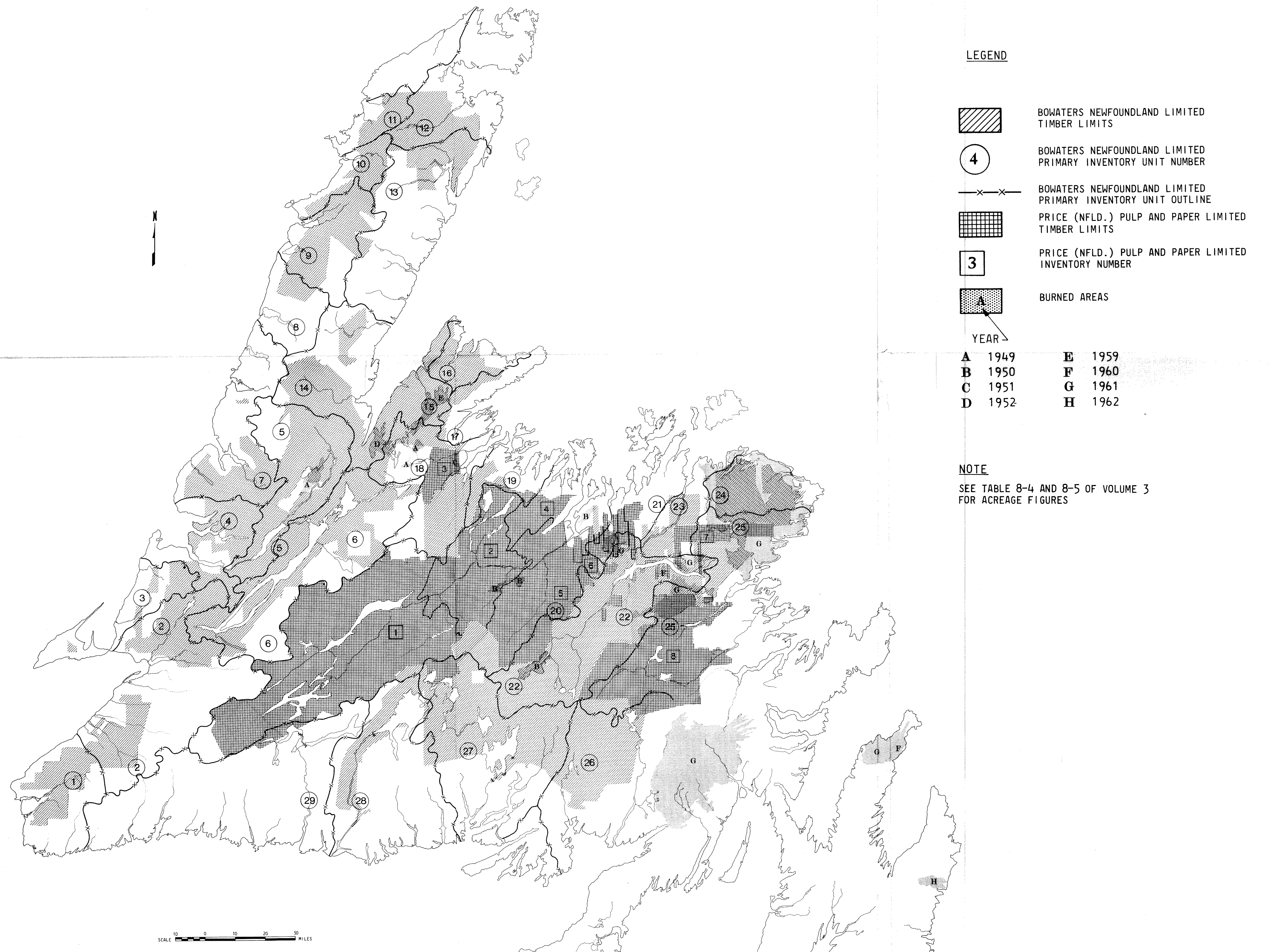


FIGURE 8-1



NEWFOUNDLAND
MAP OF EXISTING TIMBER LIMITS
AND BURNED AREAS

FIGURE 8-2

LABRADOR
SQUARE GRID FOREST DISTRIBUTION
AND RECENTLY BURNED AREAS

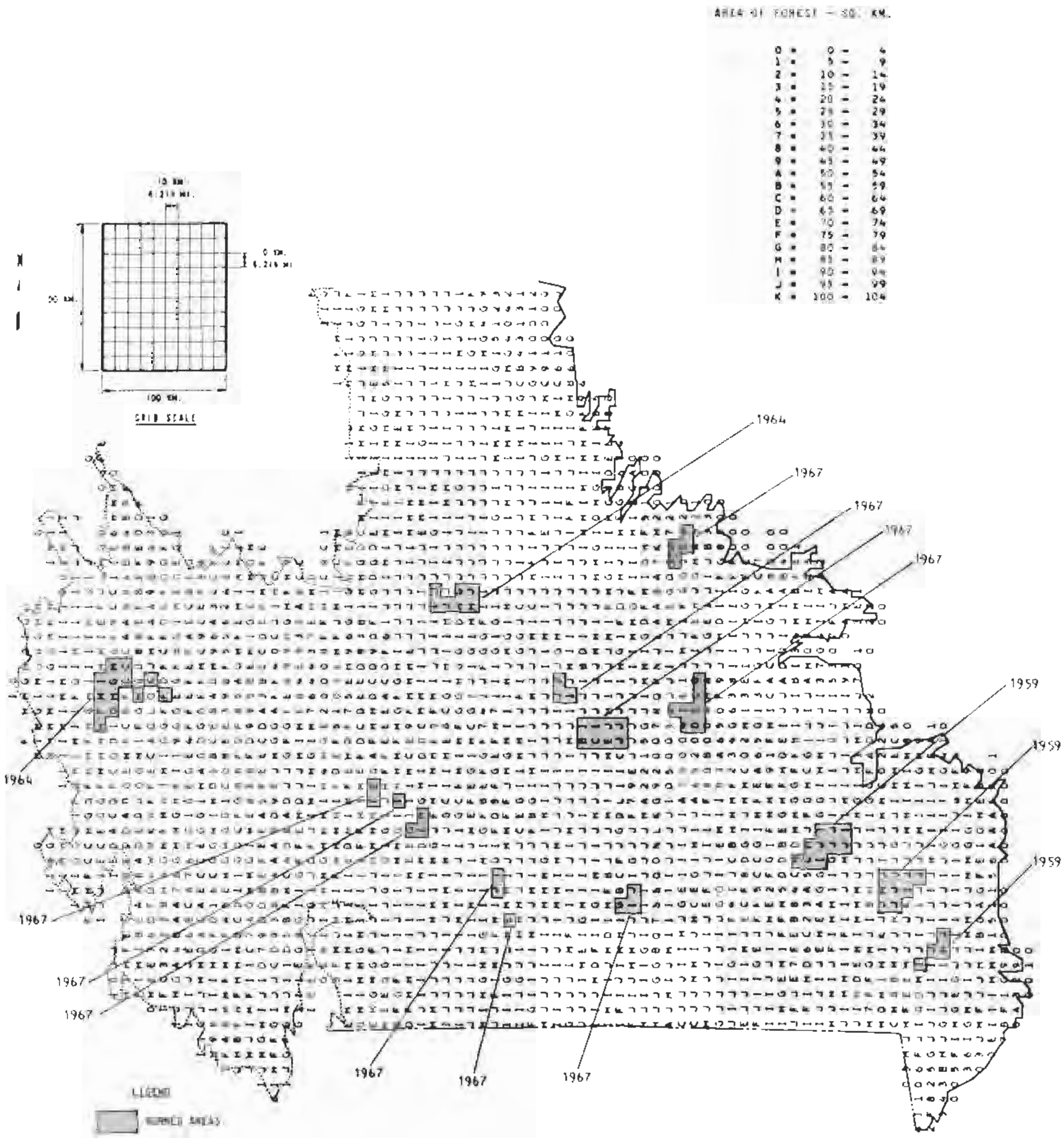


FIGURE 8-3

NEWFOUNDLAND AND LABRADOR
VALUE ADDED BY THE PRIMARY FORESTRY INDUSTRY
1951 - 1981

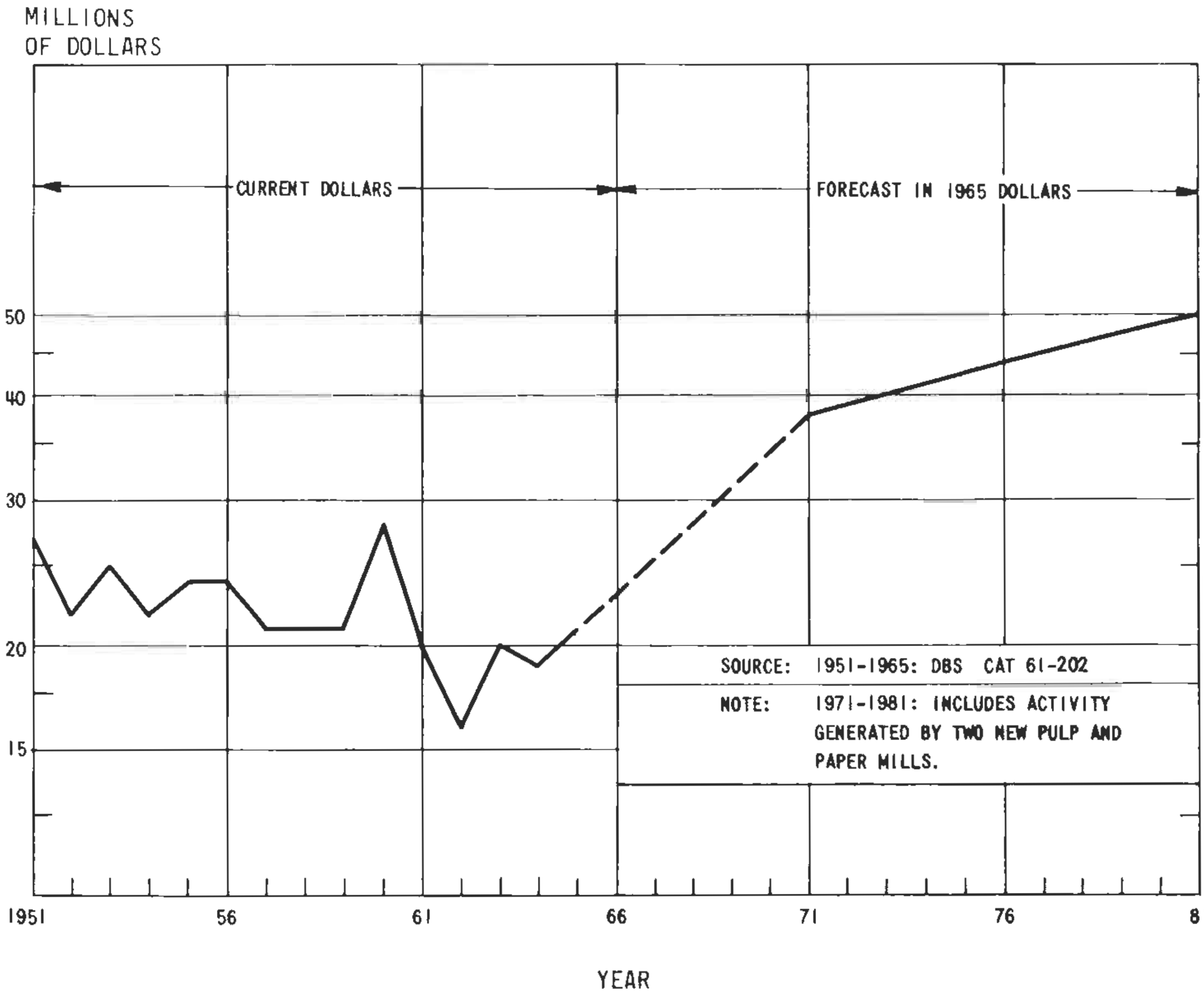
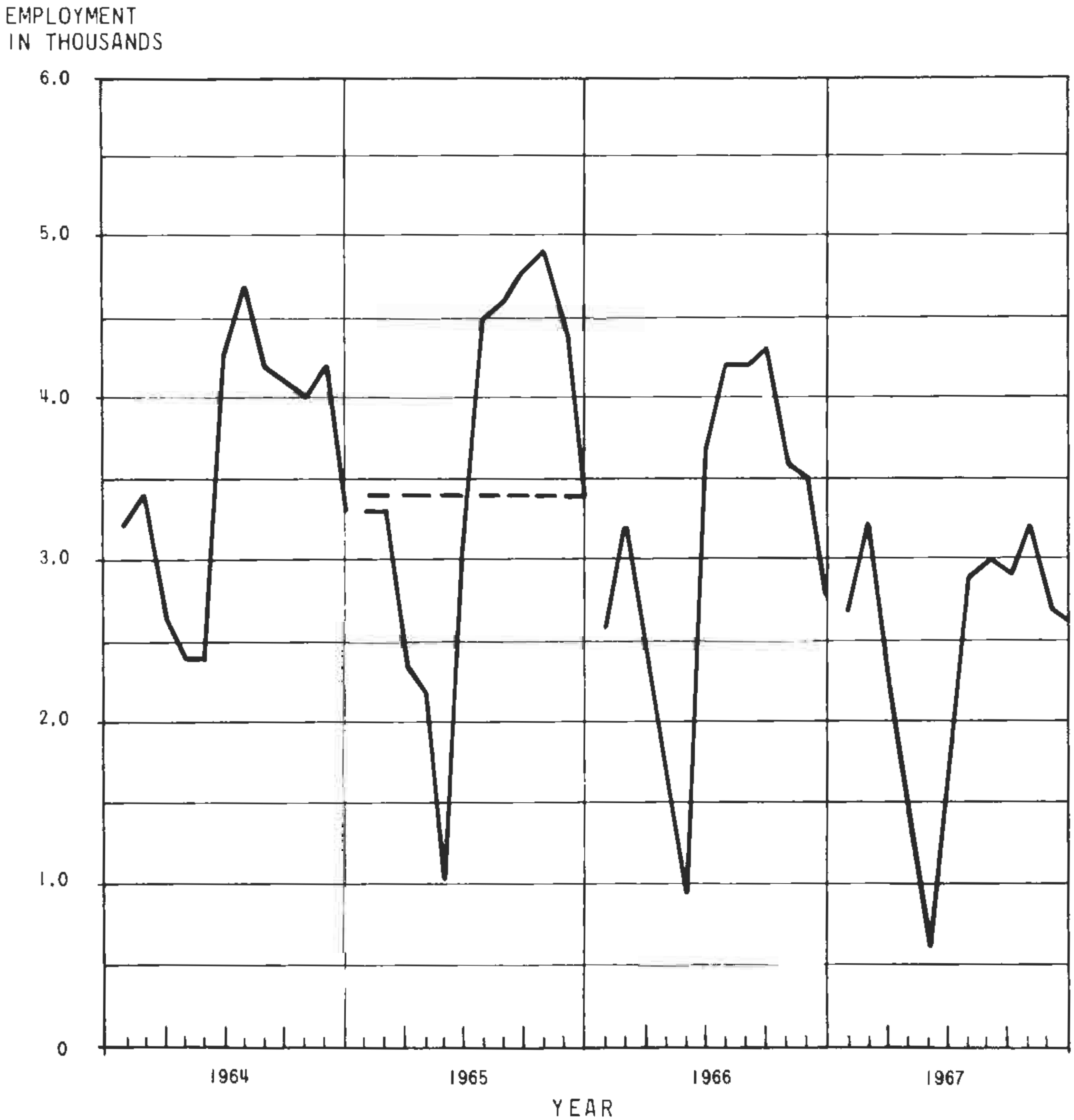


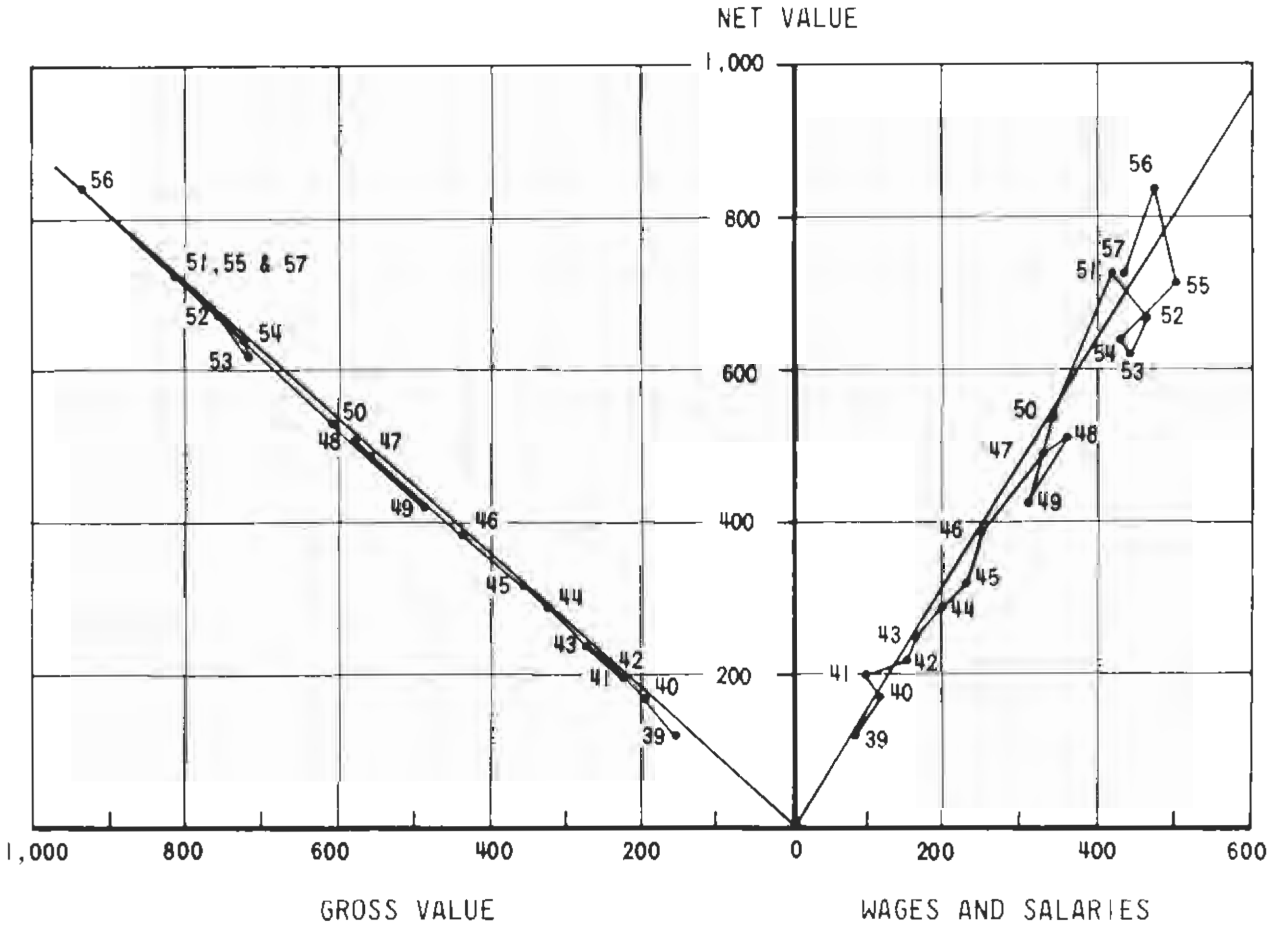
FIGURE 8-4

NEWFOUNDLAND AND LABRADOR SEASONAL PATTERN OF EMPLOYMENT IN THE PRIMARY FORESTRY INDUSTRY



SOURCE: DBS CAT. 72 - 008
LEGEND: — — — ANNUAL LEVEL OF EMPLOYMENT

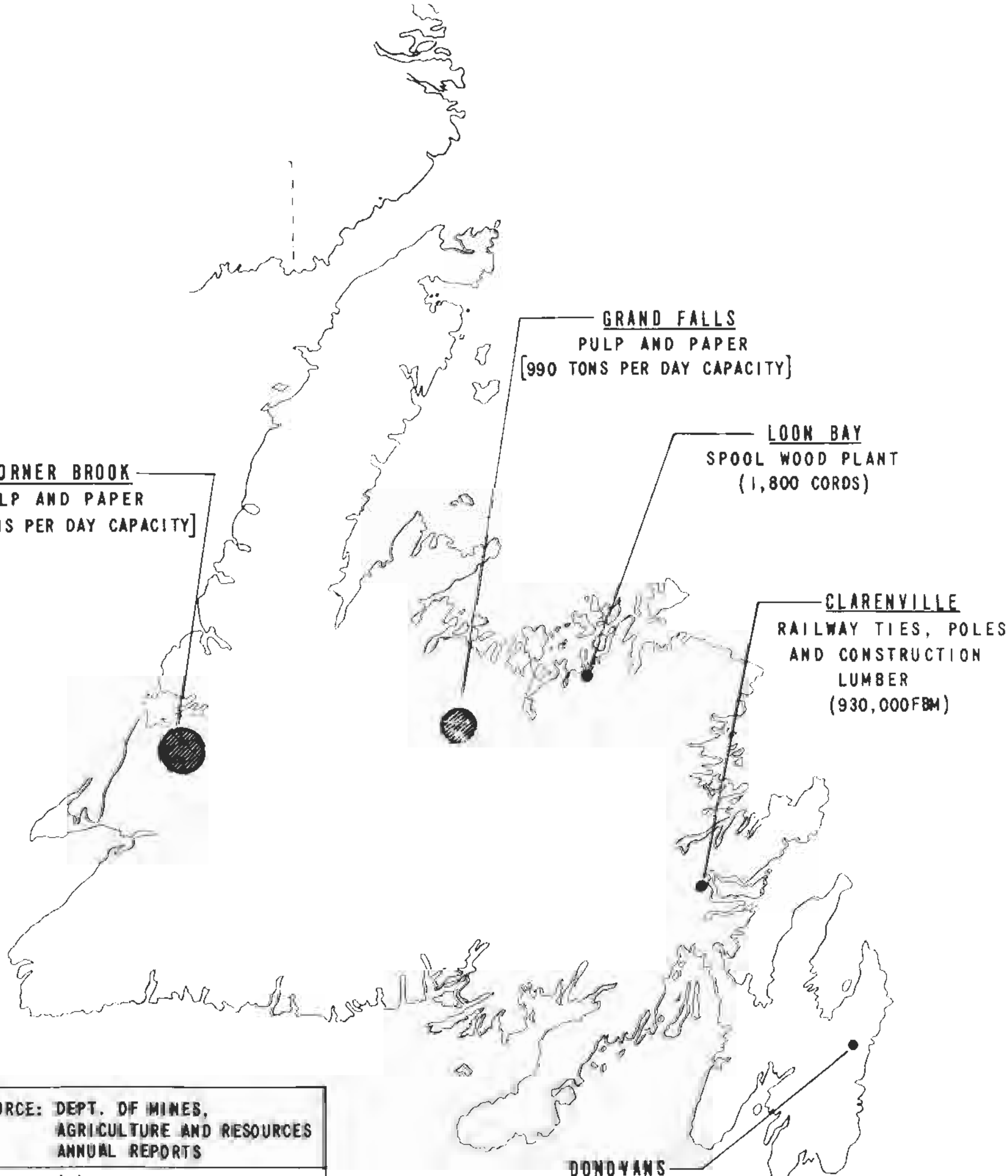
RELATIONSHIP BETWEEN ECONOMIC FACTORS
PRIMARY FORESTRY
CANADA



SOURCE: DBS CAT. 25-502 OCCASIONAL
NOTE: ALL SCALES IN MILLIONS OF DOLLARS

FIGURE 8-6

NEWFOUNDLAND
LOCATION AND RELATIVE SIZE OF PRESENT PULP AND PAPER MILLS AND LOCATION OF LUMBER MILLS



SOURCE: DEPT. OF MINES, AGRICULTURE AND RESOURCES ANNUAL REPORTS

NOTE: ( ) INDICATE ANNUAL WOOD CONSUMPTION
[ ] PRODUCTION CAPACITY TONS PER DAY

FIGURE 8-7

NEWFOUNDLAND AND LABRADOR
TRENDS AND FORECASTS OF THE PULP AND PAPER INDUSTRY
1951 - 1981

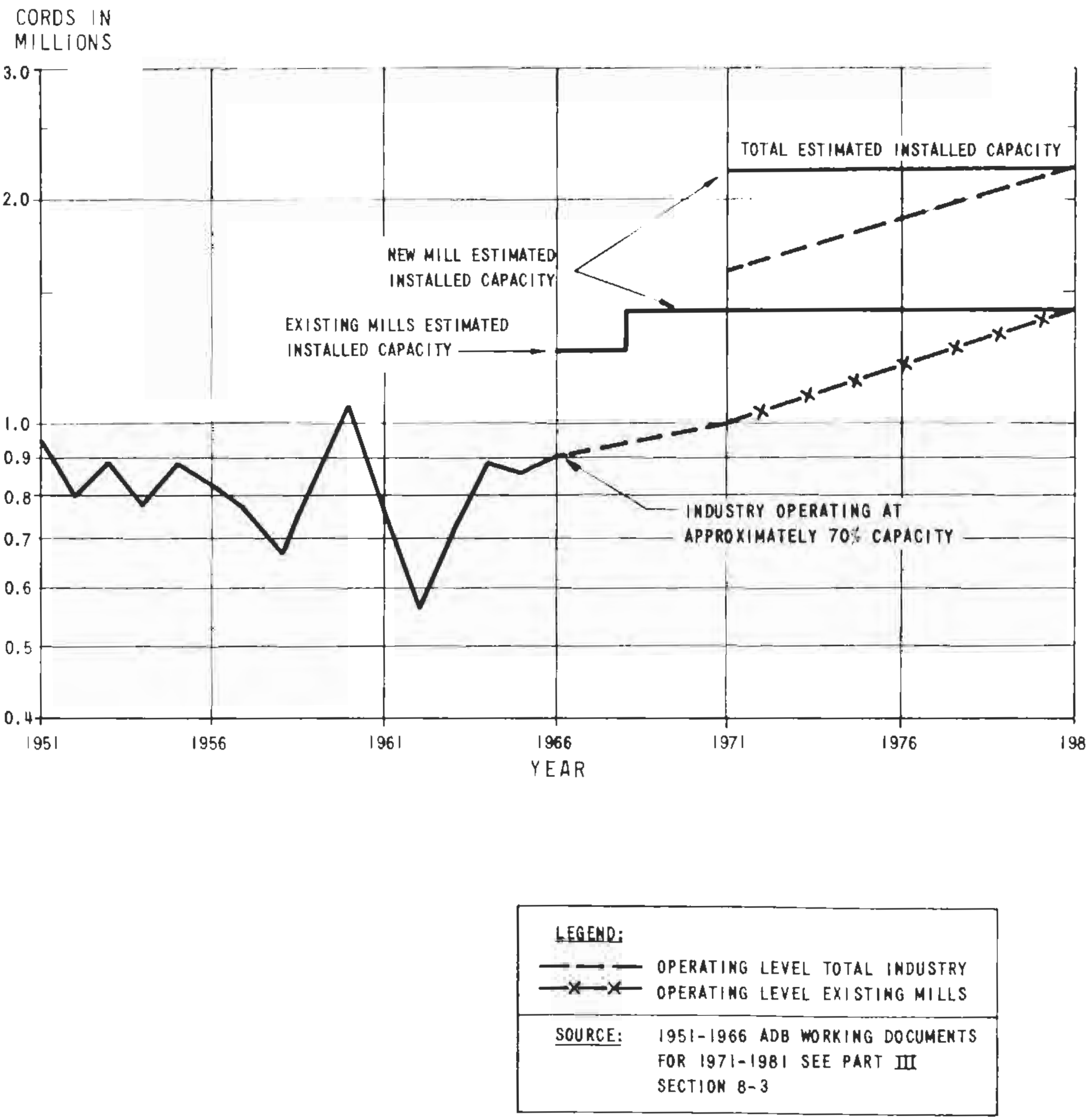
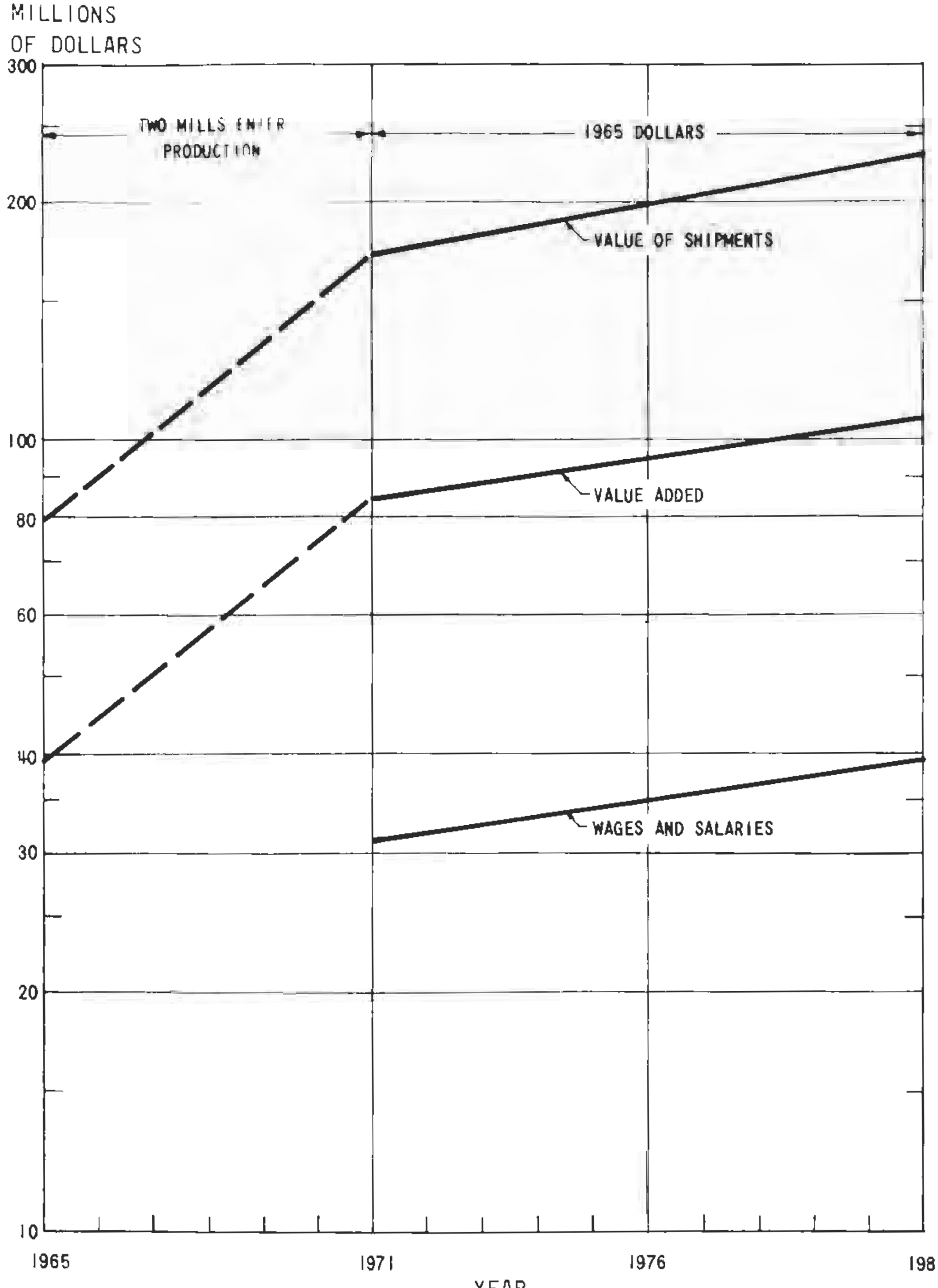


FIGURE 8-8A

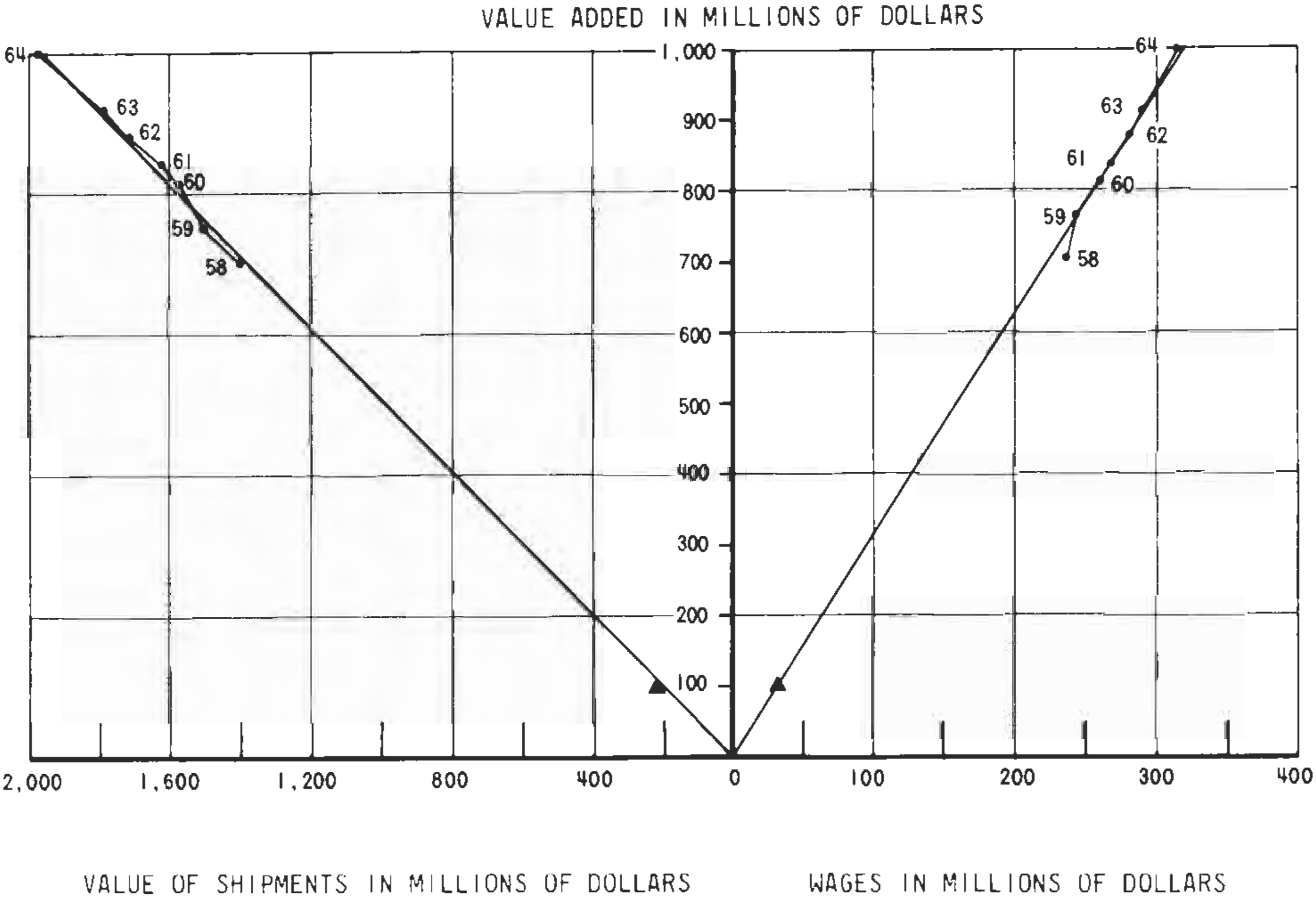
NEWFOUNDLAND AND LABRADOR
FORECASTS OF PULP AND PAPER INDUSTRY
1965 - 1981



SEE VOLUME THREE
SECTION 8

FIGURE 8-8B

RELATIONSHIP BETWEEN ECONOMIC FACTORS PULP AND PAPER INDUSTRY (MANUFACTURING ACTIVITY) CANADA



SOURCE: DBS CAT. 36-204

LEGEND:

▲ ATLANTIC PROVINCES 1963

FIGURE 8-9

NEWFOUNDLAND
EXAMPLE OF CHANGES IN REGIME FLOW
DUE TO LOG DRIVING

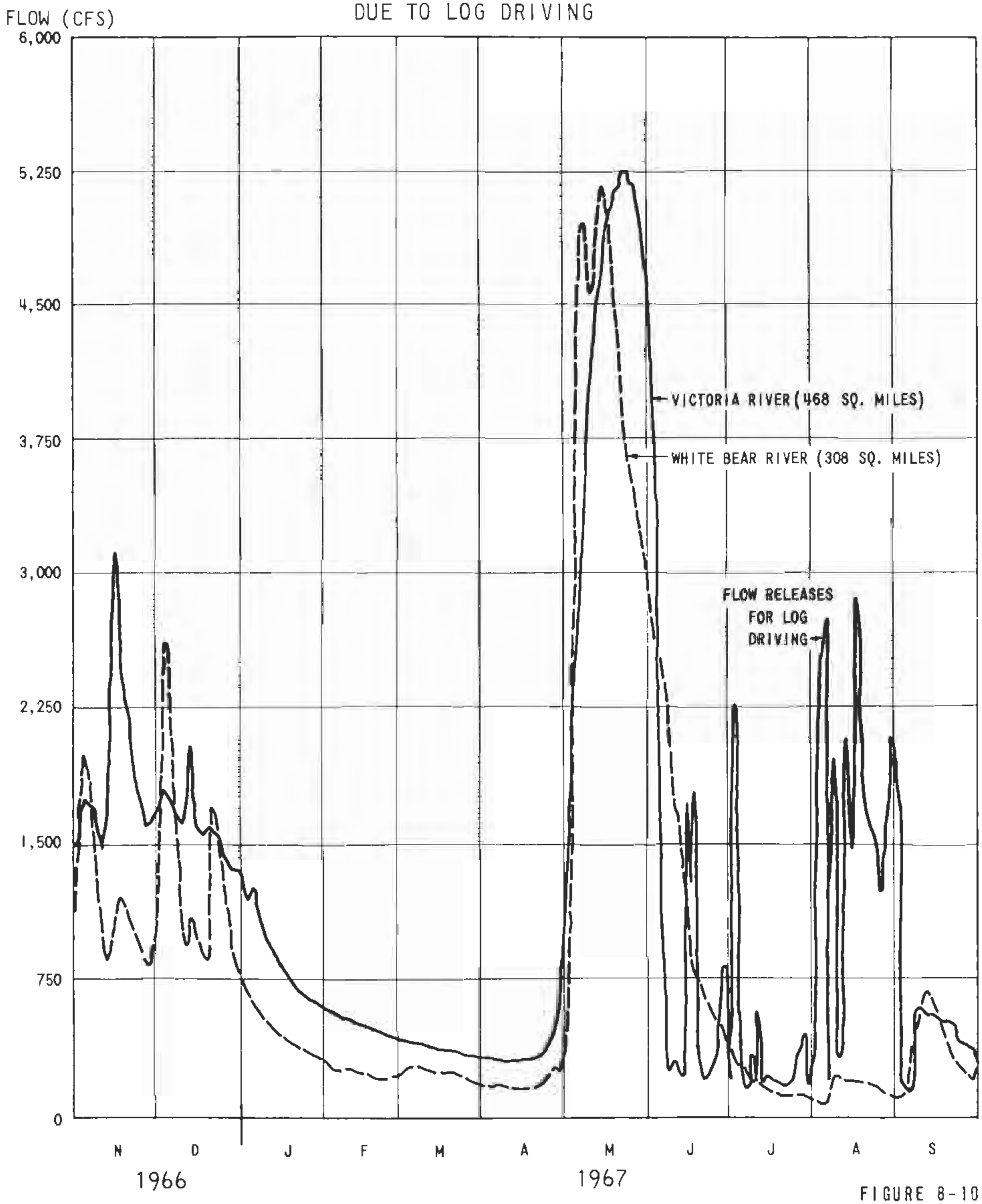
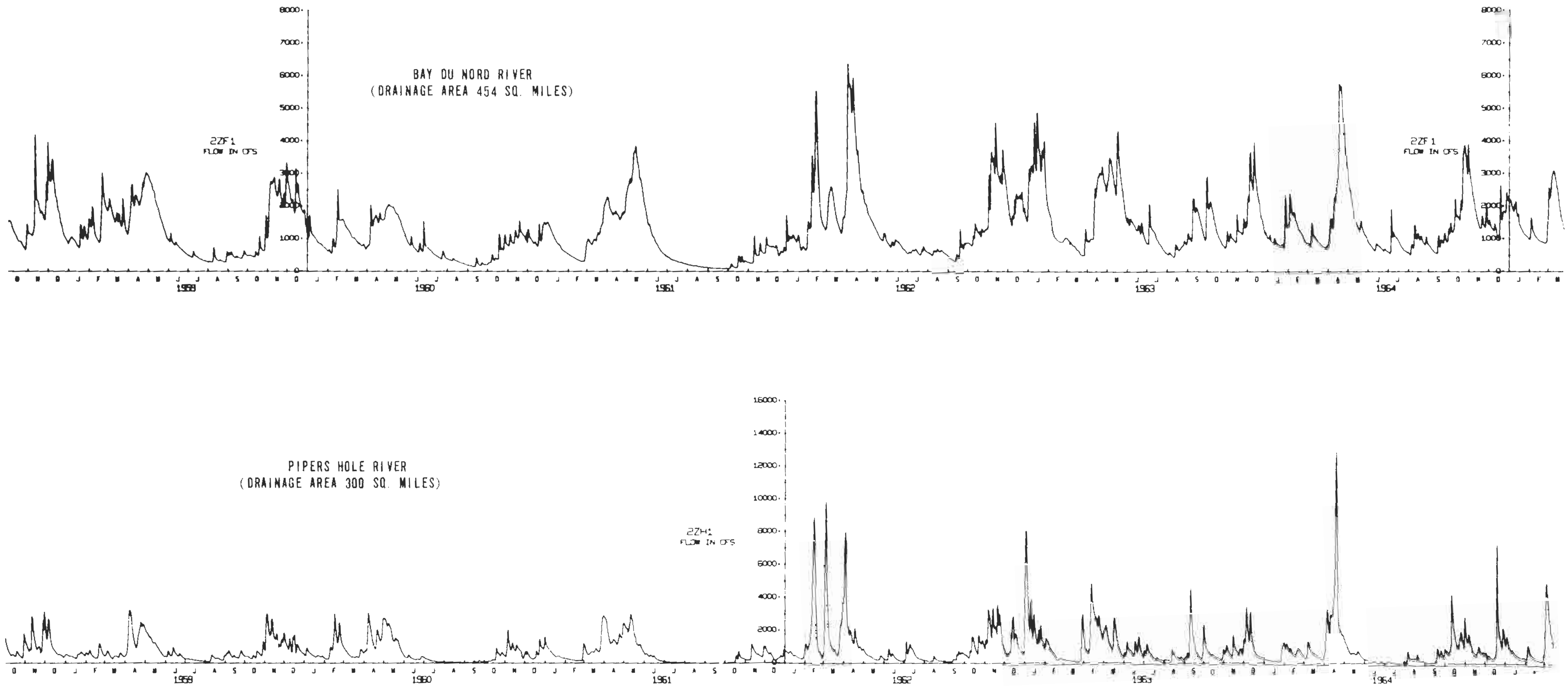


FIGURE 8-10



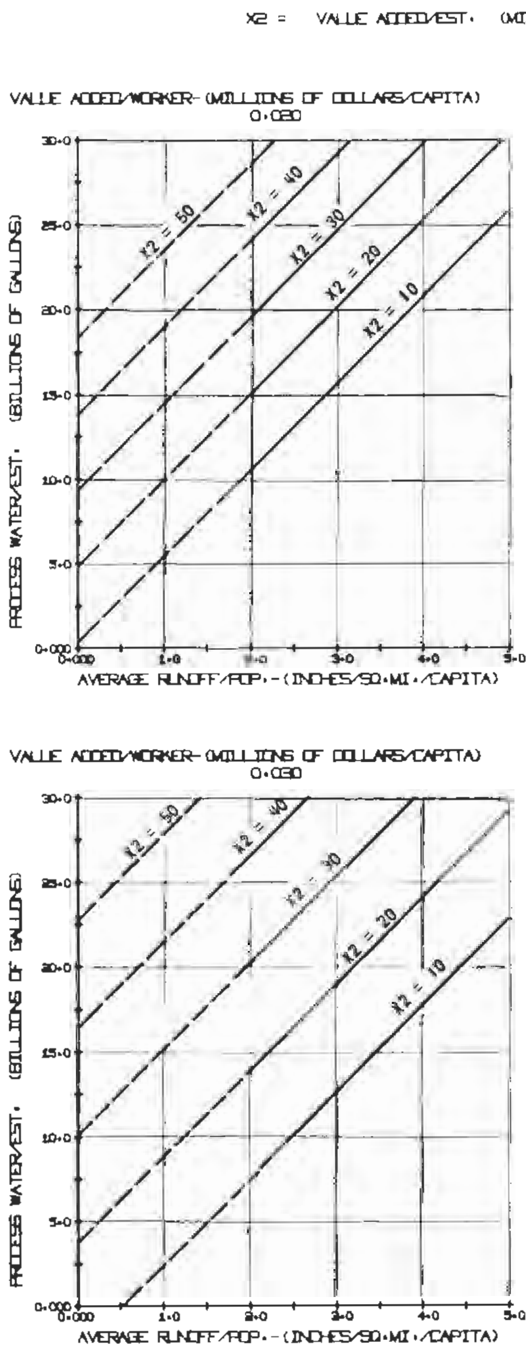
NEWFOUNDLAND

EXAMPLE OF CHANGES
IN REGIME FLOW DUE TO
DEFORESTATION BY FOREST FIRES

MEAN DAILY FLOW HYDROGRAPH
PIPERS HOLE RIVER AND BAY DU NORD
RIVER 1959-64

FIGURE 8-11

APPROXIMATE RELATIONSHIP FOR PROBABLE WATER DEMAND BY THE PULP AND PAPER INDUSTRY



LEGEND

— — — DOUBTFUL APPLICABILITY WITHIN PRESENT DAY TECHNOLOGY

SOURCE

1) U.S. CENSUS: POPULATION
2) U.S. DEPT. OF INTERIOR: HYDROLOGICAL INVESTIGATIONS ATLAS HA-212
3) U.S. STATISTICAL YEAR BOOK

FIGURE 8-12

NEWFOUNDLAND

PRESENT AND ESTIMATED FUTURE WATER DEMAND BY THE PULP AND PAPER INDUSTRY

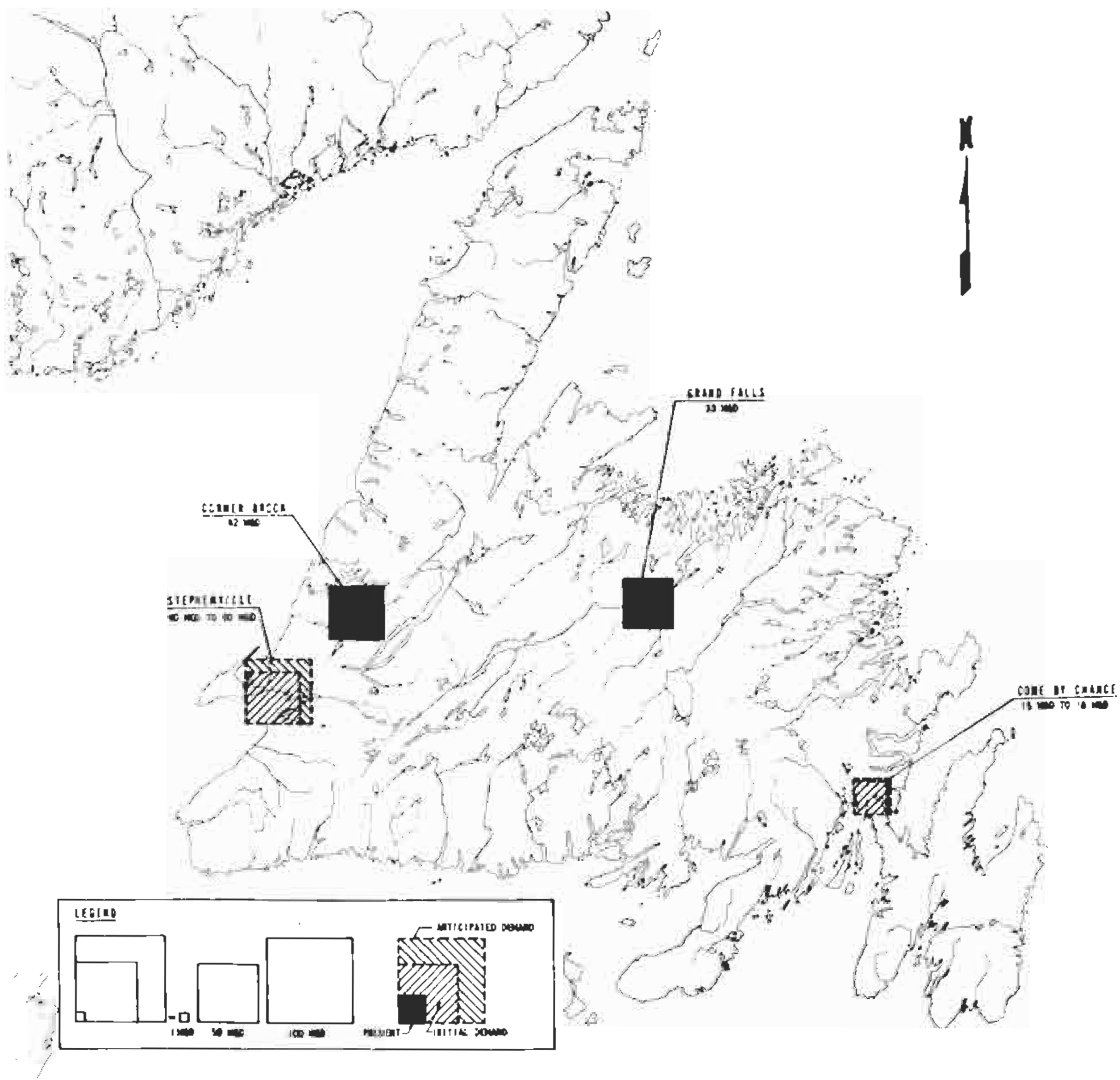


FIGURE 8-13

NEWFOUNDLAND AND LABRADOR

AREA CLASSIFICATION

		Newfoundland	Labrador	Total	Percent
		thousands of acres			
Productive forest land					
Softwood	merchantable	4,272	11,358	15,630	16
	young growth	3,231	504	3,735	4
Mixedwood	merchantable	258		258	-
	young growth	172		172	-
Hardwood	merchantable	6		6	-
	young growth	156		156	-
Unclassified*		215	1,500	1,715	2
Total productive forest land		8,310	13,362	21,672	22
Non-productive forest land		6,278	28,237	34,515	35
Total forest land		14,588	41,599	56,187	57
Non-forest land		11,757	23,605	35,362	35
Total land area		26,345	65,204	91,549	92
Water		1,405	7,005	8,410	8
Total area		27,750	72,209	99,959	100

* Includes areas of recent burn, cut-over, or windfall, not yet restocked. The 1967 estimate is over two million acres of productive forest land, unsatisfactorily stocked on the Island. (Forest Service)

Source: DBS 25-202, Canadian Forestry Statistics, 1962.

TABLE 8-1B

NEWFOUNDLAND AND LABRADOR - 1967
ESTIMATES OF MERCHANTABLE* STANDING VOLUME

	Newfoundland	Labrador	Total
	millions of cords		
Softwood	54	74	128
Hardwood	6	4	10
	60	78	138

* Stands containing 5 cords per acre of trees 4" dbh.

TABLE 8-1C

WOOD VOLUME BY SPECIES
ESTIMATES OF TOTAL STAND BY COMPOSITION

	Newfoundland	Labrador
	percent of total volume	
Balsam fir	50	20
Black and white spruce	37	71
White and yellow birch	10	5
Larch	2	4
White and red pine	1	0

Source: Forest Service

TABLE 8-2A

NEWFOUNDLAND

AREA CLASSIFICATION OF COMPANY LANDS

	Bowaters[1]	Price
	thousands of acres	
Merchantable forest	1,821[2]	1,111
Non-merchantable forest	1,576	966
Total forest	3,397	2,077
Non-forested	4,399	2,310
Total area[3]	7,796	4,387

1. No adjustment made for lands returned by Bowaters to the Crown in 1966.
2. Merchantable areas burned in 1959 and 1961 not deducted.
3. 28.4 percent of Bowaters' lands and 2.0 percent of Price lands classed as inaccessible.

Source: Bowaters and Price (Nfld) Ltd. 1966. (Quoted in Ker Report)

TABLE 8-2B

NEWFOUNDLAND

AGE CLASS DISTRIBUTION

Age Class	Crown	Bowaters	Price	Other Private Holders	Crown	Bowaters	Price	Other Private Holders
years	thousands of acres				thousands of cords			
0 to 40	1,660	1,230	682	92	-	-	-	-
41 to 80	1,020	330	600	243	9,700	3,100	5,700	1,000
81 plus	200	1,440	795	88	2,600	18,000	13,800	700
	2,880	3,000	2,077	423	12,300	21,100	19,500	1,700

Source: Forest Service, 1967.

TABLE 8-2C

NEWFOUNDLAND

PERMANENT EMPLOYMENT IN THE PULP AND PAPER MILLS

YEAR	BOWATERS			PRICE	TOTAL
	Hourly	Salary	Total		
1951	1,269	412	1,681	1,981	3,662
1956	1,461	327	1,788	1,781	3,569
1961	1,320	322	1,642	1,763	3,405
1966	1,374	321	1,695	1,447	3,142

Source: SECo Questionnaires

TABLE 8-2D

NEWFOUNDLAND

CLASSIFICATION OF BURNT AREAS BY FOREST TYPES

Year	Waste	Recent Burn	Young Growth	Cut Over	Merchantable Timber	Total*
		thousands of acres				
1947	193.6	5.2	29.4	37.4	39.2	304.8
1948	0.1	-	-	-	-	0.2
1949	18.6	0.9	1.1	11.5	5.4	37.5
1950	47.8	1.2	12.0	4.8	7.6	73.3
1951	5.7	-	3.7	1.6	2.6	13.6
1952	14.9	-	1.2	8.4	6.1	30.7
1953	0.5	-	0.1	0.8	-	1.4
1954	0.2	-	0.1	1.5	-	1.8
1955	3.4	-	0.7	0.3	0.3	4.7
1956	0.8	-	0.2	1.9	-	2.9
1957	19.4	-	1.1	1.1	0.2	21.9
1958	2.4	-	0.1	-	-	2.6
1959	9.7	-	1.1	10.4	13.0	34.2
1960	51.3	0.4	9.6	7.7	1.8	70.7
1961	592.6	17.4	54.3	36.4	364.9	1065.5
1962	10.5	0.5	1.4	-	3.2	15.6
1963	3.7	-	0.1	1.3	-	5.2
1964	286.3	-	0.7	0.1	71.2	358.2
1965	1.6	-	0.2	0.3	-	2.2
Total*	1262.9	25.7	117.1	125.7	515.7	2047.1
Average Year	66.5	1.4	6.2	6.6	27.1	107.7
Percent	62.0	1.0	6.0	6.0	25.0	100.0

* Rounded-off total

Source: Newfoundland Forest Protection Association, Annual Reports

TABLE 8-3A

LABRADOR

AREA CLASSIFICATION BY VEGETATION ZONES

	Zone	Land Area	Inland Waters
		thousands of acres	
Excellent forest	1	432	96
Good forest	2	5,960	326
Marginal and fair forest	3	18,429	1,390
Scrub and unmerchantable forest	4	18,413	3,279
Arctic and coastal tundra	5	21,716	1,502
		64,950	6,593

Source: Ker, 1967

TABLE 8-3B

LABRADOR

TIMBER VOLUME ON THE MORE ACCESSIBLE WATERSHEDS

	Vegetative Zone*	Area thousands of acres		Total Volume millions of cords	
Alexis Bay	2	521		6.4	
	3	395	916	3.2	9.6
Sandwich Bay	2	283		3.5	
	3	710	993	5.7	9.2
Lake Melville	1	229		4.2	
	2	782		9.6	
	3	1150	2161	9.2	23.0
Kaipokok	2	219		2.7	
	3	288	507	2.3	5.0
			4577		46.8

* See Table 8-3B

Source: Ker, 1967

LABRADOR

SOFTWOOD VOLUME IN PRODUCTIVE FOREST

Concession Holder	Softwood Volume millions of rough cords
Newfoundland and Labrador Corporation (NALCO)	30
British Newfoundland Corporation (BRINCO)	10
Newfoundland Pulp and Chemical Company (NPCC)	24
Unalienated Crown land	10
	74

Notes

1. Labrador - east of Longitude 63 deg West, south of Latitude 55 deg North.

2. Productive forest is here defined as forests containing 6 cords per acre or more of softwoods, as mapped by the Kennedy Commission (1955), less 12.5 percent for areas of water and an allowance for three major fires in 1959 (Paradise, Gilbert, and Lewis).

Source: Ker, 1967.

TABLE 8-3C

PRIMARY INVENTORY UNIT NO.	AREA	MERCHANTABLE (acres) Virgin	Burn	Total	UNMERCHANTABLE (acres)	WASTE (acres)	DEVELOPED LAND (acres)	TOTAL AREA (acres)
1	Codroy Valley	45,679	-	45,679	28,675	119,520	767	194,641
2	St. Georges Bay	163,427	-	163,427	141,854	176,400	394	482,075
3	Port au Port and Serpentine	23,412	-	23,412	9,851	37,237	-	70,500
4	Bay of Islands	72,790	-	72,790	93,042	99,262	1,489	266,583
5	Humber River	101,874	14,354	116,228	247,842	247,456	2,951	614,477
6	Grand and Sandy Lakes	154,466	14,046	168,512	128,183	304,408	130	601,233
7	Trout River to Parsons Pond	41,059	-	41,059	53,789	156,962	129	251,939
8	Portland Creek to River of Ponds	34,206	-	34,206	9,308	31,505	-	75,019
9	River of Ponds to Hawkes Bay	77,846	-	77,846	41,142	183,740	213	302,941
10	Castor River and St. Johns Bay	42,166	-	42,166	4,579	93,422	-	140,167
11	St. Genevieve to Flowers Cover	17,074	-	17,074	21,302	49,960	83	88,419
12	Hare Bay North	76,814	-	76,814	43,693	119,175	-	239,682
13	Canada Bay and Harbour Deep	47,050	-	47,050	30,425	83,405	-	160,880
14	White Bay North	124,501	108	124,609	22,126	160,840	74	307,649
15	White Bay South to Partridge Point	89,725	1,634	91,359	85,454	94,585	391	271,789
16	Partridge Point to Cape St. John	46,055	-	46,055	42,445	60,672	237	149,409
17	Green Bay	19,396	-	19,396	3,569	15,494	-	38,459
18	Halls Bay	38,505	40,258	78,763	53,755	166,152	-	298,670
19	Badger Bay	1,768	5,372	7,140	32,932	17,680	-	57,752
20	Exploits River	14,104	11,967	26,071	5,564	128,123	40	159,798
21	Notre Dame Bay South	5,864	17,089	22,953	28,810	28,072	53	79,888
22	Upper Gander and Lake	97,746	133,131	230,877	130,927	483,387	3,027	848,218
23	Lower Gander River	6,834	26,113	32,947	49,507	42,970	347	125,771
24	Bonavista Peninsula to Cape Freels	65,880	516	66,396	22,070	134,326	-	222,792
25	Bonavista Bay	27,487	20,075	47,562	95,874	157,060	74	300,570
26	Fortune Bay	54,814	2,639	57,453	5,889	371,386	-	434,728
27	Bay D'Espoir	123,491	28	123,519	30,294	574,488	-	728,301
28	Grey River	28,373	-	28,373	3,183	246,227	-	277,783
29	White Bear River	-	-	-	-	4,732	-	4,732
	Total All Areas	1,642,406	287,330	1,929,736	1,466,084	4,388,646	10,399	7,794,865

Source: Bowaters Newfoundland Limited

ESTIMATE SUMMARY SHEET

BOWATERS NEWFOUNDLAND LIMITED

- TIMBER LIMITS

TABLE 8-4

PRODUCTIVE FOREST LANDS	TOTAL	1	2	3	4	5	6	7	8	White Bay
	BLOCKS OR WATERSHEDS									
Merchantable (acres)	1,111,283	290,462	177,927	46,848	65,854	132,588	43,717	58,935	134,384	160,568
Non-merchantable (acres)	965,780	282,069	222,643	15,709	16,824	180,101	22,619	66,073	136,179	23,563
Total acreage	2,077,063	572,531	400,570	62,557	82,678	312,689	66,336	125,008	270,563	184,131
Non-productive land (scrub, bogs, barrens) (acres)	2,310,429	805,396	168,270	17,241	53,873	203,748	95,242	52,969	404,504	509,186
Total volume of merchantable forest (cords)	16,680,324	4,241,304	2,933,997	1,078,145	1,174,115	2,146,754	858,281	844,520	1,701,039	1,702,169
Average cords per acre (in merchantable stands)	15	15	16	23	18	16	20	14	13	11

Source: Price (Nfld) Pulp and Paper Limited

ESTIMATE SUMMARY SHEET

PRICE (NFLD) PULP AND PAPER LIMITED

- TIMBER LIMITS

TABLE 8-5

9 AGRICULTURE

9.1 The Resource

9.1.1 General Agricultural Resource

The agricultural sector of the provincial economy is extremely small, and one of the main reasons is the physical restrictions placed upon the sector by the resource base and the climatological characteristics of the area. Labrador is excluded from all discussions because only one farm was reported in the 1966 census for the area.

As shown in Volume Two A, Section 8, the Island has a relatively humid climate. The distribution of precipitation in time is fairly uniform throughout the year; however droughts of varying length do occur. For example, in the summer of 1967, conditions of near drought existed through part of June, July, and August. This has great significance to the farming of reclaimed bogland where water control could be a very stabilizing factor.

The growing season is defined as last to first frost and along the sea coast areas, is 120 to 140 days, while in the interior it averages 100 days or less. The number of heat units (Volume Two A, Table 8-2) is relatively low, thus placing a restriction on the type of crop which may be grown.

The Island's soils are not well matured, being young soils by geological standards, and their composition is not particularly well suited to agriculture. Generally they are highly acidic and have low inherent fertility. Workable agricultural soils in Newfoundland are seldom more than 18 inches deep and in most areas the soil is extremely stoney. More detailed discussion of the soils of the Province is contained in Volume Two A, Part II, Section 6.

The topography of the Island is another limiting factor in the development of agriculture, and there is virtually no vegetation above the 1200-foot level. In many areas of the Island the slope of the land restricts its agricultural use.

The largest areas of tillable land on the west coast are located in the Humber River basin and partly in the Stephenville study basin. The first is the Deer Lake to Cormack area on the Humber River, and the second is made up of the plains in the St. George's Bay district.

In the interior the largest potential agricultural areas are located on gently rolling to undulating ground moraine deposits rather than along the rivers. Suitably level ground with agricultural soils is found south of the confluence of Noel Paul's Brook and the Exploits River, beginning about five miles southeast of the Buchans railway and covering approximately 80,000 acres. There are six other areas in the interior located in the Exploits River basin: Mary Ann Lake; the southern tip of Red Indian Lake; the Exploits between Badger and Grand Falls; southeast of Badger; in an end moraine east of the Exploits and south of Badger; and in a ground moraine east of the Exploits and south of Badger. Bonavista North, about 30 miles northeast of Gander, has a potential agricultural area of about 57,000 acres.

Much of the area of the Avalon Peninsula is unsuited for agriculture including the range of hills which runs along the eastern shore of the peninsula. Within the 62,700 acres which make up Metropolitan St. John's, planning provisions call for the development of 12,925 acres of cultivated land by 1975 [1].

An area on the Avalon peninsula considered worthy of ground investigation by the Royal Commission [2] to determine the agricultural potential was a section of end moraine in the centre of the peninsula between Conception Bay and St. Mary's Bay and partly in the St. John's and environs study area.

The Burin Peninsula is similar to the Avalon, having many barrens and only a few small areas of mineral soil which are suitable for tillage. There are large areas of organic soils on the Burin Peninsula, especially in the vicinity of Winterland where a program of bogland reclamation is being carried out [3] and falls within the Burin Peninsula study area.

The remainder of the south coast region, from Fortune Bay to Cape Ray is predominantly bedrock and devoid of soil for agricultural development. In the Bay D'Espoir area, most of the land is unsuitable for agriculture and, where there is sufficient soil cover to permit it, urban development needs will likely take precedence. However, plans call for the retention of an area in the valley north of the Bay D'Espoir hydro powerhouse for establishing market gardens [4].

On the Great Northern Peninsula a low, although often narrow, coastal plain extends west of the Long Range Mountains along much of the west coast from Bonne Bay northward. A few small pockets of level alluvial land are found scattered along the rivers of the west coast and inland, but the rough topography and limited quantity of fertile soil make agricultural development extremely doubtful.

9.1.2 Bogland Resource

There is one potential exception to the generally restricted agricultural resource of the Island and that is the extensive boglands. Investigations over the past 10 years have shown that, when properly drained, limed, and fertilized, these lands can be very productive, especially when planted to forage crops and vegetables[5].

At the present time there is no accurate inventory of peat acreage and estimates range from those by the Royal Commission[2] of 2.7 million acres to those by Dr. L. Heikurainen of Helsinki, consultant to the Canada Department of Forestry, of 5.0 million acres.

In accordance with Dr. P. A. Wright of the Ontario Agricultural College during a discussion, the potential of the peat soils for forage production deserves both greater emphasis and investigation. It is highly relevant to potential expansion of both dairy and beef enterprises.

For a further discussion of the physical characteristics, see Volume Two A, Part II, Section 7.

9.2 Present Day Conditions

The existing development of the agricultural resource is very limited and the distinction between a census farm and a commercial farm must be made. As defined in the 1966 Census of Agriculture, census farms are agricultural holdings of one acre or more with sales of agricultural products of $50 or more in the twelve months prior to June 1, 1966. Commercial farms are defined as census farms with sales of agricultural products of $2,500 or more in the twelve months prior to June 1, 1966. By these definitions there were 1709 census farms in the Province of which 301 were classified as commercial.

Of the total land areas of the Island of 25.3 million acres, the 1709 census farms occupied 49.5 thousand acres of which commercial farms occupied 21.3 thousand acres. The land use according to the 1966 census was:

Improved land		20,566 acres
Under crop	12,409	
Improved pasture	5,320	
Summer fallow	258	
Other improved	2,579	
Unimproved		28,947 acres

The most striking single feature is the very small percent of total farms which can be classified as commercial farms. This is modified in part by the fact that commercial farms occupy 43 percent of the agricultural acreage. Nevertheless, the disproportionate number of small, non-commercial farms is very significant as a policy criterion.

The value of agricultural products sold in the twelve months prior to June 1, 1966 was $6.7 million. However, this figure includes the value of products traded or exchanged as well as government payments for such items as crop insurance.

Animal concentrations are a potential source of water pollution, but the total number of livestock reported on the Island is an indication of the very limited development of this sector. The following livestock were reported in the 1966 Census of Agriculture: 8554 cattle, 7307 pigs, 14,381 sheep, and 417,836 domestic fowls.

The livestock concentrations in the Province are dealt with in the sections on River Basins and Study Areas.

Some 9236 persons were reported living on census farms including all persons, regardless of their occupations, living in a dwelling situated on a census farm. This figure represents just under two percent of the provincial population. According to Buckley and Tihanyi[6] in a study based on 1961 census data, rural incomes lagged seriously behind the levels of income obtained from other activities.

From the 1961 statistics on which this classification was based, 68 percent of rural families in Newfoundland were classified as poor compared to the Canadian average of 44 percent. The same study[6] estimates that 30 to 40 percent of the farms in the Province may be classified as hard core poverty farms and they are found in all census divisions with agricultural activity.

9.3 Potential and Planned Development

The agricultural sector of the provincial economy is not expected to be of major significance over the study period but this does not mean that major changes in agriculture will not take place.

Both the Royal Commission [1] and Booth and Reston [7] base their comments on the future of the industry on the target that the Province should seek to foster low cost food supplies for the population. With this objective in view a number of potential changes become apparent.

An increase in the size and number of commercial farms would result from any policy designed to encourage the achievement of this target. According to these reports an expansion of commercial scale farming would require changes in existing systems of land tenure and farm credit. In conjunction with the growth of commercial farming, though not necessarily resulting from such growth, it may be expected that the other census farms will decline in number.

Very little factual data are available on the specific state of farming operations; therefore comments in the studies [2,7] were very general. Mixed farming appears to have the best chance of success, and it was suggested that milk, beef, and hog production would have ready markets should forage and feed be available at reasonable prices. The implications of such developments for the manufacturing sector are mentioned in Volume Three B, Part V, Section 14.3.

In this connection the potential of the boglands may be of vital importance. However, so long as major opportunities for expanding the forage producing base exist to the degree suggested there should be no obstacles except capital, to encourage these enterprises.

Specific mention was made of the fact that hay, potatoes, turnips, and cabbage account for more than 95 percent of total crop acreage. While the acreage of other crops is small, the Royal Commission [2] selected some crops as having potential for development among which were greenhouse and nursery crops.

According to the 1966 Census of Agriculture, there were 29,800 square feet of greenhouses on the Island of which 27,500 square feet were on the Avalon Peninsula. The potential available to the development of this specialized activity will be enhanced by the availability of significant amounts of waste heat in areas of relative proximity to population centres.

Another area for potential development not specifically mentioned by the Royal Commission[2] is the bogland potential which Booth and Reston[7] refer to as "...the most significant development that has occurred in Newfoundland agriculture in recent years". Indications are that, in addition to the forage crop potential, the reclaimed boglands can support both cattle and sheep pasturage and vegetable production at marketable yields. The water resources implications of this potential are dealt with in Volume Five, Section 6.

Because of the limited and questionable statistics available on the activity of the agricultural sector, no attempt has been made to define future activity in value terms.

9.4 Specific Water Demand and Wastes

Usually the largest demand for agricultural use is related to irrigation, but in the Island's condition there is no significant demand for such a use. Nevertheless, it may be considered locally, and the requirement can be based on potential evaporation. In the Island's condition, total average potential evaporation is about 20 to 30 inches, the latter figure being valid for dry years. Based on the assumption that 70 percent of this demand takes place during the growing season, the requirement would be between 15 and 20 inches per year, or about 60,000 cubic feet per year per irrigated acre. Since the estimate is based on the value of annual potential evaporation (which in the Island's condition is about 20 percent higher than actual evaporation), it is probably on the conservative side. In exceptionally dry years, however, when irrigation would be required, potential evaporation may be higher than 30 inches and the specific water demand should therefore be considered as mentioned above.

Specific demand for greenhouses may reach, according to Fair, Geyer, and Okun[8], as much as 70 gpd per 1000 square feet.

Wastewater from irrigation and greenhouses may include a variable amount of organic matter and fertilizers, in addition to suspended matter. In some cases the wastewaters from irrigation may also include pesticide residues.

Since the soils in Newfoundland are generally acid, lime will probably have to be applied, which will contribute to a reduction of the acidity of the wastewaters and of the receiver.

Water demand for livestock and BOD from livestock wastewaters are as follows:

	Gallons per Day per capita	Waste Load[9] lb. BPD/day
Horses	8.5 - 15.0	No data
Beef Cattle	8.5 - 12.0	0.56
Milk Cows	17.0 - 35.0	1.93
Hogs	2.5 - 4.0	0.25
Sheep	1.7 - 2.0	No data
Goats	1.7	No data
Chickens	0.03	0.015 - 0.025
Turkeys	0.05	No data

Specific water demand for dairy plants and slaughter houses is discussed in Section 14.4.

Specific "negative" demand for bog drainage; that is, the amount of water per unit area which may be expected to be drained, is discussed in Volume Four, Section 6.4.

9.5 Present and Forecast Water Demand and Wastes

The withdrawal demand for water in agriculture is presently limited to the irrigation of two farms (one in the Terra Nova basin, the second at Harbour Grace) where irrigation is provided for 20 and 30 acres, respectively; the greenhouses located around St. John's; and the local demand for livestock. According to the specific demand for irrigation included in Section 9.4, conservative figures for the irrigation requirements would be 7.5 million gallons per season for the Terra Nova farm and 11 million gallons per season for the Harbour Grace farm. For the other users, since their distribution and characteristics are not known in detail, even rough estimates are not possible. However, it can be stated that all the remaining requirements are of local significance only.

Wastewater of some significance can be expected only from livestock farms, especially those of chickens and hogs where the production is more concentrated. However, the very small total livestock population in the Province, given in Section 9.2, indicates that this item is of local importance only from the point of water resources.

"Negative" demand for agriculture is related mainly to soil erosion and bog draining, and is discussed in Volume Four, Section 6, and water demand for slaughter houses and dairies in Volume Three B, Section 14.

According to existing prospects, demand related to agricultural use may increase to some extent for greenhouses, and hog, chicken, and other livestock farms. Some increase in the water demand for irrigation may also occur. It is likely that the increase in demand will take place mainly around population centres and possibly in relation to the reclamation of bogs. Greenhouses may develop in areas where waste heat from cooling water will be available, especially if this occurs near a larger population centre. Noting that one million square feet of greenhouses require only 70,000 gpd, it can be stated that this type of demand will not generally be of more than local significance.

Water demand for livestock is not significant even for bigger farms. Hog farms of 10,000 would require only about 40,000 gpd. However, the wastewater from livestock farms can be significant. Keeping in mind that BOD is 0.25 pounds per day, a relatively large farm of 10,000 hogs would represent, from the viewpoint of polluting effect, a population equivalent of 17,000, and this is of some significance. The effects on water quality of locating such farms in the more populated areas should be considered.

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NEWFOUNDLAND
LOCATION AND SIZE OF DRAINED BOGLANDS

10 FISHERIES AND FISH PROCESSING

10.1 Fisheries - The Resource

This sector is concerned with the fisheries resources of the sea. The fresh water resource is discussed in Volume Four, Section 2. The brief discussion of the resource is confined to those species which are or may become of economic significance to the Province. A comprehensive review of the resource is beyond the scope of this report. However, some general comments are required to place the activities it generates into a frame of reference.

Estimates of the total fish populations inhabiting the Atlantic coast will be found in Commercial Fisheries of Canada [1]. However, it is generally agreed that the potential yield is more significant to studies of resource utilization than estimates of existing stocks. The size of yield, which varies for each species, depends on such factors as: water temperatures, light intensity, available food, existing stock size, both vertical and horizontal migration patterns, growth rates of different species, and activities of the fishing fleets.

Fourteen nations fish off Canada's east seacoast and, with the increasing pressure being placed on the world's food resources, their activities are not likely to decline. Already their aggressive expansion policies are being felt as the Canadian percentage of total catch in the north Atlantic fisheries has dropped from 36 percent in 1954 to 27 percent in 1964 [2].

Estimation of the impact of foreign fleets on the potential yield is difficult because the exploitation need not take place within coastal waters. For example, European fleets fishing off Greenland may have a direct impact on the salmon potential of Provincial waters. The activity of Provincial offshore fleets coupled with foreign activity is already affecting the catch per effort ratios of the inshore fleet, which will be discussed in the following section.

The species caught by the Provincial fleets, reported by DBS [3], are grouped in three main categories: groundfish, pelagic and estuarial, and molluscs and crustaceans.

The Atlantic groundfish resource is extremely important and represents about half of all Canadian landings. Knowledge of the resource is sufficiently developed to indicate that the catch of traditional species is now at, or close to, maximum yield. According to Templeman[4], of all groundfish species, cod is best able to support an intensive fishery. But even cod, which by landed volume accounts for 60 percent of the sustained yield of the Province's catch, is approaching maximum sustained yield except in Labrador waters. Cod, together with redfish and haddock, are the main species being affected by the activity of foreign fleets. This situation could have serious implications for the Provincial fisheries were it not for the potential that still remains relatively untapped: Greenland halibut, flounder, silver hake, pollock, and argentines.

The potential for increased pelagic catches is very good, and herring could become of considerable importance to the Provincial industry. However, there is no assurance that large herring populations will be present in a specific area at a given time. The history of the species shows wide fluctuations in abundance with herring populations appearing and disappearing with considerable rapidity.

Molluscs and crustaceans both offer potential to the Provincial fisheries. How far and how fast their exploitation may develop over the forecast period is difficult to ascertain at this point, and no provision has been made for such development in the forecasts provided by the Board. However, the experimental programs have been encouraging and the possibilities deserve mention.

The Canada Department of Fisheries believes that in certain areas along the southern sea coast of the Island, oyster beds could be developed to a commercial scale. In these areas the sea bottom and temperature are within a suitable range for the growth of the oysters.

The Atlantic, or queen crab, is found in the bays of the Avalon Peninsula. Its occurrence has been known for many years but in the past it was considered of nuisance value because it would get tangled in the fishing gear. However, a pilot plant has now been established, and indications are that the queen crab may be an important part of the crustacean resource.

Shrimp is another species which is known to exist but which have not been exploited. They are found between Ramea and Rencontre West, in the Gulf of St. Lawrence; in Trinity Bay; and in Bonavista Bay. However, the cool water of the bays may not give a sufficient yield to make commercial exploitation feasible. Despite this possible limitation, expert shrimp fishermen have been brought to the Island to demonstrate modern gear and fishing techniques, and experimental processing operations have been established at Ramea.

Table 10-5 shows the probable trends in the resource. It is assumed, for purposes of this report, that the fisheries resource is sufficient to support the activity forecast in Section 10. 3. The one qualification to this assumption is the limitation being placed on the resource available to the inshore fleet by the domestic and foreign offshore activity.

10. 2 Present Day Conditions

10. 2. 1 Fishing Fleets

This section confines itself to the discussion of the fishing fleets, not because the ships are significant water users, but because of the employment they provide in the exploitation of the resource. For hundreds of years this employment has provided a means of livelihood for large segments of the population, and as a way of life it has deep rooted sociological implications. The resource supported the establishment of small isolated fishing villages along the seacoast of the Island. The socio-economic implications of isolation and the structure of the fisheries is a very real factor in the attempts to rationalize the fleets.

According to Innis [5], Government policies in the sixteenth and seventeenth centuries were in no small measure responsible for the scattered settlement along the Island's 6000- mile coast line. Even today there are over a thousand communities along the sea coast, many with populations of fewer than 200 people. The reasons are geographic as well as historical. Many harbours are in areas where topography would not support a large community because the land rises very steeply from the sea and could not support more than a subsistence agriculture.

Today, according to Iverson and Matthews [6], many of these communities are in decline. Among the many changes arising from the transition to an urban and industrial economic structure, two are of particular significance to this study. The first involves the physical movement of populations from the outports to more developed communities. The second concerns the employment which will be available to the men leaving the fisheries, a high percentage of whom, according to Kitchen [7], are functionally illiterate.

The socio-economic characteristics of the population supported by the primary fisheries sector stem from complex interrelationships and the solution to the problems raised by these conditions are far beyond the scope of this study. However, in terms of possible water demand, certain assumptions must be made in connection with this sector. These assumptions are made in the knowledge that they do not necessarily represent future conditions. It is obvious that a functionally illiterate population, who have lived in an isolated community in whose economic structure cash did not play a major role, cannot readily be integrated into an urban community.

However, the model used in this report assumes a smooth and rapid assimilation of these people into the mainstream of the Province's economic development. This assumption was made to highlight potential problems arising from the increased water demand which could result from increasing urbanization.

The various data chosen to illustrate discussion in this section are sub-divided in DBS catalogues, into the 15 Newfoundland and Labrador fishing areas shown on Figure 10-1. Employment in the primary fisheries is reported for the inshore and the offshore fleets. By DBS definition [3], the offshore fleet is that of boats of 25 gross tons or more, and the inshore fleet is made up of boats which are less than 25 gross tons. In 1966 there were 19,324 men in the inshore fleet, which by definition had 17,315 craft. For the same year there were 962 men in the offshore fleet of 135 craft. A further classification used by DBS [3] of total employment is that of the time spent fishing: full time, 10 months or over; part time 5 to 10 months; occasional, less than 5 months. Unfortunately, this classification is not available for the inshore and offshore fleets.

Total employment in primary fishing between 1954 and 1966 is shown on Figure 10-3b. Approximately 5000 people have entered the sector, at least on an occasional basis, since the mid-1950's. Traditionally this sector, specifically the inshore fleet, has offset absolute unemployment by offering as an alternative to unemployment what is, at best, marginal employment.

The inshore fishermen are generally self-employed and are almost completely dependent on cod, a low priced fish. It was estimated by Sametz [8] that in 1965 the average catch per inshore fisherman in the Province was $810 against the average return to the Maritime inshore fisherman of $1930. The difference is not one of efficiency but rather of the species caught. The bulk of the Newfoundland and Labrador catch is cod which in 1965 brought about 4 cents per pound. On the other hand, the bulk of the Maritime inshore catch is herring, lobster and scallops. Despite this comparatively low level of earned income most fishermen will not abandon the inshore fishery until alternate employment opportunities are available.

Two other factors which hold these men immobile are their education and the present unemployment insurance provisions discussed in both the Atlantic Salt Fish Commission[9] and the Proskie Study[10]. At the time of writing there was a definite economic advantage for fishermen to operate inefficiently in the inshore fishery.

There is considerable difference between the skills of the inshore fisherman and those of an offshore fisherman. Because both catch fish, it does not follow that an inshore fisherman has unrestricted mobility into the offshore fleet. This point is underlined by the fact that in a province which has over 20,000 fishermen, many earning an exceptionally low return, there is currently a shortage of fishermen to crew the offshore fleet.

Unfortunately, no precise figures are available on fisheries earnings. In place of such data, value of landings is used and on this basis the offshore fisherman averaged $7600 against the $810 quoted for the inshore fisherman. However, as the offshore fisherman is generally not self-employed, the figures are not strictly comparable, although they do provide an order of magnitude comparison. Assuming that wages represent only 40 percent of landed value, an offshore fisherman would still average over $3000 or triple the earnings of his inshore counterpart.

Table 10-1 shows the number of fishermen by extent of employment and by fisheries area for selected years. Table 10-2 shows the same information as a percentage distribution. Generally speaking, the percentage distribution by fisheries area has remained stable. Detailed data by extent of employment and by inshore and offshore fleets are not sufficient to allow any analysis of trends.

Table 10-3 shows, for the Province and by fishing area, the total value landed, the total number of fishermen, and the landed value per fisherman for 1964, 1965 and 1966. The table also shows an index of value landed by fisherman.

Only four areas, F, G, I and J, are considerably above the Provincial average value landed per fisherman for each of the three years. These four areas account for 62 percent of total offshore employment. Of the men employed in primary fishing in area I, 44 percent are in the offshore fleet, while 22 percent are in the offshore fleet in area J. With the exception of area H, where 12 percent of the men are in the offshore fleet, the average for the remaining 12 areas is below one percent.

10.2.2 Fish Processing

Fish processing is extremely important to the Provincial economy, both because of its position in the manufacturing sector and because of its relationship to the primary resource and the employment generated at the primary level.

In 1965, the latest available figure, the manufacturing activity of the fish processing industry contributed $17.1 million value added, which represented approximately 5 percent of the value added by commodity producing industries. In the same year the industry's manufacturing activity employed 3635 people.

The volume and value of major categories processed in 1965 and 1966 are shown on Table 10-6.

For purposes of this report, discussion will be concentrated on three major processes, fresh, frozen, and salted, and one auxiliary process, fish meal. The present location of processing establishments is shown on Figure 10-4.

This report does not enter into any discussion on the marketing of fish products because the forecasts as to the value of future production were provided by the Board as basic assumptions (Section 5).

The fish processing industry, particularly in 1967 and 1968, appeared to be going through a period of change and adjustment. The outcome of this transition period will naturally have an effect on the size, location, and manufacturing characteristics of the fish processing establishments of the future. The following comments were based on information drawn from various sources, primarily reports published in the Provincial press, and as such, they are open to question, but they are indicative of the problems and prevailing trends.

The serious nature of the problems faced by the processing industry are witnessed by the closure, or threatened closure, of a number of establishments. For example, the large fresh and frozen fish processing operation owned by Steers-Ross* ceased operation in 1967. At the time of closure, the salt fish operations were expected to continue. The reasons given were financial. In May of 1968, the Newfoundland Government undertook to guarantee a million-dollar loan to avoid the closure of North Eastern Fish Industries' plants at Harbour Grace and Fermeuse. It was stated that the closure would have left 1100 employees without jobs and 2500 fishermen looking for a new buyer.

During a debate in late April 1968, the Government informed the Provincial Legislature that 21 fish plants were in danger of closing because of financial difficulties. These plants are located at St. Anthony, Englee, Twillingate, Bonavista, La Scie, two in Catalina, Harbour Grace, Dildo, Fermeuse, Trepassey, Marystown, Burin, Fortune, Grand Banks, Gaultois, Harbour Breton, Ramea, Burgeo, Rose Blanch, and Port aux Basques. This list represents the processing facilities in every major fisheries area of the Province.

The reasons behind such a diffused collapse of an industry could be attributed to the unforeseen softening of market demand and market price, but this would be an oversimplification. The underlying causes would appear to be lack of technology, lack of financial resources, and lack of marketing skills.

A rough comparison of productivity levels between Iceland and the Province suggests that the Provincial productivity is somewhat lower. This problematic relationship has also been suggested in a number of newspaper articles. If such a productivity gap does exist it could also be interpreted as a reflection of a state of obsolescence prevailing in certain sectors of the processing industry.

The present size of the major fish processing operations is summarized below.

There are eight fresh fish plants on the Island, of which four are feeder plants. In 1966 the four non-feeder plants produced 10.6 million pounds of fresh fish valued at $3.8 million. This represented just over six percent of the total value of fish production. Although fresh fish processing is still a fairly small percentage of the total market, there has been a steady upward trend in the value of this sector in recent years.

*It is noted that this establishment did not become fully operational.

There are thirty-two freezing plants on the Island. Their annual input capacity ranges in size from one million pounds to over 80 million pounds. In 1966 they produced 122.1 million pounds of frozen fish products valued at $32.8 million. This production represented just under 55 percent of the total value of fish production. The freezing process has been growing in importance and the newer plants have all been of considerable size.

Twenty-six salt plants with dryers are located on the Island. In 1966 they handled 48.2 million pounds of salt fish valued at $13.2 million, which represented 22 percent of the total value of production.

The salt fish industry is of greater importance to the Newfoundland inshore fisherman than his counterpart in the Maritime provinces. The salt fish industry is centered in isolated areas where the fishermen must process their own catch. The catch itself is limited to species which can be preserved by salting, and in Newfoundland only cod are salted. In 1963, of the groundfish landings put to salt, 98 percent were produced by fishermen[9]. Fifty-six percent of salt fish production comes from the isolated areas A and B on the north seacoast, and area O off Labrador.

Fish meal production has more than doubled in less than a decade. In 1960 there was a production of 8.0 thousand tons of fish meal, which had risen to 20.5 thousand tons by 1966, with a value in the latter year of $3.3 million.

Unfortunately, employment by type of processing is not available. As a result, only aggregate data can be used. The employment in the fish processing sector is markedly seasonal (Figure 10-5). This is a result of the number of plants around the seacoast dependent on inshore activity which, for a number of reasons, is seasonal. The new processing facilities which have been built in recent years are located in the southern half of the Island and operate year round.

10.3 Potential and Planned Development

10.3.1 Fishing Fleets

During the forecast period, the fisheries will remain one of the most important commodity producing sectors of the Provincial economy. Although its contribution in terms of gross value of production is small when compared to other sectors, its contribution in terms of employment is extremely significant.

The assumption provided by the Board was that the volume of landings during the forecast period for purposes of this study are independent of the level of employment in the inshore and the offshore fleets.

The main effect on water resources of the structural changes taking place in this sector will result from changes of location. The result of the fisheries relocation policies will be seen in the continuing abandonment of small, isolated hamlets and the movement of their populations to larger established or developing centres. On the assumption that the men leaving the fisheries will find alternate employment, the second water implication is that rising incomes will result in a higher per capita demand.

The inshore fisheries employ more than 95 percent of the men in the primary fishery. Thus, it is in the inshore fleet that the major changes in terms of employment will take place. Today many isolated and semi-isolated communities, dependent on the inshore fisheries, are going through a period of social and economic change. Changes in communications are breaking down barriers of isolation and exposing communities to new ways of life. Populations of isolated communities are being physically moved as a result of Government relocation policies to areas of, at least theoretically, greater job opportunity.

Generally speaking, the economic activity of the inshore fleet is one of diminishing job opportunities, and its position in the economy will be radically changed. The developing Provincial economy will have to create the alternate job opportunities necessary if the rationalization of the inshore fleet is to achieve any degree of success.

Today the inshore fishery employs about 20,000 men, and it is estimated for purposes of this report that this employment will decrease to about 10,000 men by 1981. The income of the inshore fishermen resulting from their fishing activity was estimated to be $1600 in terms of 1965 dollars at the end of the forecast period.

Figure 10-3a shows the inshore and offshore employment by fisheries area for 1966 and estimated by 1981. The implication is that all fishing areas will be affected by the changes taking place in the inshore fisheries. The estimate that up to 10,000 fishermen will leave the inshore fleet between 1971 and 1981 involves the possible relocation of forty to fifty thousand people. The migration patterns will be dependent on many factors, not the least of which will be existing and developing employment opportunities. Because existing education levels tend to circumscribe the mobility of the fisherman, Government policies in the area of retraining may create a transitional migration pattern. However, the most important movement in terms of size and permanence will be to the larger population centres already in existence or to developing areas where economic expansion will offer employment opportunities.

Compared to the inshore fisheries, the offshore fleets face the future from a relatively sounder economic base, although they are by no means problem free. An important difference is that while the resource is limiting inshore activities in certain areas, it can support a considerable increase in offshore activity.

The offshore fleet employs about 1000 men at the present time. It is estimated that the employment in this sector will rise to about 2500 by 1981. The income per fisherman in the offshore fisheries was estimated to be $3200 in 1965 dollars by the end of the forecast period. The real importance of the development of this sector will be the increasing dependence of the fish processing establishment on the fortunes and skills of the offshore fleet.

With one exception, the major offshore ports capable of processing a 100 million pound input annually will be concentrated on the southern half of the Island. They will probably be at Stephenville, primarily for pelagic landings; Marystown; St. John's (or Bay Bulls); and Harbour Grace. The exception would be a major offshore port between La Scie and Port aux Choix which would process the catch of the relatively undeveloped Labrador fishery.

It is quite conceivable that a number of ports which are considered offshore and which are operating now, such as Fortune, Harbour Breton, Grand Bank, Bonavista and Burin will continue to operate during the forecast period. However, the long term outlook is for relatively small establishments to close. The development, in fact the continuing existence, of the Newfoundland fisheries will rest upon the industries' ability to compete on international markets. Competitive cost structures indicate that a move to what are hopefully economies of scale with plants of input capacities in excess of 100 million pounds per year is a vital condition of survival.

The main problem to be overcome, which lies outside the terms of reference of this report, is that of increasing the efficiencies of the offshore fleets. There have been indications of declining catch ratio. However, considerable technological progress is being made, and it is assumed that no restrictions from external conditions will be placed upon the forecasts of offshore activity used in this report.

10.3.2 Fish Processing

The processing of fish is dependent on the resource, the efficiency of its exploitation and on the developments in the world markets. The aggregate level of fish processing, based on knowledge of the supply and demand in the primary and secondary fisheries sector, has been provided by the Board.

Within these given parameters, the potential development of the processing establishments, the development of the major process groups, salted, fresh, frozen, and meal will not follow parallel patterns; neither economics of the processes nor the demand patterns for the end products are identical.

Figure 10-4 shows the fish processing plants by type and location. Figure 10-8 shows the same information together with present and estimated future water demand. The source data used in the preparation of these figures has recently been updated by the Canada Department of Fisheries. The following table shows the location and type of plant which has ceased or commenced operation between the release of the source data and December 1968.

	Type of Plant		
Ceased Operation	Fresh	Frozen	Salt
Curling	x		
Isle aux Mort		x	
Rose Blanche	x		
Harbour le Cou	x		
Merasheen			x
Harbour Buffet			x
Bay Bulls			x
Portugal Cove	x		
Old Perlican		x	x
Bonavista			x
Greenspond		x	
Valleyfield		x	
Fogo	x		
New Operation			
Heart's Desire	x		
Bay de Verde	x		
Little Harbour	x		

10.3.2.1 Salt Fish

World salt fish production has been declining while the production of fresh and frozen fish has been increasing. As these processes compete for the same raw material, it is reasonable to assume that this pattern reflects a profit differential and that to compete the Provincial fisheries must follow a parallel development.

The outlook for the salt processing sector is for a level volume of production during the forecast period. It is assumed that most, if not all, of the salt fish plants which remain open during the forecast period will do so for welfare reasons.

10.3.2.2 Fresh and Frozen Fish Processing

The market demand for fresh and frozen fish has been increasing. The utilization of the world catch with an index of 100 for base year 1952 shows an increase in fresh fish market to an index of 147, and the frozen fish market to an index at 466 by 1963. The major future developments in the processing sector will occur in the processing of fresh and frozen fish.

The major change which the Provincial fresh and frozen fish processing establishments will experience during the forecast period is the centralization of processing operations. Analysis indicates that the smallest viable processing operation by the mid 1980's should have an input capacity of 100 million pounds of fish. As there appears to be no economic upper limit on the size of the production unit, it is expected that some of the establishments will be in excess of this minimum capacity.

Five processing establishments of the scale described above are planned for the Province, four of which will be freezing operations. One of these, the processing plant at Marystown with a rated input capacity of 120 million pounds a year, is already operating.

The other major expansions on the south sea coast, again with a minimum input capacity of 100 million pounds, are anticipated for the Harbour Grace and the St. John's (or Bay Bulls) areas. Between 1976 and 1981 it is expected that a major plant will be established between Port aux Choix and La Scie, possibly at St. Anthony. This plant will handle the increasing landings expected from the concentrated exploitation of the Labrador fishery.

With the exception of the above, no expansion is expected at existing fresh and frozen processing plants, although Table 10-4, which summarizes a confidential survey prepared by the Board, implies some further expansion. On this basis, apart from existing water supply problems, future water demand for fresh and frozen fish processing and any accompanying pollution problems will be related to large new plants centered in a handful of ports.

10.3.2.3 Meal and Oil Reduction

Fish meal is produced by two major processes, one utilizing the waste by-products of processing plants and the other utilizing what are known as reduction fish. The location of existing plants is shown on Table 10-8.

The potential for fish meal processing is not limited to the need to dispose of waste products. The growing recognition of the serious problem of global protein malnutrition is hastening the acceptance of fish protein concentrate, or FPC, as suitable for human consumption. Although at the present time there are some legal restrictions on the sale of FPC for human consumption, if produced from whole fish or offal, the growing acceptance of existing technology is expected to remove this obstacle[12].

The commercial development of an FPC industry is still in an embryonic stage, and while the technology is well advanced many problems of product development in terms of commercial marketing remain unsolved. These marketing problems exist in both developed and developing countries although the markets are quite different.

Canada has been a leader in the development of the FPC technology for many years beginning in the early 1950's with research by the Fisheries Research Board of Canada, which led to the development of what is known as the Halifax process[12].

It is assumed that the market for meal will continue to grow and that the utilization of the meal plants will increase over the forecast period.

The meal production plants shown on Figure 10-4 are for the reduction of wastes from the fresh and frozen processing operations, although some are capable of handling herring. At the present time, the raw material available to meal reduction plants is approximately 43 percent of the fresh and frozen end product.

It is believed that efficiencies can be introduced in the fish processing plants which would raise the raw material available to 46 percent of fresh and frozen output.

The average ratio of raw material input to meal output is in the range of 4.3:1 to 6:1. For purposes of this study a 5 to 1 ratio was deemed acceptable.

The second meal process uses reduction fish, such as herring, capelin and sand-launce. At the present only herring reduction is planned for the Province although the other species are available.

Meal production facilities for ground fish need not be located adjacent to the resource or the fresh and frozen processing facilities, as offal can be transported without damage over considerable distances. On the other hand the reduction of pelagic species, in this case herring, must be located near the resource. The raw material is subject to rapid spoilage so that its transportation for any distance is not feasible.

At the present time the meal plants are operating at about 20 percent of rated annual capacity; because of the existing seasonal pattern of the primary fishery, according to the Board, they only operate for a six-week to two-month period. As the production of fresh and frozen fish becomes a year-round operation, it is expected that the annual capacity utilization of the meal plants will increase.

The major expansion in production capacity of this sector is anticipated in the introduction of a herring reduction plant at Stephenville to provide for the exploitation of the herring resource. According to the forecasts of landings provided by the Board, the exploitation of this resource will begin in the 1971-1976 period. The capacity of this plant should be sufficient to handle the 200 million pounds of landings forecast for this area.

Oil is a by-product of meal production and the related water demand is included in Section 10-4.

10.3.2.4 Aggregate Forecasts of the Processing Sector

The pattern of employment in the fish processing sector (Figure 10-5) has been markedly seasonal. The rationalization of the primary fisheries and the centralization of the fishing ports will affect the employment pattern of the processing sector. The major plants are expected to operate on a year-round basis which will reduce the seasonal content. This change will in turn affect the average earnings in the processing sector as the employees will be working a full year rather than only a few months. The employment estimates used in the forecast period were based on discussion with the Board.

The value forecasts for the fish processing sector were based on the information provided by the Board on the volume and value of fish landings, and are shown on Figure 10-6. Because of the major changes envisioned in the location of processing plants, no attempt has been made to provide an areal distribution of the following forecasts. Individual forecasts by type of process are not included because structural changes make past data meaningless as a forecasting tool.

To calculate the value of shipments, a ratio was taken individually between the landed value of groundfish, pelagic and estuarial, and molluscs and crustacean species to value of products for the same species. The ratio for each group has not varied significantly for a number of years. The value added was calculated by applying a ratio of 42 percent to the total value of shipments. No attempt was made to estimate the value added resulting from the processing of the three major species groups. It is noted that the forecasts are given in terms of 1965 dollars.

The results of these calcualations are summarized in the following table:

Fish Processing Forecasts 1971 - 1981
(Values expressed in 1965 dollars)

	1971	1976	1981
Value of Shipments	$71.0 M	$89.2 M	$103.9 M
Value Added	$29.8 M	$37.5 M	$ 43.6 M
Wages and Salaries	$17.0 M	$20.2 M	$ 24.0 M
Employment	6000	6500	7000

10.4 Specific Water Demand and Wastewater

The literature survey as well as data from the Atlantic Region have resulted in indications on specific water demand and wastewaters generated in fish processing plants under present day conditions. A preliminary statistical analysis has yielded a relationship between fresh water use and technical and economic characteristics of the Plant. Nevertheless, all of these indications should be considered as provisional, since they are generally based on a small sample of data reflecting mainly the present day conditions, with small or average plants; whereas future plants will probably be much bigger and apply a more advanced technology. A detailed analysis of the problems related to specific water demand and wastes in fish processing plants is included in Volume Eight, Appendix B, Part II. The following comments present only the most important conclusions of this analysis.

10.4.1 Specific Water Demand

Results obtained from the questionnaire survey in the Atlantic Region fish processing plants indicate a fresh water intake demand varying between 0.7 and 10.0 gallons per pound of input fish. The variation in salt water intake is much larger, between 1.9 and 27 gallons per pound of input fish. It may be assumed that the large variation in fresh water is related to variation in cost and water availability. The variation in the salt water demand could be expected to be complementary to the variation in fresh water demand, but this is not proven by the existing data. Obviously the plant type, age, technology, and other characteristics also play a significant role in the variation of specific intake water demand and the type of water used. Thus, for example, some salt fish plants use entirely salt water.

There is a marked variation in water demand during the year related to the seasonal variation of fish processes, as illustrated in Figure 10-10. However, this figure cannot be considered as typical because it was based on a single case of a plant with an annual input capacity of 50 million pounds.

The statistical relationship between process water demand and plant characteristics (number of working hours per thousand pounds of input and index of plant type, and cost of water) is discussed in Volume Eight, Appendix B, Part II. A graphical representation of the relationship is given for convenience in Figure 10-9. Caution should be exercised in using the relationship because it is based, as previously mentioned, on a very small sample. The relationship obtained indicates that, for a cost of about 20 to 25 cents per 1000 gallons, the average water demand is between 2 and 3 gallons per pound of fish (input). The generally used figure of 2.5 gallons per pound of fish (input) falls within these average limits.

Since between 50 and 65 percent of the intake water demand is used for fluming, significant reductions in this demand could probably be obtained by changes in the technology of fish transportation. The relationship mentioned above also indicates that improved technology resulting in the reduction of number of working hours per unit of output can reduce water consumption to a significant extent.

The quality of the water used is required to comply with the standards established by the Canada Department of Fisheries regulations which require that the water have less than two coliform per 100 ml.

Process water used in fish processing plants is invariably disinfected with chlorine at dosages which vary according to the water quality and usages. Because of the high requirements with respect to the quality of water, water recirculation and/or re-use in the fish processing industry has extremely limited possibilities.

10.4.2 Wastewater Releases

There is a large variation in the quality of wastewaters released from fish processing plants, mainly because of the following factors:

a) The type of plant and technology used.
b) The degree and system of waste recovery for by-products.
c) The specific intake water.
d) The species being processed.

Whereas the first two factors influence both the total amount of wastes and their concentration, the third has some significance only from the viewpoint of the dilution of the wastewaters.

A detailed discussion of the nature and sources of wastes and of techniques used to produce high-protein by-products and thus reduce the amount of wastes is included in Volume Eight, Appendix B, Part II. This Appendix also includes a table in Section 7 of the text showing the main characteristics (BOD, COD, total solids) of wastewaters from different fish processing plants, including wastewaters from special production lines. Although these data are interesting, they are of limited value, since no details about the plant characteristics, specific water intake and wastes recovery for by-products are given. Nevertheless, since more accurate information is not available, it can be estimated from this table that the BOD of the total effluent from fish processing plants varies between 100 and 400 ppm; the COD between 250 and 1200 ppm; and the total solids between 10,000 and 35,000 ppm. It may be further presumed that the lower figures correspond to higher specific intake water demand and/or more advanced recovery of wastes for by-products, although, as mentioned previously, indications on these aspects are not available. The problem of fish plant and meal plant wastewater disposal may be solved in basically two ways, either directly to the sea or to wastewater treatment plants.

The ratio between the input and output weight in the fish processing industry is about three to one. In many areas the wastes from the processing plants become the input of the fish meal plants. This processing reduces the wastes to approximately 10 to 20 percent of the input.

10.5 Present and Forecast Water Demand and Wastewater

A series of questionnaires was circulated to existing fish processing plants, and some useful albeit incomplete information was obtained. Some further information was obtained from studies, prepared by different consultants, on the improvement, expansion, or replacement of existing water supply systems, or on new water supply systems. This together with the data included in the questionnaires on the present situation and future development circulated by the Board have formed the basis for completing Table 10-7 which describes the main technical and economic characteristics of the plant which are significant for the water use. From this, estimates were made of the present and future water demand and releases whenever such data were not included in the questionnaires or in the other sources, by means of the statistical relationship described in Section 10.4.1 and presented graphically in Figure 10-8.

The table also includes the forecast developments indicated in Section 10.4.3, and the corresponding estimated water demand and waste releases. The following conclusions can be drawn from the table:

a) The information available on the water demand for the waste releases from fish processing plants is incomplete and a more comprehensive picture would require measurements and sampling.

b) Out of the 39 fish processing plants, four have an inadequate supply because of water quantity problems; three because of water quality problems; two because of low pressure; and two because of the freezing of exposed connecting lines.

c) The cost of water which, from the available indices, is estimated at about 20 to 30 cents per thousand gallons represents a significant cost for the low value products (about 3 gallons of water per pound of fish input representing about one mill, or about 3 percent of the current landed value of such widely caught fish as cod). Reduction in cost of water or specific use could influence the economic efficiency of fish processing plants using low value fish input. However, the relative significance of this particular water cost relationship becomes very low when more valuable species of fish or crustaceans are considered.

d) Data on wastewater quantity and quality are completely missing, except for the fact that the wastes are generally discharged untreated to the sea. Estimates of the amount of suspended solids, BOD and COD, can, however, be obtained when required from the indications included in Section 10.4.2.

The future large plants having inputs of 100 million pounds per year would require supplies of water of the order of 300 to 400 million gallons per year, out of which about one-half could be sea water, provided that the quality of sea water is adequately maintained. However, because of the scale of these plants and the fact that they will probably be located near areas of relative population concentrations, it is anticipated that problems will be encountered in obtaining sea water, at an economic cost, which will satisfy the quality requirements stipulated for fish plants.

It should be mentioned that in making the estimates of the amounts of wastewaters and their quality, it may be assumed that the future large plants will probably include protein concentrate or fish meal lines and/or solid fish waste lines which will keep the amount of wastes down to the minimum possible.

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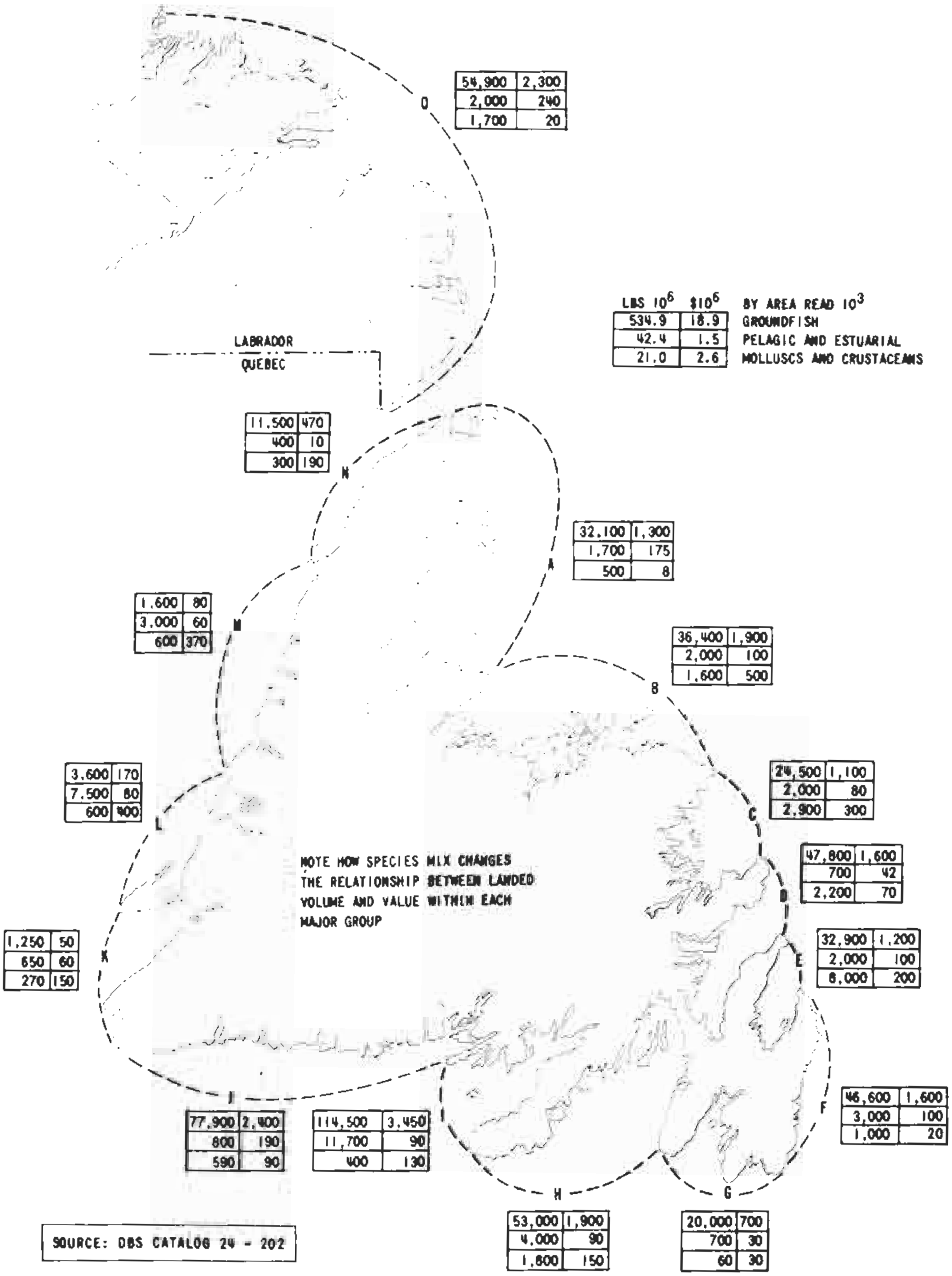
NEWFOUNDLAND AND LABRADOR

SEA FISHERIES AREAS
LANDINGS OF MAJOR SPECIES 1966



3

FIGURE 10-1

NEWFOUNDLAND AND LABRADOR
TRENDS AND FORECASTS OF THE PRIMARY FISHERIES, VALUE OF LANDINGS BY MAJOR SPECIES
1956 - 1981

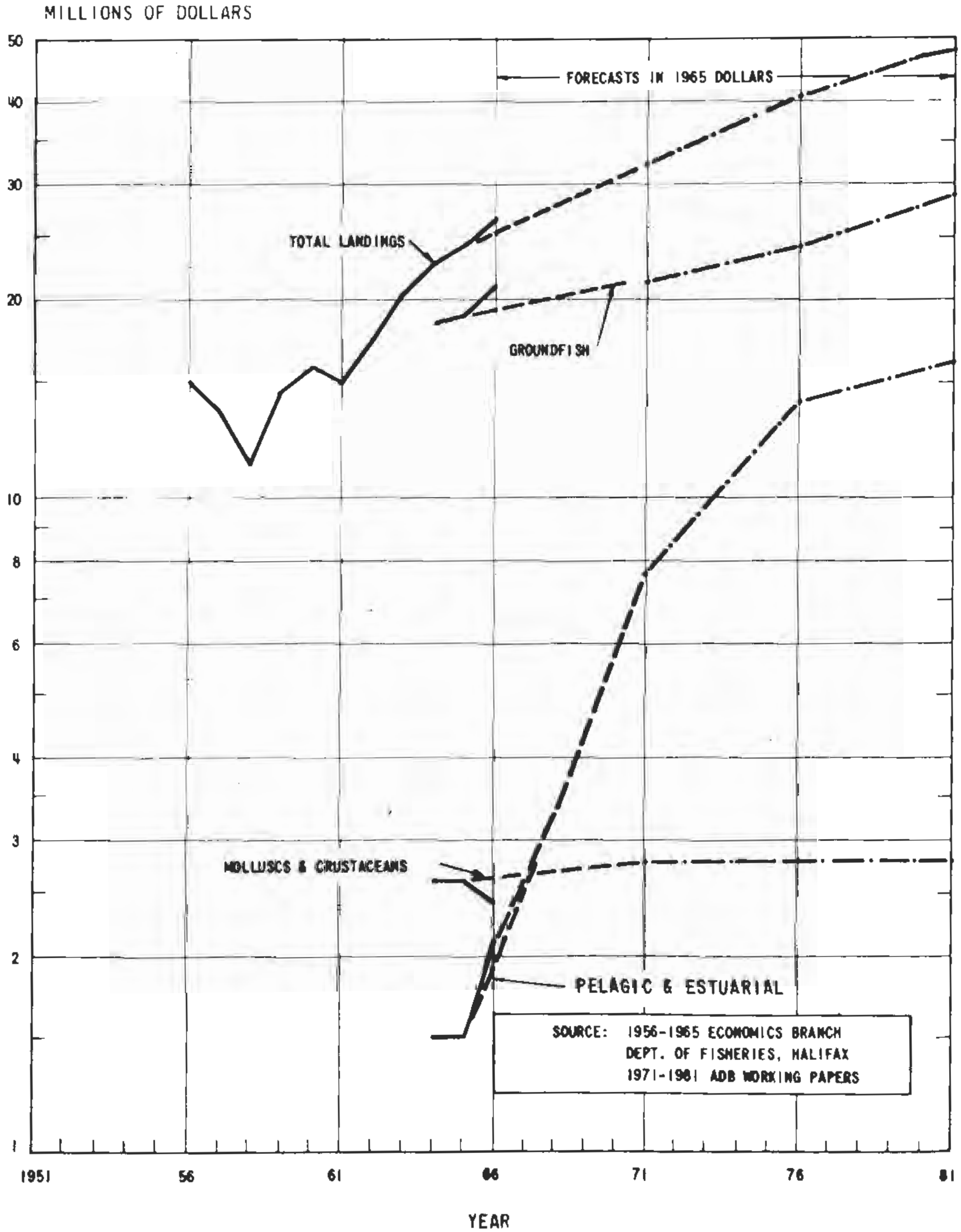


FIGURE 10-2A

NEWFOUNDLAND AND LABRADOR TRENDS AND FORECASTS IN THE PRIMARY FISHERIES, VOLUME OF LANDINGS BY SPECIES 1956 - 1981

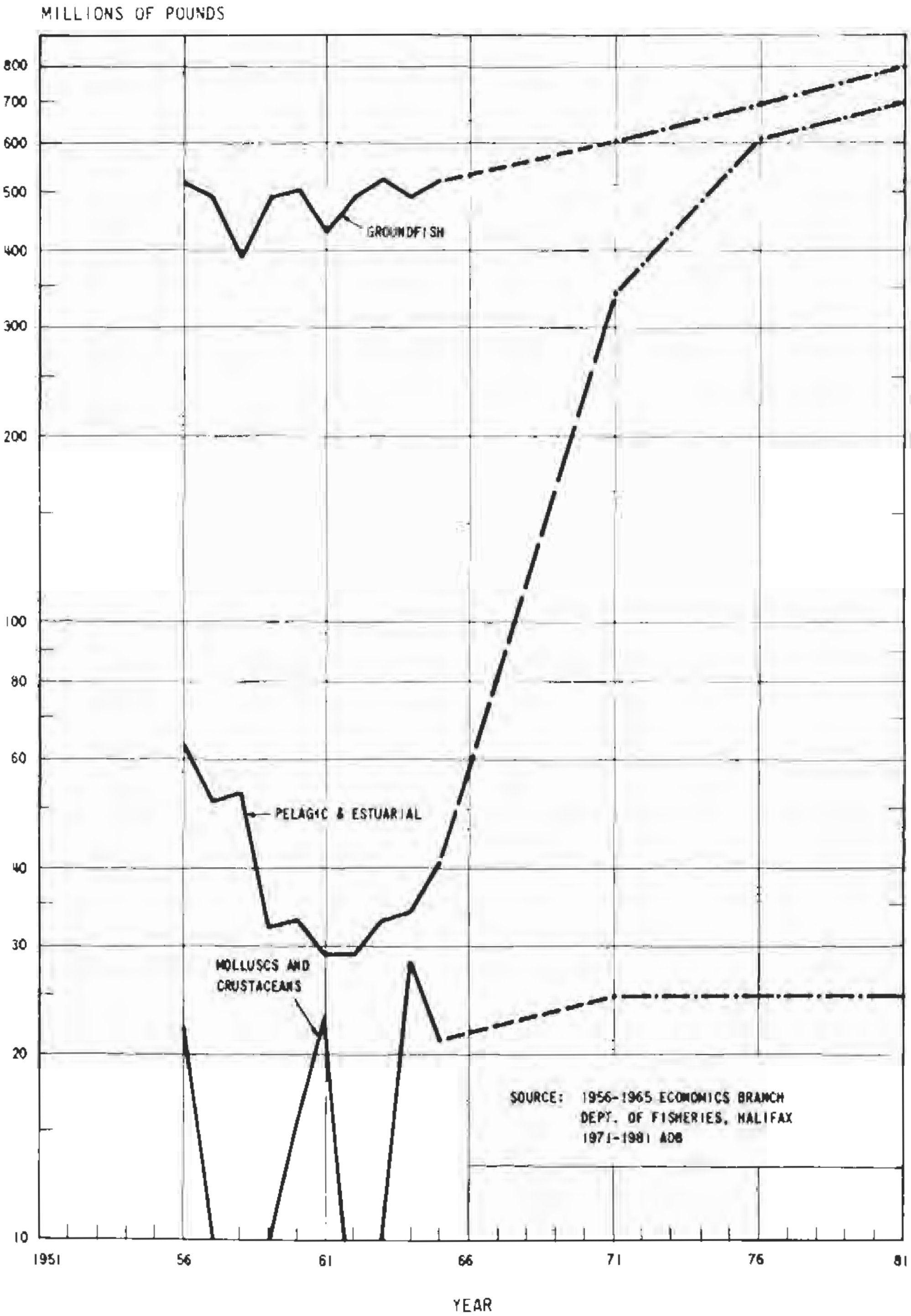


FIGURE 10-2B

NEWFOUNDLAND AND LABRADOR EMPLOYMENT IN THE PRIMARY FISHERIES, INSHORE AND OFFSHORE, BY FISHERIES AREA 1966 AND 1981

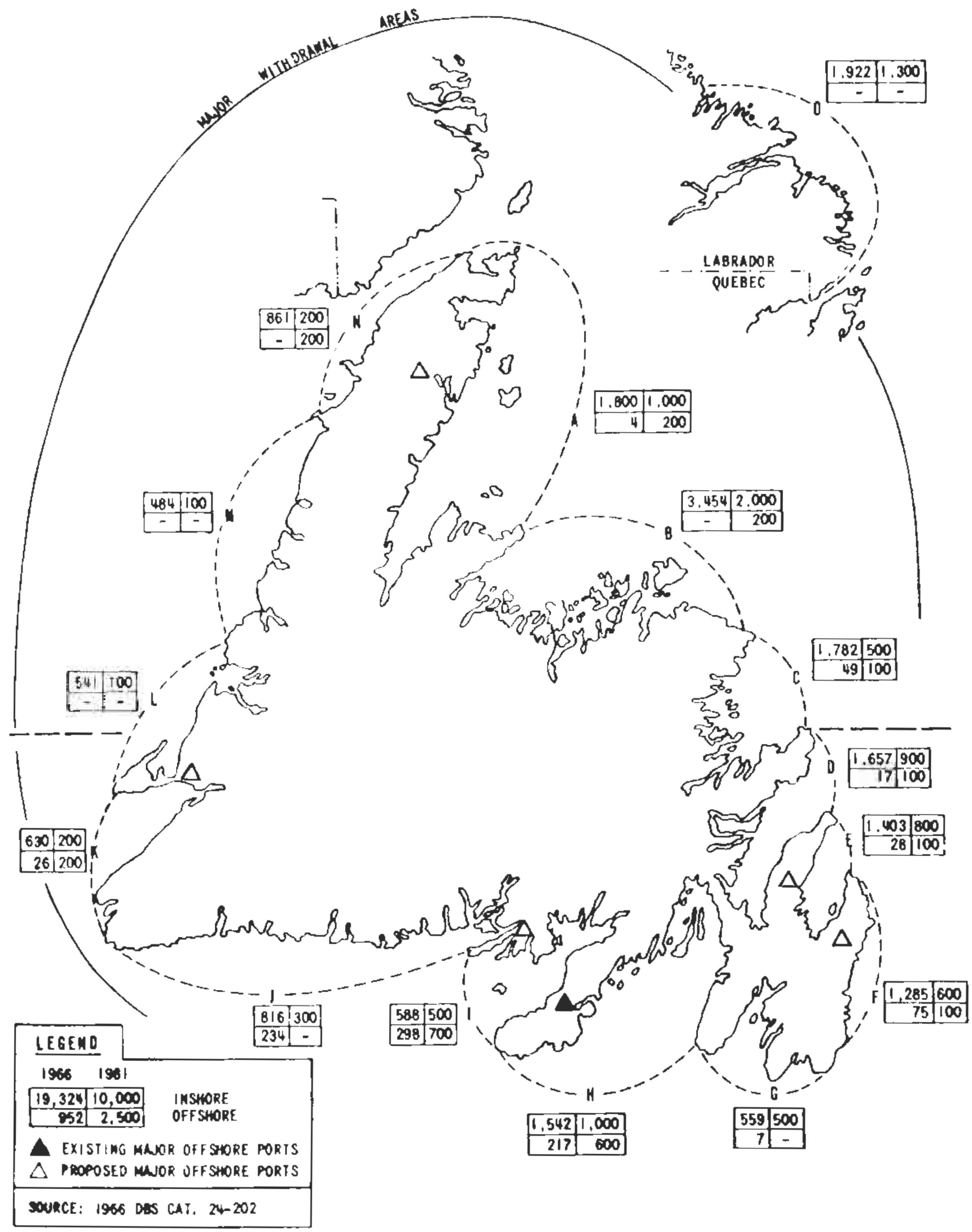
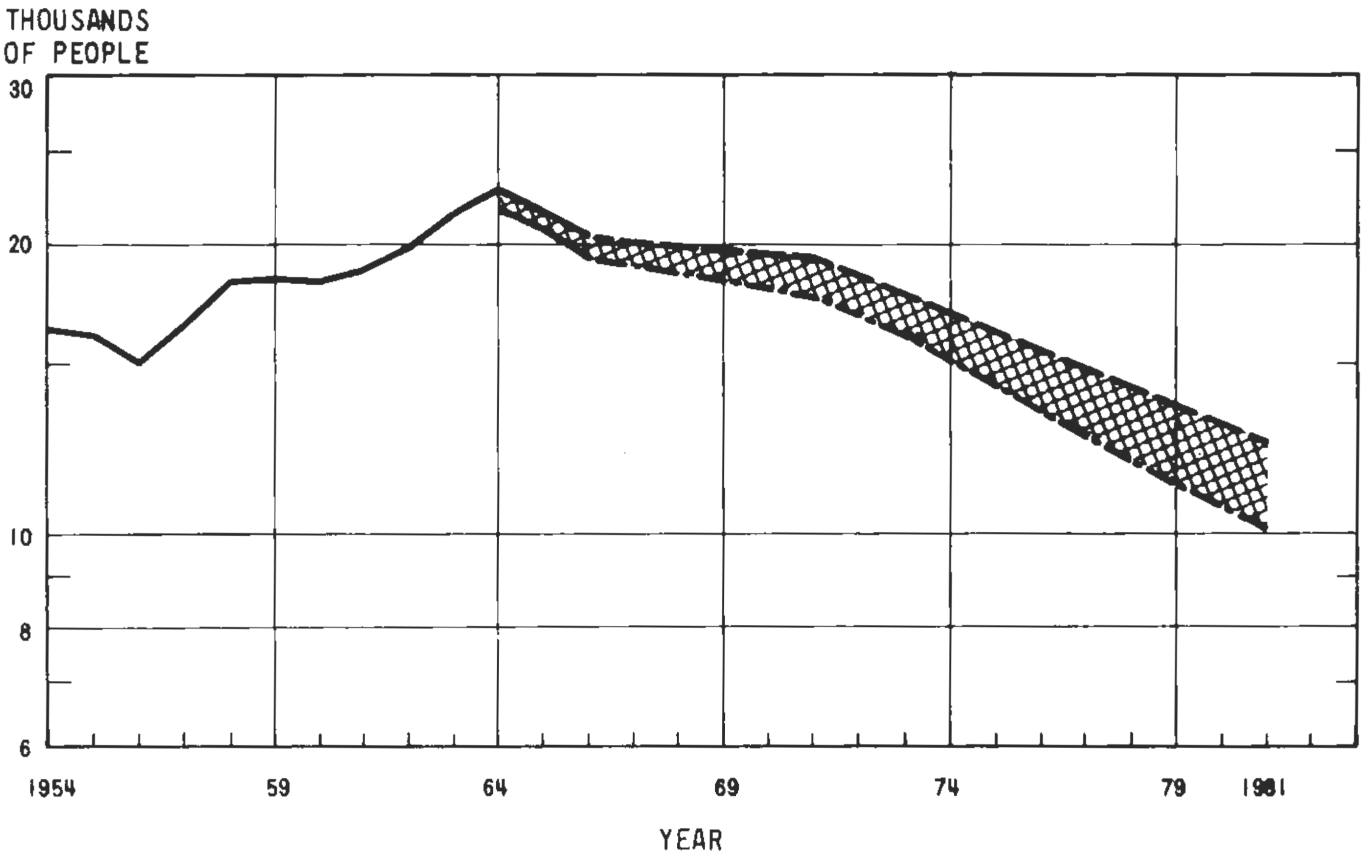


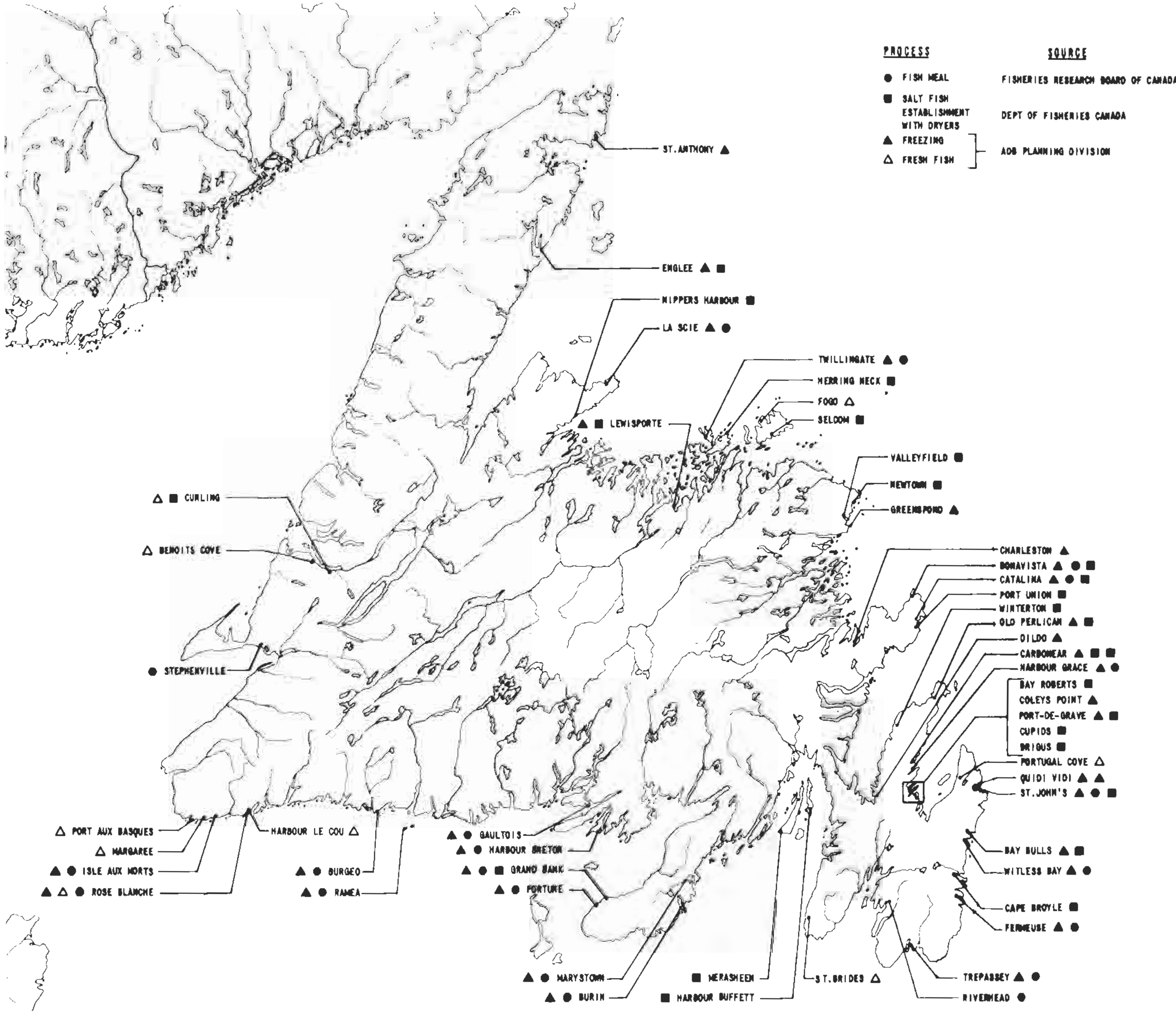
FIGURE 10-3A

NEWFOUNDLAND AND LABRADOR
TRENDS AND FORECASTS OF EMPLOYMENT
IN THE PRIMARY FISHERIES
1959 - 1981



SOURCE:	1954-1959	DEPT. OF FISHERIES
	1960-1966	DBS CAT. 24-202
	1971-1981	BASED ON DISCUSSIONS WITH ADB
LEGEND:	———	TOTAL EMPLOYMENT FORECAST
	—-—	INSHORE FISHERIES FORECAST
	XXXXXX	OFFSHORE FISHERIES FORECAST

FIGURE 10-3B

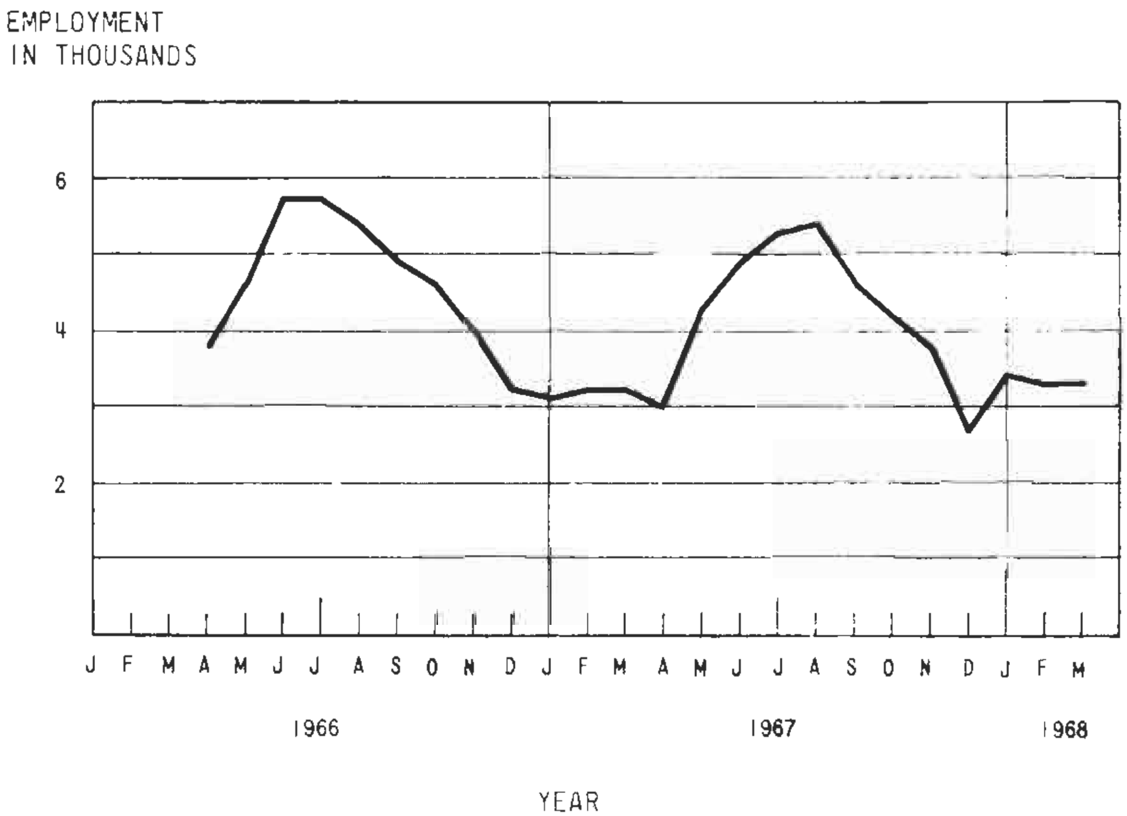


NEWFOUNDLAND

FISH PROCESSING PLANTS BY TYPE AND LOCATION

FIGURE 10-4

NEWFOUNDLAND AND LABRADOR SEASONAL PATTERN OF EMPLOYMENT IN FISH PROCESSING



SOURCE: DBS CAT. 72-008

FIGURE 10-5

NEWFOUNDLAND AND LABRADOR
TRENDS AND FORECASTS IN FISH PROCESSING INDUSTRY
1957 - 1981

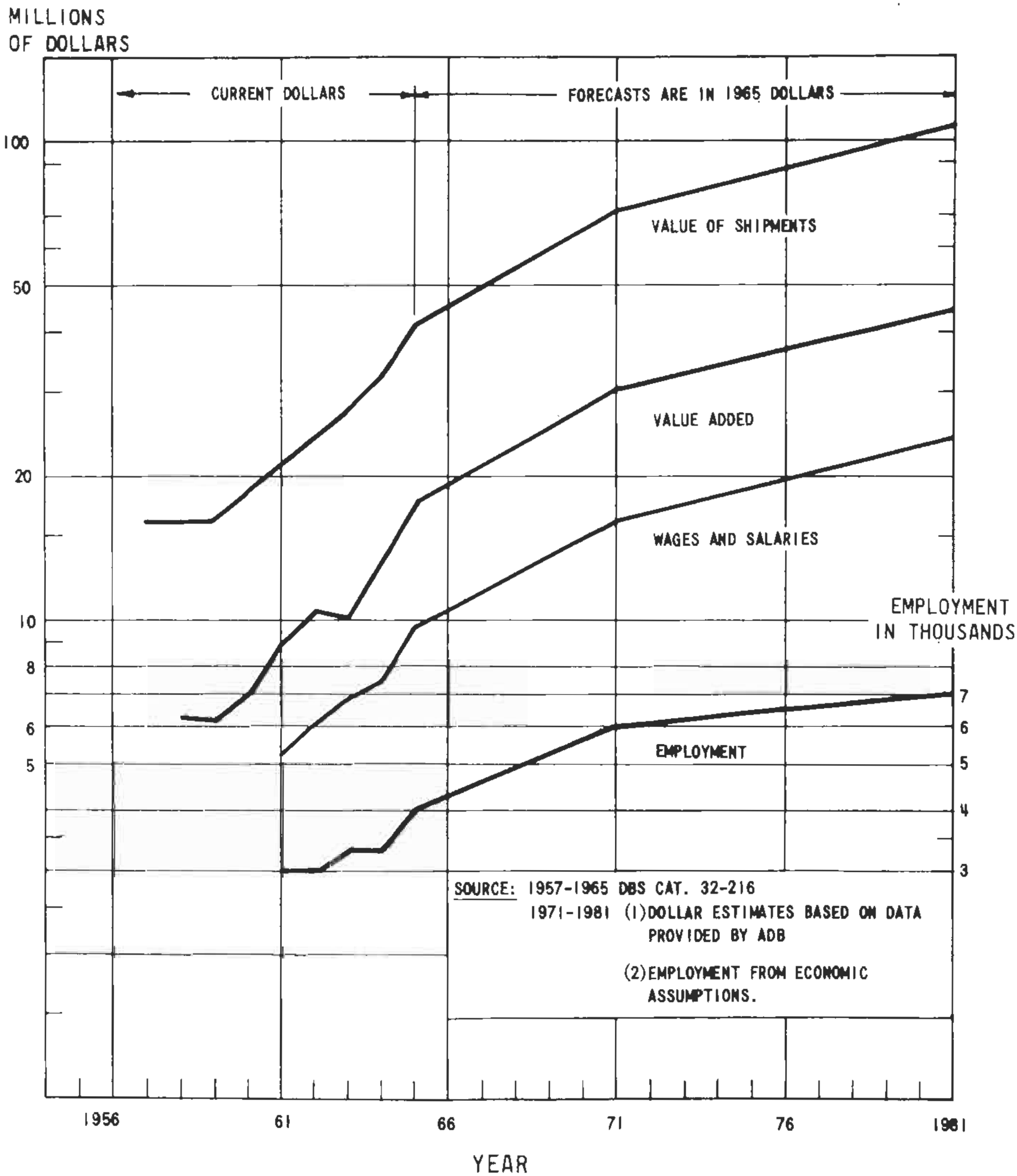


FIGURE 10-6

NEWFOUNDLAND AND LABRADOR
RELATIONSHIP BETWEEN ECONOMIC FACTORS
FISH PROCESSING (MANUFACTURING ACTIVITY)

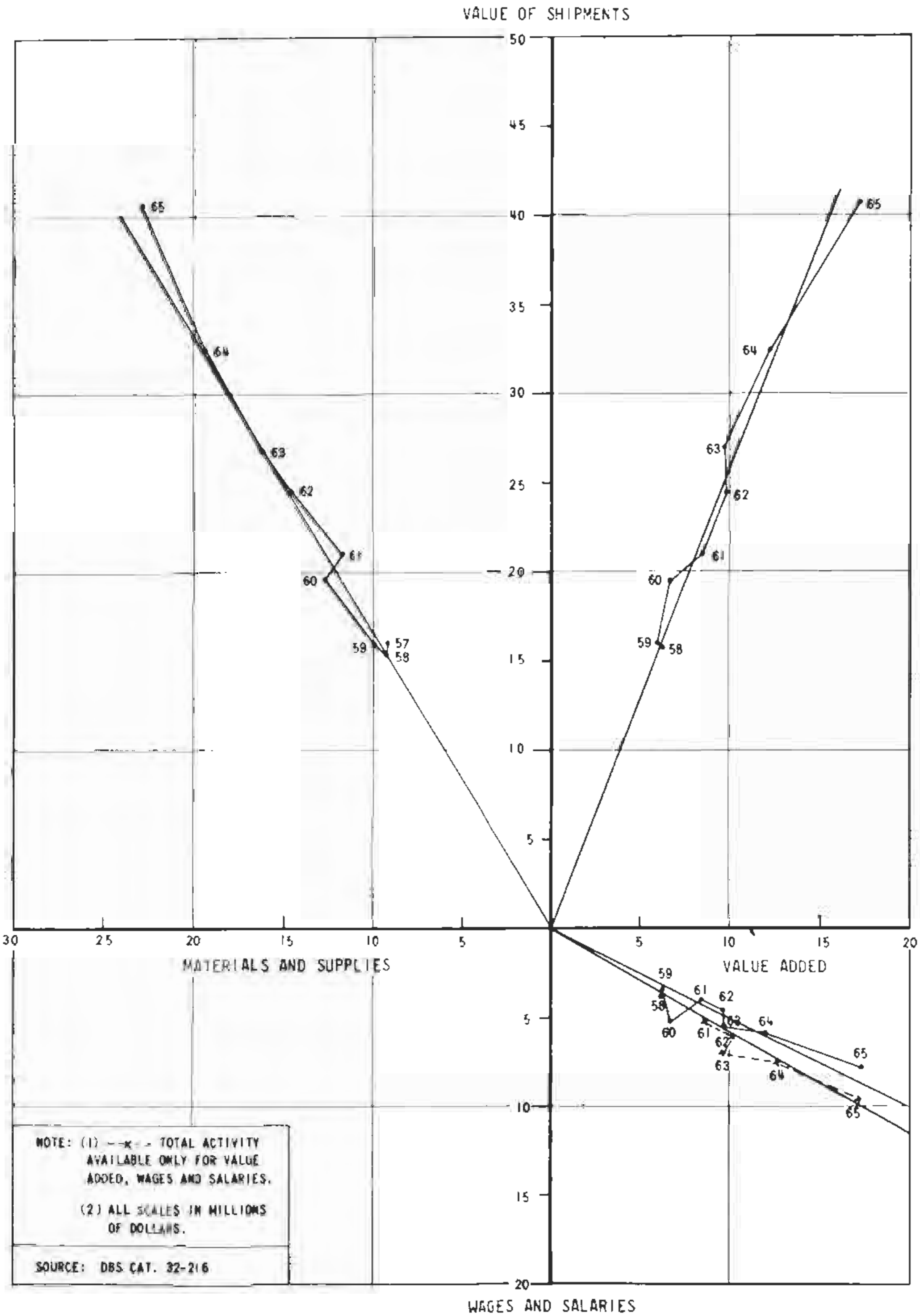
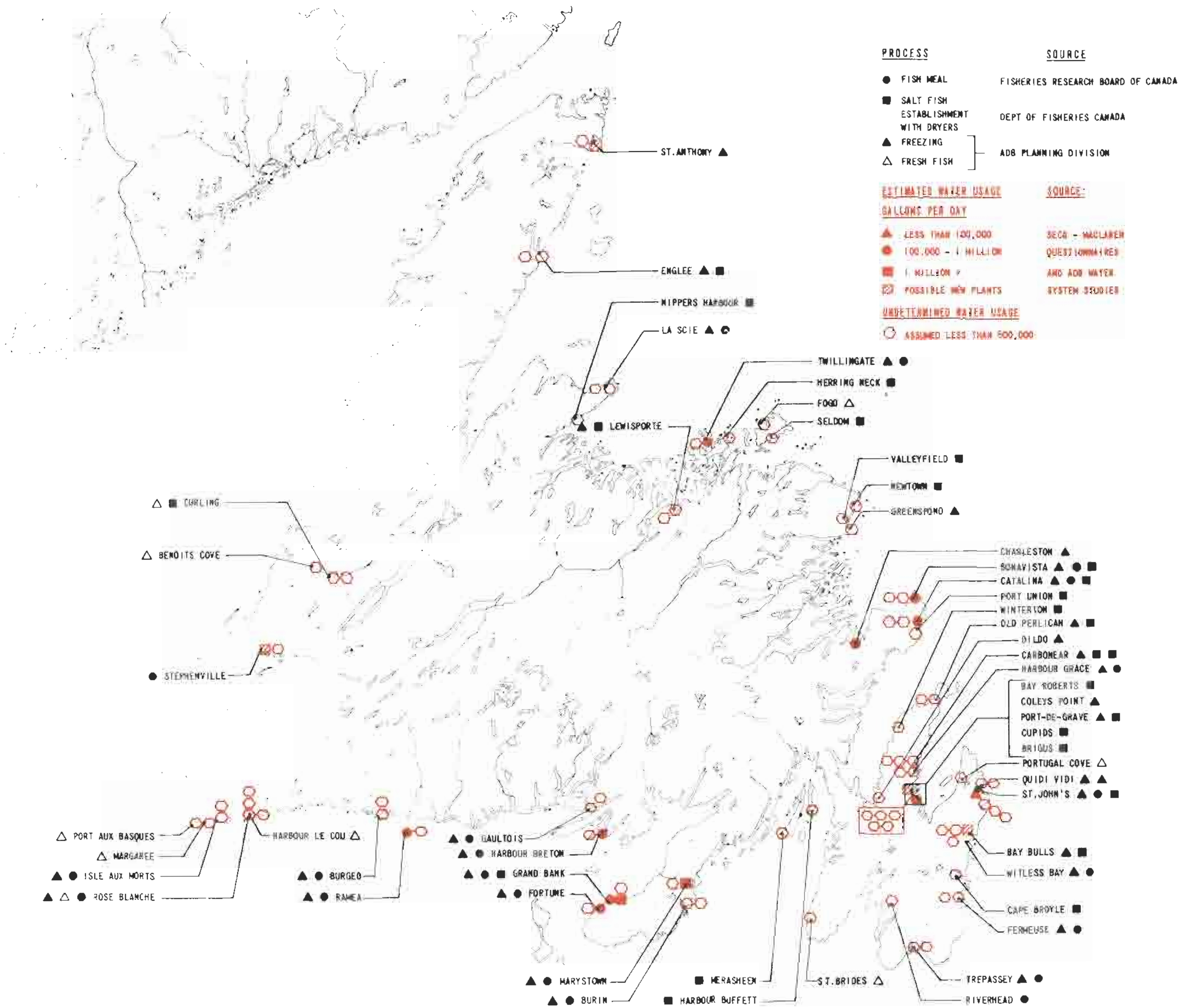


FIGURE 10-7



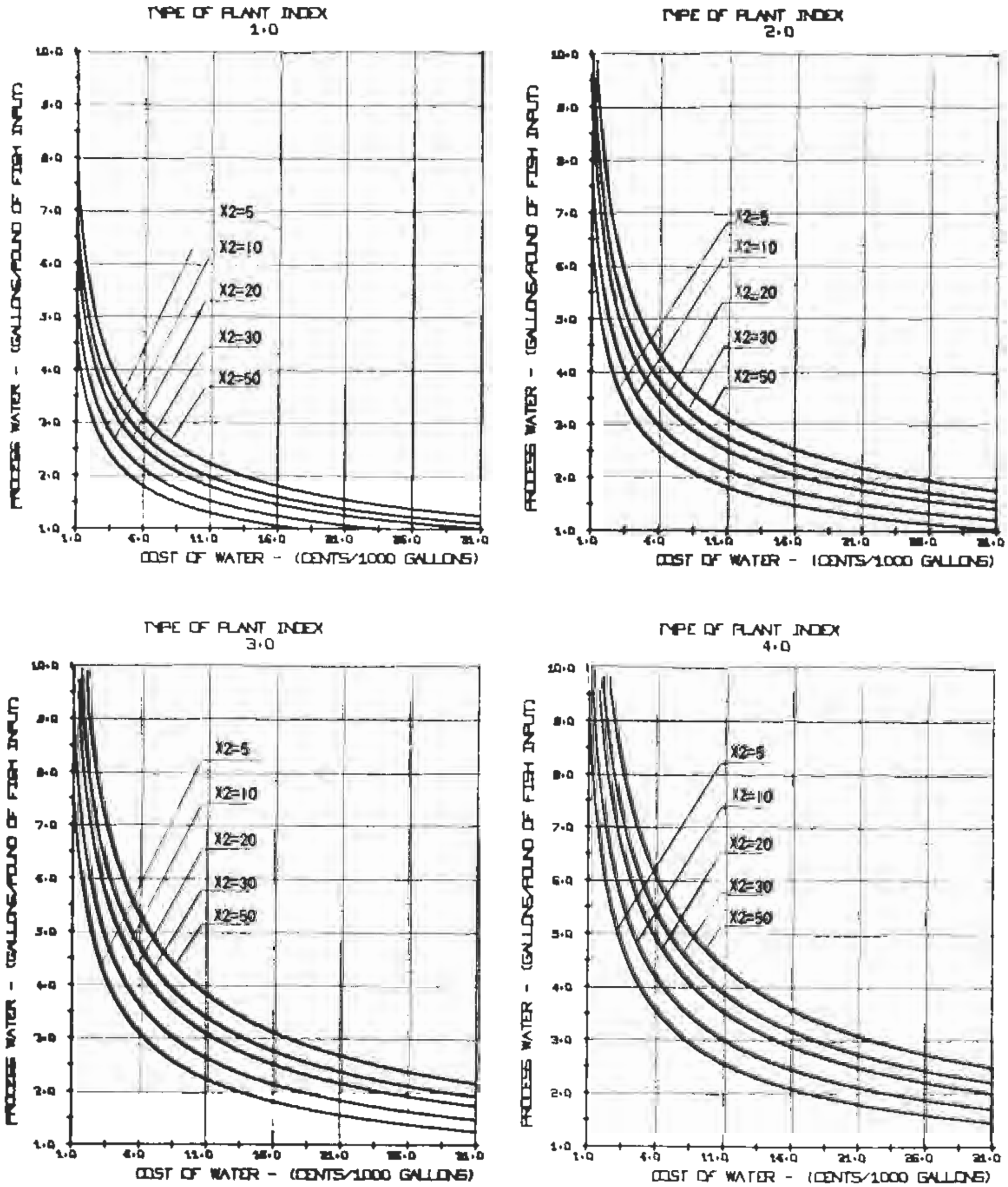
NEWFOUNDLAND

PRESENT AND ESTIMATED FUTURE WATER DEMAND BY THE FISH PROCESSING INDUSTRY

FIGURE 10-8

APPROXIMATE RELATIONSHIP FOR ESTIMATING FRESH PROCESS WATER DEMAND IN THE FISH PROCESSING INDUSTRY

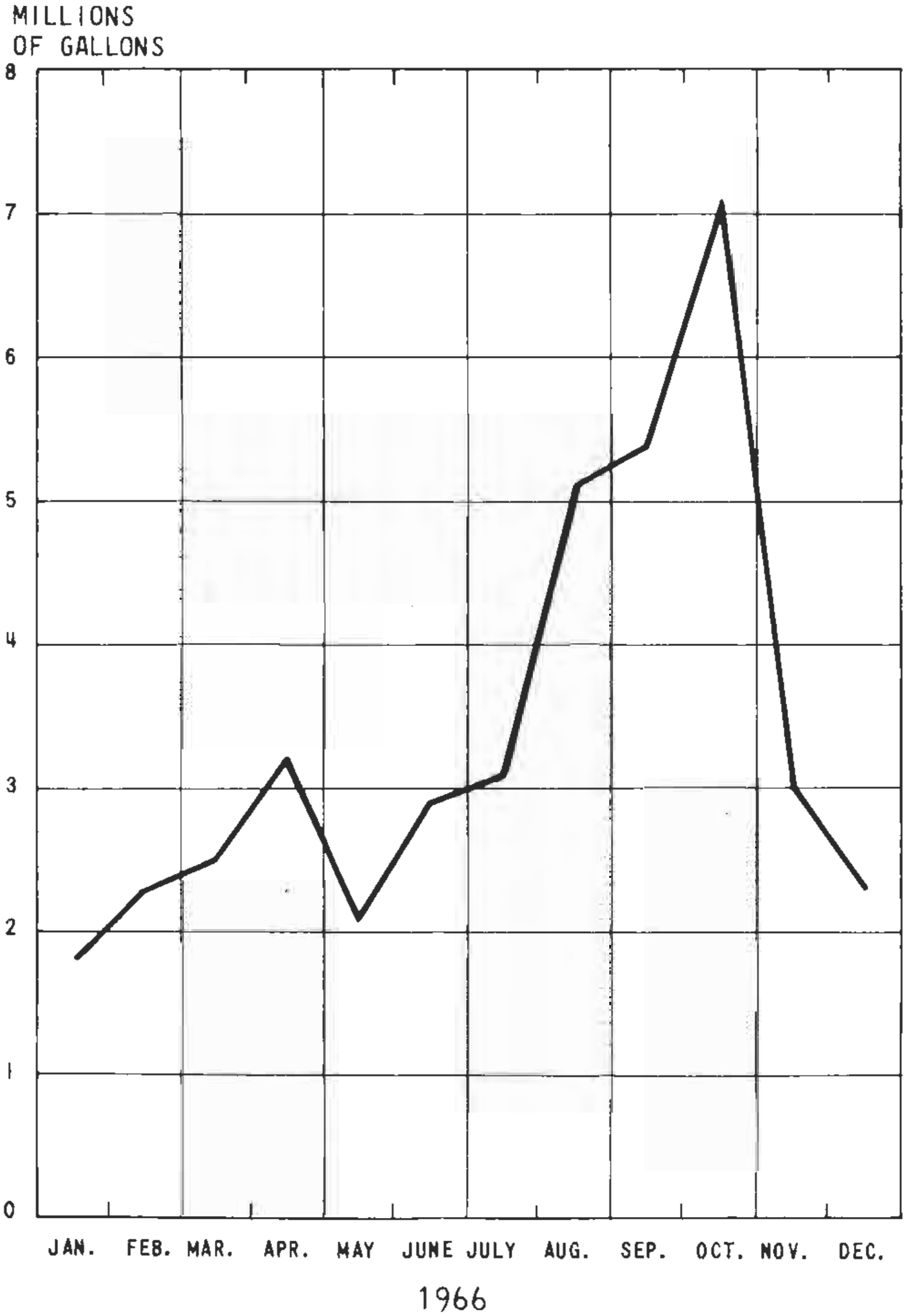
X2 = NO-HOURS/LB-INPUTX10E06



SOURCE: BASED ON DATA FROM ATLANTIC PROVINCES

FIGURE 10-9

NEWFOUNDLAND
MONTHLY WATER DEMAND
OF A FISH PROCESSING ESTABLISHMENT OF
50 MILLION POUNDS ANNUAL INPUT CAPACITY



SOURCE:	SECO-MACLAREN QUESTIONNAIRE
NOTE:	PLANT OPERATING BELOW CAPACITY

FIGURE 10-10

TABLE 10-1

NEWFOUNDLAND AND LABRADOR

NUMBER OF FISHERMEN BY EXTENT OF EMPLOYMENT, BY FISHERIES AREAS, FOR SELECTED YEARS

Area	1966 Total	1966 Full Time	1966 Part Time	1966 Occasional	1966 Inshore	1966 Offshore	1960 Total	1961 Total	1964 Total	1964 Inshore	1964 Offshore
Province	20,266	12,673	4,094	3,519	19,324	962	18,297	18,759	22,615	21,753	862
A	1,804	1,394	410	-	1,800	4	2,031	1,973	2,064	2,056	8
B	3,454	1,992	962	500	3,454	-	3,155	3,526	3,962	3,930	32
C	1,831	843	541	447	1,782	49	1,576	1,493	1,618	1,578	40
D	1,674	1,249	229	196	1,657	17	1,500	1,561	1,730	1,722	8
E	1,435	549	319	563	1,408	28	1,176	1,205	2,084	2,076	8
F	1,360	869	199	292	1,285	75	1,065	1,079	1,488	1,428	60
G	566	482	45	39	559	7	607	574	617	617	-
H	1,759	1,290	188	281	1,542	217	1,933	2,001	2,027	1,886	141
I	886	677	111	98	588	298	660	659	1,060	780	280
J	1,050	759	145	146	816	234	960	901	1,186	919	267
K	656	36	236	384	630	26	364	382	607	607	-
L	548	22	202	324	541	7	614	535	683	665	18
M	484	114	258	112	484	-	478	461	580	580	-
N	861	570	230	61	861	-	779	762	826	826	-
O	1,922	1,827	19	76	1,922	-	1,393	1,633	2,083	2,083	-

TABLE 10-2

PERCENTAGE DISTRIBUTION OF FISHERMEN BY EXTENT OF EMPLOYMENT, BY FISHERIES AREAS FOR SELECTED YEARS

Area	1966 Total	1966 Full Time	1966 Part Time	1966 Occasional	1966 Inshore	1966 Offshore	1960 Total	1961 Total	1964 Total	1964 Inshore	1964 Offshore
Total	100.0	62.5	20.2	17.3	95.3	4.7	100.00	100.0	100.0	96.2	3.8
A	8.9	6.9	2.0	-	8.9	-	11.1	10.5	9.1	9.1	-
B	17.0	9.8	4.7	2.5	17.0	-	17.2	18.8	17.5	17.4	0.1
C	9.0	4.2	2.7	2.2	8.8	0.2	8.6	8.0	7.2	7.0	0.2
D	8.3	6.2	1.1	1.0	8.2	0.1	8.2	8.3	7.6	7.6	-
E	7.1	2.7	1.6	2.8	6.9	0.2	6.4	6.4	9.2	9.2	-
F	6.7	4.3	1.0	1.4	6.3	0.4	5.8	5.8	6.6	6.3	0.3
G	2.8	2.4	0.2	0.2	2.8	-	3.3	3.1	2.7	2.7	0.0
H	8.7	6.4	0.9	1.4	7.6	1.1	10.6	10.7	9.0	8.3	0.7
I	4.4	3.3	0.5	0.5	2.9	1.5	3.6	3.5	4.7	3.4	1.3
J	5.2	3.7	0.7	0.7	4.0	1.2	5.2	4.8	5.2	4.1	1.1
K	3.2	0.2	1.2	1.9	3.1	0.1	2.0	2.0	2.7	2.7	-
L	2.7	0.1	1.0	1.6	2.7	-	3.3	2.9	3.0	2.9	0.1
M	2.4	0.7	1.3	0.6	2.4	-	2.6	2.5	2.6	2.6	-
N	4.2	2.8	1.1	0.3	4.2	-	4.3	4.1	3.7	3.7	-
O	9.5	9.0	0.1	0.4	9.5	-	7.6	8.8	9.2	9.2	-

Extent of Employment in Fishing: Full Time — 10 months or over; Part Time — 5 to 10 months; Occasional — Less than 5 months

Source: DBS Cat. 24-202 Annual

LANDED VALUE, NUMBER OF FISHERMEN, AND LANDED VALUE PER FISHERMAN
1964, 1965, 1966

		PROVINCE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1964	Value landed ($'000)	22,873	1,861	2,779	1,027	1,771	1,575	2,086	564	1,854	2,865	2,468	188	529	589	760	1,957
	No. of fishermen	22,615	2,064	3,962	1,618	1,730	2,084	1,488	617	2,027	1,060	1,186	607	683	580	826	2,083
	Value landed/fisherman	1,011	901	701	635	1,024	756	1,402	914	915	2,703	2,080	310	775	1,000	920	939
1965	Value landed ($'000)	24,101	1,475	1,965	1,087	1,647	1,590	1,912	811	2,193	3,700	2,753	312	659	561	727	2,709
	No. of fishermen	21,701	1,860	3,659	1,960	1,847	1,747	1,473	647	1,888	945	1,195	552	590	543	852	1,943
	Value landed/fisherman	1,110	790	540	550	890	910	1,290	1,250	1,162	3,920	2,300	597	1,110	1,030	850	1,390
1966	Value landed ($'000)	26,575	1,893	2,334	1,189	1,896	1,842	1,900	1,159	2,231	4,054	3,269	258	577	497	913	2,613
	No. of fishermen	20,286	1,804	3,454	1,831	1,647	1,431	1,360	566	1,759	886	1,050	656	548	484	861	1,922
	Value landed/fisherman	1,310	1,020	657	640	1,150	1,280	1,390	2,040	1,268	4,575	3,100	393	1,050	1,020	1,060	1,350

VALUE LANDED PER FISHERMAN - INDEX

1964	100	90	70	63	102	75	140	91	91	270	208	31	78	100	92	93
1965	100	67	47	48	78	79	112	109	105	340	200	52	97	90	74	125
1966	100	78	52	48	88	98	106	156	98	350	236	30	80	78	82	103

Source: DBS Cat. 24-202 Annual

NEWFOUNDLAND AND LABRADOR

PRIMARY FISHING ACTIVITY CHARACTERISTICS

TABLE 10-3

	1965								1975						
LOCATION	NUMBER OF EMPLOYEES	SHIFTS	MONTHS IN OPERATION	APPROX. ANNUAL INPUT CAPACITY ROUNDFISH '000 lbs	QUANTITY ROUNDFISH PURCHASED		VOL. OF PRODUCTION FRESH AND FROZEN '000 lbs	INSHORE FISHERMEN SERVING PLANT	NUMBER OF EMPLOYEES	SHIFTS	MONTHS IN OPERATION	APPROX. ANNUAL INPUT CAPACITY ROUNDFISH '000 lbs	PURCHASES - ROUNDFISH '000 lbs		
					GROUNDFISH '000 lbs	PELAGIC '000 lbs							GROUNDFISH	PELAGIC	OFFSHORE SOURCE
1	15-30	2	8	3,000	300	--	100	50	32	2	8	5,000	3,000	600	1,000
2	181	-	12	25,000	23,000	--	6,680	62	250	2	12	36,000	36,000	--	32,000
3	20-55	1-2		700	1,350										
4	207-280	1	12	30,000	28,180	--	7,530	20	320	1	12	65,000	60,000	--	55,000
5	136-177	-	12	12,000	8,190	50	2,500	125	400	3	12	not given	20,000	500	8,000
6	220-375	1	12	40,000	37,000	--	10,680	205	465	1	12	50,000	50,000	1,000	48,000
7	16-204	1	12	COD 20,000 MIX 14,000	8,000	7	2,700	208	300	1	8	28,000	25,000	2,000	19,000
8	178-200	1	12	25,000	15,300	12	4,400	80	225	1	12	30,000	30,000	30	25,000
9	4-40	1	12	3,000	1,600	--	485	57	120	2	8	6,000	6,000		
10	2-33	1	8	--	1,600	--		--	75	2	8	15,000	15,000	5,000	
11	23-90	-	8	860	3,700	--	22,000	160	150	2	9	15,000	15,000	3,750	--
12	10-195	1	6	17,000	3,800	--	970	210	200	1	6	daily 170	3,500	--	--
13	200-230	1	12	42,000	16,700	--	18,800	100	300	1	12	70,000	50,000	--	40,000
14									800	2	12	120,000	--	--	120,000
15	240-350	1-2	12	50,000	37,600	--	14,000	120	500	2	12	80,000	5,000	10,000	65,000
16	10-150	1-2	12	6,000	4,500	--	NOT GIVEN	400	125	2	7	6,000	6,000	--	
17	50-150	1-2	9	9,000	3,500	--	NOT GIVEN	200	150	2	6	3,000	8,000	--	--
18	20-275	1-2	9	18,000	6,000	--	NOT GIVEN	350	200	2	6	6,000	6,000	--	--
19	10-106	1	-		8,000	--	NOT GIVEN	--	200	2	9	18,000	18,000	9,000	9,000

SOURCE: QUESTIONNAIRES

NEWFOUNDLAND AND LABRADOR

SELECTED FISH PLANT LOCATIONS AND OPERATIONS - 1965 AND 1975

TABLE 10-4

PROBABLE CATCH TREND

	Probable Catch Trend
GROUNDFISH	
Catfish	Increase
Cod	Increase
Haddock	Decrease
Halibut	No change
Plaice and greysole	Increase
Pollock	Increase
Redfish	Increase
Turbot	Increase
PELAGIC AND ESTUARIAL	
Capelin	Increase
Eels	Increase
Herring	Substantial increase
Mackerel	Increase
Salmon	No change
Smelts	No change
MOLLUSCS AND CRUSTACEANS	
Lobster	No change
Scallops	No change
Squid	Increase

Source: Department of Fisheries of Canada

TABLE 10-5

NEWFOUNDLAND AND LABRADOR
FISH PRODUCTS PROCESSED
1965 and 1966

	QUANTITY -----'000 lbs---		VALUE -----$ '000----	
	1965	1966	1965	1966
Sea Fish	-	-	51,437	58,862
Fresh round or dressed	7,758	8,544	2,360	3,088
Frozen round or dressed	4,435	5,476	1,642	1,922
Fresh fillets	1,622	2,147	469	696
Frozen fillets	34,602	50,118	9,527	14,486
Frozen blocks and sticks	69,529	66,466	17,302	16,437
Green salted	46,090	44,213	8,257	9,172
Dried salted	14,329	14,924	3,711	4,029
Smoked	-	-	57	82
Pickled and vinegar-cured	-	-	772	1,000
Canned	-	-	52	91
Bait	-	-	1,028	718
Meal and Oil	-	-	2,924	4,017
Lobster and scallops	-	-	3,326	3,124
Other marine products	-	-	1,412	1,244
Total value of products			52,849	60,106

Source: DBS Cat. 24-202

ESTABLISHMENT	LOCATION	CENSUS DIVISION	PRODUCT	DATA SOURCE	PROCESSING PLANT CHARACTERISTICS: (1) INPUT (2) OUTPUT LBS 10^6/YEAR	DATE	EMPLOYMENT: PERMANENT	EMPLOYMENT: SEASONAL	MAN HOURS 10^3	SEASON	WATER SUPPLY: GAL. 10^6/YEAR REPORTED	ESTIMATED	WATER SUPPLY: COMMENTS	WASTE DISPOSAL: COMMENTS	GENERAL COMMENTS
ALLEN'S FISH PLANT	BENOIT'S COVE	5	3	A	1.1 (1)	1966	5	20	24.0	6 MONTHS	-		DAM SUPPLY-INADEQUATE PRESSURE; SMALL DAM		
ARCTIC FISHERIES LIMITED	SOUTH DILDO	1	SMALL OIL AND MEAT FROZEN [illegible]	A B	7 [illegible] 11.5 (1)	1966 1966	4 2	50 20	79.5	8 MONTHS 8 MONTHS	162.5	5.75	PROCESS USES SALT WATER ONLY. BOILERS REQUIRE 80,000 GAL. SUPPLY FROM SMALL DAM [illegible]		ADDITIONAL REQUIREMENTS-PLANT & PROCESS 100,000 G/W BOILERS 80,000 G/D [illegible]
ARCTIC FISHERIES PRODUCTS LTD.	CHARLESTON	7	3	A B	2.5 (2) 3.7 (1)	1966 1966	4 2	80 50	198.0	8 MONTHS	72.0	9.45	CHLORINE TREATMENT (40,000 G/D)		ANALYSIS BEFORE TREATMENT-UNFIT FOR USE
ATLANTIC FISH PROCESSORS	MARYSTOWN	2	3	A C	60.0 (1) 60.0 (1)	1967	-	-	-	12 MONTHS	200	200.0	FRESH WATER FROM POND	WASTES NOT CONVERTED TO MEAL DISCHARGED UNTREATED TO HARBOUR	
BAY BULLS SEA PRODUCTS	BAY BULLS	11	3	A D	1.1 (2) 60.0 (1)	1966 1966	1 300	84 YEAR	167.9 1,200.0	6 MONTHS 12 MONTHS	156.0	156.0	SURFACE DAM-CHLORINE; COOLING PLANT (SALT)	NOT TREATED - SEA	WATER SUPPLY ADEQUATE; FIGHT CONSIDERED INCREASED PLANT CAPACITY + COMMUNITY GROWTH FROM 1,000 TO 3,000
BAY ROBERTS FISHERIES LTD.	BAY ROBERTS	1	1	A	4.1 (2)	1966	24	21 - 70	100.0	8 MONTHS			SALT WATER ONLY		
GABRIEL BILLARD	HARBOUR [illegible]	3	1	A	-	-	-	25 - 28	-	-			CHLORINATED - SALT WATER	NOT TREATED	REQUIRE ADDITIONAL FRESH WATER SUPPLY FOR EXPANSION (PACKAGING ELSEWHERE)
BONAVISTA COLD STORAGE	BONAVISTA	7	3	A C B	3.6 (2) 15.0 (1)	1966 1965	6	216	2,000.0	6 MONTHS		37.5	FRESH FROM UTILITY - CHLORINATED PLUS SEA WATER	NOT TREATED	1,000 G/H REQ'D FOR PROCESSING
BONAVISTA COLD STORAGE	GRAND BANK	2	3	A F	8.6 (2)	1966 1966	330 300	60	993.0	12 MONTHS	300.0	130.0	TREATMENT REQUIRED-LOW PRESSURE UTILITY - CHLORINATED AT PLANT	WASTE WATER DISCHARGE TO HARBOUR	WANT 50% INCREASE IN PROCESSING WATER; FRESH IS A MEAL PLANT, TREATMENT PLANT 2.5 MGD CAP. SOURCE B QUOTES 40.0 MILLION LBS INPUT
BOOTH FISHERIES CAN. CO. LTD.	FORTUNE	2	3	A B C	87.8 (1) 46.0 (1)	1966 1965 1966	300 300	120 50 FOR 2 SHIFTS	630.6	12 MONTHS	F 90.0 S 275.0 127.5	86.0 125.0	FRESH WATER FROM UTILITY; 90% SALT WATER, 10% FRESH CHLORINATED	SEA - UNTREATED	[illegible] REQUIRED 22.0 MG/YEAR
BUFFET FISHERIES LTD.	GRAND BANK	2	1	B	60.0 (1)	-	-	-							
BURGEO FISH INDUSTRIES LTD.	BURGEO	3	-	C D B	20.0-28.0 (1) 5.8 (2) 28.0 (1)	1965 1966 1966	-	-	-	-	62.5 75.0	50.0-62.5 62.5	FRESH - UTILITY; EXPANSION ALLOWANCE [illegible] GAL 10^6/YEAR		
CABOT SEA FOODS	QUIDI VIDI	1	1 & 3	A B	[illegible]	1967	-	35	35.0	6 MONTHS	2.0	3.37	UTILITY CHLORINATED AT PLANT; SALT WATER USED FOR COOLING	DISCHARGE TO QUIDI VIDI BAY	NOW CONNECT ON TO UTILITY [illegible]; WOULD OPERATE YEAR ROUND WITH BETTER WATER SUPPLY
CANADA BAY COLD STORAGE	ENGLEE	9		C A	2.6 PROJECTED (1) 8.0 (1) [illegible]	1967	-	-	-	-	12.5	17.5			CE LEAN, CATHER USE SAME FISH FIGURES AS NOAH
GEO. DAWE & SONS	PORT DE GRAVE	1	1	A	-	1967	2	15 - 30	-	-			SALT WATER ONLY - NO RECORDS	TO SEA	HAVE BEEN REQUESTED TO FIND FRESH WATER SUPPLY
EARLE BROS. FISHERIES LTD.	CARBONEAR	1	1 & 3	A B	F 4.0 (2) S 10.0 (2) 8.0 (1)	1967 1965	250 10	350	1,350.0	6 MONTHS	20.0		UTILITY CHLORINATED AT PLANT	TO SEA	
FISHERMANS UNION TRADING COMPANY	PORT UNION	7	1	A	-	1966	28	70	-	-			UTILITY		PLANNING TO ADD 8.0 M LBS FREEZING PLANT CAPACITY
FISHERIES PRODUCTS LIMITED	PORT UNION	7	3	A	8.0 (2)	1966	22	260	970.0	8 MONTHS	71.0		FRESH & SALT - CHLORINATED		
FISHERIES PRODUCTS LIMITED	HOLYROOD	1	3 & BAIT	A	FISH 8.7 (2)	1966	7	26 - 84	820.0	10 MONTHS	-		WELLS & SALT - CHLORINATED	TO SEA	APPEARS TO INCLUDE LABOUR FOR BERRY PROCESSING
FISHERIES PRODUCTS LIMITED	TWILLINGATE	8	3	C A B	MAX 10.0 (1) 8.0 (2)	1966 1966	-	- 120 MAX	200.0	- 6 MONTHS	26.0 26.0	26.0	CL FOR INDUSTRIAL USE, NEEDS CHLORINATION FOR DRINKING		EXISTING SUPPLY NOT REPORTED
FISHERIES PRODUCTS LIMITED	ISLE AUX MORTS	3	3	C E I	MAX 20.0 (1) 8.4 (2) MIN 15.0 (1)	1966 1966 1966	-	-	-	-	66.0 65.0	66.0 66.0	PRESENT SUPPLY OF FRESH WATER INADEQUATE & CONTAMINATED		EXISTING SUPPLY NOT REPORTED
FISHERIES PRODUCTS LIMITED	TREPASSEY	1	3	A C	ROUND 8.0 (2) EXISTING 8.0 [illegible] 20.0 (1)	1966 1966	85	285	800.0	10 MONTHS		15.0-30.0	PLUMP (WELL) AND SALT; QUALITY & QUANTITY UNSATISFACTORY (CHLORINATED)	TO SEA	
FORT AMHERST SEA FOODS LTD.	QUIDI VIDI	1	1 & 3	A	F .1 (2) S .6 (2)	1967	20	95	95.0	6 MONTHS	9.6		FRESH WATER FROM UTILITY; NO TREATMENT	WASTE WATER TO QUIDI VIDI HARBOUR [illegible] BAY BULLS	NOW CONNECTED TO UTILITY FREEZES
GAULTOIS FISHERIES LTD.	GAULTOIS	3	2	E A	F 6.0 (2)	1966	120	15	397.5	12 MONTHS			CHLORINATED AT PLANT	DISCHARGE TO HARBOUR	
T.J. HARDY CO.	ROSE BLANCHE	3	3	A B	F 8.0 (2) (12.0)CAP. 8.0 (1)	1966	120	80	460.0	12 MONTHS		30.0	DAM & WELL CHLORINATED	NO TREATMENT	400 GPM WHEN OPERATING (ALSO PLANT AT PORT AUX BASQUES NO DATA)
J.W. HISCOCK	BRIGUS	2	1	A	8.7 (2)	1966	8	10 - 100	50.0	1 MONTH			SALT WATER ONLY	CONCEPTION BAY	
MUFFLIN FISHING INDUSTRIES LTD.	CATALINA	7	1 & 3	C A	50.0(PROPOSED) (1) 6.0 (2)	1966-P	-	-	-	-			UTILITY		
W & J MOORES LTD.	CARBONEAR	1	1	A	8.6 (2)	1966	8	80	80.0	10 MONTHS			UTILITY		
NEWFOUNDLAND QUICK FREEZE	DILDO SOUTH	1	3 3	A C	7.0 (2) 10.0 (1)	1966 1967	8	166	256.0	7 MONTHS	25.0	25.0	FRESH WATER SUPPLY [illegible] CHLORINATED; EXISTING SALT SUPPLY INADEQUATE	TO SEA	SYSTEM INADEQUATE
NEWFOUNDLAND QUICK FREEZE	ST. BRIDES	1	3	A C	7.0 (2) RSW 6.0 (1) TO 10.0 (1)	1966 1965	0	125	80.0	6 MONTHS 5-6 MONTHS	15.0 10.0	15.0-20.0	CANNED BROOK - CHLORINATED; SALT WATER INADEQUATE QUALITY - PUMPING CAPACITY INADEQUATE		POOR QUALITY BACTERIOLOGICALLY - SYSTEM INADEQUATE; FUTURE SUPPLY SALT WATER
NORTH EASTERN FISH INDUSTRIES LTD.	OLD PERLICAN	1	FILLETING ONLY	A	INCLUDED WITH HARBOUR GRACE	1966	0	95	95.0	6 MONTHS			BROOK - CHLORINATED & SALT WATER	ALL WASTES TO TRINITY BAY	FILLETS SENT TO HARBOUR GRACE PLANT FOR PROCESSING
NORTH EASTERN FISH INDUSTRIES LTD.	HARBOUR GRACE	1	3	C A	PROJ. 100.0 (1) 10.7 (2)	1966	-	-	-	-	300.0	300.0			NO DATA ON EXISTING SYSTEM
NORTH EASTERN FISH INDUSTRIES LTD.	[illegible]	1	-	C A	PROJ. 50.0 (1) 7.8 (2)	1966 1966	-	-	-	-	125.0	100.0			NO DATA ON EXISTING SYSTEM; PROCTOR & REDFERN (1966) USE NOAH DATA
NORTH EASTERN FISH INDUSTRIES LTD.	SHIP COVE		3	A	-	-	-	-		-	-		WATER SUPPLY INADEQUATE	TO SEA	NO LOCAL RECORDS; NOAHS REPORT [illegible]
NORTH EASTERN FISH INDUSTRIES LTD.	PORT DE GRAVE	1	-	C A	PROJ. 27.0 (1) .6 (2)	1966	-	-		2-3 MONTHS		82.0	FRESH & SALT WATER		NO DATA ON EXISTING OPERATIONS
OCEAN KIST PRODUCTS	BAY ROBERTS	1	1 & 3	A	F .58 (2) S .58 (2)	1966	8	8	-	-			FRESH FROM WELL - SALT WATER SUPPLY [illegible]	WASTE TO SEA	[illegible] INCLUDES SALT WATER
JOHN PENNY & SONS, LIMITED	RAMEA (ISLAND)	3	3	C I B	20.0 (1) 5.0 (2) CAP. 25.0 (1)	1966 1966 1966	180	-		12 MONTHS	50.0	50.0 82.0	QUANTITY OF FRESH WATER AVAILABLE IS [illegible]		RECOMMEND SALT WATER SUPPLY; NO DATA ON WATER USAGE
FISHERY PRODUCTS LTD.	ST. ANTHONY	9	-	C A	PROJ. 10.0 (1) 1.0 (2)	1966	-	-		-	25.0	25.0			[illegible] ASSOCIATES USE NOAH DATA
BRITISH COLUMBIA PACKERS	HARBOUR BRETON	3	3	A	30.0 (1)	1965	510	-		12 MONTHS		50.0			

PRODUCT KEY - TYPE OF PROCESS

1. SALT
2. FRESH
3. FROZEN
4. COMPLEX

DATA SOURCE KEY

- A - J.F. MACLAREN: QUESTIONNAIRE
- B - ATLANTIC DEVELOPMENT BOARD: QUESTIONNAIRE
- C - R.J. NOAH AND ASSOCIATES LTD.: WATER SUPPLY STUDY
- D - PROCTOR & REDFERN: WATER SUPPLY STUDY
- E - NEWFOUNDLAND DESIGN ASSOCIATES LTD.: WATER SUPPLY STUDY
- F - PROJECT PLANNING ASSOCIATES LTD.: WATER SUPPLY STUDY
- G - [illegible] ASSOCIATES CO. LTD.: WATER SUPPLY STUDY
- H - [illegible] & [illegible]: WATER SUPPLY STUDY
- I - LE BLANC, CATHER AND COMPANY: WATER SUPPLY STUDY
- J - FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED: WATER SUPPLY STUDY
- K - CANADIAN - BRITISH ENGINEERING CONSULTANTS: WATER SUPPLY STUDY

NOTES:

1. MAN HOURS ESTIMATES ASSUME 25 DAY/MONTH AND 10 HOURS/DAY
2. IT IS NOT CLEAR FROM DATA WHETHER MEAL PLANT REQUIREMENTS ARE INCLUDED WITH FISH PLANT NEEDS
3. NOTE ALMOST COMPLETE LACK OF WASTE QUALITY & QUANTITY DATA
4. LOCATIONS OF FISH PROCESSING PLANTS, BY TYPE OF PROCESS, NOT INCLUDED IN THIS TABLE BECAUSE OF LACK OF INFORMATION, IS GIVEN IN APPENDIX [illegible] AND PLANNING DIVISION REPORT ON THE NEWFOUNDLAND FISHERY.
5. PLANTS WITH FISH MEAL PRODUCTION AND SEPARATE FISH MEAL PLANTS LISTED IN TABLE 10-8
6. SYMBOLS F AND S IN PROCESS COLUMNS REFER TO FRESH AND SALT FISH. IN WATER SUPPLY COLUMNS REFER TO FRESH AND SALT WATER.

NEWFOUNDLAND
WATER DEMAND DATA OF EXISTING
FISH PROCESSING PLANTS

TABLE 10-7

FISH MEAL PLANTS 1967

	Estimated capacity Tons fish/24 hrs.	Capable of processing Herring	Filleting scrap	Year put in operation
NEWFOUNDLAND				
Atlantic Fish Processors Marystown	250	Yes	Yes	1967
Bonavista Cold Storage Ltd. Bonavista	150	Yes	Yes	1967
Bonavista Cold Storage Ltd. Grand Bank	120	---	Yes	1961
Booth Fisheries Canadian Ltd. Fortune	250	Yes	Yes	1960
British Columbia Packers Ltd. Harbour Breton	800	Yes	---	1966-67
Burgeo Fish Industries Ltd. Burgeo	75	---	Yes	1946
Fishery Products Ltd. Catalina	75	---	Yes	1960
Fishery Products Ltd. Isle aux Morts	75	---	Yes	
Fishery Products Ltd. Trepassey	125	---	Yes	1959
Fishery Products Ltd. Twillingate	75	---	Yes	
Fishery Products Ltd. Burin	125	---	Yes	1945
Gaultois Fisheries Ltd. Gaultois	75	---	Yes	1964
T.J. Hardy and Co. Rose Blanche	120	---	Yes	1964
Hypro Seafoods Ltd. Riverhead, St. Mary's Bay	800	Yes	---	1967
Job Brothers and Co. Ltd. La Scie	150	---	Yes	1960
Litton-Grace Corporation Stephenville	240	Yes	---	1967
Northeastern Fish Industries Ltd. Harbour Grace	150	Yes	Yes	1952-1967
Northeastern Fish Industries Ltd. Fermeuse	75	---	Yes	1956
John Penny and Sons Ltd. Ramea	50	---	Yes	1961
Ross-Steers Fisheries Ltd. St. John's	75	---	Yes	1967 or 68
Scotia Fat Salvage Witless Bay	200	---	Yes	1956

TABLE 10-8

SOURCE: FISHERIES RESEARCH BOARD OF CANADA