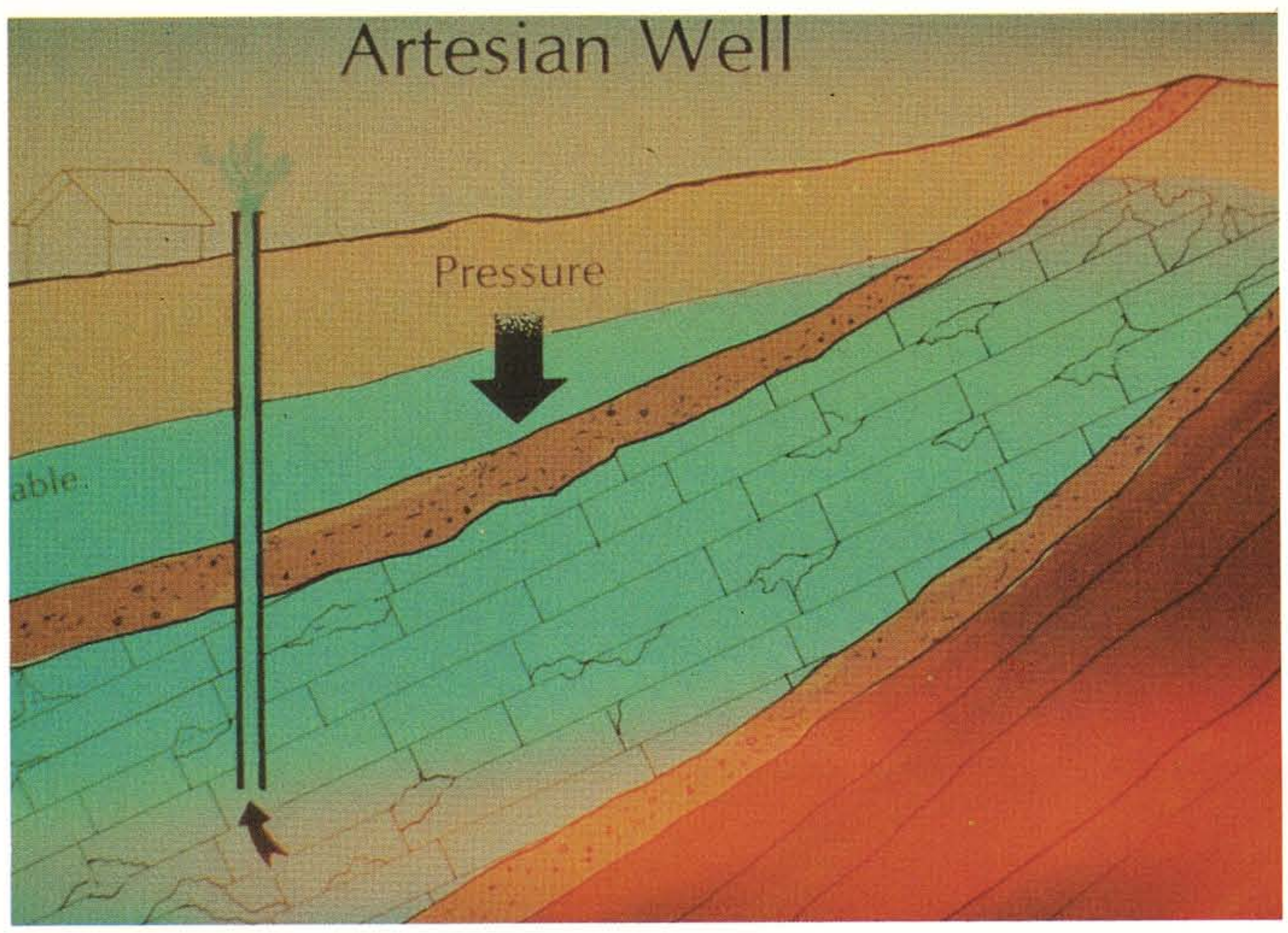
GROUNDWATER

Introduction

Below the surface of the earth lies a huge reservoir of water many times larger than the amount of water on the surface and in the atmosphere. Groundwater comes from precipitation which filters down into the soil until it reaches the water table. If the water moves through a geological formation at measurable speeds, and can be withdrawn at significant rates, this zone is called an aquifer.

Groundwater is important for two reasons. First, like surface water bodies, it feeds streams and rivers, sometimes sustaining flows during periods of low precipitation. Second, it can be intercepted by wells, thus supplying water to thousands of users in many communities.

The following two maps describe the distribution of water wells in Newfoundland and Labrador and the expected yield from various regions of the province.



Schematic of an Artesian Well

25 – Distribution of Water Wells, 1950 - 1988

The province has numerous ponds, lakes, and rivers that provide the major source of water for the population. About 29% of the population living in the smaller communities, however, relies on groundwater as a source of water. The main use of groundwater is for domestic purposes.

Most communities in the province are situated where bedrock is exposed or just below the surface, thus making the construction of community water and sewer systems very expensive. This, in addition to the "spread out" nature of houses in most communities, makes the use of water wells more economical. The groundwater obtained is generally of good quality, further increasing the advantage of water wells.

Groundwater is obtained from both dug and drilled wells. Dug wells are usually between 2 and 5 metres (m) deep, depending on the depth at which bedrock was encountered during construction. No data exists on the number of dug wells in the province. The dug wells draw upon water from the water-filled spaces between the grains of the overburden material. The porosity and permeability of overburden material, and hence the water yield, can be quite high where large grain sizes are encountered. In many locations the yield from sands, gravels, and glacial till overburden is much higher than the yield from wells drilled in bedrock. These high yield wells are found in the Codroy Valley, Bay St. George, and Deer Lake areas where the groundwater yield may vary from 20 to 140 litres per minute (l/min).

Approximately 750 wells are drilled every year in the province. More than 90% of these wells are drilled in bedrock and have an average depth of 60 metres. Fracture flow in the bedrock is the primary source of water into drilled wells. The yield of a drilled well is generally not as high as from an overburden or dug well due to the low porosity and permeability of bedrock compared with overburden material; most drilled wells yield between 3 and 10 l/min.

Figure 25.1 shows that the depths of most wells in the province are in the 30 to 45 m range. Figure 25.2 shows that the yield of wells in Newfoundland is usually less that 8 l/min. This is due to the fact that the majority of wells are located into low-yield bedrock aquifers.

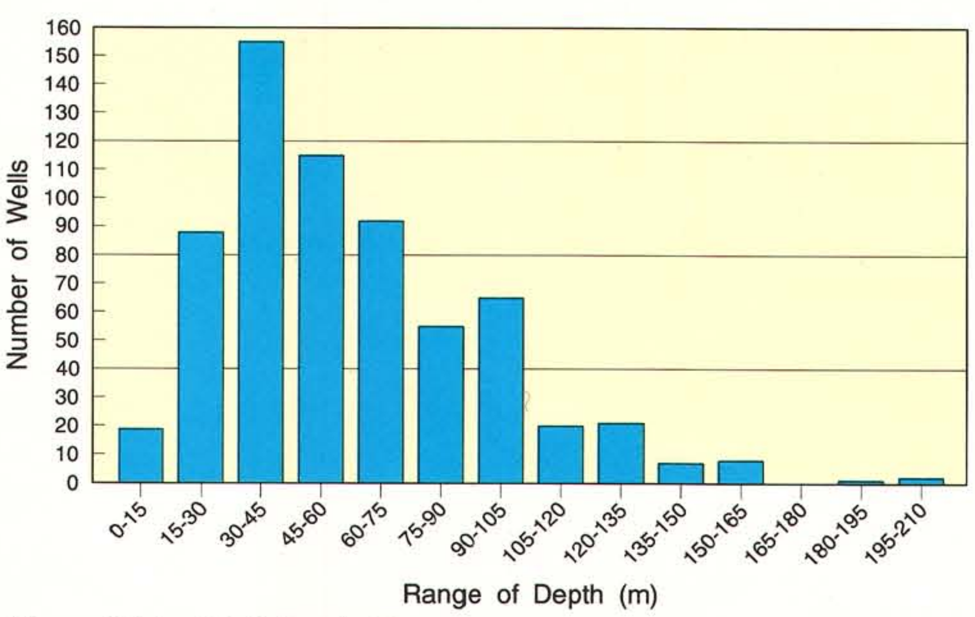


Figure 25.1 Well Depth Histogram

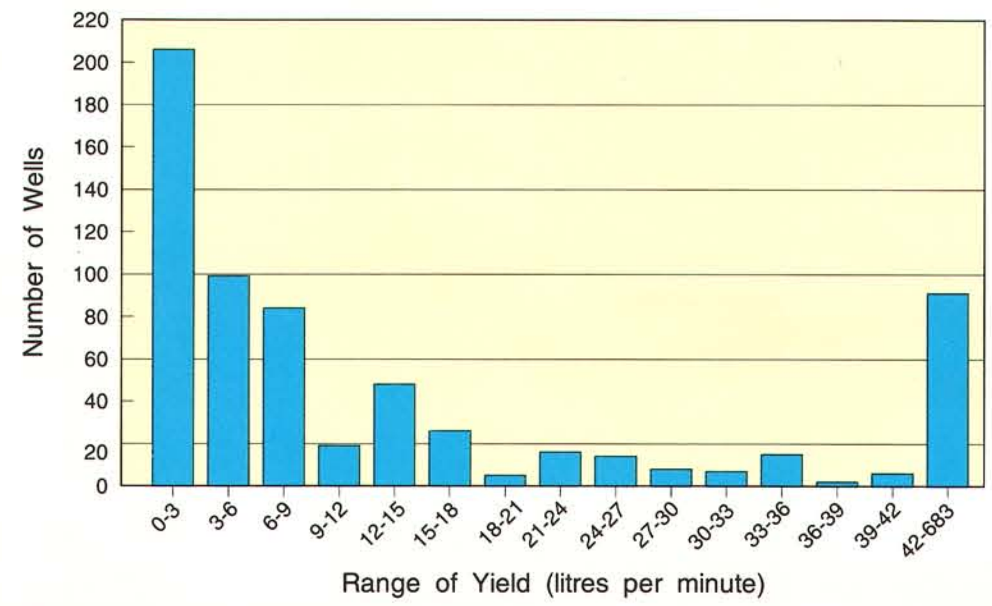


Figure 25.2 Well Yield Histogram

The map on distribution of water wells on the opposite page shows that the majority of drilled wells is located along the coasts of the province. The Avalon Peninsula has a high proportion of drilled wells because of higher population densities. Other areas where high numbers of drilled wells exist are Notre Dame Bay, the Bonavista and Burin Peninsulas, and the Bay St. George area. Factors that influence the distribution of water wells are unfavourable site conditions for surface water supplies, inadequate surface water supply through existing services, and size and development patterns of communities.

Problems with the use of water wells include salt water intrusion of coastal aquifers, road salt contamination of wells in close proximity to a public road where salt is applied for ice control purposes, oil spills from leaking underground storage tanks, and septic tank contamination of wells situated close to the distribution fields.

The process of contamination of coastal wells due to salt water intrusion is shown schematically in Figure 25.3. During pumping, water is drawn to the well from every direction of the surrounding aquifer. If a salt water/fresh water interface exists within the radius of influence of the pumping well, this interface will be drawn toward the well. The higher the pumping rate, the closer the interface approaches the well. Pumping the well at very high rates can draw this interface into the well opening and contaminate the water being withdrawn. Owners of wells in salt water intrusion areas must keep the pumping rate of their well to a minimum to avoid this problem.

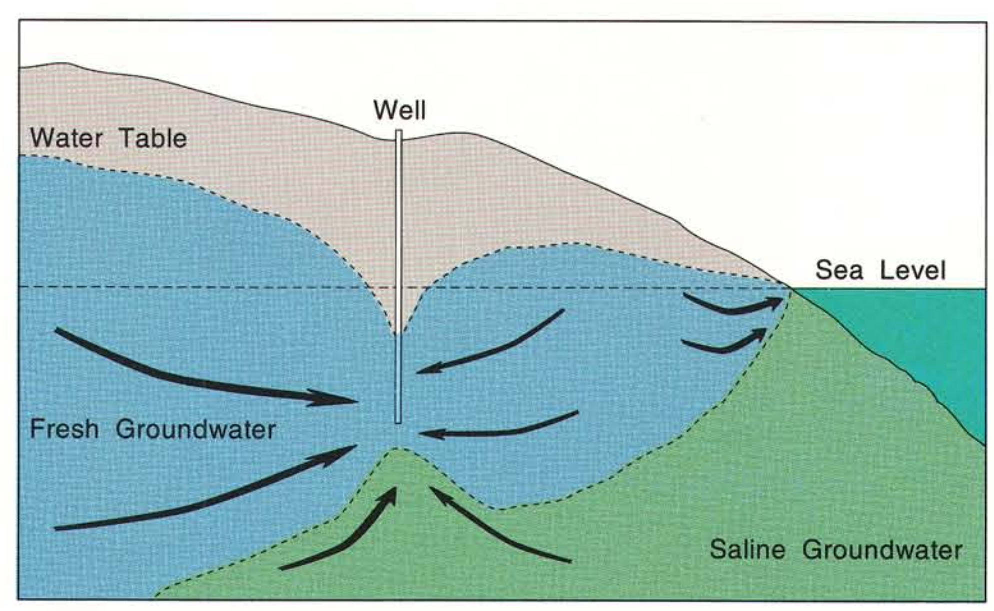
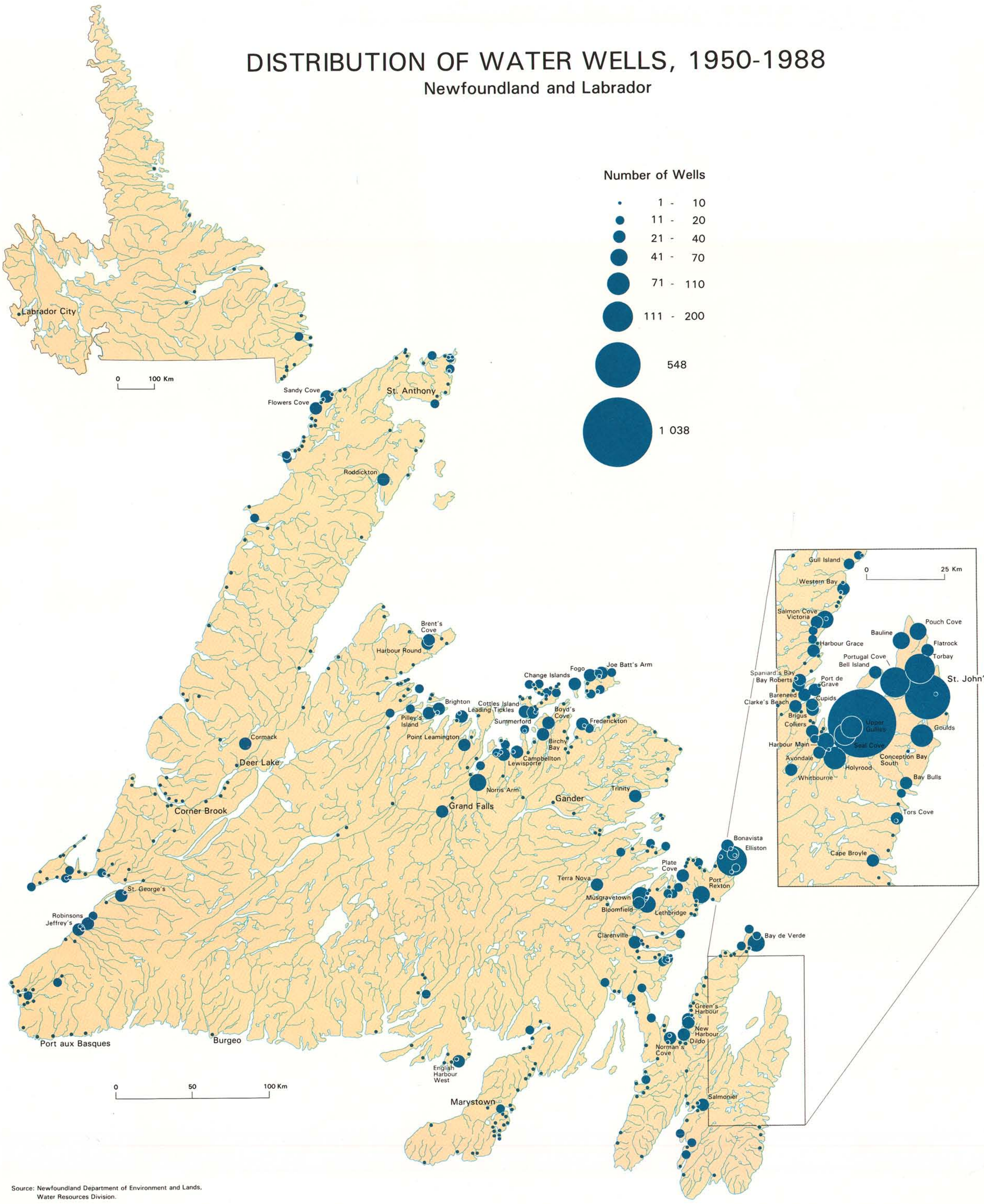


Figure 25.3 Salt Water Contamination of a Well

DISTRIBUTION OF WATER WELLS, 1950-1988

Newfoundland and Labrador



Source: Newfoundland Department of Environment and Lands, Water Resources Division.

26 – Groundwater Yield from Bedrock

The information on groundwater yield from various regions of the province, shown on the map on the opposite page, was summarized from a series of eight reports prepared by consulting firms on contracts with the Department of Environment and Lands. Figure 26.1 shows the areas of the Island to which the reports pertain. These reports were based on data contained in well drilling records prepared by local well drillers, and hydrogeological investigations that may have been done in the development of municipal water supply systems. The bulk of the information was derived from well drilling records.

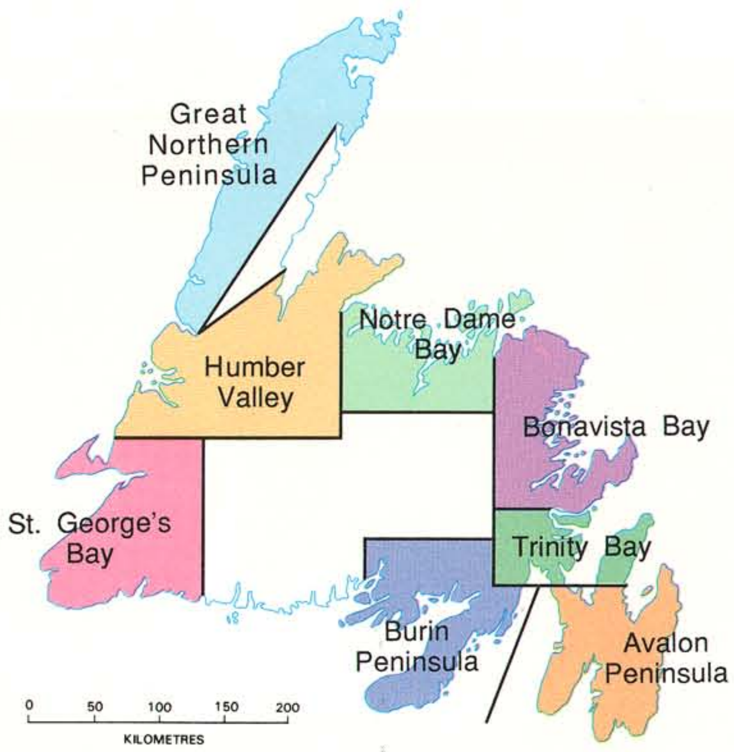


Figure 26.1 Areas Covered by Hydrogeological Reports

Since the first hydrogeological report was completed in 1979 the number of well records received from well drillers has increased every year. Before 1983 well records were submitted voluntarily by well drilling companies. After the passage of the Well Drilling Act in 1983 the number of records submitted rose dramatically.

The bedrock hydrostratigraphic maps prepared for each area covered by the hydrogeological reports were combined to form a hydrostratigraphic picture of the whole Island. As shown in Figure 26.1, some interior areas of the Island and all of Labrador were not covered by the mapping due to a lack of groundwater related information. In the preparation of the map on groundwater yield these areas were mapped using the average yield results derived for the bedrock formations of the areas that were covered.

Groundwater is an integral part of the hydrologic cycle. It has been estimated that on a world wide basis, groundwater makes up about 98% of all liquid fresh water. This may seem inconsistent with the appearance of bedrock as a solid-looking material. Bedrock, however, contains a matrix of major, small, and hairline microfractures. The volume of these open spaces in the apparently solid rock, expressed as a percentage of the total rock volume, is called porosity, and determines the volume available for storage of water. In any geologic material zones which are able to yield usable quantities of groundwater are called aquifers. This ability depends not only on the porosity, but perhaps more importantly, on the permeability of the rock. Permeability is a measure of the ability of the material to transmit water.

The groundwater yield map shows that aquifers exist beneath most land areas of Newfoundland. It has not been possible, with the data available, to map out individual aquifers in the bedrock. Such distinct zones exist, no doubt, but much more data on porosity and permeability would be required to identify them. The approach which has been utilized in the production of this map was to group geologic formations according to their yield characteristics as reported from the available well records. Using this single criterion various rock types having similar yield characteristics were included together in the same grouping. Three categories of yield, namely, low yield with a mean value of 12 litres per minute and suitable for domestic purposes, moderate yield with a mean value of 27 litres per minute and suitable for small communities, and high yield with a mean value of 58 litres per minute and suitable for larger municipal and industrial supplies, were chosen for illustration on this map.

In many rocks such as granite and shale primary openings are very small. Groundwater flow through such voids may take years. In addition to the primary openings there are four other major conduits in bedrock through which groundwater moves. These are depicted in Figure 26.2. These major void spaces are formed after the rock has formed, and are called secondary openings. Although movement in these flow paths may be relatively unimpeded it is usually very tortuous. Solution channels, in contrast to fractures, are only common in soluble rocks such as limestone. Developing a dependable well in bedrock with large primary openings is usually quite easy. Such formations, however, are not common in Newfoundland. Developing a dependable well in bedrock which has low primary porosity depends on intercepting one or more of the secondary openings; the attempt may not always be successful.

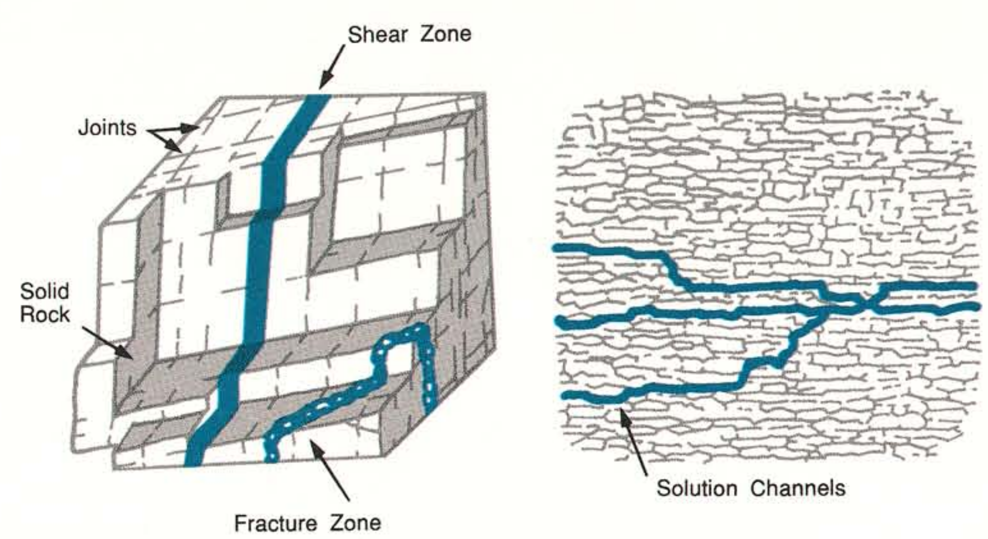


Figure 26.2 Major Groundwater Conduits in Bedrock

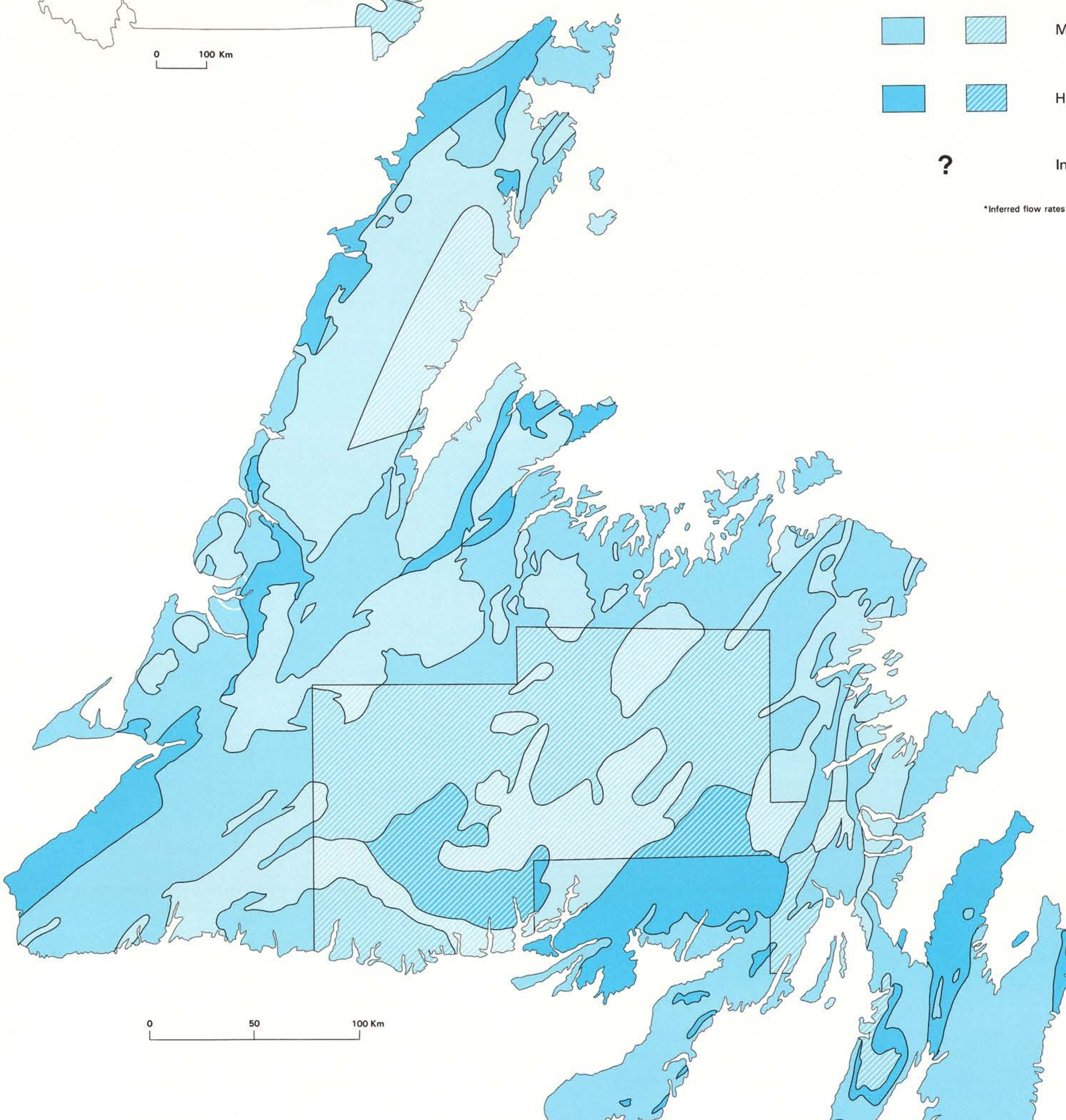
GROUNDWATER YIELD FROM BEDROCK

Newfoundland and Labrador

Flow Rate, litres per minute **(Lpm)**

Known	Inferred*	
		Low Yield mean – 12 Lpm range 1 – 136 Lpm
		Moderate Yield mean – 27 Lpm range 1 – 454 Lpm
		High Yield mean – 58 Lpm range 1 – 545 Lpm
?		Insufficient Data

*Inferred flow rates based on geology.



Source: Water Resources Reports
Groundwater Series II
Newfoundland Dept. of Environment and Lands, 1988