curacy required, there has recently been evolved what is known as the "chemical method" of measuring discharge. This method may be outlined as follows:—

Knowing approximately the volume of water to be measured, a definite quantity of chemical solution of known strength is added at a given rate to the stream or intake above the point of measurement. Owing to the turbulent nature of the stream or the churning action of the turbine wheels, this solution is thoroughly mixed throughout the whole volume of the water to be measured. In the case of a stream, samples of the water are taken some distance below the point of application of the solution, and in the case of power plants, in the tail-race. A chemical analysis of this water will reveal the amount of added chemical held in solution. Knowing the volume of the sample and the amount of solution added per unit of time, the determination of the volume of water flowing per unit of time involves only a simple calculation, for it may be readily seen that if:

Q = discharge of turbine or river.
q = discharge of salt solution.
N^0 = concentration of salt solution.
N_1 = concentration of water before addition of salt solution.
N_2 = concentration of water in tail-race or river at sampling station.

Then: $$Q = \frac{N^0 \times q}{N_2 - N_1}$$

This method of measurement has been quite recently brought forward, and the opinion is ventured that its use, especially in the case of power plant rating, will be generally adopted.

Summary and Recommendations.—The records contained in the report are the result of investigations carried on by the survey since its inception in 1912. Some stations have for various reasons been discontinued, while others have been established, the net result being a marked increase in the number of stations operated, and when the streams where miscellaneous readings are secured are considered, it will be seen that the southern part of the province is now well covered.

In the northern part of the province the work is being extended as opportunity offers and occasion arises, though, as far as possible, the need of stream flow data should be anticipated.

It is recommended that in view of the necessity of anticipating the requirement of data, that the work be extended to cover as much of the northern part of the province as possible. This extension will necessarily depend to a very great extent upon the accessibility of the various rivers and the possibility of securing continuous records. The work instituted on the Nelson should be vigorously carried on and an attempt made to secure a station that will permit of an all-year-round rating. In addition, slope gauges should be established, and if possible a suitable site for an automatic gauge selected and the same installed for the purpose of securing a rating of the river. The storage possibilities of Lac Seul should be looked into and an automatic gauge installed at some point on that lake, so that records of its variation in stage may be secured.

The necessity of some investigation into the underground water resources of the province is a question that is becoming pressing. The year 1914 was one of exceptionally low flow, and where the communities and individuals were dependent upon surface water for a domestic supply, hardship was experienced. A careful survey of the ground-water supply should make valuable and reliable information on the subject available to the general public, and as it is so closely allied to the gathering of data regarding the surface supply, it is suggested that it be carried out by this survey as soon as the necessary funds and assistance can be made available.

STUDIES REGARDING CONCRETE MIXTURES EMPLOYED IN CONSTRUCTION OF SHOAL LAKE AQUEDUCT.*

By W. G. Chace and Douglas L. McLean.

THE studies and observations on gravel concrete described in this paper were made during 1914-15 in connection with the construction of the concrete aqueduct of the Greater Winnipeg water supply from Shoal Lake, Ontario. The object of the tests was: "With a given gravel pit to obtain an aggregate which, with a minimum quantity of cement would give a concrete that would be watertight and strong."

While the major portion of published data is lacking in detail, yet the general principles which apply to the question are known and there is at present a number of methods by which lean mixtures for concrete may be made impermeable under moderate pressures. For concrete with mortar consisting of, say, one part by weight of cement to three parts by weight of sand the following methods or additions may be used to obtain the desired results: (1) Special grading of sand and stone; (2) addition of cement; (3) addition of hydrated lime; (4) addition of clay; (5) addition of fine sand; (6) use of a mixture of cement and puzzolanic material; (7) use of sand-cement. In general, gravel gives more impermeable concrete than that made from crushed stone and sand.

General Considerations Relating to Materials Available for the Water District Construction.—The country through which the aqueduct was located from Indian Bay to Winnipeg was at one time subject to glacial action and at the same or later period formed a portion of the bed of Lake Agassiz. The effect of the glaciers and the action of the waters of Lake Agassiz resulted in numerous deposits of fine sand, coarse sand and gravel throughout the country traversed by the aqueduct. At Indian Bay the deposits consist principally of fragments of igneous rocks, while close to Winnipeg they consist for the most part of limestone gravels.

As the average cost of cement per barrel of 350 pounds delivered on the site of the work was about $2.75 and as the stresses in the concrete on firm foundation were low, requiring a concrete of only moderate strength, a lean mixture with fine sand added for purpose of making the mix more impermeable appeared to be desirable.

The laboratory samples of dry aggregate varied from 25 pounds to 100 pounds, depending on the quantity of large sized material in the sample from which the laboratory sample was taken. For the sand samples one pound of dry material was used.

For use on the district work the following classification was made of the different sizes of materials: Oversize—material retained on 1½-inch screen; coarse—material passing 1½-inch screen and held on ½-inch screen; intermediate—material passing ½-inch screen and

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