areas of swamps, sloughs and muskegs have formed, making the country inaccessable, except in winter time. It was thus necessary to carry the location work forward with the greatest dispatch during the first winter season. The line was located, except for certain short portions, by the beginning of spring in 1914.

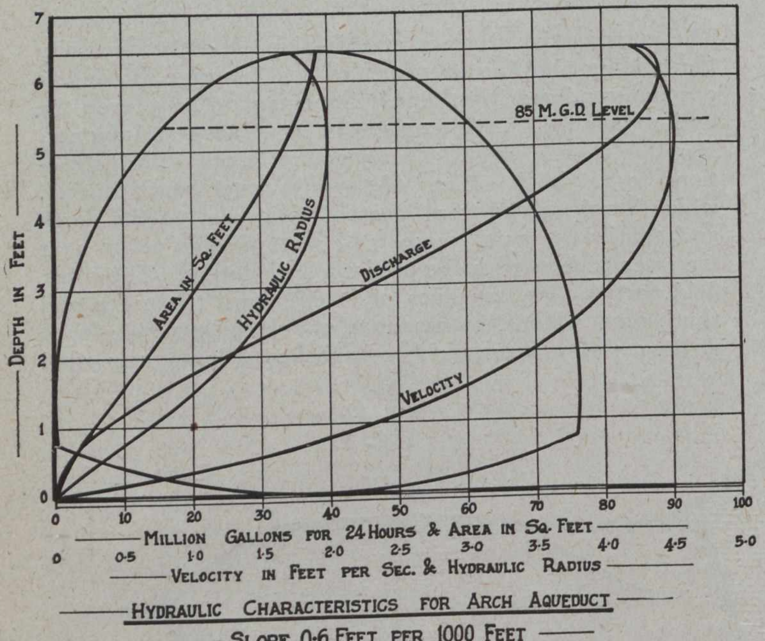


Fig. 2.

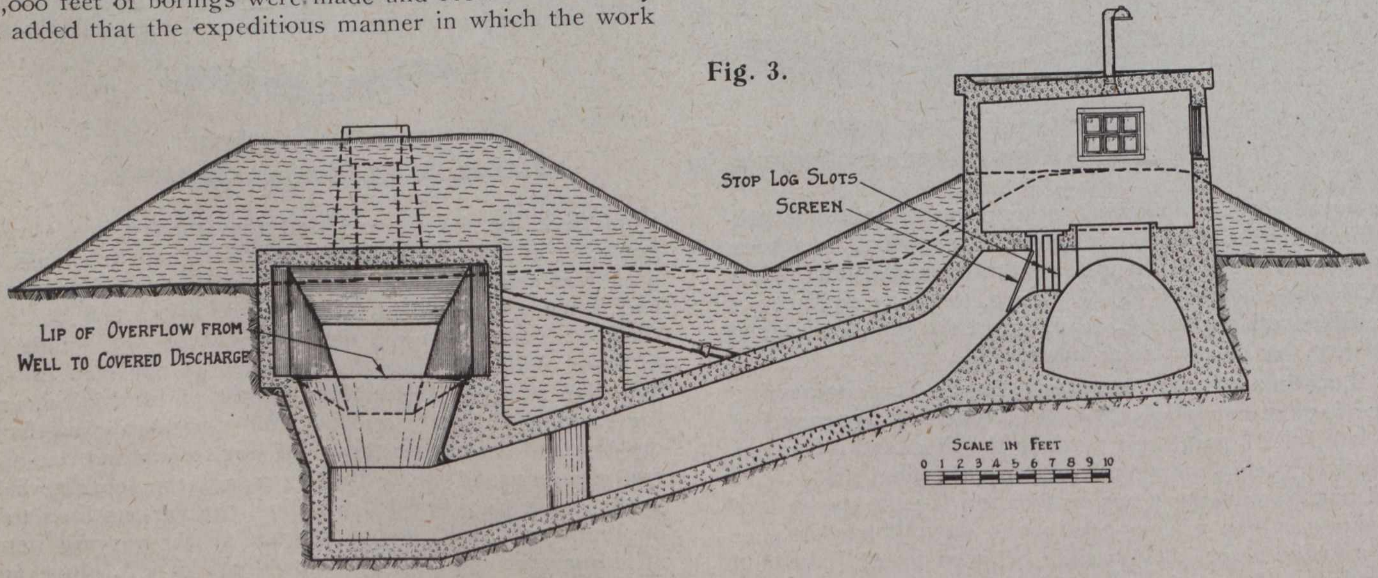
The following figures show generally the amount of work covered by the five field parties during the winter season from the time they started out until the line was located: 362 miles of transit lines; 1,317 miles of levels; 95 miles of precise levels; 380 square miles topography. Borings were also made during the process of location to determine the depth of the overlying muskegs. Some 12,000 feet of borings were made and recorded. It may be added that the expeditious manner in which the work

any one party had gone too far. The cost curves mentioned above were of material assistance in this regard.

Preliminary Design.—While the field work was in progress active work in head office was carried out on the details of design and layout. It was soon recognized that the utmost refinement in design was required to keep the cost of the work within bounds; for example, it may be pointed out in this regard that the addition of one inch thickness to the aqueduct section would add over $400,000 to the cost of construction.

To determine on the type of aqueduct structure to be adopted, studies were made of the economic and hydraulic characteristics of various concrete arch types and of a reinforced concrete box type. This latter had some advantages from an economic point of view, but the question of the life of reinforcing steel with thin concrete covering threw doubt on the desirability of its use for an aqueduct to deliver a permanent supply to a rapidly growing city like Winnipeg, and such a type would be much less rapidly built than an arch or self-supporting type. If the concrete sections were thickened up sufficiently to furnish an undoubted protection to the steel, the economies of this type disappeared and left the advantage to the concrete arch. The varying slopes of the aqueduct required different sizes of sections to accommodate the varying velocities. In analyzing the arch stresses the maximum and minimum sizes were examined and treated for various conditions of backfill loading both with the aqueduct running full and standing empty. The backfill consists of varying types of soil, principally clay and muskeg. It was decided that the type of arch lying between the semi-circle and the parabola was best fitted to resist the backfill stresses. The extreme sizes are shown in Fig. 1. Where the foundation for the structure is found to be of a rigid nature the invert is not reinforced, but in the instances where it is found necessary to place foundation fill to replace soft material, or to bring the aqueduct up to grade line, or where the foundation is not unyielding, reinforcing steel is being placed in the invert.

Fig. 3.



Section through Overflow Structure

was carried out reflects great credit on all of the field parties engaged.

The necessity for active co-operation between head office and the various field parties can readily be seen in order that the results obtained might be co-related before

In order to arrive at the proper sizes of sections for the varying slopes the curves for area, velocity, discharge and hydraulic radius were plotted for the maximum and minimum sections and for several intermediate sections. A typical curve sheet is shown in Fig. 2. As the sections