Winnipeg was estimated to be about 1900 miles, on what was assumed to be the most direct feasible route. The problem of definitely locating this route was not an easy one, as for more than half the distance the line of general directness ran through an unsurveyed, unsettled and practically unknown region cut up in all directions with a network of lakes and rivers, many of them not shown on any existing maps, and when so indicated, often found to be entirely misplaced. The engineers, had, therefore, in many cases to make their own maps, as the surveys proceeded, and had in all cases to correct and complete existing maps.

SURVEY WORK AND LOCATION.

During the autumn of 1904 and the following spring, some 34 survey parties were equipped and sent out, and before the end of 1905 there were 45 parties in the field, consisting of about 18 men each, not counting a large number of men engaged in transporting supplies by canoe and packing in summer and by dog train in winter. Each survey party had an engineer in charge, transitman, leveller, topographer, draughtsman, rodman, picketman, two chainmen, cook and eight or nine axemen and packers. Each party was given certain governing points to connect, and was instructed to thoroughly exhaust the possibilities for the most favorable and reasonably direct line between these points. Barometric explorations and compass lines were followed by preliminary lines run with transit, and plans were plotted with 10 ft. contours on a scale of 400 ft. per in.

With those plans, and with profiles on the same scale, projected locations were made on the most favorable lines and afterward actually run on the ground and called a "first location." These plans and profiles were plotted in the field, and tracings (with reports) were sent to headquarters monthly. These reports were carefully gone over by the Chief Engineer and Assistant Chief Engineer, necessary changes suggested, and instructions issued accordingly. Whenever the head of a party completed what he considered the best possible "first location," the engineer in charge was changed and another man given a chance to improve the line by making his best attempt at a revised location. The original head of the party, or a third man, was given a chance to still further revise for a final location. In this way it was found that a healthy rivalry was established and good results obtained. Revision of location is, however, never considered as finished until construction is well under way, as it is often found, after the line is cleared, that slight changes will effect a very considerable saving.

An equation table giving definite values for savings in distance, curvature, rise and fall, etc., was furnished all parties in the field, so that, having the estimated cost of construction of any two or more lines, the better one to adopt from all points of view could be at once determined. This table is given further on.

The earlier explorations and reconnaissances were made by compass and barometer, followed by transit with stadia, or chain and level. Steel-band chains were used for distances in final location. The parties consisted usually of 18 men in settled districts to 24 men in unsettled districts, six of the latter number being packers. In general, they were sent into the field in pairs, at intervals of about 80 to 150 miles, with instructions to run, respectively, east and west from some more or less well defined point. In the more remote localities, it was found impossible to fix these points at all accurately, owing to the non-existence of reliable maps; nor could the course of the indicated route be followed closely owing to the presence of some unsuspected large body of water or other topographical obstruction. Consequently, much difficulty was encountered in joining up the surveys of two approaching parties. At the head of the St. Maurice, the Tete de Bulle Indians were found to possess an unusual aptitude for cartography, and by following their rude maps, a junction was effected with the party running east from the Gatineau.

Working in a country so cut up with lake and river expansions as to be more than 50% water, absolutely unmapped and unknown, and some 250 miles from the nearest railway, two parties overlapped several miles, one being 10 miles north of the other, before communication was established between them and a connection made. A rough stadia traverse, 80 miles long, following the old Indian canoe route from Lake Abitibi to the Kenojevis River, and occupying 11 days, furnished course and distance between surveys which had started nearly 200 miles apart. In the Kenogami District, one of the earliest G.T.P. Ry parties exhausted their provisions, and searched three days without finding a line, which had been blazed north from a supply cache, to which they tied in their reconnaissance. They left behind them as a record of their experience a string of lakes bearing the suggestive names: "Storm," "Ice," "Poverty," "Stampede" and "Relief." By discharging ship's rockets simultaneously on a pre-arranged night, quick connections were in several instances effected across unsurveyed gaps.

Observations for latitude were made, of course, but as there were at the outset no means of intercommunication between the parties in remote localities, other than through the district head quarters, on the C.P.R., months elapsed before these could be interchanged.

VALUES FOR EQUATING DISTANCE, ETC., IN LOCATION.

It has been noted above that field parties were furnished with equation tables showing definite values for savings in distance, curvature, etc. The values given below were used in the final determination of location. Tables 1 and 2 give the values for distance and rise and fall. For calculating the justifiable expenditure per mile, 10 daily trains each way (equal to 20 daily trains) were assumed for the line between Moncton and Quebec, and also between Winnipeg and the junction with the branch to North Bay; between other points 12 daily trains were assumed. Justifiable expenditure per mile takes into consideration maintenance of rails, ties, ballast, etc.

ASSUMED COSTS PER FREIGHT TRAIN MILE, Engine Mile, Etc.—Train mile, $1. Engine mile, 35c., both assisting and running light; 40c. if assisting both ways, with no light running. Minimum cost for assistant engine when not at division point or used for yard work, $18 per day or $6,600 per annum. Light running 25c. per engine mile. Switching 30c. per engine mile. Doubling grades, 90c. per engine mile straight distance, or 45c. per additional engine mile.

TABLE 2.—VALUE FOR EQUATING RISE AND FALL (ALL TRAINS).

(Freight train velocity limits: max., 30 m.p.h.; min., 10 m.p.h.)

Class	Value per ft. rise and fall per train	Value per ft. rise and fall per daily train per annum Capitalized value	Justifiable expenditure per ft. of saving in rise and fall for 12 daily trains per ann.	Justifiable expenditure per ft. of saving in rise and fall for 20 daily trains per ann.
A. Minor grades ..	$0.12	$3	$36	$60
B. Minor grades ..	0.48	12	144	240
B. Ruling grades..	0.88	22	264	440
C. Minor grades ..	1.00	25	300	500
C. Ruling grades..	1.40	35	420	700

A. All rise and fall up to 30 ft.

B. Where grades require shutting off steam, but not application of brakes in descending. This class includes all rise and fall of over 30 ft. on grades less than 0.6%, and between 30 and 100 ft. on 0.6% grades and steeper grades of small drop not covered under Class C.

C. Where grades require the application of brakes and shutting off steam in descending. This class includes all rise and fall of over 100 ft. on grades of 0.6% and a proportionate fall on steeper grades.

VALUES FOR RAILWAY GRADE CROSSINGS—Justifiable expenditure to save one normal grade crossing of another railway, $40,000.

TRANSPORTATION AND SUPPLY.

Much of the early organization had to do with transport and supply problems. Through New Brunswick, Manitoba and the settled portions of Quebec existing railways, roads and steamship lines gave easy access to all parts of the line. LaTuque (at the head of navigation on the St. Maurice River), St. Gabriel, Maniwaki and Kipawa (terminals of the C.P.R. branch lines), and North Timiskaming, at the extreme end of the lake of that name, were the points of departure from which radiated canoe routes to the vast wilderness of northern Quebec. Between Lakes Nipigon and Abitibi, the Moose and Albany Rivers spread their finger-like branches southward to within short distances of the C.P.R. main line, furnishing water routes which were reached by canoe and portage from Bisco, Woman River, Chapleau, Missinabi, Grassett, Montizambert and Heron Bay. Lake Nipigon affords comparatively easy access to a hundred mile stretch across its northern drainage area; while to the west, Ignace, Dinorwic, Dryden and Kenora were used as shipping points to Sturgeon and Minnitaki Lakes, and the Wabigoon and Winnipeg Rivers.

In the autumn of 1904 and winter of 1905, from 40 to 50 completely equipped parties were placed in the field between

TABLE 1.—VALUE FOR EQUATING DISTANCE.

Class.	Train mile	Value per ft. per daily train per annum	Capitalized value per daily train per ft.	Capitalized value per daily train per annum per mile*	Saving per daily train per annum per mile of shortening.	Justifiable expenditure per mile of saving in distance per annum for 12 daily trains	Justifiable expenditure per mile of saving in distance per annum for 20 daily trains
A	0.30	2.0c.	$0.50	$2600	$104	$31,200	$52,000
B	0.50	3.4c.	0.85	4500	180	54,000	90,000
C	0.60	4.0c.	1.00	5300	212	63,600	106,000
D	1.00	7.0c.	1.75	9200	368	110,400	184,000

*Capitalized values per mile to nearest $100 and interest 4%. One daily train each way equals two daily trains.

A. Distances so short as not to affect track or train wages, aggregating less than two miles.

B. Distances affecting train wages, but not so great as to affect the number of stations or sidings. From two to five miles.

C. Distances so great as to affect number of stations and sidings required. From 5 to 75 miles.

D. Distances so great as to affect number of engine districts. Over 75 miles.

VALUES FOR EQUATING CURVATURE (ALL Trains)—The elimination of 1° of curvature will save 16c per daily train per annum (including passenger and freight trains); equal to a capitalized value of $4 per degree. Justifiable expenditure per degree of saving in curvature; $48 for 12 and $80 for 20 daily trains. If a curve is in a particularly dangerous place, which necessitates a watchman or other additional expense, the value of its elimination must be considered separately. One degree of curvature means one degree of central angle, regardless of radius of curve. It is assumed that expense due to curvature is in proportion to the total central angle.