

## APPENDIX A.

Report on Appraisal of the Canadian Northern Railway System  
and the Grand Trunk Pacific Railway.

BY

GEO. F. SWAIN, M.Am.Soc.C.E., M.Can.Soc.C.E., M.Inst.C.E.

OTTAWA, Ont., March 10, 1917.

*To the Commission of Inquiry into Railways and Transportation.**Mr. A. H. Smith, Chairman.*

GENTLEMEN,—I beg leave to submit the following report with reference to the work that has been done under my direction in making an approximate valuation of certain railroad properties in Canada.

My first invitation to attempt this work was contained in a letter from Mr. Smith, dated August 3, 1916. I proceeded at once to New York and consulted with Mr. Smith, then to Ottawa where I consulted with Sir Henry Drayton, and arranged for the organization and prosecution of the work.

## ORGANIZATION.

My first problem was to secure a competent man to represent me at Ottawa, where the office work necessarily had to be done, and to take charge of the office. I at once entered into correspondence with Mr. W. H. Chadbourn, who had assisted me previously in similar work in valuation of large railroad properties, as well as in other matters, and on September 2, 1916, Mr. Smith telegraphed me approving his appointment. Mr. Chadbourn's previous experience had been as follows: 1886, graduated from the Massachusetts Institute of Technology; 1887, Assistant Engineer, Norfolk and Western Railway; 1888, Chief Engineer, Wilmington and Conway Railway, now a branch of the Atlantic Coast Line, and Chief Engineer of the Wilmington Sea Coast Railway, now a part of the trolley system of Wilmington, N.C. He built both of these lines by force account; 1890-1906, he was with the United States Engineer Corps on River and Harbour Works, occupying positions of great responsibility in the design of the works on the Ohio river, and elsewhere; 1906-10, Chief Engineer, Chicago Great Western Railway.

Since 1910 he has been very largely engaged in valuation work, as follows: 1911-12, assisted me in valuation of New York Central Lines east of Buffalo; 1911-12, assisted Mr. W. J. Wilgus in valuation of the Lehigh Valley Railroad; 1912, assisted Mr. J. R. Kendrick in valuation of a portion of the Canadian Pacific Railway between Montreal and Toronto, the valuation being made for the company; 1913-14, in charge of the valuation of the Atlantic Coast Line for J. G. White Engineering Corporation.

In 1915 Mr. Chadbourn went to Russia for the J. G. White Engineering Corporation on professional work. While in Europe he was a member of the Commission of Relief in Belgium. He returned to this country early in 1916.

My communication with Mr. Chadbourn was largely by wire, but I had two conferences with him, in which we outlined the methods of conducting the work.

Mr. Chadbourn proceeded at once to Ottawa, where he arrived September 6, and immediately entered upon the work. He was assigned offices at first in the Royal Bank building, and later in the *Citizen* building.

In conference with Mr. Smith and Sir Henry Drayton, the question of organizing an engineering force was thoroughly considered. It would have been comparatively easy to have secured engineers from the United States who had had experience in valuation work and were familiar with the principles, points of view, and methods governing such work. In Canada, little valuation work had been done, and that largely by American engineers. The Canadian Pacific Railway a few years ago had had a valuation made of a part of its line, and had placed the work in charge of Mr. J. R. Kendrick, of Chicago. Mr. Kendrick's force of engineers, of whom Mr. Chadbourn was one, was composed entirely of engineers from the United States. Moreover, owing to the war, there was a great scarcity of engineers in Canada properly equipped with the technical knowledge requisite for this work. Nevertheless, it was decided, in view of the fact that this work was to be done for the Canadian Government, that, with the exception of Mr. Chadbourn, the engineering staff should be made up entirely of Canadians, if properly equipped men could be found. It was absolutely necessary that I should have somebody to represent me in Ottawa who was personally known to me, and on whose judgment and discretion I could thoroughly rely. Mr. Chadbourn more than fulfilled these conditions, and with him in charge of the office, I felt that the field work and office work should be done, if possible, by men familiar with and having had experience on the properties which were to be valued.

To select and organize a suitable force caused some delay, in view of the circumstances above referred to, but ultimately a very satisfactory organization was effected. None of the men whom we were able to secure, however, had had any experience in valuation work, and they had to be instructed and trained in it. I am very happy to state, however, that they entered upon the work with interest and enthusiasm, and that, as a rule, they grasped very quickly such principles of valuation as it was necessary for them to apply. To all these engineers my thanks are due for their earnest and conscientious labours. The work in the field was, in some instances, arduous, requiring long hours, and exposure to severe weather conditions, but it has been done with credit and with remarkable speed.

The following list gives the names and character of the work performed by the various engineers who have been connected with the work, together with other office employees:—

#### LIST OF ENGINEERING EMPLOYEES.

- (1) W. H. Chadbourn, M. Am. Soc. C.E., Chief Engineer. In charge of office.
- (2) C. S. Gzowski, M. Can. Soc. C.E. In charge of field examination of Canadian Northern line between Edmonton and Vancouver, including terminals at Edmonton and Vancouver; lines on Vancouver island; of line from Edmonton to Calgary, with branches; and of other branches out of Edmonton; also of the Grand Trunk Pacific from Edmonton west; also preparation of final report in the office on Canadian Northern lines above named. Assisting Mr. Gzowski in this work, were: G. H. Burnett and J. W. Chappelle, in the field and office; and L. Phillips in the office.
- (3) G. R. Balloch, M. Can. Soc. C.E. In charge of field examination of Canadian Northern lines between Port Arthur and Edmonton, including main line and branches; also preparation of final report on these lines in the office. Assisting Mr. Balloch in this work were: H. MacNeil in the field and office, and F. O'Gara, L. J. M. Howard, and J. Rainboth, in the office.

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- (4) A. H. N. Bruce, M. Can. Soc. C.E. In charge of field examination of Canadian Northern branches between Ottawa and Toronto, and main line Toronto to Capreol; also preparation of final report on these lines in the office.
- (5) T. S. Armstrong, M. Can. Soc. C.E. In charge of field examination of Canadian Northern lines between Ottawa and Port Arthur via Capreol, and preparation of final report on this line in the office.
- (6) W. H. McGaan, A.M., Can. Soc. C.E. In charge of field examination of Canadian Northern lines and branches east of Ottawa and Toronto, and preparation of report on these lines in the office. Assisting Mr. McGaan in this work, was: W. B. Elder.
- (7) N. Cauchon, A.M., Can. Soc. C.E. Specially assigned to valuation of real estate at terminals, including Montreal, Ottawa, Toronto, Port Arthur, and Winnipeg.
- (8) H. Horner, Architect. In charge of making valuation of buildings of all kinds.
- (9) B. M. Hill. In charge of field examination of the Grand Trunk Pacific line between Winnipeg and Edmonton, including branches; and preparation of report on these lines in the office.
- (10) A. L. Ford, M. Can. Soc. C.E. In charge of preparation of report in the office on Grand Trunk Pacific line between Edmonton and Prince Rupert. Assisting Messrs. Hill and Ford in this work, in the office, was: C. Gilmore.
- (11) E. C. Keefer, A.M., Can. Soc. C.E. General office assistant, engaged in working up final reports, making estimates from profiles, etc.
- (12) H. MacNeil, A.M., Can. Soc. C.E. Assisting Mr. Balloch in the field and office.
- (13) F. C. O'Gara, A.M., Can. Soc. C.E. Assisting Mr. Balloch in the office.
- (14) L. J. M. Howard. Assisting Mr. Balloch in the office.
- (15) J. Rainboth, A.M., Can. Soc. C.E. Assisting Mr. Balloch in the office.
- (16) G. H. Burnett, A.M., Can. Soc. C.E. Assisting Mr. Gzowski in the field and office.
- (17) J. W. Chappelle. Assisting Mr. Gzowski in the field and office.
- (18) L. Phillips. Assisting Mr. Gzowski in the office.
- (19) W. B. Elder. Assisting Mr. McGaan in the office.
- (20) C. Gilmore. Assisting Messrs. Hill and Ford in the office.
- (21) O. H. Larkin. Engaged in estimate of areas and values of right of way.

## CLERICAL ASSISTANTS.

- (1) A. J. Therien, File clerk and general office typist.
- (2) M. L. Ryan, Stenographer and accountant.
- (3) J. McCartin, Stenographer and accountant.

## THE WORK TO BE DONE.

I was instructed to ascertain the approximate physical value of the entire system of the Canadian Northern Railway and of the Grand Trunk Pacific Railway, and if possible, to make comparisons between certain portions of these lines and similar or adjacent portions of the Canadian Pacific lines. The entire mileage to be covered was approximately as follows:—

	Miles.
Canadian Northern System.. . . . .	9,375
Grand Trunk Pacific, main line.. . . . .	1,748
Grand Trunk Pacific branches.. . . . .	950
Canadian Pacific.. . . . .	1,352
Total.. . . . .	13,425

I was informed that the entire work must be completed by early in March at the latest, in order that the Commission might have the information in season to formulate its own report. In other words, I was allowed, from the time Mr. Chadbourn was installed in his office in Ottawa, less than six months in which to make a physical valuation of 13,500 miles of railroad.

When the work began, no information in the way of profiles, lists of structures, or any inventories of the physical properties, was in my hands. The offices had to be equipped with furniture, the force organized, the field work completed, and the results worked up in the office within this brief space of time. Nothing more will be necessary to convince those who have had anything to do with valuation problems, that unusual and peculiar methods were required in this work in order to compass it in this brief period. Railroads in the United States, and the United States Interstate Commerce Commission have been working for years on a valuation of railroad properties at great expense and with a large force of men, yet in this case two large railroad systems had to be valued in less than six months.

Notwithstanding the scant time, weather conditions were favourable, and while it was not possible to examine every detail of the properties with care, I believe that the results are, on the whole, approximately correct and fair. The most uncertain element is land, and, if further time had been available, our figures for this item might perhaps be modified. Nevertheless, nothing is more uncertain than real estate values, and experts are often very far apart as regards the value of any particular parcel of land.

Before describing the methods adopted, it may be desirable to make a brief statement of certain fundamental principles, in view of the fact that this report may be read by persons to whom the subject of valuation is unfamiliar, and who may be unaware of the uncertainties and differences of opinion involved in work of this kind.

#### SOME GENERAL PRINCIPLES OF PHYSICAL VALUATION.

The word "value" is one of the most uncertain in the dictionary of economics, and several distinct meanings are given in treatises on that subject. An object of little or no intrinsic value may have value for its possessor, but none for any one else; that is to say, its value may be entirely sentimental, and it would fetch nothing in the market. Again, an object of great intrinsic value, measured by its cost or by the cost of reproducing it, may have no value whatever in the market, because it possesses no sentimental value or no earning power; or again, an article or a property of little intrinsic value, measured by its cost or the cost of reproducing it, may have great value in the market because it has great earning power.

By the word "value" the economist usually means value in exchange; that is to say, the price which the article or property would bring as between a willing seller but one who is not forced to sell, and a willing buyer but one who is not forced to buy.

There is no sentiment about a commercial property like a railroad. The real value of such a property is measured by its earning power and by nothing else. No matter how costly or how inexpensive it may have been originally, its value in exchange will be measured by its earning power. Prospective earning power, perhaps under altered conditions, must of course be considered. Some properties, therefore, have a so-called "strategic" value, because, while they may earn nothing by themselves, they may be combined with other properties in a way to produce or enhance earnings.

If property is valued for the purposes of sale to a new owner, earning power, with the explanation above given, will therefore be the proper basis, taking account, in other words, of the uncertainties and potentialities of the future. This, however, would not be a physical value; that is to say, the value might include a large sum to represent location, good-will, patent rights or other elements which cost little or nothing, but which produce earning power.

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In the case of a public utility corporation, a valuation is generally made either for the purpose of regulating capital, or for serving as a basis of rates to be charged, or for condemnation, or for purposes of taxation. For purposes of taxation or condemnation, earning power may be fairly taken into account. For purposes of fixing rates, which are themselves sources of earnings, it would clearly be reasoning in a circle to base the value upon earning power; for purposes of capitalization, earning power has clearly no direct or necessary connection; in these cases, it is the physical value of the property which is to be determined; that is to say, the value of the various physical elements which go to make up the property.

To determine this physical value there are two, and only two, available bases:—

- (1) The original cost, or original cost less depreciation, according to circumstances;
- (2) The cost of reproducing the property at or about the time the valuation is made, or, the cost of reproduction new less depreciation, according to circumstances.

These two bases are entirely distinct, and should be kept so throughout the valuation; whichever basis is adopted, it must not be confused, with reference to any of the elements of value, with the other basis, otherwise, confusion will result, and the conclusion arrived at will be unintelligible. If the original cost is to be found, it must be found without the slightest reference to what any part of the property would cost if reproduced at the time the valuation is made. If the cost of reproduction is to be found, it must be found entirely without reference to what any part of the property cost originally. The result will then be either the original cost, or the cost of reproduction new, and this result can be used intelligently and with due regard to circumstances, and as to whether it is a fair measure of value. Much of the confusion with regard to the subject of valuation has arisen from combining these two methods.

The valuation of a property is generally for the purpose of ascertaining what the courts have termed "the present value" or "fair present value." Just what the present value, or the fair present value may be, is not easy to state, and probably cannot be stated. The courts, however, have frequently stated what it is not. They have again and again laid down the principle that it is not original cost. In some instances they have stated that it is not the cost of the reproduction new, but it is generally admitted, I think, that both the original cost and cost of reproduction new, and also the depreciation, depending upon circumstances, are all elements which may affect the judgment as to the "fair value."

If the problem of your Commission were to determine the first cost of the properties which we have considered, this would have been a problem for accountants and not for engineers, except, perhaps, for some engineering advice on certain pertinent matters. The properties in question, namely, the Canadian Northern System and the Grand Trunk Pacific, have, for the most part, been constructed within a comparatively few years. To determine their cost would be purely a book-keeping proposition, to be performed by expert accountants, with the aid of sworn statements, affidavits, vouchers, etc. Some of the lines of the Canadian Northern, however, are old lines which have been taken over into the system within recent years. I do not know what records are available, but it is very possible that to determine the original cost of these properties would be impracticable.

I have assumed, therefore, and I think it is clearly evident from the above brief discussion, that the problem assigned to me, that of making an approximate physical valuation of these properties, must necessarily be that of ascertaining the cost of reproduction new of these properties, and not the first cost. In other words, you desire to ascertain what present investment in money may fairly be said to be represented by the physical properties concerned. If certain elements of value which originally cost

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little or nothing, like some of the real estate, have appreciated in value, the enhanced or present value is to be ascertained. If this was not your object, my valuation, as above stated would be unnecessary.

With the exception of the land, however, and those lines of the Canadian Northern System which are old lines recently incorporated into the system, in other words, for the portions of the lines considered which have been built within recent years, the cost of reproduction and the original cost should nearly coincide. The land values themselves should probably not differ greatly, except in the large cities, where in some cases, land costing little originally has now become very valuable, so that its first cost and its cost of reproduction would be very different. In the case of the older roads recently bought and incorporated in the Canadian Northern System, the cost of these properties, to the Canadian Northern Company might differ greatly, both from the original cost of the properties and from their cost of reproduction new at the present time. They may have been bought at very high or at very low prices, as compared either with first cost or cost of reproduction.

These principles were briefly discussed with your Commission before the beginning of the work. The problem, therefore to be performed by the force under my direction, was to ascertain the cost of reproduction new of the properties in question at the present time. By the phrase "at the present time" is not to be understood the present moment, in view of the inflated prices for materials and labour which have come about as a result of the war; but rather, the fair cost of reproduction new, assuming that the properties were to be reproduced at fair average prices prevailing during a brief period of years just before the war. Further discussion as to the prices used will be given further on in this report.

With this brief discussion of general principles, the methods employed for the prosecution of the work, and the results obtained, may next be considered.

#### METHOD OF PROSECUTING THE WORK.

When this work was first undertaken I was given to understand that it would have to be completed by the end of the calendar year 1916. Under these circumstances, I addressed to Sir Henry Drayton, August 22, the following letter:—

August 22, 1916.

DEAR SIR,—With reference to the proposed valuation which your Commission is to make, I think it is desirable to obtain from the railway companies whatever information on this subject they already have. A detailed valuation of these properties such as is being made by the Interstate Commerce Commission, or such as has been made by various States, would cost a very large sum of money, take a very long time, and would, in my opinion, be entirely unnecessary. All that your Commission should do, it seems to me, is to apply an approximate yard stick in the manner which you yourself have suggested, namely to find the value per mile of certain typical pieces of road, and then to apply these prices to the railroads in question, having due regard to similarity of conditions and taking account of any exceptional elements of value. The first thing to do is to find out what information the companies are prepared to furnish. Very likely they can give unit prices for all the elements involved and perhaps they have inventories of the various structures and other properties which they possess, with costs, either original costs, or fair present costs.

I would therefore suggest that you ask of them such information as they are prepared to furnish, taking up in order each of the elements of value according to the classification required in your accounts, which I have not before me, but which probably follows in some general way the list below. Some of this information will probably be better obtained by personal conference between

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your engineering force and the engineering force of the companies, in order that it may be given in the form desired. I would therefore make the following suggestions, taking up in order the various elements which go to make up a railway property:—

1. *Right of way and station grounds.*—Whatever information the roads have with reference to the cost or assessed value of the right of way; width of right of way.

2. *Real estate.*—Some information as to value or cost.

3. *Clearing and grubbing.*—Cost of rock, loose rock, and earth excavation on different portions of the line. Probably the companies can give us actual contract costs covering a wide variety of conditions.

*Profiles of the lines.*—If the companies have complete profiles, they could probably loan them to your Commission for study in the office or on inspections.

4. *Tunnels.*—Number, length, section, material, cost.

5. *Bridges, trestles, and culverts.*—Possibly the Companies may have complete lists of these structures, and information regarding general dimensions, material, and type, and perhaps also cost.

6. *Ties.*—Cost and number per mile.

7. *Rails.*—Weight, date of laying, length, and cost delivered on the ground.

8. *Frogs, switches, and crossovers.*—Types used and prices paid. Perhaps the companies also have the number.

9. *Track fastenings and other materials.*—Standard type and the cost.

10. *Ballast.*—Standard cross-section of road-bed on different parts of typical portions of the line, kind of ballast and quantity per mile, cost of ballast of different kinds, under the different conditions.

11. *Track laying and surfacing.*—Cost.

12. *Cattle-guards.*—Standards, cost.

13. *Fencing right of way.*—Type, cost, and length.

14. *Interlocking and other signal apparatus.*—Statement of kind, number, etc.

15. *Crossings and signs.*—Standards and what other information the Companies have.

16. *Telegraph and telephone lines.*—General Statement.

17. *Station buildings and fixtures.*—Possibly the companies have a complete list of stations, with information regarding size and material of buildings.

18. *Shops and engine houses.*—List and general description.

19. *Shop machinery and tools.*—List and location of shops and size, and such other information as may be available.

20. *Water stations and purifying plants.*—List and general description.

21. *Coal handling plants.*—List and general description.

22. *Grain Elevators.*—List and general description.

23. *Storage warehouses.*—List and general description.

24. *Dock and wharf property.*—List and general description.

25. *Power plants and transmission.*—General statement.

26. *Snowsheds.*—Standards, length, cost.

27. *Masonry.*—Possibly the companies have complete lists of masonry structures, cost of concrete and stone work per yard on different typical sections.

28. *Overhead bridges.*—Possibly they have complete lists of these.

29. *Coal and ore docks.*—List and general description.

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30. *Floating equipment.*31. *Hotels and restaurants.*—List and general description.

Finally, statement of any other property of the companies.

Yours truly,

GEO. F. SWAIN.

Sir HENRY L. DRAYTON,

Commission of Inquiry into Railways and Transportation.

In accordance with this letter, a communication was sent to each of the Railroad Companies by Sir Henry Drayton, a copy of which follows:—

AUGUST 22, 1916.

MY DEAR MR. ——— You have already been written to for several characteristic costs. The engineer in charge of physical valuation desires the data required by the enclosed memorandum, and the Commission would be obliged if the same is forwarded at the earliest possible date.

We understand that most, if not all, of this data is available. Speaking generally, it is required for the annual report. In order that there may be no delay, the Commission will be much obliged if the company will forward the information which it can now readily compile, as well as any other further information bearing on the value of the physical asset that the company may have, at the same time indicating what, if any information desired it has not got and how long it will take to prepare it.

Yours faithfully,

H. L. DRAYTON.

Enc.

## INFORMATION REQUIRED FROM RAILWAY COMPANIES AS TO PHYSICAL PROPERTIES.

1. Right of way and station grounds: The cost to the company of purchasing or otherwise acquiring its right of way and station grounds, for each of the company's different operating divisions, and the present assessed value of the same, together with accurate data as to the width of the right of way and acreage of station grounds.

2. Information as to the cost to the company and present assessed value of the real estate owned by the company, other than the right of way and station grounds, by the different operating divisions in which it is situate, showing its acreage and the purpose to which it is put.

3. Cost per yard of solid rock, loose rock, earth excavation work, and other material on the company's several operating divisions.

4. The production of the company's working profiles under which the line was constructed; such profiles to show the classification of the different excavations and fills and their quantities.

5. The number of tunnels, their respective lengths, sections, material, cost and location.

6. A return of the company's information as to the number of bridges, trestles, showing where they are situated, their length, height, dimensions, material, type and cost.

7. A return of the company's information as to the number of culverts, showing where they are situate, their length, height, dimensions, material, type and cost.

8. The number of ties per mile and their cost.

9. The weight, date of laying, length and cost of rails at mills and delivered on the ground.

10. Such information as the Company possesses as to the frogs, switches, cross-overs, passing tracks, and sidings in each operating division; such information to show types used and standard prices paid.

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11. Details as to track fastenings and other materials used, the company's standard type and cost.
12. Ballast—Standard cross-sections of the roadbed on different parts of typical portions of the line, showing the kind of ballast used, depth, and quantity in yards, per mile, together with the cost of the different types of ballast used.
13. The cost of track laying and surfacing in each operating division.
14. The number of cattle guards in each operating division, and cost.
15. The type of fences used in each operating division, the length of fence, and cost per mile.
16. The location of interlocking and other signal apparatus in the different divisions, with information as to their character, number, and cost.
17. The cost to the company of crossings and signs, and their number in each operating division.
18. The company's telegraph and telephone lines in each operating division, the number of wires and poles used, and cost per mile.
19. The number of station buildings, freight sheds, or other facilities in each operating division, size and material, and cost to the company.
20. A list of all shops, engine houses, and turntables in each operating division, giving particulars as to size, with cost, and a general description thereof.
21. The cost to the company of the shop machinery and tools located in the shops.
22. A list of all water stations and purifying plants located on the different operating divisions, and their cost to the company.
23. A list and general description of coal handling plants and fuel stations on each operating division, and their cost to the company.
24. A list and general description of all grain elevators owned by the company on each operating division, their capacity, and cost.
25. Storage warehouses: A list and general description of all storage warehouses owned by the company on each operating division, their capacity, and cost.
26. A list and general description of all dock and wharf property owned by the company on each operating division, their capacity and cost.
27. A list and general description of all electric light, power, and transmission plants owned by the company on each operating division, their capacity, and cost.
28. A list and general description of all gas-producing plants owned by the company on each operating division, their capacity, and cost.
29. A list and general description of all snowsheds owned by the company on each operating division, and cost.
30. The number of overhead highway bridges on each operating sub-division, their length, type, and cost to the company.
31. The number of gates and electric bells maintained by the company at crossings on the different operating divisions and their cost.
32. A list and general description of all coal and ore docks owned by the company on each operating division, their capacity, and cost.
33. A list and general description of all hotels and restaurants on each operating division, owned by the company, and their cost.
34. Any other property owned by the company on its different operating divisions, its description, and value.

After the return of the Commission from its western trip, about the end of September, I was given to understand that my work need not be completed until early in March. In the meantime, no data had been received from the companies excepting a few profiles and some lists of bridges. It was essential, therefore, if any field work were to be accomplished during the season, that the field men should be started at once. The time between Mr. Chadbourn's arrival in Ottawa, September 6, and the first week in October, had been consumed in conferences with the companies with reference to the character of the material to be furnished, in preparing

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the offices, in engaging and instructing the men, in the preparation of instructions for field engineers, and in the preparation of some typical yardsticks or estimates of cost per mile of typical lines, omitting special items. It was decided to carry out a valuation reconnaissance, sending engineers over all the lines, with such profiles, lists, and other information as was available, with instructions to observe and note all elements of physical value.

Considering the difficulties in getting men, the fact that no information was available at the start, and that the men secured had had no experience in valuation work, I consider that we were as expeditious as could have been expected, in being able to start our field work, as we did, by the middle of October. It takes time to collect a force of competent men, and, on account of the war, the fact that we were limited to Canadian engineers, it took, in this case, longer than it would ordinarily have taken.

We had hoped and expected to receive from the Canadian Northern Company all profiles before the field men started on their work, in order that they might go over the lines with those profiles before them. By the middle of October, however, we had only received profiles for a portion of the lines, so that in most cases the field men were obliged to start with no data, but simply with their note-books.

On October 16, Mr. Chadbourn and I, accompanied by Mr. W. P. Kellett, a well-known Canadian engineer of Brantford, Ont., who had had to do with the construction of several railroads, and Mr. D. O. Johnson, of Toronto, a contractor of long experience in railroad work, and accompanied also by a number of our field engineers, set out from Ottawa for a trip to the Pacific coast by way of the Canadian Northern lines going west, and the Grand Trunk Pacific returning. On this trip the field engineers were instructed as to the method of taking their notes, the points to be observed, and all other pertinent matters. Each field engineer was left at a suitable point in the territory assigned him, while Mr. Chadbourn, Mr. Kellett, Mr. Johnson, and myself proceeded upon our trip, picking up from time to time other field engineers whom we had engaged, and instructing them similarly.

The main purpose of this trip was to enable Mr. Chadbourn and myself to become thoroughly acquainted with the lines on which we were engaged, the physical characteristics of the country, and also in order that we might discuss with Messrs. Kellett and Johnson and with the superintendents and engineers of the companies the question of unit prices. Each evening a session was held at which these matters were discussed, and each member of the party expressed his opinion as to the fair unit price to be assigned to each of the elements involved. Records of these opinions were kept and have been of great service in the office in deciding upon the final unit prices to be assumed. In connection with this work, Messrs. Kellett and Johnson rendered service of great value. Both of these gentlemen are men of experience and excellent judgment, and having had experience, in many cases, in the very territory through which we were riding, they were able to take account of local conditions, and to give reliable and unprejudiced opinions. The superintendents and engineers of the Canadian Northern Railway were also of much service to us, telling us actual prices paid, actual values of farm lands, actual methods of construction employed and in other ways giving information of great value, all of which was noted and used in the final figures.

The field engineers were sent over all of the lines, and instructed to take a position at the rear of the train and take note as they went along, of every element of physical value which could be observed. While stopping at stations, they were to descend from the train, observe the rails, the spacing of ties, the character and depth of ballast, width of right of way, and any other elements which the time allowed. When longer stops were made, as at division points, they were to make sketches of the yards, buildings, and other property, with as much pertinent information as possible; they were to confer with division superintendents, engineers, track foremen, and any other railroad employees who could give them information; they were to make inquiries of railroad

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officials, real estate agents and others as to unit prices, value of right of way and station grounds, and any other pertinent matter. If necessary, they were to travel several times over the line, observing each time only certain selected elements, or to return to division terminals or important towns, stopping over as long as might be necessary to gain necessary information. They were to ride on freight or passenger trains, and in some cases a gasoline motor car was put at their disposal, or they used hand-cars with the assistance of the track-gangs. In other words, by riding over the line and stopping as long as necessary at proper points, they were to make a physical inventory of the properties.

They were to observe the general character of bridges and other structures, the character and classification of material in cuts, the presence of borrow pits, the slope of the ground at cuts, the width of road bed, character of drains, presence of muskegs, or other points where difficulties were probably met in construction, the probable amount of clearing, character of telegraph lines, fences, and in short, they were to make note of any matters which were necessary in order to make it possible in the office, with the aid of the lists, standard plans, and profiles, to inventory and value the physical property.

For this work engineering experience and good judgment were of course necessary. An experienced man, by riding over a line once, especially in the prairie section, would be very apt to note with reasonable accuracy all elements of value. In more difficult country several trips over the line might be necessary, each trip being devoted to the observation of certain particular elements. Station buildings and roundhouses were all built to standard plans designated by numbers, and all that was necessary was to note the number, so that afterward in the office the inventory and valuation might be made.

In all of this work the operating officials of the company co-operated most cordially, supplying the field men with information, providing them with transportation facilities, and in general, doing all they could to facilitate the work. My sincere thanks are due to the company and its officials for their attitude and their co-operation in these matters.

A special expert was engaged to estimate the value of buildings. In his hands were placed the standard plans as soon as received from the companies, and upon them he based his estimate of cost of reproduction. This expert travelled over a good portion of the lines, visiting at all events important terminals, and inventorying all buildings of every kind, and noting character of construction and any other elements affecting cost.

The plan of work adopted will be made clearer by the detailed instructions to field engineers, which were as follows:—

## INSTRUCTIONS TO FIELD ENGINEERS.

(a) *General.*—The object of this bureau is to make a close valuation of the property of certain railroads in the Dominion of Canada. Great care must be taken to include everything that is owned by the railway companies.

Information obtained from any railroad company or any of its employees, or from local residents on any part of the line must be verified to the satisfaction of the inspecting engineer in the field. All employees must bear in mind that they are not in any way employees or agents of the railway company, and that they are to form their own conclusions without any regard to the purposes for which the valuation may be made.

Constant vigilance must be exercised to avoid omission of hidden quantities or extraordinary cost conditions. It is desired to make as rapid progress as is consistent with good work. It must be borne in mind, however, that it is not attempted to make a minute detailed inventory, but conclusions must be arrived at from a careful analysis made of analogous conditions, applying these units of measurement thus carefully.

ascertained to other similar territory, noting during inspection such variations as can be observed or discovered.

(b) *Typical Mile.*—A statement will be furnished each inspecting engineer showing the quantities covered by such of the accounting classifications as are most nearly independent of the topography of the country. Each engineer must acquaint himself thoroughly with the method of preparation of this type and must have completely in mind at all times the elements of cost which have been included therein, and those which have been omitted on account of their variability. This type has been prepared from careful inspection and stated actual quantities found in long stretches of similar country, which have been averaged so far as the quantities are concerned to include the average amount of such quantities per mile. Tentative unit costs have been used in the preparations of the type for such items as are most nearly constant. These unit costs will be revised later and the variable features together with their cost will be added on the basis of the data gathered and the opinion of the inspecting engineer in each district. The inspecting engineer is to make full notes of variations from the typical mile, also of all property not covered by this typical mile, and also such estimate of unit costs or total costs as he may be able to form.

(c) *Method of Inspection.*—The entire line will be traversed by an inspecting engineer, generally using regular trains, sometimes using gasoline inspection car as may be supplied by the railroad company, and in isolated cases possibly by a special train using a business car. It may be necessary where trains are used to arrange with the railway company for a business car. The engineer should make his notes in such a manner that his attention shall be drawn as little as possible from a close observation of the property. (See e.) In occasional places it will probably be necessary for him to walk over the line, or parts of it, or to secure the use of section-men's car.

Inspection made in the manner above described will not include large yards and terminals, which must in every case be handled by the engineer spending considerable time at the yard or terminal, having in his possession at the time the map of the same as submitted by the railway company.

The inspecting engineer having obtained from the railway company, generally through this office, such condensed data as he can carry with him, and having familiarized himself with the typical unit, should, in his field inspection, note carefully all divergencies from the standard type, both as to deficiencies and additions.

(d) *Elements of property.*—In the following paragraphs will be found notes relating to each classification given:—

(1) *Engineering.*—No attention will be paid to this item in field.

(2) *Right of Way and Station Grounds.*—The railway company will furnish data relating to width of right of way and the extra width at stations. The inspecting engineer should, so far as practicable, roughly observe this width and make occasional note of his observation. Perhaps while stopping at some station he can pace the width. It is important, however, that he should make inquiry and obtain as accurate information as practicable, as to the value of adjoining land; not what it cost the railway company to obtain the right of way, but the present real value of adjoining lands for the purpose for which they are used. This statement applies generally to rural land. In the larger towns he should make more careful inquiry, if opportunity presents itself to do this on the trip; at least he should make every effort to do so. He should remember later, in the office, in making up right-of-way values, multiples will be applied to the basic values as above secured, to represent the additional value for railway purposes on account of severance, damages, cost of acquisition, etc. He should make every effort to secure sufficient data to form a definite opinion for any particular line in its entirety, leaving very little subsequent work in this category to

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be done, otherwise the work will be very much delayed. It will be necessary for the inspecting engineer to stop at larger towns or cities for such time as may be necessary to gain the requisite information. (See *e*.)

(3) *Real Estate*.—This is an item for special investigation and will in general receive no attention from the inspecting engineer while inspecting lines, unless he can conveniently obtain information, in which case he should not omit to do so.

(4) *Grading*.—The inspecting engineer must note carefully the amount and character of work on each line. He will have with him the profile of the line, but it will not be practicable for him to note in each cut the classification of material. To attempt to do this would make it impossible in many cases for him to make any other observations, and his estimate, moreover, would be likely to be largely in error. He should, however, make general notes on each sheet as to the material in cuts, such for instance as "cuts all rock," "cuts mostly earth," or such other general observations, as to quantities or material, as the case admits. From his inspection and from such other data as he may be able to secure, the office force will check up the information received from the company.

He should also be careful to observe and make notes relative to clearing and grubbing.

A sharp lookout should be kept for any stream diversions, retaining walls, riprap, cribbing, or bulk heads. Relative to these five items, if he is not able on his first trip to make sufficient notes to make the approximate estimate he should make inquiry from proper railroad authority and possibly in some cases visit the site again.

It will be necessary to keep a sharp lookout and make notes concerning muskegs, sink holes, and the like. The railroad company will furnish data relating to such places and show their location, but the inspecting engineer must make as careful observation as time permits. It will be necessary to be liberal in treatment of these matters for it is extremely difficult to determine after completing the line what work has been necessary in such places.

Care must be taken to note where there is more than one track in order that suitable roadbed width may be taken into account.

(5) *Tunnels*.—These will be special in every case except where they are very short and therefore of little consequence. The inspecting engineer will make note of all tunnels and character of lining, if any. In case of long tunnels, the railroad company will furnish complete data which will be turned over to the inspecting engineer for him to approximately check up.

(6) *Bridges, Trestles and Culverts*.—For our units of estimation, an amount per mile expressed in dollars will be determined from profiles for territory where culverts are small and infrequent. Usually a profile will give sufficient data.

The railroad company will furnish a list of all bridges showing character, quantity of steel and quantity of masonry. The inspecting engineer should check this list as he travels over the line. If he has no list, he will note character of each bridge.

(7) *Ties*.—Determine number of ties per mile by counting the numbers of ties per rail length at times when the train is stopped, being careful to note whether 30' or 33' rail is used. Also make inquiry where possible, of section foremen, roadmasters, or others. Note also approximately the kind of ties. If they are largely of one kind, or if mixed, make note of that fact. At close of day's work make a general note from your impressions, of the condition of the ties. Make note whether the turnouts have switch timber or are laid with the ordinary track ties. Make notes and secure data, from inspection or inquiry, of the size, kind and spacing of bridge ties. Note particularly if any treated ties or treated bridge timber is found and from inquiry or inspection make sufficient notes to determine quantity.

(8) *Rails*.—Note weight of rail per yard in main tracks, and in sidings if possible. At close of each day's work, make a note relative to the condition of rail.

(9) *Frogs and switches*.—From observations made during the day's work make notes at night relative to the kind of frogs, switch stands, switches, and as to their general condition.

Make note of any railroad crossings and roughly the angle and if possible note if it is made of ordinary rail, heavily reinforced, manganese steel or any special feature relating to the same.

(10) *Track fastenings and other materials*.—Make special observations during the day and record at night notes relative to type, length, number of bolt holes in angle bars, and in case any other type of joint is discovered, make note relative to same.

Note during inspection any guard rails on curves, bridges or in tunnels.

Note or secure information relative to the use of tie plates, rail braces or anti-creepers.

(11) *Ballast*.—Be careful to make sufficient notes of the different kinds of ballast so that a close approximation can be calculated from notes. More particularly note the kind of ballast and both from inquiry and observation determine its depth, note as so many inches under the tie.

From inquiry ascertain the approximate or average distance to haul ballast on any particular line, as this feature frequently adds very materially to the cost of ballast.

(12) *Track Laying and Surfacing*.—As this is entirely a labour item it can be arrived at readily in the office, but if there are any special or unusual features which make this item more costly than is customary, make notes and state carefully the reasons for conclusions arrived at.

(13) *Railway Tools*.—No attention need be paid to this on inspection trip.

(14) *Fencing Right of Way*.—Note with reference to all the line inspected each day whether it is fenced on one or both sides, and the character of the fence. If possible make brief notes concerning cattle guards and wing fences thereto, and any side fences at highway crossings.

(15) *Crossings and Signs*.—Make such observations during his inspection as will enable him to make notes concerning approximate number of various kinds of signs, such as mile boards, whistle posts, station boards, crossing signs, etc. Note the existence and location of over or under crossings, gates, alarm bells, etc.

(16) *Interlocking and other Signalling Apparatus*.—Make general notes regarding apparatus coming under this heading and its character and location.

(17) *Telegraph and Telephone Lines*.—Observe and make such notes as may be necessary, stating whether such lines exist or not, the number of wires, the approximate number of poles per mile. Secure from proper railroad authority data with reference to number of instruments and other special apparatus coming under this heading.

(18) *Station Buildings and Fixtures*.—Make suitable notes relating to stations and accessory buildings. At each station note character and approximate dimensions of each building, platforms, and coverings:—

(a) For the usual customary small station existing at most points an estimate will be furnished and a proportional amount of same will be included in the typical mile.

(b) Where a more costly or more extensive station and other buildings exist, further data will be necessary to make a special estimate of same. In

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such case make such notes as practicable without a special stop and later secure additional data if necessary from the main office, or from railway company. In most cases sufficient data will be furnished by the railroad company.

(c) At large stations and terminals this matter will be considered by a special engineer. Make a note for each day showing general condition of buildings as good, fair or poor.

(19) *General Office Building and Fixtures.*—The inspecting engineer will not consider this matter at all unless instructed to do so. He should, however, make note of such buildings.

(20) *Shops, Engine-house and Turn-tables.*—The railroad company will furnish complete data for all structures coming under this heading, and such information will be furnished to the inspecting engineer. He should, however, make general note of their existence, character and size.

Where these structures occur at terminals and at the larger places where inspecting engineer will probably stop in any event, he should make full notes concerning the structures as to size, kind, character of construction and any other special features to enable an approximate estimate of the value of the structures to be made.

(21) *Shop Machinery and Tools.*—The inspecting engineer will give no attention to items coming under this heading unless he is specially requested to do so, in which case a full list and description of the items will be furnished him in order that he may make an approximate check.

(22) *Water Stations.*—The inspecting engineer will note the location of water stations and information concerning their character.

If there are any special features, such as reservoirs, dams, or treating plants, he must secure from proper source sufficient information for an estimate of value to be made. The railroad company will furnish complete data regarding these matters, and in general it will only be necessary for the inspecting engineer to check such information.

(23) *Fuel Stations.*—The inspecting engineer should note the location and character of all the fuel stations. Complete data will be furnished by the railroad company of all such stations and in general it will only be necessary for the field engineer to check such data.

(24) *Grain Elevators.*—The inspecting engineer should make note of the location of any elevators belonging to the railway company, and if possible state kind of construction, capacity and type.

(25) *Storage Warehouses.*—Inspecting engineer should make note of the location of any storage warehouses, and if possible give approximate size and type of construction.

Buildings coming under this classification are not the ordinary freight warehouses where freight is received for shipment, but are houses in which merchandise is stored and which is operated as a storage warehouse solely.

(26) *Dock and wharf property.*—Make such notes as practicable.

(27) *Electric light plants.*—If the existence of any plants coming under this heading come to the knowledge of the inspecting engineer he should make note of it, and notify this office promptly of its location.

(28) *Electric power plants.*—If the existence of any plants coming under this heading come to the knowledge of the inspecting engineer he should make note of it, and notify this office promptly of its location.

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(29) *Electric power transmission*.—If the existence of any plants coming under this heading come to the knowledge of the inspecting engineer he should make note of it, and notify this office promptly of its location.

(30) *Gas producing plants*.—If the existence of any plants coming under this heading come to the knowledge of the inspecting engineer he should make note of it, and notify this office promptly of its location.

(31) *Miscellaneous structures*.—Under this heading are included all structures which do not come specifically under some one of the previous classification. They should be noted in as great detail as the case warrants.

The typical unit includes an item to cover the occasional minor structures charged to this account.

(e) *Special details*.—The inspecting engineer will, before beginning his inspection, thoroughly familiarize himself with these instructions and with the pamphlet entitled "Classification of Expenditures for Road and Equipment," and will carry a copy of each with him.

He will also carry a 6-foot folding pocket rule.

He will also carry with him such data relating to the line, such as profiles, bridge lists, etc., as may be available.

He must plan his inspection with care, having reference to time schedules, the time necessary for stops in towns, etc., having in view the economical and expeditious prosecution of the work. If he goes over a line twice, once going and once returning, he should divide the work between the two trips; for instance, observing track going one way, and buildings the other.

In the course of his work, the inspecting engineer will probably be able to pick up items of information as to unit prices at the present time, fair average unit prices, and cost of certain elements. All such information should be noted, *together with its source*.

He should also note, on each line or portion thereof, the *general condition* of the property, whether it has been maintained in good operating condition, or whether it has been allowed to depreciate unduly. This should be noted on each sheet.

As soon as the inspection of a line is completed, the results should be sent, registered, to the office at Ottawa, in order that they may be examined and worked up.

Many of the items included in the various accounts are included in the typical unit. The *primary* features to be observed by the inspecting engineer are the items which vary or differ from that unit, or are not included in it, deductions or additions may be made as the facts require.

These items are the following:—

(2) and (3) *Real Estate*: Unit prices of these are, of course, subject to wide variation. The inspecting engineer can obtain much information on these matters, particularly in rural territory; but much will be obtained from the companies or will be secured elsewhere.

(4) *Grading*.

(5) *Tunnels*.

(6) *Bridges*.

(11) *Ballast*.

(14) *Fencing*.

(15) *Crossings and signs*, so far as concerns over or under crossings.

(16) *Signals*.

(18) *Buildings*.

(19) to (31) *Special items*.

For these items, more or less complete data will be furnished by the railroad company, and they should be carefully observed by the inspecting engineer, in order that a reasonably close check may be made.

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If any items are overlooked be sure that it is the small ones, such as signs; and in any event give the least attention to the least important items.

Inspecting engineers should be in thorough harmony with the general plan and methods of this work, for only in this event can the best results be obtained.

Each inspecting engineer must report daily by mail to the head office, in Ottawa, stating the work done during said day, and must keep the central office informed as to where he can be reached by mail and by telegraph. If necessary, use the telegraph, but avoid such use as much as possible, and in the event of a long message being necessary, send night-letter or day-letter as circumstances dictate.

(f) The inspecting engineer should make note of all unnecessary work, specifically stating, if possible, its character and amount.

In the manner above described, all of the lines of the Canadian Northern Railway system, with the exception of the Halifax and Southwestern Railway in Nova Scotia, and the Niagara, St. Catharines and Toronto Railway, and all of the Grand Trunk Pacific, together with a few typical sections of the Canadian Pacific, were covered by our field engineers between the middle of October and the end of the year. Very fortunately for us, there was no snowfall until late in the season, and we were able to complete our work practically with no snow on the ground.

Since the beginning of 1917, the Niagara, St. Catharines and Toronto Railroad has been inspected, though under less favourable conditions, but no inspection has been made of the Halifax and Southwestern Railway.

While the above described work was being carried on in the field, information was slowly coming in from the railroad company. As fast as received, this information was worked up in the office. So-called typical units were prepared, the items of property being classified in accordance with the classification adopted by the Railroad Commission, and the values of certain standard items, such as rails, frogs and switches, track fastenings, and other items which might fairly be assumed as standard, were listed; variable items being left to be filled in after the completion of the field work. The standard items and the quantities of excavation were worked up from the profiles, plans of stations and sidings, rail maps, and other information received from the companies.

When the field men returned, therefore, all of this information was available and all the profiles received up to that time had been gone over and the quantities calculated, assuming the surface of the earth to be level. Each field man was thereupon assigned to the final computation of lines in his territory, based on the information which he had secured with reference to slope of ground and classification, the grading quantities were corrected, all the other items checked, and the special items inserted. The record for each line with all computations, was kept in a separate book, in the front of which was pasted the typical unit for that line with the average cost per mile, excluding items purely special, and at the end of each are computed the final cost of reproduction per mile of such line, and its total cost of reproduction, including overhead charges, together with the depreciation.

The final result for each line was entered upon a card, and the cards kept together in a filing case. These cards, together with the books, constitute a permanent record of the results for each line, and can be used in future as occasion may demand.

## RAILWAY INQUIRY COMMISSION

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The following is an illustration of a typical unit and of the card which goes with it:—

## COMMISSION OF INQUIRY INTO RAILWAYS AND TRANSPORTATION.

## TYPICAL UNIT.

Canadian Northern Railway.....Saskatoon—Munson.  
Single track. 302.5 miles.

	—	Depre- ciation.
	\$	\$
2 Right of way and station grounds.....	660	0
3 Real estate.—Special.....	0	0
4 Grading.....	0	
Clearing and grubbing.....	\$3,645	
Other grading items.....	3,645	0
5 Tunnels—None.....	0	
6 Bridges—None.....	\$633	253
Trestles, etc.....	126	36
Culverts, pipes, drains, etc.....	759	
7 Ties, 2,985 per mile at 70 cents.....		
Bridge ties 1-8 M.B.M. at \$55.....	2,188	1,032
Switch ties 1-8 Turnout at \$55.....	4,053	1,189
8 Rail (60 pounds), 104 tons at \$39.02 per ton.....	49	15
9 Frogs and switches.....		
10 Track fastenings and other material—.....	\$276	
110-3 % A. bars at \$250.22 per mile=.....	53	
110-3 % bolts at 48.05 per mile=.....	213	
Spikes 3,000 ties at 2.6 pounds per tie=78 cwt. at \$2.73 per cwt.=.....		
Tie plates per mile at - each= -.....	542	163
11 Ballast, 1,646 cubic yards per mile at 75 cents per cubic yard in place.....	1,202	601
12 Track-laying and surfacing 110-3% of a mile at \$550 per mile plus (for laying) .5 of a turnout at \$50 each.....	632	316
13 Roadway tools, 1 outfit at \$160 divided by 8.....	20	10
14 Fencing—right of way—2 fence miles at \$250 per mile, plus cattle guards and gates.....	553	276
15 Crossings and signs.....	37	18
16 Interlocking and other signal apparatus, 10% station semaphore at \$40.....	4	1
17 Telegraph and telephone lines—1 mile at \$306, plus 10% for instruments, etc.....	337	112
18 Station buildings and fixtures.....	486	121
19 General office buildings—None.....		
20 Shops, etc.—Special.....		
21 Shop Machinery—Special.....	234	58
22 Water stations.....	113	23
23 Fuel stations.....	556	139
31 Miscellaneous structures.....	250	
Maintenance and temporary work during construction.....	320	64
Solidification and adaptation or deferred construction.....		
Total.....	\$16,645	
Cont.=5% of total; Dep. of C.=20%=1% of total.		166
Depreciation of Contingency item.....		\$4,658
Depreciation per mile of track.....		

NOTE.—Where details are not shown, they may be found in detail book.

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(Face of Card.)

CANADIAN NORTHERN RAILWAY.		
Card No.	Saskatoon—Munson	302.5 miles.
(Main Line)	V.S. 47	
\$16,645	(From typical unit) x 302.5 miles.....	\$ 5,035,112
Special Items	Engine-house, turntable, etc., at Kindersley.....	47,055
	Hanna.....	64,416
	Shop machinery at Kindersley and Hanna.....	19,377
	Interlocker and frogs M.P. 3-8 G.T.P.....	5,614
	Portion of Saskatoon Terminals property.....	97,500
		\$ 5,269,074
Overheads:		
Total land, \$660 x 302.5 + \$97,500	\$ 297,150, 24% on land.....	71,316
Other Meas. Items.....	4,971,924, 27.2% on O.M.I.....	1,352,363
	\$5,269,074	\$ 6,692,753

Rate per mile, \$22,125.

Inspector: Balloch.

Statements: Chadbourn.

For details of overhead percentages, see pages 31-32.

(Back of Card.)

## LAND, INTEREST AND DEPRECIATION.

(\$16,645-660) x 302.5.....	\$ 4,835,462	
Special items other than land.....	136,462	
Total less land.....	\$ 4,971,924 basic cost.	
	297,150 land.	
10% on basic cost.....	\$ 497,192	
18% on land.....	53,487	
	550,679 interest.	
17.2% on basic cost.....	\$ 855,171	
6% on land.....	17,829	
	873,000 rem. overheads.	
	\$ 6,692,753 Total.	
Depreciation (\$4,653 x 302.5).....	\$ 1,409,045	
Special items.....	34,114	
	1,443,159	
Estimated cost of reproduction less depreciation.....	\$ 5,249,591	

## DETAILED METHODS OF WORK.

The making of a physical valuation involves two distinct operations: (a) The determination of quantities; (b) the determination of the unit prices. The total value of each item is the product of the quantity and the unit price.

More detailed information with reference to the methods of obtaining these elements will be found in the report of the Chief Engineer, Mr. W. H. Chadbourn, which is attached hereto. A brief summary, however, may here be given.

## (1) Canadian Northern Railway System.

(a) Determination of Quantities.—(Using classification of Railroad Commission.)

(2) Right of Way and Station Grounds.

(3) Real Estate.

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The right of way on these lines is practically uniform in width for many miles with an increase of width at station grounds for a definite length, all dimensions being standard. The location of stations being known, together with the standard widths, the number of acres of right of way, including station grounds, per mile, is easily obtained. At larger towns and cities where the companies possess terminal property or other real estate, maps were supplied showing location of such property. The areas were computed and tabulated and the values ascertained by special investigation.

(4) *Grading*.—No attempt was made to determine quantities of grading in the field. These quantities in the case of the Canadian Northern Railway were determined from the profiles, assuming first, that the ground was level, and then modifying this result on the basis of information noted by the field engineers. Classification of material was made on the basis of notes by the field engineers, and also the amount of clearing and grubbing. Overhaul was estimated on the basis of the profiles and the location, where, although the centre line would show no cut or fill, there was cut on one side and fill on the other.

(5) *Tunnels*.—Detailed information was in every case secured from the company relating to the length and cross-section of tunnels. Field engineers noted character of material.

(6) *Bridges, trestles and culverts*.—Lists of these structures were furnished by the railroad company, and lengths were taken from the profile. Weights of steel or quantities of timber were estimated from standard diagrams, those for timber trestles having been prepared in the office, giving quantities per foot-length for various heights, based on the standard designs. Small openings, such as pipe and box culverts, were all estimated from the profiles.

*Track, including:*

(7) *Ties*.

(8) *Rail*.

(9) *Frogs and switches*.

(10) *Track fastenings*.

(11) *Ballast*.

Quantities of these items were based on observations by the field engineers together with such information as was afforded by the profiles and maps of station grounds supplied by the company.

(12) *Tracklaying and surfacing*.—To estimate this, the mileage of sidings, as determined from the profiles, together with mileage of yard tracks, as determined from maps or by the field engineers, was added to the main line mileage and an allowance was made for an average number of turnouts.

(13) *Roadway tools* were estimated arbitrarily, this item being very unimportant.

(14) *Fencing*.—Quantities of this item were estimated from observations by field engineers.

(15) *Crossings and Signs*.—This item, in general small, was estimated, based on general notes.

(16) *Interlocking and other signal apparatus*.

(17) *Telegraph and telephone lines*.

(18) *Station buildings and fixtures*.

(19) *General office buildings*.

(20) *Shops, etc.*

(21) *Shop machinery*.

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- (22) *Water stations.*
- (23) *Fuel stations.*
- (24) *Grain elevators.*
- (25) *Storage warehouses.*
- (26) *Dock and wharf property.*
- (27) *Electric light plants.*
- (28) *Electric power plants.*
- (29) *Electric power transmission.*
- (30) *Gas producing plants.*
- (31) *Miscellaneous structures.*

All these elements of value were observed by the field engineers and their general character noted. Standard plans for structures and lists of all structures existing were submitted by the railroad company. These were compared with the records of the field engineers. Most of the structures were of standard type and all that was necessary for the field engineers to do was to note the type, as for instance, "Station Building, Type 5." At yards and terminals, where a large number of buildings existed, these were either noted by the inspecting engineer, or in some cases taken from the plans which had been verified in the field. Toward the end of the work, that is, during the month of February, complete lists of property were received from the railroad company. These were compared with the data which our field engineers had procured and which had been used in our estimates and which in most cases were found to agree closely. Where time permitted and there were discrepancies, some modification of our estimates was made.

On all the British Columbia lines of the Canadian Northern system, from Yellowhead pass to Port Mann, and the lines on Vancouver island, as well as branch lines under construction, we were supplied by the company with data showing the actual pay quantities, and these were used in the estimate.

(b) *Determination of Unit Prices.*

This being an estimate of the cost of reproduction of the properties, it was necessary to take unit prices which should represent fair average values in recent years; eliminating, however, all abnormal prices due to the war, and taking account also of any definite trend in prices.

In other words, in the case of articles the price of which has fluctuated from year to year previous to the war, but in which there was no definite trend of price, either up or down, the intention was to take a fair unit price during the period of say, three to five years previous to the war.

Certain articles, however, show a definite trend in price, so that although there are fluctuations from time to time due to variations in supply and demand and other causes, the average price may be gradually increasing or decreasing. In such case, in making an estimate of the cost of reproduction, the latest fair average price, independent of what might be called accidental fluctuations, should be taken. In the case of lumber, for instance, owing to the gradual diminution of supply, the fair average price has been gradually increasing during the last ten or twenty years. In such a case it would not be fair, in an estimate of the cost of reproduction, to take the average price for a period of years, but it would be more reasonable to take the most recent price, unless the same were abnormally high or low due to accidental causes. Some other materials have illustrated the case of a gradual decrease in price, subject of course, to accidental fluctuations; such, for instance, has probably been the case in general with cement, which during the past twenty years, with the great increase in American production, has gradually dropped in price, although there have been great fluctuations depending upon the extent of building operations, which themselves have

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been largely dependent upon financial conditions. In the case of land, no account could of course be taken of what was clearly an unjustified land boom, although it might have been in steady progress for several years.

Speaking generally, therefore, the object sought has been to use fair unit prices prior to the war.

Taking up now the various items in order, the following brief statement may be made:—

(2) Right of way and station grounds.

(3) Real estate.

The unit prices for right of way were determined after inquiry made by the field engineers from all available sources, including assessors, real estate dealers, local residents, and railroad employees. A special engineer, Mr. N. Cauchon, was charged with the investigation of this subject at the larger cities and towns, including Montreal, Toronto, Ottawa, Winnipeg, and Port Arthur. At Edmonton, Calgary, and Vancouver, the field engineers made special investigations on these matters. Assessed valuations were obtained where practicable and compared with estimates received from other and independent sources.

The valuation of real estate has probably provoked greater discussion than any other in connection with valuation matters. Undoubtedly, much of the real estate now owned by the Canadian Northern Company was procured at a very low price. Nevertheless it is now very valuable, and in an estimate of the cost of reproduction its present value should be taken. At any rate, it has been taken. Of course, it may be objected to this, that the increase in value that has taken place since the original purchase has been due to the presence of the railroad, and that the whole idea of estimating the cost of reproduction by supposing the railroad to be removed, while other conditions, many of which are due to the presence of the railroad, remain the same, is an imaginary and impossible assumption. This is undoubtedly true; if the railroad were not in existence, property values would not be what they are, having been largely created by the railroad.

However, no other method seems practicable. If the increase in real estate values, which applies to private properties as well as to railroad property, has been caused by the presence of the railroad, it may be urged that the railroad should not be deprived, in a valuation of its property, of the benefit of values which it itself has brought about. It is true that the original cost was much less, but we are not estimating original cost. Here is one of the cases in which confusion between the two bases of value has frequently arisen and has rendered results misleading. It must be carefully observed, however, that in estimating the cost of reproduction although the railroad is supposed removed, it is not reasonable to assume that all other conditions remain in their present condition. Certain elements which would be clearly different if the railroad were removed, must be assumed to be different. For instance, alongside of a railroad in a farming or fruit district, a factory or canning establishment may have later sprung up, occupying land on both sides of the track, perhaps with buildings and sidings on both sides of the track, possibly with connections or pipes between the buildings, either over or under the track. Just back of the factory may be farm lands. Now in estimating the cost of reproducing that line, although the line must be taken in its actual present position, the right of way along these factory sites should not be estimated on the basis of manufacturing land, but as farm land. The factory followed the railroad, and was put where it is because the railroad was where it is. If the railroad had been 100 or 1,000 feet away, the factory would have been 100 or 1,000 feet away, alongside the railroad. If, however, the factory had preceded the building of the railroad, and the latter had been laid out through the factory property, then the right of way there should be based on the value of the land for manufacturing and not for farming purposes. This is another illustration of the fact that in estimating cost of reproduction, that reproduction must be assumed to be carried out essentially in accordance with the actual historical development of the property. It is not possible,

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however, to always carry this principle through consistently, particularly in the case of an old road. A road built fifty years ago through a city, may have really determined the character of the right of way along its line. It may be at present of poor quality, with cheap lodging houses, while a mile away may be an expensive and exclusive residence district. If the railroad had been located a mile away, these districts might have been interchanged. Nevertheless, such transposition cannot be assumed in the valuation. This is one of the difficulties of the reproduction method, which like all methods, must be applied with judgment and good sense, carrying underlying principles as far as they are fairly applicable, and no farther.

I believe it justifiable, therefore, in an estimate of the cost of reproduction to estimate real estate values as at present existing, even though they are far below or in excess of the original cost, and have been brought about in some degree by the presence of the railroad. This, at all events, gives a consistent result, and, if criticized, it can be only, as already explained, on the ground that the real value may be neither the first cost nor the cost of reproduction, and that both elements may have to be considered in determining what that real value is.

*Multiples for real estate value.*—It has been customary in many valuations, after determining the fair price of real estate per acre or per foot, based on the value of surrounding lands for the purpose for which such lands are used or available, to multiply such values by a certain factor, varying according to circumstances, to obtain the figures to be used in estimating the value of the railroad property. The use of these so-called multiples is based upon the fact that when a railroad company buys property, requiring it in a continuous strip for right of way, and in particular locations, and of particular shapes for stations or terminals, it is as a rule, necessary for the company to pay a higher price,—and sometimes a very much higher price—per unit of area, than the land would be worth for the same purposes for which adjoining property is used. In buying right of way a railroad company crosses numerous parcels of property belonging to different owners, taking portions of each estate. Such takings may damage the remainder of the estate, as for instance, where the right of way separates a farm into two portions, or where it comes between a man's house and his barn, or where it destroys his well. Furthermore, even the presence of the railroad with its noise and smoke may be a real damage to the property. If a railroad company takes one acre from a farm of ten acres, the owner claims compensation much greater than one-tenth the value of what he would take for his entire farm, and in general, it is right that he should be paid more. In other words, the railroad company has to pay not simply for the land, but for consequential or severance damages to the remaining land.

Moreover, it is practically certain that in laying out a railroad there will be buildings on some of the right of way which will have to be moved or destroyed, for which of course the railroad company must and should pay. The fact that such additional cost cannot be estimated with accuracy, is no argument against its inclusion. The additional cost would unquestionably exist by the first cost method and should reasonably be allowed for by the reproduction method. That this is true will be perfectly obvious from the following illustration: In building its terminal in New-York City, the Pennsylvania railroad was obliged to purchase several entire blocks, with the buildings upon them, paying, of course, not only for the land but for the buildings. The latter were immediately destroyed and the terminal building erected. Now, in the case of a new property like this, the original cost and the cost of reproduction will be identical. The first cost, would, of course, include the cost of the buildings which had been destroyed and which find no place in the inventory of the property. If, therefore, by the cost of reproduction method, the land is simply taken at its value or cost, the value of this piece of property is much underestimated.

Sometimes, too, an owner will "hold up" a railroad company, demanding an extremely high price for a small parcel, and juries in such cases are often liberal.

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towards owners in awarding damages. It is also unquestionably right that if a man's property is taken away from him against his will, he should be paid a sum which under no circumstances would be less than its fair value, and which, therefore, would generally be more than its fair value. Moreover, if a portion of a man's land is taken, it is easy to see that the value of the remaining land may be much less than in the proportion which its area bears to the total original area. If a railroad takes half my farm, the remainder may be worth nothing to me. Frequently the fair damages for the taking of a portion of a piece of property would be greater than the value of the entire property. This is well recognized in the principle which allows no excess condemnation of lands for public improvement in cities.

Since the decision of the United States Supreme Court in the Minnesota Rate Cases, June 9, 1913, the situation with reference to the valuation of real estate and right of way in an estimate of the cost of reproduction, has been quite uncertain. The court said:—

“Assuming that the company is entitled to a reasonable share in the general prosperity of the communities which it serves, and thus to attribute to its property an increase in value, still the increase so allowed, apart from any improvements it may make, can not properly extend beyond the fair average of the normal market value of land in the vicinity having a similar character. Otherwise we enter the realm of mere conjecture. We therefore hold that it was error to base the estimates of value of the right of way, yards, and terminals upon the so-called railway value of the property. The company would certainly have no ground of complaint if it were allowed a value for these lands equal to the fair average market value of similar land in the vicinity, without additions by the use of multipliers, or otherwise, to cover hypothetical outlays. The allowances made below for a conjectural cost of acquisition and consequential damages must be disapproved; and in this view we also think it was error to add to the amount taken as the present value of the lands the further sums calculated on that value which were embraced in the items of “Engineering,” “Superintendence,” “Legal Expenses,” “Contingencies,” and “interest during construction.”

This statement, however, may be considered to be merely a disapproval of the cost of reproduction as the real value, and not as implying that in an estimate of the cost of reproduction no multiples should be used. Certainly an estimate of value should be one thing or the other—either the cost of the reproduction (with or without the deduction of depreciation, according to circumstances) or the original cost (with or without depreciation). The true value is to be determined by the court or other determining agency on the basis of estimates, and these estimates should be either the original cost or the cost of reproduction. In estimating the cost of reproduction, it is perfectly clear that the right of way should be taken as of greater value than merely that of adjoining lands, because such value would be less than it would cost to reproduce the property, since consequential and severance damages ought to be paid and would have to be paid, in addition to a higher price for the land itself than the value of adjoining lands, for the reasons: (1) that it is taken from the owner without his consent, and (2) that only a part of his property is taken and the value of the remainder impaired.

The above considerations indicate clearly, to my own mind, at least, that the reproduction value of land must necessarily include some factor or multiple by which the fair value, if based upon the value of adjoining lands, should be multiplied. If the original cost is obtained, that original cost will surely include such multiple. What the multiplier should be is uncertain, and there is nothing to determine it except judgment and experience. Instances of actual lines which have been constructed in the United States through farming districts, have shown that the railroad company has paid for

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its right of way, on the average, four or five times the fair value of adjoining land for farm purposes. In cities and towns also, a railroad company taking land by right of eminent domain, must, as a rule, pay, in excess of its fair value; the multiple, however, being different from that in the case of farm lands.

In the present estimate, therefore, I have continued to use multiples for real estate values. If your Board should consider them unjustifiable, the estimate may easily be modified accordingly. The multiples which I have used are moderate, and much less than those which have been used in some other valuations. For the major portion of the right of way, the multiple has been two; in other words, the unit price of the right of way has been taken as twice the value of adjoining lands for the purposes for which such lands are used or available; while in cities and towns the multiple has been one and one-quarter; in other words, the value of the land has been taken at 1.25 of the value of adjoining property for the purposes for which such property is used or available. In some cases, as in large cities where special investigations were made, no specific multiples were used; or, to express it in another manner, the figure given as the fair value includes the multiple, and is our estimate of what the company would have to pay, without obtaining that figure by taking another figure and multiplying it by a factor.

*Items 4-17.*—The unit prices for grading of the various classes, clearing, grubbing, tunnels, bridges, ties, rail, frogs and switches, track fastenings and other material, ballast, track laying and surfacing, roadway tools, fencing, crossings and signs, interlocking, and telephone and telegraph lines, were determined after careful consideration and from comparison with actual contract prices, consultations with Messrs. Kellett and Johnson, as heretofore explained, discussions with the members of the engineering staff, comparison of data obtained by the field engineers, consideration of charges for freight, unit prices at mills, location of ballast pits, and indeed all pertinent information which was available. These unit prices were varied on different lines with due regard to local conditions, and the historical development of the property. In other words, a line built through a territory already occupied by another line, would have certain unit prices lower than those for the latter line, which, when built, had to construct its own roads, often through difficult ground, for transfer of materials and supplies. For this reason some of the unit prices for the Canadian Northern lines in territory through which the Grand Trunk Pacific had previously been built, have been taken somewhat lower than corresponding prices for the Grand Trunk Pacific. The endeavour has of course been made to arrive at unit prices which were fair, and while perfection in this respect cannot be attained, it is believed that the prices used can be subject to but little criticism.

*Items 18-31.*—A special engineer or architect was employed to examine the standard plans of all structures, except bridges and culverts, and to prepare estimates of the cost of reproducing the same. This engineer, Mr. Horner, visited many of the important points on the line, checking up the standard plans and informing himself with reference to unit prices, and finally made complete estimates of cost of all the standard structures.

There is but one grain elevator owned by the Canadian Northern System, namely, that in Port Arthur. This is an elaborate structure, said to be the finest and most complete grain elevator in the world. Its cost was estimated by Mr. C. D. Howe, consulting engineer and former student of the writer, and until within two years engineer for the Board of Grain Commissioners of Canada. Mr. Howe's experience, extending through a number of years in the design and construction of structures of this kind, in which he has probably had as great experience as any man in Canada, made his opinion as to the cost of reproduction of this elevator very interesting. His estimate was about 12 per cent greater than the cost as reported by the company, substantiating, therefore, to this extent, Mr. Horner's estimates for other structures which ran from 10 to 25

per cent in excess of the costs submitted by the company. This excess was due, no doubt, to increased prices since the structures were built, and the fact that many of the structures were built by the railway company, which made no charge on its books for haulage of material.

In addition to the numbered items on the Typical Unit sheet, two other items have been added which should be explained, namely: "Maintenance and Temporary Work During Construction," and "Solidification and Adaptation," or "Deferred Construction."

*Maintenance and Temporary Work During Construction.*—A contractor for a portion of a railroad line has to lay and maintain track until it is accepted by the company. After it is accepted, it will probably be used for some time for the transportation of materials, etc., to sections lying beyond. For this purpose it has to be maintained by the railroad company at a cost greater than the average cost of maintenance of a line after the grading has come to a state of equilibrium. The cost of such maintenance should fairly be charged to the cost of the work. It is an operating expense that is not met by any corresponding revenue. In the present valuation an allowance of \$250 per mile has been made for this item.

*"Solidification and Adaptation": in other words "Deferred Construction."*—After an entire line is put into operation, its maintenance will be more costly for a term of years than later, because for a certain period there is a settlement of embankments, a washing-in of the slope in cuts, a filling up of ditches, and other sources of expense, which disappear after a term of years when the work has reached a state of equilibrium; that is to say, a railroad line after being put into operation would soon show an undulating profile due to the settling of the fills, and such sags have to be taken out by raising the track and putting in new material. Oftentimes the ballast is lost in this way, as new earth has to be put in above existing ballast, and new ballast on top of that.

This item is a proper charge to construction. Its amount, like all others, is uncertain. In the valuation of the railroads of Minnesota in 1908 the engineer's report allowed a total of nearly \$12,000,000 for this item out of a grand total, not including equipment, of about \$339,000,000, or, about  $3\frac{1}{2}$  per cent of the total. Explained otherwise, the allowance for this item was nearly \$1,200 per mile. The proper amount of this item should vary with the amount of grading, increasing with the amount of earth-work. It should also vary to a certain extent, with the length of the line, independent of the amount of earth-work. In other words, the charge per mile should be a constant plus a certain fraction of the cost of grading. After careful consideration, the formula  $\$200 + \frac{1}{100}$  of the cost of grading, has been generally adopted for this item. It gives results much lower than those used in Minnesota, and lower than those which have been used in many other valuations, and very likely it is too low. For a light prairie line, where the grading costs about \$4,500 per mile, this item therefore amounts to \$350 per mile, while for a mountain section, where the grading amounts to \$45,000 per mile, it would amount to \$1,700 per mile. This latter would seem to be too much, for the reason that in such sections the fills would be largely of rock, and the settlement would be less than in the case of earth. The formula was therefore modified according to local conditions, and in some cases was made  $\$200 + \frac{1}{100}$  of the cost of grading. Like the other elements of a valuation, it is incapable of exact determination. The main point is, that it was taken as \$200 per mile plus a varying fraction of the cost of grading. I am convinced that our total allowance for this item is low.

It should be added that where the field examination of a line showed the sags had not been taken out, or ditches kept open,—in other words, that the expenditures contemplated by this item subsequent to completion of the line had not been made,—the item was either not included at all or reduced to such amount as the field engineers considered proper.