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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

RAILWAY ENQUIRY COMMISSION'S REPORT

STARTLING FACTS BROUGHT OUT BY MAJORITY REPORT—G.T.R. AND C.N.R. SAID TO BE UNABLE TO SURVIVE—HUGE SUMS MUST BE SPENT IMMEDIATELY FOR EQUIPMENT AND REPAIRS—NEW RECORD ESTABLISHED FOR VALUATION WORK

SIR Henry L. Drayton and Mr. W. M. Acworth, two of the three members of the Royal Commission to Inquire into Railways and Transportation, have submitted to parliment a majority report advocating that the government take over the Grand Trunk, Grand Trunk Pacific and Canadian Northern Railways and transfer them to a board of five trustees who shall operate them independently of the government. They also recommend that the Transcontinental, Intercolonial and Prince Edward Island Railways should be transferred to the trustees. The Dominion Railway Company, which is the name under which the trustees would probably operate, would control twenty thousand miles of railways, and would be the largest system in the world not state-operated, and second only to the government-operated German system.

Mr. Alfred Smith, president of the New York Central Lines, who is the third member of the commission and its chairman, submits a minor report dissenting from many of the views of his colleagues and advising the government to leave the railroads in private hands and to continue financial assistance from time to time as required. He states, however, that the systems should not be left as they are, but recommends the transfer to the Grand Trunk of all the Canadian Northern's eastern lines and the transfer to the Canadian Northern of all the Grand Trunk's western lines, including the Grand Trunk Pacific and its branches.

The majority report is a printed document of ninety pages, 6½ ins. x 9¾ ins., regulation government blue-book size and style, and is accompanied by two appendices,—one twelve pages long reviewing the evidence heard by the commission in its examination of Mr. E. J. Chamberlin, of the G.T.R., at Montreal on February 24th, 1917; the other, occupying seventy-four pages, presenting Prof. Swain's report on physical valuations. The minority report requires only fifteen pages, presenting no statistics and being largely commentary upon the majority report.

In addition to a short introduction and to a summary of conclusions and recommendations, the majority report is divided into six main parts.

Part I. deals with Canadian railways in general, giving mileage, capital and state aid, apportionment of mileage, gross and net revenue, investment in road and equipment, return on capital, government aid in general, government aid to Canadian Northern, government aid to

Table Indicating Prospects of the Proposed Railroad Merger

FROM REPORTS TO DEPARTMENT OF RAILWAYS AND CANALS, JUNE 30, 1916 (EXCEPT G.T.P. BRANCH LINES)

—	Can. Northern	Grand Trunk	Grand Trunk Pacific	G.T.P. Branch Lines	Intercolonial	Transcontin'nt'l	Total
	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.
Operating revenues	35,476,275 06	39,155,040 10	6,963,188 88	1,319,599 16	15,686,661 91	5,798,516 09	104,399,281 20
Operating expenses	25,244,186 12	28,782,012 69	5,902,843 30	1,370,133 51	13,323,183 16	5,360,061 58	79,991,420 36
Net operating revenue	10,232,088 94	10,373,027 41	1,060,345 58	Loss 50,534 35	2,363,478 75	429,454 51	24,407,860 84
Outside operations	.....	.....	10,588 55	.....	.....	.....	10,558 55
Taxes	741,508 11	853,596 39	.....	.....	.....	.....	1,595,104 50
Operating income	9,490,580 83	9,519,431 02	1,070,904 13	Loss 50,534 35	2,363,478 75	429,454 51	22,823,314 89
Other income	.....	3,634,123 65	.....	.....	.....	37,680 84	3,671,804 49
Gross income	9,490,580 83	13,153,554 67	1,070,904 13	Loss 50,534 35	2,363,478 75	466,135 35	26,495,119 38
Interest on funded debt	9,885,153 14	7,644,631 07	.....	.....	.....	.....	17,529,784 21
Other charges	506,010 29	2,415,539 70	.....	.....	167,214 29	808,750 86	3,897,515 14
Dividends	.....	†2,433,333 33	.....	.....	.....	.....	2,433,333 33
Total income deduct'ns	10,391,163 43	12,493,504 10	.....	.....	167,214 29	808,750 86	23,860,632 68
Surplus & loss for year	Loss 900,582 60	660,050 57	*1,070,904 13	Loss 50,534 35	2,196,264 46	Loss 342,615 51	Surplus— 2,633,486 70
Profit and loss items	267,885 85	.....	.....	.....	.....	.....	Deduct— 267,885 85
							Surplus— 2,365,600 85
Add Interest to be provided for	5,445,389 56	.....	6,668,084 04	538,760 16	.....	.....	12,652,233 76
Add Estimated loss, Prince Edward Island Railway	.....	.....	.....	.....	.....	.....	250,000 00
Total Deficiency	.....	.....	.....	.....	.....	.....	10,536,632 91

*Before charges. †Div. on guaranteed stock.

Canadian Pacific, government aid to Grand Trunk, government aid to Grand Trunk Pacific, total public investment, proportion of public investment, and historical development and growth of Canadian railways.

Part II. deals with the Grand Trunk System, the chapter headings being: G.T.P. Finance, Grand Trunk Liability for G.T.P., Grand Trunk Co.'s Proposal, Grand Trunk Case, Inception of the National Transcontinental, Letter from the President of the Grand Trunk, Hearing of Grand Trunk Officials at Montreal, G.T.P. Case, Commission's Conclusions, Parent Grand Trunk Co., Grand Trunk Maintenance Expenditure, Grand Trunk Capital Expenditure Required, Effect on Canadian Business, and Commission's Recommendation.

Majority Report Divided Into Six Main Parts.

The Canadian Northern System is fully dealt with in Part III., which reviews the C.N.R. position in 1914, the annual report for 1916, C.N.R. estimates for 1914 and 1917, comparison with Canadian Pacific, prospective requirements of C.N.R., value of Canadian Northern undertaking (1. cash investment; 2, physical basis; 3, going concern), and conclusions as to Canadian Northern.

Possible methods of public control are reviewed in Part IV. of the report and government operation is discussed and rejected. An obstacle created by the Canadian Pacific position is discussed. Receivership is considered but rejected and transfer to a new body is recommended. Suggested transfer of all railways to the Canadian Pacific or of a whole or portion of the C.N.R. to Canadian Pacific is discussed and rejected. The possibility of forming a commercial company along the lines either of the Mexican precedent or the New York Subway precedent is considered but not favorably. "Canadian Railways Should Be Under Canadian Control," is the title of the last chapter of this part.

The longest portion of the report is Part V., outlining the Dominion Railway Co. The headings of the chapters in this part of the report are as follows:—

Dominion Railway Organization Recommended.

Government Operation Not Recommended, Recommendation of Independent Board of Trustees, Constitution of Board and Tenure of Office, Board to be Non-Political, Board to be Permanent and Self-Perpetuating (including a review of Australian experience), Railways Not a Proper Subject for Direct Parliamentary Control, Growth of Extra-Parliamentary Functions of the State, Private Interests and Public Interests, Control of Dominion Railway by Railway Commission, Relation Between Trustees and their Employees, Incorporation of the Dominion Railway Co., Transfer of Stock to Trustees, Transfer of Railways to Trustees, Canadian Northern Shareholders, Charges of Misappropriation Unfounded, Canadian Northern Successes and Failures, Arbitration Recommended, Grand Trunk Shareholders, Terms of Purchase Recommended, Real Value of Grand Trunk Property, Intercolonial and National Transcontinental, Transfer of National Transcontinental Recommended, Transfer of Intercolonial Recommended (1, in the local interest; 2, in the general interest; 3, in the interest of good management), Minor Recommendations, Legal Position of Trustees, Operation of Dominion Railway Co., Finance of Dominion Railway Co., Operation to be on a Commercial Basis, Wide Powers to be Given to Trustees, Financial Responsibility of Government, Prospects of Dominion Railway, and Specimen Economies Resulting from Combination.

The sixth and last portion of the report touches briefly upon a wide variety of subjects kindred to the main investigation. It advocates railway commission control of the Dominion Railway Co., and suggests that the commission's jurisdiction be enlarged to report on new charters and on subsidies and guarantees. Overlapping of Dominion and Provincial control is condemned. It is recommended that a running audit be made of the Dominion Railway accounts and that the accounts be published in clear form, so that the taxpayers will know exactly where the government stands.

Railway councils similar to those held under the German system are recommended for future organization. Railways in excess of existing requirements are discussed. Attention is called to the necessity of improvement of highways as feeders to the railways. The Hudson Bay Railway is discussed and practically condemned. The commission were asked to report on steamship connections, but have not touched upon this subject on account of the very short time at their disposal and the complete revolution in the shipping trade caused by the war. The public is warned that the tendency of railway rates is to rise rather than fall. The report ends with a strong plea for immediate action.

The following are the conclusions and recommendations contained in the report as officially summarized by Sir H. L. Drayton and Mr. Acworth:—

Summary of the Drayton-Acworth Conclusions and Recommendations

1. The mileage of Canadian railways is very great in proportion to the population of the country. It has increased out of proportion to the increase of population.

2. Canada's natural waterways make railways less absolutely necessary than in other countries.

3. The net return is so low as to prove that more railways have been built than can be justified on commercial grounds under present conditions.

4. The public investment in railways is very large. The total amount of public capital involved in direct construction of Government lines, and cash aid, land grants and guarantees to private companies, is $968,451,000, not counting the value of lands still unsold.

5. Public aid to the principal companies, including subsidies, land grants, and guarantees, amounts to over $680,000,000. In the case of the Grand Trunk Pacific it amounts to nearly two-thirds of the total investment; in the case of the Canadian Northern to over three-quarters.

6. There have been three phases of company development: (1) Unaided enterprise, (2) assistance by subsidies and land grants, (3) assistance by guarantees. A guarantee policy is dangerous and its wisdom questionable.

7. The development of Canada justified two transcontinental lines. It did not justify three. The Grand Trunk and Canadian Northern should have been amalgamated.

8. The Grand Trunk Pacific system has cost nearly $200,000,000. The interest charges amount to over $8,800,000 per annum. The net income last year was $826,653. The liability of the Grand Trunk Company for interest amounts to over $5,000,000 per annum at present, and will rise to over $7,000,000 in 1923.

9. We cannot recommend that the Grand Trunk Company be unconditionally released from their liability. The responsibility for the National Transcontinental line

rests mainly with the Government, but that for the Grand Trunk Pacific proper belongs primarily to the Grand Trunk. The Government has voluntarily relieved the Grand Trunk of all responsibility for the National Transcontinental. In respect to the Grand Trunk Pacific proper the Government is fully entitled, morally as well as legally, to call upon the Grand Trunk Company to fulfil its contract.

10. The Grand Trunk Company proper has made unjustifiable charges to capital. Its lines have not been adequately maintained. More than $21,000,000, which ought to have been spent on maintenance in past years, has not been spent. New capital expenditure of over $30,000,000 is immediately required. The country is suffering from the company's inability to give adequate service. The Grand Trunk Railway ought to be managed in Canada, and not from London.

11. We recommend that the control both of the Grand Trunk Pacific and of the Grand Trunk be assumed by the people of Canada on terms hereafter set out.

12. The Canadian Northern has been financed mainly by the issue of guaranteed securities. Till 1914 it met the interest from its own resources. Since that date the Government has assumed very heavy obligations on behalf of the company. There is little prospect that the company would be able in the near future to relieve the Government of these obligations.

13. The company's estimate of its future capital requirements is too low; and its estimates of probable growth of earnings have been and still are unduly sanguine.

14. We estimate that as a separate undertaking it would require fully $70,000,000 of new capital within the next five years.

15. We do not recommend that further public aid be given to the Canadian Northern as at present constituted.

16. The Canadian Northern common stock represents no cash investment, and has no present value, either on the basis of the cost of reproduction of the property or on the basis of its earning power.

17. We recommend that the public take control of the Canadian Northern Company on terms hereafter set out.

18. On the assumption that the people of Canada take control of the Grand Trunk, Grand Trunk Pacific and Canadian Northern, we consider possible methods of management and operation.

19. We do not consider that operation by a minister directly responsible to Parliament would be in the public interest. It would not secure better service or lower rates.

20. If the Government operated these three railways, it would be bound in fairness to the Canadian Pacific shareholders to take over their railway also. The Canadian Pacific gives good service and should not be interfered with.

21. Special objections to direct Government ownership and operation are:—

(1) That Canadian railways operate more than seven thousand miles of line subject to the foreign jurisdiction of the United States;

(2) That the Canadian Government resources are required for war purposes.

22. We, therefore, reject the idea of direct Government ownership and operation.

23. We do not recommend that the Grand Trunk, Grand Trunk Pacific and Canadian Northern Companies be allowed to go into the hands of a receiver.

24. We recommend that the control of these three companies be transferred to a new body.

25. We have discussed and rejected the following suggestions:—

Transfer of all three railways to the Canadian Pacific.

Transfer of the Canadian Northern or a portion of it to the Canadian Pacific.

26. There is no possibility of forming a new commercial company to take over the three railways. Neither the Mexican precedent, under which the Government becomes a majority shareholder, nor the New York Subway precedent, under which the public authority shares the profits with the private shareholder, is applicable to this case.

27. Having come to the conclusion that direct ownership and operation by the Government is to be avoided, and that ownership and operation by a commercial company is not possible, we recommend that a new public authority, a Board of Trustees, be incorporated by Act of Parliament as the "Dominion Railway Company"; and that the Canadian Northern, Grand Trunk and Grand Trunk Pacific be transferred to this body.

28. We recommend that the Government assume responsibility to the Dominion Railway Company for the interest on the existing securities of the transferred companies.

29. We recommend that the Intercolonial and National Transcontinental be also transferred to the Dominion Railway Company for reasons which we give hereafter.

30. We recommend that the whole of the Dominion Railways be operated by the Trustees as one united system, on a commercial basis, under their own politically undisturbed management, on account of, and for the benefit of, the people of Canada.

31. We recommend that there be five Trustees, three railway members, one member selected on the ground of business and financial experience, and one as specially possessing the confidence of railway employees; that the original Trustees be named in the Act constituting the Board; and that their tenure of office be substantially the same as that of judges of the Supreme Court.

32. We recommend that the original Trustees retire after three, four, five, six, seven years, respectively, according to a prescribed scheme; that they be eligible for reappointment; and that all appointments subsequent to the original statutory appointments be by the Governor-General-in-Council on the nomination of the Trustees themselves.

33. We lay stress on the importance of the Board being non-political, permanent, and self-perpetuating; and in this connection point to the experience of the Australian State Railways.

34. We give reasons for concluding that railways are not a proper subject for direct parliamentary control. We point to a general tendency in modern democracies to withdraw certain subjects from this control. And we show that under parliamentary control the general interest of the whole community tends to be subordinated to the particular local and individual interests.

35. We recommend that the authority of the Railway Commission be extended to include the Dominion Railway Company's system.

36. We give the reasons for our recommendation that one of the Trustees shall be appointed on the ground of his possessing the confidence of the railway employees.

37. We recommend the transfer to the Trustees of the common stocks of the Canadian Northern, Grand Trunk and Grand Trunk Pacific, subject to certain conditions and reservations made hereafter.

38. We recommend the transfer to the Trustees of the Intercolonial and National Transcontinental Railways for reasons which we give hereafter.

39. We deal with the question of the compensation to Canadian Northern shareholders. We find the charge that Messrs. Mackenzie and Mann have misappropriated public moneys unfounded. We find that the Canadian Northern shareholders possess a system of which the lines are well located and economically constructed, and that they have raised the necessary money with considerable financial skill and at moderate rates of interest, but that they erred in unwisely duplicating lines and reaching out into unremunerative territory.

40. We recommend that the question be considered whether Canadian Northern shareholders shall be permitted to retain a moderate proportion of the $60,000,000 shares which they now hold; that the precise proportion, if any, and the relation of that proportion to their share of any future profits of the Dominion Railway Company, be fixed by arbitration.

41. We recommend that the entire share capital of the Grand Trunk, guaranteed, preference and ordinary, be surrendered to the Trustees in exchange for an annuity based on a moderate but substantial proportion of $3,600,000, the average sum paid as dividend in the last ten years; and that this annuity should increase by 40 or 50 per cent. after the first seven years.

42. We recommend that the precise figure be fixed by agreement, and that it be left to the directors of the Grand Trunk Company (1) to apportion the annuity among the five classes of Grand Trunk shareholders, and (2) to procure such assents of their shareholders as are legally required to complete the transfer.

43. We give reasons for considering that this recommendation is generous to the Grand Trunk shareholders, and why the shareholders in their own interest will do well to accept it.

44. We recommend the transfer to the Trustees of the National Transcontinental, in order that it may take the place it was built to take as part of a great inter-ocean highway, and because its financial position would be hopeless if it terminated in a dead end at Winnipeg.

45. We recommend the transfer of the Intercolonial: (1) In the interest of the Maritime Provinces, to whom the Intercolonial at present can only give a local service with no adequate terminals beyond Montreal; (2) in the interest of the taxpayer, who has a right to demand efficient and economical expenditure of his money; (3) in the interest of the railway staff, who will secure the wider opportunities of a great system.

46. We recommend that in future the Intercolonial be required to pay local taxes on the same basis as the other railways; and that the inhabitants on the line receive statutory protection against increase of local railway rates.

47. We make recommendations as to (1) non-railway property of the transferred undertakings, (2) getting in minority holdings of shares and outstanding titles to land, (3) arrangement with the holders of Canadian Northern 5 per cent. convertible income debentures.

48. We deal with the legal position of the Trustees; and point out that the Canadian Northern, Grand Trunk and Grand Trunk Pacific companies will continue to exist; and that consequently the rights of their security holders will remain undisturbed.

49. We recommend that the Trustees take over each railway as soon as the transfer can be effected, with the purpose of ultimately operating them all as a single unified system.

50. We deal with the finances of the Dominion Railway Company and point out that the Intercolonial, with no bonded indebtedness, has a considerable net revenue, and offers security on which new capital can be raised. We recommend the creation of a general and refunding mortgage of unlimited amount, to be issued as required.

51. We recommend that the Act of Parliament provide that the operation of the company shall be on a commercial basis, and that the Trustees make no general reduction in rates until the property earns a reasonable net return.

52. We recommend that there be given to the Trustees the widest powers in the management of their property.

53. We have endeavored to estimate the annual liability of the Government to meet interest unearned during the first few years of the new scheme, and we put it at about $12,500,000 per annum. We think this amount should diminish steadily but not slowly; and that with proper economic and politically undisturbed management the attainment of a satisfactory financial result is only a question of time.

54. We give specimens of the large economies which should result from combined operation.

55. We recommend the enlargement of the functions of the Railway Commission; that it have jurisdiction over all Dominion Railways; and report to Parliament on all proposed grants of charters, subsidies, and guarantees.

56. We deal with the conflict of Dominion and Provincial jurisdictions. We recommend that, to prevent this in future, the Governor-in-Council should in certain cases disallow Provincial Acts, and that no railway company should operate under both Dominion and Provincial charters.

57. We recommend that there be a continuous public audit of the Dominion Railway accounts, and that full and comprehensive reports be made annually to Parliament.

58. We recommend the establishment of Railway Councils to bring together the railway management and representatives of public interests.

59. We point out that the existing railways are in excess of public requirements and show how much traffic is required to make a railway profitable.

60. We show that the cost of hauling grain to the station is sometimes as great as that of carriage from the station to Liverpool, and recommend that the question of highway improvement and motor haulage be taken into consideration.

61. We recommend that future expenditures on the Hudson Bay Railway be reduced to the lowest possible amount.

62. We point out that railway rates are much more likely to rise than to fall in the immediate future.

63. And finally, we lay stress on the necessity for immediate action lest Canada should suffer from railway congestion even worse than that of the past winter.

Position of Grand Trunk Railway— G.T.P. was the Fatal Mistake

From the majority report it appears that government aid to the Grand Trunk amounts to $28,145,693, and to the Grand Trunk Pacific $114,470,884, and to the Grand Trunk Pacific Branch Lines $13,469,004. This includes subsidies and other cash aids as well as guarantees on bonds, and includes all provincial and municipal aid as well as Dominion government aid.

No physical valuation was made of the Grand Trunk System proper, as with the time at the disposal of the commission it was possible to make a physical valuation only of the Canadian Northern and Grand Trunk Pacific. Besides, it was thought that no useful purpose could be served by a valuation of the Grand Trunk Railway proper, the view being taken that the G.T.R. has been in operation for such a length of time that its value is best established from its earnings. These earnings, say the commissioners, must also be greatly discounted, owing to the commitments of the G.T.R. in Grand Trunk Pacific projects, amounting to $123,280,980. The G.T.R. stands as guarantor of $97,301,252 bonds and debentures of the G.T.P., and in addition have advanced $26,179,728 in cash. The present annual liability of the Grand Trunk in connection with the G.T.P. System is considerably over five million dollars per annum and in January, 1923, it will be increased to seven million dollars. The difference is on account of the Dominion Government's obligation to pay the interest on the government-guaranteed first mortgage bonds of the mountain section of the G.T.P., amounting to $1,655,121 per annum for seven years after the completion of the road, which was officially January 1st, 1916.

The Grand Trunk Railway has not been and is not being adequately maintained, says the majority report. No depreciation fund has been created for equipment. Mr. Chamberlin's evidence is that 5 per cent. on the cost of the equipment ought to be annually charged under that heading. This item, he says, would have required an annual sum of $2,750,000. The vice-president in charge of operation, Mr. Kelley, has direct responsibility for the plant. He agreed with Mr. Chamberlin's evidence and submitted a full report on the question of deferred expenditure, as follows:—

G.T.R. Summary of Deferred Expenditures.

Rebuilding and reinforcing freight car equipment		$ 8,943,971.14
Equipping freight and passenger cars with safety appliances—		
Original estimate	$850,722.50	
Already expended	392,220.89	
Balance to be expended		458,501.61
Equipping engines with safety appliances—		
Original estimate	$ 17,828.00	
Already expended	553.68	
Balance to be expended		17,274.32
Deferred renewals in Maintenance of Way Department—		
In Canada	$6,182,672	
In United States	5,578,926	
		$11,761,598.00
Total		$21,181,345.07

Montreal, March 5, 1917.

On the single item of rails the cash expenditure required to restore normal conditions is reported as $5,312,142. The cost of restoring ballast to normal conditions is reported as $2,434,000. With reference to "deferred renewals" in Canada, amounting to over six million dollars, it appears that they have accumulated during eleven years, 1906-1916, "during which period, in spite of the requirements of the property and the claims of public safety, $36,000,000 were paid out in dividends," says the report.

$21,000,000 Needed Now for G.T.R. Maintenance.

"The twenty-one million dollars dealt with above," says the report, "represent the money which the responsible officers of the company estimate to be required to put the existing plant into good normal condition. This is a revenue liability. But the existing plant is quite inadequate for existing traffic and requires large additions, for which new capital must be raised. The estimates of necessary capital expenditures submitted to us are as follows:—

"Requirements for rolling stock, shops and machinery	$26,150,000
"Requirements for automatic block signals (main line in Canada only)	3,533,000
"Requirements for installing rock ballast crushing plant	467,500
"Total	$30,150,500

"Putting together revenue and capital expenditure, we find that the Grand Trunk Railway, in the opinion of its own officers, requires over $51,000,000 spent upon it to put it in a position to meet the requirements of its to-day's business. We see no reason to expect that under existing conditions this necessary money will be provided. The effect on the country's business of deficient railway facilities is very serious.

"The Grand Trunk Company's Board of Directors is 3,000 miles away. We cannot think that the state of affairs which our investigation has disclosed could have arisen, had the Board been on the spot. We are forced to the conclusion that the control of an important Canadian company should be in Canada. But this cannot be secured as long as the Grand Trunk Railway is owned by shareholders in England. We have come to the conclusion, therefore, that the control, not only of the Grand Trunk Pacific Company, but also of the Grand Trunk Company of Canada should be surrendered into the hands of the people of Canada. We recommend that the chairman of the Grand Trunk Company be informed, that it is only on this condition that the Government is prepared to relieve his company of the obligations which it has incurred in respect to the Grand Trunk Pacific. We recur later on in this report to these two companies, in order to set out our recommendations as to their ownership and management in the future, and as to the terms to be offered to the Grand Trunk shareholders."

G.T.R. Accuses Government of Bad Faith.

The Grand Trunk have asked the government to be relieved of their G.T.P. liabilities and to have refunded to them all of the money which they have put into the G.T.P., claiming (1) that the government had in effect gone into partnership with the G.T.P., and that subsequently it had by subsidies and guarantees enabled the Canadian Northern to come into existence, and that this action of the government was, in view of its position as

partner with the G.T.P., tantamount to bad faith; (2) that the simultaneous construction of the Canadian Northern in the same territory greatly enhanced the difficulty of obtaining labor, doubled its price and also prolonged the period of construction; (3) that a new duty on steel rails was imposed after the G.T.P. Act was passed and that this added five million dollars to the cost of construction.

G.T.R. Originated the G.T.P. Undertaking.

The majority report does not accept any of these contentions. "The government was and is a government," it says, "not a mere private partner; and it retained and retains all the attributes of a government, including the power to charter new railways. We cannot suppose that the management of the Grand Trunk were ignorant of this fact when they took the act constituting the G.T.P. Co. As to (2), this no doubt was an effect which was disadvantageous to the Grand Trunk position, but the company took this risk, as it took other business risks, when it promoted its enterprise. (3) * * * The bill for the act imposing the duty was introduced three months before the agreement between the government and the G.T.P. was signed. The company, therefore, must have been aware of the government's intention. According to the correspondence, the prime minister believed in 1905 that the question of a duty on rails had been more than once discussed at the time of the inception of the scheme; Mr. Hays, for the G.T.P., believed that it had never been discussed at all."

The evidence brought out by the commission was that the Grand Trunk Pacific scheme originated with the Grand Trunk Railway, but that the government was responsible for the construction of all of the Transcontinental east of North Bay. The proposal of the company, as originally formulated, was for a line from the Pacific to North Bay. The Eastern Division, as it was then called, from Winnipeg to North Bay, was to be built by the government, and the Western Division by the Grand Trunk Pacific. The extension of the Eastern Division was entirely due to the government, but the G.T.P. concurred in it and agreed to rent the Eastern Division upon a percentage of its cost of construction. On account of the great cost of the construction of the Transcontinental, the G.T.P. refused to carry out its agreement and the government by accepting the company's refusal and commencing to work the lines themselves in effect released the company unconditionally. The line west of Winnipeg is at present being operated under the control of the Grand Trunk, the nearest point of whose rails is at North Bay, a thousand miles away.

"Financial Management Does Not Inspire Confidence."

Mr. Chamberlin, in a letter to the commission, in effect charges the government with bad faith unless the government accedes to the demands that his company be reimbursed for all G.T.P. expenditures and be allowed to withdraw from all G.T.P. obligations. "Confiscation," "crime," "repudiation of legitimate indebtedness," are among the terms used. On the other hand, the majority report says, "The Grand Trunk Pacific shareholders, in other words the Grand Trunk Co., have not shown such prudence and business foresight as would naturally encourage the government to have confidence in their future management." And again, "The financial management of the company is not such as to inspire confidence. We do not think that the credit of the Grand Trunk Co., weakened as it must be by its Grand Trunk Pacific failure, can be so maintained as to render possible the raising of sufficient capital as required."

The total issued stock of the Grand Trunk Railway is about $240,000,000, about one-half of which is preference and one-half ordinary stock. The London Stock Exchange valuation of this nominal $240,000,000 is at the present time about seventy or seventy-five million dollars, ranging from 56 for the 4 per cent. guaranteed stock, which for the past ten years has received its dividend practically in full, down to about 10 for the ordinary stock, which has never received a dividend.

The total dividends paid in the past ten years have been $36,106,439, or an average of $3,610,643 per annum. Therefore, the stock exchange valuation practically capitalizes the dividends on a 5 per cent. basis. "This in a rapidly developing country might be reasonable, if the dividends had been earned and could be maintained, but in view of the statement of the company's own officers that $21,000,000 which ought to have been spent out of the revenue for maintenance has not been so spent, it cannot be contended that the dividends have been earned. In view of the further fact that the company has to face immediate liabilities of over $5,000,000 per annum in connection with the G.T.P., and requires a capital expenditure of $30,000,000 on its own lines to put the company in proper condition to do its existing business, it can still less be contended that the dividends are maintainable."

To prevent arrears again accumulating, future charges must be $2,500,000 a year heavier than in the past on equipment alone, according to Mr. Chamberlin's judgment. Even supposing the company could raise the new capital required and only had to pay 5 per cent. for it, the additional interest charge would mean a serious reduction of the dividend, and this on the Grand Trunk lines alone, independently of the company's liabilities in respect to the G.T.P. The G.T.R. chairman has admitted that the G.T.R. are "at the end of their tether" and that it is "quite impossible for them to meet the extra liabilities arising from the G.T.P. Co."

Position of the Canadian Northern—Eastern Lines Absorb All Profits

The majority report states that the Canadian Northern System has received subsidies from the Dominion and provincial governments of $38,874,148; land grants from which $16,603,295 has been realized from sales and $17,776,514 from mortgages; loans from the Dominion government amounting to $25,858,166; and securities guaranteed by the Dominion and provincial governments to the amount of $199,141,140; or a total of public assistance, direct and indirect, of $298,253,263.

In 1914, with heavy interest payments to be made, and large construction contracts still open, the company found its resources insufficient to complete and equip its system. It estimated that it could raise on its own account $58,000,000, and appealed to the government to find the balance. An issue of $45,000,000, guaranteed by the government, yielded in cash $36,759,265, and the system was unable to sell many of the securities which it depended upon for the $58,000,000, so in May, 1916, the Canadian Northern obtained from the government a further loan of $15,000,000, and in addition the government undertook to lend the company the money necessary to pay interest either to the government itself or to the public on the $45,000,000 issue, and to date $1,756,000 has been advanced for this purpose.

According to the estimate submitted by the company, the fixed charges for the year ending June 30, 1917, will be $16,539,638, but the Dominion and British Columbia governments have undertaken to pay $4,514,507 under certain agreements. "This leaves the company to find out of net revenue about $2,500,000 more than it had available this year. An income of $2,500,000 net implies an increase of at least $9,000,000 gross, and the company itself does not venture to expect a greater increase of gross than $7,000,000.

"The above agreements to pay interest are only for two and three years respectively. The company's estimate for the year ending June 30th, 1921, is that they will then have fixed charges amounting to $18,300,000, and this burden they will have to bear unaided. (This includes interest on $2,250,000 on the new capital estimated by the company as necessary to be spent in the five years. This estimate we regard as quite inadequate.) To carry it they would need a gross revenue of $61,000,000, assuming working expenses at the moderate ratio of 70 per cent. We cannot think it safe to assume that such a result will be easy to attain.

"The Canadian Northern Railway have taken and still continue to take an unjustifiable sanguine view of its possibilities. In 1914, when the company was applying to parliament for debentures, it submitted estimates for the years 1916-18, on what was described as a very conservative basis. The estimate for gross earnings for 1916 was $54,000,000, with net earnings of $15,120,000. The fact has been that the gross earnings have been $35,476,000 and net earnings $9,373,000.

C.N.R. Did Not Meet Bonded Indebtedness.

"A further fact has been that for the year ending June 30th, 1916, interest upon $25,000,000 income debenture stock was passed, interest was charged against capital to the amount of $5,445,389, and the company was still $248,000 short of the money required to meet its bonded indebtedness.

"The company submitted an estimate to us for the five years, 1917-21. The estimate submitted to parliament for the year ending June 30th, 1917, was, gross earnings $61,000,000, net $17,700,000. The revised estimate submitted to us by the company is, gross $42,590,000, net $11,500,000. The estimate submitted to parliament for the year June 30th, 1918, was, gross $67,000,000, net $20,100,000. The revised estimate now submitted to us by the company is, gross $48,185,000, net $13,395,000.

"We think the new estimate made for us, even though more conservative than the former, is still too sanguine. We see no reason to think that the traffic will increase to any such figure as that indicated.

"We think that $40,000,000 for equipment, and perhaps $30,000,000 for additions and betterments, would be a moderate estimate of the system's needs in the next five years, assuming that the system remains separate and independent.

"We sum up the Canadian Northern situation as follows: The company is not at present able, and will not for some years to come be able, to meet its fixed charges. It will, we doubt not, increase its net earnings as the years go by. But the increased net earnings will be fully absorbed for some years to come by the interest on new capital, which must be put in, if the system is to render efficient service. The company has not now, and as far as we can see will not have in the near future, such credit as to enable it to raise the necessary capital. As we have already shown, the public investment, direct and indirect, in the Canadian Northern system amounts to $298,000,000. We do not recommend further public investment in the system, as at present constituted."

The property investment of the Canadian Northern Railway as stated in the balance sheet of June 30th, 1916, is $494,112,489. This figure has admittedly been written up to include $100,000,000 of capital stock issued without any cash consideration. "We find $37,000,000 to be maximum possible cost of the Canadian Northern system as at present existing."

Professor Swain's physical valuation of the system shows a total reproduction cost of $397,441,567. From this he deducts for depreciation $40,031,889, making the cost of the reproduction of the property in its present condition, $357,409,678. This, however, does not include equipment to the value of $56,590,418 (pre-war prices). Depreciation of equipment to the extent of $11,250,433 makes the present value $45,339,985.

C.N.R. Liabilities Equal to Its Assets?

"Putting the two valuations together, we have $402,749,663 as a fair cost of reproducing the entire physical Canadian Northern system in its present condition. Now the outstanding liabilities (bonds, debentures, notes and bank and other loans) of the company exceed $400,000,000.

"Reckoning on this basis, the liabilities are practically equal to the reproduction cost of the physical property. But the physical property does not all belong to the Canadian Northern shareholders. There are minority holdings in some of the subsidiary undertakings which imply a reduction of more than $10,000,000 in assets belonging to the Canadian Northern shareholders.

"We find, then, that on the physical basis, the value of the property of the Canadian Northern shareholders is distinctly less than the amount of the liabilities against it. On this basis the equity of the shareholders must be regarded as non-existent.

"A third basis of estimate is the value of the property for sale as a going concern. A purchaser would not consider either original cost or reproduction cost as of much importance. The price he would pay would be based on earning power, present and potential. On this basis he would consider how far the Canadian Northern is at present short of covering its fixed charges, how long it will take to reach equilibrium, how much new capital will have to be spent, how soon a dividend may be expected and at what rate. Calculating on this basis, in the light of the figures set out above, it is evident that no purchaser would offer for the property a sum amounting to the total of its liabilities.

Conclusions Regarding the Canadian Northern.

"We conclude, therefore, that the shareholders of the company have no equity either on the ground of cash put in, or on the ground of physical reproduction cost, or on the ground of the saleable value of their property as a going concern. If, then, the people of Canada have already found, or assumed responsibility for, the bulk of the capital; if they must needs find what further capital is required; and if they must make up for some years to come considerable deficits in net earnings, it seems logically to follow that the people of Canada should assume control of the property. We return later to the Canadian Northern Company in order to set out our recommendations as to its ownership and management in

the future and as to the terms to be offered to the existing shareholders."

The majority report finds that the charges of misappropriation by Mackenzie, Mann & Co. are unfounded. The sworn evidence of Canadian Northern officials shows that neither the Mackenzie, Mann Co., nor Sir Wm. Mackenzie nor Sir Donald Mann, personally, ever received a dollar from the Canadian Northern system, either as profit on contract undertakings or even as salary.

"Neither one of them have ever been a Canadian Northern voucher to the extent of one dollar," swore Mr. Hanna, the vice-president of the company. The percentage of profit which would be taken by any contractor was taken by the Mackenzie, Mann Co. entirely in common stock of the Canadian Northern Railway, and that stock represents the only profit made on all the contract work done by them on the Canadian Northern Railway. The report also finds that the road was skilfully financed and carefully and economically constructed, but that the profitable sections in the prairie provinces could not carry the unprofitable eastern extensions.

To Arbitrate Equity of C.N.R. Shareholders.

"Under the scheme we propose, the trustees will operate the Canadian Northern lines as part of a combined system. It will be impossible, therefore, for the Canadian Northern Company, as such, ever to earn a dividend on its separate stock. We suggest that, if it is decided to permit the present shareholders to retain a portion of their holding, the Act of Parliament constituting the Board of Trustees shall contain a provision for arbitration between the trustees and the Canadian Northern Company and establishing an arbitration board to act forthwith. The trustees should appoint one arbitrator and the Canadian Northern shareholders the other, and the two arbitrators should agree on the appointment of an umpire; failing agreement, an umpire should be appointed by the Chief Justice of the Exchequer Court; and the decision of the board should be final.

"The arbitrators should be empowered to decide two questions: (1) what proportion of the Canadian Northern common stock may fairly remain the property of the present holders; (2) What proportion of the earnings of the Dominion Railway Company may fairly be regarded as attributable to the Canadian Northern lines.

Must Irrevocably Deed C.N.R. to Trustees.

"To illustrate our meaning, we will assume that the arbitrators decide that 5 per cent. of the Canadian Northern shares shall remain the property of the existing holders, and further decide that one-half of the total earnings of the Dominion Railway Company will be fairly attributable to the Canadian Northern lines. Then their decision will mean that, out of any dividend declared in future by the Dominion Railway Company, 2½ per cent. (one-half of 5 per cent.) will be payable to the existing Canadian Northern shareholders or their transferees. We think the arbitrators should fix this resulting percentage once for all. It should be made a condition of the settlement that the minority shareholders of the Canadian Northern should by deed irrevocably appoint the trustees as their proxy to vote their shares. Care will of course be taken to provide that the Arbitration Board shall have regard only to the Canadian Northern lines, as they exist at the date of the passing of the Act, and that any subsequent increase of revenue due to the expenditure of additional public money shall be excluded from consideration."

Various Suggested Solutions of the Problem Are Discussed

The majority report recommends that the control of the Grand Trunk, Grand Trunk Pacific and Canadian Northern be assumed by the people of Canada. In considering how this control should be exercised, government operation was discussed and rejected for several reasons.

The opinion of the commissioners was that a receivership would be unfair to the security-holders of the companies who have a certain moral claim on the government, and would also injure the credit of Canada.

"We have recommended, then," says the report, "that the control of the three companies, Canadian Northern, Grand Trunk, and Grand Trunk Pacific pass into other hands; that the rights of the creditors of all three companies be preserved intact; but that the railways of the three companies be not handed over to, or operated by, the government. It is necessary, therefore, to find some new body or bodies to whom they can be transferred. We think the question, whether there should be one body or more, is answered by the facts that we have already recited. The Canadian Northern is weak in the East. The Grand Trunk, with the inadequate prairie branches of the Grand Trunk Pacific, would be almost powerless to compete in the West with the Canadian Northern and the Canadian Pacific. The natural tendency of the Grand Trunk and Canadian Northern organizations, if left separate, would be for each to invade the territory of the other. Remaining separate, the Canadian Northern system would need to spend many millions of dollars to obtain an adequate hold on the East in competition with the Canadian Pacific and Grand Trunk. Remaining separate, the Grand Trunk and Grand Trunk Pacific system would need to spend many millions of dollars on new branches in the West, in order to hold its own with the Canadian Pacific and the Canadian Northern. And this money would be needed at once, for till it was spent neither organization would possess a complete system. Canada cannot afford all these new railways, and does not need three competitive systems. We recommend, therefore, that the three undertakings, the Canadian Northern, the Grand Trunk, and the Grand Trunk Pacific be united in one system. To whom, then, should its management be entrusted?"

The commissioners answer this question by advocating the formation of the Dominion Railway Co., the proposed organization of which is later explained.

C.P.R. or Any Monopoly Not Desirable.

The suggested transfer of all the railways to the Canadian Pacific is rejected on the grounds that a railway monopoly is not desirable either in the hands of a company or in the hands of the state.

The suggested transfer of the Canadian Northern to the Canadian Pacific is rejected because it would re-establish what would be a practical monopoly in the Prairie Provinces and would leave the country to carry the burden of the G.T.P., which has little hope of prosperous development if isolated. The suggestion that the C.P.R. be invited to take over only the western portion of the C.N.R. was also rejected as being of even less advantage than if they were to take over the whole road, as it has the added disadvantage of leaving the country to carry the burden of the unprofitable eastern lines.

The possibility of forming a commercial company was discussed and the report merely states, "We have come to the conclusion that this course is not feasible under the

(Concluded on page 405.)

The Manufacture of Munitions and the Permanent Assets to Canadian Industry Resulting Therefrom

An Outline of the Manner in which the Manufacturers Have Responded to the Call for Munitions—Value of Production—Results of Standardization of Products and Skill

By COLONEL DAVID CARNEGIE
Imperial Munitions Board, Ottawa.

I SHOULD like to refer first to Canada's capacity to produce munitions; second, to the permanent assets to Canadian industry arising out of munitions work; and third, to the responsibility of engineers in developing these assets.

Canada's Capacity to Produce Munitions.—In September, 1914, when General Sir Sam Hughes undertook the first order for shrapnel shells, Canada's capacity to produce shells amounted to 340 18-pr. shrapnel shells per week. These were made at the Dominion Arsenal, Quebec. The capacity of Canadian factories to-day approximates 400,000 18-pr. shrapnel complete rounds per week, including cartridge cases, primers, fuses and propellants. In addition to this amazing output there is a weekly capacity in Canada for nearly 400,000 high explosive shells, ranging in sizes from 18-pounders to 9.2-in., making an approximate total weekly output of 800,000 shells. This large output, along with other supplies made independently, requires weekly about 25,000 tons of steel, 2,500 tons of brass, 750 tons of copper, 250 tons of zinc, 1,500 tons of lead, 200 tons of antimony, 150 tons of resin, several tons of ferro-molybdenum, and about 1,300 tons of explosives—500 tons of cordite, 500 tons of trinitrotoluol, 300 tons of nitrocellulose powder. Over 300,000 boxes are required for these shipments per week, and about 3¼ million lineal feet of board are used in making these boxes.

The Value of the Products.—The weekly value of these products can only be understood by people who have learned to think in millions.

The total value of orders for munitions placed in Canada approaches eight hundred million dollars, and the value of the munitions shipped is close upon five hundred million dollars.

The Amount and Value of the Plant Employed in Producing Munitions.—Looking again at the magnitude of munitions work in Canada to-day, we see 650 factories engaged in 144 towns scattered throughout every province of the Dominion, except Prince Edward Island. Cities as far apart as St. John, Newfoundland, and Victoria, B.C. (a distance of approximately 4,500 miles), are contributing to the output. Manufacturers from almost every industry in Canada have turned their attention to the production of munitions, and it is gratifying to record that few of them have failed in producing the standard of work required.

Gauge Production.—One can hardly mention this subject without being reminded of the almost insuperable difficulties which were presented in the early days of the war in obtaining gauges for munitions. We can never thank the United States manufacturers sufficiently for what they did in coming to our aid at that time. The special skill in making gauges to the limits of accuracy required could not then be found in Canada. To-day there are at least twenty factories producing gauges in Canada, and while we are not independent of help from the United States, some idea of the magnitude of the work can be understood from the monthly bill, which amounts to over $150,000 for new gauges.

During the month of March about 10,000 new gauges and checks were inspected. The usual accuracy called for on a gauge is .0003 3/10 thousandths of an inch, and for a check, 1/10 thousand.

An army of over 5,000 examiners are engaged upon the inspection under the direction of Colonel Edwards and his staff of officers.

Permanent Assets to Canadian Industry.—Hurrying from these few facts about the output of munitions in Canada, without even touching upon what would be a fascinating subject to you as engineers (I mean the scientific processes involved) and also leaving entirely out of consideration the gruesome purpose in actual warfare for which the munitions are required, I pass on to consider the value of this unholy business as a permanent asset to Canadian industry. I should like to divide the total value of the permanent assets, as I view them, into two parts. The first resulting from the standardization of products; the second from the standardization of skill.

The Standardization of Product.—No component part of munitions, however insignificant, has been made or accepted on the old principle of "good enough." Every part has been supplied to drawing and specification, with rigid examination, analysis and test before acceptance.

I think I am safe in saying that there is no industry in Canada which has been occupied in the manufacture of munitions but has passed through a process of refinement, which will leave it in a better condition when it returns to domestic pursuits after the war. If you review the great industries of Canada it will be difficult to find one which has not been actively contributing to the output of munitions.

Industries such as the iron and steel, the metals and metal products, refractory materials and fuels, lumber and timber, leather, textiles, paper, chemicals and other minor industries, have called into being processes and plant which could be adapted for munitions, and have also added new processes, new equipment and new skill where these were required.

In addition to the employment and adaptation of existing industries for munitions manufacture, entirely new industries have been brought into activity. The manufacture of munitions has given an abiding impetus to the mining and subsequent operations in the production of coal, iron, copper, nickel, zinc, molybdenum, antimony, aluminum and other metals.

The chemical industries have been accelerated by utilizing the waste products of the coke ovens for the manufacture of high explosives. These waste products after the war will be turned, by ingenuity and skill, into valuable domestic products.

*Abstract of an address before the Ottawa Branch, Canadian Society of Civil Engineers, April 26th, 1917.

The electro-chemical industries, such as the refining of copper, zinc and lead, have been initiated and will remain as a commercial asset. The electrothermic processes for the production of ferro alloys, such as ferro-silicon, ferro-manganese, ferro-molybdenum, aluminum, magnesium and other metals, have produced standardized products.

Standardization of Skill.—The widespread knowledge of new processes, involving the scientific study of metals, the flow of materials, and their physical, chemical and metallurgical values, has been such that one can hardly imagine it would have been possible for the universities and technical schools of Canada to have provided such instruction in the course of many years which has been crowded into as many months. Every workshop has been a school of training in standardizing its skill. Every factory in which steel is made and forged is now partly or fully equipped with the means for measuring temperatures and intelligently discovering the value of the materials with which they are working. In every workshop in the different provinces of Canada where shrapnel shells are made, the scientific treatment of steel is known. There is hardly a town of any importance in which the use of precision instruments and gauges for measuring shells and their component parts does not exist.

It is difficult to assess the value of this skill to Canadian industry, in which over 250,000 workers have become skilled in the art of such processes and the manipulation of such tools and gauges. It is more surprising still to know that nearly 12,000 women have become skilled in this work. Never in the history of the world has there been such an incentive to acquire such skill for a purpose the like of which our civilization should be ashamed, but which is nevertheless an asset which will be of great value in the peaceful commercial industries for the expansion of Canada.

Contributing Factor in the Standardization of Skill.—The mental processes which have been silently at work developing character while the hands of the workers have been acquiring precision in the use of tools and gauges, are factors in the life of the individual worker which cannot be overlooked. Canada has shown a rare capacity during this great war, comparable in some measure with the vastness of its territory.

The Responsibility of the Engineer in Developing These Permanent Assets.—Gentlemen, ours is an honorable profession, one crowded with vistas of research and delights the like of which even the angels might envy. This war has awakened the slumbering forces in the human mind and brought into activity engineering genius unequalled in quality hitherto. Your great waterfalls have been transformed by your skill into the most resourceful agency of power, without which we would have hopelessly failed in reaching the output of munitions named. Your skill has mined, smelted and fabricated the many metals which have proved to be of such value for munitions. The great engineering plants which have been brought into being by your skill are monuments of industry which must not be allowed to rust when this war is over. There is a great responsibility resting on you as engineers and leaders of industrial thought and action. It is greater to-day than ever before in the history of Canada. The opportunity given to you of taking and intelligently using and directing those assets of which I have spoken is of vital importance to Canada's successful industrial development. There is no need to wait for royal commissions. Power and authority are vested in yourselves; nothing will be too great for you if you see your opportunity, and if you have faith in the engineering talent of Canada. The man who was afraid and went and hid his talent in the earth brought forth the most scathing reproof ever uttered.

If I were to venture to suggest a programme for your immediate consideration, I would advise you to classify and value the engineering skill of your societies with the object of forming in Canada from their membership small committees of scientific, technical and commercial men, who would be responsible for obtaining from the accumulated reports of commissions and numerous supplies of information stored in government departments and elsewhere relating to the best standardized processes, equipments and plants for the development of the industry they represented. Each committee would therefore become the recognized source of classified information, to whom manufacturers could with confidence refer for any help and advice required.

If your inventory of classified ability were broad enough to include the fuller issues in developing the standard of products, skill and utilitarianism, I should utilize every willing member of your profession, making committees, say, of members not exceeding three, for the consideration and report of the following subjects:—

1. Industrial, technical and commercial education for our boys and girls before and after leaving the day school.
2. The classification and valuation of labor.
3. The remuneration and hours of labor.
4. The direction and character of employment in classified industries.
5. The provision of methods for the prevention of unwholesome competition between manufacturers.
6. The provision of definite standards for checking the formation of doubtful companies.

Then, with a central authority you could co-relate the efforts and information of your scientific and industrial committees for a broader policy of universal trade.

By the consideration of some such programme those valuable assets which are now the heritage of the Canadian people will make this country prosperous. Canada has its opportunity to set the pace in the world's industry. Its finances were never better. Last year its exports exceeded its imports by $340,000,000. Its natural resources cry out to you for their development. It is a country in which there is a heritage of wealth far exceeding that with which our youthful imaginations surrounded "Treasure Island." Your efforts in embracing those opportunities will be strengthened by a more complete education of the industrial workers, and by a heartier co-operation with the employees.

"A nation," said President Wilson, "is as great and only as great, as its rank and file." Will you, gentlemen, see that the rank and file who make this nation follow those lofty standards of education and sacrifice which make life great?

It would be terrible if we missed the way after such a struggle.

There is a great industrial war before us, for which we are unprepared.

A new north and south international highway from Winnipeg to San Antonio and Galveston and possibly to the city of Mexico and the Panama Canal by way of Kansas City is projected by a Kansas organization.

It has been announced in New York that a contract, providing for the reconstruction of important buildings in the destroyed cities of northern France, has been closed between the French Government and Kennedy, Mitchell & Company, bankers, of New York and London. Virtually all the material to be used will be purchased in the United States. The contract is for 200,000,000 francs.

THE GOVERNMENT WHITE ELEPHANT AT QUEBEC.

By C. V. Johnson, A.M.Can.Soc.C.E.

ALTHOUGH it is almost a year and a half since the so-called Transcontinental Locomotive and Car Shop plant at Quebec has been completed, insofar as it was allowed to be completed, there has as yet been no sign of activity within its doors, if we may except the occasional flying visits of high officials who come, look, and depart—to be seen no more.

What is the explanation for this seeming apathy on the part of those in authority? Like Bob Ingersoll, "we do not know." It cannot be that these buildings, handsome though they may be, were erected for the sole purpose of being pointed out to visitors as one of the sights of Quebec. At this time of industrial activity, when all the resources of the country are "supposed" to be organized for the purpose of assisting the Empire, would they not appear much more in keeping with the part our Dominion is expected to play if they were in full activity of producing some of the materials of which there is so great a need? Munitions, guns, locomotives, cars, or any of the thousand and one articles which go to supply the needs of those who are so nobly risking their lives for the sake of humanity.

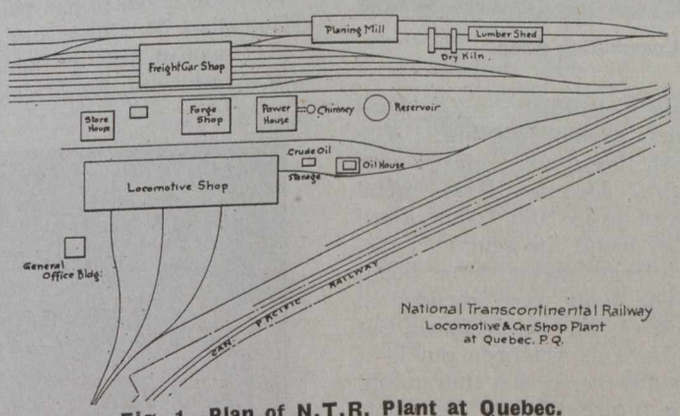

Fig. 1—Plan of N.T.R. Plant at Quebec.

Many reasonable suggestions have been put forward as to the use to which the plant might be put, and companies have even been formed with a view to securing the use of the buildings from the government for the manufacture of munitions, only to be met with the vague statement that the shops are not available at the present time. It would appear, however, that there is no necessity even to change the nature of this plant to make it serve its purpose, as it could be very well employed in turning out cars and repairing locomotives, for both of which there is a crying need on all sides.

It is very well known that the transportation problem has become serious of late; so much so, in fact, that embargo after embargo has been placed on shipments of all kinds. In order to relieve the car shortage, the demurrage charges have been boosted to a previously unheard-of figure.

The explanation of this appears to lie in the fact that while shipping has been vastly increased since the beginning of the war, the usual supply of rolling stock has appreciably decreased—due no doubt to the increased profits to be made from the manufacture of shells as against cars and locomotives. In all reason there must be an end to this sometime, else when the shortage becomes more acute—which will be in the very near future—how are the materials for munitions, the shells, and the necessities of life, to be moved from the points of supply to the ultimate consumer? Does it not seem reasonable to suppose that a resumption must be made at some time in the construction of cars, and why not now before the need becomes so great that it will seriously disorganize interior arrangements? Here, then, is a plant ready to hand, one million and a half of dollars in buildings alone, excellently situated, and requiring only the installation of machinery to make it ready to play the part for which it was originally designed, and for which it is at the present time much more needed.

In order, then, to give engineers an idea of the magnitude of this plant, a general description will be given, together with the details of the various buildings as constructed.

The Site.—The shops are situated on the western outskirts of the city of Quebec, in St. Malo Ward, not more than five minutes' walk from the end of the street car line, and immediately adjoining the C.P.R. tracks at Biggar siding. The ground at this point was formerly considered a swamp, and was frequently objected to as a site on this score, but owing to the complete system of drainage which has been installed, and the many thousands of cars of sand filling which have been spread over it, it is now well-graded and dry.

As a matter of fact, the ground never was of such a nature as to deserve the name of swamp, but was, owing to its flat nature and lack of natural drainage, the receptacle for the run-off from the hill to the south. The nature of the ground itself proved ideal for the construction of the buildings, as the rock, commonly known as Quebec shale, was encountered generally within a few feet of the surface, giving an excellent bearing for the foundations. On the other hand, this shale was a considerable handicap in excavating for drainage and water

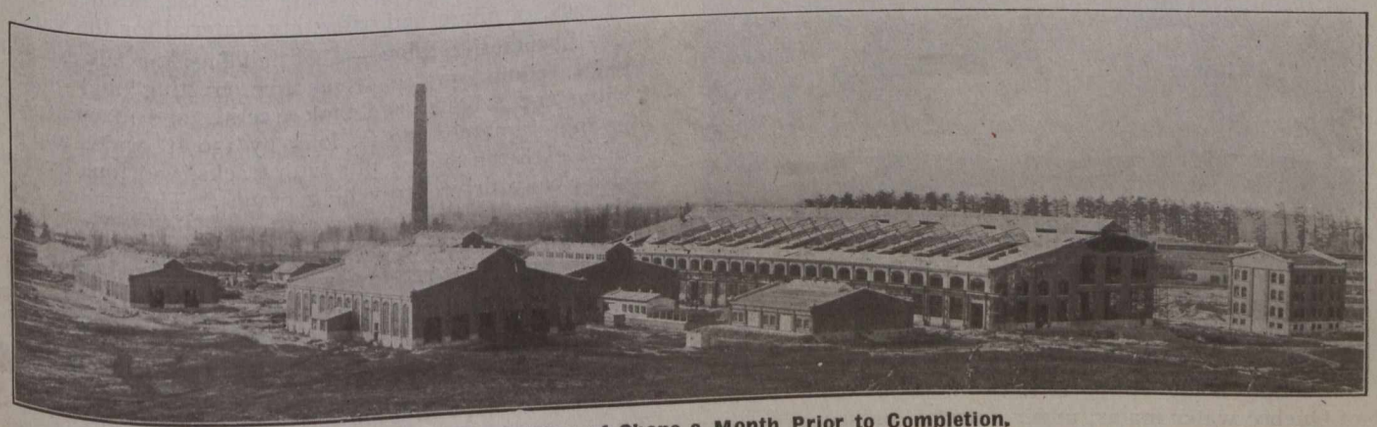

Fig. 2—General View of Shops a Month Prior to Completion.

lines, but the extra expense incurred on this account was more than compensated for by the saving in the depth of foundations for the buildings.

The Plant.—The buildings themselves (twelve in all) are generally of brick and steel construction on concrete

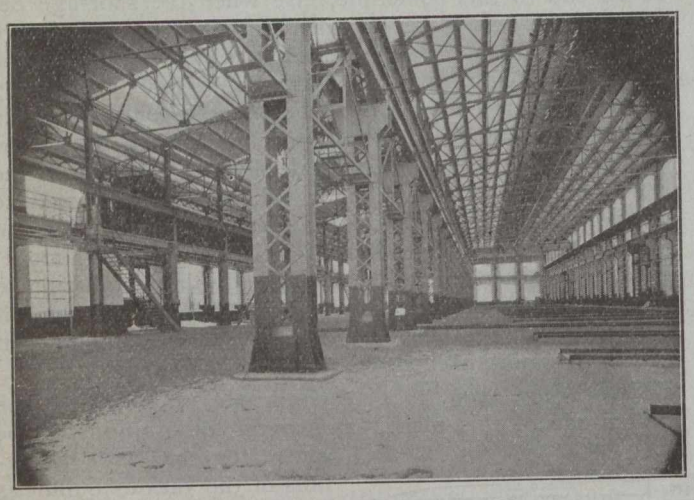

Fig. 3—Interior of Locomotive Shop.

foundations, with double wooden-sheathed roof covered with Brantford No. 3 prepared asphalt roofing. The windows are Fenestra steel sash throughout, glazed with ribbed glass; and the skylights, Douglas Bros. metal ribbed with a double thickness of ⅜-in. and ¼-in. ribbed wire glass. The doors are of wood, in general 3 ins. thick, with steel frames, the large engine doors being fitted also with pass doors. The floors were intended to be of concrete, with a 1-in. and 1½-in. mastic finish, but as no machinery foundations have as yet been put in it was decided to leave the floors undone so that they would not have to be torn up at some future date for the installation of machinery.

All the buildings, with the exception of the locomotive shop, are equipped with the Miller vacuum direct steam radiation heating system, the steam to be supplied direct from the power house. The locomotive shop is equipped with an indirect heating system consisting of

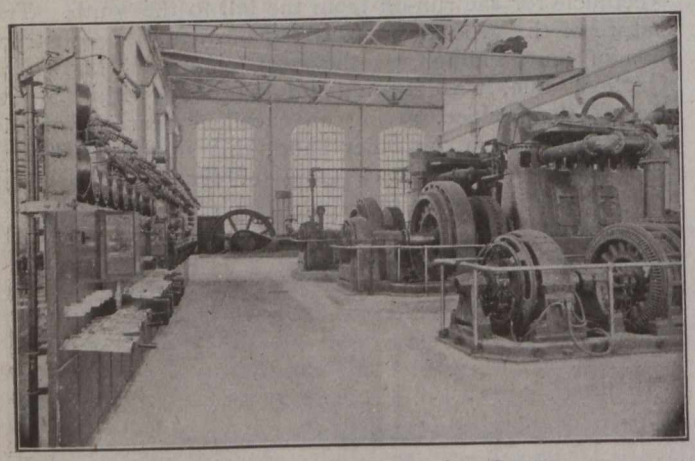

Fig. 4—Power House Engine Room.

two Sirocco fans, from which the hot air is driven through concrete ducts underground to all parts of the building.

The water system is complete throughout the plant, the supply being obtained in 10-in. mains from the city of Quebec water mains, under a normal pressure of about 100 lbs. and distributed through all the necessary branch lines to all parts of the yard and shops. An emergency system is also installed in such a manner that, in case of accident, the water may be pumped from the reservoir which forms a part of the plant. A complete system of fire hydrants has been installed both in the buildings and through the yard, as also two 6-in. standpipes for supplying the locomotives.

The drainage system is double, the roof and surface run-off being carried direct to the St. Charles River on Lesage Avenue, and the sewage being emptied into the city sewers. The yard itself is very extensive, being capable of storing an almost unlimited amount of material, besides allowing for shop expansion to many times the present dimensions.

The original plan contained some twelve miles of trackage, of which about seven miles have been laid and ballasted, these being directly connected with both the C.P.R. and Canadian government lines. A scheme was at one time broached and plans actually prepared for a double track tunnel extending from the Transcontinental line at Wolfe's Cove on the St. Lawrence River to connect with the shops; but this was later abandoned and the Canadian Northern line from the Quebec Bridge taken over instead, this giving a connecting link some six miles in length with the Transcontinental main line.

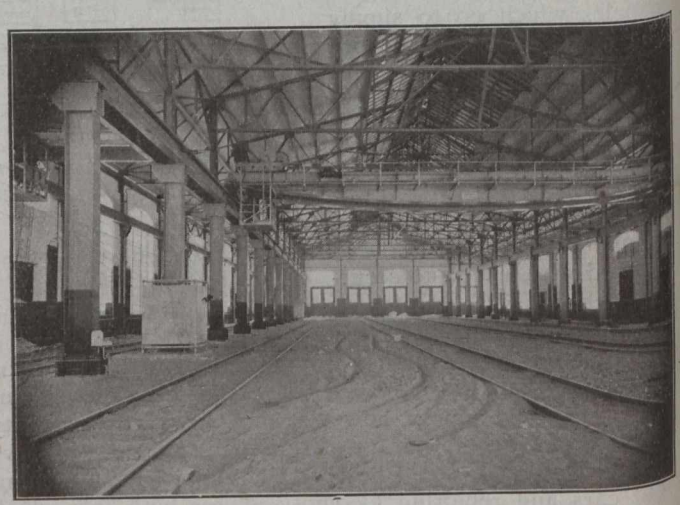

Fig. 5—Interior of Freight Car Shops.

In the construction of the shops about 135,000 cu. yds. of material was excavated, and there were employed some 3,000 tons of structural steel, 23,000 cu. yds. of concrete, 3,000,000 bricks, 850,000 ft. B.M. of lumber, 56,000 sq. ft. of window sash, 60,000 sq. ft. of skylights, and 166,000 sq. ft. of roofing material, besides 150,000 cu. yds. of filling and ballasting material for the yard.

Locomotive Shop.—This building, the largest in the plant, comprising a locomotive erecting and machine shop, and a boiler and tank erecting and machine shop, is approximately 600 ft. long by 150 ft. wide, and contains eighteen engine pits with tracks, and four overhead electrically driven travelling cranes. The cranes are of the following dimensions and capacities: Two 10-ton, respectively 20 and 50-ft. spans; one 20-ton with 68-ft. span, and one 120-ton with 74-ft. span. There is a balcony 20 ft. in width extending the full length of one side of the building, and containing the fans, lavatories, foremen's offices, etc. Three standard gauge tracks are laid in the shop and connected with the tracks in the yard. An interior view of a portion of this shop is shown in the accompanying illustration, Fig. 3.

Forge Shop.—This shop is 107 ft. wide by 155 ft. long, and is at the present time entirely empty of any equipment, with the exception of the heating and water systems.

Storehouse.—The storehouse is 78 ft. 6 ins. wide and 103 ft. 6 ins. long, consisting of a reinforced concrete floor some four feet above the ground level, together with a reinforced concrete platform outside, 10 ft. wide and extending around three sides of the building. It is also supplied with heating and water systems, and has provision for a scale which is not as yet installed.

Oil House.—This building, 50 ft. square, is constructed somewhat differently from the others, consisting of a concrete floor, 8 ft. below ground level, on which the tanks are placed, concrete walls, and an upper floor of reinforced concrete on which the pumphouse, 30 ft. by 40 ft., is situated. There are installed in the building nine tanks, seven of 3,300 gals. capacity, and two of 6,000 gals. capacity, and in addition there is a gasoline storage tank of 1,800 gals. capacity buried in the ground just outside the building, and connected with it by the necessary piping. The whole oil system is completely equipped with Bowser measuring pumps, fill boxes in the platforms with nozzles and locked valves for gravity fill from cars, manholes, indicators, drains, etc.

Crude Oil Storage.—This little building is 42 ft. 8 ins. long by 21 ft. wide, constructed entirely of reinforced con-

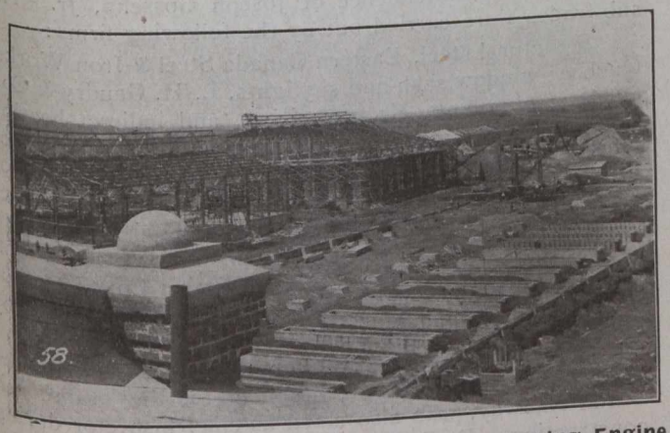

Fig. 6—View from Roof of Office Building, showing Engine Pits in Locomotive Shop and Steel Framework of Forge and Power House.

crete below the level of the ground, and containing four tanks each 7 ft. in diameter and 15 ft. long.

Power House.—The power house is 124 ft. 6 ins. long by 107 ft. wide, consisting of two compartments separated by a brick wall, one containing the boilers and the other the machinery. The equipment is practically complete at the present time, successful tests having recently been carried out by employees of the Canadian Government Railways and representatives of the manufacturers.

The engine room contains two 500-kw. and one 175-kw. steam-driven generators; two 150-kw. and one 75-kw. motor generators; one 1,500 cu. ft. air compressor; one switchboard; two pumps; feed water heater, and all the necessary connections. In the other side are situated five 500-h.p. boilers, supplied and installed by the Goldie-McCulloch Co. Fig. 4 shows an interior view of the engine room.

Forge Stores.—This is a wooden framed building covered with asbestos shingles, and fitted with an iron storage room containing iron racks, and a coke and coal storage room, together with a scrap platform with removable partitions.

Freight Car Shop.—This shop is 130 ft. wide by 285 ft. long, containing one 25-ton travelling crane with a 78-ft. span, and one 10-ton with a 20-ft. span. There are

Fig. 7—Power House.

six standard gauge tracks running the full length of the building, and connected at both ends with the yard tracks. The building is also furnished with complete heating and water systems. Fig. 5 illustrates the interior of the shop.

Planing Mill.—This is 82 ft. wide by 265 ft. long, with exhauster room on the north side, and contains two standard gauge tracks, also connected with the yard system. Heating and water systems are completely installed.

Dry Kiln.—This building is 38 ft. 4 ins. wide by 71 ft. 6 ins. long, and is constructed of brick on concrete foundations, with terra cotta lined walls, terra cotta partition in the centre, and suspended ceiling of metal lath and plaster. The heating system, which is complete, consists of approximately 1,860 sq. ft. of radiating surface, control cabinets, valves, gauges, fittings, etc. There are contained in the building four narrow gauge tracks, and at each end transfer pits on the outside of the platforms.

Lumber Shed.—The lumber shed is 40 ft. 6 ins. wide and 225 ft. 6 ins. long, wooden framed on concrete piers,

Fig. 8—Constructing Manholes with 30″ Concrete Pipe.

with wood-sheathed walls covered with asbestos shingles. It is floored with 3-in. plank laid on sleepers in a gravel fill, and has one standard gauge track through the entire length.

Office Building.—The office is 60 ft. square, consisting of three stories and a basement, and contains ample space for any staff likely to be employed in the management of the plant. The interior contains offices, draughting rooms, printing rooms, vaults, etc., and is finished throughout in hardwood, with plastered walls and ceilings, and maple flooring. The basement has a concrete floor surfaced with mastic flooring. This building is also heated with the direct radiation heating system from the power house, and is completely furnished with electric lighting, telephone wiring and bells.

Reservoir.—The reservoir is of mass concrete construction, having an inside diameter of 66 ft. and a depth of 15 ft., the capacity being 300,000 gallons. The supply pipe, 10 ins. diameter, is fitted with a float automatic control valve, besides an auxiliary valve located in the adjoining valve house. The reservoir is connected with the pumps in the power house by means of a 12-in. diameter pipe, this pipe being also connected with the main supply by means of a by-pass. All supply, suction, overflow and drain pipes are in place, together with a complete valve-operating equipment.

Midway Crane.—Between the locomotive shop on the north side, and the storehouse, forge shop and power house, is situated the midway crane runway approximately 650 ft. long, with an electrically driven travelling crane of 15 tons capacity and 75 ft. span.

Chimney.—The chimney is of reinforced concrete, 200 ft. high, and 9 ft. inside diameter at the summit. See *The Canadian Engineer* of March 16th, 1916, for article descriptive of this chimney.

Pipe Tunnel.—In addition to the plant described above, there is also constructed a yard pipe tunnel ready to receive the piping from the power house to the various buildings. This piping is not yet in place.

Construction.—The contract for the construction of these shops enjoyed the distinction of being one of the few on the Transcontinental Railway to be completed within the stipulated time. Work was commenced on September 15th, 1913, and carried on continuously winter and summer until the completion, about December 1st, 1915, one month prior to the expiration of the contract time.

During the late fall of 1913, excavation work was done for the locomotive shop, forge shop, storehouse and power house; and during the month of January, 1914, for the freight car shop, planing mill, reservoir, and office building. Concrete work was carried on until the end of December, and again resumed early in March.

During the winter of 1913 and 1914, work was very scarce in Quebec City, resulting in a great deal of unemployment, and the contractor was approached with a view to having him carry on as much of the construction as possible in the winter months. To this end he agreed to do all the excavation for the sewer and water lines, and thus employed about six hundred men all through the slack months of the winter. Excavation was naturally rather difficult owing to the severity of the winter, the great depth of frost, and large snowfall, necessitating much blasting of frozen material and a great amount of snow shovelling. The trenches for the pipe lines varied from a depth of six feet at the upper ends to twenty-two feet at the lower. Large quantities of shale and boulders were encountered, and much difficulty was experienced in keeping the trenches clear of water. Towards spring, when the strength of the sun began to be felt, such trenches as were not backfilled had to be well shored, as the Quebec shale quickly disintegrates when exposed to the sun and air, giving rise to continued slides if not held up. Nevertheless, the whole of this work was completed about the middle of March, 1914, and the working force then concentrated on the foundations for the various buildings.

During the summer of 1914 all concrete foundation work, structural steel work, and a large part of the brickwork was completed, some five to six hundred men being employed on the construction. In the winter of 1914 and 1915, the remainder of the brickwork was erected, also the oil house and chimney. That winter the whole of the excavation and concrete work was done for the yard pipe tunnel of reinforced concrete (a description of which work has already been published in the issue of *The Canadian Engineer* for February 24th, 1916).

This left the contractor free to do the finishing work and "cleaning up," and to concentrate on the yard filling, tracklaying, and ballasting, during the summer of 1915. The filling material was taken from the Montmorency pit of the C.N.R., a distance of about twelve miles from the shops, and hauled in Hart side-dump cars, unloaded with a Lidgerwood, and spread with a Jordan. In all about 5,000 cars of material were used in this work, the whole being accomplished in about two months time, although it was well into September before the tracks were completely lined up and ballasted.

The general contract was carried out by the firm of Joseph Gosselin, general contractors, Quebec and Levis, under the superintendence of Joseph Gosselin, Jr. The sub-trades were carried out by the following firms:—

Structural steel, Eastern Canada Steel & Iron Works, Quebec; window sash and skylights, L. H. Gaudry & Co., Quebec; plumbing, electric wiring, and indirect heating apparatus, Fortunat Gingras, Quebec; direct radiation heating system, F. W. Miller Heating Co., Chicago; roofing and sheet metal work, Eugene Falardeau, Quebec; painting and glazing, Ovide Lachance, Levis. The cast-iron piping was supplied by Drummond & McCall, Montreal; the steel sash, by Steel & Radiation Co., Toronto; the skylights, by Douglas Bros., Montreal; the paint, by Canada Paint Co., Toronto.

The plans for the buildings were made under the direction of H. Laberge, architect for the Transcontinental Railway, who also acted as chief inspector during construction. E. B. Forrest was engineer in charge for the N.T.R., and H. E. Balfour, assistant engineer. We are indebted to Mr. Balfour for the photographs illustrating this article.

The American production of ferro-manganese last year amounted to 208,389 gross tons, or double the normal output. In the supplies of manganese ore still more striking records have been obtained. The imports probably exceeded 560,000 tons, almost entirely from Brazil, larger, for the first time, than the imports of Great Britain.

The United States Consul at Dairen reported recently that there has been constructed at the South Manchurian Railway workshops three locomotives for the French railways in Cochin-China. The locomotives weighed 64,103 lb., and with the tender 103,053 lb. The same authority also says that the Japanese Railway Board will, in future, construct its own electric locomotives, for use on the Usui line, instead of obtaining them from Germany.

Search for graphite deposits in the United States since the war started has brought to light the largest known deposit of high grade mineral on the continent, says the New York State Department of Labor. It is between Lake George and Lake Champlain in the vicinity of Black Mountain. The veins crop out for nearly a mile with a thickness of 50 ft. The graphite content indicates a variation of 6 to 10 per cent. of the large flake variety desired by crucible makers while a 6 ft. layer assays over 15 per cent. of high grade graphite.

EFFORTS BEING MADE TO APPOINT STREAMS COMMISSION FOR ONTARIO.

ON March 29th, at Galt, Ont., a conference was held at which was strongly advocated the appointment of a provincial commission to study control of the rivers of the province. Delegates were present from Preston, Hespeler, Kitchener, Paris, Brantford and other municipalities in that section of the province.

As chairman of the Grand River Improvement Association, Mr. W. H. Breithaupt, M.Can.Soc.C.E., spoke of the work done by that association in its efforts to get improvements on the Grand River, and pointed out how the land now damaged by these floods is becoming more valuable each year, and showed how urgent it was that some steps be taken by the government to adopt some methods by which the floods could be controlled.

In the course of his remarks he referred to what was being done in various countries to cope with the problem of river control. He said, in part:—

"Let us take a brief survey of what is being done in the United States. On the Allegheny and Monongahela Rivers, which together form the Ohio River, seventeen flood prevention reservoirs in Pennsylvania, Maryland and West Virginia at a cost of $20,000,000 are now definitely projected.

"In Kansas, the State Flood Commission has reported that losses by floods during the past thirteen years have amounted to $20,066,000 in that State, an average of $4,000,000 annually, and have cost 100 lives.

"There are river commissions in a number of States across the line, and very extensive programs are constantly being elaborated and carried out.

"It is not that floods are continuing to increase very much. On the Grand River, for instance, the largest observed flood was five years ago, and it is not likely that conditions tending to large floods will become much more accentuated in our drainage basin. A great and growing need for regulation is that property subject to destruction is so greatly increasing in values. Prevention of annual damage should keep pace with such increase in values. There are important reasons besides flood control for study and general administration of matters pertaining to streams. One of them is the prevention of pollution. A river is in general the discharge canal for sewage and all manufacturing wastes, to purify which before they are thrown into the river is always a greater or less cost.

"Pollution of a stream, however, is a public detriment, and must, therefore, be prevented. Water supply for the cities and towns along the valley of a river is another great question.

"In our local area this is already becoming a difficult question in a number of municipalities, notably in the city of Kitchener. The maintenance of a good flow in the streams during periods of low water is a matter of many-sided interest. In the first place, there is the increase in value of water powers on the streams. The increased flow is in itself a large benefit in a cleaner river bed and general addition to beauty and attractiveness of the entire drainage area.

"**Commission in Quebec.**—In the Province of Quebec there has been a Streams Commission since 1912. Streams problems in Quebec are in general somewhat different from those in our province. Investigations are largely for water power, but they are also for flood control and the many other general purposes of water conservation. The Commission in Quebec spends now about $50,000 a year, and maintains a permanent staff of investigators, who in cases go far beyond actually settled territory of the province.

"**Is Urgent in Ontario.**—The need for a Commission in the Province of Ontario has been urgent for many years, and there is no question that at least a beginning should be made at once. The Commission should cover the field of the whole province, and preferably consist of members from the various main drainage areas."

As a result of the conference a deputation, consisting of Messrs. W. H. Breithaupt, J. M. Patterson, Alfred Taylor and the mayors of Preston, Hespeler, Kitchener, Paris, Brantford, Caledonia and Galt, was appointed to wait on the Ontario Government and urge the advisability of at once appointing a commission to investigate flood conditions throughout the province.

REPORT ON MONTREAL PAVING WORK.

Reviewing the whole paving situation in Montreal, a comprehensive report has been submitted to Paul E. Mercier, city engineer of Montreal, by the Milton-Hersey Co., Limited, who have the contract for the chemical and inspection work in connection with the city's paving. Among the subjects covered are Material Contracts, Asphalt Cement, Inorganic Filler, Sand, Stone, Chips, Excavating and Grading, Concrete Foundations, Binder Course, Asphalt Mixtures, Hauling of Mixtures, Pavement Surface, Asphalt Plants and Accounting Control.

The report recommends that the old granite blocks be redressed and relaid and that one or more central plants be established for recutting these blocks. It is suggested that sand be purchased in at least three grades rather than in one grade, and that suitable storage bins be constructed with belt conveyers, etc., so that sands can be mixed to approximate the ideal grading.

It is stated that the asphalt cement should be of at least three degrees of consistency as determined by the penetrometer,—one for mixtures used on light traffic streets, another for medium traffic streets and the third for heavy traffic.

Complaint is made regarding the price and supply of inorganic filler, and it is recommended that serious consideration be given to the installation of a drying and powdering plant to produce clay filler which could be used in conjunction with very fine sand. The sand situation is said to be fairly satisfactory as regards price, the contractor securing but 19c. per ton to cover pay roll, equipment charge, supervision, royalty and profit. It is complained, however, that the railway freight of 70c. a ton from sand pits to the city is too high and that application should be made for its reduction.

The price of stone-chips has been very high, says the report, and it is desirable that chips be secured at a municipal quarry if lower prices cannot be obtained. It is suggested that it might be advisable to place a small crusher in each asphalt plant, to crush the larger sizes of stone, in case a municipal quarry is not opened. Attention is called to the lack of economy in having extensive auto trucks stand for long periods while waiting to be loaded during the grading operations, unless the haul is so long as to overcome the loss of time.

Better selection of the sizes of sand and stone, so as to reduce the voids in the aggregate, is recommended in connection with the concrete foundations, and more uni-

formity in the thickness of the concrete foundations and the method of finishing. It is stated that the surface of a foundation laid for an asphalt pavement should preferably be slightly roughened, resembling as much as possible the stuccoed wall of a house, whereas some of the city gangs have been noticed to trowel the surface with the backs of their shovels, while other gangs have left it entirely rough. The variation allowed should not be greater than one-half inch from the given line, as in the case of subgrade. Grade stakes should in no case be left in the concrete, as they are apt to cause damage to the surface later on. Greater care should be taken in the setting of manholes and manhole boxes, so as to render unnecessary any adjustment of the pavement surface to meet the obstructions.

It is advocated that the binder course be dispensed with and that the asphalt be laid from curb to curb or from curb to rail on streets with car tracks. It is recommended that there be only three city asphalt plants instead of four, but that they be better situated and with a much larger capacity, equipped with tanks, steam coils, automatic scales, etc.

Attention is called to the lack of cost-control systems in the city paving work, and it is recommended that the city should adopt one of the systems already built up by some experienced paving contractor.

A comprehensive scheme of paving for the city is urged, with particular attention to a system of main arteries, so that any section of the city may be reached by these main arteries, which should be well paved and maintained in the best condition, other pavements over which there is only local traffic being neglected if necessary in order to secure the best conditions on the main traffic highways.

The report contains approximately fifteen thousand words and is very exhaustive, reviewing the whole field and offering a considerable number of valuable constructive criticisms, although there are some recommendations with which all engineers would not agree, particularly the recommendation that one type of pavement be adopted as the standard throughout the whole city, the statement that certain pavements previously laid in Montreal could not have proven economical "had they lasted forever without repair or renewal," and the recommendations regarding omission of the binder course.

There are over 2,000,000 miles of so-called roads or highways in the United States, but there are only about 30,000 miles that can be described as "improved." Ten thousand miles of the 30,000 are not traversable after a heavy rain.

In 1910, California voters approved an $18,000,000 road bond issue with which was constructed a large mileage of concrete roads. The newly constructed roads proved so satisfactory that at the close of 1916 the state approved a new $15,000,000 bond issue by vote of almost 4 to 1. In 1910, Los Angeles county voters were almost 4 to 1 against the proposition, but in 1916 they turned the tables and approved the new issue by a vote of more than 3 to 1.

The forty-first annual meeting of Willans & Robinson, Limited, was held at Rugby, England, on April 24th, 1917. The balance sheet showed a trading profit for the year of $150,600. The net profit was $100,450, after payment of debenture interest, provision for depreciation of plant and machinery, re-valuation of stocks, allowances to employees on active service, and special provision for the exceptional wear and tear and outlays arising from conditions connected with war output. The reserve account now stands at $255,020, and the total assets of the firm amount to $2,923,250.

CONSTRUCTION OF BROKEN-STONE ROADS.

By George Reakes, C.E.,
Engineer and Contractor, Beaconsfield, P.Q.

IN the early part of the 19th century two systems were introduced into England for highway purposes; the first by Telford and the second by Macadam, and from these systems the modern road engineer has drawn the principles upon which all present-day broken stone roads are made.

In the making of the waterbound macadam road, sufficient attention is not paid to the natural soil bed upon which the foundation is laid. The base should be thoroughly drained, rolled till hard and compact, and to the same grade and shape as the finished road. On this the foundation is laid either on the Telford or Macadam system, the Telford foundation consisting of large stone laid by hand in the form of a close and firm foundation, set upon their broadest edges, lengthwise across the road.

The principal defects of this foundation are the large percentage of voids left between the foundation stone, giving free access to water, and thus defeating one of the main objects of the road covering, and its high cost of construction.

The writer, in building a stretch of road a mile long, used the Telford method of hand-placed stone, and in order to reduce the percentage of voids as low as possible, spread a layer of clean stone screenings over the foundation, well-watered, broomed in and well rolled. (Owing to the close proximity of the quarry, the cost of road was greatly reduced.)

For the Macadam method, 1½-inch stone is laid to a depth of 10 or 12 inches, no binding material being used, the stone being left to work in and unite by its own angles under the traffic. The writer, in making a 3-mile stretch of macadam waterbound road, used for foundation stone broken to about 5 inches in size and laid in two layers, each layer well watered and rolled, a layer of stone screenings spread over same, well watered and broomed in to fill up all voids.

The second course of stone was 2½ inches in size and treated with water, rolling and screenings. The wearing course was of 1-inch stone, about 3 inches in depth, rolled, watered and stone screenings spread on. After the final rolling, stone screenings were again spread on and left for 14 days, when roller and water cart were again called into requisition and the whole length watered and rolled again, all surplus material being swept off.

The essentials in making successful broken-stone roads are:—

(*a*) The removal of the natural soil to such a depth as may be necessary, according to the soil and thickness of the intended covering.

(*b*) Thorough sub-surface drainage.

(*c*) The use of best materials, reduction of voids and complete exclusion of clay loam from the broken stone.

(*d*) The use of clean, sharp sand, gravel or stone screenings.

(*e*) Work to be carried out under proper engineering organization and in a systematic manner.

The question of maintenance of these roads after being built should be taken into consideration. Many municipalities making good roads seem to ignore the fact that roads, like everything else, will wear out. They are often left to take care of themselves, and this results in a heavier cost in the end for repairs.

RAILWAY ENQUIRY COMMISSION'S REPORT.

(Continued from page 396.)

circumstances as they at present exist," without outlining any of the reasoning leading up to that conclusion.

The Mexican precedent, whereby the government indirectly controls the roads through stock ownership, and the New York Subway precedent, where the government owns the roads and leases them upon terms ensuring the lessor a return on his investment, were also rejected.

Outline of Dominion Railway Co.— Its Organization and Prospects

The majority report recommends that the Dominion Railway Co. have a nominal capital of $50,000 divided into five hundred shares, each trustee holding a hundred shares registered in the joint names of each trustee and the minister of finance. The trustee, having been named first, would be entitled to the vote, but could not transfer his shares without the finance minister's signature, and the charter would provide that no share could be transferred except to a duly appointed trustee, and that the shares were to be held in trust for the Dominion.

It is recommended that the government should transfer to the trustees the $40,000,000 common stock of the C.N.R., and all the Intercolonial and N.T.R. assets; that the C.N.R. transfer the $60,000,000 stock remaining into private hands; and that the G.T.R. transfer the whole of their stock and also the whole of the common stock of the G.T.P., the latter to be without payment except for the actual cash paid for shares other than those held by the G.T.R.

The C.N.R. common stock shareholders are to be paid an annuity decided by arbitration. The G.T.R. shareholders are to be paid annually a moderate but substantial (arbitrated) percentage of the $3,600,000 dividends which they have been receiving for the last ten years. The board of trustees is to be appointed by parliament in the original instance and to consist of three experienced railway men, one financial or business man and one labor leader. The first three railway trustees are to retire respectively after three, five and seven years' service, the other trustees respectively after four and six years.

To Keep Party Politics Out of Management.

The term of office of each trustee, with the exception of the first appointments, will be seven years, and the board will thus be permanent and self-perpetuating. Upon the retirement of a trustee, his four colleagues are to name his successor, but their choice must be approved by the governor-in-council. Failing such approval, a new name must be submitted by the trustees. All trustees are eligible for re-election but must retire at the age of seventy years. In case of death or disability of any trustee, his successor is to be elected merely for the unexpired term of office.

Only the three railway trustees are expected to devote their entire time to the company. The trustees have the power to appoint vice-presidents in charge of operation and other branches of management. It is advised that the trustees should be given wide powers in determining upon centralization or local management and in regard to the combination of the systems and elimination of waste. The board is preferably to be non-political, but in case men of recognized political affiliation are chosen, it is inferred that not more than three of the trustees should be from either of the two parties.

The board of trustees is to be independent of parliament, and to manage the Dominion Railway Co. with the object of earning dividends on the entire capital cost on all the roads under their control. The government is to assume responsibility to the trustees for the interest on all securities of the new combined system.

From the table on page 389 it will be seen that there is a deficiency of about $10,500,000 on operation, during the past year, of all the roads forming the Dominion Railway Co. To this must be added the cost of settlement with the convertible income debenture holders of the Canadian Northern, the annuities payable to Grand Trunk and C.N.R. shareholders, and the interest on the capital necessary to complete the system and make urgently needed betterments and additions. Further, the commissioners do not consider that the Grand Trunk dividend is a really net surplus but that it ought to go back into the maintenance of the property. On the other hand, they say, the economies resulting from the amalgamation ought to be very large.

The commissioners take as a starting point a total deficiency of about $12,500,000 a year. They feel that it is not unreasonably sanguine to hope that this deficiency can be eliminated in the course of six or seven years. A few specimen economies resulting from combination are given. As one instance, it is said that by building thirty-five miles of new road, the Dominion Railway Co. would have a shorter Winnipeg-Toronto mileage than any of the existing roads, shorter even than the C.P.R.

Valuation of C.N.R. and G.T.P. Establishes New Record for Cost

A physical appraisal of the C.N.R. and G.T.R. was conducted under the direction of Prof. Geo. F. Swain, of Boston. A new record was made in this valuation work. No less than 13,425 miles of railway were valuated in six winter months, October to March, and at a cost of only about $3 a mile. The cost of this valuation compares with $240 per mile for the Interstate Commerce Commission's valuation of United States railroads, with $40 per mile for Prof. Swain's valuation of the New York Central Lines, and with $50 to $100 per mile for other valuations which have been made by him.

Besides 9,375 miles of C.N.R. and 2,698 miles of G.T.P. main line and branches, there were valuated 1,352 miles of C.P.R. for purposes of comparison.

Prof. Swain's engineering assistants were W. H. Chadbourn, chief engineer; C. S. Gzowski, in charge of examination of certain C.N.R. and G.T.P. lines, assisted by G. H. Burnett, J. W. Chappelle and L. Phillips; G. R. Balloch, in charge of examination of certain C.N.R. lines, assisted by H. MacNeil, F. O'Gara, L. J. M. Howard, and J. Rainboth; A. H. N. Bruce, in charge of examination of certain C.N.R. branches; T. S. Armstrong, in charge of examination of certain C.N.R. lines; W. H. McGaan, in charge of examination of certain C.N.R. lines, assisted by W. B. Elder; N. Cauchon, specially assigned to valuation of real estate at terminals; H. Horner, architect, in charge of valuation of buildings of all kinds; B. M. Hill, in charge of examination of G.T.P. between Winnipeg and Edmonton; A. L. Ford, in charge of preparation of report on G.T.P. between Edmonton and Prince Rupert; C. Gilmore, assisting Messrs. Hill and Ford; E. C. Keefer, general office assistant, engaged in working up the final reports, making estimates from profiles, etc.; C. H. Larkin, engaged in estimate of areas and values of right of way.

HIGH VOLTAGE TRANSMISSION LINE TO SPAN ST. LAWRENCE RIVER.

By Frederick T. Kaelin, E.E.,
Assistant Chief Engineer, Shawinigan W. and P. Co.

THE Shawinigan Water and Power Co., which furnishes electric power to all of the large industrial centres of Quebec Province, in order to transmit properly the increased amounts of power to its receiving stations located south of the St. Lawrence River, has found it necessary to undertake an engineering feat of considerable interest.

Designs are being prepared for the construction of a 5,000-ft. clear span of the St. Lawrence River for the conductors of the electric transmission lines, thus supplementing the existing submarine cable installation already supplying power to the mining and manufacturing districts. This span is the longest known of its kind, and will be located about 1¼ miles upstream from Three Rivers, P.Q.

The three electrical conductors will be made of the highest grade of plough steel, spaced fifty feet apart, all in the same horizontal plane, arranged thus to prevent contact with each other due to swinging. In order to connect with existing transmission lines, the crossing conductors will be insulated from the steel towers and earth against a difference of electric potential of 100,000 volts. Because of the very high tensile stresses in the cables they will not be anchored at the towers, but will be supported on the top of the towers by saddles, permitting the movement due to temperature changes, and be anchored to concrete blocks some distance behind each tower.

The mechanical problems of this arrangement of anchoring permit of easier solution than do the problems of the electrical insulation of the conductors from the earth potential of the anchorage. The magnitude of the ceramic and mechanical engineering involved in the electrical insulating problem can better be appreciated when it is pointed out that in addition to the electrical stress incident to the 100,000 volt transmission potential the insulation for each conductor must provide sufficient mechanical strength of above 100,000 pounds in compression, due to the tension of the cable. Further, the arrangement of the insulation must permit the replacement of any portions showing electrical failure without incurring hazard to the mechanical safety of the span. An elaborate arrangement of porcelain insulators of a new type, held in compression only, has been designed to fulfil the conditions specified.

The structural steel towers, one on each side of the river, weighing approximately 200 tons each, are to be built upon concrete piers located in the river, 500 ft. from each shore. These towers rise to a height of 350 ft., which is the same height as the top of the Quebec Bridge. This great height is necessary in order to provide 160 ft. clearance above the water level under maximum conditions of ice-loading of the conductors. As the river is navigable for the largest ocean vessel, this clearance must be provided.

The river bottom is composed of sand to extreme depths at this point, so the concrete footings are of considerable interest. The footing piers will be excavated by the use of concrete caissons, which, when sunk to full depth, will be filled with concrete, remaining as a part of these piers. The piers are cylindrical in section, 11 ft. in diameter, extend to a depth of 40 ft. into the river bottom, and 25 ft. above the bottom, being partially submerged. At the top, above the water level, the piers are tied together by concrete struts, forming a square, 60 ft. by 60 ft.

It is expected that the work on this long-span river crossing will start as soon as the St. Lawrence River conditions will permit. It is planned to complete the whole work in the year 1917.

SURVEY OF CANADA'S RESOURCES.

The Advisory Council for Scientific and Industrial Research is making a broad survey of the possibilities of the Dominion in the way of scientific research and other work with the available laboratories, technically trained men and other facilities, with a view to mobilizing these forces for the speedy and satisfactory solution of the many problems facing the Dominion in the readjustment of business after the war. A series of questionnaires is being sent out, chiefly to the universities, to professional men, and to the managers and directors of the Canadian industries.

The Canadian Mining Institute, the Canadian Society of Civil Engineers and the Canadian Society of Chemical Industry are co-operating with the Council in conducting this work.

A central committee has been appointed at Montreal, with branches in the various provinces, to look after the work of taking the census in such a manner as to learn the research requirements and future needs of the Canadian industries, with a view to providing for their requirements in such manner that in years to come they will not be dependent for supplies upon Germany, for instance, as in the past.

H. Mortimer Lambe is chairman of the central committee, supported by Prof. Ernest Browne, for the Canadian Society of Civil Engineers; Mr. G. M. Murray, for the Canadian Manufacturers' Association; Dr. Milton Hersey, for the Society of Chemical Industry, and H. H. Couzens, representing the Joint Committee of Technical Organizations, Ontario branch.

The provincial organizations have divided their work into districts, under local captains, so as to ensure a thorough distribution of the questionnaires.

As replies are received, they will be sent to the secretary of the Advisory Council at Ottawa, where the information gained will be considered and collated. The work is being done under the advisement of Sir George Foster, minister of trade and commerce, and under his direction further developments will depend upon the information gained.

INTERNATIONAL JOINT COMMISSION MEETINGS.

The International Joint Commission met in Toronto last week for four days. There was a full attendance, all three United States members being present, and all three Canadian members, together with both secretaries and both consulting engineers. The finishing touches were put to the Commission's report on the levels of the Lake of the Woods, and the document is now believed to be ready to be submitted to the Canadian and United States governments. It is said to be in seven volumes, three containing engineers' reports and maps, the others including the evidence and recommendations.

Editorial

MECHANICAL HANDLING OF ASPHALT.

Under the above title an article appeared in the August 3rd, 1916, issue of *The Canadian Engineer*, descriptive of a tank erected in Toronto by the Commissioner of Works, to enable the city to handle asphalt in bulk instead of in packages. The operation of this tank has been so successful, and has so materially reduced the cost of asphalt to the city of Toronto, that the subject will prove of interest to all municipal engineers who purchase any quantity of asphalt.

The Toronto tank cost, with steam coils, $1,270; the cost of the pump was $337, and the cost of the pipe lines, steam jacket and foundation for tank was $400. The total cost, therefore, was only approximately $2,000, but prices of steel structures have increased considerably since the contract for this tank was awarded, and another similar tank would no doubt cost more to-day. The Toronto tank can handle one hundred tons of asphalt at a time, which is approximately three tank-carloads.

The Department of Works of Toronto is required each year to keep in repair an increasing area of asphalt and other bituminous pavements, and in addition lays a certain number of new pavements by day labor in addition to those laid by contractors. To carry on this work approximately 2,000 tons of asphalt are used each year.

Upon the basis of 2,000 tons, all received in tank cars, a direct saving of from $5,000 to $6,000 is effected, as there is usually a differential in price between tank and package shipments of from $2.50 to $3.00 per ton in normal times. At present cost of metal packages, the differential is even higher. The average differential on all bids received by the city of Toronto for the past three years is $2.68.

To this initial saving should be added the saving in labor of stripping and of unloading and handling of packages. The saving in stripping is particularly noticeable in hot weather, when it is difficult to strip barrels.

With modern equipment, such as pumps especially built for the purpose, insulating jackets which reduce the time and cost of unloading, etc., there should be little or no demurrage to pay on the tank cars, even in severe weather.

From the above facts it will be seen that, other things being equal, the erection of storage tank and purchase of material in bulk might be an attractive proposition, even to cities which use much smaller quantities of asphalt than are bought by the city of Toronto, as the cost of the tank would probably soon be made up by the savings effected.

The whole question is largely an economic one and must be carefully figured for each city separately. What is profitable in Toronto might not be profitable in, say, Halifax, and vice versâ. The savings effected in Toronto, however, are so large that every city and town engineer who buys asphalt should sharpen his pencil some evening and figure carefully whether investment in a tank would be wise for his municipality, and when his figures are complete, they should be submitted to a competent consulting engineer for checking and further advice.

THE RAILWAY REPORT.

Neither Sir William Mackenzie nor Mr. E. J. Chamberlin appear to be pleased with the majority report of the Royal Commission to Enquire into Railways and Transportation in Canada. Sir William does not admit that the shareholders of the C.N.R. have no equity in their property. Mr. Chamberlin has issued a statement to G.T.R. shareholders, advising them not to be alarmed, and stating that the report contains inaccuracies and misleading statements and that the credit of the Grand Trunk is high and its financial position not at all as stated in the report.

If it is true that the majority report contains inaccurate or misleading statements, full details regarding these should be given to the public and to parliament at once by the Grand Trunk and C.N.R. presidents. The scheme suggested by Messrs. Drayton and Acworth appears sound, but it is such a close approximation of government ownership and operation, and the wall separating the trustees from parliament is so thin, that we should much prefer to see the railways continue as at present if financially possible. If the figures given in the Drayton-Acworth report are even approximately correct, however, there appears to be no possibility of the G.T.R. and the C.N.R. being able to weather the storm without such extensive government aid that it might be unfair to the Canadian people if given without any *quid pro quo*.

The heads of the two railway systems involved should present an outline of their plans for the future, showing that they are independent of undue government assistance and able to carry out all obligations. If their plans are feasible, parliament should let them work out their own salvation, but when advancing further money make certain of ample security. If the railways cannot stand fairly alone, and judging from the Drayton-Acworth report they most certainly cannot, and if the railways do not show any decided errors in the report, the government's course of action is obvious.

The Drayton-Acworth report is, of course, weakened by the fact that it is not unanimous, yet Chairman Smith's minority report cannot be taken with the same degree of confidence as is that of Sir Henry Drayton and Mr. Acworth. In its October 12th, 1916, issue, *The Canadian Engineer* said editorially that Mr. Smith controls important interests in Canada and has affiliations and competitions that cannot but unconsciously color his viewpoint. It was a foregone conclusion in the minds of some people that Mr. Smith would be sure to report exactly as he did. On the other hand, it appeared almost equally certain that Sir Henry Drayton, whose reputed public ownership sentiments were well known, would also report in the manner in which he did. Mr. Acworth was the only unknown quantity, and it is on account of Mr. Acworth's agreement with Sir Henry Drayton that we assign such great importance to the Drayton-Acworth report. Mr. Acworth has never been a champion of public ownership. The strenuous efforts made by the Drayton-Acworth report to get away from government operation, show Mr. Acworth's continued reluctance to recommend the elimination of private ownership. It ap-

pears that there must have been serious, outstanding and convincing reasons for Mr. Acworth's approval of the formation of a Dominion Railway Co.

Mr. Smith's report is very weak compared with the Drayton-Acworth report. The former deals largely with generalities and platitudes, the latter bristles with statistics and logic.

The majority report outlines clearly why the other roads are not turned over to the Canadian Pacific. Probably because the report is not so clear regarding why the Canadian Pacific should not be absorbed along with the other roads, many of the daily newspapers throughout Canada have taken the view that the C.P.R. should also be taken over by the government and merged with the C.N.R. and G.T.R. The C.P.R. is amply able to take care of itself. It is not evading any obligation to the government, nor is it asking for any aid. We venture the opinion that it does not want to be taken over, even if it has to meet the competition of a Dominion Railway Company. The C.P.R. shareholders expect great profits in the future when the population of Canada has been doubled or trebled. Assuming that the government could possibly raise the money necessary to buy out the C.P.R., how could it be done without the consent of shareholders who would have no reason for foregoing large future profits? Compulsory absorption of the C.P.R. would be tantamount to confiscation, and the government cannot possibly afford to make an offer sufficiently attractive to induce the C.P.R. shareholders to surrender cheerfully their bright prospects for the future.

The report is an historic document, and assuming its correctness, presents the Canadian railway situation in a very clear and concise manner. Parliament should not be dilatory in dealing with it, but very discreet. It has made many railway mistakes in the past. It cannot afford to move very far again in any direction in railway matters unless it is absolutely sure of its footing.

PERSONAL.

H. BARON, who has been electrical superintendent at Stettler, Alta., for the past two years, has been appointed chief engineer for the town of Camrose, Alta.

GEORGE BURY, vice president of the C.P.R., has arrived in Montreal from Russia.

R. P. BUTCHART, of Victoria, B.C., has been requested by the Imperial Munitions Board to associate with the Board in its work of shipbuilding on the Pacific Coast. A large organization will have to be formed in connection with the plans decided upon for the building of a great number of wooden ships. Mr. Butchart will act as business adviser and will have supervision of the organization on the coast on behalf of the Board. Mr. Butchart is head of the Pacific Cement Co., Victoria.

JOHN COLLINS, who has been with the Canadian Steam Boiler & Equipment Co., Toronto, has been appointed manager of H. L. Peiler & Company's Toronto office.

V. G. CONVERSE, general manager and chief engineer of the Ontario Power Company, of Niagara Falls, and E. D. KING, superintendent of the plant, have resigned. It is thought these resignations are due to the reported purchase of the Ontario Power Company by the Hydro-Electric Power Commission of Ontario.

GALBRAITH & CATE, LIMITED, engineers and contractors of Montreal, have decided to discontinue business until the return of their managing director and of their secretary-treasurer, both of whom are on active military service.

Dr. LOUIS HERDT, of McGill University, is acting as honorary advisor to the French government in the selection and purchase of electrical supplies. Very large orders, amounting to over $2,000,000, have been placed with Canadian firms, principally wire and cable companies, which otherwise might have gone elsewhere. At the invitation of Dr. Herdt representatives of the French government visited many of our factories and the business referred to above followed.

A. R. HOLMES, formerly secretary-treasurer and engineer of the McKinnon, Holmes Company, Limited, of Sherbrooke, Que., and GEO. H. ARCHIBALD, who has been associated for the past ten years with the Geo. H. Archibald Company, Limited, Winnipeg, have formed a partnership as engineers and builders of reinforced concrete and steel structures, and have opened an office in Toronto.

Lieut.-Col. T. C. IRVING, formerly vice-president of Robert W. Hunt & Co., Limited, engineers, and the Moffat-Irving Steel Works, Limited, Toronto, was recently gazetted as colonel in the 4th Canadian Division. Col. Irving left Toronto with the First Canadian Contingent as a captain in charge of the 2nd Field Company of the Engineers. He received the D.S.O. at the battle of Langemarck, and shortly afterwards obtained his majority.

GEORGE McKNIGHT, city engineer for Fredericton, N.B., has resigned.

P. PHILIP, formerly with the city engineer's department, Vancouver, has been appointed supervising engineer by the British Columbia government for District No. 3 at Kamloops.

Capt. STEWART M. THORNE, a graduate of the School of Practical Science, Toronto, has been decorated for bravery. Prior to his enlistment he was manager of the Trethewey mines, and was well known throughout Northern Ontario. He enlisted with an engineering unit recruited in Cobalt in January, 1916, and has been in France for the past fifteen months. He received his captaincy in the field.

G. L. WALLACE has been appointed structural engineer in the city architect's department, Toronto, to succeed R. J. Fuller, resigned.

J. L. WELLER, M.Can.Soc.C.E., chief engineer in charge of the work on the new Welland Ship Canal, and all his engineering staff, have been relieved of their positions owing to the complete closing down of the work on May 2nd. None of the contractors' plant can be sold without the special consent of the Dominion Government.

R. YOUNG, a gas expert of Pittsburg, Pa., has been appointed manager of the St. Thomas, Ont., gas plant.

WINNIPEG SUB-SURFACE FORMATION.

The regular meeting of the general section of the Manitoba Branch of the Canadian Society of Civil Engineers was held last Thursday evening in the Engineering Building of the University of Manitoba. Mr. Rankine read a paper, "Sub-Surface Formation of the Winnipeg District and the Types of Suitable and Unsuitable Foundations for Its Heavy Structures."