

BUILDING THE NORTHERN TRANSCONTINENTAL RAILWAYS

**The Grand Trunk Pacific and Canadian Northern
Through the Yellowhead Pass and to the Pacific**



**By Grant S. Bailey, P.Eng.
Delivered to the Lexington Group – History Panel
Calgary, Alberta
September 30th, 2010**

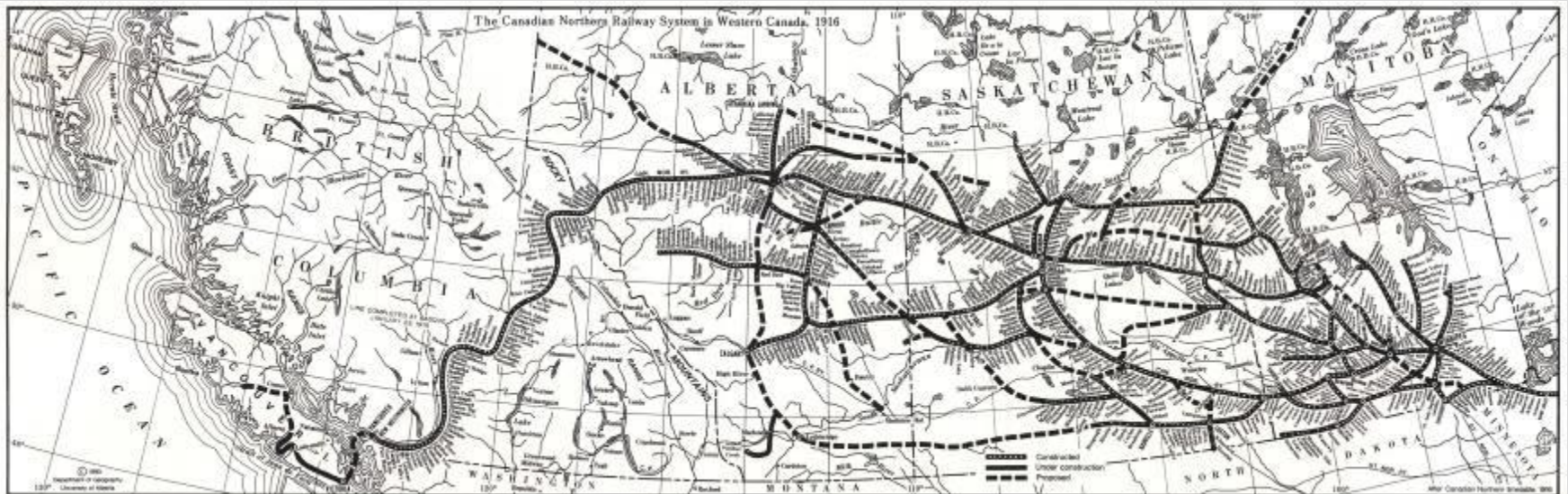
The Yellowhead Route



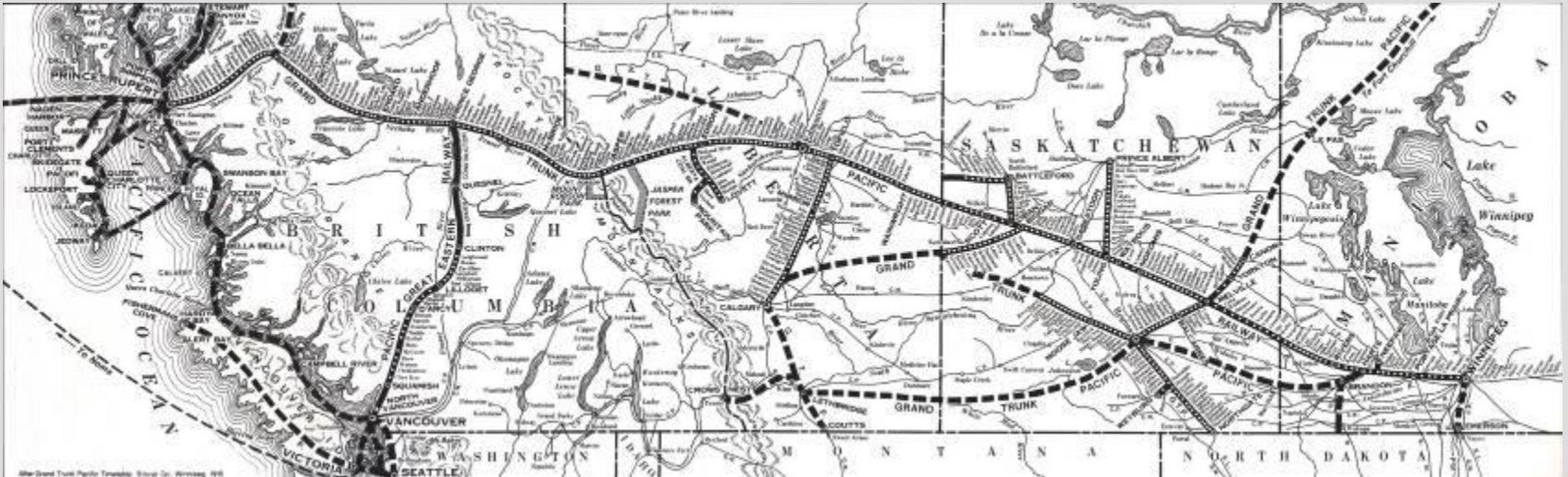
“True, the adoption of this route has robbed the construction of the Grand Trunk Pacific of spectacular engineering achievements. One looks in vain for those wonderful loops and spirals by which other lines ascend and descend the mountain chains. Yet the most impressive feature about this railway is the fact that it crosses the awe-inspiring Rocky Mountains at a lower altitude and with a greater ease than many other lines span the rolling desert, and it does that without recourse to prodigious, costly, or picturesque work.”

F.A. Talbot

The Railways



The Railways



The Leaders



Sir Wilfrid Laurier



Charles Melville Hays



Sir William Mackenzie



Sir Donald Mann

All men of vision, determined, competitive, and with an unshakable belief in the vast potential of Canada.

Transcontinental Empires

With the availability of what seemed like unlimited government subsidies and guarantees, both GTPR and CNoR were bent on the construction of their own transcontinental empires.



Grand Trunk Pacific Railway

- The GTPR chose a Pacific coast terminus on Kaien Island in Northern B.C. due in part to the closer proximity of this location to the Pacific Rim (subsequently named Prince Rupert)



Prince Rupert

- Construction commenced eastward from Prince Rupert in 1908 and continued westward from Edmonton in 1909.



Canadian Northern Railway

- The CNoR chose a Pacific coast terminus just inland from Vancouver at a location on the Fraser River they called Port Mann. From there lines would be constructed to extend to Vancouver and to the delta of the Fraser River.



Port Mann

- Construction commenced both westward from Edmonton and eastward from Port Mann in 1910.

Two Railways through the Yellowhead



Grand Trunk Pacific Railway

- The GTPR surveyed several prospective routes through the Rocky Mountains.



Figure 3.7 GTP Mountain Section alternative routes, 1906, and selected communities, 1917

- The choice of their final route was closely guarded until their plans to build through the Yellowhead were filed with the Department of Railways and Canals in 1906.
- After considerable lobbying by the rival companies, GTPR was granted first rights to build through the Yellowhead.



Canadian Northern Railway

- Although CNoR had filed plans to build through the Yellowhead before the GTPR, no intended Pacific coast terminus had been shown in these plans.
- The federal government viewed the CNoR plans as incomplete and approved the GTPR plans first.
- The CNoR was thus forced to resurvey and modify their route through the Yellowhead Pass.



GTPR Chief Engineer B.B. Kelliher's Yellowhead Recommendation Letter

NO 43 V. 306 4402 p 2
COPY.
Montreal, Que., November 1st., 1906.

Mr. Frank T. Morse,
Vice Pres. & General Manager.

Dear Sir:-

After three years of extensive surveying and study of the mountain district between Edmonton and the Pacific Coast, embracing Exploration, Reconnaissance and Preliminary Instrumental surveys through every available route over the Rocky Mountains from Yellow Head Pass on the south to Peace River Pass on the north (both inclusive), the route via Yellow Head Pass is recommended as incomparably the best available for the location of the Grand Trunk Pacific Railway between Edmonton and Prince Rupert.

The result of our surveys for the first two years presented four routes as available through the mountains: one via Yellow Head Pass, one via Tapaniti Pass, one via Pine River Pass, and one via Peace River Pass. In order to more accurately determine the comparative merits of these four routes, detail surveys were made on each during the past year. The result of these surveys is represented by attached blue-prints of map and profile, a comparative statement of each of the four routes, and a comparative estimate, from all of which it will be seen that the Yellow Head Pass route is greatly superior to the others in every element of comparison, with the exception of a slight disadvantage in total curvature.

The route via Yellow Head Pass is 30 miles shorter than via Tapaniti Pass, 21 miles shorter than via Pine River Pass, and 103 miles shorter than via Peace River Pass. It admits of a 0.4% grade against westbound traffic between Edmonton and the Coast (as it is reasonable to presume that our Engineers in the field are right in their statement that the 6 miles of 1.0% grade shown on profile between Mile 443 - 449 can be eliminated) and a 0.4% grade against eastbound traffic except about 20 miles of 1.0% between Miles 290 - 310. The result of this is, as

“the route via Yellowhead Pass is recommended as incomparably the best available for the location of the GTPR . . . ”

“It admits of a 0.4% grade against westbound traffic between Edmonton and the coast . . . and a 0.4% grade against eastbound traffic except about 20 miles of 1.0% between Miles 290 and 310”

GTPR Chief Engineer B.B. Kelliher's Yellowhead Recommendation Letter

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Mr. Frank W. Morse,
Vice Prost. & General Manag

Dear Sir:-

After three years of a the mountain district between Ed embracing Exploration, Reconnois surveys through every available from Yellow Head Pass on the sou north (both inclusive), the route recommended as incomparably the of the Grand Trunk Pacific Railwa Rupert.

The result of our surv presented four routes as availabl via Yellow Head Pass, one via Taz Pass, and one via Peace River Pa determine the comparative merits surveys were made on each during these surveys is represented by a profile, a comparative statement a comparative estimate, from all the Yellow Head Pass route is gre every element of comparison, with disadvantage in total curvature.

The route via Yellow He than via Wapiti Pass, 91 miles sh and 108 miles shorter than via Pe a 0.4% grade against westbound tr Coast (as it is reasonable to pro field are right in their statemen grade shown on profile between Mi and a 0.4% grade against easthoun of 1.0% between Miles 290 - 210.

compared with the other lines on a basis of six freight trains per day each way, that it saves 8 helping engines on the Wapiti Route, 3 helping engines on the Fine Route, and 9 helping engines on the Peace Route.

It has 1840 feet less raise and fall than the Wapiti, 1750 feet less than the Fine, and 2570 feet less than the Peace Route.

The Yellow Head Route first cost is \$3,490,000.00 less than the Wapiti, \$4,536,100.00 less than the Fine, and \$6,251,000.00 less than the Peace Route.

The only item not favorable to the Yellow Head Route is that it has 392° more curvature than the Wapiti, 1306° more than the Fine, and 554° more than the Peace Route.

The summation of these items, all of which affect the first cost of construction, or the subsequent extra cost of operation capitalized shows the route via Yellow Head Pass to be \$10,512,800.00 less than the Wapiti, \$15,983,320.00 less than the Fine, and \$2,097,560.00 less than the Peace Route.

The present condition of the territory between Edmonton and Prince Rupert shows no local traffic advantage on either route as against the other, that would justify any lengthening of the main line or above all any increase in the lowest rate of gradient available via the Yellow Head Pass.

Yours truly,

Sgd. B. B. Kelliher,

Chief Engineer.

Factors Considered

← Helper Engines

← Rise and Fall

← First Cost

← Curvature

← Traffic

GTPR Chief Engineer B.B. Kelliher's Yellowhead Recommendation Letter

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Yours truly,

Sgd. B. B. K

GRAND TRUNK PACIFIC RY..

EDMONTON TO PRINCE RUPERT.

Values of the various routes as compared with Yellow Head Pass Route, computed on a basis of six freight and two passenger trains per day each way.

Yellow Head Pass Route taken as 0.00

Tappiti Route.

Excess in first cost	\$ 3,490,000.00
Excess in distance, 30 miles,	3,102,000.00
Excess in number of helping engines required (8)	2,800,000.00
Excess raise and fall, 1840 feet,	<u>1,168,160.00</u>

Total, \$10,560,160.00

Credit 592° less curvature 47,360.00

Total excess Tappiti over Yellow Head \$10,512,800.00

Peace River Route.

Excess in first cost	\$ 4,536,100.00
Excess in distance, 91 miles,	9,409,400.00
Excess number of helping engines required (3)	1,050,000.00
Excess raise and fall, 1750 feet,	<u>1,092,000.00</u>

Total \$16,087,500.00

Credit 1306° less curvature 104,180.00

Total excess Peace over Yellow Head \$15,983,320.00

Yellow Head Route.

Excess in first cost	\$ 6,251,000.00
Excess in distance, 108 miles,	11,167,200.00
Excess number of helping engines required (9)	3,120,000.00
Excess raise and fall, 2570 feet,	<u>1,603,680.00</u>

Total \$22,141,880.00

Credit 554° less curvature 44,320.00

Total excess Yellow Head over Yellow Head \$22,097,560.00

Correct:

Sgd. B. B. Kelliher.

Chief Engineer.

Office of Chief Engineer,

Montreal, Que., November 1st., 1906.

GTPR Chief Engineer B.B. Kelliher's Yellowhead Recommendation Letter

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GRAND TRUNK PACIFIC RAILWAY.

COMPARATIVE ESTIMATES OF VARIOUS ROUTES SURVEYED

From
EDMONTON to PRINCE RUPERT, B.C.

	Distance in miles	Ruling Gradient	Helper Gradient	Helping Districts.						Total helping engines required	Average curvature per mile	Total curvature	Raise W. bound	Fall W. bound	Average Cost per mile		Total Cost
				Westbound			Eastbound								Grading & Bridging	Track, Buildings, etc.	
				No.	Total helping mileage	No. of Engines required	No.	Total helping mileage	No. of Engines required								
Via Yellow Head Pass	955	0.4	1.0	1	6	1	1	21	3	4	45840	3150	5270	330100.	314000.	\$42,115,500.00	
" Wapiti Pass	985	0.4	1.0	3	49	6	3	33	4	12	45248	5050	7110	32300.	14000.	45,605,500.00	
" Pine River Pass	1046	0.4	1.0	2	19	3	5	30	4	7	44534	4920	7020	30600.	14000.	46,651,600.00	
" Peace River Pass	1063	0.4	1.0	2	16	2	5	94	11	13	45286	5700	7840	31500.	14000.	48,366,500.00	

Correct:

Sgd. B. B. Kelliher.
 Chief Engineer.

Office of Chief Engineer,

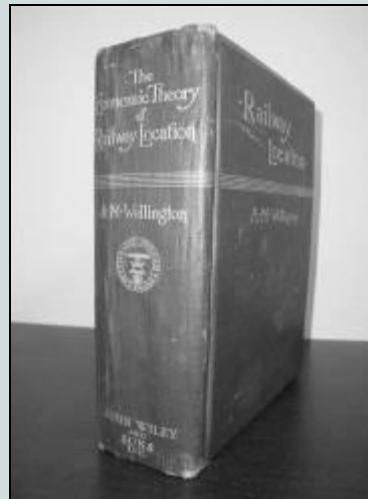
Montreal, Que., November 1st., 1906.



First Cost to be Last Cost



- Both the GTPR and CNoR set very high standards for their new lines to the Pacific Coast. This was likely the result of:
 - an abundance of loan guarantees;
 - a desire to have a future operating advantage;
 - lessons learned from the CPR;
 - the influence of the latest in Engineering practices.
(Wellington's Economic Theory of Railway Location)
- Both railways were determined that **“first cost would be last cost”**.



Wellington's Economic Theory of Railway Location - 1895

TO THE
GREAT MEN OF
A FORMER GENERATION,
WHO ORIGINATED THE AMERICAN
RAILWAY SYSTEM, THIS ATTEMPT TO IM-
PROVE UPON THEIR PRACTICE IS ADMIRINGLY
INSCRIBED, IN TOKEN OF RESPECT
FOR THEIR FAR-SIGHTED
SAGACITY AND STILL
UNEQUALLED
SKILL.

The Highest Standards



Grand Trunk Pacific Railway

- The standard to be used for construction appears to have been largely driven by Hays himself.
- The line would be constructed to a standard to equal the GTP main line between Toronto and Montreal.
- Compensated ruling grades were not to exceed 4/10ths of one percent.
- Curves were not to exceed 6 degrees.
- Steel bridges and heavy rail would be used.
- After Hays' death with the sinking of the Titanic, these standards were maintained by Division Engineer C.C. Van Arsdoll, who became known as "Four Tenths Van".



Canadian Northern Railway

- Prior to construction of their line to the Pacific coast, CNoR had largely balanced construction costs to the traffic available.
- By 1910, the construction of an inexpensive line to be improved later was regarded as an expensive and impractical procedure.
- Canadian Northern appointed T.H. White as Field Engineer. Mr. White had come from the CPR and was determined to avoid the CPR experience.
- Ruling grades were not to exceed 1/2 of one percent (Uncompensated?).
- Curves were not to exceed 6 degrees
- Steel bridges would be used

The Yellowhead Pass

The GTPR was completed through the Yellowhead in 1911 and the CNoR followed in 1913. While the physical challenges were not great, the choice of the Yellowhead Route in combination with the very high standards employed produced two of the finest railways to cross the Continental Divide.

Between Jasper and Resplendent (45 miles)

- No gradient exceeded 0.5 %
- No curve exceeded 6 degrees
- 1 tunnel with a length of 315 feet
- No significant structures

North American Railways - Comparative Grades and Elevations

Railway	Primary Passes	Maximum Grade	Maximum Elevation
Canadian Northern	Yellowhead, Albreda	0.7%	3,706
Grand Trunk Pacific	Yellowhead	1.0%	3,724
Union Pacific		1.8%	8,013
Great Northern	Marias, Stevens	2.0%	5,202
Canadian Pacific	Kicking Horse, Rogers	2.2%	5,321
Northern Pacific	Homestake, Bozeman	2.2%	5,500
Chicago, Milwaukee, St. Paul and Pacific	Pipestone, Snowqualmie	2.5%	6,322
Western Pacific / Denver & Rio Grande Western	Tennessee, Silver Zone, Beckwourth	2.5%	10,240
Sante Fe	Raton, Glorieta, Campbell, Cajon	2.6%	7,421

CANADIAN PACIFIC RAILWAY COMPANY
OFFICE OF THE CHIEF ENGINEER
WINNIPEG, MAN. Aug. 11th, 1914

George Bury, Esq.,
Vice President,
Winnipeg, Man.

Dear Sir,-

I send you herewith Mr. T. C. Macnabb's report on the physical features of the G.T.F., Winnipeg to Prince Rupert, a distance of 1748 miles.

As in the report on the G.T.F., the most important feature is the cost. In this case, however, Mr. Macnabb was not so fortunate in getting information on the cost given and his survey of \$50,254,201 is simply an estimate made by himself. I am inclined to believe, and he agrees with me, that if this estimate errs at all, it errs by being considerably less than the actual cost and by not taking into account the maintenance charges for a number of years which will have to be expended a vast sum to build the best possible work of protection to reduce the maintenance cost and to prevent in case of slight ground movement the road can be built that will prevent heavy maintenance charges. If there is any general criticism to be made of this road it is that the design is too good to be justifiable by the amount of traffic in sight.

CPR Evaluation of GTPR August 11, 1914

“If there is any general criticism to be made of this road it is that the design is too good to be justifiable by the amount of traffic in sight.”

(2)

I am sure you will get a good idea of the country and the character of the road by reading this report and by a study of the photographs accompanying the same. One feature that is rather significant is the small number of elevators on their main line as compared with those on our present main line.

Yours truly,
John A. G. ...
Chief Engineer.

305-0.

Completion



Grand Trunk Pacific Railway

- The Grand Trunk Pacific route to the Pacific was completed with a last spike ceremony at Fort Fraser, B.C. on April 7th, 1914.



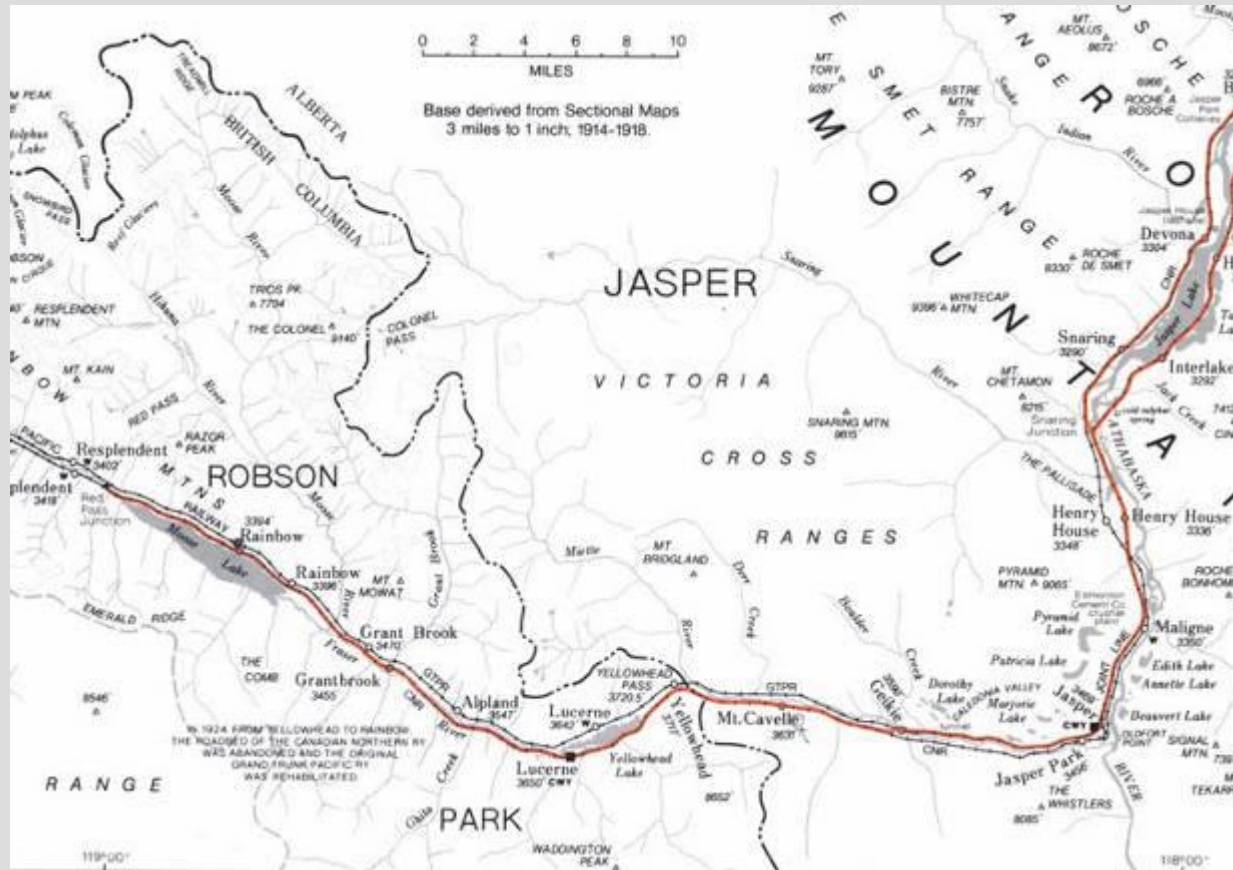
Canadian Northern Railway

- The Canadian Northern route to the Pacific was completed with a last spike ceremony at Basque, B.C. on January 23, 1915.



Consolidation through the Yellowhead

Phase One - War Measures Act 1917



Red line indicates the joint track following the 1917 rationalization.

Consolidation through the Yellowhead

Phase Two –Reclaiming the GTPR Yellowhead to Rainbow

- In 1924, the old Grand Truck Pacific between Yellowhead and Rainbow was relaid, rehabilitated, and reopened. The Canadian Northern track between these locations was subsequently abandoned. This completed the consolidation of the duplicate trackage between Edmonton and Red Pass Junction.
- The eventual mileage of each railway's former main lines between Edmonton and Red Pass used for the mainline of the Canadian National Railway was as follows:

GTPR – 213.35 miles

CNoR - 59.87 miles



Still Existing Canadian Northern Bridge Piers in the Yellowhead

Failure of the CNoR and GTPR

The spectacular waste of constructing and operating two expensive railways through difficult territory when there was barely enough traffic for one led to the failure of both the Canadian Northern and the Grand Trunk Pacific within 5 years of the railways being completed.

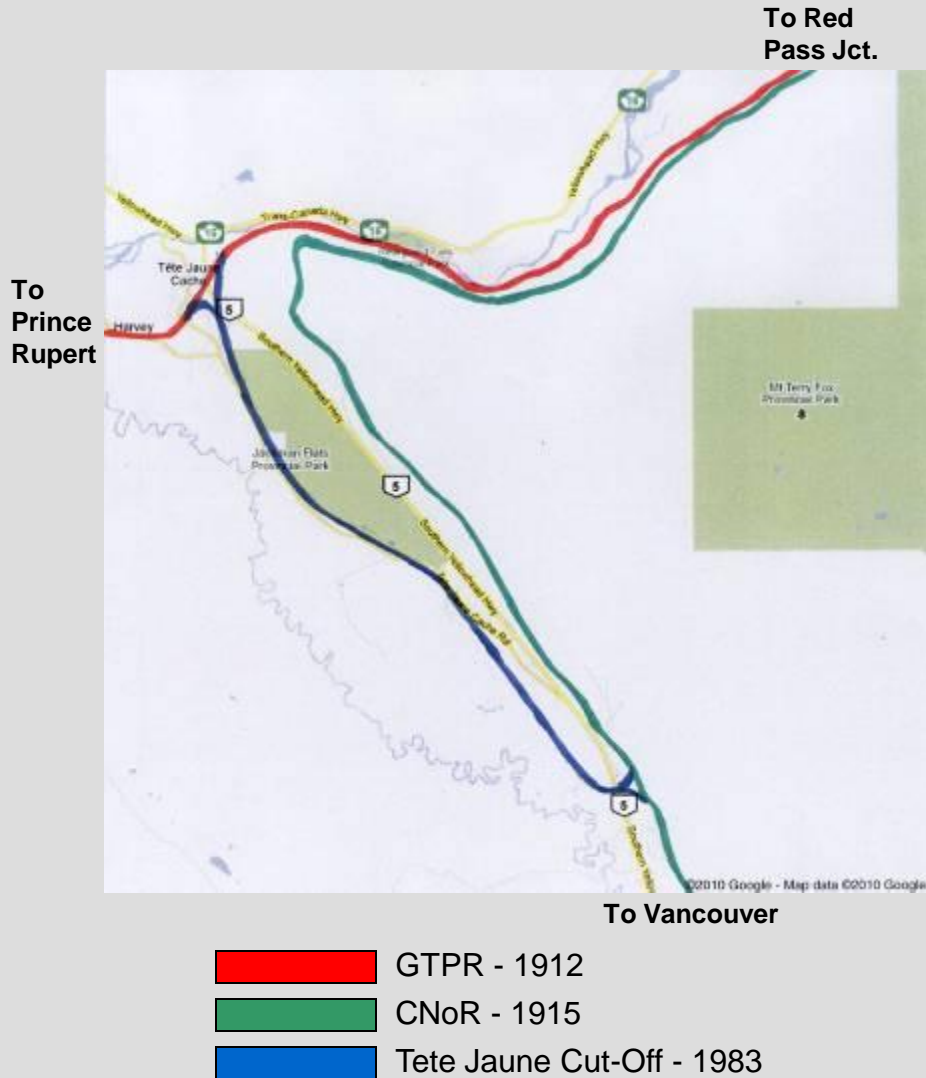
These failures were the result of:

- Too much railway, not enough traffic
 - Extremely expensive construction and huge debt
 - The effects of World War I
-
- On September 6th, 1918 Canadian Northern was nationalized.
 - On March 7th, 1919 Grand Trunk Pacific was nationalized.

Both railways became part of the newly incorporated Canadian National Railway system. CN has been the beneficiary of the route and high standards of the CNoR and GTPR ever since.



The Tete Jaune Cut-Off - 1983



- In 1983, CN extracted one final benefit from the former GTPR and CNoR duplicate routes west of Red Pass Jct. by constructing the new Tete Jaune cut-off.
- This new 10 mile connection effectively allowed all eastbound trains from either Vancouver or Prince Rupert to run on the lighter 0.7% CNoR grade west of Red Pass and all westbound trains to run down the 1.0% grade of the former GTPR.
- It also effectively created 30 miles of double track for CN on their core transcontinental main line route to Vancouver.



Two Fallen Flags Leaving a Formidable Route Legacy for the Canadian National



Time Permitting

Engineering Challenges to the West of the Yellowhead



GTPR



Building a flat land railway through the mountains of northern British Columbia

Engineering Challenges to the West of the Yellowhead



GTPR

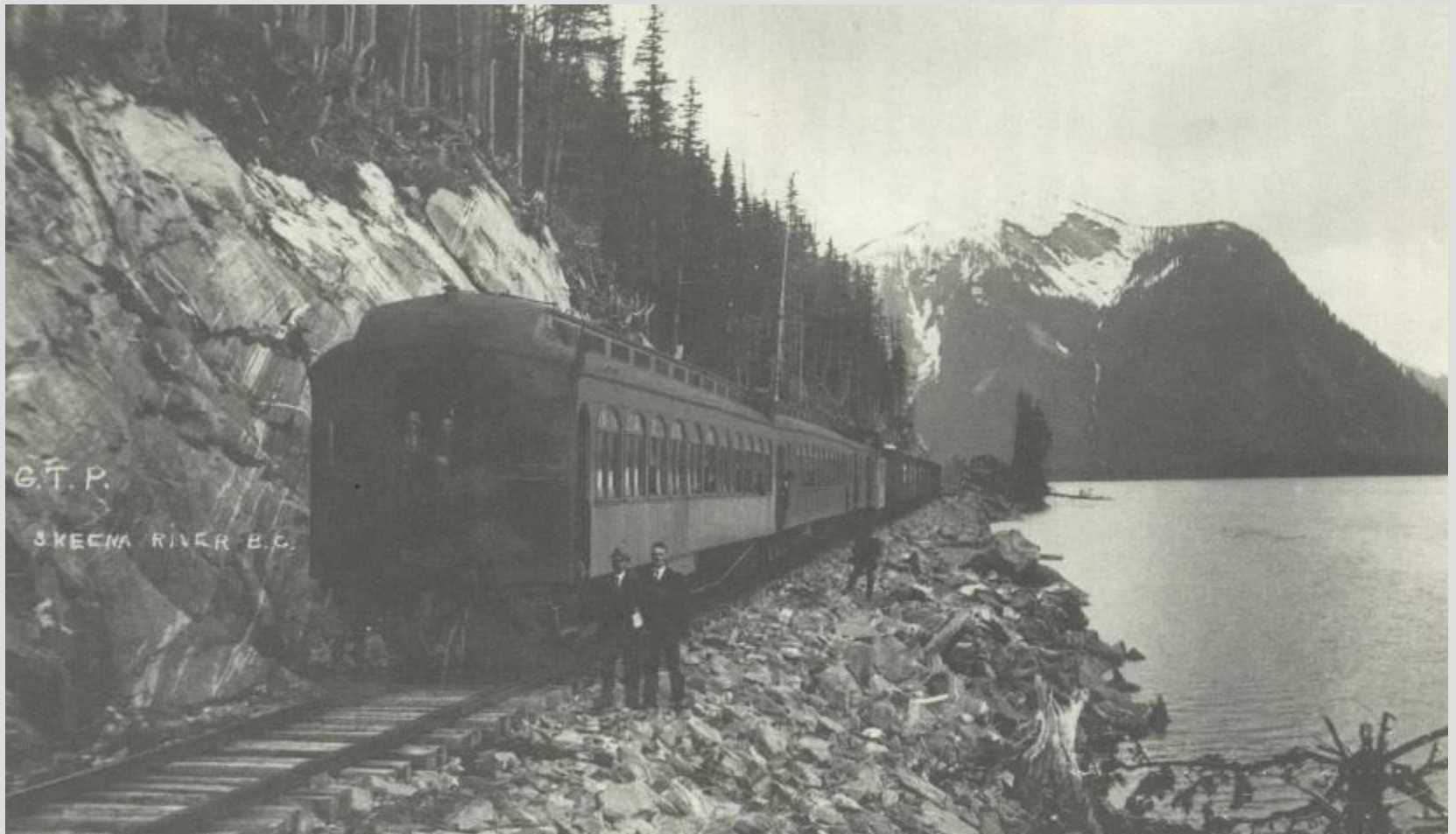


Carving 100 miles of right-of-way along the banks of the Skeena River

Engineering Challenges to the West of the Yellowhead



GTPR



60 miles of absolutely level grade through the Coast Mountains

Engineering Challenges to the West of the Yellowhead



Canadian Northern



Construction on the cliff directly above the operational GTPR west of Red Pass

Engineering Challenges to the West of the Yellowhead



Canadian Northern



Wrong side of the
Thompson and Fraser
Rivers

Engineering Challenges to the West of the Yellowhead



Canadian Northern



Continuous rock work through the treacherous Fraser Canyon

Engineering Challenges to the West of the Yellowhead



Canadian Northern

Numerous Significant Bridges

