

ANNUAL REPORT  
of  
SURVEY and CONSTRUCTION of HIGHWAYS  
in the Dominion Parks, 1914.

A. W. Gray, B.Sc.  
Chief Engineer.

Ottawa, March 31st, 1915.

J. B. Harkin, Esq.,  
Commissioner of Dominion Parks,  
Ottawa, Ontario.

Dear Sir,

I beg leave to submit herewith the  
Annual Report of the Highway Work conducted in the  
Dominion Parks during the season of 1914, by myself  
and staff:

The work in general consisted of  
Location work in Rocky Mountains, Yoho and Glacier  
Parks,

Parks, and the construction of the unfinished portion of the Banff-Windermere Motor Road in the Rocky Mountains Park.

LOCATION:-

The first location work undertaken was the projection of an alternate route from Banff to Lake Minnewanka for coach and auto traffic.

Reconnaissance work had been done on this line during the season of 1913, and location was begun early in July, 1914.

This road, as proposed, can be divided into two sections.

1. The Route from Banff to Anthracite
2. The Route from Anthracite to Lake Minnewanka. The first section offers two possible routes. The present Banff-Calgary Road may be widened and improved as far as Anthracite, or a road may be constructed around the northern base of Mt. Rundle to Anthracite, and thence to the Lake.

This latter route, while necessitating the building

building of a bridge across the Bow River, would afford a more direct entrance to Banff from Calgary for Motor Cars. Besides being a scenic route it can be made safe for traffic without great difficulty or expense.

On reaching the vicinity of Anthracite both routes follow the one location to Lake Minnewanka.

A description of the second route to Anthracite and of the location from there to Lake Minnewanka is here given:-

On leaving Banff, the line follows the present road past the Golf Links to the eastern extremity of what is now known as the Loop road, around the foot of Mt. Rundle. Leaving the constructed road at this point the line skirts the base of Mt. Rundle, on the south bank of the Bow, to a point below the junction of the Cascade and Bow Rivers.

At this point it crosses the Bow River, and running in a northerly direction, crosses the Canadian Pacific Railway and the Banff-Calgary Road at a point just east of the "Hoodoo Banks", and about one and one half miles east of Anthracite and four and one quarter miles from Banff. After ascending to the top  
of the

of the Grand Banks on a 5% grade, the line passes through Upper Anthracite Village.

Produced from here in a northerly direction it passes along the base of Mt. Inglismaldie through Lots 8, 17, 20 and 21, Township 26, and joins the present Banff-Minnewanka Road just west of the bridge over the lake outlet.

The length of the line from Anthracite to Lake Minnewanka is four miles. The material encountered is clay, gravel and loose rock, with occasional out crops of solid rock, until the vicinity of the Lake is reached. In the last half mile the line traverses fairly level country, the surface material being a sandy loam.

Clearing and grubbing throughout are fairly light.

#### LOCATION.

#### LAGGAN to FIELD ROAD.

August, September and October, 1914.

With the construction of the last section of the Banff-Castle Road in progress, and the proposed road

road from Castle to Laggan already located, there remained of the contemplated chain of highways through the most noted portions of the Rocky Mountains, only the Laggan to Field line to be located.

Acting under instructions from the Dominion Parks Branch, Ottawa, the Location work of this road was begun on August, 15th.

GENERAL LOCATION:

It had been previously decided to follow the south side of the Bow River, since more picturesque country would be traversed than on the north side, and a satisfactory line could be located that would afford lower cost and less difficulty in construction.

PARTICULAR LOCATION:

The south end of the Government bridge over the Bow River at Laggan was the natural point of commencement of this line, since it would be a continuation of the Castle-Laggan line, located in 1913, which terminated at this point.

After a thorough reconnaissance it was found advisable not to follow the Bow River closely throughout, but to climb by easy grades to a heavily timbered

timbered bench about two miles from Laggan, and some four hundred and fifty feet above the bridge.

On commencing at the Bow Bridge the line turns sharply to the west, and, skirting the edge of the Bow River, rises to a level crossing of the Lake Louise Railroad near the south end of the bridge over which it crosses the Bow.

It then follows the edge of the River for three quarters of a mile, when it begins to climb to the bench previously mentioned. A maximum grade of six per cent need not be exceeded on this portion. The first mile of the line is through thick scrub—jackpine,—the second mile traversing brule, with occasional patches of pine and spruce, until the wooded bench is reached. The material encountered is coarse gravel and loose rock.

With this bench as the objective, two other lines were run, connecting with this first or "A" line at Station 122.

Since it is evident that visitors motoring through the Park would visit Lake Louise, the Canadian Pacific Railway Chalet, it was thought advisable, while

on the

on the ground, to locate a line beginning near the Chalet and joining the Laggan-Field line, some two miles from Laggan.

The presence of a road constructed on this line would obviate the necessity of tourists, who wished to travel to Field by the Laggan-Field road, returning to Laggan.

The evident<sup>value</sup> of such a road is such to give it precedence in construction over the portion from Laggan to the connection point.

Two good location lines were run for this purpose,- The first, called the "B" line commencing 3600 feet from the Lake Louise Chalet at a point on the Laggan-Lake Louise Road. Traversing thickly wooded country of balsam and spruce, this line by a very direct route of two miles along which easy grades can be developed, joins the "A" line at Station 122.

The second, or "C" line begins at a point on the Laggan-Lake Louise Road 1000 feet from the Canadian Pacific Railway Chalet and after running for a little over a mile joins the "B" line at Station 44.

While.

While a little longer throughout than the "B" line, it thus affords better grades. The material to be expected in the construction of both lines is, loose rock, large boulders and coarse gravel, <sup>and</sup> no serious difficulty is offered by either.

From Station 122 on the bench, the "A" line is produced northwesterly, traversing well-wooded country of jack pine and 10"-12" spruce, the latter predominating. The position of the proposed route now affords splendid views of Mt. St. Piran, along whose base it skirts, and the Bow Valley with the town of Laggan to the north east.

Some three miles from Laggan the line crosses near the foot of an old snow slide. The mass of large tree-trunks, boulders and other debris at its base, together with the clean-swept hill-side, gives an indication of the tremendous speed and power of these mountain avalanches.

Owing to the complete removal of all supports that would enable a heavy mass of snow to again accumulate, there is no danger of a repetition of this occurrence.



occurrence.

The line now runs for about a mile through fairly heavy timber, spruce and balsam, with a diameter of from 10 to 12 inches, until it reaches a point south of the Great Divide, from which a short branch road can easily be constructed to that noted spot. From here also a splendid view of Mt. Bosworth can be obtained.

Large boulders here become more numerous, with coarse gravel and loose rock.

Near this point and five miles from Laggan, at Station 259, the line crosses the Inter-provincial Boundary and enters Yoho Park.

The line now begins to descend, <sup>and</sup> just west of the boundary, passes to the south of Sink Lake. This lake is about 2000 feet long and 1500 feet wide with quick sand bottom.

Still dropping, the line reaches the level of the Canadian Pacific Track one mile east of Hector Station. Considerable solid rock is encountered in this portion. The line now reaches Kicking Horse

Lake

Lake, which is fed by Cataract Creek. This lake is about one half mile wide and one mile long. One of the prettiest sections of the proposed road is that along its shores. The line skirts for over a mile, the southerly edge of the lake, in which, on calm days, the images of the surrounding mountains are reflected in every detail. Toward the west a splendid view may be obtained of Cathedral Mountain.

From the west end of the lake, the object<sup>ive</sup>~~ure~~ of the line is the old Canadian Pacific Railway grade from Hector to Field, it being the intention of the Department to utilize it for highway purposes.

The best connecting route with this grade was that traversing an old Canadian Pacific Railway gravel pit, keeping between the main line of the railroad and the face of the pit.

By this location two crossings of the Canadian Pacific Railway main line and three of the Kicking Horse River are avoided, since, owing to the

the roughness of the country these are the obstacles to the only alternate route.

At the present there is not sufficient room between the track and face of the gravel pit for a road of full width. It is advisable, on this account., that the Railway Company be requested to further excavate on the pit face, when requiring material for ballasting or fill purposes.

The line now follows closely the centre line of the Grade. Very little expenditure will make this a first-class road. The surface is of well-packed cinders, and will be excellent for motor traffic. Bridges are in very good condition, necessitating only guard rails and new planking.

The line is so located on the grade that the widening necessary will require the minimum amount of material.

This section of the proposed road through the Kicking Horse Canyon, is extremely interesting.

Descending on a  $4\frac{1}{2}$  per cent grade, the line

line follows closely the windings of the river. On either side steep walls of rock bound the narrow Pass, while below the river winds its turbulent course towards the far distant Pacific.

After following the old grade for three and one half miles the line descends 365 feet to the Government Bridge across the Kicking Horse River.

Considerable development is necessary to reach this point without exceeding the maximum grade of six per cent.

The line now follows the present Government road for a distance of three and three quarter miles to a point opposite the town of Field. This road is in very good condition, only a few changes, widening and straightening, being necessary.

The timber encountered along this portion is varied in species; cedar, fir, birch, spruce and balsam being fairly plentiful. The fir and cedar range from 8 to 12 inches in diameter.

When opposite Field the line is produced on tangent across the River Flats to the Mt. Stephen Hotel yards. By this means a crossing of the present

present recreation ground is avoided. The erection of a single span bridge at the river crossing, and the protection of the north banks of the water course, against floods, by a breakwater will be necessary. The road can be easily constructed across the Flats at this point and the Recreation Ground left intact.

The line was completed and tied into a hub at the north west corner of the Mt. Stephen Hotel yards on October 27th, 1914.

GENERAL:

The plan adopted in locating the Laggan Field Line was similar to that followed in Railway Location with immediate construction as the object.

Reconnaisances were made by the chief of the party who, after a consideration of low grades, economic construction and scenic points, indicated the general route of the line.

Where it was difficult to judge between two or more routes, preliminary lines, for the purpose of obtaining levels and topography, were run over each.

A study

A study of the plans and profiles plotted from the information obtained, would generally reveal the best location. On the location line all curves were run in on the ground, and stakes, properly marked, were driven at all B.C.'s, E.C.'s and even stations.

A careful line of levels was run throughout. Sufficient topography was taken, not only to permit of a preliminary estimate of quantities being made, but also to offer in the office, the opportunity of considering further developments and changes that the pressure of time and expense in the field forbade.

A report on the cost per mile of the lines run in connection with this Location Survey is appended.

LOCATION - MISCELLANEOUS.

In addition to the location of the Banff, Minnewanka and Laggan-Field roads several minor location and revision lines were run.

As no curves were run in on the Castle-Laggan Road, located <sup>in</sup> 1913, and as the location of the first

first portion could be improved in many cases, the line was "re run from Castle to Eldon Flats", a distance of six and three quarter miles.

Four miles were run by the construction party of Section 2, Banff-Castle Road, and the remainder by the Laggan-Field Location Party.

It was the intention that the latter party should re-locate also, some two miles near the Laggan end of the line. Owing however, to the deep snow, and stormy weather, work was stopped on November 6th and the party disbanded.

...LAGGAN TO FIELD LOCATION SURVEY...  
(Distance...16.4 miles)

...TABLE OF COSTS..

<u>LINE.</u>	<u>Miles run.</u>	<u>Average Cost per mile.</u>	<u>Total Cost.</u>
Exploration	45	\$ 1.00	\$ 45.00
Preliminary	10.5	25.00	262.50
Location (only)	19.5	56.23	1096.50
		Total Cost	\$ 1404.00

Total Cost per Mile of Located Line.....\$. 72.00

.....





Revelstoke from Motor Road



Lake on location of alternate route to Lake  
Minnewanka

# Laggan-Field Location



Country traversed by located road,  
Laggan-Field.



Laggan-Field Location



Boundary Monument near "Great Divide"



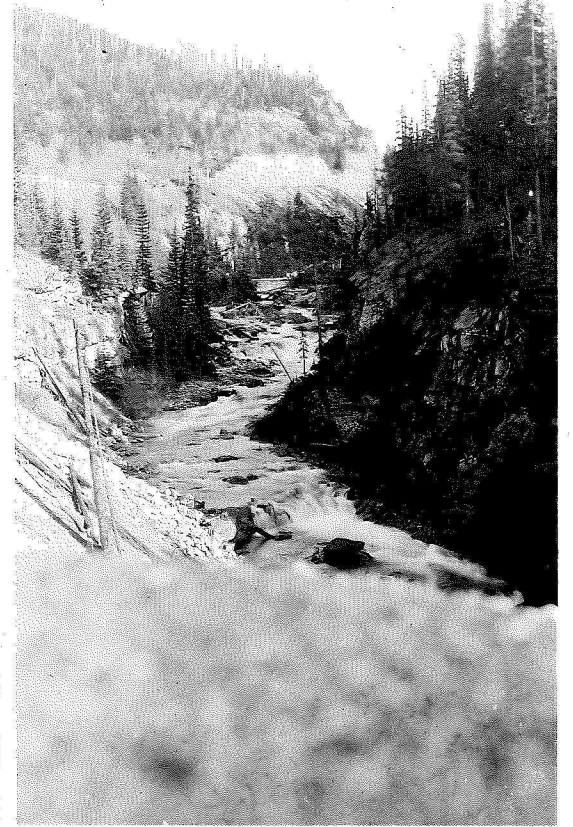
Foot of Yoho Pass, near Emerald Lake

Laggan-Field Location



Near Location of Laggan-Field Road.

Laggon-Field Location



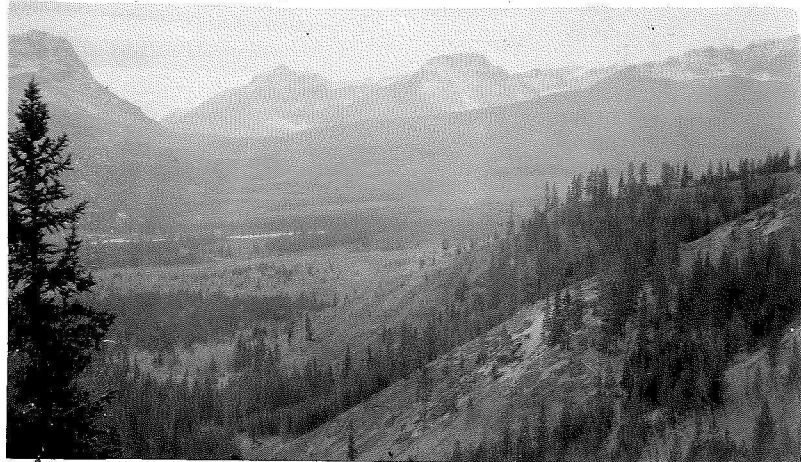
Kicking Horse River

# Castle-Laggan Location



## Silver Falls 1 mile West of Mt. Castle

3. Storm Mt.                      2. Mt. Whymper                      1. Boom Mt.



Bow Valley - South West from Silver Falls.

Castle-Laggar Location

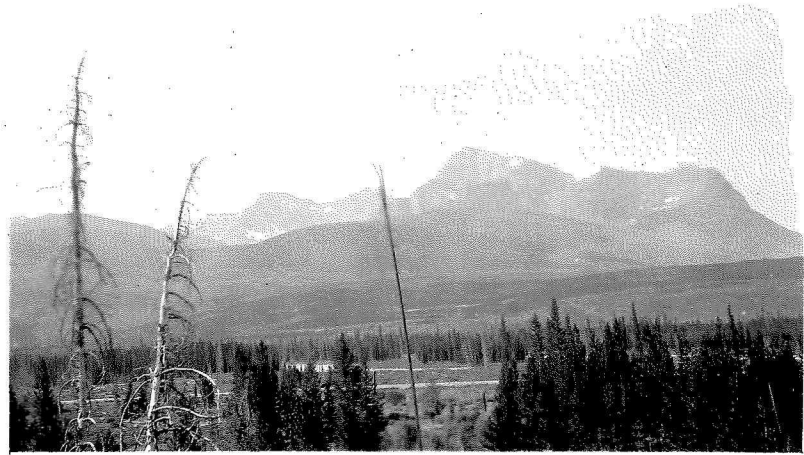


Bow Valley - South East from Silver Falls



View from point on located Road

Castle-Laggan Location



Storm Mt. from point on located Road.



Location Party en route





Location work near Nakimu Caves



Location - General.



Entrance to Moraine Lake



Near Emerald Lake

CONSTRUCTION:

In March 1914, it was decided by the Department to have the most important highway construction of the season, viz. the completion of the Banff-Windermere Road through the Rocky Mountains Park, built by contract.

SCOPE OF WORK:-

The work under consideration consisted of a connecting link of seven miles of the Banff-Castle Road lying between Sawback and Johnston Creek, and seven miles of the Castle Vermilion Pass Section, lying east from the British Columbia boundary line to two and one-half miles west of Mount Castle.

The construction of the Banff-Castle portion, known as Section 2 for convenience, was necessary to connect the portions of the Banff-Castle Road, built by day-work in the preceding year, and thus afford a completed road throughout.

A location survey of this section had been made in 1913.

The purpose of the construction of the

Castle-Vermilion

Castle-Vermilion Pass Road, known as Section 4, was to afford a finished road from Mount Castle to the inter-provincial boundary, where it would make connection with that constructed by the British Columbia Government.

Some two and one half miles of road, due west of Mount Castle had already been constructed, there remaining some seven miles to be completed.

A Location Survey of this portion had been made in 1912, and practically all clearing with rough grading at certain points, had been undertaken in this same year by Haffner & Wurtele, Civil Engineers, Vancouver, British Columbia.

OFFICE PREPARATIONS:-

Plans, profiles and specifications were prepared in the office of the Dominion Parks Branch, Ottawa. Tenders for the construction of both sections were called for and were received up to June 17th at the office of the Deputy Minister of the Interior.

FIELD PREPARATIONS:-

Field work, preparatory to construction, was begun on Section 2, Banff-Castle Road, on June 2nd, and on Section 4, Castle Vermilion Road on June 18th.

This

This work consisted of re-staking the centre line of the road, staking the location of culverts, setting clearing stakes and cross-sectioning. Several revisions were found advisable on Section 2 and were run in.

On section 4, it was found that nearly all stakes of the 1912 Location Survey had been lost or destroyed, and it was found necessary to practically re-run the line.

In doing so, several revisions, affording a better location, were contemplated, but since the time for cross-sectioning the lower portion of the road was short, it was decided to make these changes at a later date.

AWARDING OF CONTRACTS:-

In the meantime, B. J. Reddick of Calgary had been awarded the contract for Section 2, Banff-Castle Road, and, with his outfit arrived on the ground on July 21st. A few weeks later Mr. Reddick was also awarded the contract for Section 4, Castle-Vermilion Road, submitting the lowest tender in both cases.

W. Pearson, representing Mr. Reddick,

arrived

arrived on Section 4 with his outfit on August 21st and at once began work. Subsequently the subletting of this portion, Section 4, by B. Reddick to W. Pearson was authorized by the Department, and Mr. Pearson took full charge of the construction of the section.

An extract table of the bids submitted by the various contractors is here appended.

#### CONSTRUCTION / SECTION 2.

##### GENERAL:-

The work on this section lay between Station 170, at Sawback Siding, and Station 522, at which point it made connection with the road built east from Mt. Castle in 1913.

Rapid progress was made on the first five miles to be constructed as the material encountered was very light.

Clearing and grubbing on the first half-mile was fairly easy, the growth consisting of poplar, and a few large spruce. Light gravel, with a few scattered boulders, was encountered.

At the end of this portion, more open  
country

country with light clearing and grubbing was traversed. The material was a sandy loam with a few patches of boulders and loose rock.

Very light surface material of a sandy-loam composition was encountered in going through a wide belt of jackpine. As this surface soil was unsuitable for a subgrade, it was wasted and the roadbed excavated to more suitable material. Similar material was encountered at intervals to Station 440, where the line leaves the gently sloping foothills and enters the rolling country of Hillsdale. While the growth up to this point is light, consisting of poplar and small jackpine, interspersed with open glades, it here becomes considerably heavier. Eight inch spruce, thick poplar, and jackpine are encountered from Station 440 to 522.

Owing to the hilly country, steep side-slopes and deep drains, the only heavy excavation on the road, is on this portion. In a length of two miles some 12000 cubic yards of material were excavated, while the first five miles of the road only necessitated a total excavation of some 14300 cubic yards.

The material encountered here was a surface loam of varying thickness, overlying ledges of slate

slate and shale classed as loose rock, with occasional small ledges of solid rock in the heavy cuts.

These geological conditions continued until a junction of the road with that previously constructed in 1913 was effected at Station 522.

#### DETAILS OF CONSTRUCTION.

##### CLEARING:

Owing to the sandy nature of the soil, which necessitated the retention of moisture on the road surface as long as possible, the width of clearing was reduced from 50 feet, as originally intended, to 34 and 40 feet. By this means it is hoped that the drying of the road surface after rainfall will be retarded, and consequently the liability of the sandy soil to cut up under traffic greatly lessened.

On all sharp curves sufficient extra width was cleared on the inner side of the road to afford an unobstructed view of the curve for a safe distance ahead.

Wherever possible, trees that would improve the appearance of the road were left untouched, slight deviations being made in one or two cases to save particularly fine specimens!

Considerable difficulty was experienced

by



by the contractor in burning the cleared material. Owing to the excessive dryness of the undergrowth in July and August, there was the greatest danger of the fire spreading beyond the limits of the Right of Way. After several attempts to burn the material as cut and cleared, which ended in the whole force being called to fight incipient bush-fires, it was decided to pile material on the edge of the road until more favorable burning conditions prevailed. By burning only after rainfall, and delaying until the end of September, all material was finally cleared up.

From a consideration of the difficulty encountered in this instance, it would seem advisable to have all clearing and burning done, either in the spring or late fall, by day work or separate contract.

DRAINAGE:-

Owing to the porous nature of the soil the average amount of surface drainage is small and a rainfall of some hours duration is soon absorbed. A short and heavy run-off during the spring freshet, however, necessitates larger culverts than would appear necessary from a casual study of the ground.

Hewn

Hewn log box culverts were most generally used, being placed wherever streams or stream-beds were crossed, and at all sags where the drainage of the vicinity would naturally seek outlet.

Four-log drains were placed in the subgrade in several cases where water in side ditches would be carried an excessive distance, if drained to a box culvert.

Wherever possible, diversion ditches were employed to divert water from two or more neighboring channels to one outlet.

One bridge was found necessary, over Pilot Creek, and was well built.

With the exception of the hewing necessary for the matching of the crib-logs and deck-planking, timber in the rough was used throughout. The length of the bridge is 27 feet over all. The width between wheelguards, available for traffic, is 16 feet.

The piers consist of rock-filled <sup>cribs</sup> excavated to three feet below the stream bed, with heavy backfilling. The sides of the stream above and below are

protected

protected by rip-rap. Hand rail and wheel guard are in place on the bridge.

GRADES-

With the exception of a short section in Hillsdale the grades on the road, as constructed, are very light.

It was necessary in some cases to make a false grade in order that the minimum drainage slope of 0.33 per cent be obtained. The average grade throughout is an undulating one of 1.5 per cent.

Entering Hillsdale, the original location showed a 9 per cent grade for 600 feet, but this was reduced by a revision to a 7 per cent for a distance of 500 feet. This is the heaviest grade throughout, the remaining grades through Hillsdale being 3 or  $3\frac{1}{2}$  per cent.

CRIB WORK:-

The steep sideslopes along which the road is located in Hillsdale, necessitated crib work at different portions to hold the toe of the slopes and keep the road-bed from slipping.

Logs in the rough, with a minimum diameter of eight inches, were used for all such work, and all ties, anchor logs and face logs were well drifted together.

together.

Along the top of the cribs, wheelguards and guardrails were placed. The latter were made exceptionally strong by the posts being brought down to the base of the crib, and being well spiked to the ties throughout their length.

Cribbing, with guardrail and wheelguard, was constructed along 740 feet of the road, and cribbing without guardrail along 375 feet.

#### FINISHED ROAD:-

The width of finished road-bed varied from 16 to 20 feet. In the section between Stations 170 and 445, where grading was very light, a width of 20 feet in cut and 18 feet in fill was given. A cross section of this portion, in cut, consisted of a 3 foot ditch on either side of a 20 foot finished road, with a crown of 10 inches.

Through the heavier work of Hillsdale, where additional width meant very heavy side cuts, a finished road of 16 feet in cut and fill was constructed.

On all curves, an additional width was given to the road, the outer half being super-elevated according

according to the degree of sharpness. Particulars of extra width, crown and super-elevation are given in the description of the work on Section 4.

A road grader was used with good results on portions of the road and its advantages on a road of this type, for both construction and maintenance purposes, cannot be too strongly emphasized. The use of a split-log drag to preserve the crown of the road, in the early spring and late fall, is advisable, especially for the present season, when the road is still in a green condition.

The weather experienced throughout was very favourable, the work being stopped but one and one half days owing to a wet snowfall in the middle of September.

The work of Construction was completed on October 17th, and teams, wagons and material returned to Calgary, via the Calgary-Banff Road.

Appended are detailed reports of the cost per mile of the road, with other particulars, and graphs showing the progress of construction.

# CHART

OF  
CONTRACTORS' BIDS - SECTS. 2 & 4.

UNIT	ITEM	LOW	HIGH	AVERAGE
Acre	Cutting and Clearing	20 <sup>00</sup>	75 <sup>00</sup>	46 <sup>00</sup>
"	Stumping and Grubbing	30 <sup>00</sup>	150 <sup>00</sup>	59 <sup>00</sup>
Cu. Yd.	Excavation - Earth	.20	.70	.39
"	Loose Rock	.50	.95	.66
"	Solid Rock	1.15	2.20	1.62
Lin. Ft.	Round Logs in Drains	.07	.08	.075
"	Hewn " in Culverts	.10	.35	.19
"	Round " in Crib	.04	.08	.07
Cu. Yd.	Crib-filling with Stone	.25	1.00	.69
"	Piling out Reserved Stone	.35	1.00	.61
Lin. Ft.	5" Drainage Tile	.10	.40	.25
Lb	Iron Drift Bolts	.06	.12	.09
Lb	" Screw Bolts	.10	.15	.11
Lin. Ft.	Guard Rail	.03	.07	.05

Section 2



View from Queen's Park, on Motor Road.



Bow River from Queen's Park.

Banff-Castle Highway  
Section 2.



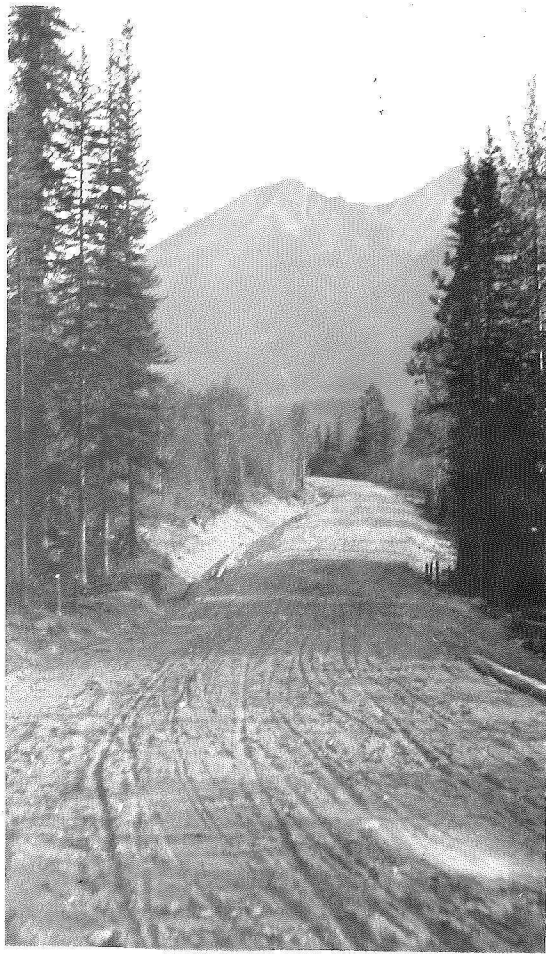
Sta. 188. Clearing



First Grading, Sta. 198



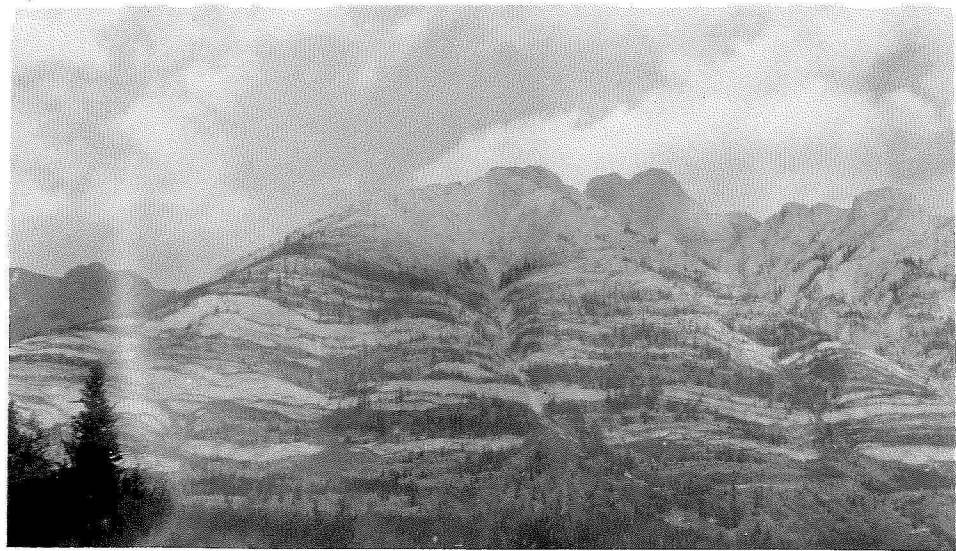
Section 2



Sta 198



Sta 220



Sawback Range from C. P. R. Tracks

Section 2



Road over Rock Wash - Sta. 296

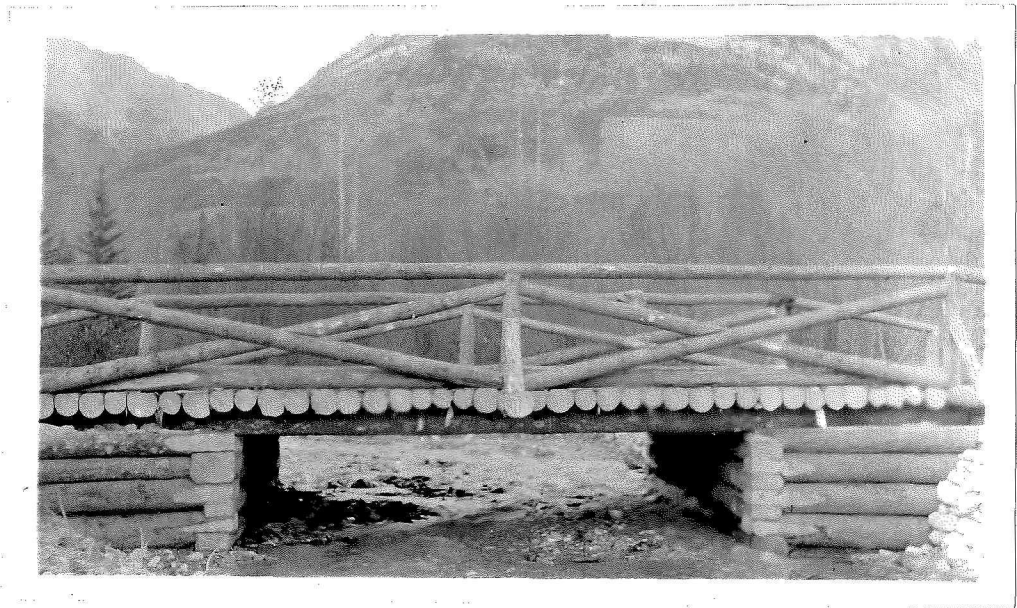


Sta. 260.

Section 2



Road over Rock Wash, - Sta. 299



Bridge at Sta. 397.

Section 2



Culvert Construction- Banff-Castle Rd.

Pilot Mt. in background.

Section 2



- Hillsdale -  
Grading - Sta. 465



Cribwork and Guard Rail - Sta. 470.

Section 2



Finished Road- near Johnston Creek



Finished Road- Castle Mt. in background.

# GRAPH

showing  
Cost and Progress of Construction  
Section 2  
Banff-Castle Road

Scale of Distance  
Stations  
170  
195  
220  
245  
270  
295  
320  
345  
370  
395  
420  
445  
470  
495  
520

Cost Scale

\$12,289.43 Total Cost  
12,000

PROGRESS CURVE

TOTAL COST CURVE

## Sect. 2.

Max Length built per week = 5880 Ft.  
Min. " " " " = 875 Ft.  
Average Length built per week = 2950 Ft.  
" " " " day = 492 Ft.  
Average Cost per day = \$168.34  
" Yardage per 100 Ft. = 74.3  
" Cost " " = \$34.71  
Average Cost per Mile = \$1832.69

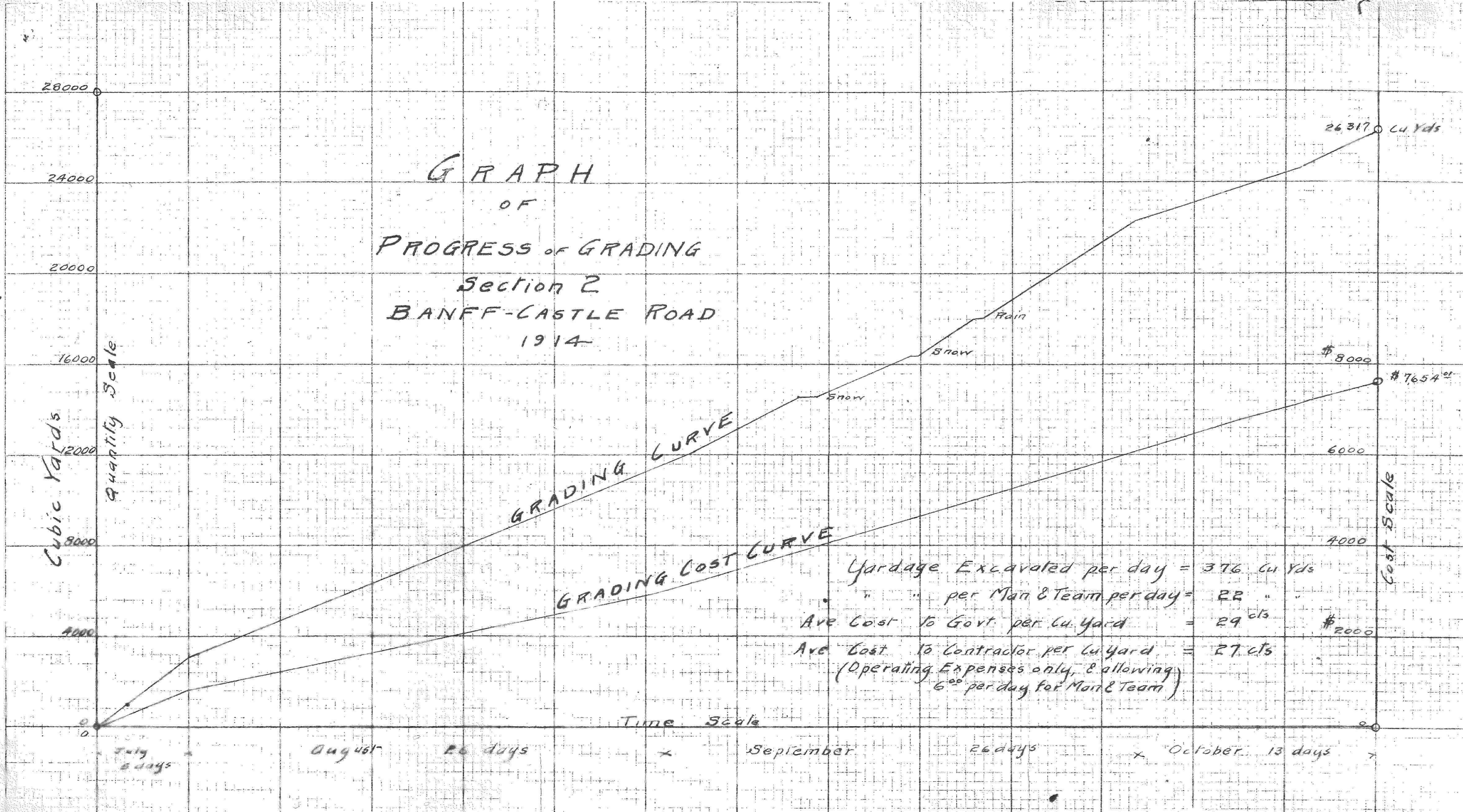
4,000  
3,000  
2,000  
1,000

## Time Scale

July 29 0  
10  
20  
30  
40  
50  
60  
70  
73 Days  
Oct. 1  
Oct. 15



# GRAPH OF PROGRESS OF GRADING Section 2 BANFF-CASTLE ROAD 1914



Yardage Excavated per day = 376 Cu Yds  
 " " per Man & Team per day = 22 "  
 Ave Cost to Govt. per Cu Yard = 29 cts  
 Ave Cost to Contractor per Cu Yard = 27 cts  
 (Operating Expenses only, & allowing  
 6<sup>00</sup> per day for Man & Team)



# BANFF-CASTLE ROAD

## SECTION 2.

### Cost Details per Mile.

Mile	Sta. 5/16	Clearing		Grubbing		Solid Rock		Loose Rock		Earth		Overhaul		Hewn Logs		Round Logs		Crib Logs		Drift Bolts		Bridge		Total for Each Mile
		30°/Acres	35°/Acres	12°/Cu. Yd.	50°/Cu. Yd.	25°/Cu. Yd	1°/Cu. Yd/100 <sup>ft.</sup>	10°/Lin. Ft.	7°/Lin. Ft.	7°/Lin. Ft.	10°/Lb	10°/Lin. Ft.												
		Quantity	Amt. \$	Quantity	Amt. \$	Quantity	Amt. \$	Quantity	Amt. \$	Quantity	Amt. \$	Quantity	Amt. \$	Quantity	Amt. \$	Quantity	Amt. \$	Quantity	Amt. \$	Quantity	Amt. \$	Quantity	Amt. \$	
4	170 To 211+20	2.810	84.30	2.810	98.35	4.0	5.00	42.5	21.25	3352.4	838.10	Nil	—	1120.0	112.00	184.0	12.88	Nil	—	196.1	19.61	Nil	—	\$ 1191.49
5	211+20 To 264+00	5.092	152.76	5.092	178.22	22.0	27.50	199.0	99.50	2716.0	679.00	—	—	1314.0	131.40	504.0	35.28	—	—	278.5	27.85	—	—	1331.51
6	264+00 To 316+80	4.146	124.38	5.385	188.47	32.0	40.00	359.0	179.50	2214.2	553.55	—	—	2452.0	245.20	304.0	21.28	—	—	391.9	39.19	—	—	1391.57
7	316+80 To 363+60	4.460	133.80	4.460	156.10	Nil	—	4.2	2.10	2757.0	689.25	—	—	480.0	48.00	408.0	28.56	—	—	129.6	12.96	—	—	1070.77
8	363+60 To 422+40	4.892	146.76	4.892	171.22	5.0	6.25	6.3	33.15	2291.8	572.95	—	—	854.0	85.40	208.0	14.56	—	—	130.6	13.06	27.0	270.00	1313.35
9	422+40 To 475+20	3.458	103.74	4.261	149.13	13.0	16.25	409.2	204.60	6747.0	1686.75	1064.9	10.64	948.0	94.80	208.0	20.16	12289.0	860.23	876.0	87.60	Nil	—	3233.90
10	475+20 To 522+20	3.860	115.80	3.860	135.10	267.4	334.25	1802.4	901.20	3012.9	753.23	Nil	—	512.0	51.20	432.0	30.24	5607.0	392.49	433.3	43.33	—	—	2756.84
Stals		28.718	861.54	30.760	1076.60	343.4	429.25	2882.6	1441.30	23091.3	5772.82	1064.9	10.64	7680.0	768.00	2328.0	162.96	17896.0	1252.72	2436.0	243.60	27.0	270.00	\$ 12289.43

# BANFF-CASTLE HIGHWAY

## Monthly Progress Reports

JULY      AUGUST      SEPTEMBER      OCTOBER

	Quantity	Amt. \$	Quantity	Amt.	Quantity	Amt.	Quantity	Amt.	Unit
Cutting <sup>and</sup> Clearing	2.81	8430	22.048	661.44	3.860	115.80	-	-	acre
Stumping <sup>and</sup> Grubbing	2.81	98.35	24.090	843.15	3.860	135.10	-	-	"
Solid Rock	-	-	48.0	6000	67.5	8437	128.0	160.0	Cu Yd
Loose Rock	-	-	422.7	211.39	1323.8	661.90	985.1	492.55	"
Earth	3229.4	807.35	7864.6	1966.15	9367.0	2341.75	2816.9	704.22	"
Hewn Timber	369.0	33.21	4517.0	406.53	2282.0	205.38	1448.0	130.32	lin Ft
Round Logs	88.0	6.16	1312.0	91.84	16520.0	1156.40	1844.0	129.08	"
Crib-filling with Stone	-	-	-	-	-	-	28.0	21.00	Cu Yd.
Guard Rail	-	-	-	-	-	-	1480.0	103.60	lin Ft.
Drift Bolts	610	6.10	876.3	87.63	1330.9	133.09	3578	3578	lb.
Overhaul	-	-	-	-	-	-	741.0	7.41	Cu Yd.
Totals		\$ 1035.47		\$ 4328.09		\$ 4833.79		\$ 1783.96	

Grand Total, Monthly Estimates, \$ 11,981.31

#### SECTION 4.

---

##### GENERAL CONSTRUCTION:-

Owing to the fact that the season was well advanced when construction was begun on this road, August 21st, it was necessary to make all possible speed in order that the work be completed before the approach of winter.

To expedite construction, the sub-contractors let out some two-thirds of the work to small contractors, or stationmen, who worked simultaneously on different portions of the road.

This was feasible since the presence of a tote road from Mt. Castle to the boundary line, made it possible to draw in supplies to all portions under construction.

From Station 116 + 50, where construction was begun, the road winds by easy grades with occasional switch-backs, four and one half miles, until it reaches Station 349. This station, on a bench near Boom Creek, is the highest point of the road, being 5661 feet above sea level.

From this

From this point, following gentle natural slopes, it dips down for the remaining two and one miles to the Interprovincial Boundary Line at Station 482 + 25, the elevation at this point being 5342 feet.

The material encountered throughout had a high percentage of loose rock, consisting of boulders and cemented gravel.

Solid rock in ledges was encountered in the last mile, and throughout the Section in the form of large boulders exceeding one cubic yard in measurement.

The heaviest portion of the work was the first and last two miles. The middle and lighter portion being already partially graded at intervals where necessary for the tote road, besides traversing gentler side slopes with few ravines.

CLASSIFICATION:-

As is usual in construction the material to be excavated was divided into three classes:-

1. Solid Rock, including all rock in masses or ledges in its original or stratified bed and position, and all boulders and detached masses of rock exceeding one cubic yard in measurement.

2. Loose Rock, including all shale,  
slate.

slate, soapstone, cemented gravel and hardpan, all boulders and detached rock exceeding one cubic foot and less than one cubic yard in measurement and all other rock that cannot be removed without the use of pick and bar <sup>butt</sup> ~~and~~ does not require blasting.

3. Earthm including all loam, clay, sand, gravel and all other material which does not come under 1 and 2.

Some 28000 yards of material were excavated in the course of construction, approximating Earth, <sup>3,544</sup> 11,900 cubic yards, - Loose Rock, <sup>17,061</sup> 13,000 cubic yards, - Solid Rock, <sup>10,574</sup> 3,350 cubic yards.

Whenever possible the finer and better surfacing material encountered in cuts, was reserved for crowning. Several beds of fair gravel were found, the material from these being used to crown the softer portions of the grade, and other portions where the excavated material from cuts was too coarse for this purpose.

#### CROWNING AND DRAINAGE:-

As good drainage is essential to Road preservation, a fairly high crown was decided upon, ~~and~~ half the

the width of the finished road-bed in inches being the height of crown desired. An 18-foot width of finished road would thus have a crown at centre of 9 inches. Owing to the coarseness of the material generally encountered, which made it unsuitable for crowning purposes, it was found very difficult to obtain a full crown at certain points. Material reserved for crowning, after spreading and removing large stones, proved insufficient for the purpose. It was then necessary to haul more material for crowning purposes from Borrow Pits.

The presence of boulders of assorted sizes throughout the subgrade, being a rough Telford foundation, ensures good drainage of the road surface.

Good drainage was also provided for at wet portions of the road, by placing 4-log drains in the subgrade at advantageous points. At all streams or where indications pointed to a fair flow during spring or fall, box culverts were provided of ample size to accommodate the maximum run-off.

Throughout this Section, owing to the  
clayey

clayey nature of the soil, and the presence of hardpan close to the surface, the surface drainage was considerable. This necessitated many culverts and drains besides those already placed in the ground during the construction of 1912.

Wet weather, followed by heavy frosts, made thorough drainage for construction purposes difficult.

FINISHED ROAD:-

The width of the finished road of this section was determined by the factors of safety and economy. In a road of this character, an increase of 4 foot in width is equivalent to an increase in yardage of over 10 %. In the portions of the road which included Rock work, a finished width of 16 feet in cut and fill was adopted. This width not only affords sufficient room for all classes of traffic, but also was a great saving in cost over a 18 foot or 20 foot road. The last two and one half miles of road was finished to this width.

The remaining portion of the road, five and one half miles, was finished to a width in cut of 18 feet and in fill 16 feet.

EXTRA WIDTH AND SUPER-ELEVATION:-

An extra width, depending on degree of curvature and elements of danger, was given to the road-bed on all curves. This extra width varied from two to eight feet, the road on the sharpest type of curve used, 90°, having a width of 24 or 26 feet.

The outer half of the road-bed was given a super-elevation on all curves.

The super-elevation for a particular curve was derived from the formula, "Super-elevation in inches = 1 % of width of road x degree of Curvature." If the width of road-bed is 26 feet on a 90° curve, the difference in elevation between the inner and outer edges of the road is 1 % of 26 x 90 = 23.4 inches.

This formula is designed to give safe turns for an automobile travelling 30 miles an hour.

GRADES:-

By means of the Revisions previously mentioned, which were run in soon after construction on the lower portions of the road had commenced, the maximum grade was reduced to 6 % and several dangerous curves eliminated. A minimum grade of 0.33 % was maintained



maintained throughout for drainage purposes.

As the major portion of this road is of a 2 to 4 % grade, no trouble is anticipated with standing water in side ditches.

During the last month of construction, the heavy frosts considerably retarded the progress of the work. Material formerly loosened up by a pick plough now had to be blasted.

Towards the completion of the work, the wintry weather made satisfactory progress very difficult. Snowfalls, after October 20th were frequent, and when Engineers and Contractors with their work completed, left the Section on November 6th, snow to a depth of three feet covered the Pass.

Details of excavation and costs per mile, with graphs of progress of the work are appended, together with blue prints showing the construction of guard rail, cribbing and culverts employed on both roads.

GENERAL:-

With the construction of these two sections of the Banff-Windermere Road, there is now complete a graded road through the Rocky Mountains Park, extending from Calgary to beyond the interprovincial

boundary

boundary in the Vermilion Pass.

This road, besides traversing some of the most beautiful sections of the Bow River Valley, brings within easy reach of the tourist many noted scenic points, formerly only accessible by means of ponies and pack trails.

Massive Mountain, the canyon of Johnston Creek, Castle Mountain, Vermilion Pass Valley with Mts. Storm and Whympet, and Boom Creek and mountain are but a few of the many points of interest and beauty.

Two miles up Boom Creek from the motor road, is Boom Lake, fed by a hundred streams from a glacier at its head, and rivalling Lake Louise in beauty.

Nearer the British Columbia boundary a splendid view of the Altrude Lakes is obtained, and the eleven miles of road already constructed by the British Columbian Government, west of the boundary line, afford unequalled sights of the mountains guarding the valley of the Vermilion River.

In conclusion, I would state that while the high character of construction desired on the two sections of the motor highway was not attained in all cases, it is felt that, on the whole, the work was well done, and reflects credit on the Department as an example of earth road building.

For the sum expended a good showing was made, and I feel that a step has been taken towards better and cheaper road-construction in the Dominion Parks.

Finally I wish to commend the work of the Resident Engineers and their assistants during the progress of construction, who by their faithful and diligent service were largely responsible in bringing the work to a satisfactory completion.

Respectfully submitted,

*Andrew W. Gray*

Castle - Vermilion Pass Highway  
Section 4



Right of Way - Sta. 128.



Commencement of Grading - 1914 - Sta. 117.

Section 4



Construction, near Sta. 186.



Grubbing, - Sta. 196.



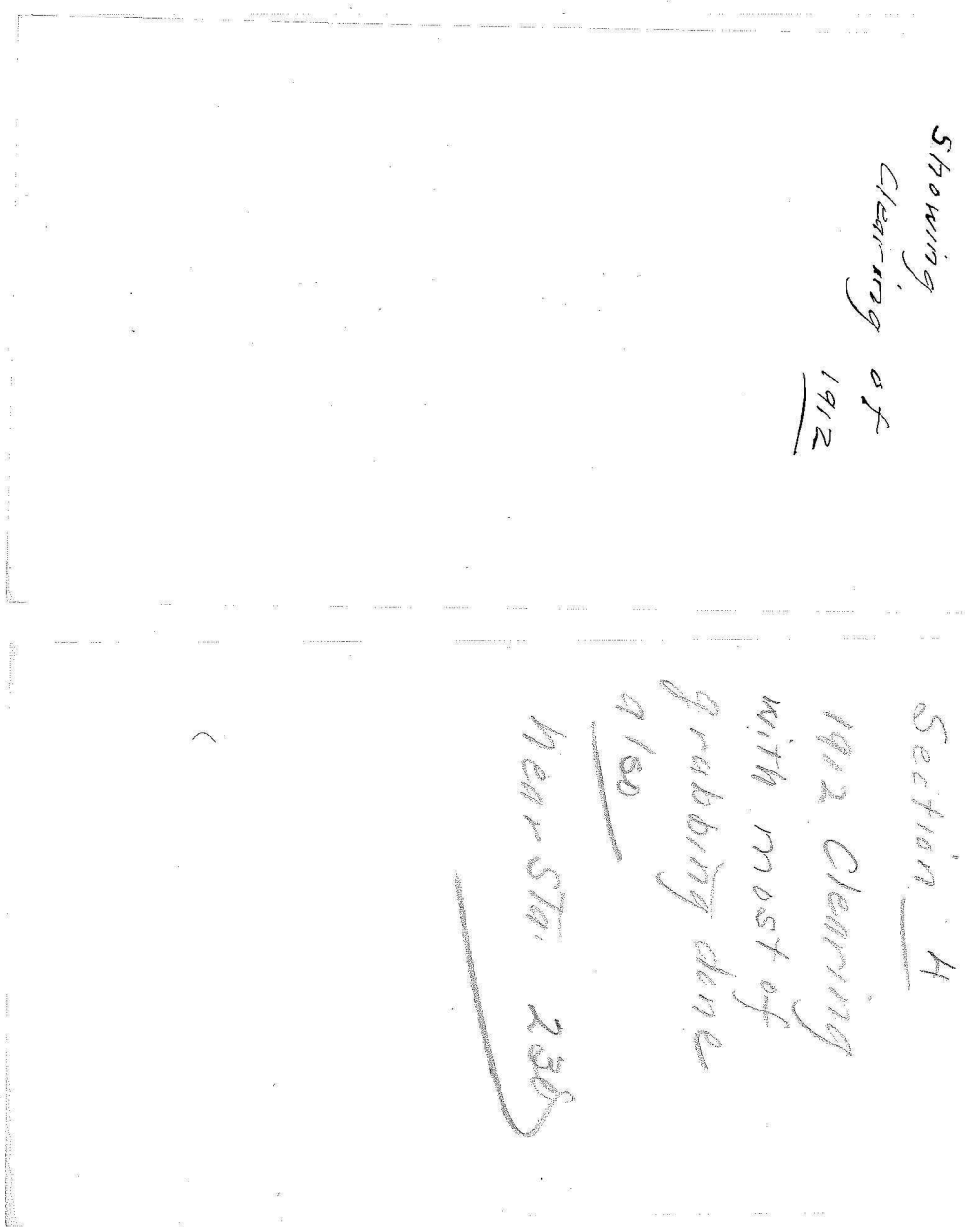
*Castle - Vermilion Rd.*



*West from Sta. 478 - Sect. 4.*



Revision - Sect. 4 - Castle - Ver. Rd  
East from approx. Sta. 475



Showing  
Clearing of  
1912

Section 4  
1912 Clearing  
with most of  
grubbing done  
also  
near Sta. 238

C



Castle-Yermilion Road-



Construction at Sta. 117- Section 4

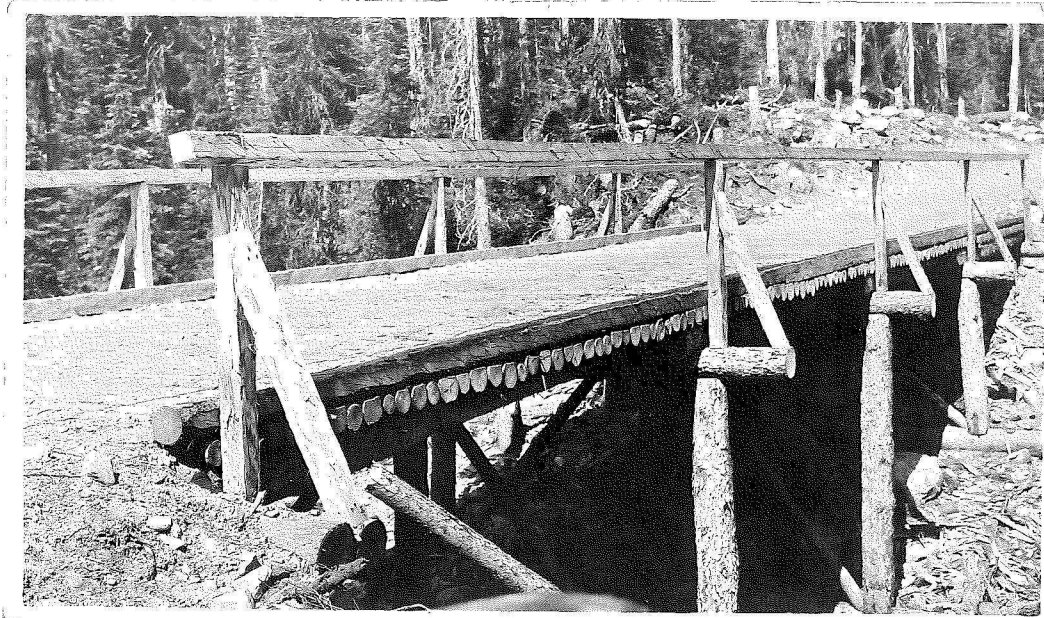


West from 348 Sec. 4.

191A

Contractor's Camp and Teams - Sta. 250 -  
Sect. 4.

191A



Section 4

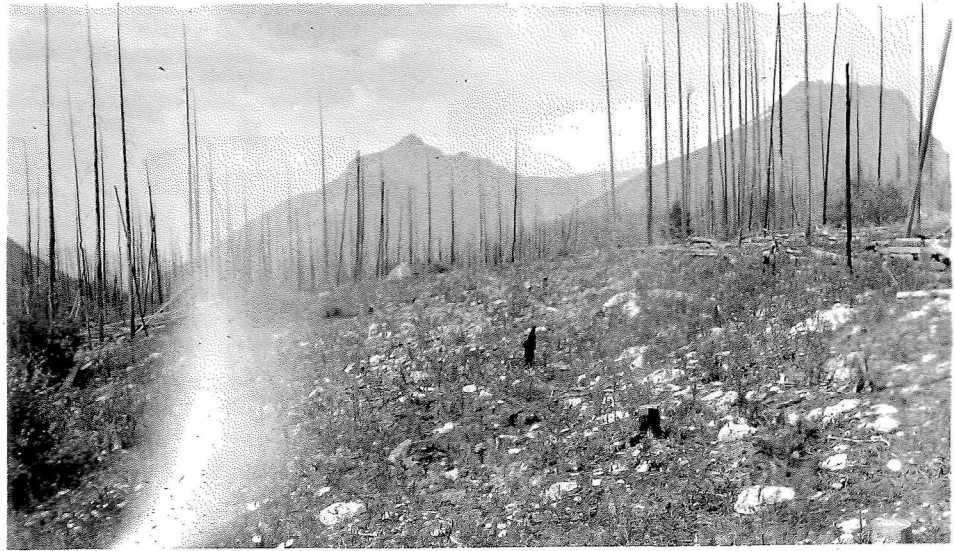


Old Tole Road and Contractors' camp -  
near Sta. 275.

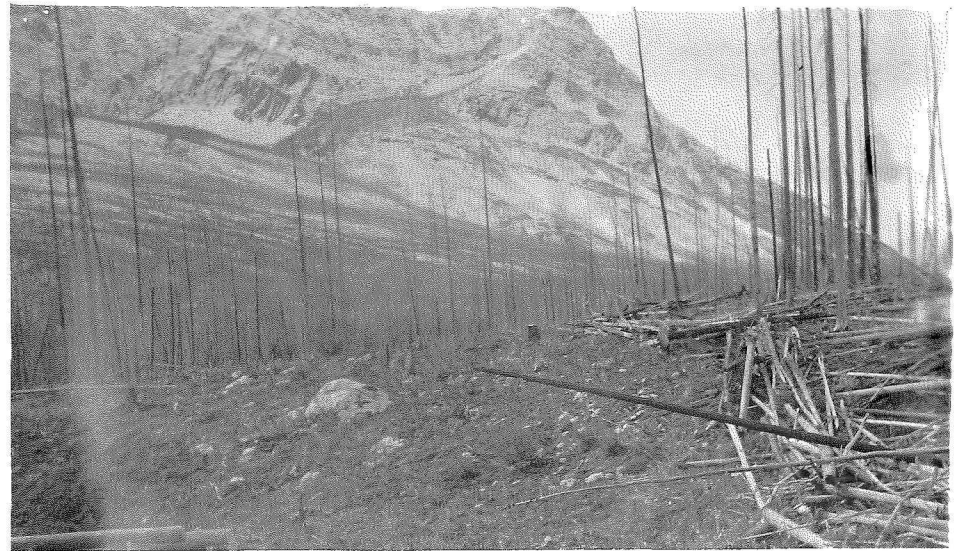


Castle Mt. - from Sta. 229.

Section 4



Sta. 230.- Right of Way.



Sta. 233.- Storm Mountain.

Section 4



Part of Grading, - Sta. 212.



Grading, - Sta. 347.

Section 4



Contractor's camp and teams.

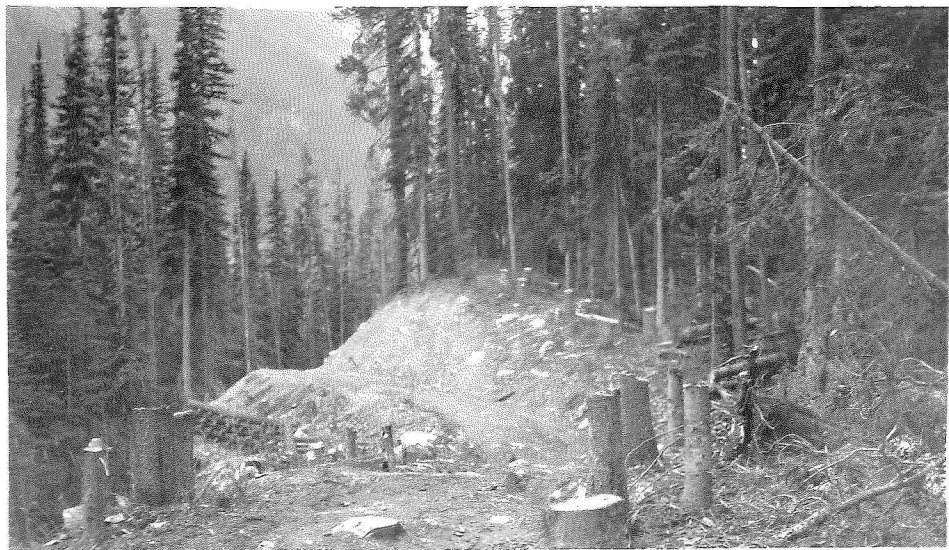


Sta. 250 - Mt. Whympier in background.

## Section 4



Highest point, - 5661 ft - above sea level - Sta. 349.  
Toll Road in foreground.



Sta. 425, - showing partial construction of 1912.

Section 4



Sta. 450.- during Construction



Sta. 475.- after clearing



Section 4



Sta. 477- after clearing.



Sta. 480- old corduroy.



Breaking camp at Castle Mt. - Nov. 9-14<sup>th</sup>



# CASTLE-VERMILION HIGHWAY

## Monthly Progress Reports

	August		September		October		November		Unit
Cutting <sup>2</sup> Clearing	—	—	1.510	45.30	—	—	—	—	Acre
Pumping <sup>2</sup> Grubbing	4.990	174.65	6.870	240.45	10.599	370.96	1.555	54.43	"
Solid Rock	720	90.00	497.1	621.37	2317.3	2896.63	4066	508.25	Cu. Yd.
Loose Rock	605.4	30270	24367	1218.35	7031.4	351570	18775	938.75	"
Earth	13656	40968	7003.8	2101.14	4098.8	1229.64	5722	171.66	"
Hewn Logs	1066.0	95.94	788.4	70.95	—	—	—	—	Lin. Ft.
Crib Logs	—	—	—	—	2498.5	199.88	—	—	"
Round Logs	4936	34.55	615.9	43.11	1218.4	85.29	2530	17.71	"
Drift Bolls	136.0	13.60	187.5	18.75	274.6	27.48	273	273	Lb.
Overhaul	—	—	—	—	—	—	1323.7	13.23	Cu. Yd.
		\$		\$		\$		\$	
Totals		1121.12		4359.42		8329.58		1706.76	

Grand Total - Monthly Estimates. - \$ 15,512.88

# CASTLE-VERMILION ROAD

## SECTION A

### Cost Details per Mile

Mile	Sta. to Sta.	Clearing 30°/Acre		Grubbing 35°/Acre		Solid Rock 125/Cu. Yd.		Loose Rock 50 <sup>1</sup> / <sub>2</sub> /Cu. Yd.		Earth 30 <sup>1</sup> / <sub>2</sub> /Cu. Yd.		Overhaul 1 <sup>1</sup> / <sub>2</sub> /Cu. Yd/100FT		Hewn Logs 10 <sup>1</sup> / <sub>4</sub> /Lin. Ft.		Round Logs 7 <sup>1</sup> / <sub>4</sub> /Lin. Ft.		Crib Logs 8 <sup>1</sup> / <sub>4</sub> /Lin. Ft.		Drift Belts 10 <sup>1</sup> / <sub>2</sub> /Lb		Total for Each Mile
		Quantity	Amnt.	Quantity	Amnt.	Quantity	Amnt.	Quantity	Amnt.	Quantity	Amnt.	Quantity	Amnt.	Quantity	Amnt.	Quantity	Amnt.	Quantity	Amnt.	Quantity	Amnt.	
				\$ &		\$ &		\$ &		\$ &												
3	116+50 to 158+40	Nil	-	3.129	109.52	104.0	130.00	1011.4	505.70	1026.6	307.98	Nil	-	376.0	37.60	208.0	14.56	Nil	-	50.54	5.05	\$ 1110.41
4	158+40 to 206+75	"	-	3.700	129.50	528.1	660.13	2549.6	1274.80	3514.0	1054.20	328.3	3.28	690.0	69.00	399.6	27.97	"	-	91.04	7.10	3227.98
5	206+75 to 253+53	"	-	3.581	125.34	192.0	240.00	2723.6	1361.80	1742.5	522.75	Nil	-	738.4	73.84	748.0	52.36	"	-	208.64	20.86	2401.95
6	253+53 to 312+61	"	-	2.766	96.31	71.0	88.75	1241.1	620.55	1726.0	517.95	163.6	1.64	Nil	-	286.0	20.02	"	-	30.90	3.09	1348.81
7	312+61 to 365+41	"	-	3.788	132.58	188.0	235.00	1405.5	702.75	944.1	298.23	Nil	-	"	-	147.0	10.23	"	-	14.00	1.40	1380.25
8	365+41 to 418+21	1.477	44.31	3.995	139.82	406.6	508.25	2092.1	1046.05	1259.0	377.85	1857.5	18.51	"	-	253.1	17.72	"	-	27.30	2.73	2155.24
9	418+21 to 472+70	1.270	38.10	4.134	144.69	1721.5	2151.87	1952.3	976.15	1071.8	321.54	Nil	-	"	-	446.0	31.22	2498.5	199.88	199.10	19.41	3882.86
10 (part)	472+70 to 482+50	0.060	1.80	0.110	3.85	147.8	184.75	71.8	35.90	572.2	171.66	Nil	-	"	-	93.2	6.52	Nil	-	9.10	.91	405.39
<b>Totals</b>		2.807	84.21	25.203	882.10	3359.0	4198.75	13047.4	6523.70	11907.2	3572.16	2343.4	23.43	1854.4	185.44	2580.9	180.66	2498.5	199.88	625.62	62.56	\$ 15912.89

# GRAPH

OF

PROGRESS OF GRADING

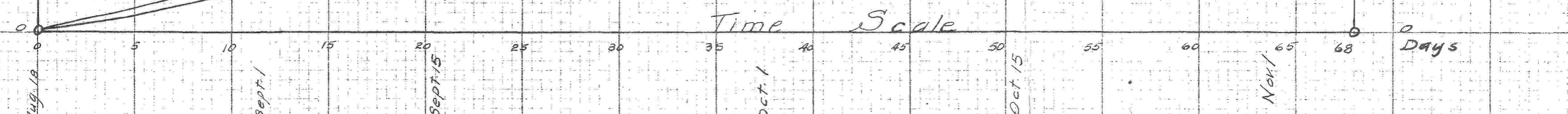
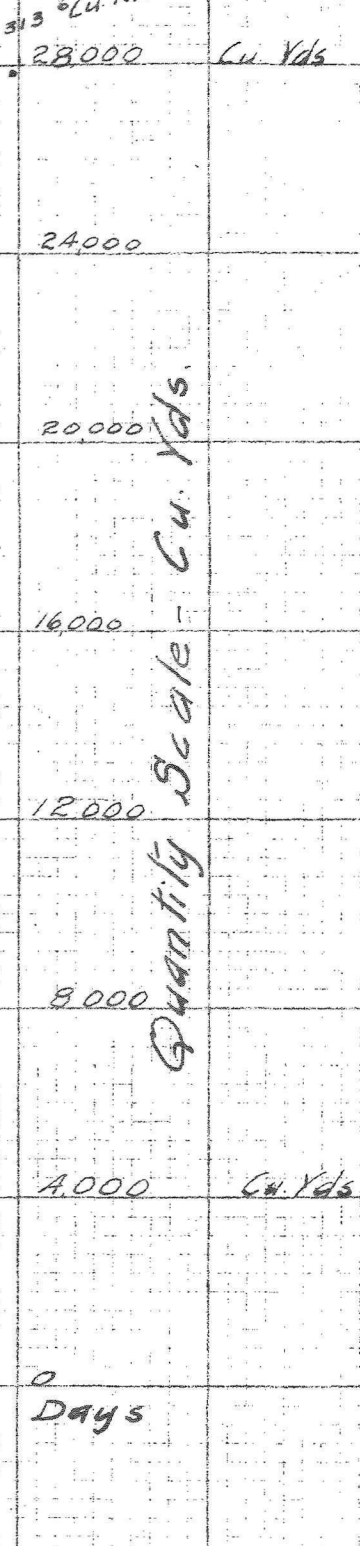
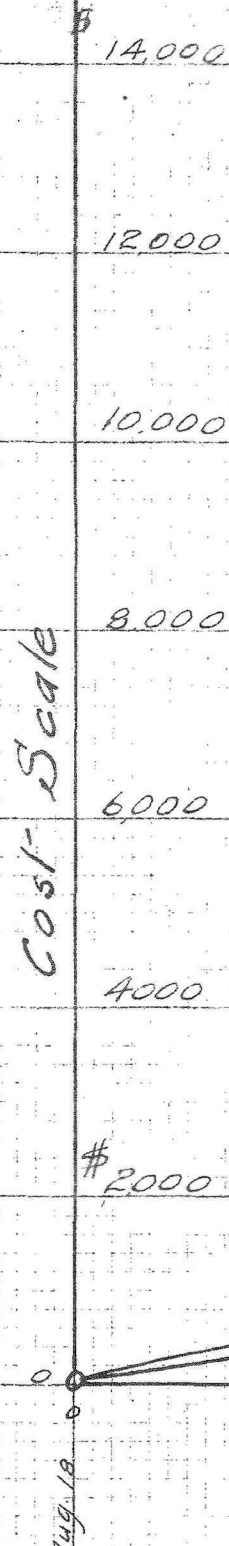
SECT. A

CASTLE-VERMILION

ROAD

Cost Scale

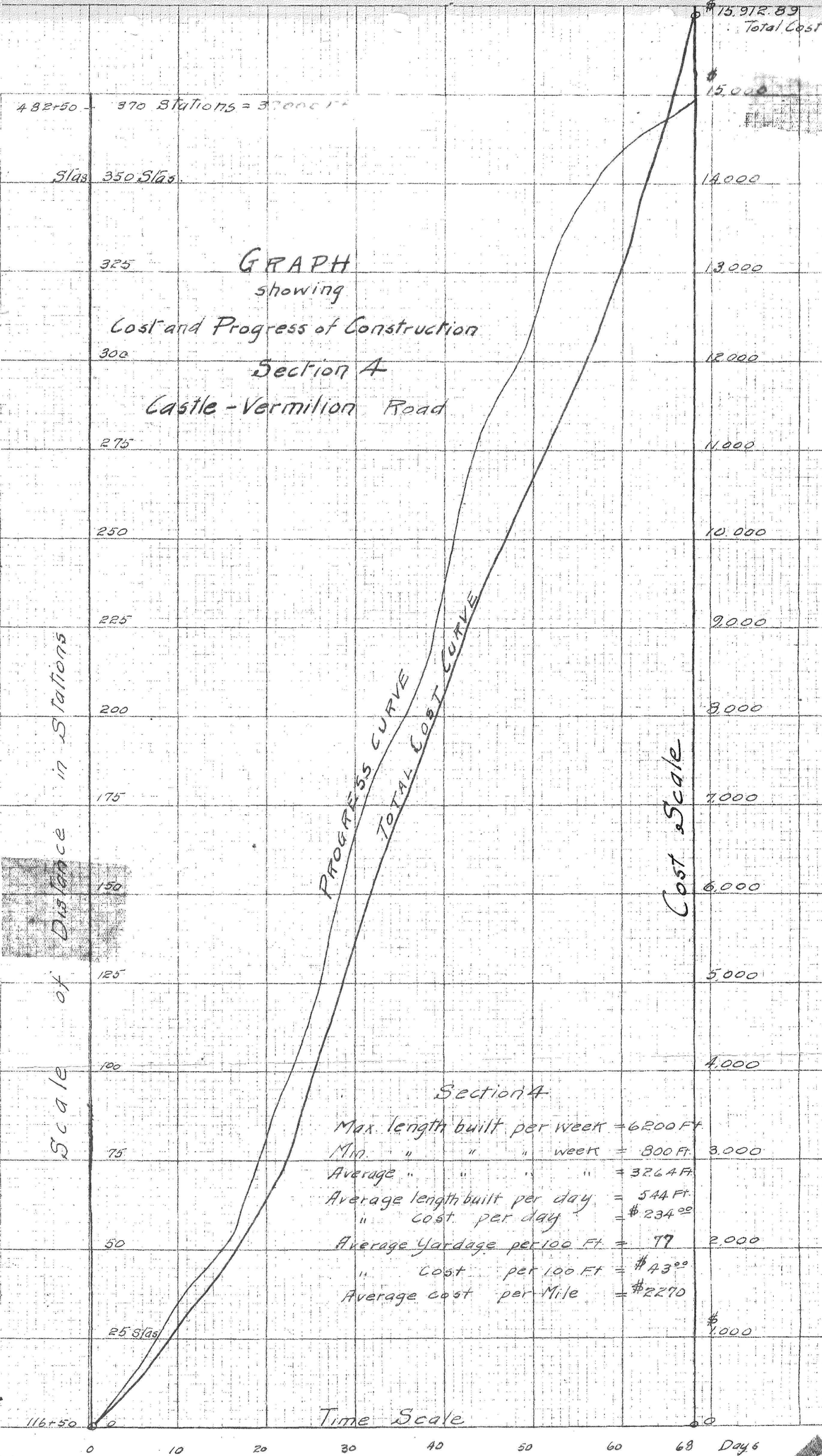
Quantity Scale - Cu. Yds.



GRADING CURVE  
GRADING COST CURVE

\$14,318.04 → 28,313 Cu. Yds.

Ave. Yardage moved per day = 416 Cu. Yds.  
 Yardage per day per Man & Slip Team = 16 " "  
 Ave. Cost to Dept. per Cu Yd = 50 cts  
 Ave. Cost to Contractor " " = 44 cts  
 (Operating Expenses only & allowing  
 6<sup>00</sup> per day per man & team.)



GRAPH  
 showing  
 Cost and Progress of Construction  
 Section 4  
 Castle - Vermilion Road

Scale of Distance in Stations

Cost Scale

PROGRESS CURVE  
 TOTAL COST CURVE

Section 4

- Max. length built per week = 6200 Ft.
- Mm. " " " week = 800 Ft. 3,000
- Average " " " " = 3264 Ft.
- Average length built per day = 544 Ft.
- " cost per day = \$234<sup>00</sup>
- Average Yardage per 100 Ft. = 77 2,000
- " Cost per 100 Ft. = \$43<sup>00</sup>
- Average cost per Mile = \$2270

Time Scale

482+50 - 370 Stations = 37000 Ft

Stas 350 Stas

325

300

275

250

225

200

175

150

125

100

75

50

25 Stas

116+50

\$15,912.89 Total Cost

\$15,000

14,000

13,000

12,000

11,000

10,000

9,000

8,000

7,000

6,000

5,000

4,000

\$1,000

0 10 20 30 40 50 60 68 Days

Fig. 1

ROAD IN EARTH EXCAVATION

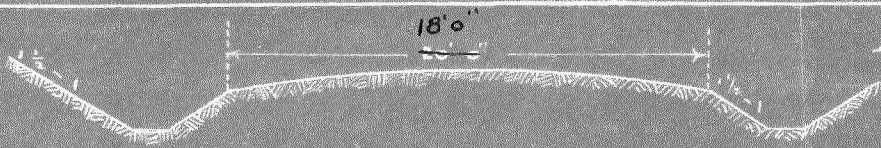


Fig. 2

ROAD IN EMBANKMENT



Fig. 3

ROAD IN ROCK EXCAVATION

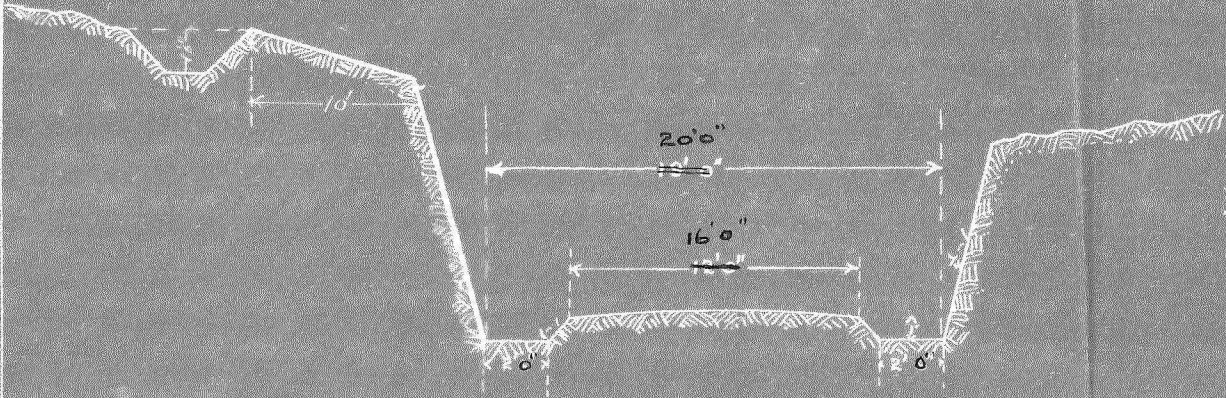


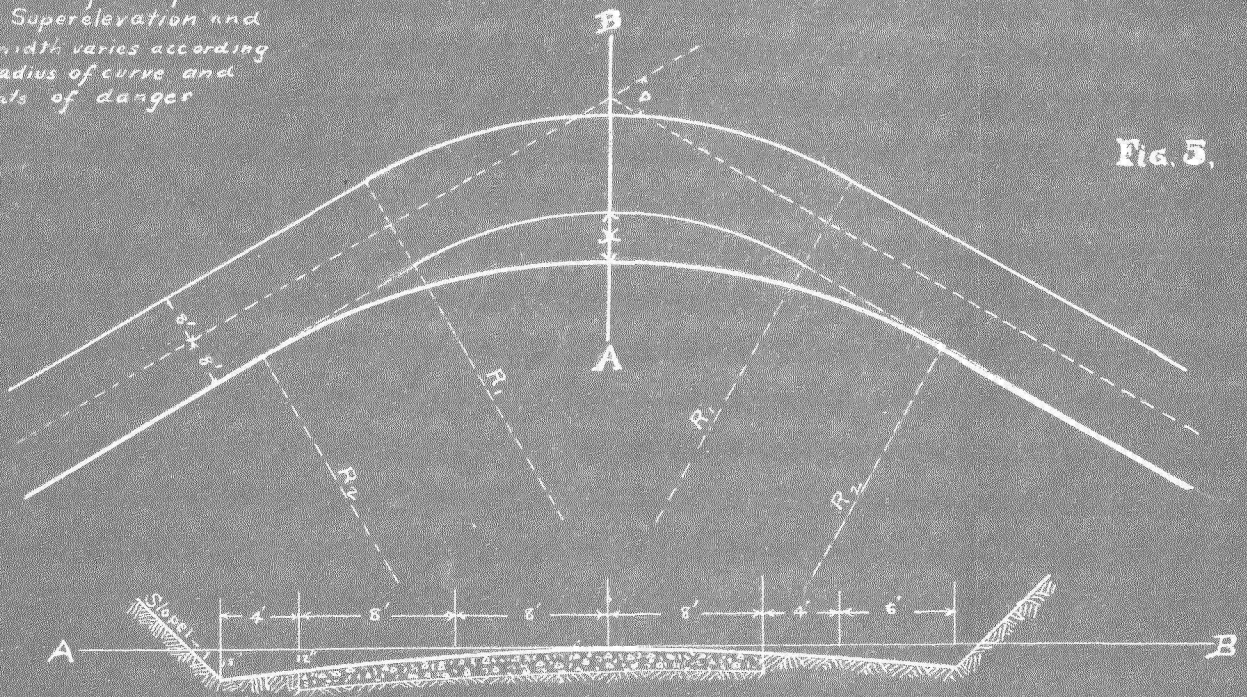
Fig. 4,

CROSS SECTION OF ROAD IN SANDY SOIL



x varies from 2 ft. to 8 ft. — Superlevation and extra width varies according to the radius of curve and elements of danger

Fig. 5,



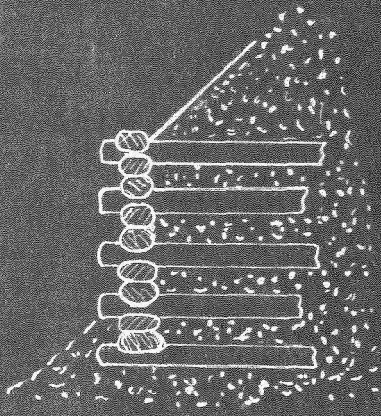
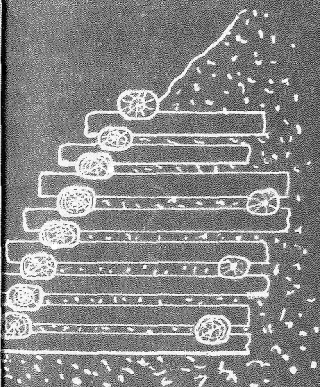
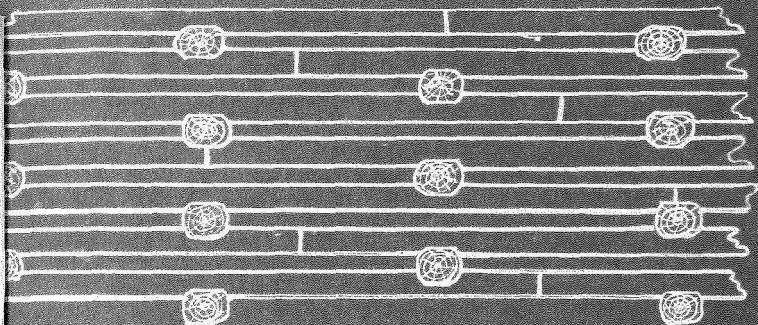
SECTION A-B

Sketch Showing Widening of Roads on Curves. Accompanying Specification May 1914.

aw Gray B.Sc.  
Dom. Public Highways

SIDE HILL

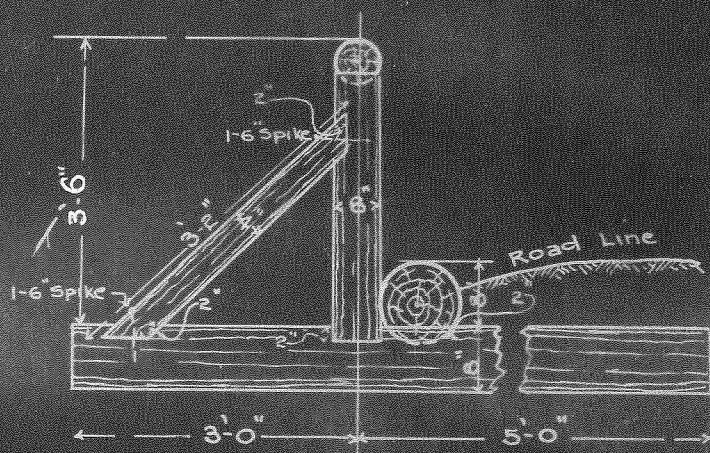
CRIB-WORK



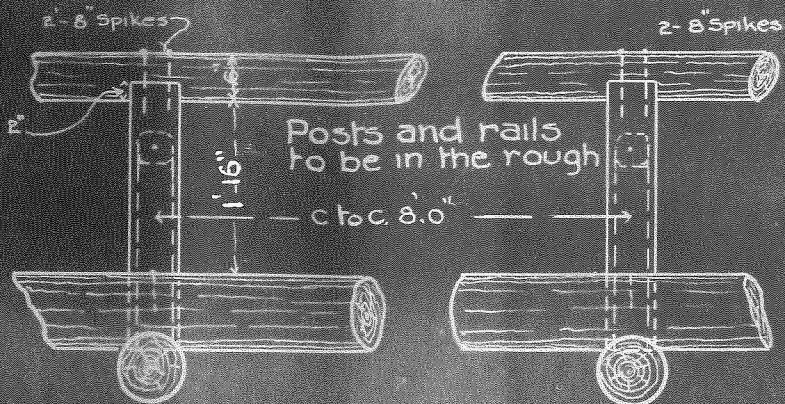
Note - Use Sound timber 8" dia. or over  
 Drift Bolt timbers with  $\frac{1}{2}$ " round Iron.



# WOODEN GUARD RAIL



SECTION



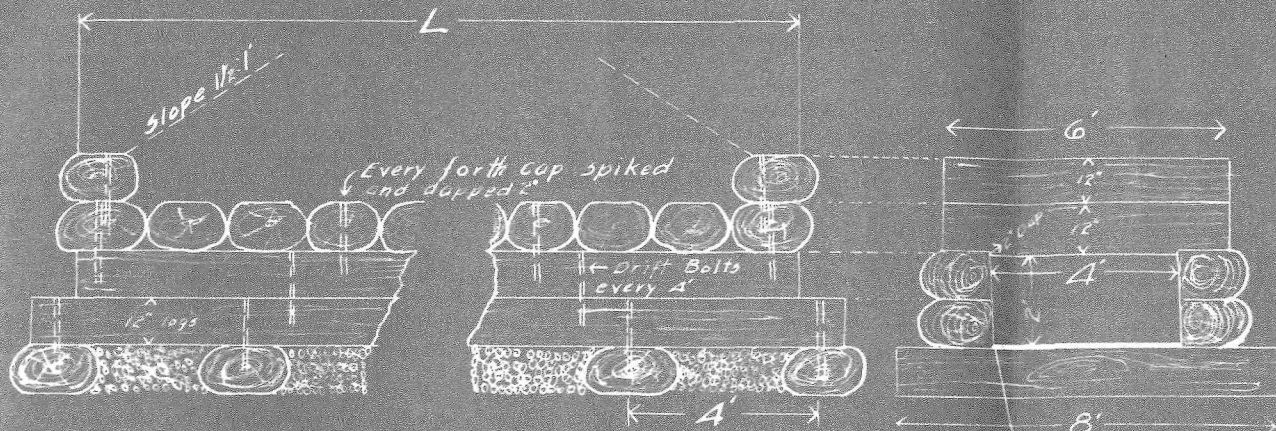
ELEVATION

Scale  $\frac{1}{2}$ " = 1 Foot

Bill of Material (Per. Bent)

1-6" Post	2'-10" Lgth.
1-4" Brace	3'-2" "
1-6" Rail	8'-0" "
1-8" Mud Sill	8'-0" "
1-10" Wheel Guard	8'-0" "
2-6" Spikes	
2-8" "	

# CULVERTS 2' x 4'

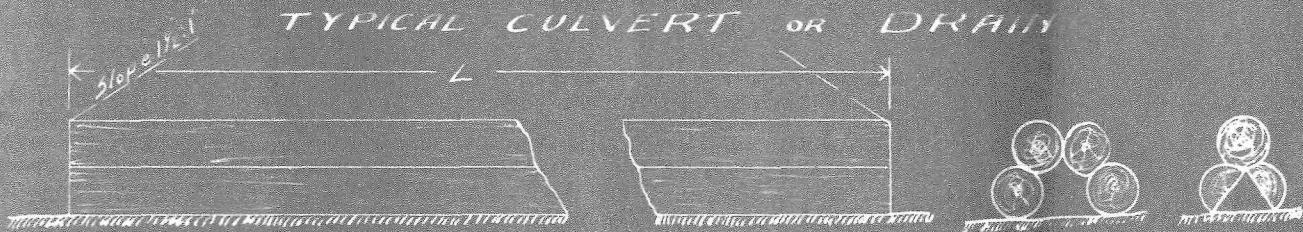


Space between mudsills to be filled with broken stone or coarse Gravel.

SIDE ELEVATION

END ELEVATION

## TYPICAL CULVERT OR DRAIN



SIDE ELEVATION

END ELEVATION

"L" to be determined by height of fill  
 Diameter of logs when kern to be not less than 8".  
 Drift Bolts to be of 1/2" to 3/8" round Iron.

Accompanying Specifications May 1914

A. W. Gray B.Sc.

Dominion Parks Highway Engineer