(No. 55.)

1868.

TASMANIA.

MAIN LINE RAILWAY.

REPORT OF ROYAL COMMISSION.

Laid upon the Table by the Colonial Treasurer, and ordered by the House to be printed, August 18, 1868.

ROYAL COMMISSION

ON

THE MAIN LINE RAILWAY.

REPORT

OF

THE COMMISSIONERS,

Together with an Abstract of the Minutes of the Proceedings of the Commission; Particulars of the Evidence taken; Copies of the Reports accompanying the Plans and Sections of various Routes; Statistics relating to Traffic, and other Documents.

PRESENTED TO BOTH HOUSES OF PARLIAMENT BY COMMAND.

Tasmania:

JAMES BARNARD, GOVERNMENT PRINTER, HOBART TOWN.

1868.

CONTENTS.

MAIN LINE RAILWAY COMMISSION.

(Seal.) VICTORIA *by the Grace of* GOD *of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith.*

To our trusty and well-beloved CHARLES STUART CANSDELL, Esquire, WILLIAM DODERY, Esquire, ADYE DOUGLAS, Esquire, the Honorable PHILIP OAKLEY FYSH, Esquire, the Honorable FREDERICK MAITLAND INNES, Esquire, DAVID LEWIS, Esquire, and the Honorable JAMES MILNE WILSON, Esquire.

GREETING:

WHEREAS We have thought it expedient for divers good causes and considerations Us thereunto moving that Enquiry should forthwith be made as to the probable Cost of constructing a Main Line of Railway to connect Hobart Town with Launceston, and providing such Railway with sufficient and effective Locomotive and Rolling Stock: Know ye that We, reposing great trust and confidence in your fidelity, discretion, and integrity, have authorised and appointed, and by these Presents do authorise and appoint you the said CHARLES STUART CANSDELL, WILLIAM DODERY, ADYE DOUGLAS, PHILIP OAKLEY FYSH, FREDERICK MAITLAND INNES, DAVID LEWIS, and JAMES MILNE WILSON, or any three or more of you, to make diligent Enquiry into the probable Cost of constructing a Main Line of Railway to connect Hobart Town with Launceston, and providing such Railway with sufficient and effective Locomotive and Rolling Stock: And for the better discovery of the truth in the premises We do, by these Presents, give and grant unto you or any three or more of you full power and authority to call before you all such persons as you shall judge necessary by whom you may obtain information in the premises: And Our further will and pleasure is, that you or any three or more of you shall reduce into writing under your hands what you shall discover in the premises, and do and shall, on or before the Thirtieth day of June, One thousand eight hundred and sixty-eight, certify unto Us in Our Executive Council in Tasmania, in writing under your hands respectively, your several proceedings by force of these Presents, together with what you shall find touching or concerning the premises upon such enquiry as aforesaid: And We further will and command, and by these Presents ordain, that this Our Commission shall continue in full force and virtue, and that you Our said Commissioners or any three or more of you shall and may, from time to time, proceed in the execution hereof, and of every matter or thing herein contained, although the same be not continued from time to time by adjournment: And We do hereby command all and singular Our loving subjects whomsoever within Our said Colony of Tasmania that they be assistant to you and each of you in the execution of these Presents: And we direct and appoint that HUGH MUNRO HULL, Esquire, shall be Secretary to Our said Commissioners, and We command that he shall be assistant to them in the execution of these Presents.

In testimony whereof We have caused these Our Letters to be made Patent, and the Public Seal of Our Colony of Tasmania to be hereunto affixed.

Witness Our trusty and well-beloved Colonel THOMAS GORE BROWNE, Companion of the Most Honorable Order of the Bath, Captain-General and Governor-in-Chief of Tasmania and its Dependencies, at Hobart Town, in Tasmania aforesaid, this Second day of November, One thousand eight hundred and sixty-seven.

T. GORE BROWNE.

By His Excellency's Command,

THOS. D. CHAPMAN, *for the Colonial Secretary.*

GOVERNMENT NOTICE.

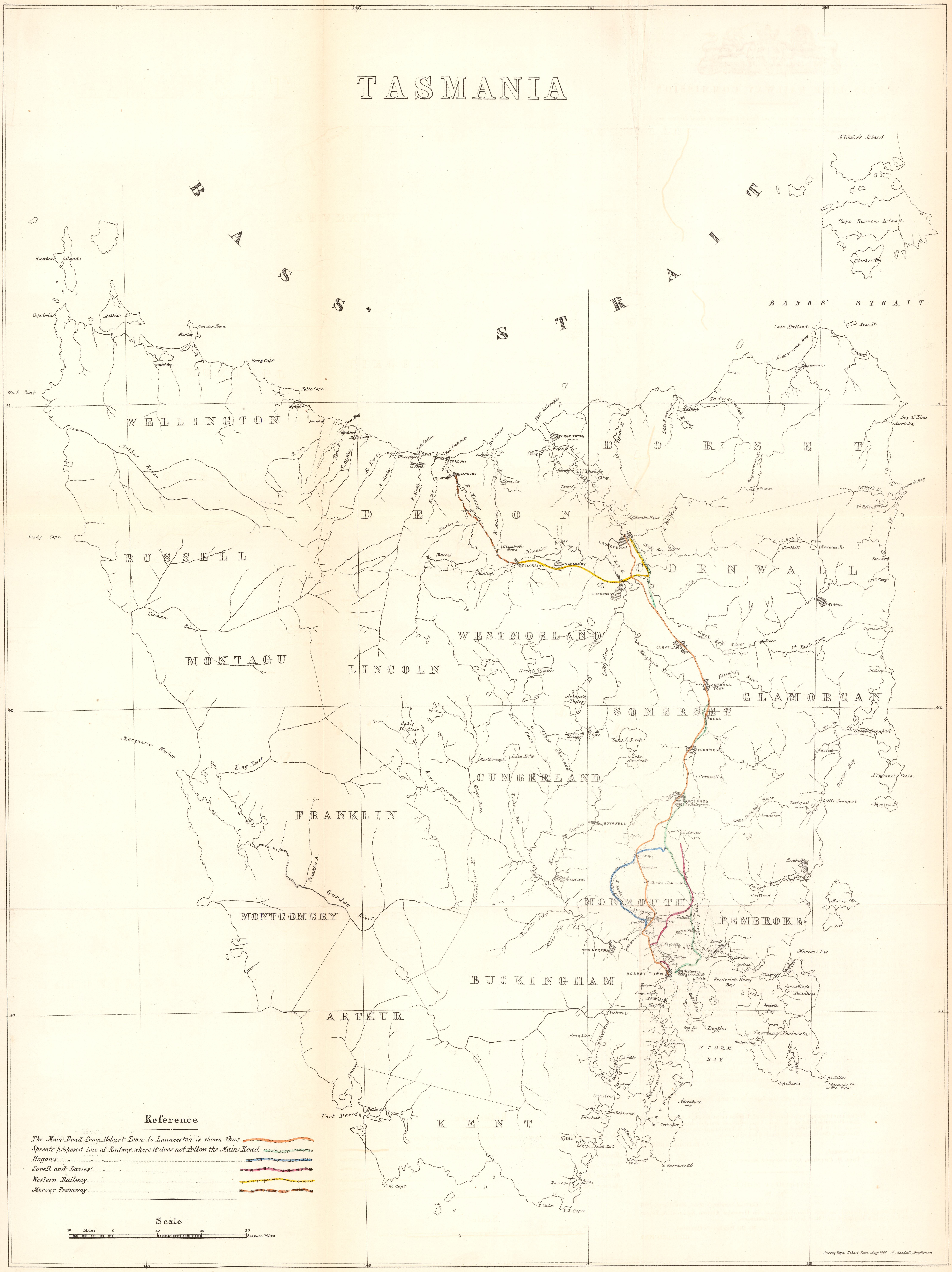
No. 76.

Colonial Secretary's Office, 30th March, 1868.

THE Governor in Council has been pleased to appoint the Honorable ALFRED KENNERLEY, Esquire, M.L.C., to be a Member of the "Main Line Railway Commission."

By His Excellency's Command,

RICHARD DRY.


TASMANIA
BASS STRAIT
BANKS' STRAIT
Flinder's Island
Cape Barren Island
Clarke Id.
Hunters Islands
Cape Grim
Robbins Id.
Circular Head
Stanley
Rocky Cape
Table Cape
West Point
Cape Portland
Swan Id.
Ringarooma Bay
Bay of Fires
Georges Bay
St. Helens
Sandy Cape
WELLINGTON
DEVON
DORSET
RUSSELL
CORNWALL
WESTMORLAND
MONTAGU
LINCOLN
GLAMORGAN
SOMERSET
CUMBERLAND
FRANKLIN
MONMOUTH
PEMBROKE
MONTGOMERY
BUCKINGHAM
ARTHUR
KENT
Arthur River
Pieman River
Macquarie Harbor
King River
Gordon River
Franklin R.
Great Lake
Lake St. Clair
Lake Echo
Meander River
LAUNCESTON
GEORGE TOWN
LONGFORD
WESTBURY
DELORAINE
TORQUAY
LATROBE
FINGAL
CLEVELAND
CAMPBELL TOWN
ROSS
TUNBRIDGE
OATLANDS
BOTHWELL
HAMILTON
NEW NORFOLK
HOBART TOWN
RICHMOND
Great Swanport
Oyster Bay
Maria Id.
Marion Bay
Frederick Henry Bay
Forestier's Peninsula
Tasmans Peninsula
STORM BAY
Cape Pillar
Tasman's Id.
Adventure Bay
Port Davey
S.W. Cape
South Cape
S.E. Cape
Recherche
Kingston
Franklin
Victoria
Reference
The Main Road from Hobart Town to Launceston is shown thus
Sprents proposed line of Railway where it does not follow the Main Road
Hogan's
Sorell and Davies'
Western Railway
Mersey Tramway
Scale
10 Miles 0 10 20 30 Statute Miles.
Survey Dept. Hobart Town Aug: 1868 A. Randall, Draftsman.

REPORT.

To His Excellency Colonel Thomas Gore Browne, *Companion of the Most Honorable Order of the Bath, Captain-General and Governor-in-Chief of the Colony of Tasmania and its Dependencies.*

May it please Your Excellency.

We, the undersigned Commissioners appointed by the Commission of Her Most Gracious Majesty to enquire into the probable cost of constructing a Main Line of Railway to connect Hobart Town with Launceston, and providing such Railway with sufficient and effective Locomotive and Rolling Stock, respectfully submit our Report thereon.

Report chiefly limited to Southern Section of proposed Line from Hobart to Oatlands.

We have deemed it advisable, considering the small sum of money voted by Parliament for the service of this Commission, to limit our enquiries chiefly to the country lying between Hobart Town and Oatlands, through which that part which may be distinguished as the Southern section of a Main Line Railway would probably pass: and we have been confirmed in this course by the knowledge that it is only in that portion of the proposed line that any difficulties of construction may be expected; and because, while the part from Longford to Launceston which will form the Northern section of it has already received the sanction and assistance of Parliament, and is now in process of construction, the remainder of the line, which lying between Oatlands and Longford will probably form the Midland section, is of a very easy character, and may well be left to be the subject of future enquiry and survey during the construction of the Northern and Southern sections.

The evidence which we have taken, and the plans, sections, Engineers' reports, and other documents which accompany this Report, have, therefore, main and almost exclusive reference to the Southern section of the proposed Railway.

Speed—effect of upon cost of construction.

The point which, more than any other, will be found upon enquiry to govern the cost of a Railway, is the maximum speed at which it is intended to be capable of being *profitably* worked. The difference between the cost of a Railway capable of being worked at a high rate and one capable of being worked at only a low rate of speed, where constructed upon table land and no wide streams intervene, is inconsiderable, and would not much, it is alleged, exceed £1000 per mile extra: but if the country to be traversed be mountainous, and yet its requirements demand a high rate of speed, the line must be constructed with ruling gradients and curves of such a favourable character as could not possibly be obtained without extensive cuttings, embankments, tunnels, and other earthworks involving great cost. If, however, only a medium rate of speed be required, less favorable gradients and curves may be adopted, and so heavy earthworks avoided, and the cost of construction considerably reduced.

It will therefore be apparent that the rate of speed being fixed will, to a very large extent, affect if not actually determine the gradients and curves: these being fixed will determine the choice of route; and it is the character of the earthworks and bridges to be encountered on that route which will chiefly affect the cost of construction.

Hence it is that the transit requirements of old and new countries being so different, Civil Engineers have of late years recognised two classes of Railways, technically known as Heavy and Light Railways; the one being constructed for the transport of the heavy traffic of highly developed countries at high rates of speed, and the carrying power of the other being restricted to the lighter traffic of new countries at lower rates of speed.

We have, therefore, addressed ourselves very diligently to the consideration of the rate of speed which would be sufficient to meet the requirements of the traffic of a Main Line Railway in Tasmania.

In some countries where the seats of manufactures are situated at great distances from the ports and principal markets, the highest rate of speed is found to be desirable,—can be made remunerative by an extensive and constantly increasing trade,—and may, perhaps, be necessary to maintain competition with other markets.

High rate of speed not of primary importance.

But in an insular country of very limited area, and of partial development, where the greatest distance from any inland district to a port cannot exceed 70 miles, and where the necessities and competitions known only to advanced countries do not exist, a high rate of speed cannot be a matter of primary importance.

And, indeed, even in the most wealthy and advanced countries, where the Railways are constructed in the most perfect manner, the bulk of the traffic is not conducted at high rates of speed.

Rates of speed in England, Europe, America, and Australia.

		Miles per Hour.
In England	the Express Trains run from	34 to 47
Ditto	the Fast Trains average about	36½
Ditto	the Ordinary Trains run from	18 to 30
Ditto	the Slow Trains average	19½
In France	the Express Trains run from	25 to 35
Ditto	the Ordinary Trains run from	16 to 25
Ditto	the Slow Trains average	18
In Belgium	the Quickest Trains run from	29 to 35
Ditto	the Slowest Trains run from	18 to 23
In Prussia	the Quickest average	29
Ditto	the Slowest run from	17 to 21
In Austria	the Quickest run from	20 to 29
Ditto	the Slowest run from	14 to 21
In Bavaria	and along the Rhine the Quickest Trains run from	24 to 32
Ditto	the Slowest Trains would run from	13 to 24
In Italy	the Quickest Trains run from	24 to 30
Ditto	the Slowest Trains run from	15 to 24
In America	the Quickest Trains run from	20 to 25
Ditto	the Ordinary Trains run from	15 to 20
In New South Wales	the Quickest Trains run from	25 to 27
Ditto	the Ordinary Trains average	20
In Victoria	the Quickest Trains average	25
Ditto	the Ordinary Trains average	20

It will be seen by the foregoing Table, which we have compiled from the latest authorities, that the English Express Trains average, including stoppages, 40 miles per hour; but it must be remembered that so high a speed is only attainable on ways and with locomotives constructed in the most perfect manner, and at so great a cost for construction, fuel, and wear and tear of machinery, carriages, and permanent ways, as to favour the opinion entertained by many that Express Trains are run at a loss, which has to be covered by the profits made out of the running of slower Trains.

But if the Express Trains be excluded from the foregoing Table, it will be seen that the bulk of the passenger traffic in England is conducted at an average speed of less than 25 miles, and on the Continent at speeds varying from 17½ to 20½ miles per hour; while very much of the goods traffic is conducted, even in England, at about 15 miles, and on the Continent at rates as low as 13 miles per hour. And in our sister Colonies of New South Wales and Victoria, where the Railways have been constructed at an expense scarcely below the best examples in the Mother Country, and in a manner which would permit of their being worked at the highest rates of speed, an average rate of 20 miles per hour is found to be sufficient to satisfy the ordinary demands of the public.

Cheap rather than fast transit needed.

Assured by these facts that in a new country cheap rather than fast transit is needed, and satisfied by our enquiries that to construct a Railway capable of being worked at a very high rate of speed would entail an extra expenditure of from £2000 to £2500 per mile, according to the gauge adopted, beyond what would otherwise be necessary; and bearing in mind also that agriculture is the industry mainly capable of development in Tasmania, and that the amount of traffic from such source is necessarily limited in quantity as compared with manufacturing or mining pursuits, which have yet to be developed here, we deem it to be our duty to recommend that the Main Line Railway should be constructed to be worked at a maximum speed of 25 miles for passenger traffic, and of 15 miles per hour for goods.

The next point to which we have directed our attention is that of the Gauge which ought to be adopted for Railways in Tasmania. Gauge—effect of upon cost of construction and working.

The choice of gauge affects the subject committed to our enquiry in two ways: firstly, as to the cost of construction; and secondly, as to the cost of working the railway when completed; and we have been extremely fortunate in having had the opportunity of examining an Engineer of great authority upon this particular question.

The gauges mostly in use are the 4-8½ and 5-3, and recently the narrow or 3-6 has obtained the favourable opinion of many Engineers as suitable for use in very mountainous countries.

Gauges, some much narrower and others very much broader than these, are in use, in exceptional cases, and have their special advocates: but we are satisfied that a gauge of less than 3-6 would not be advisable except for a railway to be carried through very difficult and mountainous country, and intended mainly for the transport of minerals; and also that a broader gauge than 5-3 can give no advantage which would compensate for the necessarily increased cost of construction and working.

The gauge chosen by the pioneers of railway construction in England was 4-8½, and that gauge has been continued there, and adopted by the whole continent of Europe, with the exception of Spain, where the gauge is 5-6, and by the United States, with the exception of the New York and Erie, which has a 6 feet gauge. One exception only is to be found in England—the Great Western—the original gauge of which was fixed at 7 feet, but the example has never been copied; and even that line is now laid almost throughout with a third rail, so that it may be worked on the smaller gauge of 4-8½. English gauge of 4-8½ generally adopted.

The gauges of the Irish railways, which at first varied from 6-2 downwards, were finally fixed by Parliamentary authority at 5-3, and this gauge has been adopted by our sister colonies of Canada and Victoria.

During the last few years the 3-6, or narrow gauge, has been introduced into Sweden, Norway, and Queensland, and apparently with great advantage as to cost there, but at the expense of considerable loss of speed. We have consulted with the greatest care all that has been advanced both for and against this gauge, and have come to the conclusion that, though it offers great economy in the construction of railways in countries where extensive mountain ranges have to be crossed, and other physical difficulties encountered, it would not be desirable to adopt it in countries where those difficulties do not exist.

The data by which to determine the choice of a gauge are various. The practical datum is found in the requisite dimensions of carriages intended for the convenient and safe conveyance of passengers: the scientific data are mainly supplied by the fact that the narrower the gauge the less will be the friction of the wheels, especially on curves of sharp radii; and the financial datum is the additional cost which must be incurred in avoiding or working unfavourable curves. Data by which gauge should be determined.

These data point to different results, and any settlement of the question must be a compromise of the solutions to which they would separately lead; but we believe that the requisite conditions of comfort, speed, construction, and cost have been found to combine most perfectly in the 4-8½ gauge, and, fortified by the examples of England, Scotland, Europe, America, and our Sister Colony of New South Wales, we beg to recommend the adoption of that gauge as the standard gauge for Railways in Tasmania.

Upon the question of Route, we have availed ourselves of the Report upon a Preliminary Survey made some years since by the late James Sprent, Esquire, Surveyor-General, under the authority of Your Excellency's predecessor; and we have had several trial Surveys made of the country near a difficult part of the route laid down in that Report to see whether the extreme gradients encountered there could be avoided. Routes surveyed—Sprent's Line.

We have also had a Plan and Section made of the Main Road from the third milestone on the New Town Road to Ross-street, Oatlands. Main Road.

We have also had a Preliminary Survey made of a Route *viâ* Austin's Ferry, following the Old Beach Road, to Brighton. Austin's Ferry to Brighton.

Austin's Ferry. Route extended northwards.

We also had this Survey extended from Brighton, to ascertain whether a favourable line could be found by which, while avoiding the difficulties of "Spring" and "Constitution" Hills, it could be taken nearly along the course of, and ultimately connected with, the Main Road at some point on the Southern side of Oatlands.

The same extended to Sprent's Line.

We also had the Austin Ferry route extended from Brighton in a north-easterly direction, to ascertain whether it could be connected by a favourable line with the line surveyed by Mr. Sprent.

Valley of the Jordan Line.

Desirous also of making our enquiries as complete as possible, we deemed it advisable to have the Valley of the Jordan examined, to see whether a favourable route could be obtained in that direction: and we regret that the inclement weather which immediately followed the commencement of this work so delayed the Surveyors employed, that we were not able to report to Your Excellency as early as we hoped to have been able to do.

Routes from third milestone to Southern Terminus.

And, as a necessary supplement to all these preliminary surveys, we have had plans and sections prepared of two routes from the third milestone into town, to ascertain the probable cost of reaching a suitable Southern terminus.

Advantages and difficulties of each route.

The result of these enquiries is shown by the following summary of the engineering difficulties which would have to be encountered on each route.

Sprent's Line.

By Mr. Sprent's Line the ruling gradient would be favourable, but there would be a tunnel near Kangaroo Point, which would be a very expensive work, and besides this a gradient of 1 in 12 would have to be encountered for a length of about one mile and a half. This we have, however, found by a barometrical survey might be reduced to about 1 in 30, but by a very objectionable rise of about five miles.

Austin's Ferry to Brighton.

By the Austin's Ferry route a very favourable line can be obtained, which has the advantage of avoiding the difficulties of Pontville.

Austin's Ferry northwards.

The extension survey of the Austin's Ferry route, by which we attempted to obtain a favourable line, which, while running near to the main road, would avoid the difficulties of Spring and Constitution Hills, was abandoned, as after repeated trials no practicable route could be found.

Austin's Ferry eastwards to Sprent's.

The extension survey of the Austin Ferry route, by which we sought a favourable line to the eastward, was more successful. In this direction a favourable line was found by which the difficulties of Spring and Constitution Hills may be avoided, but only by running into and adopting the before-mentioned objectionable rise of 1 in 30 for a length of about five miles.

Valley of the Jordan.

The route viâ the Valley of the Jordan is reported to promise favourable gradients from Pontville to Picton; but beyond that a good line could not be secured except by an expensive tunnel, several viaducts, and considerable earthworks; and even with such an outlay there would be long lengths of gradients of from 1 in 36 to about 1 in 50; besides which the line has the disadvantage of running away from the Main Road traffic for upwards of 33 miles, and, in making the necessary detour, of increasing the length of the line by about twelve miles as compared with any other route.

Effect of route on cost.

We are aware that the choice of route forms no part of the duty directly entrusted to us by Her Majesty's Commission; and we should not have caused any preliminary Surveys to be made if we had not found the questions of route and cost of construction so inseparable as to make it impossible to determine the one without considering the other.

Route recommended.

As a mere question of cost of construction and maintenance, no less so as regards the charges for transit, and of time in getting across the Island, the shortest line ought, of course, to be preferred unless it presents greater engineering difficulties than would have to be encountered elsewhere, or unless it would leave the principal townships without railway transit: and we have satisfied ourselves that the survey we have had made of the Main Road indicates that a line in its vicinity will present no greater length of objectionable gradients than will have to be encountered in any other of the surveyed routes. Assured also that it would give a line as short as any that can be found,—that it will afford the advantage of railway transit to the greatest number,—and that the Bridgewater Causeway presents the most economical means of crossing the river, we have deemed it right, in estimating the cost of the Main Line Railway, to assume that the Southern and Midland Sections of the line should be taken as near to the Main Road as is found to be practicable.

Our enquiries have also satisfied us that, whatever route may be ultimately chosen, only about one-fifth of the length of the line between Hobart Town and Oatlands will present engineering difficulties involving extensive earthworks.

Assured as to this important fact, and assisted by the numerous estimates which have been placed at our service showing the average cost of Colonial Railways upon lands presenting only ordinary undulations, and also the cost of additional earthworks in parts where the contour of the country presents more difficulties than would have to be encountered here, we venture to submit to Your Excellency the following approximate estimate.

Estimate.

We find that, upon land presenting only ordinary undulations, the construction of a Railway of the 4-8½ gauge can be accomplished for the sum of £3500 per mile. To the whole length of the line, at this rate, must be added the cost of the additional earthworks which would have to be encountered on difficult portions of the line, and the cost of Bridges and Rolling Stock.

The extra earthworks will not in this country exceed £3000 per mile; the cost of Bridges must depend upon the number and breadth of the streams to be crossed; and the amount of Rolling Stock may safely be left to be increased as traffic is developed.

On these data our estimate is based; and we have divided the work into Sections, so that Your Excellency may readily see the great difference in the cost of constructing the several parts.

MAIN LINE RAILWAY.

Southern Section. (Hobart to Oatlands.)

Southern Section.—Hobart Town to Oatlands.

(*Distance,* 51·34—*say* 52 *Miles.*)

	£
Cost of constructing 52 miles on table land, at £3500 per mile	182,000
Cost of extra earthworks in difficult parts, averaging ⅓rd = say, to 14 miles, at £3000 per mile	42,000
Cost of adapting Bridgewater Causeway or of a Steam Ferry to carry the Railway Train, say	30,000
Cost of Terminal arrangements	15,000
Cost of Bridges above 35 feet span, say	15,000
Cost of Railway Stock, say	30,000
Contingencies, say	36,000
	£350,000

Midland Section. (Oatlands to Longford.)

Midland Section.—Oatlands to Longford.

(*Distance,* 55 *Miles—say* 56 *Miles.*)

	£
Cost of constructing 56 miles on table land, at £3500 per mile	196,000
Cost of extra earthworks in difficult parts—say 10 miles, at £3000 per mile	30,000
Cost of Bridges, say	15,000
Cost of Rolling Stock, say	20,000
Contingencies, say	9000
	£270,000

Northern Section. (Longford to Launceston.)

Northern Section—Longford to Launceston.

(*Distance,* 18 *Miles.*)

	£
Cost of constructing 18 miles if on table land, at £3500 per mile	63,000
Cost of extra earthworks, assuming two-thirds of the whole length of the line to be of very difficult character, say 12 miles, at £3500 per mile	42,000
Cost of Terminal arrangements	15,000
Cost of Bridges, say	28,000
Cost of Rolling Stock, say	15,000
Contingencies, say	17,000
	£180,000

SUMMARY.

	£
Southern Section, (Hobart Town to Oatlands)	350,000
Midland Section, (Oatlands to Longford)	270,000
Northern Section, (Longford to Launceston)	180,000
	£800,000

Average per mile.

The foregoing estimates give the sum of £6730 as the average cost per mile of the Southern Section; £4821 as the average cost per mile of the Midland Section; £10,000 as the average cost per mile of the Northern Section: and the totals, making the above sum of £800,000, give £6349 as the average cost per mile for the whole length of the line, the same being calculated as 126 miles to allow for sidings.

All the items in the detailed estimates from which these averages have been struck have been so carefully considered, that we feel assured they will be found sufficient for the construction of a Railway capable of the heaviest goods traffic and of passengers at a rate of speed should it be found necessary beyond that recommended by us; and we desire to add that, if extreme economy were deemed essential, we believe that a Railway, sufficient in all respects for the present requirements of the Colony, could be constructed for a sum not much, if at all, exceeding £700,000.

Probable revenue from traffic.

In conclusion, we have the honor to report to Your Excellency the result of our enquiries as to the revenue which may be expected from traffic to meet the working expenses of the Railway, and the interest on the capital which would be employed in its construction.

We have availed ourselves of Traffic Returns taken by the Government which, though obtained for another object, are not the less valuable for, and must be beyond all suspicion when applied to, this purpose. We have supplemented these Returns by others, some taken under our instructions, and some from the evidence taken by a Joint Committee of both Houses, as to the traffic which may be expected to pass along the Launceston and Western Railway.

But beyond the Traffic shown in these Returns, which it may be fairly assumed would soon more than double itself if the advantages of Railway transit were within reach, we beg to remind Your Excellency that a large saving would be made in the conveyance of Her Majesty's Mails, and in other matters connected with the administration of Her Majesty's Government, and in the maintenance of the Main Road.

And besides these items, which may be taken as representing the present traffic, we believe that a large development of it in cattle, sheep, meat, bark, and especially in coal, may be expected, of which no account whatever has been taken by us in our enquiries.

We therefore feel justified, upon a careful review of the returns obtained, and of the evidence taken by us, in assuming that at least 100,000 tons of goods now pass every year along the Main Road for an average distance of at least 20 miles. This tonnage, at rates averaging *5d.* per ton, (a rate considerably under the average rates charged in the adjoining Colonies), would yield a revenue of upwards of £40,000; and we believe that the passenger traffic would supplement this by a further sum of £47,000 at the least.

The financial result of the proposed work based on the foregoing estimates would, we believe, stand thus:—

		£
Receipts from Goods Traffic for 100,000 tons at an average charge of *5d.* per ton for an average distance of 20 miles (say)		41,000
Receipts from Passenger Traffic for 14,000 journeys between Hobart Town and Launceston, at an average of £1 10*s.* each journey (say)	£21,000	
For 40,000 intermediate journeys at 10*s.* each journey (say)	£20,000	
For 60,000 short journeys from each terminus at 2*s.* each journey (say)	£6000	
		47,000
Saving to Her Majesty's Government in the conveyance of Mails, in matters connected with the Judicial and Police Departments, and in the maintenance of the Main Road (say)		12,000
Carried forward		£100,000

		£
Forward		100,000
Working expenses taken at 50 per cent. on gross receipts	£44,000	
Interest on capital £800,000 at 6 per cent	48,000	
		92,000
Surplus		£8000

These financial results show that, taking into consideration the saving which will be made by Her Majesty's Government in the conveyance of Mails, and matters connected with the Judicial Departments, and in the maintenance of the Main Road, the receipts of a Main Line Railway may not only be expected to discharge its own working expenses, and interest on the capital employed in its construction, but to leave the above surplus, or, what in effect is the same, relieve the Government of an equal amount of expenditure.

And finally, we have the honor to conclude our Report by adverting to the fact that, besides the direct advantages which will flow from the construction of the Main Line Railway, there are others which, though indirect, are scarcely less important.

All which we respectfully submit to Your Excellency's consideration.

CHAS. STUART CANSDELL. (L.S.)
P. O. FYSH. (L.S.)
ALFRED KENNERLEY. (L.S.)
JAMES MILNE WILSON. (L.S.)
D. LEWIS. (L.S.)

HUGH M. HULL, *Secretary.*
14th August, 1868.

DAYS OF MEETING.

PRESENT.

1. November 13, 1867. Mr. Cansdell, Mr. Fysh, Mr. Wilson.
2. December 20, 1867. Mr. Cansdell, Mr. Fysh, Mr. Wilson.
3. February 5, 1868. Mr. Cansdell, Mr. Fysh, Mr. Wilson.
4. February 10, 1868. Mr. Cansdell, Mr. Innes.
5. February 19, 1868. Mr. Cansdell, Mr. Fysh, Mr. Wilson.
6. February 28, 1868. Mr. Cansdell, Mr. Fysh, Mr. Innes, Mr. Lewis.
7. March 5, 1868. Mr. Cansdell, Mr. Fysh, Mr. Lewis, Mr. Wilson.
8. March 7, 1868. Mr. Cansdell, Mr. Fysh, Mr. Lewis.
9. March 12, 1868. Mr. Cansdell, Mr. Fysh.
10. March 20, 1868. Mr. Cansdell, Mr. Fysh.
11. March 25, 1868. Mr. Fysh.
12. April 28, 1868. Mr. Cansdell, Mr. Fysh, Mr. Kennerley.*
13. May 5, 1868. Mr. Cansdell, Mr. Fysh, Mr. Kennerley, Mr. Lewis, Mr. Wilson.
14. May 12, 1868. Mr. Cansdell, Mr. Fysh, Mr. Kennerley.
15. May 19, 1868. Mr. Cansdell, Mr. Innes, Mr. Wilson.
16. May 26, 1868. Mr. Cansdell, Mr. Fysh, Mr. Wilson.
17. June 2, 1868. Mr. Cansdell, Mr. Fysh, Mr. Kennerley.
18. June 8, 1868. Mr. Cansdell, Mr. Fysh, Mr. Kennerley.
19. June 16, 1868. Mr. Cansdell, Mr. Fysh, Mr. Lewis, Mr. Kennerley.
20. June 19, 1868. Mr. Cansdell, Mr. Fysh, Mr. Innes, Mr. Lewis, Mr. Kennerley, Mr. Wilson.
21. June 23, 1868. Mr. Cansdell, Mr. Fysh, Mr. Kennerley, Mr. Lewis, Mr. Wilson.
22. June 25, 1868. Mr. Cansdell, Mr. Kennerley, Mr. Lewis.
23. June 30, 1868. Mr. Cansdell, Mr. Fysh, Mr. Kennerley, Mr. Lewis, Mr. Wilson.
24. July 14, 1868. Mr. Cansdell, Mr. Lewis, Mr. Kennerley, Mr. Wilson.
25. July 23, 1868. Mr. Cansdell, Mr. Innes, Mr. Wilson, Mr. Kennerley, Mr. Fysh.
26. August 4, 1868. Mr. Cansdell, Mr. Innes, Mr. Kennerley, Mr. Fysh, Mr. Wilson.
27. August 8, 1868. Mr. Cansdell, Mr. Kennerley, Mr. Fysh, Mr. Wilson, Mr. Dodery.
28. August 14, 1868. Mr. Cansdell, Mr. Kennerley, Mr. Innes, Mr. Douglas, Mr. Lewis, Mr. Dodery, Mr. Wilson, Mr. Fysh.

* The Honorable Alfred Kennerley, Esq., M.L.C., was added to the Commission at this date.

WITNESSES EXAMINED.

PROCEEDINGS of the ROYAL COMMISSION *appointed to consider the probable Cost of constructing a* MAIN LINE OF RAILWAY *to connect Hobart Town with Launceston.*

WEDNESDAY, NOVEMBER 13, 1867.

Present—C. S. CANSDELL, Esquire, M.H.A., in the Chair; the Hon. J. M. WILSON, Esquire, M.L.C.; the Hon. P. O. FYSH, Esquire, M.L.C.; H. M. HULL, Esquire, Secretary.

1. The Royal Commission was read appointing C. S. Cansdell, Esq., W. Dodery, Esq., A. Douglas, Esq.' the Hon. P. O. Fysh, Esq., the Hon. F. M. Innes, Esq., David Lewis, Esq., the Hon. J. M. Wilson, Esq., to be Commissioners, and H. M. Hull, Esq., to be Secretary.

2. On the motion of Mr. Wilson, Mr. Cansdell took the Chair.

3. Letters were read from Mr. Douglas and Mr. Dodery, stating that they were unable to attend the meeting.

4. *Resolved,* That the meetings of the Commission be not open to the press.

5. Ordered, that the following papers be prepared for next meeting, if possible:—

   1. Mr. Sprent's Map of proposed Line.
   2. Mr. Sprent's Reports in *Gazette* 1856.
   3. County Maps showing the Line marked in red.
   4. All papers connected with the Launceston and Western Railway.

6. Mr. Falconer, Director of Public Works, to be summoned for next meeting.

The Commissioners adjourned at 5·50 to Monday next at 4.

FRIDAY, DECEMBER 20, 1867.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. J. M. WILSON, Esq., M.L.C.; the Hon. P. O. FYSH, Esq., M.L.C.

The Commissioners met in Mr. Fysh's office.

1. *Resolved,* That Returns of Traffic should be obtained from certain parts of the main line of road.

2. *Resolved,* That authority be given to Mr. Cansdell to apply to the Survey Office for the fullest information respecting the present main road, its width, curves and gradients, where it could be improved for rail purposes, and the class of land adjoining the road.

WEDNESDAY, FEBRUARY 5, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. J. M. WILSON, Esq., M.L.C.; the Hon. P. O. FYSH, Esq, M.L.C.

1. The Chairman stated, that since the last meeting of the Commission he had applied by letter addressed to the Honorable the Colonial Treasurer, requesting the Government to have the goodness to instruct the Survey Department to furnish the Commission with tracings of such maps relating to the main road in the possession of that Department as the Commissioners may consider will be of assistance in their inquiries; and further, to direct that Department to have a survey made of the main road from Hobart Town to Oatlands; and further, to instruct the Surveyors employed to report as to such alterations of, and deviations from, the present main road as would reduce the present gradients and curves, and otherwise improve such road.

2. The Chairman further stated, that subsequently Mr. Calder had, by direction of the Honorable the Colonial Treasurer, enquired of him, and he had furnished that gentleman with full particulars as to the various points upon which the Surveyors employed on the survey of the main road should be requested to take notes and report.

3. The Chairman further stated, that subsequently he had had several interviews with the Honorable the Colonial Treasurer and Mr. Calder; but being without any official reply from the Government to his former application, he had that day written again requesting an answer, to enable him to advise the Commission as to the course the Government would pursue in the matter, and that just previously to the meeting he had been favoured with a letter from the Honorable the Colonial Treasurer enclosing a report from Mr. Calder as to the probable expenses of such a survey, and as to the utility and prospective profit to be obtained by converting part of the main road into a railway, and suggesting how, by providing cheap means of transit, new markets might be opened up for agricultural produce in the neighbouring Colonies, and furnishing in support of such suggestions very elaborate Tables as to the nature and quantities of various articles of farm produce now imported by the adjoining colonies from other places, which with cheaper transit could be supplied by this Colony.

4. Read—

   Letter, (copy) C. S. Cansdell, Esq., to the Honorable the Colonial Treasurer, 16th January, 1868.

   Letter, (copy) C. S. Cansdell, Esq, to the Honorable the Colonial Treasurer, 5th February, 1868.

   Letter, the Honorable the Colonial Treasurer to C. S. Cansdell, Esq., 4th February, 1868.

   Report, J. E. Calder, Esq., Surveyor-General, to the Honorable the Colonial Treasurer, 27th January, 1868.

   Memorandum by C. S. Cansdell, Esq., as to the points upon which the Surveyors employed ought to be required to report.

5. The Commission deliberated as to the several matters which, having regard to the small amount voted by Parliament to defray the expenses of the enquiry, ought first to engage the attention of the Commission; and the Commissioners present being of opinion that it would be desirable, before entering upon the consideration of any other route, to consider how far the main road could be made available for the purposes of a railway, the Chairman entered at great length into his views upon that matter, stating that he should propose—

(1.) That the road now presenting an average width of about 50 feet should be increased at the least to an uniform width of 2 chains (132 feet), out of which the present road, increased when and where necessary to one chain in width, should be reserved for the railway, leaving a public road on each side of the width of 33 feet, and preserving the present hedges and fences.

(2.) To prevent the expense of purchasing the frontages, two chains might be required on one side only of the main road,—one chain to be reserved for the railway, and the other for a road giving access to the adjoining lands.

(3.) That for the present only one line of rails should be laid down: for by working the railway on what is known by engineers as the reciprocal system of starting and running the trains, one line would, with sidings at various places, be found sufficient for all the traffic which would be likely to be developed for years to come.

(4.) That as traffic is developed, the width of one chain (66 feet) reserved for the railroad would be sufficient to allow of ultimately laying down four lines of full gauge railway.

(5.) That neither the main road nor the route of the main road should be adopted by the railway in entering Hobart Town; but that a separate line should be constructed from some point on the main road about the third milestone beyond New Town, and then taking a course which would be parallel to and between Campbell-street and the Domain to a passenger terminus there, and thence crossing Macquarie-street by a bridge, and continuing probably along the course of the creek and extending to a jetty or goods terminus on the shore of the river, from the same point at New Town through the Domain to the same terminus on the shore of the river, so as to afford the greatest facility for shipping and unshipping cargo. The line might afterwards be extended along the Hobart Town Creek up to the Cascades.

(6.) That, to avoid too great an interference with private property, the road railway on this system, instead of passing through the main streets of the inland townships, might be constructed so as to pass round behind,—the up line on one side and the down line on the other.

The Chairman also entered at great length into explanations of the advantages and disadvantages of the narrow (3 feet 6) gauge; and having shown that the route adopted and the working speed required would to a great extent determine the gauge which could be most advantageously and profitably used, and that if the main road could, by being considerably widened as proposed by him, be made available for the substratum of the railway, that the difference of expense between laying down a 3 feet 6 or 5 feet 6 gauge would probably not exceed 10 per cent., while if a route were adopted away from the main road the difference in the cost of construction would be at the least 30 per cent. in favour of the narrow or 3 feet 6 gauge: and having stated that he had been favoured with letters, reports, and estimates from M. R. Scott, Esq., Secretary of the Indian Tramway Company, H. W. Wickes, Esq., Secretary and Engineer of the Indian Branch Railway Company (now the Oude and Rohlicund Railway) and Sir C. Fox, C.E., which would support his views thereon,—

6. Read—

Letter from M. R. Scott, Esq., to C. S. Cansdell, Esq., 26th June, 1866. (*See* Appendix.)

Ditto, the same to the same, 26 July, 1866. (*See* Appendix.)

Report by Sir C. Fox to C. S. Cansdell, Esq., 19th July, 1866, on the construction of Colonial railways. (*See* Appendix.)

Letter, M. R. Scott, Esq., to C. S. Cansdell, Esq., 22nd May, 1867. (*See* Appendix.)

Report and estimate, Sir C. Fox to C. S. Cansdell, Esq., 16th May, 1867, on the construction of railways in Tasmania. (*See* Appendix.)

Copy Report, C. D. Fox, Esq., C.E., to Sir C. Fox, 24th August, 1864, on the Norwegian Railways, forwarded by Sir C. Fox to C. S. Cansdell, Esq. (*See* Appendix.)

7. The Commission then deliberated upon the letters, reports, and estimates just read; and the Chairman urged upon the Commissioners that the adoption of the main road as the route and basis of the Main Line Railway would not only conserve the interests of persons resident on the main road, and afford the advantages of cheap transit to the largest number of persons, but save at least 75 per cent. of the cost of surveying and engineering, and of the earthworks, bridges, culverts, walling, and ballast, as against a new route, and the whole also of the otherwise necessary outlay for an electric telegraph and inland stations; while, on the other hand, a route away from the main road would destroy the trade of all the townships on the present route, and render transit also very dear, if not destroy it altogether. And the Commissioners, on consideration, being of opinion that whether or not the main road (widened as suggested by the Chairman) should be found to be available as the basis of the railway, yet that any main line between Hobart Town and Launceston should certainly take the route of the main road for at least a large part of its way, it was, on the motion of Mr. Fysh, seconded by Mr. Wilson,—

8. *Resolved*, That a plan and section of the main road is necessary to assist the Commissioners in their enquiries; and that the Chairman do prepare, or cause to be prepared, the draft of a specification for a staff and level survey of the main road, from some point to be afterwards agreed on, between Hobart Town and Oatlands, to be completed with plans, sections, and cross sections to a scale, and in the manner as usually required for deposit and known as a Parliamentary and Engineering Survey, such survey to contain notes of all the points set forth in the Memorandum prepared by Mr. Cansdell and read at this meeting, and particularly that the Surveyors in making such survey be required to report specially as to the gradients exceeding 1 in 30, and as to curves of less than 5 chains, and the best means of improving them, and that advertisements be issued for tenders for executing such survey.

9. *Traffic Returns.*—The Chairman reported that he had not taken any further steps to obtain returns of the traffic on the road, partly because the expense would be altogether beyond the sum voted, and partly because he had had handed to him the original returns of traffic on the main road taken, by order of the Government in 1863, to ascertain whether it would be advisable to put up more toll-houses on the main road. And the Chairman having stated that he was preparing tabulated statements from these returns, the question was allowed to stand over.

The Commissioners adjourned at 6·15.

MONDAY, FEBRUARY 10, 1868.

Present—C. S. CANSDELL, Esq., M.H.A.; the Hon. F. M. INNES, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

There being no quorum, at 5·5 the Chairman adjourned the Commission, and requested the Secretary to write to the absent Commissioners, urging their attendance at the next meeting.

WEDNESDAY, FEBRUARY 19, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. P. O. FYSH, Esq., M.L.C., the Hon. J. M. WILSON, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. Read the specifications for a plan and section of the main line of road from the third milestone to Oatlands.

2. *Resolved*, That the Chairman be authorised to prepare an advertisement calling for tenders for the said plan and section of the main line of road, the specification to be placed in Mr. Cansdell's office for reference by intending Surveyors.

3. Read a Letter addressed by Mr. S. V. Kemp to Mr. Innes, on the subject of the advisability of a survey being made.

4. Read a Letter from Mr. D'Arcy Murray to Mr. Cansdell on same subject.

5. Read a Letter from Mr. Edmund Hodgson, offering his evidence on the subject of the road between Hobart Town and Jericho.

6. Ordered to be acknowledged, and asked whether he is prepared with information on the subject for the Commissioners.

The Commissioners adjourned at 5·55.

FRIDAY, FEBRUARY 28, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; DAVID LEWIS, Esq., M.H.A.; the Hon. F. M. INNES, Esq., M.L.C.; the Hon. P. O. FYSH, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. W. Hanson, Esq., C. E., from South Australia, was called in and examined.

The Commission adjourned at 12.

THURSDAY, MARCH 5, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. J. M. WILSON, Esq., M.L.C.; the Hon. P. O. FYSH, Esq., M.L.C.; DAVID LEWIS, Esq., M.H.A.; H. M. HULL, Esq., Secretary.

1. The Chairman opened five tenders for the survey of the main line of road between Oatlands and the third milestone, in accordance with specifications issued by order of the Royal Commission.

1. Francis Butler, £9 a mile.
2. Gordon Burgess, £450.
3. John Thomas, £400.
4. Hogan, Sorell, and Davies, £300.
5. Edward Innes, £2 17*s*. a mile.

2. *Resolved*, That the Chairman do consult to-morrow with the Surveyor-General as to his opinion of the capability of the parties tendering to do the work well, and report to the Royal Commission at next meeting.

The Commission adjourned.

FRIDAY, MARCH 7, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. P. O. FYSH, Esq., M.L.C.; DAVID LEWIS, Esq., M.H.A.; H. M. HULL, Esq., Secretary.

1. The Chairman reported that he had consulted with the Surveyor-General as to the capability of the gentlemen who had tendered for the survey, and that Mr. Calder had stated that they were all competent surveyors.

2. Mr. Lewis moved that the tender of Mr. Innes be accepted. Mr. Fysh seconded. Question put and passed.

3. *Ordered*, That the Secretary write to Mr. Innes, informing him that his tender has been accepted by the Royal Commission, and that the Chairman wishes to confer with him on the subject.

4. The Secretary to write to the unsuccessful tenderers informing them of the non-acceptance of their tenders.

The Commission adjourned.

THURSDAY, MARCH 12, 1868.

Present—C. S. CANSDELL, Esq., M.H.A.; the Hon. P. O. FYSH, Esq., M.L.C.

There being no quorum at 5 o'clock, the Chairman requested the Secretary to write to the absent Commissioners, requesting their attendance at the next meeting, and adjourned the Commission.

FRIDAY, MARCH 20, 1868.

Present—C. S. CANSDELL, Esq., M.H.A.; the Hon. P. O. FYSH, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

There being no quorum, the Chairman adjourned the Commission.

WEDNESDAY, MARCH 25, 1868.

Present—The Hon. P. O. FYSH, Esq., M.L.C.

No quorum.

TUESDAY, APRIL 28, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. P. O. FYSH, Esq., M.L.C.; the Hon. A. KENNERLEY, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. Read—Mr. F. M. Innes's letter of 25th March, 1868, suggesting that Mr. S. V. Kemp should be examined.

2. Mr. Edmund Hodgson was called in and examined.

3. *Ordered,* That Mr. Flexmore be summoned for half-past 4 on Tuesday next.

4. *Ordered,* That a Map showing the Roads in the Island be called for from the Surveyor-General.

The Commission adjourned at 10 minutes to 6.

TUESDAY, MAY 5, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. A. KENNERLEY, Esq., M.L.C.; DAVID LEWIS, Esq., M.H.A.; the Hon. P. O. FYSH, Esq., M.L.C., the Hon. J. M. WILSON, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. The minutes of last meeting were read and confirmed.

2. *Ordered,* That a Map of the Colony showing the lands alienated, and also the roads of the Colony, be prepared at an expense not exceeding £10.

3. The Chairman reported that Mr. George Innes, the surveyor, had completed his survey of the road, and that he will have the plan and section completed and sent in with the field notes, &c., in three weeks.

4. Mr. Hodgson's evidence of 28th April was read over for the information of the Commissioners who were not present on the day the evidence was taken.

5. *Ordered,* That Mr. Calder be summoned for next meeting, and to be informed that he will be examined as to the advantage of the Valley of the Jordan as part of the route for a railway, and generally on the question.

6. *Ordered,* That Mr. Falconer be summoned to give evidence as to the expense of road-making and other matters.

7. The Commission deliberated on the discussion of the question of having a survey made from the third milestone to a southern terminus by two routes, one *viâ* Park-street, and the other *viâ* the Domain, to Macquarie-street, and the Chairman was requested to make enquiries as to the cost thereof.

8. On discussion of the traffic returns taken for the Government some years since, it was arranged that in calculating the tonnage carried on the road carts and waggons should be assumed, for traffic, to be ⅔ of a ton per horse, or ⅓ of a ton per bullock.

The Commission adjourned at 20 minutes to 6.

TUESDAY, MAY 12, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. A. KENNERLEY, Esq., M.L.C.; the Hon. P. O. FYSH, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. Mr. Calder, the Surveyor-General, was called in and examined.

2. The Chairman reported that the Map referred to at last meeting could not be obtained at a less expense than £12.

Ordered, that that amount be sanctioned.

3. The Chairman reported that he had seen Messrs. Sorell and Davies as to the two routes into Town, and they had offered to do the work on the same specification as that of Mr. Innes for £20.

Resolved, That the Chairman be authorised to employ Messrs. Sorell and Davies accordingly, the work to be done within a time to be fixed by the Chairman.

4. *Ordered,* That Mr. Falconer be summoned for next meeting, to be examined as to the cost of road-making generally, and as to the expense of widening the present main line of road.

The Commission adjourned at 25 minutes past 5.

TUESDAY, MAY 19, 1868.

Present—C. S. Cansdell, Esq., M.H.A., in the Chair; the Hon. J. M. Wilson, Esq., M.L.C.; the Hon. F. M. Innes, Esq., M.L.C.; H. M. Hull, Esq., Secretary.

1. The Minutes of last meeting were read and confirmed.

2. An apology for the absence of the Director of Public Works, who is on a visit of inspection to Scottsdale, was read.

3. *Resolved,* That Mr. Falconer be summoned for Tuesday next.

4. The Commission having deliberated upon the advisability of the plan and section of the two routes to a southern terminus *viâ* Park-street and *viâ* the Domain being reduced in scale;

Ordered, That the Chairman do make arrangements with Messrs. Sorell and Davies as to the reduction in the scale of their plans of the routes into town.

5. *Ordered,* That the Chairman do communicate with the Bridgewater Commissioners as to their willingness to arrange for the utilization of the Causeway for the purposes of the railway, and as to the desirability of the Commissioners avoiding the expenditure of moneys on the repair of the Causeway until the point has been determined.

The Commission adjourned at 5 P.M.

TUESDAY, MAY 26, 1868.

Present—C. S. Cansdell, Esq., M.H.A., in the Chair; the Hon. P. O. Fysh, Esq., M.L.C.; the Hon. J. M. Wilson, Esq., M.LC.; H. M. Hull, Esq., Secretary.

1. The Minutes of the last meeting were read and confirmed.

2. The Chairman reported that he had seen Messrs. Davies and Sorell, and that their plans would be on the scale of ten inches to the mile.

3. The Director of Public Works was called in and examined.

4. *Resolved,* That a copy of the Return of Tolls taken on Bridgewater Bridge, for the same period as those now in possession of the Commission for the other parts of the main road, be procured for the information of the Commission.

5. *Resolved,* That the Chairman do arrange for a Return of the Traffic on the New Town Road near the Queen's Asylum, for the month of June next.

6. *Resolved,* That the Chairman do see Mr. Hogan, the Surveyor, as to the survey of the line proposed by Mr. Hodgson, and to report the result to the Commission at its next meeting.

7. Read copy of the Letter addressed by the Chairman to the Commissioners of the Bridgewater Causeway, in accordance with the Resolution passed at the last meeting of the Commission.

The Commission adjourned at 10 minutes to 6.

TUESDAY, JUNE 2, 1868.

Present—C. S. Cansdell, Esq., M.H.A., in the Chair; the Hon. A. Kennerley, Esq., M.L.C.; the Hon. P. O. Fysh, Esq., M.L.C.; H. M. Hull, Esq., Secretary.

1. The minutes of the last meeting were read and confirmed.

2. Henry Bilton, Esq., was called in and examined.

3. The Chairman reported that he had seen Messrs. Davies and Sorell, who had informed him that their plans would be ready for next Tuesday's meeting.

4. The Chairman reported that he had arranged with a man at the Police buildings, near the Queen's Asylum, to take the Traffic Returns at that point for a fortnight, or for the same time that the other Returns were taken, charging 25*s*. a week for his services.

5. Mr. Hogan's Letter read, offering to survey the line of road up the Valley of the Jordan for £100.

The Commissioners declined to accept his offer.

6. *Ordered,* That Mr. Hogan be summoned to attend and give his evidence on Thursday at 4.

7. *Ordered,* That Mr. Flexmore be summoned to attend on Tuesday next, at 4.

8. *Resolved,* That the portions of the Appendix and Evidence be at once placed in the Printer's hands, so as to prevent delay in its preparation to lay before the Parliament at its ensuing Session.

The Commission adjourned at 5 minutes to 6 o'clock.

MONDAY, JUNE 8, 1868.

Present—C. S. Cansdell, Esq., M.H.A., in the Chair; the Hon. P. O. Fysh, Esq., M.LC.; the Hon. A. Kennerley, Esq., M.L.C.; H. M. Hull, Esq., Secretary.

1. The minutes of last meeting were read and confirmed.

2. Read Mr. Bilton's Letter expressing regret that he had not yet revised his evidence, on account of illness.

3. Read the Bridgewater Commissioners' Letter in reply to that addressed to them by the Chairman.

4. Mr. W. Hogan, Surveyor and Civil Engineer, called in and examined.

5. *Ordered,* That Mr. Hodgson and Mr. Flexmore be summoned for Friday.

6. *Resolved,* That Mr. Nowell the Statistician, Mr. Oldham, and Mr. Nichol be summoned at a future meeting.

The Commission adjourned at 10 minutes past 5 to Friday next.

TUESDAY, JUNE 16, 1868.

Present—C. S. CANSDELL, Esq. M.H.A., in the Chair; DAVID LEWIS, Esq., M.H.A.; the Hon. P. O. FYSH, Esq., M.L.C.; the Hon. A. KENNERLEY, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. The minutes of last meeting were read and confirmed.

2. Read a Letter from Mr. George Innes, on the subject of the unavoidable delay in his sending in his plans.

3. Read a Letter from Mr. Hodgson, suggesting that Mr. Falconer should go over the line with him.

4. The Secretary reported that he had written to the Government for authority for the papers of the Commission being printed at the Government Printing Office; and that he had also written for information as to the cost of carriages and tariffs of traffic from the other Australian Colonies.

5. Mr. Edmund Hodgson was called in and examined.

6. The Chairman read to the Commission various Reports and Papers on the subject of light railways, gradients, and gauges, as to locomotives on ordinary roads, and Reports and Estimates as to the construction of railways in New Zealand, which were ordered to be printed and annexed as Appendices to the Commissioners' Report.

7. *Ordered,* That Mr. Nowell, the Statistician, be summoned for Friday.

The Commission adjourned at 6.

FRIDAY, JUNE 19, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. A. KENNERLEY, Esq., M.L.C.; the Hon. P. O. FYSH, Esq., M.L.C.; the Hon. F. M. INNES, Esq., M.L.C.; DAVID LEWIS, Esq., M.H.A.; the Hon. J. M. WILSON, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. The minutes of last meeting were read and confirmed.

2. Read the Colonial Secretary's Letter, approving of printing being done in the Government Printing Office.

3. Mr. Rowland Davies was called in and examined.

The Commission having deliberated as to the advisability of further surveys;

4. *Resolved,* That the Chairman do make arrangements for a reconnaissance survey of the lines pointed out by Mr. Bilton and Mr. Hodgson, and that Mr. Hogan be asked to undertake that suggested by Mr. Hodgson, at an expense not exceeding £100,—and Messrs. Sorell & Davies to be asked to undertake the other.

In the event of none of the above Surveyors being able to undertake the work, then the Chairman be authorised to treat with other Surveyors.

5. The Statistician to be summoned for next meeting.

The Commission adjourned at 6·5 to Tuesday next at 4.

TUESDAY, JUNE 23, 1868.

Present—C. S. CANSDELL, Esq., in the Chair; the Hon. A. KENNERLEY, Esq., M.L.C.; DAVID LEWIS, Esq., M.H.A.; the Hon. P. O. FYSH, Esq., M.L.C.; the Hon. J. M. WILSON, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. The minutes of the last meeting were read and confirmed.

2. The Chairman reported that he had made arrangements with Mr. Hogan for the reconnaissance survey of the line up the Jordan Valley.

3. The Statistician, Mr. Nowell, was called in and examined.

4. *Ordered,* That the Collector of Customs be summoned for next meeting, and to be prepared to give evidence as to the weight of packages of imported goods.

5. The Chairman produced Tenders from Messrs. Sorell and Davies for a survey of the line by Austin's Ferry, for a sum of £135.

Resolved, That the Chairman be authorised to make the necessary arrangements as to the survey.

The Commission adjourned at 6 o'clock.

THURSDAY, JUNE 25, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; DAVID LEWIS, Esq., M.H.A.; the Hon. A. KENNERLEY, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. The minutes of last meeting were read and confirmed.

2. The Collector of Customs was called in and examined.

3. *Ordered*, That the Statistician be summoned for next meeting.

The Commission adjourned at 5.

TUESDAY, JUNE 30, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. A. KENNERLEY, Esq., M.L.C.; the Hon. P. O. FYSH, M.L.C.; the Hon. J. M. WILSON, Esq., Esq., M.L.C.; Mr. Alderman DAVID LEWIS, M.H.A.; H. M. HULL, Esq., Secretary.

1. The minutes of the last meeting were read and confirmed.

2. Letter from the Colonial Secretary read, extending to 31st July the time for the Commission to bring up their Report.

3. Letter from Messrs. Sorell and Davies read, asking for information as to bench marks to connect their survey *viâ* Austin's Ferry with main road and Valley of the Jordan surveys.

4. The Chairman reported that Mr. Innes, the surveyor, had been written to, urging him to send in his plans and report, from which information was required for the other surveyors.

5. Mr. Nowell, the Government Statistician, was called in and examined.

6. *Ordered*, That the Collector of Customs in Launceston be requested to furnish information with regard to that port, similar to that supplied by the Collector in Hobart Town.

7. Read a Letter from Mr. Sorell, claiming additional remuneration for preparing the map of the Colony, showing the alienated and Crown lands and the roads of the Island.

Resolved, That the claim be referred for the opinion of the Surveyor-General.

8. The Commissioners deliberated on the heads of their proposed Report.

The Commission adjourned at 5·20.

TUESDAY, JULY 14, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; Mr. Alderman DAVID LEWIS, M.H.A.; the Hon. A. KENNERLEY, Esq., M.L.C.; the Hon. J. M. WILSON, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. Mr. George Innes, surveyor, produced his plans of the survey of the main line of road between New Town and Oatlands, which were carefully inspected by the Commission, and he was examined fully thereon.

2. *Resolved*, That Mr. Innes be allowed to draw £100 on account of his contract.

3. *Resolved*, That Messrs. Sorell and Davies's account for preparing a map of the Colony, shewing the Crown lands, leased lands, and alienated lands, and also the roads of the Colony, for the sum of £18 18*s*., be paid.

The Commission adjourned at 6.

THURSDAY, JULY 23, 1868.

Present—C. S. CANSDELL, Esq., M.H.A., in the Chair; the Hon. F. M. INNES, Esq., M.L.C.; the Hon. A. KENNERLEY, Esq., M.L.C.; the Hon. J. M. WILSON, Esq., M.L.C.; the Hon. P. O. FYSH, Esq., M.L.C.; H. M. HULL, Esq., Secretary.

1. The Minutes of the last meeting were read and confirmed.

2. The Report of Mr. Surveyor Innes was read.

3. The Report of Messrs. Sorell and Davies, surveyors, was read.

4. The Commissioners proceeded to discuss the several points of their Report, as follows:—1. Speed; 2. Class of railway; 3. Gauge; 4. Traffic; 5. Route.

Resolved, That a speed of from 20 to 25 miles per hour for passengers, and of 12 to 15 for goods, is sufficient to meet the requirements of this Colony.

Resolved, That the English gauge, of 4ft. 8½in., be recommended.

Resolved, That the class of railway technically known as light railway is sufficient for the requirements of the Colony.

Resolved, That the Chairman be requested to draw up a Draft Report to be considered at a future meeting.

5. *Resolved,* That Mr. Hogan be examined on his plans at next meeting.

6. *Resolved,* That the Chairman do apply to the Government for a further extension of time to bring up the Report: a fortnight suggested.

7. *Resolved,* That the Chairman do write to Mr. Surveyor Innes, expressing the satisfaction of the Commission at the diligence and ability with which he has prepared his plans and report on the main line of road.

The Commission adjourned at a quarter to 6.

TUESDAY, AUGUST 4, 1868.

Present—C. S. Cansdell, Esq., M.H.A., in the Chair; the Hon. F. M. Innes, Esq., M.L.C.; the Hon. A. Kennerley, Esq., M.L.C.; the Hon. P. O. Fysh, Esq., M.L.C.; the Hon. J. M. Wilson, Esq., M.L.C.; H. M. Hull, Esq., Secretary.

1. The minutes of last meeting were read and confirmed.

2. Read Mr. W. Hogan's Letter of 3rd August, reporting on his survey.

3. *Ordered,* That the balance of Mr. Innes's contract money be paid.

4. *Ordered,* That a small map be prepared, showing the various routes proposed for the railway. Mr. Fysh and the Chairman to arrange the matter.

5. The Chairman laid upon the table an elaborate and carefully prepared chart, showing the traffic on the main road.

6. The Draft Report, so far as relates to speed, traffic, and route, was read and approved.

7. *Resolved,* That the Draft Report be printed, and a copy of the proof sheet sent to each member of the Commission for further consideration.

The Commission adjourned at 1·10.

SATURDAY, AUGUST 8, 1868.

Present—C. S. Cansdell, Esq. M.H.A., in the Chair; the Hon. A. Kennerley, Esq., M.L.C.; the Hon. P. O. Fysh, Esq., M.L.C.; the Hon. J. M. Wilson, Esq., M.L.C.; W. Dodery, Esq., M.H.A.; H. M. Hull, Esq., Secretary.

1. The minutes of the last meeting were read and confirmed.

2. Read Mr. Hogan's Report on his Survey of the Valley of the Jordan route.

3. Discussion on the Draft Report resumed, and the remaining paragraphs relating to the probable cost of construction and revenue having been read, the Commission deliberated thereon, and having approved of the same, ordered that it be printed in draft and circulated amongst the members.

The Commission adjourned at 1·25.

FRIDAY, AUGUST 14, 1868.

Present—C. S. Cansdell, Esq., M.H.A., in the Chair; A. Douglas, Esq., M.H.A.; the Hon. F. M. Innes, Esq., M.L.C.; Mr. Alderman Lewis, M.H.A.; the Hon. A. Kennerley, Esq., M.L.C.; the Hon. J. M. Wilson, Esq., M.L.C.; W. Dodery, Esq., M.H.A.; the Hon. P. O. Fysh, Esq., M.L.C.; H. M. Hull, Esq., Secretary.

1. The minutes of last meeting were read and confirmed.

2. Read Draft Report.

3. Paragraphs 1 to 42 were approved.

4. On the consideration of Paragraphs 43, 44, 45, and 46, relating to the estimated cost of constructing the Main Line Railway, it was

Resolved to increase the estimate by the sum of £100,000, to make greater provision for earth-works, terminal arrangements, and contingencies.

5. The remainder of the Report was approved, subject to such alterations as the foregoing Resolution to increase the estimate would render necessary.

6. *Resolved,* That the Report as amended be approved as the Report of the Commission.

7. *Resolved,* That the Chairman do report to His Excellency in accordance with the terms of the Commission.

ROYAL COMMISSION ON THE MAIN LINE RAILWAY.

MINUTES OF EVIDENCE TAKEN BEFORE THE COMMISSION.

FRIDAY, 28TH FEBRUARY, 1868.

PRESENT.
The Hon. P. O. FYSH, Esq., M.L.C.
The Hon. F. M. INNES, Esq., M.L.C.
Mr. Alderman DAVID LEWIS, M.H.A.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

WILLIAM HANSON, *of Adelaide, Esq., C.E., examined.*

W. Hanson, Esq C.E. 28 Feb., 1868.

1. *By the Chairman.*—I believe, Mr. Hanson, you are a member of the Institute of Civil Engineers, of England? Yes; and I have been connected with railways, in England and in the Colonies, since the year 1836. I was seven years under Robert Stephenson, and have since been engaged for upwards of twelve years in the construction of railways in South Australia and New South Wales.

2. And I think, Sir, you have given particular attention to the question of the gauge of railways? Yes; and I was examined in England by the Committee of the House of Commons on the special enquiry into the relative advantages of the broad and narrow gauges. By the broad gauge I mean the 7 feet gauge, upon which the Great Western Railway from London to Bristol is constructed; by the narrow gauge I mean the English gauge of 4-8½.

3. I think, Sir, I had better intimate that the Commissioners, to prevent any misunderstanding as to the evidence taken in this enquiry, have determined to distinguish the 3-6 gauge as the narrow gauge, the 4-8½ as the English gauge, and the 5-3 as the Victorian gauge. I believe you were the advocate of the 4-8½ or English gauge in that enquiry before the House of Commons? Yes, I was specially examined in favour of the 4-8½ gauge, as I was of opinion that goods could be carried more economically on that than on the broad (7 feet) gauge.

4. Have you formed any opinion as to the construction of railways upon what is called in the Colonies the narrow or 3-6 gauge? Yes; and if you purpose using nothing but horse-power you may adopt it; but I am disposed to consider that if you intend either presently or ultimately to use a locomotive engine, 4-8½ should be the lowest gauge adopted.

5. Will you state to the Commissioners the main objections which you entertain against the adoption of the 3-6 gauge? Yes. The 3-6 gauge does not afford sufficient room for the proper gearing of the locomotive, and necessitates the placing of the cylinders outside, by which you get so much more outward weight, which produces a wabbling or, as we call it, a fish-tail motion, and more wear and tear; while the 4-8½ or, better still, the 5-3 gauge gives more room for the gearing of the locomotive, and, by permitting the cylinders to be placed inside, saves oscillation. The Irish and Indian railways are constructed on the 5-6 gauge.

6. Is it not the fact that, even in locomotives constructed for the 4-8½ gauge, Engineers have in some instances recently returned to the old plan of having the cylinders outside? Yes, I am aware that it is sometimes adopted, but it is not generally approved.

7. Apart from the question of cost, have you any preference for the 5-3 over the 4-8½? Yes; I think 5-3 would be the best gauge: 4-8½ affords sufficient room for the proper gearing of the locomotives, but theoretically there is more advantage in the 5-3 gauge.

8. But apart from the mechanical advantages which you consider the 4-8½ or 5-3 gauges have over the 3-6 gauge, would not the adoption of the narrow gauge considerably reduce the cost of the construction of railways in Tasmania? No, I think not.

9. Would it not permit of great saving in the cost of embankments, cuttings, viaducts, and bridges? No; the saving in cuttings or earth-works by adopting the narrow gauge is almost nothing. In making these in South Australia I adopted a greater width than I now believe to be necessary. Instead of 24 feet at the bottom 18 feet would be sufficient, and in low banking 16 feet would do.

10. Are you not aware that Sir Charles Fox, in a discussion before the Institute of Civil Engineers on Light Railways, recently expressed himself very favourably on the narrow or 3-6 gauge as best adapted for Colonial Railways, and stated that the adoption of it in Queensland had reduced the cost of difficult portions of the country on the Main and Little Liverpool Ranges by two-thirds? No. I have never understood Sir Charles Fox to be in favour of the narrow gauge, and I am not disposed to believe that any such saving could be made.

11. Then, notwithstanding the physical difficulties which Tasmania would present to the construction of Railways, you would prefer the 4-8½ gauge? Yes; the 4-8½ or 5-3, but I should prefer the 5-3. The 3-6 gauge would have its advantages, but I think the other would be the best.

W. Hanson, Esq. C.E.

12. But, supposing that by the difficult nature of the country, and to avoid heavy earthworks, we were obliged to adopt curves having radii of five chains or even less, would you not in such case use the 3-6 gauge? No; I should prefer to use the 5-3 gauge. I would advise that the curves be made to fit the gauge, rather than the gauge the curve. It is true the narrow gauge would allow sharper curves. You would use what is called the Bogie engine or American engines with 3-6 wheels, but in the long run it would be cheaper to use the 5-3 gauge; and I am of opinion that by adopting engines on the American system you might do, as in America, work round a four-chain curve on the 5-3 gauge.

13. Would not the narrow 3-6 gauge permit of steeper gradients than the 5-3 gauge? No; there is not much difference. It would depend on the weight of the engine.

14. Are you aware that the advantages of the 3-6 gauge, as used in Norway, Queensland, and other parts, were very recently discussed at a meeting of the Institute of Civil Engineers in London, and approved by several of the most eminent engineers of the day? Yes; but I adhere to my own opinion. I have said the 3-6 gauge has some advantages—it will permit of sharper curves—but by that you would have a longer line, and though you would save in the works you would lose in the distance and permanent way.

15. Are you aware that Mr. Mallet, the President of the Irish Institute of Civil Engineers, has declared himself very strongly as to the great saving effected by adopting a narrow gauge, and has given it as his opinion that not only the cost of constructing two similar lines differing in gauge, but also the cost of working them, would approach the ratio of the cube of the length of axle, or, what was the same, of the breadth of gauge? I have not tested Mr. Mallet's opinion, but I believe he is very wrong. I go broadly on the system that carriages and engines are to be fitted to the loads they should carry. The point to consider is how to carry a ton of goods for a mile at the lowest cost, and I believe you can carry on the English 4-8½ gauge cheaper than any other.

16. Would not the 3-6 gauge permit a considerable reduction in the cost of the rolling stock? No; the narrow gauge will not save anything in the rolling stock, but would probably be more expensive. The light engines cost more to keep in order. The heavy engines are not near so expensive.

17. But will not the use of the 4-8½ or 5-3 gauge necessitate the adoption of a heavier rail, and so increase the cost of construction? No; I can use any weight of engine. In South Australia the 40lb. rail is used on the 5-3 gauge. I used a 65lb. rail in South Australia for a 22 ton engine. With a 10 ton engine 40lb. would do.

18. Would not the narrow gauge effect some saving in the cost of fuel? No; it would rather increase it.

19. Would not the adoption of the narrow gauge, by reducing the weight of engines and rolling stock, enable a railway to be worked with less hands, and so reduce the cost of maintenance of way? No; I think not materially, because to carry an equal tonnage you would require a larger number of carriages, and for the same reason there would be no saving in the cost of locomotive power, while at the same time the narrow 3-6 gauge will not permit high speed. 25 miles an hour ought to be the maximum speed when the engine is running, but you would not get more than an average of 12 to 15 miles an hour out of light engines. Considering also that you would have to carry wool and other bulky articles, the English 4-8½ or 5-3 gauge would be the best for the Colony.

20. But that fact has not prevented the adoption of the 3-6 gauge in Queensland, where they have a large quantity of wool to carry? No; but I am notwithstanding of opinion that bulky produce requires a broader gauge.

21. I believe you have given special attention to the relative advantages of horse traction as against locomotives? Yes. In branch lines horses would be best, and I would prefer the narrow 3-6 gauge; but in view of a probable increase of traffic, and the subsequent employment of locomotives, the advantage of having all the stock in one gauge would more than counterbalance the advantage of using horses instead of locomotives in the branch lines. I would advise the use of horse traction on a branch line. I should certainly begin with it.

22. I believe you have compiled tables showing the relative cost of traction by horses and locomotives? Yes; and you may take it as a rough but ready estimate that as long as 26 horses will work the line it is cheaper than a locomotive, if you estimate the horse and driver to cost from 6*s.* to 7*s.* a day. The locomotive has, however, the advantage of speed; and when the tonnage to be carried is above 50 tons, and the distance above 12 miles, locomotives should be preferred.

23. Would you advise any particular difference in the construction of lines intended in the first instance for horse traction? No; I should have all the lines made in the same manner, but horses would require lighter sleepers. £1000 a mile would be saved by horse power.

24. Have you given your attention to the question of laying down rails on ordinary roads? No; but I believe that in India there are rails on macadamised roads, but my own impression is that they will throw the road aside, and go in for a railway. For instance, a gradient of 1 in 20 on a road is not thought much of, but on a rail it would be frightful. In England railroads were begun with gradients of 1 in 330, and I know of one now which is 1 in 23, but it is frightfully expensive. As to the feasibility of using some portion of the main line road for a railway, I might employ it as a guide, but I would not use it. Were a locomotive employed on the main line of road, no horses could travel on it. I should be sorry to meet a train even with the best horse. You can, as far as my eye goes, find a much better line of road than the present main line, more to the west of Oatlands.

25. I suppose you are aware that besides the adoption of the plan of railways on the ordinary roads by the authorities in India, Mr. Bridges Adams and Mr. Page have both recommended the conversion of the highways of England into railways, and that that course has been suggested in the Report of the Royal Commission on Railways which has just concluded its sittings in England? Yes; but I am still of opinion that the rail and the road are not fitted to go together, even with a screen. It could not be put on your roads, the gradients are excessive—look at Pontville, for instance.

26. Your objections to road railways seem to be chiefly limited to the difficult gradients which would be encountered, and to the effect of locomotives on horses. As to horses, are you not aware that a Committee of the House of Commons in 1831 reported most favourably upon the use of the locomotives on the highways, and that before and since that time many such engines have been run loaded with passengers through the streets of London, and many of the main roads of England, without accident? Yes; but in all such cases the speed was limited to about 15 miles an hour. *W. Hanson, Esq. C.E.*

27. If locomotives on roads have not been found to be productive of accidents, would not the putting of them upon rails laid down upon the road considerably reduce the chance of accident? Obviously so, but still I should prefer putting the railway away from the road.

28. Have you formed any opinion as to the probable cost of constructing railroads, considering the very difficult nature of this country? Yes; allowing £1500 a mile more in this colony for earthworks than in South Australia, a light railway could be made for about £7000 a mile.

TUESDAY, 28TH APRIL, 1868.

PRESENT.

The Hon. A. KENNERLEY, Esq, M.L.C.
The Hon. P. O. FYSH, Esq., M.L.C.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

MR. EDMUND HODGSON, *of Glen House, Macquarie-street, examined.* *Mr. E. Hodgson.*

29. *By the Chairman.*—You are, I believe, Mr. Hodgson, particularly acquainted with the Valley of the Jordan? Yes, I was formerly a farmer and stockholder in the Lovely Banks District, where I lived for five or six years; and I have personally inspected the country from New Town to Oatlands, of which I know ever nook and corner, having once possessed much stock and having to ride over the country. 28 April, 1868.

30. What, in your opinion, is the route which should be adopted for that part of the Main Line of Railway between Hobart Town and Oatlands? The line on which a railroad could be best carried from New Town to Oatlands would be alongside the Main Line of Road to Bridgewater.

31. At what part would you suggest the river should be crossed? The line should cross the river on the causeway.

32. Will you state the route which you are desirous of suggesting to the Commission? After passing the river, instead of keeping along the line of road, it should turn to the left soon after crossing the bridge, which would bring you to the back of the Crooked Billet, and thus the Horseshoe Bridge would be avoided. In passing from the Crooked Billet the hill going down into Pontville should be avoided by crossing the road and keeping to the right. Pontville would form a station, being central, as regards Richmond, Tea Tree, and Bagdad. The road should then be crossed near Cavey's Inn, and the route should keep up the valley of the Jordan on the Bridgewater side, and continue on the course of the valley as far as Elderslie. From Elderslie the line should go up the Jordan, through the Black Brush and Hunting Ground, and come out at Picton, near Mr. Kemp's, on the opposite side of the Jordan. From Picton the line should keep Berthon's Marsh to the left, and go up to the head of the marsh, then on to the foot of the Serpentine Gully, and thence up Quoin Creek into the Little Lovely Banks, and on to Hollow Tree Bottom; from thence it is an easy road all the way to Oatlands, after crossing the road and keeping away near Lemon Springs and down by Anstey Barton, or keeping to the right of the main road from Fourteen Tree Plains.

33. What advantages do you claim for the route you have suggested? My line would avoid the difficulties of the Horseshoe Bridge, Pontville Bridge, Constitution Hill, and Spring Hill. When Mr. O'Connor was Director of Roads, I pointed out my line near Spring Hill; but he remarked that it would ruin the new innkeeper at the London Inn, then just erected at a great expense. Besides the advantages of avoiding those difficult parts of the main road, Elderslie would command the country within 10 miles of Hamilton, to which there is a tolerable road now through extensive agricultural lands. Picton station would come within two or three miles of Green Ponds, and within 10 of Bothwell; and when it reaches Hollow Tree Bottom it would be within seven miles of Jerusalem to the right.

34. What would be the difference in length between the line you propose and that of the present road? The difference in the distance from Pontville to Picton, I think, would be about three miles longer, and from Picton to Oatlands the line would be the same as by the main road. Another great advantage of this line over that of the road, which would have to be widened, would be to cheapen the cost of construction, and that it would embrace a large portion of the agricultural country on this side of the Island, and the most populous part of the Colony.

35. Are you informed as to the nature of the gradients which would have to be encountered in the route suggested by you? I am convinced that in the distance from Pontville to Picton, which is 18 miles by my proposed line, there is no gradient of more than 1 in 100, and the country abounds with timber and road-making materials.

36. Where would your proposed line join Mr. Sprent's proposed route? At Mercer and Guest's lands in the Hollow Tree Bottom.

37. Have you formed any opinion as to the nature and quantity of the earthworks which would have to be encountered if your proposed route were adopted? Yes. From Picton to Hollow Tree Bottom there would be only hill-side cuttings, and no bridges or culverts of any magnitude. The gradient would not be

Mr. E. Hodgson. more than 1 in 50 or 60 in any case. It is somewhat scrubby from the Back Bottom or Little Lovely Banks to Hollow Tree Bottom.

38. Have you anything to add to your evidence? Yes; I recommend that a survey should be made of the line. It is at present practicable for vehicles carrying produce, and has been for years past. The only difficult part is from the Hunting Ground to Picton, or about a mile or so. I should be willing to undertake the survey myself.

39. *By Mr. Fysh.*—Whatever reliance the Commission might place in your capabilities, neither the Parliament nor the public would be satisfied with a survey conducted by you, as you are not a Civil Engineer. I understand road engineering and levelling, and have occasionally exercised myself therein during upwards of 45 years that I have been in Tasmania; and in 1826 I suggested and sent in a plan to Governor Sir George Arthur of the present line of road over Constitution Hill.

Tuesday, 12th May, 1868.

Present.

The Hon. P. O. FYSH, Esq., M.L.C.
The Hon. A. KENNERLEY, Esq., M.L.C.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

J. E. Calder, Esq. 12 May, 1868.

JAMES ERSKINE CALDER, *Esquire, Surveyor-General, examined.*

40. *By the Chairman.*—Are you well acquainted with the valley of the Jordan, and can you afford the Commission any information as to whether it would be desirable to adopt it as part of the route of the Main Line Railway? I was pretty well acquainted with the country round about the Jordan in former times, but I have not formed any opinion as to its advantages as a line for the Main Line Railway. Indeed I paid no attention to the subject when there, which was in 1835.

41. Have you any knowledge of the gradients which would have to be encountered by adopting that route? My knowledge of the gradients along that line is excessively general. I have not been through the country at the back of the Crooked Billet from Bridgewater Causeway since 1835, (except as a mere traveller) when I was surveying in this quarter. Of the gradients hereabouts I can give no positive opinion. Mr. Sprent, I believe, considered that this part of the country would be open to great objections, and evaded it in his survey. I also fear that the Jordan route would be an objectionable one in another point of view, namely, by running away from population. With regard to the physical difficulties of the Jordan route, I beg to refer you to Mr. Sprent's Report of 18th February, 1856.

42. Have you formed any opinion as to the route which it would be best to adopt for the Main Line Railway? Yes; my opinion is that the route should be taken along the main line of road or within a few miles of it. Under the present improved construction of engines, many difficulties which would have prevented the adoption of that route a few years since could probably be got over now.

43. Do you think that the plan of utilising the present main road by converting some parts of it into a railway is open to objections? No; I should see no objection to the main road or a part of it being used for the railway, say by taking one side of it; the crown of the road need not be taken, or the whole of the road, but the rail might possibly run on one side of it.

44. Supposing it should for such a purpose be deemed advisable to widen the main road, can you inform the Commission as to the probable cost of widening it to an uniform width of 2 chains, reserving the present road for the purposes of the railway, with the present hedges and fences, and making a half-chain road on each side? No; it is not in my power to give an idea of the cost of widening the main road, nor do I think it would be necessary to do so, as it is already a chain wide in most places, and almost all through above 60 feet wide, and only in a few places is it under 50 feet. Its narrowest parts are at O'Brien's Bridge, and the southern entrance into Green Ponds.

45. Would not the route indicated along the Jordan valley avoid the severe gradients at Pontville, Constitution Hill, and Spring Hill? Yes; but even by the Jordan route there would be cuttings which would be expensive; and as Oatlands has an elevation of 1337 feet, and the Jordan but a very slight fall during much of its course before it enters the Derwent, you would have to encounter a great rise somewhere to the south of Jericho.

(Mr. Hodgson's evidence, taken by the Commission on the 28th April, was here read to Mr. Calder.)

46. Having heard Mr. Hodgson's evidence as to his suggested route, do you think he is correct in believing there is an easy gradient all the way, and a practicable cart-track throughout? I should think not: a great part of his line is in the valley of the Jordan, and as the fall of the river is very trifling between Bridgewater and some point near Elderslie, the gradient would be all the more severe beyond. There are no doubt, summer roads or cart tracks in some parts of the route, but as I have not been there for 33 years, I could give no idea of the roads. By taking the Jordan route you, of course, abandon much of the present main road and its population.

47. Will you inform the Commission as to the quantity of crown lands which, lying within 10 miles of each side of the main line, are now unalienated? There is not much crown land unalienated lying within that distance of the main road, and, with slight exceptions, it is very inferior. To illustrate the main road settlement I produce a map showing all the land along the line, alienated and otherwise: beyond Oatlands there is no unalienated land within 10 miles of the main line.

48. What in your opinion would be the effect of a railway upon private property? I believe a railroad

would be of great advantage to private properties; its tendency would be to increase their value. It would, in my opinion, be far more profitable to the community to run a railway through private properties than through the crown land of the unsettled districts at present. J. E. Calder, Esq.

49. Is there any foundation for the statement which has several times appeared in print, that there are two millions of acres of unalienated land within easy distance of the main road? It is not true; but, if such statements have been made, it possibly arose from a misconception of facts. Some years ago our Surveyors valued nearly 1,200,000 acres of crown land which it may have been thought lay near the main road, but none of it was near to it.

50. What in your experience has been the effect of constructing good roads upon the subsequent alienation of lands adjacent to such roads? It has invariably happened that the land on each side has been rapidly taken up. The main road was begun in 1817, before much land was granted; and now on either side of the road, for 10 miles and more, nearly every inch is taken up. You will see by the map, that wherever there is a principal road all the land is taken up along it.

51. With reference to giving the advantages of railway transit to Hamilton and Bothwell, would it in your opinion be best to take the main line round by these places, or to reach them hereafter by means of branch lines? It would, I think, be better to adopt the main road, or a line near to it, as the route for the Main Line Railway, and to reach Hamilton and Bothwell by branch lines. I believe the general opinion of the country would be in favour of this.

52. What in your opinion is the average value per acre of the land lying on each side of the main road? If we include all towns its value is about £4 per acre; this valuation relates to more than a million and a half acres.

53. *By Mr. Kennerley.*—Supposing a Main Line Railway were constructed across the Island, are there any agricultural districts, now almost shut out from a market, from which produce could then be sent into market with increased advantage? Yes; for example the Eastern Marshes, York Plains, &c., and by feeders or branch lines the valley of Brighton and Richmond, where there is much beautiful land not at present brought into cultivation, which could then be most profitably farmed. Again, beyond and north of Oatlands there are large tracts nearly all along the main line, now devoted to pasture, that could be easily put under crop, if any inducement arose to encourage the spread of agriculture.

54. *By Mr. Fysh.*—Would any portion of the land on each side of the main road, now devoted solely to sheep farming, be capable of profitable cultivation if it had the advantage of cheap transit? Yes, I think so,—there is a great deal of sheep land which might be cultivated within eight or nine miles of the road.

QUESTIONS subsequently submitted to the Witness by the Chairman.

55. Have you formed any opinion as to the probable increase in the value of property by putting a Railway through it?

56. Have you formed any opinion as to the probable result of the construction of a Main Line of Railway upon the condition of the Colony?

57. I presume you look to Agriculture as the chief means for the advancement of the Colony, and to our sister Colonies as the purchasers of our surplus produce?

58. Can you inform the Commission what amount of supplies of farm produce are purchased by the sister Colonies?

59. I believe you do not share in the opinion that Victoria is getting more independent of outside supplies every year?

60. Will you have the kindness to furnish the Secretary with a copy of the Statistics you have prepared for the use of the Commission?

Survey Office, 8th July, 1868.

Sir,

In reply to the five questions which you have done me the honor to ask of me (which are transcribed above) on subjects connected with the contemplated construction of a Main Line of Railway, I take leave, in the way of reply, to hand you an extract from a letter written by me to the Honorable Colonial Treasurer on the 27th January last on the very subjects that your questions relate to, and which embraces exactly the information that your queries would elicit from me.

The Statistical Tables that you ask for I need hardly say are quite at your service.

I remain, Sir,
Your very faithful Servant,
J. E. CALDER.

The Chairman, Main Line Railway Royal Commission.

EXTRACT from a Letter written by me to the Honorable Colonial Treasurer, 27th January, 1868.

* * * * * * *

With regard to that part of our conversation that turned on the utility and prospective profit of converting the Main Line from an ordinary road into a railroad, it is possible that under a contingency such conversion would have a beneficial effect on the income of the Colony, as well as on the value of a large proportion of the private lands of the same, which might in no lengthened period equal the cost of that conversion.

This contingency, put in the shape of a question, is this:—Are we likely to find profitable markets for any considerable increase of our agricultural productions? For if we are, then no doubt cultivation might so extend itself as to increase the utility of the line considerably; but if, on the other hand, we are not likely to find outlets for a largely increased production, it is difficult to see what we can require a through railway for, when the produce of about sixty miles of the country lying right and left of such line would be confined as at present chiefly to wool.

J. E. Calder, Esq.

Let us look round us and see whether such markets exist or not, and we shall then discover what our neighbours take of the farm produce of other countries, which no doubt some of the lands that lie within ten or a dozen miles of the existing main line of road could be speedily put into a condition to contribute to the supply of in a considerable degree; for within the area alluded to there is much good or fair land, either open or so lightly timbered that might be put into crop at no great cost, if any inducement arose to encourage it.

The supplies of farm produce required in the last two years, for which returns are published, viz. 1865 and 1866, by the five Colonies of Victoria, New South Wales, South Australia, Queensland, and New Zealand amounted in value to £8,225,810 worth,* whereof Tasmania furnishes only £709,533, or only about one-twelfth of it. Now if a railroad would enable us to export at a profit half as much more farm produce as we send away at present, the subject of constructing one becomes worth consideration.

The figures above given prove that there is no want of markets near at hand to go to in which a vast quantity of farm produce is annually disposed of, to which (with the lands we possess) we might contribute in a larger degree than we do at present.

That we furnish only one-twelfth of the farm produce required by our neighbours is doubtless traceable to several causes; but the chief of these, as it seems to me to be, are two, namely the high prices of labour and of land carriage.

Of the former, considering our proximity to so many gold-producing Colonies whose prices must govern our own, there seems no prospect of any abatement of its cost for some years to come, if at all; but not so with the other obstruction to farm progress, viz., a high-priced land carriage, which a railway might do a good deal to modify (though of course at the expense of additional taxation), and if it lessened it in any considerable degree, as is the natural tendency of such a means of transport, then agricultural farming might be carried on, even in the interior, with a fairer chance of profit than it offers at present. If the country is to advance, it must be by extending its agriculture. We have no mineral wealth that we know of to assist us forward. Our pastures, unless improved, will carry but little more stock than they support at present, and of manufactures, except of the simplest kind, we have none, and are in no condition to engage in any yet awhile; but we may advance our agriculture, and thus increase the income of the country: but this object is not likely to be achieved unless our means of transport are so improved as to enable our farmers to send their produce to market at a much lesser cost than they pay at present for its transport; and whenever this state of things is brought about, it must have a beneficial influence on the value of the lands that lie within easy reach of any thoroughfare which provides a cheap means of carriage to market.

That the existing main line of road has already increased the value of the land lying within ten or a dozen miles of itself, (perhaps 1,600,000 acres,) many fold is too obvious to be denied. The present annual rental value of the same is much about £400,000,† that of the whole Colony having been computed by the Official Valuators at £700,488 for 1866; it is therefore worth, at 6 per cent., six or seven millions of money, even though so much of it is still waste, and produces only a minimum instead of a fair return. Its worth per acre is therefore about £4 all towns included. Would a railway further increase this value by one per cent. per annum? If it will, then this increase will be equal to double the interest of the money required for the conversion of a narrow strip of the present land, (say a fifth or a fourth of it) into a railway, that is if the gradients which are severe on about seven miles of it interpose no insuperable objection to the work.

Reverting to the subject of markets for farm produce, the chief of which is Victoria, I have observed that it is usual to say she is becoming more and more independent of outside supplies every year; but this is not exactly true, at any rate up to the end of 1866, which is the latest date for which her official returns are made up. Taking the three years which preceded the close of 1866, her returns indeed show a serious falling off in her purchases of Bran, Flour, Potatoes, and Preserves, but a considerable increase is observable in the supplies she has received of several other important articles of consumption. Of Bacon, Butter, Fruit, Oats, Wheat, and Hops she has received a largely increased supply, and of every article of Live Stock also. But with the other Colonies our farm produce trade is not maintaining its ground, though our general trade shows a fair increase in all, except New Zealand, where in 1866 it was not quite a fourth of what it was in 1864.

That such a railway as the one now proposed will at present pay for its own construction and maintenance I fancy no one seriously believes; but if we are to have one, it must be in consideration of the indirect advantages it may confer on the country, by enlarging the agriculture of the districts it passes through, and perhaps also by increasing the value of the land in the neighbourhood; and if for these prospective advantages the Colonists of Tasmania are content to incur the cost and responsibilities of the undertaking, no one, I presume, has any right to object to their determination.

In conclusion I take leave to say that this letter would have been forwarded to you several days ago, but as I have had to make extensive references to numerous Statistical Returns to enable me to deal with one part of the subject, the results of which are respectfully presented to you in tables at the end of this letter, its completion has been unavoidably delayed till this day.

I have, &c.,

J. E. CALDER.

N.B.—Mr. Cansdell's letter of the 16th instant is herewith returned.

Tuesday, 26th May, 1868.

Present.

The Hon. J. M. WILSON, Esq., M.L.C.
The Hon. P. O. FYSH, Esq., M.L.C.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

W. R. Falconer, Esq. 26 May, 1868.

WM. R. FALCONER, Esq., *Director of Public Works, examined.*

61. *By the Chairman.*—The traffic returns now on the table, and which you some time ago handed in to this Commission, were taken by order of the Government? Yes; for the purpose of seeing whether any further toll-gates should be put up on the main road.

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* See Tables at end showing the demand of these five Colonies for twenty-one articles.

† The rental of Hobart Town and Launceston is £204,889.

62. I observe that they do not include the traffic on this side of Bridgewater. Could that deficiency be supplied? I do not think Mrs. Joseph keeps a daily return at the New Town toll-gate, but no doubt she would give the Commission a return for a week or two on being paid for her services. *W. R. Falconer, Esq.*

63. How far on this side of Launceston is the Cocked Hat toll-gate? The Cocked Hat Station is 8 miles from Launceston, at the end of the Evandale Road. There is no toll taken there, though a toll-house was erected.

64. Can the traffic taken as passing that toll-gate be considered as part of the main line road traffic? The returns which were taken at the Cocked Hat would be swelled by a portion of the traffic from Longford and Evandale, but no portion of the Westbury and Deloraine road traffic could come in by that part of the main road, for they would join the main road within the boundary of the town of Launceston.

65. Can you inform the Commission as to what would be the probable expense of widening the main road to an uniform width of two chains? I cannot say, without a survey. The cost would vary very much; in some parts the road is flat, in others, steep and difficult for cuttings. I can form no opinion of the cost. On the flat table land the cost of widening the road would be very little, for there would be no excavations. On all the road through by Tunbridge and Saltpan Plains there would be a comparatively trifling expense; but where cuttings are required it would be expensive. In some places, say at Spring Hill, it would be cheaper to make a new road altogether, and in other places to deviate from the line.

66. What is the average cost of a macadamised road of one chain in width? The cost of constructing a road such as our main line, taking it at a chain wide all through, and metalled say on an average of 30 feet, would cost not less than £3000 a mile.

67. What is the usual width of the country roads? About half a chain wide; few of them are metalled, they are mostly gravelled; where they are metalled or gravelled it is only about 12 feet wide. I cannot say what is their average cost, for they vary so much. From Deloraine to Elizabeth Town the road would probably cost £2000 a mile; there is plenty of metal along the line.

68. What has the New Huon Road cost per mile? The New Huon Road down to Leslie cost nearly £2000 a mile, including the numerous culverts, and the clearing of the road, which was heavily timbered. This road is a chain wide at this end, and half a chain elsewhere.

69. I believe you have had considerable experience in the construction of tramways in Scotland, as well as here. Can you inform the Commission as to their average cost of construction? I have had some little experience in tramways in Scotland, and here also. Their cost varies considerably. We have had plans given out for tramways here and have received tenders varying from £200 to £700 and £800 a mile, all to be made of wood. I consider slab roads preferable to tramways for the general wants of the community, except where saw-mills exist, and then tramways would be more suitable.

70. What is the condition and bearing strength of the bridges and culverts on the main road? Some of the bridges on the main road which are built of wood are not at present in good repair, and could not be trusted to carry heavy loads, such as at Pontville and Bagdad; the culverts are mostly in fair order, with stone walls; they were quite safe when the traction engine passed over them.

71. Can you inform the Commission as to the best way of avoiding the heavy gradients of Constitution and Spring Hills? I hand in a map of the old main road, and a proposed deviation between Oatlands and Jericho by which the gradients would be reduced, but which was not carried out on account of the expense. At that time (1838), even with the aid of prisoners, it was not considered necessary to make roads with the easiest gradients. I believe the deviation proposed would be cheaper than widening the present road, and better gradients would be obtained. It would increase the length of the line by only about 55 chains.

72. Do you think that a better line than the present main road could be found *viâ* the valley of the Jordan? I know some parts of the valley of the Jordan, but not sufficiently of the part near Bridgewater to speak with certainty; but no doubt a better line could be obtained than the present main line. I cannot, however, speak of it with confidence. There is no question that the main line between this and Bridgewater could be much improved by deviations.

73. *By Mr. Wilson.*—If the main road were used for railway purposes, would it interfere with the ordinary general traffic? It would, at first, very much. It would have the same effect as the railways had in England when they first started, but in time the horses would become accustomed to the noise.

74. Can you give any opinion as to the difference in the expense of laying a line of rails on the main road and making a new route? It is quite impossible to say without a survey.

75. Do you think it would be more economical in the end to lay out a line of railroad with improved gradients, or confine it to the main road? Some portions could be considerably improved by deviations, and other portions could be used, or the railway might be kept a little way from the line. A new line could be made with much easier gradients, and I consider would be a great improvement upon the present mode.

76. Between the terminus of the Bridgewater Causeway and Green Ponds would you recommend an entire deviation from the main line of road? I could not say without a previous survey. The Brighton hill is a very bad place, having a gradient of about 1 in 13.

77. Are the difficulties less after you pass the *Half-way House* than between Green Ponds and that part? Yes, from Antill Ponds to Cleveland it is almost a level all the way, and from Cleveland to Perth the road is slightly undulating. There are no great difficulties to be overcome. The worst half of the road is from Hobart Town to Antill Ponds. I believe that a line could be carried from Tunbridge down the Macquarie River to Longford, and go through a much richer portion of the Country than that between Cleveland and Perth.

78. Would anything short of a complete engineering survey of an entire line give any data of its cost?

W. R. Falconer, Esq.

I do not think it necessary to have so complete and expensive a survey at once. Trial surveys could be made correctly for about £15 a mile; the tramway from Deloraine to the Mersey cost £10 a mile, and that was partly through bush country, more troublesome than that between Hobart Town and Launceston.

79. Are you of opinion that the Bridgewater Causeway would be sufficient for the ordinary traffic and the line at the same time? It is quite wide enough for the two, but another bridge would be required.

80. Could sleepers for the railway be found along the line of road at a reasonable cost? Yes, at a few miles back from the road. We pay, on the main road, about 8*s.* each for telegraph poles, and on the George Town line, where timber is plentiful, we pay 3*s.* each.

81. What is your general opinion as to the railway travelling on the main road? I think a new line preferable, if it can be constructed at a reasonable cost, and thus leave the present line for ordinary traffic; but a new line would open out new country and traffic: the going away, however, from the main road would give rise to claims for compensation. Some of the gradients on the main road must be avoided, and hence the whole line could not be used. It would be cheaper to have a new line at some of these places.

82. *By the Chairman.*—The objection to use the main road at Constitution and Spring Hills is, that it would cost less to make deviations than to widen the present road.

83. *By Mr. Fysh.*—Given we have a main road on which to place a railway, what would be the difference of cost in forming a new line of railway? Having the road formed, a great portion of the expense would be saved; the sleepers would lay on the road, and only ballast and rails would have to be put in.

84. *By the Chairman.*—Can you state the average cost of ballast here? Hand-broken metal costs from 2*s.* 4*d.* to 4*s.* per cubic yard; or when carted and delivered on the road, from 5*s.* 6*d.* to 9*s.* per cubic yard, according to the distance from the quarry. If the metal were broken by stone-breaking machines it would cost somewhat less. Such ballast would, however, be very expensive, and it would be requisite to look out for gravel quarries, and use gravel wherever it can be procured.

85. What is the average price of sleepers here? Sawn sleepers not less than 10*s.* per 100 feet. The sleepers would be 9 feet long, and 10 inches broad, and 5 inches thick. These could be got for about 3*s.* 4*d.* to 5*s.* each according to locality.

86. Referring to the Traffic Returns which you have handed into the Commission, would all the Longford traffic pass through the Cocked Hat Hill gate? A great deal of the Longford traffic goes by the Hagley road, and this traffic would not come into the Cocked Hat returns.

87. What has been the average cost of maintaining the main road? The cost used formerly to be about £12,000 a year. It is now reduced to £4000 on the whole line of 121 miles. The average cost for 10 years has been from seven to eight thousand pounds.

88. Will not so large a reduction in the cost of maintenance necessitate a considerable expenditure hereafter? No; £5000 a year will keep it in good order,—we could manage with £4000, but the Epping Forest road, which is all made with gravel, is now being metalled.

89. How do you account for the present economical maintenance of the main road? Formerly gangs of men were kept on the road, with overseers, even where the numbers were only 6 and 7 men. Now, we have men distributed all along the line with from 4 to 10 miles to each, and each man is held responsible for his section of the road.

TUESDAY, 2ND JUNE, 1868.

PRESENT.

The Hon. A. KENNERLEY, Esq., M.L.C.
The Hon. P. O. FYSH, Esq., M.L.C.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

H. Bilton, Esq., J.P.
2 June, 1868.

HENRY BILTON, Esq., *J.P.*, *Coroner, called in and examined.*

90. *By the Chairman.*—You have had a very lengthened Colonial experience, I believe, Mr. Bilton? Yes; I have resided in Tasmania for upwards of forty years, and during a great part of that time I have been largely engaged in agriculture and sheep farming.

91. You are well acquainted with the line of country between Hobart Town and Oatlands, and I believe you have given considerable attention to the question of the best route to be adopted for a main line railway between Hobart Town and Launceston, and especially as to the point where the Derwent could be most advantageously crossed? Yes; I know the country well between the Derwent and Oatlands; and many years ago I was consulted by Governor Arthur as to the point where the main road ought to cross the Derwent, and I recommended that it should cross from a point called Abbott's or Emmet's location on this side to the base of Mount Direction on the other.

92. What would be the advantages of crossing at this point? It would afford the best opportunity of bridging the river, and by following the route of the Old Beach Road to the east side of Brighton you would avoid the difficulties presented at Pontville.

93. How did you propose to utilize this neck of land for that purpose? I proposed to bridge the river at the part nearest to the main road, and then blast and remove the ground underneath, and with the debris fill up the old bed of the river on the other side. The force of the stream would soon clear a passage under the bridge; and the whole expense, if Government labour were employed, would not be very great. I also proposed that that neck of land should be purchased, which could at that time have been done for £500;

a township laid out and sold in allotments, which would have realised a considerable sum; the new channel bridged over, and the road carried to its termination. There would be plenty of material for filling up the old channel. Circumstances have, however, now materially altered the labour part of the business, which at that time was only a secondary consideration.

94. Supposing the river were crossed at this point, in which direction would you continue the route? I suggest that the line should be continued, after crossing the river, into the Old Beach district. The land there is favourable for road making, being a clay subsoil. This line will pass along the lower Old Beach road, through Ransley's, Pearce's, Fitzgerald's, Reynolds's, Clark's, to the Tea Tree road before it reaches Brighton; then through Butler's, Kimberley's, passing to the right of Pontville Hill, entering the main road near the 17th milestone. The whole of these roads may be considered bush roads, scarcely any of them have been marked out, and but little done to them at any time. I originally suggested that the line should be carried through the Tea Tree Brush, Evans's, Elliot's, Griffiths's, the Ring, Tills, &c., to the junction of the Jerusalem and Richmond roads; thence along the former, leaving the Colebrook Dale a little on the left; passing on to the Flat-topped Hill, which is the only difficulty of any consequence in this line, and would require to be met by some extra power, unless a more favourable track could be found along the west. The line should then pass through Stokell's, leaving Lake Tiberias on the left, through Ladd's Paddock (formerly Meredith's), Willson's, Blue Hill Marshes, Hudspeth's, Roberts's, to York Plains; or by turning off after crossing Ladd's Paddock through Harrison's, Clark's, Broad Valley, and Foord's (having Lake Dulverton on the right), and through the Oatlands township to the main road. I suggested to Colonel Arthur the great advantages that would be secured to the Colony by constructing a tramway through it, and I proposed this route as presenting less engineering difficulties than any I am aware of, and having at the same time the advantage of passing through lands adapted to agricultural purposes.

95. Would not Austin's Ferry offer a very favourable route? Yes, but the width of the river and its great depth at that point would preclude your attempting to bridge it.

96. It is scarcely likely the Commission will report in favour of bridging the river except it were done by utilizing the present causeway; if, therefore, any other route than that viâ Bridgewater were adopted, the river would have to be crossed by a steam ferry capable of carrying the entire train of carriages, as is done in Scotland and America. In that case would a route viâ Austin's Ferry offer any advantages? Yes, you would get into the Old Beach road at once, passing through the Compton estate, Reynolds's, and Gage's, by the Old Black Boy to the Tea Tree road to Brighton, avoiding Pontville altogether.

97. Can you give the Commission any information as to the route *viâ* Bridgewater? If you cross at Bridgewater you must, in order to avoid Pontville, take the old Brighton Road, and then strike a new line through Butler's and Kimberley's to Brighton skirting the Jordan. By taking the old road you would avoid Pontville altogether.

98. What gradients would have to be encountered in taking the line *viâ* Abbott's or Austin's Ferry? There would be easy gradients throughout; at one point (Bedford's) you could avoid the hill by going to the west.

99. Austin's, or Stony Point Ferry, was, I think, at one time used as the main road? Yes; after being for many years used as a cross road.

100. Do you know the width of the road? It is not, I think, a chain wide. It is not as wide as the main road; that is usually a chain wide.

101. Is this old road fenced at the present time? On the line I recommend it is partially fenced.

102. Are there many streams or creeks to cross? No; none of consequence.

103. Which of these routes, Abbott's Point or Austin's Ferry, would offer the best gradients? If a steam ferry were used to carry the train instead of bridging the Derwent, Austin's or Stony Point, or Forsyth's Point, Heathercombe, further up, would afford better gradients than Abbott's Point—the land on the Cove Point side, being more level, would not cost so much in construction.

104. These routes ultimately unite in one; at what point would it strike the main road? It would join the present main road about two miles from Bridgewater: unless a turn were made you could not avoid Pontville.

105. Do you consider that either of these routes, *viâ* Abbott's or Forsyth's or Austin's Ferry, would give a better line than the main road? Yes; either of them would decidedly be preferable to the present main line of road: but you might, if it is desirable to adopt the route of the main road, cross at Bridgewater, and by taking the old Brighton road, which turns off the main road to the right near the Broadmarsh road about three miles from Bridgewater, avoid Pontville; and if the Bridgewater causeway and bridge were utilised by the railway, a considerable portion of the difficulty would be avoided.

106. Would it not be possible to cross the river above Bridgewater? No; not without great expense, unless you went up to New Norfolk.

107. Are you well acquainted with the country round the valley of the Jordan? No; I don't know much of it.

108. Are you acquainted with any part of the opposite bank of the river beyond Bridgewater which would offer a favourable route? I imagine a line could be carried along the Back River Valley on towards Green Ponds; but I cannot speak accurately, and it would be too far to the west for a main line route.

109. Can you offer any suggestion as to the best means of avoiding Constitution Hill? I am not able to say how you could avoid the difficulty of Constitution Hill. Spring Hill could be avoided by verging off to the Stony Hut Valley, passing away from Picton and coming into Jericho near the Church.

110. You are well acquainted with the quality of the lands on both sides of the road to Oatlands: can you say whether any and what amount of it now devoted to sheep farming would be cultivated if it had the

H. Bilton, Esq., J.P.

2 June, 1868.

advantage of cheap transit? There is no question but that much of it would be brought into cultivation if they had cheap transit. It would be used more for agricultural than for any other purpose. On the line through the Tea Tree to Jerusalem there is a large extent of land available for cultivation independently of crown lands. There are holders of locations of 400 or 500 acres who would let out their lands to small farmers for cultivation. At present the difficulties of transit take away all the profits on hay crops, and the greater part of those on cereals.

111. You think then if a railway were pierced through the Island, sheep-farming would give place to agriculture? Yes; my decided opinion is that if there were cheap transit, the large proprietors would encourage that valuable class, a small tenantry; and a farmer could obtain a livelihood for his family on a very small farm, which, unless cultivated, would feed barely any stock. Without cheap transit it is hopeless to look for such results, and I am sure the want of easy transit for produce to market has driven many of our best farmers to the adjoining Colonies. Whilst wool remains at its present high price the larger proprietors will look to wool as their staple produce, for sheep-farming is the best employment for capital at the present time; but if a railway would enable them to cut up some portion of their lands into farms, the fact of being able to get a better return for their money than wool, would give them more inducement to do so.

112. *By Mr. Fysh.*—As you are well acquainted with the country between Hobart Town and Bridgewater, will you inform the Commission which in your opinion would be the best route to take? I believe a better route cannot be obtained for railway purposes than from Macquarie Point through the Domain to Cornelian Bay, crossing New Town Rivulet and the road leading from Glenorchy to the Risdon Road, through Alcock's, the Race-course, and Dunn's to the fourth milestone on the main road, or it might be carried through Butler's and Read's, crossing Humphrey's rivulet lower down through Lester's and Berresford's to the bridge near Overall's on the main road, thence to the Seven Mile Hill, which should be passed on the right, and along at the back of the *Traveller's Rest* through Chigwell to the main road at the bridge which crosses Fawkner's Rivulet.

113. *By the Chairman.*—Do you know the route up Park-street across the saddle by Mr. Chapman's to New Town Bay? Yes; the difficulty would be the saddle: if that could be avoided, the gradients would be easy down to the right through Mr. Roope's and across the upper part of New Town Bay, then passing Alcock's and the Race-course, and coming out near the fourth milestone into the present main road.

MONDAY, 8TH JUNE, 1868.

PRESENT.

The Hon. P. O. FYSH, Esq., M.L.C.
The Hon. A. KENNERLEY, Esq., M.L.C.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

W. Hogan, Esq., C.E.

8 June, 1868.

WM. HOGAN, *Esq., C.E., and District Government Surveyor, examined.*

114. *By the Chairman.*—Your name is William Hogan, and you are a District Government Surveyor? Yes.

115. I believe you were engaged for some years on the Ordnance and Contour Surveys in England? Yes; and I have been since for 15 years attached to the Survey Department of Tasmania.

116. In what Districts of the Colony have you been principally employed? My knowledge of the lands of the Colony is confined to those about the Huon, and along both sides of the Main Road up to Oatlands.

[Mr. Hodgson's Evidence was here read to the Witness]

117. Having heard Mr. Hodgson's evidence, do you think the gradients might be improved between Hobart Town and Oatlands by taking the line suggested by Mr. Hodgson? Yes; I think so.

118. Do you know Mr. Sprent's Line by Jerusalem, and are you well acquainted with the contour of the land in that neighbourhood? Yes; there is one part near the Hollow Tree Bottom where a deviation or a stationary engine would be necessary. The gradient there is about 1 in 12. This difficulty cannot be avoided if you keep Sprent's Line, because the hills shut in the land until you get to the table land on which Oatlands is situated: but there is a rise up to the head of the Coal River, leaving Flat-topped Hill and Hollow Tree Bottom to the west, up to Lake Tiberias,—then there is a complete level to Oatlands. This would be a total distance of about 17 miles.

119. *By Mr. Kennerley.*—Have you heard the inhabitants of your District complain of their great outlay for want of cheaper means of transit? Yes; such complaints are general among the small agricultural farmers, and particularly in the winter season.

120. What effect, in your opinion, would a Railway have upon agriculture in your District? I am sure that, if cheap transit were available, there would be 100 acres cultivated for every 1 now under the plough. At the present time the cartage eats up the profit on their produce.

121. What parts are comprised within your District? My District is part of the County of Monmouth,—from Oatlands to Richmond and Pittwater on the East, and the Jordan River to the West.

Tuesday, 16th June, 1868.

Present.

The Hon. A. KENNERLEY, Esq., M.L.C.
The Hon. P. O. FYSH, Esq., M.L.C.
Mr. Alderman DAVID LEWIS, M.H.A.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

MR. EDMUND HODGSON *further examined.*

Mr. E. Hodgson. 16 June, 1868.

122. *By the Chairman.*—I believe, Sir, you have made some calculations as to the probable traffic of a Main Line Railway which you wish to lay before the Commission? Yes; I have taken pains to ascertain the weight of crops in Tasmania, and I have taken the statistics of the crops of 1863 for my groundwork, and I find little or no change in the returns for 1865 to need any fresh calculation. The crops give a gross weight of about 163,476 tons; and deducting the quantities required for seed and for internal consumption, I find that about 85,088 tons of surplus produce would probably be carried to market by railway. The present cost of carriage of goods on the main road is from £6 to £7 a ton across the Island, but I have only taken the probable charge on the railway at 20*s.* a ton: thus from Hobart Town to Bagdad, 5*s.* per ton; to Green Ponds, 7*s.* 6*d.*; to Oatlands, 10*s.*, and so on. Assuming an average rate of 10*s.*, the goods traffic would yield £42,544. As regards passenger traffic, I find that in Victoria a number equal to the whole population of the Colony travel twice a year, and the charge there is per 100 miles, 1st class, 31*s.* 6*d.*; 2nd class, 23*s.* 6*d.*: and yet the Victorian railroads do not reach more than two-thirds of the population, whereas a Main Line to Launceston would come within the reach of nearly the whole population of this colony. Here I take two-thirds of the population travelling once a year the 120 miles there and back, and £1 the charge each way, or divide the population into three different fares, say 40,000 at 5*s.* trips, 40,000 at 10*s.* trips, and 20,000 to and from Launceston at 20*s.* each way,—this would give from passenger traffic a further revenue of £70,000. I have next considered the meat supply of Hobart Town and Launceston with the adjoining districts, and calculate the population so supplied to be about 45,000 persons, and to consume 1 lb. each per diem; and if we take sheep at 45 lbs. each, this would require 365,000 sheep, the carriage of which to market at 6*d.* each would give a further revenue of £9125. Then there would be our wool, 5 millions lbs., to be carried to the ports (say) at one-eighth of a penny per lb., which would give £2600; then there is the mail contract £2000, and the goods now carried by sea between the two ports 8600 tons, which (say) at 10*s.* would amount to £4300, making altogether the sum of £130,568 annual revenue from traffic of all kinds.

Friday, 19th June, 1868.

Present.

The Hon. P. O. FYSH, Esq., M.L.C.
The Hon. F. M. INNES, Esq., M.L.C.
Mr. Alderman DAVID LEWIS, M.H.A.
The Hon. A. KENNERLEY, Esq., M.L.C.
The Hon. J. M. WILSON, Esq., M.L.C.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

ROWLAND DAVIES, *Esq., C.E., called in and examined.*

Rowland Davies Esq., C.E. 19 June, 1868.

123. *By the Chairman.*—You are a Civil and Mechanical Engineer, and I believe, Mr. Davies, you have been admitted an Associate of the Institute of Civil Engineers? Yes.

124. May I ask upon what Engineering works you were engaged while in England? During my apprenticeship to Messrs. Simpson & Thompson, Mechanical Engineers of Pimlico, I was employed chiefly on water-works or machinery connected therewith,—works such as those at Stoke Newington, Lambeth, &c.; and while a pupil of Messrs. Saunders and Mitchell, and Henry Martin, Civil Engineers of Westminster, I was employed in the "screw-pile" business, Broughton and Coniston Railway, various detail surveys in the Locomotive Department of the North London Railway; and at Manchester was Engineer to the East India Company, to which Company Mr. Martin was Consulting Engineer.

125. The plan and sections now on the table, showing two practical routes into the city from the third milestone, were prepared by you and your partner, Mr. Sorell, for this Royal Commission? Yes.

126. Are they the result of actual survey, and were the levels all correctly taken? The lines of the suggested routes were the result of actual surveys; and the surveys have been made and the levels taken with an accuracy beyond that usually adopted by Engineers in making a reconnaissance or trial survey. The lines of Rail have been traversed by us with offsets and other details, and those portions of survey comprising the levels and objects surrounding and intermediate to the routes, as laid down on the plan, are compiled from accepted surveys by Messrs. Sorell, Thomas, and others.

127. In surveying the Domain route you have, I believe, avoided going through the Government House grounds. We have: we never supposed the line would be allowed to go through the Government House grounds, and we therefore took the levels along the existing road, indicating, however, by dotted lines such deviations as we thought desirable, including a viaduct across the Royal Society's gardens.

Rowland Davies, Esq., C.E.

19 June, 1868.

128. What are the ruling gradients on that line? The ruling gradients are about 1 in 65: the gradients along the road are steeper, say 1 in 50, but a railway following a line as near as possible to the road need not have gradients steeper than 1 in 60 to 65. It is impossible to be accurate in the matter of gradients until the line itself is surveyed and staked out,—in fact they must be, to a large extent, guesses.

129. Could you not obtain a more favourable line by running closer down to the river bank? Yes undoubtedly; there would be a good practical curve round by the Battery, and the gradients by such route would be improved, but then we should have to carry the line through the Government House grounds.

130. By the grounds I suppose you mean the meadow by the road side? Yes; we could get through by a short cutting into the slope of the meadow, and a short tunnel under the carriage drive, just at the entrance to the grounds.

131. You would run through into the quarry on the other side of the drive? Yes; and then pass through the Royal Society's gardens, probably by a cutting which would destroy the gardens to a great extent.

132. Both the routes now under discussion—this *viâ* the Domain, and the other *viâ* Park-street—meet at New Town Bay? Yes; and we have avoided crossing cultivated lands, for which a heavy rate of compensation would be required. The line would cross at the head of the bay, but there would be a difference in the levels of the crossing according to the line chosen.

133. If the route by Park-street were adopted the minimum gradient would, I think, be about 1 in 60? Yes; the levels might be reduced to that; but to get so favourable a gradient would necessitate a tunnel of about 25 chains.

134. And an extensive viaduct at New Town Bay? Exactly so.

135. If, then, the route through Park-street were adopted you would have to approach New Town Bay at a high elevation? Yes.

136. And if the route by the Domain were adopted you would be able to cross New Town Bay on a level? Yes, upon a dead level all along by Page's and Cornelian Bay to Risdon bridge. In one case there would be a simple viaduct on piles over New Town Bay, in the other case a long embankment and viaduct, and, generally speaking, heavy works.

137. You have said the two lines unite at New Town Bay. What direction would the line take afterwards? It would pass through Pitt's farm, and join the main road at a point between the 4th and 5th milestones, passing behind the Racecourse.

138. What gradients would be encountered after passing the Risdon bridge? They are all favourable: there are no engineering difficulties: it would be a very easy line all through to O'Brien's Bridge.

139. Supposing the ordinary rise and fall of Park-street would give you a gradient of 1 in 40, could you avoid the peak of the saddle by a small cutting? The maximum gradient which, by good management, we could get on the north side would be 1 in 25 or 30. I consider the steeper gradient best. You would pay too much to get the lower gradient.

140. Supposing the Commission to recommend that Hobart Town be approached by Park-street, and by means of a tunnel, what gradient would be obtained? The tunnel in that case would be 25 chains long, the maximum gradient from Macquarie-street would be 1 in 60—and on the other side 1 in 45; but I cannot be sure of the gradients, they can only be approximate till the line is surveyed.

141. If the route by tunnel in Park-street were adopted what would be the depth of cutting? There would then be about 60 chains of cutting besides the tunnel, a maximum depth of 60 feet, average 25 feet. The saddle is sharp, not double; the present road runs along the ridge and goes down abruptly into the gully.

142. What is the ruling gradient by the Domain? It requires survey. I cannot say: it is not more than 1 in 60.

143. I believe you entertain some special views as to the best route to be adopted for the Main Line Railway. Will you be good enough to make them known to the Commission? I should say take the line from Launceston down to Bridgewater, there put the engine and train on a steamer and float them down to the New Wharf. This is the course pursued at the Forth in Scotland, where the sea in the Frith is rough. You would only lose about half an hour in time. The steamer with apparatus would cost say £30,000; at the Forth it cost £26,000, at the Tay £17,000. You would lose the traffic between town and Bridgewater, but the loads would not be unshipped, they would be brought down to the ships at the Wharf, and then the waggons could be drawn on the wharf and traverse the streets as in New York. The expense of a line from here to Bridgewater would be, I imagine, £10,000 a mile, making a total of at least £120,000 to Bridgewater; then a bridge over the Derwent at Bridgewater would cost at a rough guess £120,000 more, or a total of £240,000 to get to the north side of Bridgewater. Or instead of a bridge have a steam ferry, as at the Tay in Scotland,—the ferry bridge might be sent out in compartments from home and built up here.

144. Though you estimate the cost of the line as far as Bridgewater at £10,000 a mile, I suppose a line beyond could be constructed for less? Yes, at a cost of about £5000 a mile. The increase in the cost would be on this side, on account of the heavy cuttings and the valuable properties the line would run through.

145. As to gauge what would be the difference in the cost of the line if constructed with the 5-3 feet gauge as against the 3-6 feet gauge? The 5-3 feet gauge would cost about 50 per cent. more than the 3-6 feet gauge, and the 4-8½ feet gauge in proportion; because in the 4-8 or 5-3 feet gauge with heavy traffic you would require rails of from 70 to 85 lbs. to the yard. With the narrow gauge you would have lighter rails, say 40 to 50 lbs., the embankments would not cost so much, the cuttings much less, the bridges not two-thirds of the expense. Engineers in England are now going in for Light Railways with steel rails and spring tires, &c., all suitable for light traffic. The question of speed would depend on the weight of traffic. In India the speed on light rails has reached 40 miles an hour.

146. What is the usual running speed of a light railway? A light railway would average a good 20 miles an hour. In America the average is not 20 miles an hour, except on the express trains, which average 25 miles an hour. On light rails you would have 4 or 5 tons per wheel, you could secure sharper curves,—for whilst a 3-6 feet gauge would take a 5 chains curve, a 5-3 feet gauge would require 8 chains curve. Then, again, when the common iron rails wear out they are unsaleable, but steel rails are always saleable when no longer available for railway purposes. *Rowland Davies, Esq., C.E.* 19 June, 1868.

147. *By Mr. Lewis.*—Have you examined any other entrance to the city, say following the Rivulet up to the Queen's Asylum? I have not, but it is possible that another and a straighter line could be obtained into town, but then we should have to take down houses. However, I am not now prepared to give an opinion on the subject. There is one way by which the rail might be taken the Domain route without injury to the Royal Society's Gardens or the grounds of Government House, that is by allowing the line to follow the sea-shore where favourable, cutting only through abrupt points; and where the bank was unfavourable, the line, supposing the bottom to be rocky, might run on tressels, if the bottom be mud or sand on piles,—as across, for instance, such places as Cornelian and New Town Bays.

Tuesday, 23rd June, 1868.

Present.

The Hon. P. O. FYSH, Esq., M.L.C.
The Hon. A. KENNERLEY, Esq., M.L.C.
The Hon. J. M. WILSON, Esq., M.L.C.
Mr. Alderman DAVID LEWIS, M.H.A.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

E. C. NOWELL, *Esq., Government Statistician, examined.*

E. C. Nowell, Esq. 23 June, 1868.

148. *By the Chairman.*—Are you prepared to furnish to the Commission the Agricultural Statistics of the districts adjacent to the main road, part of the produce which it may be assumed will pass along some part of the main road, made up to the 31st March last? Yes; I now lay the paper on the table. (Paper handed in, see Appendix H 2.)

149. Have you prepared a return showing the expenditure on the main line of road for the last five years? Yes; I now produce it. (See Appendix H 2.)

150. Will you be good enough to complete the returns of the weight of agricultural produce of the year 1867, and of the land in cultivation for the before-mentioned districts? Yes, I will do so.

151. Can you also furnish the Commission with tables of the population calculated up to the present time? Yes; I can easily give you the population of Hobart Town and Launceston and other places on the main line road, by allowing for the increase since the last census, but it would only be approximatively correct, as I believe that the Devon and North Coast districts have recently taken away a large number from the south.

Thursday, 25th June, 1868.

Present.

The Hon. A. KENNERLEY, Esq., M.L.C.
Mr. Alderman DAVID LEWIS, M.H.A.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

THOMAS TRAILL WATT, *Esq., Collector of Customs, examined.*

T. T. Watt, Esq. 25 June, 1868.

152. *By the Chairman.*—Have you prepared an approximate return of the amount of goods entered inwards by sea from Launceston? Yes; it amounts to 1822 tons in 1867. I put in a telegram from the Collector at Launceston, which shows that the tonnage inwards there was 1965 for the same year.

153. What is the rate of freight between Hobart Town and Launceston? 30*s.* a ton; and the average voyage is three weeks, there and back. A vessel has just been wrecked in the river Tamar, having on board a large cargo of sugar, &c. for the Hobart Town market, despatched from Launceston.

154. Can you inform the Commission as to the tonnage entered inwards to the port of Hobart Town in 1867? Yes; it was 43,127 tons,—but if you deduct cattle vessels, and the *City of Hobart*, and whalers, there would not be more than about 15,000 tons of goods inwards.

155. Have you estimated the gross weight of package goods brought into this port in 1867, which are charged by measurement of 40 cubic feet to the ton? Yes; I take the gross weight of apparel and soft goods at 5700 tons, ironmongery and hardware at 7500 tons: this does not include coals.

156. Can you furnish a similar estimate for the port of Launceston? I imagine a similar return could easily be obtained from Launceston, on application to the Collector of Customs there.

157. Can you inform the Commission as to what proportion of these goods go up the country? Some say half go up, others say one-third; but I think the latter estimate too low. Many bulky articles go into the interior, and I should say an estimate of one-half would not be far off the truth. Sugar and tea, bagging, implements, &c. are all bulky articles, and are largely sent into the country districts.

TUESDAY, 30TH JUNE, 1868.

PRESENT.

The Hon. P. O. FYSH, Esq., M.L.C.
The Hon. J. M. WILSON, Esq., M.L.C.
The Hon. A. KENNERLEY, Esq., M.L.C.
Mr. Alderman DAVID LEWIS, M.H.A.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq.. M.H.A., in the Chair.

E. C. Nowell, Esq.
30 June, 1868.

E. C. NOWELL, *Esq., Government Statistician, further examined.*

158. *By the Chairman.*—These papers which you now hand in, Mr. Nowell, are the amended returns of agricultural produce for 1867? Yes; but there are many articles not included in these returns, such as bark, bacon, dairy produce, &c., the means of obtaining the weight of which are deficient; I have estimated the weight of the other articles according to the best information at my command.

159. Have you formed any opinion as to the effect which a railway would have upon agriculture? I am of opinion that the construction of the railway will be the means of inducing agriculturists to extend their operations, as it will afford them cheaper means of transit for manures from the ports, and for their grain, &c., to the ports. As to the returns I have handed in, I may mention that last year the crops were considerably below the average: to represent an average crop, one third should, in my opinion, be added to the quantities given in the return.

MONDAY, 27TH JULY, 1868.

PRESENT.

The Hon. A. KENNERLEY, Esq., M.LC.
The Hon J. M. WILSON, Esq., M L.C.
Mr. Alderman DAVID LEWIS, M.H.A.
H. M. HULL, Esq., Secretary.
C. S. CANSDELL, Esq., M.H.A., in the Chair.

George Innes, Esq., C.E.
27 July, 1868.

GEORGE INNES, *Esq., C.E., District Surveyor, called in and examined.*

160. *By the Chairman.*—Your name is George Innes, and you have been, I believe, for a long time in the service of the Government as District Surveyor? Yes.

161. The drawings now produced by you are the plan and sections of the main road, prepared by you under contract with this Commission? Yes.

162. Are these plans and sections laid down in strict accordance with the terms of the specification for the survey as issued by this Commission? Yes.

163. And the Reference Book you now also produce has been prepared with the same care? Yes.

164. Will you have the kindness to describe to the Commissioners the nature and character of the road, and of the land adjoining each side of the road? Yes.

[The Witness here entered into a very full explanation, sheet by sheet, of the plan and section, describing the gradients, curves, cuttings, embankments, bridges, culverts, and other particulars of the road, and of the gradients and character of the lands adjoining on each side of it, and of the improvements which could be made therein by certain deviations; but as all the evidence given is contained in the Report and Reference Book accompanying the plan and section of the road, both of which are hereinafter printed, the further evidence of the Witness taken at this sitting is omitted.]

APPENDICES.

APPENDIX A.

SPECIFICATION FOR A SURVEY OF PART OF THE MAIN LINE ROAD.

APPENDIX A.

Survey and Section of Main Line Road.

1. THE Main Line Railway Royal Commissioners require an accurate Survey and Section of part of the Main Line Road commencing at the third milestone near Cooley's Inn, New Town, and terminating at Ross-street, Oatlands.

2. The Plan and Section must be accompanied by the Cross Sections hereinafter mentioned, and by a Reference Book containing the particulars hereinafter set forth.

Plan.

3. The centre of the Main Road to be assumed as the centre line of the proposed Railway.

4. A scale of distances to be marked along the whole length of the plan of the road, showing each mile and furlong from the commencement of the centre line.

5. All radii of curves which do not exceed one mile are to be written on the Plan in chains.

6. The position of all needful cuttings, embankments, viaducts, and tunnels which would be necessary to improve the road, so that no part thereof should present a gradient exceeding 1 in 5C, nor a curve having a radius of less than 8 chains, to be distinctly shown on the Plan, and to be also distinguished thereon by numbers or marks corresponding to like numbers or marks in the Reference Book, wherein is to be entered the length and other necessary particulars of the same.

7. Wherever the Surveyor meets with any gradient exceeding 1 in 30, or with any curve of less than 8 chains radius, he will be required, after completing his survey of that part of the road, to examine the adjoining country and report how such gradient or curve, as the case may be, can be best avoided or improved, and a better road obtained. All suggested deviations must be indicated on the Plan in the manner usually adopted, and with reasonable accuracy.

8. The Surveyor must take note of any difficulties which may be anticipated in increasing the width of the whole road to two chains, and particularly as to the side of the road where such increase of width could be best made; the lines of suggested increase of width must be indicated on the Plan in the way deviations are usually distinguished. The parts of the road presenting any such difficulties to be marked on the Plan, and distinguished by numbers or other marks corresponding with the like numbers or other marks in the Reference Book, wherein must be entered full particulars of such difficulties and any other information or suggestion which may be necessary in relation thereto.

9. Of this Survey a properly finished Plan, with field notes, must be furnished to the Commissioners on a scale of one half inch to the chain; every object lying within one chain of each side of the centre of the road, such as is usually shown by Surveyors on their plans, must be carefully and neatly delineated on such Plan,—namely, all houses and outbuildings, distinguishing those of wood from such as are constructed of brick or stone, the former by being coloured brown, and the latter red. Hotels and public buildings to be distinguished by their particular designations; water and fences to be coloured in the usual way. Gardens and ponds to be shown, and all bridges, culverts, drains, &c., to be also shown and distinguished by numbers corresponding to numbers in the Reference Book, and their descriptions therein noted, whether of brick, stone, or timber, and their widths and bearing strengths: cultivated lands to be distinguished from ordinary bush lands. Water runs crossing the road or such portions of them as approach it within one chain, with all diverging roads, whether cross, bye, or private ones, (stating where they lead to,) to be carefully laid down. The width of the road under survey to be very exactly represented, and also expressed in figures on the Plan. Existing road cuttings and other earth works to be indicated with reasonable accuracy. The nature of the soils on each side of the road to be described in a general manner on the Plan, stating whether they be of sand, clay, gravel, agricultural, loam, or of what, and whether bouldery or otherwise, and whether cultivated, or capable or not capable of cultivation. The position of all fixed rocks, where they are exposed, to be shown with distance from the surface as nearly as possible. They must also be described as shottery or solid, as the case may be, and whether sandstone, slate, or ironstone, (as we call the prevailing rocks that lie along the main road.) The surface slopes to be sketched in as hilly land is usually shown.

10. In the field the Surveyor will be required to mark every station with a short sound peg not less than two inches through and six long, to be driven in to its full length, so that it shall not be displaced without difficulty; and its position should be so indicated that it may be easily found either by marking the nearest fence with a notch or notches, the distance of which from the station must be given in the field notes.

11. Permanent bench marks, indicating the level of the spot, to be left at the rate of about three per mile; such bench marks to be marked and described in the field notes and on the Plan in such a manner as to be easily found.

12. The line to be laid down with reference to the true meridian, the magnetic being shown.

13. A fair copy of the field book and notes taken in making the Survey to be deposited with the Plan.

Section.

14. The centre of the main road to be assumed as the line of Section.

15. The horizontal datum line of the Section to have marked upon it a scale of distances corresponding exactly with those marked along the centre line of Plan.

16. In laying down the sectional line the heights of all points above the datum line of which the level has been taken to be marked on the Section according to scale. The levels and different rates of inclination of the road, and the length of all bridges, causeways, and culverts, to be laid down in the Section and marked according to scale. Levels to be reduced in the field as the work proceeds, so that errors may be immediately detected.

APPENDIX A.

Survey and Section of Main Line Road.

17. In laying down the Section care must be taken that the measurements of all distances be made as nearly horizontal as possible, or they must afterwards be reduced in a proper manner.

18. The Section to be taken with a good spirit level, and drawn on the following scales.

19. Horizontal distances to be shown on a scale of 6 chains to one inch; vertical distances on a scale of 40 feet to one inch.

Cross Sections.

20. Cross Sections are to be made whenever the ground has a steep slope in a direction transverse or oblique to that of the centre line of the road.

Reference Book.

21. The Reference Book to contain the following particulars as to that part of the main road under survey:—

1. A table of the lengths of all straight lines.
2. A table of the lengths and gradients of each rise.
3. A table of the lengths and radii of all curves.
4. A table of the lengths and character of all cuttings, embankments, viaducts, and tunnels, which would be necessary to keep the gradients and curves within the limits mentioned in paragraph 6.
5. A table of the bridges, causeways, and culverts, showing their respective length, width, and bearing strain, and whether constructed of stone, brick, or timber.
6. A table of the roads crossing the line of survey.
7. A table of the lengths of the road formed by rock cuttings.
8. Reports as to suggested deviations and improvements as required by paragraph 7.
9. Reports as to widening road as required by paragraph 8.

22. The work to be completed, and the Plan, Sections, Cross Sections, and Reference Book to be delivered to the Commissioners on or before Wednesday, the 13th May, 1868.

23. Each contractor is to state in his tender the day when he undertakes to deliver the Plan, Section, Cross Sections, Reference Book, and copy of field book and notes to the Commissioners.

24. The whole work to be done to the perfect satisfaction of J. E. Calder, Esq., Surveyor-General.

Papers on Light Railways.

APPENDIX B 1.

Light Railways in India.

PAPERS ON LIGHT RAILWAYS.

APPENDIX B 1.

Indian Tramway Company, Limited,
62, Moorgate-street, London, E.C., 26th June, 1866.

DEAR SIR,

ON the 18th instant I had the pleasure of receiving your note under date 23rd April, 1866, and in reply I shall be happy to give you the best information in my power, as well as put you in possession of the means of getting fuller information if you so desire it, and assist thereby your views of introducing effective Light Railways into your Colony at a reasonable but sufficient expense.

Our primary and firm decision and stipulation has been to be free from Government interference and supervision, excepting only so much as is necessary for public safety. This we have found practically (though now avowed) stands much in the way in India, where nearly all officials are Government men, and there is certainly a jealousy of any independent power coming upon the stage. Hence we have only made 1 short line of 18 miles and 65 chains from the Arconum Junction, where the Madras Railway (a guaranteed standard line) bifurcates N.W. to join the Great Indian Peninsula Railway from Bombay, and the continuation of the Madras Line across the Continent to Beypore. Our little Line runs south from Arconum Junction to Conjeveram.

Railway on the road.

This Line is so laid for 14 miles 43 chains; the remainder of the Line is where no road previously existed. Of the former part some portions of the ordinary road had to be widened where it was not wide enough to accommodate the Railway and road traffic. There are also many other points which are producing constant negotiation, with the usual and almost unavoidable official efflux of time in getting matters settled and completed. It has been decided under all circumstances, and from past experience, not in future to lay Rails upon any ordinary road.

In reply to this portion of your enquiry. These Light Railways show they will fully answer the objects and intentions of the Promoters; viz. that of effectual opening up the country at a moderate cost. In proof of this I would refer to the Queensland Government in Australia, whose Railway system on 3 feet 6 gauge at a very moderate cost is quite a success. 4 feet 8 gauge does the immense work of this country (England); and with double lines, no present man's life would find 3 feet 6 gauge insufficient in Tasmania, while the lightness and facility of managing the Rolling Stock at the Stations necessitate the minimum of hands at Country Stations, and with ordinary traffic where 100 tons of goods for transport in one day is a large collection. We have for trial carried 95 tons at 35 miles per hour safely, with an expenditure of 11lbs. of coals per mile.

For a Colony opening a Railway system I would suggest the plans and experience of the Queensland Government, doing it as a Government matter in preference to a Company for the facility of getting the thing done, and the Colony to have the advantage of a Railway system. That Government is so much nearer your Colony, you could not do better as a well-wisher to yourself and co-Colonists than confer with them. Their work has been done through Sir Charles Fox and Son, of 8, New-street, Spring Gardens, London, who are also one of our Engineers, and most clever and responsible parties, thoroughly efficient.

I enclose printed copy of their report in our early days, which will afford you much information.

I enclose also copy of Mr. Charles Douglas Fox's Report on the Norwegian Light Railways. Also, as asked for, the last Report to our Shareholders in November, 1865, with the Board's experience of the results of our little experimental line. The arrangements with the Government of India for the extension of our line to Pondicherry are not yet completed, but nearly so it is hoped, for the portion which runs through British Territory. The arrangements with the French Government are also in a forward state. When completed, this line, supplementing the Great Trichinopoly Trunk Road, will be the best paying line in India. This line, however, in deference to the requests and co-operating subsidy of the French Government, will be of standard gauge, 5 feet 6, so as to afford them a through traffic without breaking bulk or change of carriages from Pondicherry to all parts of India, as the maps will point out to you, and completing the inter-communication whenever the line is again extended from Belpur, or as some maps call it Vigoupoorum, 120 miles to Trichinopoly, on the Great Southern of India Railway.

Any further assistance I can be of I shall be happy to render upon hearing from you, "for the general benefit of all," which should be the earnest wish of every one desiring to be useful to his fellow man.

I am, dear Sir,
Yours very truly,
M. R. SCOTT, *Secretary I. T. Company (Limited.)*

CHARLES STUART CANSDELL, *Esq., Hobart Town,*
Member of the House of Assembly, Tasmania.

APPENDIX B 2.

APPENDIX B 2

Indian Tramway Company. Report by Sir C. Fox, C.E.

London, October 17th, 1862.

ENGINEERS' REPORT.

To the Chairman and Directors of the Indian Tramway Company, Limited.

GENTLEMEN,

IN compliance with your instructions, we have now the honor to report that, having given the subject of constructing Tramways in India—as Tributories to the Trunk Lines of Railway, or as a cheap mode of connecting towns in districts through which the Trunk Lines do not pass—our careful consideration, we have arrived at the following conclusions:—

The question of the highest importance connected with this subject is the one of width of gauge, or in other words, shall these branch lines be of the same gauge as the Trunk Lines, (5 ft. 6 in.); or shall they be of some smaller gauge, and if so, what shall it be?

There can be no doubt that if some such dimensions as 3 ft. 4 ins. be adopted, an important reduction on the cost of construction as compared with that of the 5 ft. 6 ins. gauge would be effected, amounting to a saving of 30 per cent.; but the use of so small a gauge will be attended by serious inconveniences, such as transhipment of all passengers, goods, and cattle at the points of junction, a much greater number of engines, carriages, and waggons, for carrying on the same amount of traffic, and consequent upon this, a correspondingly large number of Company's servants, from which it will, we think, be evident that traffic carried on the narrower gauge cannot fail to be much more costly thon on the wider one.

Difference of cost of 3-4 and 5-6 gauge on level land.

We are, however, of opinion that the difference in cost of the two gauges need not exceed the per-centage already given, because the use of the wider one does not necessarily entail the use of such a rail and sleepers as those used on the Trunk Lines, and that in fact those of a much lighter description may be used if the following condition be strictly complied with, viz.—that the Locomotives used on these branch lines should be so constructed as never to have a greater load on any one pair of wheels than that which is placed upon a pair of wheels under a fully loaded carriage or waggon, which in this case would be a maximum of about 6 tons, arrived at as follows:—

Weight of 4-wheel waggon in use on Indian Railways	4 tons.
Full load carried by such waggon	8 ,,
Total weight on rail by four wheels................	12 tons,

or 6 tons on each pair of wheels; so that an engine having three pairs of wheels would be so constructed and balanced as to have 6 tons only on each, and as we would certainly not recommend an average speed of more than 20 miles an hour—and we would not desire less—an engine of this kind and weight could be made to draw a very satisfactory load over ordinary gradients with great economy.

When it is borne in mind that on Railways in England, and Trunk Lines in India, engines weighing upwards of 30 tons, and often having a load of 14 tons on one pair of wheels, are allowed to run at the velocity of 40 miles an hour on rails of not more than 70 lbs. a yard, it will be obvious that when the load on a pair of wheels is reduced from 14 tons, and is never permitted to exceed 6 tons, and the velocity is brought down from 40 to 20 miles an hour, that rails weighing, say, 40 lbs. a yard, and not more, will, under the circumstances above given, be comparatively stronger, and actually as durable as the heavier ones; for it must be remembered that the heavy rails are not required for carrying the carriages and waggons, but are rendered necessary only by the extreme weight placed on the driving wheels of the locomotive, and the high speed attained. We, therefore, report that if the maximum load on every pair of wheels be limited to 6 tons, and the speed to 20 miles an hour, a rail of 40 lbs. will satisfactorily answer every purpose with safety and durability, and it follows as a matter of course that if light rails only are necessary all the appendages may be correspondingly light also.

Should it be objected that engines of 18 tons will not obtain adhesion enough to enable them to draw sufficient loads, then, by employing another pair of wheels with a load of 6 tons also—raising the total weight of engine to 24 tons—an additional proportionate load may, by this means, be dealt with; and the best proof that no difficulty now exists in constructing an engine with four pairs of wheels, driven by being coupled together, is that many such are working at the present time; and if engines of this kind are found to answer the purpose of ascending steep inclines with fair loads, there can be no reason why they should not draw heavy ones on easier gradients.

* * * * * * * * * *

On the perusal of this Report you will naturally say, why, if the necessity of using heavy rails and expensive permanent way be so easily dispensed with, has it not been already done on lines in England? And our reply is simply, that notwithstanding our opinion frequently expressed, it has been impossible to prevail on Companies to try the experiment, simply because there is a feeling prevailing, and in which the Government Engineers fully coincide, that all the works of Branch Lines should be strong enough to bear the heaviest engines used on the Main Lines. Had it, however, been otherwise, we are confident that very many shareholders in Tributory Lines, who now get little or no dividend, would at this moment be in receipt of satisfactory incomes.

We are obliged to confess that it seems strange that matters apparently so small as restricting the load upon each pair of locomotive driving wheels to 6 tons, and the speed to 20 miles an hour, should exert so important an influence over the cost of branch lines; but such is simply the fact, and the results here exhibited will, we believe, bear the fullest investigation.

It is manifest that if, instead of using waggons of 5 ft. 6 ins. gauge, capable of holding 8 tons, those of the smaller gauge be adopted, holding but 2 tons, four times the number of waggons will be required for transmitting the same weight of goods, and something like the same proportion will be found to obtain with regard to passengers; and as the aggregate weight of four small waggons will certainly exceed that of one large one, the proportion of tare and tret will obviously be in favour of the latter, and as the load drawn by a locomotive may be taken to be in great measure represented by its weight, or in other words by the adhesion of its wheels upon the rails, the one weighing 18 tons on the wider line will draw nearly twice as much as the one weighing 10 tons on the narrower one, consequently double the number of engines with their enginemen and firemen will be required, and the number of working parts to be kept in repair, both as regards engines and waggons, greatly augmented.

Speed.

The comparison above is made, assuming the speed to be the same on both gauges, but if the wider one be worked at 20 miles an hour, as against the narrower one at 10 miles an hour, then in the latter case as the time absorbed in making a journey will be doubled, a still larger quantity of rolling stock will be required for working the narrower line.

From what has been stated it appears to us the most economical gauge for railways is that on which the largest load can be conveyed on one pair of wheels, without permanent injury to the surface of the rails; for it must not be forgotten that it is the surface of a rail that first wears out, and not its substance: and further, that the surface of a heavy rail has no more power of endurance than that of a light one, and in a small degree not so much, and as a 40 lb. rail is quite sufficient for the passage at 20 miles an hour of wheels bearing no greater load than 3 tons each, it becomes perfectly clear that the use of the heavy ones is only called for to meet the additional stress of higher velocities and the greater, though often unnecessary, load placed on the driving wheels of engines in general use.

To meet these conditions we have long been of opinion that a gauge of 5 ft. 4 ins. would practically be about the best, and the two extra inches, which added to this make up the Indian gauge, is in fact so small a difference as to need no remark; nay, rather ought we to rejoice that the standard gauge of India approaches so very nearly to the exact gauge which we would now adopt for both Trunk Lines and Branches if called upon to decide that important question.

Referring to the paragraph in the prospectus in which it is stated—"It is proposed to work the traffic with bullocks and a superior class of waggons, and the passenger traffic with carriages and horses, and where practicable with light engines of a form and description specially applicable to the purpose,"—we beg to observe we are of opinion that in all cases the use of locomotive power will be found the most convenient and profitable. * * * *

Railways on the roads.

Taking it for granted that the Indian Government gives the Company power to lay their permanent way on the surface of the existing roads, which have already received 12 inches of ballast, or that they grant such a sum of money as will enable the Company to construct such a road, then we estimate the cost of constructing a branch line with 40 lb. rails, laid to a gauge of 5 ft. 6 ins., including iron, fencing, stations, telegraph, 10 per cent. for contingencies, and all charges for management, engineering, and incidental charges at £4000 a mile (see Appendix), and as we have taken the cost of a branch line, with 30 lb. rails, laid to a gauge of 3 ft. 4 ins., at £2800, it appears that a saving of 30 per cent. in outlay would be made by adopting the latter plan.

In conclusion, however, we beg to say that, upon a review of all the circumstances of this important matter, we are prepared to recommend the use of the present gauge of 5 ft. 6 ins. in the construction of the Tributory Lines of India, being persuaded that the additional outlay of capital will be much more than countervailed by the saving in working expenses, to say nothing to the many important points of increased convenience which the use of such gauge will present.

We have the honor to be,
Gentlemen,
Your faithful Servants,
CHARLES FOX.

APPENDIX.

Estimate of one mile on road £4000.

ESTIMATE of One Mile of Branch Line of 5 ft. 6 in. Gauge.

	£	s.	d.	£	s.	d.
Fencing of five wire strands, with wrought iron standards.......	280	0	0			
Forming, preparing, and draining surface of road.......... ..	200	0	0			
Ballast, 1½ cubic yard, per yard lineal = 2640 C. yards at 5s....	660	0	0			
Sleepers, creosoted, No. 1760 at 7s.	616	0	0			
Rails, 40 lbs. per yard = 63 tons at £14........................	882	0	0			
Fastenings, say..	100	0	0			
Laying, 1760 yards at 1s. 3d....................................	110	0	0			
Stations, proportionate charge per mile, say....................	400	0	0			
Telegraph, with 2 wires and instruments.........................	50	0	0			
				3298	0	0
Contingencies, 10 per cent.				329	0	0
				£3627	0	0
Expenses of management and engineering and incidental charges				373	0	0
Total cost per mile............. ...				£4000	0	0

Appendix B 3.

NORWEGIAN LIGHT RAILWAYS.

Appendix B 3.

On Light Railways in Norway. Report by C. D. Fox, Esq., C.E.

Trondhjem, August 24th, 1864.

Dear Sirs,

Through the kindness of Mr. Pihl, the Engineer of the Government, I have been enabled to carefully inspect the works on the various Railways in this country.

The Railway from Christiana to Eidsvold, which was constructed by an English company, is of the 4-8½ gauge, and of ordinary construction. Its chief peculiarity is a long incline of 1 in 42, which is worked by the use of a bank, or assistant engine, at the back of each train in ascending. The permanent way on this line consists of bridge rails, fastened by wood screws to inferior longitudinal timbers, kept in gauge by frequent cross sleepers.

The Swedish Government having adopted the 4-8½ gauge, the Norwegian Government has, in the construction of the line from the above-mentioned Railway to the Swedish frontier, been compelled to make use of a similar gauge. The works on this line are very well executed, but do not call for special remark.

The Norwegian Government have constructed, and have in full operation, two lines of railway of the 3-6 gauge, one of which has been open two years, from Grundsett to Hamar, on the Miosen Lake, a distance of 24 English miles, and one which has been opened for some months from Trondhjem to Storen, on the road to Christiana, a distance of 30 English miles. Having passed twice over each of these lines on the locomotive, and having examined their details with much care, I would report as follows:—The Grundsett and Hamar line runs through a fairly easy country, has considerable lengths of 1 in 70, with curves of 1000 feet radius, and has cost, including rolling stock and stations, £3000 per mile. The train, on which I was, consisted of six carriages and a brake van, and we ran, with great ease and perfect steadiness, at the rate of 32 miles per hour; the working speed, however, does not exceed 15 miles per hour, including stoppages. The engines, which are almost identical with those sent out to Queensland, with the exception that they are tank engines, and provided with arrangements for coal burning instead of wood, weigh, in steam, 14 tons. They were constructed by Messrs. R. Stephenson & Co., are without bogies, and run with great ease and steadiness, and with great economy of fuel. They with ease take a gross load of 90 tons upon this line, running at 18 miles per hour, and using 120 lbs. steam. The works on the line generally are of a substantial character; the bridges are, however, strongly constructed in timber. The line is kept in a most creditable state of repair, not surpassed by any English railway, and my impression certainly is that the running of the trains is particularly free from any vibration. Two trains each way are run during the summer, and one train each way during the winter, in each case being mixed passenger and goods.

Grundsett Line 3-6, cost, £3000.

The Trondhjem and Storen line runs through a difficult country, has but very small portions of horizontal, and chiefly gradients of 1 in 100; there are, however, 5 miles of 1 in 52, and in the opposite direction from the summit, 4 miles of 1 in 42, followed by 4 miles of 1 in 65, and 1 in 100. Frequent curves are found throughout the line, but especially on the heavy gradients, where they are chiefly osculating curves, ranging from 700 feet to 1000 feet radius.

The earthworks on the line are heavy, including several rock cuttings, and some embankments of very bad clay. There are 12 large bridges, on the length of 30 miles, 3 of them of great height and length, the largest being the "Sloppen" bridge over the river "Nid," which is 620 feet in length, and has 5 principal spans, of 70 feet each, the piers being 100 feet in height. The piers to high water level are of masonry, to resist the ice, but the rest of the bridge is entirely of timber, substantially and securely constructed, and showing but very slight vibration during the highest wind. The timber girders are 10 feet in depth, and 11 feet apart, and are upon Warren's principle.

There are two terminal stations and six intermediate stations, and three stopping places. The stations are well arranged, and are buildings of wood, substantial, and carefully constructed. There is also a considerable length of sidings and workshops at the Trondhjem terminus. The rolling stock consists, at present, of 3 locomotives, 2 brake vans, 6 passenger carriages, 40 goods' waggons of several kinds, and 50 ballast waggons. The total cost of the Railway, including rolling stock and stations, has been £6000 per mile. The working speed does not exceed 15 miles an hour, including stoppages, or an average running speed of 12 miles per hour, on the steep incline, and 18 miles per hour on the remainder of the line. The train with which I came consisted of 6 goods' waggons, full, 1 ditto, empty, 1 cattle waggon, full, 4 passenger carriages nearly full, and the brake van, or an aggregate gross load with the engine of 118 tons, which we ran with at, sometimes, 30 miles per hour with perfect ease. Nothing can exceed the steadiness of both engines and carriages. In ascending the steep incline of 1 in 52, an assistant engine was attached, increasing the gross load to 133 tons, or 66½ tons of gross load per engine, which was taken up with the greatest ease, at from 12 to 15 miles per hour. It is not found necessary to have horizontal portions on the inclines, except where a station occurs, in which case it is advisable, in order to facilitate stopping and starting. Although the curves on these lines are not very sharp, yet in the stations they have curves of 330 feet radius, and these are taken with great ease. The engine on which I rode was made by Messrs. Slaughter, Gruning, &, Co., now the Avonside Engine Company, Limited, Bristol, and, with the exception of being a tank engine, and for coal burning, is made from the same pattern as those for Queensland. It is fitted with a Bissell's bogie, which acts beautifully; when first received on the line, not long since, it had considerable swaying movement, and this was found to arise from the driving wheels not having the balance weights properly adjusted; this having been done, the engine has given great satisfaction since, and can, with ease, take a gross load of 75 tons up the inclines of 1 in 42, and 1 in 52, at 12 miles per hour. The traffic in winter is very large, and two trains a day are then run each way, which in the summer are reduced to one mixed passenger and goods.

Trondhjem Line 3-6, cost £6000.

Upon both of these lines I would remark as follows:—The permanent way consists of rails of almost exactly Queensland section, weighing 37 lbs. per yard on the level portions, and 40 lbs. on the inclines, fished at every 21 feet with fishes 11 inches long and secured to transverse sleepers 2 feet 6 inches apart from centre to centre by dog spikes only, no bolts or joint plates being used. The sleepers are of pine, 6 feet 6 inches long, uncreosoted, 9 inches by 4½ inches, half round, laid round side up, and this is adzed so as to increase the bearing of the rail to from 4 inches to 5 inches, and an inward cant of 1 in 20 is given to the rail. The ballast, which is of good quality, is 8 feet 6 inches wide and 1 foot 8 inches thick. The crossings are reversible, and the switches self acting. The fencing is a very substantial post and 4 rail fence, of ordinary design. The lines are 14 feet wide at formation level; semaphore signals are only used at important stations, flags sufficing for every purpose in other places. The engines are very nearly all alike, with the exception of the bogie, which is only fixed on that made by Messrs. Slaughter, Gruning, & Co. They make ample steam for the tractive and adhesive power of their driving wheels. The rolling stock very much resembles the Queensland stock. The passengers' carriages are 19 feet long, on 4 wheels, without bogies, 6 feet 6 inches wide, and 9 feet 3 inches high, outside. The goods' waggons are 21 feet long and 6 feet 6 inches wide, but are found

Papers on Light Railways.

APPENDIX B 3.

On Light Railways in Norway. Report by C. D. Fox, Esq., C.E.

to be less convenient than waggons 14 feet long. The stock is only provided with one buffer in the centre, forming also the drawbar, but I still think the usual double buffers are preferable. The under frames of the stock are of wood, that being so cheap here.

The general repairs on the line only employ one man to every mile, and I wonld again testify to the excellent condition of all the works on the line. The permanent way, some of which has stood the test of two Norwegian winters, is, without exception, the smoothest road I have been on, and though the dog spikes seem insecure, when compared with the bracket chair, yet they have never been known to fail, and I should recommend their being used, except on very steep inclines.

These lines, which run through a thinly populated district, already more than pay their expenses, a result far beyond what was anticipated for the present.

The Government are now busily engaged in the construction of a further length of 56 miles of these railways, and I have the assurance of Mr. Pihl that so thoroughly satisfactory have the results proved, that nothing but the 3 feet 6 inches gauge will be used in this country, on any lines which may be independent of the Swedish gauge. The Government have just ordered two more engines, of similar design, from Messrs. Slaughter, Ganning, & Co.

I have pleasure, in conclusion, in recording my opinion that these lines are capable of carrying a very considerable traffic with economy and safety, at speeds exceeding 12 miles per hour, and that these light railways are fully equal to the necessities of this or any other rising country.

I have the honor to be,
Dear Sirs,
Your obedient Servant,
CHARLES DOUGLAS FOX.

SIR CHARLES FOX AND SON,
8 *New-street, Spring Gardens, London, S. W.*

APPENDIX B 4.

Letter on Light Railways from M. R. Scott, Esq., Secretary of Indian Tramway Company.

APPENDIX B 4.

Indian Tramway Company, Limited,
62, *Moorgate-street, London, E.C., 22nd May*, 1867.

DEAR SIR,

YOUR letter of 25th August, 1866, in reply to mine (with enclosures) dated 26th June, 1866, came to hand 15th October, 1866. In compliance with your request in that letter I forwarded by Southampton mail on 18th December, 1866, three copies of the Board's Reports to our meeting of 7th December, 1866, containing copies of the Report of our Resident Engineer, which I am sure contained information interesting to you in reference to the powers and efficiency of the narrow gauge of 3 feet 6, and the consequent smaller expense than lines of wider gauge. I hope these reached you safely, but I have not heard from you since the letter of 25th August, nor have I any advice of the arrival of my letter of 26th July, 1866, enclosing an important communication from Sir C. Fox and Son, upon the subject of your first communication to me; viz. the opening up of Tasmania with Light Railways.

Presuming, however, that all these are in your hands, and the subject has still your earnest attention, I now forward for your consideration two letters from the same gentlemen, pointing out the best mode of getting your object accomplished, with drawings to illustrate the rails and fixings recommended, and the rolling stock alluded to in the letters. The rough estimate and detail in the letter not marked private will help and guide you in getting out and maturing any arrangements you may find wanting to lay your plans in form before the Government for their consideration, previous to entering upon a matter of so much importance to your Colony and the community in general.

Suggests that Government should construct the Line.

My only object is the general welfare of your Colony, which must accrue from the introduction of a Railway system economically and efficiently carried out. I have no other interest, as this Company's operations will be confined to India; and I have also pointed out in my letter of 26th June, 1866, it would be better for the Government to undertake the Railways than any Private Company, more especially as illustrated by the success of the Queensland Government, and the Railways introduced there with the co-operation of Sir Charles Fox & Son here. By book post I send you also two copies of a paper on Light Railways, by Charles Douglas Fox, (the son) published under the authority of the Institution of Civil Engineers here in London.

I hope you will advise me of the arrival of all these, and add a few lines to say how you are advancing; and if any further information will be useful I am quite at your service.

My fourth son is an officer on board H.M.S. *Challenger*, the Commodore's ship, which was lately (the early part of this year) at Hobart Town. His name is "Munro Scott;" he is only a Master Assistant, but he is a very steady good son. If it is in your way to show him any attention in compliment to me and my interest in the subject under my pen, it will be a great gratification to me.

To resume my subject. A reference to the officials of the Queensland Government will, I am sure, satisfy you how the plan detailed in the private letter to me from Sir C. Fox and Son, now enclosed, dated 16th May, 1867, has answered, and how they have been served satisfactorily by those gentlemen under a similar arrangement.

I am, dear Sir,
Yours very truly,
M. R. SCOTT.

CHARLES STUART CANSDELL, *Esq., Hobart Town, Tasmania.*

Appendix B 5.

Papers on Light Railways.

Appendix B 5.

On Light Railways in Norway, India, and Queensland, by C. D. Fox, Esq., C.E.

THE INSTITUTION OF CIVIL ENGINEERS.

November 27, 1866.

CHARLES HUTTON GREGORY, Vice-President, in the Chair.

No. 1166.—*On Light Railways in Norway, India, and Queensland.** By Charles Douglas Fox, *M. Inst. C.E.*

The subject of the construction of Light Railways is one of daily increasing importance. In Great Britain, the trunk lines have been made with a view to carry an immense traffic at high speeds; and, in most instances, in a massive manner well suited to their purpose. Other countries have followed this example; and throughout Europe, first-class railways may be found, with ruling gradients of 1 in 100, minimum curves of 20 chains radius, and rails weighing from 60 lbs. to 84 lbs. per yard, worked by locomotives having from 10 tons to 16 tons on a pair of wheels, and weighing from 30 tons to 45 tons each. But, on the other hand, railways have been constructed, especially in America, to be worked by locomotives equally heavy, although with general works, and especially permanent way, unsuited for such traffic; and thus have arisen heavy working and maintenance expenses, and numerous accidents.

A demand is now arising for railway intercommunication between places not of sufficient importance to justify the cost of a first-class railway; especially in colonies and other countries where such communication is required for the purpose of attracting population, and where, for many years, the traffic is sure to be of a comparatively light character.

By the term "Light Railways," the author would wish to be understood such as, either being branches from existing trunk lines, or being intended for districts requiring the development of their traffic, should be constructed in a thoroughly substantial and durable manner, equal in their details as to quality to the best trunk lines, but with every part made only of such strength as to carry loads represented by the rule, that no pair of wheels should be allowed to have more than 6 tons upon it. This would enable these lines to carry the rolling stock of all other railways of similar gauge, with the exception only of the locomotives.

Grundsett Line, 3-6, cost £3000.

The first railways constructed upon this principle, which have come under the author's notice, are those of the Norwegian Government; the designs for which were prepared, and the works carried out, under the guidance of Mr. Carl Pihl, the State Engineer. The author visited these lines in 1864, and was struck with their efficiency and economy. With the exception of the line from Christiania to Eidsvold, which was constructed some years since by Mr. G. P. Bidder (Past President Inst. C.E.), and the branch therefrom to the Swedish frontier—both of which are of the 4 feet 8½ inches gauge, that being the gauge adopted in Sweden—the railway system of Norway is upon the light principle, and of the 3 feet 6 inches gauge. The two lines visited by the author may be taken as types of the system. The first, from Grundset to Hammar on the Miösen Lake, a distance of 24 English miles, passes through an easy undulating country, has ruling gradients of 1 in 70, with curves of 1000 feet radius, and has cost, including rolling stock and stations, £3000 per mile. The second, from Trondhjem to Stören, a distance of 30 English miles, passes through a difficult country. The earthworks are heavy, including several rock cuttings and embankments of bad clay. There are 12 large bridges on the length of 30 miles, three of them of great height and length, the largest being the Sloppen Bridge over the River Nid. This is 620 feet in length, and has five principal spans of 70 feet each. The piers are 100 feet high, making the total height of the viaduct 110 feet. Up to high water level the piers are of masonry, to resist the ice, but the rest of the bridge is of timber. The timber trusses are 10 feet in depth, and 11 feet apart, and are constructed upon Warren's principle. These structures are so carefully put together, that there is scarcely any vibration during the highest wind. The gradients on this line are chiefly 1 in 100. There are, however, 5 miles of 1 in 52, and in the opposite direction from the summit, 4 miles of 1 in 42, followed by 4 miles of 1 in 65 and of 1 in 100. Frequent curves are found throughout the line, but especially on the heavy gradients, where they are chiefly reverse curves, ranging from 700 feet to 1000 feet radius. There are two terminal stations, six intermediate stations, and three stopping places, with workshops and engine and carriage sheds at Trondhjem. The total cost of the line, including rolling stock and stations, has been £6000 per mile.

Trondhjem Line cost £6000.

The permanent way upon these lines consists of flat-bottomed rails, weighing from 37 lbs. to 40 lbs. per lineal yard, fished at every 21 feet, with plates 11 inches long, and secured by dog spikes only to transverse sleepers, 2 feet 6 inches apart from centre to centre; no fang bolts or joint-plates being used. The sleepers are of pine, 6 feet 6 inches long, by 9 inches by 4½ inches in section, uncreosoted, and half-round, laid the round side up, and adzed, to increase the bearing of the rail, to 5 inches. An inward cant of 1 in 20 is given to the rail. The ballast occupies a space of 8 feet 6 inches wide, and 1 foot 8 inches thick, and is of good quality. The crossings are reversible, and the switches self-acting. The permanent way, after having stood the test of several Norwegian winters, forms a very smooth road. Its repairs employ one man per mile. The general works are thoroughly substantial, the bridges and stations being of pine timber. The lines are 14 feet wide at the formation level. * * * * * *

The ordinary working speed required by the traffic does not, however, exceed 15 miles an hour, including stoppages. In ascending the incline of 1 in 52, an assistant engine was attached, increasing the gross load to 133 tons, or 66½ tons of gross load per engine, which was taken up with ease at about 12 miles to 15 miles per hour. The passenger carriages are 19 feet long, on four wheels, without bogies, and 6 feet 6 inches wide, by 9 feet 9 inches high outside. The goods wagons are 21 feet long, and 6 feet 3 inches wide. A single central buffer is adopted, forming also the drawbar. The under frames are of wood. These lines, which run through thinly populated districts, already more than pay their expenses, and the results of their working have been so satisfactory, that this system is being rapidly extended.

Arconum Railway Line on the road—results.

The railway from the Arconum Junction of the Madras Railway to the town of Conjeveram, 19 miles in length, and of the 3 feet 6 inches gauge, was constructed by Sir Charles Fox (M. Inst. C.E.), and Mr. G. Berkley, (M. Inst. C.E.), as Engineers, and by Mr. B. Holloway, as Resident Engineer, for the Indian Tramway Company, Limited. It has now been working eighteen months with most satisfactory results.

The line, which runs over a flat country, is formed chiefly of a low embankment, with frequent culverts for drainage, and with two iron bridges, on screw piles, of considerable size, to cross rivers exposed to heavy floods. The works are substantially executed. The permanent way consists of flat-bottomed rails, 35½ lbs. to the yard, properly fished, and secured by dog spikes to transverse teak sleepers, 2 feet 6 inches apart from centre to centre, and well ballasted. The locomotives and other rolling stock are nearly similar to those used on the Norwegian lines,

* The discussion upon this Paper occupied portions of two evenings, but an abstract of the whole is given consecutively.

Papers on Light Railways.

APPENDIX B 5.

On Light Railways in Norway, India, and Queensland, by C. D. Fox, Esq., C.E.

adapted, however, to the difference of climate. The cost of this line, which was constructed by the Company's officers, was £3200 per mile, including telegraph and stations, or £3900 per mile including all management and rolling stock. Although the traffic does not require a greater working speed than from 12 miles to 15 miles per hour, the trains have at times been run, with perfect safety, at upwards of 40 miles per hour, including stoppages. During the Festival Days, in May, 1866, twenty-two thousand persons travelled on the line. The relation of the cost of working to the gross receipts does not exceed that of an ordinary line.

The Government railways of the colony of Queensland—to which Sir Charles Fox (M. Inst. C.E.), together with the author, are the Consulting Engineers—form at present the most extensive system to which this principle has been applied. These lines have been laid out by Mr. A. C. Fitzgibbon, (M. Inst. C.E.), the Engineer-in-Chief to the Colonial Government, who, upon his arrival in the Colony, found that the chief want of the country was means of intercommunication, and that it would be better supplied by constructing light, but substantial, railways, than by continuing to spend something like the same amount on roads. Careful surveys were accordingly made, and it was found, that whilst the country both above and below the main range of hills was of an easy character, yet to surmount this range, cut up as it is by numerous and deep ravines, would require works of no ordinary character, and such as, for a line with ordinary curves and gradients, would be simply prohibitory in cost. The matter excited much interest in the Colony; and the Government having, upon the advice of their Engineer, determined upon adopting a system of Light Railways, with a gauge of 3 feet 6 inches, much opposition was raised, resulting in the final adoption of the Government plans.

The Southern and Western Railway of Queensland will run from the town of Ipswich to Toowoomba, a distance of 78 miles, and will then divide into two branches, one running to Dalby, a distance of 52 miles, and the other to Warwick, a distance of 62 miles, making a total of 192 miles. About 50 miles have been opened for traffic, and the remaining 142 miles are in course of construction, partly by Messrs. Peto, Brassey, & Betts, and partly by local contractors. A further length of upwards of 200 miles is under survey. The Little Liverpool incline on this line, which passes a ridge 700 feet in height, is 3 miles in length, and has ruling gradients of 1 in 50, with curves of 6 chains radius. The main incline, which crosses a ridge 1400 feet high, is 16 miles in length, and has ruling gradients of 1 in 50, with frequent curves of 5 chains radius. The earthworks on this portion of the line are very heavy, with cuttings in rock, and 11 tunnels, also in rock, which have been lined with brick-work, and of which one is 27 chains in length. There are also about twenty iron bridges, with lattice girders, 12 feet wide between the girders, and in spans varying from 60 feet to 100 feet, with an amount of water-way almost unparalleled on a similar length of line. One of the chief works is the bridge over the River Bremer close to the Ipswich terminus, for carrying a single line of narrow-gauge railway, and a public road 25 feet wide. It has a width of 37 feet between the parapets, and consists of three spans of 150 feet each. The abutments are of stone. The piers, which are 60 feet high, consist of cast-iron cylinders, 6 feet in diameter, sunk into the bed of the river, and filled with concrete. Both the main and the cross girders are of lattice construction, the former being 12 feet deep. The top flange is composed of cast iron in a tubular form, the bottom tie of Howard and Ravenhill's rolled links. The cross girders are 6 feet apart from centre to centre, are 37 feet long, and 1 foot 9 inches deep. The strains upon the various parts are in all cases within the limits fixed by the Board of Trade, the rolling load being taken at ¾ of a ton per lineal foot of single line. The total weight of the superstructure is only 12 cwt. per lineal foot of the bridge, which is less than one-third the weight of bridges of similar span and width sent out to the Colonies for railways of ordinary construction.

The stations on these lines are of an ornamental and somewhat extensive character. The termini at Ipswich and Toowoomba, several of the roadside stations, the engineering workshops, and the engine and carriage sheds, have been sent from England, Messrs. Fisher Brothers having been the contractors for them. They are framed in iron and wood, and covered with zinc, and are fitted with traversers, turntables, cranes, weighbridges, tanks, and pumping engines, of the same description as those used in England. * * * * * * * * * *

The ballast, which is very expensive in Queensland, consists of broken rock. * * * * * *

The sleepers are cut out in the forest, and at once adzed, to give accurate bearings for the rails, by a machine sent from England, which, accompanied by a portable engine, can run on the railway to the nearest point, and then, having moveable flanges on its wheels, is drawn by horses to the site where the trees are felled. In this way great saving in haulage and in labour is effected. The cost of the permanent way, including ballast of broken stone, is £2162 per mile, as compared with £2996 per mile, the cost of the permanent way on the railway of a sister colony.

The cost of these railways taken from Mr. Fitzgibbon's estimates is as follows:—

	Total, including Surveys, Land, Superintendence, Stations, Sidings, and Rolling Stock. Per mile.		*Works only Per mile.*
	£		£
Ipswich to foot of Main Range, omitting Little Liverpool Range	7732	..	6660
Little Liverpool Range	12,532	..	11,400
Main Range	11,132	..	10,000
Toowoomba to Dalby	5589	..	4567
Toowoomba to Warwick	5990	..	5445
Actual average cost	8600	..	..

Cost per mile.

From this it will be seen, that these lines may be constructed, under the most difficult circumstances, for between £11,000 and £12,000 per mile, and under ordinary circumstances for £6000 per mile, including everything, and this notwithstanding the rates of labour ruling in the Colony; being from six to seven shillings a day for an unskilled labourer, and from ten to twelve per day for a skilled workman. It must also be remembered, as remarked by Mr. Fitzgibbon, that "the construction of the road and the various appliances employed are in all respects equal to any railway in the world, excepting only that they are limited in power to the wants of the case." * * * *

It so happens that, in the three cases referred to in this Paper, the gauge is 3 feet 6 inches. But the author considers, that the gauge is after all a matter which must be entirely dependent upon surrounding circumstances, and which, if kept within certain limits, will not affect the cost in ordinary countries to nearly so great an extent as that which, the author would repeat, is in his opinion the basis of the Light Railway system—the reducing of the weight upon every wheel in the train (including the engine wheels) to 3 tons, the limitation of the speed to 25 miles per hour, and the adaptation of every detail to these conditions. In Queensland, the gauge of 3 feet 6 inches was determined on for the following reasons:—first, there were already two gauges in Australia, so that uniformity was out of the question; secondly, a curve of 5 chains radius on this gauge is nearly equal to a curve of 8 chains radius on the 4 feet 8½ inches gauge, and the country, on the Main and Little Liverpool Ranges, is of so peculiar a character, with frequent ravines and spurs running out from the main range, that it was found, by a careful survey and estimate, that to adopt curves of 8 chains radius, as used upon the Blue Mountains, New South Wales, upon this portion of the line, would be to increase the cost more than three-fold. In the item of viaducts alone the cost would have been £35,040 per mile as against £6100, an amount quite beyond the means of the Colony. The gauge was therefore fixed at 3 feet 6 inches, and the minimum radius of the curves was reduced to 5 chains.

APPENDIX B 5.

Difference in the cost of 3-6 and 4-8½ gauge in difficult country.

In a country, however, where the trunk lines already exist of either the 4 feet 8½ inches or some other gauge, and where the country through which the branch line has to pass is not of a peculiarly difficult character, requiring very sharp curves, it would, in the author's opinion, be generally found advisable to avoid break of gauge, constructing the branch upon the light system, so that it may take all the rolling stock which the parent line may bring to it, with the one exception of the locomotives.

In conclusion, the author trusts that this Paper may elicit a discussion which shall bring forward more forcibly than he has been able to do, the importance of a system which he believes will be found before long to have much influence upon railway construction for branch lines, both in this and other countries, especially where the amount of traffic is somewhat limited, and where high speeds are not required.

APPENDIX B 6.

APPENDIX B 6.

Indian Tramway Company, Limited,
62, *Moorgate-street, London, E.C.*, 26 *July*, 1866.

DEAR SIR,

AFTER my letter to you by last mail, in reply to yours of 23 April, '66, I applied to Sir Charles Fox & Sons if they could afford any further information, and they have entrusted me with the enclosed paper upon the subject addressed to you, which I have much pleasure in forwarding. I shall be at all times interested in hearing how you get on with the introduction of Light Railways into Tasmania.

I am, dear Sir,
Yours truly,
M. R. SCOTT, *Secretary.*

CHARLES STUART CANSDELL, ESQ., M.H.A.,
Hobart Town.

APPENDIX B 7.

APPENDIX B 7.

Letter from Sir Charles Fox and Sons to C. S. Cansdell, Esq., on the construction of railways where population and traffic are limited.

Spring Gardens, London, S.W., 19*th July*, 1866.

SIR,

THROUGH Mr. Scott, the Secretary of the Indian Tramway Company, we have received your enquiry with reference to Light and Narrow Gauge Railways. We shall be most happy to give you the result of our experience as Joint Engineers to the Indian Tramway Company, who have constructed 18 miles of 3-6 gauge, and as Engineering Agents to the Queensland Colonial Government, who are constructing about 300 miles of similar gauge, Mr. Fitzgibbon and Mr. Plews being the Chief Engineers, the one in the Southern and Western, and the other in the Great Northern Districts.

We also understand from Mr. Scott that he has forwarded you a copy of a report prepared by a member of our firm upon Norwegian railways.

The question of so constructing railways as to meet the requirements of countries having but a sparse population, and a traffic requiring development, has long engaged our attention.

In many of the Colonies the grave error has been committed of constructing first class English railways equal to the heaviest traffic, and to speeds of from 40 to 50 miles per hour, whilst when opened the requirements of the country have been found not to demand a higher speed than 20 miles per hour, which has, in consequence, become the working speed. The cost of these lines, say £20,000 per mile, has been such as to render them unremunerative, and to throw a serious impediment in the way of further progress.

In the United States, and other foreign countries, on the other hand, an equally grave error has been committed. With the view of economising, the railways have been most badly constructed, with permanent way quite unsuited for the heavy trains passing over it,—and the result has been to make the working and renewal expenses so disproportionately heavy as to render profit in most instances very difficult to obtain.

The real requirement, it appears to us, is to construct a railway having all its details of first-rate quality, but made in every part only sufficiently strong and heavy to adapt it for the traffic of the country through which it may be intended to pass, and thus, whilst keeping down the first cost, to also provide for economical maintenance.

We find by experience that a railway of either 4-8½ or 3-6 gauge, as the case may be, will be found of ample capacity for the traffic of any newly opened country for at least 50 years to come, if it be constructed in all its parts to transport loads represented by a maximum weight of 6 tons upon any pair of wheels, and at speeds not exceeding 25 miles per hour.

3-6 or 4-8½ gauge sufficient for years to come.

The railways constructed and at work both in India and Queensland are based upon this principle, and are found to answer admirably. Although the working speed is kept down, yet trains have often travelled upon them with the greatest comfort and safety at 35 miles per hour.

Speed.

The substructure of the Queensland lines, which may be taken as an example, is of the usual description, but proportioned properly to the general light character of the works; the bridges, some of which are very large, being chiefly constructed of iron with masonry or brickwork foundations. The earthworks on the main range portion of the line are very heavy, including several long tunnels. The permanent way is laid with rails weighing 40 lbs. to the yard, flat-bottomed, fitted with check rails on the sharpest curves, secured to cross sleepers and ballasted in the usual manner. The terminal and roadside stations, which are usually composed of iron, zinc, wood, and glass, have been sent from this country complete ready for erection, as have also the repairing shops, tools, engine and carriage sheds, and complete fittings for every department.

Bridges. Earthworks. Rails 40 lbs. Stations.

Papers on Light Railways.

APPENDIX B 7.

Engines.

The line is worked generally by engines weighing 15 tons, and capable of drawing 60 tons of gross load up 1 in 120 at 20 miles, or up 1 in 40 at 12 miles per hour. These engines have four wheels driven and two other wheels fitted in some cases with Bissel's bogie, in others with Adams' radial axle boxes. To work the main incline some 15 miles in length, and having numerous gradients of 1 in 50, and curves of 5 chains or 330 feet radius, special engines are provided having 12 wheels, driven and yet capable of passing round the sharpest curves with ease. These engines, which are very powerful, and equal to at least double the duty of the other class, weigh 30 tons; and it will thus be seen that in both classes the weight on each pair of wheels does not exceed from 5 to 6 tons.

Carriages.

The rolling stock for both passengers and goods is equal to that of the best English railways, and supplied with every comfort, but made as light as possible.

The first class passenger carriages are 32 feet long, with five compartments, and hold 30 passengers; the second class, of similar length, hold 40 passengers.

£7000 per mile, including earthworks & bridges. £4000 if road provided.

It is found that in ordinary country where the earthworks are light and the bridges small the total cost of these railways, including stations, rolling stock, and all expenses for a single line with passing places, is £7000 per mile,—and this takes into account the heavy rate of wages payable in the colonies, and the cost of freight and carriage of all materials from this side. In India, where the Government have provided roads, the cost has not exceeded £4000.

The cost of the Queensland railway for the few miles crossing the main range, and meeting with unusual difficulties, is £15,000 per mile including everything.

So far as the Queensland railways have been worked the result shows a return of about 8 per cent. on the capital expended.

Difference in cost of different gauges in easy country.

The question of gauge is one which very much depends upon circumstances. If, as in Queensland, there is no existing gauge, and it is necessary in order to construct the line cheaply to use very sharp curves, in order to run round the mountain spurs, then the 3-6 gauge is by far preferable; but if there is already a railway existing, say of 4-8½ or 5-0 gauge, and the country through which the line proposed would pass is of an ordinary character, then it would be injudicious in our opinion to introduce a second gauge, and the cost in *easy country* will not be very different for any of the above gauges. The great saving lies in making the railway light in all its parts.

As we take a deep interest in this question, and are busily engaged as engineers in the construction of light railways, we should be very happy to co-operate in their introduction into your Colony.

We cannot suggest any better way of making yourself thoroughly acquainted with the details of the system than by a visit to Queensland, where we are sure the able Government Engineer, Mr. Fitzgibbon, who, acting under the orders of the Hon. A. Macalister, the Minister of Lands and Works, was the chief mover in their introduction, will be happy to give you every particular. His head quarters are at Ipswich.

We are quite aware that what are called railways are sometimes constructed for less sums than those mentioned; but whilst on the one hand we deprecate extravagant and unnecessary expenditure, we equally object to so construct a line as that it becomes a constant source of expense and annoyance,—and, after lengthened experience, we do not believe that a railway to give satisfaction can at colonial rates be constructed for less than we have named.

We are, Sir,

Your most obedient Servants,

CHARLES FOX & SONS.

CHARLES STUART CANSDELL, ESQ.,
Hobart Town, Tasmania.

APPENDIX B 8.

Letter from Sir Charles Fox and Sons, with estimate for Light Railways in Tasmania.

APPENDIX B 8.

TASMANIAN RAILWAYS.

Spring Gardens, S.W., 10th May, 1867.

DEAR SIR,

WE feel some difficulty, in the absence of more detailed local information, in giving you definite views as to the best policy to be adopted with reference to the construction of railways in this Island, but we will endeavour to lay before you, as briefly as possible, the chief points which we consider should receive the careful attention of those interested in the development of the Colony.

The policy of railway construction adopted in England and America respectively has been very different. In England first-class railways, costing from £25,000 to £40,000 per mile, have been constructed for carrying heavy loads at speeds of 30 to 50 miles per hour, which railways are worked at a per centage of about 45 per cent. of the gross receipts. In America, where it was imperative to keep down the first cost, the railways were many of them originally mere tracks constructed in the most temporary manner, and therefore maintained and worked at a very heavy per centage. These railways, having developed the traffic, were gradually replaced by more efficient constructions.

The wise course appears to us to lie between these two extremes, and we would lay down the following fundamental principles:—

1st. That, whilst care is taken to construct lines in every way adequate to provide for the traffic, the strictest economy should be practised in all matters connected with their construction.

2nd. That, at the same time, it will not be found truly economical to construct lines which, though their first cost be low, shall be very expensive to work and maintain.

3rd. That therefore the railways should be in their details of material and workmanship of the very best quality, but proportioned in every part to the light traffic which may be expected.

4th. That the materials of the Colony should be made use of wherever practicable.

We understand that at present no gauge is established in the Colony, that the country is mountainous, that the proposed railways will run through districts commanding but a small traffic, and that great speed is not required.

Gauge. Under these circumstances we should recommend the adoption of the gauge of 3 ft. 6 ins., as being wide enough to ensure safety at moderate speeds, and yet allowing of the use of sharper curves, narrower bridges, tunnels, and earthworks, smaller sleepers, and less ballast than a broader gauge; and this gauge being adopted, we should then propose as follows:—

Load. 1st. To limit the load on any wheel in the trains to 2 tons.

Speed. 2nd. To limit the working speed to a maximum of 20 miles per hour, or say a speed of 15 miles per hour including stoppages.

Earthworks. 3rd. To make the embankments 13 feet, and the cuttings 14 feet wide at the formation level, and to fence the line throughout with native or wire fencing.

Gradients and curves. 4th. To make the maximum gradient 1 in 30, and the sharpest curve on the main line of 300 feet radius.

Bridges. 5th. To construct all bridges with a width of 11 feet between the parapets, and to carry a rolling load equal to three-fourths of a ton per lineal foot. Such bridges when above 40 feet span to be of wrought iron lattice construction, manufactured and fitted here, so as to give as little trouble as possible in the Colony.

The total cost of the ironwork for a bridge of 50 feet span, delivered in the Colony, would not exceed £350, and for a bridge of 100 feet span, £800. If timber suitable for the smaller bridges cannot be obtained on the spot, these also could be made of iron.

Permanent way. 6th. To construct the permanent way with rails of the best manufacture, flat bottomed, and weighing 30 lbs. per yard in lengths of 20 feet, properly fished at the points, and secured to sleepers 2 ft. 6 ins. apart from centre to centre. If durable timber can be obtained, then these sleepers should be 7 ft. 6 ins. long, rectangular 6 inches wide by 3 inches deep, and the rails secured to them by dog spikes. If, however, the native timber is not durable, then we should recommend the use of De Bergne's iron sleepers, as shown on the sketch sent herewith, 14 inches diameter, the rails being secured to them by the patent fastenings. We have had considerable experience of these sleepers, and they answer admirably, make a smooth road, are easily packed, and are of course most durable, wearing out many timber ones.

Ballast. The ballast should be of gravel or broken stone, and amount to 2000 cubic yards per mile of single way.

Steel rails. We append an alternative price for iron or steel rails. If the increased mileage rate be not an insuperable obstacle, we most strongly urge the adoption of the latter. No iron rail is ever free from lamination, in consequence of its being manufactured from a bundle of bars; but the Bessemer steel rails, rolled as they are from a solid steel ingot, are homogeneous and have no such tendency to laminate. We have now had several years' experience of these rails, and they are found to wear out at least twenty of the best iron rails. The durability of the rail is of double importance where, as in Tasmania, the freight and carriage form a considerable proportion of the cost of the rails.

Stations. 7th. To establish stations and passing places about every ten miles unless local circumstances require them oftener. Each of these stations should consist of a dwelling for the railway servants, a small waiting room, goods shed, sidings, and water supply for the locomotives. The termini should further be provided with offices, stores, workshops, and shelter for the whole of the rolling stock; small dwellings would also be required, one to each mile for the passengers, with a foreman's house every five miles. It is important to provide thus for the men, as they are kept near to their work and are at hand when wanted. The signals, switches, and crossings, turntables, tanks, pumps, tools, &c. would probably be sent from this side, but the buildings should be of the simplest form possible, and of timber or other suitable native material.

Telegraph. 8th. To erect a telegraph line throughout, as the capabilities of a single line are thereby immensely increased.

Locomotives. 9th. To work the railways with locomotives weighing either 12 tons on 6 wheels or 16 tons on 8 wheels, according to the traffic; all the wheels to be driven, and the engines to be capable of passing round the sharpest curves. We have many similar engines at work with the very best results, both as to steadiness of running and economy of working.

Carriages. 10th. To provide passengers' carriages comfortably fitted up, and to hold from 50 to 60 passengers each, and goods' waggons to carry from 5 to 6 tons of goods, as well as timber trucks, horse and cattle vans, carriage trucks, and all other descriptions of rolling stock; the whole to be made as light as possible, adapted to the sharpest curves, and fitted with wheels of 2 feet diameter. The stock to be 6 feet 6 inches wide, the centre of gravity being as low as possible.

We append a drawing giving some of the proposed details, and an approximate estimate for such a line of railway through ordinary country,—of course if the earthworks are very heavy, or the bridges very numerous and large, items 2 and 3 would have to be increased, but this can only be judged of on the spot. The amounts taken by us would certainly suffice unless the country were very mountainous, as the steep gradients and sharp curves proposed would enable the contour of the country to be followed very closely.

Freight. Our estimate includes an amount of £4 per ton upon all materials from this side for freight and carriage. If the land carriage were short this amount would be greatly reduced.

We are, dear Sir,

Yours faithfully,

CHARLES FOX & SONS.

M. R. Scott, *Esq.*, 62, *Moorgate-street, E.C.*

Papers on Light Railways.

APPENDIX B 8.

Estimate for Light Railway, 3-6 gauge.

With steel rails and iron sleepers, £4500 per mile.

With iron rails, £4135 per mile.

With timber sleepers, £3935 per mile.

ESTIMATE for a Light Railway 3 ft. 6 ins. Gauge, not less than 50 Miles in length, through level Country without large Rivers.

	£	s.	d.
Fencing	250	0	0
Forming and levelling	700	0	0
Bridges and culverts	300	0	0
Side ditches	50	0	0
Level crossings	50	0	0
Telegraph	50	0	0
Permanent way with steel rails and iron sleepers	2015	0	0
Contingencies, 5 per cent. on above	170	0	0
Locomotives and rolling stock, plant, and machinery	400	0	0
Stations and sidings	300	0	0
Management, engineering, and sundries	250	0	0
Say £4500 per mile.	£4535	0	0
If iron rails are used, deduct	400	0	0
Say £4100 per mile.	£4135	0	0
If timber sleepers are used, deduct	200	0	0
Say £3900 per mile.	£3935	0	0

APPENDIX B 9.

Discussion on Light Railways before Institute of Civil Engineers; extracted from the proceedings of the Society.

APPENDIX B 9.

INSTITUTION OF CIVIL ENGINEERS.

4 DECEMBER, 1866.

Discussion on Paper No. 1166, on Light Railways.

Mr. C. D. FOX said, since the Paper was written a few facts had come to his knowledge resulting from the system which he advocated having been at work six months longer. The system he was there to support was, that a Railway should be made proportionate to the traffic which was to be carried on it; and in order so to proportion the Railway for a light traffic, it should be constructed in such a manner as to carry safely, at a speed of from 15 to 25 miles per hour, a rolling load in no case exceeding 3 tons on each wheel. * * *

Queensland lines average £8600.

Norwegian £3000 to £6000.

Indian £3900, the road being given by the Government.

If the railway system was to be extended not merely to the highways but to the byways of traffic, it would be necessary to find out some means of reducing the cost of construction. The lines in England had cost from £29,000 to £33,000 per mile; those in France, about £27,000 per mile. The Railways in Ireland had cost about £15,000 per mile; and those in India about the same. It was difficult to make a satisfactory comparison because some were double and others single lines, and in many cases the prices of land varied considerably; but in Queensland, wherethe rates of wages were excessively high, the average cost of the line was only £8600 per mile. The Norwegian lines have cost about £6000 per mile through the more difficult country, and over the ordinary country only £3000. The line constructed by the Indian Tramway Company had been made at an average cost of £3200, or including rolling stock for a large traffic £3900, per mile,—the land being granted by the Government, and the earthworks being generally very light. He wished to add, that he was not here speaking of lines in any way inefficient. He believed those lines were as well constructed as any that could be found. * * * * * *

Light railways had been constructed in America but had yielded different results; inasmuch as it was a common practice to make the works light and then run heavy engines over them, and that was not the way to get good results. This question had now become an important one in this country. There were many places in England, Ireland, and Scotland in great need of railways which could not bear the cost of an ordinary line, but if they could be made at from £4000 to £5000 per mile including everything, no doubt there would soon be a rapid extension of the railway system. * * * * * * * * *

Mr. G. W. HEMANS said, it seemed at the first view that the reduction of the gauge of a railway from 4·8½ to 3·6, being only a difference of 14½ inches, could not possibly result in such an enormous saving as that which had been mentioned. It was stated that an efficient railway could be made complete, and doing all the work as well as a more costly one, for £3000 per mile, including stations and rolling stock. That no doubt was a solitary instance, but other facts were given which brought out the cost of these narrow-gauge, light railways, constructed under the most formidable difficulties, only as high as £12,500 per mile, with long viaducts of great height and heavy work of all kinds. * * * * * * * * * *

Mr. G. B. BRUCE could not quite agree in the presumed necessity for introducing these light railways into England. His own impression was, that there was really very little difference in the cost between making a line which would carry moderately heavy rolling stock and making a line to carry very light stock. The bridges might perhaps be a little lighter, and to that extent there would be a saving. The permanent way, again, would be lighter, and that would save something; but when it came to the question of stations nothing really was saved, because whatever might be the gauge of the railway the stations must be in accordance with the traffic which had to be carried: and if a comparison were to be made between two railways, and it was said the stations relatively cost only so much, it conveyed no definite impression to the mind, because the number and extent of the stations depended on the traffic to be accommodated which might be very different in the two cases. The other elements in the case, such as land, signals, and all the apparatus connected with a railway, must be the same, and he believed the same would apply to the rolling stock; viz., that it would cost more or less in proportion to the number of tons to be carried and the number of passengers to be conveyed, whether the stock was light or heavy. Therefore, in all that constituted the capital of the line, he thought the saving was little or nothing when the amount of passengers and goods which had to be carried were taken into consideration. With regard to the adoption of a narrower gauge, the question had been in a great measure answered by Mr. Fox, who said he did not insist upon the gauge, but it was rather dependent on the amount of load brought upon the permanent way. * * *

He thought that the idea of introducing a narrower gauge than 4·8½ was a mistake. There would be a little saving in the cost of construction, and little or nothing in rolling stock, because the engines might be just as light as the engines in the 3·6 gauge if desired; therefore he thought it would be well to hesitate before introducing the system elsewhere.

Mr. BLAIR submitted that the expense and construction of a first class railway with a single line of way had been greatly overstated. Mr. Fox had represented that the cost of English railways had been about £30,000 a mile; and, by way of comparison, represented the colonial railway referred to in the Paper as costing only one-fifth of that sum or thereabouts. Now, under ordinary circumstances, for lines executed through poor districts, such as the north west of Ireland and parts of Scotland, £6000 per mile had been found ample for every expense of construction, including commodious stations, extensive sidings, complete signals, and suitable appliances for the traffic being conducted in an economical manner. As an instance of this, he mentioned the Great Northern and Western (of Ireland) Railway of about 85 miles in length, the cost of which, including every preliminary and executive expense, had been only £6000 a mile. That railway had superior fencing, numerous road bridges, and other works that in a new country might be dispensed with.

G. N. and W. of Ireland Railway cost only £6000 per mile.

Mr. EDWARD WOOD thought the author was right in principle, and it was satisfactory to find that the system had been worked out on so large a scale with such economical results. * * * *
He had in fact for many years adopted the principle Mr. Fox had enunciated, viz., that of fixing a limit to the weight to be placed upon the driving-wheels of the engine. The first case he had to deal with was a line of the ordinary English gauge, the Copiapo Extension Railway, originally designed for horse traffic. He had to design a locomotive to run without injuring the rails, which weighed 42 lbs. to the yard. Locomotives of 32 tons weight had worked upon that line for six years, and the road was now in as good order with regard to the rails as it was after the first six months' working. * * * * * * * *
In the case of two other railways in Chili he had to deal with the rolling stock in the same way. * *
The Tonjoi railway, with curves of 187 feet radii, gradients of 1 in 19 for four or five miles, and a gauge of 3·6. The gauge of the other line, the Carrigal railway, was 4-2, and the same class of engine worked on it.

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Mr. HODGE remarked that in the early days of railways he had considerable experience in making light roads, especially in the United States. In a country like Australia cheap railways were essential, involving curves of short radius and steep gradients; but looking at the nature of the traffic he did not think this description of gauge suitable for English lines, excepting in cases like the Festiniog line,—and even then he believed the gauge of 4-8½ might have been adopted with advantage, as the cost would not have been much greater, and the disadvantages of so narrow a gauge were considerable.

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Mr. F. W. SHIELDS agreed that the permanent way, stations, and other matters must remain pretty much alike on either system; and he considered the only way to account for the great economy in the cost of the Queensland railways must have consisted in the reduction of earthworks and masonry, caused by the adoption of sharp curves and steep gradients throughout the line. If curves of 5 chains radius, and steep gradients of 1 in 50 were used, a large amount of cutting and embankment would of course be saved: in fact, by that means the earthworks would be reduced to a minimum. Taking the cost of earthworks at 20 per cent., and the bridges at 15 to 20 per cent. of the whole expenditure, there would be a margin of 35 to 40 per cent. on which a great saving could be made: and in earthworks alone he dare say three-fourths of the ordinary cost would be saved. In short the reduction of the gauge admitted of the curves being decreased, and that seemed to him the chief point in which this system was productive of economy. With regard to the advantages of this system in Australia as compared with England he could say a few words. He had laid out lines in Australia, and had found a remarkable difference in the two countries. Australia was a new country with few other lines of communication of any kind; whereas in England provision must be made at every step for passing other railways, roads, and canals to either over or under the line, involving cuttings, embankments, and other heavy works which could not be obviated by the adoption of any curves or gradients whatever. In Australia therefore the benefit of the economy resulting from the use of sharper curves allowable on the system under discussion could be fully realized; and it seemed to him that this system could be applied with greater advantage in Australia than in England. It occurred to him also to remark that in his own experience in Australia he made it a rule to use the materials of the country as far as he could. * * * *
The timber of Australia was amongst the best in the world. He had never seen any woods which exceeded in strength and durability those of New South Wales; and he should be inclined to use them in construction as far as possible. He would suggest that Mr. Fox should be asked what was the average amount of earthwork per mile on the Southern and Western Railway of Queensland, in order to enable an estimate to be made how far its low cost per mile was due to the circumstances he had endeavoured to explain.

Light Railways permitting sharp curves and steep gradients suited to Australia.

Timber of Australia.

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Capt. H. W. TYLER said, when he was on the Giovi incline in June, 1866, the engines were worked foot-plate to foot-plate. He thought there was one important saving which had not been referred to, but which had been effected by adopting a narrower gauge in certain localities; namely, in the avoidance of heavy works in mountainous countries. In flat countries very little saving could be effected by reducing the gauge from 4 feet 8½ inches to 3 feet 6 inches. But in mountainous districts sharper curves, which worked more easily on the narrower gauge, could be better employed. By climbing round the sides of hills instead of passing through them, an enormous amount of rock cutting, of embankments, of viaduct, and even of tunneling—costly works, which were almost prohibitory if the object were to make an inexpensive railway,—might frequently be avoided.

* * * * * * *

Mr. T. E. HARRISON said, he had been accustomed for many years past to study the statistics of the traffic of railways. In a purely agricultural district, without either manufactures or mineral productions, the calculation of what the cost of the line ought to be, to make the traffic pay, was of a very simple kind. He was satisfied that the results of actual traffic to be produced from any line of that nature were not more than from £7 to £10 per mile per

Papers on Light Railways.

APPENDIX B 9.

Discussion before Institute of Civil Engineers.

week; and he took that traffic return as the basis of what the cost of the line ought to be, which to pay 5 per cent., and with 50 per cent. for working expenses, ought not to exceed £3600 and £5200 per mile respectively. Generally speaking, in this country a mistake was made at the commencement. Instead of estimating what the country was likely to produce, and then saying, unless the line could be constructed for a certain price it would not pay 5 per cent., lines were laid out without regard to the question whether the traffic was likely to pay or not. He was satisfied, if promoters would take a more commercial view of the matter, and if the lines were constructed only at such a cost as to afford reasonable prospects of the traffic giving a fair return upon the capital, there would be found even at this time abundance of people ready to invest their money; but when a line was made at a cost commensurate with a traffic of £20 per mile per week, whilst the actual traffic only produced £10, then, he thought, people would be acting an insane part to put their money into it.

Mr. W. B. ADAMS said, with regard to the general consideration of light and heavy railways, it involved chiefly the question of cost. He agreed that a line should be constructed in reference to the traffic that was to come upon it, paying 10 per cent. on the outlay, with one half for working expenses; but if it was supposed that railways could not be made for less than £30,000 a mile, then of course it could not be expected that such lines would be provided in poor or sparsely peopled districts. If it was worth while to improve the traffic by a cheaper kind of haulage, substituting the locomotive for the horse, regard must be paid to the work to be done. With reference to the curves one would hardly venture to say what they might ultimately be brought to. Captain Tyler had given an account of what was done on the Festiniog Railway; but an engine was now being built in Wales to go round curves, not of chains, but of feet, and of so small a radius as 17 feet 6 inches. The gauge was 3 feet, and he supposed that it was thought that it would pay. With regard to the saving in width of gauge, it could only have reference to the lightness of the rails, the extent of interval between the sleepers, and the amount of earthwork. Others being equal, a less cost made the narrow gauge desirable; but whatever the gauge was, the bodies of the carriages to run on it might be made twice the width of the gauge.

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Mr. FOX, in reply upon the discussion, said, with reference to the enquiry as to the quantity of earthwork per mile on the Queensland line, he would state that of the total cost of that part which came out at £9000 per mile, the proportion for excavation was about £2500. On the part costing £6000, the excavation was £1050.

* * * * * * *

It was estimated that the minimum traffic on the Queensland line would pay 8¼ per cent. on the capital expended, and letters from the Colony stated that 8 per cent. had been realised. It seemed there was an apprehension, that he advocated break of gauge, and the introduction of the narrower gauge in England. He did no such thing, though this might in certain cases be desirable. His object was to lay down an important principle, the reduction of the weight on the driving wheels, by using an increased number of wheels, and by making the rolling loads as light as possible. He believed, with due care, railways might be made in England, through an ordinary country, for £5000 per mile. As to the sharp curves and steep gradients, they were only used on particular parts of the line—over mountain ranges—therefore much of the saving in an ordinary country could not be attributed to sharp curves. If they had not been adopted on the Main Range, the expenditure would have been ruinous; and if the minimum radius had been 8 chains instead of 5 chains, the cost of that portion of the line would have been at least £30,000 per mile more. But that was not the general reason why these light lines had been cheaply made; it was because all the parts were properly proportioned, and made as light as they could be. In earlier days, when labour was cheap, it would no doubt have been better to use the excellent native timber, than to have sent out iron structures from this country ready to be fitted up.

Railways through ordinary country can be made for £5000 per mile.

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Railways should be proportioned to their traffic, and it was important to have as light a weight on the driving wheels as possible; as by so doing the weight of every part of the structure might be kept down.

Papers on Steep Gradients and Sharp Curves.

APPENDIX C 1.

Paper by Captain Tyler, C.E., read before the Institute of Civil Engineers.

PAPERS ON STEEP GRADIENTS AND SHARP CURVES.

APPENDIX C 1.

No. 1160.—"*On the working of steep Gradients and sharp Curves on Railways.*" *By Captain* HENRY WHATELY TYLER, *Associate Inst. C.E.*

THE comparative terms steep and sharp have acquired at the present day a signification very different from what they conveyed to engineers a few years since. The locomotive engine has been gradually trained and adapted to gradients of 1 in 100, 1 in 50, 1 in 25, and 1 in 12; combined with curves of from 30 chains down to 15, 10, 5, and even 2 chains radius; and during all this progress, the result of so much labour and ingenuity, the system of bite or adhesion by plain surfaces has steadily triumphed as a means of converting steam power into tractive force. The well known rack-rail of Blenkinsop, as well as the archimedian screw of Grassi, and the grooved wheels of other inventors, have all succumbed before it. The co-efficient of adhesion was always in the first instance under estimated. Legs or feet were most cleverly contrived to enable engines to walk, so to speak, before they could run; and the central rail system of Vignoles and Ericcson, patented so far back as 1830, was intended to provide extra adhesion on what are now considered moderate gradients, in place, apparently, of the rack-rail. The defects of the rack-rail appear to have been,—the risk of fracturing the teeth, the liability of the teeth to be choked with dirt, snow, or ice, the slip which resulted as the teeth began to wear, and the continued blows which they occasioned to the locomotive, causing it to be, in fact, always "on the rack."

Grooved wheels afford obviously increased bite; but there must be, when they are used for locomotive purposes, continual abrasion from unequal travel of the surfaces in contact, with increased friction on curves, and some loss of power, in proportion to the increased bite obtained, from what may be termed back-adhesion.

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Examples of steep gradients on English Lines.

In this country the Lickey Line of 1 in 37, the incline of 1 in 30 on the Folkstone Harbour Branch, the Oldham incline of 1 in 27, and the navigation incline of the Taff Vale Railway of 1 in 18, have, with others, been worked for a greater or less number of years with what may be called engines of ordinary construction. And it was stated in this Institution in 1858, that an eight-wheel coupled engine, weighing 24 tons, was in the habit of taking its tender and a car load of iron, together weighing 25 tons, over a gradient steeper than 1 in 10, at a speed from 8 to 10 miles

Paper by Captain Tyler, C.E., read before the Institute of Civil Engineers.

an hour. This required, however, as will be observed, an adhesion of between one-fourth and one-fifth of the weight of the engine, which is more than could be relied upon, at all events in this climate. But in conveying heavy loads up gradients much less steep than those referred to, a want of extra adhesion has been seriously felt, and various expedients have been resorted to for obtaining it. The most comprehensive proposal with this view was that of M. Flachat, who, in a paper laid before the Society of Engineers in Paris, in 1859, desired, in constructing railways over the Alps, to utilise the adhesion, not only of all the wheels of the engine and tender, but also, by the use of additional cylinders, &c. to them, of all the vehicles composing a train. M. Flachat says, "La puissance motrice, au lieu d'être concentrée sur six roues, s'appliquerait ici à 32 ou 40 roues; elle sera donc dans des conditions d'utilisation bien supérieures. Ce qui manquera aux unes, par une diminution éventuelle d'adhérence, sera reporté sur les autres, de telle sorte que cette puissance ne pourra s'annuler à la fois entièrement pour tout un train, comme cela a lieu par le patinage de la machine." Mr. Sturrock has acted in this country, *sed longo intervallo,* in the same direction, having contented himself with adding cylinders and the necessary apparatus to his tenders, which he has now for some time employed as assistant engines on certain parts of the Great Northern Railway. The engine and steam tender together weigh, when fully loaded, between 60 and 70 tons. M. Thouvenot, on the continent, and Mr. Fairlie—who has published a most interesting pamphlet on the subject—in this country, employ two tank engines in one, placed as it were back to back, and united as to their boilers and fire-boxes. They thus obtain double engines, which are intended to be worked by two men only, which have double power intended to run either end foremost, and which are adapted for sharp curves. There being four cylinders, the wheels under each engine are coupled together, independently of those under the other engine. M. Thouvenot's engine weighs upwards of 80 tons, while Mr. Fairlie estimates his heavy goods engine at 60 tons, and states that it would draw (including its own weight) 170 tons, up a gradient of 1 in 12, at 10 miles an hour.

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In the ordinary system of obtaining adhesion by bearing-wheels only, whether of an engine and tender, or of a double engine, or of two engines coupled together, the weight of the motive power requires to be increased for a given amount of adhesion, in proportion to the load or to the steepness of the gradient. The limit of the gradient up which such an engine can take a load may roughly be defined by the co-efficient allowed for adhesion.

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Central-rail system.

The central-rail system was first patented, as already stated, for extra adhesion by Mr. Vignoles and Mr. Ericcson, on the 7th September, 1830; and next, on the 15th October, 1840, by Mr. H. Pinkus, in England. It was proposed by the Baron Séguier, in December, 1843, to "L Académie des Sciences," as a means of safety for general application, and patented by him three years later. It was again patented in England by Mr. Seller, under the name of A. V. Newton, on the 13th July, 1847; and lastly by Mr. Fell, who has, with the assistance and influence of Mr. Brassey, been the first to carry it into practice, in January and December, 1863. It has been tried with two engines, and upon two experimental lines. The first experimental line, 800 yards long, containing 180 yards of straight line, on a gradient of 1 in 13·5, and 150 yards of curves with radii of 2½ and 3½ chains, was on the Cromford and High Peak Railway, in Derbyshire. The second a mile and a quarter long, on an average gradient of 1 in 13, containing besides others 480 yards of curves with radii varying from 4 to 2 chains, and terminating at an elevation of 5815 English feet above the sea, was laid on the road over the Mont Cenis.

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Mont Cenis Railway.

The programme submitted to the French and Italian Governments, to serve as a basis for the locomotive trials to be made on Mont Cenis, is as follows:—

MONT CENIS RAILWAY.

January, 1865.

Length of experimental line....................	2 kilomètres
Elevation above the sea........................	1773 mètres, 5815 English feet
Mean gradient..................................	1 in 13
Maximum gradient	1 in 12
Curves, minimum	40 mètres radius.

In the demand for the concession presented to the French Government, the traffic of the Mont Cenis Railway was estimated at 2,500,000 francs per annum, consisting of 48,000 passengers and 30,000 tons of goods; or 132 passengers and 82 tons of goods per day. It is proposed to perform this service by three trains per day each way, in the manner described below:—

	NO. PER DAY.			NO. PER ANNUM.	
	Trains.	*Passengers.*	*Goods.*	*Passengers.*	*Goods.*
No. 1. One train per day each way, carrying 40 passengers, viz., *Passengers. Trains. Passengers. Days.* 40 × 2 = 80 × 365	2	80	..	29,200	..
No. 2. One train per day each way, carrying 26 passengers, viz., *Passengers. Trains. Passengers. Days.* 26 × 2 = 52 × 365	2	52	..	18,980	..
Also 20 tons goods, viz., *Tons. Trains. Tons. Days.* 20 × 2 = 40 × 365	..	..	40	..	14,600
No. 3. One train per day each way, carrying 24 tons goods, viz., *Tons. Trains. Tons. Days.* 24 × 2 = 48 × 365	2	..	48	..	17,520
Total per day	6	132	88		
Total per annum......................	..	..	..	48,180	32,120

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Mont Cenis Railway.

The weight and speed of the above trains will be as follows:—

No. 1.	Weight of train	16 tons.	
	Mean speed per hour		12 kilomètres.
No. 2.	Weight of train	40 tons.	
	Mean speed per hour		8 kilomètres.
No. 3.	Weight of train	48 tons.	
	Mean speed per hour		6 kilomètres.

The results of the different experiments with these engines are all given in the following Tables, which show that considerably more could be performed than had been proposed in the programme handed to the French and Italian Governments.

* * * * * * * * * * *

It does not appear that this system, or any other yet developed, can compete with the central rail system for general traffic on very steep gradients up to 1 in 10 or 1 in 12; and the principal questions that remain to be considered are, the relative economy of summit lines with steeper gradients and tunnel lines with less steep gradients, and the limit from which the centre rail may be profitably employed. The best comparison that can at present be made in regard to the former point is between the Mont Cenis Railway and the Grand Alpine Tunnel.

Difference in favour of summit line over tunnel,

The Italian Commissioners who reported on the experiments on the Mont Cenis, themselves admit a saving of 84,000,000 frs. out of 123,000,000 frs. in favour of an improved and permanent summit line as compared with the tunnel line which the Italian Government is engaged in constructing to connect Modam with Susa.

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both as to construction and cost of working.

The Italian estimate thus modified shows a saving in favour of the summit line of 104,800,000f. out of 133,800,000f., or in other words places the total cost of constructing and permanently working this particular summit line at less than one-fourth of the tunnel line. The Italian Commissioners who reported to their Government upon the best mode of crossing the Swiss Alps, took considerable pains also to calculate the relative cost of conveying passengers and goods by tunnel lines or summit lines such as that over the Mont Cenis. Taking into account the total capital to be expended and the cost of working in each case, they came to the conclusion that the cost of the tunnel line would be—for goods 28 centimes per ton per kilomètre, and for passengers 17 centimes each per kilomètre, as against on the summit line; for goods 10 centimes per ton per kilomètre, and for passengers 6 centimes each per kilomètre, showing that there would be a reduction of total cost amounting to about 64 per cent. in favour of the summit line, with a loss of time for passengers of 38 minutes upon 48 miles against the summit line in the passage of the Mont Cenis. The particular gradients on which the central rail may properly be applied must, of course, vary with the co-efficient of adhesion and other local circumstances, and be left in each case to the discretion of the engineer.

Traction power of ordinary and central-rail engines.

Neglecting the questions of speed and steam power, and assuming one-tenth as the co-efficient of adhesion, then the proportions of net load that could be taken up the following gradients by two engines each of 20 tons, one of ordinary construction and the other with horizontal wheels and a supplementary adhesion of $1\frac{1}{2}$, would be respectively:—

For 1 in 20	20 tons net load for ordinary engine		or 1 to 4
	80 ,, ,, central rail engine		
For 1 in 16	12 ,, ,, ordinary engine		or 1 to 5
	60 ,, ,, central rail engine		
For 1 in 12	4 ,, ,, ordinary engine		or 1 to 10
	40 ,, ,, central rail engine		

Similarly for an adhesion of $\frac{1}{7}$:—

For 1 in 20	39 ,, ,, ordinary engine	or 1 to $3\frac{1}{4}$
	129 ,, ,, central rail engine	
For 1 in 16	27 ,, ,, ordinary engine	or 1 to $3\frac{1}{2}$
	99 ,, ,, central rail engine	
For 1 in 12	15 ,, ,, ordinary engine	or 1 to $4\frac{1}{2}$
	69 ,, ,, central rail engine	

But these advantages would of course only be available as long as the adhesion was insufficient in an ordinary engine for the steam power, and would disappear in such a case as that which—though it can hardly be credited—was reported from the Alleghanny Mountains in America, in the paper already referred to, where on a gradient steeper than 1 in 10 an ordinary engine (with an adhesion apparently of $\frac{1}{4}$) is stated to have worked with a load. * * Precise calculation is, however, of limited value when the co-efficient of adhesion, the principal element, is so very variable. But no English engineer would probably contemplate working any considerable length of railway permanently on a steeper gradient than about 1 in 25 without the margin for adhesion afforded by, and the additional safety of, the central rail; and it might no doubt be frequently used with advantage on gradients less steep than 1 in 25. A country which requires very steep gradients demands also, in most cases, very sharp curves; and the central rail contributes to safety as much in respect to the latter as to the former. It also contributes in an important degree to economy by diminution of friction in passing round very sharp curves, by which loss of power, and wear and tear, are equally avoided; and it may be added in conclusion, as a result of experience, that the bearing wheels of the engine left the bearing rails once during construction, and once before the Italian Commission on the Mont Cenis experimental railway, and were brought back to them on both occasions by the guiding power of the central rail.

APPENDIX C 2.

Discussion on the preceding paper.

APPENDIX C 2.

INSTITUTION OF CIVIL ENGINEERS.

EXTRACTS from the Discussion on the preceding Paper on the 12, 19, *and* 26 *March*, 1867.

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Captain TYLER said, in contrast to the working by the central rail system on the Mont Cenis, he would refer to some practical results of the working of a steep gradient on a railway which he had recently visited; viz., the Navigation incline of the Taff Vale Railway near the Aberdan junction, 16 miles from Cardiff. He was accompanied by the Engineer of the line, Mr. George Fisher, who had furnished him with the following particulars of the incline and of the engines with which it was worked. The gradients were in ascending successively 1 in 28, 1 in 21-80, 1 in 20-74, for shorter distances, and then 1 in 17-80 for 420 yards. The average of the whole was about 1 in 20 for half a mile. The system of traction by rope, on which this portion of line was formerly worked, was abandoned two years

Steep gradients on ordinary system.

ago, and since that time locomotives had been employed. The expense for six months was £900 with the locomotives against £700 with the rope and stationary engine. The tank engines, specially employed for working the traffic up this incline, weighed in working order 36 tons. They had six wheels all coupled 4 feet in diameter. The diameter of the cylinder was 16 inches, with a stroke of 24 inches. The pressure of steam in the boiler was 130 lbs. The maximum load was 45 tons, and the regulated load 25 tons, the former giving $\frac{1}{8}$ and the latter $\frac{1}{10}$ as the co-efficient of adhesion. It was interesting to compare these results with the working of the engines on the central rail system. On the navigation incline the engine weighed 36 tons, taking a regulated load of 25 tons up an incline of 1 in 20; whereas on the central rail system an engine weighing only 20 tons could take a load of 40 tons up an incline of 1 in 12. In fact the programme of working the Mont Cenis Railway provided for an average gross load, exclusive of the engines, of 40 tons for goods trains and 25 tons for passenger trains; and the cost of locomotive power was found to be nearly a penny per ton per mile for goods, including fuel, grease, wages, and maintenance. Similarly for passenger traffic the cost for locomotive power for one journey from St. Michael to Susa was estimated at 96 francs, which gave a little more than a farthing (1·2 farthing) per mile for each passenger.

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Mr. MENDES COHEN, of New York, would give the results of his experience in working the Baltimore and Ohio Railway, through Virginia. The gradients on that line were generally heavy. On the mountain division, 60 miles in length, there were 37 miles varying but slightly from 1 in 45, at which maximum there were 17 miles in one continuous gradient. The goods traffic was worked by engines weighing, exclusive of tender, about 27 tons, on eight connected chilled wheels 43 inches in diameter, with cylinders of 19 inches diameter and 22 inches stroke, hauling nine cars weighing about 135 tons. In addition to these, there were other and much heavier gradients of a temporary character, adapted for the purpose of working over the tunnel ridges during the progress of the construction of the tunnels, to continue the line without waiting for the completion of the tunnel work. In the first instance the gradient adopted was 1 in 10 as a maximum, and it was not intended to work this temporary line with locomotives. The line was built with a view of hauling car loads of iron across the mountains by horse power, and continuing the construction of the works on the other side. However, when the line was laid it was determined to try the working with locomotives. The engines just described were tried on this gradient, and readily took up a load of one car weighing about 14 tons. Under favourable circumstances they could take up two, but one was the usual load. * * * * * * * * *

Mr. CONYBEARE said, * * * * * in laying out a mountain line, on which sharp curves were inevitable, it was always desirable to allow for the increased resistance on such curves, by flattening the gradient where they occurred, and thus to equalize the draught on all portions of the ascent. But, unfortunately, in attempting this engineers had hitherto worked very much in the dark, owing to the want of authentic experiments on the increment of resistance, due to curves of different radii at varying speeds, with engines and carriages of a given wheel-base. Resistance due to curves.

It was strange that a series of experiments admitting of such easy execution as these do should not yet have been instituted to determine a matter so important in mountain railway making.

M. Latrobe, the Engineer of the Alleghanny Mountain Lines described in Mr. Isaac's Paper, published in America many years ago the following table of such resistances stated to have been founded on experiments on a level:—

TABLE showing the Resistance due to Curves, by Mr. Latrobe.

Radius in Chains.	*Resistance is equivalent to that of an ascent of—*
40	1 in 1949
35	1 in 1747
30	1 in 1448
25	1 in 1236
20	1 in 993
15	1 in 734
10	1 in 482
8	1 in 389
5	1 in 248
3	1 in 149

But Mr. Conybeare had found in practice that the relaxation in gradient prescribed by this table was wholly insufficient to counteract the increase of resistance occasioned by curvature on steep gradients. It appeared, too, that in American practice this table had been found altogether insufficient. * * * *

The sharpest curve he had ever met with was one close to the Town of Rhymney, on a mineral line, called the old Rhymney, which he had converted into a passenger line. This curve he had ascertained by two measurements to be $1\frac{3}{4}$ chain radius. The line was worked by tank engines, having six wheels coupled, with a wheel base of 11 feet 6 inches, which ground round it at the rate of 3 miles or 4 miles an hour only. The curve by which the Great Northern joined the Metropolitan Railway was $7\frac{1}{2}$ chains radius, on a gradient of 1 in 46; and the North-western had this year deposited plans for an extension to Dowlais, which joined the Brecon and Merthyr at that place, with a curve of $7\frac{1}{2}$ chains on 1 in 40. He thought that at present there was a disposition to under-rate the objection to such curves as these. * * * * * * Curve of $1\frac{3}{4}$ chain.

Mr. C. H. GREGORY, *V.P.*, said, Mr. Conybeare had alluded to the variations in the estimates of the amount of retardation arising from curves, but he had omitted to mention one circumstance which would account for the difference, viz.—the structure of the engine. With engines having a long wheel base, and rigidly parallel axles, serious retardation was unavoidable on sharp curves; but the use of bogies, radiating axles, and other appliances, had already greatly diminished the resistance arising from curves, and further improvements might be anticipated in the same direction.

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The annexed Table, which he had prepared, of the available power derived from the various engines hitherto found most effective in working inclines showed the superiority of the central rail system:—

Papers on Steep Gradients and Sharp Curves.

APPENDIX C 2.

	Diameter of Cylinder.	Length of Stroke.		Diameter of Driving Wheel.		Weight in Working Trim.	Weight available for adhesion.	Adhesive Power, taking 450 lbs. per ton, (or 1·5th.)	Tractive Power of 90 lbs. Mean Pressure.	Proportion of Weight of Engine to Tractive Power.	Weight on each Driving Wheel.	Weight which can be taken up 1 in 12, exclusive of Weight of Engine. Adhesion. 1-10th	1-5th
	inches.	ft.	in.	ft.	in.	tons.	tons.	lbs.	lbs.	tons.	tons.	tons.	tons.
Mr. Fell's Engine, 4 wheels coupled ..	15	1	4	2	3	17	17	7650 10,800 18,450	12,000	3·17	4·25	29·6	43
Mountain Top, 6 wheels coupled......	16½	1	8	3	6	24·5	24·5	11,025	11,670	4·70	4·1	3·3	35·5
Oldham Engine, 6 wheels coupled	15	2	0	5	0	29·15	29·15	13,117	8,103	8·06	4·86	3·5	11
Ditto	15	2	0	4	0	29·15	29·15	13,117	10,130	6·44	4·86	3·5	21·5
Fairlie's Engine, 8 ditto, four cylinders	15	1	10	4	6	42·0	42·0	18,900	16,507	5·70	5·25	5·7	41
North London Engine, 4 wheels coupled	17	2	0	5	9	42·0	30·0	18,500	9,050	10·39	7·5	0·0	3·2
Oldham, (Goods), 6 wheels coupled ..	17	2	0	5	0	49·0	33·65	15,142	10,410	10·54	5·6	0·0	3
Semmering, ditto, 8 wheels coupled ..	18·7	2	1	3	7¾	55·25	55·25	24,862	18,000	6·87	6·9	7·4	35
Giovi, ditto, 8 ditto, four cylinders	14	1	10	3	6	55·25	55·25	24,862	18,500	6·69	6·9	7·4	35

Gradients of 1 in 17,

Mr. WM. NAYLOR thought, at the same time, it was important to see what could be done with inclines in climates where snow did not exist. Capt. Tyler had stated, from information he had received from the Manager of a railway in Wales, that an incline of 1 in 17 was worked by an engine of 36 tons weight in working order, with wheels 4 feet in diameter, cylinders 16 inches in diameter, and a length of stroke of 24 inches, and with a pressure on the boiler of 130 lbs., the regulated load being 25 tons. That seemed to him to be a light load; and from inquiries he had made about the same incline he had ascertained that the engine weighed in working trim 36 tons, and that the fixed load was 40 tons, but on one occasion the locomotive Superintendent had himself taken up 45 tons. The Lickey

1 in 37.

incline, of 1 in 37, had been worked for a number of years with engines weighing 35 tons, which took up loads of 140 tons, or nearly four times the weight of the engine.

Mr. W. LLOYD had been engaged during the last twelve years in the construction of some of the principal steep inclines in the world. Most of the illustrations and ideas connected with this subject had been derived from Europe alone. His own experience was that many things which were good in Europe frequently caused a great deal of difficulty in foreign countries; and there was one thing in Mr. Fell's engine, admirable as it was, which struck him would cause difficulty in practical operation on a railway abroad—that was the extreme intricacy of the machinery. Simplicity was an essential element in all things connected with a railway in countries distant from the great centres of industry.

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Objection to two classes of engines in Colonies.

He had stated in a paper read before the Institution, that in his opinion it was most essential that engines of the ordinary class, and all of the same class, should be used on distant railways abroad. Directly two classes of engines on such railways were introduced the difficulties in the workshop were quadrupled. He knew instances in which an engine of 40 tons had carried a load of 163 tons up 1 in 50 at 10 miles an hour, or four times its own weight on the driving wheels.

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He was delighted to hear that a load of 40 tons could be taken up an incline of 1 in 12, because many expedients had been tried to get over the difficulty of so steep an ascent.

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Copiapo Railway £6500,

Steep gradients and sharp curves.

He would now advert to the Copiapo Extension Railway, from Pabellon to Chanarcillo, for which Mr. E. Woods, M. Inst. C.E., was the consulting Engineer in this country. The summit at Molle was upwards of 4450 feet above the sea, and Pabellon, where the line commences, was about 2200 feet above the same level. It had been in operation since February, 1861, and was worked by Messrs. Hawthorn's engines. It was 26 miles in length, and the cost, including equipment, was £6500 per mile. It consisted of three inclined planes, one rising 2276 feet in 14½ miles, with an average gradient of 1 in 33, but for short distances of 1 in 26 and 1 in 28 over a portion of the incline. The second was a descending gradient from Molle to Pajonales, 1990 feet in 9⅝ miles, with an average gradient throughout of 1 in 24. On one portion, however, there was a gradient of 1 in 20, with curves of 720 feet radius, and on other gradients of 1 in 21 and 1 in 24 there were curves of 490 feet radius, in some cases reversed two or three times and without any intermediate straight line. The last-mentioned inclined plane was an ascending one, with gradients of 1 in 34 and 1 in 25 in the direction that the chief loads were carried, the principal traffic being from the silver mines to the coast. He was sent by the Government of Chili to determine the kind of engine that was best adapted for working such lines. The train he took up weighed 57 tons; it went over the gradient of 1 in 20 with curves of 720 feet radius without difficulty. The retardation by the curves was not more serious than could be overcome by moderating the weight of the train, and there was never any occasion for the weight to exceed 70 tons or 80 tons as the traffic did not require heavier trains than that. The cost had generally to be regarded in working steep inclines; but in a country like that of which he was speaking it did not enter into the calculation, inasmuch as the price paid for the transmission of goods was so high that almost any cost would be more than remunerated by the rate of prices charged. The engines had six coupled wheels, 4 feet in diameter; the cylinders were 16 inches in diameter, with a length of stroke of 24 inches; and the fuel burnt was, at the time he spoke of, about an equal quantity of coal and coke. The paying load was two-thirds of the weight of the train. The consumption of fuel was 75½ lbs., and the water 66½ gallons per mile. He considered one-fourth of the weight on the driving wheels was fairly taken up by the engine.

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Mr. E. WOODS could corroborate what had been said with regard to adhesion under favourable circumstances, and it was confirmed by the results of Mr. Lloyd's practice in Chili. * * * * *

He had stated on a former occasion that this line was not originally designed for locomotives, but was intended to be worked by animal power. It was so worked for two or three years; but the expense caused it to be abandoned, and locomotives substituted. The lightness of the rails (42 lbs. to the yard) compelled him to design engines in which the weight on the driving wheels should not be greater than those rails would stand, and the engine he had designed had outside cylinders, six coupled wheels 4 feet in diameter, with a four-wheeled bogie in front, to pass round curves of 500 feet radius. The weight of the engine in working order was 32 tons, and that of the tender 25 tons: on the driving wheels it was 24 tons. * * * * The coefficient of adhesion was as nearly as possible one-fourth of the driving weight. The climate of Chili was, however, peculiarly favourable for working steep gradients. There was very little rain at any time, and the rails were almost always in good order. * * * * * * The speed was necessarily limited in descending: the rule was that the trains should not descend at a greater speed than 12 miles an hour, but that was sometimes a little exceeded; the average speed up and down was about 13 miles an hour. * * * * He thought a well-proportioned all-coupled engine could take itself up an incline of 1 in 4 with its own wheels if the rails were clean and in good order.

COPIAPO EXTENSION RAILWAY, 1860.

TABLE 1.

Particulars of Engines.

Outside cylinders. Six coupled wheels, 4 feet diameter. Four-wheeled bogie. Cylinders 16 inches diameter, and 24 inches stroke.

	tons.
Weight of Engine in working order	32
Ditto Tender ditto	25
Total	57

TABLE 2.

Loads taken over this line, gradients averaging 1 in 23 and 1 in 30. Heaviest train ever taken over the line:—

	tons.	tons.
Engine	32	
Tender	25	
		57
Gross load of Waggons and Carriages	..	77
Total weight	..	134

Ordinary Trains:—

	tons.		tons.
Engine	32		
Tender	25		
		..	57
Mineral Trucks—Tare		11	
Minerals, &c.—Nett		26	
		37	
Passenger Carriages, with Passengers		13	
			50
Total		..	107

Mean speed of Train, 13⅓ miles per hour.

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South Devon Railway.

Mr. MARGERY would remark, that the atmospheric system led to steep inclines being adopted on the South Devon Railway, over which the trains were now worked with locomotives. The curves varied from 15 to 20 chains radius. The goods engines having cylinders 17 inches in diameter with a length of stroke of 24 inches, and 6 coupled wheels 4 feet 9 inches in diameter, took up the Dainton incline a load of 180 tons at a speed of about 10 miles an hour, the weight of the engine being 38 tons. The passenger engine having cylinders 17 inches in diameter, with a length of stroke of 24 inches, and four coupled driving-wheels 5 feet 9 inches in diameter, with bogie wheels 3 feet 6 inches in diameter, took seven loaded carriages, making a total load of about 90 tons up the same incline at a speed of about 10 miles an hour. * * * * * * * * *

Mauritius Railway—ruling gradient 1 in 27.

Mr. J. A. LONGRIDGE had laid out a railway in the Mauritius some years ago, which was subsequently executed, and though not worked by himself for passenger traffic he had worked it for ballasting and for the transport of materials. The ruling gradient of that line was 1 in 27. The ballast trains consisted of twenty waggons in fine weather, with an engine at the front and back, which he believed was a safe way of working these heavy gradients, because it rendered them, to a great extent, independent of the breaks.

Each of these engines weighed 37 tons, and each truck-load weighed 13½ tons, making a total load of 270 tons, besides the two engines weighing 74 tons. It was found that in fine weather, when the rails were dry, the inclines of 1 in 27 could be ascended, with wheels 3 feet 9 inches in diameter, at about 8 miles an hour; but when the rails were wet with rain or dew, the load had to be reduced by four, six or more trucks: the coefficient of friction, under these circumstances, came out as one-fifth. * * * * * * *

He had had lines under his notice on which as a rule the gradients were generally good, but with here and there a steep gradient for a distance of half or three-quarters of a mile; and when this had to be got over with a heavy load there must be an engine sufficiently powerful to draw it. Under such circumstances, he thought it worthy of consideration, whether it would not be best to have an eight-wheeled engine, having four driving-wheels, with a balance lever supported near the centre of gravity of the engine, and provided with a lever arrangement, by which the springs could be screwed down when the engine was running, so as to throw the whole weight upon the driving-wheels when going up a gradient, and when running on a level distribute the weight over the whole of the eight wheels equally. Such an arrangement would obviate the use of sand in going up an incline; it would be simply necessary to screw down the springs, and throw the weight upon those springs while going up the gradient. In that case the steep gradients might be laid with heavy rails and the light gradients with light rails. In this proposed engine the axles of the driving-wheels would be placed within 5 or 6 feet of each other, while the leading and trailing axles would be fitted with Adam's radial axle-boxes, and such an engine could move with ease round curves of very small radii.

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Mr. ROBERT TREFUSIS MALLET referred to a tramway constructed for Mr. Crampton on the Ottoman Railway on which he had been engaged, which he believed showed the extreme limit of what could be done on inclines by ordinary locomotives without special means of adhesion being applied, as in the case of the central rail on the Mont Cenis Line.

Ottoman Railway 1 in 11.

Mr. F. R. CRAMPTON said there was nothing peculiar about the incline just referred to, but it had acted most perfectly. The gradient was 1 in 11 for a length of 2400 feet, 600 feet of which had curves of 400 feet radius, descending about the same distance with inclines of 1 in 15 and 1 in 20, the total length being about one mile. About 100 tons per day were taken over this gradient of 1 in 11, and about 100,000 tons had been carried over the whole length up to the present time. The gross load was about 23 tons, of which the engine weighed 10 tons, leaving 13 tons of working load behind the engine. The adhesion was about one-fifth, so that the maximum was almost attained.

Mr. HAWKSHAW, Past President, said, in some cases no doubt the effect of steep gradients might be to increase very greatly the cost of transit. If they occurred for instance on a coal line where large loads could otherwise be taken, the intervention of these inclines would be objectionable. In other cases, where frequent loads of moderate weight were dealt with, steep gradients did not increase the cost in the same ratio. Therefore unless the nature and amount of the traffic, the frequency of the trains, and the necessity for frequent trains were known, but little could be made of these questions of cost. Taking the railways of this country generally they varied greatly in gradients. On one railway, the Lancashire and Yorkshire for instance, which had steep gradients almost throughout, it would be found carrying at a certain amount of profit, and working at a certain per-centage of cost. On another line with good gradients, such as the North-eastern or the Great Western, it would be found that the per-centage of expenses and the amount of profit did not greatly differ from that in the other case. That merely showed, having regard to average loads, gradients had not that effect generally which obtained in special cases when they had only great loads to carry. The question of steep gradients was much discussed 20 years ago, and it seemed to be raised now as if it were new. He could give a little information with regard to some steep gradients which had been worked for many years with the heaviest traffic perhaps in the kingdom. Some of the statements put forward as doubtful, or remaining to be proved, had been satisfactorily proved by long experience. Between Manchester and Oldham, for instance, the traffic was enormous. That railway consisted of gradients beginning with 1 in 59, 1 in 49, and varying from that to 1 in 124, till it approached Oldham, where the gradient rose to 1 in 30 and 1 in 27. Inclines of 1 in 30 or 1 in 40 at the time that railway was made were considered unsuitable for locomotives, and those inclines were accordingly fitted with apparatus to get rid of the difficulty. He had occasion to remove that apparatus, and since that period locomotives alone were relied on, and from that day to this the traffic has been worked satisfactorily. The locomotives were nothing very unusual, they were of the sort commonly used on the Lancashire and Yorkshire line, and their performances were as follows:—The engines for ordinary trains had six wheels coupled, and weighed 29 tons each exclusive of the tender; they ordinarily took a load of 80 tons exclusive of engine and tender to Oldham, but in slippery weather 15 or 20 tons less. Another class of engine used for heavier trains had also six wheels coupled, weighed 33 tons 13 cwt. exclusive of tender, while both together weighed 49 tons. These took up a load of about 120 tons exclusive of their own weight, and in slippery weather about 20 tons less. These classes of engines had been working for many years, and for such traffic it was clearly not worth while for the company to lay out a large sum of money to get rid of those gradients. The question as to how far extreme gradients might be pushed was one that could not be solved unless all the details were known of the nature and extent of the traffic, but it was quite clear that for a traffic like that between Manchester and Oldham the gradients he had mentioned were worked without difficulty. On some other parts of the line there were gradients of 1 in 44, 1 in 50, &c., and several of the important towns on the line were approached by such inclinations, while the traffic was second to none in the kingdom in magnitude, and yet the average working expenses were not greater than on other lines which had not these heavy gradients. But in reference to the question of expense, he did not wish to be understood to say that gradients of 1 in 27 or 1 in 30 were good and to be adopted lightly, or that there might not be cases in which it would be better to lay out a large sum to get easier gradients.

Working expenses not greatly affected by steep gradients, except where loads are beyond the average.

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Manchester and Oldham 1 in 27.

Sir CHARLES FOX, in referring to the observations made by Mr. Hawkshaw, said, a few months ago he went to Oldham to inspect the incline plane of 1 in 27 on the Lancashire and Yorkshire Railway Company's branch to that town, and was not a little surprised at the admirable manner in which the ascent of that incline was performed by the locomotive. There was one point which caused him some amusement if not instruction. On that occasion he asked the engineer whether in going up the incline they ever had such a train load as to be beyond the power of the steam in the engine. They replied, that such was the case occasionally, and in that event they put on the breaks and waited till the steam got up sufficiently to enable them to walk up to the top of the incline. They added, that they never had to run back with their trains. The boilers of their engines being strong and good they had great confidence in them, and so they waited on the incline till there was sufficient pressure of steam attained to take them up.

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Mr. J. W. GROVER remarked, that though his practical experience in working gradients did not extend beyond those of 1 in 45, yet he had reflected upon the subject a good deal. If it was wanted to get as much friction as possible out of a certain weight, whatever it might be, and the weight were solved into two forces each acting at an angle of 60° with the vertical, the pressure on any substance at right angles to them by each of these forces would be equal to the weight; and with both, of course, they would produce the effect of doubling the weight. This result would be effected by V grooves in the driving wheel. The same point had occurred to other engineers fifteen or twenty years ago, but no one had ever tried the thing in practice, and he brought it before the Institution now in the hope that some gentleman possessed of an engine might be induced to make the trial by turning up the tires in the way he had pointed out. The grooves were cut V shaped, and if a round headed rail were used the principle of the wedge would come into operation by the two bearing surfaces on the rail; and if the angle of the groove were 60°, double the effect of the weight of the locomotive would be obtained without actually increasing the weight of it at all.

Effect of V grooved wheels.

Mr. Grover illustrated his views by reference to a model, in which three equally weighted discs of wood represented wheels with the ordinary concave form, and V grooves cut at different angles; a moveable strip of wood, with a rounded upper edge, represented the rail, and was raised or lowered to show various gradients; the wheels being placed upon the rail and prevented from turning on their axles by means of keys, the rail was gradually raised at one end until it assumed such a slope as to make the disc slide down it, thereby representing relatively the gradient that the respective wheels would climb. By this it was shown that whereas the ordinary form of wheel in wood would slide on a gradient of 1 in 7½, the V groove of 90° would just move on 1 in 6, and the V groove of 60° on 1 in 4. Several patents had been taken out involving this principle, but nothing practical appeared to have been done.

CAPTAIN TYLER, in reply upon the discussion, said, in the first place he had referred at the commencement of his paper to the system brought forward by Mr. Grover. He had said:—"Grooved wheels afford obviously increased bite; but there must be when they are used for locomotive purposes continual abrasion from unequal travel of the surfaces in contact, with increased friction on curves, and some loss of power in proportion to the increased bite obtained from what may be termed back adhesion." He thought he had described fully, though briefly, in that sentence the real difficulties in the way of the application of that system. The most important question of all was, perhaps, that of the co-efficient of adhesion. He understood Mr. Conybeare to say, that it was independent of climate; but he thought the widely varying opinions which had been expressed showed very clearly that the contrary was the case,—viz., that the value of that co-efficient varied, as might be expected, to a great extent in different climates; and he thought that such variations from climate afforded the only explanation by which to account for the wide difference of opinion that had been expressed.

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So much then with regard to gradients which had been worked by a locomotive for passenger traffic in this country. The gradients which had mostly been referred to varied from 1 in 27 to 1 in 40 and 1 in 50; but these gradients could hardly be compared with that mentioned by Mr. Crampton, of 1 in 11, with those which had been temporarily used in America, or with those on the Mont Cenis Railway. In speaking of certain railways in South America, Mr. Lloyd had expressed the opinion, that it would rarely be necessary to employ a steeper gradient than 1 in 20 in crossing mountain ranges. He supposed Mr. Lloyd applied that remark to the Alps, as well as to other mountains. But it was not, in practice, so much a question of what could be done if money were no great object. The question was, rather, whether having a certain height to surmount, it was better worth while to go to the greater expense of making gradients of even 1 in 20 for longer distances, or whether it was not more advantageous to make a shorter line with steeper gradients at a greatly reduced cost. Whatever might be the ruling gradient—1 in 20 or 1 in 12— the same height would in such a case have to be overcome, and the same depth to be descended again; and when, by constructing a shorter line at a cheaper rate, with gradients of 1 in 12, the journey could at less speed be made in as short a time, he did not see why it should not be done. He would demonstrate his meaning by the aid of some figures, showing the relative cost of certain lines with different gradients and curves on some others of the Alpine Passes. For the passage of the Simplon, with gradients of 1 in 25 and curves of 200 mètres radius, the estimated cost for 255 kilomètres from Bouveret to Arona, was 156,410,000 francs; while for the same pass, with gradients of 1 in 16, and curves of 150 mètres radius, the estimated cost was only 130,410,000 francs; and with gradients of 1 in 12, and curves of 40 mètres radius, the cost of a line, laid on a proportion of the public road where available, was estimated at only 65,000,000 francs.

Saving by adopting steep gradients in some cases.

For the Lukmanier Pass, from Coire to Bellinzona, with gradients of 1 in 40, and curves of 300 mètres radius, the tunnel line, 116½ kilomètres long, was estimated to cost 223,282,108 francs; while in the case of a summit line for the same Pass, without any public road on which to lay it, and therefore with all new works—with gradients of 1 in 20, and curves of 150 mètres radius—the cost for a length of 145 kilomètres was estimated by the same Engineer at 53,749,954 francs. Much of the discussion had related to the effect of curves, and to the reasons why engines and trains did not travel round them so easily when the curves were sharp; but those remarks had not been accompanied by any good practical suggestions for getting over the difficulty. Mr. Fell had done so to some extent on the Mont Cenis experimental line, by flattening the gradients on the curves; and the question was asked, to what extent this had been carried out. Mr. Fell had so far altered his original section that, on very sharp curves, he relaxed the gradient from, say, 1 in 13 to 1 in 15 or 15½, at the same time that he increased the gradient on the straighter portions to about 1 in 12; he then found that his engine gained speed on the curves, and that, in fact, he had done rather too much. But the circumstances of this case differed materially from those which were ordinarily met with. The various vehicles—of short wheel base—travelled with extra ease round the curves of this line, because the horizontal guide-wheels of the wagons, and the horizontal wheels of the engine, acting upon the central rails, tended to keep them in their proper position on the curves, and to prevent some of the prejudicial action from coming into play. When very sharp curves were used—and he believed they must be used more and more—it was thought necessary, under the prevailing system, to employ engines of short wheel base, and that necessitated overhanging weights in front of the leading, and behind the trailing-wheels, and led to the use of an objectionable kind of engine. And there were other objectionable things to which he would take the opportunity of referring. The weight on the driving wheels was frequently so enormous that it became a matter of difficulty alike with the engineers who had to construct, and with those who had to maintain a railway. He thought it was time some decision was come to as to the limit of weight that should be placed on each pair of wheels. He was afraid, now that steel tires were so extensively used, those weights would be greater than ever. Locomotive constructors had hitherto been checked by the tendency of wrought iron to be crushed. There was a risk of squeezing the tires out when they were loaded beyond a certain point; but now that steel tires had come into common use, he feared the weights on the driving wheels would be further increased, and that still heavier tank-engines, with overhanging ends, would inflict greater strains on the bridges and the permanent way.

PAPERS ON THE RELATIVE COST AND ADVANTAGES OF NARROW AND BROAD GAUGES.

Papers on Narrow & Broad Gauges.

APPENDIX D 1.

Festiniog Railway, 2-6 gauge.

APPENDIX D 1.

EXTRACTS from Articles in the "Civil Engineer and Architect's Journal" on the Festiniog Railway.

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But there are also many other districts in which lines of cheaper construction are required. Railways on the gauge of 4ft. 8½in. can hardly be made more economically than at present, as far as regards the permanent way or the works. Cheap lines necessitate steep gradients, which require heavy engines, and heavy engines require substantial bridges and a strong permanent way. On the other hand, with a narrow gauge, lighter rails and sleepers, less ballast, and cheaper works generally may be employed; sharper curves may be laid down; very heavy gradients

Papers on Narrow & Broad Gauges.

may, particularly in mountainous districts, be more cheaply avoided; and lighter engines, with lighter vehicles, may be made to do all the work required, where high speed is not demanded, and where the traffic is not heavy.

APPENDIX D 1.

Norwegian Railways, 3-6 gauge.

The Norwegian Government, as it appears from an interesting report by Mr. C. D. Fox, has constructed, and has in full operation, two lines—the one from Grundsett to Hamar, twenty-four miles long, and the other from Throndhjein to Storen, thirty miles long—both on a gauge of 3ft. 6in. The former, with gradients of 1 in 70 and curves of 1000 feet radius, through a moderately easy country, has cost, including rolling stock and stations, £3000 per mile. The latter, through a more difficult country, with gradients of 1 in 42 and curves of 700 feet to 1000 feet radius, has cost £6000 per mile. The rails weigh thirty-seven pounds to the lineal yard, and are fished at the joints. The sleepers are of native pine timber, 2ft. 6in. apart, 6ft. 6in. long, and 9in. by 4½in. in section, and the rails are secured to them by dog spikes only. The engines weigh fourteen tons, in steam, and the carriages are 9ft. 3in. high and 6ft. 6in. wide. The speed is about fifteen miles per hour, including stoppages. The Norwegian Government is so pleased with the result that an additional length of fifty-six miles of this gauge is now in course of construction, and no other gauge is contemplated for the traffic of that country.

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Swedish Railways, 3-6 gauge.

Mr. PETER BRUFF remarked that all the Norwegian lines alluded to were isolated. The original line made by Mr. Stephenson and Mr. Bidder had been extended to the confines of Sweden, and was entirely constructed on the gauge of 4ft. 8½in., with which the other lines of the country were never likely to be brought into communication. Radiating axle-boxes, he understood, had been recently introduced on the Norwegian lines with considerable success. The weight of rails generally adopted was 37lbs. to the yard, laid in lengths of 21ft., the rails being flat-bottomed, 3½in. high, with a base of 3in., laid on cross sleepers, and fish-jointed. In some cases a plated joint had been used, which, from the experience obtained in England, was not considered a desirable arrangement. Upon the subject of narrow gauge Norwegian railways he had, however, received a communication from Mr. Pihl, who, in 1856, was entrusted by the Norwegian Government with the task of supplying railway communication between Throndhjein (about 350 miles north of Christiana) and Storen—the point from which two main carriage roads ran south; and between Hamar, on the Lake Mjosen (about fifty-six English miles north of Christiana, with which it was in direct communication by rail and steamer), proceeding eastward to Elverum, upon which the traffic of the Glommen Valley converged. Mr. Pihl stated that he determined, from the difficulties of the country and the smallness of the traffic to be accommodated, that he should not be justified in recommending such an outlay as would be involved by the formation of a railway as ordinarily constructed. He, therefore, recommended a gauge of 3ft. 6in. This was adopted by the Government and confirmed by the Legislature (Storthing) in 1857, and shortly afterwards the works of both lines were proceeded with.

The works upon the Hamar line, being the more easy of construction, were sufficiently advanced to be used for goods traffic in the summer of 1861. The total cost of this line, for twenty-four and a-half English miles, had amounted to about £3000 per English mile. This included a large iron bridge, on stone piers, about 900 feet long for ordinary road purposes only, rolling stock of three locomotives, six passenger carriages, three break-vans, and fifty goods waggons, with the necessary ballast waggons and tools for repairs; also two terminal stations and six intermediate stations and stopping places, a carriage shed, and small repairing shop. Although the works were not of a heavy character, there were nevertheless many difficulties to contend with, the line having to ascend upwards of 400 feet and to cross extensive and deep swamps.

The Throndhjein line of thirty-one and a-half English miles, running through a difficult country, required many heavy works of construction, among which were numerous large bridges, some being from 70 feet to 100 feet high, several cuttings, containing from 50,000 cubic yards to 70,000 cubic yards each, and others through rock of more than thirty feet in depth. The cost of this line was necessarily greater than the former, in all about £5000 per English mile, including four engines, eight passenger carriages, three break vans, sixty goods and plank waggons, besides twenty ballast trucks, with the necessary implements for the repairs. There were, besides the terminal stations, six intermediate stations and three stopping platforms. At Throndhjein there were also goods and carriage sheds, and a workshop for the repair of rolling stock. This line had to cross a ridge more than 500 feet in height in the first Norwegian mile from Throndhjein. The greater part of this distance was constructed on one side of the ridge, with gradients of 1 in 42 and 1 in 65, and on the other side 1 in 52, the curvature being of about 900 feet radius; whereas on the other portion of the line, where the gradients were seldom more than 1 in 100, curves 750 feet were frequently resorted to. The width at the formation level in cuttings and on embankments was thirteen feet nearly; the slopes, according to circumstances, were from 1½ to 1 to 3 to 1. The ballast was 8ft. wide at the top and 1ft. 9in. in thickness. The sleepers were of half round pine, 6ft. 6in. long, placed 2ft. 6in. apart on the curves and steep gradients, and 2ft. 9in. apart on the straighter portions of the line. The rails were flat-bottomed and fished at the joints in the usual way, 3½in. in height, and weighing 37lbs. per yard, except on the steep inclines, where rails of 41lbs. per yard were laid. The rails were fastened to the sleepers by dog-spikes only, no bolts or bottom plates being used. Ransome's chilled crossings and Wild's self-acting switches were used throughout. The bridges were all of timber, except where large rivers had to be crossed, and spans from 50ft. to 100ft. were required, in which case stone piers were carried up above flood-level. The superstructure made use of in those cases was Howe's system of trellise work, with iron suspending rods. The rolling stock consisted of tank engines. with three pairs of wheels, two pairs being coupled for drivers, these having an available weight for traction of from eleven to twelve tons out of the fourteen tons to fifteen tons, the total weight. The last engines procured were provided with bogies, on Bissel's or Adam's system. The cylinders were ten inches in diameter, with a length of stroke of eighteen inches, and the driving wheels were three feet in diameter. All the engines were made in England, with the exception of one made at Throndhjein, and were working efficiently. The passenger carriages were constructed to carry the usual number of passengers, as in England, and were arranged for two classes only, the compartments being fitted up as first and third. The goods waggons were made to carry five tons, and were only a few inches narrower than the ordinary kind, these widths being obtained by having the springs attached to brackets inside the sole bars, thereby allowing the lowering of the body and, in consequence, the centre of gravity. The buffers were all central and 2ft. 6in. above the rail level, and served also as draw-bars. The couplings on those last constructed were self-acting when the waggons were brought together. As this narrow gauge allowed a correspondingly larger wheel base than the ordinary gauge the waggons ran very steadily. Some of the waggons were constructed to carry planks 24½ft. long, and had a length of wheel base of 13ft.

The usual rate of speed was about fifteen miles per hour, including stoppages, and the train ran quite as steadily on this line as on the broader gauges. The traffic on these lines, though considerably below that of the lowest of the English lines, had already fully paid the working expenses, while the impulse given to the development of the resources of the country must undoubtedly, in the course of time, produce a corresponding and satisfactory increase of revenue.

In order to show the economy of construction, Mr. Pihl mentioned that, simultaneously with the construction of these lines, an extention of about fifty English miles was constructed from the old trunk line built by Messrs. Stephenson and Bidder in 1850-53 to the Swedish frontier, of the ordinary gauge of 4ft. 8½in., the cost of which was about £6400 per English mile, the rate of wages and the class of work being, as nearly as possible, of the same description.

In addition to the two narrow gauge lines described, there was in course of construction another line of the same gauge, between the town of Drammar and the Lake Ramdsfjorden, about fifty-seven English miles in length, besides several branch lines in preparation. None of these several lines would ever have been made had not the small cost justified and encouraged the undertakings.

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Mr. PIHL added that, last summer, Mr. Charles D. Fox inspected the narrow gauge lines in Norway. All the details, with the engines and rolling stock, were unreservedly placed at his disposal; and on leaving he wrote—"With reference to the interesting question of the 3ft. 6in. gauge, I shall return convinced of the thorough efficiency of such a gauge for the purposes of a new country, and of the wisdom of adopting such a gauge where the traffic is not very heavy."

Mr. PHIPPS inquired, whether the economy of these narrow gauge lines did not consist chiefly in the diminished cost of construction, rather than in working the traffic of the line? In his opinion the cost of haulage per ton could not differ much, whatever the gauge might be; but as regarded the construction of the line, it would, of course, be less on the narrow way. These narrow ways were obviously suited for mountainous districts, where the curves being necessarily sharp and frequent, it became important to reduce, as much as possible, the friction arising from wheels keyed fast upon the axles, which was obviously done by diminishing the width of gauge. On tolerably level ground, with the ordinary alterations of cutting and embankment, where the slopes formed so large a proportion of the whole earthwork, the saving from narrowing the gauge would probably not be considerable.

Mr. BRUFF replied that, though considerable economy in the earthworks arose by adopting sharp and reverse curves on the Norwegian lines, the bridges and viaducts were extremely heavy, so much so, as to have astonished him when he was informed of the prices at which the lines had been carried out. No doubt, the economy of construction was greater than if a heavier rolling stock and permanent way had been employed throughout.

Mr. GREGORY, V. P., remarked that, with the narrow gauge, a shorter wheel base of the engines could be adopted, which gave greater ease in traversing sharp curves.

Mr. ROBERT MALLETT said, as yet no mention had been made of another narrow gauge line, which had been a long time in successful operation, viz., that between Antwerp and Ghent, the gauge of which, he believed, was only 2 feet 3 inches. He could not give the precise particulars of the rolling stock, but could state generally that the carriages were wider than those on the Festiniog Railway, and they carried heavier loads. *Antwerp and Ghent Railway, 2-3 gauge.*

The subject of narrow gauge lines was not new to him. About eleven years ago he recognised the advantages, in respect of cheap railways and traffic, which would arise from narrow gauge lines; and in 1855 he had proposed to Mr. Hemans a line along the north shore of the Bay of Dublin, to have a gauge of only 2 feet 6 inches. That project, for reasons it was not necessary then to go into, was not carried out; a Bill, however, was presented in the present session of Parliament for a similar line, and he hoped it might be made on the narrow gauge. In viewing the question of narrow gauge and ordinary gauge railways, it was necessary to consider, what he might call the prudential considerations, those that related to the circumstances of traffic, &c., separately from those which were of a purely physical character. He met in Sicily last year Colonel Yule, late of the Bengal Engineers, and he had many opportunities of discussing with him what had passed relative to Indian tramways, or branch railways. Colonel Yule's opinion was decidedly in favour of narrow gauges, and he considered that in India it was simply a question between the bullock cart or these narrow gauge lines, as feeders to the trunk lines. Reverting now to the purely physical considerations, it appeared to him, as a physical necessity, that, not only the original cost of two similar lines differing in gauge, but also the cost of working them, would approach the ratio of the cube of the length of axle, or what was the same, of the breadth of gauge. A little consideration would show that, however startling, this proposition, without having any pretensions to be a mathematical truth, was nevertheless approximately true. As an illustration of this—if the axle of a carriage, as a cylindrical shaft, exposed to cross strains, were taken, it would not admit of dispute, that for equal strength, on different gauges, the diameter must vary as the cube of the length, or of the gauge; therefore the weight of the axles would be in that ratio, and so must be that of the wheels to carry them. *Great saving in cost.*

* * *

There were some special physical advantages in narrowing the gauge; for example, engines or carriages could go round a sharp curve more easily with a 2ft. gauge than with a 7ft. gauge: this fact had had some doubt thrown on it, but its truth was obvious, from the consideration that if the two rails could be brought closer together, or into one, there would be no longer any resistance at all in going round, due to the outer and inner wheels having to go over different lengths of curve in equal times.

Mr. SAVIN said, he had not at first imagined that a line of so narrow a gauge as the Festiniog Railway could be worked successfully with locomotives; but he had travelled on that line both with locomotives and in the boat carriage, and he thought it a great success, both in regard to its adaptation to the circumstances of the locality, and in its commercial results. He agreed that the gauge of railways in any one country should be uniform, as far as through systems of working were concerned; but having had some experience in Wales, he thought it impracticable to carry out the broad gauge in that country. He had seen various gauges in operation, from 2ft. up to 3ft. 6in.; his own feeling was in favour of 2ft. 3in. or 2ft. 6in., where the valleys were crooked and steep sided. In this way many physical difficulties might be avoided, by the adoption of curves of shorter radius; a 2ft. gauge line might be fitted to the contours of the hill sides, in such a manner as to reduce the cost of railway communication to a minimum. A line sixteen miles long, for which he had given £20,000, was laid on the gauge of 2ft. 3in., and that line had been extended into a district similar to that which the Festiniog Railway passed through. There would have been very little chance of carrying a Bill for a railway on a gauge of 4ft. 8½in. in that district, and the result would have been that, but for this class of railway, the present development of the mineral resources of those valleys would not have been attained; and it was especially with reference to districts such as this, that the subject was worthy of the fullest consideration on the part of engineers.

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Mr. E. WOODS thought it was evident, from the observations which had been made, that no one system could be laid down, nor any one gauge be fixed upon, as applicable to all conditions of locality, traffic, &c., but that each district must be treated according to its circumstances. With regard to the Indian gauge of 5ft. 6in., he could quite understand it was most desirable to construct branch lines on the same guage as the main lines, and in a flat

Papers on Narrow & Broad Gauge.

APPENDIX D 1.

country like India the difference of cost as between a gauge of 5ft. 6in. and a narrower gauge would not be great, the principal item being in the additional length of the cross sleepers. The rails might be lighter than those of the main line, and the engines for working the branches made light in proportion. Six years ago he had to construct a railway in Chili, twenty-seven miles in length. The line was situated in the lower range of the Andes, where the gradients were necessarily severe and the curves sharp. Here curves of 500 feet radius, in combination with gradients varying 1 in 20 to 1 in 30, constantly occurred. It was said, by the engineers of the country, that it would be impossible to work that line with locomotives, and accordingly it was laid out for mule traffic, and it was worked by mule power for eighteen months. But, owing to the seasons of drought and other causes, the expenses of working were so high, that a decision was come to by the Directors to work the line by locomotive power. He was called upon to design the engines, and in his design he limited the weight on the driving wheels to 7½ tons, but the difficulty was to get sufficient adhesion to take the loads up the severe inclines of 1 in 20 for seven miles, and 1 in 30 for twelve miles. That difficulty was overcome by putting six driving wheels to the engines, and placing the front end on a bogie truck. The rails, of 42lbs. to the yard, had stood exceedingly well, and up to this time were in good working order; for though the engines weighed thirty tons, the weight being distributed over so many wheels, had produced no sensible injury to the rails. The ordinary working speed on the inclines was about twelve miles per hour.'

1 in 20 for 7 miles, and 1 in 30 for 12 miles.

From the experience of the working of that line, it was evident that railways of light and inexpensive construction might be advantageously worked, if due regard were paid to the adaptation of suitable rolling stock.

APPENDIX D 2.

RAILWAY FROM NELSON TO THE WEST COAST.

APPENDIX D 2.

Estimate for Railways in New Zealand, by HENRY WRIGG, C.E.

***REPORT** upon the best Line for a Railway between Nelson and Cobden, with a Branch to Westport; and upon the probable Cost of constructing the same.*

(From the Provincial Government Gazette.)

To *His Honor* OSWALD CURTIS, *Superintendent of Nelson Province.*

3-6 gauge, £4210.

4-8½ guage, £4708; and

5-3 gauge, £5148

SIR,—The extraordinary weather which prevailed in the Buller and Grey districts from September of last year to the middle of January of the present year, so interrupted my examination of those districts, and so debarred the progress of my party, as to lead to my being detained in the field very much longer than I anticipated.

2. Unfortunate as this detention has been in many ways besides that of its cost, it is, on the whole, not to be regretted, for it has enabled me to see the country under the most unfavorable circumstances, and has shown me, by the most unerring of all guides, the proper levels to be adopted, viz., that of seeing the highest known floods of the chief rivers of the district.

3. The heavy floods which have occurred repeatedly in the Rivers Buller and Grey, and their tributaries, during my passage through the interior of the country, will have a highly important bearing upon the general elevation which the line of the proposed railway should have over the ordinary water line of those rivers, and also upon the character of the bridge structures best calculated to successfully resist the action of similar floods; and, consequently, these considerations will have a material effect on the gross cost of a line of railway that will be safe and secure from damage by floods under all circumstances.

4. Had I not seen these floods, I could not have credited any description of their heights and velocities, and I should have probably fallen into the error of recommending works at unsuitable levels, and so, perhaps, have been instrumental to the expenditure of a large sum of money in a fruitless effort to secure permanency to works, the evils of which no reasonable amount of after expenditure could have corrected. I am, therefore, glad that I have seen these floods, for I have secured a full knowledge of their heights and effects, which free me from the chance of making any serious errors in reference thereto.

5. I may, however, say that this knowledge will add to the amount of my estimate of the cost of the works. At the same time, I may observe that I am so fully impressed with the grave responsibility of the task which your Government has done me the honor to place in my hands, that I shall endeavour to approach the estimates with the greatest care, and submit to your Honor as truthful a representation of the character of the country to be dealt with, and the probable cost of the undertaking, as the nature of a preliminary survey will permit.

6. But it must be borne in mind, that without absolute sections before you, all estimates must be in some degree speculative and uncertain; and though the utmost care may be taken by the most practical Engineer, without plans and sections before him he may fall into errors. Hence it is that I have urged your Honor's Government to prepare detailed plans and sections, so that estimates of the probable cost of the works might be deprived, as much as possible, of uncertainty.

7. Having failed to convince you that such an expense was necessary, I have found it my duty to substitute what may be called a sketch map of the country, exhibiting the general direction of several routes, the curves that are likely to be obtained, and the special works that will in all probability be found necessary.

8. In no other way could I conveniently endeavour to convey to capitalists in England the general character of the works they would be called upon to execute as by a "sketch map." I do not, by any means, wish you to think that such a document is certain of being considered satisfactory, for it can only convey a sketch of the *probable* position of the line, and the works necessary. It does, in fact, represent my *opinion*; whereas a survey and section might show other results, somewhat at variance with my opinion.

9. Having laid before your Honor the possibility of errors arising in estimates based upon imperfect data, and the delay that may arise in negociating for its construction, in the absence of accurate surveys and levels, I have endeavored to apply myself, so as to reduce these risks to a minimum; and with this view the Chief Surveyor's department has prepared copies of such existing surveys of the districts through which the several routes pass as I required, upon which I have laid down, from sketches made in the field, the direction curves and other information referring to the proposed works, none of which could be conveniently or so well described in this report.

10. Four sets of *sketch maps* have been prepared. One on a small scale, showing the direction of several routes which have been examined. A second on a larger scale, shows a route from Nelson to Cobden *viâ* the Big Bush and the valley of the River Inangahua. A third, showing an alternate line branching at River Matakitaki *viâ* the Maruia Plains and forming a junction with the first route at the meeting of the Upper and Little Grey Rivers. A fourth shows the branch to Westport, commencing at the River Inangahua, and descending the valley of the Buller River to Westport. These *sketch maps*, in the absence of plans and sections, will convey to the eye some idea of the nature of the country through which the line may pass, the nature of the excavations that may be necessary, and the chief works required. Route.

11. Before determining upon the general direction of a line of railway, it is necessary that three material points should be kept in view. These points are—

A.—To have the line as direct between the termini as possible, consistent with proper gradients.

B.—To adopt the least expensive line.

C.—To secure the special objects for which the line is projected.

Now these points for consideration are frequently inconsistent with each other, and must be abandoned.

* * * * *

24. There are numerous lengths on the river bank flat.

25. On the whole length of line gravel of the finest quality for ballasting abounds, so that the cost of providing ballast will be moderate.

26. All the cuttings necessary, with a few exemptions, will be *side-cuttings*, so that no long leads are necessary, as most of the material excavated can, when desired, be disposed of by the shovel only.

27. Timber for sleepers and bridge purposes can be had all along the line, excepting from Nelson to Fox Hill, a distance of about twenty-two miles.

28. From the Devil's Grip to the River Newton there are some special works necessary to secure good curves on the line of railway, by regulating and controlling the wide bends of the river bed, where its course is in various channels, only used when in flood. The cost of these works would be about £10,000.

29. There are numerous important bridges to be provided, some of which are costly; for instance, over the Rivers Wairoa, Wai-iti, Hope, Howen, Matiri, Newton, Buller, Inangahua, and Grey. These are all large rivers, subject to heavy floods. Numerous bridges over large rivers.

30. From the observations I made in the early part of this report regarding the height and velocity of the floods to which these rivers are subjected, it is necessary that, when practical, the water-way of these bridges should be in one span; for it is not at all desirable for any bridge structure over such rivers to have supports in the water-way; but there are some four cases where this is not practicable with timber as the material.

31. With the material that can be procured along the line, there is no difficulty in constructing timber bridges with clear water-ways of 200 feet, to carry a single line of rails, at from £16 to £20 a foot lineal, according to the width of gauge. Exact estimates of the cost of these bridges cannot be given in the absence of detailed drawings, but the prices I have named in the estimate attached will be ample to construct substantial bridges to carry a single line of rails.

32. While on the question of these large bridges, I would draw your Honor's attention to the ease with which they could be constructed to accommodate both railway and ordinary road traffic. It would, in my opinion, be a desirable stipulation to make with any company undertaking the construction of the line, that this public convenience should be secured, which could be done at a very small additional cost, and without one traffic interfering with or endangering the safety of the other.

33. Upon the whole length of this route there is only one tunnel apparently necessary. This is on the south bank of the Buller, about one mile below the junction of the Lyell with the Buller.

34. I am not sure but that a detailed survey would show that even this solitary tunnel could be dispensed with; for its construction is only necessary in order to shorten the distance of the line about three miles. The length of the tunnel would be about 600 yards. Tunnel 600 yards.

35. Some excavations, and a well-drained and metalled horse-track, extending from Jacklin's store to the Saddle, has lately been finished by Mr. O'Connor, which enables me to form some opinion of what material this tunnel will consist. It will have to be carried through rock, which is granitic; and water will, I think, be found very troublesome in the execution of the work. It is, therefore, a question which detailed surveys, sections, and borings can alone determine, as to the prudence of making the increased length of line in substitution for the tunnel, in preference to the shorter line having a tunnel. I shall, however, in my estimates provide for the tunnel being constructed.

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42. I do not anticipate that the ruling gradient along the entire route need to be more severe than 1 in 60, which is a good working gradient for such a country as is under consideration, and one on which full control may be had by brakes over a descending train. I should, therefore, recommend that the maximum gradient should not be greater than this. Gradients.

43. When you get to gradients steeper than 1 in 60, the effect of gravity becomes largely increased, and the power of a locomotive engine is severely tested to overcome this force, while that of the brakes is greatly reduced in descending the incline.

44. On a well constructed railway, in fair working order, the friction to overcome one ton drawn on the level ranges from seven to ten lbs. Calling it ten lbs., the force to overcome the friction of 200 tons drawn on the level would be 2000 lbs.

45. Leaving out of consideration (for the sake of simplicity) the effects of resistance of the atmosphere, weight of the engine, as well as fractions, the following table will show what an extent of power is lost when a railway departs from a perfect level and a right line. I need hardly say that the resistance from curved rails is not taken into account in this table:—

46. *TABLE to illustrate the Effects of Gravity.*

(Load drawn on the Level 200 tons.)

Gradients.	*Friction taken at 10 lbs. per ton.*	*Effects of Gravity.*	*Resistance from Friction and Gravity.*	*Tons which can be drawn by the same Engine.*
Level	2,000	Nothing	2,000	200
1 in 100	2,000	4,480	6,480	62
1 in 90	2,000	4,977	6,977	57
1 in 80	2,000	5,600	7,600	53
1 in 70	2,000	6,400	8,400	48
1 in 60	2,000	7,460	9,466	43
1 in 50	2,000	8,960	10,960	37
1 in 40	2,000	11,200	13,200	30
1 in 30	2,000	14,600	16,600	24

47. From this table can be observed the rapid increase of the consumption of the engine's power to overcome gravity as the gradients are increased; and it follows that (leaving the speed the same throughout, and not noticing the weight of the engine itself) if a locomotive exerts its full power on the level, the gross tons that it can haul from terminus to terminus will be confined to that which it can draw up the steepest gradient on the line.

48. Hence the importance of adopting a reasonable gradient as the ruling one, so that engines of moderate weight may be able to draw the gross load required; for, if this is not observed, and heavy engines become necessary, then it must be noticed that a more substantial and more costly permanent way is unavoidable.

49. Besides these considerations, there are others which should influence the fixing of the ruling gradient. It must be remembered that when a locomotive is drawing a load upon a level it has only the friction of the moving parts of itself, which is constant, and that of the load drawn, which varies, to overcome; but upon an incline it has not only the gravity of the *profitable* load it draws to overcome, but that of its own weight as well, which is an *unprofitable* load; and, therefore, the more steep the gradient is, the more weight the engine must have to haul a given load, and, consequently, the greater the loss of power to overcome the gravity of the engine. Now loss of power is loss of money.

50. All this has reference to *ascending* gradients, but to safely *descend* long gradients is of equal importance, and though there is scarcely a limit to the power of brakes, their application is costly; so that safely descending long and severe gradients is simply a question of cost.

51. Experience has shown me that in practice 1 in 60 is the steepest gradient that can be descended in safety by heavy mineral trains with a reasonable application of brakes, and from the foregoing table (No. 46) it may be observed that the braking power required on gradients below 1 in 60 becomes rapidly increased; for to bring a descending train to a state of rest upon a gradient of 1 in 70, the power of the brakes necessary is represented by 8400 lbs.; on 1 in 60, by 9466 lbs.; on 1 in 50, by 10,960 lbs.; while 1 in 40 is 13,200 lbs.

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Gauge.

113. As regards the question of gauge, this must, in some measure, be determined partly by the nature of the traffic which may be expected to arise, and partly from the formation of the country to be passed through, the curves in the line that are necessary to save a great outlay, and the financial position of the Province; the latter, perhaps, being the chief consideration.

114. If the great bulk of the traffic is certain to consist of minerals, high speed is not only unnecessary, but absolutely injurious, and a very narrow gauge of say 3ft. 6in. would suffice; but if in the course of time the passenger and goods traffic became of equal importance with that of the minerals, then a gauge of not less than 4ft. 8½in., or not more than 5ft. 3in., according to the nature of the traffic, may be desirable.

115. The advantages of forming a railway on so narrow a gauge as 3ft. 6in. are not real ones—they only *appear* to be so. Cheapness in the first cost of construction,—being best suited to sharp curves,—and the completion of which is more likely to come within the means which the Province has at its disposal, are certainly matters of much moment; but these apparent advantages must be received with some caution, as it is well known to practical engineers that there are extra charges and cost per cubic yard, in the excavations of a very narrow gauge, that are greatly reduced, and may be said to disappear, when the gauge is of a moderate width.

116. Time is an element of consequence in the constrution of all large public works, regulating, as it does, the period for which the capital engaged in the formation of the undertaking lies unproductive. The quicker, therefore, that a large public work can be completed, the better for those having capital in the concern, and *vice versa.*

117. I may illustrate my meaning better, perhaps, by assuming a case thus:—If a line whose gauge was 3ft. 6in. had 4,000,000 cubic yards of earthworks to be removed in full cuttings, and another line whose gauge was half as much more, that is, 5ft. 3in., had 6,000,000 cubic yards of earthwork to remove, then what I mean to convey to your Honor is, that though the gauges and quantity of earthworks are strictly proportional, not only would the 6,000,000 yards on the broader gauge be removed as soon as the 4,000,000 yards on the narrower gauge, but it would be done at a less cost per cubic yard. Experience has clearly shown, that within certain limits of gauge, this is a fact; and enquiry as to the result of constructing railways of 3ft. 6in. gauge in other colonies would, I have no doubt, sustain what I have advanced.

118. We must, however, guard against falling into error by applying this knowledge under all circumstances, for its correctness is only applicable when the cuttings on the line are *full* cuttings, that is not *side* cuttings, for the width of a cutting regulates the size of the earth waggon that can be used, and the number of men that can be daily employed; and from this cause, cost of excavations, time of execution, and cost of management, are much enlarged.

119. But in "side cuttings," where nere is no lead, or where the lead is very short, and where the material excavated may be cast away by the shovel, the distinction as regards relative cost of earthworks does not apply. Now, as the excavations on the line of route I propose would generally be in side cutting, and but few full cuttings be found necessary, it follows that the generally admitted fact, that the excavations on a railway whose gauge is

3ft. 6in. are more costly in proportion to that of one whose gauge is 4ft. 8½in. or 5ft. 3in., only applies, in the case of the proposed Nelson and West Coast Railway, to a limited extent; but it is necessary, I think, that I should draw your attention to these facts, so that objections which capitalists may make to the construction of so great a length on such a narrow gauge may be removed.

120. A railway having a large traffic and a gauge of 3ft. 6in. has, compared with one whose gauge is 4ft. 8½in. or 5ft. 3in., some disadvantages. *a.*—Its safe working is less certain; *b.*—its speed is more limited; *c.*—its servants are more numerous; *d.*—its rolling stock is of greater extent; and, *e.*—its cost of working larger.

121. It must be recollected that the chief cost of a railway, having a gauge larger than 3ft. 6in., is generally to be attributed in this Colony not so much to the increased cost of the excavations as to that of the permanent way, by reason of the ballasting being greater in quantity, the sleepers larger, and the rails heavier. In the sketch (fig. 1) given on the next sheet, which may be taken as a cross section representing the average of the sidelong ground to be passed over by the railway where it does not occupy the Valley of the Buller, it will be observed by an inspection of the figures that the excavation and embankment necessary in the case of a railway having a gauge of 3ft. 6in. and one whose gauge is 4ft. 8½in. is only increased 15in. in width, and 21in. in width when the gauge is 5ft. 3in., *half* of which represents the extra width of the cutting on the hillside.

Earthworks.

121A. This then would form a very moderate item in the increased cost of the broader gauges, and should not weigh in the choice of gauge; for we find from the cross section before us that for every mile of railway the gauge of 3ft 6in. would require about 3450 cubic yards of excavation; that of 4ft. 8½in. about 3924 cubic yards; and that of 5ft. 3in. about 4540 cubic yards: the calculation being based on the assumption that the width of the carriage shall exceed the width of the rails by 2ft. 6in., and that a space of 3 feet is maintained throughout the line between the sides of the carriage and the edge of the formation level; so that the least width of roadway for the several gauges would be 12ft., 13ft. 3in., and 13ft. 9in. respectively.

122. Now, as I said before, the permanent way is the item which increases the cost so largely, for while slow speeds are adopted rails of 42lbs. weight per yard would suffice for the gauge of 3ft. 6in.; 54lbs. per yard would be required for a 4ft. 8½in. gauge; and 60 lbs. per yard for the gauge of 5ft. 3in. In one case there would be an increase of 25 per cent. in the gross weight of the rails necessary, and in the other nearly 50 per cent. as compared with those necessary for the narrow gauge of 3ft. 6in.

123. So that, as excellent timber exists in numerous places along the route, and superior ballast is procured on the site of the works, the extra cost of these items in the broader gauges is not a very heavy one, and the whole question of the relative cost of the broader gauges over one of 3ft. 6in. would mainly resolve itself into the state of the iron market at the time of constructing the line.

124. The important advantage of adopting so narrow a gauge as 3ft. 6in. is the facility it gives of safely passing, with moderate speeds, severe curves on the line of rails. This is its chief point of recommendation, and, if slow speeds are to be followed, one of great consideration in a mountainous country like the Province of Nelson.

4-8½ gauge recommended.

125. The gauge of 4ft. 8½in. certainly presents, in my judgment, the most tempting arguments for its adoption; for, contrary to the narrow gauge of 3ft. 6in.: *a.*—its working is more certain; *b.*—its speed may safely reach the average of 20 miles an hour, on a line where the curves would be as sharp as a radius of 10 chains, and be very numerous; *c.*—its servants would be less numerous; *d.*—its rolling stock of less extent; and, *e.*—its cost of working less.

126. Supposing, however, that the narrower gauge of 3ft. 6in. was adopted as the one best adapted for mineral traffic, and that in the course of time other traffic was so developed as to require higher speeds, then a broader gauge becomes at once necessary, and the question arises at what cost can this change of gauge be accomplished.

127. The reason is obvious, for the curves would have to be decreased in severity, the ballasting must be widened, the sleepers be replaced by longer ones, and a heavier rail substituted for that which would suffice for a gauge of 3ft. 6in.

Cost of altering gauge hereafter.

128. Now, I have no hesitation in saying that such a change would be very costly indeed, if the line was, in the first instance, laid out simply for a gauge of 3 ft. 6 in., and regardless of possible future increase of width being necessary; and this cost would be greatly augmented from the necessity of keeping the traffic on the line open while the alteration of gauge was being made.

129. I need hardly say that, under such conditions, the cost of the new works would, of necessity, be very much in excess of what they would be if constructed under ordinary circumstances.

130. So that we must come back to the consideration as to how far it is prudent to construct a railway of some 200 miles long at a moderate cost, but a very narrow gauge, with the certainty of being only able to accomplish a very limited speed, against a broader gauge, of say 4ft. 8½in., where higher speeds may be safely attained.

131. The curves on the trunk line that I propose need not, I think, exceed a radius of 10 chains, but on the branch to Westport curves whose radius is 7½ chains are very frequent.

132. We must not, I think, on a gauge of 3ft. 6in. calculate upon attaining with *perfect safety* a speed greater than about 12½ miles per hour on the average, which would enable the journey from Nelson to Cobden to be accomplished in about 14 hours, and from Nelson to Westport in about 11½ hours.

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136. It appears, therefore, that in determining the gauge to be adopted, a variety of present circumstances, as well as those which are not only possible but probable to arise, must be duly weighed; and to me it seems that though there are very strong inducements to adopt a gauge as small as 3ft 6in., its effects must be to localise and limit the good that would arise from its construction, and to exclude from the Province of Nelson all those great benefits which a through traffic secures to a district.

137. These are some of the many points which your Honor's Government have to consider respecting the best gauge for the proposed railway. If you are convinced that so long a line should be constructed as for a mineral traffic only, then adopt a gauge of 3ft. 6in.; but if you think that a larger view of the question should be taken, as to how the gauge would benefit the whole of the Middle Island, that the traffic would be of a mixed character, and

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that a portion, if not the whole line, might be considered as forming a part of a trunk line to Canterbury and elsewhere, then adopt a gauge of 4ft. 8½in.

APPENDIX D 2.

Culverts and bridges.

138. During my examination of the routes I endeavoured to ascertain, by the existing water-courses, the probable average cost per mile of culverts and small bridges. So long as the spans necessary are less than 35ft., they will not be separately noted—so that in the estimates which follow the cost of bridging will be in two items, viz.—a rate per mile for small bridges under 35 feet span, and the estimated cost of bridges of larger spans.

139. Before going into the consideration of the estimates, it is necessary for me to observe that, as the works in the valley of the Buller are of quite a different character from those on the other parts of the line, I purpose making a separate estimate for each portion, so as to arrive at more accurate results; and for this purpose I attach a sketch of a cross section, which may be taken as an average of the side cuttings, for one-third the length of the line in the Buller valley, below the Devil's Grip. It must be observed that there are places where the cross sections would be less favorable than is shown in figure, while on the other hand there are many places where they would be more favorable, so that on the whole the sketch may be taken, excluding the retaining wall, as a fair average, as far as my judgment goes. The pitched facing to the embankment would be necessary in some cases where the natural slope terminates close to the edge of the river.

* * * * *

Estimate for one mile, exclusive of large bridges and heavy earthworks.

APPROXIMATE Estimate for One Mile of Railway, exclusive of large Bridges and of all Works in the Valley of the Buller.

144. The gauge being 3ft. 6in:—

	£	s.	d.
Clearing 10 acres of bush, at £6	60	0	0
Average excavation, 4000 cubic yards, at 1*s.* 3*d.*	250	0	0
Fencing	168	0	0
Draining	40	0	0
Two level crossings, complete	80	0	0
Accommodation gates	30	0	0
Ballasting, 2077 cubic yards, at 2*s.*	207	14	0
Sleepers, 1760, at 2*s.* 3*d.*	198	0	0
Rails, 66 tons, at £11	726	0	0
Fish joints and spikes	30	0	0
Plate-laying, 1760 lineal yards, at 2*s.*	176	0	0
Total	£1965	14	0

3-6 gauge, £1965.

145. The gauge being 4ft. 8½in.:—

	£	s.	d.
Clearing 10 acres of bush, at £6	60	0	0
Excavations, 4600 cubic yards, at 1*s.* 3*d.*	287	10	0
Fencing	168	0	0
Draining	40	0	0
Two level crossings, complete	80	0	0
Accommodation gates	30	0	0
Ballasting, 2444 cubic yards, at 2*s.*	244	8	0
Sleepers, 1760, at 2*s.* 6*d.*	220	0	0
Rails, 85 tons, at £11	925	0	0
Fish-joints and spikes	35	0	0
Plate-laying, 1760 lineal yards, at 2*s.*	176	0	0
Total	£2265	18	0

4-8½ gauge, £2265.

146. The gauge being 5ft. 3in.:—

	£	s.	d.
Clearing 10 acres of bush, at £6	60	0	0
Excavations, 5290 cubic yards, at 1*s.* 3*d.*	331	2	6
Fencing	168	0	0
Draining	40	0	0
Two level crossings, complete	80	0	0
Accommodation gates	30	0	0
Ballasting, 2628 cubic yards, at 2*s.*	262	16	0
Sleepers, 1760, at 2*s.* 9*d.*	242	0	0
Rails, 95 tons, at £11	1045	0	0
Fish-plates and spikes	40	0	0
Plate-laying, 1760 lineal yards, at 2*s.*	176	0	0
Total	£2474	18	6

5-3 gauge, £2474, to which must be added for heavy earthworks

147. To each of these estimates for one mile of railway we must add when the line is in the Valley of the Buller, below the Devil's Grip, as follows:—

	£	s.	d.
For 3 feet 6 inch gauge, 15,580 cubic yards of excavation, at 3*s.*, = £2337 — £250 =	2087	0	0
For 4 feet 8½ inch gauge, 18,186 cubic yards of excavation, at 3*s.*, = £2727 18*s.* — £287 10*s.* =	2440	8	0
For 5 feet 3 inch gauge, 20,340 cubic yards of excavation, at 3*s.*, = £3051 — £331 2*s.* 6*d.* =	2719	17	6

£2087 for 3-6 gauge. £2440 for 4-8½ gauge, and £2719 for 5-3 gauge,

We then arrive at the estimates of the entire line as follows, and the branch to Westport.

148. Estimate of trunk line from Nelson to Cobden; gauge 3 feet 6 inches:—

together with the cost of bridges, according to their number and span.

				£	s.	d.
125 miles of railway, no part of which is in the Valley of the Buller, below the Devil's Grip, at £1965 14s. per mile				245,610	10	0
55 miles of railway, the whole of which is in the Valley of the Buller, below the Devil's Grip, at £4052 14s. per mile				222,898	10	0
Small bridges and culverts, less than 30 feet span, about 6400 feet, at £4				25,000	0	0
Large Rivers—		£	£			
Wairoa	450 feet, at 16	..	7200			
Eighty-eight	80	..	1280			
Wai-iti	200	..	3200			
Kerr's	40	..	640			
Hope	80	..	1280			
Granite	40	..	640			
Owen	120	..	1920			
Matiri	300	..	4800			
Newton	120	..	1920			
Buller	300	..	4800			
Dee	100	..	1600			
Inangahua	200	..	3200			
Curtis'	120	..	1920			
Greenfield's	150	..	2400			
Sharp's	100	..	1600			
Adams'	50	..	800			
Little Grey	40	..	640			
Wood's	50	..	800			
Little Grey	50	..	800			
Ditto	200	..	3200			
Big Grey	400	..	6400			
Duffer's Gully	50	..	800			
Ahaura River	300	..	4800			
Nelson's	200	..	3200			
Red Jack's	60	..	960			
Maori's	50	..	800			
Twelve-mile	40	..	560			
Big Grey	400	..	6400			
Deep Gully	50	..	800			
Coal Creek	100	..	1600			
				69,960	0	0
Protective works on the Buller				8400	0	0
Retaining and breast-walls, say				1000	0	0
Viaduct at 99¾ miles, or in lieu, cross the Buller twice				9600	0	0
Road bridges, and diversion of public roads				2000	0	0
Stations				9000	0	0
Land				17,000	0	0
Telegraph, 180 miles, at £60				10,800	0	0
Detailed survey				6300	0	0
Total				£627,569	0	0

149. Estimate of branch to Westport:—

	£	s.	d.
27 miles of Railway, all of which is in the Valley of the Buller, at £4052 14s. per mile	109,423	18	0
Small bridges and culverts, 810 feet at £4	3,240	0	0
Retaining the Breast-walls, say	3,000	0	0
Stations	1,600	0	0
Land	3,000	0	0
Telegraph, 27 miles, at £60	1,620	0	0
Detailed survey	945	0	0
Total	£122,828	18	0

Cost of Rolling Stock.

150. The Rolling Stock for such a Line would not be heavy, and may be taken as follows:—

	£	s.	d.
10 Locomotives, at 2,000	20,000	0	0
10 Passenger carriages, at £200	2,000	0	0
5 Guard vans, at £200	1,000	0	0
40 Cattle trucks, at £50	2,000	0	0
300 Coal trucks, at £40	12,000	0	0
Repairing shop and machinery, say	5,000	0	0
	£42,000	0	0

Estimate in detail if of 3-6 gauge.

151. The cost of the trunk line and the branch would therefore be about as follows:—

	£	s.	d.
Trunk	627,569	0	0
Branch	122,828	18	0
Rolling stock	42,000	0	0
	792,397	18	0
Contingencies at £10 per cent.	79,239	14	0
Total	£871,637	12	0

Papers on Narrow & Broad Gauges.

APPENDIX D 2.

152. Therefore, as the total distance is 207 miles, the cost per mile will not exceed £4210.

If of 4-8½ gauge.

153. Estimate for trunk line, gauge 4ft. 8½in.:—

	£	s.	d.
125 miles of Railway, no part of which is in the Valley of the Buller, at £2265 18*s*.	283,237	10	0
55 miles of Railway, the whole of which is in the Valley of the Buller, at £4706 6*s*. per mile	258,846	10	0
Small Bridges as before	25,000	0	0
Large Bridges as before, but increased in cost according to increased width	77,247	0	0
Protective Works on the Buller	9,275	0	0
Viaduct	10,600	0	0
Road Bridges, and Diversion of Roads	2,000	0	0
Retaining Walls	1,000	0	0
Stations	9,000	0	0
Land	17,000	0	0
Telegraph	10,800	0	0
Detailed Survey	6,300	0	0
Total	£710,306	0	0
Contingencies at £10 per cent	89,717	12	0
Total	£986,893	12	0

154. Estimate of branch to Westport:—

	£	s.	d.
27 miles of Railway, all of which is in the Valley of the Buller, at £4706 6*s*. per mile	127,070	0	0
Small bridges, as before	3240	0	0
Retaining and breast-walls	3000	0	0
Stations	1600	0	0
Land	3000	0	0
Telegraph	1620	0	0
Detailed survey	945	0	0
Total	£140,475	0	0

155. Rolling stock £46,395 0 0

156. Summary:—

	£	s.	d.
Trunk line	710,306	0	0
Branch line	140,475	0	0
Rolling stock	46,395	0	0
Total	£897,176	0	0

If of 5-3 gauge:

157. Estimate of trunk line, gauge 5 feet 3 inches:—

	£	s.	d.
125 miles of railway, no part of which is in the Valley of the Buller, at £2474 18*s*. 6*d*. per mile	309,365	12	6
55 miles of railway, the whole of which is in the Valley of the Buller, at £5194 16*s*. per mile	285,714	0	0
Small bridges, as before	25,000	0	0
Large bridges, as before, but increased in cost according to increased width	80,162	0	0
Protective works in the Buller	9625	0	0
Retaining and breast-walls	1000	0	0
Viaduct at 99¾ miles, or in lieu, cross the Buller twice	11,000	0	0
Road bridges, and diversion of public roads	2000	0	0
Stations	9000	0	0
Land	17,000	0	0
Telegraph	10,800	0	0
Detailed survey	6300	0	0
Total	£766,966	12	6

158. Estimate of branch to Westport:—

	£	s.	d.
27 miles of railway, all of which is in the Valley of the Buller, at £5194 16*s*. per mile	140,252	0	0
Small bridges and culverts	3240	0	0
Retaining and breast-walls, say	3000	0	0
Stations	1600	0	0
Land	3000	0	0
Telegraph	1620	0	0
Detailed Survey	945	0	0
Total	£153,664	0	0

159. Rolling stock 48,125 0 0

160. Summary:—

	£	s.	d.
Trunk line	766,966	12	6
Branch line	153,664	0	0
Rolling stock	48,125	0	0
	968,755	12	6
Contingencies, at £10 per cent.	96,875	11	3
Total	£1,065,631	3	9

161. A summary of the cost of the Railway on different gauges will stand thus:—

		£ s. d.		Per Mile.
3 feet 6 inches gauge	=	871,637 2 0	..	£4210
4 feet 8½ inches gauge	=	986,893 12 0	..	£4768
5 feet 3 inches gauge	=	1,065,631 3 9	..	£5148

Papers on Narrow & Broad Gauges.

APPENDIX D 2.

Summary showing relative cost of each gauge.

166. If, then, a 3ft. 6in. gauge was adopted the dividend would be £9 19*s.* 9*d.* per cent.; in a 4ft. 8½in. gauge, £8 1*s.* 2*d.* per cent.; if a 5ft. 3in. gauge, £7 1*s.* 9*d.* per cent.

* * * *

I have the honor to be,
Sir,
Your obedient Servant,
HENRY WRIGG,
Civil Engineer, A.I.C.E.

Nelson, 31*st March,* 1868.

PAPERS ON LOCOMOTIVES ON ORDINARY ROADS WITHOUT RAILS.

Papers on Passenger Locomotives on ordinary Roads without Rails.

APPENDIX E 1.

EXTRACTS from Minutes of Evidence taken before a Committee of the House of Commons in 1831.

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APPENDIX E 1.

Evidence before Select Committee of House of Commons, 1831.

Mr. NATHANIEL OGLE examined.—Their experimental vehicle, weighing about 3 tons, has been propelled from London to Southampton, and on the roads in the vicinity of Milbrook, at various speeds. The greatest velocity obtained over rather a wet road, with patches of gravel upon it, was from 32 to 35 miles an hour, and, on a good road, could have increased that velocity to 40 miles. They have ascended a hill with a soft wet bottom, rising 1 foot in 6, but at rather a slow rate. They have ascended one of the loftiest hills near Southampton at 16½ miles an hour. Went from the turnpike gate at Southampton to the 4-milestone on the London road, a continued elevation with a very slight descent, at a rate of 24½ miles an hour, loaded with people. * * * *

Ogle's carriage.

The two cylinders communicate with their pistons with a crank-axle, to the ends of which either one or both wheels are affixed, as may be required. One wheel is found sufficient, excepting under very difficult circumstances, and when the elevation is about 1 in 6, to impel the vehicle forward. Explosion is impossible, because the cylinders of which the boiler is composed are so small as to bear a greater pressure than could be produced by the quantity of fire beneath the boiler; and if any one of these cylinders should be injured it would become merely a safety valve to the rest. Have never, even with the greatest pressure, burst, rent, or injured their boilers; and they have not once required cleaning, after having been twelve months in use. * * *

When going at 10 miles an hour, can stop within a less space than a carriage drawn by horses can. Has seen 19 persons upon it when going at the rate before mentioned. Thinks the injury done by steam carriages are not one-half of that which is caused by horse-drawn carriages. Their wheels are cylindrical, with flat tires, and 5 feet 6 inches in diameter. Have never met with any accident; not one bolt, not one screw, has ever given way during 12 months, and under circumstances which would have destroyed any other carriage. They have, beyond all question, realized the power of propelling vehicles of any weight at any required velocity, and the remaining improvements they are engaged in regard slight details merely. Finds from experience that the larger the cylinder the better.

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Summer's carriage.

Mr. W. ALLTOFT SUMMERS, Engineer, examined.—Has superintended the building of two steam vehicles; the lightest of the two weighed about 2 tons 10 cwt. Travelled in it when there were ten persons upon it, at the average rate of about 9 miles an hour, from Cable-street, Wellclose-square, London, to within two and a half miles of Basingstoke, when the crank shaft broke, and the carriage was put into a barge and sent back to town. This is not the carriage, however, to which the previous evidence of Mr. Ogle refers, nor is it upon the same principle, except that the boiler with which it was furnished has been transferred to the vehicle by Mr. Ogle. When going to Basingstoke tried to increase the speed, but were unable to do it, because the size of the engines would not consume the quantity of steam generated. There were three cylinders, each 4 inches in diameter, and the stroke of the piston in each was 12 inches; in the carriage described by Mr. Ogle the cylinders are 7½ inches each in diameter, and the stroke of each is 18 inches. Has travelled in this new carriage 15 miles per hour with 19 persons on the carriage. * * Has no doubt of its being able to carry 3 tons at the rate of 10 miles an hour, exclusive of its own weight; and after certain improvements which they have in view are completed, feels assured that much greater weights may be carried at that rate. Has never tested this by experiment, but grounds his opinion on having seen the steam blowing off at both safety valves with tremendous violence when travelling at the rate of 30 miles an hour; has continued travelling at the rate of 30 miles an hour, 4½ hours very frequently, and could have continued longer had they not required a fresh supply of water, the tank not being quite large enough. Since the last improvement in the furnace they have never found any difficulty, when the fire is in good order, in travelling over the worst and most hilly roads. * * * * * * *

Were the carriage to go at the rate of 5 miles an hour only instead of 10, it would be able to carry a much greater weight than 3 tons; cannot exactly say how much. * * * *

Has never had any accident from horses being alarmed; the noise is not so great as that of a vehicle drawn by horses. * * * * *

The steepest hill they have ever ascended was 1 foot in 6; that was the hill at Shirley, for a distance of about 200 yards. Both the wheels were in gear at the time, and there was not the slightest symptom of their slipping. Ascended it at a velocity of nearly 5 miles an hour, with 14 or 15 persons on the carriage. Can stop the vehicle within a distance of 12 feet. . . . The engine is calculated at 20 horse power.

* * * * *

Papers on Passenger Locomotives on ordinary Roads without Rails.

APPENDIX E 2.

Report of above Select Committee.

APPENDIX E 2.

REPORT of a Select Committee of the House of Commons appointed to investigate and report upon the Subject of Steam Carriages (Road Locomotives) in the Year 1831.

THE Committee after examining several eminent Engineers came to the following conclusions :—

"That sufficient evidence has been adduced to convince your Committee,—

"1. That carriages can be propelled by steam on common roads at an average rate of 10 miles per hour.

"2. That, at this rate, they have conveyed upwards of 14 passengers.

"3. That their weight, including engine, fuel, water, and attendants, may be under 3 tons.

"4. That they can ascend and descend hills of considerable inclination with facility and safety.

"5. That they are perfectly safe for passengers.

"6. That they are not (or need not be if properly constructed) nuisances to the public.

"7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses.

"8. That, as they admit of greater breadth of tire than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will cause less wear of roads than coaches drawn by horses.

"9. That rates of toll have been imposed on steam carriages which would prohibit their being used on several lines of road were such charges permitted to remain unaltered."

APPENDIX E 3.

Hancock's steam omnibuses.

APPENDIX E 3.

AN ACCOUNT of the Road Locomotives constructed by Mr. HANCOCK, *Sir* GOLDSMITH GURNEY, SIR JAMES ANDERSON, DR. CHURCH, COLONEL MACERONI, *and others, extracted from works on Steam Locomotives, by* BREES, HEBERT, *and other Civil and Mechanical Engineers.*

EXPERIMENTS to ascertain these various points occupied Mr. Hancock till the beginning of the year 1831, so that full six years had elapsed from the commencement of his locomotive pursuits before the Infant was produced in a state somewhat to the satisfaction of his own mind. The trials made during this probationary period comprise a total of many hundred miles, all made upon the high roads near London, principally in the vicinity of Stratford; between which place and Whitechapel, vehicles of every description being in constant motion, afforded him an excellent opportunity of obtaining practical experience under every circumstance of difficulty in which a steam carriage might be expected to be placed; and this consideration determined him to give the most frequented road the preference. In February, 1831, he commenced running the Infant regularly on the road between Stratford and London, not, certainly, with an anticipation of profit, but as a means of dissipating any remaining prejudices, and establishing a favourable judgment in the public mind as to the practicability of steam travelling on common roads. Mr. Hancock observes, that it is an undeniable fact, and a source of proud satisfaction to him, that a steam carriage of his construction was the first that ever plied on a common road, and that he achieved this triumph single-handed. * * * *

Blowing off steam, either from the safety valve or from the engines, creates no nuisance, because it is injected "into the fire in every direction," and so destroyed. The carriage can be turned in little more than ten feet, and stopped in much shorter space that any horse-coach. * * * *

In October, 1832, Mr. Hancock determined to make a trip to Brighton. On Wednesday, October 31, this steam carriage came from Stratford, through the streets of the city, at the different speeds necessary to keep its place behind or before other carriages, as occasion required, and took up its quarters on Blackfriars Road, to prepare for the following day's trial. Accompanied by a scientific friend, a distinguished officer in the navy, I joined Mr. Hancock's friends on the next morning, making eleven passengers in all. We started at the rate of nine miles an hour, and kept this speed until we arrived at Redhill (where all coaches at this season require six horses), which we ascended at the speed of between five and six miles an hour. The bane of the journey was an insufficient supply of coke and water; the water, indeed, we were obliged to suck up with one of Hancock's flexible hose pipes, at such ponds and streams as we could find. These difficulties delayed the completion of the journey (subsequently performed by steam in less than five hours) till next day; but on our return our speed was much increased, and one mile was accomplished up hill at the speed of 17 miles per hour. * * * *

During the year 1835 he also brought out a gig calculated for the accommodation of three persons; he ran it repeatedly, and it is not to be believed by any but those who travelled by it how easy the motion of it was. The limit of its speed was probably from 27 to 30 miles, but it was seldom worked more than 17 or 18 miles per hour.
* * * * * * *

The Infant, in the Autumn of 1832, ran to Brighton—the first steam carriage that had been seen there; again, it ran there in the summer of 1833, as did the Autopsy. The first day the Automaton was worked it took a party to Romford and back, without the smallest repair or alteration being required. * * * *
It travelled on the ordinary road at 12 to 14 miles, and ascended the hills, which are very steep, at 7 or 8 miles per hour. * * * * * *

The average working speed of the carriages is from 10 to 12 miles an hour, though they may be pushed far beyond this. The fuel costs about 2½*d.* per mile.
* * * * *

Road Locomotives by Gurney, Anderson, Church, and others.

Mr. Gurney (now Sir Goldsmith Gurney) was the next engineer who applied himself to the subject of steam locomotion on common roads. His first engine was constructed in 1830. It weighed 2 tons, and drew a carriage containing 18 passengers, at a speed of 10 to 13 miles an hour.

After some experiments this engine and carriage, and one or two others constructed on the same plan, were placed upon the road between Cheltenham and Gloucester as regular Stage Coaches. Notwithstanding much interested opposition, extravagantly heavy tolls, and many mishaps and breakdowns, they maintained their places upon the road for about four months, running four times a day, the distance of nine miles having been performed in the average time of fifty-five minutes. Although so far successful, this mode of transit soon proved to be a failure in a commercial sense, and was abandoned at a great loss; and Sir Goldsmith Gurney, after having devoted many years of time and large sums of money to the construction of steam carriages to run on common roads, finally abandoned the idea.

Papers on Narrow & Broad Gauges.

APPENDIX E 3.

* * * * *

Mr. Scott Russell, Sir James Anderson, Dr. Church, Colonel Maceroni, and several other persons, down to the time of the last Great International Exhibition, afterwards devoted much time and money to the construction of road locomotives. Some of them were models, and others were made of full size, and fairly tried on the ordinary roads, but not one was found equal, in a commercial view, to the task of conveying passengers in competition with the usual coaches.

PAPERS ON LOCOMOTIVES ON ORDINARY ROADS WITH RAILS.

Papers on Locomotives on ordinary Roads with Rails.

APPENDIX F 1.

APPENDIX F 1.

LOCOMOTIVES ON RAILS ON HIGHWAYS.

Extracted from "Road and Rails," by W. BRIDGES ADAMS, *C.E.*

Proposals by W. Bridges Adams, C.E., to convert ordinary Roads into Railways.

WHEN we look over the map of England, and behold how very small is the amount of railway mileage compared with the mileage of turnpike roads and other highways, we naturally ask, must these roads and all the property bordering them be for ever doomed to stagnation,—be condemned to a transit analogous to that of Chinese junks for slowness, and without the economy of railway transit? There is no valid reason—nothing to prevent their almost immediate conversion into practical railways over almost their whole mileage, provided only that the landholders and the inhabitants of unrailroaded towns and villages will awake from their slumber.

Objectors will cry out that it cannot be, that the outlay is too great,—from £10,000 to £50,000 per mile. This has been, but need not be again. There are 22,000 miles of turnpike-road in England and Wales. What they have cost to make is beside the question: there they are, and £8,000,000 have been borrowed on them on mortgage, and their interest is in arrear. And little as is the work done upon them, their annual maintenance costs £33 per mile. Are these roads, and the many more miles of highway and parish and farm-roads connected with them, and all the property they lead to, to lie comparatively waste, or to continue to be worked at a cost ten times that of railway highways by steam, or shall they be made into practicable railways wherever steam may do the work of horses at a cheaper rate?

Upon the solution of this question depends the practicability of placing the progress of agriculture side by side with that of manufactories in the districts still unoccupied by railways. Haulage on to the land and haulage off is the great daily cost to farmers. Without cheap transit into their very farm-yards they cannot have cheap coal—at least in the south,—and without cheap coal they cannot have steam-engines or machinery. Without machinery farmers cannot make good profits, or their landlords obtain large rents. In the general question of physical progress our chemists are in arrear of our machinists. In agricultural questions they are in advance of our machinists.

Thirty years ago there was a strong public excitement in favour of steam-carriages on highways and turnpike-roads. Townspeople, villagers, innkeepers, landlords, road trustees, all were opposed to them. It was said they would frighten horses, would blow up, would not go up hill, would overturn themselves down hill, and many other things. But they went on. Walter Hancock ran his steam-carriage as an omnibus for four months, many times daily, between Paddington and the Bank. He climbed the hill of Pentonville, with the most execrable of all roads below him, and he descended it, and he did not frighten horses, and he did not blow up. On the subject of frightening horses there seems to be an unreasonable impression. To begin, horses belong to the few, steam belongs to the many. Horses will bear, when trained, the firing of cannon, therefore they can be trained to bear the hissing of steam. And the many have a right to say, "the engine is docile, submits to guidance; let the horses make way for the engine till they cease to be self-willed. A shying horse is a wild creature and a dangerous one, and the owner ought not to bring him into public thoroughfares till he becomes a civilised and not a wild horse."

The highway locomotists accomplished much, but rarely did they succeed in getting good workmanship into their engines, still less a good plan. And, worse than all, they had only a yielding, rough, and jolting road for their propelling fulcrum: this would ultimately have been amended, but the worst and final blow at the time was the advent of railways.

The railways were made with edge rails above the surface of the ground, and that, saying nothing of the speed, seemed a conclusive reason against any attempt to lay down rails whereon to apply steam on the turnpikes. Thus the possibility of making the turnpike-road serve two purposes seems never to have occurred. Yet all that is required, mechanically, is to insert efficient rails or trams on the surface of the roads at the same level. By this mode any kind of vehicle may cross and recross the road without impediment.

The objections will be:—

Objections answered:- as to Cost,

First, cost. Answer—£1500 to £2000 per mile would pay all the cost, steam-carriages and waggons inclusive. Mere farm rails about £500 per mile.

Frightening horses,

Secondly, frightening horses. This difficulty has been before disposed of.

Hills to be mounted,

Thirdly, difficulty of mounting hills. Answer—The Birmingham and Gloucester Railway has a three-mile hill of one in thirty-seven, which has been worked for many years with very heavy machinery. And the ruling gradient of the turnpike-road is one in thirty. Practicable light engines can be made to surmount this with a load behind of sixteen tons, say one hundred and fifty passengers. The same engines may travel twenty-five miles per hour on the level, and at a reduced pace take one hundred tons of goods and engines behind it.

Speed,

Danger, and

Fourthly, accidents from speed. Answer—It is not necessary to run more than stage-coach speed, and an engine would be quite as amenable to control in stopping and starting.

Difficulty of passing through towns.

Fifthly, the difficulty of passing through towns and streets.—This depends entirely on the class of rail or tram laid down, and the kind of engines and carriages used. The engines and carriages used on ordinary railways, with their requirements of turn-tables, and points, and crossings, would not answer; nor does it follow that it would always

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be desirable to use the main streets of a town for the rails or trams. But there is less risk from vehicles that follow a particular track than from those which cross diagonally over a road; children and passengers can easily avoid the definite rail, but not so easily the indefinite track of the ordinary carriage. The driver of a self-guided machine has only to increase or diminish his speed; when he has to steer the machine also the risk is greater.

Landlords, townspeople, villagers, innkeepers, farmers, and others are all interested in bringing this thing about. The turnpike bond-holders are also interested in it. Are not the trustees, secretaries, clerks, and surveyors also interested in it? At first sight it may seem otherwise, for they get by no means large stipends, and why should they trouble themselves to increase their work?

The reason seems plain. If the roads earn more money, higher salaries and wages can be afforded. No man can thrive so well by poor customers as by wealthy ones. The fund for paying increased salaries would come out of the savings in repairs and maintenance, for rails under light machines would neither deflect nor abrade.

It is not proposed to do all at once that which will follow in succession, the application of rails to twenty-two thousand miles of highway, at a cost of fifty millions; involving an amount probably equal to a whole year's surplus profits of the whole community. But let us imagine the results that would gradually be realised.

Advantages.

Light locomotives, not needing a legion of officers and machinists, but attended to each by its own captain, with an individual interest in its well-doing, would bring from the farms their produce of grain and dead meat—for no live meat ought to come through the town, poisoning it with the offal instead of leaving it on its own farm. Or they could bring what has never yet been brought, a sufficient stock of green vegetables to supply the consuming power of the towns on to the Main-line Stations, or convey them on the railed highway to the market direct. They could be brought direct to the market from the very farm yard; and light movable rails, for the purpose of horse transit, could carry manure on to the field and bring produce off it, from and to the farm yard. The same engines can be arranged to work as stationary farm-engines, by merely lifting the wheels a short distance from the rails, and connecting them by a belt to the thrashing-machine, the turnip-cutter, and the chaff-cutter, or a small saw-bench and morticing-machine to execute various wood or other work for farm purposes. With fitting machines, many of the farm labourers, with aptitude, would become carpenters or turners, or engine-fitters after a little practice. And the engine might also be run on to the fields to pump water for irrigation. * * *

Will be accomplished before long.

Long it cannot be ere our suburban roads and country roads will have iron rails inserted in their surfaces, over which locomotives with small wheels will work in hilly districts, and locomotives with larger wheels on more level districts. George Stephenson was right in preferring iron to gravel for road surfaces; right in preferring levels to inclines; but, notwithstanding, it is good to have the iron surface to the inclined road where the traffic is small till such time as the increased traffic will pay for levelling. The great trunk lines need feeders, and the branches of nature's trees are ever smaller than the trunks. When the time shall come that the roads leading to our farms and pastures shall be all iron lines, fuel and materials of all kinds will permeate the bye as well as the high roads, and a general mechanical education of the farm labourers will raise them more in the scale than the labourers of manufacturing towns. The squalid huts will pass away and be no more, the easy means of transit will unlock the latent faculties, and the labour both of townsmen and countrymen will be convertible to either locality. Steam has been hitherto a worker only for the general public, or for the purposes of production; but steam or some other form of heat has yet to be converted to all kinds of domestic purposes, whereby drudgery—the application of men and women to mere slave labour—will become extinct.

APPENDIX F 2.

Street Locomotives on Rails in New York, Philadelphia, San Francisco, and other cities.

APPENDIX F 2.

LOCOMOTIVES ON RAILS LAID ON THE STREETS OF NEW YORK, PHILADELPHIA, SAN FRANCISCO, AND OTHER CITIES AND TOWNS.

Extracted from "Roads and Rails" by W. BRIDGES ADAMS, *C.E.*

In the United States of America, when railways commenced, the roads were of a very inferior kind both in town and country, and there was little difficulty in persuading the community to permit the rails to pass freely through towns, just stipulating that through the streets the engine should be unhooked and horses substituted to draw the trains. Then the engine was allowed to draw the trains at a slow pace, and subsequently a bell was suspended from an overhead gibbet, to be rung by the passing train as an automatic notice. * *

If only one line of carriages is to be used along the street rail, it is evident that all must move at the pace of the slowest; and if they be railway carriages, with wheels only adapted to run on rails, they cannot pass each other unless duplicate rails be used to turn off. But this requires wide streets.

If therefore rails and railway carriages are to be used along a line of street with shops, the railway, either single or double, must be in the centre; and on either side must be a double space for carriages of the ordinary kind, one-half for passengers and the other half for carriages to draw up at the doors. Therefore, a street of traffic with one central line of rails would require to be 50 feet in width, and with two lines of rails upwards of 60 feet. * *

The attempts that have been made to lay down rails on common roads have not been judicious. To place a mass of timber underground as a foundation, liable to rot and difficult to get at to repair, is a mistake; and a still greater mistake is to make too light a rail. Moreover, the edges of the rails must in all cases be guarded by paving, in order to prevent grooves being cut in the softer materials in which they are bedded.

There is another difficulty; such rails must belong to the public and not to monopolists. The object professedly aimed at, to keep the monopoly of the edge-rail, while proffering to give the advantage of the train to the public, is a transparent pretext. To use the tram it would be necessary to alter at a great expense the width of the wheels of some thirty varying classes of vehicles; and if they were altered the monopoly of a flange to the wheel would be worth nothing, for the vehicles on a well-arranged tram would run quite as lightly as those on the edge rail, unless the flange wheels were greatly enlarged and of better construction. The problem must some day be solved. *

EXTRACT from CAPTAIN MURRAY'S *Travels in the United States*, 1857.

* * By the time our luggage was ticketed the train had arrived; some tumbled out, others tumbled in; the kettle hissed, and off we went, the first few hundred yards of our journey being along the street.

Not being accustomed to see a train going in full cry through the streets, I expected every minute to hear a dying squeak as some of the little urchins came out jumping and playing close to the cars; but they seemed to be protected by a kind of instinct, and I believe it would be as easy to drive a train over a cock-sparrow as over a Yankee boy. * * * * *

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APPENDIX F 2.

EXTRACT from the Illustrated News, *14th July,* 1866.

A STREET IN SAN FRANCISCO. * * In one respect the San Franciscans are in advance of the inhabitants of the cities of the Old World. The street is provided with a tramway, on which steam cars or omnibuses run, and that too up the steep acclivities of the broad and noble streets, which have been carried far up the hills that back the city looking from the magnificent bay.

EXTRACT from Sir S. M. PETO's *Work on America,* 1866.

* * The citizens residing in the towns and populous places of the different districts have hailed the approach of a railway as a blessing. Under certain regulations lines have been permitted to be laid down in the main streets and thoroughfares of the cities, so that the trains may traverse them at prescribed speeds, and so that goods may be put upon trucks at the very doors of the warehouses and shops. Whilst most people in our country have in fact repelled the railroads from their localities, the people of the United States have invited them to their very streets and doors. * * * *

[Besides the examples given above, steam omnibuses run through the streets of Philadelphia upon rails laid down upon the crown of the road, and as the streets are too narrow to permit of more than one line of rails the carriages run up one and return down the adjoining street. The steam omnibus is also in use in the City of Nantes; and the Italian Government are so satisfied with the great saving which has been obtained by putting the Mont Cenis Railway on the ordinary road, that they have determined to continue that line to Florence, (a distance of 120 miles), using for that purpose the crown of the high road.—*Note by Chairman.*]

APPENDIX F 3.

APPENDIX F 3.

Proposal by Civil Engineers to convert the ordinary high roads of Ireland into Railways.

EXTRACT from the Report of the Royal Commission on Railways, England, 1867. *Vide* SIR ROWLAND HILL's *Special Report.*

* * * * *

Some of the witnesses recommend that cheap narrow gauge railways, such as I have called "railroad by-ways," should be made when wanted on the ordinary high roads of Ireland; but the majority of witnesses, including Colonel Yolland and Captain Rich, (Railway Inspectors to the Board of Trade,) and Sir John Macneill, prefer taking new routes; and all three are of opinion that such lines may be made and worked at a comparatively low cost. Sir John Macneill gives detailed plans and estimates of a line 11 miles long, 3½ feet gauge, which he proposes to construct between Downpatrick and Newcastle at an average cost per mile (including land and rolling stock) of £3533. Sir John Macneill recommends that on these subsidiary lines there should be no intermediate stations, but that the porters should travel with the train, which, the speed being comparatively low (15 miles an hour) and the train light, should stop whenever necessary, as for instance when crossing any road (the porters opening and closing the gates), and "even at any farm house if they saw a signal." These and other suggestions, made with a view to economy and public convenience, appear to be deserving of the most careful attention in connection with the arrangements which have been recommended. Sir John Macneill proposes (as suggested above) to carry two classes of passengers only, and recommends rates of 1*d.* and 0¼*d.* per mile respectively. He is of opinion that on the line he has proposed the traffic, which he estimates at only £6 10*s.* per mile per week, will suffice to defray all expenses and to afford a profit of 5½ per cent. on the capital. * * * *

APPENDIX F 4.

APPENDIX F 4.

Locomotives specially designed for Road Railways, by Mr. Page, C.E.

NEW LOCOMOTIVE SPECIALLY DESIGNED FOR ROAD RAILWAYS, BY MR. PAGE, *C.E.*

(Extracted from the *Tasmanian Times* of 13 March, 1868, quoting from *Geelong Advertiser* of 24 April, 1868.)

THE subject of Road Railways is a very interesting one for Tasmania, because if Road Railways can be put down on the Main Line of Road, they can be put down on any other road in the Colony with equal facility, and possibly even at less expense. The use of common roads for steam locomotion was always a favourite theory with some of the earliest practical advocates of the adoption of the steam engine as a motive agent for land carriage. Then it was thought—and the theory has supporters still—that steam traction could be applied to common roads without using rails. But of late years the opinion has been gaining ground that the existing high roads and cross roads of Great Britain might be cheaply converted into railroads, by laying rails upon them, without deviation and on their present levels. The difficulty has always been to provide such a tractive power as should suffice to overcome the resistance offered by the steep gradients of the innumerable macadamised roads which traverse the United Kingdom in all directions. This question has occupied a great many minds; and of late years a Mr. Page, a Civil Engineer of some eminence, has devoted himself almost exclusively, and as it would seem with great success, to the practical solution of this interesting problem.

We are indebted to the *Geelong Advertiser*, of the 24th ultimo, for a notice of some important experiments recently made in England by Mr. Page with an engine and rails expressly designed for Road Railways. We are bound to say that the result of these experiments affords strong confirmation of the views, on this subject, which Mr. Cansdell has from time to time enunciated, when dealing in public with the question of railways in Tasmania. We reproduce the article from the *Geelong Advertiser* entire, as the simplest way of bringing the whole subject before the public. It is certainly a very startling account. And if the results said to be attained by model engines on Mr. Page's plan are really attainable in actual practice on common roads, no doubt a new era has commenced in steam locomotion and land carriage. And if these results are attainable at the cost per mile named in the article we are about to quote, all we can say is the sooner railways on Mr. Page's plan are applied to the roads of Tasmania, the better for the country and its material interests. We shall watch with some anxiety for further accounts of the actual adoption of this system on an English road. Once found to answer in practical working, the system will soon spread; and when it has received the stamp of success and public approval in England we may hope for its early adoption in Tasmania:—

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"One of the first matters probably that will engage the attention of Parliament will be a loan for railway extension, and the construction of feeding lines to our main trunks which we some time ago pointed out as most necessary, not only to increase the facility of railway transit, but as required to bring into play our railway scheme, and to make the whole a payable undertaking. We desire to bring before our readers some information we have obtained of a new method of ascending steep gradients, whereby the expenses of tunnelling and cuttings are avoided. The invention for which a patent has been taken out is made by Mr. Thomas Page, *C.E.*, &c., the eminent engineer, for the purpose of enabling locomotives to ascend steeper inclines than those practicable by the ordinary engines. Experiments have been attended with results which, had they been established in the early days of the railway system, would, it appears, have saved many millions of expenditure. On a model railway, about one-sixth of the full size, worked by a steam locomotive, the ascent of a gradient of 1 in 10 was witnessed by Captain Tyler and Colonel Yolland, Colonel Rich, and Major Hutchinson, the officers of the Railway Department of the Board of Trade. Since then another model railway on which the locomotive was worked by a spring showed the ascent of 1 in 4, in the presence of General Sir John Fox Burgoyne, *G.C.B.*, Captain Douglas Galton, *C.B.*, Major Wrottesley, Mr. Brassy, Mr. Blount, of Paris, Mr. Merton, and Messrs. Soldatenkoff & Chloudoff, from Moscow, Mr. Suturgio, and Mr. Grube, of Petersburgh. On a third series of trials the ascent was made of a gradient of 1 in 3 in the presence of Mr. Duncan M'Gregor and Mr. Herbert, of the Board of Trade; and lastly a further trial, on which occasion the extraordinary result was obtained of the ascent of a gradient of 1 in 2½, and there appeared to be no reason why even the gradient of 1 in 2 could not have been accomplished had the arrangements necessary for such a trial been made. These inclines are more severe than anything known in railway practice in England or elsewhere, and the experiments were made for the purpose of showing what could be accomplished by the fact of adhesion of the driving wheels of the engine and the surface of the rail or tram. The principle of the arrangement is, that there should be the least resistance given to the load to be drawn, but the greatest resistance to the driving wheels of the locomotive, the surface of which, and of the tram on which they work, are such as to prevent any 'slip' of the wheels. In the carrying out of this principle the peripheries of the wheels are made broad and slightly serrated, and the roughness of the tram on which the driving wheels run is made in proportion to the steepness of the incline. For Alpine locomotives the trains could be worked with facility at 1 in 10. The system is stated to be admirably adapted for branch lines and extensions, and thus prove valuable feeders to main lines. The tram railway for locomotives of this description could, it is stated, be constructed at a cost of not more than from £1500 to £1800 per mile, as there would be no occasion for incurring heavy expenditure for tunnels, cuttings or embankments, such as have involved railways in so large a portion of their expenditure. The fact that the locomotives on this system would be able to travel on ordinary inclines points to the possibility of adapting portions of turnpike roads to this mode of travelling, a matter which is in contemplation by Mr. Page and the gentlemen associated with him in carrying out the new system. As to this latter adaptation, the locomotive is described as resembling an ordinary road waggon in appearance, and will be free from the disadvantage of the noise of the steam escaping from the blast pipe, and from whistling, &c. The steam will be expanded in the cylinders, being cut off at 1-8th of the stroke on a level, and only worked at full pressure upon going up a steep incline. The arrangement consists of a tram of iron, stone, or timber on which the driving wheels of the locomotive run, and from the breadth of the wheel which is increased six or eight inches, and the roughness of the tram, a sufficient adhesion, or commonly speaking 'bite' is obtained, by which the locomotive will ascend steep gradients, with a heavy load. On the inner edge of the tram a rail two inches wide and an inch thick is fixed, on which the carriages run with flanged wheels, as on ordinary railways. There are no flanges on the locomotive driving wheels but the engine is furnished with vertical or diagonal guide wheels bearing against the inner edges of the train, and keeping the locomotive on the proper line. The advantages are stated to be first, extensive feeders to main lines of railway may be obtained at very moderate cost by laying down the tram railway on the sides of coach roads in localities which could not bear the expense of the construction of a branch line on the ordinary railway system; and it is stated to be evident that had the tram railway system been adopted for the ordinary branch railways at home, many millions of money ruinously invested might have been saved, and a very considerable per centage derived from this judicious mode of applying capital for railway purposes. Secondly, for countries in which the introduction of railways is yet in its infancy, the tram railway system recommends itself especially as furnishing at a small expense the means of railway communication on existing roads without the necessity of providing the special expensive construction of embankments, cuttings, bridges, and tunnels to form the line on a new route. The plan is considered most desirable for India, the Continent of Europe, for the formation of a railway over the Alps and Carpathians, and for crossing the heights of Asia Minor, and joining the Bosphorus with the Tigris and Euphrates. It is considered also that great advantages can be obtained in providing railway transit by the side of existing roads, by which the produce of the farm, the mine, the quarry, and the timber of our forests, can be conveyed with much greater facility. The cost at home is estimated as we have said at £1500 to £1800 per mile, but where timber and stone is abundant, that rate may be considerably reduced. We think the above facts and information worthy of attention on the part of our engineers and railway authorities; what the country wants is cheaper and effective feeding lines to the main trunks, and by Mr. Page's new system it would appear these feeding lines can be constructed more cheaply and efficiently than it has been hitherto calculated."

Capable of surmounting the steepest gradients.

By using this Locomotive Road Railways could be constructed for from £1500 to £1800 per mile.

Reports on Preliminary Surveys of proposed Routes for the Main Line Railway.

COPIES OF REPORTS ACCOMPANYING PLANS AND SECTIONS OF VARIOUS ROUTES.

APPENDIX G 1.

APPENDIX G 1.

Report of the late JAMES SPRENT, Esq., Surveyor-General, on a route from Kangaroo Point *viâ* Richmond, &c.

***REPORT** by Mr.* SPRENT *of his Examination of the Country between Hobart Town and Launceston with the view to the Construction of a Railway.*

Hobart Town, 18th February, 1856.

SIR,

HAVING received Your Excellency's instructions, as conveyed in the letter of the Colonial Secretary of the 14th December last, to proceed with all possible dispatch with the Preliminary Railway Survey, as explained in my Report, I have in consequence examined with barometers the country between Hobart Town and Launceston; and I now proceed to report to Your Excellency the result of my labours.

In whatever way we endeavour to advance into the interior of the Island we meet with a positive rise, in addition to the usual undulations of a hilly country. In making northerly from Hobart Town two directions present themselves,—the one easterly, having to deal with the valleys of the Coal River; the other westerly, having to deal with the valleys of the Jordan. But in each case, before we come to either of these waters, we have to advance some fifteen miles from the starting-place before the positive rise into the interior fairly commences.

By the eastern route we come to the Coal River at Richmond, about fifteen miles from Kangaroo Point. The valley of the Coal River at this place forms a plain, several miles in extent, in each direction. At Campania the valley becomes more contracted by the commencement of one of the branches of the Quoin Range at the Coal River

Sugarloaf, known also as Gunning's Sugarloaf. At Blinkworth's Farm (Lower Jerusalem), the valley further contracts, forming little more than a narrow ravine; and this latter feature, with very few exceptions, is maintained nearly up to the source of the Coal River. The Wallaby Rivulet forms a deep ravine at its junction with the Coal River: but, in advancing up this ravine, the country opens out into a small valley, in which is situated the township of Colebrook Dale, generally known as Jerusalem. This township or small valley is almost surrounded by high hills; but the lowest undulation in these, except from the south, lies in the north-westerly direction. At about four miles from Colebrook Dale in this direction, after a sharp rise, we attain nearly the highest point of the line of road between Richmond and Oatlands.

If we advance into the interior by the westerly direction from Hobart Town, the positive rise would begin at Pontville; a considerable elevation would be attained at Constitution Hill; while Spring Hill would be the highest point upon the whole line of road from Hobart Town to Launceston. The two lines would meet at Jericho, with very little difference in the distance gone over.

I have examined these several directions with the greatest care, and the continuation to Launceston. I will describe the first of these routes at the greater length, as it is the one which, in my judgement, has the decided preference in every point of view.

In commencing the Eastern Route, we start from the Judge's Point, the northern head of Kangaroo Point or Bay, and move onwards under the coast range in the direction of the present line of road to Richmond. The point is rather elevated—probably not less than 50 feet—above the level of the sea. At about 3½ miles from the point, we are met by a depression in the range over or under which the road must pass. The depression assumes the character of a narrow ridge, composed of a sand or clay-stone formation—for both rocks abound on the surface in the locality. The elevation of the ridge is about 480 feet above the sea, or 430 feet above the starting-place. If a tunnel were cut at 200 feet below the top of the ridge, we should reduce the rise to 230 feet above the starting-place, with a distance of 3½ miles, making the rise 66 feet per mile, or a gradient of 1 in 80. The tunnel might be a quarter of a mile long.

On the north-east side of the ridge, from the top to about seven miles from the starting-point, there is a descent of 370 feet. If we take 200 feet from this for the tunnel, we have 170 feet descent in a distance of 3½ miles, or 48 feet in one mile, or a gradient of 1 in 108. This point is nearly on the same level as Richmond; and, by keeping a little more to the eastward of the present line of road, I should anticipate very little difficulty in moving in that direction.

The line would leave Richmond a little to the right, near the residence of Mr. Buscombe, passing over a flat country towards the Coal River at Carrington, Campania, &c., to Stockdale, in the occupation of Mr. J. Stokell. In this neighbourhood the land near the river is about 375 feet above Richmond, distant about nine miles. This, if the rise were uniform, would give a mean rise of 42 feet per mile, or a gradient of 1 in 126; but as the rise from Richmond would not be of this uniform character, higher gradients would present themselves, but still of a favourable description.

From Stockdale to Clitherow's Creek the land near the Coal River rises some 30 feet, and thence leaving the river a further rise of 320 feet will bring us to Colebrook Dale; that is, from Stockdale the rise would be about 350 to the Township of Colebrook Dale. This rise would commence most favourably near Stockdale, spreading over a distance of some 6 miles or more to Jerusalem. This would give a rise of about 60 feet in a mile, or a gradient of 1 in 88. This rise would require much sidelong cutting and embanking, but a gradient such as above stated could be obtained.

The road would cross Colebrook Dale on the west side, or would cross lands lying on the west side of this township.

From Colebrook Dale to where the present road crosses the Wallaby Rivulet, moving north-westerly, there is a rise of some 150 feet in about 2 miles, or 75 feet in 1 mile, or a gradient of 1 in 70; but by some adjustment this gradient may be improved.

From this crossing to the upper boundary of Mr. J. Robertson's Farm of 640 acres, there is a rise of about 645 feet in 1½ miles or 430 feet per mile, or a gradient of 1 in 12, a rise beyond the power of any locomotive. Then there would be required a stationary engine.

From Mr. Robertson's upper boundary to a point in Mr. Stokell's property about a mile along the road, we arrive at the highest point of lower lands in this quarter at 75 feet above Mr. Robertson's boundary; this with a little adjustment would give a gradient of 1 in 80.

From this last place by the way of Jericho to Lemon Springs (Frost's Inn), the road would be found not far from the level; Lemon Springs Public-house being probably some 30 feet higher.

From Lemon Springs there is a descent of about 130 feet over a distance of 4 miles into Oatlands: but there are some small undulations in this distance, if we follow the present line of road. I should propose leaving Oatlands on the west, passing on to the east side of the lake. By this means I would hope to avoid undulations, descending more uniformly to the level of the lake at or near Ford's grant: I should also commence the rise to St. Peter's Pass at a much earlier period than I should be able to do by keeping the west side of the lake. The gradient from Lemon Springs to the Dulverton Lake would be by no means unfavourable.

From Oatlands to St. Peter's Pass there is a rise of some 220 feet in 1½ miles; but by passing round the east side of the lake the distance would be 3 miles, and by some adjustments this rise could be reduced, and a gradient of about 1 in 80 be obtained.

From St. Peter's Pass to Antill Ponds, about half-way to Launceston, there is a descent of about 700 feet in a distance of 8½ miles, or a descent of 82 feet in a mile, or a gradient of 1 in 63. I do not think this gradient can be much improved,—it may probably be made by artifice 1 in 70.

From this the country undulates, dipping towards the rivers and rising moderately in the intermediate parts, without much positive decline, until we come into the neighbourhood of the South Esk at Perth or Morven. But from Antill Ponds we can move in two directions, either by the way of Campbell Town or by the way of Ellenthorp Hall and Lincoln, each direction meeting in the neighbourhood of Perth. Each direction possesses some advantages peculiar to itself. By the way of Campbell Town we keep upon the upper ground, and are ready to take advantage of any favourable opportunities which may present themselves in the valley of the South Esk for crossing that river. Whilst by the way of Ellenthorp Hall and Lincoln we lose level in the valley of the Macquarie River; and have again to make an ascent to the valley of the South Esk. But on the other hand, by the eastern direction we cross the Blackman, Macquarie, and Elizabeth Rivers; while on the western route we cross only the Blackman and the Macquarie Rivers: each direction is worthy of minute consideration in a detailed survey.

I have examined the country minutely in the neighbourhood of Perth and Morven, and I find no way of approaching Launceston so favourable as that by the way of Morven or Evandale.

Launceston is nearly surrounded by a girdle of rather high hills. The range comes up from the west side of the Tamar, and passes on towards Perth where it declines. Near Launceston it throws off a low spur forming the Sandhill and Windmill Hills of that locality, and abuts closely upon the North Esk. More southerly it throws off another spur of a higher character a little to the south of the junction of the Evandale with the main line of road. This spur rises to about 800 feet above Launceston, over which the road passes; but trending in an easterly direction towards Morven, it declines as it advances. A little to the east of that township the spur forms a small declination, *Reports on Preliminary Surveys of proposed routes for the Main Line Railway.*

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about 1½ miles from the South Esk, and is the dividing ridge between the waters of the North and the South Esk. Crossing this ridge we come upon a valley leading down to the North Esk, and the waters of this valley join the North Esk at Mr. Rose's Estate at Corra Linn. The top of this ridge is above the junction with the North Esk about 470 feet, and the distance is about 7 miles. This would give a descent of 67 feet in a mile, or a gradient of 1 in 80. But upon a detailed survey this gradient is susceptible of some improvement. The North Esk at this junction is about 75 feet above Launceston, and about 6 miles distant. The entrance to Launceston would be by the way of the Racecourse.

Upper Coal River.—Above Clitherow's Creek on the Coal River the valley becomes very contracted; but, in endeavouring to form a road in that direction northerly, this is the place at which the rise would commence. The road would be upon the west bank. I have examined this bank, as well as the river, minutely several times. The general aspect is great irregularity and difficulty of access, with very deep precipitous sandstone cliffs. The land between Lake Tiberias and the Coal River is elevated above Clitherow's Creek about 1270 feet, or about 240 feet above Oatlands: the distance is about 14 miles. This would give a rise of 91 feet in a mile, or a gradient of 1 in 58. Having attained this rise, there would be little difficulty in moving onwards towards Oatlands, the country in this interval being rather favourable for Railway operations.

I tried the river still further on easterly near Mr. Rumney's grant, leaving the valley of the river upon Mr. Brock's leased lot No. 179; and, making almost due north, I passed over some of the spurs of Mr. Seymour upon Mr. Wilson's land, and in this way came upon the early waters of York Rivulet. But the lowest passage I could obtain this way was about 400 above Oatlands.

From what I have seen of this upper part of the Coal River, the formation of a Railway in this direction would be a work of great difficulty, and attended with largely increased expenditure.

I have examined carefully the Dulverton Rivulet and the Jordan after the junction. The first few miles of the rivulet after leaving Oatlands are suitable for Railway operations. The rivulet soon enters a ravine, and, joining the upper part of the Jordan coming from Jericho, continues in it, with very little exception, until within a short distance of the Bothwell Road, near the Cross Marsh. There are very few of the more usual features of a valley adjacent to this water-course. The river has excavated itself a bed generally in sandstone, but with very frequent bends and short narrow points, admitting of very little improvement by artificial means. The whole seems to be upon too small and irregular a scale to encourage the prosecution of extensive works of a bold character.

It struck me frequently whilst traversing these ravines that they might be made available for local purposes. The descent is very moderate and regular; and there is generally in the bottom a limited breadth of land suitable for a narrow roadway. Hence a tramway, formed upon longitudinal sleepers and held up by tressels, could be made so as to meet the requirements of the locality. The road would as a whole be circuitous; but as it would run through the farms on either side, this would not be severely felt by many on the whole line. The descent from Oatlands to the Cross Marsh is about 630 feet; the distance may be about 26 miles by the river, giving a descent of 24 feet in a mile, or a gradient of 1 in 220. I did not examine the Jordan any lower down.

I have examined the main line of road from Hobart Town to Oatlands, more particularly in the vicinities of Constitution and Spring Hills. I could find no directions in which these great rises could be avoided. The rising and falling at these positions seem favourable for tunnels; but these would be of great length, and, passing through ironstone, works of great labour and enormous expense.

Here my Report properly ends. I have established the fact that a Railway between Hobart Town and Launceston is practicable; and now the subject is in the hands of Your Excellency. It is a question of economy, and one involving a great variety of important considerations. This great question naturally resolves itself into two parts—one relating more particularly to the nature of the road, and the speed; the other to the ways and means. The first refers to subjects connected with my own profession, and requires from me some discussion, by which Your Excellency may be put in possession of a certain kind of information absolutely necessary for entering upon the second part of the enquiry, and for the final arrangement and determination of the whole subject.

1. In England, railways are made with two lines of rails; but in America and New South Wales one line only is the general character; where the traffic is particularly active, two lines are requisite. In the case of one line, the breadth of the roadway may be taken at 20 feet,—that is, 6 feet for the rails, 5 feet on each side of the rails, and 2 feet each for a drain on each side of the road. In sidelong cuttings one drain only would be required,—and in embankments none. When two lines of rails are laid down, the breadth of the roadway would be about 32 feet,—that is, 12 feet for the rails, 6 feet for the interval between them, 5 feet each for the sides, and 4 feet for two drains.

2. *Speed.*—This is one of the most important questions in the whole range of railway economy; it stamps the feature, and to a great extent the expense of the whole operation; and, when once determined, many of the ulterior arrangements take their places as a matter of course. In England, the speed is of the highest character,—and in an active traffic time requires such; and hence in the construction of railways any amount of expense incurred to acquire these essentials. But here, where traffic is limited, time would not form so important an article or element in the problem,—it would be rather a luxury than an essential,—and a much less speed than is usual in England would suit our requirements. In America we may find the best parallels to our own case: in this part of the world railways prevail to a much greater extent than in any other quarter. The rate of travelling when the traffic is active is, perhaps, equal to that in Europe; but in parts where the traffic is limited, the speed is much below that of Europe. In the first we find the rates from 20 to 30 miles an hour; while in the second class the rates are about 14 or 15 miles an hour for Passenger trains, and 12 miles an hour for Goods trains.

3. *The gradients and curves.*—A road constructed for these latter rates—viz. 15 miles for passenger, and 12 miles for Goods trains—would differ widely from a road on which great rapidity was required. The gradients might range of a high character, and the curves changing the direction of the lines might be of a much less radius. In Tasmania, from the nature of the country, the gradients must be unavoidably high; and, as there would be frequent changes in the direction from the quantity of sidelong cutting, much would depend upon the character given to the curves which effect these changes. In railways when high speed is expected, high gradients are not allowed except with stationary engines, and the curves are necessarily large, having a radius of seldom less than half a mile,—and the present practice is further increasing this minimum; but in low rates of speed curves of small radius will not be dangerous. In America, Dr. Lardner states, such curves having a radius of 1000 feet are usual; and occasionally curves of 500 feet, and even less, are allowed:—still he affirms that railway accidents are unknown there.

4. *Traffic.*—The probable amount of traffic is another important element bearing upon the nature and construction of the railway, but particularly upon the nature of the rails. In England rails are invariably made of iron: at first 35 lbs. per yard was thought a sufficient weight,—but now rails are used of double that weight; and on some lines rails of 80 lbs. have been recommended for the future. But in America, where the traffic is light, Dr. Lardner states that the rails consist of bars of iron of two and a half inches broad, and from five to seven tenths of an inch thick, nailed or spiked down to planks, laid longitudinally on the road, in parallel lines at the proper width, so as to form what are called continuous bearings. Some of the most profitable lines, he further adds, and those of which the maintenance has proved the least expensive, have been constructed in this manner. In railways of considerable traffic rails of from 20 to 30 lbs. per yard have been laid down; and in some cases of still greater traffic

other means have been adopted to give additional strength to such rails: owing to the facility of obtaining wood, and its cheapness, the strength necessary for the road is obtained by reducing the distance between the sleepers, so as to supersede the necessity of greater height to the rails.

Reports on Preliminary Surveys of proposed routes for the Main Line Railway.

APPENDIX G 1.

Report of the late JAMES SPRENT, Esq., Surveyor-General on a route from Kangaroo Point *viâ* Richmond, &c.

5. *Expense.*—The subject of expense is one of a very general nature. In England the expenses are very great, and very many are caused by circumstances which do not exist here. We are particularly situated,—we have particular means, and are free from legal, Parliamentary, and other expenses which swell to a large amount at home. In America we find railways constructed at very varied sums. Dr. Lardner gives a list of about 150 lines; the maximum expense of these is £22,222 per mile, and the minimum £2107 per mile, each with the plant. The first is perhaps a double, and the second a single line.

The above subjects form the principle items in giving the character to a railway operation, and with the question of the ways and means constitute the whole subject.

I am under a strong sense of the importance of such works in this Colony, but at the same time I feel that we have little experience suitable to our position to guide us. We must, if possible, form a system of our own, taking in from others whatever may be adapted to our own situation, means, and traffic. It is not difficult to see that Your Excellency can do but little by following English models; but, with the command of hard timber which this Colony possesses, something can be done approximating closely to our present requirements, and even making a moderate advance into the future.

It has occurred to me that I might gather much information upon the subject in New South Wales, by examination of the works now in active operation, and those projected but not yet finished. If Your Excellency should entertain a similar opinion, I should take great pleasure in visiting that Colony at my own expense, under my usual pay and allowances. Awaiting Your Excellency's further commands upon this subject,

I have the honor to be,
Your Excellency's obedient Servant,
JAS. SPRENT.

I have added to this report a map of the country round Oatlands; it shows the positions of the different parts of the line.

To His Excellency
SIR H. E. F. YOUNG, *Knt.*

APPENDIX G 2.

APPENDIX G 2.

Report of the late JAMES SPRENT, Esq, on Branch Line *viâ* Perth, Longford, Westbury, and Deloraine.

REPORT on the Preliminary Survey by the late JAMES SPRENT, *Esq., Surveyor-General, of a Branch Line to connect the Main Line Railway with Longford, &c.*

Hobart Town, 10th June, 1856.

SIR,

HAVING received your instructions to make a preliminary survey of the country in the direction of Perth, Longford, Westbury, and Deloraine, so as to show the practicability of connecting these places by a Branch Railway with the proposed Main Line of Railway between Launceston and Hobart Town, I have the honor to report the result of my examinations.

A branch to the above-named places would leave the main line a little to the north of Morven—probably about 10 miles from Launceston—on or near the ridges dividing the waters of the South Esk from those of the North Esk. It would cross the road from Morven to Launceston, and keeping near the South Esk would pass through Perth, and following the present road to Longford would meet the South Esk. It could cross this river at the large bend near Mr. Clayton's, where we should come upon the road from Longford to Carrick. Following this road for some two or three miles, and then leaving it to the right, we could advance to the Liffey, leaving the Township of Carrick also upon the right, and crossing the Liffey at some place near the Township boundary most suitable for the purpose. We could then advance towards Westbury much in the same direction as the present line of road, either entering Westbury as at present, or about three quarters of a mile more to the southward.

Leaving Westbury as circumstances would permit, we could readily advance onwards a little to the south of the present road for about two or three miles from Westbury, and then on the north side of the present road until we made Deloraine.

Another direction might be obtained from the South Esk. Crossing that river at some place near the present bridge, we might follow the direction of the road to Bishopsbourne for about three miles; then cross through the Lagoons, the Bishopsbourne estate, and the Liffey to the location to Thomas Thomson, now part of the Reibey estate, and thence in a line very little irregular onwards towards Westbury.

I examined minutely the direct route—viz., from the crossing opposite Mr. Clayton's at the South Esk to Westbury; but the low range between the South Esk and the Liffey always presented serious difficulties, both in rising from the South Esk and in descending to the Liffey, and again in rising from the Liffey, which rendered this direction very objectionable.

I will now describe the gradients which may occur in these several lines.—The main line of Railway would cross the Morven ridge at an elevation above Launceston of about 550 feet; and at probably about 10 miles from that place the branch road to Perth would commence. This branch would pass westerly over the Morven ridge, leaving the Township of Morven a little to the left or south, and crossing the road from Morven to Launceston at about 1¼ miles from the commencement, with a rise of about 30 feet at the road. Between this and Perth there is a low range coming from the north west which dips to its lowest elevation near the river, forming a small flat. This part is about three quarters of a mile distant from the crossing of the road, and is elevated about 45 feet above that place: hence we have a rise of 75 feet in about two miles, or 37½ feet in one mile, or a gradient of 1 in 140. This point is about three miles from Perth, and about 35 or 40 feet above that place; and, as we are upon the crossing of the ridge on the side next to the river, we may enter Perth in a winding direction, but at a very low gradient,—say 13 feet in

Reports on Preliminary Surveys of proposed routes for the Main Line.

APPENDIX G 2.

Report of the late JAMES SPRENT, Esq., on Branch Line *viâ* Perth, Longford, Westbury, and Deloraine.

a mile, or 1 in 406. From Perth, following the road to Longford, there is a descent of 62 feet at the Toll-bar in a distance of about two miles, or 31 feet in a mile, or a gradient of 1 in 170. From the Toll-bar to the proposed crossing-place of the South Esk opposite Mr. Clayton's, there is a further descent of 85 feet in about two miles more, or 42½ feet in one mile, or a gradient of 1 in 124. This last gradient could be reduced by having a bridge rather elevated above the river—say 30 feet—which would also much improve the gradients on the opposite side. From Morven to the South Esk, at or near this place, there is little room for choice: the natural features of the country are such as to admit of no other direction; but from this, the country is not of so strictly a limited character.

If we cross the river at Mr. Clayton's, we come upon the road from Longford to Carrick in a hollow, in which, at some seasons of the year, there is a small creek or rivulet,—and this would be the level of a bridge over the South Esk, at some thirty feet above the river. From this place we have a smart rise of 50 feet in about half a mile, and then for about three quarters of a mile a descent of about 20 feet, showing an undulation susceptible of great improvement, and capable, by cutting, of being reduced to a gradient of a moderate description. From this place through the estates of Messrs. Dumaresq and Reibey we pass onwards towards Carrick by a series of small undulations, but upon the whole with very little rise. These undulations are very moderate, and could be reduced nearly to a level. We come to the Liffey on the south side of the township of Carrick. The banks here are bold, the span narrow, and each side very much upon the same level. After crossing the river, we approach the main line of road from Launceston to Westbury, and can move onwards in that direction towards Westbury. After leaving the Liffey for about two miles and a half, the country is nearly level, or dips very slightly; but at about four miles from Carrick, opposite the residence of Mr. Dry, we have a depression of about 70 feet below Carrick. This depression is of short duration, and runs off in about one mile to its former level: hence this depression may be much relieved, and by the usual appliances converted into a moderate gradient. From this place a series of very gradual rises brings us to the township of Westbury, having a total rise from the depression opposite Mr. Dry's to the highest part of the township along the road of 140 feet in a distance of about five miles. The Quamby Rivulet upon the western side of the township of Westbury is depressed below the township about thirty feet; but, as the ground soon rises on the opposite side of the river, a bridge of that elevation would make up this defect, and this undulation would present no difficulty.

From Quamby Rivulet, in the direction of Deloraine, there is a continuous rise for about two miles and a half, amounting at the top to 175 feet. If we deduct 30 feet for the bridge at the river, we have only a rise of 145 feet, or 58 feet per mile, or a gradient of 1 in 91. This gradient could be further improved by a cutting at the top of the rise. From this point to the Deloraine bridge there is a series of rises, or rather small undulations, which, upon the whole, make a rise of 133 feet in a distance of about six miles and a half, or about 20 feet per mile, or a gradient of 1 in 264. The present undulations in the road would be much avoided by keeping nearer the river in this latter part of the line.

Westbury might be entered to the southward of the present line of road, and, crossing the river about half a mile above the present bridge, we might again come upon the main road about two miles from Westbury. This direction would have the advantage of avoiding the more occupied portion of the town.

In endeavouring to move directly from the South Esk to Westbury, the chief impediment is a low flat range, lying between the South Esk and the Liffey, declining on the north towards the Meander, and on the south towards Longford. The route I have just described passes over the northern dip; and the road to Bishopsbourne passes over the southern shoulder, at the commencement of the dip towards Longford. On leaving the South Esk, the road to Bishopsbourne advances along the most favourable spur for about two miles and a half to three miles, rising about 160 feet in that distance; but this would not give a mean gradient, the latter part of the rise being much more rapid. Much, however, could be done by cutting, &c., but this would be of an extensive description. From this we should pass over levels for probably two miles, among or near to the lagoons, and thence by a moderate descent to the Liffey; after which there would be no difficulty in moving towards Westbury.

Following the direct line to Westbury from the South Esk, we should cross the range before mentioned at a higher elevation; probably at not less than 200 feet above the South Esk, in a distance of one mile and a half or two miles, under the most favourable circumstances, or 100 feet per mile, or a gradient of 1 in 53. We should then pass over the top for about two miles, and then have a descent to the Liffey of a rapid character, with a similar rapid rise on the opposite side, when, as before, the difficulties would cease.

The most direct line would, of course, be the shortest, but would, under the most favourable circumstances, have by far the highest gradients. The route by the way of Carrick would be the nearest to the direct line in distance, would have the more favourable gradients, and would not exceed the direct line by more than one mile. The way by Bishopsbourne would be the longest line, and would have more objectionable gradients than the Carrick line, but less than the direct line. On these accounts I would recommend the line by the way of Carrick as possessing the most advantages, either for the facility of construction, or in the ultimate working.

I examined the line of road from Carrick to Launceston. From Carrick to Entally there are several undulations, but those could be very much reduced by the usual means. The whole descent to the bridge at the latter place is about 90 feet in a distance of 4 miles, or about 22½ feet per mile, affording very favorable gradients. On leaving the bridge there is rather a sharp rise in passing up the village of Hadspen, and then a descent to a level very little above that of the bridge. This rise might probably be avoided by following the river until this undulation is passed. About half a mile from this valley we come to the Traveller's Rest, and the junction of the Longford and Norfolk Plains road, at about 50 feet of a rise. Proceeding onward for about 1½ miles more, we come to the highest part of the road between Hadspen and Launceston, having a rise in these two miles of about 190 feet, or 95 feet per mile, or a gradient of 1 in 55. From this point to the junction with the Launceston road to Hobart Town, a distance of about 2 miles, there is a descent of about 530 feet, or 265 feet per mile, or a gradient of 1 in 20. The business part of Launceston is still further depressed. The Tamar is depressed about 640 below this point.

I am not aware of any other route in this neighbourhood more favourable for a direct line than this one over which the road now passes.

A map of these localities accompanies this Report.

I have, &c.,

JAS. SPRENT.

The Honorable Colonial Secretary.

APPENDIX G 3.

Report by G. Innes, Esq., on Plan and Section of Main Line.

APPENDIX G 3.

REPORT by GEORGE INNES, *Esquire, District Government Surveyor, accompanying Plan and Section of the Main Line Road from the 3rd Milestone to Oatlands.*

SIR,

I AM now able to supply a general Report in connection with my recent survey of part of the main line of road, under a contract with the "Main Line Railway Royal Commissioners."

The object of this survey, as I understand it, was chiefly to ascertain the practicability, or perhaps I should rather say advisability, of utilising the existing road by adopting it as the basis for a line of Railway, which it has been suggested might be constructed upon its centre or crown.

I regret to be compelled to state that the information I have acquired during the progress of the work, and the preparation of the plans, forces me to the conclusion that it is, to say the least, eminently undesirable that a Railway should be constructed in the manner proposed.

I am, however, fully alive to the necessity which exists for adopting the cheapest known principle in the construction of a Railway through a Colony like ours, where for a long period only a comparatively limited amount of traffic, and consequent return for the outlay, can be expected, but I can hardly see how the advantages sought for, viz., economy of construction, can be attained in the case under notice.

It can scarcely be contemplated that the locomotive and ordinary traffic should indiscriminately occupy the same road, as such an arrangement, although probably quite practicable in exceptional cases or combined with very low rates of speed, would, in my opinion, neither satisfy the public nor indeed the requirements of the country. It must, therefore, be admitted that another and separate road would have to be constructed for purposes of ordinary traffic: in fact, from the tenor of the instructions for my guidance, I may presume that such was contemplated.

I would, therefore, point out that the width of the present road, which has been constructed at a very considerable cost, is far in excess of present, and probably future, railway requirements,—so that here, to commence with, an element of unnecessary "waste" would be exhibited. I am also of opinion that the cost (other circumstances being favourable) of laying down a Railway upon the existing road—increasing its width as suggested to two chains—and constructing another by its side for ordinary traffic, would exceed in amount the sum required for the construction of a better line apart from, and independent of, the main line of road.

But another, and more fatal objection, to the project as a whole exists in the fact demonstrated by the Plans and Sections I have forwarded, that neither the gradients nor curves of the existing road are such as any Engineer could admit for a line of Railway passing through a country where so much better could be obtained without extraordinary cost. I will illustrate this by the following analysis from the Tables of Gradients and Curves relating to that portion of the road between New Town and Bridgewater:—

Gradients.

From New Town to Bridgewater, distance in chains	680
Aggregate length of gradients exceeding in steepness 1 in 60, in chains	270

Curves.

From New Town to Bridgewater, distance in chains	680
Number of curves of a less radius than 40 chains	39
Aggregate length in chains	207
Number of curves of a less radius than 20 chains	28
Aggregate length in chains	143

It will thus be seen that of this part of the road, (about 8½ miles) upwards of two-fifths of its length presents what I may here term impracticable gradients, and that the curves are likewise, to say the least, exceedingly objectionable.

I wish it, however, to be understood that, notwithstanding my application of the term "impracticable" in connection with gradients exceeding 1 in 60, I am by no means so ignorant upon railway subjects in general, or of the extraordinary revolution in such matters now in actual progress, as to contend either that steeper gradients are not constantly worked on many lines constructed upon the ordinary principle, or that in certain exceptional cases of engineering difficulty gradients of a higher rate of inclination than any presented by the Main Line of Road may not be successfully surmounted; but in the former case heavier locomotive engines, and consequent increased cost of construction and working expenses, are involved; and with regard to the latter, I would remark that a mode of construction which might be most suitable in a more remote locality, with natural features of a less favourable character, would be out of place in this particular instance of a portion of a line passing through a comparatively level country, within a short distance of its principal terminus, and upon which the maximum amount of traffic might be expected.

It is true the present road might be so altered as to adapt it to the end proposed, but such alterations and improvements would necessarily extend in most cases much beyond the limit within which the objectionable gradients and curves are confined, thereby involving a very large amount of additional cost.

Although, for the reasons I have stated, I cannot do otherwise than consider that many serious objections exist to the construction of a Railroad upon the crown of the existing highway, I think it by no means impossible that some modification of the proposal might be favourably entertained, and I beg in continuation to offer a few remarks upon the general subject of a "Main Line Railway."

Here, however, I must point out that, from the nature of the work required of me by the Commissioners, the extent of my observations was necessarily so limited as to preclude the possibility of this being of much service excepting in connection with a line of Railway proposed to be constructed in the immediate vicinity of the road itself. It is, therefore, only of the practicability or otherwise of that particular work that I feel able to speak with the slightest degree of confidence.

As a commencement I may at once express my opinion that the natural features of the country in the immediate vicinity of the main line of road between Hobart Town and Oatlands, are such, that the construction of a railway

Report by G. Innes, Esq., on Plan and Section of Main Line.

APPENDIX G 3.

with favourable gradients, say none less than 1 in 50, would be a most costly undertaking. At the same time, I believe all difficulty may be overcome and the route rendered feasible by adopting for short distances, and in certain places which I will hereafter point out, the improved principle now in operation on the line over Mont Cenis, by the aid of which gradients of 1 in 15 or 20 may easily be surmounted.

One, I may almost say the first, consideration in connection with any particular route which may hereafter be selected for a Main Line Railway will be the means of crossing the Derwent, whether by a fixed bridge or by a steam pontoon. Viewed in an economical light the latter should no doubt receive the preference, but, as it is a question which must obtain a much fuller investigation than I have the opportunity of giving to it, it is needless for me to hazard an opinion: should, however, (as is most probable) this plan be decided upon, the crossing place would probably be lower down than the site of the present bridge, and I should indicate the vicinity of Austin's Ferry. Up to this point from Hobart Town there would, I apprehend, be little difficulty in securing a favourable line involving no very considerable expense for earthworks. After crossing the Derwent the Railway would either follow the valley of the Jordan or pass through Old Beach,—in either case the earthworks will probably for some few miles be of an expensive character, but the necessity for bridging the Jordan and the hill at Brighton will by this means be avoided. The line I am proposing would join the main road about half a mile beyond Brighton; from thence, running by its side for some miles with occasional slight deviations or until reaching the foot of Constitution Hill, very favourable gradients being up to that point perfectly attainable, I should then suggest a considerable deflexion to the left, passing over another saddle of the Constitution Hill range in order to avoid the main road altogether, and thus obviate the inconvenience which might otherwise arise from the necessity for crossing and recrossing it. Here the gradients would be steep, and the improved principle (with the middle rail) brought into operation. The line would again join the main road at the further extremity of Green Ponds, pass along the side of it to Melton Mowbray with ordinary gradients, from thence ascending Lovely Banks Hill by the aid again of the third rail. From the top of the hill I should again suggest a circuit to the left, involving however some rather heavy earthworks, but by which it seems to me that some considerable part of the Spring Hill difficulty may be overcome, and the distance for which steep gradients would be required reduced to a minimum. For a part, however, of the ascent, and probably the whole of the descent, of Spring Hill the improved principle must again be used. From Jericho to Oatlands ordinary gradients can with little difficulty be obtained excepting in the descent of Lemons Hill, which however might possibly be avoided.

In my view of the matter it would be preferable in those cases where steep gradients are unavoidable to adopt the very steepest admissible, for these important reasons,—1st, Better curves could be obtained; 2ndly, There would be a minimum distance of expensive cuttings and mode of construction; 3rdly, There would be a diminution of speed for a less period of the journey: for in this respect I apprehend, although I do not know as a fact, that the difference between the speed attained upon a gradient of 1 in 15 and upon one of 1 in 30 would not be in proportion to the difference in distance.

By the method I propose the total length of "heavy gradients" between Hobart Town and Oatlands would not exceed 10 miles, involving probably an extra half hour for the journey.

I am aware that some other routes have been proposed as more favourable for the construction of a Railway between Hobart Town and Launceston: of their merits or demerits I know nothing, and therefore will not presume to express an opinion beyond this, viz., that the route followed by the main road should receive a fair and impartial consideration owing to these important facts;—1st. That an existing and long established channel of communication through a country cannot be diverted into a new course without serious injury thereby resulting to individuals and communities; and with reference to this I may state that I could not avoid noting in my progress that the improvements in the various towns passed through are even now far in excess of their actual requirements. 2ndly. That an important principle to be studied in the proposed construction of a Railway should be the absorption to the greatest possible extent of the already existing traffic, thus ensuring a certain amount of immediate reproductiveness.

Under these circumstances it appears to me that, viewed as a national work to be constructed at the public cost, the question of which particular route or mode of construction should be adopted is one to be settled by Legislative decision, based upon the fullest information obtained and submitted, rather than by the "ipse dixit" of any particular engineer or engineers.

For the reasons to which I have already adverted, viz., the limited nature of my survey, I cannot be expected to supply even an approximate estimate of the cost of constructing a Railway in the manner and upon the route I have indicated; I shall therefore confine myself in this respect to a mere opinion, based, of course, upon my general knowledge of the country, that the cost of earthworks for a single line of rail should little if at all exceed £1000 per mile. Here, however, I must explain that I by no means contemplate that the radii of the curves should arbitrarily be limited to 40 or even 20 chains, there being no doubt exceptional cases (which should be as few as possible) in which such a restriction would entail increased cost not counterbalanced by the advantage thereby derived.

In conclusion, and bearing upon the question of cost, I would urge the importance of sufficient regard being paid to the essential elements of success in any Railway, viz., that its cost of construction, maintenance, and working should be so regulated with regard to the wants of the community as to admit of establishing the lowest possible rate of charges, and to afford a reasonable hope that at no very distant period a sufficiently clear return may be expected to cover the interest upon the original outlay.

I have the honor to be,
Sir,
Your very obedient Servant,
GEORGE INNES.

The Chairman,
Main Line Railway Royal Commission.

[REFERENCE BOOK referred to in the preceding Report, and accompanying the Plan and Sections of the Main Road from the 3rd Milestone to Ross-street, Oatlands.]

TABLES of Straight Lines, Curves, Gradients, and Particulars of Culverts, Bridges, Cuttings, and Embankments in each Sheet of Plans.

No. of Sheet.	Chains of straight Lines.	Chains of Curve.	Radii of Curves.	Inclination of Gradient.	Length of Gradient. Level	Rise.	Fall.	Bridges and Culverts.	Roads, &c.	Chains of Cutting or Embankment.	Description of Cuttings.
			chains.								
1 NEW TOWN.	71	5	13	1 in 60	..	..	30	Culvert No. 1, rough stone, timber top, (bad order), 24 in. x 24 in. No. 2, 24 x 24, stone, (good). No. 3, 24 x 24, brick, stone, and wood, (fair order.) No. 4, 24 x 15, stone, (good.)	Street	None	
	4			About level	50				Lane to Risdon Road		
									Occupation road		
									Street		
Total....	75	5									
2 O'BRIEN'S BRIDGE.	10	7	25	1 in 35	..	9		Culvert No. 5, 28 x 28, (double), stone, (good.) Bridge No. 1, (O'Brien's), masonry abutments, timber top, diagonal braced, span, 36 feet; height of water way, 6 ft. 8 in. Good repair.	Occup. road	None	
	16	7	14	1 in 89	..	3			Private road to Mrs. Murray's		
	19	5	9	1 in 79	..	..	6		Lane to Tolosa		
	16			1 in 39½	..	..	6		Private road		
				1 in 46	..	..	6		Victoria-street		
				About level	6				Lane		
				1 in 70½	..	6			Private road		
				About level	15				Street		
				1 in 48½	..	4			Private road		
				1 in 48	..	..	5				
				1 in 50½	..	..	6				
Total....	61	19		1 in 96	..	..	8				
3 O'BRIEN'S BRIDGE.	6	9	60	About level	5			Culvert No. 6, 42 in. diameter, circular brick, (bad.) No. 7, 36 in. diameter, circular brick. No. 8, 36 in. ditto ditto, (bad.) Bridge No. 2, masonry abutments, timber top, span, 14 feet; width, 66 feet; height of water way, 11 feet.	Occup. road	13	Clay.
	33	10	60	1 in 39	..	9			Ditto	11	Sandstone and clay.
	22			1 in 94	..	3			Private road	7	Clay.
				About level	30				Ditto		
				1 in 53	..	..	9		Lane		
				1 in 95	..	..	6		Occup. road		
				About level	9						
				1 in 62	..	..	8				
Total....	61	19									
4 GLENORCHY.	6	6	60	1 in 66	..	..	9	Culvert No. 9, 36 x 36, stone-brick arch, (bad.) No. 10, 36 diameter, circular brick, (good). No. 11, 36 diameter, ditto (good.) No. 12, 36 diameter, ditto, (bad. No. 13, 24 x 24, flat topstone, (bad.)	Private road	5	Shottery ironstone and clay.
	14	15	20	About level	6				Occup. road	4	
	18	6	30	1 in 122	..	..	12		Right of way to river	3	Clay.
	8	4	10	1 in 56	..	..	3		Private road to T. Y. Lowes	3	Clay, gravel, & boulders.
		3	5	About level	3						Ditto (both sides.)
				Ditto	3				Ditto		
				1 in 66	..	6			Private road		
				1 in 42	.	..	5				
				1 in 76	..	3					
				About level	6						
				Ditto	6						
				1 in 125	..	6					
				1 in 32	..	3					
				About level	4						
Total....	46	34		1 in 28	..	7					
5	25	5	9	1 in 132	..	3		Culvert No. 14, 15 x 18, masonry, (bad.) Bridge No. 3, masonry, timber top; span, 10 feet; width, 48 feet; height of water way, 7 feet 6 in.; very strong.	Occup. road	5	Clay, gravel, & boulders (both sides).
	11	3	20	1 in 55	..	..	12		Ditto		
	7	4	8	1 in 100	..	..	3		Private road	12	Embankment.
		3	30	1 in 94	..	6			Ditto	7	Shottery ironstone and boulders.
		5	5	1 in 40	..	6			Occup. road		
		7	15	1 in 30	..	3				3	Ditto (both sides).
		6	15	1 in 40	..	..	9				
		4	20	1 in 36	..	..	4				
				1 in 18	..	..	6				
				1 in 36	..	..	2				
				1 in 66	..	3					
				1 in 21	..	4					
				1 in 28	..	2					
				1 in 45	..	6					
Total....	43	37		1 in 128	..	11					

No. of Sheet.	Chains of straight Lines.	Chains of Curve.	Radii of Curves.	Inclination of Gradient.	Length of Gradient. Level	Rise.	Fall.	Bridges and Culverts.	Roads, &c.	Chains of Cutting or Embankment.	Description of Cuttings.
			chains.								
6	5	3	20	About level	10			Culvert No. 15, 48 x 60,		10	Clay, gravel & boulders
	10	7	16	1 in 38	..	..	14	masonry arch, (good).	Occup. road		(both sides).
	3	5	10	About level	6			Nos. 16 & 17, 30 x 72,	Road to Austin's	18	Embankment.
		11	60	1 in 76	..	8		ditto (good). No. 18,	Ferry	10	Shottery ironstone (both
	14	10	25	About level	15	..		24 x 28, flat top-stone,			sides.
	5	7	16	1 in 49	..	27		(good).		2	Clay.
								Bridge No. 4, masonry		4	Embankment.
								arch, 9 ft. 6 in. x 8 ft.;		6	Clay.
Total....	37	43						40 feet wide; very strong.		4	Embankment.
7	8	8	40	1 in 40	..	10		Culvert No. 19, 24 x 18,	Lime-kiln road	7	Embankment.
	4	4	10	1 in 23	..	4		stone, timber top, (fair).	Private road	13	Clay (both sides).
	35	6	30	1 in 28	..	4		Nos. 20 & 21, ditto, (fair.)		8	Embankment.
	7	8	40	1 in 45	..	..	8			8	Clay.
				About level	5	..				6	Ditto, (both sides.)
				1 in 96	..	9				17	Shottery sandstone and
				1 in 25	..	..	6				clay.
				1 in 19	..	..	17			11	Embankment.
				1 in 25	..	..	5				
				1 in 70	..	..	5				
				About level	5						
				1 in 100	..	..	2				
Total....	54	26									
8	13	5	8	About level	11			Culvert No. 22, 30 x 12,	Occup. road	13	Embankment.
	14	5	12	1 in 34½	..	9		flat top-stone, (fair order.)	Street	8	Marl and boulders, (both
BRIDGE-		4	8	Level	15			No. 23, 24 x 8, ditto,			sides).
WATER.	11	3	5	1 in 66	..	..	9	(good.) No. 24, 18 x 9,		2	Embankment.
	3	4	8	About level	11			ditto, (good.) No. 25,		18	Clay.
	3	7	18	1 in 24	..	..	3	18x12, ditto, (good.)			
	8			About level	9						
				1 in 78	..	3					
				1 in 89	..	..	5				
				About level	5						
Total....	52	28									
9	2	2	4	Level	70			Culvert No. 26, 60 x 36,	Occup. road	5	Clay.
	2	15	70	1 in 70	..	5		stone, timber top, (good).	Road to New	11	Gravel and boulders.
BRIDGE-		4	7	Level	5			No. 27, 24 x 24, flat top-	Norfolk	8	Shottery sandstone.
WATER.	4	3½	5					stone, (good.)		36	Causeway, Bridgewater.
	1	7½	20					Bridge No. 5, Bridgewater.		5	Bridge, ditto.
	37	2	4								
Total....	46	34									
10	14	5	10	Level	11			Bridge No. 5, Bridgewater.	Occup. road	12	Bridge, (Bridgewater).
		9	12	1 in 37	..	9			Ditto		
		13	60	1 in 24	..	7			Street		
BRIDGE-		6	20	1 in 70½	..	13			Ditto		
WATER.	20	5	6	About level	15				Ditto		
	4	4	12	1 in 41½	..	4					
				1 in 28½	..	7					
				1 in 18	..	6					
				1 in 42	..	3					
Total....	38	42		1 in 122	..	5					
11	4	3	10	1 in 102	..	7		Culvert No. 28, 24 x 24,	Private road to	8	Solid sandstone, (both
	65	5	5	About level	12			arched brick and stone,	Mayfield Park		sides).
	4	5	5	1 in 60	..	3		(good).	Occup. road	5	Embankment.
	14			1 in 33	..	7		Bridge No. 6, masonry		8	Shottery ironstone (both
				1 in 72	..	6		arch, 4 ft. x 5 ft. 9 in.,			sides.
				About level	4			(very good.)		5	Embankment.
				1 in 26½	..	3				4	Solid and shottery iron-
				1 in 17	..	3					stone (both sides).
				1 in 30	..	2				7	Clay and boulders (both
				1 in 78	..	11					sides).
				About level	3						
				1 in 25	..	..	7				
				1 in 17	..	..	4				
				1 in 56	..	..	3				
				1 in 25	..	3					
				1 in 18½	..	3					
				1 in 73	..	2					
				1 in 29	..	5					
				1 in 44	..	2					
				1 in 120	..	..	2				
Total....	87	13		1 in 45	..	..	8				

No. of Sheet.	Chains of straight Lines.	Chains of Curves.	Radii of Curves.	Inclination of Gradient.	Length of Gradient.			Bridges and Culverts.	Roads, &c.	Chains of Cutting or Embankment.	Description of Cuttings.
					Level	Rise.	Fall.				
12	80		chains.	1 in 60	..	..	7	Culvert No. 29, 24 x 24,	Broad Marsh	7	Embankment.
				1 in 116	..	7		circular brick, (good).	Road		
				1 in 33	..	6			Street	10	Clay (both sides).
				1 in 24	..	4			Occup. road	5	Clay and loose rock.
				1 in 49	..	6					
				About level	8						
				1 in 66	..	..	9				
				1 in 52	..	4					
				1 in 36	..	4					
				1 in 99	..	..	3				
				1 in 38	..	..	9				
				About level	4						
				1 in 82	..	2					
				1 in 66	..	7					
13	65	8	40	1 in 45	..	4		Culvert No. 30, 20 x 18,	Street	5	Clay and loose rock.
	2	5	40	About level	11			flat top-stone, (good).	Ditto	6	Sand ditto (both sides).
				1 in 44	..	..	13			7	Ditto (ditto).
				About level	3						
				1 in 54	..	6					
				About level	26						
				Ditto	10						
				1 in 50	..	..	2				
				1 in 24	..	..	5				
Total....	67	13									
14	23	4½	12	1 in 22	..	..	12	Bridge No. 7, Brighton,	Road to Old	5	Clay and shottery iron-
	4	2½	4	1 in 52	..	..	6	masonry, timber top, 5	Beach		stone (both sides).
PONTVILLE.	3½	9	17	1 in 100	..	..	5	spans, each about 20 ft.,	Street	3	Solid sandstone (both
		4	10	1 in 20	..	..	3	masonry good, top indif-			sides).
		9½	40	1 in 19	..	..	5	ferent.	Ditto	4	Brighton Bridge.
		8	15	1 in 18	..	11		Culvert No. 31, flat top-	Ditto	9	Solid sandstone.
		12	50	1 in 13½	..	13		stone, 29 x 18, (good).		9	Ditto.
				1 in 21	..	3		Nos. 32, 33, and 34, ditto,			
				1 in 57	..	..	5	18 x 18, (good).			
				About level	17						
Total....	30½	49½									
15	80			1 in 112	..	13		Culvert No. 35, 18 x 18,	None	None	None.
				About level	10			stone, (good)			
				1 in 94	..	10					
				About level	20						
				Ditto	8						
				Ditto	12						
					..	7					
16	80			About level	13			Culvert 36, 18 x 18,	Occup. road	None	None.
				1 in 60	..	..	6	(double), wood and stone,	Ditto		
				1 in 61	..	..	4	(bad).			
				About level	10						
				Ditto	15						
				1 in 105	..	32					
17	36	10	60	1 in 87	..	13			Private road	None	None.
	16	5	16	1 in 55	..	25			Occup. road		
	13			1 in 42	..	9					
				1 in 36	..	18					
				1 in 76	..	..	15				
Total....	65	15									
18	65	9	40	About level	3			Culvert No. 37, 36 x 50,	Private road	None	None
	6			1 in 110	..	7		masonry and timber,			
				1 in 69	..	23		(good). No. 38, 24 x 18,			
				1 in 23	..	6		stone, (good). No. 39,			
				1 in 25	..	6		30 x 24, stone, (good).			
				About level	4			No. 40, 36 x 36, stone,			
				1 in 60	..	..	6	(good). No. 41, 24 x 24,			
				1 in 41	..	4		stone, (good).			
				About level	6						
				Ditto	6						
				1 in 66	..	..	4				
				1 in 26	..	..	3				
				About level	2						
	71	9									

No. of Sheet.	Chains of straight Lines.	Chains of Curve.	Radii of Curves.	Inclination of Gradient.	Length of Gradient. Level	Rise.	Fall.	Bridges and Culverts.	Roads, &c.	Chains of Cutting or Embankment.	Description of Cuttings.
			chains.								
19	15	7	20	1 in 66	..	4		Culvert No. 42, 18 x 18,	Occup. road	4	Ironstone.
	33	9	40	1 in 15	..	2		stone, (good). No. 43,	Private road	6	Clay.
BAGDAD.	10	4	8	1 in 27	..	3		26 x 48, arched masonry,	Ditto		
	2			1 in 62	..	..	4	(good). No. 44, 24 x 30,	Ditto		
				1 in 21	..	4		stone, (good). No. 45,			
				1 in 55	..	..	2	24 x 12, (double), stone,			
				1 in 20	..	..	5	(good). No. 46, 24 x 18,			
				1 in 37	..	..	4	stone, (good). No. 47,			
				About level	10			36 x 24, rough stone			
				1 in 66	..	10		arch, (good). No. 48,			
				About level	25			36 x 24, stone, (good).			
				1 in 54	..	3		Bridge No. 8, 3 arches of			
Total....	60	20		About level	4			rough stone, very bad			
								order.			
20	72	8	40	1 in 68	..	43		Culvert No. 49, 24 x 16,	Private road	None	None.
				1 in 52½	..	37		stone, (good). No. 50,	Occup. road		
BAGDAD.								24 x 18, stone, (good).			
								No. 51, 24 x 12, stone,			
								(good).			
21	12	5	6	1 in 27	..	3		Culvert No. 52, 24 x 24,	Private road	14	Shottery and solid sand-
	36	5	15	1 in 38	..	5		stone, (good). No. 53,	Ditto		stone, rotten slate and
CONSTITUTION	7	5	5	1 in 73	..	5		30 x 30, stone, (good).	Ditto		clay, and solid iron-
HILL.	5	5	6	1 in 43	..	6					stone.
				1 in 31	..	11				8	Clay, rotten slate and
				1 in 44	..	9					sandstone.
				1 in 34	..	5					
				1 in 23	..	36					
Total....	60	20									
22	2	55	4	1 in 21	..	53		Culvert No. 54, 24 x 24,	Street	4	Clay, rotten, slate, and
	2		4	1 in 26	..	5		stone, (fair). No. 55,			sandstone.
CONSTITUTION	10		4	1 in 18½	..	10		24 x 72, stone, (good).	Ditto	9	Rotten slate sandstone,
HILL.	1		5	1 in 60	..	5		No. 56, 18 x 12, stone,			shottery ironstone and
	5		4	1 in 27	..	7		(fair). No. 57, 18 x 18,			clay.
	5		8	1 in 22	..	10		stone, (fair). No. 58,		5	Solid ironstone and clay.
	4		40					33 x 72, stone masonry,		3	Clay.
	6		12					(good). No. 59, 27 x 36,		14	Shottery sandstone, rot-
			4					ditto, (good). No. 60,			ten slate ironstone clay
			6					double: 1, masonry,			gravel and boulders.
			7					30 x 72; 1, circular ditto,		2	Embankment.
								5 feet diameter, both		4	Clay, gravel & boulders.
								very good.		5	Clay and boulders.
										2	Ditto.
										12	Clay & rotten sandstone.
Total....	35	55								7	Solid sandstone.
23	5	6	7	1 in 23	..	29		Culvert No. 61, 18 x 18,	Street	5	Clay.
		9	30	About level	3			stone, (good).	Road	4	Solid sandstone.
CONSTITUTION		6	20	1 in 25½	..	..	5		Road	8	Ditto.
HILL.	14	2	4	1 in 19	..	..	19		Private road	13	Ditto.
	5	5	4	1 in 11	..	..	3		Occup. road	17	Clay and shottery sand-
	35	7	14	1 in 27	..	..	4				stone.
		6	7	1 in 44	..	..	18				
				1 in 54	..	..	19				
Total....	59	41									
24	17	5	12	1 in 72	..	..	25	Culvert 62, 18 x 18, stone,	Private road	53	Clay, gravel, clay, and
	1	4	5	1 in 28	..	..	19	(good). No. 63, 78 x 42,			boulders.
CONSTITUTION	4	3	4	1 in 35	..	..	16	masonry, timber top,		17	Solid ironstone.
HILL.	3	3½	4	1 in 48	..	..	40	(very good). No. 64,			
	4	4	30					24 x 24, stone, (good).			
	22	3½	10								
		3	5								
	8	5	12								
	3½	2½	4								
		4	7								
Total....	62½	37½									
25	52	5	20	1 in 41	..	..	7	Culvert No. 65, 48 x 24,	Private road	None	None
	23			1 in 86	..	..	3	stone, (bad). No. 66,	Ditto		
GREEN PONDS.				About level	7			96 x 90, masonry, tim-	Street		
				1 in 88	..	..	4	ber top, (good).	Ditto		
				1 in 56½	..	..	6		Occup. road		
				1 in 46	..	..	3		Roadway		
				1 in 25	..	..	3				
				1 in 43	..	..	19				
Total....	75	5		1 in 62	..	..	28				

No. of Sheet.	Chains of straight Lines.	Chains of Curve.	Radii of Curves.	Inclination of Gradient.	Length of Gradient.			Bridges and Culverts.	Roads, &c.	Chains of Cutting or Embankment.	Description of Cuttings.
					Level	Rise.	Fall.				
26	80		chains.	1 in 66	..	..	30	Culvert 67, 12 x 12, stone,	Street	None.	
				About level	32			(good.) No. 68, 69 x 70,	Ditto		
GREEN PONDS.				1 in 72	..	..	5	18 x 18, (good.) No. 71,	Ditto		
				About level	13			78 x 36, stone & timber,	Ditto		
								(bad).			
								Bridge, No. 9, masonry			
								arch, 5 x 7, (good order.)			
27	2	7	40	1 in 87	..	7		Culvert Nos. 72, 73, 74,	None	11	Clay and gravel (both
	71			About level	5			18 x 18, stone, (good).			sides)
				Level	7			Culvert Nos. 75 & 76,		9	Embankment.
				About level	18			24 x 24, ditto, (bad).		9	Clay and gravel (both
				1 in 76	..	10					sides)
				1 in 132	..	2					
				1 in 99	..	..	3				
				1 in 36½	..	..	5				
				1 in 66	..	..	3				
				1 in 99	..	6					
				1 in 41	..	5					
				1 in 88	..	4					
Total....	73	7		About level	5						
28	27	8	20	1 in 88¾	..	..	5	Culvert No. 77, 36 x 36,	Road to Brock's	12	Embankment.
	13	8	12	1 in 36	..	..	10	stone, (bad). No. 78,	Private road to	7	Clay and gravel
	24			1 in 58½	..	..	2	12 x 12, stone, (good).	Mount Ver-	1	Clay.
				About level	4			No. 79, 18 x 18, ditto,	non		
				1 in 50	..	6		(good). No. 80, 24 x 26,	Roadway		
				1 in 113	..	5		ditto, (good). No. 81,			
				1 in 65	..	..	5	15 x 15, ditto, (good).			
				1 in 55	..	..	5				
				About level	5						
				1 in 78	..	..	10				
				About level	15						
Total....	64	16		1 in 75	..	8					
29	11	7	25	1 in 97	..	3		Culverts Nos. 82, 85 & 86,	Road to Kelvin	3	Clay.
	17	10	14	1 in 72	..	..	24	18 x 18, stone, (good).	Grove	10	Embankment.
	35			About level	45			Nos. 83 & 84, 12 x 12,		6	Clay (both sides).
				1 in 125	..	8		ditto, (good).		35	Embankment.
								Bridge, No. 10, 20 ft. x 5ft.			
								6 in., masonry, timber			
Total....	63	17						top, (very bad.)			
30	10	6	20	1 in 92	..	2		Culverts Nos. 87 & 88,	Private road	19	Clay and sandstone.
	9	4	10	1 in 59	..	5		18 x 18, stone, (good).	Ditto	4	Ditto.
MELTON MOW-	4	12	30	1 in 52½	..	5		No. 89, 30 x 24, ditto,	Public road to		
BRAY.	14	11	30	1 in 46	..	8		(good). No. 90, 24 x 18,	Bothwell		
		6	15	About level	7			ditto, (good).			
		4	10	1 in 56½	..	6		Bridge No. 11, 12 x 9,			
				1 in 39	..	14		masonry, timber top,			
				1 in 52	..	5		(bad).			
				About level	5						
				1 in 72	..	5					
				1 in 48	..	18					
Total....	37	43									
31	4	4	20	1 in 60½	..	7		Culvert No. 91, 24 x 30,	Occup. road	6	Clay and sandstone.
	42		15	1 in 49	..	10		stone, (good). Nos. 92,		10	Embankment.
LOVELY BANKS			40	1 in 35	..	8		99 & 101, 24 x 24, ditto,		6	Shottery sandstone and
HILL.			4	1 in 22	..	8		(good). No. 93, 24 x 12,			clay (both sides).
		30	20	1 in 39	..	8		ditto, (good). Nos. 94		6	Embankment.
			20	1 in 34	..	11		and 95, 24 x 24, (double)		9	Ditto.
			6	1 in 28	..	15		stone, (bad). No. 96,		14	Clay, gravel, and shotty
			4	1 in 25	..	13		18 x 18, stone, (good).			ironstone.
								Nos. 97 & 98, 18 x 18,			
								ditto, (good). No. 100,			
Total....	46	34						15 x 15, ditto, (good.)			
32	7	7	16	1 in 27	..	8		Culvert No. 102, 24 x 18,	None	21	Shottery and solid iron-
	4	6	8	1 in 30	..	10		(double) stone, (good).			stone.
LOVELY BANKS	13	4	12	1 in 28	..	18		Nos. 103 & 106, 18 x 18,		11	Clay and sandstone.
HILL, (Top).	4	6	10	1 in 32½	..	15		stone, (good). No. 104,		9	Clay.
	3	3	20	1 in 36	..	5		18 x 12, ditto, (good).		15	Rotten slate sandstone
	2	5	10	Above level	4			Nos. 105, 107, 108, 109,			and clay.
		5	5	1 in 100	..	..	3	24 x 18, ditto, (good).		5	Sandstone clay and rot-
		8	30	1 in 86	..	..	11				ten slate (both sides).
		3	5	1 in 45	..	..	3				
				1 in 22	..	..	3				
Total....	33	47									

No. of Sheet.	Chains of straight Lines.	Chains of Curve.	Radii of Curves.	Inclination of Gradient.	Length of Gradient. Level	Rise.	Fall.	Bridges and Culverts.	Roads, &c.	Chains of Cutting or Embankment.	Description of Cuttings.
			chains.								
33	15	15	6	1 in 22	..	..	4	Culverts Nos. 112, 113,	Private road to	32	Solid sandstone, clay,
	4	6	4	1 in 25	..	..	27	114, 118, 18 x 18, stone,	" Bisdee's"		sandstone and clay.
LOVELY BANKS	3	3	12	1 in 22	..	..	5	(good). Nos. 115, 116,		3	Shottery sandstone (both
	10	3	12	1 in 33	..	..	11	& 117, 24 x 24, ditto,			sides.
		6	20	1 in 55	..	..	6	(good).		4	Embankment.
		9	60	1 in 52	..	14				12	Sandstone and clay (both
		6	10	1 in 76	..	6					sides).
				1 in 44	..	..	7				
Total....	32	48									
34	4	8	10	1 in 50	..	..	2	Culverts No. 119, 18 x 24,	None	6	Embankment.
	5	4	10	About level	5			stone, (good). Nos. 120,		12	Clay.
SPRING HILL.	2	6	11	1 in 37	..	15		122, 123, 125, 126, 128,		9	Ditto.
	15	5	12	1 in 33	..	43		and 129, 18 x 12, ditto,		48	Ditto.
	6	3	12	1 in 26	..	15		(good). Nos. 121 and			
		4	20					124, 15 x 15, ditto, (good).			
		6	40					No. 127, 15 x 24, ditto,			
		7	20					(good).			
		5	16								
Total....	32	48									
35	..	80	All curves, ranging from 4 to 40 chains radius.	1 in 24	..	46		Culvert Nos. 130 & 134,	Road (private)	21	Shottery ironstone and
				1 in 20	..	3		18 x 18, stone, (good).	to Pentycink's		rotten slate, shottery
SPRING HILL.				1 in 30	..	5		Nos. 131, 132, 136,			sandstone.
				1 in 24	..	26		18 x 12, ditto, (good).		7	Embankment.
								No. 133, 24 x 24, ditto,		45	Shottery ironstone and
								(good). Nos. 135 & 137,			clay, solid ironstone,
								24 x 12, ditto, (good).			solid sandstone.
36	..	80	All curves, ranging from 4 to 40 chains radius.	1 in 23	..	3		Culvert No. 138, 12 x 24,	None	5	Shottery slate and clay.
				1 in 23½	..	13		stone, (bad). No. 139,		2	Clay.
SPRING HILL.				1 in 33	..	5		18 x 18, ditto, (good).		7	Solid ironstone.
				1 in 49	..	4				3	Clay.
				1 in 27	..	5				3	Ditto and boulders.
				1 in 22	..	4				3	Ditto.
				1 in 19	..	3				36	Rotten slate and clay,
				1 in 23½	..	43					clay and boulders and
											shottery ironstone.
37	3	4	8	1 in 22½	..	7		Culverts No. 140, 32 x 24,	None	10	Clay and boulders.
	3	5	5	1 in 18½	..	6		stone, (good).		46	Solid ironstone, shottery
SPRING HILL.	10	3	4	1 in 14½	..	4					ironstone, clay and
	4	5	12	1 in 19	..	14					boulders.
	9	8	40	1 in 24½	..	9				2	Solid ironstone.
		10	12	1 in 23	..	18				4	Solid ironstone, clay and
		4	5	1 in 29	..	9					boulders.
		12	40	1 in 19	..	3				9	Shottery ironstone.
				1 in 88	..	2					
				1 in 33	..	..	8				
Total....	29	51									
38	0	10	25	1 in 29	..	..	20	Culvert No. 141, timber,	Private road to	20	Solid ironstone, clay and
	3	7	15	1 in 41	..	..	1	48 x 48, (bad). Nos.	" Savages"		shottery ironstone.
SPRING HILL.	6	3	4	About level	11			142, 143, 18 x 12, stone,		8	Clay.
	4	10	30	1 in 63½	..	..	5	(good). No. 144, 24 x 18		20	Ditto.
	2	10	40	1 in 33	..	..	43	ditto, (good).		18	Ditto.
	4	12	40								
	1	8	20								
Total....	20	60									
39	5	5	10	1 in 33	..	..	46	Culvert No. 145, 18 x 12,	None	77	Clay and boulders, solid
	6	8	15	1 in 34	..	..	10	stone, (good). Nos. 146			ironstone.
SPRING HILL.	4	8	20	1 in 31	..	..	24	and 148, 30 x 30, ditto,			Clay and boulders, shot-
	4	4	20					(good). Nos. 147, 149,			tery ironstone.
	12	4	15					151, 153, 24 x 24, ditto,			
		10	30					(good). Nos. 150 & 152,			
		10	40					24 x 18, ditto, (good).			
Total....	31	49									

No. of Sheet.	Chains of straight Lines.	Chains of Curve.	Radii of Curves.	Inclination of Gradient.	Length of Gradient. Level	Rise.	Fall.	Bridges and Culverts.	Roads, &c.	Chains of Cutting or Embankment.	Description of Cuttings.
40	74	6	chains. 15	1 in 30½	..	..	6	Culvert No. 154, 24 x 30, stone, (bad). No. 155, 24 x 36, ditto (double) (good). No. 156, 24x24, stone, (good). No. 157, 24 x 12, ditto, (good). No. 158, 30 x 24, ditto, Bridge No. 13, 2 spans each, 20 feet, masonry with timber top, (bad order.)	Occup. road	4	Clay.
JERICHO.				1 in 48½	..	..	11		Ditto		
				1 in 56	..	..	5		Ditto		
				1 in 62	..	..	10				
				1 in 36½	..	..	5				
				1 in 53	..	..	5				
				About level	10						
				1 in 30	..	..	5				
				1 in 51½	..	..	5				
				About level	5						
				1 in 99	..	3					
				About level	7						
				1 in 99	..	3					
41	24	4½	5	About level	12	...		Culvert No. 159, 27 x 30, stone, (double), (good). No. 160, 36 x 48, ditto, ditto, (good). No. 161, 30 x 30, ditto, ditto, (good) No. 162, 12x15, stone, (good). No. 163, 30 x 24, ditto, (good).	Private road	4	Embankment.
	9	5	6	1 in 66	..	5				4	Ditto.
	6½	3	20	1 in 94	..	10				7	Ditto.
		9	20	About level	5	..				36	Ironstone (shottery and solid.
		12	40	1 in 63	..	5					
		8	7	1 in 30	..	2				7	Embankment.
				1 in 39	..	11					
				1 in 66	..	7					
				About level	20	..					
				1 in 66	..	3					
Total....	39½	41½									
42	52	3	5	1 in 48	..	2		Culvert No. 164, 15 x 12, stone, (good). No. 165, 15 x 15, ditto, (good). No. 166, 30 x 36, ditto, good). No. 167, 6 x 6, rough stone arch, (good). No 168, 18 x 12, stone, (good).	Occup. road	2	Embankment.
	3	5	5	About level	10	..				3	Shottery ironstone (both sides).
	8	4	3	1 in 92	..	25					
	1	4	10	About level	10	..				7	Shottery ironstone.
				1 in 73	..	10				14	Solid and shottery ironstone.
				1 in 82½	..	10					
				About level	13					20	Embankment on one side.
Total....	64	16									
43	48	13	40	1 in 66	..	7		Culvert No. 169, 24 x 30, stone, (good). No. 170, 18 x 24, (4 culverts), stone, (good). No. 171, 24 x 36, (double), ditto, (good). No. 172, 18x18, stone, (good).	Private road to "Wilson's"	5	Embankment.
	19			About level	30	..					
				1 in 57	..	4					
				1 in 99	..	26					
				About level	13						
Total....	67	13									
44	25	11	15	1 in 129	..	7		Culvert No. 173 & 174, 21 x 24, stone, (good), No. 175, 15 x 20, ditto, (bad). No. 176, 24x24, ditto, (good).	None	3	Clay (both sides.
	10	9	30	1 in 55	..	5				9	Embankment.
	14	7	20	1 in 34½	..	15				4	Clay.
	4			1 in 57½	..	7				10	Clay.
				1 in 83½	..	18				4	Embankment.
				About level	25						
				1 in 62	..	3					
Total....	53	27									
45		7	20	1 in 42	..	4		Culverts No. 177, 42 x 36, masonry, (good). No. 178, 15 x 18, stone, (good). No. 179, 20x12, ditto, (good).	Roadway	10	Clay.
		5	25	1 in 99	..	3				4	Sandstone and rotten clay stone (both sides).
		7	20	1 in 49	..	..	7				
	17	4	20	1 in 29	..	..	13			10	Ditto (one side).
	9	8	16	1 in 44	..	..	4			4	Embankment.
	16	7	15	1 in 102½	..	..	14			13	Shottery sandstone.
				1 in 49	..	4				5	Embankment.
				1 in 23	..	11				4	Clay (both sides).
				1 in 33	..	7				12	Clay (one side).
				1 in 66	..	4					
				Level	2	..					
				1 in 37½	..	..	7				
Total....	42	38									
46	13	3	8	1 in 35	..	..	42	Culvert No. 180, 18 x 18, stone, (good.) No. 181, 18 x 12, ditto, (good). No. 182, 24 x 18, ditto, (good). No.183,24x24, ditto, (good). No. 184, 30 x 24, stone, (double), (good).	None	40	Clay and boulders.
	15	5	10	1 in 26	..	..	21			4	Ditto.
	7	4	6	1 in 39	..	..	12			6	Embankment.
	5	5	5	About level	5					5	Clay and boulders (both sides).
	6	6	14								
		5	5							6	Clay.
		6	40							5	Embankment.
										2	Sandstone.
Total....	46	34									

No. of Sheet.	Chains of straight Lines.	Chains of Curve.	Radii of Curves.	Inclination of Gradient.	Length of Gradient. Level	Rise.	Fall.	Bridges and Culverts.	Roads, &c.	Chains of Cutting or Embankment.	Description of Cuttings.
47	4 4 22 27	5 6 6 6	chains. 6 12 30 40	About level 1 in 102	32 ..	 48		Culvert No. 185, 18 x 24, stone, (good). No. 186, 36 x 24, ditto, (good). No. 187, 24 x 24, ditto, (good). No. 188, 18 x 18, ditto, (good).	Street	16	Rock and sandstone.
Total....	57	23									
48 OATLANDS.	20 54	6	15	About level 1 in 75 1 in 32 1 in 61 1 in 85 1 in 28 1 in 42 About level	17 13	 8 10 7	 9 9 7	Culvert Nos. 189 and 190, 18 x 18, stone, (good).	Street Ditto Lane Street Ditto Ditto	None	
Total....	74	6									
49	9 17 chs. 80 lks.	5	8	About level 1 in 46 About level 1 in 85 1 in 92	5 .. 6	 5	 9 6·80	..	Street Street Lane Street Ross-street	None	
Total..	26 chs. 80 lks.	5									

GENERAL SUMMARY of Straight Lines and Curves.

No. of Sheet.	Chains of straight Line.	Chains of Curves.	No. of Sheet.	Chains of straight Line.	Chains of Curves.	No. of Sheet.	Chains of straight Line.	Chains of Curves.
1	75	5	18	71	9	35	—	80
2	61	19	19	60	20	36	—	80
3	61	19	20	72	8	37	29	51
4	46	34	21	60	20	38	20	60
5	43	37	22	35	55	39	31	49
6	37	43	23	59	41	40	74	6
7	54	26	24	62·50	37·50	41	39·50	41·50
8	52	28	25	75	5	42	64	16
9	46	34	26	80	—	43	67	13
10	38	42	27	73	7	44	53	27
11	87	13	28	64	16	45	42	38
12	80	—	29	63	17	46	46	34
13	67	13	30	37	43	47	57	23
14	30·50	49·50	31	46	34	48	74	6
15	80	—	32	33	47	49	26·80	5
16	80	—	33	32	48			
17	65	15	34	32	48			
	1002·50	377·50		954·50	465·50		623·30	529·50

TOTAL LENGTH, chains .... 3942·80

ANALYSIS of the preceding Tables, showing the Length of each Gradient under each Head, and whether the same rises or falls, counting from Hobart Town.

GRADIENTS EXCEEDING—																										About Level.	
1 *in* 20.		1 *in* 30.		1 *in* 40.		1 *in* 50.		1 *in* 60.		1 *in* 70.		1 *in* 80.		1 *in* 90.		1 *in* 100.		1 *in* 110.		1 *in* 120.		1 *in* 130.		1 *in* 140.			
Rise.	Fall.	Rise.	Fall.	Rise.	Fall.	Rise.	Fall.	Rise.	Fall.	Rise.	Fall.	Rise.	Fall.	Rise.	Fall.	Rise.	Fall.	Rise.	Fall.	Rise.	Fall.	Rise.	Fall.	Rise.	Fall.		
chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains	chains
6	6	7	6	9	6	4	6	4	6	6	30	6	6	3	5	3	8	7	3	7		6	12	3		50	13
3	4	4	5	9	4	6	5	6	9	3	8	3	5	2	3	6	6	32	2	13		11	2	2		6	10
3	17	2	3	3	2	6	5	25	3	3	9	8	15	7	4	9	3	48	5	7		5				15	15
11	19	4	7	3	14	27	9	3	12	7	9	3	25	13	5	10	5		3	5		8				5	3
13	3	4	5	9	9	10	8	37	3	23	7	5	5	7	11	6	3		14			7				30	4
2		7	12	9	4	4	8	6	2	4	9	13	10	4	9	3	6·80									9	6
10		7	3	7	16	3	13	5	6	10	6	6	24	2	9	2										6	6
3		3	3	2	5	2	18	5	5	43	4	11		10		3										3	2
6		3	5	6	10	6	40	6	2	5	6	2		18		3										3	10
4		5	5	4	11	4	7	5	19	7	4	5				10										6	25
14		4	4	18	8	9	3	14	6	5	4	10				25										6	4
3		3	19	5	43	4	19	4	2	5	28	8				26										4	3
		6	3	11	46	6	3	5	5	7	30	5				3										10	7
		6	3	5	10	9	7	7	6	3	3	6														6	32
		3	4	14	24	5	1		2	7	5	10														15	13
		4	27	8	6	8	11		5	3	5	8														5	5
		3	5	8	5	18	7		5	4	10															5	7
		36	20	11	5	10	4		5	7																11	18
		53	13	10	7	4	7																			15	5
		5	21	15	42	2																				11	4
		7	9	43	12	4																				9	5
		10		5		4																				5	15
		29		15		5																				70	45
		8		5																						5	7
		15		5																						11	5
		13		2																						15	4
		8		11																						12	5
		18		15																						4	11
		15		7																						3	10
		46		10																						8	5
		3																								4	7
		26																								11	12
		3																								3	5
		13																								26	20
		5																								10	10
		4																								17	10
		43																								10	13
		7																								20	30
		9																								8	13
		18																								12	25
		9																									2
		11																									5
																											32
																											17
																											13
																											5
																											6
12	5	42	21	30	21	23	19	14	18	18	17	16	7	9	7	13	6·80	3	5	4		5	2	2		87	
78	49	489	182	284	289	160	181	132	103	152	177	109	90	66	46	109	31·80	87	27	32		37	14	5		1013	

TOTAL LENGTH, chains............... 3942·80

Reports on Preliminary Surveys of proposed routes for the Main Line Railway.

Appendix G 4.

REPORT by Messrs. Sorell and Davies, *Civil and Mechanical Engineers, accompanying Plans and Sections of two Routes from 3rd Milestone to a Southern Terminus—one viâ Park-street, and the other viâ the Domain.*

Appendix G 4.

Report by Messrs. Sorell & Davies, Civil Engineers, on the routes from 3rd milestone to a southern terminus *viâ* Park-street and *viâ* the Domain.

Sir,

Having received instructions from you to examine the levels from Hobart Town to the third (3rd) milestone on the Main Road viâ Park-street, and compare them with levels viâ Domain and Cornelian Bay, as a preliminary step towards a Railway Survey, we have the honor to forward you a Plan, Sections, Field Notes, and explanatory Report.

The Plan shows a detailed survey of the lines we were instructed to examine, with the features of the intermediate and surrounding country. The dotted lines indicate the approximate direction that must be followed by Railways, and stating more or less closely the routes under consideration.

The Sections show the actual levels taken by us, with such other information as we thought well to afford with regard to probable railway routes and other difficulties to be surmounted.

It must be understood that all work shown in dotted lines is merely approximate, although we feel sure that a future Engineering Survey in the same direction will deviate but little from the lines indicated.

Starting from Macquarie-street Bridge we obtain a level gradient to a point nearly midway between Bathurst and Liverpool-streets, thence to the Park-street saddle a gradient of 1 in 60, entailing however cuttings and tunnel as indicated on Plan and Section. South of saddle the gradient would average one in forty-five (1 in 45), crossing the New Town Creek Bay by a viaduct, and thence passing by a very easy gradient to O'Brien's Bridge.

We have indicated, however, another system of gradients on Plan and Section, supposing that your Commission will probably consider the claims of the modern Light Railways. The Section will show that supposing the "Light Railway" to be adopted we increase the gradients to one in forty (1 in 40) and one in thirty (1 in 30); the latter gradients if increased to one in twenty-five (1 in 25) would materially decrease the first cost of a railway, by reducing the height of viaduct, embankments, &c. that will be found necessary in the neighbourhood of the "Risdon Road" and "New Town Bay."

In accordance with your instructions we examined the Domain route, taking levels from Macquarie-street Bridge to Bridge in Cornelian Bay, whence to O'Brien's Bridge there is no further difficulty. The Section will show that the gradients on such line are every where easy,—but we have to state that the cuttings, owing to the steepness of the Cross Sections and the character of the rock, will be heavy throughout. We have simply shown the Section of this line and direction on plan, believing it improbable that the said lines (viâ Domain) will ever be carried out.

With regard to position of stations, approaches in the immediate neighbourhood of the wharves, &c., we feel it would be absurd to give a decided opinion till your Commission have decided the character of Railway to be adopted. We shall, however, be happy to afford your Commission any further information we possess that may be deemed requisite.

We have, the honor to be,
Sir,
Your obedient servants,
SORELL & DAVIES, *Civil Engineers, &c.*

To C. S. Cansdell, Esq., M.H.A.,
Chairman Main Line Railway Royal Commission.

Appendix G 5.

Appendix G 5.

Report by Messrs. Sorell & Davies, Civil Engineers, accompanying Plans of the Routes *viâ* Austin's Ferry.

REPORT by Messrs. Sorell *and* Davies, *Civil Engineers, accompanying the Plans of the Routes surveyed by them viâ Austin's Ferry.*

Stone Buildings, 23rd July, 1868.

Sir,

In accordance with your instructions we have the honor to report that we have finished the examination of the different routes entrusted to us; and for convenience of reference we have divided the same into sections, distinguished by letters.

No. 1. Section A B, on topographical map No. 1, embraces the route from Austin's Ferry to the point from which the line would diverge either to join the main line of road or to pass easterly through the Native Corners, a distance of about 8 miles. See plan No. 1 for detail information.

No. 2. Section B C on plan No. 2, carries us on until we meet Sprent's Line, a distance of about 12 miles.

No. 3. Section C D on plan No. 2, shows the portion of Sprent's Line which would probably be made available, 4 miles.

No. 4. Section D E on plan No. 2, follows up the Valley of the Upper Coal River until the desired height is attained. The distance is about 10 miles.

No. 1 Section presents a most favourable aspect. The approaches from the south-western side so as to cross the River Derwent indicate no more than ordinary difficulty. We, however, can discover nothing in the Dog-nose Point route to enable us to recommend it in preference to crossing at Austin's Ferry. By the first-mentioned route some four miles extra of rail would be required, without any compensating advantage.

Referring to Section No. 1, the engineering difficulties are extremely slight, the gradients light, and no curves of short radius. Should it be desired to connect this section with the main line of road, it will be necessary to cross the Strathallen Creek, as shown by dotted red line on plan No. 2, so as to avoid the sharp rise from the bridge over the Jordan River at Pontville.

No. 2, Section B C. There will be but little difficulty in taking the line *viâ* Native Corners into Sprent's Line to the eastward of Gunning's Sugar-Loaf. *Report of Messrs.* SORELL *and* DAVIES, *accompanying Plans of route viâ Austin's Ferry.*

No. 3. Section C D has been already reported upon by Mr. Sprent.

No. 4, D E. From this point the real difficulty commences. Mr. Sprent was perfectly correct in stating that a certain height must be arrived at. Finding this positive, we endeavoured to lessen the impracticable gradient of 1 in 12 (on Mr. Sprent's route) by commencing our rise from a distance which would admit of the gradient being spread. APPENDIX G 5

Section D E shows a line following the Coal River Valley, skirting Brandy Bottom, and winding along the east side of Whisky Hill, and the other portions of the dividing range between the Coal River and Wallaby Rivulet, and crossing into and following up a deep ravine leading in the direction of Hunter's Creek, from which it is separated by a narrow saddle, which could be pierced by a short tunnel if it were found necessary, so as to materially lessen the gradient. The route would, in any case, follow up Hunter's Creek, until Lake Tiberias is arrived at by an easy gradient. Here the chief difficulty ends. We proposed to obtain a ruling gradient of not more than 1 in 30, on Section D E; but the line requires accurate detail survey before anything approaching a positive opinion could be pronounced as to the nature of the work required. The country is difficult and scrubby, and it is hence impossible to estimate the length gained by the various curves the ground presents for the rail.

We have tried in vain to reach the table land through the Native Corners to the westward of Sprent's Line, so as to join it in the Hollow Tree Bottom, (the highest point on the line.) The spurs from the Quoin Mountain are most unsuited for railway purposes, and every pass presenting the slightest hope has been carefully examined and as carefully represented on No. 2 plan. The result of examination of the only line worthy inspection is shown in burnt sienna. A very slight glance at the plan will convey the nature of the work required, and pronounce the route impracticable.

As we found that the ground foiled every attempt on our part to master the difficulty to the westward, we turned our attention to the eastward, and the result of our labours we have shown on No. 2 topographical map. We feel sure that the maps will convey more information than we could possibly do by the most elaborate report.

We may, perhaps, be expected to say a few words as to the advantages presented by the route we indicate. In an engineering point of view, comparing it with Mr. Sprent's Line, the tunnel on the Kangaroo Point Road is avoided, and the sharp gradient of 1 in 12 reduced to 1 in 30, and the terminus placed in the city instead of at Kangaroo Point.

In a commercial point, the Clarence Plains and Kangaroo Point traffic would be lost, but this deficiency would be amply compensated by the gain of Brighton, Broadmarsh, Upper Bagdad, Old Beach, and adjacent country, and the advantages of cheap transit brought within reach of Green Ponds and New Norfolk.

SORELL & DAVIES, *Civil Engineers, &c.*

The Chairman Royal Commission Main Line Railway.

APPENDIX G 6.

APPENDIX G 6. Supplementary Report by Messrs. SORELL and DAVIES as to route *viâ* Austin's Ferry.

SUPPLEMENTARY REPORT on the Routes viâ Austin's Ferry.

Stone Buildings, July 30th, 1868.

SIR,

As a wish has been expressed on your part for a more general report than that furnished by us with plans, I beg to lay before you the following description of the line examined by us with its approaches on the Hobart Town side.

The first portion of the line we were instructed to survey starts from Austin's Ferry, crossing Gage Brook, and opening up the agricultural district generally known as the Old Beach; then skirting the valley of the Jordan it reaches the Bagdad Plains near Brighton, where the line would diverge on level ground, either to meet the main road between Bagdad and Constitution Hill, or to follow the Tea Tree Bottom to the valley of the Coal River by a route to be hereafter described.

The whole of the country between Austin's Ferry and the Bagdad Plains is of a light undulating description, favourable for the construction of a railway, requiring no bridges of any importance as far as our survey extends, obtaining easy gradients and curves of considerable radius, without having resort to heavy cuttings and embankments. The highest point on the existing road is, by barometrical observation, 363 feet above the sea, at Austin's Ferry; and this moderate height would be very materially reduced by the necessary windings of the railroad, as the existing road goes over hill and dale in a very primitive fashion.

It is necessary here to say that, supposing the main road route to be followed from the close of our survey, the Strathallan Creek would have to be crossed at a place not unlike the ravine crossed by the well-known Horse Shoe Bridge. By a detour of no great distance, however, the Strathallan might be crossed where it is a mere brook.

Should the route recommended by Sprent, and since examined and improved by us, be adopted, the line at the close of the Austin's Ferry survey would skirt the valley of the Strathallan, passing through the Tea Tree Brush and by Native Corners, sweeping round Gunning's Sugar-loaf into the Coal River Valley, near Campania, where it would join Sprent's Line: this line, so far, though not surveyed, has been carefully examined by us, and found to present no difficulties.

From Campania Sprent's Line may be more or less closely followed until a point near the junction of the Wallaby Rivulet with the Coal River is met. It must be here stated that the valley of the Coal River, though having little fall, is at times narrow and tortuous, but not so much so as to throw any great obstacles in the way of road construction.

We attempted, according to instructions, to force our way through the Native Corners tier to Jerusalem, or some point in the Coal River Valley, where we might effect a junction with Mr. Sprent's Line: we found, however, the tier perfectly impracticable, so had to fall back on the Tea Tree Brush and Campania line, as the shortest line available for the junction of our Austin's Ferry line with Sprent's Kangaroo Point route.

On examining Sprent's Line from Jerusalem up the Hollow Tree Bottom, we could come to no other conclusion than that his remarks as to gradient, &c. were perfectly justified by the bluff and broken nature of the country. We were unable to materially reduce his gradients of 1 in 12 by that route.

After much examination we think we have hit upon a line diverging from Mr. Sprent's, near the junction of the Wallaby Rivulet and the Coal River valley, that will bring us out on the Lake Tiberias table land, on a level (or nearly so) with Oatlands, and without intervening hills, and this without having to incur impracticable gradients, or, generally speaking, very heavy works.

The route then recommended by us as worthy of further survey skirts the Coal River, taking the western ridges forming the basin known as Brandy Bottom, rounding Whisky Hill, and winding the range till it reaches a line

Supplementary Report on the routes viâ Austin's Ferry.

slightly below the existing road from Jerusalem to Lake Tiberias and Mount Seymour, commonly known as Stokell's Road, piercing a saddle by a tunnel or cutting of no great length, and emerging in the gully of Hunter's Creek, whence it is perfectly easy to reach the Table Land at Lake Tiberias.

APPENDIX G 6.

The barometrical observations on this route give, supposing the line to be straight, a gradient of somewhere about 1 in 30: the more circuitous route that a railway must take would modify the gradients to an extent impossible to estimate without survey.

With regard to the approaches to Austin's Ferry from Hobart Town, having reason to think that a bar existed across the river having sound bottom and no great depth, we requested Mr. Gould to furnish us with a Geological Report and sketch of same: copies are appended to this report.

We have the honor to be,
Sir,
Your obedient Servants,
SORELL & DAVIES.

C. S. CANSDELL, *Esq., M.H.A.*,
Chairman Main Railway Royal Commission.

APPENDIX G 7.

Report by C. GOULD, Esq., as to practicability of crossing Austin's Ferry.

APPENDIX G 7.

MEMORANDUM FOR MESSRS. SORELL AND DAVIES.

SUPPLEMENTARY REPORT by C. GOULD, *Esq., on the Approaches to the Route viâ Austin's Ferry, and upon the Practicability of crossing the River at that Point.*

THE following remarks upon the structure of the approaches to Austin's Ferry are illustrated by a Plan, enlarged to the scale of 8 inches to 1 mile, from the lithographic county sheet furnished by the Survey Office.

It is important for precision that a special survey should be made of the approaches, and that portion of the river immediately adjoining, as details can only be given approximately upon such a Plan as the accompanying one.

It appears by the soundings which I have taken, that the channel crosses obliquely from the ferry upon the left bank of the river to the point marked A upon the Plan on the right bank, and the set of the current is in the same direction. The greatest depth from ferry to ferry is about five fathoms, and the width of three fathoms water about 12 chains. The remainder of the distance varies in depth at ordinary high water from 3 fathoms downwards.

At the ferry upon the right bank the formation consists of sandstone, dipping at a low angle to S. 60° W. It is probable that these extend to the verge of the channel, as indicated on the Plan, without any considerable thickness of superficial mud, so that a firm basement for causeway purposes or the support of buttresses may be relied on.

Basaltic rock in situ should be found at the opposite bay beneath the ferry-house, and would also afford a first-class foundation for buttresses.

With regard to the deep channel, it is more probable, in my opinion, that the rock is sandstone than basalt, and I should not expect it to be very far below the superficial drift.

It will be seen from the soundings, that in the direction of the line A B the average depth of the channel is increased, and the depth somewhat diminished. The formation is basaltic at A, and concealed on the opposite point by a bank of loose gravel. The distance is much greater than that of the first line, and the chances of a good foundation less. It may also be observed, that if suitable in position, a good crossing may be obtained shorter than either of those referred to above at 8 or 10 chains distance above the ferry upon the right bank.

July 31*st*, 1868. (Signed) CHARLES GOULD.

APPENDIX G 8.

Report by W. HOGAN, Esq., accompanying Plan and Section of route viâ Valley of the Jordan.

APPENDIX G 8.

REPORT by W. HOGAN, *Esq., C.E., accompanying Plan and Section of the Route viâ the Valley of the Jordan.*

New Town, 6*th August*, 1868.

SIR,

I HAVE the honor to inform you that, in accordance with my instructions from the Royal Commission on the Main Line Railway, I have examined the Valley of the River Jordan, from Picton to the point at which the Main Road and Broad Marsh Road meet at Pontville.

I also made a Staff Level and Flat Survey of a line from Picton to the Hollow Tree Bottom, the result of which I beg to submit in the following remarks.

Commencing at the junction of the Green Ponds Rivulet with the Jordan and proceeding southerly, I find that a viaduct of some extent would be required across the Green Ponds Rivulet, and extending beyond the line of inundation across a small flat. For the first two miles and a half the banks are rather unfavourable; the formation is basaltic, and would require some stiff cutting for nearly half the distance: the south bank appears to be the most favourable. This distance will bring me to Miss Clark's property in the Hunting Ground, where the Valley opens to the extent of between one and two miles, and is of a favourable character, and narrows gradually for three-fourths of a mile past Mr. Weedon's farm-house. Here this Valley ends, and touches on a sandstone formation on the west bank of the river. From Mr. Pitt's farm, (A on plan) I would be disposed to follow the west bank, and close under the present road, where a short cutting of about 10 feet (at 6 on plan) would materially shorten the line and keep it away from the river for about half a mile.

From this point (C on plan) the hills assume a bolder appearance, and would confine the line to about the present road, where occasional cuttings of a slight nature would be requisite. This would bring me to Mr. Reynolds' farm, about where the line would strike the Broad Marsh main road, below which it would continue to within about half a mile of Elderslie Township, where the spur of a ridge will again force the line to the banks of the river, and round a sharp turn (D on plan). Through Elderslie the line would be slightly below the present road, and strike it again at Mr. Brock's farm, (E on plan). It must then follow close to the road for about three miles, which, I may say, is almost perfectly level—in fact, I believe the general direction of the road would be found to be the best route to adopt, as it has been skilfully selected. At the point (F on plan) it would be necessary to bridge the river twice, as a severe cutting has been made for the road, close up to which the river runs from Tonks' Inn, (G on plan). The line might lead straight away for Pontville without difficulty, or if towards Bridgewater, about as indicated on plan. I cannot but come to the conclusion that this route is well worthy of a careful investigation in the event of the proposed undertaking being carried out, and the correct area of lands cultivated and available for cultivation determined, which would be within what I might term traffic distance. I am disposed to believe it would be found to be a very considerable area. I cannot say that I have come across any real difficulties on this line: the bridging, where necessary, would be of a moderate character.

APPENDIX G 8.

Report by W. HOGAN, Esq., as to route *viâ* Valley of the Jordan.

From the junction of the Green Ponds Rivulet with the Jordan a gradient of about 1 in 60 can be obtained to the head of the Folly Farm Flat, passing within a short distance of Mr. Brock's farm-house, and crossing the main road about one mile south of Melton Mowbray. A distance of about 3½ miles (A on plan) from this point I meet a sharp ascent of 1 in 15 for about 20 chains, which brings me to the summit of a narrow sandstone ridge; this rapidly descends to the Quoin Creek 137 feet in 7½ chains, (6 on plan). A tunnel through this ridge would do away with the gradient of 1 in 15, as the Quoin Creek is about the same level as the point at which the gradient of 1 in 60 would cease to be available, or it might be avoided by turning from Folly Farm Flat before mentioned up the Serpentine Rivulet, to its junction with the Quoin, then by that creek to the point at which the tunnel would strike. This would lengthen the line something over one mile, and some severe cutting would be requisite to obtain the necessary curve from the Serpentine Rivulet to the Quoin Creek, the junction being rather unfavourable. On the whole, I should be of opinion that the straight line through a short tunnel would be the best; this, however, would be alone determined by minute detail. I may here state, in connection with this portion of the work,—that is from Picton to the Quoin Creek, a distance of about 2½ miles as levelled by me,—that I arrive at an altitude of only 120 feet on the banks of the Quoin.

I am now in the Valley of the Quoin, the south bank of which I follow for a distance of a little better than a mile to its junction with the Valley with which I have to deal. The bank for this distance on the whole is of a very favourable character, admitting of fair curves and slightly sloping. I cross one stream where bridging of a moderate description would be necessary, (C on plan). The gradient for this mile could be got at 1 in 130; but I find I should have to adopt 1 in 62, to keep above some sandstone rocks. A viaduct of about 100 feet span 25 feet high would be required here to cross the Quoin, and over a small flat to the south bank of the Valley which I now follow. From this point to Mr. Smith's farm, the property of Mr. Bisdee, a distance of three quarters of a mile, the Valley becomes contracted for about 20 chains, averaging about 2 chains in width, and bounded on both sides by sandstone rocks of a broken character. For a short distance a cutting would be required to admit of the gradient being 1 in 80 for the last three quarters of a mile, to rise a small point of a ridge where the Valley turns nearly at right angles to the E. (C on plan). From this point for the next three-quarters of a mile the south bank of the Valley, which I still adhere to, is favourable, being generally of a slightly sloping character: a very little cutting being required, this distance could be reached by a gradient of about 1 in 50. From this point (D on plan) the Valley becomes a narrow pass, and presents a most rugged appearance. As it would be necessary to hold every foot of ground already gained, a cutting of nearly 10 chains becomes indispensable, through a friable sandstone rock; the gradient would be also 1 in 50. From this point to a hut at Mr. Whiting's farm, a distance of three-quarters of a mile, the ground is favourable, being of a slightly sloping character, and at which point the Valley dies out, and I arrive at the open ground of Mr. Whiting's farm. This distance will be arrived at by a gradient of 1 in 40. From this point to a small hill south of and close to Mr. Whiting's house, I get the sharpest pinch on the whole line; the distance about 50 chains would have to be arrived at by a gradient of about 1 in 36, through an otherwise favourable country. From this point to a saddle (E on plan) about 15 chains N. E. of Mount Mercer, a distance of 1 mile, I rise 249 feet, and would require a cut through the saddle of 40 feet to give a gradient of about 1 in 40 for that distance. From this point to another saddle, a distance of 1¾ miles, and which is the only obstacle between me and the Hollow Tree Bottom; this I get through with a cut for a few chains of about 40 feet, and which gives a gradient for the last 1¾ miles of 1 in 42. With this cut I would be at an altitude of 976 feet above my starting point near Picton Township, and 72 feet above the difficulty which Mr. Sprent encountered in endeavouring to reach the Hollow Tree Bottom from the Jerusalem side. From this I continued my line into the flats between Mr. Salmon's farm and Mr. Stokell's, for a distance of 1 mile, which would be at a gradient of 1 in 72; in fact, the ground for any gradient can be had on this part of the line, as the ground is most favourable. I consequently close at a point where the ground is almost perfectly level to Jericho, at an altitude of 904 above my starting point, which, supplemented by Mr. Innes's height on the main road of 664 feet, gives a total altitude in the Hollow Tree Bottom of 1568 feet, and 231 feet above Oatlands. For any future reference I have connected my levels with Mr. Stokell's farm buildings. My Plans are in progress, and shall be forwarded with as little delay as possible.

I have the honor to be,
Sir,
Your obedient Servant,
WM. HOGAN.

CHAS. STUART CANSDELL, *Esq., M.H.A.*,
Chairman Main Line Railway Royal Commission,

STATISTICS RELATING TO TRAFFIC AND OTHER MATTERS.

Statistics relating to Traffic and other matters.

APPENDIX H 1.

APPENDIX H 1.

Tables showing Farm Produce imported by adjoining Colonies.

[Tables furnished by J. E. CALDER, Esq., Surveyor-General, and referred to in his Evidence.]

TABLE of some Articles of Farm Produce, manufactured and unmanufactured, imported by the Colonies of Victoria, New South Wales, South Australia, Queensland, and New Zealand during the Years 1865 *and* 1866.

COLONY.	1865.		1866.		TOTAL.	
	Quantity.	*Declared Value.*	*Quantity.*	*Declared Value.*	*Quantity.*	*Declared Value.*
BACON AND HAMS.						
	cwts.	£	cwts.	£	cwts.	£
Victoria	denom. various.	48,692	denom. various.	93,640	denom. various.	142,332
New South Wales	3099	14,394	3670	18,335	6769	32,729
South Australia	2383	10,337	1833	9594	4216	19,931
Queensland	2279 pkgs.	11,384	937 pkgs.	8647	3216 pkgs.	20,031
New Zealand	no entry.	..	unknown.	..	unknown.	..
						215,023

Statistics relating to Traffic and other matters.

APPENDIX H 1.

Table furnished by J. E. CALDER, Esq., showing Farm Produce imported by the adjoining Colonies.

COLONY.	1865. Quantity.	1865. Declared Value.	1866. Quantity.	1866. Declared Value.	TOTAL. Quantity.	TOTAL. Declared Value.
BRAN.						
	bushels.	£	bushels.	£	bushels.	£
Victoria	309,377	29,021	123,116	10,495	432,493	39,516
New South Wales	102,313	6752	24,353	1212	126,666	7964
South Australia	nil.	..	nil.	..	nil.	nil.
Queensland	99,735	10,569	29,319	10,836	129,054	21,405
New Zealand	no entry.	..	unknown.	..	unknown.	unknown.
					688,213	68,885
BUTTER.						
		£		£		£
Victoria	denominations various.	70,606	denominations various.	143,848	denominations various.	214,454
New South Wales*		3564		14,533		18,097
South Australia		1773		6652		8425
Queensland		28,945		32,829		61,774
New Zealand	..	no entry.	no entry.	unknown.	..	..
						302,750
CHEESE.						
		£		£		£
Victoria	denominations various.	40,905	denominations various.	75,959	denominations various.	116,864
New South Wales†		..		..		..
South Australia		6496		11,407		17,903
Queensland		6718		9056		15,774
New Zealand		10,214		unknown.		10,214
						160,755
FLOUR.						
	tons.	£	tons.	£	tons.	£
Victoria	19,568	452,854	14,415	259,034	33,983	711,888
New South Wales	24,322	501,871	29,832	502,408	54,154	1,004,279
South Australia	102½	1871	503	7618	605	9489
Qneensland	11,416	265,134	14,637	261,105	26,053	526,239
New Zealand	19,801	383,546	unknown.	..	19,801	383,546
					134,596	2,635,433
FRUIT, GREEN.						
	bushels.	£	bushels.	£	bushels.	£
Victoria	178,457 and 40 tons	98,223	203,863 and 58 tons.	113,268	382,320 and 98 tons.	211,491
New South Wales	36,133	21,736	9969	16,159	46,102	37,895
South Australia	not given.	6892	not given.	4892	not given.	11,784
Queensland	27,617	23,622	24,163	17,502	51,780	41,124
New Zealand	25,993	19,605	unknown.	..	25,993	19,605
					506,195 and 98 tons.	321,899
GRAIN, BARLEY.						
	bushels.	£	bushels.	£	bushels.	£
Victoria	11,149	3117	345,451	75,547	356,600	80,664
New South Wales	598	188	43,678	6845	44,476	7033
South Australia	no separate entry.		no separate entry.		no entry.	..
Queensland	973	293	1591	420	2564	713
New Zealand	18,904	8561	unknown	..	18,904	8561
					422,344	96,971
BEANS AND PEAS.						
	bushels.	£	bushels.	£	bushels.	£
Victoria	6628	2795	6384	2224	13,012	5019
New South Wales	no entry.	..	2532	592	2532	592
South Australia	no entry.	..	no entry.	..	no entry.	..
Queensland	1003	376	661	309	1664	685
New Zealand	no entry.	..	unknown.	..	unknown.	..
					17,208	6296
OATS.						
	bushels.	£	bushels.	£	bushels.	£
Victoria	508,665	96,613	546,954	145,811	1,055,619	242,422
New South Wales	593	263	86,850	5352‡	87,443	5615
South Australia	no separate entry.		no separate entry.		no separate entry.	
Queensland	15,402	3840	16,816	5099	32,258	8939
New Zealand	99,295	24,746	unknown.	..	99,295	24,746
					1,274,615	281,722

* Butter and Cheese.

† See Butter.

‡ Correctly quoted.

Statistics relating to Traffic and other matters.

APPENDIX H 1.

Table furnished by J. E. CALDER Esq., showing Farm Produce imported by the adjoining Colonies.

COLONY.	1865. Quantity.	1865. Declared Value.	1866. Quantity.	1866. Declared Value.	TOTAL. Quantity.	TOTAL. Declared Value.
WHEAT.						
	bushels.	£	bushels.	£	bushels.	£
Victoria	1,001,625	466,480	1,279,474	433,119	2,281,099	899,599
New South Wales	692,826	305,418	1,093,081	351,973	1,785,907	657,391
South Australia	no separate	entry.	no separate	entry.	..	..
Queensland	286	84	5063	1573	5349	1675
New Zealand	331,116	129,186	unknown.	..	331,116	129,186
					4,403,471	1,687,851
HAY.						
	tons.	£	tons.	£	tons.	£
Victoria	432	3216	22	145	454	3361
New South Wales	73	420	183	790	256	1210
South Australia	45	204	65	572	110	776
Queensland	11,497 bales	22,409	11,281 bales	21,137	22,778 bales	43,546
New Zealand	no entry.	..	unknown	..	..	..
						48,893
HOPS.						
		£		£		£
Victoria	denominations varions.	48,179	denominations various.	70,263	denominations various.	118,442
New South Wales		11,143		7678		18,821
South Australia		14,286		16,002		30,288
Queensland		1435		910		2345
New Zealand		23,925		..		23,925
						193,821
LIVE STOCK, HORSES.						
	number.	£	number.	£	number.	£
Victoria	2370	42,128	2439	34,354	4809	76,482
New South Wales	106	3692	135	11,967	241	15,659
South Australia	no entry.*	..	no entry.*	..	no entry.	..
Queensland	2015	28,622	1147	15,738	3162	44,354
New Zealand	306	9395	unknown.	..	306	9395
					8518	145,890

* Description of Stock not distinguished. Total value imported in the year 1865, £40,858; in the year 1866, £33,816.

COLONY.	1865. Quantity.	1865. Declared Value.	1866. Quantity.	1866. Declared Value.	TOTAL. Quantity.	TOTAL. Declared Value.
HORNED CATTLE.						
	number.	£	number.	£	number.	£
Victoria	52,476	335,677	53,546	324,445	106,022	660,122
New South Wales	6	2200†	1	40	7	2240
South Australia	no entry.	..	no entry.	..	no entry.	..
Queensland	13	1763	43	610	56	2373
New Zealand	7337	88,397	unknown.	..	7337	88,397
					113,422	753,132

† Correctly quoted.

COLONY.	1865. Quantity.	1865. Declared Value.	1866. Quantity.	1866. Declared Value.	TOTAL. Quantity.	TOTAL. Declared Value.
PIGS.						
	number.	£	number.	£	number.	£
Victoria	2367	6218	3486	4394	5853	10,612
New South Wales	119	103	4	8	123	111
South Australia	no entry.	..	no entry.	..	no entry.	..
Queeensland	305	350	49	43	354	393
New Zealand	no entry.	..	unknown.	..	unknown.	..
					6330	11,116
SHEEP.						
	number.	£	number.	£	number.	£
Victoria	214,711	217,832	281,968	250,000	496,679	467,832
New South Wales	1284	9099	239	3037	1523	12,136
South Australia	no entry.	..	no entry.	..	no entry.	..
Queensland	175	9260‡	214	6097	389	15,357
New Zealand	9529	27,952	unknown.	..	9529	27,952
					508,120	523,277

‡ Correctly quoted.

COLONY.	1865. Quantity.	1865. Declared Value.	1866. Quantity.	1866. Declared Value.	TOTAL. Quantity.	TOTAL. Declared Value.
MALT.						
	bushels.	£	bushels.	£	bushels.	£
Victoria	232,621 & 476 tanks, &c.	125,721	249,155 & 585 tanks, &c.	162,861	481,776 & 1061 tanks, &c.	288,582
New South Wales	44,408	21,892	48,539	23,822	92,947	45,714
South Australia	46,608	14,043	95,256	32,302	141,864	46,345
Queensland	167	170	no entry.	..	167	170
New Zealand	no entry.	..	unknown.	..	..	..
					716,754 & 1061 tanks, &c.	380,811

Statistics relating to Traffic and other matters.

APPENDIX H 1.

Table furnished by J. E. CALDER, Esq., showing Farm Produce imported by the adjoining Colonies.

COLONY.	1865. Quantity.	1865. Declared Value.	1866. Quantity.	1866. Declared Value.	TOTAL. Quantity.	TOTAL. Declared Value.
OATMEAL.						
		£		£		£
Victoria	denominations various.	1262	denominations various.	5554	denominations various.	6816
New South Wales		3479		7829		11,308
South Australia		..		..		..
Queensland		no entry.		3486		3486
New Zealand		3175		..		3175
						24,785
ONIONS.						
	tons.	£	tons.	£	tons.	£
Victoria	248	3816	173	3495	421	7311
New South Wales	306	3572	263	3095	569	6667
South Australia	no entry.	..	no entry.	..	no entry.	..
Queensland	146,835 lbs.	3280	409,870 lbs.	3460	556,705 lbs.	6740
New Zealand	no entry.	..	unknown.	..	..	..
						20,718
PRESERVES.						
		£		£		£
Victoria	denom. various.	33,476	denom. various.	27,893	denom. various.	61,369
New South Wales	..	..	..	..	..	..
South Australia	..	..	..	..	..	..
Queensland	..	..	..	..	..	..
New Zealand	..	..	..	..	..	..
						61,369
POTATOES.						
	tons.	£	tons.	£	tons.	£
Victoria	7526	44,276	3203	20,177	10,729	64,453
New South Wales	5967	36,118	9904	60,312	15,871	96,430
South Australia	4950	30,847	6017	37,883	10,967	68,730
Queensland	3350	26,297	3933	28,503	7283	54,800
New Zealand	no entry.	..	unknown.	..	unknown.	..
					44,850	284,413

RECAPITULATION.

TOTAL Imports of Twenty-one Articles of Farm Produce, manufactured and unmanufactured, of the Five Colonies of Victoria, New South Wales, South Australia, Queensland, and New Zealand, for the Two Years 1865 *and* 1866.

Article.	Quantity.	Value.	Article.	Quantity.	Value.
		£			£
Bacon and Hams	denom. various	215,023	Hay	denom. various	48,893
Bran	588,213 bushels	68,885	Hops	ditto	193,821
Butter	denom. various	302,750	Live stock—Horses	8518 head	145,890
Cheese	ditto	160,755	Horned Cattle	113,422 ditto	753,132
Flour	134,596 tons	2,635,433	Pigs	6330 ditto	11,116
Fruit, green	506,195 bushels and 98 tons	321,899	Sheep	508,120 ditto	523,277
			Malt	716,754 bushels	380,811
Grain—Barley	422,344 bushels	96,971	Oatmeal	denom. various	24,785
Beans and Peas	17,204 ditto	6296	Onions	ditto	20,718
Oats	1,274,615 ditto	281,722	Preserves	ditto	61,369
Wheat	4,403,471 ditto	1,687,851	Potatoes	44,850 tons	284,413
					8,225,810

Appendix H 2.

RETURNS FURNISHED TO THE COMMISSION BY E. C. NOWELL, ESQ., GOVERNMENT STATISTICIAN, AND REFERRED TO IN HIS EVIDENCE.

TABLE A.

RETURN of Agricultural Produce *for the Year ended March* 31, 1868, *in the Rural Municipalities, part of the Produce of which may be assumed to pass over some portion of the Main Line of Road.**

MUNICIPALITIES.	*Wheat.*	*Barley.*	*Oats.*	*Peas.*	*Beans.*	*Tares.*	*Potatoes.*	*Turnips.*	*Carrots.*	*Mangel Wurzel.*	*Onions.*	*Grass-seed.*	*Hay.*	*Fruit.*
	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.	Tons.	Tons.	Tons.	Tons.	Tons.	Bushels.	Tons.	Bushels.
Bothwell	7293	4107	4186	170	77	450	103	161	..	35	..	252	480	2179
Brighton	48,123	6929	13,105	3738	182	..	693	243	18	232	7	1626	2225	6699
Campbell Town	8995	1325	4379	224	13	..	200	..	17	283	4	55	751	3310
Evandale	51,921	16,435	45,451	924	42	228	429	..	320	542	36	25,046	212	2110
Green Ponds	34,185	7970	14,199	2481	90	31	363	727	16	258	..	305	1062	2384
Longford	124,020	12,376	53,190	910	216	477	298	320	75	920	56	4900	3740	6591
Oatlands	28,573	12,221	31,395	805	..	..	652	938	4	6	4	1450	1639	1388
Ross	6344	588	2340	30	..	..	26	..	..	37	..	40	552	500
Fingal	17,250	7700	9612	1085	40	120	842	43	6	42	8	341	1160	3393
Glenorchy	5623	2452	1928	3017	568	50	221	28	169	570	66	190	1775	8472
Deloraine	53,606	7020	123,332	2041	..	80	881	130	17	177	9	821	895	1125
Westbury	145,548	2945	82,320	2560	153	176	1416	450	64	336	..	4536	2784	2896
Total	531,481	82,068	385,437	17,985	1381	1612	6124	3040	706	3438	190	39,562	19,192	41,047

E. C. NOWELL, *Government Statistician.*

* The crops of this year are considerably below the average: to represent an average crop one-third should be added to these quantities. (*See* Mr. Nowell's Evidence.)

Statistics relating to Traffic and other matters.

Appendix H 2.

Table furnished by E. C. Nowell, Esq., showing Agricultural Produce for 1868.

Statistics relating to Traffic and other matters.

APPENDIX H 2.

Return as to Land under cultivation.

TABLE B.

RETURN of LAND UNDER CULTIVATION *in the Year ended March 31st, 1868, in the Rural Municipalities, part of the Produce of which may be assumed to pass over some portion of the Main Line of Road.*

Municipality.	*Under Crop.*	*Gardens and other Lands under Cultivation not included in the foregoing.*	*Under Fallow.*	*New Land broken up during the Year.*	*Total.*
Bothwell	1649	150	166	49	2014
Brighton	7458	2382	1548	102	11,490
Campbell Town	1683	86	300	136	2205
Deloraine	11,853	13,233	783	173	26,042
Evandale	10,841	72	1830	140	12,883
Fingal	2451	3137	107	45	5740
Glenorchy	2011	191	1461	58	3721
Green Ponds	4961	155	516	177	5809
Longford	13,441	200	3484	204	17,329
Oatlands	4910	57	830	297	6094
Ross	1056	47	130	2	1235
Westbury	19,326	47,455	..	454	67,235
	81,640	67,165	11,155	1837	161,797

E. C. NOWELL, *Government Statistician.*

TABLE C.

ESTIMATED WEIGHT *in Tons for the Year ended March* 31, 1868, *of the Agricultural Produce in the Municipalities, part of the Produce of which may be assumed to pass over some portion of the Main Line of Road:—*

	Tons.		*Tons.*
Wheat	14,249	*Brought forward*	32,690
Barley	1832	Carrots	706
Oats	6883	Mangold Wurtzel	3438
Peas	482	Onions	190
Beans	37	Grass-seed	353
Tares	43	Hay	19,192
Potatoes	6124	Fruit	770
Turnips	3040	Wool	1396
Carried forward	32,690	*TOTAL	58,735

E. C. NOWELL, *Government Statistician.*

* The crops of this year were considerably below the average: to represent an average crop one-third should be added to their quantities. (*See* Mr. Nowell's Evidence.)

Statistics relating to Traffic and other matters.

APPENDIX H 2.

TABLE D.

Return as to Repairs of Main Road.

RETURN of Expenditure from the Colonial Treasury on the Main Line of Road for the last Five Years.

	£	s.	d.
1863	5692	0	9
1864	8706	19	7
1865	5987	8	6
1866	3997	16	2
1867	3915	8	7
TOTAL	£28,299	13	7

For 1867 the Expenditure is taken from the Return furnished by the Director of Public Works for the Statistics of that year: for the previous years, from a Return to an Order of the House of Assembly in 1867.

E. C. NOWELL, *Government Statistician.*

TABLE E.

Return as to Road Rates paid by Districts contiguous to the Main Road.

STATEMENT showing the Amount of RATES *raised in the Road Districts, part of the Produce of which may be assumed to pass over some portion of the Main Line of Road; the Amount of Aid contributed by Government; and the Amount expended on Roads in the said Districts in the Year* 1867.

DISTRICTS.	*Amount of Rates in the Pound.*	*Total Amount of Rates raised.*	*Aid contributed by Government.*	*Amount expended on Roads by the Trusts.*
	s. d.	£ s. d.	£ s. d.	£ s. d.
BOTHWELL.				
On Private Property	0 4	262 16 10	131 8 5	437 12 5
On Crown Lands	0 2			
BRIGHTON (Broad Marsh.)	0 6	116 11 11	58 5 11	120 9 0
CAMPBELL TOWN (Northern Macquarie.)				
On Private Property	0 6	819 5 0	409 12 6	798 16 5
On Crown Lands	0 3			
DELORAINE	1 0	289 15 0	144 17 6	619 4 4
EVANDALE	0 3	265 12 10	132 16 5	532 13 0
GREEN PONDS.				
On Private Property	0 3	180 4 6½	90 2 3	218 12 6
On Crown Lands	0 1½			
LONGFORD	0 6	1180 11 1	590 5 6	1448 16 8
Special Rate	0 1			
OATLANDS.				
On Private Property	0 3	372 13 8	186 6 10	354 17 6
On Crown Lands	0 1½			
ROSS, SOUTHERN MACQUARIE	0 3	207 18 0½	103 19 0	273 9 10
WESTBURY	0 10	1081 7 10	540 13 11	1616 8 2
TOTAL		£4776 16 9	2388 8 3	6420 19 10

The first three columns are filled up from the Assistant Colonial Treasurer's Statements published in the *Gazette* of April 7, 1868; the last column from Returns furnished by the Trusts, the amounts not including contingent expenses.

E. C. NOWELL, *Government Statistician.*

Appendix H 3.

* *TRAFFIC RETURN taken for One Month extended so as to show the present Amount of Traffic yearly on the* Main Line Road, *excluding all that passing into Launceston from Westbury, Deloraine, and Longford, except as to the Longford traffic that small part which passes the "Cocked Hat."*

Stations. (*a*)	Passengers: On Foot.	Passengers: On Horses.	Passengers: In Stage Coaches. (*b*)	Passengers: In Gigs, Spring Carts, &c. (*c*)	Goods by Carts, Drays, and Waggons, drawn by— 2 Wheels: 1 Horse.	2 Wheels: 2 Horses.	2 Wheels: 3 Horses.	4 Wheels: 2 or 4 Horses (*h*)	4 Wheels: 5 or 6 Horses. (*h*)	4 Wheels: 2 or 6 Oxen (*h*)	Passengers: Number of Passengers passing through Stations per Month.	Number of Passengers passing through Stations per Year.	Average Number of Miles assumed to be travelled by each Passenger passing through Stations. (*d*)	Number of Miles travelled by all the Passengers passing through Stations in the Year.	Average Fare per Mile. (*e*)	Annual Revenue from Passengers passing through Stations.	Goods: Weight of Goods passing through Stations per Month, in Tons.	Weight of Goods passing through Stations per Year, in Tons.	Average Number of Miles Goods passing through Stations are assumed to be carried.	Total Annual Mileage of Goods passing through Stations, in Tons.	Average Rate per Mile. (*l*)	Annual Revenue from Goods passing through Stations.
NEW TOWN.																£ s. d.						£ s. d.
Week ending 14 June, 1868	2723 (*f*)	216	300	4730 (*f*)	952 (*i*)																	
Week ending 21 June, 1868		234	300																			
Week ending 28 June, 1868		237	300																			
Week ending 5 July, 1868		284	300																			
	2723										2723 x 13	35,399	x 6	212,394	@ 3*d.*	2654 18 6						
		6901									6901 x 13	89,713	x 6	538,278	@ 3*d.*	6728 9 6						
					952 tons												952 x 13	12,376	x 6	74,256	@ 8*d.*	2475 4 0
BRIDGEWATER.																						
Week ending 20 Sept. 1863	79	46	228	64	12	37	..	42	..	..												
Week ending 27 Sept. 1863	75	27	228	90	9	33	..	50	..	..												
Week ending 4 Oct. 1863	52	41	228	54	13	27	..	30	..	..												
Week ending 11 Oct. 1863	60	50	228	57	9	12	..	38	..	..												
	266										266 x 13	3458	x 6	20,748	@ 3*d.*	259 7 0						
		1341									1341 x 13	17,433	x 7	122,031	@ 3*d.*	1525 7 9						
					(*h*) 312 Vehicles, Traction Power = 741 horses = 494 tons												494 x 13	6422	x 7	44,954	@ 8*d.*	1498 9 4
BRIGHTON.																						
Week ending 20 Sept. 1863	34	34	228	40	26	10	9	23	4	12												
Week ending 27 Sept. 1863	33	27	228	27	6	11	5	17	10	..												
Week ending 4 Oct. 1863	21	15	228	39	5	27	12	24	10	..												
Week ending 11 Oct. 1863	51	25	228	44	2	22	14	24	10	1												
	139										139 x 13	1807	x 6	10,842	@ 3*d.*	135 10 6						
		1163									1163 x 13	15,119	x 19	287,261	@ 3*d.*	3590 15 3						
					284 Vehicles, Traction Power = 771 horses = 517 tons												517 x 13	6721	x 19	127,699	@ 8*d.*	4256 12 8
OATLANDS.																						
Week ending 20 Sept. 1863	87	53	156	46	51	18	6	14	1	9												
Week ending 27 Sept. 1863	93	57	156	50	46	40	15	12	1	18												
Week ending 4 Oct. 1863	137	89	156	74	62	42	23	13	2	21												
Week ending 11 Oct. 1863	96	72	156	68	60	45	21	24	7	26												
	413										413 x 13	5369	x 6	32,214	@ 3*d.*	402 13 6						
		1133									1133 x 13	14,729	x 29	427,141	@ 3*d.*	5339 5 3						
					577 Vehicles, Traction Power = 1101 horses = 734 tons												734 x 13	9542	x 29	276,718	@ 8*d.*	9223 18 8
ROSS.																						
Week ending 20 Sept. 1863	189	54	156	27	38	22	6	8	3	44												
Week ending 27 Sept. 1863	212	56	156	34	28	28	..	8	1	4												
Week ending 4 Oct. 1863	207	50	156	41	35	33	4	11	2	30												
Week ending 11 Oct. 1863	213	59	156	41	14	21	6	7	6	36												
	821										821 x 13	10,673	x 6	64,038	@ 3*d.*	800 9 6						
		986									986 x 13	12,818	x 15	192,270	@ 3*d.*	2403 7 6						
					[illegible]												[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CAMPBELL TOWN.																					
Week ending 20 Sept. 1863	..	139	156	108	69	45	7	29	9	29											
Week ending 27 Sept. 1863	..	122	156	93	49	48	6	32	6	30											
Week ending 4 Oct. 1863	..	142	156	108	66	47	19	33	2	19											
Week ending 11 Oct. 1863	..	147	156	100	50	54	23	32	4	22											
1583											1583 x 13	20,579	x 8	164,632	@ 3*d.*	2057 18 0						
730 Vehicles, Traction Power = 1480 horses = 987 tons																	987 x 13	12,831	x 8	102,648	@ 8*d.*	3421 12 0
CLEVELAND.																					
Week ending 20 Sept. 1863	65	28	156	24	4	3	1	7	5	..											
Week ending 27 Sept. 1863	65	25	156	22	1	2	..	12	2	1											
Week ending 4 Oct. 1863	69	45	156	30	9	6	..	17	3	3											
Week ending 11 Oct. 1863	66	25	156	25	14	8	1	10	4	7											
265											265 x 13	3445	x 6	20,670	@ 3*d.*	258 7 6						
848											848 x 13	11,024	x 11	121,264	@ 3*d.*	1515 16 0						
120 Vehicles, Traction Power = 309 horses = 206 tons																	206 x 13	2678	x 11	29,458	@ 8*d.*	1981 18 8
SNAKE BANKS.																					
Week ending 20 Sept. 1863	40	40	156	15	3	7	3	5	9	..											
Week ending 20 Sept. 1863	58	19	156	36	4	4	..	14	4	..											
Week ending 4 Oct. 1863	64	41	156	31	3	3	..	12	9	..											
Week ending 11 Oct. 1863	44	19	156	45	2	6	4	8	5	3											
206											206 x 13	2678	x 6	16,068	@ 3*d.*	200 17 0						
870											870 x 13	11,310	x 11	124,410	@ 3*d.*	1555 2 6						
108 Vehicles, Traction Power = 344 horses = 229 tons																	229 x 13	2977	x 11	32,747	@ 8*d.*	1091 11 4
COCKED HAT.																					
Week ending 20 Sept. 1863	144	150	432	245	116	52	..	82	2	4											
Week ending 27 Sept. 1863	142	131	432	268	87	30	15	76	1	6											
Week ending 4 Oct. 1863	182	210	468	325	92	16	12	57	7	5											
Week ending 11 Oct. 1863 (*g*)	156	164	444	279	98	32	9	72	3	5											
624											624 x 13	8112	x 6	48,672	@ 3*d.*	608 8 0						
3548											3548 x 13	46,124	x 9	415,116	@ 3*d.*	5188 19 0						
899 Vehicles, Traction Power = 1733 horses = 1155 tons																	1155 x 13	15,015	x 9	135,135	@ 8*d.*	4504 10 0
											23,830 Passengers	309,790 Journeys		2,818,049 Mileage		£35,225 12 3 Revenue	5785 Tons	75,205 Tons		923,260 Mileage		£30,775 6 8 Revenue

* These Traffic Returns do not include the passengers and goods coming by steamer from Bridgewater, nor any part of the traffic passing into Launceston from Westbury and Deloraine, and only that part of the Longford traffic which reaches Launceston by the Main Road excluding that which goes by the Muddy Plains Road. These Returns also exclude all sheep, cattle, and horse traffic.

(*a*) The whole of the traffic appearing in this Table, except that under the head of "New Town," is taken from Returns obtained by the Government in 1863 for the purpose of seeing whether additional Toll-gates would be advisable. The Returns were taken at a very dull period of the year, and doubtless give a very unfavourable monthly average. The Returns for "New Town" were taken at the Police Station corner of the avenue leading to the Queen's Asylum, and at a very unfavourable time of the year also.

(*b*) The stage coaches are assumed to carry only six passengers.

(*c*) Gigs, spring carts and other private vehicles are only assumed to carry the driver.

(*d*) The average number of miles assumed to be travelled by each person passing through a station is ascertained by taking the mean of the distance between the next preceding and the next following station.

(*e*) The average fare per mile is assumed at a low rate. The present charge by coach is 4*d.* per mile outside and 3*d.* per mile inside. And the Railway fares in Victoria are 4*d.* for first class and 3*d.* per second class. Supposing the second class passengers to be in the proportion of 2 to each first class passenger, the average fare per mile ought to have been taken at 3·333 instead of at 3*d.*

(*f*) All persons known to be resident in the district were omitted. In taking the traffic at this station the number passing weekly were not separately distinguished. The same remark applies to persons passing in gigs, dog carts, spring carts and other private carriages.

(*g*) The Returns obtained by the Government of traffic passing the "Cocked-hat Toll-gate" for the week ending the 11th October, 1863, is wanting. The omission is supplied by taking the average of the three previous weeks.

(*h*) In estimating the weight of the loads, vehicles returned as having 2 or 4 horses have been calculated as 3 horse loads; those as having 5 or 6 horses as $5\frac{1}{2}$ horse loads; and those returned as drawn by 2 to 6 oxen have been assumed as averaging 4 oxen and equal to 2 horse loads.

(*i*) In taking the traffic passing this station the daily tonnage was not separately distinguished.

(*k*) In this and all the like estimates which follow, the load of each horse has been assumed to average $\frac{2}{3}$, and that of a bullock to average $\frac{1}{3}$ of a ton: both of these estimates being considerably below the draught of horse and bullock teams according to a Return furnished to the Parliament of Victoria for a similar purpose.

(*l*) The average rate assumed here is 8*d.* per ton per mile, while the lowest present rate by carriers on the Main Road is 1*s.* per ton per mile. This is under the average of the rates of charge for goods traffic in the adjoining Colonies.

Statistics relating to Traffic and other matters.

APPENDIX H 4.

Return as to Tonnage entered Inwards at Launceston.

APPENDIX H 4.

QUESTIONS submitted by the Royal Commission on the Main Line Railway to the Collector of Customs at Launceston.

The Tonnage entered Inwards in 1867 being 29,945 tons, what would be about the tonnage of Goods?

This question can only be answered by giving a proximate estimate of the Tonnage of Goods, say you add one-fourth to the Registered Tonnage, thus—

	Tons.
Registered Tonnage	29,945
Add one-fourth	7486
Say about Tonnage of Goods	37,431

What is the gross weight of Package Goods brought into Launceston in 1867 which are charged by measurement at 40 cubic feet to Ton?

Package Goods	51,477 cubic feet
Divided by 40	1287 Tons

Can you state what proportion of these Goods go up country?

I cannot.

R. H. WILLIS, *Collector.*

Launceston, 2nd July, 1868.

APPENDIX H 5.

Return as to Tonnage of Vessels trading between Hobart Town and Launceston.

APPENDIX H 5.

PORT OF LAUNCESTON.

TABLE showing the TONNAGE *of* SHIPS *trading between* HOBART TOWN *and* LAUNCESTON.

Arrivals from Hobart Town.			Departures for Hobart Town.		
Date.	*Vessel's Name.*	*Tonnage.*	*Date.*	*Vessel's Name.*	*Tonnage.*
1866.			1866.		
Jan. 11.	Storm Bird	96	Jan. 8.	Storm Bird	96
27.	Ditto	96	25.	Ditto	96
Feb. 20.	Ditto	96	26.	Ripple	25
Mar. 16.	Ditto	96	Feb. 12.	Storm Bird	96
April 5.	Ditto	96	Mar. 12.	Ditto	96
6.	Tasman	79	April 3.	Ditto	96
26.	Macquarie	126	20.	Tasman	79
27.	Storm Bird	96	24.	Storm Bird	96
May 3.	Ben Bolt	8	May 4.	Petrel	59
5.	Petrel	59	21.	Storm Bird	96
17.	Harriet Nathan	113	21.	Tasman	79
21.	Tasman	79	June 4.	Petrel	59
23.	Storm Bird	96	14.	Storm Bird	96
June 4.	Petrel	59	25.	Petrel	59
20.	Storm Bird	96	July 13.	Storm Bird	96
27.	Petrel	59	17.	Petrel	59
July 18.	Ditto	59	Aug. 10.	Ditto	59
21.	Storm Bird	96	18.	Storm Bird	96
Aug. 11.	Petrel	59	27.	Petrel	59
11.	Mida	229	Sept. 13.	Storm Bird	96
23.	Storm Bird	96	Oct. 2.	Petrel	59
Sept. 19.	Ditto	96	26.	Ditto	59
Oct. 9.	Petrel	59	Nov. 10.	Tasman	79
29.	Tasman	79	20.	Petrel	59
Nov. 1.	Petrel	59	Dec. 4.	Tasman	79
20.	Ditto	59	5.	Petrel	59
22.	Tasman	79			
Dec. 10.	Petrel	59			1987
10.	Tasman	79			
		2458			

TOTAL.

Tons Inwards	2458
Tons Outwards	1987
	4445

Stated to be all with full Cargoes.

GEORGE FISHER.

ADDENDA.

THE following Papers having come to hand since the Report of the Commission and the Appendices have been printed, are inserted here.

MEMO. for the Royal Commission, Hobart Town.

LAUNCESTON AND WESTERN RAILWAY.

	£ s. d.
The cost of the Works between Launceston and Longford, as per Messrs. Overend and Robb's contract, is	91,265 3 5
Rails, as per estimate	18,065 3 5
Timber Bridges	4303 1 0
Masonry and Iron Bridges	23,399 9 10
	£137,032 17 8

To which will have to be added the cost of Stations and Rolling Stock.

DOYNE, MAJOR, & WILLETT.

Melbourne, August 13, 1868.

STATEMENT of TOLLS *received at the Bridge at Bridgewater during the several Quarters from* 1*st January*, 1863, *to* 31*st December*, 1867.

	1863.	1864.	1865.	1866.	1867.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1 January to 31 March	297 1 5	284 2 6	272 3 8	287 8 10½	308 3 9
1 April to 30 June	266 19 4½	258 9 0	262 18 0	261 12 9	279 9 8½
1 July to 30 September	227 0 0½	238 2 9½	229 14 7	232 16 10	256 15 5
1 October to 31 December	245 15 3½	274 18 2	255 7 9½	257 12 8	290 19 11
Totals	1036 16 1½	1055 12 5½	1020 4 0½	1039 11 1½	1135 8 9½

Office of Bridgewater Commissioners, 5th August, 1868.

The Hon. F. M. INNES, *Bridgewater Commissioner.*

⁂ The Commissioners think it only due to themselves, in support of their estimates of the probable traffic on the Main Road, to note that the above Returns, which may be considered as a fair index to the actual traffic on the Main Road at all seasons of the year, show that their estimate of the probable traffic having been calculated from Returns taken in the most unfavourable month of the year, may be considered as at least 20 per cent. under the real amount of traffic.

LENGTHS of Surveyed Lines.

1. Length of Sprent's Line from Kangaroo Point to Oatlands, 49 miles.
2. Length of Sorell and Davies' Line to Oatlands, 48 miles.
3. Length of Hogan's Line to Oatlands, 60 miles.
4. Length of Main Road to Oatlands, 52 miles.
5. Total length of Sprent's Line, 117 miles.
6. Total length to Launceston, 121 miles 39 chains.

NOTICE.

THE Commissioners having ascertained, since the Commission closed its labours, that Messrs. W. M. Purkiss, H. B. Chapman, and C. S. Cansdell, jun., decline to accept any remuneration for the Clerical services they have rendered to the Commission, deem it only right to make this public acknowledgment of their valuable assistance.

JAMES BARNARD,
GOVERNMENT PRINTER, TASMANIA.