REPORTS

BY

THE ENGINEER-IN-CHIEF.

(ALSO REPORTS BY THE RESIDENT ENGINEER OF THE AUCKLAND AND MERCER RAILWAY, ON THE EXTENSION SURVEY OF THAT LINE; AND BY THE DISTRICT ENGINEER OF OTAGO, ON THE DUNEDIN AND MOERAKI LINE.)

PRESENTED TO BOTH HOUSES OF THE GENERAL ASSSEMBLY, BY COMMAND OF HIS EXCELLENCY.

WELLINGTON.

1872.

SCHEDULE.

REPORTS BY THE ENGINEER-IN-CHIEF.

No. 1.

GENERAL REPORT.

Mr. Carruthers to the Hon. J. D. Ormond.

Sir,— Public Works Office, Wellington, 30th June, 1872.

During the last Session of Parliament, an agreement having been entered into with Messrs. John Brogden and Sons for the construction of works, no time was lost in making the necessary working surveys and preparing plans of structures. As the work done last year consisted only of trial lines, sufficient to give a rough estimate of the cost of the lines, but far from sufficient to enable a contractor to tender, this has been a work requiring time.

It is a not uncommon plan to let a contract on similar surveys, but whenever this is done the contractor puts on a price to cover risk, which it would have been bad policy in the Government to pay. I feel sure that not less than £500 a mile would have been lost by adopting this policy, and it is out of question that this saving on the cost has well paid for the delay.

The works which Messrs. Brogden have tendered for, and for which their tenders have been accepted, are:—

	Miles.	Construction.	Maintenance.
Newmarket to Mercer	39·07	£166,724	£2,200
Napier to Puki Puki	18·13	50,807	860
Wellington to Hutt	8·00	28,616	400
Picton to Blenheim	17·10	75,534	1,000
Dunedin to Clutha (Taieri Section)	34·55	142,000	1,835
Invercargill to Mataura	39·56	86,697	2,135
Total	156·61	£550,378	£8,430

When account is taken of the contingencies of rise in cost (due more to the scarcity of skilled sub-contractors, iron masters, founders, mechanics, and others, than to any actual rise in the price of labour) which takes place even in England and other thickly peopled countries, on the beginning of large public works, I am of opinion that the work would not be done by small contractors cheaper, on the whole, than Messrs. Brogden have contracted to do it, while the risk to the Government is of course much reduced, or altogether done away with, by having a firm with a reputation to lose, to undertake the work.

Besides the above lines, works and surveys were in progress elsewhere, which will be examined detail.

Kawa Kawa Railway.

This line is intended to facilitate the transport of coal from the mines to deep water. Working surveys have been prepared and the line staked out on the ground, by Mr. Lowe, so that work might shortly be begun. Since last year, however, the mines have been flooded, and until the Company have settled to put down machinery for pumping them out, it would be premature to begin the construction of the railway.

Kaipara Railway.

This work was begun by the Provincial Government of Auckland. The contract for its construction was let to Mr. Edgar, and the first sod turned on 31st August, 1871. In January, 1872, the work was taken over by the General Government.

Nearly one-half of the work in New Zealand has been done. Unfortunately the present state of the iron market at home is such that light rails can hardly be bought at any price, and tenders could not be got for the rails. This will cause some delay in the completion of the contract. The works are under the charge of Mr. Harding.

Kaipara and Riverhead Railway.

Trial surveys from Auckland to the Riverhead terminus of the Kaipara Railway have been made by Mr. J. J. O'Neill, with the view of bringing the line to Auckland. The country is rough, and a railway will be expensive. Estimates have not yet been prepared.

Auckland and Mercer Railway, and Onehunga Branch.

This work was begun some years ago by the Provincial Government of Auckland, but abandoned after a good deal of work had been done.

Pending the preparation of plans and sections of the whole line, work was begun in January, 1872, between Auckland and Newmarket, under a contract with Messrs. John Brogden and Sons, and has been actively carried on. The tunnel at Newmarket has been pierced with a driftway, a waggon road laid through, and a locomotive engine has been put upon the rails to lead earthwork from the cuttings to the reclamation of the station ground.

At both ends of the tunnel the ground is a very treacherous clay, which before gave much trouble to the Provincial Government by slipping into the cutting. Piling has been resorted to, to prevent this, a portion of which has been done, and has been effective.

The reclamation of land for the station ground has made good progress, Fort Britomart being demolished for the purpose.

Only a small portion of the Onehunga branch has to be done, the greater part of the earthwork having been made by the Provincial Government; this awaits the completion of the work between Auckland and Newmarket.

From Newmarket to Mercer the working plans have been made, and the contract let to Messrs. John Brogden and Sons. The work is under the charge of Mr. James Stewart, A.I.C.E.

Extension of Auckland and Mercer Railway.

A reconnaisance survey has been made by Mr. Stewart, a copy of whose report is attached.*

* See Enclosure No. 1.

Napier and Ruataniwha Railway.

The section of this line from the Port of Napier to Paki Paki has been surveyed, working plans made, and the contract let to Messrs. John Brogden and Sons.

A few men have been employed on the construction of the work between the port and town, but only about £400 has been spent. This was undertaken for the relief of the men who were unemployed, and whom it was desirable to keep ready for the real beginning of work.

Manawatu to Wanganui.

Trial surveys from Manawatu Gorge to the Wanganui River have been made. The plans are now in hand.

A delay occurred, due to objections on the part of the Natives to surveys being made through their land, but the objections have been removed, and the survey finished.

New surveys, which are now being made, are required over part of this line, as the hill sides have shown a dangerous tendency to slip, and this part of the country will have to be abandoned.

A length of about seven miles, beginning at the Palmerston and Manawatu Road, has been felled and cleared.

Wanganui to Waitotara.

The contract surveys have been completed and the plans are now in hand.

Waitara to New Plymouth.

The prelimary surveys are complete, and part of the working surveys. Mr. Blackett visited the district lately to decide between two lines which had been surveyed—the coast and the inland lines. In the meantime the inland line is being set out for contract.

The surveys between Waingongoro and Whenuakarua, which were made last year, have been lockspitted again, so as to preserve the work formerly done.

Wellington to Masterton.

Fifteen miles of the contract survey are complete, and the contract for eight miles let to Messrs. John Brogden and Sons. The data for the other seven miles have been given to Messrs. Brogden and Sons; their tender is expected in a few days.

The line across the Rimutaka is being surveyed for contract, but as the country is very difficult, it will take some time to complete.

Mr. Rochfort is in charge of the surveys, under the supervision of Mr. H. P. Higginson, M.I.C.E.

Brunner Coal Mine Railway.

The contract surveys are nearly ready.

Canterbury Railways.

On 1st May last the line from Addington to Kaiapoi, about twelve miles, was opened for public traffic. From Kaiapoi to Rangiora, the forming is done and rail-laying going on. From Rangiora to Kowai the contract surveys are ready and plans are in hand.

The contract surveys for the four branch railways enumerated below are complete or nearly so:—

Rangiora to Oxford, Rolleston to Southbridge, Kaiapoi to Eyreton, and Rolleston to Malvern.

Selwyn to Rakaia.

The line is ready for the rails.

Rakaia to Ashburton.

Contract survey nearly ready.

Timaru and Washdyke.

The works here were begun in October, and about five-eighths of the grading and forming have been completed.

Waitaki to Moeraki.

New trial lines have been run, and the contract survey is nearly complete, on an amended line.

Waireka Branch.

Surveys of this branch have been made, and the plans are in hand.

Waitaki Bridge.

Some of the iron girders have arrived, and have been conveyed to the site of the Bridge. The rest are shortly expected.

Moeraki to Dunedin.

* A reconnaissance survey has been made by Mr. Blair, whose report is annexed. * See Enclosure No. 2.

Dunedin to Clutha.

The works for 5½ miles from Dunedin have been let to Mr. A. J. Smyth, who is carrying out his contract with energy. The grading and bridging are complete, the tunnel only being unfinished. The length of the latter is 946 yards, of which 570 yards are done. The material met with has been a soft sandstone, very favorable for tunnel work.

The next section of 34½ miles has been let to Messrs. John Brogden and Sons.

The work at the Clutha end, 10½ miles long, was let in August last, but the contractor having failed, it was let again in March to Messrs. Blair and Watson, at an advance of thirty per cent. on the first contract. The new contractors are making good progress with their work.

Invercargill to Mataura.

The contract for this line has been let to Messrs. John Brogden and Sons.

Popotuna to Clyde.

At the request of the inhabitants, the work on the Tuapeka branch was suspended, and a reconnaisance survey undertaken, to examine the country between the Invercargill line at Popotuna and Clyde. Mr. Millar, to whom this is intrusted, has not yet reported on it, but I expect shortly to receive his report.

Winton to Kingston.

Surveys have been made to avoid the two crossings of the Oreti River, which were intended in the first surveys, and comparative estimates are being prepared. Sixteen miles of contract survey are ready, and the rest in hand.

Moeraki Jetty.

The materials for this jetty were purchased by the Provincial Government of Otago and transferred to the General Government. The erection is being done by contract, under the superintendence of Mr. Barr, the Provincial Engineer.

JOHN CARRUTHERS,
Engineer-in-Chief.

The Hon. the Minister for Public Works.

Enclosure 1 in No. 1.

REPORT ON THE EXTENSION SURVEY OF THE AUCKLAND AND MERCER RAILWAY.

Mr. J. STEWART to Mr. J. CARRUTHERS.

SIR,— Auckland, 4th June, 1872.

I have the honor to report that, in pursuance of the directions contained in a minute by the Engineer-in-Chief, of date 16th April last, I proceeded on the 22nd ultimo to Waikato, for the purpose of examining as to which of the frontier settlements there seem most suitable, for the purpose of directing the line of survey, for railway extension.

Regarding the general route from Mercer as far as Ngaruawahia, I believe no question can arise,—the proper right bank of the river being the natural line. In detail, for a length of sixteen or eighteen miles between Whangamarino and Rangiriri, two courses may be chosen from—a westerly one by the river bank, or an easterly one inland of the broken range of hills over which the coach road is taken. Both routes are swampy, and of about the same length. The easterly or inland one seems to me preferable, and would in general pass along the ends of the spurs of the hills as they border the Whangamarino swamps; the elevation of these at this line of route being amply sufficient to afford a surface line and good drainage, while the route by the river banks is so low as to be always for a great length flooded by the risings of the river.

In a distance of eleven miles from Rangiriri to the Taupiri Gorge, I believe only one cutting, and that of moderate dimensions, will be found, and only a few small swamps; about ten miles of this length would be mere ditching and forming over plains a few feet above flood level. In Taupiri Gorge also the line is much easier than I had anticipated. It will be of much the same character of works as from Mercer to Whangamarino, namely, cuttings through a succession of spurs crowding on the coach road, and a general difficulty to get room for both. Strong and close fencing would be necessary at both these places between the road and river, to prevent cattle or horses shying and getting over the banks. The bridges are easy on this part, and under the average of those on the line north of Mercer. On the whole, I feel it safe to say that an easier forty miles of railway construction will not be found in New Zealand than from Mercer to Ngaruawahia.

From Ngaruawahia southwards, the route is necessarily determined in a great measure by the main question of the most suitable place at which to terminate. The frontier settlements are three in number, namely, Cambridge, Kihikihi, and Alexandra. I understand by the term most suitable frontier, in the first place, the position most suitable for future extension into the interior, and in the second place, one that will serve well the wants of the present settlements by running the line to it.

I was very soon satisfied that if the line was taken to Alexandra, it could only be with the view of being hereafter extended over the frontier by way of Kihkihi and Orakau, as however inviting the valley of the Upper Waipa is for railway making—so far as excellence of soil, ease of construction, a certainty of carrying a great population in future, is concerned—the Rangitoto Ranges blending with those of the Upper Mokau, present a barrier against extension towards Taupo far too formidable to think of when easier routes are available. No doubt the immense district of good land lying between Alexandra and Kawhia will eventually want a railway, but it will be a branch and not the main trunk

line of the Northern Island that will best serve it. If an available pass existed leading from the Upper Waipa Valley by the westward of the Rangitoto Range into the Taupo Plateau, it would be a question then between Alexandra and Kihikihi, requiring for its solution an examination of such pass, and in a general way the whole route lying through a country only recently allowed, in a passive sort of way, to be traversed by Europeans. But all whom I have consulted, and who have travelled the route, agree in declaring the country to be exceedingly mountainous and impracticable.

The route by Kihikihi means the old native track from Te Awamutu to Napier *via* Taupo, by which the overland mails were carried for many years, and it passes our frontier line at Orakau.

This track has not been lately used as a road to Taupo, but I am informed the country is good between the eastern side of Rangitoto and the Waikato; that the range of the mountain blends gradually with the central plateau, and presents no special difficulties. That the valley by Orakau to this plateau of Upper Waikato is generally favourable, is evident from the fact that hills of very moderate elevation on the banks of the river far above Manugatautari are visible at Alexandra. I examined the Native track beyond Orakau for some miles, and the country looks very favourable for the purpose in view.

The route to Taupo by Cambridge runs through the Maungatautari Gorge, keeping the proper right of the river; southward of the above range, by crossing the Waikato, the line might take the same country as by Orakau. I do not think the Cambridge route is likely to prove so easy in point of construction as that by Orakau,—speaking of extension to the interior,—and I believe it only remains to consider if questions of locality are likely to prove more favourable, and influence decision in favour of the former. And towards this, I am inclined to think that had the question been between Cambridge and Alexandra alone, without reference to extension, the proximity of the latter to the large Native population, and its consequent strategical position, would, even if other things were not equal, point to it as the terminus of the railway. And it is clear that a line by Te Awamutu, Kihikihi, and Orakau, presents practically the same advantageous features, and on this head is preferable to a more easterly route.

The question of strictly local traffic is the only other point which presents itself in the comparison, and looking to the equally excellent quality of the land in all the frontier settlements, and the steady progress each is making in settled population, it is impossible to say that Cambridge in this respect possesses any advantages over a strictly central route. Considering, again, that Cambridge and Alexandra are each at the head of a navigable river, a central route between would afford more accommodation to the country than one alongside either river.

For the foregoing reasons, then, I believe some suitable position in the valley of the Mangahoi just below Kihikihi and about mid-way between Te Awamutu and Orakau, to be the most suitable place for a temporary terminus; the line to be hereafter extended across the frontier at Orakau.

Having arrived at this conclusion, I feel that it will not be proper to leave the subject without considering it in another aspect—one which has commended itself to all with whom I have spoken in the Waikato, and to those elsewhere who are interested in the question of opening up the greatest amount of country at the least expense. The proposal is to use the river between Mercer and a suitable head of navigation for conveyance of traffic, and make a railway from that point to the frontier. The money which would be otherwise expended in making a railway along the banks of a navigable river, to be invested by the Public Works Department in the Colonial Funds, and be thus available for extension into the interior when the proper time for so doing arrives.

It is not without some hesitation that I enter on this subject, being one foreign to the instructions under which I am writing; but, as I believe the cost to be a proper one, and the policy of making use of the river, so long as the traffic can be carried on it, so commendable to common sense, and in consequence having a reasonable chance of being adopted, I feel that any investigation would not be complete were it to leave out consideration of the case from this view, especially as a greater amount of diversity of opinion might arise as to where the head of the navigation should be considered to exist, than as to the best locality of the frontier terminus.

The inquiry with this view presents a problem more difficult for me to solve, with satisfaction to myself, than that of the frontier. The consideration is a wide one, extending over a choice between the present heads of navigation, Cambridge and Alexandra, the lower and more central position of Ngaruawahia, or any intermediate point on either river. Cambridge possesses the deepest and shortest river, but the swifter current renders the time in steaming from Ngaruawahia to Cambridge or Alexandra practically the same. Alexandra is not now accessible in the height of summer, but I am satisfied that there are only three very trifling obstructions, and the expense of removing them, and making the whole river navigable at all times, with any steamers which can pass the shallows of the Lower Waikato, would be very small, and is, on the other hand, compensated by the greater difficulty in getting the line away from the Waikato, near Cambridge, and at same time have terminus and wharf on the same level. This last circumstance influences the inquiry to such an extent, that I estimate it would require fully a mile and a half of a gradient of 1 in 50 to rise from a good wharf level, near Cambridge, to the centre level of the Moana Tua Tua swamp; and a gradient like this could only be placed in a gully, of which there are several suitable, but all requiring heavy works, although the soil is the most easy conceivable. Towards this end, I examined a gully near the town belt of Cambridge South, Walker's Gully, and Mystery Creek; also, a main outlet of the Rukuhia Swamp, below Hamilton, all more or less favourable.

If an intermediate point on one of the rivers is to be chosen, those places on the Waikato present the attractions of least distance. Presuming the terminus would be where I have before stated, just below Kihikihi, the following will afford a comparison:—

	Miles.
Alexandra to Terminus	12
Ngaruawahia	32
Hamilton	21
Mystery Creek	16
Walker's Gully to Orakau	11
Cambridge	11

The last two are measured to Orakau, as it is more direct than the other place, to the respective starting points. The country in all the routes is very easy, and after reaching the general level from the river, most remarkably so. Unless some overwhelming natural advantages should overrule it, I believe it to be desirable to prefer one of the present townships to making another at the starting point. Starting, then, from Alexandra, sixty miles of construction would be saved from Mercer, from Cambridge sixty-one, from Hamilton fifty-one, and from Ngaruawahia forty miles. Carrying the principle to the utmost of making most use of water carriage, and taking other things into consideration, I believe Alexandra to be the best point. Next, I prefer Hamilton, which, although requiring ten miles more railway than from Cambridge, takes a more central route in the delta. I must here note that steamers which could best carry on a great traffic on Lower Waikato, are not suitable for plying between Ngaruawahia and Cambridge or Alexandra, although they would do to Hamilton very well, unless it could always be insured that two steamers would not require to pass each other in these rivers.

The comparison being reduced to the limits of Hamilton and Ngaruawahia, I am inclined to think best of the latter; its central position, good accommodation for wharves, and easy ascent by moderate gradients to the plateau level, go very far to weigh against an extra eleven miles of the very easiest construction in the delta. The route would be towards Hamilton, after reaching the latitude of which it would be much the same as from the latter place, crossing the Rukuhia Swamp in a direction about south by east, finding an easy way into the valley of the Mangapiko, and at Te Awamutu leading two or three miles up the Mangahoi to the terminus. The whole route is through a country being rapidly settled and brought into a state of cultivation. The Rukuhia and other swamps, now in process of drainage, will for eight or nine miles present great facilities of construction, and eventually prove a most productive district.

By the adoption of the policy I have here advocated, the money otherwise required for forty miles of construction below Ngaruawahia, would, when required, suffice to extend the line nearly forty miles from Orakau towards Taupo. As to the suitability of the river to carry an immense traffic, I have for the last eight or nine years had occasion to closely study this subject, and feel assured that steamers drawing 2 feet 6 inches of water, or even less, can be got to steam twelve miles an hour in still water, and take a total paying load of 60 tons, within suitable limits of length and breadth of beam. This speed would make the up-journey to Ngaruawahia in four hours, and down in two hours fifty minutes, against a railway, if at fifteen miles an hour, two hours forty minutes each way; if at twenty miles an hour, two hours each way.

I cannot conclude without expressing my sense of obligation to many gentlemen in the Waikato, who by rendering information, the result of much travelling and intelligent observation, greatly facilitated my work, and by personally guiding one to the more salient points of observation, saved much time in forming my judgment of the work I had to do.

I was also much gratified to find a general desire to sink minor differences of opinion, in the endeavour of all to secure the public good.

I have, &c.,
JAMES STEWART, A.I.C.E.,
Resident Engineer.

The Engineer-in-Chief, Public Works.

Enclosure 2 in No. 1.

REPORT ON RAILWAY FROM DUNEDIN TO MOERAKI.

Mr. BLAIR to Mr. CARRUTHERS.

SIR,— Dunedin, 21st February, 1872.

I have the honor to inform you that, in accordance with your instructions, I have made a reconnaisance survey for a railway between Dunedin and Moeraki, and I now beg to submit the following report thereon:—

The work was only carried on when it did not interfere with my other engagements, which, together with the difficulty of getting to some portions of the routes examined, has delayed its completion till now.

The accompanying plans show the lines examined—

No. 1, coloured yellow, leaves the Otago Southern Trunk Railway on the Taieri Plain, passes up the Silver Stream, and down the south branch of the Waikouaiti River to the Waikouaiti Township.

No. 2, coloured red, leaves the Otago Southern Trunk Railway at the south end of the Caversham Tunnel, runs up the Waikorai Valley to the head, then passes to the west of the reservoir, and through a low saddle at Lothian Bank into the valley of the Water of Leith. The line follows this valley up to the dividing range between it and the Waitati Stream, then works down on the west side of the latter to the Waihema Creek, which is crossed a little above the main road. The plans show the red line continued to Moeraki, but being the only route from Blueskin northwards, this portion will be described under a separate head.

No. 3, coloured blue, leaves the Port Chalmers Railway at Pelichet Bay, and passes through a saddle at Dundas Street and the Botanical Gardens. The Leith Valley is then followed up to near the summit, where this line merges into No. 2.

No. 4, coloured green, leaves the Port Chalmers Railway at Black Jack's Point, and rises up the range to the head of the valley, at Sawyer's Bay. It then passes under the Main North Road, near the eighth mile-post, and works down the northern slope of Mount Cargill, and the west bank of the Waitati, to the head of Blueskin Bay, where it merges into No. 2.

No. 5, coloured brown, is a continuation of the Port Chalmers Railway round the coast to Blueskin.

In addition to the above, my attention has been directed to a line (not shown on plan) straight through the range from the Port Chalmers Railway at Sawyer's Bay to Blueskin Village.

I will first consider those routes that present the least facilities for railway construction, or are otherwise objectionable.

No. 1. The country traversed by this line is a very rough one; with the exception of a few miles at the Taieri Plain and Waikouaiti, the rivers flow in precipitous gorges and ravines. The course of the Silver Stream in particular is remarkably wild, there being scarcely half a mile of open valley in the whole distance, while the banks are broken up by lateral spurs and gullies as close as they can be. The main branch of the Silver Stream terminates in the Silver Peak Mountain, a range 2,000 feet high, but there is a small branch that comes close to the source of the Waikouaiti, with a comparatively narrow range between; its height being 1,450 feet. Independent of the inconvenient distance this route is from Dunedin, the difficulties it presents are sufficient to preclude its adoption.

No. 6. The Coast Route. As there is so little space between the tunnel and the jetty at Port Chalmers, it would probably be necessary to leave the present railway at Mussel Bay, and pass to the north of George Street and the Graving Dock, in which case another tunnel would be required. The line would then skirt the sea for the whole distance to Blueskin, following the most minute indentations of the coast or cliffs. So far as gradients are concerned, it would be first-class, being dead level; but the minimum radius of curves would require to be reduced to about 50 feet in order to avoid heavy tunnelling. There are no serious difficulties from Port Chalmers to the Heads, but beyond this I fear it would be impossible to construct a useful line at anything like a reasonable cost. The cliffs of hard rock are almost perpendicular, and of a great height, and run out into the sea at all the promontories, while the bays consist of drifting sand almost as difficult to deal with. I have put some notes on the plans at this place, which will better enable you to judge of its character. Taken altogether, I do not think that a suitable line can be got in this direction.

Line from Port Chalmers Railway at Sawyer's Bay to Blueskin, being on a low level, would require a tunnel about two miles long, through a basaltic mountain range, so it cannot be considered.

The routes from Dunedin to Blueskin are now reduced to three, and I will consider them together. In examining them, I have worked for gradients of 1 in 50; but it might be an advantage to adopt steeper ones.

Before commencing this survey, I was under the impression that the saddle between the Leith and the Waitati was about 500 or 600 feet high, in which case it would be possible to run up the Leith Valley, as shown by Route No. 3. I find, however, that the saddle is ascertained by the Survey Department to be 1,190 feet above sea level, which height agrees with my own barometrical observation. It would therefore be necessary either to adopt Route No. 2, or to work to a steeper gradient.

To the head of the Kaikorai Valley, a distance of three miles, Line No. 2 runs on very favourable ground; with the exception of two or three stream bridges, there is literally no work. From this point to the Leith Valley, the ground is very rough, and broken up by deep gullies, and a considerable amount of earthwork and bridging would be required. The Leith Valley itself is by no means unfavourable for running up a gradient; there are two or three streams to be crossed at a high level, but the cost of doing so would not be very great.

Assuming that an elevation of 800 or 900 feet were attained, the saddle between the Leith and Waitati could be got through by a tunnel not more than 20 chains long; under this level the valley of the Leith gets flatter, and the length of tunnel would increase rapidly.

Generally, on the south side of the range, No. 2 Line presents no serious obstacle to the construction of a railway; but, unfortunately, the north side is not equally favourable. The objections to it are,—

1. There is not distance to get down from the high level reached at the summit; and
2. The ground on the slope of the range above Blueskin Bay is very irregular, and broken up by deep gullies, entailing heavy works of all kinds.

The above objections induced me to try for a greater length of line on the north side of the range, and finding this could not conveniently be done from the Leith saddle, I examined another between the head of Sawyer's Bay Valley and the east branch of the Waitati. Its height is 1,100 feet, and the distance from sea level on both sides, on Line No. 4, about seven miles. This would make the summit level of railway about 400 feet below the saddle. The length of tunnel required will probably be about 40 chains.

I think that generally this route presents greater facilities for the construction of a railway than the one *via* the Leith, and it has the additional advantage of being a direct continuation of the Clutha line, while the other would leave Dunedin on a branch.

Before proceeding to make a regular survey of a line from Dunedin to Blueskin, I would recommend that sections be made of these two saddles down to a height of say 500 feet above sea level to determine the length of tunnel required, and that borings be taken to ascertain the nature of the materials in them. This will go a long way towards deciding on the relative advantages of the two routes.

Between Blueskin and Waikouaiti the ground generally falls with a uniform slope from the top of the ranges to the coast, terminating in perpendicular clay cliffs of from 100 to 150 feet high. There are numerous hollows and gullies in the slope, but nothing that cannot be got round by sharp curves. The line would keep at a level of from 150 to 200 feet above the sea, and the gradients would be all good. As the highest cliffs are at Brinn's Point, it is possible that the line from thence to the Waikouaiti River may be too steep. There being no detailed survey of the Maori reserve, I could not fix level points on the plan. Should this be the case, it will be necessary to take the route indicated by a dotted line. At the proposed crossing, the Waikouaiti River is about five chains broad, and the ground seems to be suitable for an ordinary pile bridge.

For two-thirds of the distance from Dunedin to Waikouaiti, the route above described runs through dense bush, accessible only at certain points, therefore the line shown on the plans must be taken as indicating merely the general direction intended to be taken. The same remark applies to all the other lines leaving Dunedin, except the one round the coast.

From Waikouaiti to Moeraki the country is much easier, and the plans more definite, so the line has been laid down with greater precision. The following is a general description of its course:—

Leaving the Government township of Hawksbury, near the middle of the lagoon, it rises on the slope to the east thereof, crosses the main road, and runs almost straight to the saddle, about 20 chains westward from the Bendigo Hotel. At this point the line trends eastward, re-crosses the main road, below Trigonometrical Station H and regains the flat in section 39, block 4, Hawksbury District. It then runs round the point of the spur into the Green Swamp and Pleasant Valley, striking the latter at the lower fellmongery. Pleasant Creek is crossed on Mr. Hepburn's property, and for the remainder of the distance up the valley the line keeps to the east of the road between the creek and the high ground. Opposite Mr. Douglas's homestead it takes a sharp curve eastward, following up the water-course in sections 22 and 14, block 4, Hawksbury District, and enters Palmerston by the Manse Gully and Rimbrake Street. Leaving Palmerston, the railway runs due east for two miles, and crossing the Waihemo about two miles below the main road, it ascends to a saddle in the Horse Ranges immediately below Puke Iritai, and one and a quarter miles from Shag Point. The coast is then followed to a lagoon in section 14, block 2, Moeraki District, where the line bends sharply inland and runs down a gully to within 2 chains of the main road at the Kartigi School House. From this point to its termination at the junction with the branch to Port Moeraki, the railway keeps parallel with the North Road.

The total length of line from Waikouaiti to Moeraki by the route just described, is about twenty-two miles, and for the whole distance the country is remarkably easy and suitable for railway construction. There are only two places where any "grading" is required; one is getting out of Waikouaiti, and the other is at the saddle in the Horse Ranges, the height of the ranges to be thus ascended being about 130 and 150 feet respectively. The former can be run up and down with gradients of 1 in 60 or 70, but probably it will be necessary to have 1 in 50 on the north side of the latter. Any cuttings required will be through soft lime or sandstone. There are only two streams of importance to cross, the Waihemo River and Pleasant Creek. The former will require a bridge 150 feet long, and the latter one of about 60 feet. In both cases the sites seem suitable for pile-driving.

A large quantity of shingle for ballasting could be got at the Waihemo River, and the district can produce stone lime and timber suitable for railway purposes.

I will not attempt to give an estimate of the cost of constructing a railway from Dunedin to Waikouaiti, as the country possesses peculiarities that prevent a comparison being made with lines already made or estimated. But from Waikouaiti to Moeraki this difficulty does not exist, and I would have little hesitation in fixing the cost at something under £4,000 per mile.

With reference to the cost of making a further survey of this line, I think that a Parliamentary survey of the portion between Waikouaiti and Moeraki might be made in five or six weeks, by one party, at a cost of about £100, *i.e.*, about £5 per mile, exclusive of office work.

It is very difficult to estimate the cost of making a detailed survey of the remainder of the line; it will necessarily be very heavy, and the work will take a long time; in which case it might be better o postpone it till the working survey is required, or make the Parliamentary survey of such a character as to serve for the working one.

In connection with this subject, I might suggest the consideration of the question as to whether it would not in the meantime be advisable to divert the traffic of the Waikouaiti and Shag Valley Districts to Port Moeraki, by making that portion of the line.

I have, &c.,
W. N. Blair,
District Engineer.

The Engineer-in-Chief, Wellington.

No. 2.

REPORT ON THE WAITAKI BRIDGE.

Mr. Carruthers to the Hon. J. D. Ormond.

Sir,— Public Works Office, Wellington, 24th November, 1871.

I have the honor to submit the plans for a railway and road bridge over the Waitaki River, with estimates of the cost of each.

1. An iron plate girder bridge of 54 spans of 66 feet, each supported on piers consisting of two 4-feet cylinders of cast iron, filled with concrete, and sunk to a depth of 24 feet below the lowest water level; the under side of girder being seven feet above highest flood. The total depth from under side of girder to bottom of cylinder being 37 feet 9 inches.

The estimated cost of this bridge is £57,988.

2. A wooden bridge of 44 spans of 80 feet each, supported on piers precisely similar to those of plan No. 1. The tension booms and the three end braces would be of jarrah timber, the whole of the remaining parts would be of totara. As protection from fire, a coating of gravel four inches thick, set in cement, would cover the whole floor, and the booms would be protected from the weather by a covering of zinc. The estimated cost of the bridge is £38,936.

3. An iron plate girder bridge of 110 spans of 33 feet each, supported on piers, each consisting of two sets of solid piles. Each set is made up of three solid piles 4¾ inch diameter, and driven to 24 feet below lowest water-level. The piles will be long enough to reach three feet above ordinary low water-level. An iron ring will be shrunk hot into the heads of the piles, and further secured by a set screw. On the rings a casting will rest which will bind together the heads of the piles, and act as a base for the upper work to rest on. A ring of iron shrunk in hot will also tie the pile heads together, and thus relieve the casting from undue strain.

The upper work consists of a strongly braced iron frame, carrying a wooden cap, on which the girders rest. The girders are these already ordered for the bridge.

The piers were designed by Mr. Blackett, and I fully approve of the designs, which are cheap, effective, and ingenious. The estimated cost of the bridge is £34,183.

In all the above plans it is proposed to let the highway traffic pass on the same platform as the railway traffic. The bridge will therefore be closed to the public except at stated hours of the day. The roadway will be 19 feet wide, giving room for two drays to pass.

I consider plan No. 1 certainly the best of the three designs, except that it is too expensive; comparing it with plan No. 2, there is a difference in first cost of £19,000, which, put at compound interest at 5 per cent., would replace the destructible part of No. 2 plan every nine years. I have no doubt that the wooden bridge would last twenty years instead of nine, so it would be sound policy to adopt the wooden bridge as against plan No. 1.

Plan No. 3 has much to be said both for and against it. The spans are too small to allow drift timber to pass, and I do not, therefore, consider it a perfectly durable bridge. It is apt, also, on account of the smallness of the spans, to cause excessive scouring during the usual floods. Its advantages are its cheapness, and the fact that it comes within the amount appropriated by Parliament. It could also be erected in six months from the time the piles arrive from England, while the other plans would take fully a year. The girders are already ordered, and will soon be on their way out.

On the whole, I consider the advantages, especially the cheapness of this plan, sufficient to give it the preference over the others, and therefore recommend its adoption.

I think the iron work ought to be ordered at once by the Government from England, and the erection submitted to public tender here.

JOHN CARRUTHERS,
Engineer-in-Chief.

The Hon. the Minister for Public Works.

NOTE.—No. 3 design was the one approved of.

Nos. 3 and 4.

REPORTS ON AUCKLAND AND MERCER RAILWAY.

Mr. CARRUTHERS to the Hon. J. D. ORMOND.

SIR,— Auckland, 6th January, 1872.

I have the honor to report that I have examined the line from Auckland to Onehunga, and recommend the adoption of the line known as the Tunnel line.

There have been three lines surveyed from Fort Britomart to Newmarket—the Coast line, the Domain line, and the Tunnel line—the last being the one formerly adopted by the Province of Auckland, and on which a great deal of work has been done, and the land bought throughout. Mr. Wrigg, to whom the surveys were intrusted, has prepared comparative estimates of the three lines, showing the cost of the Coast and Tunnel lines to be the same, and that of the Domain line to be less by £7,000. There must be added, however, to the Coast line the cost of pitching the slopes of the sea embankment with stone, £3,600, and a further sum of £6,100 for additional earthwork not provided for in the estimate, so that the Coast line is the most expensive of the three; it is also the worst, as it is one and a quarter miles longer than the Tunnel line, very curved, and with a ruling gradient of 1 in 40 against 1 in 47 on the Tunnel line. The Domain line is estimated, as above stated, at £7,000 less than the Tunnel line, and corrections since made in the quantities of earthwork increase this to £7,500. Against this saving, there must be placed—firstly, the cost of land for one mile and sixty-seven chains, most of which is through the Domain; secondly, the maintenance and working expenses for 32 chains of line, by which the Domain exceeds the Tunnel line in length. This is a more serious item than is generally supposed by the public, for assuming twelve trains a day (six each way) —which is a low estimate, seeing that the Mercer and Onehunga branches both pass over this part of the line—the extra cost, at 7s. 6d. per train mile, would be £1 16s. a day, or £657 a year, equal, if capitalised at 5 per cent., to £13,140.

By far the greatest objection to the Domain line is the excessive curving and steep gradients. There is a gradient of 1 in 40 for one mile twenty-three chains, and nearly the whole of this is on reversing curves of 5 chains radius.

On the Tunnel line, the steepest gradient is 1 in 47 for one mile and eight chains, all of which is either straight or on easy curves. On the Domain line, special engines would be required, entailing extra first cost and increased expense in repairs; while on the Tunnel line, ordinary engines can be employed, and in any case, the resistance due to the curves and steeper gradients combined would make three engines necessary for the same load that one engine could take up the Tunnel line.

The only objections to the Tunnel line are, the Tunnel itself and the open cutting at the mouth of it. The former is 320 yards in length, probably through soft sandstone, but full information has not yet been obtained as to the material. The open cutting at the end is very bad indeed; it consists of slippery clay, which has already slipped into the cutting formerly made, the ground for a distance back of 200 feet having given way, so that two houses are in danger of coming down. It will require great care to make this part of the line, but I feel no hesitation in saying that the difficulty may be successfully met without excessive cost.

It has been assumed that similar material would not be met with on the Domain and Coast lines, and no provision for such contingency is made in the estimates. I am convinced, however, that two or three cuttings on the Domain line, and one at least on the Coast line, would turn out just as bad, and would require still more expensive works than are required on the tunnel line.

SUMMARY.

Coast Line.

This line is the longest, the most expensive, and the worst for working; its length is three miles 31 chains; the total rise and fall is 168 feet; steepest gradient, 1 in 40; sharpest curve, 6 chains radius.

Domain Line

Is 32 chains longer than the Tunnel line, has steeper gradients and bad curves; the total rise and fall is 54 feet greater than the Tunnel line. Its cost, when provision is made for slips in cutting, is as high as for the Tunnel line, and the land for it would have to be acquired. The difficulties in construction would be as great as on the Tunnel line.

Its length is two miles 32 chains; total rise and fall, 222 feet; steepest gradient, 1 in 40; sharpest curve, 5 chains.

Tunnel Line.

It is the shortest and by far the easiest to work; is not more expensive than the Domain line to build. The land is already bought, so no delay need take place in beginning the work. Engineering difficulties are no greater than on the other lines.

Its length is two miles; total rise and fall, 168 feet; steepest gradient, 1 in 47; sharpest curve, 13½ chains radius.

Beyond Newmarket, as far as Onehunga station, there is very little earthwork and bridging to be done, the greater part of it having been already done by the Provincial Government. There will be some little trouble in getting down from the station to the wharf. Surveys are now being made, and until they are done, I am of course unable to speak with any certainty on the subject.

In conclusion, I have the honor to recommend that the work from Fort Britomart to Newmarket be begun at once, under the contract entered into with Messrs Brogden on the 18th December last.

I have, &c.,

JOHN CARRUTHERS,
Engineer-in-Chief.

The Hon. the Minister for Public Works.

Mr. CARRUTHERS to the Hon. J. D. ORMOND.

SIR,— Public Works Office, Wellington, 24th June, 1872.

This railway begins at the breakwater at Auckland and runs, *via* Drury, to the Waikato River at Mercer, a branch line running to Onehunga. The district through which it runs, or which is tributary to the railway, contains one-fifth of the entire population of New Zealand.

For the most part the land on each side of the railway is of good quality, and will eventually maintain a large agricultural population, who will have a ready market for their produce in Auckland and the Thames. It is difficult to place a limit to the future traffic which may be expected when the Waikato Valley becomes fully settled, and the coal mines which it contains shall be opened up and advantageously worked. At present, settlement is almost prohibited by the want of easy communication with Auckland, which this railway will supply, and a large increase to the population of the valley may be confidently looked for as soon as the works are undertaken.

The political advantages which will be gained by bringing Auckland into quick communication with the Waikato are incalculable.

The following traffic may, I think, be expected within two or three years of the completion of the line, with the prospect of a large increase in a few more years:—

Passengers to and from Onehunga, 32,000, at 1s.	£1,600
Goods to and from Onehunga, 60,000, at 1s. 6d.	4,500
Passengers, main line, 40,000, at 3s. 4d.	6,666
Goods, main line, 6,000, at 5s.	1,500
Coals, 30,000 tons, at 6s. 8d.	10,000
Firewood, 1,500 cords, at 3s. 4d.	2,500
Parcels and miscellaneous	234
	£27,000
I estimate the working expenses, including renewals, at	£19,000
Expected profit (about 3 per cent)	8,000

A great deal of the country through which the railway runs is very rough and broken, with some heavy basalt cuttings, and a great many bridges and culverts.

Wherever good foundations are expected, the piers and abutments of bridges are designed for stone.

This increases the first cost of the works of course, but it is, I think, good economy, as the expense of renewals will be lessened. The gradients are steep, 1 in 40 being the steepest; the curves are, however, comparatively easy.

I have &c.,

JOHN CARRUTHERS,
Engineer-in-Chief.

The Hon. the Minister for Public Works.

No. 5.

REPORT ON KAWA KAWA RAILWAY.

Mr. CARRUTHERS to the Hon. J. D. ORMOND.

SIR,— Auckland, 15th January, 1872.

I have the honor to submit the following report on the proposed extension of the railway from the Kawa Kawa Coal Mines to deep water.

The existing line is about three miles in length, terminating at a point of the Kawa Kawa River where there is a sufficient depth of water for large barges. The coal is here emptied into the barges and towed down the river to deep water, where it is loaded into coasting vessels. By extending the line as proposed for four and three-quarter miles, and erecting a wharf at the terminus, the coal would be delivered direct on board the vessels at a point where there is sufficient depth of water for vessels of the largest class.

As the surrounding country is very thinly peopled, there can be expected only a very small general traffic for the railway, which may depend almost entirely on the mines. At present, the latter turn out about a hundred tons a day, and it is fair to assume that this would be much more with increased facilities for shipment, and with the advanced demand due to increasing population.

If carefully managed, the present traffic would more than pay working expenses; and there is, I think, every prospect of a fair dividend when the mines shall be more fully developed.

No sections have yet been taken over the proposed line, nor have quantities of work been taken out, so I am not in a position to furnish any estimate, further than to say that, after a careful examination of the country, I am of opinion that the line may be built for the amount appropriated for the purpose, viz., £40,000.

I have, &c.,
JOHN CARRUTHERS,
Engineer-in-Chief.

The Hon. the Minister for Public Works, Wellington.

No. 6.

REPORT ON THE PICTON AND BLENHEIM RAILWAY.

Mr. CARRUTHERS to the Hon. J. D. ORMOND.

SIR,— Wellington, 16th January, 1872.

The line begins near the wharf at Picton, and ends at the north bank of the Opawa, the length being 17⅛ miles.

It was intended that the line should be carried across the Opawa into Blenheim, but the expense of doing so would be very great, and would bring no corresponding advantage to the railway. The Opawa has of late become the principal channel of the Wairau River, and this so lately that it has not yet had time to get into train. Its bed is now only forming itself, and it is difficult to predict what effect the piers of a bridge would have. The present road bridge has greatly affected the bed, and has made the river shift considerably. It appears to me, also, very likely that the river will soon leave its present bed altogether, and join the Omaka. Should it be decided to carry the line across the river, it would be necessary, in order to interfere as little as possible with the river, to use very long spans (say 160 feet each); and such a bridge could not be built of the required length of 640 feet for less than £6,400. It does not appear to me that there will be any loss of traffic to the railway by thus stopping short of the Town of Blenheim, as there is a good road and a bridge across the river, which will, when lengthened, as proposed by the Provincial Government, give ready access to the railway.

The country through which the line runs is unfavourable to railway construction, and with every regard to cheapness, it has been impossible to reduce the earthwork below 16,200 cubic yards a mile, of which a great proportion of the cuttings is rock. To avoid the floods, it has been necessary to keep the rails at a height of about 10 feet above the plains of the Tua Marina, which, has of course, much increased the quantity of earthwork.

There are 3,600 lineal feet of wooden bridges, the most important being the bridge over the Waitohi—a trestle 600 feet long and 45 feet high; and that over the Wairau, which is 1,200 feet long and 25 feet high. Heart of black birch will be exclusively used.

The culverts will be of timber throughout.

It is proposed to fence only the first two miles near Picton, and to make good all existing fences with cattle guards, where they cross the line.

Roads will be all crossed on the level. Warning posts will be placed at each crossing, as is done in America and Germany, but no gates will be built nor watchmen engaged.

The rails will weigh 30 lbs. to the yard. Sleepers will be of heart of black birch, 2,050 to the mile, and just sufficient ballast will be used to keep the sleepers from sinking into the banks.

The curves and gradients are very severe, as will be seen by the table affixed.

It is quite evident, from the lightness of the permanent way and the steepness of the gradients, that only a very moderate speed is provided for; ten or twelve miles an hour will be as fast as ought to be attempted.

Two locomotives, three passenger carriages, and seventeen goods waggons are estimated to be sufficient for the opening of the line. The passenger carriages have a central passage, and seats arranged omnibus fashion.

The stations will be of the simplest kind. Buildings will be erected only at the termini.

The estimated cost is as follows:—

Work in New Zealand	£70,018
Rolling stock (including erecting)	7,961
Permanent way materials	10,169
Stations	1,852
	£90,000

The permanent way material and rolling stock have been ordered in England.

I affix an estimate of probable traffic and working expenses, by which it appears that the line may be expected to pay working expenses, and a renewal fund of £2,350 a year for replacing bridges, &c., and still have a sum of £3,238 a year left as profit; this is equal to $3\frac{2}{3}$ per cent. on the cost. I have been, of course, much guided by persons living on the spot in the revenue return, both as to quantities and prices, but I consider the estimate fair. There is some difference of opinion as to whether the railway will divert the trade from Port Underwood to Picton. I think myself it will do so, but have kept this item separate in the revenue return. Even without it, there will be a profit of £1,176 on the other traffic, after paying working expenses and renewal fund.

I have kept the estimate of working expenses high enough to insure its not being exceeded.

I have, &c.,

JOHN CARRUTHERS,

The Hon. the Minister for Public Works. Engineer-in-Chief.

No. 7.

REPORT ON NAPIER AND PAKI PAKI RAILWAY.

Mr. CARRUTHERS to the Hon. J. D. ORMOND.

Public Works Office, Wellington, 6th May, 1872.

THIS railway begins at the Port of Napier, and extends to the end of the Napier Plains, a distance of 18 miles 30 chains. It forms the first section of the Napier and Ruataniwha Railway, and is intended to be built eventually to Masterton, where it will join the Wellington and Masterton Railway, thus connecting Napier with Wellington, and, by means of the Manawatu and Wanganui Tramway, with the West Coast.

The country through which it passes is rich and fertile, but is principally pastoral, and as the whole of the population of the Province of Hawke's Bay is only 6,000, the traffic to be expected will be small. Short railways seldom pay, unless they join large towns. In an agricultural district, where the distance is less than twenty miles, it is generally cheaper for farmers to use their own cattle to cart their produce, than to pay railway fares; and I do not, therefore, think there will be much local traffic on the line. The through traffic will also be small until the line is extended to Ruataniwha, as the wool-growers will be obliged to use drays to bring their wool as far as Paki Paki, and will generally prefer going eighteeen miles further to Napier, to transferring into railway wagons. The closest economy in management will be required to pay working expenses, and no avoidable expense in construction should be incurred.

From Napier to Pakowhai, a distance of about twelve miles, there is great difference of opinion as to the position in which the line is to be placed. Three lines have been proposed, viz.:—

1st. Coast line. 2nd. Meanee line. 3rd. Purimu Creek line.

Coast Line.

In an engineering point of view, there cannot be a doubt that the Coast line is the best. It begins at the wharf at the port, crosses to Gough Island on a trestle, then on an embankment to Battery Point, thus closing the Iron Pot Harbour, except at one narrow entrance. Had this been done some years ago, the Iron Pot would still, in all probability, have been a harbour instead of a mud bank, and even now the entrance will be deepened and improved by forcing the tide through a narrow channel, and keeping out the muddy stream which now flows in at the entrance where the embankment will be.

From Battery Point the line skirts Scinde Island to the town of Napier, then along the shingle beach to the Waitangi Creek, which is crossed on a trestle. Keeping close to the road and parallel to the Ngarararoro River for three miles, it crosses the latter river twice, once above and once below Pakowhai.

A great change in the train of the Ngarararoro has lately taken place. The river has abandoned its bed for several miles, taking a new course from one point to another, the new channel following the course of the Ohiwa and Tutaekuri Waimate Rivers, and joining the old bed at Pakowhai. The first of the above-mentioned crossings is over the full stream, the second over the abandoned bed. Instead of them, a single crossing of the new channel at Pakowhai might be adopted, but it would be more expensive and not so safe as the double crossing. The old bed at the Ngarararoro is again crossed at 16 miles 10 chains.

Except the bridge over the Iron Pot, Waitangi Creek, and the three crossings of the Ngarararoro, the only expensive work will be the first mile, skirting Scinde Island: the rest of the line is remarkably easy of construction, and there is only one point, a chain or two in length, at the ninth mile, where danger from floods exists.

Meanee Line.

This line follows the Coast line for four and a half miles, and then, leaving the shingle beach, it crosses a lagoon which in floods has four or five feet of water in it, and then follows the road parallel to the Meanee River for three miles, on land subject to floods; then for two miles on land seldom or never flooded, to the Tutaekura Waimate and Ohiwa Rivers, which now form the main stream of the Ngarararoro; after crossing which it joins the Coast line again.

The advantages of this line are, that it brings the railway a mile and a half nearer the Meanee, Taradale, and Redcliff Townships, at the same time, however, taking it three and a half miles farther from West Clive. The advantages and disadvantages seem to me to about balance each other. The people of Clive will sometimes use the railway, as they are six and a half miles from town, but the people of Meanee, who are only four and a half, will, in all probability, be better served by the omnibus, as at present, and will use the railway very little, while the Redcliff and Taradale people may be put out of the question altogether, as they would not change their conveyance after coming two or

three miles for the sake of the four or five remaining. At all events, it is hopeless to expect that freight would be put on the railway for such a short distance.

The disadvantages are, a slight increase of length, three miles of flooded land, and a bad crossing of the new bed of the Ngararoro, where it has not yet got into train.

If the railway were kept high enough to be out of floods, a large increase in the cost of construction would be entailed; and I think constant litigation would arise with owners of property in the banks of the Meanee, who would complain of the railway works preventing floods from getting away into the lagoons and thence into the Ngararoro River. Half a mile of bridging would also be required across the lagoons between the Meanee River and the beach.

If the rails were kept low, so that floods would pass over them, the cost might be reduced to within £1,000 of the cost of the Coast line, but the maintenance would be largely increased.

In 1867, the road to Meanee, alongside of which the line is located, was covered with 3 feet of silt, and the present road has been metalled over the silt; and there are still visible, at other parts of the line, the tops of fences which have been buried. The effect on the working expenses of the line may be imagined, if rails, sleepers, and ballast had to be dug up. Floods like this do not often occur; but every year the rails would be under water, the traffic stopped, and the ballast spoilt by the silt and the mud mixed with it.

Purimu Creek Line.

This line leaves the coast at Scinde Island, and crosses the mouth of the Meanee River; then runs for four miles over land more or less subject to floods; then crosses the Meanee River again, and two miles further on, joins the Meanee line.

There would be a mile of bridging on this line more than on the Coast line, half of which would be in salt water, liable to the ravages of the Seredo. It would pass within one mile of Taradale, two miles of Redcliff, and a mile and a half off Meanee, and would probably secure the passenger and parcel traffic of the former townships, which would, however, be very trifling, and certainly not worth the extra expenditure of £20,000, which this line would cost more than the Coast line.

This line might safely be kept above flood level, but would, of course, be more expensive than if kept down on the ground.

Revenue Estimate.

	£	s.	d.
Passengers, 30 per diem, 9,000, at 6s. 8d.	3,000	0	0
Goods, 5 tons per diem, 1,500, at 10s.	750	0	0
Wool, 100 tons, at 10s.	50	0	0
Timber and firewood	250	0	0
Coal	125	0	0
Parcels and miscellaneous	125	0	0
	£4,300	0	0

With care and economy the working expenses will not exceed this sum, but the renewal fund will have to be provided for by increased traffic.

I have, &c.,
JOHN CARRUTHERS,
Engineer-in-Chief.

The Hon. the Minister for Public Works.

P.S.—12th July, 1872.—On the extension of the railway to Waipawa, or even to a point not so far, it would secure the whole of the wool, merchandise, and timber traffic for the up-country, which would be sufficient to pay the extra working expenses due to the extension of the line.

The principal traffic would be timber, and, since my report was written, a new timber trade has sprung up which will bring twenty tons a day, or £3,000 annually to the line. The timber is brought to Paki Paki in waggons, and there transferred to large drays; when the railway is completed, it will be transferred to the railway waggons, thus increasing the revenue of the Paki Paki Section to £7,300.

The working expenses will amount to £6,200, calculating for this increase in the traffic, leaving £1,100 a year for sinking fund for renewal of bridges, which will be ample.

The Paki Paki Section will thus pay its working expenses, independently of its extension to Ruataniwha.

J. C.

No. 8.

REPORT ON INVERCARGILL AND MATAURA RAILWAY.

Mr. CARRUTHERS to the Hon. J. D. ORMOND.

SIR,— Public Works Office, Wellington, 7th June, 1872.

The Invercargill and Mataura Railway forms the western section of the proposed Otago Trunk Line, of which the Dunedin and Clutha Railway forms the eastern section. Both of these lines have been sanctioned by the Legislature, and will be carried on simultaneously. It is not at present proposed to construct the middle section from Clutha to Mataura; but it is necessary, in estimating the probable revenue of the Invercargill and Mataura Railway, to take into consideration its probable future construction, and the large extension of traffic which would follow.

At present, the traffic between Invercargill and Dunedin is done almost entirely by sea, but on the completion of the Invercargill and Mataura, Dunedin and Clutha Railways, a great part will go by land. There is, also, a large traffic between Dunedin and Lake Wakatipu, a part of which will be diverted from its present channel, on the completion of the Dunedin and Clutha, Invercargill and

Mataura, Winton and Kingston Railways, all of which will be completed nearly at the same time; and the whole of this traffic will be diverted when the middle section of the trunk line from Clutha to Mataura is completed.

It is estimated that the amount now paid by passengers and goods along the line of the railway is £7,000 a year; to which must be added £3,000 for the expected increase in the business of the Woodlands Meat Preserving Works, making £10,000; and it may be safely assumed that the total amount paid for carriage will increase rather than decrease with the cheapness and facilities which the railway will offer. I think it a very moderate estimate to assume that the local traffic will rise to at least £12,300 a year, at which I estimate the working expenses, including removal of permanent way and rolling stock. The through traffic between Invercargill and Dunedin, and Lake Wakatipu and Dunedin, would cover renewal of bridges and other timber work, and probably leave enough to pay a small dividend. When the middle from Clutha to Mataura is finished, there would be, I have little doubt, sufficient traffic to pay a fair dividend on the whole cost.

The indirect advantages of the railway will be great. The traffic of the Bluff and Invercargill Railway will be largely increased, and a fine agricultural district will be opened up, at a cost very little exceeding what would be required for a macadamized road.

The line passes through a generally favourable country. There is, however, one cutting containing 95,000 cubic yards hauled on an average three-quarters of a mile. The most important structure is the Mataura Bridge, consisting of 10 timber spans of 40 feet, supported on masonry piers and abutments. There are nine other bridges of an aggregate length of 567 feet.

The rails will be 40 lbs. to the yard on cross sleepers, bedded in ballast.

The gradients and curves are comparatively easy.

I have, &c.,
JOHN CARRUTHERS,
Engineer-in-Chief.

The Hon. the Minister for Public Works, Wellington.

No. 9.

REPORT ON WELLINGTON AND MASTERTON RAILWAY.

Mr. CARRUTHERS to the Hon. J. D. ORMOND.

SIR,— Public Works Office, Wellington, 29th June, 1872.

This line, leaving Wellington, passes by the valley of the Hutt, across the Rimutaka Range, into the valley of the Wairarapa, in which Masterton lies. It is proposed at some future date to extend it to the Manawatu Gorge, where it will join the lines from Napier and Taranaki, and eventually will join the line running southwards from Auckland.

When it is considered that Wellington is the only harbour in the North Island south of Auckland, it is at once apparent how absolutely necessary this line is to the opening up of the country.

At present the whole traffic of the Wairarapa Valley is done by carts and coaches crossing the Rimutaka Range; the cost of cartage being enormous. Under such disadvantages it is out of the question that the country will ever become thickly settled.

The sea coast of the Province of Wellington on the east is without harbours fit even for small vessels, and the good road is, besides, cut off by high ranges from the coast. The only outlet available, therefore, for the part of the Province to the east of the Rimutaka Ranges is by way of Wellington.

The west coast of Wellington and the Provinces of Hawke's Bay and Taranaki are scarcely less dependent on Wellington, as they possess only one or two small harbours.

It will thus be seen that the future prosperity of these Provinces almost depends on the Railway, and that there will be no competition to speak of by sea carriage or otherwise which will tend to detract from the traffic of the railway.

The part of the line at present to be let for contract extends from Wellington to the Upper Hutt. It is very difficult to arrive at a trustworthy estimate of the amount of traffic which it will command. I think the following is a safe estimate:—

Timber and wool from the Wairarapa, 12,000 tons, at 5s.	£3000
Passengers to Hutt, 20 per diem, 7000, at 1s. 6d.	525
Passengers to Upper Hutt and Wairarapa, 15,000, at 4s.	300
Firewood from Hutt, 5,000 chords at 2s. 6d.	625
Merchandise, 4,000 tons at 5s.	1,000
Mails, parcels, &c.	250
Total	£5,700

There are at present two coaches daily to the Hutt, and no less than eight large drays engaged in carrying merchandise, besides the timber waggons are in constant employment on the Hutt Road.

The tolls of the Kaiwarrawarra toll-gate are let at present for £2,000 per annum, so that I think above estimate may be considered under, rather than over, the mark. I estimate the working expenses, including renewals, at £5,500 per annum.

The above estimate of revenue applies only to the line in its unfinished state terminating at the Upper Hutt, and I have no doubt will be largely increased when the line over the Rimutaka is complete.

The curves and gradients of the line are very favourable.

I have, &c.,
JOHN CARRUTHERS,
Engineer-in-Chief.

The Hon. the Minister for Public Works.

No. 10.

REPORT ON DUNEDIN AND CLUTHA RAILWAY.

Mr. CARRUTHERS to the Hon. J. D. ORMOND.

SIR,— Public Works Office, Wellington, 4th July, 1872.

This railway is perhaps the best placed of all the proposed lines in New Zealand for doing a large traffic. It is of sufficient length, and passes through a fertile district, which is well settled.

An estimate of revenue was prepared in 1865 by the late Mr. Patterson, in which he estimates the gross revenue at £113,750, and the net revenue at £45,500 per annum, or 16 per cent. per annum on the cost, as let to Messrs. Brogden. This is certainly too sanguine. The following appears to me to be more nearly what may be expected:—

	£	s.	d.
Passengers, through, 9,000, @ 12s. 6d.	5,625	0	0
„ 20 miles, 12,000, @ 5s.	3,000	0	0
„ 6 miles, 45,000, @ 1s. 6d.	3,375	0	0
Coal, 60,000 tons, @ 3s. 4d.	10,000	0	0
Merchandise, 35,000 tons, @ 10s.	17,500	0	0
Timber, 60,000 feet, C.B.M. @ 4s.	12,000	0	0
Sundries	1,000	0	0
Total receipts	£52,500	0	0
Working expenses	36,000	0	0
Net revenue	£16,500	0	0

This represents a profit of about 6 per cent. per annum.

The line is unfavourable as regards gradients and curves, the worst part being at the Chain Hills, where curves of 7½ chains radius occur on a gradient of 1 in 40.

I have, &c.,
JOHN CARRUTHERS,
Engineer-in-Chief.

The Hon. the Minister for Public Works.