NEW ZEALAND
GOVERNMENT GAZETTE.
PROVINCE OF CANTERBURY.

Published by Authority.

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By His Honor's Command,
THOMAS WILLIAM MAUDE,
Provincial Secretary.

VOL. X.] WEDNESDAY, SEPTEMBER 23, 1863. [No. XV.

REPORTS OF THE PROVINCIAL GEOLOGIST
ON THE
COAL MEASURES AND LIGNITIFEROUS BEDS OF THE RIVER KOWAI,
TRIBUTARY OF THE RIVER WAIMAKARIRI.

REPORT OF THE PROVINCIAL GEOLOGIST ON THE KOWAI COAL MEASURES.

Geological Survey Office,
Christchurch, January 20th, 1862.

The Kowai River Coal measures occur in a basin five miles long and from one to two miles broad, running east and west. They rest unconformably on older palæozoic rocks, the age of which cannot yet be exactly ascertained, as the few and only fragmentary fossils which I was able to detect in this region are of too indistinct a character to admit of their being compared, with certainty, with any European, or other well known species. They are all of the same species and belong to the Annelids, having at the same time great resemblance to Serpulites, from which, if we may judge from such meagre data, I should assign to these rocks a silurian age.

These palæozoic rocks are highly inclined, and sometimes much disturbed, and consist of slates of different colours, of alumschists, mudstones, sandstones and pebble-beds, all much jointed; many of them have all the character of a true graywacke, the cement being partly arenacious and partly of a kaolin nature.

Interstratified with these rocks we find, as well north as south of the Kowai river, greenstones associated with hornstones and cherts and deposits of manganese and carbonate of iron.

Limestones are exceedingly rare, and with the exception of a large deposit of a fine brecciated and veined marble of a grayish and bluish white colour, south of the river Hawkins, in which I could not detect the least trace of any fossils, and of another dark compact limestone in the Mount Torlesse Range, the whole mountains are singularly devoid of this rock.

These older palæozoic rocks have been broken through by augitic greenstones, not only before the deposit of the coal (the basin of which, by pressure from both sides, has been in a great measure formed by these eruptions), but even after the first layer of carbonaceous matter had been deposited new eruptions took place, through which these layers were greatly changed, and of which I shall have to speak when treating of the coal measures themselves.

New deposits of coal, and, without doubt, of large thickness, the growth of the vegetation probably assisted by the high temperature then existing, were again formed, which most likely remained undisturbed until volcanic agency began to work in this Island, towards the eocene sub-division of the tertiary period.

From the stratigraphical position of the rocks in the

ranges south of the coal basin, it is evident, that during this great disturbance of the earth's crust, they were not only thrown up, but even folded over and pressed towards the north west, so that, in consequence, the edges of the coal basin were upheaved to their present position, although as far as I could judge from the strike and dip of the strata in the basin itself, and from analagous facts ascertained in other parts of the world, the centre of the basin remained probably undisturbed.

These extensive thick deposits of palæozoic age are, in their lithological character, identical with the Ashburton and Rangitata rocks, on which repose, also unconformably, rocks of the carboniferous period, as shewn by the fossils contained in them. We may therefore presume that this coal basin is here the representative of the same age.

The coal basin of the Kowai has, at the spot where carboniferous rocks crop out above the drift, a breadth of nearly 6,000 feet, enlarging more towards the east. I also traced rocks belonging to this carboniferous formation as far as the Thirteen Mile Bush Range, at a distance of four miles and a half, and also in a westerly direction, towards Mr. M'Farlane's Station, to an equal distance from the drive, which was executed under my direction on behalf of the Provincial Government of Canterbury.

The enormous extent of the great drift formation, which had here been deposited, conceals almost entirely the existence of the carboniferous strata, and we owe it only to the occurrence of a slip at the side of the range, dividing the waters of the Kowai from those of the Hawkins, that they have become visible, the before-mentioned rocks, occurring at other spots, belonging only to the lowest series of the coal formation.

Thirty feet above the river some blackish and slaty shales were exposed, dipping at an angle of 70 degrees towards north-north-west. By causing the drift, which had slipped at this point, to be removed, two seams of coal were exposed, and the drive, of which a detailed section is annexed, was begun.

The drift formation, which covers the whole eastern side of the Province of Canterbury, consisting of deposits derived from the waste of the Southern Alps during the glacial period, overlies, in the manner before stated, coal-bearing strata, which at their outcrop are nearly on their edges. Below these loose deposits we meet with beds of a similar nature, but evidently of a greater age and of a more local character. Small pieces of coal and shale are imbedded with boulders, in a tenacious loamy cement, partly ferruginous, filling up all the interstices between carboniferous rocks. At places, some carboniferous beds, being more liable to be destroyed, have been washed out at their outcroppings and their place taken by loose conglomerates, white sand, and small seams of lignite, the impressions of characteristic plants proving them to be of marine origin. The existence of these beds, of a young tertiary age, and to all appearance interstratified between the rocks of the carboniferous period, was very perplexing until I succeeded in tracing their origin.

As we meet a large basin of the same age at much higher altitudes, near the sources of the River Kowai and, in every direction in this part of the province, we may assume that in the basin of the Kowai also the coal measures will be overlaid by deposits of that age which stand in close connection with the volcanic action at the western sides of the Canterbury plains, they being deposited shortly before its principal occurrence.

We therefore ought not to be surprised, if in boring for coal at a more convenient spot, we should meet above them deposits belonging to these tertiary series.

The coal formation has, and probably to a great extent, been denuded in its upper members. I found only at one spot, about 120 yards in a north-west direction from the drive, and on the northern banks of the Kowai, out-cropping from the drift, a cliff of a greyish thick bedded sandstone with some thin shaly beds interstratified, the strike and dip of which corresponded with the strike and dip of the shales exposed on the southern banks of the Kowai, so that we can with safety assume, that we have so much more to add to the thickness of the coal measures and principally to those of their strata which are of a more destructible character.

Entering the drive, the first stratum belonging to the coal measures, which, in a descending series, has not been denuded, is a bed of drift coal of a remaining thickness of 2 feet 3 inches.

I call this seam and some succeeding ones drift-coal, because they consist for the most part of trees, lying confusedly above each other without any order, seeming to be drifted together. Some of these trees are of large diameter, their bark is smooth and has for several inches been changed into hard shiny coal, whilst their interior, not being of the same hard structure, and rotting sooner, has been filled up with clays coloured by carbon and in layers, so as to show how their interior has gradually been filled up.

Amongst these trees, and often lying over their bark, as well as between the black stratified shales, we find the only fossils which hitherto have been observed by me, all of the same species, although in great abundance. These impressions of the carboniferous flora, from two lines to four inches broad, belong to a plant allied to the equisetaceæ.

May we not assume that these coal measures were formed like several of those on the continent of Europe, in the interior of a large continent? The absence of carboniferous or mountain limestone, so far as observations have been made, gives additional weight to this hypothesis.

	ft.	in.
Below this seam of drift-coal	2	3
Lies a small band of black slaty shale ...	0	3
After which we meet the first seam of laminated coal of a thickness of	0	7

After which the following seams, with their intervening beds of shale are underlying:—

	ft.	in.
Black slaty shale	0	2
Drift-coal	3	8
Laminated coal	1	11
Black slaty shale	0	3
Drift-coal	2	11
Laminated coal	1	4
Blackish slaty shale	3	10
Shaly coal	3	1
Black slaty shale	0	10
Coal	3	4
Blackish slaty shale	0	9
Coal	1	0
Brown earthy shale	1	6
Laminated coal	2	4

Whilst the other seams strike regularly through, this last seam of 2 ft. 4 in. exhibits the important and interesting fact that it runs out in the drive, so that we may infer that it becomes, as is usual, broader in its downward course towards the centre of the basin. But had we not even this proof, we might conclude, from the nature of the whole deposits that we have here, the outgoing upper end or edge of the basin.

Below these last seams we find again:—

	ft.	in.
Blackish slaty shale	0	3
Brown earthy shale	1	4
Laminated coal	0	7
Drift coal, with patches of white clay... ...	2	1

As other beds, belonging to this carboniferous series, but of a different character, lie below the last-mentioned seam, we find, by calculation, that although the upper members of these coal-bearing strata are denuded, and most probably, as before mentioned, to a great extent, yet, notwithstanding this fact, we meet here 34 ft. 3 in., in which seven seams of laminated coal are imbedded. If the coal-bearing strata already show such a well-developed character, there can be no doubt (of course always taking into consideration any possible local disturbance, but of which at present no signs are observable) that more towards the centre of the basin large stores of this precious mineral are only awaiting the enterprising hand of man to be brought to light.

Below the last seam we meet a new deposit, argillaceous sand, in which small patches of drift coal are imbedded, sometimes surrounded by white clays. Insensibly, these sands change into a rock, which, although much altered by decomposition, exhibits all the characteristics of greenstone tufas. Imbedded in these soft beds are large boulders, often several tons in weight, consisting of a dark augitic greenstone. As the greenstones which we meet amongst the palæozoic rocks, partly interstratified with them, partly breaking through them, are of great age, the occurrence of tufas, belonging to them, will be another proof that these coal measures belong to a remote period. Below these tufacious beds another small coal seam became exposed, but instead of showing the usual character, it had been changed into coke or cinder, with prismatic partings.

It is therefore evident that these greenstone tufas were deposited when still at a very high temperature, probably during the eruption; the changes from coal into coke-like beds being, without doubt, at the same time assisted by boiling water under high pressure.

Below this bed, and after passing through several strata of white clays, alternating with small layers of ironstone, a second but larger cinder bed is reached, resting upon clays partly calcined. That the greenstone eruptions took place at several distinct periods, is proved by a new and larger greenstone tufa bed, equally full of boulders, often of large size and all of the same nature. This latter deposit is divided by small streaks of carbonaceous matter from a stratum of argillaceous sandstone, replete with layers and veins of quartz, which form the bottom beds of the coal measures. It lies unconformably against the edges of a true greywacke sandstone, the strike and dip of which correspond with the general stratigraphical character of the rocks in the range south of the coal measures. I observed this latter stratum, which from its greater hardness had better resisted the action of the waves than the greenstone tufas above it; also in some other places in the valley of the Kowai.

As the seam and other strata in the drive, standing at a high angle towards the horizon, are only overlaid by deposits of the great drift formation, of a thickness of 15 to 20 feet, it is natural that they are very liable to be affected by the percolation of surface water, with which in fact we had great trouble in making the drive.

Almost everywhere the strata were so much saturated, that it was with the greatest difficulty that in the drive I was able to observe any difference between the coal seams and the shales and dark clays near them, and only by drying the coal in the sun, when it again became hard and shiny, was I able to fix with accuracy the position and thickness of each seam. As this investigation, undertaken on behalf of the Provincial Government, has shown us that we have here only the outcropping end or edge of the coal basin before us, it would be unwise to begin to work the coal at such a spot, because, as is generally the case, the seams are not of that regularity which we may expect to find more towards the centre of the basin, and although coal may be worked at almost every angle, it will be more convenient to choose a spot where a lesser dip of the carboniferous beds gives not only greater facility in working the seams, but also offers more advantages for raising the fuel.

The best spot therefore to work these coal measures will be more towards the centre of the basin, and I would recommend borings to be undertaken at the southern corner of Mr. Watts Russell's sheep yards, where I have no doubt, the dip of the seam will be inconsiderable.

If, as I anticipate, the coal-bearing strata have not been disturbed, we shall meet them there again below the surface of the plains at between 250 and 300 feet, or lying at an angle of 5 to 10 degrees towards the north.

I append to this report, first:—A section showing the results of the works undertaken for the Provincial Government; second:—A geological map of the Kowai river coal fields, upon which I have marked all the spots where I observed rocks belonging to the carboniferous series; together with a horizontal section of the coal measures with their probable position; and third and lastly, a vertical section of the coal-bearing strata which have been passed through by the drive.

As the coal has already been practically tested, its value for steam and forging purposes has been fully proved; and I am certain, that an analysis made to ascertain its chemical constituents will show a very large amount of carbon contained in it.

APPENDIX

TO THE REPORT ON THE KOWAI COAL MINES,

Dated January 20th, 1862.

Geological Survey Office,

Christchurch, Sept. 11th, 1863.

On returning from a re-examination of the lignitiferous beds at the head of McFarlane's stream, I visited the scene of my former labours in the Kowai, in order to see if the mining operations undertaken by the Kowai Coal Mining Company would offer me any

new information on a subject of so much importance to the Province.

Unfortunately, the drain, which shortly before my arrival had been in good order, had in some way or other become choked up, so as to make it impossible for me to visit the principal drive.

This was much to be regretted, as many valuable data would doubtless have come within my observation. However, being accompanied by one of the miners, who gave me the necessary information on the spot, I was, nevertheless, enabled to gain a general insight into the results obtained.

The Kowai Coal Mining Company have driven two galleries, and not only connected them with the Government drives, but have also driven cross galleries from the latter.

In my former report, I stated that part of the older carboniferous rocks in the basin had been destroyed, and that they had been replaced by young tertiary beds, so that in some instances they nearly followed the same strike and dip.

The most conspicuous instance of this occurrence is to be seen a few hundred feet south of the drive mined by me on behalf of the Provincial Government. The Kowai Coal Mining Company has here driven a gallery of a few chains, following a seam of a few inches in thickness, and of a very inferior lignite. Not being able to enter this drive, I had to content myself with examining the specimens of rock which were excavated from it; but I could see no other rocks than those indicated by the face of the cliff where the drive enters, and, in reference, which I mentioned in my former report, that the old carboniferous rocks had been replaced by deposits of a much more recent age, and which would never yield any workable coal seams.

For the reasons already stated, I could not enter the main drive, excavated into the carboniferous rocks, but the few data which I obtained on the spot, fully confirmed my former statements, based upon sufficiently clear and conclusive results, and obtained nearly two years ago, in the two galleries driven on behalf of the Provincial Government, viz: that we meet here with the edge of a large coal basin, the seams thinning out or sometimes disappearing altogether; that the direction of the strata is sometimes changed, for which we may easily account, by bearing in mind that it is at the edge of a basin where the strata are more liable to be disturbed than in the centre, and lastly, that only by boring, could a satisfactory result be obtained.

Of the borings undertaken, that on the right bank of the Kowai, below the terrace, was useless, as it was on the boundary of the carboniferous and the underlying older palæozoic rocks, and the other in the riverbed of the Kowai was too close to the mouth of the main drive, and was not carried down to the proper depth.

But a most interesting and instructive fact was revealed by a cross-drive, executed by the Kowai Coal Mining Company, in a north direction from the gallery excavated under my superintendence, to the description of which I shall devote a few words.

In my former report, I stated that during the formation of the carboniferous rocks in the Kowai, eruptions of augitic greenstone had taken place, as shewn not only by greenstone ashes or tufas deposited upon the first few small layers of vegetable matter, but also by the fact, full of suggestive instruction, that these small seams of coal were changed into cinder-like beds, with prismatic partings.

From these observations, made in the drive, I concluded that these eruptions had taken place in the neighbourhood.

Now, after having excavated the cross-drive in question for about a chain, the miners came upon dyke-like masses of a very hard greenstone, from which the beds of greenstone tufa which I passed through had been derived, and which, on examination, proved to be augitic greenstone or diabase, and thus my former conclusions were fully verified.

But I must confess, that I did not expect this greenstone so near to the drive in question, and that I attributed the metamorphic action, as observed in the lowest seams of the Kowai coal measures, rather to secondary causes, than, as now ascertained, to primary ones, the more so, as nowhere in the neighbourhood had I observed any eruptive rocks in situ.

The close neighbourhood of these diabases to the coal measures, does not in any way change my previous conviction, that by boring more towards the centre of the basin, we may meet with larger seams of coal, regularly striking and dipping at a much smaller and more workable angle, the more so, as the greenstone eruptions took place before the deposition of the principal seams, and even were this not the case, have we not many instances in well known coal fields in the old world, that trap dykes break through them without changing either the character of the coal or so disturbing them as to impede their working.

Of course, I have to repeat, that there may be many disturbances which are hidden from us, throwing the seams into such a position, that either they cannot be reached or are not workable when reached; but as this coal field is of importance not only to Christchurch alone, but also to the whole of New Zealand, the expense of thoroughly efficient borings could not be considered lost, even if the results did not answer our just expectations.

Geological Survey Office,
Christchurch,
Sept. 11th, 1863.

Sir,—In accordance with your instructions, I have re-examined the lignitiferous tertiary basin lying behind Big Ben, the northern summit of the Thirteen Mile Bush Range; but as no new facts of importance were added to the knowledge I obtained of the character of the district two years ago, it is unnecessary for me, in this report, to do more than present you with the results of my previous examination.

They will tend to show you, that the coal which we find there, is a lignite or brown coal, and not a true coal, and as lignites of nearly the same quality are found nearer Christchurch, which can be obtained with little cost, I considered it not of sufficient value to have induced me to recommend the Provincial Government to lay a reserve upon it, the more so as this small basin is rather difficult of access.

During the last week, I learnt that persons may possess some knowledge of practical mining without even knowing the difference between true coal and lignite, although both minerals may be easily distinguished by their different specific gravity, lustre, fracture, streak, &c. As this want of information may lead to heavy losses among our community at large, it

may not be superfluous if, before entering into the main object of this report, I describe briefly the geological and mineralogical characteristics of lignite or brown coal.

Every coal of tertiary age is called a lignite, because in many instances its woody structure can still be clearly discerned; it is called brown coal, not only from its brown streak, but also because some kinds, when decomposing, become dark brown, and are then used as pigments—(umbra). Lignite, besides being light and bulky, has much less carbon than true coal, so that 60 per cent. of carbon may be considered a fair average, but it has a larger amount of oxygen, and is, besides, often impregnated with sulphuret of iron and mixed with argillaceous matter; even the best qualities are, therefore, seldom used for steam purposes, and in most instances the empyreumatic smell and the great amount of iron pyrites which it contains, are sufficient reasons to prevent its being used for domestic purposes.

There are, it is true, some lignites which graduate insensibly into coal, but they are very rare, and when they occur we can trace the change of their characteristic structure to local and secondary causes, as for instance, volcanic eruptions in the neighborhood.

There is another marked difference between true coal and lignite, namely, that whilst the former retains its compactness and crystalline structure when in contact with the atmospheric air, the latter soon cracks and crumbles away.

The specimen in our geological collection, taken two years ago from the best part of the main seam of the tertiary lignitiferous beds in question, has already cracked in different directions, although it has been carefully bound with strings; and will soon be nothing but a heap of crumbling fragments.

I may here add from Dr. Page's "Handbook of Geological Terms," his description of lignite:—"Wood coal or fossil wood, more or less mineralised and converted into coal. The lignites are usually of a dull, dark-brown appearance, compact or laminated, and revealing the woody texture; and never present the crystalline structure or pitchy lustre of true coal. They burn with much smoke and dull flame, are poorer in carbon or coke than common coal; give much less heat, and leave, in general, a large residuum of earthy ashes."

All the lignites of the province of Canterbury are of nearly the same character, being of a very medium quality; they may safely be compared to the Motupipi lignite, in Massacre Bay, but are far inferior in quality to those of Drury, Auckland, or to that of Jenkins' coal mine, of Nelson. In the geological part of this report I shall dwell at more length upon this subject, and describe those seams of lignite which have already come within the range of my observation. I shall now proceed to sketch the position of the lignitiferous beds lying on the north-western flank of the Thirteen Mile Bush Range, and afterwards give you a description of their geological structure.

In ascending the Kowai, where it issues from between the Mount Torlesse and Thirteen Mile Bush Ranges, we find it dividing into two main branches, the principal one of which flows in a north and south direction from the centre of Mount Torlesse, whilst the smaller one, known as McFarlane's stream, after flowing for about three miles in a west to east direction, has a north and south course, its principal sources lying in the western slopes of Big Ben, the name given to the northern part of the Thirteen Mile Bush Range.

A ridge about 3,600 feet high, divides the head waters of the McFarlane stream from those of the Acheron, whilst another range, of an altitude of 4,000 to 4,500 feet, running parallel with the Thirteen Mile Bush Range, forms the western water-shed towards Lake Linden.

As the valley of McFarlane's stream, above Mr. Thomas' station is very rocky and precipitous, and covered with dense bush, the track usually taken to reach the open country at the sources of the stream, is over a grassed saddle, 3,074 feet above the sea. This country is remarkably broken, as the loose character of the tertiary strata has offered little resistance to the mountain streamlets descending from the flanks of Big Ben.

This basin, lying at an altitude of 2,700 to 3,200 feet above the level of the sea, is bounded on the eastern side by the western slopes of Big Ben, on the western by the eastern slopes of the Lake ridge; and on the southern by the ridge or saddle which unites the two ranges; and is traversed by the numerous small branches of the McFarlane stream, the principal ones coming from Big Ben.

The Thirteen Mile Bush Range consists of palæozoic rocks of varied character, clay slates, alternating with sandstones.

The slates are sometimes blue, assuming the character of a true clay slate, and sometimes become coarse and lighter in colour, when they may be called greywacke slates.

The sandstones also undergo many alterations from a dark steel colour and compact semicrystalline structure to true greywacke or mudstones.

Some abound in minute specks of mica, others take a black colour as if from carbonaceous matter, and some become gritty and even change into pebble beds.

Although many minor charges are observable, the general strike of these unfossiliferous strata is from north-north-east to south-south-west, with a dip from 60 to 80 degrees to the west-north-west.

The same strata occur in the Lake ridge, of which I examined only its northern termination at Porter's Pass, where the strata have whirled round, striking from the west-north-west to the east-south-east, with a dip of 70 to 85 degrees to the north-north-east.

But I may here state that the strata stand often in a vertical position, and that reversed dips also sometimes occur.

When examining the extent of the Kowai coal measures, I ascended McFarlane's stream and found several pieces of coal in its bed, which, although very small, I instantly discerned to be lignites.

Although the existence of this tertiary basin so high in the mountains was unknown to me, it was not quite unexpected, as I had previously received fossils and lignite from another tertiary basin of large extent in the upper Waimakariri country.

There is not the least doubt, that during some epochs in the tertiary period, the greater part of New Zealand was submerged beneath the sea, and also that two sub-divisions, at least, are represented by different formations, enclosing deposits of lignite.

To the older subdivision, belong the lignite beds of Drury, Auckland, the strata of Whangaroa and Aotea harbours, in the Northern Island, and the extensive beds, associated with brown coal, which stretch, with little interruption, from Cape Farewell to the mouth of the Grey, and without doubt, even still farther down into our Province, overlying unconformably the carboniferous beds of secondary age, at the Buller and Grey rivers.

There are many species of pecten, terebratula, Waldheimia, Scalaria, Struthiolaria, as well as many species of Echinidæ, as for instance Brissus eximius, Schizaster rotundatus, Hemipatagus formosus (Zittel), by which we may easily distinguish the older subdivision from the younger, of which the strata of Hawke's Bay, in the North Island, and the valley of the Awatere, in the Middle Island, are the most clearly defined.

The greater portion of the species in the latter strata are extinct, as for instance Ostrea ingens, Pecten Triphooki, Crassatella ampla, Dentalium Mantelli, Turbo superbus, Natica Denisoni, Struthiolaria, canaliculata (Zittel), but there are also some species amongst them which are identical with living ones, of which I may name Voluta pacifica (Sol.), Purpura textiliosa (Lam.), and Trochita dilatata (Quoi).

In both sub-divisions teeth of the Lamna species are met with.

But there are also some intermediate links which seem to connect these subdivisions; amongst them the large beds of Motupipi stand in close connection with the older subdivision in which Pecten athleta, Pecten Burnetti (Zittel), and some others, occur very frequently.

The extensive tertiary and lignitiferous beds on the eastern side of our Province are also of an intermediate character, although they incline more towards the younger subdivision. As we may soon expect a complete description of these fossils, by professor McCoy, of Melbourne, it would be presumptuous to attempt to anticipate the valuable labours of this eminent palæontologist.

But I may here state, that in our Province, we meet with not only littoral but also pelagic beds, in which several fossils of the older group occur, as well as many of the younger one; besides fossil bones of cetaceæ, and teeth of Lamna, Oxyrhina, and Carcharias.

The knowledge of our fossiliferous beds is not yet sufficiently advanced for us to be able to state with certainty which of the species are extinct, and to assign to the different beds their correct ages, by classifying them according to their fossils.

Owing to the usually soft nature of the tertiary beds, they have in many instances disappeared, partly by erosion and partly by other causes, amongst which the glaciation of this island, during the post peiocene period, ranks foremost; and in fact, if we examine the portion of the remaining tertiary beds, we may observe that not only are they generally protected by an upper stratum of unusual hardness, but at the same time they are mostly situated in such localities as to diminish the action of glacial coverings, or of the enormous glaciers of the postpliocene period.

Bearing in mind this important fact, we may easily understand the reason that no tertiary deposits are to be found in the main channels of the present rivers.

The tremendous glaciers above referred to have not only excavated the loose tertiary strata, but have furrowed deeply into the hard palæozoic rocks beneath, forming, in this manner, below our present glaciers, such broad and straight shingle river valleys, as to make those of the European Alps and even of the Himalayas sink into insignificance when compared to them.

The extensive lignite beds which are situated at the foot of the eruptive ranges near Mount Somers (Trip's coal), are preserved, like the Motupipi coal, by a hard bed of magnificent flaggy limestone and the lignite bed of the Malvern Hills, by a capping of compact doleritic rocks.*

The fossils in the former beds show that they have been deposited in deep water, whilst those of the latter have all the characteristics of littoral origin, a large species of Astrea, some of the single shells often two inches thick, being the principal fossil, although Natica, Voluta, and many others are also abundant. The tertiary basin at the head of McFarlane's stream is also an outlier of this extensive formation. It owes its preservation to its position in a small valley between two longitudinal chains, and therefore has not been so much affected by the glaciation of New Zealand as it would have been had it been situated in the main line of the moving ice masses, which cross the longitudinal chains in a diagonal direction, or of the huge torrents rushing from them as they retreated towards the central chain.

We may also ascribe its preservation partly to the circumstance that one of the upper strata consists of a very hard ferruginous conglomerate which has generally well resisted the erosive action of running water.

This may readily be discerned at those spots where this stratum has been cut through, the beds below it having been easily destroyed.

Landslips and deep gullies cross the basin in every direction, showing clearly that had it not been for this hard stratum the whole basin would soon have disappeared.

It is about half a mile broad and two miles long, the latter direction being nearly north and south, and is of littoral origin, as shown not only by the lithological character of its beds, but also by the only fossil shell which occurs, a large species of ostrea, which is identical with that of the lignitiferous beds of the Malvern Hills.

The strike of the beds: where exposed in the centre, is from west-north-west to east-south-east, with a dip towards the south-south-west, at an angle of 17 to 21 degrees.

At the edge of the basin the strata are very much disturbed, pointing to the great revolutions of the earth's crust which have taken place after their deposition.

That the principal of these great changes has been occasioned by the eruption of dolorites and other volcanic rocks is beyond doubt, the more so as such an occurrence is well shown in the magnificent sections in the River Hororata, near Rockwood, in the Malvern Hills, where the lignitiferous beds have not only been broken through by dolorites, but have at the same

* The same rocks occur also in Niedermennig in Germany, where they are extensively quarried for millstones, and form a very important article for exportation to all parts of the world.

time been bent and thrown over. We cannot, therefore, be surprised when, at the first locality in which we meet with these tertiary beds, at the edge of the basin in crossing the saddle at the northern slopes of Big Ben, we find them broken, distorted, and sometimes placed vertically. In the short interval of about 30 yards, in slips on the slopes of Big Ben, many strata are exposed, consisting of small seams of lignite, alternating with argillaceous or arenaceous shales, pipeclay, loose sands of different colors, all more or less impregnated with ferruginous matter, and in which strike and dip change constantly.

In a line from north to south, I noticed the following changes :—

Strike S.S.E.	to	N.N.W.,	dip towards	E.N.E. 53 deg.
„ N.	to	S.	„	E. 88
„ N.W.	to	S.E.,	„	N.E. 76
„ S.W.	to	N.E.,	„	S.E. 78

There are other changes which show us that the disturbances which have taken place at the edge of this basin are of the character usually occurring in lignitiferous and carboniferous beds, and that they have therefore not been occasioned by faults or throws as has been stated by persons on the spot.

This disturbance is hidden in many places by the detritus, which descends often in one continuous talus from the summit of Big Ben.

The altitude of the position of these disturbed beds above the centre of the basin or trough, confirms my theory still more strongly.

In descending towards this centre for abont 200 feet, we observe a magnificent section in the first branch of M'Farlane's stream, which flows from Big Ben in a north-westerly direction. It is here that the seam of 4 ft. 7 in., which I examined two years ago, is exposed, and that the different pieces of land are situated, which have been bought by Mr. Thomas and the Kowai Coal Mining Comany.

A remarkable feature in these beds is, that the whole are not only very much impregnated with sulphuret of iron, but that some of the deposits, consisting of loose sands, are full of a slight efflorescence of sulphur for which I cannot yet account, but which may almost lead us to the conclusion that they were deposited during volcanic eruptions in the neighbourhood, notwithstanding no other signs of such occurrences are to be found there. Looking at the constituents of the rocks which form this basin, the enormous quantity of sands which resemble the deposits of the same formation in the Malvern Hills is astounding.

As the sands in the latter are derived from the decomposition of eruptive rocks, quartzose porphyries, &c., in the neighbourhood, and which now form but a very inferior portion of that zone, I am inclined to think that those of the McFarlane stream basin are also derived from the same source, although such rocks do not occur anywhere in the neighbourhood.

We must therefore assume that either the eruptive rocks, from which the sands in McFarlane's basin were derived, have entirely disappeared from its neighbourhood, or that in the tertiary period the eruptive zone in the Malvern hills was much higher and more extensive, being easily decomposed by the waves of the sea, which broke furiously againt it, and above which its isolated masses stood as large islands.

At the same time we may presume, that the sea carried those sands in a westerly direction, and deposited them in deep fiords, or in shallow bays between high headlands, which, in tertiary times formed the eastern shore of the Middle Island of New Zealand

In order to show what repeated changes have taken place, oscillations of level being, without doubt, one of the principal causes, I shall enumerate the different beds as they follow each other.

The following strata are noticed in a descending order, the seams of lignite are carefully measured, whilst the thickness of the other strata is only approximately given.

		ft.	in.
	Reddish brown ferruginous sandstones forming often a hard conglomerate and including layers and nodules of clay, or sandy iron ore	2	0
	Greenish loose sands, sometimes variegated	3	6
	Pinkish, sometimes variegated	1	0
	Greenish, yellowish do.	3	0
	Pinkish do.	1	6
	Greenish, darker do.	0	9
	Pink do.	1	6
	Greenish do.	1	0
	Sand, pinkish, sometimes compact and then more argillaceous, sometimes with a slight efflorescence of sulphur, and sometimes with remains of plants which have served for the deposition of clay iron ore	3	0
	Yellowish green loose sands, alternating with pink ones	3	5
	Sandstone, in some parts hard and compact, in others looser, of a dark iron rust or greenish colour	0	10
	Bluish clays	0	6
	Sands, partly reddish, partly pink or greenish, with a mixture of clay, sometimes forming a loose sandstone	8	0
	Variegated loose sands, not argillaceous	9	0
	White loose quartzose sands	2	3
	Loose sands of different colours ...	11	6
	Dark slaty clays	4	6
	Green sands	0	6
	Oyster bed, consisting of very large specimens, the species identical with that of the lignitiferous beds of the Selwyn, very compact, but sometimes intermixed with small quantities of green and pink loose sands	1	10
	Sandy clays somewhat stratified ...	3	0
	Oyster bed, identical with the former ...	1	3
	Shale, sometimes very sandy	4	9
1.	Lignite inferior, and full of sulphuret of iron	0	6
	Grey pipeclays	1	0
	Greenish sands	1	9
	Dark grey clays	1	0
	The last three alternating	4	0
	Sands of different colours	3	3
	Shale	2	0
2.	Lignite	0	8
	Clays and shale, often sandy, with remains of plants, without doubt of marine origin, changed into lignite ...	4	0
3.	Lignite	0	7
	Sandy clays, sometimes shaly	7	0
	Clays and sands in different colours alternating	15	0

	ft.	in.
Sands finely stratified	1	6
Shale	4	0
4. Lignite, with a great amount of sulphuret of iron	1	5
Pink sandy clays sometimes shaly ...	11	0
Very ferruginous sands	2	0
Dark shale...	2	0
Do. somewhat slaty	5	0
5. Lignite	1	6
Under-clay	1	9
Ferruginous sands	3	6
Shale, somewhat slaty	2	0
6. Lignite	0	8
Shale	2	1
7. Lignite	0	6
Shale	0	9
8. Lignites, very inferior and shaly ...	1	4
Shale, enclosing remains of plants changed into lignite	2	0
9. Lignite, more or less shaly	1	9

The seams 6, 7, 8 and 9, approach each other towards the west and seem ultimately to form one single seam.

	ft.	in.
Shale and sand alternating	20	0

They are full of vegetable remains changed into lignite, but their appearance shows that they were not derived from driftwood. They are not generally interstratified, but are found dipping at various and often very high angles in many directions, so as to imply that they were marine plants (Kelp), struggling against the sands deposited in this tertiary bay, and being gradually covered by them. Impressions of smaller marine plants are also abundant, but not sufficiently clear to define any specific difference between them.

	ft.	in.
Dark shale	1	9
10. Main seam of lignite, containing nodules of pale yellow clay (bolus) and other smaller ones, consisting of retinite or fossil resin	4	7
Clays	1	0
11. Lignite	1	1
Clays, dark and changing into shale ...	0	6
Dark shale, or sometimes impure lignite	1	0
Shale, slaty and argillaceous	3	0
Yellow ferruginous and white loose sands	11	0

Inclosing driftwood (?) changed into lignite, no forms are so distinct as to be able to pronounce if they belong to cryptogamic plants, or are parts of dicotyledonous or monocotyledonous wood.

	ft.	in.
12. Lignite	0	11
Bluish clays, changing insensibly into ferruginous and argillaceous loose sandstone	8	0

This is the lowest stratum of this lignitiferous bed which is observable, as the debris of the higher strata which have fallen, covers everything.

In looking at the lithological character of the beds enumerated, there is no doubt that they were deposited in a very shallow bay, that several times, by oscillations, dry land appeared, the configuration and character of which gave rise to extensive swamps.

There are no indications whatever that the seams of lignite have been formed by drift trees or by submerged forest vegetation, to which latter occurrence many of the extensive lignite beds in Germany owe their existence, and where not only large stems of trees are continually met with, in which the woody structure is so little obliterated that the annual rings can be counted, but where the lower part of the trunks, with the roots, may still be seen standing upright in their original position. Were the beds formed, like those of Germany, from terrestrial vegetation, we should meet, as we do there, with impressions of dicotyledonous plants, or perhaps leaves, fruits and stems of palms, as in their German analogues.

We have sufficient proof that such impressions of dicotyledonous leaves and large drift trees do exist in New Zealand, in the fact that I discovered them in the tertiary beds of the river Buller.

As before stated, the only impressions to be met with are of such character that they can only have been produced by marine or fresh-water plants. No sign of woody structure is to be observed anywhere amongst the seams, and the appearance of the lignite is such, that the only inference to be drawn from it is, that it has been produced from submerged peat-beds, covered with marine deposits, in a shallow bay.

In conclusion, I may observe, that of the seams enumerated above, No. 10 would alone be of any value for working, because it is comparatively speaking superior to the other and smaller seams, and the strata above it will be found to be in many instances destroyed or greatly disturbed by slips, occasioned by the undermining action of the mountain streamlets. Although a part of this tertiary basin has passed into private hands, I nevertheless think it my duty to point out to you the real character of the coal it contains, and to request you to give publicity to the results of my labours in that part of the Province, so that the question, whether it contains true coal or merely lignite, may at once be set at rest.

I beg to enclose an appendix to my report on the Kowai coal measures, of January 20th, 1862.

And have the honor to be,
Sir,
Your most obedient servant,
JULIUS HAAST, Ph. D., F. G. S., &c
Provincial Geologist.

To His Honor S. Bealey, Esq.,
Superintendent of the Province of Canterbury.

REPORT FROM THE PROVINCIAL ENGINEER

TO

HIS HONOR THE SUPERINTENDENT OF CANTERBURY,

ON THE PROGRESS OF PUBLIC WORKS FOR THE YEAR 1862-1863.

(Laid on the Table of the Provincial Council, July 29.)

Office of Public Works,
Christchurch, July 1st, 1863.

Sir,—I have the honor to report upon the progress of the Public Works of the Province since the commencement of the financial year, and at the same time to offer a few suggestions with regard to future works.

I.—WORKS OF THE CURRENT YEAR.

1. The auditor's comparative statement of estimates and expenditure will furnish a clear idea of the amount of public works completed during the last nine months; whilst the returns furnished by the district engineers of the unpaid balances on outstanding contracts will shew the extent of the works still in hand, for which provision has to be made in framing the estimates for the ensuing year.

2. I have the satisfaction of reporting a satisfactory progress in the works of the Moorhouse Tunnel. On the 30th ultimo, the workings extended to a length of 1087 lineal yards, viz., 541 on the Lyttelton and 546 yards on the Christchurch side of the hill. This is 49 yards less than two-fifths of the whole length, a result highly to the credit of the contractors, considering that two years only have elapsed since they commenced operations, and that the works were carried on during the first year under great disadvantages, in consequence of the rush to the Otago gold-fields and the temporary suspension of our steam communication with Melbourne. On the Christchurch side the north tunnel front has been built of the Heathcote Valley grey stone, and the brick lining has been carried through the soft ground to its junction with the rock, a distance of 136 yards. With the exception of a few chains at the Lyttelton entrance, and of some doubtful ground near No. 3 shaft, which will probably require partial lining, the tunnel has been taken out to its full size to within a short distance of the faces of the headings.

3. The works on the plains are in a forward state, the whole of the line from Ferrymead to Christchurch being ready for the permanent way. Two hundred tons of rails have arrived per Metropolis, and a future consignment of rails and chairs sufficient to complete five miles of line may be expected to arrive during the present month.

4. The wharf at the Ferrymead station is in a forward stage of progress, and the timber is being cut for the station buildings at the contractors' steam mills in Pigeon Bay.

5. The preparation of the contracts for the buildings at the Christchurch Station has been delayed in consequence of the demands made for the land required for the site of the Station, it having been a question whether the site first proposed should not be abandoned. These claims, however, having been settled by arbitration, the contracts may now be prepared and the works put in hand at once, so that the line may be opened between Christchurch and Ferrymead early in the ensuing spring.

6. The first locomotive, contracted for by Messrs. Holmes and Co, has been delivered at the Ferrymead station in good condition, and the rolling stock now being manufactured to their order at Melbourne, is in a forward state, and will be ready for delivery in August next.

7. Mr. William White, of Kaiapoi, who during the last session of the Provincial Council obtained permission to lay down a tramway from the Little River bush to Christchurch, has commenced operations at various points between these places, but as he has not deposited any plans or sections of the proposed line, I would strongly urge that he should be peremptorily restrained from entering upon any of the waste lands or road reserves, until his plans have been submitted to and approved by the Provincial Engineer.

8. The telegraph between Lyttelton and Christchurch has been working in a very satisfactory manner ever since its erection. The report of your telegraph engineer will inform you of the financial results attendant on the opening of the present line, and of the steps which have been taken for the construction of the line to the Otago frontier.

9. It may be proper here to observe, with regard to the Telegraph Station in Heathcote valley, that its importance is not to be estimated by the amount of public messages received, but by the facility which it affords of communication between the Railway Offices in Heathcote valley and the Public Works Offices in Christchurch. In cases of tunnel accidents also the power of summoning medical assistance without delay is an advantage which alone is worth the whole cost of maintaining the station.

It would be impossible in this report to give anything like a complete account of the works that have been executed on the various roads throughout the province. It will, however, be well to point out what has been accomplished in the improvement of the principal lines of road since the date of my last report.

10. The works on the Sumner road have progressed steadily for many months past, and, with the exception of some portions of the flats which still remain unmetalled, the road may be said to be finished from the old Heathcote Ferry to the summit of Evans' Pass, from which point to Lyttelton the road is under the charge of the Municipal Council of that town. The saddle at Evans' Pass has been lowered,

the whole of the ascent from Sumner valley has been thoroughly metalled, and a great deal of improvement has been effected at Sumner by blasting away points of rock where the road was dangerously narrow.

11. The works at the drawbridge at the old Heathcote Ferry are suspended until the arrival of the ironwork, which was shipped some months ago per Holyrood, now considerably overdue. The bridge can be opened at any time within a month after the delivery of the ironwork upon the site of the bridge.

12. Great improvements have been made in the Dyer's Pass road, the Governor's Bay road, and Charteris Bay road, which have the effect of rendering the country at the head of the harbour much more accessible than before. The Governor's Bay road has been widened the whole of the way from the jetty in Dyer's Bay to the west side of the Maori Pass, thus opening a cart road between Lake Ellesmere and Port Cooper, and the ravines at Governor's Bay have been spanned by stone bridges, which though of small size, deserve mention as being the first stone bridges built in the province.

13. The bridle path between Purau and Duvauchelle's Bay has been cleared of timber throughout its whole length, and benchings cut at the steep sidings; it is now in good order with the exception of a few places which require blasting, and may be kept in good repair at a comparatively small annual outlay. Great progress has also been made with the cart road between Duvauchelle's Bay and Akaroa.

14. A great deal of improvement has been made on the North Road, but the only works which call for special notice are White's new bridge at Felton's Ferry, the drawbridge erecting at Baxter's Ferry, and the works now in progress for opening the permanent line through the Weka Pass, which are in a forward state and will be completed before the end of the present year.

15. The drawings for the proposed wrought iron bridge over the Hurunui have been prepared and forwarded to the Nelson Government for their approval. It is proposed at present only to bridge that part of the channel which is covered in ordinary freshes, and to carry the road over the remainder of the river bed on low embankments. This arrangement greatly reduces the original estimates, but it must be considered only as an experiment. Should an extraordinary fresh, however, make a breach in the proposed embankments, they can readily be repaired in a few days at a moderate cost.

16. There is little to call for remark in the works on the South Road, which are all of an ordinary character, with the exception of those at the new ferry now being established at the Rakaia. The principal work has been done near Timaru, and between Timaru and the Otago frontier. So soon as the works at the Weka Pass are completed the permanent line of road will be open from frontier to frontier, a distance of about 200 miles, a work of which any colonial Government might well be proud.

17. The road over Porter's Pass to Craigie Burn and Lake Pearson is now open for dray traffic; this line of road is a good instance of what may be done by careful engineering over a most difficult country at a very small expense. It is very desirable to extend this road up the Esk Valley to the township reserve at the west end of Lake Sumner, which is likely to become of importance as a depôt in connection with bridle roads, branching from this point to the valleys of the Waiau, Maruia, Grey and Teremakau.

18. The principal drainage works undertaken during the past year, have been the extension of the Rangiora main drain, the completion of the drainage of the Papanui district, and the clearing of the rivers Avon, Heathcote, and Halswell; all these works have been executed successfully and with highly beneficial results.

II.—ROAD SURVEYS.

19. Since the date of my last general report, the Road Surveyor's department has been placed under the Chief Surveyor, that officer being at the same time instructed to furnish a copy of the plan, and longitudinal section of each new line of road to the public works department for the approval of the Provincial Engineer before marking the road reserve on the authenticated map of the Province. This arrangement appears likely to work well, leaving as it does to the Survey Department the entire management of the work of the Road Surveyor, whilst at the same time it ensures the concurrence on all engineering questions of the Provincial Engineer, who is the officer practically responsible for the construction of the roads.

20. The province has lately sustained an irreparable loss by the death of the late Road Surveyor, Mr. H. Whitcombe, who was drowned whilst crossing the Teremakau, on the West Coast of the province, on his return from an exploration undertaken to ascertain the practicability of opening a route to the West Coast, by way of the valley of the Okitika, from the head of the southern branch of the Rakaia. Mr. Whitcombe's scientific attainments and thorough knowledge of his profession rendered him peculiarly fitted for the appointment he held, the duties of which he discharged conscientiously under a series of painful hardships up to the hour of his death. Few men could be named more useful in life or more regretted in death than the late Henry Whitcombe, and it will be long before his name or his services can be forgotten. Mr. Whitcombe's last journey has shewn the impracticability of forming a dray road to the West Coast by way of the Rakaia, and it may now be considered as proved that the only two really available passes are those over the Teremakau saddle, in the extreme north, and at the head of the Wanaka Lake, in the extreme south of the province.

21. The former of these passes has been opened by the cutting of a bridle track through the bush, under the directions of Mr. Charlton Howitt, who reports the country near the mouth of the Teremakau to be auriferous, although it is as yet uncertain whether gold exists in paying quantities. This track will probably be open for packhorses the whole of the way to the mouth of the river Grey by the end of the winter, when a considerable amount of traffic may be expected on the road, especially if the Teremakau gold-field is found on examination to rival the neighbouring gold-fields of the Lyell and Buller. Looking at the importance of the Teremakau Pass, I think it is very desirable that no time should be lost in laying out and reserving the permanent line of road over the saddle, throughout the whole distance from the mouth of the Grey on the West Coast to the main gorge of the Hurunui, from

which point to the plains the road has already been set out by Mr. Whitcombe. A few miles of bush-cutting on the north side of Lake Sumner and at the south-east corner of Lake Brunner would open a communication between this line of road and the valleys of the Waiau and the Grey.

22. It is of equal importance to secure a road up the Esk Valley from Lake Pearson, where the present dray track terminates, to the township reserve at the west end of Lake Sumner. A dray track could be formed along this line at a very moderate cost as far as Lake Sumner, from which point a short line cut through the bush on the north side of the lake in the Nelson Province would throw open the upper valley of the Waiau, and open up a communication with the Lyell diggings by way of the Maruia.

23. A third line of road, which deserves careful examination, is that from the Wanaka Lake to Jackson's Bay over the pass recently explored by Dr. Haast. The connection of Jackson's Bay with the Otago diggings, is a question of such deep importance to the future interest of the Canterbury Province, that I think it would be desirable at once to cut a horse track through the district for the purpose of assisting future explorations, preparatory to laying out either a dray road or a line of railway, as circumstances may render most desirable.

24. I have made special reference to the three lines of road just described, because it would probably be necessary to make special arrangements for setting them out, and to take distinct votes of the Provincial Council for the purpose, in addition to that for the ordinary road surveys. I would, however, at the same time urge the importance of keeping the last named work well in advance of the land sales as the only means of securing available lines of road at a moderate cost, and of avoiding those extortionate claims for compensation which have become a by-word and a reproach in Canterbury.

III.—ESTIMATES FOR NEW WORKS.

25. The work of preparing the Public Works estimates will be greatly simplified for the future if the Provincial Council should sanction the plan of transferring the management of the ordinary road works to local boards; as in this case, it will simply be requisite to place a fixed proportion of the land fund at the disposal of each district, leaving the road boards to arrange the distribution of the grants, and to supplement them by local rates, where necessary.

26. Pending the consideration of this important change in the management of the public works, it is unnecessary for me to make any suggestions with regard to those works which are simply of local importance, and which will probably be executed under local superintendance. There are, however, several important undertakings to which the attention of the public has been directed for some time past, and the execution of which cannot be long delayed without injury to the interests of the Province. They may be summed up as follows:—

Harbour improvements.

Improvement of the Heathcote navigation.

Extension of Telegraphic communication.

Bridges over the Large Rivers.

I propose to offer a few remarks on each of these subjects.

27. Year by year the trade of the Port has been rapidly increasing, without any addition being made to the wharfage, until the deficiency of wharf accommodation has become a most serious evil.

28. The simplest way of relieving the present pressure is at once to add a length of 50 yards to the present jetty, making it 30 feet wide from end to end, and dredging out a berth on each side for large steamers. The sum of ten thousand pounds would be sufficient to effect this improvement, and to provide rails, trucks, steam crane, mooring buoys, and everything requisite for working the jetty efficiently.

29. In the next place I would urge the importance of running out a jetty 300 yards long on the line of the railway tunnel, as proposed in my report of last year, and would recommend that this work should be put in hand at a sufficiently early date for it to be completed simultaneously with the opening of the railway into Lyttelton.

30. I consider this jetty to be essential to the proper working of the railway, and that it cannot be dispensed with. Whether accommodation shall be given for vessels drawing more than 12 feet by the extension of the proposed jetty into deep water, by an extensive system of dredging, or by building a pier at Officer's Point, is a further question, which, considering the heavy cost of each of the plans suggested, requires the most careful consideration on the part of the Government. Meanwhile it is desirable to procure a steam dredging machine, as this is certain to be required whatever plan may be adopted.

31. I would also recommend employing the prison gangs to blast away the cliff at Officers' Point, running out the rock to form a breakwater on the line recommended by the Commission for the new pier. Every yard of breakwater thus formed will increase the shelter afforded by Officers' Point to vessels lying at the jetties, whilst the cost of the work, if done by prison labour, will be trifling in comparison with the result to be obtained.

32. The river trade has increased greatly during the last twelve months, and many of the vessels employed are of large tonnage. It is therefore very desirable to remove the shoals on the flats, which at present are a serious cause of delay. There are also several rocky points between the old and new ferries, which are dangerous to vessels and should be removed. I would recommend appropriating a sum of £3,000 for the purpose of removing the shoals and easing the sharp bends in the channel between Sumner and the Railway Wharf.

33. As I have explained my views with regard to the Rakaia and Hurunui bridges in my last annual report, I have here only again to urge the importance of these works.

34. I would call your attention to the advantage to be derived by running a telegraph wire to the West Coast at the mouth of the Grey, in connexion with a line to be promoted by the Nelson Government from Nelson to the same point, by way of the Buller diggings. The opening of this line would be a valuable step towards the settlement of the West Coast, and the through messages to Nelson would probably pay the working expenses.

IV.—GENERAL SUMMARY.

35. In retiring from the management of the Public Works Department, after having held the office of Provincial Engineer ever since the first establishment of the Public Works Department in 1854, it may be desirable that I should take a brief review of the progress effected during that period in the internal communications of the province.

36. The works undertaken by the Canterbury Association, under whose auspices the settlement was founded in 1848, were necessarily limited in extent, and the greater part of the money at the disposal of the Association was expended in forming the site of the port town, in erecting the necessary public buildings, and in beginning the cart road to the plains over the port hills. If to these we add a rough bridle track over Mount Pleasant, some temporary wooden bridges, a few miles of road ditches, and a short length of gravelled road between Christchurch Quay and Christchurch, the enumeration of the public works executed previous to 1853 is tolerably complete.

37. With the establishment of Provincial Government in 1853 a new era commenced in Canterbury, and one of the first steps taken by the local government early in 1854, was to appoint a commission of engineers to report on the best method of forming a communication between the port and the plains. The works recommended by this commission were the completion of the Sumner Road and the improvement of the Heathcote navigation, whilst the commissioners pointed out the line of railway now in construction between Lyttelton and Christchurch as a work to be undertaken at some future period.

38. The first important work undertaken by the Provincial Government was the cutting a track through the bush on Banks' Peninsula, to connect the harbours of Lyttelton and Akaroa by a line which, rising at an easy gradient from Purau beach, follows the summits of the ranges, and crossing Mount Sinclair at an elevation of 2600 feet, descends by gentle inclines into Duvauchelle's Bay. This was followed by the resumption of the works on the Sumner Road, but under an important change of plan. The original line laid out by Captain Thomas rose at a uniform gradient from Lyttelton to Evans' Pass, whence it descended into Sumner Valley in the same manner. Although the gradient of this road was unexceptionable, its cost would have been very great, as it intersected the rocky terraces formed by the lava streams of which the Port hills are composed, rendering it necessary to make a series of heavy rock cuttings and high retaining walls alternating with each other throughout the whole of the ascent and descent. Your engineer took the step of remodelling the gradients so as to correspond with the inclinations of the lava streams, by which means the road has been cut for the most part in soft clay and through the soft crumbling rock found in the upper portion of the lava streams whilst it rests on a floor of solid rock. By this means both rock cutting and walling are reduced to a minimum, and the road was opened at a comparatively small cost. It was intended to cross the ridge by a tunnel 350 yards long, at a depth of 260 feet below the summit of the original line, but political considerations having interfered with the completion of the plan, the traffic is to this day carried over the saddle by the zig-zag track made for opening a temporary communication, pending the boring of the tunnel.

39. Simultaneously with the roading of the country the land fund began rapidly to increase, and from the year 1856 the public works gave indications of the importance they have since assumed, and which has materially contributed to enhance the the rising reputation of the Canterbury province.

40. The River Heathcote, whose tortuous channel was traversed with difficulty by decked vessels only of the smallest class, has been rendered accessible to steamers and schooners of large tonnage by placing leading marks at the bar and staking out the channel.

41. The Sumner Road, even though unfinished, forms a well travelled communication between Lyttelton and Christchurch; and the River Heathcote will shortly be spanned by a drawbridge, the ironwork of which is now on its way from England.

42. The Provinces of Nelson and Otago have been connected by a good road extending through the whole length of the Canterbury province, a distance of two hundred miles.

43. The bays in Banks' Peninsula have been brought into communication with the port town by means of bridle-roads through the bush.

44. District roads branching in various directions open up for settlement nearly the whole of the available country between the seaboard and the ranges, whilst a great deal of the back country, formerly deemed inaccessible, can now be reached by dray-track or bridle-path. Even that terra incognita, the West Coast, will soon be accessible for pack-horses by the track now in progress over the Teremakau Pass, the completion of which, by opening a way to the western gold-fields, is likely to lead to important results.

45. Efficient systems of arterial drainage are in progress throughout the Rangiora, Papanui, and Halswell districts, which will have the effect of permanently reclaiming many thousand acres of valuable swamp land, the greater part of which has already been purchased from the Crown.

46. The electric telegraph has been introduced into the province, the line between Lyttelton and Christchurch being the first opened for public use in New Zealand.

47. And lastly, the main lines of railway have been laid out throughout the province; and the construction of the tunnel through the port hills, the key to the whole railway system of Canterbury, is so far advanced as to leave little doubt of the line between the port and the capital being opened in the course of the year 1866.

48. There are several points connected with the above mentioned works which are worth placing on record.

1st. They extend over a district 200 miles in length and 130 miles in breadth.

2nd. Their cost, amounting in round numbers to two hundred and eighty-three thousand pounds, in addition to that of the Lyttelton and Christchurch railway, has been defrayed out of the yearly revenues of a province of which the whole population even now little exceeds 20,000 souls.

3rd. They have been carried out with an unusually small percentage of accidents, only four fatal cases having occurred during the whole period referred to.

4th. They have been executed, with trifling exceptions, without exceeding your engineer's estimates, or interfering with the labour required for the ordinary industrial pursuits of the country.

5th. There are no disputed accounts or outstanding claims from contractors, with the exception of balances due on current accounts.

Lastly. The whole of the works have been designed as portions of a general scheme for opening up the waste lands of the province which was laid down by your Provincial Engineer soon after his appointment, and which has been steadily carried out year by year as circumstances permitted. The close correspondence which may be traced between the sums annually spent on the public works and the amounts received from the land sales would seem to bear satisfactory testimony to the soundness of the scheme in a financial point of view.

49. The great work of opening up the Canterbury province for settlement may be said virtually to be completed so far as the eastern seaboard is concerned, although for many years a heavy outlay will be required upon the roads before they can be brought into thorough order. But much greater works still remain to be done. The progress of the province demands the introduction of increased facilities of communication and harbor works. Telegraphs and railways must be undertaken at a heavy cost to meet the rapidly increasing requirements of the settlement.

It will tax the utmost skill, both of the engineer and the financier, to make these works self-supporting in so small a community as that of Canterbury, yet it is most desirable that this should be done so as to leave the land fund free for the ordinary works of the province.

In the earnest hope that your administration of the public works may be marked with the success which has attended the efforts of your predecessors in office,

I have the honor to remain, sir,
Your obedient servant,
E. Dobson,
Late Provincial Engineer.

REPORT FROM THE PROVINCIAL ENGINEER

TO

HIS HONOR THE SUPERINTENDENT OF CANTERBURY,

UPON THE RE-ORGANIZATION OF THE PUBLIC WORKS DEPARTMENT.

Railway Offices, Heathcote Valley,
July 21, 1863.

SIR,—In accordance with your request, I have the honor to report upon the proposed reorganization of the Public Works Department.

The business of the Public Works Department has long since out-grown the machinery provided for its execution, and it is a matter for very serious consideration how the department can be reorganised on an efficient footing without at the same time saddling the revenue with a costly permanent staff.

The most pressing difficulty in the management of the public works is the absence of an administrative head of the department. The duties appertaining to a Minister of public works have been hitherto discharged to a certain extent by the Provincial Secretary; but it would be simply idle to suppose that an officer whose time is fully occupied with the multifarious duties attendant on the Secretary's office can make himself practically acquainted with the details of the business of the Public Works Department. Hence two serious evils arise. On the one hand, in the majority of instances the Government have no alternative but to fall back upon the recommendation of the Provincial Engineer: thus making him an administrative as well as an executive officer; whilst on the other hand serious delays in the prosecution of the works are of constant occurrence for the want of some one to represent the Public Works Department in the Executive Council.

A simple and practical remedy appears to me to be the placing of the department under the charge of a Minister of Public Works, who should be a member of the Provincial Council, with a seat in the Executive. This officer should have the assistance of a secretary, who must be an engineer by profession, and whose office would be a permanent one; and of a head clerk, who would be the accountant to the department. Subject to the control of the Minister of Public Works would be the three principal divisions of the Public Works Department, viz.:—

Surveys.
Roads and Bridges.
Buildings.

The Survey Department, under the management of the Chief Surveyor, would embrace

The topographical survey.
The roads survey.
The geological survey.

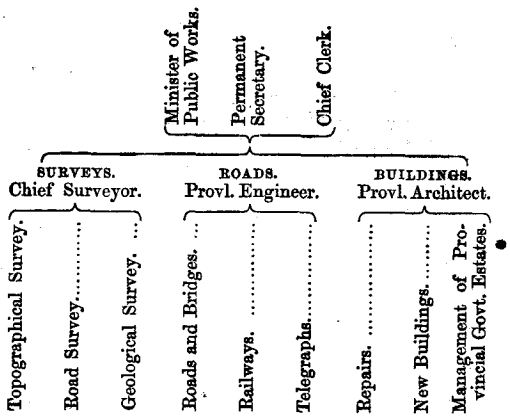
The department of Roads and Bridges, under the charge of the Provincial Engineer, would comprise the sub department of

Roads and Bridges.
Railways.
Telegraphs.

The department of Public Buildings, under the charge of the Provincial Architect would include

The maintenance of existing public buildings.
The erection of new public edifices.
The management of the Provincial Government estates.

This plan will be better understood by reference to the following diagram:—



I take for granted, in sketching out this plan for the management of the public works, that the ordinary business connected with the roading of the settled districts will be handed over to local boards, each having its own road surveyor, the Provincial Engineer acting as consulting engineer to the local boards, but taking the entire management of what may be called the pioneer works requisite for opening up of new districts in which the public works will be paid for out of land revenue instead of local rates, as must for the future be the case in those districts which have already received their full share of the land fund. So soon as this change shall have been made the staff at present employed in the Provincial Engineers Department may be dismissed, leaving the Minister of Public Works to recommend for reappointment any gentleman whose assistance it may be desirable to retain on the personal staff of the Provincial Engineer, which, however, need only consist of a survey assistant, a draftsman, and a copying clerk.

The works of the Lyttelton and Christchurch Railway will of course remain under the sole charge of the resident engineer until their completion, when the management of the line will devolve on the Provincial Engineer.

It is scarcely necessary for me to point out that in the event of the adoption of these suggestions those members of the Provincial Engineer's staff whose services are dispensed with would have a just claim on the consideration of the Government, in proportion to their length of service.

I have the honor to remain, sir,
Your obedient servant,
E. DOBSON,
Late Provincial Engineer.

Christchurch: Printed at the Union Printing Office, Gloucester Street, by WARD and REEVES, Official Printers to the Provincial Government of Canterbury.