1911.

NEW ZEALAND.

DEPARTMENT OF LANDS:

SURVEYS

(ANNUAL REPORT ON).

Presented to both Houses of the General Assembly by Command of His Excellency.

CONTENTS.

The SURVEYOR-GENERAL to the Right Hon. the MINISTER OF LANDS.

SIR,— Department of Lands and Survey, Wellington, 24th June, 1911.

I have the honour to submit herewith the annual report on the survey operations of the Department for the twelve months ended the 31st March, 1911.

I have, &c.,

JOHN STRAUCHON,

Surveyor-General.

The Right Hon. Sir Joseph George Ward, Bart., P.C., K.C.M.G., Minister of Lands.

REPORT.

THE number of surveyors employed during the year ending the 31st March, 1911, was 124, of whom 95 were employed in the North and 29 in the South Island, and consisting of 57 staff, 17 temporary, and 50 contract surveyors. In addition to these licensed surveyors a number of cadets and assistants were employed.

The total cost of the surveyors and their parties amounted to £82,787, and the completed works returned in each class—with the exception of Maori Land Board and gold-mining surveys—greatly exceeds that of the previous year. The cost per acre, compared with several of the classes in the preceding year, shows it to be considerably less, which may perhaps be accounted for by the favourable weather conditions that prevailed.

The following is a summary of the principal work completed during the past year:—

TABLE A.

Class of Work.	Area.	Cost per acre.	Total Cost.
			£ s. d.
Triangulation	434,731	1·06d.	1,934 1 5
Topographical	2,305,549	1·26d.	12,106 1 7
Rural, by staff	300,747	2·34s.	35,193 12 1
Rural, by licensed surveyors	25,564	1·90s.	2,429 9 10
Rural, by licensed surveyors (costs not available)	8,404	..	..
Village and suburban	1,754	10·44s.	881 0 8
Village and suburban, by licensed surveyors (costs not available)	90	..	..
Town	544 (in 974 sections)	26·54s. per section	1,292 13 6
Native Land Court, by staff	51,862	13·4d.	2,897 1 2
Native Land Court, by licensed surveyors	261,150	13·64d.	14,847 15 4
Native Land Court, by licensed surveyors (costs not available)	127,572	..	..
Maori Land Board	31,897	29·26d.	3,889 8 6
Gold-mining, by staff	..	..	..
Gold-mining, by licensed surveyors	1,752	4·41s.	386 6 9
Gold-mining, by licensed surveyors (costs not available)	1,257	..	..
Roads and railways	338 miles	£20·48 per mile.	6,928 19 5

TRIANGULATION.

The area returned this year, of 434,731 acres, made up of 430,031 acres by staff and 4,700 acres by contract surveyors, is greater than usual, but was found necessary to properly govern the large extent of settlement surveys. The work returned for the North Island amounted to 252,550 acres, Auckland contributing 86,400 acres, Taranaki 30,150 acres, and Wellington 136,000 acres; the South Island returned 182,181 acres, of which Nelson contributed 170,620 acres, Westland 10,000 acres, and Southland 1,561 acres.

In connection with the laying-down of suitable base-lines for the purpose, as stated in previous reports, of controlling and bringing into harmony groups of uncontrolled minor work, with their different standards of length, &c., I am pleased to be able to state that the Eltham-Okaiawa base-line, about 10 miles in length, which necessitated a total chainage of 39·8 miles, has been completed by Mr. Langmuir, Inspector of Surveys, in whose hands the work has been thoroughly and accurately dealt with. The preliminary work of putting in the end and intermediate blocks and tubes, together with the preparation and ranging of this base-line, was carried out by Mr. T. G. Sole, of New Plymouth, with very great care and exactitude. Bases have also been measured in the Wairarapa District, Wellington; at Eltham, in Taranaki; and at Matamata, in Auckland; while others will be measured as opportunity offers.

STANDARD SURVEY.

The work under this head in the Auckland District remains under the supervision of Mr. J. Langmuir, Inspector of Surveys, who has Mr. H. M. Kensington, District Surveyor, associated with him. During the year the standard surveys of the City of Auckland have been proceeding satisfactorily. Seventeen plans have been completed with tracings in duplicate, and these have been submitted to the Auckland County Council for approval of the proposed alignments. Of a total of forty plans required,

twenty-three have been completed, leaving seventeen to finish with their tracings in duplicate, which it is estimated will take another six or seven months. Mr. H. M. Kensington, District Surveyor, who has been engaged on the final work of the Rotorua standard survey and on the alignment survey of Takapuna, reports the chainage of 17 miles in connection with the first-mentioned and 8 miles in connection with the latter survey. These surveys, requiring as they do such great care and attention to details, have been carried out by Mr. H. M. Kensington with such excellent results as to reflect the highest possible credit to him. He has also prepared the plans of both these surveys. Besides the work already mentioned, his services have been required in connection with the standard surveys of the City of Auckland and the Borough of Parnell. In these surveys, as in those of Rotorua and Takapuna, the reinstating and fixing of many standard blocks was found necessary, owing to their having been disturbed by street alterations. Office-work in this class of survey has also claimed a large share of his attention. He is now engaged on the standard survey of the Borough of Parnell.

Mr. J. D. Climie, Inspector of Surveys, has completed the Hutt - Emerald Hill standard traverse, 9 miles in length, with excellent results. This survey necessitated the fixing of forty new concrete blocks. Standard traverses were also made by him at Hastings and Waipukurau, and these, along with the other standard survey, which will prove of very great convenience for future surveys, entailed a very large amount of extra detail work, and this has been carried out with great care and skill.

The standard survey of the City of Dunedin was commenced this year by Mr. W. T. Neill, District Surveyor, who reports that 36 miles of street have been traversed and numerous blocks inserted. Good progress has been made, and I look forward to its completion in first-class style and at a reasonable cost.

Settlement Survey.

Under the respective headings of "Rural" and "Village and Suburban," the surveys of 334,715 acres and 1,844 acres have been completed during the year, and if the subdivisions of Native lands under the Maori Land Board for the purpose of leasing to the public, comprising 31,897 acres, be added, the surveys executed for settlement purposes total 368,456 acres, divided into their respective districts thus: Auckland, 70,664 acres of sectionized Crown land and 7,016 acres of Maori Land Board subdivisions; Hawke's Bay, 55,474 acres of Crown land and 3,887 acres of Maori Land Board subdivisions; Taranaki, 8,839 acres of Crown land and 18,306 acres of Maori Land Board subdivisions; Wellington, 48,591 acres of Crown land and 2,688 acres of Maori Land Board subdivisions; Nelson, 61,228 acres of Crown land; Marlborough, 44,015 acres of Crown land; while the remaining districts contribute 47,748 acres of Crown lands. In addition to the above might be mentioned the provisional survey of an area of 32,502 acres for Maori Land Board in the Auckland District.

The area of settlement surveys, &c., in the hands of the staff surveyors at the close of the year was 690,518 acres, contract surveyors 54,135 acres, or a total of 744,653 acres, exclusive of an area of 122 acres of town subdivisions. Out of this total an area of about 82,000 acres has been completed in the field, but the plans have not yet been sent in.

Native-land Survey.

An area of 472,481 acres was surveyed during the year, comprising 440,584 acres of Native Land Court and 31,897 acres of Maori Land Board surveys, which, with the exception of an area of 566 acres, are distributed in the four North Island districts of Auckland, Hawke's Bay, Taranaki, and Wellington. Of the 440,584 acres for Native Land Court work, an area of 51,862 acres was completed by the staff surveyors and 388,722 acres by licensed surveyors, of which 127,572 acres were paid for by the Native owners. Of the Maori Land Board surveys of 31,897 acres, an area of 11,807 acres was completed by staff surveyors and 20,090 acres by licensed surveyors. Apart from the total of 472,481 acres, the undermentioned provisional surveys were made by staff surveyors, viz.: 32,502 acres for Maori Land Board, in which roads were graded and subdivisions schemed out preparatory to surveys being let to contract surveyors, and a compass survey of 17,430 acres for Native Land Court.

The surveys contemplated to be put in hand and those actually in progress reach a total of 629,870 acres. Out of this total, 207,050 acres will be surveyed by staff surveyors, comprising 133,007 acres for Native Land Court, 79,343 acres for Maori Land Board, and 14,700 acres for landless Natives in the Southland District; while the balance of 422,820 acres will be in the hands of licensed surveyors, comprising 352,807 acres for Native Land Court and 70,013 acres for Maori Land Board.

Gold-mining Survey.

During the year 3,009 acres (in 56 claims) were surveyed. Of this total 1,752 acres (in 23 claims) were completed in the Auckland District by contract surveyors, at a cost of 4·41s. per acre; the balance of 1,257 acres (in 33 claims), distributed in Auckland, Nelson, Otago, and Southland Districts, being completed by licensed surveyors, the costs of which were paid for privately. The claims were distributed thus: Auckland, 26; Nelson, 5; Otago, 23; Southland, 2.

Inspections.

During the year the system of inspection has been thoroughly carried out, though not quite as generally as could have been wished, owing to the Inspectors having been so much engaged in pressing work, such as city and other standard surveys, &c.; still, enough has been done to show that the work, with a few exceptions, is highly satisfactory. When the large number of surveyors engaged is considered it is not unnatural to expect that one or two may lapse into such a state of carelessness that causes action to be taken whereby others may be prevented from falling into the same error. In this connection the Surveyors Board in their suspension during the year of one license will doubtless act as a deterrent to others whose work may fall so far behind the proper standard of efficiency.

In the Auckland District Mr. W. J. Wheeler, Inspecting Surveyor, has been kept very busy, and reports a marked improvement in quality of the work in most of the surveys inspected. Owing to the transfer of Mr. Haszard to Canterbury, the southern portion of the Auckland District has been without an Inspecting Surveyor, and this has necessitated, when opportunity offered, utilizing the services of several of the staff surveyors for the purpose. It was also found necessary, owing to special circumstances requiring it, to send Mr. J. D. Climie, Inspector of Surveys, to make inspections at Kawau Island and Taupo.

For that portion of the North Island south of the Auckland District, Mr. J. D. Climie, Inspector of Surveys, has been kept very actively employed, at times his duties having carried him into the Auckland District as shown above, also into the Taranaki, Nelson, and Hawke's Bay Districts. He reports having made twenty-three inspections during the year—viz., eleven land Transfer Surveys and one road survey in the Wellington District; three in the Hawke's Bay District; five staff surveys in the Nelson District; and three staff surveys in the Taranaki District. These gave satisfactory results. Eleven inspections were made by Messrs. G. H. Bullard, Inspecting Surveyor, and T. Brook, District Surveyor; these were found to be up to the required standard, with the exception of two which have been returned to the surveyor for amendment. Four inspections were made by staff surveyors in the Nelson District. The inspections in the Westland District, with the exception of that of one private surveyor, gave very satisfactory results. Only three formal inspections were made in the Canterbury District, owing to the urgent work required on pastoral-run and settlement survey work.

Tidal Survey.

The work of this survey has consisted in the analysis, by means of the tidal abacus of Sir G. H. Darwin, K.C.B., F.R.S., of the Wellington self-registering tide-gauge records for the year 1909, and the prediction of the tides for Wellington for the year 1912. The results of the predictions are furnished to the Marine Department for transmission to the Hydrographer to the Admiralty, and will be published in the "British Admiralty Tide Tables"; and they will also be published by the Marine Department in the "New Zealand Nautical Almanac" for 1912.

As in the previous year, much care has been necessary to overcome initial difficulties and to arrange the various processes in the best way so that all results may be checked, and a number of improvements, which experience has proved desirable, will be introduced in the coming year.

Operations for 1911–12.

The new year commenced with a field staff of seventy-four surveyors, who have a very large amount of work on hand and in actual progress. This, as is always the case, will be largely added to from time to time. There is also the prospect of further purchases under the Land for Settlements Act and by the Native Land Purchase Board, as well as heavy calls for the survey of Native land in connection with Native Land Boards, and these, coupled with miscellaneous work, will, I am sure, keep the surveyors more than fully occupied during the year.

The principal classes and area of work on hand at the beginning of the year, together with the number of surveyors employed, will be found in Table 2, and is summarized as follows: Triangulation, 3,270 square miles; settlement, 690,518 acres; town, 122 acres; Native-land surveys, 207,050 acres; roads, 192 miles. Those areas coming under the heading of "settlement," "town," and "Native-land survey," and which may be classed as subdivisional surveys, give a total of 897,690 acres. This large area, however, does not represent all new work, for the survey of some 120,000 acres has been completed in the field, the mapping of which has yet to be done.

Of the foregoing areas the Auckland staff has an area of 268,398 acres of settlement lands, 32,000 acres of which has been completed in the field, besides Native-land surveys of 125,841 acres. In addition to this, a total of some 116,000 acres spread over the district and representing Crown and national-endowment land is anticipated to be surveyed for selection, which is more than ample to keep the staff as well as contract surveyors fully employed.

In the Hawke's Bay District the staff has in hand 95,650 acres of settlement land and 41,580 acres of Native land, comprising 13,480 acres for Maori Land Board and 28,100 acres for Native Land Court. Of the Native Land Court area, 23,000 acres has been completed in the field. In addition to the foregoing areas, there will be the subdivision of the Manawaangiangi Block, of 12,000 acres lately purchased by the Crown through the Native Land Purchase Board.

The Taranaki staff has in hand 113,550 acres of settlement land—9,500 acres of which is completed in the field—besides 2,866 acres of Native surveys.

In the Wellington District the area in hand for settlement amounts to 69,724 acres, of which 4,406 acres is completed in the field. The Native surveys total to 21,920 acres, comprising 14,850 acres for Maori Land Board and 7,070 acres for Native Land Court, 875 acres of which is completed in the field.

The staff of the Nelson District has 62,570 acres of settlement work in hand, 10,000 acres of which has been completed in the field. In addition to this it is proposed to put in hand some 33,000 acres, which, with the survey of applications for selections received, as well as the necessary triangulation and other current work, will be sufficient to keep both staff and contract surveyors busy for the coming year.

The Marlborough District, with 11,900 acres of settlement land, 7,950 acres of which is completed in the field, 143 acres of Native and 31 miles of road surveys, will have also ample work in hand.

Westland has in hand 20,066 acres of settlement surveys, of which some 5,000 acres has been completed in the field. There is also a necessity for some extension of standard-survey work in the principal towns of this district.

The Canterbury District has in hand some 3,000 acres of settlement land. In addition to this there will be the subdivision of an area of about 106,000 acres, comprising the Sherwood Downs land, of 56,500 acres, lately acquired under the Land for Settlements Act, and 49,870 acres of pastoral land to be offered as small grazing-runs at the end of the coming year. There will also be the survey of the Glynn Wye freehold—about 7,000 acres—as also the road through same. In order to cope with the above-mentioned survey the staff will need some further assistance.

The Otago staff has on hand 32,400 acres of settlement surveys, 15,000 acres of which is completed in the field.

Southland has in hand 13,144 acres of settlement land, 700 acres of which is nearly completed in the field; and the subdivision of 14,700 acres for landless Natives, situated in the Forest Hill, Waimumu, and Lindhurst Survey Districts.

In addition to this there will be some 18,000 acres to survey, inclusive of a block of some 5,400 acres recently acquired by the School Commissioners and now administered by the Lands Department, besides that of miscellaneous surveys.

In addition to what has been outlined above there will be the extension of the secondary and probably some additional minor triangulation to be undertaken during the year in various districts. The proposed operations for the coming year will be found fully detailed in the reports of the respective Chief Surveyors in Appendix I.

Surveyors Board.

In connection with the Surveyors Board, Mr. T. Humphries and myself attended the Conference of Surveyors Boards at Hobart in January last. In an appendix will be found an outline of the general work of the Surveyors Board for the past year.

Magnetic Observatory.

Throughout the year the work has been carefully attended to by Mr. Skey and his assistant Mr. Maben. The Adie magnetographs and the Milne seismograph have worked very satisfactorily, the latter showing seventy-four quakes, the records of some of which are reproduced and shown in connection with Mr. Skey's annual report. When time permitted further progress was made with the reduction to epoch of field observations.

The Magnetic Observer's report makes interesting reference to the visits to the Observatory of Dr. Bauer, Director of the Magnetic Department of the Carnegie Institute; of Captain Scott's second polar expedition to the Antarctic; and also to that of Lieutenant Pennell, R.N., in connection with the determination of magnetic force and inclination. The report also incidentally refers to interruptions occasionally caused to the observatory work through the running of the Christchurch electric tramways.

A daily record has been kept of the meteorological changes, &c.; various other matters of interest are also referred to; and, altogether, Mr. Skey's report, with annexed diagrams and tables, is well worthy of perusal.

Transit of Halley's Comet.

On my invitation a number of former high officers in the Lands and Survey Department assembled near the Observatory in the Botanical Gardens, Wellington, to observe the transit of Halley's Comet across the sun's disc on Thursday, 19th May, 1910. The observing party comprised Messrs. J. McKerrow, J. W. A. Marchant, and T. Humphries, all former Surveyors-General; Mr. A. Barron, formerly Assistant Surveyor-General; Mr. C. W. Adams, a former Chief Surveyor; and myself; while Messrs. W. G. Rutherford, Chief Draughtsman, Public Works Department, and Mr. C. E. Adams, Chief Computer in the Lands and Survey Department, had charge of the photographic operations. Although careful observations were made with four telescopes, no certain sign of the comet could be detected on the sun's disc. Photographs of the sun were taken at intervals of five minutes from 2 p.m. to 2.55 p.m. (New Zealand mean time), when clouds stopped further exposures. A close examination of the photographs did not, however, disclose any trace of the comet.

Departmental Changes.

Consequent on the promotion of Mr. F. W. Flanagan, Commissioner of Crown Lands, Canterbury, to the position of Valuer-General, the following promotions, transfers, &c., were made in the Survey Branch of the Department during the year: T. N. Brodrick, Chief Surveyor, Hawke's Bay, to be Chief Surveyor, Canterbury; C. R. Pollen, Chief Draughtsman, Auckland, to be Chief Surveyor, Hawke's Bay; H. D. McKellar, Land Transfer Draughtsman, Auckland, to be Chief Draughtsman, Auckland, while T. K. Thompson was promoted to that of Land Transfer Draughtsman in his place; D. W. Gillies, Chief Draughtsman, Nelson, to be a District Surveyor, Auckland; F. E. Greenfield, Draughtsman and Surveyor, Blenheim, to be Chief Draughtsman, Nelson; Assistant Surveyor O. N. Campbell, transferred from Wellington to Auckland; J. G. Wilson, Draughtsman and Surveyor, Marlborough, to Land Transfer Branch, Canterbury; Miss Montgomerie, Draughtswoman, Westland, to Auckland. Messrs. C. A. Mountfort, District Surveyor, and H. E. Girdlestone, Assistant Surveyor, of the Wellington Staff, have been attached to the Head Office staff for the purpose of carrying out the standard and triangulation surveys respectively.

The following resigned their positions during the year: Assistant Surveyors J. C. Young and T. A. Johnston.

It is with great regret that the Department has to chronicle the loss by death, on the 14th March, after a very short and painful illness, of Mr. George Paterson Wilson, Draughtsman of the Head Office staff. He was one of the oldest as well as one of the ablest draughtsmen in the service; of a retiring and kindly disposition, and one who took a great interest in his work and that of the Department. It can also justly be said that he was a faithful servant, and who was found at his post to the last.

Mr. H. McCardell, Acting Chief Draughtsman at the Head Office, reports as follows for the year 1910–11:—

One of the principal works of the year was the preparation of the Census Enumerators' districts for the Dominion. This took up the time of practically the whole of the staff for over three months. The information shown on the maps supplied contained the counties, boroughs, town districts, ridings of counties, road districts, electoral districts, harbour districts, mining districts, and provincial districts. There were fifty-eight districts in all, and duplicate copies of each were made.

New additions of the following survey districts were issued during the year: Corwar, Puhipuhi, Whernside, Onamalutu, Spaxton, Tennyson, Aria, Ohura, Mahoe, Tangitu, Rangi, Cairnhill, Ohika, Jacobs River Hundred, Moutere, Forest Hill Hundred, Table Hill, and Awamoko.

The following plans were drawn for photo-lithography: Taumarunui Borough; sheet 4, Auckland, revised and brought up to date; Hawke's Bay, Taranaki, and Wellington, as revised by the local offices, were published on both the 4-mile and 8-mile scales.

Land-tenure maps of the following counties were prepared for the Hamilton Survey Office: Coromandel, Thames, Piako, and Matamata.

Twenty-five registration districts were prepared for the Registrar-General.

During the year 202 townships (Government and private) were examined, reported on, and, when satisfactory, recommended for the approval of His Excellency the Governor under section 16 of the Land Act, 1908.

Maps of the following counties were published, viz.: Bay of Islands, Opotiki, Waitomo, Westland (three sheets), Takaka, Clifton, part of Piako and Whakatane, as well as those of the towns of Marton, Hastings, and Tauranga.

Among other duties performed by the draughtsmen there were 181 descriptions made; measuring-bands tested, one 7-chain, three 6-chain, three 5-chain, and four 1-chain; ten Proclamations were prepared and gazetted under the New Zealand State-guaranteed Advances, Act, 1909; ten Proclamations were prepared and gazetted under the New Zealand State-guaranteed Advances Act, 1909, as amended by section 22 of the New Zealand State-guaranteed Advances Amendment Act, 1910; nine licenses were prepared and issued to surveyors, enabling them to practise under the Land Transfer Act, 1908.

Thirty-two schedules for the Local Bills Committee of the House of Representatives were examined and certified to.

Good progress has been made with the map of the City of Wellington and Suburbs mentioned last year, and the completion may be looked for at no distant date.

Sheet 5, Auckland, is being brought up to date, and a new map of the Nelson District is in progress.

During the coming year responsible duties will have to be carried out by draughtsmen in connection with the preparation of maps for the Representation Commissions for the readjustment of the boundaries of the electoral districts of the Dominion. This will entail an immense amount of work, as seventy-six popular descriptions of proposed electorates will have to be prepared, and subsequently seventy-six detailed descriptions defining in technical terms the boundaries of the electoral districts as finally determined by the Commissioners. In addition to this, maps on a 16-mile scale will have to be prepared and published, and three sets of large-scale maps—one for the Clerk of Parliaments, one for the Chief Electoral Officer, and one for the Head Office—will have to be prepared.

I have again to thank all the officers for their assistance given me during the year.

Mr. C. E. Adams, Chief Computer, reports:—

Triangulation.—Horizontal and vertical angles have been observed at trigonometrical stations—Bull Hill, Mount Dundas, Mount Holdsworth, and Rangitumau, in the Wellington district—by Mr. H. E. Girdlestone, using a 10-in. vernier Everest theodolite. The angles have been checked and made ready for calculation. The probable errors of the various sections of the Eltham–Okaiawa base-line and of the whole base have been checked.

Tidal Survey.—The Wellington tidal records have been harmonically analysed for the year 1909, and the tides predicted for the year 1912. The tide-tables have been supplied to the Marine Department for publication in the "New Zealand Nautical Almanac," and to the Hydrographer to the Admiralty for publication in the "British Admiralty Tide Tables." A full description of the met hodsand processes adopted is given in Appendix V. Mr. T. G. Gillespie and Mr. J. J. Hay have assisted in carrying out these calculations in a satisfactory manner.

APPENDICES.

APPENDIX I.—SURVEYS.

AUCKLAND.

Surveys.—The gross area of all classes of surveys completed this year by staff and private surveyors was 446,964 acres, together with 379 miles of roads, &c., being an increase of 185,632 acres and 119 miles over last year's totals.

Minor Triangulation.—86,400 acres minor triangulation and connecting triangles, East Taupo, Rotorua, Mangonui, and Hokianga Counties, at a cost of ½d. per acre. The total area surveyed by staff surveyors was 81,700 acres, costing ½d. per acre; while the area by contract surveyors was 4,700 acres, costing 1½d. per acre.

Topographical Survey for Selection.—Provisional surveys under this heading include 16,593 acres Crown land, 12,000 acres of which is to be opened as unsurveyed; 32,502 acres of Native land for Maori Land Board; roads graded and scheme of subdivisions prepared, the surveys to be let to contract surveyors; and 17,430 acres of compass survey for the Native Land Court; the total being 66,525 acres, costing 5d. per acre.

Rural.—Total of 70,257 acres surveyed—51,219 acres by staff, at 2·8s. per acre; 12,039 by private surveyors, at 1·7s. per acre; and 6,999 by private surveyors, the cost of which is not available. The closures of work executed by the staff show very good results, the total being 164 closures for 470 miles, at a mean error per mile on meridian of 0·55 links and perpendicular 0·46 links.

Village and Suburban.—Total of 407 acres, in 170 sections—269 in 54 sections by staff, at 9·8s. per acre; 48 in 60 sections by private surveyors, at 39·2s. per acre; and 90 acres in 56 sections by private surveyors, cost of which is not available.

Town Section Survey.—174 acres into 460 sections, costing 22·8s. per section, exclusive of ½ acre by contract surveyor.

Native-land Survey.—Total area of Native land surveyed was 299,004 acres, into 704 subdivisions. The staff surveyors completed 48,810 acres in 196 subdivisions, at a cost of 15·4d. per acre, of which 43,578 acres in 179 subdivisions was for Native Land Court, and 5,232 acres in 17 subdivisions was for Maori Land Board. Private surveyors completed 250,194 acres in 508 subdivisions, of which 225,802 acres in 426 subdivisions, inclusive of an area of 1,784 acres for Maori Land Board, cost 8·1d. per acre, and the balance of 24,392 acres in 82 subdivisions, the cost of which is not available.

Gold-mining Survey.—Twenty-six claims surveyed, representing a total of 1,868 acres.

Roads, &c.—The staff surveyed 181 miles, at £21·76 per mile; private surveyors 6 miles, the cost of which is not available.

Other Work.—This comprises a great variety of work—viz., survey of school-sites, repairs to trig. stations, redefining old boundaries, exploration, reports on Crown lands, &c.

Inspections.—Thirty-two inspections of contract surveys and two of staff by Mr. Wheeler, and one each of contract surveys by Messrs. Edgecumbe, Blake, and Barlow. Mr. Wheeler reports that, with the exception of two surveyors, the work inspected has come well within the regulation limits, and there has been a marked improvement in the general execution of most of the surveys inspected; but there are still a number of surveyors who neglect the numbering of pegs properly, which causes much loss of time and uncertainty both to the survey profession and the general public.

Contract Survey.—Surveyors have on hand 20,923 acres of Crown land, the cost of which has been deposited; and also 344,717 acres of Native land.

Office-work.—Plans examined: 116 plans of 529 Crown sections, total area 51,159 acres; 31 mining plans, totalling 2,055 acres; 42 residence-sites (for Warden), 84 sections, 26 acres; 7 plans showing the route of electric transmission-line for Waihi Gold-mining Company; 102 Native Land Court plans, of 366 subdivisions, totalling 166,513 acres; 477 Land Transfer plans, area 75,274 acres, in 4,076 allotments; 272 plans taking and closing roads, totalling 379 miles; taking 52 acres of land for railway purposes, and proclaiming 1,458 acres reserves for various purposes: the total number of plans of all classes checked being 1,047. There were 1,443 tracings, &c., made for posters, surveyors, selectors, and others. Three Native Land Courts were attended, and £89 18s. 10d. on three blocks collected at the Courts: total amount for liens collected during the year, £1,038 12s. 8d. Fourteen charging orders were obtained for £306 3s., and 190 acres 3 roods 12 perches (valued at £319 4s. 2d.) were cut off to satisfy liens on nine blocks. 219 applications for financial authority were forwarded to Head Office, and 231 authorities to survey were issued, equalling 298,854 acres, at an estimated cost of £19,375 6s. 10d., to private surveyors, and 23,417 acres to staff surveyors. Nine candidates were examined for surveyors' unlicensed assistants. 322 chain-lengths of surveyors' steel tapes were tested, and certificates issued. There were applications to Head Office for Government loans of a total amount of £14,819 over 34,095 acres. 3,209 plans were indorsed on certificates of titles, leases, and Native Land Court orders, &c. 2,289 plans were indorsed by Mr. A. B. Harding, of the Land Transfer Office. Fees collected, £246 6s. 3d.

Proposed Operations, 1911–12.—Twenty-six surveyors—eighteen staff and eight temporary—have on hand 268,398 acres of Crown land; 125,841 acres of Native land, of which 51,013 acres is for Maori Land Board and survey of roads through Native lands to give access to Crown lands. In addition to

the above total, the larger areas of Crown land proposed to be surveyed for selection are situated as follows: Opotiki County, 10,257 acres; West Taupo County, 26,550 acres; Raglan County, 11,982 acres; Hokianga County, 12,031 acres, including 4,022 acres national endowment; Waitomo County, 6,639 acres; Awakino County, 7,064 acres; Whangarei County, 4,900 acres; Bay of Islands County, 11,333 acres, including 4,023 acres national endowment; East Taupo County, 10,600 acres, including 8,000 acres national endowment; Rotorua County, 14,262 acres.

Accounts.—The Accountant reports that the number of vouchers passed through the books during the year amounted to 2,239, representing an expenditure of £54,050 8s. 9d. On his Imprest Account 1,634 vouchers requiring payment were made by 2,207 cheques, totalling £23,714 4s. 6d., and the amount imprested by the Paymaster-General was £23,800. On his Official Account 927 cheques were issued for the sum of £13,975 14s. 3d. The average number of men on survey parties requiring payment was ninety-one per month, and on timber parties four. The amount collected for survey liens during the year amounted to £1,038 12s. 8d.

Transfers, &c.—Mr. C. R. Pollen, Chief Draughtsman, was appointed Chief Surveyor and Commissioner of Crown Lands at Napier as from the 1st August, his place being filled by Mr. H. D. McKellar, promoted from Land Transfer Draughtsman, and Mr. T. K. Thompson appointed Land Transfer Draughtsman on same date. Mr. J. H. O'Donnell, Receiver of Land Revenue at Napier, was appointed to the same position here on the 1st April, *vice* Mr. T. M. Taylor, who retired last year. The field staff was increased by four surveyors. One transferred from the Public Works Department, one each from other districts, and one assistant surveyor appointed. Twelve draughtsmen were added to the office staff by new appointments and transfers from other districts, and two left on transfer to other districts and branch offices, making a net addition of ten. An exchange of typists was arranged with Nelson, and one clerical cadet was appointed and one clerk resigned. Under the Kauri-gum Act, 1910, six Rangers were appointed during the year.

Conclusion.—Work in all branches shows a steady increase, and my thanks are due to the various officers of the field and office staff for the able manner in which they have carried out their several duties.

ERIC C. GOLD SMITH,
Chief Surveyor.

HAWKE'S BAY.

Minor Triangulation.—No work of this nature has been executed during the year.

Rural.—The survey of 55,474 acres, comprising 125 sections, has been completed at an average cost of 2·21s. per acre. The greater part of this was work done in the previous season, the plans of which were not completed till this year, and comprises Clydebank and Tongoio Settlements, Pastoral Run 47, Ngatapa, Huiarua Block, part of Ruahine Forest Reserve, and Tamaki No. 4 Block.

Native-land Survey.—11,341 acres in 73 subdivisions have been completed during the year, comprising 10,822 acres, by staff surveyors—inclusive of an area of 3,887 acres for the Maori Land Boards, and 519 acres by contract surveyors. Apart from these there were 43,722 acres completed by private surveyors.

Other Work.—This includes miscellaneous surveys, inspections, and reports.

Inspections.—Eleven inspections have been made during the year by Messrs. Bullard and Brook, District Surveyors. Most of the surveys were found up to the required standard, with the exception of two, which have been returned to the surveyor for amendment.

Roads, &c.—Forty-nine miles have been surveyed, at a cost of £18·46 per mile.

Traverse Closures.—The staff surveyors' traverse closures vary from 0·23 of a link to 1·7 of a link on meridian, and 0·28 of a link to 1·62 links on perpendicular, per mile.

Proposed Operations, 1911–12.—Mr. Brook will complete survey of Omahu No. 2 and Tongoio South Blocks, and will be available for other surveys that may be required for settlement, the Native lands and the Maori Land Board; he will also make field inspections. Mr. Roddick will complete the survey of the Upper Motu Block, 4,600 acres, and be available for Tahora Block of 48,000 acres. Mr. Farnie will complete the survey of the Marangairoa, Pariwhero, and Tangakaka Blocks, 25,600 acres, for the Native Land Court, and report on roading a number of Native blocks on the east coast. Mr. Walshe will complete the survey of the Pohokura Block, 40,000 acres, as also an area of 150 acres at Pohui. Mr. Cagney will complete the survey of the Tutaekuri No. 1 Block, 12,500 acres, for Maori Land Board, and be available for other surveys in that locality. Mr. Ward will complete the survey of Pastoral Run 48, 2,900 acres, and the roads, and commence the survey of the Crown lands, 48,000 acres, in Tahora Block. These areas represent a total of 95,650 acres of settlement land and 41,580 acres of Native land. Besides these there will also be the subdivision of the Manawaangiangi Block, 12,000 acres, lately acquired by the Crown, but which has not so far been allotted to any surveyor.

Office-work.—The Chief Draughtsman reports that 557 plans have been examined and approved (an increase of 179 on previous year), representing an area of 187,874 acres. These divided up in their several classes are as follows: 349 Land Transfer—1,875 lots, 80,974 acres; 90 Native Land Court—551 lots, 84,188 acres; 86 Public Works plans—525 lots, 1,763 acres; and 32 Departmental plans—102 lots, 20,949 acres. In addition to these, 717 instruments of title, such as transfers, leases, mortgages, &c., have been examined and reported on; 600 tracings have been prepared for surveyors, settlers, local bodies, and other Departments; 17 tracings for photo-lithography prepared, including the Borough of Gisborne and suburbs.

Transfers.—Mr. Brodrick, Commissioner of Crown Lands and Chief Surveyor, was transferred to Christchurch in August, and I was promoted from Auckland to succeed him in Napier.

In conclusion, I beg to thank the staff for their co-operation and assistance.

C. R. POLLEN,
Chief Surveyor.

TARANAKI.

Surveys.—The gross area surveyed during the year under the various headings by staff and contract surveyors totals 57,666 acres, and 17·04 miles of roads.

Triangulation.—An area of 30,150 acres has been completed, and the preparation for measurement of a ten-mile base in the Ngaire-Waimate Survey Districts has been carried out by Mr. T. G. Sole.

Rural.—A total of 8,839 acres under this head has been completed, in 40 sections, all of which is situated in rough forest country.

Town Section Survey.—An area of 3 acres, comprising 12 lots, in the Tangitu Township was surveyed, and 20 acres in the Huirangi and Mataitawa Townships were repegged.

Maori Land Board Subdivisions.—Three contract surveyors were employed upon the subdivision of Native lands brought under the jurisdiction of the Maori Land Board, resulting in a return of 18,306 acres in 42 sections. All these lands are situated in the Counties of Ohura and Waitomo.

Native Land Court Survey.—One small survey of 348 acres was completed by Mr. District Surveyor Wilson, and thirty-one authorities were issued during the year under the Native Land Act, 1909, to private authorized surveyors, for survey of Native land, covering 76 subdivisions, of a gross area of 56,502 acres, at an estimated cost of £4,811. Of these, 7 authorities, covering 19 subdivisions, of a total area of 7,525 acres, have been completed and plans deposited. Of authorities issued prior to 1st April, 1910, under the Native Land Court Act, 1894, eight plans, covering an area of 10,933 acres, in 10 blocks, have been received and approved during the year.

Roads, &c.—In this class, 17·04 miles were completed, at a cost of £375 14s. 6d., or £22·05 per mile.

Inspections.—The usual inspections have been carried out over survey-work in progress, and a special inspection was made over Messrs. Wilson, Richmond, and Grigor's surveys by Mr. J. D. Climie, Inspector of Surveys.

Other Work.—The expenditure under this head amounts to £190 9s., made up of cost of inspections over road, contract, and Land Transfer surveys, inspections and reporting *re* subdivision of Wanganui River Trust land, and general miscellaneous field-work.

Office-work: *Examination of Plans.*—The total number of plans checked under all heads in the ordinary Survey Branch was 127, with 312 traverse sheets: these covered 361 sections, of a total area of 99,574 acres, and 35 miles 32 chains of roads taken or closed. Settlement surveys of Crown lands were represented by 15 plans, containing 99 subdivisions, of a total area of 24,437 acres. Subdivisional surveys under contract for Maori Land Board, 6 plans, with 32 subdivisions, totalling 12,105 acres; 2 trigonometrical plans, covering 30,150 acres; 36 plans defining 35 miles 32 chains of roads taken and closed; 40 Native Land Court plans, of 27,424 acres, in 35 subdivisions; 10 miscellaneous plans, of 22 subdivisions, containing 422 acres; 12 office compilations, of 4,664 acres, and 109 sections; and 5 township plans, of 24 acres, in 63 sections.

Land Transfer.—116 plans, with 164 traverse sheets, were checked and approved, covering 391 sections and subdivisions, of an area of 9,347 acres.

Titles.—The plans placed on instruments of title of all kinds were 1,683, and 299 copies of leases and licenses were prepared.

Compilations.—For photo-lithography, 13 drawings and tracings were prepared, and 16 new block-sheets were compiled.

Miscellaneous.—The usual demands made on the office staff were attended to, comprising the supplying of information to the general public, data to the staff for execution of surveys, information for local bodies and for other Departments, &c. For the Valuer-General 120 tracings were prepared, and 73 for selectors. All recording on block-sheets, record, reserve, index, and other maps has been kept up to date. There were 31 applications for authority to survey Native blocks received and dealt with during the year.

Proposed Operations for 1911–12.—A staff of three permanent surveyors, with cadet, and two temporary surveyors and one licensed assistant are at present engaged upon settlement work along the eastern and north-eastern boundaries of the district. The total area covered by these operations amounts to 104,050 acres, comprising 94,550 acres of new work in Mapara, Ohura, Rangi, Mahoe, Taurakawa, Omara, and Momahaki (Wellington) Survey Districts, and 9,500 acres final survey over provisional work in the Tangitu Survey District. In addition to the above, a partial survey has been made over an area of 13,000 acres in the Mimi and Waro Survey Districts. This work is at present suspended for the more urgent demands of settlement in the Wanganui Valley.

Of the totals given above, 104,050 acres is made up of ordinary Crown lands, and 13,000 acres is national endowment.

In conclusion, I desire to thank all the officers, both field and office staff, for their active assistance and co-operation during the year.

FRANCIS SIMPSON,
Chief Surveyor.

WELLINGTON.

Secondary Triangulation.—Mr. Mountfort, who took over this work from Mr. Lowe, handed it on to Mr. Girdlestone in order to proceed with a much-wanted revision on the minor triangulation around Wellington. Mr. Girdlestone is now engaged, under the direction of the Surveyor-General, in completing observations at principal trigs, which will enable the revision and recomputation of the fundamental work of the whole of the district upon accurate data.

The triangulation executed by Mr. Mountfort around Port Nicholson combines into a homogeneous whole the standard surveys of Wellington City, Petone, Lower Hutt, and Hutt Valley and surrounding country, and provides an unimpeachable foundation for the subdivisional surveys spreading through

the environs of the City of Wellington and suburban lands. It also provides for the connection of the triangulation of the district from the new Tauherenikau base direct to the district zero and meridian; incidentally, also, a mysterious set of differences in the old work, amounting in the aggregate to many links, has been cleared up.

In this connection I might urge the importance of verifying the points marked upon the meridian of Mount Cook, of the accuracy of the present positions of which, within certain limits, there is now grave doubt. The triangulation now effected enables the accurate comparison of the meridians of Opaki South and Mount Cook, and it is found that the difference is less than a second of arc, subject to possible corrections.

Standard Survey.—These are now under the control of the Surveyor-General, and Mr. Mountfort has been detached from my staff to undertake an extension of the Wanganui work; while surveys of this kind in Karori Borough are also in contemplation.

Topographical Survey for Selection.—In this class the principal area is in the South Waimarino, where at first five, and latterly two, surveyors, with several assistants and cadets, have been at work; an area of 23,419 acres was made ready for selection, but awaits being placed on the market until the final surveys have been completed. Another area of 2,000 acres towards the head of the Pohangina River is in hand.

Rural.—The completion and final survey of last year's topographical surveys in South Waimarino is the principal item in this class, with a little scenery-preservation survey-work.

Town Section Survey.—This comprises a township in the Hutt Valley, and extension of existing townships on the Main Trunk line.

Native Land Court Survey.—As the Government has undertaken the prime cost of this work in order to facilitate the settlement of Native lands, several private surveyors have been authorized to undertake blocks for which the Judges have requisitioned surveys, and these appear in table 45. Two staff surveyors also have the same class of work in hand, and the total area of 39,736 acres therefore represents land which is coming into reproductive use.

Roads, &c.—There are no further railway surveys this year, and the length of roads, independently of those laid out in the course of subdivision, is very small, but a considerable length—some 25 miles—has been graded by a staff surveyor for private survey contract.

Other Work.—This heading includes the usual miscellaneous collection of small scattered surveys of cemetery, school, observatory, and other sites, boundary-pegging, reports, schemes, diagrams, inspections, *et hoc genus omne*, and there is yet a long string of similar surveys awaiting their turn.

Proposed Operations, 1911–12.—The settlement work for the coming year will be chiefly in the South Waimarino Block, where an area of 60,000 acres is in hand. There will be a considerable number of Native Land Court surveys, which will be principally done by licensed private surveyors. A fair amount of road, township, village, and small-settlement surveys will also be undertaken in various localities, and in addition to this there is a great accumulation of miscellaneous work all over the district, and I hope to put one or two surveyors on to this duty before starting their next season's permanent work.

Office-work.—The staff throughout the year has remained at a minimum strength, and it has been impossible to do more than cope with absolute daily necessities, and this at times with considerable difficulty. There are, however, so many grave problems involved in the condition of the permanent records and irreplaceable originals that the provision of two more draughtsmen and the training of two more field cadets will, I trust, enable a serious endeavour to be made to grapple with them in the coming year. There is much, too, that could be done in the multiplication of publications to diminish the difficulty of meeting the public demand for information and maps.

Examination of Plans.—The number of new plans received under all heads was 274, and 296 were approved, being 177 in the general computing branch, and 119 in the statutory plan branch. These two branches have a total of 70 plans on hand. The new plans in the general branch covered 64,556 acres Crown sectional, 67,973 acres Native surveys, 279 acres town surveys, and 216 acres Maori Land Board Surveys. In the statutory plan branch 101 plans passed through all stages, and a further 111 had been completed and sent away for proclamation. There is a class of plan in this branch of work which absorbs an altogether disproportionate and inordinate amount of time and effort—*i.e.*, plans of road-deviation entailing constant intersection of two roads. The cost of preparation and check of such plans merely for the eventual correction of title is so seriously out of proportion to the result as to be worth legislative action to curtail it.

Land Transfer Branch.—In this branch 259 plans were received and 221 approved, while 68 applications, 2,083 transfers, 185 leases, 255 mortgages, 111 Orders in Council, 79 Proclamations, 381 balance certificates, 9 caveats, and 108 other dealings were put through by the staff, and 5,173 plans were put on certificates of title.

Native Land Court Work.—The work in this branch is on the increase, due to the effect of the new Act tending to release Native land and render it available for settlement and use. Orders for 375 subdivisions, covering an area of 119,295 acres, were made out, while fresh surveys of 41,000 acres in 264 subdivisions were received, and surveys of a further 37,634 acres are actually in progress. Crown liens to an amount of £2,132 8s. were collected, and an area of 2,325 acres became Crown land in satisfaction of liens. A number of orders of all kinds, certificates, authorities, nominations, &c., were dealt with in the ordinary routine.

General Draughting Work.—The staff on this work had been kept very busy during the year, having been short-handed, and it has been impossible to do much permanent record or compilation work. The supply of data for surveys, tracings of completed transactions for departmental and extra-departmental record, for selectors and others, and duplicates of some classes of plan have formed the bulk of the work, but some 16 block tracings of old and perishing records have been made, while 12

tracings in lieu of block-sheets have been made as an expedient to take up the back work and preserve original working-plans. The work done includes 1,174 tracings of all kinds, 42 new plans made, and 12 new Crown-grant record maps. All surveys coming from the field have been recorded on the different standard maps.

Miscellaneous.—There was, of course, the usual volume of miscellaneous duties, which cannot be tabulated, in attendance on the public, correspondence, searches and supply of information from maps, &c.

Changes of Staff.—Assistant Surveyors O. N. Campbell and T. A. Johnston have left the staff of this district, the former transferred to the Auckland District and the latter proceeding to England to take up civil engineering. Messrs. C. A. Mountfort and H. E. Girdlestone have been attached to the Head Office staff on standard surveys and triangulation respectively.

I have again to acknowledge the assistance I have received from both the indoor and field staff, as well as all private surveyors whose work has come before me.

JAMES MACKENZIE,
Chief Surveyor.

NELSON.

Minor Triangulation.—The area returned of this class of work was an extension of the present system of triangulation to control sectional surveys in the Glenroy and Maruia Valleys, containing an area of 170,620 acres, at a cost of 1·49d. per acre. The whole of the triangulation down the Buller Valley and up the Maruia Valley has been recomputed by polygons, in terms of the Imperial standard, from a remeasurement of the Waimea base on to verification bases on the Braeburn Settlement and Maruia Plains. The closure on to the Maruia base showed a difference of 0·57 link per mile, and on to Braeburn 0·35 link per mile. Previously the triangulation from the Waimea base to the bases at Collingwood and West Haven had been recomputed by polygons, in terms of the Imperial standard, and also gave excellent results.

Standard Survey.—There is still the need of a revision of the standard survey of the City of Nelson, and very probably this work will be undertaken during this year, as the City Council have agreed to make a contribution towards its cost, and with this help the work will be put in hand. Owing to the more urgent surveys of selected areas being required, it has been impossible to undertake any standard traverses of the main roads to control the subdivisions of properties being brought under the Land Transfer Act. This work is of great importance, and becoming more necessary as time goes on.

Rural.—The staff surveyors have executed 52,132 acres at 2·31s. per acre, and contract surveyors 9,064 acres, at 2·22s. per acre. The work done by the staff compares favourably as regards cost with the contract work, and with three exceptions the work has been executed at a very low cost. Another contract of 5,000 acres has just been completed in the field, and three contracts have been let recently for a total area of 20,000 acres. The surveys of selected areas in the Inangahua County are being executed by Mr. Montgomerie by contract, and Mr. Snodgrass is making the surveys of a number of applications in the Buller County. These surveys are apparently being carried out in a satisfactory manner, but it is very essential that all the contract surveys should be subjected to field checks by an Inspecting Surveyor, and it is very difficult to spare the services of a staff surveyor, and my own time is too fully occupied to undertake the work. When these contracts are completed, with the work being done by the staff, the arrears of the surveys of selected areas will be within reasonable limits, and it will be possible to get the surveys of unselected Crown lands made and the blocks opened for settlement.

Inspections.—Mr. J. D. Climie, Inspector of Surveys, made inspections of the work of four staff surveyors with satisfactory results; and four insepctions have been made by staff surveyors.

Other Work.—This work consists chiefly of field inspections, reports, and minor surveys, which cannot be shown in the general return.

Roads, &c.—These roads were all laid off in short lengths, principally to give access to Crown lands or deviations from existing roads to improve the grades.

Mining Survey.—No surveys of this class were executed by staff surveyors, but five mining surveys, comprising 125 acres, were returned by contract surveyors. The fees for the payment of these surveys were deposited with the Wardens.

Land Transfer Office.—The Land Transfer Draughtsman reports that 94 plans were examined and approved, comprising 3,430 acres, and that 39 other plans were examined and returned for correction; 149 deeds were passed, and 185 certificates of title were made out in duplicate (370 diagrams).

Proposed Operations, 1911–12.—The contract survey for the completion of the trig. and subdivisional survey of D'Urville Island is nearly completed, and the work is now being inspected by a staff surveyor.

An area of 62,570 acres is in the hands of the staff surveyors, of which about 10,000 acres is completed in field. The unallotted applications number fifty-nine, and contain an area of 24,000 acres.

During the year I propose to have the survey of the Howard Block, 20,000 acres, the Matiri Extension Block, 8,000 acres, and the Waimea Block, 5,000 acres, put in hand. As it is proposed to open the Brighton Block, of 8,000 acres, and Mokihinui Valley Block, of 4,000 acres, for selection on pastoral license, the survey of applications received in these blocks, together with other current work, with work in hand and proposed as above, the staff and contract surveyors will be fully occupied.

Office-work.—During the year 92 sectional plans (embracing 78,890 acres), 18 road plans, 5 trigonometrical plans, and 20 miscellaneous plans, with an aggregate of 470 traverse sheets, were examined; 36 certificates of title in lieu of Crown grants were issued (in triplicate); 184 tracings

examined, 52 reports furnished, and 39 leases examined for warrants. Diagrams were drawn by contract on 64 Crown titles in quadruplicate, 79 in triplicate, 42 in duplicate, and 3 singly: total number of diagrams, 580.

Photo-lithographic tracings were executed of Takaka County, the Moutere, Ohika, and Hope Survey Districts, and the Borough of Westport. Tracings were also made for the purpose of publishing a four-mile map of the northern portion of this Island. A much-needed map of the Waimea County has been partly compiled for lithography, but is now in abeyance owing to there being no officer available to complete it. The same applies to the map of the Borough of Nelson. The preparation of tracings and data for surveyors, and tracings for the Valuation Department and for settlers and others, occupied a large amount of time.

A very large extent of the triangulation has been recomputed on the polygon system, and brought in terms of the Imperial standard. Several new selection maps are urgently required, but, owing to the stress of current work, cannot yet be undertaken. Maps on a 20-chain scale were prepared of Mokihinui, Kawatiri, Orikaka, Ngakawau, and Steeples Survey Districts for the Geological Survey Branch of the Mines Department. Maps for the Census Enumerators were also compiled.

Changes of Staff.—During the year the indoor staff has been subject to several changes: Mr. Kelly has retired on superannuation, and Mr. Wilkinson has taken the field; Mr. Roebuck is leaving shortly, having received an appointment in Western Australia; and Mr. Wright is to be transferred to Napier. The above are all capable officers whose services I am sorry to lose.

ROBT. T. SADD,
Chief Surveyor.

MARLBOROUGH.

Triangulation.—With the exception of a little breaking-down to fix settlement and other work, no triangulation has been done in this district; although some which is quite good in the field-work requires to be recomputed in polygons, to avoid a multiplicity of values for one point. This we hope to do during the winter.

Rural.—Under this heading 44,010 acres have been completed, at an average cost of 1·45s. per acre. This is a slightly better result than last year's return, owing to the block being larger and the weather generally much better for field operations. The whole area of this class of work has been hilly bush-clad country, generally densely covered by forest and undergrowth.

Town Section Survey.—Twenty-three acres, in eighty-nine sections, has been completed in the Town of Picton. This work was rendered rather costly, in a great measure, by the thick scrub and gorse growing over the land, and, of course, entailed a great deal of work outside of the survey of the sections so as to be assured that we were not encroaching on other rights. The Native work has been, generally, the survey of isolated sections, where frequently it cost as much to get to the place as to do the survey when there.

Roads, &c.—This item has been very unsatisfactory this year; the cost has been at the average rate of over £32 per mile. Much of the work has been either in heavy bush of thick scrub; and, in the case of the 6 miles done under my own supervision, was over very broken bush country and before any road had been formed. Work done under these conditions is, in my opinion, a very great mistake—the land should be acquired by agreement, and on a magnetic survey. The final survey could then wait until the road has been formed, and the traverse and side pegs could be put in at less than half it requires to do the survey of the grade line as blazed through the bush in the first instance.

Other Work.—Under this heading there appears a sum of £112, the value of 13½ miles of revision and extension of the standard survey of Blenheim. This works out at about £8·3 per mile, and is, I think, under the circumstances, reasonable.

Standard Survey.—The standard surveys of both Picton and Blenheim are in a fairly good state now, and should only require trifling attention for many years to come.

The past season has been unusually suitable for survey-work in the field.

Proposed Operations, 1911-12.—I would recommend that Mr. Morgan Carkeek should complete some applications for land in the Sounds before he retires. Mr. Hodgkinson has been detailed to make the very much needed survey of the railway-line between Picton and Blenheim. Mr. Hunt has his hands full of settlement-work in the Heringa Survey District and Upper Pelorus Valley. With our staff reduced by the retirement of Messrs. Carkeek and Seymour, we shall probably find it difficult to do the survey-work required in this district, and, although out of the 121,000 acres which we hope to have ready for settlement in this district during the coming year all but about 4,000 acres is either already surveyed or does not require survey, we shall, I expect, have to defer many matters for want of a surveyor. The work done in this district reflects great credit to the officers employed not only for the zeal in which they have performed their duty, but the extreme accuracy under rather adverse conditions. The particulars of twenty-one closures taken at random are as follow: Number of stations, 834; length in miles, 39·12; mean error—on meridian 1·18 links, and on perpendicular 1·36 links, per mile.

Standard Traverse, Town of Blenheim.—Number of stations, 63; length in miles, 4·74; mean error—on meridian 0·14 of a link, on perpendicular 0·33 of a link, per mile; number of closures, 5: but neglecting one rough closure over banks, river, &c., the mean error per mile is 0·14 of a link on meridian and 0·16 of a link on perpendicular.

F. STEPHENSON SMITH,
Chief Surveyor.

WESTLAND.

Triangulation.—The total work completed under this head comprised in various connecting triangles is 10,000 acres, costing £27 16s. 8d., or 0·6d. per acre.

Topographical Survey for Selection.—An area of 16,640 acres was dealt with, costing altogether £174 19s. 4d., or 2·52d. per acre, comprising chiefly pastoral land in mountain-tops.

Rural.—The work completed under this heading comprised 13,306 acres, subdivided into 67 sections at a total cost of £2,067 18s. 5d., or an average of 3·10s. per acre—the work of the four staff surveyors. Of this area District Surveyor Wilson contributed 1,295 acres, chiefly small isolated sections widely scattered in heavy-bush country. District Surveyor Morison surveyed 6,850 acres in Taramakau Valley and in the Moana Block. This surveyor was also employed for two months in the Canterbury Land District in the survey of an area of 190,500 acres of pastoral runs. District Surveyor Harrop surveyed 371 acres in 5 selections at Paroa and Cobden. An area of 4,790 acres in Waiho andWataroa Districts was surveyed by Mr. Cunningham, most of his surveys being in dense bush and swamp country, and executed under unfavourable conditions of weather and floods.

Village and Suburban.—Mr. Harrop surveyed 888 acres at Cobden into 62 sections, at a total cost of £256 19s. 4d., or 5·78s. per acre.

Town Section Survey.—2,745 acres in all were surveyed, in 50 lots, in the towns of Hokitika and Cobden, at a cost of £68 14s. 4d., or an average of 27·48s. per lot.

Roads, &c.—9 miles were surveyed in Taramakau Valley and Cobden, at a total cost of £147 18s., or an average of £16·43 per mile.

Other Work.—Returns show a total cost of £397 4s. 6d. The chief items under this head were supervision of engineering-works and inspection of surveys.

Inspections.—The field inspections, except in the instance of one private surveyor, showed very satisfactory results.

Chainage Closures.—The mean of 34 closures returned by the staff and comprised in 93 miles of traverses give an average of 0·45 of a link per mile.

Proposed Operations, 1911–12.—The areas allotted for survey to the four staff surveyors are chiefly as follows (besides 8,300 acres nearly finished) : (1) Completion of an area of about 3,200 acres of applications in the valleys of Grey, Ahaura, and Nelson Creek, including topography of Ahaura Valley ; (2) numerous isolated areas, totalling about 3,200 acres, in the localities of Waimea, Hohonu, and Kanieri ; (3) a few small areas, say about 100 acres, at Waiwhero ; (4) about 3,300 acres in the district between Mikonui and Waiho, with (5) some 800 acres of scattered applications in the far south. Some extension of standard work is desirable in the towns of Greymouth, Cobden, and Hokitika, in order to facilitate field and office check in Land Transfer plans. I hope to put this in hand during the coming year.

Office-work.—During the year 116 plans were received, classified as follows : 28 Land Transfer, 16 statutory, 9 mining, and 63 relating to land-settlement : of these, 113 have been examined. 917 copies of plans were placed on title-deeds—namely, on Crown leases 791 copies, and on Land Transfer titles 126 copies. Fifty transfers were also examined. Sixteen tracings have been made for photo-lithography, chiefly for sale plans. Two 40-chain district maps were completed and three others well advanced. Two new application maps were made. The new safe has been thoroughly brought up to date, thereby greatly facilitating field and office work ; 100 lithograph maps have been mounted ; census maps were prepared for use of sub-enumerators ; numerous reference maps on special subjects were brought up ; considerable attention has been given to Land Transfer record maps (involving the making of 998 tracings), gazetting reserves, and furnishing field data for surveyors and the public generally.

Office-work in Progress.—This comprises a photo-lithographic tracing of Jackson's Bay portion of Westland County, well advanced ; a revised lithograph of the Town of Cobden, deferred until completion of important current surveys ; continuation of Land Tranfser records of Greymouth, Hokitika, and Cobden. Further 40-chain maps of the busier portions of Grey County are also well in hand. The work of finally indexing the safe is progressing as opportunity offers, and current record maps are steadily being prepared for ready reference.

Changes of Staff.—Field Cadet H. M. Thompson passed to grade of Assistant Surveyor, and was transferred to Southland at end of March, after ten months' efficient service in this office. The following officers of the draughting staff—viz., R. P. Dykes and Miss S. M. Montgomerie—were transferred to Auckland early in November, the former having four years and the latter a year and a half of capable service in this office. Also, at the end of March, Draughtsman G. C. Warren, after four years' useful service here, was transferred to the Head Office, Wellington. My thanks are due to the staff for their hearty and intelligent co-operation during the past year.

G. H. M. McCLURE,
Chief Surveyor.

CANTERBURY.

Rural.—The total area surveyed under this heading for the year amounts to 10,126 acres, in 84 sections, being nearly all blocks under the Land for Settlements Act, and comprising the new settlements of Ruapuna No. 2, Clandeboye No. 2, Kohika No. 2, Meadows, Stoke, Allanholme, and Drayton. These blocks were all in open agricultural country. With the exception of the Stoke Settlement, comprising an area of 980 acres, which was done by a contract surveyor, the surveys have been carried out by our own staff.

Topographical Survey for Selection.—Under this heading 1,456,179 acres are returned. Nearly the whole area consists of subdivisional surveys of pastoral runs, the leases of which expire on the

1st March, 1912, but which had to be disposed of twelve months before the expiration of the existing leases. Owing to the rough nature of the country and its low value, it was considered that prismatic compass and chain traverses tied on to the trig. stations at intervals by theodolite bearings, and having the new unfenced boundaries carefully pegged on the ground, would be amply sufficient to meet all requirements and put the new lessees in possession of their runs; this system was therefore adopted, and hence I am obliged to return the work as topographical. In addition to the survey of the boundaries, all intersecting fences were traversed, partly to get them placed on the maps in their correct positions, and partly to facilitate the work of valuation of the improvements, which will have to be undertaken three months before the expiry of the old leases. While these surveys were in progress the staff was augmented by the temporary transfer of District Surveyor Morison from Westland to Canterbury, and the employment of three unauthorized assistants, who worked under the direction of the authorized surveyors. While all the surveyors employed on this arduous work deserve commendation for the manner in which they carried out their duties, I desire particularly to remark on the thoroughness and energy displayed by District Surveyor Allom in connection with it.

Town Section Survey, Roads, &c., and Gold-mining Surveys.—I have nothing to report under these headings.

Land Transfer.—Work in this branch of the Department has continued to increase during the year, some 336 survey plans having been checked and passed. In addition to the tabulated matter shown in Table 4, I append hereto a schedule compiled by Mr. Leversedge, showing a complete list and the nature of the dealings carried out during the year. I am glad to be able to report that the accumulation of work is being gradually overtaken, which is very creditable to the officers employed, considering the unusual rate at which it has been coming in of late.

Other Work.—During a slack time last winter, Mr. District Surveyor Allom extended the standard traverse along 26 miles of roads outside the city boundaries. The plans of this work have not yet been made, but I expect he will be able to complete them during the coming winter, and also to further extend this very necessary work.

Inspections.—Owing to the pressure of pastoral-run and settlement surveys, only three formal inspections have been made during the year, though in numerous cases Mr. Haszard has gone out to clear up title-discrepancies in connection with Land Transfer surveys.

Proposed Operations, 1911–12.—During the present year the undermentioned lands will be prepared for settlement, and offered to the public before the 1st March next: Waihao Downs (settlement land), 3,604 acres; Sherwood Downs (settlement land and surrendered run), 56,500 acres; pastoral runs in the Mackenzie and Coleridge Districts to be offered as small grazing-runs, 82,100 acres; pastoral land surrendered by the Acland family, to be offered as small grazing-runs, 49,870 acres: total, 192,074 acres. With the exception of the Mackenzie runs the whole of the above lands require subdivisional survey in the spring. In addition to this, the road through the Glynn Wye freehold and the freehold itself (about 7,000 acres) must be surveyed before the 1st of next March, in order that the new lessees of the adjoining runs may be placed in possession of their holdings. To cope with this work I shall only have Mr. District Surveyor Allom left on my staff after the 1st May, as Mr. Gray returns to Wellington on that date, so that I shall require the services of at least two more surveyors from the 1st September to enable me to have the Mount Peel and Sherwood Downs properties subdivided in time. Mr. Allom will finish the survey of Waihao Downs early in May, after which I propose to let him do a few small surveys that are on hand, finish his plans in this office, and then send him on to Glynn Wye to lay off the road and survey the freehold. The road will be an important one some day, and should be laid off by a man of experience, and I have therefore chosen Mr. Allom to do it.

Changes of Staff.—I was transferred to this district from Napier in July last, *vice* Mr. F. W. Flanagan, who was promoted to be Valuer-General. Mr. Thomas Maben was superannuated on the 31st May, after many years of faithful service. Mr. Assistant Surveyor Young resigned on the 30th September and left for Queensland, and Mr. J. G. Wilson was transferred from the Marlborough District to the Land Transfer Branch here.

Office-work.—The Chief Draughtsman, Mr. Haszard, reports that the office staff has had a particularly busy year, getting out data for over a million acres of pastoral-run survey, tracings for Land Purchase Board and land-for-settlements blocks, besides the ordinary routine of office check and record. During the month of February the full strength of the staff was concentrated on the preparation of maps for the Census Enumerators. As shown in the tabulated return, 587 plans have been placed on leases. Photo-lithographic tracings have been prepared and revised for about 1,500,000 acres of pastoral-run country and of 10,000 acres of land-for-settlement blocks. Fifteen Public Works plans in triplicate, totalling 45; 29 road-deviation and other plans; and 7 plans under the Land for Settlements Act have been checked and recorded. Numerous tracings and descriptions have been prepared for *Gazette* notices, also a tracing of Akaroa Harbour for the Admiralty. Mr. Schmidt has been engaged since last August on an up-to-date map of the Timaru Borough, which will show all the latest subdivisions; the plan is now about two-thirds completed. The compilation required much research in the Deeds Office, which will explain why such plans take so long to make.

In continuation of the work mentioned in last year's report, six more county maps have been compiled and the tenures coloured off, for exhibition in the office corridor. We have no proper lithograph plan of the Amuri County, so I am having one compiled for photo-lithography. Some progress has also been made in overtaking the arrears of the Crown-grant record plans.

In conclusion of this report, I beg to record my appreciation of the manner in which the whole staff has worked, and of the valuable assistance I have received from Mr. Haszard.

T. W. Brodrick,
Chief Surveyor.

OTAGO.

Minor Triangulation.—No work was done under this heading, but a revision of triangulation is necessary in several districts, and should be taken in hand when a surveyor is available.

Topographical Survey for Selection.—Four staff surveyors were engaged on this work—one of them, however, for only three months—the total area returned for the year being 726,920 acres, divided, at a cost of 2·7d. per acre, into 261 subdivisions as follows: 84 runs, total area 704,840 acres; 177 sections, total area 22,080 acres. Most of the field-work of this area was done last year, and each of the surveyors was assisted by an unlicensed assistant owing to the scarcity of surveyors and the necessity for placing the runs on the market by a certain date. For this latter reason a considerable amount of compass traverse was allowed in the defining of the boundaries of small grazing-runs.

Standard Survey.—The standard survey of the City of Dunedin was commenced this year by Mr. W. T. Neill, who reports that 36 miles of streets have been traversed to date. He will be assisted in this work during the coming year by Mr. S. T. Burton.

Town Section Survey.—Ten plans of new towns were examined, and approved by His Excellency the Governor under section 16 of the Land Act, 1908.

Mining Survey.—These surveys were all executed by private surveyors for fees paid by the applicants, the number of sections being 23 and the area 972 acres.

Roads, &c.—Fifteen plans were received and approved, comprising thirteen surveys by private surveyors and two by the staff.

Land Transfer Survey.—Eighty-six plans, representing an area of 7,000 acres, were examined, recorded, and approved. During the past year it has been noticeable that the surveyors have paid more attention to the requirements of the Survey Regulations, with the result that the plans sent in have been more readily checked, and fewer delays have occurred.

Proposed Operations, 1911–12.—The principal work for the year will be the continuation of the standard survey of the City of Dunedin by District Surveyor Neill. He will from time to time be assisted by Assistant Surveyor Burton. District Surveyor Calder will be transferred from Naseby, which has been his headquarters for the last eighteen years, to Dunedin, where he will occupy the position of Office Surveyor and Computer. District Surveyor Barron will be occupied on the subdivision of part of Moutere Run, which will probably occupy him till called in for the winter. On resumption of field-work he will take up the subdivision of part of Turnbull's run at Wanaka. Other "spotting" surveys will be allocated between Surveyors Calder, Barron, and Burton, as expedience may direct.

Office-work.—The plans examined, recorded, and approved are as follows: 86 Land Transfer, 15 road and railway, 16 mining, and 56 staff: total, 173. Plans for photo-lithography: 43 sale-plan tracings for photo-lithography were made, and plans of Awamoko, Otepopo, and Moeraki Survey Districts. A map of Table Hill and Tokomairiro Survey District was revised and brought up to date for publication. Two maps of Wakefield Survey District and the settlement blocks in Bannockburn and Nevis Survey Districts were drawn and printed in this office. Additions were made to Grant's four-mile map of the Otago Land District, and a litho. of Block II, Teviot Survey District, published. Diagrams were drawn on Crown titles—239 duplicate, 314 triplicate; total, 1,420.

In the Land Transfer Branch diagrams were drawn on certificates of title—18 single, 972 duplicate, and 9 triplicate; total, 1,989. About 1,100 deeds and other instruments were passed.

Since October, 1910, one draughtsman has been almost continuously employed preparing a complete set of new maps for the Valuation Department. Eleven large maps of electoral districts were compiled for Public Works Department. The census maps occupied most of the staff for about three weeks. The surveys of Matakanui, Northburn, Morven Hills, and Kawarau Runs, comprising about 543,000 acres, were plotted by the office staff, there being 60 large plans and about 20 smaller ones. Miscellaneous work comprised the preparation of tracings for field surveyors, settlers, &c., and mounted lithos for Run Classification Commissioners. Work for other Departments is evidently on the increase, the total cost being £665. With the assistance of a draughtsman recently appointed, we expect to make good progress in the compilation of secondary record maps, showing all transactions since the issue of the Crown grant. Twelve certificates of title were prepared for closed roads, 365 tracings for Valuation Department, 152 census maps. It is very desirable that one draughtsman should be employed continually preparing plans of blocks and districts for photo-lithography. The only lithographic draughtsman hitherto available for this work will now have to be employed in preparing plans of the standard survey of Dunedin.

In the lithographic office, 982 lithographs were printed, 1,023 maps were mounted, and 33 books repaired and rebound.

I have pleasure in reporting that the office staff have worked in a very satisfactory manner during the year.

E. H. Wilmot,
Chief Surveyor.

SOUTHLAND.

Minor Triangulation.—The only item under this head is an area of 1,561 acres in New River Hundred by Mr. Macpherson. This was necessitated by one of the trig. stations having been shifted.

Rural.—23,011 acres were executed during the year, in 119 sections, most of which consisted of hilly bush country. Of this area 1,131 acres represent sawmill areas, the surveys of which were paid for by fees deposited by applicants.

Village and Suburban.—172 acres, in 13 sections, were surveyed by Mr. Drury in the Longwood District.

Town Section Survey.—Of the 44 acres under this head, 12 acres, in 21 sections, were surveyed by Mr. Otway in Wyndham District, and 30 acres, in 48 sections, by Mr. Drury in Waiau District, the remaining 2 acres having been executed by a private surveyor, paid for by applicant.

Gold-mining Survey.—44 acres: these were two special claims, surveyed by private surveyors and paid for by applicants.

Roads and Water-races.—Six miles were surveyed by the staff in connection with lands to be opened for settlement.

Other Work.—The expenditure under this head represented traverses of water-races, tramways, &c., in connection with settlement surveys, reports, Mr. Falkiner's unfinished landless Natives survey, &c.

Proposed Operations, 1911–12.—Mr. Otway has in hand 3,000 acres in Longwood and Jacob's River Hundreds, 700 acres of which are nearly completed. Mr. Macpherson will be fully employed on a block of 9,000 acres in the Aparima District. Mr. Falkiner, on completion of the survey of the landless Natives block in Hokonui District, will take in hand a block of 5,000 acres in Mokoreta District. Mr. Drury will continue cutting up lands in the Longwood District, and 4,400 acres of cut-out sawmill areas. Mr. Thompson, who has just joined the staff, will be engaged on surveys of 8,000 acres in Alton, Longwood, and Campbelltown Hundreds. A survey will also be required of about 5,400 acres recently acquired by the School Commissioners and now administered by the Lands Department. There are in addition many miscellaneous surveys to be completed as opportunity arises.

Office-work.—During the year 75 ordinary survey plans, representing 34,862 acres, were examined and passed, and also 9 railway land plans; 33 photo-lithographic tracings for sale plans were made; 178 working tracings for surveyors, and 373 miscellaneous tracings. Two new lithographic drawings of survey districts were made, one drawing was revised, and another drawing is well in hand; 24 local bodies' schedules in duplicate were prepared, and 280 lithographs, plans, &c., were mounted; 4 new application maps have been compiled to take the place of old and dilapidated ones, and others are in course of preparation. The 4-mile map of Southland and Wallace Counties was revised with a view to its republication, and the Head Office Southland County map was brought up to date. The revision of the Valuation Department's maps of ridings, and preparation of maps for census sub-enumerators, occupied a large amount of the officers' time. At the request of the Head Office, a drawing of the northern portion of Stewart Island was prepared for the use of the Department of Tourist and Health Resorts. This necessitated the inspection of the actual roads and tracks in use, and this information, together with the general topographical features of that portion of the Island, has resulted in the publication of a map which is of considerable importance and interest to tourists and the public generally. Additions were made to the small pictorial map of the Dominion to enable a second issue of the map to be made. The principal drawing-work during the year has been in the direction of the preparation of a new topographical map of the Dominion, to be issued on a ten-mile-to-the-inch scale. The drawing has been projected on an eight-mile scale, and it will be published in four sheets, which can be joined together to make the complete map. As each of the sheets will be about 5 ft. 6 in. by 4 ft. 6 in., some idea may be formed of the extent of the map. I trust the work will be finished and the map published about the end of the present year.

In the Land Transfer Branch, 102 plans, covering an area of 10,446 acres, were examined and passed. As another draughtsman has now been added to the staff, I trust that time will be found during the coming year to resume work on the Land Transfer record and other public maps, so as to endeavour to bring all the ordinary lithographs of the district up to that state of usefulness required for general purposes.

The general work of the office has considerably increased during the year, and I have to thank the staff for their cordial assistance.

H. M. Skeet,
Chief Surveyor.

APPENDIX II.

THE MAGNETIC OBSERVATORY AND THE MAGNETIC SURVEY.

The routine and other observational work of the Observatory have been carried on successfully during the year, and, as in previous years, comprise magnetic, seismological, and meteorological observations.

The Adie magnetographs have been kept in continuous operation, and the work of developing and annotating the records obtained duly performed. Throughout the year the absolute observations necessary for standardizing the curves have been duly made. For the information of other observatories, the magnetograms of most of the principal magnetic storms are reproduced herewith. The reproductions, in four sheets, are on a scale of three-eighths of the originals, so that the values of ordinates for the comparison of fluctuations are—

Declination curve	+ 1 mm. =	− 3·0′ of arc.
Horizontal-force curve	=	− 0·00013 c.g.s. unit.
Vertical-force curve	=	− 0·00010 c.g.s. unit.

The work of measurement and tabulation of the magnetograms has been substantially advanced during the year, and in future each annual report will include the tabulated hourly values of the magnetic elements for the year. The reduction of the 1910 curves is not sufficiently advanced for inclusion in this report.

Milne Seismograph No. 16.

The Milne seismograph has enabled us to obtain records of seventy-four earthquakes, and some of the most important of these are reproduced in three sheets herewith. This instrument has now been provided with a quick-moving recorder, giving a more open time scale on the records, which facilitates the identification of the various places of the motion, and also facilitates inter-comparison with records obtained at different places.

Magnetic Survey.

During the year further progress has been made with the reduction to epoch of the field observations.

Dr. L. A. Bauer, Director of the Magnetic Department of the Carnegie Institution, made a friendly visit to the Observatory in May. Dr. Bauer expresses great satisfaction at the magnetic work being done by the Government of New Zealand, and emphasizes the desirability of the extension of the field observations to the remainder of New Zealand's dependencies. He also strongly advocates the periodic reoccupation of certain stations in the main Islands, in order to exactly determine the amount of the secular change in the different parts of New Zealand. This is of importance from the point of view of the world magnetic survey now being carried out by his Department. Dr. Bauer states that the field-work of his Department is confined to ocean regions and other parts where accurate magnetic work has not been done, and the world survey aims at incorporating with these observations the work that has been and is now being done by various Governments.

Antarctic.

The year 1910 has been remarkable for the departure of Captain Scott's second polar expedition to the Antarctic. Lyttelton was the base for finally fitting out the "Terra Nova" for its journey, and Christchurch was made a magnetic base for the expedition. Dr. Simpson and Mr. Wright were busily engaged for some weeks at the Observatory in completing the adjustment of their instruments for use in the Antarctic, and in swinging a set of half-second gravity pendulums belonging to the expedition. Lieutenant Pennell also redetermined the constants of the relative Lloyd Creak circles, used for determining the total magnetic force and inclination. Dr. Simpson was given facilities for the erection of the Eschenhagen self-recording magnetographs to be used on the expedition, and was enabled to detect and remedy several minor defects in them, thus insuring their successful running at Winter Quarters.

A concrete pier was erected in the Observatory grounds to enable these observers to use their meridian transit instrument. In order to enable the expeditionary observers to devote their time to other indespensable work, I personally cleaned and erected the instrument, setting up a meridian-mark, and regulated their sidereal clock preliminary to their making the gravity observations. Groups of star transits were observed on a considerable number of nights to control the sidereal clock rate over the days on which the pendulums were swung. The excellently clear nights especially favoured this work.

A programme of observation of international magnetic term-hours in connection with the expedition was arranged by the Royal Society, and the Observatory was asked to co-operate, and is doing so. Owing to some of the term-hours coming during the time of running of the Christchurch electric tramways, it has not been possible to observe all the term-hours at the Observatory itself. At such times thirty second eye-readings of declination have been made at Amberley, some thirty miles north of Christchurch, and situated therefore beyond the range of tramway disturbance, and these will suffice at any rate to determine the comparative ranges of disturbances noted here and at Winter Quarters. The programme arranged has been based upon the results obtained from the observations made in connection with Captain Scott's previous expedition in 1902–4. In making the outside eye-observations I have been ably assisted by Mr. Eric N. Webb, of Canterbury College, and I am glad to be able to state that Mr. Webb has been engaged by the Magnetic Department of the Carnegie Institution to assist Mr. E. Kidson in magnetic work in Australia, undertaken to further the magnetic survey of the globe.

Meteorological Observations.

Daily throughout the year at 9.30 a.m. and 5 p.m. there have been made observations of the temperature, pressure, and humidity of the air, its direction and velocity of motion, the amount of cloud and rainfall, and the daily ranges of temperature. Monthly abstracts of these have been forwarded to the Weather Forecast Department, and a daily summary of the observations has been published for the information of the public.

A tabular statement of the monthly totals of rainfall for ten years is appended, giving also the yearly totals, and the means for the respective months. The average annual rainfall at Christchurch for the ten years has been 27·216 in.

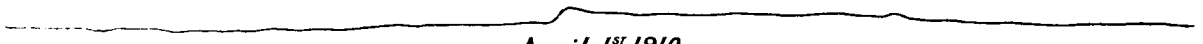
General.

During the year the Christchurch Domain Board has carried out very considerable improvements in the vicinity of the Observatory, including the formation of a small artificial lake. In order to avoid the putting-down of iron artesian wells in the immediate neighbourhood of the Observatory, the Department made a small grant to the Board, enabling them to bring the overflow from Victoria Lake in to supply the new lake, thus avoiding interference with the magnetic field at the Observatory.

I was rather unfortunate in losing the services of my very capable assistant, Mr. B. V. Pemberton, towards the end of 1910. Mr. Pemberton has been transferred to the Meteorological Department, Wellington, as first assistant to Mr. D. C. Bates. His place here has been taken by Mr. Thomas Maben. To both Mr. Pemberton and Mr. Maben I am much indebted for their valuable assistance during the year.

I have to acknowledge with thanks the receipt of many valuable reports and publications on magnetic science, &c., from various British and foreign observatories and scientists, too numerous to mention.

Henry F. Skey, B.Sc.,
Officer in Charge.



April. 1st 1910.

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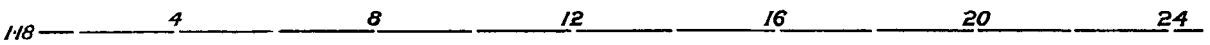

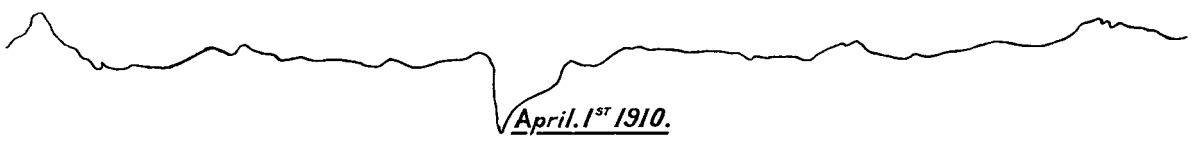

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— H.F. Chch.—

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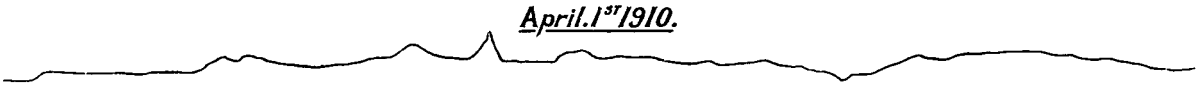

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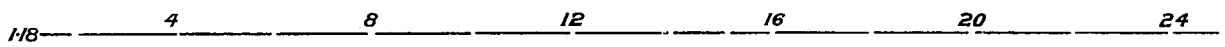

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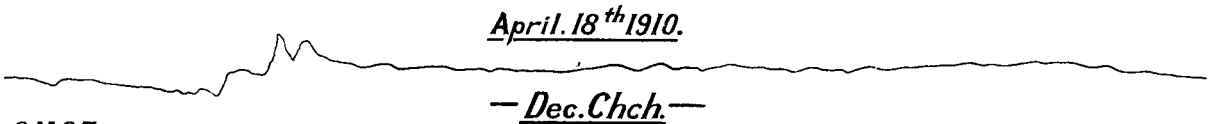
April. 18th 1910.



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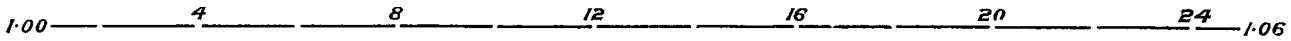

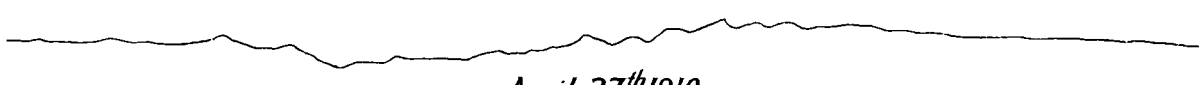

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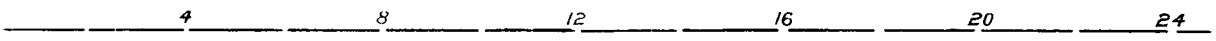

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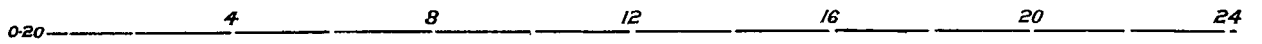

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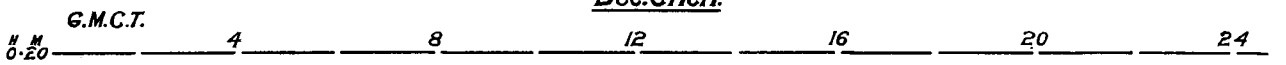

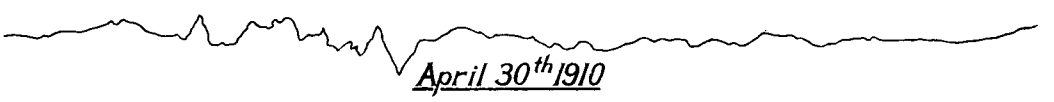

April 30th 1910

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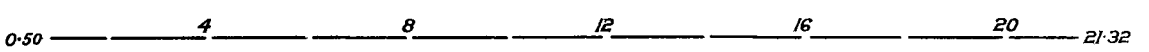

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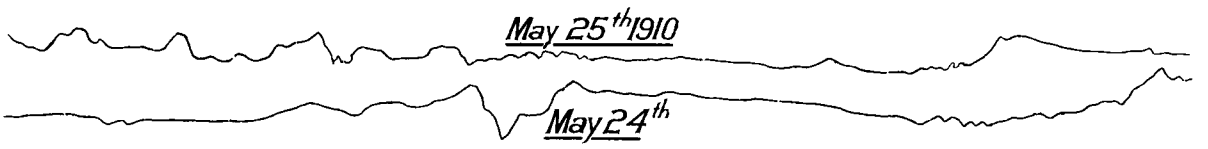

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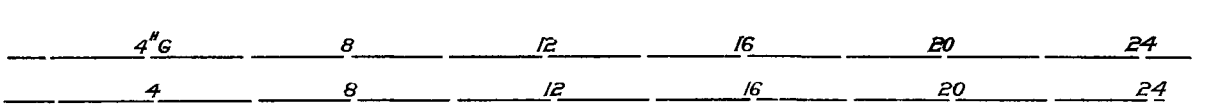

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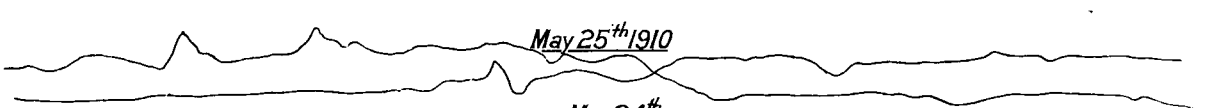
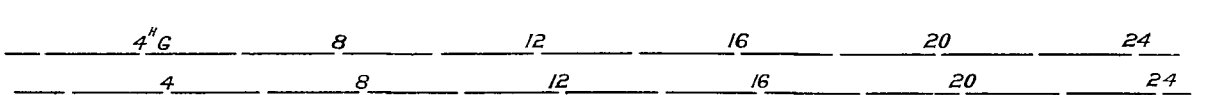


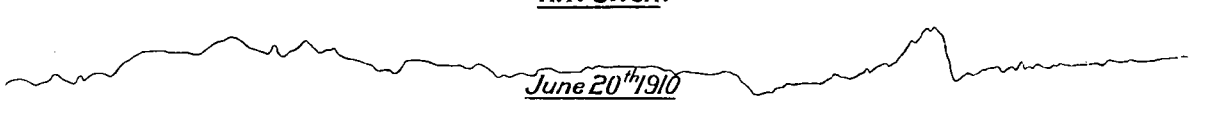
May 24th

—Dec Chch.—

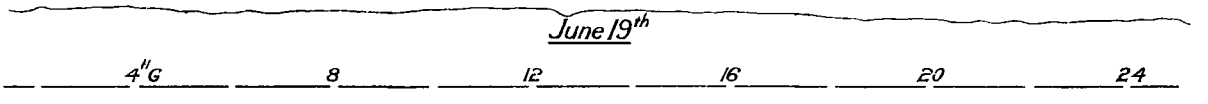


—H.F. Chch.—

June 20th 1910



June 19th



—H.F. Chch—

August 11th 1910

Aug 10th

2" G 4 8 12 16 20 24

2" 4 8 12 16 20

Aug 11th 1910

Aug 10th

—Dec Chch—

4" G.M.C.T 8 12 16 20 24

4 8 12 16 20

—H.F. Chch—

Aug 19th 1910

Aug 18th

0" G 4 8 12 16 20

4 8 12 16 20

Aug 19th 1910

Aug 18th

—Dec Chch—

0 4 8 12 16 20

4 8 12 16 20

—H.F Chch—

Aug 23rd 1910

Aug 22nd

0 4 8 12 16 20

0 4 8 12 16 20

Aug 23rd 1910

Aug 22nd

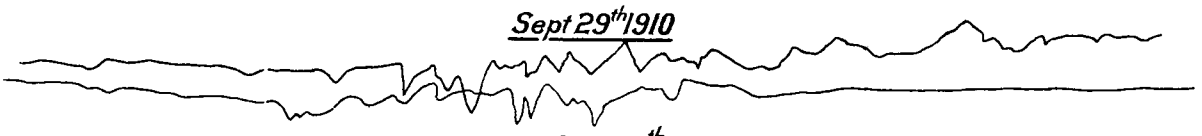
—Dec Chch—

0" G 4 8 12 16 20

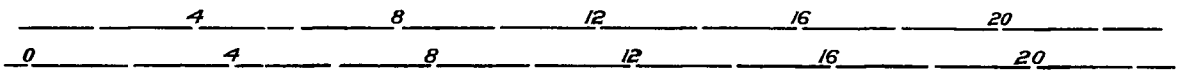
0 4 8 12 16 20

—H.F. Chch.—

Sept 29th 1910



Sept 30th



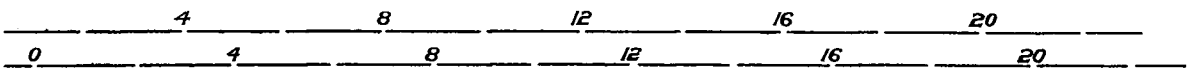
—Dec.Chch.—

Sept 29th

Sept 29th 1910

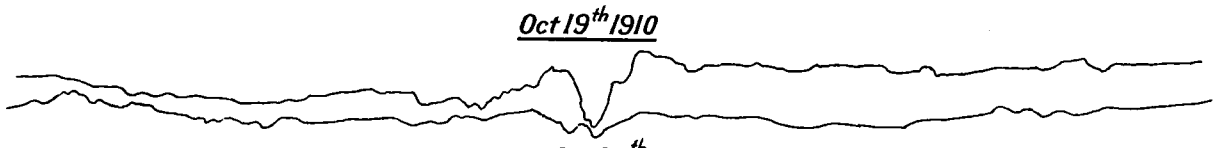
Sept 30th

Sept 30th

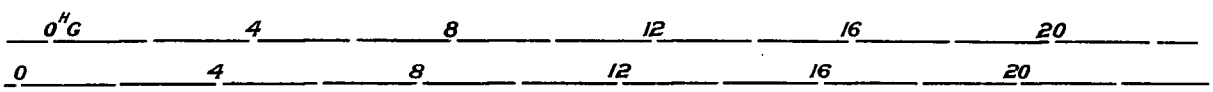


—H.F. Chch.—

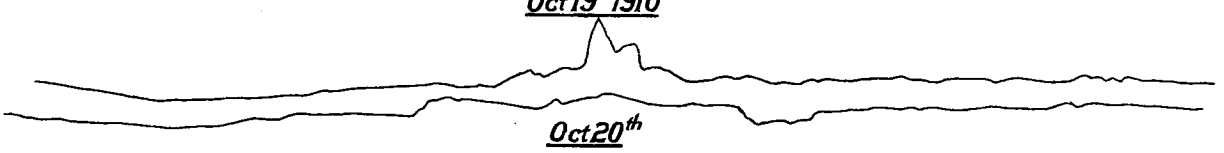
Oct 19th 1910



Oct 20th

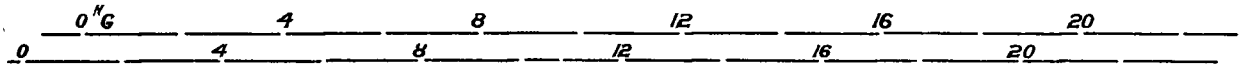


Oct 19th 1910

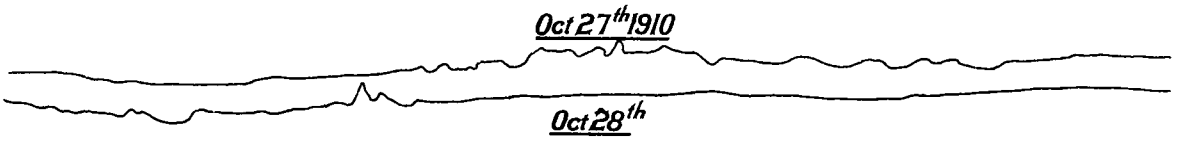


Oct 20th

—Dec.Chch.—

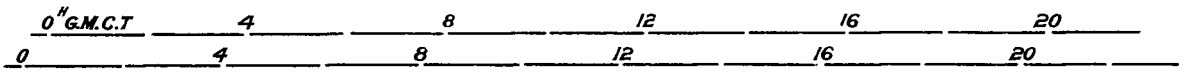


Oct 27th 1910



Oct 28th

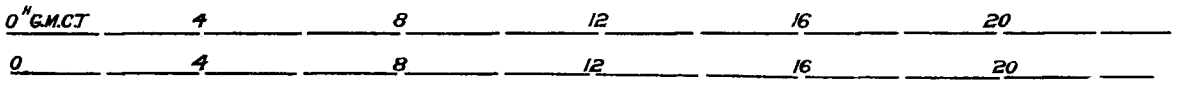
—Dec.Chch.—



—H.F. Chch—

Oct 27th 1910

Oct 28th



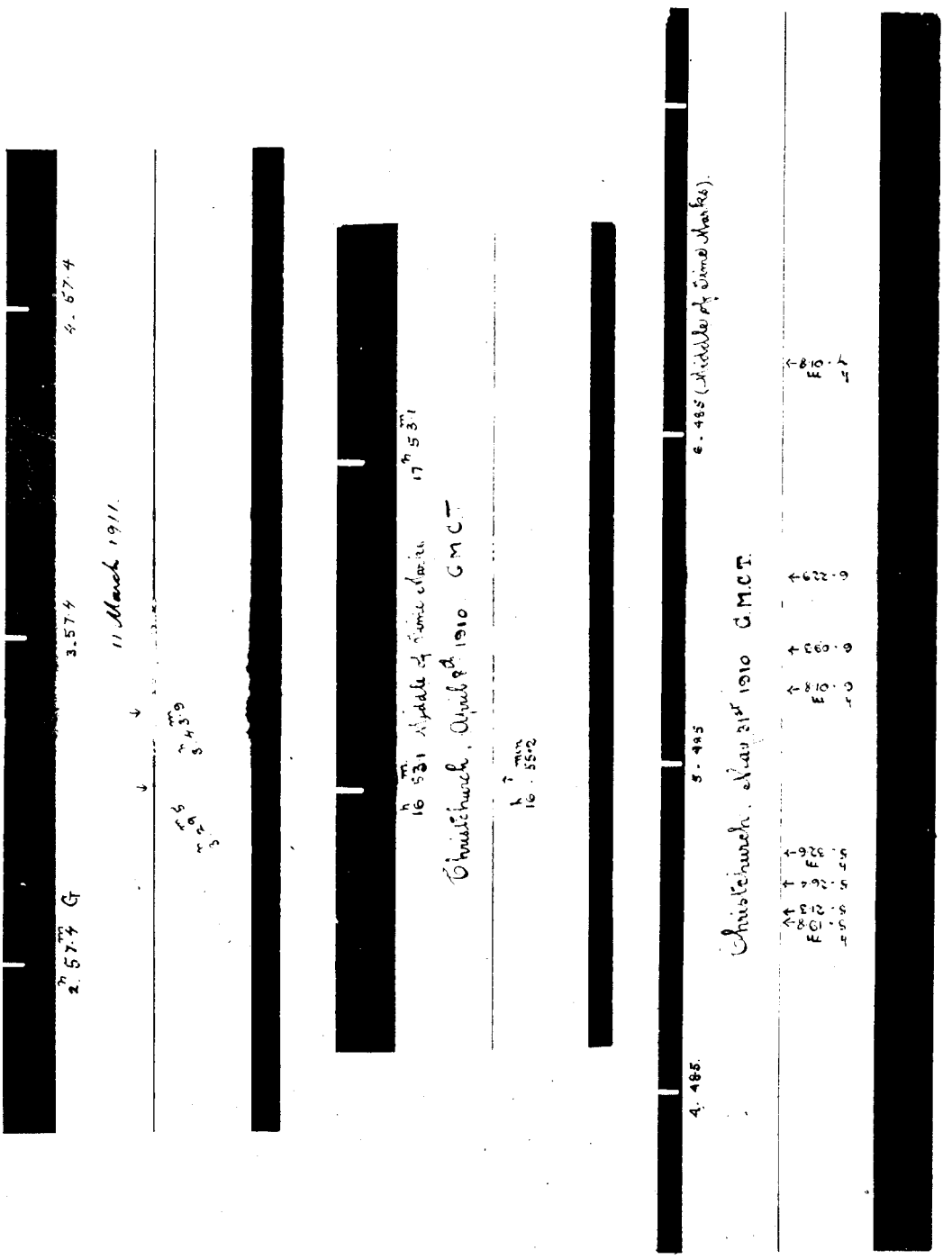
MONTHLY RAINFALL IN INCHES RECORDED AT THE MAGNETIC OBSERVATORY, CHRISTCHURCH, NEW ZEALAND (WITH THE NUMBER OF RAINY DAYS PER MONTH)

Means.		Month.	1902.		1903.		1904.		1905.		1906.		1907.		1908.		1909.		1910.		Totals.	
Inches.	Days.		Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.
2·192	10·2	January ..	0·470	6	2·469	7	1·742	6	1·648	12	2·569	13	0·931	9	0·550	6	5·147	21	4·206	12	19·732	92
1·447	6·6	February ..	0·810	6	1·413	8	1·974	8	2·385	7	3·974	13	1·088	5	0·042	2	0·560	6	0·775	4	13·021	59
3·387	10·8	March ..	5·365	12	1·009	5	2·837	11	1·785	11	4·237	10	1·801	11	3·342	15	6·466	8	3·637	14	30·479	97
1·659	10·1	April ..	2·490	12	2·596	12	0·423	9	1·355	11	2·253	8	1·365	15	1·845	13	2·373	4	0·232	7	14·931	91
1·980	11·0	May ..	2·270	10	3·326	15	3·041	10	0·984	6	2·822	12	1·500	16	0·912	9	1·610	11	1·358	10	17·823	99
2·531	13·2	June ..	1·860	13	1·311	12	2·819	17	5·000	15	3·478	10	0·922	8	2·509	15	1·826	11	3·056	18	22·781	119
3·128	14·2	July ..	1·250	7	1·527	12	2·204	10	1·860	15	3·935	18	1·722	13	7·881	20	1·730	14	6·043	19	28·152	128
1·802	11·4	August ..	1·548	12	1·586	14	2·550	10	1·027	11	1·582	11	2·886	14	0·743	8	2·405	11	1·894	12	16·221	103
2·463	10·6	September ..	2·582	12	1·396	7	4·080	11	5·522	15	1·311	13	4·123	14	1·678	8	1·188	12	0·290	3	22·170	95
2·338	9·3	October ..	1·175	7	0·381	6	6·229	12	3·231	14	0·249	4	1·657	10	2·194	14	6·168	13	0·210	4	21·494	84
1·454	9·6	November ..	0·987	10	1·671	11	1·386	10	2·294	9	2·308	10	0·973	12	0·724	6	2·202	11	0·540	7	13·085	86
2·785	9·3	December ..	7·973	19	0·313	4	4·066	16	1·349	12	0·778	4	0·540	4	3·497	17	3·607	8	2·940	11	25·063	84
7·216	126·3	Totals ..	28·780	126	18·998	113	33·351	130	28·440	138	29·496	126	19·508	131	25·917	133	32·282	130	25·181	121	244·952	1,136

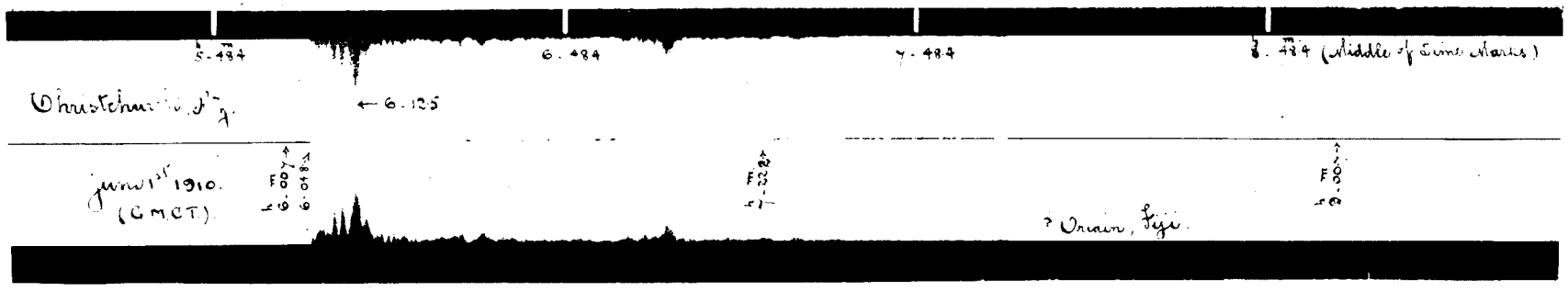
Earthquake Records by Milne Seismograph No. 16, at Christchurch.

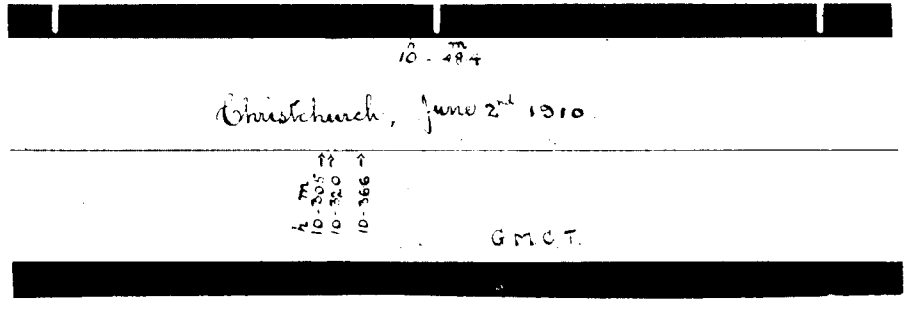
Preliminary tremors or first phase, P_1; second phase, P_2; third phase or large waves, P_3; duration, D amplitude, A.; air tremors, Ats. Time is Greenwich civil mean time.

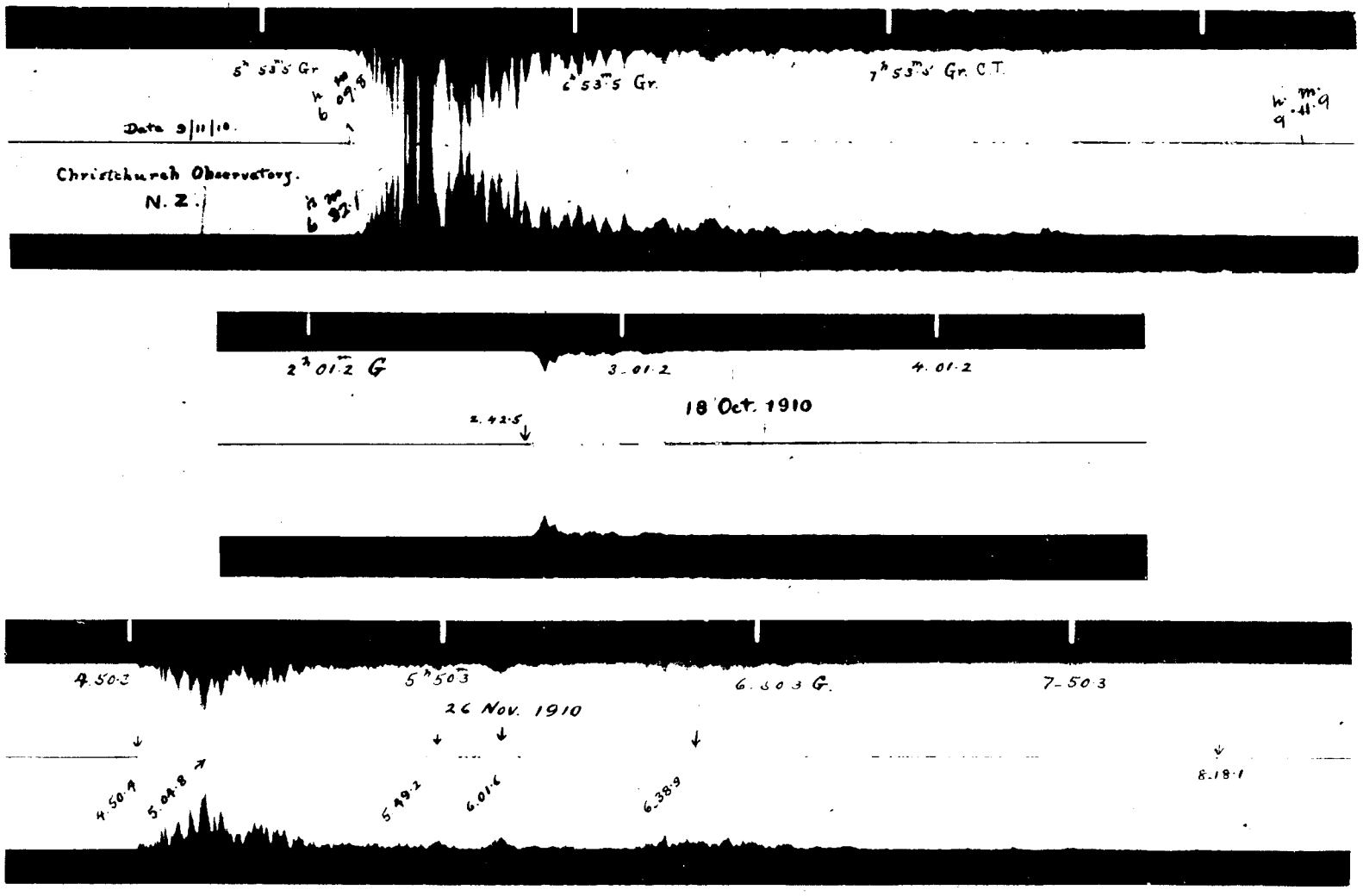
Date.	Commencement.	Max.	Max. Amplitude.	Duration.	Remarks.
1910.					
April.	H. m.	H. m.	Mm.	H. m.	
1	13 35·3	14 27·8	0·9	1 38·5	
4	5 23·7	..	..	0 08·2	Slight thickening.
8	Indefinite	16 55·2	0·9	Indefinite	P_1 and D. obscured by Ats.
12	0 50·3	0 50·6	1·5	1 04·4	Preceded and followed by minute Ats.
13	5 56·6	5 58·7	0·4	0 18·5	
16	Indefinite	13 09·3	..	Indefinite	P_1 and D. obscured by Ats.
18	7 34·9	..	..	0 41·0	Thickening of line.
20	22 28·5	22 49·0	..	1 14·4	Preceded by continuous Ats.
23	Indefinite	15 52·8	1·3	Indefinite	P_1 and D. obscured by Ats.
27	2 16·3	..	..	0 35·1	Thickenings.
May.					
1	4 44·7	4 46·3	0·25	0 11·8	
1	Indefinite	18 45·7	5·5	Indefinite	P_1 and D. obscured by Ats.
5	0 57·4	1 09·8	0·2	0 41·0	
6	23 22·9	23 29·1	0·4	0 38·0	
8	18 25·2	18 34·4	0·1	0 20·0	
10	18 32·7	..	..	0 35·4	Small swellings.
13	2 33·6	2 36·2	0·3	0 12·8	
15	4 42·0	4 49·5	0·15	0 26·4	
21	22 58·3	23 07·5	0·2	0 22·5	
22	6 48·1	7 10·6	0·4	1 11·2	
29	8 38·4	..	..	1 26·1	Minute tremors, possibly Ats.
29	11 12·2	..	..	0 06·1	Slight swellings.
31	5 19·8	5 21·3	0·15	0 06·6	
31	5 32·6	6 01·8	..	..	
		6 09·3	..	..	
		6 22·9	0·7	1 29·2	
June.					
1	6 00·7	6 12·5	5·1	3 00·0	? Origin in Fiji.
2	10 30·5	10 32·0	0·2	0 06·1	
5	5 02·6	5 04·6	0·1	0 27·1	
9	6 50·0	..	..	0 05·1	Minute.
9	8 10·5	..	..	0 02·5	Minute.
13	13 08·1	13 13·2	0·3	0 39·5	
23	10 16·6	10 20·7	0·4	0 26·9	
24	2 58·9	..	..	0 14·3	Very slight.
29	10 51·5	11 03·8	..	..	
		11 08·7	17+	Indefinite	End obscured by quake following.
29	Indefinite	14 28·9	4·2	Indefinite	P_1 obscured by preceding quake ended 15h. 49·5m
July.					
5	10 42·1	10 46·0	1·0	..	
		10 54·4	1·1	..	
		10 59·3	0·9	1 11·0	
7	8 26·8	8 58·7	1·0	..	
		9 14·1	0·8	..	
		9 23·3	1·1	1 57·5	
11	20 36·0	20 39·4	1·2	..	
		20 47·3	1·5	0 53·5	
12	21 08·0	21 12·1	7·0	..	
		21 37·7	3·5	1 47·2	
15	12 08·5	12 14·0	1·0	..	
		12 21·8	1·0	..	
		12 25·3	1·0	1 19·5	
15	21 48·7	21 51·9	0·2	..	Swellings.
		21 56·7	0·3	0 14·8	Preceded and followed by minute tremors.
19	19 33·5	19 39·3	0·2	..	
		19 52·2	0·2	0 22·0	
24	15 27·7	15 38·9	2·0	0 31·9	
29	10 38·1	11 01·3	2·5	..	
		11 14·3	2·3	1 14·3	
Aug.					
5	15 38·3	15 39·5	0·6	0 05·9	
10	20 49·6	21 08·2	0·4	0 38·3	
21	5 36·3	5 53·6	7·0	..	
		5 55·1	5·0	2 31·1	
Sept.					
7	7 33·9	7 51·4	7·0	1 25·0	
9	9 00·0	9 19·8	5·1	..	
		9 28·4	3·0	0 55·3	
10	12 21·9	12 33·4	1·4	0 38·3	
Oct.					
7	7 05·8	7 11·0	2·4	..	End obscured by Ats.
		8 26·5	1·0	0 57·0	
7	11 54·4	12 07·9	2·2	0 53·0	
12	8 00·2	8 06·8	1·0	0 28·6	
18	2 42·5	2 47·7	4·0	1 10·4	
30	7 47·5	7 53·7	2·5	0 51·7	
Nov.					
9	6 09·8	6 32·1	17·5	3 03·1	Reproduced.
10	12 28·4	12 40·4	2·0	0 30·6	Duration doubtful owing to Ats.
26	4 50·4	5 04·8	10·8	..	


2. 57.4 G
3.57.4
4. 57.4
11 March 1911
Christchurch, April 21st 1910 G.M.C.T.
4. 485.
5. 495
6. 485 (Middle pair timed Sharks).
Christchurch, April 21st 1910 G.M.C.T.

Face page 20.]


5.484
6.484
7.484
8.484 (Middle of time marks)
Christchurch, N.Z.
← 6.125
June 1st 1910.
(G.M.C.T.)
F 6.007
6.018
F 7.224
F 8.001
? Ovalau, Fiji.


10.484
Christchurch, June 2nd 1910.
F 10.320
10.366
G.M.C.T.
4.482
Christchurch June 1st 1910. G.M.C.T
F 9.967


5h 53m 5 Gr
h m 09.8
b
Date 9/11/10.
Christchurch Observatory.
N. Z.
h m 52.1
b
6h 53m 5 Gr.
7h 53m 5 Gr. C.T.
h m s
9 41 9
2h 01m 2 G
3. 01. 2
4. 01. 2
18 Oct. 1910
2. 42. 5
4. 50. 3
5h 50m 3
6. 50 3 G.
7. 50. 3
26 Nov. 1910
4. 50. 9
5. 04. 8
5. 49. 2
6. 01. 6
6. 38. 9
8. 18. 1

5128

EARTHQUAKE RECORDS BY MILNE SEISMOGRAPH NO. 16, AT CHRISTCHURCH—*continued*.

Date.	Commencement.	Max.	Max. Amplitude.	Duration.	Remarks.
1910.					
Nov.	H. m.	H. m.	Mm.	H. m.	
26	..	5 49·2	2·0	..	
		4 01·6	2·1	..	End obscured by Ats.
		6 38·9	1·5	3 27·7	
Dec.					
1	3 52·3	3 55·4	0·6	0 16·5	
2	3 20·2	3 26·4	1·5	0 25·9	
3	7 58·3	8 04·5	16·4	..	
		8 38·0	1·0	1 21·7	
3	4 13·8	4 30·3	0·8	0 21·7	
4	11 05·4	11 10·6	17·0	..	
		11 30·0	3·5	1 45·6	
10	9 37·4	9 47·0	17·5	..	
		10 00·2	5·0	11 36·3	
11	3 57·0	4 04·2	0·7	0 20·5	
12	23 55·9	0 21·7	0·8	0 42·3	
13	12 25·6	12 58·6	1·6	1 16·5	
14	20 54·4	21 02·7	1·5	1 07·3	
16	14 55·3	15 26·3	5·1	..	
		15 41·8	3·5	2 17·6	
1911.					
Jan.					
2	22 59·7	23 05·9	14·0	1 52·7	
3	23 46·3	0 26·6	1·4	..	
4	..	1 05·9	1·5	2 33·8	
7	2 33·2	3 05·2	1·0	1 13·5	
8	16 24·7	16 27·8	0·8	Uncertain	End obscured by Ats.
8	9 26·8	9 32·0	2·5	..	
		9 41·4	1·5	0 38·2	
10	16 37·7	16 46·2	7·4	0 55·0	
16	9 08·8	9 37·8	1·0	0 41·4	
Feb.					
7	9 42·4	9 46·5	0·8	0 12·4	
7	9 59·9	10 02·0	0·6	0 10·4	
17	10 14·6	10 29·1	0·5	0 51·7	
17	23 23·9	23 50·8	2·0	0 47·6	
21	23 46·0	23 49·1	0·2	0 07·0	
25	16 12·7	16 17·1	0·8	0 01·5	
Mar.					
11	3 29·5	3 43·9	1·5	0 52·7	
17	9 28·2	9 30·3	1·0	0 07·3	
21	4 04·2	4 22·4	0·2	0 42·5	

1 mm. = 0·49″ tilt, static. B.P. = 14·5 seconds.

APPENDIX III.—SECONDARY TRIANGULATION.

MEASUREMENT OF ELTHAM–OKAIAWA BASE-LINE, TARANAKI.

[By J. LANGMUIR, Inspector of Surveys.]

As, with the exception of a better class of balance, the same apparatus was used in a similar manner as at the measurement of the Wairarapa base, reported upon last year, there is no necessity for a repetition of the description of method or gear used, but a few extra diagrams are given, which I think desirable, as supplementary to those published last year and for fuller information.

GEOGRAPHICAL POSITION OF BASE.

The southern terminal of the base, or Trig. Station B, Waimate Survey District, is about 39° 33′ south latitude, and 174° 11′ east longitude. The northern end of the base, or Eltham Trig. Station, is about 39° 25′ south latitude, and 174° 16′ east longitude.

SELECTION OF BASE.

The base was first suggested by Mr. H. M. Skeet, now Chief Surveyor, Invercargill, about March, 1897, when, as District Surveyor, he was carrying out the triangulation of the Taranaki District. At the time, in the ordinary sense of what was expected in the characteristics of a base-line, it had not

much to recommend it, but was the best that had presented itself, and as, as time went on, no better one could be found, it was finally examined and approved by the Surveyor-General, Mr. J. Strauchon, in October, 1909. Instructions for the measurement were issued on the 17th December, and on the 11th January following Mr. T. G. Sole, Office Surveyor, New Plymouth, started the preliminary ranging and preparation of the line, including the insertion of all the permanent marks, which work was carried out in a very satisfactory manner. The terminal marks are of the same description as those described last year. The intermediate permanent marks on the line are galvanized trig. tubes, bedded and set in concrete. Of these there are thirteen points so marked, distributed over the whole length of the line, seven of them being on public roads, where they will be readily available as standard points for Land Transfer and other surveys. The many stop-pegs along the line are of heart of totara, 2 ft. by 3 in. by 3 in., countersunk in all cases about 8 in. to 10 in., where they will last for many years, and will also be available as reference points.

Character of the Country.

The character of the country over which the base runs may be described as exceptionally rough for a work of this nature, as I think will be recognized by a study of the plan and section given in Fig. No. 2. In addition also to the natural roughness of the line, artificial obstacles in the shape of post-and-barb-wire fences and large boxthorn hedges were frequent, 120 fences of all descriptions having to be crossed in the course of the measurements.

Mr. Sole supplies the following information: The preparation survey was started on the 31st January, 1910, and completed on the 28th April following. Among the various works necessary thirty boxthorn or berberry hedges with ditches and banks had stiles built over them, and 21 chains of plank footways were required to cross streams, ponds, and swamps. The labour included, besides the building of stiles and bridges, the clearing and pegging of the line, taking down and re-erecting two minor trig. signals, concreting in the stones and tubes at the terminals, and also ten other tubes along the line. Mr. Sole also supervised the erection of the two large signals at both ends of the line, and before the practical work was put in hand he visited all the settlers along the line and obtained their consents in writing to the line being taken through their properties.

All the settlers through whose properties the line runs have to be thanked for the assistance given to its establishment by the ready permission given to traverse their properties, insert pegs and permanent tubes, cut back hedges, and for camping facilities.

Standard of Length.

The standard of length for the measurement of this line was the Imperial standard steel tape No. 4, deposited with its balance No. 4 in the District Survey Office, New Plymouth. This tape has been certified to by the Standards Branch of the Board of Trade, London, as being 0·001 in., or 0·000126 link, long at 62° Fahr. (see page 28 of report for the year 1909–10), or it is standard length at 61·798° Fahr. To verify the above, a comparison of this tape No. 4 with the Imperial Standard steel tape No. 1, Head Office, was made under the following conditions:—

1. The Imperial standard steel tape No. 1, with its certificated standard balance No. 2, were used in the laying-down of the comparator.
2. Four certificated thermometers, Nos. 263, 264, 265, 266, and two uncertificated, in light metal cases, were used. The latter, as far as they could be compared, were found to be in accord with the certificated thermometers, but, when working out the means, double values were given to those with certificates.
3. Twenty determinations of the comparator were made, involving 120 readings of the thermometers; ten of these determinations were made before the Imperial standard tape No. 4 was tested, and ten after the test was completed.
4. Twenty separate tests of the Imperial standard tape No. 4 were made, also involving 120 readings of the thermometers.
5. The conditions of weather and surroundings were practically perfect. The heavy-canvas comparator tent, used for the first time during the measurement of this base, amply vindicated its construction by the convenience it gave and the results obtained.

Results of the Tests.

The Imperial standard tape No. 4, by the Standards Branch of the Board of Trade, London, is Imperial standard 100 links at 61·798° Fahr., and the same tape by the above test standard 100 links at 61·767° Fahr.—difference, 0·031 of one degree Fahr., corresponding to a difference in length between tapes No. 1 and No. 4 of 0·000019 link. Although this comparison is exceedingly satisfactory, tests with the other district standard steel tapes will be necessary.

Comparison with Previous Triangulation Values.

Present determination	= 79605·1228 links.
Value by the original triangulation derived from the Waitara base, measured in 1878	= 79604·3 ,,
	0·8228 links.

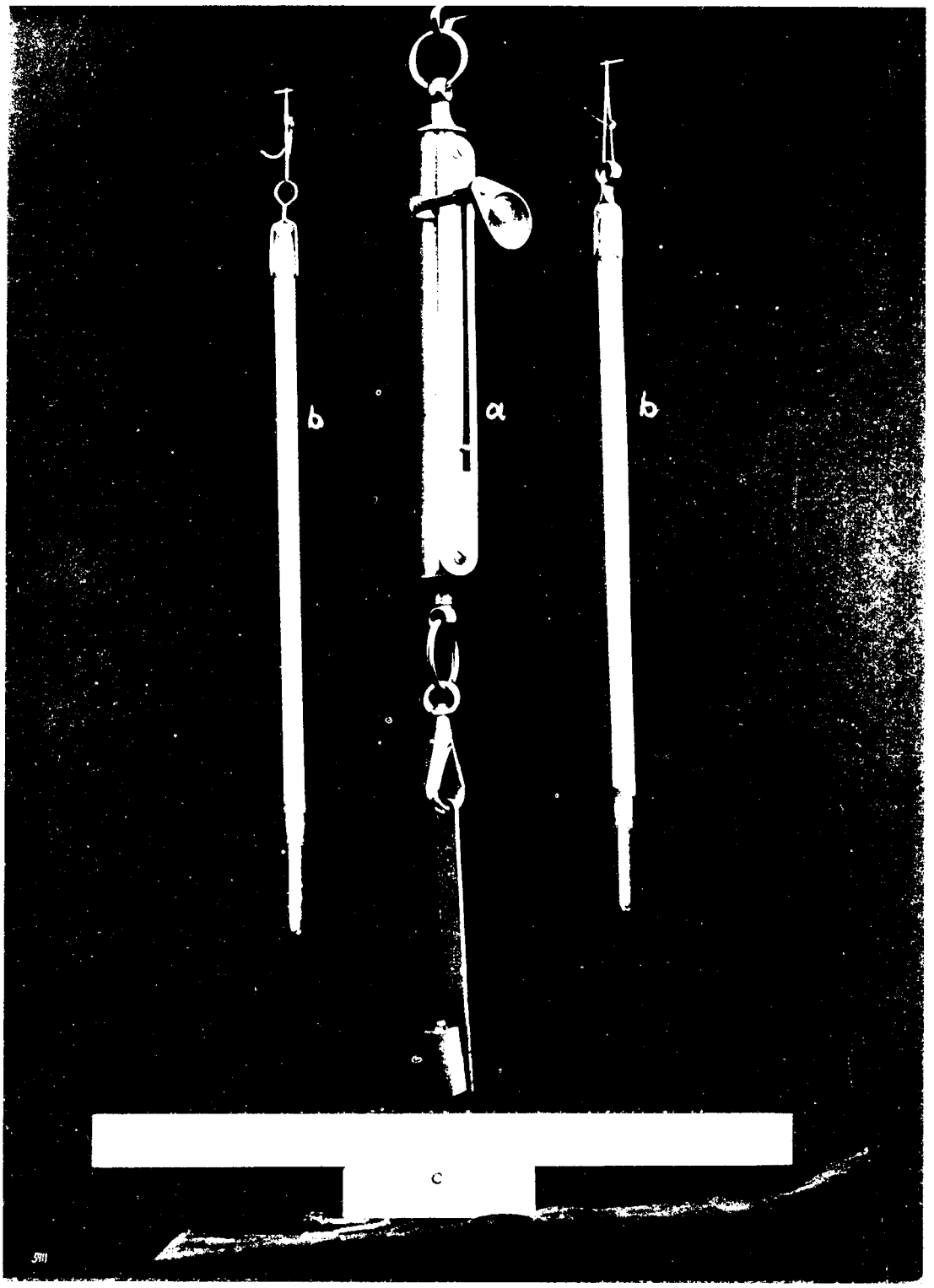
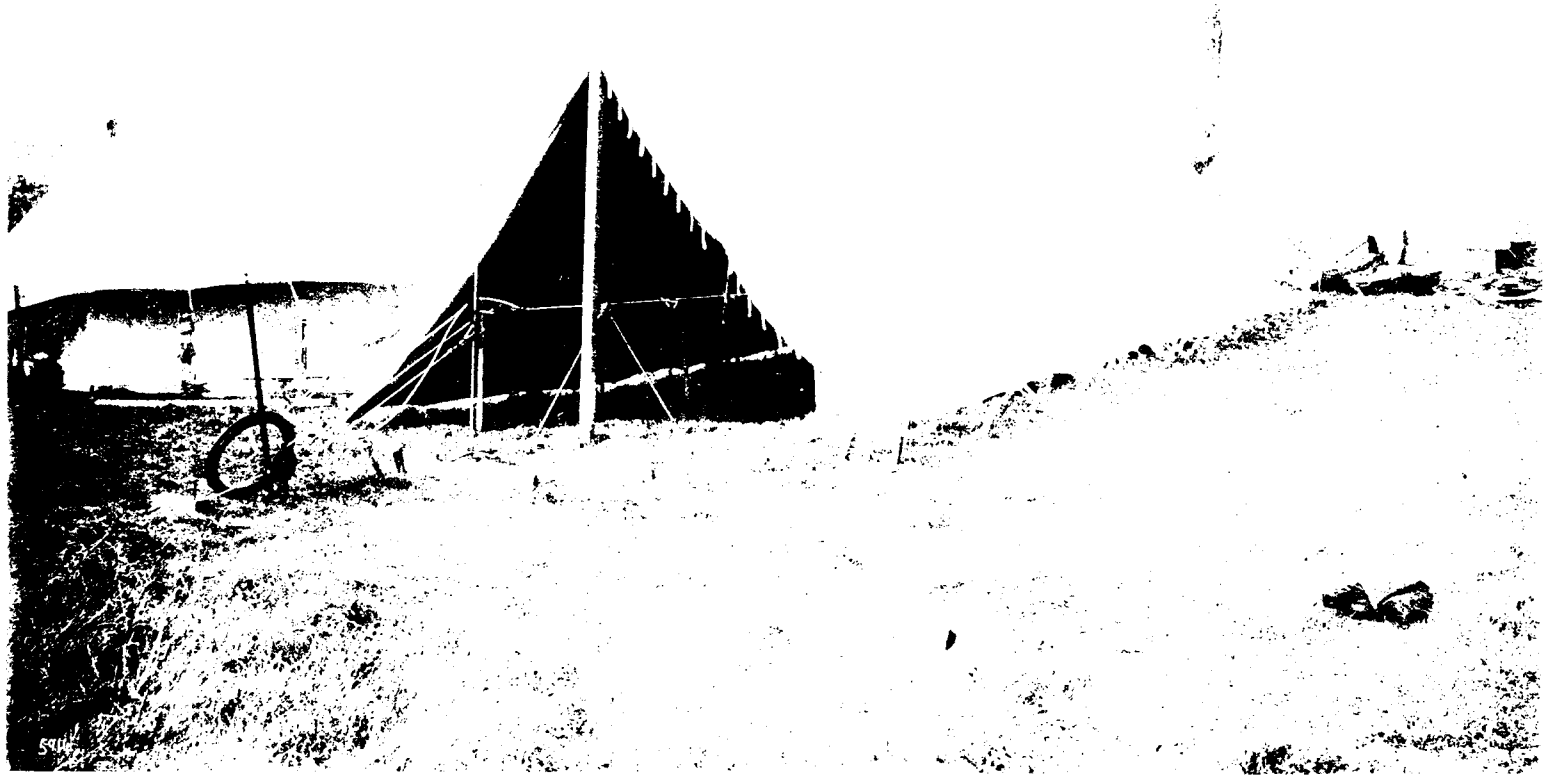


Fig. No. 3



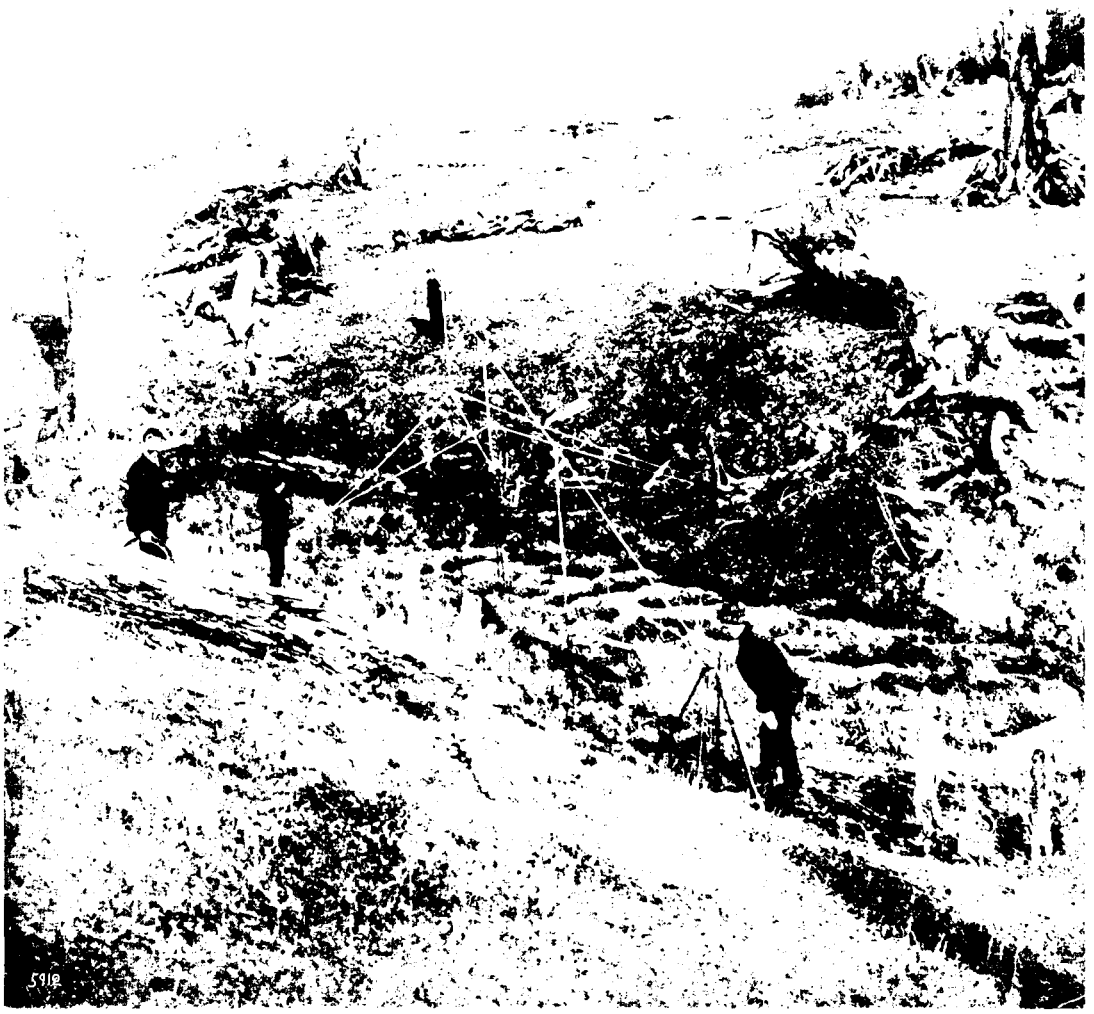


FIG. NO. 5.

A MEASUREMENT ACROSS A GULLY, WITH SUPPORTS IN POSITION; THOSE IN BOTTOM OF GULLY WERE UP TO 15 FT. ABOVE THE GROUND LEVEL.

FIG. NO. 6.

CARRYING TAPES FORWARD.

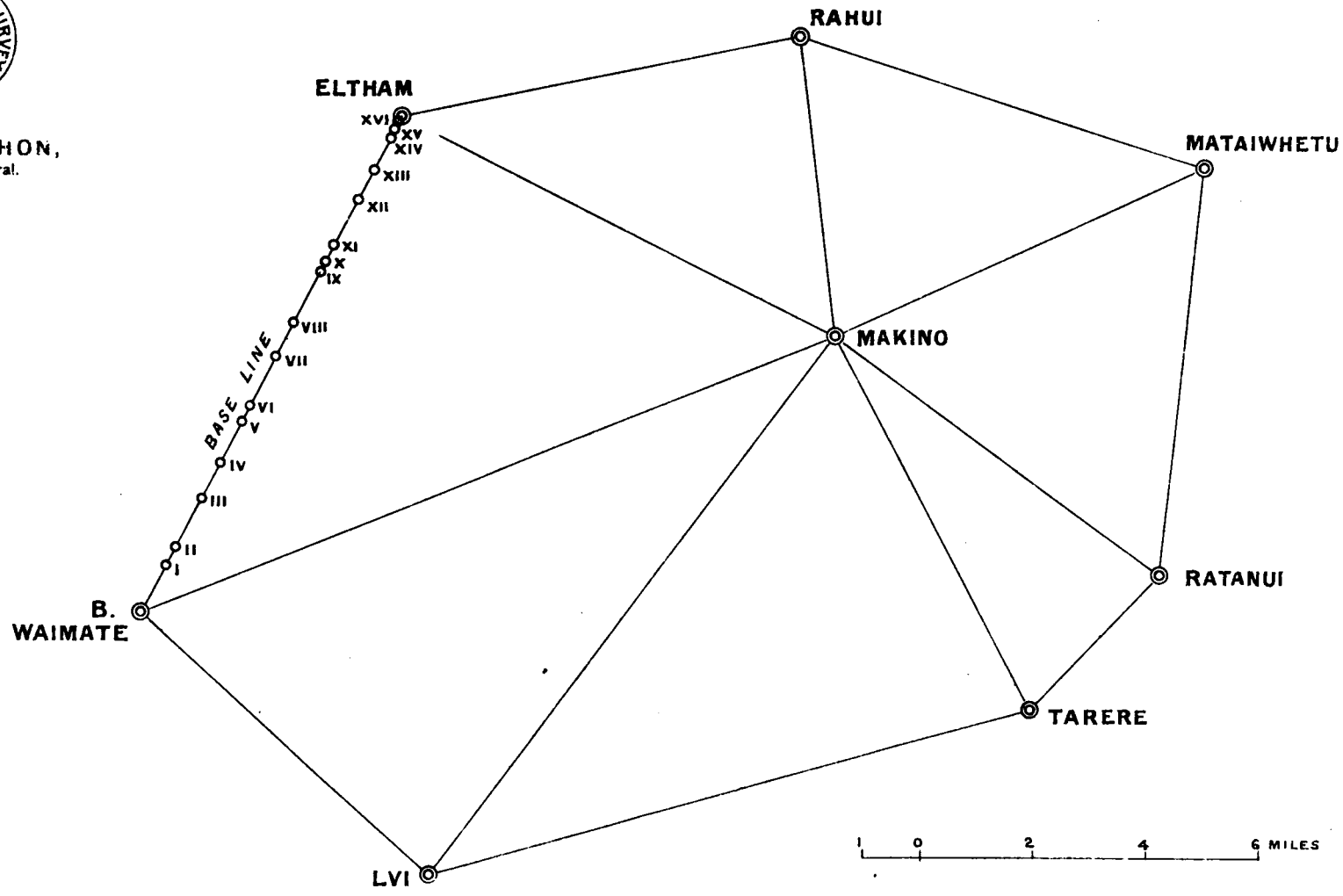
Fig. No. 8.

Nature of Country, looking North from Stop Peg (*aa*), Fig. 2, to Etchy — Trig. Station, on the Sky line.

ELTHAM–OKAIAWA BASE LINE.—Fig. 1.

N.Z. LANDS AND SURVEY

J. STRAUCHON,
Surveyor-General.



C.-1A.

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J. STRAUCHON.
Surveyor-General.

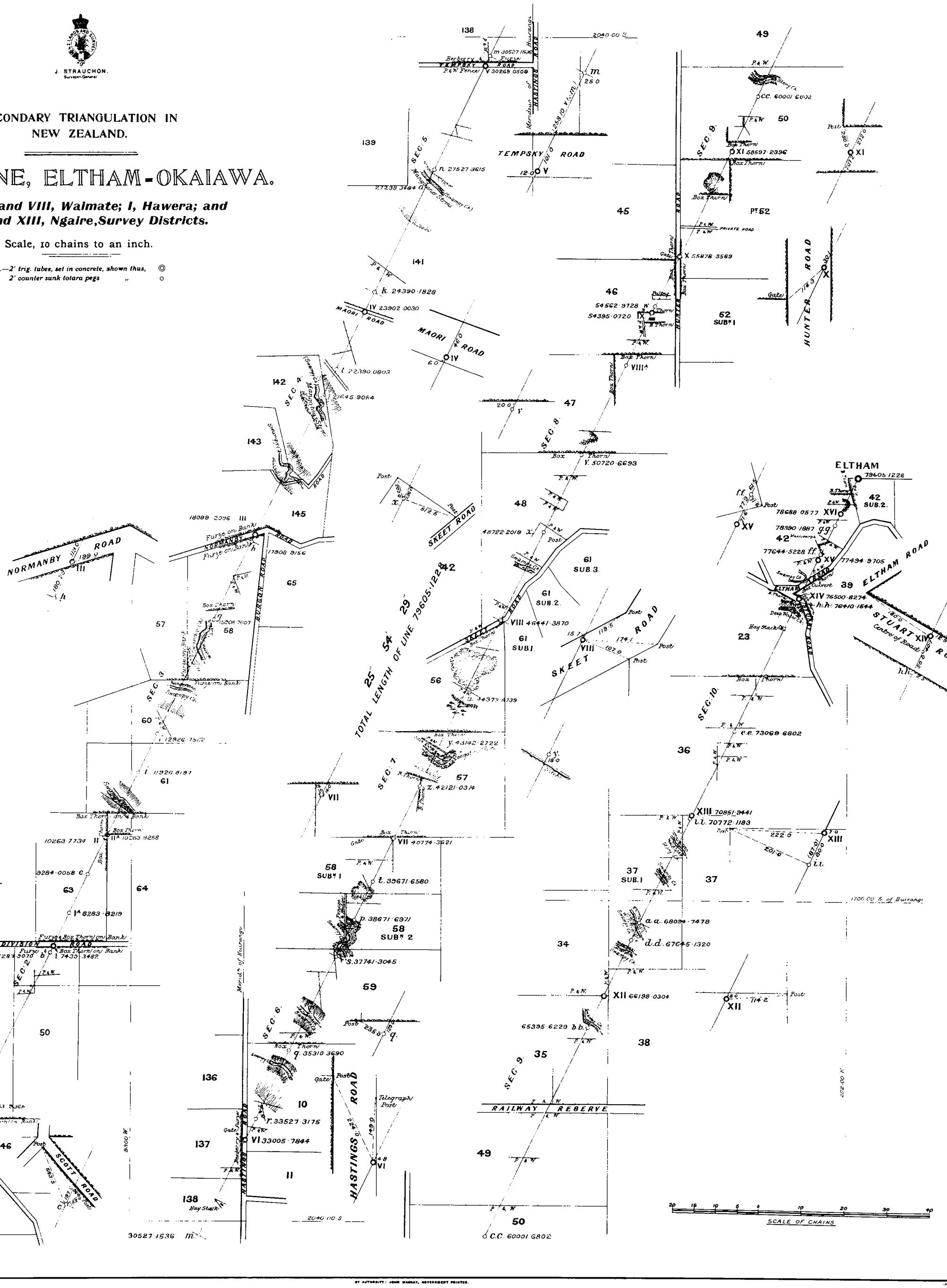
SECONDARY TRIANGULATION IN NEW ZEALAND.

BASE LINE, ELTHAM-OKAIAWA.

Blocks IV and VIII, Waimate; I, Hawera; and IX and XIII, Ngaire, Survey Districts.

Scale, 10 chains to an inch.

Note.—2' trig. tubes, set in concrete, shown thus, ◎
2' counter sunk totara pegs „ ○



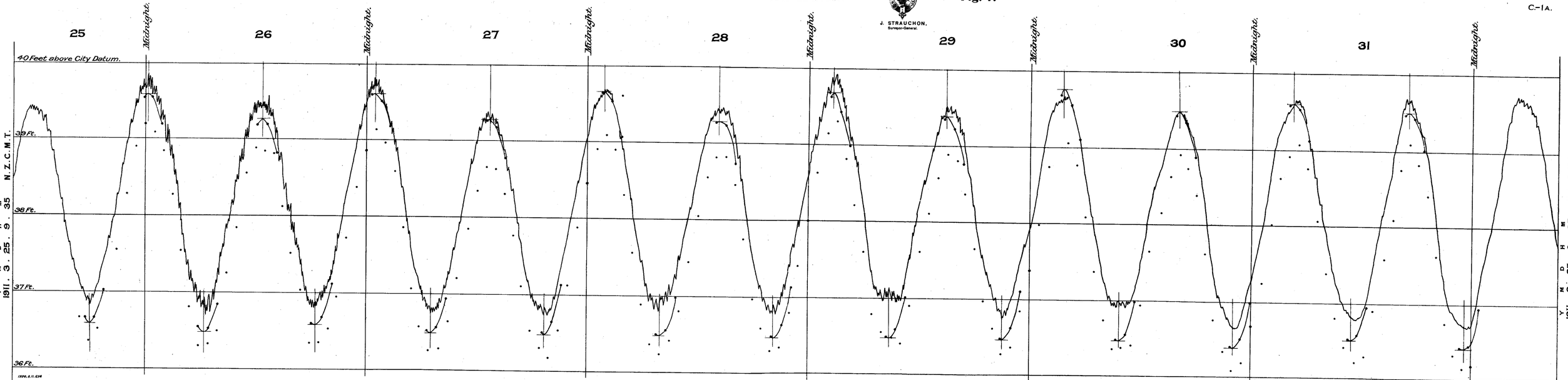
Drawn by E. Wood, June, 1911.

BY AUTHORITY: JOHN MACKAY, GOVERNMENT PRINTER.

1911. MARCH. *Fig. 1.*

J. STRAUCHON, Surveyor-General.

C–1A.

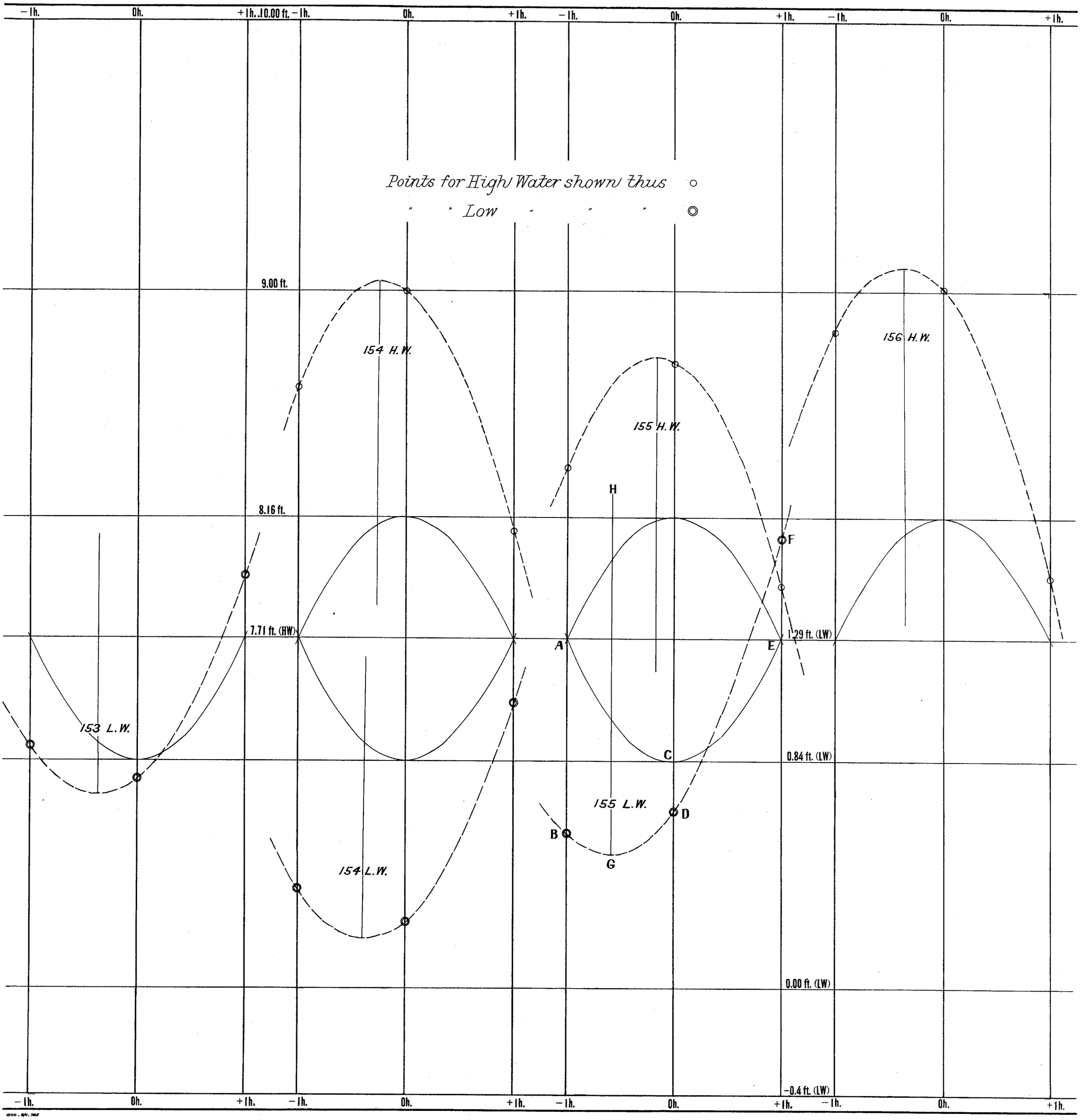


Predictions shewn in Red.

BY AUTHORITY: JOHN MACKAY, GOVERNMENT PRINTER.

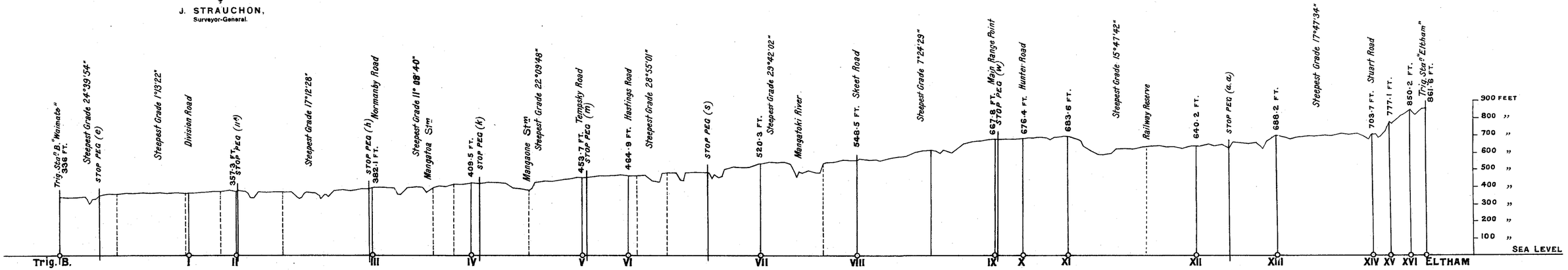
Fig. 2.

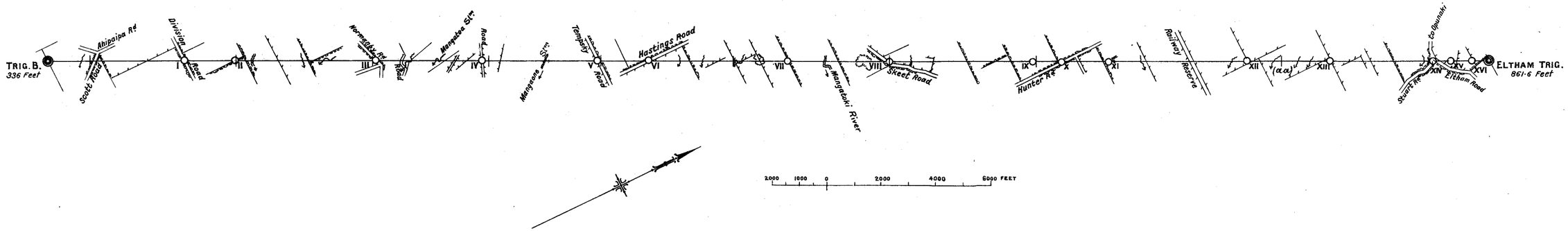
TIDAL SURVEY OF NEW ZEALAND.—Prediction of Tides for Auckland, 1912.



ELTHAM-OKAIAWA BASE LINE.—Fig. 2.

J. STRAUCHON,
Surveyor-General.





A. J.
1900.8/11.715

By Authority: John Mackay, Government Printer.

This close comparison is a very favourable coincidence, but in 1905 Messrs. Skeet and Bullard remeasured the Waitara base, with the following results :—

Mr. Skeet used a 10-chain band, weighing 2·5 lb., and under a strain of 14 lb.; Mr. Bullard used a 5-chain band, weighing 18 oz. 9 gr. under a strain of 14 lb. In both cases the bands were supported, at 1-chain intervals, about 3 ft. above the ground. The bands were in terms of the Imperial standard steel tape No. 4—the same reference tape as used for the present measurement.

	Links.
Value by Mr. Skeet	15944·712
Value by Mr. Bullard	15944·842
Difference	0·130
Mean	15944·777
Original length of the base as used in the triangulation of the Taranaki District and measured in 1878	15942·700
Difference	2·077

Now, if the line Eltham–B (Waimate) by the old triangulation is brought into terms of the amended value of the Waitara base by Messrs. Skeet and Bullard, the value will be 79614·671 (S.O., New Plymouth). Present measurement, 79605·123; difference, 9·548, representing about 0·96 of a link per mile.

The following tables and illustrations are forwarded :—

Table No. 1.—Results of the measurements.
Table No. 2.—Results of the comparison of the New Plymouth standard steel tape No. 4 with the Head Office Imperial standard steel tape No. 1.
Fig. No. 1.—Diagram showing the base net of triangles.
Fig. No. 2.—Plan and section of base.
Fig. No. 3.—Balance with reader, &c.
Fig. No. 4.—Canvas shelter-tent.
Fig. No. 5.—Measurement across a gully.
Fig. No. 6.—Carrying tapes forward.
Fig. No. 7.—Nature of country looking north from stop-peg (*aa*).
Fig. No. 8.—Nature of country looking south from stop-peg (*aa*).

I also forward two tracings, on a scale of 10 chains to an inch, giving all the detail mean measurements along the line, one copy being for the Taranaki District Office.

Table No. 1.—Results of Measurements, Eltham–Okaiawa Base, Taranaki.

No. of Section.	No. of Measurement.	No. of Tape.	Edge of Tape.	Date, 1910.	Direction.	Temperature-range.	Weather.	Individual Measurements at Sea-level and Means. (Equal Weights.)	Residuals Means, Measurements.	Probable Error of Arithmetical Means.	Remarks.
						Deg. Fahr.		Links.	Links.	Links.	
1	1	02	B	April 5	N.–S.	61–68	Strong south-west wind	2284·0880	— ·0015	..	Level and broken. Steepest grade, 24° 39′ 54″.
	2	03	B	,, ...	N.–S.	61–68	,, ...	2284·0932	— ·0067		
	3	02	A	April 6	S.–N.	61–68	Moderate south-west wind	2284·0827	+ ·0038		
	4	03	A	,, ...	S.–N.	61–67	,, ...	2284·0823	+ ·0042		
							4	·3462			
								2284·0865	..	± ·0017	1 in 1,343,580.
2	1	02	B	April 1, 2	N.–S.	61–68	Light south-east breeze	7999·8235	+ ·0157	..	Nearly level, good chaining ground. Steepest grade, 1° 13′ 22″.
	2	03	B	,, ...	N.–S.	61–68	,, ...	7999·8582	— ·0190		
	3	02	A	April 6, 7, 8	S.–N.	56–78	6th, south-west wind; 7th, fine calm;	7999·8416	— ·0024		
	4	03	A	,, ...	S.–N.	55–77	8th, fairly calm	7999·8335	+ ·0057		
							4	·33568			
								7999·8392	..	± ·0049	1 in 1,632,620.
3	1	02	B	April 13, 18, 19 ..	N.–S.	58–68	Wind stopped work on 13th; 18th, light	7624·9761	+ ·0137	..	Broken ground. Steepest grade, 17° 12′ 28″.
	2	03	B	,, ..	N.–S.	54–67	westerly winds; 19th, strong winds with showers	7624·9969	— ·0071		
	3	02	A	April 9, 11, 13 ..	S.–N.	56–79	9th, light south-west wind; 11th, south-	7624·9930	— ·0032		
	4	03	A	,, ..	S.–N.	55–80	west wind; 13th, high wind	7624·9932	— ·0034		
							4	·39592			
								7624·9898	..	± ·0031	1 in 2,459,717.
4	1	02	B	April 21, 22	N.–S.	55–66	Calm and at times light wind ..	6481·2583	+ ·0090	..	Level to broken. Steepest grade, 10° 08′ 40″.
	2	03	B	,, ...	N.–S.	54–66	,, ,, ..	6481·2543	+ ·0130		
	3	02	A	April 20, 21	S.–N.	58–69	20th, south-east wind; 21st, calm and	6481·2800	— ·0127		
	4	03	A	,, ...	S.–N.	58–75	light wind	6481·2765	— ·0092		
							4	·10691			
								6481·2673	..	± ·0043	1 in 1,507,300.
5	1	02	B	April 27, 28	N.–S.	53–61	27th, south-east breeze; 28th, light	6136·9603	+ ·0105	..	Undulating, level, and broken. Steepest grade, 22° 09′ 48″.
	2	03	B	,, ...	N.–S.	53–61	south-east wind	6136·9653	+ ·0055		
	3	02	A	April 28, 29	S.–N.	49–66	28th, light south-east wind 29th, light	6136·9766	— ·0058		
	4	03	A	,, ...	S.–N.	48–68	south-east wind	6136·9810	— ·0102		
							4	·38832			
								6136·9708	..	± ·0032	1 in 1,917,842.

6	1	02	B	May 11, 12	N.–S.	58–68	11th, calm with light rain; 12th, light south-west wind and showers	7214·1617	— ·0108	..	Level to broken. Steepest grade, 28° 55′ 01″.
	2	03	B	,, ...	N.–S.	57–70		7214·1581	— ·0072		
	3	02	A	May 12, 13	S.–N.	55–65	13th, cold with strong south-west wind	7214·1412	+ ·0097		
	4	03	A	,, ...	S.–N.	54–64		7214·1425	+ ·0084		
							4	·6035			
								7214·1509	..	± ·0036	1 in 2,003,976.
7	1	02	B	May 24, 25, 26 ..	N.–S.	53–62	24th, cold south-west wind, showers; 25th, south-west wind, frequent showers; 26th, strong south-west wind	8700·0912	— ·0087	..	Generally broken, with the steepest grade on the base, 29° 42′ 02″.
	2	03	B	May 27, 31	N.–S.	53–62	27th, strong south-west wind; 31st, south-east wind	8700·0949	— ·0124		
	3	02	A	May 17, 18, 19 ..	S.–N.	43–65	17th, south-west wind; 18th, light north-east wind; 19th, fine, calm	8700·0703	+ ·0122		
	4	03	A	,, ..	S.–N.	40–65		8700·0735	+ ·0090		
							4	·3299			
								8700·0825	..	± ·0042	1 in 2,071,448.
8	1	02	B	May 23, 24	N.–S.	46–60	23rd, fair day; 24th, cold south-west wind, showers	8121·5956	— ·0098	..	Undulating and level. Steepest grade, 7° 24′ 29″.
	2	03	B	,, ...	N.–S.	45–60		8121·6040	— ·0182		
	3	02	A	May 19, 21	S.–N.	50–58	Fine, calm	8121·5711	+ ·0147		
	4	03	A	,, ...	S.–N.	50–58	,, ...	8121·5724	+ ·0134		
							4	·23431			
								8121·5858	..	± ·0056	1 in 1,450,325.
9	1	02	B	June 6, 7, 8	N.–S.	51–67	6th, fine, calm; 7th, fair, light wind; 8th, light cold wind	13531·7756	— ·0006	..	Undulating and broken. Steepest grade, 15° 47′ 42″.
	2	03	B	,, ...	N.–S.	52–67		13531·7831	— ·0081		
	3	02	A	June 13, 14, 15, 16 ..	S.–N.	48–64	13th, fine, cold north-east wind; 15th, light wind, very cold, showers; 16th, cold south wind	13531·7653	+ ·0097		
	4	03	A	,, ..	S.–N.	48–63		13531·7761	— ·0011		
							4	·31001			
								13531·7750	..	± ·0025	1 in 5,412,877.
10	1	02	B	June 24, 25, 29 ..	N.–S.	46–54	24th, cold south-west wind; 25th, dull, with light wind; 29th, dull and cold, with light rain	11510·3605	+ ·0145	..	Level, undulating, and broken. Steepest grade, 17° 47′ 34″.
	2	03	B	,, ..	N.–S.	46–58		11510·3612	+ ·0138		
	3	02	A	June 20, 21, 22 ..	S.–N.	40–61	20th, light cold south wind; 21st, fine, with light south wind; 22nd, wind and rain	11510·3884	— ·0134		
	4	03	A	June 24	S.–N.	40–62	24th, dull cold south-west wind ..	11510·3900	— ·0150		
							4	·15001			
								11510·3750	..	± ·0055	1 in 2,092,866.
							Sum of arithmetical means ..	79605·1228	..	± ·0128	1 in 5,142,370.

TABLE NO. 2.—COMPARISON OF IMPERIAL STANDARD STEEL TAPE NO. 4 (NEW PLYMOUTH) WITH THE HEAD OFFICE, WELLINGTON, IMPERIAL STANDARD STEEL TAPE NO. 1.

Comparator laid down with the Imperial Standard Tape No. 1, using its Balance No. 2. Balance No. 2 also used at the comparisons of Tape No. 4.—2nd July, 1910.

No. of Test.	Observed Difference from Comparator.	True Value of Comparator.	Value of Tape at each Test from Columns (2) and (3).	Differences of Tape at each Test, from Imperial Standard 100 links.	Differences in Column (5) given in Degrees Fahr.	Mean Temperatures at Tests. Degrees Fahr.	Temperature at which Tape is Imperial Standard. Sums of (6) and (7).	Temperature at which No. 4 New Plymouth Standard Tape is Imperial Standard by the Standards Branch of Board of Trade.
(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)	(8.)	(9.)
	Links.	Links.	Links.	Links.	Deg.	Deg.	Deg.	Deg.
1	+ ·0003	99·99438	99·99468	— ·00532	8·512	53·12	61·632	61·798
2	+ ·0003	99·99438	99·99468	— ·00532	8·512	53·10	61·612	
3	+ ·0004	99·99438	99·99478	— ·00522	8·352	53·18	61·532	
4	+ ·0004	99·99438	99·99478	— ·00522	8·352	53·31	61·662	
5	+ ·0004	99·99438	99·99478	— ·00522	8·352	53·39	61·742	
6	+ ·0006	99·99438	99·99498	— ·00502	8·032	53·58	61·612	
7	+ ·00065	99·99438	99·99503	— ·00497	7·952	53·60	61·552	
8	+ ·0006	99·99438	99·99498	— ·00502	8·032	53·76	61·792	
9	+ ·0007	99·99438	99·99508	— ·00492	7·872	53·80	61·672	
10	+ ·0006	99·99438	99·99498	— ·00502	8·032	53·82	61·852	
11	+ ·0007	99·99438	99·99508	— ·00492	7·872	53·84	61·712	
12	+ ·0008	99·99438	99·99518	— ·00482	7·712	53·88	61·592	
13	+ ·0008	99·99438	99·99518	— ·00482	7·712	53·85	61·562	
14	+ ·0007	99·99438	99·99508	— ·00492	7·872	53·80	61·672	
15	+ ·0005	99·99438	99·99488	— ·00512	8·192	53·78	61·972	
16	+ ·0004	99·99438	99·99478	— ·00522	8·352	53·74	62·092	
17	+ ·00035	99·99438	99·99473	— ·00527	8·432	53·67	62·102	
18	+ ·0004	99·99438	99·99478	— ·00522	8·352	53·64	61·992	
19	+ ·00025	99·99438	99·99463	— ·00537	8·592	53·58	62·172	
20	+ ·0003	99·99438	99·99468	— ·00532	8·512	53·30	61·812	
						20	1235·340	
				Mean temperature at which No. 4 tape is Imperial standard ..		61·767		61·798
								61·767
				Difference between present test and test by Board of Trade				= 0·031

Twenty determinations of the comparator were made, involving 120 readings of the thermometer. Ten of these determinations were made before the Imperial standard tape No. 4 was tested, and ten after the test was completed.

At the twenty separate tests of the Imperial tape No. 4 scheduled, 120 readings of thermometers were also taken, and when working out the means in both cases double values were given to the certificated thermometers.

The standard reference tape for all measurements of the Eltham-Okaiawa base is the Imperial standard steel tape No. 4 deposited in the District Survey Office, New Plymouth, with its certificated balance No. 4. This tape and balance were tested by the Standards Branch of the Board of Trade, London, the tape being certified to as being 0·001 in. longer than Imperial standard at 62° (see page 23, Survey Report for the year 1909–10), or Imperial standard at 61·798° Fahr.

NOTE.—The whole of the work in connection with the above results was carried out under practically perfect conditions of weather, the day being densely cloudy and free from wind, drizzling rain falling at intervals. Comparator was laid down in shelter-tent. Six thermometers in all were used, four being certificated thermometers of the Department, Nos. 263, 264, 265, and 266, the two others being in accord with these, all being distributed along the length of the tape, hanging vertical, and with their bulbs touching same. The certificated thermometers were out of their copper tubes. Observers: R. T. Goulding at the rear end, J. Langmuir reading scale.

APPENDIX IV.

REPORT OF THE SURVEYORS BOARD.

THE Board, acting in conjunction with the six Australian Surveyors Boards, conducted examinations of candidates for surveyors' licenses in September, 1910, and March, 1911. At the September examination twenty-one candidates sat, and of these Mr. Geoffrey St. Vincent Keddell, Lands and Survey Department, Wellington, passed the examination; while Mr. Richard Samuel Thompson, Dunedin, Mr. William Moody Gray, Lands and Survey Department, Christchurch, and Mr. Robert Thomson Goulding, Auckland, who had previously passed in some of the subjects, completed their examinations.

At the March examination there were eighteen candidates, of whom the following completed their examinations: Mr. Hugh Montgomery Thompson, Lands and Survey Department, Hokitika; Mr. William Prentice Black, Dunedin; Mr. John Patrick Larkin, Te Kuiti; Mr. Robert Mitchell McIver,

Christchurch; Mr. John Dennis Jack, Wellington; Mr. Harben Robert Young, Assoc.M.Inst.C.E., Westport; Mr. Robert McGregor Mowat, Wairoa, Hawke's Bay; and Mr. Roland Evelyn Fry, Auckland. The Board issued certificates of competency and licenses to the successful candidates.

The deaths of the following licensed surveyors were reported: Robert Campbell, Whangaroa; Ernest Combes, Blenheim; August Philip Mason, Wellington; Francis Pavitt, Devonport; George John Roberts, Hokitika; and Frank Blackwood Sewell, Federated Malay States.

The Board for 1911 consists of Mr. J. Strauchon, Surveyor-General, *ex officio;* Mr. Thomas Humphries, President of the New Zealand Institute of Surveyors, Lower Hutt; and Mr. T. N. Brodrick, Chief Surveyor, Christchurch, nominated by the Minister of Lands; Mr. H. Sladden, Wellington; and Mr. J. W. Harrison, Auckland, nominated by the Council of the Surveyors' Institute. At the first meeting of the Board, Mr. J. Strauchon was unanimously elected Chairman.

The list of licensed surveyors, now numbering 447 as at 1st January, 1911, was published in the *Gazette* on 26th January, and copies of the list were supplied to surveyors on application being made for them.

The Canterbury College advised the Board that a course in surveying is now being provided at Canterbury College under the direction of Mr. W. F. Robinson, licensed surveyor, and particulars of the subjects taught in the course—which extends over two years—were also supplied. The College applied for some recognition of this course in the form of a reduction in the time which has to be spent under a licensed surveyor by a candidate for examination. The Board resolved to grant the following concessions to Canterbury College students who have passed all the subjects of examination in the surveying course at Canterbury College, provided the lecturer is a licensed surveyor of New Zealand, and so long as the course of instruction has the approval of the Board—namely, the same concessions as are given to graduates in civil or mining engineering as provided in Regulation 6 (*d*) [*i.e.*, candidates must be professionally employed in the field to the satisfaction of the Board for a period of two years with a qualified surveyor or surveyors in private practice]. The Board also resolved to grant exemption in physics, geology, and mathematics (including spherical trigonometry) to any student who has passed in these subjects at Canterbury College in the surveying course.

The Board held an inquiry under section 16 of the Surveyors Institute and Board of Examiners Act, 1908, into certain alleged errors and misrepresentations of surveys executed by Mr. George Whitcombe, licensed surveyor, Kawhia, with the result that, after hearing all the available evidence, Mr. Whitcombe's license was suspended for two years from 21st September, 1910.

The papers for the September examination were set by the Tasmanian Board, while those for the March examination were set by the Victorian Board.

A Conference of Surveyors Boards was held at Hobart, Tasmania, in January, 1911, at which Mr. J. Strauchon, Surveyor-General and Chairman of the Board, and Mr. Thomas Humphries, President of the New Zealand Institute of Surveyors and a member of the Board, were the Board's representatives. An abridged report of the important business transacted thereat is published in the *New Zealand Surveyor*, Wellington, for March, 1911. At this Conference Mr. A. A. Spowers, Surveyor-General of Queensland, and Mr. E. A. Counsel, Surveyor-General of Tasmania, were selected as the representatives of Australia and New Zealand to attend the Conference of Surveyors-General in London, in May, 1911.

The Board authorized Mr. C. Hastings Bridge (a former member, and now on a visit to London) to afford the representatives any information on New Zealand methods and practice of surveying should they request him to do so.

The total number of cadets and articled pupils is now forty-four.

JOHN STRAUCHON, Chairman.
Wellington, 31st March, 1911. C. E. ADAMS, Secretary.

APPENDIX V.

TIDAL SURVEY.

[By C. E. ADAMS, M.Sc., F.R.A.S., Chief Computer.]

HARMONIC ANALYSIS.

THE records for the year 1909 of the Wellington self-registering tide-gauge have been harmonically analysed, using the tidal abacus of Sir G. H. Darwin, K.C.B., F.R.S.* There were a number of breaks in the record, aggregating four weeks, and ranging from fifteen minutes to four days. It was necessary to interpolate the missing records, and the method adopted was to make tracings of the tidal curve both twenty-nine days before and twenty-nine days after the break, superimpose one tracing on the other after adjusting them for the exact period of 28 days 23 hours 33 minutes,† and then to draw the mean curve from the two tracings, fit it into the break, and measure it. As the record on the Wellington tide-gauge‡ differs from most others, a full-size diagram is given in Fig. No. 1. It will be noticed that the record is on unruled paper. All straight lines have been drawn after the paper was removed from the gauge. Formerly the times at which the record starts and ends were marked on the sheet, and the other times were interpolated between them, on the assumption that the gauge-clock has a uniform rate. Experience has shown that sometimes the rate of the clock is altered by vibration of the shed in which it is housed, and to improve the time-control the pencil-carriage has recently been connected electrically with the mean-time clock of the Hector Observatory, so that at every mean solar hour an independent mark is made on the record-sheet, exactly 1·14 in. from the pencil. These

* Scientific Papers: Vol. I, Oceanic Tides, p. 216. † U.S. Coast and Geodetic Survey Report, 1907, p. 492.
‡ Trans. N.Z. Institute, Vol. xli (1908), p. 407.

marks are shown in the figure. Consequently it is now no longer necessary to interpolate between the starting and ending times on the record-sheet. The scales on the diagram are—vertical, 1 in. to 6 in.; horizontal, 6 in. to 1 day. The ordinates were measured twice independently at every mean solar hour, and the measurements called over and checked. The additions on the abacus were done by means of the Mercedes adding-machine, which has been of invaluable assistance in this work, and in every set of additions the gross totals were checked for each tide before the abacus was arranged for the next tide. The whole of the analysis has been done in duplicate, and independent checks have been applied wherever possible. It is hoped, therefore, that no serious errors remain undetected.

As the Millionaire and the Brunviga printing calculating-machines were largely used in the analysis, a number of abbreviations were introduced on the printed computation forms: thus, it was found to be unnecessary to enter the individual products in columns vi, vii, ix, x, xvi, xviii, in the analysis of M, for it was easy with the machine to obtain the final sum without recording the intermediate results; and similarly for the other tides; and in the S series the constant divisions by 12 and 30 were postponed until the final result was reached. On sheets 11 and 12, the natural tangents of ζ were obtained on the machines, and then the valuable tables of Professor O. Lohse (Tafeln für numerisches Rechnen mit maschinen, Leipzig, Verlag von Wilhelm Engelmann, 1909) were used to obtain ζ in degrees and decimals. These tables give the trigonometrical functions (sin, csc, tan, cot, sec, and cos) for each hundredth of the degree to five decimals, and are invaluable for this work; they also contain tables of reciprocals of numbers, squares, and square roots, &c. The table of square roots is most conveniently arranged, and gives opposite the argument a both $\sqrt{a}$ and $\sqrt{10a}$. The first differences are given both in the trig. functions and in the square-root table. In calculating H, it was found most convenient to square A and B and sum the results on the machine, and then to use the square-root table. An independent analysis for the S series was carried out, using the gross totals from sheet 1, and adding in the values of the omitted days, the results compared as under:—

Tide.		Abacus, Sheet 11.	Independent Analysis.	Differences.
		Ft.	Ft.	Ft.
S_1	B_1	+·0026	+·0020	+·0006
	A_1	-·0048	-·0048	0·0000
S_2	B_2	-·0506	-·0575	+·0069
	A_2	+·0994	+·1018	-·0024
S_4	B_4	+·0001	+·0001	0·0000
	A_4	-·0051	-·0051	0·0000
S_6	B_6	-·0043	-·0044	+·0001
	A_6	+·0023	+·0022	+·0001

Harmonic Tidal Constants for Wellington, New Zealand, 1909.

Latitude, 41° 17′ S.; longitude, 174° 46′ E.

A_0		37·931 ft.	Q	H	0·036 ft.
S_1	H	0·005		κ	26·35
	κ	151·36	L	H	0·093
S_2	H	0·112		κ	141·99
	κ	332·98	N	H	0·431
S_4	H	0·005		κ	95·47
	κ	181·34	ν	H	0·125
S_6	H	0·005		κ	107·37
	κ	298·67	μ	H	0·082
M_1	H	0·007		κ	81·28
	κ	30·85	R	H	0·024
M_2	H	1·594		κ	169·69
	κ	133·65	T	H	0·056
M_3	H	0·022		κ	317·20
	κ	184·01	MS	H	0·039
M_4	H	0·030		κ	137·58
	κ	275·89	2SM	H	0·039
M_6	H	0·013		κ	19·73
	κ	76·55	Mm	H	0·116
O	H	0·110		κ	260·23
	κ	33·66	Mf	H	0·048
K_1	H	0·078		κ	172·03
	κ	77·59	Msf	H	0·161
K_2	H	0·042		κ	60·87
	κ	312·25	Sa	H	0·049
P	H	0·023		κ	201·65
	κ	53·04	Ssa	H	0·073
J	H	0·007		κ	165·59
	κ	143·21			

Values of H are in English feet, κ in degrees.

These values are corrected for the errors made in the printed computation forms supplied by the Cambridge Scientific Instrument Company (see Proc. Roy. Soc., Series A., Vol. 84, No. A 572, "On a Mi take in the Instructions for the Use of Certain Apparatus in Tidal Reductions," by Sir G. H. Darwin, K.C.B., F.R.S.).

Other Values of the Harmonic Tidal Constants for Wellington, New Zealand.
Latitude, 41° 17′ S.; longitude, 174° 46′ E.

		(1.)	(2.)
A_0			37·742
S_2	H	0·089	0·108
	κ	325	308
M_1	H	0·007	
	κ	106	
M_2	H	1·598	1·702
	κ	137	123
M_4	H	0·045	
	κ	332	
M_6	H	0·015	
	κ	135	
O	H	0·099	0·121
	κ	36	194
K_1	H	0·085	0·071
	κ	81	275

		(1.)	(2.)
K_2	H	0·060	0·029
	κ	339	308
P	H	0·028	0·023
	κ	67	275
Q	H	0·019	
	κ	13	
L	H	0·034	
	κ	71	
N	H	0·353	0·449
	κ	104	83
ν	H	0·068	
	κ	108	
Sa	H	0·241	0·073
	κ	54	295
Ssa	H	0·035	0·204
	κ	240	212

1. Tide Tables for the year 1911, p. 456, U.S. Coast and Geodetic Survey, Washington: Hourly ordinates for one calendar year, 1894.

2. Harmonic Tidal Constants for certain Chinese and New Zealand Ports, by Thomas Wright, Proc. Royal Society, London, A. Vol. 83, p. 127: Times and heights of high and low water for the year 1901.

PREDICTION.

The predictions depend on a graphic method, controlled by calculation. Schedule No. 1 is prepared giving the times of high and low water of the M_2 tide throughout the year. Column 1 gives the consecutive number of the M_2 high water; column 2, the month; column 3, the day of the month; column 4, the state of the M_2 tide, high or low water; column 5, the mean solar times in hours and decimals of M_2 high and low waters; column 6, the correction to the M_2 times as obtained from diagram (see Fig. 2); column 7, the corrected time of high and low waters of the tide; column 8, the heights in feet and decimals as scaled from the diagram (see Fig. 2); column 9, the correction to the heights due to the long-period tides; column 10, the corrected heights of high and low water.

The times in column 5 are New Zealand civil mean time: 0 h. is midnight, 12 h. is noon, and 24 h. is midnight. Beginning with the time of the first high water of M_2 after noon on 1st January, 1912 —*i.e.*, 16·12 hours—and adding to it on the calculating-machine the interval between the M_2 times of high and low water (= 6·2103006 h.), the other times in column 5 are readily obtained. Independent checks are applied periodically.

Schedule No. 1.—Example for Auckland Tides for Year 1912.

Tide.	Month.	Day.	State of Tide.	M_2 Time.	Correction from Diagram.	Corrected Time.	Height from Diagram.	Correction from long period tides.	Corrected Height.
(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(7.)	(8.)	(9.)	(10.)
				h.	h.	h.	Ft.	Ft.	Ft.
0	January ..	1	H.	16·12					
			L.	22·33					
1	,, ..	2	H.	4·54					
			L.	10·75					
2	,, ..	3	H.	16·96					
153	March ..	20	H.	20·47	− 0·04	20·43	8·54	− 0·14	8·40
	,, ..	21	L.	2·68	− 0·36	2·32	0·71	− 0·14	0·57
154	,, ..	21	H.	8·89	− 0·19	8·70	9·03	− 0·14	8·89
	,, ..	21	L.	15·10	− 0·36	14·74	0·16	− 0·14	0·02
155	,, ..	21	H.	21·31	− 0·20	21·11	8·76	− 0·14	8·62
	,, ..	22	L.	3·52	− 0·59	2·93	0·48	− 0·14	0·34
156	,, ..	22	H.	9·73	− 0·36	9·37	9·10	− 0·14	8·96

Schedule No. 2 gives the differences between the high-water times of M_2 and of each of the component tides at intervals of ten M_2 tides. The initial entries are obtained from the following table, for Auckland, 1912, 1st January :—

Tide.	κ	V_0+u.	$\zeta = \kappa-(V_0+u)$.	Speed.	ζ Speed.	Difference from M_2 Time.
	Deg.	Deg.	Deg.	Deg.	h.	h.
M_2	204·9	85·58	119·32	28·9841042	4·1167	..
N_2	174·3	131·94	42·36	28·4397296	1·4895	− 2·6272
S_2	265·3	0·00	265·30	30·0000000	8·8433	+4·7266
&c.						

The intervals between high waters are:—

	h.	Difference from M_2.	10 times Difference.
		h.	h.
M_2	12·42060122		
N_2	12·6583482	+0·2377470	+2·37747
S_2	12·0000000	−0·4206012	−4·206012
&c.			

Hence, in forming the column for N_2 the initial value − 2·6272 is set on the calculating-machine and ten times the difference (= 2·37747) added continuously. When the values in the N_2 column exceed the interval between the N_2 high waters, an adjustment is made as shown at tide No. 70, where the interval 12·6583 is subtracted. This always keeps the intervals between the M_2 and N_2 high waters small, and is a convenience when adjusting the N_2 tide in place on the table as described below. In a similar way the other columns are filled up.

Schedule No. 2.—Auckland, 1912.

Tide No.	N_2	S_2	K_1	M_4	K_2	ν_2
	h.	h.	h.	h.	h.	h.
0	− 2·63	+ 4·73	− 5·40	+ 0·42	− 1·74	− 2·27
10	− 0·25	+ 0·52	− 9·93	+ 0·42	− 6·27	− 0·22
20	+ 2·13	− 3·69	− 14·47	&c.	− 10·80	+ 1·83
			K_1 = 23·93			
			+ 9·46			
30	+ 4·51	− 7·89	+ 4·93	..	− 15·34	+ 3·89
					K_2 = 11·97	
					− 3·37	
40	+ 6·88	− 12·10	+ 0·40	..	− 7·90	+ 5·94
		S_2 = 12·00				
		− 0·10				
50	+ 9·26	− 4·30	− 4·13	..	− 12·44	+ 8·00
					K_2 = 11·97	
					− 0·47	
60	+ 11·64	− 8·51	− 8·67	..	− 5·00	+ 10·05
70	+ 14·02	− 12·72	− 13·20	..	− 9·54	+ 12·10
	N_2 − 12·66	S_2 = 12·00	K_1 = 23·93			
	+ 1·36	− 0·72	+ 10·73			
80	+ 3·73	− 4·92	+ 6·20	..	− 14·07	+ 14·16
					K_2 = 11·97	ν_2 = 25·26
					− 2·10	− 11·10
90	+ 6·11	− 9·13	+ 1·67	..	− 6·64	− 9·04
100	+ 8·49	− 13·33	− 2·87	..	− 11·17	− 6·99
&c.		S_2 = 12·00				
		− 1·33				

On a table 12 ft. by 3 ft. a sheet of tracing-cloth is laid down, and on the cloth at intervals of 6·2103 in. lines are drawn across to represent, on a scale of 1 in. to 1 hour, the times of M_2 high and low waters. Parallel to and 1 in. distant from these lines other lines are drawn to represent the times 1 hour before and 1 hour after the M_2 high- and low-water times. (See Fig. 3.) On separate sheets of tracing-cloth 14 ft. long by 8 in. wide the N_2, S_2, K_1, M_4, K_2, and ν_2 tides are drawn to a scale of 1 in. to 1 hour longitudinally and 5 in. to 1 ft. transversely. To set these curves in their correct relative positions reference must be made to Schedule No. 2. Thus, for N_2 it is seen that its H.W. takes place at − 2·63h., that is, 2·63 hours before M_2 high water; accordingly the N_2 curve is placed so that its H.W. is 2·63 in. to the left of the M_2 H.W. At the other end of the table, at the 10th M_2 H.W., the N_2 H.W. is checked from Schedule No. 2, and is 0·25h. earlier than the M_2 H.W. In a similar manner the curves of the other tides are arranged and clamped to the table.

The ordinates of the curves are next measured graphically on strips of paper, at − 1h., 0h., and + 1h. from each M_2 high and low water; the transverse lines on the lowest sheet of tracing-cloth enable this to be readily done, and the resulting sum shows the correction to the M_2 curve. In Fig. 2 are shown portions of the M_2 curve drawn to scales of 2 in. to 1 hour and 5 in. to 1 ft.—*i.e.*, the same scale for heights as the other curves. Thus, in the case of the 155th low water, A C E represents part of the M_2 curve and AB, CD, and EF are the corrections due to the other tides obtained graphically from Fig. 3. The points B, D, and F then represent points on the curve of the tide, and it remains to determine the time and height of low water. For this purpose a series of template curves $h = (H_m + 0{\cdot}2\,k)\cos i$ are drawn on separate pieces of tracing-cloth. h is the ordinante of the curve; H_m is the semi-range of the M_2 tide; k is an integer from + 7 to − 7; i is the speed of the M_2 tide in degrees per mean solar hour.

One of the templates is now selected, and, keeping the line G H parallel to the hour-lines, the curve is adjusted until it passes through the points B, D, and F as shown in red on Fig. 3. The point G then represents the position of low water, and the correction to the M_2 low-water time is obtained

by scaling the distance of G from the 0h. line. The datum for heights is the Admiralty one, and is 4·5 ft. below mean sea-level for Auckland. The height is scaled from the diagram. The following template curves are shown on the diagram in red :—

Tide.	Template, Value of k.	Tide.	Template, Value of k.
153 L.	− 1 ..	154 H.	+ 7
154 L.	+ 1 ..	155 H.	+ 7
155 L.	+ 1 ..	156 H.	+ 7

In practical work an excellent check is afforded by noting the value of k in the templates used. Any sudden variation in k is at once investigated and traced to its source. In this way errors are easily detected.

Check of Predictions.

To check the Wellington predictions, the tide-record for 1911, March 25 to 31, has plotted on it in red the results obtained from a diagram similar to Fig. 2. It will be noted how well the times of high and low water agree with actuality, while the heights also agree very fairly.

As so much plotting from co-ordinates is required a co-ordinatograph is being obtained, and when that instrument is available a number of improvements will be effected. Thus the K curves will be associated together and the combined curve drawn, and similarly in other cases, and, instead of the M_2 curve only being used on the diagram, all the M curves will be used. But for the present it has been found simpler to keep the curves separate.

Datum Levels.

In the report on Datum Levels drawn up by Sir G. H. Darwin (British Association Report for 1886, pp. 40–58, reprinted in Scientific Papers Vol. 1, p. 97, by Sir G. H. Darwin), a description of a datum to be called the " Indian spring low-water mark," is given. And in the Tide Tables for 1911, published by order of the Lords Commissioners of the Admiralty, p. vi, this datum has been adopted for places where there is a large diurnal inequality. The datum suggested is to be below mean sea-level a distance equal to the sum of the mean semi-ranges of the tides M_2, S_2, K_1, and O. Thus for Wellington—

Tide.	Semi-range. Ft.
M_2	1·594
S_2	0·112
K_1	0·078
O	0·110

the suggested datum is 1·894 ft. below mean sea-level. But this takes no account of the relatively large N tide (H = 0·431 ft.); nor of L (H = 0·093 ft.); ν (H = 0·125 ft.); μ (H = 0·082 ft.); which are all larger than the K_1 tide (H = 0·078 ft.). Perhaps it might be well to define the datum as being below mean sea-level a distance equal to the sum of the mean semi-ranges of *all* the short-period tides. Or, for practical purposes, it might be sufficient to include only those short-period tides whose semi-ranges are greater than one-tenth of the M_2 semi-range.

List of Automatic Tide-gauges in New Zealand.

Tide-gauges from which continuous records are obtained are established at Auckland, Wellington, Lyttelton, Port Chalmers, Dunedin, Bluff, Westport, and Greymouth ; while at Napier and Wanganui the records are irregular, owing to the exposed positions of the gauges.

Level Bench-marks.

A start has been made with a precise levelling survey, and over twenty bench-marks established between the Wellington Harbour Board tide-gauge on Jervois Quay, Wellington, and the Public Works Department tide-gauge at Seatoun. (See Fig. 4 for the situation of the bench-marks and their heights, which are in terms of the Wellington City datum.) The mean sea-level as determined from hourly ordinates of the Wellington tide-gauge for 1909 was 37·931 ft. in terms of the same datum.

Mr. Frank C. Hay, Assoc.M.Inst.C.E., Assistant Engineer of the Public Works Department, carried out the levelling with a high degree of precision.

Other Methods of Harmonic Analysis of Tidal Observations.

As opportunity offers other methods of harmonic analysis are investigated. Among them Dr. Börgen's* method has been tried, and a complete example of the analysis of the K_2 tide is given.

The observations submitted to analysis are those given in the Great Trigonometrical Survey of India, Vol. xvi, and are hourly observations for Bombay for the year 1884. The hourly observations were first summed continuously throughout the year, and were cut down to one decimal of a foot and written out in a list of sums as under :—

Day.	h. 0	h. 1	h. 2		h. 22	h. 23
0	155	130	91	..	142	161
1	322	284	213	..	260	308
2	488	454	365	..	349	429
367	43697	43809	41081	..	40413	42754
368	43834	43194	41160	..	40544	42896

* Ueber eine neue Methode, die harmonischen Konstanten der Gezeiten abzuleiten, Von Admiralitätsrath Prof. Dr. Börgen, Annalen der Hydrographie und Maritimen Meteorologie, Juni, Juli, August, 1894.

The figures in the list are given in tenths of a foot. The method consists in selecting from the list the particular days that will give the best values of the tide sought, at the same time eliminating the effect of the S tides and reducing the effect of the other tides as much as possible.

Example for K_2 tide :—

If the following lines are used from the list—

(185–97) – (96–8),

i.e., equal intervals of 88 days—then the S tides are completely eliminated and the maximum value is obtained for the K_2 tide.

If the following lines are used when the observations extend over a year, a further value is obtained :—

(362–274) – (273–185).

The selection of these lines and the sums from the list is shown in detail on the schedule, giving the twenty-four values of D, which are subjected to analysis. S_t and S_6h+_t are next formed, and then Δ_t.

The calculation of the values of $F^1 = \sum_0^5 \Delta_t \sin (9+t)i$ and $G^1 = \sum_0^5 \Delta_t \cos (9+t)i$ is most readily done on the calculating-machine, and the printed record obtained on the arithmotype is very useful for checking from. The corrections due to the tides M_2, N, L, ν, T, and R are calculated and applied to F and G. The rest of the calculation is shown on the schedule, where comparisons with the results in Vol. xvi of the Indian Survey, p. 296, are also given, the differences in the values of κ and R being 4°·745 and 0·0020 ft.

Reference must be made to Dr. Börgen's paper for details of the method. The whole of the calculation is, however, given in full, and the brevity of the method will be appreciated by those who have had experience in the analysis of tidal observations. For the other tides more lines from the list of sums are used ; but even then the labour of analysing a year's observations is estimated by Dr. Börgen to be about one-tenth of the labour of the method proposed by Sir W. Thomson and Mr. Roberts, and to be about one-third or half of that of Darwin's abacus.

K_2.

(1.)

	+		−	
m	$n_1 - 1$	n_3	n_2	$n_2^1 - 1$
1	8	185	96	97
2	185	362	273	274

(2.)

t	$\sin (9+t)\,i$	$\cos (9+t)\,i$
0h	− 0·99992	+ 0·01290
1	− 0·85877	+ 0 51236
2	− 0·48628	+ 0·87380
3	+ 0·01720	+ 0·99985
4	+ 0·51605	+ 0·85656
5	+ 0·87589	+ 0·48252

(3.)

	$\mathfrak{f}x,y$	$\mathrm{N}x,y$.
For K_2	+ 231·31	5°·6748
M_2	− 0·20619	157·2318
N	+ 1·1526	253·6761
L	+ 3·2203	60·7877
ν	+ 0·83144	218·0195
T	+ 10·695	177·1626
R	− 10·695	182·8374

(4.)

	Correction for F^1.	Correction for G^1.
For M_2	$- 11{\cdot}471A_m - 2{\cdot}475B_m$	$+ 2{\cdot}732A_m - 11{\cdot}770B_m$
N	$- 10{\cdot}939A_n - 3{\cdot}588B_n$	$+ 4{\cdot}043A_n - 11{\cdot}364B_n$
L	$- 11{\cdot}832A_l - 1{\cdot}281B_l$	$+ 1{\cdot}374A_l - 11{\cdot}967B_l$
ν	$- 11{\cdot}033A\nu - 3{\cdot}448B\nu$	$+ 3{\cdot}876A\nu - 11{\cdot}443B\nu$
T	$- 12{\cdot}004A_t - 0{\cdot}301B_t$	$+ 0{\cdot}292A_t - 11{\cdot}989B_t$
R	$- 12{\cdot}022A_r - 0{\cdot}111B_r$	$+ 0{\cdot}087A_r - 11{\cdot}977B_r$
	or approximately,	
Correction =	$- 11{\cdot}550\Sigma A_y - 1{\cdot}867\Sigma B_y$	$+ 2{\cdot}067\Sigma A_y - 11{\cdot}752\Sigma B_y$.

(5.)

$$A = + 0{\cdot}083127\ F - 0{\cdot}00011230\ G$$
$$B = - 0{\cdot}00011230\ F + 0{\cdot}083549\ G.$$

R and ζ are determined from the equations—

$$R \sin (\zeta - N) = \frac{A}{\mathfrak{f}}$$
$$R \cos (\zeta - N) = \frac{B}{\mathfrak{f}}$$

while H and κ are determined from—

$$H = \frac{1}{f} R$$
$$\kappa = \zeta + (V_o + u).$$

K_2.—From List of Sums.

n	0 h.	1 h.	2 h.	3 h.	4 h.	5 h.	6 h.	7 h.	8 h.	9 h.	10 h.	11 h.
8	1081	1138	1126	1046	921	784	672	632	663	757	903	1067
185 × 2	43674	43872	42562	40236	37502	35266	34176	34648	36542	39394	42496	44810
362	43282	42754	40793	37927	34937	32607	31538	32087	34103	37059	40203	42528
	+ 88037	87764	84481	79209	73360	68657	66381	67367	71308	77210	83602	88405
96 + 97	22030	22064	21169	19738	18090	16777	16281	16866	18364	20495	22816	24655
273 + 274	66486	66441	64114	60169	55669	51908	49757	49912	52247	56154	60539	63874
	− 88516	88505	85283	79907	73759	68685	66038	66778	70611	76649	83355	88529

	12 h.	13 h.	14 h.	15 h.	16 h.	17 h.	18 h.	19 h.	20 h.	21 h.	22 h.	23 h.
8	1222	1327	1371	1334	1227	1077	916	776	709	712	778	881
185 × 2	45650	44670	42168	38556	34926	31978	30464	30556	32346	35408	38804	41794
362	43502	42870	40800	37782	34791	32468	31510	32036	33945	36786	39796	42185
	+ 90374	88867	84339	77672	70944	65523	62890	63368	67000	72906	79378	84860
96 + 97	25665	25589	24565	22647	20415	18343	16829	16154	16498	17728	19388	20944
273 + 274	65164	63931	60466	55496	50691	47002	45573	46559	49788	54594	59774	64059
	− 90829	89520	85031	78143	71106	65345	62402	62713	66286	72322	79152	85003
D_t	− 479	− 741	− 802	− 698	− 399	− 28	+ 343	+ 589	+ 697	+ 561	+ 247	− 124
D_{12+t}	− 455	− 653	− 692	− 471	− 162	+ 178	+ 488	+ 655	+ 714	+ 584	+ 266	− 143

Calculation of Corrections.

	M_2	N	L	ν	T	R	
ζ_y	328·944	328·124	103·829	354·621	349·632	46·684	G.T. Survey of India, Vol. xvi, p. 295–97.
N_y	157·232	253·676	60·788	218·020	177·163	182·837	Annalen der Hydrographie und Maritimen Meteorologie, 1894, Juli.
$\zeta_y - N_y$	171·712	74·448	43·041	136·601	172·469	223·847	
Sin $(\zeta_y - N_y)$	+ 0·14415	+ 0·96339	+ 0·68252	+ 0·68708	+ 0·13107	− 0·69273	
Cos $(\zeta_y - N_y)$	− 0·98956	+ 0·26811	+ 0·73087	− 0·72658	− 0·99138	− 0·72120	
f_y	− 0·20619	+ 1·1526	+ 3·2203	+ 0·83144	+ 10·695	− 10·695	Ann. der Hyd., &c.
R_y	4·2264	1·0331	0·0474	0·0539	0·2366	0·0292	G.T. Survey of India, Vol. xvi, p. 295–97.
$f_y R_y$	− 0·87144	+ 1·1908	+ 0·15264	+ 0·04481	+ 2·5304	− 0·31229	
$f_y R_y \sin(\zeta_y - N_y) = A_y =$ ..	− 0·12562	+ 1·1472	+ 0·10418	+ 0·03079	+ 0·33166	+ 0·21633	Approximate Corrections.
$f_y R_y \cos(\zeta_y - N_y) = B_y =$ ..	+ 0·86234	+ 0·3193	+ 0·11156	− 0·03256	− 2·5086	+ 0·22522	$\Sigma A_y = +1·7045$. Cor. for $F^1 = -11·550$ $\Sigma A_y - 1·867$ $\Sigma B_y = -17·778$ } Ann. der Hyd., &c., 1894, Juli.
							$\Sigma B_y = -1·0227$. Cor. for $G^1 = +2·067$ $\Sigma A_y - 11·752$ $\Sigma B_y = +15·542$ }
							Complete correction : Cor. for $F^1 = -21·843$ } Ann. der Hyd., &c., 1894, Juli.
							Complete correction : Cor. for $G^1 = +17·311$ }

K_2.

	I	II	III	IV	V	$i = 30^\circ 0821372$ per mean solar hour.		
t	D_t	D_{12+t}	S_t	S_{6+t}	Δ_t	$(9+t)\,i$	$\sin(9+t)i$	$\cos(9+t)i$
			I + II		III − IV			
0	− 479	− 455	− 934	+ 831	− 1765	270·7392	− 0·99992	+ 0·01290
1	− 741	− 653	− 1394	+ 1244	− 2638	300·8214	− 0·85877	+ 0·51236
2	− 802	− 692	− 1494	+ 1411	− 2905	330·9035	− 0·48628	+ 0·87380
3	− 698	− 471	− 1169	+ 1145	− 2314	0·9856	+ 0·01720	+ 0·99985
4	− 399	− 162	− 561	+ 513	− 1074	31·0678	+ 0·51605	+ 0·85656
5	− 28	+ 178	+ 150	− 267	+ 417	61·1499	+ 0·87589	+ 0·48252
6	+ 343	+ 488	+ 831					
7	+ 589	+ 655	+ 1244					
8	+ 697	+ 714	+ 1411					
9	+ 561	+ 584	+ 1145					
10	+ 247	+ 266	+ 513					
11	− 124	− 143	− 267					

	Uncorrected Values.	Corrections for other Tides.	Corrected Values.
$F^1 = \sum_0^5 \Delta_t \sin(9+t)i$	+ 5214·14509	− 21·843	= + 5192·302 = F
$G^1 = \sum_0^5 \Delta_t \cos(9+t)i$	− 6945·15068	+ 17·311	= − 6927·840 = G

$A = + 0{\cdot}083126.\ F - 0{\cdot}00011230.\ G = + 432{\cdot}393$

$B = - 0{\cdot}00011230.\ F + 0{\cdot}083549.\ G = - 579{\cdot}397$

$\tan(\zeta - N) = \frac{A}{B} = - 0{\cdot}74628$

$\zeta - N = 143^\circ 267$

$N = 5{\cdot}675$ Ann. der Hyd., &c., 1894, Juli, p. 264.

$\zeta = 148{\cdot}942$

Compare $\zeta_2 = 144{\cdot}197$ G.T. Survey of India, Vol. xvi, p. 296.

Difference = 4·745

$A^2 + B^2 = 522664{\cdot}59$

$R\,\mathfrak{f} = \sqrt{A^2 + B^2} = 722{\cdot}955$

$\mathfrak{f} = 231{\cdot}31$ Ann. der Hyd., &c., 1894, Juli, p. 264.

$R = 3{\cdot}125$

$\frac{1}{10}R = 0{\cdot}3125$ ft.

Compare $R_2 = 0{\cdot}3105$ ft. G.T. Survey of India, Vol. xvi, p. 296.

Diff. = 0·0020 ft.

153 L.W.

154 H.W.

154 L.W.

155 H.W.

155 L.W.

156 H.W.

N_2

S_2

K_1

M_4

K_2

ν_2

1500.8/11-724

Fig. 3.

Fig. 4.

Plan showing

POSITION OF BENCH-MARKS ON CONCRETE BLOCKS CONNECTING

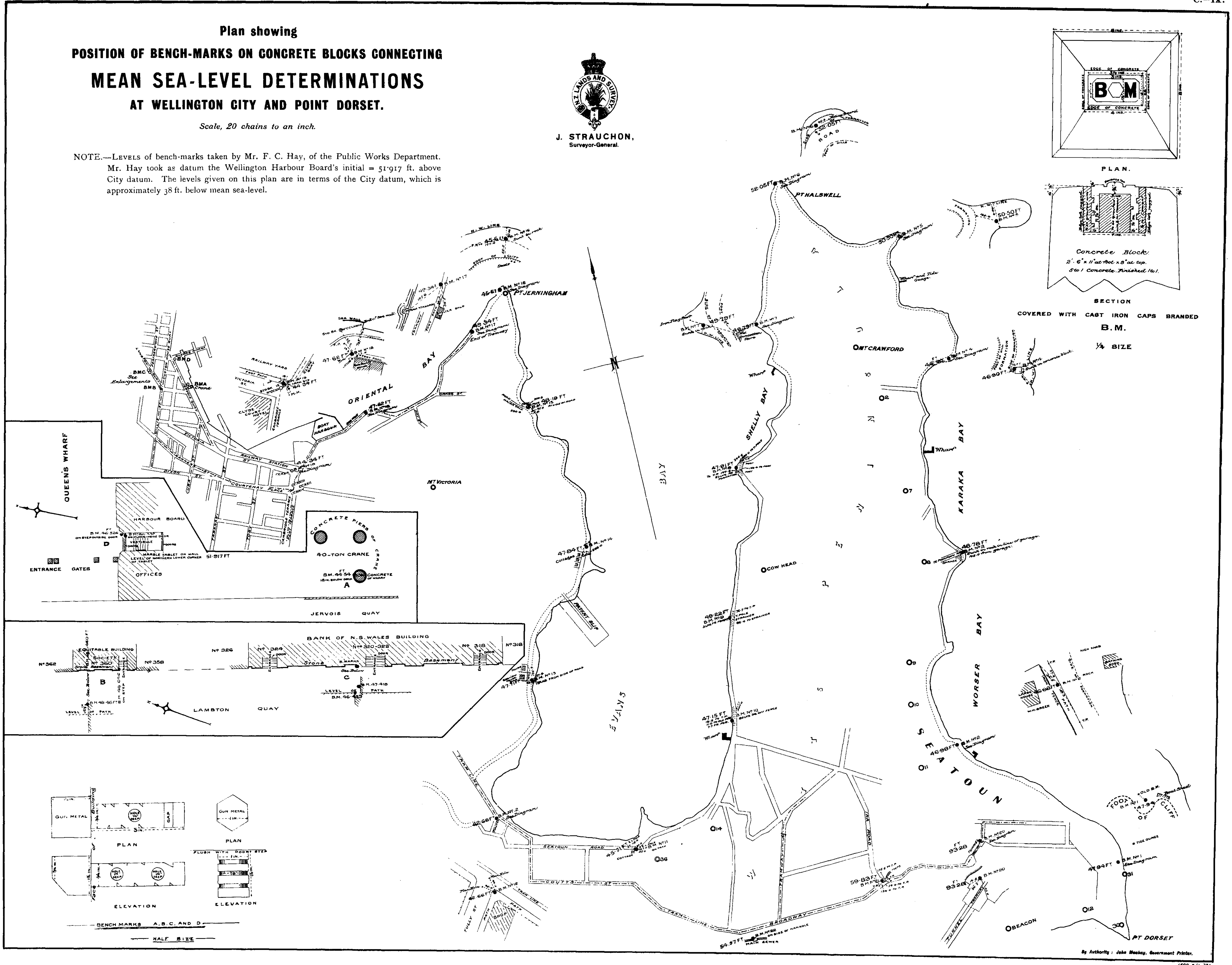
MEAN SEA-LEVEL DETERMINATIONS

AT WELLINGTON CITY AND POINT DORSET.

Scale, 20 chains to an inch.

NOTE.—Levels of bench-marks taken by Mr. F. C. Hay, of the Public Works Department. Mr. Hay took as datum the Wellington Harbour Board's initial = 51·917 ft. above City datum. The levels given on this plan are in terms of the City datum, which is approximately 38 ft. below mean sea-level.

J. STRAUCHON,
Surveyor-General.



By Authority: John Mackay, Government Printer.

1500.-8/11-723.

Table 1.—Return of Field-work executed by the Staff and Contract Surveyors from 1st April, 1910, to 31st March, 1911.

Surveyor and District.	Minor Triangulation.		Topographical Survey for Selection as "Unsurveyed Land."		Rural.		Village and Suburban.			Town Section Survey.			Native Land Survey.			Gold-mining Survey.			Roads, Railways, and Water-race		Other Work.	Total Cost of Surveyors and Parties from 1st April, 1910, to 31st March, 1911.
	Acres.	Cost per Acre.	Acres.	Cost per Acre.	Acres.	Cost per Acre.	Acres.	No. of Sections.	Cost per Acre.	Acres.	No. of Sections.	Cost of Sections.	Acres.	No. of Secs. or Divs.	Cost per Acre.	Acres.	No. of Sections.	Cost per Acre.	Miles.	Cost per Mile.	Cost.	
		d.		d.		s.			s.			s.			d.			s.		£	£ s. d.	£ s. d.
Auckland ..	86,400	0·5	66,525	5·0	63,258	2·6	317·0	114	14·25	174·5	461	23·0	(a) 267,596 (b) 7,016	600 22	8·86 29·19	1,752	23	4·41	181·41	21·75	4,011 7 2	32,839 12 4
Hawke's Bay	..	..	..	..	55,474	2·21	..	..	..	170·0	25	8·9	(a) 7,454 (b) 3,887	36 37	15·66 20·56	..	..	..	49·12	18·46	568 13 3	5,932 2 1
Taranaki ..	30,150	1.0	..	..	8,839	2·84	..	..	..	23·36	54	19·59	(a) 348 (b) 18,306	1 42	26·87 22·72	..	..	..	17·04	22·05	190 9 0	8,064 0 1
Wellington	136,000	0.93	32,285	8·59	48,283	2·35	308·0	71	15·6	52·5	99	15·0	(a) 37,048 (b) 2,688	50 78	8·08 86·6	..	..	..	35·0	15·57	1,601 6 5	10,687 2 3
Nelson ..	170,620	1·49	7,000	1·5	61,196	2·4	32·0	2	8·0	24·0	104	16·81	..	..	..	..	..	..	19·97	18·05	623 6 4	8,471 14 1
Marlborough	..	..	..	..	44,010	1·45	5·0	2	24·04	30·0	111	45·10	(a) 562	23	30·72	..	..	..	16·25	32·17	428 15 9	3,645 1 7
Westland ..	10,000	0·6	16,640	2·52	13,306	3·10	888·0	62	5·78	27·45	50	27·48	..	..	..	..	..	..	9·0	16·43	397 4 6	3,500 6 5
Canterbury	..	..	1,456,179	0·22	10,126	1·01	6·25	4	30·56	..	..	..	(a) 4	4	450·0	..	..	..	..	..	247 18 3	2,141 16 0
Otago ..	..	..	726,920	2·7	205	4·58	26·0	15	26·0	0·25	1	100·0	..	..	..	..	..	..	4·5	6·1	381 14 5	3,751 15 6
Southland..	1,561	0·92	..	..	21,614	2·9	172·0	13	11·12	42·0	69	43·2	..	..	..	..	..	..	5·95	16·0	253 8 3	3,751 8 10
Means and totals	434,731	1·06	2,305,549	1·26	326,311	2·30	1,754·25	283	10·44	544·06	974	26·54	344,909	893	10·81	1,752	23	4·41	338·24	20·48	8,704 3 4	82,786 19 2
Licensed surveyors (paid by applicants)					8,404	..	90·0	56	..	2·0	1	..	127,572	..	..	1,257	33	..	6·0	..		
Totals					334,715	..	1,844·25	339	..	546·06	975	..	472,481	..	..	3,009	56	..	344·24	..		

(a) Native Land Court. (b) Maori Land Board.

Table 2.—Return showing Surveyors employed and the Work on Hand on 1st April, 1911.

Chief Surveyors.	Surveyors employed.			Work on Hand.					
	Staff.	Temporary.	Contract.	Land District.	Trig.	Settlement.	Town.	Native Land Survey.	Roads.
					Sq. Ml.	Acres.	Acres.	Acres.	Miles.
E. C. Gold Smith	18	8	..	Auckland ..	29*	268,398	113	125,841	139
C. R. Pollen ..	6	1	..	Hawke's Bay	..	95,650	2	41,580	4
F. Simpson ..	3	2	..	Taranaki ..	..	113,550	..	2,866	..
J. Mackenzie ..	7	..	..	Wellington ..	3,200†	69,724	..	21,920	4·75
R. T. Sadd ..	4	4	..	Nelson ..	41*	62,570	..	..	..
F. Stephenson Smith	2	2	..	Marlborough	..	11,900	..	143	31
G. H. M. McClure	4	..	..	Westland ..	..	20,066	0·5	..	0·25
T. N. Brodrick ..	2	..	..	Canterbury ..	..	3,116	6·5	..	2
E. H. Wilmot ..	4	..	..	Otago ..	..	32,400	..	..	..
H. M. Skeet ..	3	2	..	Southland ..	..	13,144	..	14,700	11
Total staff surveyors	53	19	..	..	3,270	690,518	122	207,050	192
Contract surveyors	..	..	40	Auckland ..	..	20,923	..	344,717	20·75
	..	..	5	Wellington ..	..	..	..	37,634	..
	..	..	5	Nelson ..	..	33,212	14	40,469	..
Total contract surveyors	..	..	50	..	..	54,135	14	422,820	20·75
Total staff and contract surveyors	53	19	50	..	3,270	744,653	136	629,870	212·75

* Minor triangulation. † Secondary triangulation.

Table 3.—Plans placed on Crown Grants and other Instruments of Title from the Crown from 1st April, 1910, to 31st March, 1911.

Land District.	Number.					Cost.
	Singly.	In Duplicate.	In Triplicate.	In Quadruplicate	Total Copies.	
						£ s. d.
Auckland	..		645	188	3,209	194 7 0
Hawke's Bay ..	3	252	133	72	1,194	83 10 2
Taranaki	..	26	172	13	620	50 19 5
Wellington	2	18	505	..	1,553	77 13 0
Nelson	3	42	79	64	580	88 16 11
Marlborough ..	1	34	138	..	483	91 12 0
Westland	..	181	143	..	791	60 0 0
Canterbury	33	34	15	116	610	100 4 3
Otago	12	239	314	..	1,432	192 0 0
Southland	97	70	353	35	1,486	105 8 0
Totals	151	1,157	2,497	488	11,908	1,044 10 9

Table 4.—Work done under the Land Transfer Act, etc., from 1st April, 1910, to 31st March, 1911.

Land District.	Number of Plans passed.	Deeds and other Instruments passed.	Number of Plans placed on Certificates of Title.					Miscellaneous Plans, &c.	Cost.
			Singly.	In Duplicate.	In Triplicate.	In Quadruplicate.	Total Copies.		
									£ s. d.
Auckland ..	477	2,340	18	2,271	..	..	2,289	138	1,309 16 1
Hawke's Bay ..	349	717	..	1,077	58	..	2,328	35	662 12 2
Taranaki ..	116	..	9	509	12	..	1,063	..	236 5 7
Wellington ..	221	3,235	5,173	..	..	..	5,173	..	1,515 6 4
Nelson ..	94	149	..	185	..	..	370	..	136 12 9
Marlborough ..	26	..	7	165	6	..	355	..	72 3 10
Westland ..	25	50	..	39	16	..	126	..	50 8 9
Canterbury ..	336	2,969	21	2,323	32	..	4,763	9	1,411 10 10
Otago ..	86	1,100	18	972	9	..	1,989	..	300 0 0
Southland ..	102	51	25	588	3	..	1,210	..	305 9 2
Totals ..	1,832	10,611	5,271	8,129	136	..	19,666	182	6,000 5 6

Table 5.—LITHOGRAPHS AND PHOTOGRAPHS PRINTED AND SOLD, FROM 1ST APRIL, 1910, TO 31ST MARCH, 1911.

Land District.	Number of Lithographs printed.	Number of Photographs printed.	Amount of Fees received from Sale of Maps, Lithographs, &c.
			£ s. d.
Auckland	4,700	..	179 2 2
Hawke's Bay	..	..	93 4 7
Taranaki	..	..	60 19 8
Wellington	..	..	41 14 2
Nelson	..	..	7 2 0
Marlborough	..	..	24 5 3
Westland	..	..	20 4 3
Canterbury	..	..	60 9 3
Otago	982	..	82 10 9
Southland	..	..	51 15 5
Totals	5,682	..	621 7 6

Approximate Cost of Paper.—Preparation, not given; printing (1,500 copies, including illustrations, maps, and diagrams), £146.

By Authority: JOHN MACKAY, Government Printer, Wellington—1911.

Price 2s. 3d.]

NORTH ISLAND
(TE IKA-A-MAUI)
NEW ZEALAND

T. HUMPHRIES
Surveyor General.

Scale of English Miles
10 5 0 10 20 30 40 50 60 70 80 90 100

Reference
Cities thus
Boroughs
Towns
Railways
Roads
Boundaries of Land Districts
Projection - Rectangular Tangential

Reference to State of Public Surveys.
Meridional Circuit
Minor Triangulation
Section Survey under check
Section Survey built

TASMAN SEA

MIDDLE ISLAND

Three Kings Is
North Cape
Great Exhibition Bay
Hauraki Gulf
Bay of Plenty
Hawke Bay
North Taranaki Bight
South Taranaki Bight
Golden Bay
Tasman Bay
Karamea Bight
D'Urville I.
Cloudy Bay
Palliser Bay
South Latitude
Mahia Peninsula
NAPIER
WELLINGTON
NELSON
BLENHEIM
SOUTH PACIFIC OCEAN
TE MOANA-NUI-A-KIWA

RAOUL or SUNDAY Id
Scale

Denham Bay
Herald Islets
Lat. 29° 15' S.
Long. 177° 55' W.

MACAULEY Id
Scale

CURTIS Id
Scale

L'ESPERANCE Rk
Scale

KERMADEC ISLANDS

COOK ISLANDS

South Latitude
Suwarrow
Palmerston I.
Nassau I.
Nicholson I.
Rarotonga
Mangaia
Penrhyn I. (Tongareva)
Rakahanga (Reirson I.)
Manihiki
Humphrey I.
Danger I.
Nassau I.
Harvey I.
Mitiaro
Mauke
Atiu
Takutea
Manuae
Parry I.
Lat. 20° S.
Long. 160° W.
Long. 157° 30' W.
Long. 165° W.
Long. 170° W.
Long. 175° W.
Long. 180°
Long. 170°
Long. 160°

175° East Longitude

BY AUTHORITY: JOHN MACKAY, GOVERNMENT PRINTER.

T. HUMPHRIES
Surveyor General.

SOUTH ISLAND
(TE WAI-POUNAMU)
NEW ZEALAND

Scale of English Miles

0 5 0 10 20 30 40 50 60 70 80 90

Reference

Cities ..... thus DUNEDIN
Boroughs ..... Rangiora
Towns and villages ..... Kaiapoi
Railways and stations .....
Roads .....
Boundaries of Land Districts .....
Projection – Rectangular Tangential

Meridional Circuit
Minor Triangulation
Section Survey under check
Section Survey built

Golden Bay
Tasman Bay
Karamea Bight
Cloudy Bay
Pegasus Bay
Banks Peninsula
Canterbury Bight
Otago Peninsula (Otakou)
Foveaux Strait
Stewart Island (Rakiura)

T A S M A N S E A

S O U T H P A C I F I C O C E A N

(TE MOANA-NUI-A-KIWA)

South Latitude

167° 30' 168° 30' 169° 30' 170° East Longitude 171° 30' 172° 30' 173° 30' 174°

41° 42° 43° 44° 45° 46° 47°

BOUNTY Is
ANTIPODES Is
AUCKLAND Is
CAMPBELL Is
(REKOHU OR WHARE-KAURI)
CHATHAM ISLANDS
Scale of English Miles

By Authority: John Mackay, Government Printer.