PROVINCE OF BRITISH COLUMBIA

REPORT

OF

WATER RIGHTS BRANCH

OF THE

DEPARTMENT OF LANDS

HON. WILLIAM R. ROSS, K.C., Minister

WILLIAM YOUNG, Comptroller

FOR THE YEAR ENDING DECEMBER 31ST

1915

THE GOVERNMENT OF
THE PROVINCE OF BRITISH COLUMBIA.

PRINTED BY
AUTHORITY OF THE LEGISLATIVE ASSEMBLY.

VICTORIA, B.C.:
Printed by WILLIAM H. CULLIN, Printer to the King's Most Excellent Majesty.
1916.

VICTORIA, B.C., February, 1916.

To His Honour FRANK STILLMAN BARNARD,
Lieutenant-Governor of the Province of British Columbia.

MAY IT PLEASE YOUR HONOUR:

Herewith I beg respectfully to submit the Annual Report of the Water Rights Branch of my Department for the year ending December 31st, 1915.

WILLIAM R. ROSS,
Minister of Lands.

WATER RIGHTS BRANCH,
DEPARTMENT OF LANDS,
VICTORIA, B.C., February, 1916.

The Hon. William R. Ross, K.C.,
Minister of Lands, Victoria, B.C.

SIR,—I have the honour to submit herewith the report of the Water Rights Branch for the year 1915. The report embodies a brief analysis of the work of the Branch, including matter that was touched upon in the interim report of 1914. The report of the Chairman of the Board of Investigation for 1915 is also submitted herewith.

I have the honour to be,
Sir,
Your obedient servant,

WILLIAM YOUNG,
Comptroller of Water Rights.

REPORT OF THE WATER RIGHTS BRANCH.

VICTORIA, B.C., December 31st, 1915.

The Hon. William R. Ross, K.C.,
Minister of Lands, Victoria, B.C.

SIR,—I have the honour to report concerning the administration of the Water Rights Branch of the Department of Lands for the year 1915. The report of the Chairman of the Board of Investigation accompanies my report and will be found hereinafter.

ORGANIZATION.

The general plan of organization as outlined towards the end of 1912 and beginning of 1913 has been followed. Even though a large percentage of our staff has joined the Forces, the organization has been maintained with satisfactory results. The current work has been taken care of and reasonable progress made in disposing of old applications and Board-work. War conditions, however, have affected field-work, and, aside from general administration and Board-work, the District Engineers have not undertaken any extra work except such as was considered necessary.

In view of the improvement in transportation by railways, a revision of boundaries of districts is advisable. North-east and South-east Kootenay might be taken care of from one office; Kettle Valley, Southern Okanagan, and Similkameen might now be taken care of from Penticton. The Nelson District could easily include a part of the Railway Belt to the east and west of Revelstoke; a portion of the Railway Belt might be put in with the Upper Okanagan. The district of which Kamloops is the headquarters is at present too large for one man to successfully handle, particularly as the North Thompson is now accessible by the Canadian Northern. In the circumstances, the Ashcroft Water Recording District might well be added to the present Nicola District. Provision will require to be made for the territory along the Grand Trunk Pacific, as water rights for the several purposes are being granted and local administration is essential. And since the Pacific and Great Eastern Railway has opened a section of the country where irrigation has been practised for many years, and where some important power-developments are under consideration, the formation of a district must shortly receive consideration. The effect of such a reorganization would mean not only economy, but greater efficiency in administration.

"WATER ACT."

The features in respect of irrigation in the "Water Act" which were in particular referred to in my interim report of 1914 have again proven their value, not only to the irrigator, but to the administration in disposing of what had hitherto been difficult problems.

Those features of the Act designed in the interest of the carrier companies, except in one instance, have not as yet been taken advantage of, although in several cases there are indications that reorganization is taking place. In other instances new legislation may be necessary, but which can only be decided upon when the report, now in progress, on the physical and financial conditions of a number of the irrigation companies has been handed in. The indications are that the "land and water company" provision is being taken advantage of shortly by one of the large organizations, and may, in part, prove a solution to the difficulties of some of the other organizations.

It has been suggested that the District Engineers be authorized to receive applications on behalf of the Water Recorders. This would in several districts prove of great convenience to water applicants. With several other amendments of more or less importance this suggestion might be considered.

In the matter of new legislation, the experience of the year has brought out the fact that legislation is necessary in respect of waterworks systems for smaller towns that as yet are not incorporated. At present the only course open to the residents of such towns is incorporation under the "Joint-stock Companies Act" as water companies. The great difficulty met with is the raising of money, which would in a measure be overcome by legislation similar to the "irrigation corporation" chapter of the "Water Act."

New sections have been prepared in respect of collection of rentals. As the Act stands at present, the penalty for non-payment is cancellation of the licence. This has not the desired effect, and accordingly the proposed sections, if enacted, will provide the necessary machinery for the enforcement of payment.

The need of control of artesian water as a resource of the Province is obvious. Legislation is necessary not only for the protection of existing interests, the prevention of waste, but for the regulation of future development. To this end investigation has been carried on that information may be available.

In passing, reference may be made to important amendments to the "Health Act" in respect of plans for waterworks systems. Although approval of plans is still necessary under both the "Water Act" and "Health Act," the effect of the amendments has been to bring about better co-operation with the Board of Health and the simplifying of procedure to the advantage of the corporation or municipality.

Rules and Regulations.—That the language of the "Water Act" of 1914 might be conformed with, and since experience had shown that other amendments were essential, a revision of the rules and regulations as adopted on January 13th, 1914, was prepared and submitted for the consideration of the Executive Council. The effect of the changes proposed is to eliminate the survey-construction feature in the treatment of the small water-users. No change is made in the part dealing with water-power, although, while it is desirable that those sections governing the staking should remain as they are, it is obvious that the whole problem of record fees and rentals will require to be carefully gone into. The question to be considered is whether it is advisable to continue as at present or modify the fees and at the same time make such provision as will permit of agreements being entered into for periods not exceeding twenty years. The problem is particularly important if the development and opening up of various sections of the Province is to be encouraged.

Railway Belt.—Considerable progress has been made in the administration of water within the Railway Belt. The disposal of records by the Board of Investigation in many places has brought the advantages of the irrigation provisions of the "Water Act" to the attention of irrigators. The Heffley Creek District, which was for some years contentious, has been successfully disposed of, the irrigators taking advantage of the water-users' community. Many applications that were pending the enactment of the "Railway Belt Water Act" have been disposed of. There are, however, difficulties ahead in administration of water on some creeks, although the Board has adjudicated on the records. Complete surveys of such creeks will be necessary to ascertain reservoir possibilities, and, if possible, work out systems of rotation in use that will be just and reasonable for those interested.

Regulations for the disposal of lands valuable in connection with water privileges in the Railway Belt are now under consideration by the Department of the Interior. The purpose of such is twofold—to better protect the water resources, and to, as far as possible, bring the procedure for entry upon Dominion Crown land in connection with water rights into conformity with that in use for Provincial Crown lands. The latter purpose is to the advantage of applicants, more particularly those whose interests are on the border lands partly in the Railway Belt and partly outside.

The records, grants, licences, Orders in Council, etc., referred to under subsection (1) of section 5 of the "Railway Belt Water Act" have received considerable attention during the year. Owing to the press of organization, Board-work, district-work, etc., it was impossible to touch these problems earlier. Now that a beginning has been made, it is anticipated that early in the coming year the procedure will be decided upon and completed to the satisfaction of all interested.

Since the administration of water in the Railway Belt has been under the control of the Province the cost has been in excess of the revenue. This is largely due to the work necessary to the Board in the adjudication of records. This expense has been greater because the most difficult problems in respect of irrigation are in the Railway Belt, problems that can only be settled after considerable field-work. Statements have been submitted to the Receiver-General, but more detail has been called for. The new statement is now well advanced and should be ready by the end of the fiscal year. As referred to in my interim report of last year, an important question must be considered in arriving at the revenue. This involves the necessity of classifying all licences, records, etc., either as Dominion or as Provincial, and

the question is, "What principle of classification should be adopted?" The problem received careful study towards the end of 1914, a memorandum being submitted in which three principles are set out, and which are as follows (the second of which has been followed in the preparation of our statement) :—

The first is to look only to the place where the water is diverted. If that is on Dominion land the record is classed as a Dominion record. This principle, if followed, would result in the classification of a large number of records as Dominion that are really for use on the patented lands in the Railway Belt.

The second is to look to the place of use of the water or of the power developed from the water. If that is on Provincial or patented lands the record would be called a Provincial record, even though the point of diversion is on Dominion lands. This principle, if followed, would result in very few records being classed as Dominion, for, while many have their points of diversion on Crown lands, the place of use is nearly always on patented lands. The matter of book-keeping for the Provincial authorities would be thereby simplified.

A third possible principle might be that the lands are to be ignored altogether, and that a record or licence granting an absolute right to the use of water, once issued, like a patent to land, terminates the Dominion jurisdiction over the water granted. This principle, if followed, would result in classifying as Dominion only such grants as were not absolute in their nature, such as leases.

Indian Reserves.—In respect of water rights on Indian reserves the co-operation arranged for in 1914 has continued and is of considerable assistance in the administration of these rights.

GENERAL WORK.

As already stated, war conditions have affected field-work to some extent. Only such work as was essential and the completion of special work has been carried on. Of such, mention may be made of the completion of artesian-water investigation on the Lower Mainland; the completion of water-supply investigation on Seymour and Lynn Creeks, which is of considerable importance to Greater Vancouver, and the work on prospective irrigation corporations in the Okanagan. Of these, however, only in the last named has field-work been carried on.

Field-work in connection with irrigation has been taken up wherever occasion demanded. It will, however, be necessary to devote considerable time on a number of creeks in the Railway Belt where, even though records have been disposed of, a complete knowledge of physical conditions is essential before the water available can be equitably administered. Surveys of a number of creeks in the Okanagan have been completed in connection with the formation of irrigation-corporation work, particular attention being given to reservoir possibilities.

Water-power investigation has not been carried on to the extent desired. During the year a map has been prepared showing the location of developed and undeveloped powers. These are referred to in the report dealing with the Drawing Office. As at least three years of stream-flow data is necessary in estimating the extent of a water-power, the figures given in the water-power list should be taken with reserve.

Duty of water investigation has been carried on wherever possible, but not to the extent desired. The outlook, however, is that there will be some co-operation with the Department of Agriculture during the coming season.

SURVEYS.

In my report of 1913 your attention was called to the importance of both hydrographic and topographic surveys. In passing, it is of interest to note the progress made. In 1912 a Chief Hydrographer was appointed and the work undertaken by the Province, the work already having been undertaken by the Dominion within the Railway Belt. The reorganization in 1913, which brought about co-operation between Dominion and Province, gave the work such an impetus that to-day practically every stream of any importance in the southern portion of the Province is now under observation, there being upwards of 1,000 gauges established. The work is being carried forward as rapidly as conditions will permit. Topographic work has also received attention, several important districts being dealt with. In this respect particular mention may be made of the work carried on under the direction of G. H. Dawson, Surveyor-General, in the Okanagan Valley. The importance of this work cannot be overestimated, as it, in part, forms the basis of any undertaking looking to the development of every acre that may be brought under irrigation.

Attention is again directed to the necessity for continuing survey investigation. Particular mention must be made of water-powers, estuary and swamp lands, and irrigation either by artesian wells or pumping to the low-lying benches from streams or lakes. The importance of water-power investigation cannot be overestimated, and although stream-measurement has been established in many instances, the details of the power-sites are yet to be fully ascertained. Such details cover location and physical conditions, which with stream-flow data will enable Engineer advisers to report promptly and thus give an impetus to development that would be otherwise delayed. Looking towards colony settlement, surveys of estuary and swamp lands should be shortly taken up to determine the location and extent of such lands and the conditions that obtain. The problem of pumping will require attention. In this particular, attention is drawn to the Thompson River Valley contiguous to Kamloops. An ample supply of electric power is now available from the Kamloops hydro-electric plant on the Barriere River, and what is required is not only responsible engineering advice, but a series of contour surveys that will enable the land-owner, who is considering irrigation by pumping, to submit accurate data on which to obtain prices from the manufacturers of pumping machinery. Pumping data is being gathered wherever obtainable that we might have it available for inquirers.

BULLETINS AND OTHER REPORTS.

The hydrographic bulletin referred to in last year's report was not issued as anticipated; as but a few months remained in the year, it was decided to hold it open for the full year's returns. It is now about ready for the printer and in due course will issue.

Mention may be made of the report on developed water-powers of 1,000 horse-power and upward, by G. R. G. Conway, Advisory Engineer of the British Columbia Electric. This report was prepared at the instance of the Department of the Interior for the Panama-Pacific Exposition and is a valuable one, as it sets out the facts in respect of developed powers in the Province. Several hundred copies are being supplied to the Water Rights Branch, where they may be had on application.

Attention is directed to the hydrographic report for the year 1914 recently issued by the British Columbia Hydrographic Survey under the supervision of R. G. Swan, Chief Engineer. This report contains sufficient data on many streams to permit of reasonably close estimates being arrived at, particularly in respect of water-power.

With reference to the report of the Commission of Conservation on the Water-powers of British Columbia, it was expected that it would issue during the year. In the month of November we were advised that, owing to pressing matters at Ottawa requiring attention, it was not possible to complete all the manuscript as yet, although such was being worked on at every possible opportunity. In view of the time that has lapsed since the Commission concluded its field-work, the report should issue some time during the coming year.

GENERAL OFFICE.

As no changes of importance in the methods of administration have taken place during the year, the report of the General Office is largely statistical. The Chief Clerk, C. A. Pope, reports as follows:—

The work has in a measure been handicapped by the reduction in the staff caused by the number of enlistments. In this connection it is of interest to note the difference at the outbreak of war and at the present time:—

Inside Staff.	July, 1914.	Dec., 1915.
Executive	4	3
Clerical	26	17
Draughtsmen	12	5
Office Engineers	3	3
Totals	45	28

Of the number that now comprise the staff, some four or five have intimated their intention of shortly enlisting.

The above figures refer only to the inside staff. The normal outside staff consists of seven District Engineers, about four Field Engineers not assigned to any particular district, about six Assistant Engineers, and from six to ten rodmen and axemen. This has been reduced to six District Engineers and two assistants and one Divisional Engineer. Of these, two District Engineers have enlisted.

I cannot speak too highly of the spirit in which those who have remained on the staff have undertaken the extra work that has been put upon them, the results of which are evident in the showing set out in the following statement of applications received and disposed of.

The statement shows that 283 applications for licences were received during the year, of which 257 were granted and 131 refused or withdrawn, a gain on pending applications of 105.

In applications for approval of plans of works, 49 were received and 122 granted, a gain on the pending applications of 73.

Month.	Applications for Licences received.	Granted.	Disallowed or withdrawn.	Applications for Approval of Plans received.	Granted.	Authorizations issued.	Conditional Licences issued in respect of			Final Licences issued in respect of		Approval of Plans issued.	Petitions for Approval of Undertaking received.	Certificates issued.	Mail.				
							Board Orders.	New Applications.	Permits or Authorizations.	Board Orders.	Conditional Licences.				Letters inward.	Daily Average.	Letters outward.	Daily Average.	Parcels mailed.
January	27	15	8	11	20	2	8	13	16	1	..	4	2	..	739	24	917	30	45
February	23	17	16	.	15	1	33	16	11	4	..	4	..	..	859	30	1,433	51	34
March	14	19	19	8	10	4	7	15	5	2	..	5	..	1	876	29	1,295	43	505
April	26	21	8	1	17	2	..	19	10	..	..	7	..	2	723	24	1,220	40	35
May	21	18	7	4	16	4	..	14	8	..	4	8	1	..	702	22	1,573	50	44
June	30	30	8	9	14	1	..	29	6	..	1	8	..	..	696	23	1,075	35	18
July	39	13	3	7	..	..	79	13	5	15	1	..	1	..	694	22	1,364	44	22
August	32	25	6	2	8	..	47	25	1	3	..	2	2	..	576	20	1,049	34	11
September	28	13	11	1	2	3	31	10	2	2	2	..	..	1	592	20	1,196	40	17
October	16	25	12	2	7	..	73	25	3	5	..	4	2	..	567	18	1,027	33	20
November	19	17	27	2	10	..	21	17	10	4	3	..	..	..	559	19	948	32	19
December	8	44	6	2	3	4	56	40	3	11	..	..	1	..	543	17	1,096	35	12
Totals	283	257	131	49	122	21	355	236	80	47	11	42	9	4	8,126	..	14,193	..	782

Expenditure.—In the following statement the expenditure of the past nine months is compared with the expenditure for the preceding year.

EXPENDITURES.

	12 Months ending March 31st, 1915.		9 Months ending December 31st, 1915.	
Surveys—				
Fieldmen, salaries	$57,058 40	...	$17,357 50	...
Fieldmen, expenses	31,273 81	...	2,597 10	...
Miscellaneous—Camp equipment, instruments, etc.	6,428 53	$94,760 74	613 37	$20,567 97
Stream-gauge readers, Province	...	1,627 28	...	902 20
B.C. Hydrographic Survey	...	9,033 79	...	4,997 43
Board of Investigation—				
Salaries	5,800 00	...	4,349 99	...
Expenses	2,383 95	8,183 95	1,572 99	5,922 98
Climatic statistics, rainfall, etc.	...	800 35	...	516 42
Expert assistance—				
Salaries	8,206 06	...	3,499 99	...
Expenses	835 10	9,041 16	363 70	3,863 69
Public irrigation corporations—				
Salaries	5,406 33	...	3,522 32	...
Expenses	3,096 24	8,502 57	1,423 68	4,946 00
Office salaries—				
Permanent clerical staff	17,180 50	...	8,372 99	...
Temporary clerical staff	6,300 00	23,480 50	4,737 65	13,110 64
Draughting Office and Office Engineers	...	15,077 20	...	8,835 01
Totals	...	$170,507 54	...	$63,662 34

Revenue.—The revenue for 1915 as set out in the following statement is below the average. This is accounted for by two important factors, the first being the general financial depression obtaining, the other being the change in the basis of the collection of rentals, particularly in relation to power. In consequence of this, when an amount is tendered as rental, before bringing it to account the amount of water used or power developed must first be ascertained. In the case of the smaller power plants in particular, this often takes considerable time. As a result there is a considerable sum of money on hand, not included in the statement, which will be accounted for as revenue when this necessary information is forthcoming.

REVENUE FOR YEAR ENDING DECEMBER 31ST, 1915.

Purposes.	Record Fees.	Rentals.	Totals.
1. Domestic	$ 204 50	$ 94 00	$ 298 50
2. Waterworks	332 50	279 65	612 15
3. Mineral-trading	50 00	36 00	86 00
4. Irrigation	892 00	1,992 50	2,884 50
5. Mining	754 50	3,996 84	4,751 34
6. Steam	16 00	726 75	742 75
7. Fluming	75 00	32 00	107 00
8. Hydraulicking	150 00	188 00	338 00
9. Miscellaneous	446 00	490 80	936 80
10. Power	4,065 00	11,634 19	15,699 19
11. Clearing-streams	100 00	252 50	352 50
12. Storage	384 65	393 10	777 75
13. Conveying	...	...	...
14. Lowering-water	30 00	...	30 00
15. Certificates of approval	500 00	...	500 00
Totals	$8,000 15	$20,116 33	$28,116 48

SUMMARY OF REVENUE TO DECEMBER 31ST, 1915.

Total record fees and rentals of year ending—	
June 1st, 1910	$ 4,057 18
June 1st, 1911	49,591 04
June 1st, 1912	29,849 08
June 1st, 1913	37,794 60
June 1st, 1914	42,004 94
December 31st, 1914*	18,195 97
December 31st, 1915	28,116 48
Total	$209,609 29

* Seven months.

DRAWING OFFICE.

E. G. Marriott, Chief Draughtsman, reports as follows:—

There has been considerable change in the Drawing Office during the period covered by this report. The removal of the Geographical Branch to their new quarters in the main building placed at our disposal a large room which in every way is very suitable for the work.

During the past year the Engineers in charge of approval of plans, etc., and hydrographic data enlisted. This meant reorganization to enable the remaining staff to successfully cope with the work. To this end several of the Field Engineers have been retained in the office, who also assisted in keeping pace with the work required by the Board of Investigation. It, however, has not been possible to make final lists and maps showing all confirmed records and subsequent licences in any district, except for the area around Kelowna, and in the circumstances the amount and quality of work completed up to the present has not reached the standard aimed at.

The number of standard water-rights maps has been increased from 228 to 740, and another 100 will probably be sufficient to cover the area under investigation by the Board, the more northerly parts of the Province remaining to be dealt with as circumstances will permit.

The plats to accompany the orders of the Board have been drawn as needed, and are at present somewhat ahead of their requirements. About 1,000 have been completed to date.

Among the other varying work carried out, prominence need only be given to the list and map of some of the power-sites of British Columbia of 500 horse-power and over. This work was prepared for exhibit at the Canadian Pavilion of the Panama-Pacific Exposition.

In preparing the list a careful analysis was made of all water records, licences, engineers' and surveyors' reports, and 457 sites were indexed. The value of the list lies in the fact that a large amount of information has been gathered together, and that the map shows the position of many of the sites. In many instances, however, the information available was scanty and insufficient to check the amount of power given. In the list, wherever the figures are uncertain, note is made under the "Remarks" column.

The 270 power-sites given are divided under the following heads:—

Wholly or partially developed	30
Sites applied for	93
Sites known and unstaked	147

They are numbered so as to be easily located on the map. In respect of the map, it has been decided not to publish it for a time. Several have been prepared and are available in the offices for reference.

With regard to those power-sites located by the Commission of Conservation, the figures must for the present be taken with reserve. A. V. White, of the Commission, intimates that it is unnecessary to emphasize the paucity of the hydrographic information existent for the northerly part of the Province. With respect to the estimates given, while these were based on such data as were available, it is clear that without explanation the quantities mentioned might be misleading. When the report on the "Water-powers of British Columbia" is published, in connection with the tabular material relating to horse-power, there will be explanatory notes and comments, also description governing the use of the tables.

WATER-POWERS OF 500 HORSE-POWER AND OVER.

No.	Creek.	Tributary of.	H.P.	Applicant or Licensee.	Remarks.	Source of Information.
	ALBERNI WATER DISTRICT—					
1*	Ash River	Stamp and Somas Rivers	11,500	....	....	Water Rights Branch, 1913 Report, p. 40.
2†	Beaver Creek	,, ,,	3,000	Alberni Hydro-Elec. Power Co.	....	Application.
	DRINKWATER RIVER—	GREAT CENTRAL LAKE.				
3†	Della Falls	 875		Big Interior Gold Mines, Ltd.		
4*	Rapids below Lower Canyon	 4,300		....		
5*	Lower Canyon	 3,325		....		
6*	Between Lower and Upper Canyon	 1,880		....		
7*	Between Upper Canyon and Bridge	 2,400		....		
8*	Drinkwater Falls	 1,050		....		
			13,830	....	....	1913 Report, p. 40.
10*	Great Central Lake	Stamp and Somas Rivers	21,900	....	Alternative to development on Upper Stamp River	,, p. 40.
11*	McBride Creek	Great Central Lake	800	....	....	,, p. 40.
12†	Nahmint River	Alberni Canal	2,400	Central Island Power Co., Ltd.	....	,, p. 41.
14†	Sarita River	Barkley Sound	3,350	British Pacific Hydro-Elec. & Tramways, Ltd.	....	Application.
15†	Sproat River	Somas River	6,400	Vancouver Island Elec. Railways Co., Ltd.	....	1913 Report, p. 40.
16*	,,	,,	7,600	....	Additional to normal power and dependent on Great Central Lake Development (*see* No. 10)	,, p. 41.
17†	Stamp River	,,	19,000	Ritchie-Agnew Power Co., Ltd.	....	1913 Report, p. 40, and company's data.
18*	Upper Stamp River	,,	3,800	....	....	1913 Report, p. 40.
19*	View Lakes	Great Central Lake	1,200	....	....	,, p. 40.
20†	Gold River	Muchalat Arm	4,000	G. J. Cox	....	Application.
	ASHCROFT WATER DISTRICT—					
1†	Anderson River	Fraser River	8,500	Imperial Power Co.	....	Application.
3*	Coquihalla River	,,	8,400	....	....	1913 Report, p. 44.
4†	Emory Creek	,,	3,000	Imperial Power Co.	....	Application.
7†	Nahatlatch River	,,	36,000	,,	....	B.C. Hydrographic Survey Report, 1913, p. 239.
8†	Nicolum River	Coquihalla River	10,000	McKenzie & Mann	Included in figures given for joint scheme (*see* No. 14).	
10†	Silver River	Fraser River	11,500	Silver River Power Co.	....	Application and B.C. Hydrographic Survey Report, 1913, p. 127.
11†	Siwash Creek	,,	4,000	Imperial Power Co.	....	Application.
12†	Skuzzy Creek	,,	5,600	,,	....	,,
13†	Spuzzum Creek	,,	10,000	,,	....	,,
14†	Sumallow River	Skagit River	35,000	McKenzie & Mann	Joint scheme with Nicolum River (*see* No. 8)	Data submitted by company.
15†	Texas Creek	Fraser River	3,000	Imperial Power Co.	....	Application.
16†	Yale Creek	,,	3,600	,,	....	,,
	BARKERVILLE DISTRICT—					
18†	Swift River	Cottonwood River	10,000	Quesnel Hydr. Gold Mining Co.	Plant installed, not now in operation.	

	Fernie Water District—					
2†	Bull River	Kootenay River	6,500	Bull River Elec. Power Co.	....	Water Rights Branch, 1912 Report, p. 95.
3†	Elk River	"	11,600	Crow's Nest Pass Electric Light & Power Co.	....	do. p. 99.
5*	Phillips Creek	"	750	....	....	1913 Report, p. 74.
6†	Wild Horse Creek	"	850	D. F. Basden	....	Engineer's Report.
	Fort Fraser Water District—					
1†	Stellaquo River	Fraser Lake	6,000	Fraser Lake Water & Power Co.	....	Application.
2*	Stony Creek	Nechako River	1,600	....	....	"
	Fort George Water District—					
1*	Beaver River	South Fork, Fraser River	900	....	....	Surveyor's estimate.
2*	Boulder Creek	Canoe River	...	....	Over 1,000 horse-power per mile	1912 Report, p. 32.
3*	Cottonwood River	South Fork, Fraser River	700	....	....	Surveyor's estimate.
4*	Fraser River	....	5,600	....	At Lower Falls	*See* No. 8.
5*	"	....	5,600	....	At Upper Falls	"
6*	Harvey Creek	Canoe River	...	....	Over 2,000 horse-power per mile	1912 Report, p. 32.
7†	Hixon Creek	Government Creek	850	E. Bloomfield	....	Application.
8†	Moose River	Fraser River	24,000	Yellowhead Pass Light & Power Co.	....	Data submitted by company.
9*	Raushuswap River	South Fork, Fraser River	2,000	....	....	Surveyor's estimate.
11†	Willow River	Fraser River	19,000	Fort George Power Co.	....	Data submitted by company.
	Golden Water District—					
1*	Blaeberry River	Columbia River	2,000	....	....	Data uncertain.
2*	Columbia River	....	...	....	Power-site at Surprise Rapids, horse-power unknown.	
3†	"	....	5,700	Canadian Pacific Rly.	....	Data submitted by company.
4*	Cummins Creek	Columbia River	3,800	....	....	1912 Report, p. 31.
5*	Spillimacheen River	"	3,850	....	....	1913 Report, p. 77.
6*	Wood River	"	5,000	....	....	1912 Report, p. 32.
	Grand Forks Water Dist.—					
3‡	Kettle River	Columbia River	5,000	West Kootenay Light & Power Co.	Site at Cascade; developed.	
4‡	North Fork, Kettle River	"	700	Granby Mining, Smelting & Power Co.	Developed.	
	Hazelton Water District—					
2§	Boulder Creek	Bulkley River	1,000	Grand Trunk B.C. Coal Co., Ltd.		
3§	Bulkley River	Skeena River	40,000	....	At Hagwilget Canyon.	
3A§	"	"	27,000	....	At Moricetown Falls.	
4§	Copper River	"	7,500	....		
6§	Mud Creek	Bulkley River	500	....		
7§	Skeena River	....	30,000	....	Kitsalas Canyon; proximity of railroad may interfere with development.	
8§	Bulkley River	Skeena River	20,000	....	At Beaumont Canyon.	
9§	"	"	25,000	....	Canyon 37 miles above Hazelton.	
10§	"	"	6,300	....	At Telkwa; proximity of railroad may interfere with development.	
12§	Canyon Creek	"	1,500	....		
14§	Driftwood Creek	"	750	....		
15§	"	Bulkley River	500	....		
18§	Gold River	Skeena River	600	....		
24§	Morice River	Bulkley River	8,000	....		
27§	Porphory Creek	"	500	....		
28§	Skeena River	....	20,000	....	Canyon just north of Hazelton.	

* Powers available. † Powers staked. ‡ Powers developed and under development. § Powers available, investigated by Conservation Commission of Canada.

WATER-POWERS OF 500 HORSE-POWER AND OVER—*Continued.*

No.	Creek.	Tributary of.	H.P.	Applicant or Licensee.	Remarks.	Source of Information.
	HAZELTON WATER DISTRICT—*Concluded.*					
29§	Skeena River	....	15,000	....	20 miles above Babine River.	
30§	"	....	10,000	....	Canyon near 3rd Telegraph Cabin.	
31§	"	....	14,000	....	Canyon 9 miles above 4th Telegraph Cabin.	
32§	Telkwa River	Bulkley River	700	....		
33§	"	"	1,000	....	Canyon near Pine Creek.	
36§	Big Slide Creek	Skeena River	1,300	....	Near 3rd Telegraph Cabin.	
	KAMLOOPS WATER DISTRICT—					
1†	Adams River	Shuswap Lake	6,500	B.C. Hydraulic Power Co. ...	....	Application.
2‡	Barriere River	North Thompson River..	20,000	Kamloops Hydro-Elec. Co. ...	2,200 horse-power developed.	
6*	Canim Lake	Clearwater River	...	.....	Horse-power unknown, but must be considerable.	
7†	Clearwater River	North Thompson River..	2,000	Imperial Power Co.	....	Application.
14*	Myrtle River	Clearwater River	...	.....	Helmcken and Dawson Falls.	
16*	Seymour River	Shuswap Lake	600	.....	....	Data uncertain.
	KASLO WATER DISTRICT—					
2†	Cedar Creek	Kootenay Lake	1,700	Consolidated Mining & Smelting Co.	....	Application.
3‡	Coffee Creek	"	590	Kootenay Air Supply Co.	Developed.	
5†	Kaslo Creek (South Fork)	"	520	O. T. Stone	....	Application.
8‡	Tam O'Shanter Creek ...	"	520	New Canadian Metal Co.	Developed.	
	LILLOOET WATER DISTRICT—					
1†	Bridge River	Fraser River	147,000	Bridge River Power Co.	....	Data submitted by company.
2*	Cayoosh Creek	"	2,000-5,000	.....	....	1913 Report, p. 51.
4†	Portage Creek	Seton Lake	900	Portage Creek Power & Light Co.	....	Application.
	NANAIMO WATER DISTRICT—					
2†	Campbell River	Seymour Narrows	85,000	Campbell River Power Co. ...	....	Data submitted by company.
4†	Englishman's River	Strait of Georgia	840	British Pacific Hydro-Elec. & Tramways, Ltd.	....	" "
5*	Little Qualicum River ...	"	...	...	....	1913 Report, p. 40.
6‡	Millstone River	"	1,300	Nanaimo Elec. Light, Power & Heating Co.	Partial development.	
7*	Nanaimo River	"		....		
	Site No. 1	" 5,000		....		
	Site No. 2	" 11,200		....		
	Site No. 3	" 6,800		....		
	Site No. 4	" 3,000		....		
			26,000	....	....	Engineer's report.
9‡	Puntledge River	Comox Harbour	22,500	Canadian Collieries, Ltd.	12,000-horse-power plant in operation.	
10*	"	"	4,600	....	Site below Canadian Collieries development.	1913 Report, p. 40.
	NELSON WATER DISTRICT—					
5‡	Kootenay River	Columbia River	16,300	West Kootenay Light & Power Co.	Lower Bonnington Falls; 4,000 horse-power developed.	
6*	"	"	36,000	....	Bonnington Pool Falls	1912 Report, p. 34.

7‡	Kootenay River	Columbia River	6,850	City of Nelson	Upper Bonnington Falls; 4,000 horse-power developed.	
8‡	"	"	23,000	West Kootenay Light & Power Co.	Up. Bonnington Falls; 16,000 horse-power developed.	
9*	"	"	...	....	Site at Granite Bridge	1912 Report, p. 34.
10*	"	"	20,000	....	Canyon near Thrums	" p. 34.
12†	Pend d'Oreille River	"	84,000	Pacific Exploration Co.	Near junction with Columbia	1912 Report, p. 36, and application.
13*	"	"	24,500	....	9 miles from mouth	1912 Report, p. 36.
14*	"	"	26,000	....	15 miles from mouth	" p. 36.
15*	"	"	38,000	....	At junction with Salmon River	" p. 36.
20*	Salmon River	Pend d'Oreille	4,000	....	....	" p. 38.
22†	Sheep Creek	Salmon River	800	Motherlode Sheep Crk. Min. Co.	....	Data submitted by company.
23A†	"	"	640	Amalgamated Gold Mines of Sheep Creek, Ltd.	....	Application.
23B†	"	"	800	R. H. Leach	....	"
	New Denver Water Dist.—					
5†	Four-mile Creek	Slocan Lake	1,000	G. H. Aylard	....	"
	New Westminster District—					
1†	Chehalis River	Harrison River	22,000	Canadian Pacific Rly.	Joint scheme with Statloo River gives 37,000 horse-power	Data submitted by company.
2†	Chilliwack River	Fraser River	70,000-100,000	Vancouver Power Co., Ltd.	....	" "
3‡	Coquitlam and Buntzen Lakes	Fraser River and North Arm, Burrard Inlet	84,000	Vancouver Power Co., Ltd.	Developed.	
4†	Green River	Lillooet Lake and River	16,000	Nairn Falls Power Co.	....	Data submitted by company.
6†	Jones Lake	Jones Creek	29,000	Vancouver Power Co., Ltd.	....	" "
7†	Lillooet River	Pitt River	25,000	Burrard Power Company	....	" "
10†	Pemberton Creek	Lillooet River and Harrison Lake	950	Pacific Great Eastern Development Company	Only small portion of power staked	Application.
11†	Rushton Creek	Pitt Lake	1,000	E. J. Fader	....	Application and B.C. Hydrographic Survey Report, 1913, p. 123.
13†	Statloo River	Harrison River	15,000	Canadian Pacific Rly.	*See* Chehalis River, No. 1.	
14†	Stave River	Fraser River	75,000	Western Can. Power Co., Ltd.	50,000 horse-power developed.	
15†	Tamihy Creek	Chilliwack River	8,000	S. Fader	....	Application.
16†	Munro Creek	Pitt River	1,200	Gilley Bros., Ltd.	550 horse-power developed.	
	Prince Rupert District—					
1†	Ain River	Masset Inlet	7,800	British Canadian Lumber Corporation	....	Data submitted by company.
2†	American Creek	Bear River	7,200	R. M. Stewart	....	Application.
4†	Browns Creek	Ecstall River	8,000	Browns Sawmill Development	....	"
5†	Cascade Creek	Salmon and Bear Rivers	1,200	Salmon Bear River Mining Co., Ltd.	....	"
7‡	Falls River	Ecstall River	15,000	Prince Rupert Hydro-Elec. Co., Ltd.		
8†	Glacier Creek	Goose Bay	720	J. L. Parker	....	"
13†	Khtada River	Skeena River	10,000	Prince Rupert Hydro-Elec. Co., Ltd.	....	Data submitted by company.
15§	Kitsumgallum River	"	6,000	....		
16†	Kumeolon Creek	Grenville Channel	2,500	Grenville Development Co., Ltd.	....	Application.
19†	Madeleine Creek	Ecstall River	3,200	Prince Rupert Hydro-Elec. Co., Ltd.	....	"
22*	McKnight Creek	"	3,200	....	....	"
23†	Meziadin River	Nass River	...	Canadian North Eastern Power Co., Ltd.		
24*	Mountain River	Rennell Sound	4,800	....	....	Application.
27*	Nass River	Portland Inlet	150,000	....	....	Surveyor's estimate.

* Powers available. † Powers staked. ‡ Powers developed and under development. § Powers available, investigated by Conservation Commission of Canada.

WATER-POWERS OF 500 HORSE-POWER AND OVER—*Continued.*

No.	Creek.	Tributary of.	H.P.	Applicant or Licensee.	Remarks.	Source of Information.
	PRINCE RUPERT DISTRICT—*Concluded.*					
28†	Kawon River (Quan) ...	Masset Harbour	650	British Canadian Lumber Cor., Ltd.	....	Application.
29†	Raney River	Rennell Sound	2,150	Rennel Sound Dev. Co., Ltd.	....	"
32†	Thulme River	Wark Channel	8,000	Corporation of Prince Rupert	....	"
33†	Twin River	Rennell Sound	1,200	Rennel Sound Dev. Co., Ltd.	....	"
36‡	Woodworth Lake	Fern Passage	1,650	City of Prince Rupert	1,650 horse-power developed at present.	
37§	Aaltanhash River	Graham Reach	5,800	....		
39§	"A" Tributary	Brim River	1,000	....		
40§	Dome River	Aaltanhash Inlet	2,000	....		
41§	Inlet Creek	Gardner Canal	800	....		
42§	Kiltuish River	"	2,500	....		
43§	Lizette Creek	Mussel Inlet	4,500	....		
44§	McAlpin Creek	"	1,500	....		
45§	Mussel Creek	"	3,500	....		
46§	Poison Cove River	"	2,000	....		
47§	Price River	Gardner Canal	500	....		
48§	See-kwya-kin River	Kemano River	600	....		
49‡	Swanson Bay River	Graham Reach	1,250	Swanson Bay Forests, Wood, Pulp & Lumber Mills, Ltd.	Developed.	
50§	Ta-cha-stes Creek	Kemano River	1,600	....		
51§	Triumph River	Gardner Canal	4,500	....		
52§	Wachwas Creek	"	900	....		
53†	Carter River	Finlayson Channel	5,000	Carter River Power Co.	....	Application.
54†	Cougar Lake, etc.	Surf Inlet	900	Surf Inlet Power Co., Ltd. ..	....	"
55‡	Falls Creek	Observatory Inlet	7,325	Granby Consolidated Mining & Smelting Co.	7,325-horse-power plant installed.	
	PRINCETON WATER DISTRICT—					
1*	Ashanola River	Similkameen River	2,000	....	....	Data uncertain.
2†	Nehumpshan Creek	"	1,600	South Okanagan Power Co. ..	....	Application.
5*	Similkameen River	Okanagan River	...	....	Near Junction of Roche and Passayton Rivers.	
6‡	"	"	1,600	Daly Reduction Co., Ltd.	Developed.	
7†	"	"	2,200	Ashawota Power Co.	....	Application.
8*	Susap Creek	Similkameen River	650	....	....	Data uncertain.
11‡	Twenty-mile Creek	"	525	Daly Reduction Co.		
	QUESNEL WATER DISTRICT—					
3†	Niagara River	Quesnel Lake	800	Jovian Power Co.	....	Application.
6†	Spanish Lake, etc.	Quesnel River	...	L. Muller	....	"
7†	Swamp River	"	...	Atlas Power Co., Ltd., and Cariboo Power Co., Ltd.	....	"
	REVELSTOKE WATER DISTRICT—					
1*	Akolkolex Creek	Columbia River	4,000	....	....	B.C. Hydrographic Survey Report, 1913, p. 295; 1914, p. 431.
2*	Gold Creek West	"	...	....	Averages 5,000 horse-power per mile	Water Rights Branch, 1912 Report, p. 32.
3‡	Illecillewaet River	"	2,300	Revelstoke Power & Light Co.	Developed.	
6*	Smith Creek	"	...	....	Averages 1,400 horse-power per mile	1912 Report, p. 34.
7*	Soard Creek	"	...	....	Averages 2,800 horse-power per mile	" p. 32.

	Vancouver Water District—					
1*	Ashloo Creek	Squamish River	2,000	....	....	Data uncertain.
3†	Brandt Creek	Indian River	1,500	Westminster Power Co.	*See* No. 17.	
5‡	Britannia Creek	Howe Sound	2,275	Britannia Mining & Smelting Co.	Developed (total power on creek).	
6‡	Buntzen Lake	Burrard Inlet	84,000	Vancouver Power Co., Ltd.	Developed (*see* No. 3, New Westminster District joint scheme).	
8†	Cedar Creek	Howe Sound	2,000	G. F. Whalen	....	Application.
9*	Chapman Creek (Mission Creek)	Gulf of Georgia	800	....	....	Engineer's Report.
10†	Cheakamus River	Squamish River	34,000	British Columbia Power & Electric Co., Ltd.	There are other power-sites on this river which have not yet been investigated	Data submitted by company.
14†	Furry Creek	Howe Sound	3,000	Howe Sound Power Co.	....	" "
15†	Hixon Creek	Indian River	11,000	Westminster Power Co.	*See* No. 17.	
16§	Huaskin Lake	Drury Inlet	1,800	....		
17†	Indian River	Burrard Inlet 9,600		Westminster Power Co.	All included in one scheme of development.	
	Brandt Creek	Indian River 1,500		" "		
	Hixon Creek	" 11,000		" "		
	Norton Creek	" 4,700		" "		
	Young Creek	" 4,700		" "		
			31,500	....	....	Data submitted by company.
18‡	Jane Creek	Britannia Creek	900	Britannia Creek Mining & Smelting Co., Ltd.	Joint scheme with Marmot Creek (*see* Nos. 5 and 22).	
19†	Lloyd Creek	Homfray Channel	2,000	Crescent Sand & Gravel Co.	....	Application.
20†	Mamquam River	Howe Sound	7,200	Newport Water Co., Ltd.	....	"
21*	"	"	4,500	....	....	"
22‡	Marmot Creek	Britannia Creek	900	Britannia Mining & Smg. Co., Ltd.	Joint schemes with Jane Creek (*see* Nos. 18 and 5).	
23‡	Mill Creek	Howe Sound	2,000	B.C. Sulphite Fibre Co.	Partly developed.	
25†	Monmouth Creek	Squamish River	900	Pacific Great Eastern Development Co.	....	Data submitted by company.
26§	Necleetsconnay River	North Bentinck Arm	2,500	....		
27†	Norton Creek	Indian River	4,700	Westminster Power Co.	*See* under No. 17.	
28‡	Powell River	Malaspina Strait	32,000	Powell River Pulp Co., Ltd.	24,000 horse-power already developed.	
30†	Sallust Creek	Burrard Inlet	1,170	Consolidated Contractors, Ltd.	....	Application.
31†	Shannon Creek	Howe Sound	1,700	Newport Brick & Tile Co.	....	Data submitted by company.
34†	Stafford River	Loughborough Inlet	4,000	Davidson Ward Co.	....	Application.
35*	Stony Creek	Cheakamus River	5,000	....	....	Surveyor's estimate.
36*	Tastsquam River	Bella Coola River	3,000	....	....	"
39†	Young Creek	Indian River	4,700	Westminster Power Co.	*See* under No. 17.	
40§	Brem River	Toba Inlet	4,000	....		
41§	Canyon Creek	South Fork, Toba River	17,000	....		
42§	Chewson Creek	Toba Inlet	5,000	....		
43§	Dalley River	Rivers Inlet	700	....	2 sites.	
44§	Dean River	Dean Channel	1,200	....		
45§	Doos River	Rivers Inlet	6,000	....		
46§	Eckheimick River	Bute Inlet	4,000	....		
47§	Falls Creek	North Fork, Toba River	5,000	....		
48§	Forbes River	Homfray Channel	1,000	....		
49§	Genesse Creek	Rivers Inlet	2,000	....		
51§	Hatchery Creek	"	1,000	....		
52§	Hazel Creek	Toba River	3,500	....	At Mackenzie Falls.	
53§	Ice River	Bute Inlet	2,500	....		
54§	Ickna Creek	South Bentinck Arm	4,000	....		
55§	Indian River	Rivers Inlet	1,400	....		
56§	Klinaklini River	Knight Inlet	15,000	....		
58§	Memeky River	Salmon River (Johnstone Strait)	1,550	....	2 sites.	

* Powers available. † Powers staked. ‡ Powers developed and under development. § Powers available, investigated by Conservation Commission of Canada.

WATER-POWERS OF 500 HORSE-POWER AND OVER—*Concluded.*

No.	Creek.	Tributary of.	H.P.	Applicant or Licensee.	Remarks.	Source of Information.
	VANCOUVER WATER DISTRICT—*Concluded.*					
60§	Moses Creek	Rivers Inlet	600	....		
62§	Neechantz River	Rivers Inlet	1,000	....		
63§	Noscall River	Dean Channel	7,000	....		
64§	Nusash River	,,	600	....		
65§	Owens Creek	North Fork, Toba River	2,000	....		
66§	Rodell Creek	Bute Inlet	3,000	....		
67§	Salmon River	,,	4,500	....		
68§	,,	Johnstone Strait	1,200	....		
69‡	Sandle Lake	Rivers Inlet	3,000	Good Hope Cannery Co.	Partly developed.	
70§	Scow Quiltz River	Dean Channel	4,000	....		
71§	Seymour River	Seymour Inlet	4,000	....		
72§	Sheemahantz River	Rivers Inlet	4,500	....		
73§	Sim Creek	Knight Inlet	6,500	....		
74§	Slide Creek	,,	3,000	....		
75§	Summit Creek	South Fork, Toba River	1,500	....		
76§	Tahumming Creek	Toba Inlet	1,000	....		
77§	Talcomy River	South Bentinck Arm	1,400	....		
79§	Thomlinson Creek	South Fork, Toba River	5,500	....		
80§	Toba River (South Fork)	Toba Inlet	4,700	....		
81§	Little Toba River	,,	1,600	....		
82§	Twenty-two-mile Creek	Bute Inlet	3,000	....		
84§	Unnamed river	Ellerslie Channel	1,800	....		
85§	,,	,,	2,000	....		
86§	Wah-kash Creek	Knight Inlet	6,000	....		
88§	White River	Johnstone Strait	5,000	....		
89‡	Scott-Goldie Creek (Crocker Creek	North Arm, Burrard Inlet	1,500	Scott-Goldie Quarry Co., Ltd.	Partly developed.	
90‡	Link River	Dean Channel	12,500	Ocean Falls Co., Ltd.	Developed.	
91‡	Granite Falls Creek	Vancouver	...	Coast Quarries, Ltd.	Partly developed; information incomplete.	
	VERNON WATER DISTRICT—					
2†	Mission Creek	Okanagan Lake	1,000	Belgo-Canadian Fruitlands Co.	....	Application.
3†	Shuswap River	Mabel Lake	1,200	Couteau Power Co.	....	Data submitted by company.
4†	,,	,,	4,150	,,	....	,, ,,
	VICTORIA WATER DISTRICT—					
5‡	Goldstream	Saanich Arm	2,500	B.C. Elec. Rly.	Developed.	
6†	Gordon River	....	10,000	British Pacific Hydro-Elec. & Tramways, Ltd.	....	Application.
8‡	Jordan River	....	25,000	Vancouver Island Power Co.	Developed.	
10†	Nitinat River	Nitinat Lake	720	Central Island Power Co.	....	Application.
11†	Nimpkish River	Broughton Strait	67,000	E. L. Kinman	....	,,
15†	McGoogin Creek	Nitinat River	6,000	J. R. McKinnel and others	....	,,
17§	Amazon Creek	Quatsino Sound	1,100	....		
18§	Benson River	,,	1,000	....		
19†	Kokish River	Broughton Strait	10,000	White Bros. Lumber Co.	....	Application.
20§	Marble Creek	Quatsino Sound	8,200	Colonial Lumber Paper Mills, Ltd. (one site only)	Total for 3 sites.	
23§	Upper Nimpkish River	Broughton Strait	3,500	....	Camosin Canyon.	
24§	,,	,,	3,000	....	Big Falls above Moss River.	
25§	,,	,,	1,500	....	Above mouth of Davie Creek.	
26§	Quatze River	Hardy Bay	500	....		

27§	Raging River	Quatsino Sound	1,500	....		
28§	Shushartie River	Queen Charlotte Sound..	1,200	....		
29§	Tsi-itka River	Johnstone Strait	500	....		
	Windermere Water Dist.—					
1*	Findlay Creek	Kootenay River	6,400	....	Total of several powers of 2,000 horse-power and under	1913 Report, p. 77.
2*	Forster Creek	Columbia River	4,000	....	Total of 2 sites	„ p. 77.

* Powers available. † Powers staked. ‡ Powers developed and under development. § Powers available, investigated by Conservation Commission of Canada.

DISTRICT OFFICES.

The work of the year in the several district offices has been more of an administrative nature than in the two previous years. As was expected, the completion of Board-work increased this work, there being many investigations and settlements of disputes, all of which were personally dealt with by the District Engineers.

The offices at Cranbrook and Revelstoke have been temporarily closed. In the case of the former, work was taken over early in the summer by the District Engineer at Nelson, as H. B. Hicks, District Engineer at Cranbrook, had enlisted. In respect of Revelstoke, the Engineer has been brought into the head office to assist on Board and Drawing Office work.

All Board meetings were attended by the District Engineer responsible for the section in which the meetings were held. Here and there, where the engineering information was not complete enough, a record had to be again gone over. When the number of records investigated is considered, the few cases wherein it was necessary to check up speaks highly for the thorough manner in which the District Engineers supervised the work. Engineering investigation has been carried on wherever possible, but not to anything like the extent desirable. In many places the success of the district administration depends largely, if not wholly, upon a knowledge of the physical conditions.

ENGINEERING INVESTIGATION.

Attention was drawn to the growing importance of this phase of the work in last year's report. A feature that stands out this year is the assistance given the Health Department on several very important matters. Particular attention is drawn to the completion of water-supply investigation on Burrard Peninsula in respect of Greater Vancouver. Although this particular work could be continued to cover a number of minor points, from a departmental standpoint anything that now remains to be done can be taken up by the municipalities interested. A summary of the work done during the year is as follows:—

WATER-SUPPLY TO CITIES, TOWNS, ETC.

GREATER VANCOUVER.

The work of investigation on the Capilano River was carried on under the supervision of E. A. Jamieson during 1913. During the season of 1914 he also supervised the establishment of a contour showing the area lying below the Capilano intake on the north shore of Burrard Inlet. In respect of the Seymour River, Lynn Creek, and headwaters of the East Fork of Capilano River, since 1913 the work has been supervised by W. C. Smith, who, during the year just ended, has been employed in working up field-notes, collecting general information and data that will permit of the better administration of rights held by the municipalities which comprise Greater Vancouver.

The 1913 report touches on the streams and general physical conditions, including figures that showed the extent of the alienated timber on the Seymour River. During 1914 the alienated timber on the Capilano was cruised, the figures being given hereinafter. As referred to in our report of 1913, the importance of retaining the timber on this particular watershed cannot be too greatly emphasized. In many places there are signs of freshet streams where the sub-surface is seen to be nothing but a mass of boulders. At the sides of these courses can be seen the shallow depth of surface soil, bound, as it were, into a mat by the roots of the timber, which, if allowed to be cleared off, would cause the formation in many places to wash down, leaving nothing but the sub-surface of boulders. The timber fulfils the purpose of regulating the run-off, a factor to be considered by the municipalities which hold water rights on the creek.

The timber cruise made by the Forest Branch in 1914 showed the following figures on the Capilano River. Timber on Lots 1284, 1285, 1286, 1287, 1288, 1289, 1290, 1291, 1292, 1293, 1294, 1295, 1532, and 1563. Total area, 4,960 acres. Crown-granted in 1891 and 1892.

Species.	Total Feet B.M.
Douglas fir	8,267,000
Red cedar	74,797,000
Hemlock	30,036,000
Balsam fir	23,776,000
Total	136,876,000

On 1,345 acres of Crown lands bordering this alienated area the figures are as follows:—

Species.	Total Feet B.M.
Cedar	11,186,000
Hemlock	5,715,000
Balsam	3,534,000
Fir	5,115,000
Total	25,550,000

For general reference this investigation has been written up in greater detail and is now being assembled under one cover. It will comprise water rights, timber, lands, mining claims, precipitation, run-off, topographic maps and surveys of reservoir-sites.

This report deals with reservoir possibilities, the following sites in particular: Burwell (or Stony) Lake, Palisade (or Upper Lost) Lake, Lynn Lake, Kennedy Lake, and Loch Lomond (or Seymour) Lake.

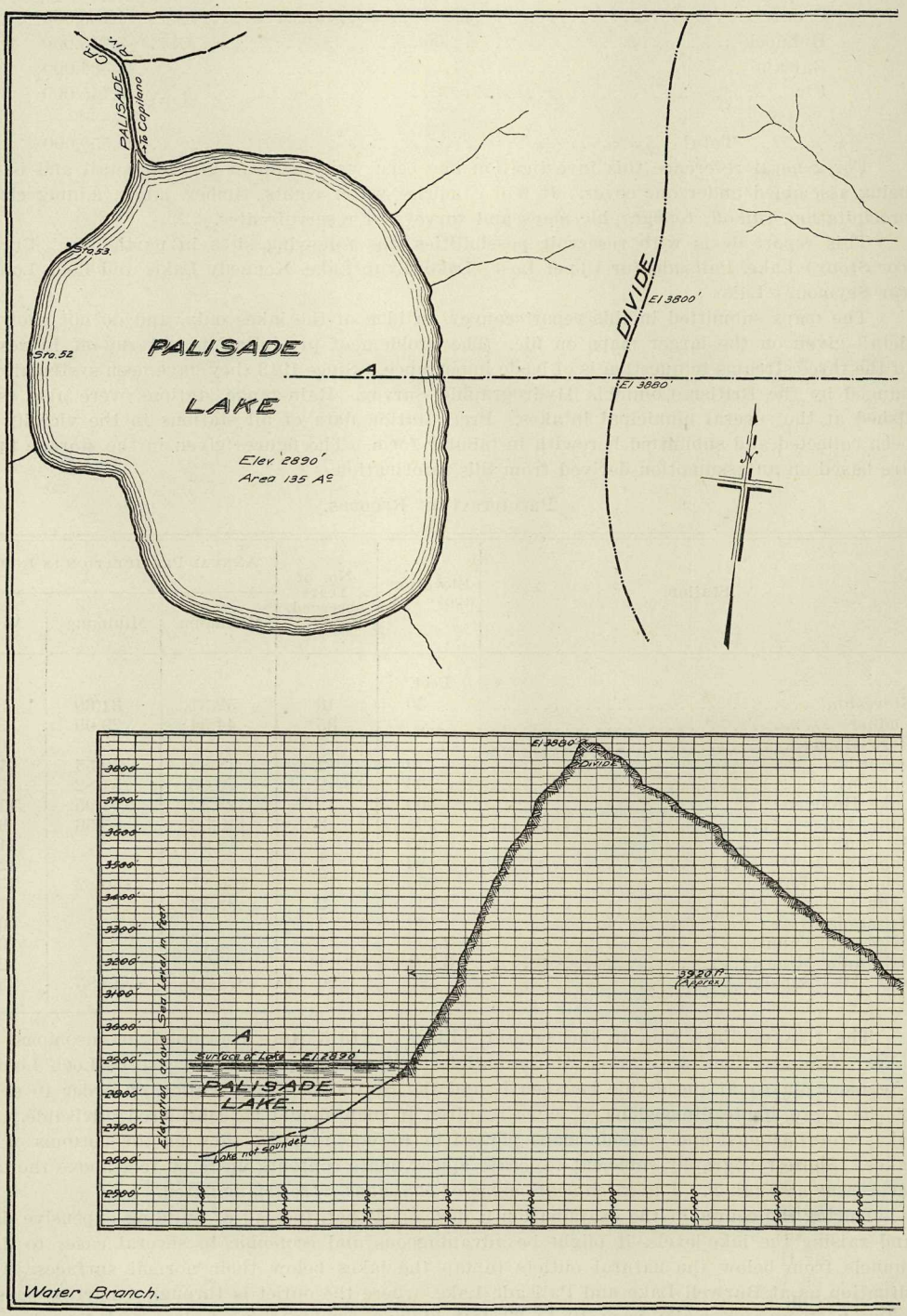
The maps submitted in this report convey an idea of the lakes only, and do not show the detail given on the larger maps on file. The problem of precipitation and run-off in respect of the three streams in question is of basic importance. Since 1913 they have been systematically gauged by the British Columbia Hydrographic Survey. Rain-gauge stations were also established at the several municipal intakes. Precipitation data of all stations in the vicinity has been collected and submitted herewith in tabular form. The figures given in the storage tables are based on an assumption derived from this information.

PRECIPITATION RECORDS.

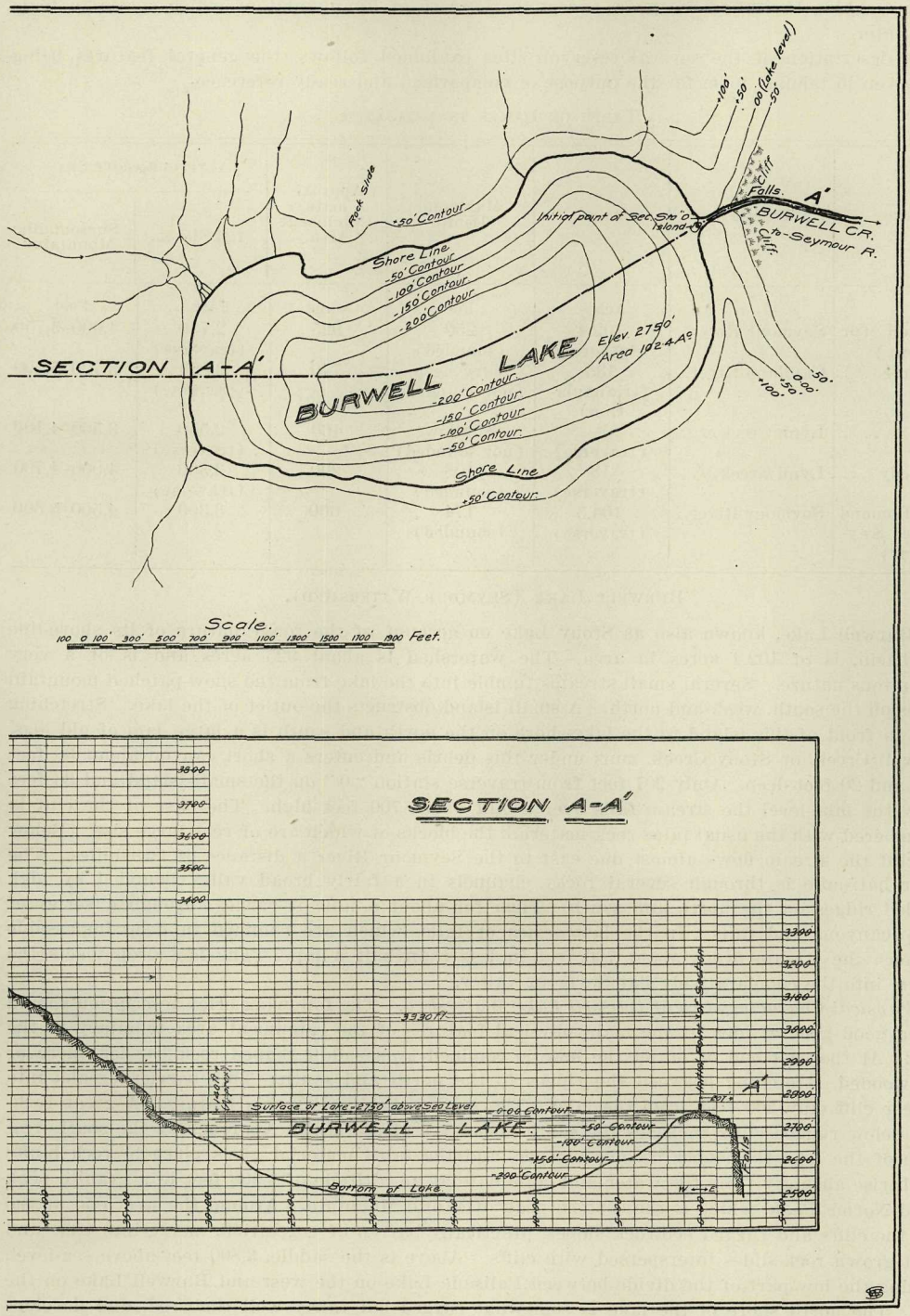
Station.	Elevation above Sea.	No. of Years observed.	Annual Precipitation in Inches.		
			Maximum.	Minimum.	Mean.
	Feet.				
Steveston	30	19	52.31	31.69	38.31
Ladner	...	35	44.54	29.09	36.06
Port Moody	...	1	...	...	63.18
Coquitlam	30	12	78.89	59.55	71.50
Vancouver	136	12	76.00	51.82	59.29
Lake Buntzen	400	12	123.32	104.95	111.00
Lake Lillooet	400	3	110.53	85.56	98.94
Seymour River	465	2	118.66	...	110.00
Capilano River	480	1	...	...	124.48
Coquitlam Lake	550	12	166.87	130.82	154.00
Lynn Creek	637	2	98.42	...	77.39
Britannia Beach	30	1	...	...	67.50
Britannia Tunnel	2,200	1	...	...	106.86
Britannia Mine	3,700	1	...	...	120.00
New Westminster	330	20	75.32	45.85	57.05

The traverse-lines run up the several valleys in 1913 were continued to encompass the lakes. Cross-sections were taken at the outlets of the lakes, and in the case of Loch Lomond (Seymour Lake) at the divide between it and the Stawamus River Valley, in order to arrive at the approximate dimensions of dams required if such should be considered advisable. The lakes were sounded and contour maps plotted in 10-foot intervals showing the bottoms of the lakes. Shore topography sufficient to locate approximate contours up to 50 feet above the lake-levels was also taken. The catchment-basins of the lakes were triangulated.

During the course of the examination it developed that, instead of building expensive dams and raising the lake-levels, it might be advantageous and economic in several cases to drive tunnels from below the natural outlets to tap the lakes below their normal surfaces. In a situation as at Burwell Lake and Palisade Lake, where the outlet is through a narrow passage between steep rock walls from 10 to 20 feet high, a combination of dam and tunnel seems feasible. The short, low dam required would make it possible to shorten the tunnel considerably, thus reducing the cost of tapping the lake.



Map of Palisade
Also section through lakes



and Burwell Lakes.
and over divide.

The limiting capacity of each of the reservoirs considered is governed by the quantity of water reaching the lake each year, except in the case of Lynn Lake, of which special note is made later.

A description of the several reservoir-sites examined follows, the general features being first given in tabular form for the purpose of comparison and ready reference.

TABLE OF LAKES INVESTIGATED.

Lake.	A Tributary of	Area.	Maximum Depth.	Approximate Catchment Area.	Altitude above Sea.	
					Lake-level.	Surrounding Mountains.
		Acres.	Feet.	Acres.	Feet.	Feet.
Burwell (or Stony)	Seymour River..	102.4 (traverse)	250 (sounded)	925	2,750 (traverse)	4,000–5,750
Palisade ...	Capilano River..	135 (triangulation)	Very deep (not sounded)	770	2,890 (traverse)	3,700–5,500
Lynn	Lynn Creek....	4 (traverse)	Shallow (not sounded)	460	2,550 (traverse)	3,500–4,100
Kennedy ...	Lynn Creek....	18 (traverse)	108 (sounded)	200	3,300 (traverse)	4,000–4,700
Loch Lomond (or Seymour)	Seymour River..	104.5 (traverse)	174 (sounded)	600	3,300	4,500–5,300

BURWELL LAKE (SEYMOUR WATERSHED).

Burwell Lake, known also as Stony Lake on account of the rocky nature of its shore-line and basin, is of 102.4 acres in area. The watershed is about 925 acres and is of a very precipitous nature. Several small streams tumble into the lake from the snow-patched mountain ridges on the south, west, and north. A small island obstructs the outlet of the lake. Stretching from in front of this island to the lake-shore on the north and south is a large jam of old logs. Burwell Creek, or Stony Creek, runs under this debris and enters a short canyon about 30 feet wide and 20 feet deep. Only 207 feet from traverse station "0" on the small island and 36 feet below the lake-level the stream falls over a cliff about 700 feet high. The base of the cliff is encumbered with the usual talus-rock material, the blocks of which are of very large size. Below the cliff the stream flows almost due east to the Seymour River a distance of two miles. The upper half-mile is through several rocky channels in a fairly broad valley bounded by high wooded ridges on the north and south. Then for about a mile it rushes through a series of rocky canyons and falls. In the last series of falls, which are confined in deep impassable canyons, the stream drops about 700 feet in less than half a mile. The last drop ejects the stream into the comparatively flat Seymour valley.

Physical Characteristics of Burwell Lake Watershed.—The following brief description should give a good general idea of the main physical features of the catchment area tributary to the lake: At the east end or outlet the lake is confined by a saddle-shaped rock barrier, more or less wooded, stretching between the ridges to the north and south. This barrier breaks into a sheer cliff only 200 feet from the lake. The section A-A′ shows this feature. A great rock-slide below rugged cliffs encircles the south-east curve of the lake. Approaching the south-west angle of the lake the slopes become steeper, and the talus material gives place to rock bluffs which rise abruptly from the water and culminate at an altitude of 4,900 feet in a granite peak called Norma Peak, which is the eastern peak of White Mountain. Around the west end of the lake the cliffs and rugged bed-rock slopes, practically barren of vegetation, merge into tree- and shrub-grown rock-slides interspersed with cliffs. Above is the saddle, 3,800 feet above sea-level, forming the low part of the divide between Palisade Lake on the west and Burwell Lake on the east. The north shore of the lake is somewhat rugged but fairly well timbered, and develops a more gently sloping area about 15 feet above the lake. Above this area the very rugged, precipitous, barren side of Cathedral Mountain rises to an altitude of 5,750 feet above the sea, being 3,000 feet above the lake. A great snow-field stretches away to the north of Cathedral

Mountain. All summer the lake-basin is filled with the sound of small streams fed by melting snow rushing down the mountain-sides.

The situation appears to be an ideal site for a reservoir where water may be stored in considerable quantity and for long periods before being delivered to the city. The air is always cool in the basin on account of the high altitude and the close proximity of large masses of snow. Generally speaking, reservoirs and watersheds lose considerable water by evaporation, but it is probable that at Burwell Lake and at the other lakes described hereinafter the loss by evaporation is very small, as the air over them is usually cool and moist. Loss by seepage is probably very small on account of the bed-rock nature of the basin and the steep mountain-slopes.

Survey.—A traverse was run up the bed and banks of Burwell Creek from its mouth to the lake at its source. At all convenient transit stations on the creek traverse-readings were taken on the mountain-peaks and the main topographical features were noted.

The survey of the lake was accomplished by a shore-line stadia traverse completely around the lake, with many side-shots to more completely define the area. From the shore-line traverse stations many readings were taken on the surrounding mountain ridges and peaks in order to define the watershed limits with a fair degree of accuracy. It was considered inexpedient and unnecessary to make any actual traverse of the watershed boundaries, as a careful system of triangles probably defines the area within 5 per cent.

In order to tie Palisade Lake, tributary to Capilano River, to Burwell Lake, a system of triangles was used with two connected base-lines on the separating ridge. From these base-lines a series of triangles were also projected to define the peaks and ridges around the lakes. These triangles were of great service in conjunction with the readings taken from the lake traverse stations. A line was run from station "O" at the outlet of the lake up the shoulders of the mountains on either side to a height of 100 feet above the lake, side topography being taken by stadia and hand-level.

The elevation of the lake above sea-level is 2,750 feet. This figure is based on the 677-foot contour-line surveyed around a proposed storage-basin above the Seymour Falls projected in 1910 by the City of Vancouver. The tie with Palisade Lake on the Lynn Creek traverse continuation run in 1913 checks the elevation closely.

Soundings.—A raft was constructed and about 300 soundings taken, using a heavy iron weight on a 200-foot reel chain conveniently placed on the raft. Soundings were taken at 25-foot intervals, starting at certain selected stations of the shore-line traverse and running in directions designed to cover the lake in the most comprehensive way. It proved to be a very deep body of water. In several cases the 200-foot chain found "no bottom" at 400 feet from the shore. In order to determine the depth where the 200-foot chain failed to find bottom, a marline line was used and depths up to 240 feet were thus determined. The maximum depth is probably even greater than this and may exceed 250 feet.

The following table of areas and capacities shows the value of this lake as a storage-basin:—

BURWELL (OR STONY) LAKE.

Contours.	Area at Contour.	Storage between Consecutive Contours.	Accumulated Storage above or below Present Lake-level.	
	Acres.	Acre-feet.	Acre-feet.	Imp. Gals.
+50 feet	132.50	1,292.50	5,844.50	1,591,500,000
+40 "	126.00	1,226.25	4,552.00	1,239,500,000
+30 "	119.25	1,162.50	3,325.75	905,500,000
+20 "	113.25	1,108.75	2,163.25	589,000,000
+10 "	108.50	1,054.50	1,054.50	287,000,000
Present lake-level	102.40	+—0	...	...
—10 feet	94.50	984.50	984.50	268,000,000
—20 "	87.00	907.50	1,892.00	515,000,000
—30 "	81.00	840.00	2,732.00	743,700,000
—40 "	76.50	787.50	3,519.50	958,000,000
—50 "	72.50	745.00	4,264.50	1,160,800,000

+Above lake-level. —Below lake-level.

Area of watershed, 925 acres (triangulated); elevation of lake above sea-level, 2,750 feet; elevations of mountains about lake, 4,000 to 5,750 feet above sea-level.

PALISADE LAKE (CAPILANO WATERSHED).

Palisade Lake lies slightly over 3,900 feet west of Burwell Lake and at an elevation of about 140 feet higher. It is the largest lake on the Burrard Peninsula, being about 135 acres, with a watershed area of approximately 770 acres. It forms the headwaters of Palisade Creek, which flows into the East Fork of the Capilano River.

The physical characteristics of the catchment-basin are very similar to those of Burwell Lake watershed. White Mountain extends across its southern limit at an average elevation of from 5,000 to 5,300 feet above sea-level. The slopes from White Mountain carry large quantities of snow throughout the year, large quantities being observed in the late summers of 1913 and 1914 when the lake was visited by the survey parties. Circling the lake on the west the ridge falls away to a saddle forming the lowest part of the divide between Palisade Lake and Lynn Lake at an altitude of 3,670 feet above sea-level. To the north of the saddle the ridge rises to a peak 4,100 feet above the sea, then continues westerly, forming the northerly boundary of the Lynn Lake basin.

Palisade Lake catchment area is extremely precipitous, the average mountain-slopes being over 45 degrees in many places, particularly on the east and south. Great cliffs and massive rock-slides are the prominent features, but trees and shrubs are fairly plentiful on some of the slopes.

Survey.—Palisade Lake and Lower Palisade Lake were included in the Lynn Creek traverse of 1913. The traverse was of the usual stadia-transit type, using two targets. To define the lake a system of triangles was employed, using the course from traverse stations 52 to 53 as a base-line. The surrounding mountain ridges and peaks were located by intersecting shots from convenient traverse stations.

No actual soundings were taken on Palisade Lake as time would not permit, but all the conditions indicate that it is very deep. From the general contour of the basin and comparison with Burwell Lake it may safely be said to be at least as deep as Burwell Lake—i.e., 250 feet. The following table of capacities gives approximately the capacity of the lake from 50 feet below to 50 feet above its normal level. The area at each successive 10-foot contour-line below the lake datum is assumed to be only 90 per cent. of that at the contour-line above, while each successive 10-foot contour above the lake datum is assumed to encompass 105 per cent. of the area of the next contour below. It is, however, advisable that these assumptions be verified.

PALISADE LAKE.

Contours.	Area at Contour.	Storage between Consecutive Contours.	Accumulated Storage above or below Present Lake-level.	
	Acres.	Acre-feet.	Acre-feet.	Imp. Gals.
+50 feet	172.50	1,683.75	7,650.00	2,082,000,000
+40 "	164.25	1,602.50	5,966.25	1,624,000,000
+30 "	156.25	1,526.25	4,363.75	1,188,000,000
+20 "	149.00	1,453.75	2,837.50	772,700,000
+10 "	141.75	1,383.75	1,383.75	376,700,000
Present lake-level	135.00	+—0	...	...
—10 feet	121.50	1,282.50	1,282.50	349,300,000
—20 "	109.25	1,153.75	2,436.25	663,300,000
—30 "	98.50	1,038.75	3,475.00	946,300,000
—40 "	88.50	935.00	4,410.00	1,200,800,000
—50 "	79.75	841.25	5,251.25	1,429,800,000

+Above lake-level. —Below lake-level.

Area of watershed, 770 acres (triangulated); elevation of lake above sea-level, 2,890 feet; elevation of mountains about lake, 3,700 to 5,500 feet above sea-level.

Storage may be secured in Palisade Lake by building a dam at the outlet of the lake or by tapping it below its normal surface, or by a combination of the two plans. Attention is drawn to the relation between this lake and Burwell Lake and the possibility of a tunnel between the two to connect up the former with the Seymour system.

Lower Palisade Lake (Capilano River Watershed).

Lower Palisade lies 2,000 feet north-west of Palisade Lake. The waters of Palisade Lake literally tumble into it. The lake is 26 acres in area and is 1,807 feet above sea-level. As time would not permit of the survey being carried farther, it was decided to leave this lake for future consideration.

Lynn Lake (Lynn Creek Watershed).

Lynn Lake is a shallow 4-acre body of water situated at an altitude of 2,550 feet above sea-level at the headwaters of the main stream of Lynn Creek, sometimes called the North Fork of Lynn Creek. Its catchment area is about 460 acres of precipitous mountain-slopes in the form of a large amphitheatre.

The lake lies in a long basin above two mountain shoulders which shut off the lake watershed from the valley below. The watershed is bounded on the east by the ridge which forms the west boundary of Palisade Lake watershed, and on the north and west by a similar range with peaks reaching 4,000 feet above the sea.

Survey.—The survey was conducted in a manner similar to the survey described above. The contours about the lake were plotted from general ground slopes and side stadia shots.

The following table gives the storage capacity which may be developed by constructing a dam between the mountain shoulders at the outlet of the lake. The run-off far exceeds the storage capacity of the reservoir which would be created by the building of a dam 50 feet high, but should conditions arise which would make the further development necessary a larger portion of the run-off could be stored by constructing a higher dam.

Lynn Lake.

Contours above Lake-level.	Area at Contour.	Storage between Consecutive Contours.	Accumulated Storage.	
	Acres.	Acre-feet.	Acre-feet.	Imp. Gals.
50 feet	34.75	330.00	1,048.75	285,500,000
40 ,,	31.25	288.75	718.75	195,670,000
30 ,,	26.50	221.25	430.00	117,040,000
20 ,,	17.75	138.75	208.75	56,840,000
10 ,,	10.00	70.00	70.00	19,060,000
Present lake-level	4.00	...	...	...

Area of watershed, 460 acres (triangulated); elevation of lake above sea-level, 2,550 feet; elevation of mountains about lake, 3,500 to 4,100 feet above sea-level.

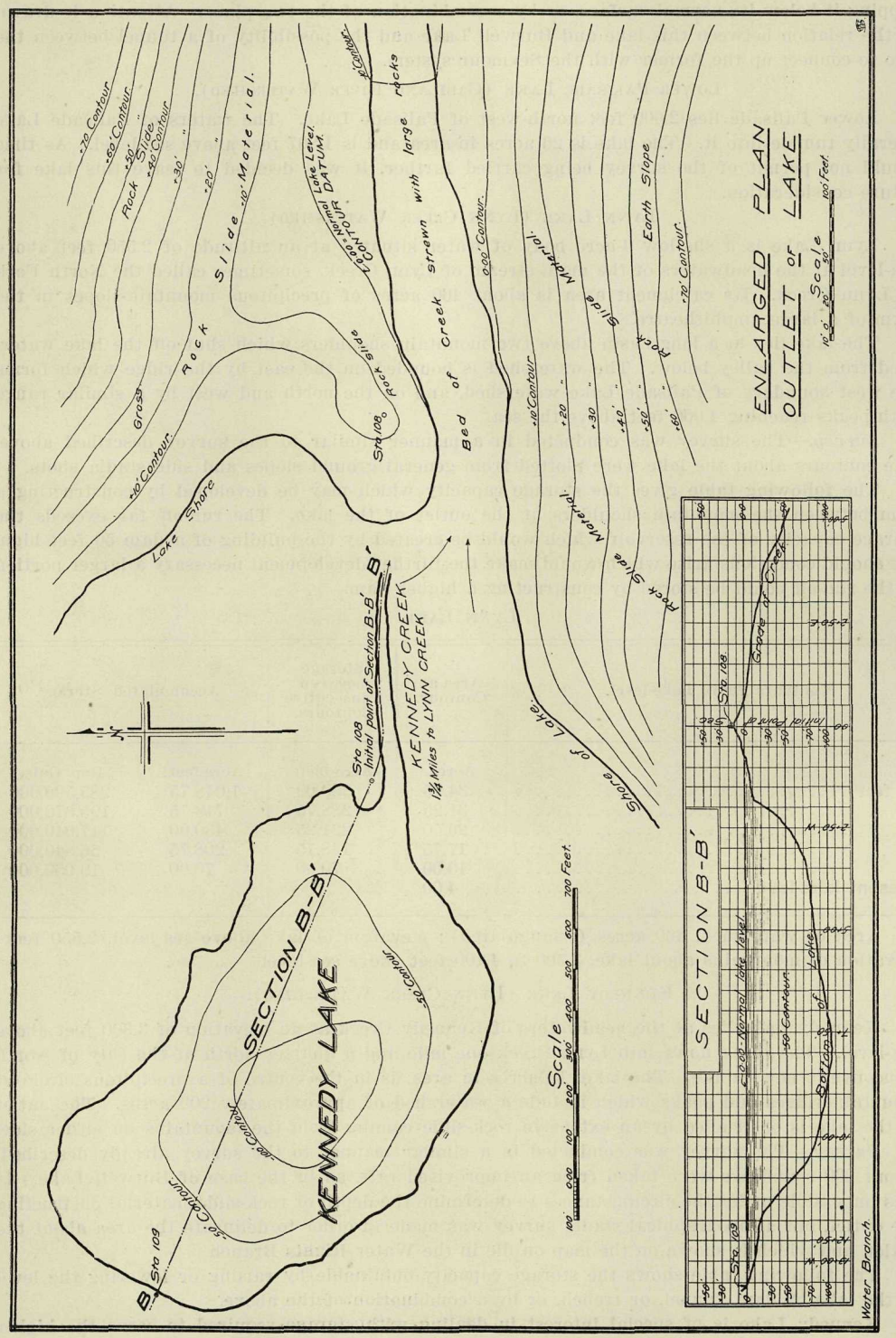
Kennedy Lake (Lynn Creek Watershed).

Kennedy Lake lies at the headwaters of Kennedy Creek at an elevation of 3,300 feet above sea-level. The creek flows into Lynn Creek one mile and a quarter north of the City of North Vancouver's new intake. The lake, 18 acres in area, is in the centre of a precipitous circle of mountain ridges and peaks which include a watershed of approximately 200 acres. The outlet of the lake is obstructed by an extensive rock-slide coming from the mountains on either side.

Survey.—The survey was conducted in a similar manner to the survey already described. About 230 soundings were taken from an improvised raft, as in the case of Burwell Lake. It was impossible under the circumstances to determine the depth of rock-slide material obstructing the outlet, but a topographical stadia survey was made in order to delineate the area about the outlet, and which is shown on the map on file in the Water Rights Branch.

The following table shows the storage capacity obtainable by raising or lowering the level of the lake by dam, tunnel, or trench, or by a combination of the above.

Kennedy Lake is of special interest in dealing with storage required to serve the higher levels on the north shore of Burrard Inlet.



Map of Kennedy Lake.

KENNEDY LAKE.

Contours.	Area at Contour.	Storage between Consecutive Contours.	Accumulated Storage above or below Present Lake-level.	
	Acres.	Acre-feet.	Acre-feet.	Imp. Gals.
+50 feet	25.00	243.75	1,087.50	296,000,000
+40 "	23.75	231.25	843.75	229,600,000
+30 "	22.50	218.75	612.50	166,700,000
+20 "	21.25	205.00	393.75	107,200,000
+10 "	19.75	188.75	188.75	51,400,000
Present lake-level	18.00	+—0	...	...
—10 feet	14.75	163.75	163.75	44,600,000
—20 "	12.50	136.25	300.00	81,700,000
—30 "	11.00	117.50	417.50	113,700,000
—40 "	9.75	103.75	521.25	141,900,000
—50 "	8.75	92.50	613.75	167,100,000

+Above lake-level. —Below lake-level.

Area of watershed, 200 acres (triangulated); elevation of lake above sea-level, 3,300 feet; elevation of mountains about lake, 4,000 to 4,700 feet above sea-level.

LOCH LOMOND (OR SEYMOUR LAKE).

Loch Lomond is situated at the headwaters of the main stream of Seymour River. It is 104.5 acres in area and at an altitude of about 3,300 feet above sea-level. It is fed by a precipitous mountain area of approximately 600 acres, on which snow remains in patches throughout the summer.

Survey.—In 1913 the Seymour River traverse was run to Loch Lomond and the lake area was defined by a system of triangles. In 1914 the work was continued, and the lake-shore traversed and the watershed limits were defined by a system of triangles from convenient traverse stations.

The bottom of the lake was defined by 750 soundings, using a heavy weight and 200-foot reel chain in a manner similar to that described above in connection with Burwell Lake.

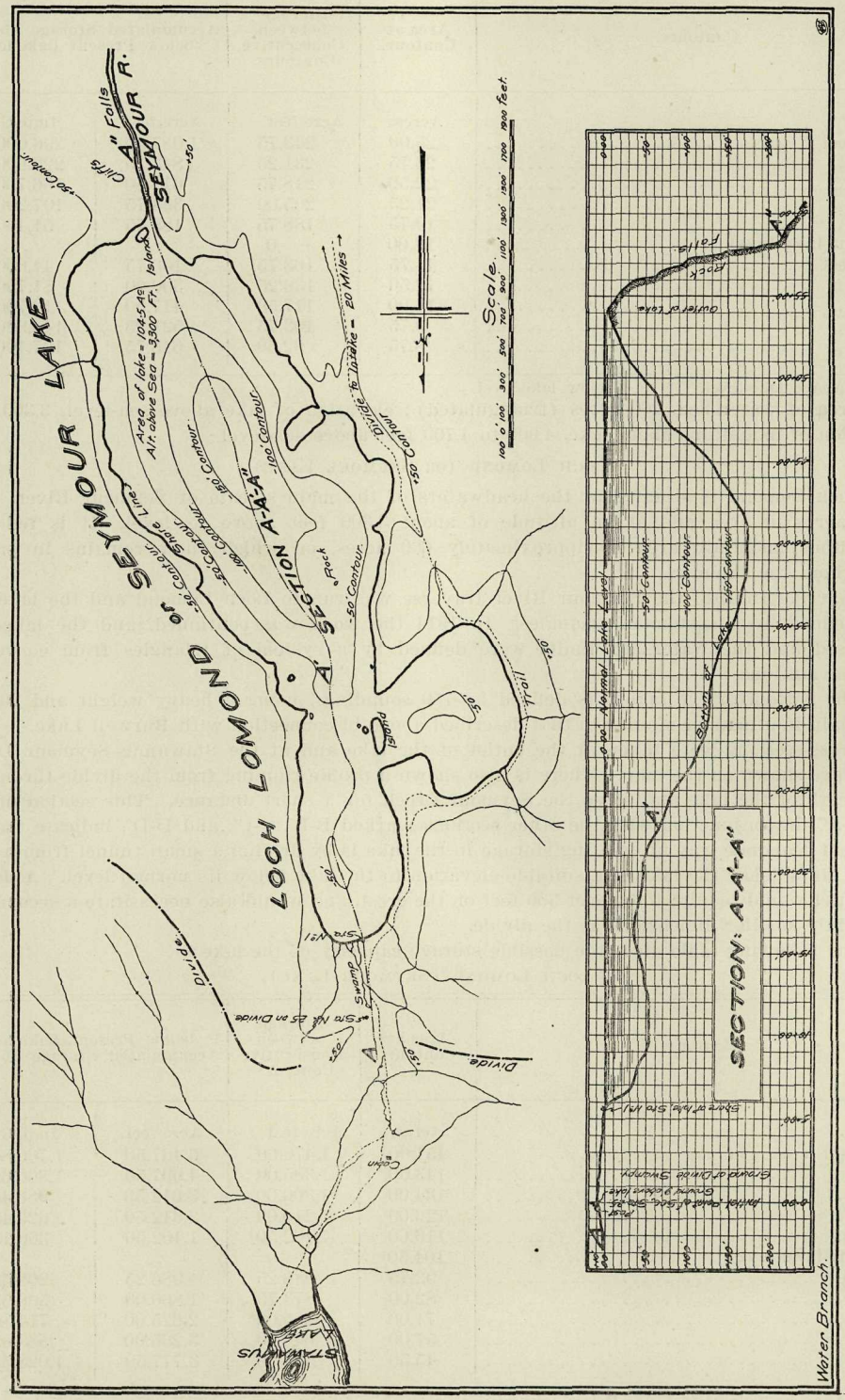
Cross-sections were taken at the outlet of the lake and at the Stawamus-Seymour Divide. These are shown on the map. There is also shown a profile running from the divide throughout the length of the lake and down the Seymour Creek for a short distance. This section marked A-A′—A″, in conjunction with the other sections marked B-B′, C-C′, and D-D′, indicate that the apparent economic way of creating storage in the lake is by driving a small tunnel from a point on the cliffs below the lake at a suitable elevation to the lake below its normal level. A dam at the outlet would require to be over 300 feet on the crest, and would also necessitate a second dam of slightly smaller dimensions at the divide.

The following table gives the possible storage capacity of the lake:—

LOCH LOMOND (SEYMOUR LAKE).

Contours.	Area at Contour.	Storage between Consecutive Contours.	Accumulated Storage above or below Present Lake-level.	
	Acres.	Acre-feet.	Acre-feet.	Imp. Gals.
+50 feet	151.00	1,470.00	6,467.50	1,760,800,000
+40 "	143.00	1,385.00	4,997.50	1,360,600,000
+30 "	134.00	1,300.00	3,612.50	983,450,000
+20 "	126.00	1,210.00	2,312.50	629,450,000
+10 "	116.00	1,102.50	1,102.50	300,150,000
Present lake-level	104.50	+—0	...	...
—10 feet	92.75	986.25	986.25	268,500,000
—20 "	82.00	873.75	1,860.00	506,500,000
—30 "	71.00	765.00	2,625.00	714,800,000
—40 "	57.00	640.00	3,265.00	889,050,000
—50 "	45.50	512.50	3,777.50	1,028,550,000

+Above lake-level. —Below lake-level.



Map of Loch Lomond (Seymour Lake).

Area of watershed, 600 acres (triangulated); elevation of lake above sea-level, 3,300 feet; elevation of mountains about lake, 4,500 to 5,300 feet above sea-level.

TABLE SHOWING STORAGE POSSIBILITIES OF LAKES.

Lake.	Area of Present Water Surface.	Area of Drainage-basin above Lake.	Estimated Run-off above Lake.	Storage Capacity.	
	Acres.	Acres.	Acre-feet.	Acre-feet.	Imp. Gals.
Burwell	102.4	925	6,938	6,938	1,888,700,000
Palisade	135.0	770	5,775	5,775	1,572,250,000
Lynn	4.0	460	3,450	1,047	285,500,000
Kennedy	18.0	200	1,500	1,467	408,000,000
Lock Lomond	104.5	600	4,500	4,500	1,225,000,000
Totals	363.9	2,955	22,163	19,727	5,379,450,000

NOTE.—In estimating the run-off of the several lake watersheds, precipitation of 120 inches with a run-off of 75 per cent. has been allowed.

CITY OF NELSON.

In company with Dr. Arthur, Local Medical Health Officer, W. J. E. Biker made an inspection of Cottonwood Creek. In the report submitted, attention is called to the present source of pollution—viz., a ranch which extends along the creek with building in close proximity. Attention was also directed to other sources of pollution—viz., the Great Northern Railway (Nelson and Fort Sheppard), mining activities, and agricultural development. The problem is one to be dealt with by the Board of Health and city.

KALEDEN.

Here the Kaleden Fruitlands Development Company owns a combined irrigation and domestic water-supply system, obtaining water for the most part from Sheep Creek, a tributary of Beaver Creek, which flows into Okanagan Lake near Penticton. This system is to serve some 3,000 acres of bench land. As an outcome of a complaint to the Board of Health from the Kaleden Farmers' Institute on the contamination of the domestic water, O. F. D. Norrington, District Engineer at Penticton, made a report after a careful inspection of the water-supply. Owing to the present scarcity of money it would not appear possible to make any great permanent improvement, but the cleaning-out of the watercourse at a number of points, more especially through several sloughs, was recommended as a temporary help towards keeping the supply from serious contamination.

REVELSTOKE.

As a result of a complaint of the Canadian Pacific Railway that an insufficient supply was being furnished, O. J. Bergoust, District Engineer at Revelstoke, was requested to make an examination of the supply the city was getting, and what portion was being diverted to the Canadian Pacific Railway. The water is taken from Hamilton, Bridge, and Tapping Creeks, the Canadian Pacific Railway having a licence on the last named. As a result of the measurements made, it was found that the railway was obtaining more than its arrangement with the city called for, and that the city was diverting an amount equivalent to 500 gallons *per capita*. It was ascertained that the reason for this large amount was due to the need for flushing the sewerage system, and that before it could be reduced reconstruction was necessary.

GOLDEN.

As a water-supply system has been under contemplation for some time, examination of the several sources in the vicinity of the town was made by O. J. Bergoust. Hospital Creek as a possible source has been systematically gauged throughout the low-water period and appears to be adequate.

SANITARY REPORTS.

At the request of the Board of Health, investigation and reports on the sewage-disposal problem of the Cities of Nelson and Cranbrook were made. W. J. E. Biker, District Engineer at Nelson, carried out this work to the satisfaction of the Board, accompanying his report in both instances with comprehensive plans. It is understood that these reports will be either referred to at length or printed in full in the Annual Report of the Board of Health, and for such reason are not submitted herein.

SMALL ARTESIAN WELLS.

The problem of artesian water was taken up in the season of 1914, the work being under George Anderson. In the report of that year reference was made to the conditions that obtained and the necessity for legislation that would not only protect the vested interests, but provide administrative machinery in respect of the drilling of new wells and the control of subterranean water as a natural resource of the Province.

Although the field was fairly well covered in 1914, it was found necessary to devote a few days in the field during the early summer in checking up a few points. Time was then taken in working up the notes and compiling general information that will be of use to any who may be interested in this form of development. The information will be under one cover and will comprise the details of existing wells as far as obtainable, maps and other data, also notes on legislation in other countries.

That this report may be more complete the summary given in the interim report of 1914 is again briefly given, with general information in tabular form and a diagram and table of the several datum-planes in use in the section under investigation.

The present condition in respect of the use of artesian water in the district comprising Vancouver City, the Municipalities of North, South, and West Vancouver, Point Grey, Burnaby, Maple Ridge, Richmond, and the Districts of Delta, Surrey, and Langley is as follows:—

The total number of wells located was 356, of which 345 are in British Columbia and eleven just over the border in the United States adjoining the Hazelmere artesian area. In respect of cost, the figures obtained show a total of $63,900 for 206 wells. The investment in order to get a flowing well on each ranch varies from $75 to $1,000. The wells drilled are usually 2 and 3 inches in diameter and from 25 to 300 feet deep, with a few from 350 to 600 feet deep. Some twenty-five wells vary from 6 to 8 inches in diameter and from 25 to 1,000 feet deep, and there is one well 12 inches in diameter and 1,480 feet deep. The wells are classified under three heads:—

(1.) *Work done by Provincial Government.*—At the Prison Farm, Burnaby, 1 well; at the Customs-house on Pacific Highway, 1 well; at the Cloverdale Road Department store-shed, 3 wells; total wells drilled by Government, 5.

(2.) *Undertaken by Private Individuals.*—In this class some 268 wells were drilled, representing 177 separate interests, in which in some cases there is co-operation. In two cases two individuals have combined to develop water on the property of one of them. In two other cases water is given free from wells to neighbours who have put in the necessary piping, conveyed the water from the wells to their places, in one case 1,700 feet away. In another, one well supplies ten houses and a livery-barn free, except to one user, who is charged 50 cents per month. On quite a number of the ranches it was found necessary to drill from two to three, and in one case five, in another six, and in yet another eight wells before water was found in sufficient quantity. The investigation showed that of the 266 private wells, only 165 were flowing and discharging some 1,355,400 gallons per 24-hour day.

Some of these wells discharge as follows: Gallons per 24-hour day, 30,000; 50,400; 72,000; 79,000; 100,000; 150,000. All the wells in this class are flowing under natural pressure, and most of them deliver the water at 3 to 5 feet above ground-level; in other cases from 10 to 26 feet above.

The remainder of these private wells are either failures or the water does not flow above ground, but merely rises and stands in the pipe, in some cases at ground-level.

(3.) *Undertaken by Corporations.*—Under this class of ownership a large quantity of water has been developed by means of sixty-nine wells drilled for, or by twenty-seven corporations. Of these, eleven are capable of discharging 332,700 gallons per day under natural pressure above ground-level, and other 1,159,900 gallons are pumped daily from thirty wells.

Of these eleven flowing wells, ten discharge some 32,700 gallons under natural pressure above ground-level, and one well, which when opened discharged about 300,000 gallons per day, is now capped and not used; it was drilled for gas and oil.

General.—It should be pointed out that 101 wells in Cloverdale and Langley Districts discharge a total of some 450,492 gallons per day, whilst the total requirements of the seventy-four interests dependent on this water amounts approximately to 50,000 gallons per day. As these wells are all running uncontrolled, it can be seen that some 400,000 gallons per day are running to waste. In one case a well drilled for a ranch in Cloverdale, the requirements of which would not exceed 1,000 gallons per day, has been running 79,000 gallons per day. In and around Cloverdale some thirty-six wells have been drilled, thirty-three of which discharge 109,000 gallons per day, the total cost of these wells being $5,800, whereas the well which discharges 79,000 gallons cost about $150. The flow of many of the wells is decreasing and nothing has been done to try and improve them.

The following table has been compiled to show average depths, cost, and flow:—

TABLE OF AVERAGE DEPTHS, COST, AND FLOW.

Totals.	No Data available.	Used for Results in Cols. 5 and 6.	Totals.		Averages.
1.	2.	3.	4.	5.	6.
			SURREY—		
90	5	85	Depths of wells, feet	14,088 / 85	Per well, 165.75 feet.
90	25	65	Depths of casing, feet	9,776 / 65	Per well, 150.40 feet.
90	12	78	Discharge 24 hours, gals.....	349,908 / 78	Per well, 4,486 gals.
90	12	78	Depths per 100 feet	14,088	4.03 feet.
			Gals. per 24 hours	3,499	
90	6	84	Cost of wells	$13,404 / 84	Per well, $159.60.
			Cost of wells	$13,404 / 14,088	Per foot, 95 cents.
			Cost of wells	$13,404 / 3,499	Per 100 gals. per 24 hours, $3.85.
			HAZELMERE—		
56	3	53	Depths of wells, feet	9,079 / 53	Per well, 171.24 feet.
56	15	41	Depths of casing, feet	5,592 / 41	Per well, 136.40 feet.
56	19	37	Discharge 24 hours, gals.	338,700 / 37	Per well, 9,154 gals.

TABLE OF AVERAGE DEPTHS, COST, AND FLOW.— *Concluded.*

Totals.	No Data available.	Used for Results in Cols. 5 and 6.	Totals.		Averages.
1.	2.	3.	4.	5.	6.
			HAZELMERE—*Concluded.*		
56	19	37	Depths per 100 feet	9,079	2.65 feet.
			Gals. per 24 hours	3,387	
56	4	52	Cost of wells	$7,326	Per well, $140.90.
				52	
			Cost of wells	$7,326	Per foot, 81 cents.
				9,079	
			Cost of wells	$7,326	Per 100 gals. per 24 hours, $2.16.
				3,387	
			LANGLEY—		
156	1	155	Depths of wells, feet	37,490	Per well, 241.87 feet.
				155	
156	66	89	Depths of casing, feet	16,700	Per well, 186.50 feet.
				89	
156	49	107	Discharge 24 hours, gals.	924,870	Per well, 8,643 gals.
				107	
156	49	107	Depths per 100 feet	37,490	4.05 feet.
			Gals. per 24 hours	9,248	
156	2	154	Cost of wells	$22,244	Per well, $144.44.
				154	
			Cost of wells	$22,244	Per foot, 59 cents.
				37,490	
			Cost of wells	$22,244	Per 100 gals. per 24 hours, $2.40.
				9,248	

In taking the elevations of the wells the various datum-planes in use were noted, and while it may be slightly out of place to continue at length in the matter, a few words of explanation are essential.

To reduce as far as possible, due to length of time between aneroid-reading at wells and the daily base, the rail-level at prominent points on the railway nearest each well was used as datum-planes and bench-marks for future reference, their elevation values being obtained from the railway engineers, reducing them eventually by means of the equation to mean sea-level. The following diagram of the equation and accompanying table for the various datum-planes in use in the Fraser River Valley and around Vancouver corresponds to Dr. Dawson's mean sea-level as established at Vancouver. On the large map showing the location of the wells the elevation is in each instance given.

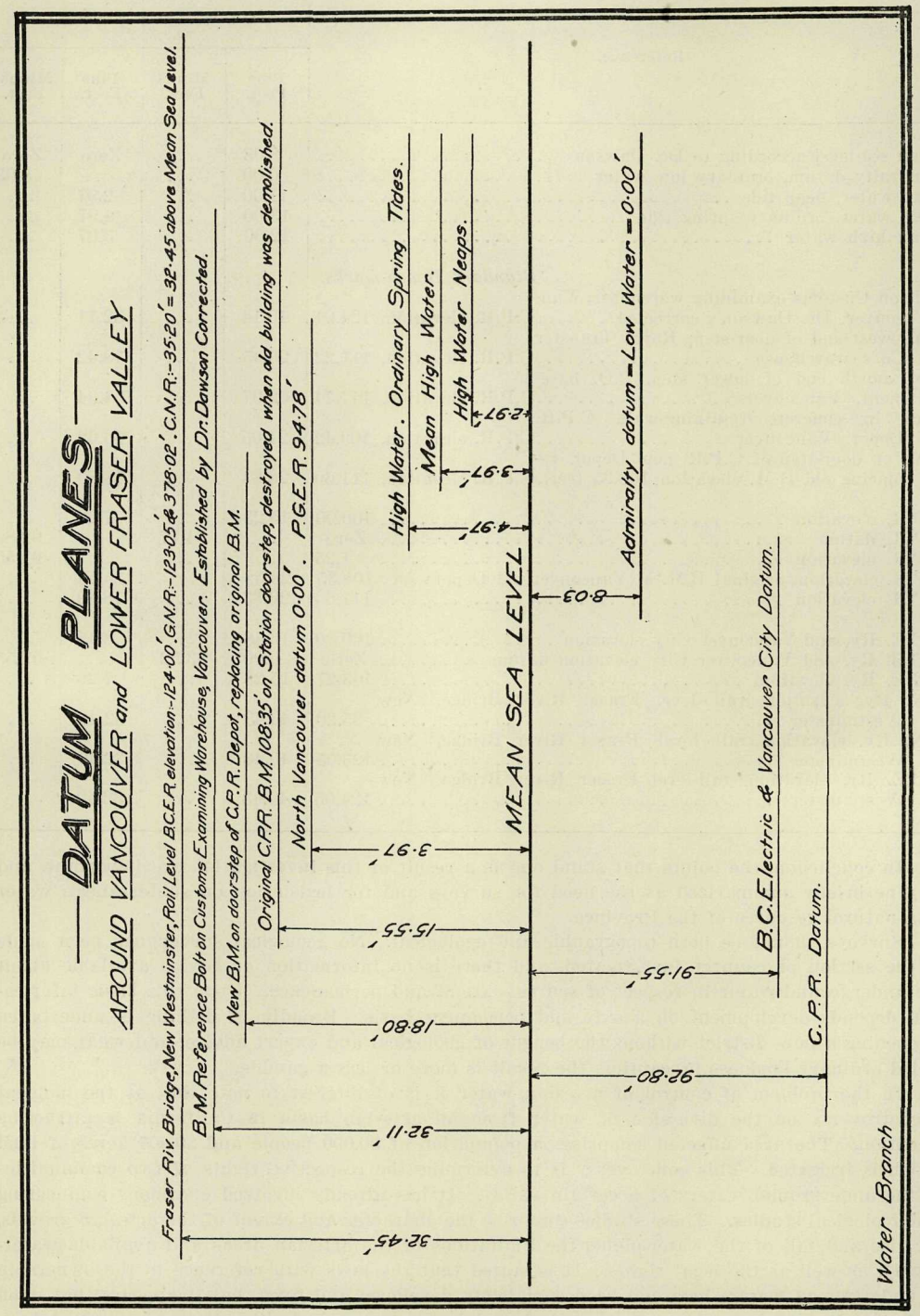
British Columbia Mainland Datum-planes, Bench-marks, and Elevations Values.

Reference.	O.L.W.		M.S.L.	
	Plus Feet.	Minus Feet.	Plus Feet.	Minus Feet.
Mean sea-level according to Dr. Dawson	8.03	...	Zero	Zero
Admiralty datum, ordinary low water	0.00	...	...	8.03
High water, neap tide	11.00	...	2.97	...
High water, ordinary spring tide	13.00	...	4.97	...
Mean high water	12.00	...	3.97	...
Standard Bench-marks.				
Bolt on Customs examining warehouse, Vancouver, Dr. Dawson's corrected.....C.P.R. elevation, 124.91	40.14	...	32.11	...
B.M. west end of door-step, Royal Transfer Co.'s warehouse .....C.P.R. elevation, 111.22	26.45	...	18.42	...
B.M. north end of lower step, P.O. basement, Vancouver .....C.P.R. elevation, 147.74	62.97	...	54.94	...
Tack in concrete retaining-wall, C.P.R. Depot, Vancouver .....C.P.R. elevation, 109.42	24.65	...	16.62	...
B.M. on door-step of C.P.R. new Depot, replacing old B.M. elevation, 108.35 feet..C.P.R. elevation, 111.60	26.83	...	18.80	...
C.P.R. elevation 100.00	15.23	...	7.20	...
C.P.R. datum ..... Zero	...	84.77	...	92.80
C.P.R. elevation 1.25	...	...	...	91.55
C.P.R. elevation, original B.M. at Vancouver old Depot 108.35	23.58	...	15.55	...
C.P.R. elevation 111.60	26.83	...	18.80	...
B.C.E. Ry. and Vancouver City elevation 100.00	16.48	...	8.45	...
B.C.E. Ry. and Vancouver City elevation datum ..... Zero	0.00	83.52	...	91.55
P.G.E. Ry. elevation 103.27	15.23	...	7.20	...
C.N. Ry. elevation, rail-level Fraser River Bridge, New Westminster 35.20	40.43	...	32.40	...
G.N. Ry. elevation, rail-level Fraser River Bridge, New Westminster 123.05	40.43	...	32.40	...
B.C.E. Ry. elevation, rail-level Fraser River Bridge, New Westminster 124.05	40.43	...	32.40	

In conclusion, the points that stand out as a result of this investigation are important, and may be briefly summarized as the need for surveys and for legislation on subterranean water as a natural resource of the Province.

Surveys should be both topographic and geological. No geological survey has been made of the section of country investigated, and there is no information or advice available about the underground water in respect of source, extent, and permanence. Upon this basic information depends development on a safe and permanent basis. Broadly, if drilling is undertaken in opening a new district without the benefit of geological and expert advice, and what may be called ordinary business precaution, the result is more or less a gamble.

In the problem of control of artesian water it is of interest to note that at the moment a controversy on the diversion of water from an artesian basin in California is attracting attention. The area affected comprises a population of 50,000 people and 80,000 acres of land which is irrigated. This controversy is to determine the respective rights of two communities to the underground waters of a certain valley. It has already involved enormous engineering and geological studies. These studies comprise the character and extent of the artesian gravels, the rise and fall of the water-plane, the limitations of the artesian areas and available water-supply, as well as the legal rights. It is stated that the laws with reference to the ownership of underground waters have not been completely developed and fixed, but it appears that upon various rulings interests having prescriptive rights were granted titles if the water had been developed for five years without protest.


DATUM PLANES
AROUND VANCOUVER and LOWER FRASER VALLEY
Fraser Riv. Bridge, New Westminster, Rail Level B.C.E.R. elevation:-124·00'. G.N.R.:-123·05' & 378·02'. C.N.R.:-35·20' = 32·45 above Mean Sea Level.
B.M. Reference Bolt on Customs Examining Warehouse, Vancouver. Established by Dr. Dawson Corrected.
New B.M. on door-step of C.P.R. Depot, replacing original B.M.
Original C.P.R. B.M. 108·35' on Station door-step, destroyed when old building was demolished.
North Vancouver datum 0·00'. P.G.E.R. 94·78'
High Water. Ordinary Spring Tides.
Mean High Water.
High Water Neaps.
Admiralty datum = Low Water = 0·00'
MEAN SEA LEVEL
B.C.Electric & Vancouver City Datum.
C.P.R. Datum.
32·45'
32·11'
18·80'
15·55'
3·97'
4·97'
3·97'
+2·97'
8·03
91·55'
92·80'
Water Branch

The value to and the part artesian water has taken in the development of Surrey and Langley in particular has probably never been fully realized. And as the land in these and other districts are brought under cultivation and the population increases there will be all the greater need for the protection and control of artesian basins.

PROPOSED PUBLIC IRRIGATION CORPORATIONS.

Kelowna.—The report on the water-supply for the proposed corporation was completed early in the year from the information obtained by O. F. D. Norrington, District Engineer at Penticton, and J. F. Rowlands. Both Mill Creek and Scotty Creek watersheds were thoroughly investigated. This report has been incorporated in the report of the Board of Investigation to the Minister respecting the feasibility and practicability of the project. A preliminary report of the Board was discussed at a meeting with the proposed trustees held at Kelowna during March, 1915.

Westbank.—With the exception of contouring Indian Reserve No. 9, field-work was completed during 1914; however, owing to the Indian Department having applied to be included in the proposed corporation, the reserve has been surveyed in the same manner as the rest of the land—i.e., in 10-foot contours. The plotting of this survey has been completed and is now under consideration by the Board of Investigation.

It is unnecessary in this report to describe in detail the results of the survey, but the following notes will perhaps be interesting:—

Powers Creek, from which this district will obtain its water-supply, is sixteen miles and a half in length, having its source at an elevation of 4,730 feet, and with a total fall of 3,600 feet, equivalent to a 4.13-per-cent. fall. The creek has only two tributaries of importance, one flowing in from the south at a point ten miles and a half up Powers Creek; this fork is four miles and a half in length. The other tributary, called the North Fork, flows in one mile below the South Fork and is three miles long. At the head of the main creek are three lakes, two of which are suitable reservoir-sites. Their catchment areas are, however, not large, being only 796 acres. Estimating on a basis of 24 inches precipitation and 35 per cent. run-off, a total of 557 acre-feet are available for storing. This run-off is deduced from the run-off obtained from Penticton Creek, mention of which is made later.

At the head of the South Fork is a lake which makes a good site; it has a catchment area of 1,190 acres, and on the same basis has an estimated run-off of 833 acre-feet.

The North Fork is only a small stream; however, it is found that by means of a short cut it is possible to divert water from a good-sized lake situated at the head of the South Fork of Bear Creek. It has long been thought locally that this lake naturally flowed into Powers Creek, but this is now shown not to be the case.

Three trial ditch-lines from Powers Creek were run, the longest of which is three miles and a half to where it enters the proposed territorial limits.

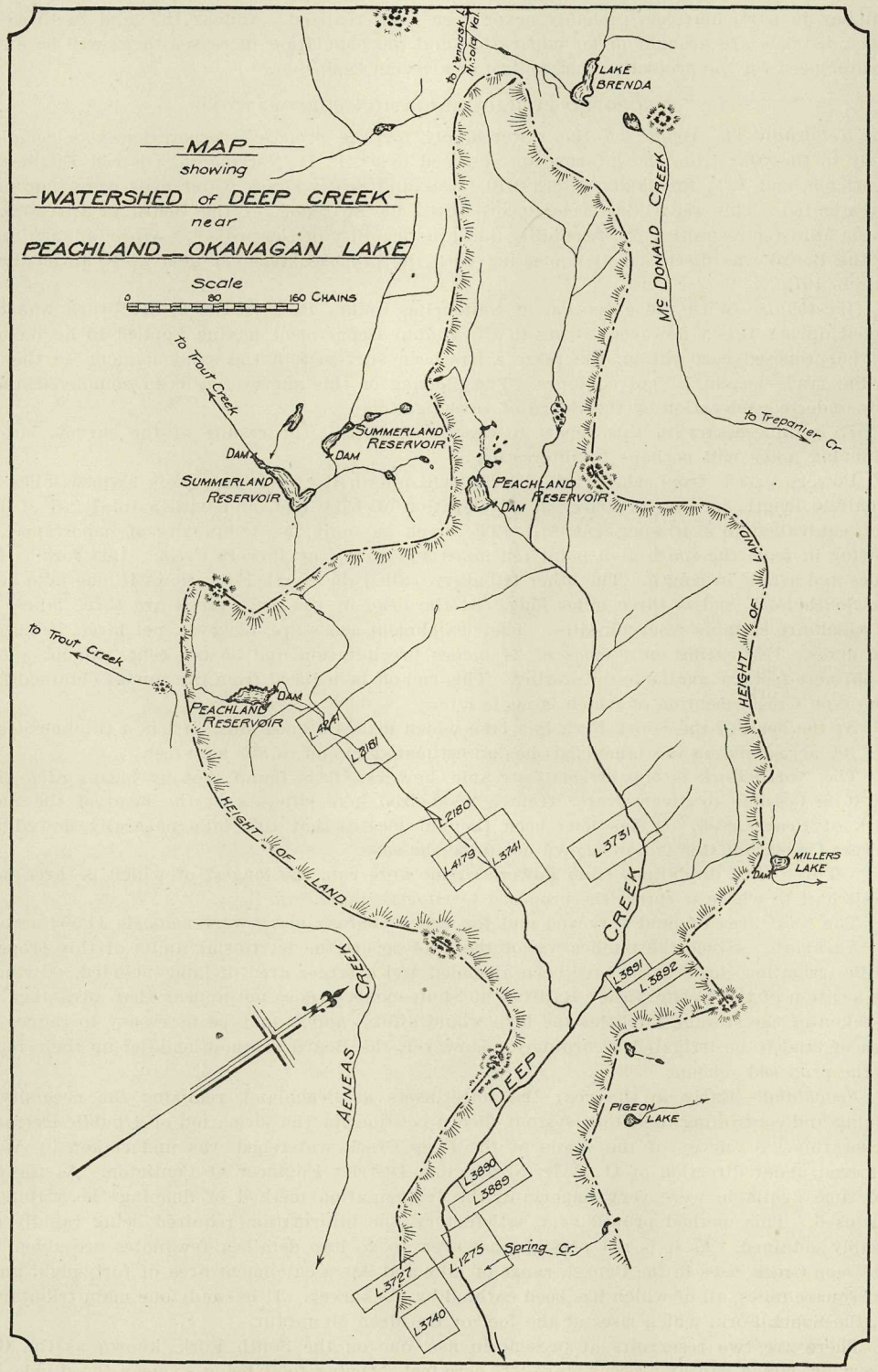
The total area of land surveyed and for which contour maps were made is 11,500 acres.

Naramata.—Since the publication of the 1914 report the territorial limits of this proposed public irrigation corporation have been amended and a larger area of land included. Owing to the location of the Kettle Valley Railway at Shuie Lake, it does not appear that advantage can be taken of the storage facilities the lake would afford, and it may be necessary to reduce the area of land to be irrigated accordingly. However, the Board are now making up their report on the proposed scheme.

Peachland.—Early in the year the water-users at Peachland, realizing the necessity of owning and controlling their own system, filed a petition for the formation of a public irrigation corporation. A survey of the whole of the Deep Creek watershed was undertaken by W. C. Cameron under direction of O. F. D. Norrington, District Engineer at Penticton. As the cost and time available were very important, the triangulation method of defining the watershed was used. This method proved very satisfactory, the information required being rapidly and cheaply obtained. As it is not possible, however, to go into detail, a few notes are given.

Deep Creek rises in the Penask range of hills and has a catchment area of forty-eight and a half square miles, all of which has been covered by the survey. It has only one main tributary—i.e., the South Fork, which rises at the foot of Kathleen Mountain.

There are two reservoirs at present in use, one on the South Fork, known as the Glen Reservoir, which can at present store 227 acre-feet. Owing to it being so near the divide and


MAP
showing
WATERSHED of DEEP CREEK
near
PEACHLAND_OKANAGAN LAKE
Scale
0 80 160 CHAINS
to Trout Creek
SUMMERLAND RESERVOIR
DAM
SUMMERLAND RESERVOIR
DAM
PEACHLAND RESERVOIR
DAM
LAKE BRENDA
McDONALD CREEK
to Trepanier Cr.
HEIGHT OF LAND
to Trout Creek
PEACHLAND RESERVOIR
DAM
L 4241
L 2161
2180
L 4179
L 3741
L 3731
MILLERS LAKE
DAM
HEIGHT OF LAND
DEEP CREEK
L 3891
L 3892
AENEAS CREEK
PIGEON LAKE
L 3890
L 3889
L 1275
Spring Cr.
L 3727
L 3740

having a catchment area of only two and a half square miles, it does not fill to its full capacity. It is found, however, that this catchment can be increased by diverting water from a small creek which flows down past the Silver King Mine into the reservoir. In June this creek had a flow of 1.6 c.f.s., and which appears to be well maintained. The other reservoir is situated on the main Deep Creek and at present can store 531 acre-feet, having a catchment area of four square miles. On July 3rd this reservoir was overflowing at rate of 1.8 c.f.s. Just above this reservoir are numerous beaver-swamps, the whole tapering to a narrow outlet affording a good dam-site. The catchment area is three square miles, but as this area is also part of the catchment of the reservoir below, it is doubtful if there would be sufficient run-off to fill both. Apart from this reservoir-site and the two present reservoirs, with the exception of a small beaver-meadow on the main creek which is not considered as being large enough, there are no other good locations. The upper reaches of the creek are for the most part bare and rocky.

An interesting result of this survey is that it has been found possible to divert a fair-sized creek which flows down to Penask Lake, on the Nicola Divide, into the head of Deep Creek by means of a few hundred feet of ditch. This creek has a catchment area of six and a half square miles. Lake Brenda, lying quite close and having an area of 40 acres, can also easily be diverted into Deep Creek by means of a ditch. This lake could be lowered 5 feet by cutting a beaver-dam.

The Board of Investigation is now engaged on the compilation of its report to the Minister as to the feasibility and practicability of the proposed public corporation.

WATER-USERS' COMMUNITIES.

Considerable attention appears to have been given to section 160, 1914 "Water Act," by water-users during the past season, and several "water-users' communities" are now in the process of formation. There have been many small difficulties which have for the most part arisen from the "happy-go-lucky" way users had in the past of handling their water affairs, but now machinery is provided, no one knows better than the water-user how satisfactory it will be to have his water affairs looked after in a businesslike way. The following are the communities now forming:—

Trepanier Water-users' Community, Peachland.—Water-users on the Trepanier Townsite have until now had water delivered by the Townsite Company, which under a yearly verbal agreement obtained permission to carry the water required in the Huston-Drought ditch. Now the Trepanier people are forming themselves into a community to acquire a share in the ditch, and also to take over the Trepanier Townsite Company's distribution system.

Another Community is in course of formation in the same neighbourhood, but higher up Trepanier Creek. These people intend to construct joint works for their several properties.

Lower Trout Creek Water-users' Community, near Summerland.—Two years ago the users at Lower Trout Creek applied to the District Engineer at Penticton to draw up an arrangement whereby each could get his fair share of water. The putting-in of divisors was recommended and a schedule of rotation by time agreed upon. This has worked very satisfactorily for two seasons, with only minor troubles. The question of maintenance of the works and the collection of rates for same has arisen, and the people have decided to form themselves into a community.

Botanie Valley, near Lytton.—Although a community has not been formed, the need of closer co-operation on the part of water-users in this valley is bound to follow shortly. The present arrangement of ditches might have been devised to waste as much water as possible. On the west side of the creek are two ditches about six miles long and a shorter one paralleling each other. One of the longer ones was shown by tests made in 1914 to be in a very bad condition and wasting an enormous percentage of water. As the property under it can be effectively served by a much shorter flume and ditch, it is desirable that all the works be brought under one management. At the present time a dam on Botanie Lake constructed jointly by some of the water-users is being worked co-operatively. This co-operation should extend further, and by eliminating one of the long ditches and working with full channels under a system of rotation the large waste at present going on would be decreased.

Laluwissen Creek, Twenty Miles North of Lytton.—A water-users' community has been suggested at this point, and it is hoped that the farmers will see the benefit to be derived thereby. During the past season a reconnaissance survey was made by F. W. Knewstubb of the storage possibilities on the watershed of Laluwissen Creek. Two sites were located on the South Fork; the one selected as the most suitable being half a mile above the forks, and in

such a position that it will, by construction of about one mile and a half of feeder-ditch, command also the greater part of the North Fork catchment area. The survey shows that an earth dam could be constructed having a maximum height of 40 feet and would impound 1,900 acre-feet of water.

A Water-users' Community was suggested for some properties near Revelstoke, but owing to the fact that only half-hearted interest was shown by some of the parties, the community did not take concrete form. There appeared to be a difficulty in the matter of financing the construction of the works.

RECONNAISSANCE SURVEY FOR STORAGE-SITES.

Owing to the general retrenchment policy pursued during the past season, it has been impossible to extend these surveys as would have been desired.

Mention has been made previously of surveys for the Kelowna, Westbank, and Peachland proposed public irrigation corporations, and for the proposed water-users' communities in Botanie Valley and at Laluwissen Creek.

Owing to the lack of information regarding the headwaters of Canyon Creek, from whence the Canyon Creek Irrigation Company of Kelowna draws water, a reconnaissance survey was made early in the year. The survey shows that the capacity of the company's reservoir at the head of the creek can only be increased at a great expense, and it is not considered there is a sufficient catchment area to warrant the expenditure.

A considerable amount of water collected by the East Fork of Canyon Creek enters the main stream at a point approximately four miles down-stream from the Canyon Creek Irrigation Company's dam. This water runs to waste in the early spring, but it is found that it could be saved by constructing a ditch one mile and a quarter long which would deliver it into the head of Hydraulic Creek, and so into the South Kelowna Irrigation Company's reservoir. As water from the latter company's system can be turned into the Canyon Creek Irrigation Company's system and the respective lands are adjacent, co-operation between the two companies would without doubt bring mutual advantages.

Fourth of July Creek.—About six miles west of Grand Forks. A careful investigation of the main creek by C. Varcoe, District Engineer at Grand Forks, proved conclusively that the storage of water cannot be economically developed.

Jewel Lake and Creek, North of Greenwood.—The investigation of the lake revealed the possibilities of additional storage. The present storage capacity represents an annual run-off of a fraction over 3 inches from the land directly tributary. It would be safe to assume that the present storage could be doubled. This is a matter of interest to the City of Greenwood, which suffers periodically from a deficient water-supply. By raising the present high level of the lake 1 foot some 52,000,000 gallons (additional to the present storage) could be stored.

McMynn Lake, near Myncaster.—An investigation showed that storage is feasible. A dam 20 feet high would impound approximately 1,000 acre-feet.

Sawmill Creek, South of Kelowna.—The survey of this watershed failed to disclose storage possibilities of any value, and it would appear, without going into the matter in detail, that pumping from Okanagan Lake may have to be resorted to for the low-lying land in order to release the late creek run-off for the higher benches.

Storage of Water by Means of flooding Waste Land.—It has been suggested that the storage of water by the flooding of waste lands at the headwaters of streams could be taken advantage of where no facilities exist for building reservoirs. With this object in view, C. Varcoe made a reconnaissance survey of the headwaters of Morrissey and Hardy Creeks near Grand Forks. In both cases it was found that the land which might readily lend itself to such purpose was not waste land, although at an elevation of close on 4,000 feet, but occupied land mainly pre-emptions.

Percentage of Run-off to Precipitation.—Some interesting data has been collected in respect of the percentage of run-off to precipitation in the Southern Okanagan. There is difficulty generally in securing precipitation data at the higher elevations, but with the advent of the Kettle River Railway crossing the valley an opportunity presented itself, and a meteorological station was established at Princeton Crossing in September, 1914.

The precipitation during 1915 was approximately 26.6 inches, so 24 inches has been assumed as a conservative figure.

The run-off of Penticton Creek has been measured for the past two years as follows:—

1914—

Total run-off	31,316 acre-feet.
Run-off per acre for whole year	0.74 acre-feet per acre.
Run-off, April 22nd to September 30th	24,974 acre-feet.
Run-off per acre, April 22nd to September 30th	0.59 acre-feet per acre.

Assuming a precipitation of 24 inches, the run-off equals 37 per cent. of precipitation. It will be noted that 80 per cent. of the run-off occurred between April 22nd and September 30th.

1915—

Total run-off	26,494 acre-feet.
Run-off per acre for whole year	0.62 acre-feet per acre.
Run-off, April 22nd to September 30th	24,506 acre-feet.
Run-off per acre, April 1st to September 30th	0.58 acre-feet per acre.

Assuming as above a precipitation of 24 inches, the run-off equals 31 per cent. of precipitation; 93.5 per cent. of the run-off occurred between April 1st and September 30th.

POWER POSSIBILITIES OF STREAMS.

During the past season this phase of engineering-work has not received a great deal of attention, but it is hoped that in the future more investigations can be made.

Franklin Creek, a tributary of the North Fork of Kettle River, was investigated by C. Varcoe. The result of the investigation was not satisfactory and showed that the power available at low water would not justify the cost of development.

Sproat and Stamp Rivers.—The investigation of the power-sites was undertaken during 1913. Stream-measurements have been continued by the British Columbia Hydrographic Survey and will be published in the Stream-flow Bulletin. There are at present going to waste some 50,000 or 60,000 continuous horse-power, most of which can be developed at a reasonably low cost, including storage to meet any ordinary conditions of demand. It is, of course, obvious that this amount is far in excess of any likely market in the immediate neighbourhood for some time so far as lighting, traction, and the usual commercial demand is concerned. There appear, however, to be excellent opportunities for pulp, metal-reduction, and electro-chemical industries, for which raw materials and the necessary energy are at hand.

Small Water-power Installations in Operation.—Through the agency of the reports made by the Engineers for the Board-work, considerable data has been obtained relative to the numerous small power-developments in existence, but it is not thought wise to publish the information obtained until complete. Especially is it desirable to classify all the plants on an equitable basis, as the annual rentals for the use of the power depend on the data obtained. Owing to the fact that the construction of many of these developments took place long before the organization of the Water Rights Branch, this information was not on file.

DUTY OF WATER INVESTIGATIONS.

It has not been possible during 1915 to undertake any systematic experiments of ascertaining the duty of water for the various districts of the Province. However, in several cases it has been possible, with the co-operation of interested parties, to keep measurements of the quantities of water used. The following are the figures obtained:—

Westbank.—With the co-operation of C. E. Clarke, of the Westbank Irrigation Company, measurements were kept at an 18-inch Cippoletti weir on Powers Creek.

Area under irrigation	241 acres.
Irrigation period	98 days.
Total quantity of water used	316 acre-feet.
Total quantity used per acre	1.3 acre-feet.

Penticton.—With the co-operation of J. W. Jackson, of the municipality, the following measurements were kept of the water used from Penticton and Ellis Creeks:—

Area under irrigation	1,850 acres.
Irrigation period	133 days.
Total quantity of water used	2,588 acre-feet.
Total quantity used per acre	1.4 acre-feet.

Kelowna-Glenmore Valley.—With the co-operation of W. L. Reed, of the Kelowna Irrigation Company, the following measurements were obtained of water used from Mill Creek:—

Area under irrigation	1,860 acres.
Irrigation period	123 days.
Total quantity of water used	1,617 acre-feet.
Total quantity used per acre	0.9 acre-feet.

It would appear from the above that when irrigation-water is carried through large systems and properly controlled, less water is required to be diverted from the streams than where individual diversions are made, and the tendency to take advantage of the several modes of working co-operatively under the "Water Act" cannot be too strongly fostered.

PUMPING WATER FOR IRRIGATION.

Attention is being increasingly drawn to this important phase of work where the physical condition of the country lends itself. At the present time pumping is resorted to around Grand Forks and Kamloops, and it will not be long before owners of lands in other parts of the Province realize its possibilities where their lands are adjacent to large streams or lakes.

During the past season C. Varcoe, District Engineer at Grand Forks, and W. R. Pilsworth, District Engineer at Kamloops, have collected data relative to the annual cost of plants in their respective localities. In the Grand Forks District several forms of primary power are used, electrical energy being the most common. In the Kamloops District Diesel engines are working, but it should not be long before electric energy from the City of Kamloops hydro-electric plant at Barriere River is used for this class of work. From the data at present on file it would appear that sufficient care or experience has not been utilized when designing and installing the apparatus. Furthermore, the installing of individual pumps by each water-user is not desirable, and a much more efficient and therefore cheaper installation could be constructed and operated if joint systems were put in.

ENGINEERING-WORK FOR THE BOARD OF INVESTIGATION.

The work for the Board has been gradually decreasing, as practically all the records in the lower portion of the Province have been reported on, a few isolated cases only requiring attention. There, however, still remain to be investigated the records in the vicinity of Quesnel and the Skeena District.

METEOROLOGICAL REPORT, 1914-15.

Meteorological work during the past year has been carried out on the lines previously laid down. Four new stations have been established, making a total of eighty-three stations now regularly reporting. The temperature and hygroscopic stations have been maintained in an efficient condition and the reports sent in with regularity.

In addition to the usual routine, a good deal of analytical work has been carried out, the following stations having had their records analysed on Binnie's system: Alberni, Agassiz, Barkerville, Beaver Lake, Clayoquot, Coquitlam, Cowichan, Goldstream, Kamloops, Kelowna, Ladner, Nass Harbour, New Westminster, Nicola Lake, North Nicomen, Princeton, Quesnel, Revelstoke, Rossland, Salmon Arm, and Victoria.

The following table, chiefly compiled from information supplied by the Dominion Government, shows the variations of precipitation from the average on forty-nine stations:—

PRECIPITATION, 1914-15.

Name of Station.	No. of Years' Observation.	Average Precipitation.	1914-15 Precipitation.	Above Average.	Below Average.	Remarks.
		Inches.	Inches.	Inches.	Inches.	
Agassiz	14	60.18	53.95	...	6.23	
Alberni, V.I.	19	67.92	68.54	0.62	...	
Barkerville	26	34.67	34.90	0.23	...	
Bear Creek, V.I.	4	91.99	76.57	...	15.42	Lowest recorded.
Beaver Lake	20	34.82	20.80	...	14.02	Lowest recorded.
Bella Coola	14	42.65	34.84	...	7.81	
Lake Buntzen	12	109.06	80.10	...	28.96	Lowest recorded.
Chilcotin (Big Creek)	11	13.51	13.20	...	0.31	
Chilliwack	11	59.10	42.93	...	16.17	Lowest recorded.
Clayoquot, V.I.	15	121.58	112.11	...	9.47	
Coquitlam	13	70.17	53.47	...	16.70	Lowest recorded.
Lake Coquitlam	12	150.50	111.47	...	39.03	Lowest recorded.
Cowichan, V.I.	21	38.71	32.13	...	6.58	
Cranbrook	7	15.31	15.80	0.49	...	
Denman Island	7	51.35	50.09	...	1.26	
Elko	4	21.08	23.99	2.91	...	Highest recorded.
Enderby	5	19.99	22.99	3.00	...	Highest recorded.
Ferguson	7	48.19	40.08	...	8.11	
Goldstream, V.I.	19	63.92	41.26	...	22.66	Lowest recorded.
Grand Forks	6	16.79	19.38	2.59	...	
Hedley	11	11.76	14.07	2.31	...	
Hedley (Nickel Plate)	10	24.30	16.21	...	8.09	Lowest recorded.
Hope	5	49.61	34.16	...	15.45	Lowest recorded.
Hornby Island	5	44.19	45.51	1.32	...	
Jordan River, V.I.	7	67.30	49.90	...	17.40	Lowest recorded.
Kamloops	21	10.46	11.80	1.34	...	
Kelowna (Okanagan Mission)	12	12.53	12.63	0.10	...	
Ladner	15	35.07	21.12	...	13.95	Lowest recorded.
Nanaimo, V.I.	12	39.38	32.91	...	6.47	
Nass Harbour	15	78.46	56.63	...	21.83	Lowest recorded.
Nelson	11	26.68	23.32	0.77	3.36	
New Westminster	21	56.43	43.99	...	12.44	Lowest recorded.
Nicola Lake	37	11.17	11.94	...	...	
North Nicomen	21	74.43	52.46	...	21.97	Lowest recorded.
Penticton	7	12.03	14.48	2.45	...	Highest recorded.
Princeton	16	13.42	14.66	1.24	...	
Quatsino	12	111.65	78.39	...	33.26	Lowest recorded.
Quesnel	14	15.43	11.54	...	3.89	Lowest recorded.
Revelstoke	11	41.24	36.53	...	4.71	
Rossland	10	29.46	33.14	3.68	...	
Salmon Arm	12	19.21	22.01	2.80	...	
Saltspring Island	6	37.27	31.35	...	5.92	Lowest recorded.
Stave River Falls	6	74.92	61.88	...	13.04	Lowest recorded.
Steveston	19	37.81	28.95	...	8.86	Lowest recorded.
Stuart Lake	21	16.30	13.10	...	3.20	
Summerland	7	12.97	13.42	0.45	...	
Vancouver	13	58.17	44.72	...	13.45	Lowest recorded.
Vernon	12	14.35	16.35	2.00	...	
Victoria	41	29.29	17.18	...	12.11	
Wilmer	5	13.81	15.69	1.87	...	Highest recorded.

NOTE.—The above figures will be incorporated in the 1916 "Stream-flow Bulletin."

This table shows very clearly the scarcity of precipitation during the past season at no less than eighteen stations; the quantity was the smallest yet measured, and the majority of these stations had fairly long records to judge by. The shrinkage is most noticeable at Goldstream, Quatsino, and the whole of the Lower Fraser River Valley from Steveston to Agassiz. The

serious aspect is that this is the record year of drought, so that, should 1915-16 be also a dry year, drainage-basins may be taxed to supply the demands for water made on them.

The general drought of the Coast (this word is used purely in a comparative sense) did not extend to the Interior; on the contrary, many of the stations report more rain than usual. In every case this rain occurred during the summer months when it was most wanted, and it notably contributed to good grain and fruit crops.

It is interesting to note that the three stations at the highest altitudes in the south portion of the Province have experienced the Coast drought—viz., Lake Jones, Glacier, and Hedley. It would appear as if temperature conditions on the Coast and the Interior altitudes did not favour precipitation, whilst the valleys and low hills received an unusual amount of rain.

Thunder-storms were very marked during June, July, August, and September; they were not only numerous, but exceedingly violent, and ranged from the Cascades to the Rockies. Certain localities are usually visited by thunder-storms every summer and autumn, but the past season experienced a range quite out of the ordinary.

Dealing with the precipitation month by month, the Coast and Vancouver Island Stations exhibited the following characteristics:—

At Victoria, Nanaimo, Goldstream, Bear Creek, Beaver Lake, and Cowichan there was a marked deficiency during the months of October, November, and December, culminating in an exceedingly dry January, a month which usually contributes a large proportion of the winter rains. This general deficiency extended to Clayoquot, although not to so great a degree.

At Alberni the winter precipitation appears to have been normal owing to a very heavy precipitation in the month of October, and at Clayoquot a heavy October precipitation compensated for a lighter than usual fall in January.

At all the Island stations the precipitation during February, March, and April was subnormal, although not to very marked degree. May, June, July, and August were also normal, although July furnished showers of local importance at several stations. August was quite below the normal and was followed by a very dry September, very little rain falling, even at those stations which usually receive a fair amount during this month.

On the Coast Mainland stations Nass Harbour had a dry October, December, and January. March and April were normal, and May, June, July, and August were dry, whilst September was abnormally so.

At Prince Rupert the records were about the average for a station which has been in existence but a short time.

At Bella Coola and Vancouver October and November were normal, December and January dry, February to July normal, August was dry, and September extremely so.

Coquitlam and Agassiz received their normal precipitation for the months of October and November; December and January were dry; March, April, and May were normal; June dry; July normal; August was dry, and September experienced a record scarcity of rain.

At New Westminster a dry December and very dry June, July, August, and September were recorded; the other months were normal.

At the Interior stations plenteous rains marked the months of May, June, and July, notably in the vicinity of Kamloops, Salmon Arm, and the upper end of the Okanagan Valley, also including Revelstoke and Glacier, Grand Forks, Nicola, and Nelson.

Barkerville and Quesnel also felt the effect of the summer rains, which influenced to a marked degree the precipitation of Soda Creek and Big Creek (Chilcotin).

In the East Kootenay this unusual precipitation was most marked, and it had a most beneficial effect over the Dry Belt in not a few cases, causing irrigation to be hardly necessary.

The outlook for the coming year shows that ere long the numerous stations established by the Provincial Government will supply most valuable information. Owing to the war it has been difficult to keep all the stations going and the records unbroken. If it had not been for the thought and care taken by many observers to avoid such a break, several stations would have been abandoned; fortunately, however, these gentlemen have fully realized the necessity of unbroken records and have exerted themselves to ensure the continuity of the works. With such a spirit shown by the observers, it is permissible to hope for the best character of records.

I have the honour to be,

Sir,

Your obedient servant,

WILLIAM YOUNG, B.Sc., M.CAN.SOC.C.E.

REPORT OF THE BOARD OF INVESTIGATION.

December 31st, 1915.

The Hon. William R. Ross, K.C.,
Minister of Lands, Victoria, B.C.

Sir,—The Board of Investigation has the honour to report respecting its work during the year ending December 31st, 1915.

Determination of Rights under Acts prior to the "Water Act, 1909."—Meetings of the Board have been held at the following places during 1915: Vancouver, January 19th; Victoria, February 23rd; Ashcroft, March 17th; Vernon, March 19th; Oyama, March 22nd; Kelowna, March 23rd and 24th; Armstrong, March 26th; Vancouver, April 27th; Quilchena, April 29th; Merritt, May 3rd; Chase, May 4th; Barriere, May 5th; Chinook Cove, May 7th; Kamloops, May 28th; Nakusp, May 31st; Edgewood, June 2nd; Castlegar, June 3rd; Nelson, June 4th and 5th; Trail, June 7th; Rossland, June 8th; Salmo, June 10th; Kaslo, June 14th and 15th; Balfour, June 16th; Creston, June 17th; Lillooet, September 8th; Clinton, September 9th and 10th; Quesnel, September 13th; Barkerville, September 15th and 16th; Alkali Lake, September 20th; Dog Creek, September 21st; Hanceville, September 24th; Alexis Creek, September 25th; Bechers, September 27th; 150-Mile House, September 29th; Victoria, October 7th; New Westminster, December 16th and 17th.

A schedule is attached showing the result of the Board's work in each water district from the year 1909 to December 31st, 1915.

From the passage of the "Water Act, 1909," to the present time: 3,781 water rights have been confirmed; 1,904 water rights have been cancelled; 400 water rights are held for further consideration; 358 water rights in favour of Indians are also held over; and 587 water rights will be heard later; making a total of 7,030.

Appeals.—There have not been any appeals from decisions of Board during this year. Two appeals entered last year have since been decided, the ruling of the Board being maintained in both cases. In one case where notice of appeal had been given, no further proceeding has been taken.

Riparian Rights.—Section 6 of the "Water Act, 1914," required every riparian proprietor claiming any right to divert water or any right to the exclusive use of water for any purpose by virtue only of his being such riparian proprietor to file with the Board, on or before June 1st, 1916, a statement of his claim. Up to date sixty-eight such claims have been filed. It is proposed to deal with these after June 1st, 1916.

Renewal of Void Licences.—Section 16 of the "Water Act, 1914," authorizes the Board to renew certain licences which have become void on account of the powers granted thereunder not having been exercised. Forty-six applications have been filed, of which two have been granted; twenty-seven have been refused, principally because they did not come within the terms of the section; and seventeen are pending.

Amendment of Licences.—Section 43 of the "Water Act, 1914," provides that the Board may, after notice to parties affected, amend licences which have been imperfectly issued or are inaccurate. No applications have been made under this section.

Cancellation of Licences or Authority.—Section 17 provides that in certain events a licence or authority for the diversion or use of water may be cancelled. No application has been made under this section.

Approval of Undertaking.—Section 79 provides that the Board shall hear the petition for approval of undertaking and report thereon to the Minister. Forty-one petitions have been filed, of which twenty-four have been granted and twenty-seven are still pending.

Acquisition of Licences by a Municipality.—Sections 138, 139, and 140 provide that the approval of the Board is necessary when a municipality purchases or expropriates a licence. No application has been made under these sections.

"Rivers and Streams Act."—Section 142 provides that every person to whom any power or authority has been granted under the "Rivers and Streams Act" (R.S.B.C. 1897, chapter 168) who has not surrendered such authority shall file a statement of claim with the Board. No such authority has been surrendered, nor have any claims been filed under this section.

Surplus Water.—Section 156 provides that the Board may determine the manner and terms under which certain licensees may dispose of the surplus water or power held under their licences. No application has been made to the Board under this section.

Mutual Water Companies and Land and Water Companies.—The Board has not been called upon to exercise its jurisdiction under sections 162 and 168.

Irrigation Districts.—The petition of the Kelowna Irrigation Company, which was filed in 1914, has been considered, and the Board presented to the petitioners the results of their inquiries.

Extensions of Time for Commencement of Works under Water Records.—There have been many such applications, and extensions have been granted when it could be done without affecting injuriously later licensees who had made beneficial use of the water.

Tolls chargeable by Companies.—Only two schedules of tolls have been presented to the Board, and these have been approved.

Indian Rights.—A large number of claims for water rights for the use of Indians have been filed during the past year for which no entries appear to have been made in the Water Recording Offices of the Province. All these have been adjourned to enable the Indian Department to produce evidence.

Railway Belt.—The only part of the Railway Belt where the claims to water rights have not yet been heard is in the vicinity of Deadman River, a tributary of Thompson River, west of Kamloops Lake, where there are forty-one water records or claims.

Fees for the Use of Water in the Development of Power.—The rules prescribe that these shall be based upon the net energy (expressed in horse-power) which can be developed on the site from the amount of flow granted, and provide that for the purpose of fixing the annual rental the Board shall ascertain and appraise the value of a horse-power at each water-power plant. The Board has made a study of the subject, and Mr. Davis, a member of the Board, has compiled much information for use in making such an appraisal; but there are not yet sufficient data available to complete it, and the Board has, under authority of clause 65 of the Rules and Regulations, ordered that until the first appraisal of the output of any plant and its classification thereunder are completed, the rental shall be 25 cents per horse-power per annum.

I submit as an exhibit to this report a memorandum on this subject prepared by E. Davis, a member of the Board.

I have, etc.,
J. F. ARMSTRONG,
Chairman of Board of Investigation.

BOARD OF INVESTIGATION PROGRESS REPORT, DECEMBER 31ST, 1915.

	Confirmed.	Cancelled.	Pending.	Indians.	Not heard.	Total.
Alberni	...	...	...	...	31	31
Atlin	...	...	...	...	115	115
Cariboo—						
Barkerville	110	131	3	...	...	244
Quesnel	11	6	...	...	163	180
Fort George	...	...	...	...	...	...
Cranbrook	202	105	1	8	...	316
Golden	280	57	4	...	4	345
Hazelton	...	...	...	...	43	43
Kamloops	740	364	25	123	75	1,327
Lillooet	235	198	14	61	...	508
Nanaimo	...	...	...	...	16	16
Nelson	399	182	3	...	...	584
New Westminster and Vancouver	194	104	26	1	52	377
Nicola	168	77	10	35	...	290
Osoyoos	720	241	12	9	...	982
Revelstoke	60	40	4	...	...	104
Similkameen	456	217	202	21	...	896
Skeena	...	...	...	...	73	73
Stikine and Liard	...	...	...	...	15	15
Slocan and Kaslo	137	71	4	...	...	212
Victoria	23	9	78	...	...	110
Yale	46	102	14	100	...	262
Totals, 1915	3,781	1,904	400	358	587	7,030
Report, 1914	2,500	1,138	975	271	2,124	7,008
Increase	1,281	766	...	87	...	22
Decrease	...	...	575	...	1,537	...

MEMORANDUM *RE* ANNUAL RENTALS OF WATER-POWERS.

Considerable data has been collected for ascertaining the value of a horse-power as outlined in section 65 of the Rules and Regulations. The following is a summary of the method proposed. Should difficulty be found in following it out it will be modified:—

1. Ascertain the cost of constructing the water-power plant, including the transmission of power to and the transformation at the place of use, which would mean the consideration of:—
   - (*a.*) Cost of water privilege, being cost of recording fee paid at time of obtaining water permit:
   - (*b.*) Preliminary costs of engineering investigations as to feasibility of project:
   - (*c.*) General expenses, such as organization, legal expenses, contingencies, etc.:
   - (*d.*) Interest during construction:
   - (*e.*) Engineering:
   - (*f.*) Cost of equipment complete:
   - (*g.*) Cost of fuel auxiliary plant (if any).
2. Ascertain the cost of constructing the auxiliary plant (if any) which would have to be used on account of low water in river, which would mean:—
   - (*a.*) The determination of the size of auxiliary fuel plant to be allowed:
   - (*b.*) The costs as outlined for a fuel competitive plant under item 4.
3. Ascertain the yearly cost per kilowatt-hour of running the water-power plant and the auxiliary plant (if any). This would mean the consideration of:—

(*a.*) Fixed charges:
- (1.) Interest:
- (2.) Taxes:
- (3.) Insurance:
- (4.) Depreciation:
  - (*a.*) Obsolescence:
  - (*b.*) Wear and tear.

(*b.*) Operating expenses:
- (1.) Repairs and supplies:
- (2.) Labour:
- (3.) Water rentals.

(*c.*) The annual costs for the auxiliary fuel plant (if any) as outlined for a competitive fuel plant under item 5.

4. Estimate the cost of a fuel plant necessary to produce a similar quantity of power. This would mean the consideration of:—

(*a.*) General expenses, such as organization, legal expenses, contingencies, etc.:
(*b.*) Interest during construction:
(*c.*) Engineering:
(*d.*) Cost of equipment.

5. Estimate the yearly cost per kilowatt-hour of running the fuel plant with a load similar to that on the water-power plant during the preceding year. This would mean consideration of:—

(*a.*) Fixed charges:
- (1.) Interest:
- (2.) Taxes:
- (3.) Insurance:
- (4.) Depreciation:
  - (*a.*) Obsolescence:
  - (*b.*) Wear and tear.

(*b.*) Operating expenses:
- (1.) Repairs and supplies:
- (2.) Labour:
- (3.) Fuel.

6. Compare items 3 and 5 and note the difference. This difference would then be used by the Board to classify the various plants.

Under this method it is considered that whatever rate the Board should fix between 25 cents and $1 per horse-power per annum, the rates to be paid as between each company should be in the same ratio as the figures obtained under part 6 for each company.

E. DAVIS, M.CAN.SOC.C.E.,
Member of the Board.

APPENDICES TO WATER REPORT.

APPENDIX No. 1.

IRRIGATION HEADGATES.

Farmer's Headgate.

The farmer's small headgate shown in Fig. 1 will deliver up to 4 second-feet in the ditch below under favourable conditions of grade and size, assuming the gate-box can be kept full of water.

It will be noticed that the two inner planks of the front wings extend 1 inch beyond the inner face of the side-walls, thus forming front guides. The extension of the two planks in the front cut-off wall above the floor-boards by an inch makes a tighter gate; the gate fits down behind them.

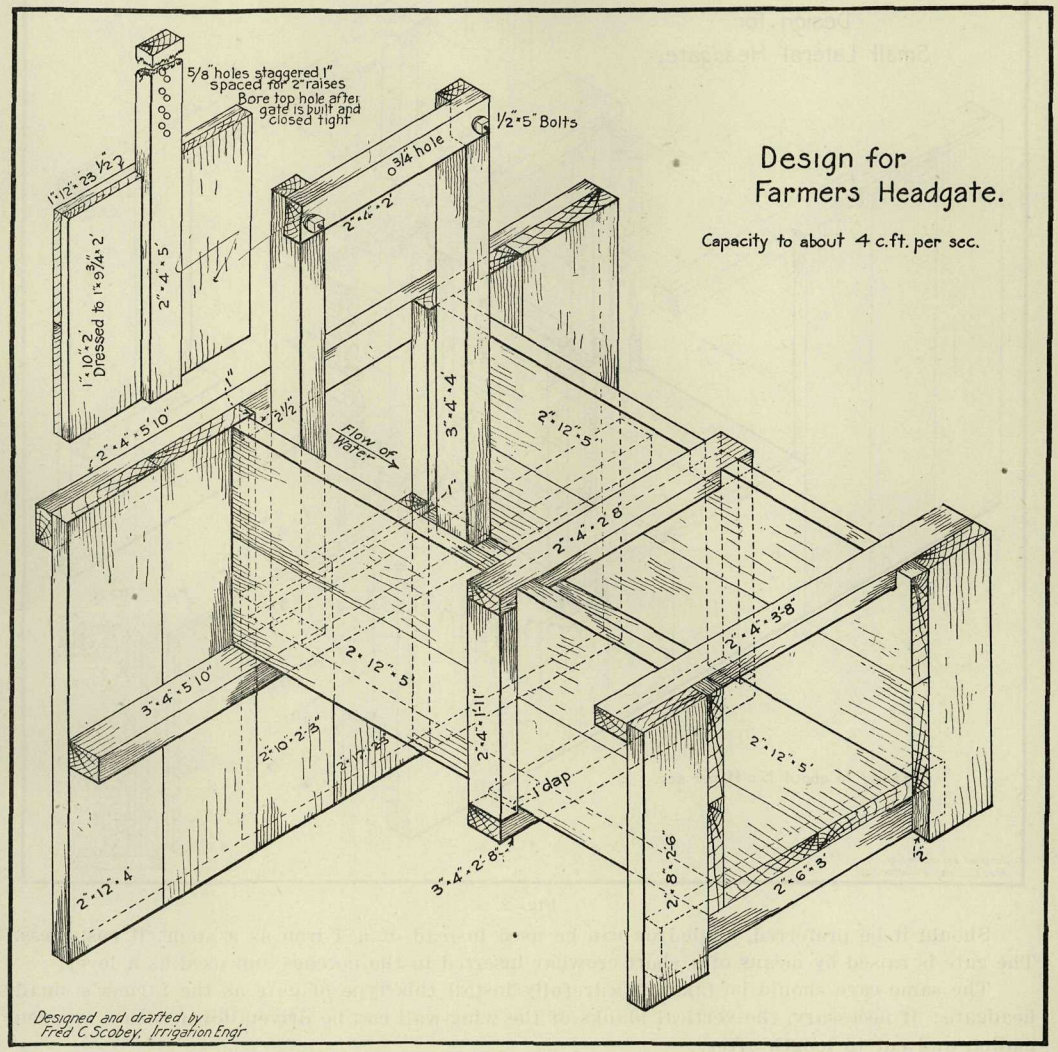


Fig. 1.

If possible, the stem of the gate should be hardwood and the holes bored therein staggered as shown; 5/8-inch holes will take a 1/2-inch pin, which could have an iron ring at one end and a small slot at the other to receive the tongue of a thin padlock.

The dimensions of lumber are suited to a structure of the size indicated; a considerable increase in size would need other dimensions and a rearrangement of struts and braces.

The depth of the wing and front walls must be determined by the nature of the soil; one of sand would require a greater depth than those shown. Whatever depth be decided on, the dirt excavated must be well puddled round the walls, thoroughly tamped down with a rammer, previously having been worked to the consistency of stiff mortar. If the dirt be replaced in a dry state, carelessly shovelled in, there is every likelihood of a washout.

SMALL LATERAL HEADGATE.

The small lateral headgate shown in Fig. 2 is 3 feet high and 3 feet wide, with a capacity of about 15 second-feet under favourable conditions.

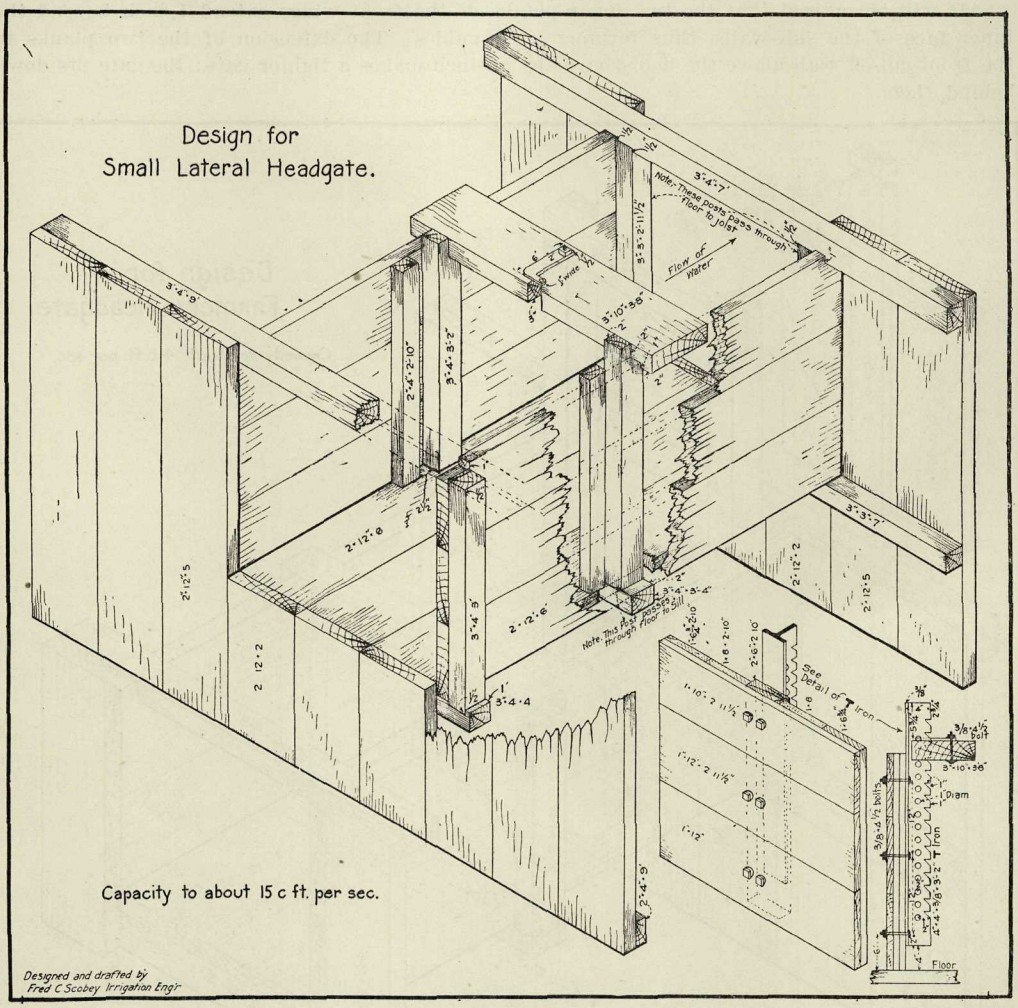


Fig. 2.

Should it be preferred, angle-iron can be used instead of a T-iron as a stem; it costs less. The gate is raised by means of a short crowbar inserted in the notches and used as a lever.

The same care should be taken to carefully install this type of gate as the farmer's small headgate; if necessary, the vertical planks of the wing-wall can be driven down with a wooden mallet, and cut to length after.

Timber should be notched and fitted as shown in the drawings; whilst this entails slightly more labour at the time, it adds a great deal to the strength and stiffness of the structures.

Bills of material for both types of gates are appended; the lateral type has quantities for three sizes.

FARMER'S HEADGATE. CAPACITY UP TO ABOUT 4 SECOND-FEET (DEPENDING ON GRADE AND CONDITION OF THE DITCH BELOW THE GATE).

Bill of Lumber.

Use.	Pieces.	Dimensions.	Feet, B.M.
Side boards	4	2″ x 12″ x 5′	40
Floor	2	2″ x 12″ x 5′	20
Front wings	4	2″ x 12″ x 4′	32
Front cut-off wall	1	2″ x 12″ x 2′ 3″	5
,, ,, ,,	1	2″ x 10″ x 2′ 3″	4
Cap	1	2″ x 4″ x 5′ 10″	4
Joist	1	3″ x 4″ x 5′ 10″	6
Gate-posts	2	3″ x 4″ x 4′	8
Cap for gate-posts	1	2″ x 4″ x 2′	1
Sill	1	3″ x 4″ x 2′ 8″	3
Cap	1	2″ x 4″ x 2′ 8″	2
Posts	2	2″ x 4″ x 1′ 11″	3
Lower wings	2	2″ x 12″ x 2′ 6″	10
Cut-off sill	1	2″ x 6″ x 3′	3
Cap	1	2″ x 4″ x 3′ 8″	3
Bolts	2	½″ x 6″	...
Gate-stem	1	2″ x 4″ x 5′	3
Gate-boards	2	1″ x 12″ x 23½″	4
,,	2	1″ x 10″ x 2′	4
		Total feet, B.M.	155

Two bolts ½″ x 5″, with washers for each end.

HEADGATE FOR SMALL LATERAL. CAPACITY UP TO ABOUT 15 SECOND-FEET (DEPENDING ON GRADE AND CONDITION OF THE LATERAL BELOW GATE).

(As per Plans in Drawing. Bottom, 3 feet wide; sides, 3 feet high.)

Bill of Lumber.

Use.	Pieces.	Dimensions.	Feet, B.M.
Side boards	6	2″ x 12″ x 6′	72
Floor	3	2″ x 12″ x 6′	36
Front wings	6	2″ x 12″ x 5′	60
Front cut-off wall	3	2″ x 12″ x 2′	12
Joist	1	2″ x 4″ x 9′	6
Sill	1	3″ x 4″ x 4′	4
,,	1	3″ x 4″ x 3′ 4″	4
Posts	2	3″ x 4″ x 3′	6
Cap (front wings)	1	3″ x 4″ x 9′	9
Lower wings	4	2″ x 12″ x 5′	40
Lower cut-off wall	3	2″ x 12″ x 2′	12
Joist	1	3″ x 3″ x 7′	5
Posts	2	3″ x 3″ x 2′ 11½″	5
Cap	1	3″ x 4″ x 7′	7
Front guides	2	2″ x 4″ x 2′ 10″	4
Rear guides	2	3″ x 4″ x 3′ 2″	6
Foot-plank	1	3″ x 10″ x 3′ 8″	10
Gate-boards	1	1″ x 10″ x 2′ 11½″	3
,,	2	1″ x 12″ x 2′ 11½″	6
,,	2	1″ x 8″ x 2′ 10″	4
,,	2	1″ x 6¾″ x 2′ 10″	4
,,	1	2″ x 6″ x 2′ 10″	3
		Total feet, B.M.	318

T-iron—One piece 4″ x 4″ x ⅜″ x 3′ 2″, bored as per detail.
Bolts—Seven ⅜″ x 4½″, with washers for each end.

HEADGATE FOR SMALL LATERAL. CAPACITY UP TO ABOUT 20 SECOND-FEET (DEPENDING ON GRADE AND CONDITION OF THE LATERAL BELOW GATE).

(As per Plans in Drawing, except 4 feet wide instead of 3 feet wide.)

Use.	Pieces.	Dimensions.	Feet, B.M.
Side boards	6	2″ x 12″ x 6′	72
Floor	4	2″ x 12″ x 6′	48
Front wings	6	2″ x 12″ x 5′	60
Front cut-off wall	4	2″ x 12″ x 2′	16
Joist	1	2″ x 4″ x 10′	7
Sill	1	3″ x 4″ x 5′	5
,,	1	3″ x 4″ x 4′ 4″	5
Posts	2	3″ x 4″ x 3′	6
Cap (front wings)	1	3″ x 4″ x 10′	10
Lower wings	4	2″ x 12″ x 5′	40
Lower cut-off wall	4	2″ x 12″ x 2′	16
Joist	1	3″ x 3″ x 8′	6
Posts	2	3″ x 3″ x 2′ 11½″	5
Cap (lower wings)	1	3″ x 4″ x 8′	8
Front guides	2	2″ x 4″ x 2′ 10″	4
Rear guides	2	3″ x 4″ x 3′ 2″	6
Foot-plank	1	3″ x 10″ x 4′ 8″	13
Gate-boards (front)	1	1″ x 10″ x 3′ 11½″	4
,, ,,	2	1″ x 12″ x 3′ 11½″	8
,, (back)	2	1″ x 10″ x 2′ 10″	5
,, ,,	2	1″ x 10¾″ x 2′ 10″	5
,, ,,	1	2″ x 6″ x 2′ 10″	3
		Total feet, B.M.	352

T-iron—One piece 4″ x 4″ x ⅜″ x 3′ 2″, bored as per detail.
Bolts—Seven ⅜″ x 4½″, with washers for each end.

HEADGATE FOR LATERAL. CAPACITY UP TO ABOUT 28 SECOND-FEET (DEPENDING ON GRADE AND CONDITION OF LATERAL BELOW GATE).

(As per Plans in Drawing, except 4 feet wide and 4 feet high instead of 3 feet wide and 3 feet high. Cut-off and wing-walls 1 foot deeper.)

Use.	Pieces.	Dimensions.	Feet, B.M.
Side boards	8	2″ x 12″ x 6′	96
Floor	4	2″ x 12″ x 6′	48
Front wings	6	2″ x 12″ x 7′	84
Front cut-off wall	4	2″ x 12″ x 3′	24
Joist	1	2″ x 4″ x 10′	7
Sill	1	3″ x 4″ x 5′	5
,,	1	3″ x 4″ x 4′ 4″	5
Posts	2	3″ x 4″ x 4′	8
Cap (front wings)	1	3″ x 4″ x 10′	10
Lower wings	4	2″ x 12″ x 7′	56
Lower cut-off wall	4	2″ x 12″ x 3′	24
Joist	1	3″ x 3″ x 8′	6
Posts	2	3″ x 3″ x 3′ 11½″	7
Cap (lower wings)	1	3″ x 4″ x 8′	8
Front guides	2	2″ x 4″ x 3′ 10″	5
Rear guides	2	3″ x 4″ x 4′ 2″	8
Foot-plank	1	3″ x 10″ x 4′ 8″	13
Gate-boards (front)	1	1″ x 10″ x 3′ 11½″	4
,, ,,	3	1″ x 12″ x 3′ 11½″	12
,, (back)	2	1″ x 10″ x 3′ 10″	7
,, ,,	2	1″ x 10¾″ x 3′ 10″	7
,, ,,	1	2″ x 6″ x 3′ 10″	4
		Total feet, B.M.	448

T-iron—One piece 4″ x 4″ x ⅜″ x 4′ 2″, bored as per detail (for additional foot).
Bolts—Seven ⅜″ x 4½″, with washers for each end.

APPENDIX No. 2.

USEFUL WATER DATA.

Duty of Water.

One second-foot is generally considered sufficient to irrigate 120 acres of land.

One second-foot flowing 120 days equals 240 acre-feet.

One second-foot flowing 120 days would cover it 2 feet in depth. If applied on 100 acres it would cover it 2.4 feet in depth.

Three to four acre-feet capacity in the reservoir is usually considered necessary to irrigate 1 acre of land in addition to overcoming all seepage and evaporation losses.

From 1 to 3 acre-feet on the land, depending upon the kind of crop, and the rainfall in the particular locality, is usually considered sufficient. One acre-foot on the land, if properly distributed, is equal to 12 inches of rainfall.

From 3 to 5 acre-inches is applied for each irrigation, depending upon the kind of crop and the method employed in irrigating.

From 1 to 3 second-feet is usually considered a good irrigation-head. Irrigators on the same stream may secure a better head through the adoption of rotation in use of water.

One-half inch per acre continuous flow is equivalent to 1 inch per acre used every other day or week, or 1½ inches per acre used every third day or third week, rotating with others.

Water Units.

The cubic foot per second is the standard for measuring rate of flow. It is abbreviated second-foot or sec.-ft.

One sec.-ft. equals 35.7 miners' inches.

The miners' inch is a very indefinite unit, and its use should be discontinued.

The acre-foot is the standard unit of volume.

One acre-foot equals 43,560 cubic feet; equals ½ sec.-ft. flowing 24 hours; equals 1 acre covered 12 inches deep or 12 acre-inches.

One cubic foot equals 6.25 gallons and weighs 62.5 pounds.

The unit of work is the foot-pound, or the amount of work to overcome a weight of 1 pound falling 1 foot.

Power equals rate of work, equals work divided by time.

One horse-power equals 550 foot-pounds per second.

One horse-power equals 1 cubic foot of water falling 8.8 feet in one second.

To calculate horse-power (theoretical), multiply flow in second-feet by vertical fall in feet, and divide by 8.8.

To calculate net horse-power on wheels of 80 per cent. efficiency, multiply flow in second-feet by fall in feet, and divide by 11.

One and one-third horse-power equals about 1 kilowatt.

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VICTORIA, B.C.:

Printed by WILLIAM H. CULLIN, Printer to the King's Most Excellent Majesty.

1916.