

STATE OF WASHINGTON

FOURTH BIENNIAL REPORT

OF THE

Department of Conservation
and Development

From October 1, 1926, to September 30, 1928



ERLE J. BARNES, Director

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C. W. Karney.....	Chief Assistant Director.....	Olympia
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C. W. Karney.....	Supervisor	Olympia
R. K. Tiffany.....	Chief Engineer.....	Olympia
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Geo. C. Joy.....	Supervisor	Olympia
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DIVISION OF WATER RESOURCES—		
R. K. Tiffany.....	Supervisor	Olympia
Chas. J. Bartholet.....	Asst. Supervisor.....	Olympia
DIVISION OF GEOLOGY—		
Dr. Harold E. Culver.....	Supervisor	Pullman
DIVISION OF COLUMBIA BASIN SURVEY—		
R. K. Tiffany.....	Chief Engineer.....	Olympia

LETTER OF TRANSMITTAL.

STATE OF WASHINGTON.
DEPARTMENT OF CONSERVATION AND DEVELOPMENT.

Oct. 15, 1928.

To His Excellency, Roland H. Hartley, Governor.

Sir: I have the honor to submit herewith, in accordance with law, the Fourth Biennial Report of the Department of Conservation and Development, covering the period Oct. 1, 1926, to Sept. 30, 1928.

Respectfully,

ERLE J. BARNES.

Director Department of Conservation and Development.

DIVISION OF FORESTRY.

Hon. Erle J. Barnes, Director,
Department of Conservation and Development,
Olympia, Washington.

Dear Sir: Herewith are submitted the Twenty-third and Twenty-Fourth annual reports of the Division of Forestry, covering the period from October 1st, 1926, to September 30th, 1928.

Very truly yours,

GEO. C. JOY,
State Supervisor of Forestry.

INTRODUCTORY.

Herein is published the twenty-third and twenty-fourth annual reports of the State Supervisor of Forestry for the years 1927 and 1928.

A comparison of the fire losses for the past four years with losses for previous years shows a very material decrease in loss and damage done by forest fires. This is most gratifying and in measure compensates for expenditures made for the protection of our forest lands.

This is the result of a more combined and determined effort on the part of all protective agencies and to a finer appreciation of forestry and its influence upon the welfare of the state by the public. The change from a disinterested, uninformed public to one demanding knowledge of the subject and action to perpetuate forest industries has been gradual, fostered by a knowledge of what has occurred in the Eastern states, the movement of the lumber industry out west and of prevailing stumpage values.

An indication of the advance of forestry is the changed attitude of some lumbermen. In spite of the fact that present economic conditions make the lumber industry a rather hazardous business, a number of the larger operators are planning and conducting their operations with the purpose of securing successive crops of timber and thus continue their operations for an indefinite period.

The attitude of these operators that "timber is a crop and not a mine," augurs well for the future of our forests and forest industries, but it should be borne in mind that raising a crop of timber is a long-time, hazardous undertaking, and that until some change is made in our present system of taxing forest growing lands, whereby encouragement and some assurance as to costs of production is given the grower, it should not be expected that efforts on any extensive scale will be made to practice private forestry.

The need for legislation in this direction is urgent. There are approximately three million acres of logged-off, or otherwise denuded, privately owned forest land in the state and there is from one hundred and fifty thousand to two hundred thousand acres of land, additional, logged off each year. A large proportion of the land logged off ten or more years ago is in a fair state of natural reforestation. This has been brought about through "checker board" logging where ownerships intermingled and owners, large and small, removed their timber in advance of others. This practice has served to supply seed trees within seeding distance of hundreds of thousands of acres of logged-off land with the result as noted. But a different situation now presents itself.

With the advent of high lead logging and the blocking of timber in larger units for logging operations, the logged areas are swept clean of seed trees for such distances that it is certain a long period of time will elapse—too long, in fact—before natural reforestation will take place on such areas.

Such a situation could be remedied and natural reforestation assured, if those who are logging on a large scale were to leave a "setting" or more—economic units of timber—standing along their main line roads, where no extra expense would need be entailed in logging it five, ten, fifteen or twenty years hence. Such blocks of trees would suffice to seed surrounding areas. Reforestation by selective area cutting is practiced in European countries. It is the most practical, economic method. County Assessors should recognize the value of such practice to the community at large and place a lower valuation for taxation on timber thus left for seed.

Artificial planting of forest trees, under present methods, now costs around \$10.00 per acre. This is a large investment to put into land with the almost certain prospect of not getting any returns for at least forty or fifty years, and with a possibility that the planted trees may be destroyed by fire. Reforestation by natural means is just as effective and can be had for a great deal less money.

A step forward making for stability in handling our logged-off forest lands is that their ownership be fixed in public and private hands, those having the will and ability to administer them in such fashion as to not only produce a new crop of timber, but also to utilize that crop to fullest advantage. The sooner the status of these lands is fixed in such ownership, the better. There is ruinous waste in the way young timber is now being harvested. This waste must be prevented if a sufficient supply of timber for future needs is assured.

We are now giving protection to all denuded forest lands, regardless of ownership, so that their reforestation by natural means may be furthered and brought about. The destruction of young timber by fire has been reduced so that the loss from this cause is a very small percentage of the whole. But under present ownerships, methods of taxing and lack of system and methods in handling, a considerable portion of the good accomplished through protection is dissipated through forced harvesting of immature timber and the resultant waste which follows in the wake of such harvesting.

A great step forward in the preservation of this young timber would be the enactment of legislation which would permit of forest lands held for forest growing purposes only, to be put in a special class for taxation and the tax fixed at a very nominal rate during the period of growth, with a deferred tax or yield tax to be paid at time of cutting the new crop. Under such a law, requirements and methods of harvesting to prevent waste and to keep the land producing timber could be enforced by the state. Action along this line is most urgent. It should receive favorable consideration at the coming session of the Legislature.

The disposition of our logged-off forest land areas has yet to be worked out. Only a small proportion of the whole have as yet been let go for taxes, and most of these so let go have been purchased by individuals and companies who will, no doubt, continue to hold them and pay taxes for an indefinite period.

But the amount of logged-off lands reverting for taxes is increasing and there is every reason for believing that the movement is rapidly gaining momentum and that within the next decade large acreages of such lands will have passed to county ownership, and the counties will be unable to resell them.

That such a situation will develop is inevitable unless some action is taken by the state to encourage the holding of such lands by private owners. For the state to step in and purchase all of these lands and reforest them is too gigantic an undertaking for even the state to assume. Aside from this, if the state were to acquire such lands, it would unquestionably make the matter of financing acute in some counties.

The state should purchase some of these lands where they can be had at a low figure and are favorably located with respect to rapid forest growth and for blocking in State Forest areas.

When our present reforestation law was enacted providing for the purchase of logged-off lands with "utility bonds," what was then known as the "Adamson Act" was repealed. This law provided for cash purchase of lands. The new law also provides for cash purchase but makes no provision whereby this may be done. There has been no appropriation for the purpose and monies coming into the "forest development fund" from any source can be used only in payment of interest and principal on the utility bonds. The law should be amended authorizing the State Forest Board to accept gifts of money to the state and to make provision for use of any monies in the fund for the purchase of lands or for other forest activities.

The tables contained herein show the number of forest fires which have occurred, the area burned over, loss to timber, logs and other property, and the receipts and expenditures of the Division.

Tables No. 1 and No. 2 show number and cause of fires, the area burned over and the loss and damage to timber and other property in each county for 1927.

Tables No. 3 and No. 4 show the number and cause of fires, the area burned over and the loss and damage to timber and other property in 1928.

Table No. 5 shows receipts and expenditures from state appropriations.

Table No. 6 shows receipts and expenditures from the federal allotments under Clarke-McNary Act.

Table No. 7 shows receipts and disbursements from assessment of privately owned forest lands.

Table No. 8 shows amounts recovered in settlement of expense incurred in fighting fires.

All items of expenditure in the foregoing financial tables are segregated to accommodate the budget requirements of the United States Forest Service under the Clarke-McNary Act and are made up as follows:

Administration: Salaries and traveling expense of officers and clerks, and office supplies.

Field Personnel: Salaries and traveling expense of wardens and patrolmen.

Improvements and Equipment: Trail work, construction and maintenance of lookout stations, tools and field equipment.

Fire Suppression: Wages and expense of fire fighters.

All Other Expense: Telephone, telegraph, postage, printing and miscellaneous expense.

Table No. 9 shows amounts expended out of the several funds for fire prevention and suppression in each county, and the amounts due the state from the several counties as reimbursement for one-third of expenditures made from state appropriations.

Table No. 10 shows number of acres of forest land assessed for protection costs by the state. This assessment is levied on all privately owned forest lands for which the owner does not voluntarily provide protection.

Tables No. 11 and No. 12 show forest assessment collections received from County Treasurers from October 1, 1927, to September 20, 1928.

Table No. 13 shows number of burning permits granted, classification and acreage of land burned over under such permits, the number of arrests for violation of the forest protection laws, and the fines and costs assessed under such arrests.

Table No. 14 shows expenditures of all agencies—private, state and federal—during the two-year period.

ADMINISTRATION.

The State Supervisor of Forestry is head of all forest protective agencies in the state, except the U. S. Forest Service and U. S. Reservations. Approximately 9,000,000 acres of forest land comes under this department's jurisdiction for protection, of which 3,600,000 is represented in private owners' protective organizations, 3,900,000 assessed by the state for costs of protection, 400,000 acres vacant public lands and 1,100,000 of state owned land. Members of private protective organizations contribute directly to the respective agencies for protection of their lands. Forest patrol assessments levied by the state on privately owned lands are collected by the respective county tax collecting officers and remitted by them to the Supervisor of Forestry. Such funds are used to give protection to the lands so assessed. The vacant public lands which intermingle with state and privately owned lands are protected by this department out of funds appropriated for the Department of the Interior for this purpose.

Through operation of the compulsory patrol law, the cooperation received under the Clarke-McNary act and contribution by the Department of the Interior, forest protection has, in this state, been put upon a stable, adequate basis. Under the compulsory patrol law, the forest land owner must furnish protection for his land or the Supervisor of Forestry is authorized to do it for him and the costs of such protection are assessed against the land.

Under the Clarke-McNary act, the federal government acknowledges its responsibility for a share of the state's forestry activities and provides for an allotment of funds to forest producing states for such purpose. This state received allotments of \$50,955.00 and \$69,155.00, respectively, for the two-year period. Most of these funds are used to give protection against fire to all forest lands regardless of ownership. Special effort is made through use of this money to protect lands which are reforestation. The amount allotted is based upon the amount needed to give adequate protection to all forest lands in the state and the amounts expended for fire prevention by the state and private owners for protection. Money expended for fire suppression is not taken into account. Adequate fire-prevention measures reduce both fire losses and fire-control costs, hence the government stresses fire prevention.

The Department of the Interior made very substantial contributions for the protection of the vacant public lands, \$2,836.51 and \$11,940.34, respectively, being paid out for fire prevention during 1927 and 1928.

In Eastern Washington, our work was being carried on in nine protective units, each forested county comprising one of these units. The funds raised by assessment of forest lands were used only in the county from which they were derived. The consequence was that when one of these county units was subjected to a series of fires, as happens occasionally, the funds of that county were exhausted with the result that the assessment on forest lands had to be raised to the maximum of five cents per acre, the limit which the law allows, and a larger amount of money from the state appropriation had to be used than that county was entitled to. To remedy this situation, the Legislature of 1925 raised the state wide forest land assessment limit from five cents to seven and one-half cents per acre. Governor Hartley very wisely vetoed this act. In order to take care of the situation, we placed the forest assessment funds of eight of

these counties in one fund. This gave stability to and made more equal the assessments levied for forest protection in these counties, with the result that the assessments have been reduced in the high rate counties, the highest rate in any county now being three cents per acre.

We now have more money in the State Assessment Fund than ever before and unless an unprecedented number of fires occur in several of the Eastern Washington counties next year, we can still further reduce assessments, which we hope to accomplish. This is made possible by application of the principle, "in unity there is strength." In all counties of Western Washington the forest protection assessments were reduced from five cents per acre to three and one-half cents per acre this year.

Translated into dollars, on the acreage involved in these reductions, this means that the forest land owners of the state will pay over \$40,000.00 less for protection of their property than they paid last year.

FOREST FIRES IN 1927.

From the standpoint of weather the forest fire season of 1927 was normal.

This was chiefly due to the absence of occurrence of any extended period of low humidity conditions and to timely, seasonal rains.

The most extended period of high temperatures of record in Western Washington occurred between July 15th and August 7th, and while this period was marked by several days when the humidity went down to and below the danger point of 30 per cent, the length of time of such depression on each of these days was of short duration, while the return to normal in humidity was rapid and continued through the nights and this condition was most effectual in helping to control fires.

Most fires occurred during this period of hot weather, but only one fire assumed large proportions and did any appreciable amount of damage.

This fire was started by lightning on the Columbia National Forest in Southern Skamania County. It covered an area of 45,000 acres, practically all of which was in the old "Yacolt Burn." The fires of 1902 killed an immense amount of old growth fir timber and these trees, now dead snags, through which no subsequent fire had burned, constituted a hazard through which the fire spread and made it most difficult to check or control. All of the burned area was covered with a good stand of second growth timber around 20 years of age. Most of this was killed. Ten million feet of old growth timber was killed. This will be logged so the loss in merchantable timber will be light. The greatest loss is in the young growth destroyed.

A combination of thousands of rotting snags, a severe lightning storm followed by dry, windy weather, set at naught the best efforts at fire prevention and control. It is a good exemplification of what snags do to further the spread of fire. They make it impossible of control.

Another fire, in a bad location where it threatened a large amount of valuable timber, was started by lightning in the extreme Northwest corner of Skamania County on Green River.

This fire was hard to check as it originated in an old burn back in the mountains where it was hard to get men and supplies. It was controlled by the wardens of this department, the Washington Forest Fire Association and the United States Forest Service. Very little damage was done, but a considerable amount of expense was incurred fighting the fire.

One other fire of serious proportions occurred from lightning in green merchantable timber on the headwaters of the Deschutes River in Lewis County. This fire killed two million feet of timber and covered twelve hundred acres of ground before it could be brought under control. It was in an inaccessible, rough country.

Another fire in Pacific County in logged-off land assumed serious proportions and for a time threatened the young growth timber on the state's reforestation block near Wallville. This fire was started in some unknown manner on July 23rd, the hottest day of the year. It was kept out of the young growth timber. It burned some slashings of the Sunset Timber Company but did not do any damage to merchantable timber or other property. It cost several thousands of dollars to control.

Two serious fires occurred on logged-off land in Grays Harbor County. In one instance 30 acres of second growth was killed. A large amount of slash was burned by these fires. One fire was started by berry pickers, the other by Cascara bark peelers.

A bad fire occurred in Eastern Jefferson County in slashings of the Hama Hama Logging Company. No damage was done but the cost of control was upwards of \$2,000.00. The origin of the fire could not be determined.

Another fire in logged-off land, partly covered with slashings, occurred near Ashford in Eastern Pierce County.

In every instance where fires burned on logged-off land in slash the party responsible for the slash paid all or the greater portion of the cost of fire control.

While quite a number of fires occurred in Eastern Washington counties, there were none of serious proportions or that caused any appreciable amount of damage.

On other pages of this report are tables showing in detail the number of fires by counties, their causes, the acreage burned over and damage done.

The loss to standing timber, logs, logging equipment and other property was the least it has been in any one of the past fifteen years.

Costs:

The cost of protection to all agencies was less than that of last year. However, the assessments levied on members of private agencies were kept up in order for these agencies to complete payment of last year's indebtedness and to carry on this year's work.

The assessments levied by this department on privately owned forest lands were made the same as for 1926 with the exception of Pend Oreille County where the assessment was lowered from five cents per acre to four cents per acre. If it is possible this year the assessments in Stevens and Pend Oreille counties should be still further reduced from four cents to three cents per acre.

The Stevens County Timber Protective Association was so hard hit by expense last year that it has taken them all of this year to pay back bills. The state carried on most of the work in that county and this will enable the association to pay all of its accounts.

On another page of the report is shown a table giving the acreage and rate of assessment of forest land by counties.

Organization:

Our field force was composed of 165 district and county wardens and patrolmen. Four special law enforcement officers were employed. Their work had a very salutary effect in a better observance of the law.

Three new portable fire fighting pumps with hose, a new Dodge delivery truck and other tools were added to our list of equipment.

Cooperation:

There was the same cooperation between all protective agencies as last season. These consist of private associations, the U. S. Forest Service, the U. S. Department of Interior, railroad companies, logging operators and citizens.

It is pleasing to note the interest and goodwill manifested by our citizenry in forest protection. Two hundred twenty-five citizens were given private ranger commissions, 160 employees of the U. S. Forest Service were commissioned as wardens and rangers, 22 for Indian Agencies, 124 for private protective agencies and 190 to serve as logging camp fire wardens. The combined force of all protective agencies was 655 men—men employed and paid to prevent and control fires.

Fire weather warning forecasts were made and sent out by Weather Bureau officials at Seattle. This service is most helpful in our work. These forecasts are dependable and are a sure index of an imminent critical fire hazard. Over 75 per cent of all forest fires start and spread during these periods of weather. The forecasts enable us to strengthen protection work at the right time; logging operators and railroad companies exercise greater care and burning under permit can be held to a minimum until the critical period is past. The fire weather warning service is making people "fire conscious" at times when care with fire means most for forest protection. We have had the best of cooperation from Weather Bureau officials and we thank them for this service.

From a comparison of costs of forest protection and of losses from forest fires during the past six years, it appears that we may have passed the peak in losses and, while we may have reached the peak in expenditures, it is doubtful if any appreciable decrease in costs of protection can be anticipated for several years to come or until the annual replacement of forest cover of young growth from 15 to 20 years old becomes equal in acreage to that logged off each year. The replacement of our forests on denuded areas is going on and already there is appreciable visible evidence that the young growth on a large amount of logged-off land has reached an age where it is of sufficient size and stand to very materially reduce the fire hazard therein.

There is no question but what protection of cut-over lands is the most effective and cheapest method of producing a new crop of timber. It will probably be necessary to resort to artificial reforestation on areas where fires have been too frequent and which are too far distant from seed trees for natural reforestation to take place. In the National Forests replanting of such areas is now being pushed. The Long-Bell Lumber Company is planting some 2,000 acres of their cut-over lands this year and the City of Seattle is reforesting its water shed, around Cedar Lake, in the same manner.

These two projects are being carried forward in order that reforestation of the lands may be hastened which, according to the best information obtainable on the reproduction of Douglas Fir, means setting the crop forward at least five years.

Protection of our logged-off lands from fire is doing more to further reforestation of these lands than can be accomplished in any other way. The cost of protection is distributed between state, federal and private agencies.

For the past three years, these costs have been borne by each agency in the following proportions: State Appropriation 17.7%; Federal (under Clarke-McNary Act) 7.9%; Private Agencies 75.4%.

The benefits derived from protection against fire should be stressed, not only from the standpoint of protecting merchantable timber and other valuable property but also the saving of young timber for the future.

TABLE NO. 1—ORIGIN, NUMBER AND CLASSIFICATION OF FIRES, 1927.

COUNTIES	LUMBERING OPERATIONS			RAILROADS		RECREATION			Brush Burning	Lightning	Incendiary	Miscellaneous	Total	
	Donkey	Log Locomotive	Miscellaneous	Locomotive	Miscellaneous	Campers	Smokers	Berry Pickers						
Chelan.....			1	1		1	4		2	28		3	40	
Clallam.....	1	2	2			1	5	1	3	8		2	23	
Clark.....		2	2				5		3		3	1	14	
Cowlitz.....			1	3		1	2		3	1	4	6	21	
Ferry.....										2		2	2	
Grays Harbor.....	1	4	1	3			8	2	2	1		3	25	
Island.....						5	1					8	18	
Jefferson.....		2				1	4	1	1	5	1		14	
King.....		1	5	7		10	39	8	9	13	5	15	112	
Kitsap.....						5	5	1	4			3	19	
Kittitas.....		2		2			4		1	13	1	4	29	
Klickitat.....	2	1	4	8		6	4	5	2	7	4	6	38	
Lewis.....	2	2		2		2	6	2	2	1	5	3	49	
Mason.....										22		5	27	
Okanogan.....						2	1		1		2	1	11	
Pacific.....	3		1	4		3	5		1	21		13	48	
Pend Oreille.....	3		3	6		8	20		7	14	7	10	78	
Pierce.....										11		4	22	
San Juan.....	2		3	9		13	7	4	2	9	4	4	58	
Skagit.....		1	1			1	1		2	2	1	1	10	
Skamania.....	3	2	1	7		8	13	11	12	6	4	14	82	
Snohomish.....				22		6	22		2	2		6	60	
Spokane.....			2	20		2	8		2	24		16	74	
Stevens.....		2	4	4		2	2		1	2		8	28	
Thurston.....						3							4	4
Wahkiakum.....	1		1			4		4	3	8		4	38	
Whatcom.....													9	9
Yakima.....						2	3							
Totals.....	19	14	36	98	4	91	182	43	64	219	55	155	980	
U. S. Forest Service.....	12			8		43	45		6	704		16	834	
Totals.....	31	14	36	106	4	134	227	43	70	923	55	171	1,814	

CLASSIFICATION OF FIRES, 1927. Class A (under ¼ acre), 943; Class B (¼ to 10 acres), 574; Class C (over 10 acres), 297.

TABLE NO. 2—FOREST FIRES, OUTSIDE NATIONAL FORESTS, REPORTED BY STATE AND PRIVATE AGENCIES, 1927.

COUNTIES	AREA BURNED OVER										MERCHANTABLE TIMBER		LOSS AND DAMAGE TO PROPERTY	
	Number Fires	Merchan- table Timber	Repro- duction	Cutover	Burned Over	Other Lands	Total	Timber Killed B. M.	Timber Dest yed B. M.	Logs Dest yed	Logging Equipment	Settlers and Others		
Chelan.....	40	714	24	30	.....	5	773	45	.....	.....	.....	550 00
Chelan.....	23	37	16	10	.....	5	68	.....	.....	800 00	.....	.....
Clark.....	14	.....	14	85	.....	79	180	.....	.....	.....	.....	42 00
Cowlitz.....	21	.....	1,004	1,816	.....	103	2,923	.....	.....	.....	.....	.....
Ferry.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Grays Harbor.....	25	.....	60	112	1,140	66	1,384	25	.....	.....	.....	.....
Island.....	18	.....	54	655	14	30	751	.....	.....	.....	.....	.....
Jefferson.....	14	.....	29	198	20	208	208	.....	.....	.....	.....	.....
King.....	112	1,204	7	536	101	1,446	3,294	.....	.....	.....	.....	200 00
Kitsap.....	19	50	141	8	.....	3	208	.....	.....	.....	.....	.....
Kittitas.....	29	435	122	2	80	3	642	80	.....	.....	.....	15 00
Klickitat.....	38	3	3	106	.....	370	482	.....	.....	.....	.....	.....
Lewis.....	49	1,255	115	1,063	.....	1,113	3,486	219	.....	.....	.....	126 00
Mason.....	27	21	342	750	452	150	1,715	30	3,000	3,350 00	.....	.....
Okanogan.....	11	40	250	.....	.....	420	920	350	506	3,600 00	.....	.....
Pacific.....	48	452	39	67	110	40	624	15	.....	.....	.....	.....
Pend Oreille.....	78	.....	7	.....	762	1,228	3,912	1,077	43	6,068 00	.....	5 00
Pierce.....	22	2	.....	41	80	31	154	.....	.....	.....	.....	65 00
San Juan.....	58	4	40	111	283	786	1,224	21	.....	2,500 00	.....	250 00
Skagit.....	10	169	63	350	190	62	894	.....	20	1,200 00	.....	1,000 00
Skamania.....	82	242	33	7,138	121	40	7,574	35	.....	4,000 00	.....	1,300 00
Snobomish.....	60	133	1,534	600	7	463	2,737	25	10	.....	.....	715 00
Spokane.....	74	630	201	50	50	314	1,609	130	300	9,500 00	.....	370 00	
Stevens.....	28	35	40	2,386	145	175	2,781	.....	75	.....	.....	400 00
Thurston.....	4	.....	.....	.....	.....	.....	285	.....	4	.....	.....	.....
Wahkiakum.....	88	120	20	833	355	484	1,812	.....	.....	.....	.....	.....
Whatcom.....	9	.....	1	.....	.....	.....	1	.....	.....	.....	.....	.....
Yakima.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Totals.....	980	5,797	4,117	19,253	4,011	7,517	40,695	2,612	3,990	31,018 00	.....	10,017 00	
U. S. Forest Service.....	834	.....	.....	.....	.....	.....	56,468	41,590	.....	1,500 00	.....	6,000 00

Total loss and damage to all classes of property, \$128,145.00.

FOREST FIRES IN 1928.

Weather is the major factor affecting the occurrence of forest fires. It affects fires by causing an increased or decreased inflammability of the material on which fires feed, with a corresponding increase in their rate of spread. The relative humidity of the air and rainfall are the two most potent factors affecting inflammability. During the fire season rain is intermittent and its effect is often of too short duration, but the influence of relative humidity is continuous and the degree of fire hazard rises or falls with every attendant change of this phase of the weather; thus, a few days of low humidity may undo all the effects of heavy rains. In respect to rainfall and humidity, this season was bad. "June, July and August were probably the driest three-month period of record in Western Washington. Days with low humidity were above the average in number."

On other pages of this report is given a full discussion of the cause and effect of weather on the occurrence of fires by Mr. Geo. W. Alexander, meteorologist, Fire-weather Warning Service, Seattle, Washington. Mr. Alexander has for the past four years been making a special study of this most important phase of forest fire work and is an authority on the subject.

The largest fire in the state was started by lightning in July in Okanogan County. It burned over approximately eighteen thousand acres of land. About three thousand acres of this was merchantable timber, the balance being cut-over, sparsely timbered or sage brush land. Considering the size of the fire, the loss to standing timber was small. The fire in green timber burned on the ground and the loss was confined to scattered trees burned down and young growth killed. Over \$7,000.00 was spent in its control.

Lightning was a prevalent cause of fires in the Eastern part of the state, but outside of the one large fire in Okanogan County all were confined to small areas and only small loss was occasioned thereby. This is partly due to the fact that most of these lightning storms were accompanied with rain, which helped to control the fires until they could be reached and extinguished.

An unusual number of fires from railroad locomotives occurred in Spokane County. A considerable amount of ground was burned over by these fires. The railroads paid all expense connected with their control. However, a bad situation was created. Better supervision will be extended this area next year to the end that such fires be prevented.

In the Douglas fir region west of the Cascades, the only damaging fires occurred in and were caused by logging operations. There were no large fires in green timber but there were a number of very bad fires in logged-off areas. Our reports show that more logs were destroyed than in any previous season since 1922. Eight fires did most of this damage. The amount of loss in logging equipment was not large. Most of the loss was covered by insurance, but insurance cannot cover the loss to the community in logs burned up—these cannot be replaced. Logging operators were not culpable in the occurrence of these fires. There was no lack of what is considered adequate prevention. Three of the largest and most damaging fires came from properly screened oil burning locomotives. However, all of the fires occurred on days of low humidity. This would indicate that more drastic measures of prevention are necessary during such periods, even to the possibility of closing down the camps, if such fires are to be avoided in the future. The great mass of highly

inflammable material created by a logging operation is a veritable tinder box and must be handled as such during bad fire days.

To better appreciate the full significance of such hazards, I might say that one of the fires mentioned cost the company interested over \$40,000.00 to control; this cost together with the damage done amounted to over \$100,000.00. Another of the fires cost \$9,000.00 to control, another \$7,000.00, and still another over \$50,000.00. This is out of all proportion to the costs of control on lands which have been logged off and the slashings disposed of by burning.

Several fires in logging slashings were of incendiary origin, though none of these occurred in slashings adjoining active logging operations, hence no damage was caused thereby. A number of fires in slashings and logged-off lands were started by berry pickers. Fires from the foregoing causes occurred during July and August and are to a considerable extent responsible for the so-called "smoke nuisance" complained of by many.

The owners of logged-off lands are now contributing their share of protection costs, and protection against fire has been extended to all such lands. We are endeavoring to prevent and control fires on these lands to the end that they may be reforested and to keep the atmosphere clear of smoke. Ninety-five per cent of the area burned over this year was logged-off land. These constitute our greatest fire problem. The problem is aggravated by seekers in one form or another of recreation and by those employed in the logging industry. As an evidence of the truth of this statement, I will add that King County is the most populous in the state and it also has the largest number of fires, making it evident that the number of fires in Western Washington increases or decreases in direct ratio to the population.

Thus the problem with fire on forest lands is much the same as in the city. It appears impossible to prevent all fires, therefore, a good strong organization for their control must be maintained.

During the latter part of August and through September and October several periods of ideal slash burning weather prevailed. This was taken advantage of and some 90,000 acres of logging slash was burned for protection. Accidental fires during the summer burned another 50,000 acres of slashings. This acts to reduce the fire hazard for succeeding years.

ORGANIZATION.

The organization of our field force has been somewhat altered since we took up the work in 1925.

We have put most of our field work in charge of four Chief District Wardens, these men being on duty all of the year. This has worked out satisfactorily and has strengthened the work very materially. It has brought about closer cooperation between our own men. All supervising District Wardens are paid jointly by private protective agencies and this department. This makes one organization and duplication of work is avoided.

Airplane service was supplied by the U. S. Forest Service with planes stationed at Tacoma and Spokane. These planes were at our service outside of the National Forests with the exception of a small part of the southwestern part of the state. It was not necessary to make use of them. Forest Service officials made several reconnaissance trips.

Two Special Law Enforcement officers were employed during the fire season. The work done by these men had a very salutary effect in law observance and was of much help to the field wardens.

We had about the same complement of men—district wardens, county wardens, rangers and lookout men—as heretofore. More than ninety per cent of our employees come back to us each year. They are an experienced, faithful and loyal force of men.

COOPERATION.

A new agreement was entered into between this department and the Washington Forest Fire Association with the U. S. Forest Service, fixing responsibility for the protection of certain areas and providing for control of fires in a neutral zone one mile wide on each side of the National Forest boundary. This agreement makes the forest officer first discovering a fire in this zone responsible for its control and designates how the expense of fire fighting shall be divided. Under the agreement duplication of work is avoided and areas are blocked in protective units and each unit allotted to the agency which can handle it to best advantage. We protect certain areas of National Forest land in exchange for which the Forest Service protects scattered state and privately owned lands in National Forests. Thus responsibility for the protection of all forest lands is fixed and expense of protection is curtailed.

We contracted with the Forest Service for the protection of several thousand acres of state and privately owned land in Northwestern Stevens County, Ferry County and in Kittitas County for certain stated amounts. These lands intermingle with National Forest lands and can be and are given protection at less cost than we could do the work for.

We have special agreements and contracts covering protection of privately owned lands assessed by the state with the Eastern Washington Timber Protective Association, Tesemini Timber Protective Association, Ferry County Timber Protective Association, Washington Forest Fire Association, Polson Logging Company, W. E. Boeing, Crown Willamette Paper Company, Eastern and Western Lumber Company, Carlisle Lumber Company and the Vernon Parrish Lumber Company. All of these agreements and contracts fix responsibility for protection of the lands involved.

The Department of the Interior this year made a splendid contribution for the protection of the vacant public lands, located in the forested districts of this state. Under agreement with Mr. W. S. Boyer of that department, located at Portland, Oregon, we furnished protection for the public lands through our field service, Mr. Boyer paying for the work direct from his department. He was authorized to and did expend \$11,940.34 in the work. All of the amount was expended in the work of fire prevention, it being understood that we would pay cost of fire suppression. The arrangement proved very satisfactory and enabled us to give a far greater degree of protection to the districts where these lands are located than ever before.

Mr. Boyer took a keen interest in protection work and went out in the field to get first hand knowledge of what was being done. We deeply appreciate the interest manifested in the work of protection and accept this as evidence that the department intends to shoulder its full share of responsibility along with the rest of us, to the end that full protection may be provided for all of our forest lands.

The Weather Bureau continued the investigative work begun four years ago and gave us the full benefit of their study into the causes and influences of the weather affecting the fire hazard and the control and spread of fires. Fire warning forecasts were sent out whenever such weather seemed imminent.

More recording instruments were installed so that conditions in certain localities might be noted and a study made into their cause and whether or not conditions were the same in every district. It is evident from observations made already from these recording instruments that the same conditions do not prevail over all portions of Western or Eastern parts of the state simultaneously, and that while it is safe to have fire burning in Skagit County one day, it may not be safe in Grays Harbor County the same day.

Mr. George W. Alexander, attached to the Weather Bureau at Seattle and who is making fire weather studies his especial business, hopes to obtain data enough through these local weather stations to enable him to forecast fire-weather conditions locally. Mr. M. B. Summers, in charge of the Weather Bureau office at Seattle, is entitled to our thanks and appreciation for the assistance he has rendered us. He and Mr. Alexander have labored hard to make the fire-weather service of their department of real value to all protective agencies. They have rendered signal service already and the prospects are that there will be still greater achievements in this line.

Officials of railroads, logging operators and camp superintendents, the press and the public generally, all gave us friendly, hearty cooperation. The public's interest in forest protection, preservation and use is still unwavering and promises to continue, which is due in part, no doubt, to man's innate love and admiration of the trees. This interest in forestry should be fostered, not only to satisfy man's esthetic nature, but more by reason of the forests' immense value to the state from an economic standpoint, both now and in the future.

Our thanks are due Mr. C. M. Granger, District Forester, and his force of National Forest officers at Portland, and to the Forest Supervisors of National Forests in this state. We have had better cooperation this year with all members of the National Forest organization than ever before. On another page of this report will be found a statement showing the amount received through federal allotment under the Clarke-McNary act. Since our incumbency in this office in 1925, the allotment has been increased from \$33,220.00 in that year to \$69,155.00 this year. As already stated, the Department of the Interior expended \$11,940.34, making a total for the Federal Government as their contribution to protection in this state, \$81,095.34.

IMPROVEMENTS.

In cooperation with the Washington Forest Fire Association and the U. S. Forest Service the old railroad grade of the Clark County Timber Company, running east from Yacolt to old Camp Eleven, a distance of sixteen miles, was cleared and graded and converted into a good auto road. This route was formerly covered by foot patrol and several hours time were required to make the round trip. Now it can be run over in a few minutes and if desirable, that district can be covered several times a day during bad fire weather. Some of our regular patrol force were put on early in the spring to do this work.

Twelve miles of old logging road extending from Cape Horn in Skamania County to the Washougal Ranger Station was similarly opened up. This greatly facilitates the patrol and protection of the old Washougal burn. Skamania County, through its Board of County Commissioners, participated in this improvement, expending \$240.00 on the project.

The trail from Merrill Lake in Cowlitz County to the Kalama River was widened and graded to permit of use of the "Pony Auto" (a narrow gauge

automobile), now in use between Cougar, on Lewis River, to the lake. This makes more easy of access the fine stand of timber on the Kalama River and permits of more frequent patrol of the heavy timber through which the road passes, a distance of approximately ten miles. Twenty-five miles of new trail were constructed in other localities and fifty miles of old trail repaired.

Ten miles of new telephone line were constructed and one hundred twenty-five miles reconstructed.

A new cable foot bridge was constructed across the Cowlitz River at Cowlitz Falls, near Nesika in Lewis County. The U. S. Forest Service and Lewis County cooperated in this work. This bridge affords an outlet for a rather inaccessible timbered area which has hitherto been difficult to get in and out of. Most of our improvement work is done by our field men during the fire season at times when they are not otherwise engaged.

We purchased a new truck last year and have replaced all of our portable fire fighting pumps with new ones and have added to the number already on hand, and have also replenished and added to our supply of hose and other equipment.

We are planning to and have already done some work towards establishing a lookout on Boyer Peak in Southwestern Pend Oreille County. The work will be completed next spring. This will overlook a large area in Stevens, Pend Oreille and Spokane counties.

TABLE NO. 3—ORIGIN, NUMBER AND CLASSIFICATION OF FIRES, 1928.

COUNTIES	LUMBERING OPERATIONS				RAILROADS		RECREATION			Brush Burning	Lightning	Incendiary	Miscellaneous	Total
	Donkey	Log-ging		Miscellaneous	Loco-motive	Miscellaneous	Camp-ers	Smok-ers	Berry Pickers					
		Loco-motive	Loco-motive											
Chelan.....				1	10		2	29	1	3		6	61	
Chillam.....	2	4	2	2			4	4	1	4		17	45	
Clark.....				1	8		4	9	1	7		7	37	
Cowlitz.....	1	1	5				1	1		3		4	20	
Ferry.....				3				3				1	3	
Grays Harbor.....	1	5	3		2			8	1	7		2	45	
Island.....	1			1			21	10	2	5		7	11	
Jefferson.....	1	0	1		8		17	57	2	32		4	11	
King.....	1		2				1	7	1	3		2	8	
Kittitas.....				2		1				3			7	
Klickitat.....	1		2					28		4		10	7	
Lewis.....	1	5	7		3		3	6	1	11		9	74	
Mason.....	1	4	7		3		3	7		2		4	35	
Panogan.....				4									4	
Pend Oreille.....	2		4		11		1	3	2	15		2	5	
Pierce.....		3	5		2		14	41		23		27	151	
San Juan.....				4	5		11	16		15		18	1	
Skagit.....		7	1		1								1	
Skamania.....				1	4			4					5	
Snohomish.....				1	1		1	1	6	11		4	4	
Spokane.....				12	52		7	62	10	10		8	21	
Stevens.....				1	48		3	21	6	6		6	11	
Thurston.....				1	6		1	11	1	3		6	69	
Wahkiakum.....				1	1			2	3	8		3	18	
Whatcom.....	1		2		1		2	14	2	11		15	1	
Yakima.....				2			4	5				1	3	
Totals.....	20	44	71	167	15	120	374	20	180	112	128	347	1,598	
U. S. Forest Service.....			9		19	83	98		14	200	7	20	450	
Totals.....	20	44	80	167	34	203	472	20	194	312	135	367	2,048	

CLASSIFICATION OF FIRES, 1928. Class A (under ¼ acre), 604; Class B (¼ to 10 acres), 899; Class C (over 10 acres), 615.

TABLE NO. 4—FOREST FIRES, OUTSIDE NATIONAL FORESTS, REPORTED BY STATE AND PRIVATE AGENCIES, 1928.

COUNTIES	AREA BURNED OVER						MERCHANTABLE TIMBER			LOSS & DAMAGE TO PROPERTY		
	No. Fires	Mer- chantable Timber	Repro- duction	Cut- Over	Burned Over	Other Lands	Total	Timber Killed B.M.	Timber Destroyed B.M.	Logs Destroyed B.M.	Logging Equip- ment	Settlers and Others
Chelan.....	61	243	160	11	90	1,898	2,402	48.	.....	3.	.....	\$7,300 00
Challam.....	45	805	182	9,000	1,111	311	11,415	1,500.	.....	10,000.	\$16,800	1,200 00
Clark.....	37	.....	.....	4,108	59	237	4,398	.....	.....	50.	700	915 00
Cowlitz.....	20	20	6	2,979	5,529	.....	8,534	.....	.....	11,538.	28,000	.....
Ferry.....	3	.....	100	60	.....	113	273	.....	.....	.....	.....	400 00
Grays Harbor.....	45	.....	855	4,157	1,688	1,301	7,999	.....	.....	.....	100	.....
Island.....	42	.....	4	347	5	179	535	.....	.....	.....	.....	8 00
Jefferson.....	29	29	145	621	61	61	910	.....	.....	1,000.	.....	700 00
King.....	166	80	1,856	1,297	845	1,921	5,999	700.	.....	200.	.....	500 00
Kitsap.....	20	90	.....	1,183	30	371	1,614	4,000.	.....	15,010.	3,000	.....
Kittitas.....	17	31	81	600	600	477	1,789	2.	.....	22.	.....	1,705 00
Klickitat.....	55	692	450	336	89	1,280	2,847	30.	100.	.....	.....	3,171 00
Lewis.....	74	105	335	4,177	1,505	53	5,775	376.	.....	.....	500	595 00
Mason.....	63	354	1,180	2,614	2,939	561	7,657	200.	.....	5,980.	5,000	2,680 00
Okanogan.....	21	3,205	5,320	1,049	2,300	7,850	19,724	500.	100.	300.	7,000	.....
Pacific.....	18	.....	30	1,690	147	.....	1,837	.....	.....	.....	.....	235 00
Pend Oreille.....	69	488	20	1,146	629	12	2,235	.....	1.	.....	30	7,675 00
Pierce.....	191	58	90	1,355	1,885	2,931	6,289	115.	.....	.....	.....	25 00
San Juan.....	13	.....	61	1	30	74	166	.....	.....	.....	.....	40 00
Skagit.....	95	112	132	169	588	741	1,742	.....	.....	.....	.....	40 00
Skamania.....	72	.....	3	90	50	182	325	.....	.....	.....	.....	25 00
Snohomish.....	73	25	112	3,067	1,083	187	4,494	.....	.....	1.	.....	.....
Spokane.....	131	2,778	2,945	878	2,330	20,864	30,864	6,830.	.....	300.	6,200	14,895 00
Stevens.....	174	3,296	3,397	5,651	315	2,339	15,168	300.	5.	.....	.....	7,115 00
Thurston.....	66	125	1,041	10,517	1,460	232	13,375	75.	.....	691.	101	100 00
Wahkiakum.....	12	15	2	2,917	.....	60	2,994	.....	.....	.....	.....	.....
Whatcom.....	57	5	3	515	236	1,921	2,680	.....	.....	.....	.....	1,634 50
Yakima.....	9	91	98	35	335	.....	559	3,114.	.....	.....	.....	.....
Totals.....	1,508	12,610	27,005	62,537	24,475	27,822	155,049	17,792.	205.	45,094.	\$81,199	\$51,465 50
U. S. Forest Service.....	450	.....	.....	.....	.....	.....	10,339	.....	.....	.....	.....	.....

Total loss and damage to all classes of property, \$410,754.50.

TABLE NO. 5—STATE APPROPRIATION—GENERAL FUND.

	October 1, 1926, to March 31, 1927	April 1, 1927, to September 30, 1927	October 1, 1927, to September 30, 1928
Appropriation.....		\$160,000 00	
Unexpended.....	\$4,089 90		\$84,300 79
Credits—			
Cancelled warrant.....	59 69		123 56
Recovery, fire-fighting costs	23 50		
Totals.....	\$4,173 09	\$160,000 00	\$84,424 35
Expenditures—			
Administration.....	\$658 57	\$4,844 29	\$4,991 67
Field personnel.....	432 58	65,796 32	56,555 70
Improvements and equipm't	1,472 28	2,764 40	2,682 68
All other.....	1,607 30	2,204 83	2,886 81
Fire suppression.....		89 37	42 98
Totals.....	4,170 73	75,699 21	67,159 84
Balance.....	①\$2 36	\$84,300 79	\$17,264 51

① Reverted to Treasury, April 1, 1927.

TABLE NO. 6—FEDERAL ALLOTMENT—CLARKE-McNARY.

	October 1, 1926, to September 30, 1927	October 1, 1927, to September 30, 1928
Unexpended.....	\$17,168 06	\$8,425 65
Reimbursement.....	23,904 41	91,205 08
Recovery fire fighting costs.....	165 00	281 99
Cancelled check.....	45 72	
Interest earned.....	132 69	285 71
Totals.....	\$41,415 88	\$100,198 43
Expenditures—		
Administration.....	\$3,417 48	\$3,378 00
Field personnel.....	12,044 82	30,063 26
Improvements and equipment.....	2,798 79	2,409 39
Other expense.....	680 89	827 30
Fire suppression.....	14,048 25	20,001 53
Totals.....	32,990 23	56,677 68
Balance.....	\$8,425 65	\$48,520 75

TABLE NO. 7—FOREST ASSESSMENT COLLECTIONS—CLERKS FUND.

	October 1, 1926, to September 30, 1927		October 1, 1927, to September 30, 1928	
Unexpended.....		\$8,867 90		\$8,017 25
Collections.....		6,338 95		6,200 05
Interest earned.....		131 82		107 36
Totals.....		\$15,338 67		\$14,324 66
Expenditures—				
Administration.....	\$3,282 81		\$4,730 49	
Field personnel.....	3,824 07		1,662 09	
Other expense.....	214 54		121 53	
Totals.....		7,321 42		6,514 11
Balance.....		\$8,017 25		\$7,810 55

FOREST ASSESSMENT COLLECTIONS—STATE FUND.

	October 1, 1926, to September 30, 1927		October 1, 1927, to September 30, 1928	
Unexpended.....		\$2,092 17		\$16,445 11
Collections.....		119,630 30		119,974 44
Interest earned.....		207 02		570 83
Recovery—Fire fighting.....				536 77
Totals.....		\$121,929 49		\$137,527 15
Expenditures—				
Field personnel.....	\$1,467 88		\$6,074 24	
Improvements and equipment.....	637 19		205 57	
Other expense.....	27 54		1 28	
Fire suppression.....	3,651 15		6,475 61	
Paid to associations.....	99,700 62		99,144 34	
Totals.....		105,484 38		111,901 04
Balance.....		\$16,445 11		\$25,626 11

TABLE NO. 8—RECOVERIES FOR FIRE FIGHTING.

	October 1, 1926, to September 30, 1927		October 1, 1927, to September 30, 1928	
Unexpended.....		\$43 50		\$88 45
Receipts.....		307 80		864 12
Totals.....		\$351 30		\$952 57
Expenditures—				
Fire fighters.....	\$74 35		\$63 63	
State Treasurer—General.....	23 50			
State Assessment Fund.....			536 77	
Clarke-McNary Fund.....	165 00		281 90	
Totals.....		262 85		882 30
Balance.....		\$88 45		\$70 18

TABLE NO. 9—STATEMENT SHOWING AMOUNT EXPENDED IN EACH COUNTY FOR FIRE SUPPRESSION AND PROTECTION, AND THE AMOUNT DUE THE STATE FROM THE COUNTIES FOR ONE-THIRD OF EXPENDITURES FROM STATE APPROPRIATION (5785 Rem.).

COUNTIES	October 1, 1926, to Sept. 30, 1927			October 1, 1927, to Sept. 30, 1928		
	Clarke-McNary, Clerks and State Fund	State Appropriation	Due from Counties	Clarke-McNary, Clerks and State Fund	State Appropriation	Due from Counties
Chelan.....	\$3,365 76	\$2,614 91	\$871 64	\$2,038 60	\$912 01	\$304 00
Clallam.....	1,267 70	3,149 22	1,049 74	2,254 33	3,801 76	1,267 25
Clark.....	395 33	1,455 10	485 03	580 34	1,499 39	499 80
Cowlitz.....	469 01	1,684 46	561 49	1,191 79	2,970 90	990 30
Ferry.....	328 63	1,099 67	366 56	800 04	287 34	95 78
Grays Harbor.....	556 49	2,127 79	709 26	1,351 65	2,470 23	823 41
Island.....	935 52	810 48	270 16	396 04	931 14	310 38
Jefferson.....	1,205 30	2,837 27	945 76	1,587 77	2,882 51	960 84
King.....	1,545 96	5,811 62	1,937 21	2,708 46	6,339 57	2,113 19
Kitsap.....	396 12	1,170 99	390 33	783 75	1,377 67	459 22
Kittitas.....	2,200 74	2,526 86	842 29	2,559 17	893 93	267 98
Klickitat.....	1,008 56	3,055 35	1,018 45	2,813 19	1,591 40	530 47
Lewis.....	2,989 46	3,349 86	1,116 62	3,118 88	3,491 89	1,163 96
Mason.....	237 01	1,178 93	392 98	1,089 23	1,378 82	459 61
Okanogan.....	1,629 07	2,166 70	722 23	9,138 64	1,291 65	430 55
Pacific.....	464 10	2,042 16	680 72	3,462 68	2,321 43	773 81
Pend Oreille.....	1,588 61	2,781 24	927 08	3,546 95	890 36	296 79
Pierce.....	3,849 72	3,204 85	1,068 28	1,482 15	2,857 82	952 61
San Juan.....	215 23	634 87	211 62	301 56	547 79	182 60
Skagit.....	815 59	2,659 29	886 43	947 61	2,916 10	972 03
Skamania.....	419 24	1,477 79	492 60	2,206 79	1,132 37	377 46
Snohomish.....	1,287 47	3,714 57	1,238 19	3,020 13	3,822 55	1,274 18
Spokane.....	677 71	1,957 76	652 59	4,990 67	688 80	229 60
Stevens.....	3,872 07	4,134 32	1,378 10	4,220 17	1,768 04	589 85
Thurston.....	813 62	1,684 24	561 41	3,481 30	1,592 63	530 88
Wahkiakum.....	155 66	967 51	322 50	559 74	1,203 02	401 00
Whatcom.....	1,320 68	3,847 36	1,282 45	766 91	3,725 81	1,241 93
Yakima.....	1,575 54	2,113 41	704 47	2,212 22	978 19	326 06
Whitman.....				54 06		
Totals.....	\$35,585 90	\$66,258 58	\$22,086 19	\$63,664 82	\$56,475 12	\$18,825 04

TABLE NO. 10—STATEMENT SHOWING NUMBER OF ACRES OF PRIVATELY OWNED FOREST LANDS ASSESSED FOR PROTECTION COSTS.

COUNTIES	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Chelan.....	86,661	93,400	88,162	90,303	90,265	204,743	198,517	206,453	204,740	204,164	167,460
Clallam.....	6,965	6,891	16,709	17,088	17,787	90,867	92,494	129,298	145,138	149,768	157,149
Clark.....	13,915	13,978	46,177	54,416	73,392	15,419	17,007	49,475	54,130	50,846	52,670
Cowlitz.....	95,352	85,650	90,087	115,624	58,697	71,504	77,869	77,790	123,351	129,757	122,261
Ferry.....	37,337	1,803	1,798	3,171	123,042	120,880	137,257	3,062	56,151	54,479	54,292
Grays Harbor.....	35,127	70,683	70,961	69,459	60,662	3,171	3,142	80,411	84,029	33,850	32,710
Island.....	2,120	48,548	82,707	88,476	86,414	68,835	61,549	107,977	140,219	130,169	98,545
King.....	46,980	46,980	88,550	106,555	97,406	84,321	86,652	107,977	88,491	34,079	335,604
Kitsap.....	32,232	32,824	37,801	42,777	2,348	2,508	2,348	15,645	230,079	234,880	235,267
Kittitas.....	68,770	71,430	86,729	94,445	106,541	198,407	201,103	233,661	230,079	267,904	264,746
Lewis.....	21,945	26,886	31,678	32,759	37,470	104,680	157,152	250,533	118,341	125,813	119,291
Mason.....	81,052	120,511	121,001	129,200	126,026	100,326	99,472	96,719	136,445	139,275	130,266
Okanogan.....	15,063	22,320	26,997	40,758	39,461	39,391	56,191	78,384	92,006	88,348	128,709
Pacific.....	8,770	107,384	166,464	157,696	228,441	54,677	64,285	76,066	144,500	155,680	157,977
Pend Oreille.....	21,945	26,886	31,678	32,759	37,470	220,972	229,713	182,569	221,027	223,511	224,420
Pierce.....	81,052	120,511	121,001	129,200	126,026	105,935	106,713	132,555	144,500	155,680	157,977
Skagit.....	15,063	22,320	26,997	40,758	39,461	48,064	39,448	44,380	94,226	107,007	108,248
Skamania.....	44,643	38,566	38,546	44,990	51,997	132,810	130,630	122,496	144,640	173,632	177,978
Snobomish.....	41,756	38,791	53,535	59,001	73,660	59,864	58,437	66,000	108,697	106,019	102,459
Spokane.....	41,756	38,791	53,535	59,001	73,660	42,418	41,813	57,850	89,698	110,419	112,770
Stevens.....	44,643	38,566	38,546	44,990	51,997	70,590	82,065	81,684	91,493	146,248	172,312
Thurston.....	21,945	26,886	31,678	32,759	37,470	186,346	482,254	494,353	543,744	563,638	559,506
Wahkiakum.....	41,756	38,791	53,535	59,001	73,660	49,192	49,192	71,568	76,262	115,049	115,739
Wahatcom.....	41,756	38,791	53,535	59,001	73,660	32,144	30,171	37,765	47,151	46,393	50,088
Yakima.....	651,734	905,265	1,366,593	1,533,260	1,607,585	61,115	71,456	86,006	103,263	116,448	120,469
Totals.....	651,734	905,265	1,366,593	1,533,260	1,607,585	2,591,387	2,646,300	3,112,160	3,754,389	3,976,311	3,968,631

TABLE NO. 11—STATEMENT SHOWING FOREST ASSESSMENT COLLECTIONS RECEIVED FROM COUNTY TREASURERS. October 1, 1926, to September 30, 1927.

COUNTIES	1917-1921	1922	1923	1924	1925	1926	Total
Chelan.....		\$12 45	\$58 52	\$93 49	\$1,072 90	\$2,245 40	\$3,482 76
Clallam.....	\$185 68	20 72	98 20	132 43	1,778 02	3,428 18	5,643 23
Clark.....	21 44	14 00	14 20	83 25	325 68	1,192 76	1,651 33
Cowlitz.....	246 54	121 85	102 16	145 15	782 85	3,534 10	4,932 65
Ferry.....	99 51	57 04		65 52	344 03	628 88	1,194 98
Grays Harbor.....	107 67	112 20	128 21	199 58	2,324 71	10,745 95	13,618 32
Island.....	18 60	32 90	26 12	6 50	234 05	706 93	1,025 10
Jefferson.....	92 12	40 80	56 63	181 20	642 61	2,534 51	3,547 87
King.....	164 47	44 87	38 73	78 91	1,214 57	4,342 03	5,883 58
Kitsap.....				17 06	348 87	787 99	1,153 92
Klickitat.....		7 02	10 27	29 60	506 74	4,242 77	4,796 40
Lewis.....	150 88	165 45	145 92	235 15	829 83	3,366 28	4,257 16
Mason.....	4 80	23 00	29 21	50 05	888 36	4,744 57	5,739 99
Okanogan.....		20 12	31 06	107 04	271 41	1,828 37	1,758 60
Pacific.....	243 36	91 45	139 12	308 90	1,019 81	4,755 19	6,557 83
Pend Oreille.....	292 40	196 91	247 05	435 80	1,761 69	3,986 03	6,919 88
Pierce.....	8 77	13 25	20 88	74 73	836 33	2,771 46	3,934 92
Skagit.....	95 19	75 90	61 88	114 77	1,136 32	4,799 09	6,263 15
Skamania.....	37 60	265 50	270 10	376 55	967 07	2,260 18	4,177 00
Snohomish.....	34 60	30 02	49 61	254 93	870 75	3,239 79	4,479 70
Spokane.....					354 90	2,882 93	3,237 83
Stevens.....	691 58	229 38	416 87	636 41	3,023 78	9,686 73	14,684 75
Thurston.....	36 90	25 96	17 81	52 39	537 55	3,409 95	4,080 56
Wahkiakum.....	36 72	41 20	29 75	43 20	147 02	818 53	1,116 42
Whatcom.....	137 35	108 40	99 89	235 31	768 13	3,114 18	4,463 26
Yakima.....		4 37	10 96	17 82	146 75	1,428 75	1,608 65
Totals.....	\$2,706 18	\$1,768 86	\$2,128 89	\$4,087 69	\$23,873 92	\$91,403 71	\$125,969 25

TABLE NO. 12—STATEMENT SHOWING FOREST ASSESSMENT COLLECTIONS RECEIVED FROM COUNTY TREASURERS. October 1, 1927, to September 30, 1928.

COUNTIES	1917-1922	1923	1924	1925	1926	1927	Total
Chelan.....	\$70 17	\$38 10	\$71 57	\$117 44	\$861 57	\$2,097 26	\$3,256 11
Clallam.....	215 61	3 50	58 56	96 40	1,504 63	3,236 40	5,145 10
Clark.....	41 90	15 12	100 10	202 90	311 45	1,252 62	1,924 09
Cowlitz.....	271 71	86 80	114 25	282 80	679 30	3,406 37	4,841 23
Ferry.....	79 86		37 98	38 14	375 99	591 14	1,223 11
Grays Harbor.....	143 66	95 96	129 77	553 88	2,093 16	10,238 17	13,254 60
Island.....	8 20	2 48	34 85	183 20	170 85	648 29	1,047 87
Jefferson.....	63 33	21 44	72 75	88 80	597 10	2,450 20	3,293 62
King.....	192 20	43 20	98 31	200 92	1,055 34	3,744 64	5,334 61
Kitsap.....	14 00		3 97	31 27	293 07	704 36	1,046 67
Klickitat.....	4 93	6 43	21 78	56 22	227 70	4,283 86	4,600 92
Lewis.....	40 00	18 25	86 94	132 03	741 98	3,229 91	4,249 11
Mason.....	79 84	54 60	109 05	188 51	823 27	3,868 46	5,123 73
Okanogan.....	31 20	20 76	25 13	187 85	437 56	4,134 51	4,877 61
Pacific.....	170 87	38 00	48 42	67 15	380 12	1,652 37	2,217 26
Pend Oreille.....	1,114 91	83 44	118 63	244 63	1,147 96	4,630 17	6,395 70
Pierce.....	31 11	337 55	405 00	588 68	1,767 79	3,305 76	7,519 69
Skagit.....	204 68	1 11	21 78	174 86	1,151 54	3,092 39	4,472 79
Skamania.....	44 10	41 48	51 65	119 36	1,369 77	4,608 78	6,395 72
Snohomish.....	144 68	25 09	192 22	310 45	814 44	2,226 14	3,612 44
Spokane.....		24 56	77 40	130 50	661 91	3,018 37	4,057 42
Stevens.....	731 64	383 48	580 33	695 00	725 27	3,660 88	4,386 15
Thurston.....	7 50	122 59	145 42	167 29	4,069 97	9,548 25	16,008 67
Wahkiakum.....	25 60	12 80	51 70	84 75	1,318 63	3,401 05	5,162 48
Whatcom.....	121 21	44 26	46 45	134 53	215 35	869 00	1,259 20
Yakima.....	2 50	5 40	16 80	16 80	830 04	3,025 59	4,202 13
Totals.....	\$3,927 21	\$1,526 40	\$2,720 81	\$5,094 41	\$24,755 93	\$88,149 73	\$126,174 49

TABLE NO. 13—BURNING PERMITS ISSUED, CLASSIFICATION AND ACREAGE OF LAND BURNED UNDER PERMITS, NUMBER OF ARRESTS AND FINES AND COSTS ASSESSED DURING SEASONS OF 1927 AND 1928.

COUNTIES	SEASON 1927						SEASON 1928					
	Burning Permits			Arrests and Fines			Burning Permits			Arrests and Fines		
	Permits	Fire	Protec- tion	Agri- culture	Number	Fines and Costs	Number Permits	Camp Fire	Protec- tion	Agri- culture	Number	Fines and Costs
Chelan.....	124	24	738	208	63	.....	11	101	177	8	\$110 50
Clallam.....	379	5	1,405	1,427	618	.....	9	2,393	2,415	1	7 50
Clark.....	561	86	1,439	1,651	857	\$81 00	131	1,248	1,917	.....	.....
Cowlitz.....	592	109	1,570	1,512	869	27 50	71	2,771	2,058	.....	.....
Ferry.....	89	45	218	339	127	.....	48	672	38	2	.....
Grays Harbor.....	862	1	1,764	2,121	1,003	113 50	4	6,087	1,610	.....	.....
Island.....	196	1	51	1,856	290	.....	7	2,444	2,710	.....	.....
Jefferson.....	172	19	248	2,622	290	.....	22	1,461	2,248	2	25 00
King.....	2,198	32	1,465	4,953	2,184	39 50	64	6,959	4,467	4	49 50	
Kitsap.....	451	9	4,409	1,009	684	154 70	51	2,615	1,059	5	101 10	
Kittitas.....	103	24	812	392	44	27 50	20	687	202	1	12 50	
Klickitat.....	438	30	270	9,389	571	.....	61	3,776	4,937	5	144 00
Lewis.....	1,975	107	7,275	7,275	2,706	168 50	145	15,478	12,089	.....	.....
Mason.....	614	6	2,019	1,121	647	37 50	1	6,934	890	.....	.....
Okanogan.....	92	20	181	806	131	10 00	6	385	274	.....	.....
Pacific.....	296	20	4,394	873	343	63 75	18	3,008	2,322	.....	.....
Pend Oreille.....	408	82	1,159	1,718	471	48 50	101	616	3,266	3	55 00	
Pierce.....	1,844	41	10,173	6,135	2,190	25 00	56	6,412	8,503	2	14 00	
San Juan.....	98	11	92	661	2	.....	17	252	949	1	.....
Skaft.....	792	37	1,513	4,707	985	.....	95	2,222	5,457	1	27 50
Skamania.....	106	17	214	1,107	128	.....	33	483	421	1	12 50
Snouhomish.....	2,466	32	1,107	12,252	2,611	271 75	60	1,642	12,487	4	121 25	
Spokane.....	552	.....	5,558	5,055	685	67 50	2	7,795	6,350	3	53 00
Stevens.....	570	86	1,051	7,311	987	73 10	73	1,311	10,218	6	92 00	
Thurston.....	1,062	6	6,271	3,212	1,327	116 50	4	10,106	5,077	3	82 50	
Wahkiakum.....	1,107	15	1,240	3,433	216	.....	86	3,924	1,124	.....	.....
Wahatcom.....	1,003	30	625	3,649	1,294	25 00	16	922	4,023	2	17 50	
Yakima.....	12	77	15	5	9	.....	40	41	12	.....	.....
Totals.....	18,111	913	57,276	75,751	22,381	\$1,353 30	1,202	89,901	97,934	54	\$921 35	

**TABLE NO. 14—FOREST PROTECTION EXPENDITURES, 1927 AND 1928.
PRIVATE, STATE AND FEDERAL.**

NAME OF PROTECTIVE AGENCY	Private Agencies Membership	State Assessed and Contracted	Expenditures for Prevention and Suppression
1927			
Washington Forest Fire Association.....	\$31,013 25	\$20,805 50	\$169,658 44
Eastern Washington Timber Protective Association..	2,230 00	2,244 20	7,112 87
Stevens County Protective Association.....		5,595 06	1,737 06
Ferry County Timber Protective Association.....		542 92	1,210 15
Tesemini Timber Protective Association.....	30 00	11 19	159 65
Private Patrol Districts.....	4,800 00		83,505 33
Total Private.....	\$38,073 25	\$29,198 87	\$263,383 50
United States Forest Service.....	\$116,000 00		\$641,900 00
Department of the Interior.....	5,733 33		2,836 51
State and Clarke-McNary.....	11,150 00①	\$10,407 73②	125,965 35
Total State and Federal.....	\$132,883 33	\$10,407 73	\$770,701 86
Grand Total All Agencies.....	\$170,956 58	\$39,606 60	\$1,034,085 36

NAME OF PROTECTIVE AGENCY	Private Agencies Membership	State Assessed and Contracted	Expenditures for Prevention and Suppression
1928			
Washington Forest Fire Association.....	\$30,470 00	\$20,868 50	\$162,015 87
Eastern Washington Timber Protective Association..	2,230 00	2,217 95	9,488 28
Stevens County Timber Protective Association.....			1,481 04
Ferry County Timber Protective Association.....		514 35	890 00
Tesemini Timber Protective Association.....	30 00	11 19	8,500 00
Private Patrol Districts.....	4,800 00		49,139 87
Total Private.....	\$37,530 00	\$23,611 99	\$231,515 06
United States Forest Service.....	\$116,000 00		\$648,000 00
Department of the Interior.....	5,733 33		11,940 34
State and Clarke-McNary.....	11,150 00①	16,038 05②	143,108 33
Total State and Federal.....	\$132,883 33	\$16,038 05	\$803,048 67
Grand Total All Agencies.....	\$170,413 33	\$39,650 04	\$1,034,563 75

①State owned Forest Lands, 1,115,000 acres (Merchantable Timber, Second Growth, Logged-off and Old Burn).

②Private Lands Assessed by State, Protection for which the Division of Forestry Assumes Responsibility.

Honorable Erle J. Barnes, Director,
Dept. of Conservation and Development,
Olympia, Washington.

Sir: It gives me pleasure to submit, herewith, report of the Division of Hydraulics for the Biennium, October 1, 1926, to September 30, 1928.

I deem it appropriate to express my appreciation of the faithful and efficient work of the entire office staff. This, with some improvement of methods, and with the elimination of speculative filings, has made it possible to handle the steadily growing increase of work with no increase in the number of employees.

Acknowledgment is also due to the field force, water masters and stream patrolmen for their patient and tactful handling of the many difficult problems with which they have had to deal; and to individual water users, power companies, cities and irrigation districts for the fine spirit of cooperation always shown by them toward the representatives of this office.

Respectfully submitted,

R. K. TIFFANY,
State Supervisor of Hydraulics.

PERSONNEL.

DIVISION OF HYDRAULICS.

At Close of Biennium, 1927-1928.

R. K. Tiffany.....	Supervisor
Chas. J. Bartholet.....	Assistant Supervisor
Gwendolyn Hallahan.....	Secretary
Elma Dodds.....	Reporter
Marvel Rotchford.....	Stenographer
Clarence E. Douglass.....	Hydrographer and Inspector

FOREWORD.

Water is the very life blood of modern industry and civilization.

As human life depends on water for its sustenance, so have the centers of human society been dependent upon, and hence been located near to ample water supplies. The first and universal need was for water for domestic, stock and irrigation uses. Later water became important as a means of transportation, and ever since that time the great cities of the world have been founded near the seashore and builded on the wealth derived from ocean commerce.

Then the water wheel was discovered and for some centuries humankind flocked to the falling streams. This movement in our country made New England for many decades preeminent in industrial, social and cultural development. The transmission of energy by electric current made it possible for industry to move away from the waterfall; but still it cannot stray far from the flowing stream, for now comes the age of chemistry and in nearly all chemical processes water, oceans of water, is an essential feature—water for blending; water for mixing and sorting; water for power; water as a solvent; and, besides these, the modern community uses ever-increasing amounts of water to carry away wastes of all kinds; water to beautify home grounds, streets and parks; water for gardens, farms and golf courses.

More and more with the advancing years, the health, happiness and advancement of human society depends upon an ample supply of this liquid; and Washington, with its thousands of lakes and streams, perpetually renewed as the rising vapors are wafted from the ocean to the great mountains, there to fall again as rain or snow; Washington with her fertile plains, perennial forests, treasure-laden hills and kindly climate is destined to become a center of civilization and culture second to none the world has ever seen.

WATER RESOURCES OF THE STATE.

Irrigation.

During the past two years there has been a slow but steady development in irrigation, comparable to that of the preceding decade. This development has come chiefly as a result of individual or small cooperative enterprises.

In North Central Washington the construction of the power transmission lines along the Columbia, Wenatchee and Okanogan rivers has stimulated the building of pumping plants, which have brought into cultivation considerable areas of excellent land with low pumping lifts and good transportation facilities. These developments, while small in comparison with the larger projects of earlier years, are in the main sound and will undoubtedly be permanent.

The only large irrigation construction under way is the building of the Kittitas division of the Yakima Project of the U. S. Bureau of Reclamation. This division is now about sixty per cent complete and it is understood that some water will be delivered during the irrigation season of 1929.

There has also been a healthy development under the Wapato canal in the Yakima Indian Reservation, where new lands, aggregating 3,000 acres, have been added during the past two years. In the Wapato division there is

under construction a pumping unit consisting of three 700 H. P. turbines direct connected to three 30" centrifugal pumps, each with capacity of 50 s. f. with an actual lift of 85 feet above main Wapato canal. Under this unit water for 11,000 acres of land will be available in 1929.

It is estimated that 567,000 acres are now irrigated in the counties east of the Cascade Mountains, and that there remains 2,583,900 acres of land that is irrigable under approved projects. In counties west of the Cascade Mountains, approximately 30,500 acres are irrigated. The area adaptable to irrigation in these counties is not known. It may be as high as 500,000 acres. The rate of development will, of course, depend upon the demand for the products of more intensive farming.

The increase of irrigation in Western Washington is clearly evident from applications for permits to appropriate public waters and the developments observed and reported in connection therewith. The need for irrigation in this area is obvious from the fact that this region has just experienced four months of good growing weather, during which only 1.75 inches of rainfall was recorded at Olympia, a typical station. During this period pastures were dry and no field crops were produced on any of the unirrigated land. And this has been a typical year. Irrigation in Western Washington means at least a doubling of the crops possible under natural conditions.

For these reasons we have freely encouraged irrigation developments in Western Washington and often gave advice to prospective water users toward the planning of their developments. The number of applications for permits to appropriate water for irrigation in Western Washington is now approximately equal to those received from Eastern Washington.

Cost of Irrigation Projects: Engineering studies have been made in more or less detail of most of the possible projects, and these studies indicate that a few of the smaller developments may be built at a cost of \$50.00 to \$100.00 per acre; but that the larger projects, including the Horse Heaven, new divisions of the Yakima, the Quincy and the Columbia Basin Projects, will probably cost \$150.00 and upward per acre. This figure seems high when compared to the earlier projects, the cost of which ranged from \$60.00 to \$100.00 per acre, but the cost is really not excessive if the land can be placed in the hands of actual settlers at its real value, and the lands brought to production gradually, and not so rapidly as to injure or destroy potential markets.

The principal reasons for the increased cost are as follows:

1. The land closest to the streams has all been developed. Much longer canals over rougher country, with frequent tunnels, are required to reach lands in the remaining projects.
2. The low water flow of all streams available for irrigation is already appropriated. Storage reservoirs, generally quite expensive, will be required for future developments.
3. The cost of labor and materials is now two to three times what it was when the first canals were built.

Crop reports of the U. S. Bureau of Reclamation give Washington first rank in returns per acre, and if our irrigation development is carried on at a rate commensurate with the demand for its products, it is probable that all of the area above mentioned may be profitably reclaimed, and that its reclamation will add immensely to the wealth and prosperity of the state.

The following tabulation shows by counties the area of irrigated and irrigable lands in the state:

COUNTY	Irrigated Land	Irrigable Land
Asotin.....	4,600	.....
Adams, exclusive of Columbia Basin.....	3,000	1,000
Benton.....	50,000	304,400
Chelan.....	35,000	15,000
Clallam.....	10,500	10,000
Columbia.....	4,000	1,000
Douglas.....	7,100	26,000
Ferry.....	2,600	16,000
Franklin, exclusive of Columbia Basin.....	3,000	2,000
Garfield.....	1,000	2,000
Grant, exclusive of Columbia Basin.....	8,000	1,000
Kittitas.....	75,000	89,000
Klickitat.....	12,500	29,000
Lincoln.....	3,800	1,000
Okanogan.....	40,900	42,800
Pend Oreille.....	3,000	3,000
Skamania.....	1,000	4,500
Stevens.....	15,000	10,200
Spokane.....	17,000	10,000
Thurston.....	2,000	5,000
Walla Walla.....	30,000	50,000
Yakima.....	250,600	163,000
Western Washington Scattering Developments.....	18,000	.....
Total exclusive of Columbia Basin.....	597,600	785,900
Columbia Basin.....	.....	1,800,000
Grand Total.....	.....	2,585,900

Water Power.

No area in the United States offers more favorable opportunity for development of water power than the slopes of the Cascade and Olympic mountain ranges in Washington. The general elevation of these high ranges is from 3,000 to 8,000 feet above sea level, with four high glacial peaks from 10,000 to 14,000 feet in elevation.

The streams draining these areas reach sea level in a comparatively short distance, making available the rapid fall essential for economical development of water power. Another feature which adds greatly to the value of these streams for power development is the heavy precipitation in the mountains, ranging from 80 to 140 inches annually. The winter precipitation forms snow fields and glaciers insuring an abundant water supply and a well-maintained flow during the summer season.

For maximum development on most streams, however, some storage is desirable, and good storage sites are available in connection with most of the power streams. Climatic conditions are such that ice has never been known to cause interruption in the operation of hydro-electric plants on the Western Slope, and as most of the power streams are within the humid portion of the state there is no conflict with irrigation development.

There are sixty-nine hydro-electric plants in operation at the present time with enlargements or extensions planned to several others. The principal developments during the biennium are briefly noted as follows:

City of Seattle—Skagit River project. First unit of 50,000 horsepower completed. Ultimate development to be 350,000 horsepower. Second unit

consisting of the development of about 100,000 horsepower at Diablo Canyon was commenced during the biennium and is now well under way. The city is also building a new 20,000 horsepower unit at Cedar Falls and a unit of 37,500 horsepower at the Skagit River Gorge plant.

Chelan Electric Company—At Chelan Falls, with 600,000 acre feet of storage, in Lake Chelan. First two units of 68,000 horsepower have been completed during the biennium. Ultimate development to be 136,000 horsepower.

The Northwestern Power & Light Co. has completed the construction of an additional plant on Elwha River in Clallam County with a capacity of 20,000 horsepower.

Engineering investigations are still in progress looking toward development of upwards of 100,000 horsepower on the Cowlitz River between Mayfield and the mouth of the Cispus River.

DEVELOPED WATER POWER IN THE STATE OF WASHINGTON.

Plants Under Operation.

Note: Numbers refer to location on the map.

No.	COUNTY	STREAM	LOCATION		Developed Horse-power	HEAD	OWNERSHIP
			Section	Twp. Range			
1	Pend Oreille	Sullivan Creek	22	39 N. 43 E.	6,000	400	Inland Portland Cement Co.
2	Stevens	Colville River	29	36 N. 38 E.	1,600	133	Stevens County Power & Light Co.
3	Ferry	O'Brien Creek	35	36 N. 33 E.	1,500	75	Republic Light and Power Co.
4	Pend Oreille	North Fork Callispel Creek	26	32 N. 43 E.	500	369	Washington Water Power Co.
5	Stevens	Jump-off Joe Creek	2	31 N. 40 E.	300	85	Kulzer Electric System.
6	Spokane	Little Spokane River	2	31 N. 43 E.	3,000	16-24	Mount Spokane Power Co.
7	Spokane	Spokane River	11	25 N. 43 E.	3,800	24	Spokane Municipal Water Supply.
8	Spokane	Spokane River, Upper Falls	18	25 N. 43 E.	13,400	65	Washington Water Power Co.
9	Spokane	Spokane River, Lower Falls	18	25 N. 43 E.	11,800	64-74	Washington Water Power Co.
10	Spokane	Spokane River, Ninemile Falls	6	26 N. 42 E.	16,000	58	Washington Water Power Co.
11	Lincoln	Spokane River, Long Lake	13	27 N. 39 E.	94,000	172	Washington Water Power Co.
12	Stevens	Spokane River, Little Falls	20	27 N. 39 E.	32,800	73	Washington Water Power Co.
13	Okanogan	Smilkameen River	13	40 N. 26 E.	2,500	79	Washington Water Power Co.
14	Chelan	Chelan River	.....	27 N. 23 E.	68,000	378	Chelan Electric Co.
15	Okanogan	Methow River	2	34 N. 21 E.	100	43	Upper Methow Valley Light & Power Co.
16	Okanogan	Twisp River	12	33 N. 21 E.	171	33-26	Twisp Light & Power Co.
17	Okanogan	Twisp River	8	33 N. 22 E.	172	21	Twisp Roller Mills & Power Co.
18	Adams	Palouse River	6	14 N. 37 E.	95	29	G. W. Glidersleeve.
19	Walla Walla	Snake River	30	9 N. 31 E.	1,000	10	Burbank Irrigation District.
20	Benton	Yakima River, Sunnyside Canal	30	9 N. 25 E.	2,000	77	United States Bureau of Reclamation.
21	Benton	Yakima River, Sunnyside Canal	26	9 N. 24 E.	200	52	United States Bureau of Reclamation.
22	Benton	Yakima River, Sunnyside Canal	30	9 N. 24 E.	200	21	United States Bureau of Reclamation.
23	Yakima	Yakima River, Sunnyside Canal	27	9 N. 23 E.	200	73	United States Bureau of Reclamation.
24	Yakima	Yakima River, Sunnyside Canal	9	10 N. 22 E.	800	46	United States Bureau of Reclamation.
25	Yakima	Yakima River, Sunnyside Canal	2	9 N. 22 E.	500	63	United States Bureau of Reclamation.
26	Yakima	Columbia River	23	13 N. 18 E.	2,000	26	Pacific Power & Light Co.
28	Yakima	Naches River	23	13 N. 18 E.	500	38	Pacific Power & Light Co.
29	Yakima	Naches River	13	14 N. 17 E.	10,100	151	Pacific Power & Light Co.
30	Yakima	Naches River	3	14 N. 17 E.	1,900	63	Pacific Power & Light Co.
31	Klickitat	Spring Creek	19	4 N. 15 E.	250	285	Pacific Power & Light Co.
32	Klickitat	White Salmon River	30	4 N. 11 E.	100	15	Pacific Power & Light Co.
33	Klickitat	White Salmon River	10	3 N. 10 E.	18,000	168	Northwestern Electric Co.
34	Klickitat	White Salmon River	24	6 N. 10 E.	300	10	Tront Lake Power and Light Co.
35	Kittitas	Yakima River	32	18 N. 18 E.	1,600	52	City of Ellensburg.
36	Chelan	Wenatchee River	10	24 N. 17 E.	180	180	Washington Coast Utilities.
37	Chelan	Wenatchee River	10	24 N. 17 E.	7,000	187	Great Nor. Ry. (Wash. Elec. Co., agent).
38	Chelan	Wenatchee River	26	24 N. 18 E.	3,284	155	Puget Sound Power and Light Co.

DEVELOPED WATER POWER IN THE STATE OF WASHINGTON—Continued.
Plants Under Operation.

Note: Numbers refer to location on the map.

No.	COUNTY	STREAM	LOCATION		Developed Horse-power	HEAD	OWNERSHIP	
			Section	Twp. Range				
39	Chelan.....	Entiat River.....	18	25 N.	1,474	78	Puget Sound Power and Light Co.	
40	Whatcom.....	North Fork Nooksack River.....	31	40 N.	2,346	175	Puget Sound Power and Light Co.	
41	King.....	Baker River.....	2	35 N.	53,620	215	Puget Sound Power and Light Co.	
42	King.....	Snoqualmie River.....	19	8 E.	13,404	280	Puget Sound Power and Light Co.	
43	Pierce.....	Snoqualmie River.....	30	24 N.	13,404	260	Puget Sound Power and Light Co.	
44	Pierce.....	White River.....	7	5 E.	80,432	460	Puget Sound Power and Light Co.	
45	Thurston.....	Puyallup River.....	4	17 N.	26,800	865	Puget Sound Power and Light Co.	
46	Clark.....	Deschutes River.....	20	18 N.	2,210	84	Puget Sound Power and Light Co.	
47	Cowlitz.....	Kalama River.....	7	0 N.	1,805	40	Puget Sound Power and Light Co.	
48	Clark.....	Big Tree Creek.....	1	3 E.	110	148	C. R. Miller.	
49	Clark.....	Washougal River.....	32	4 E.	204	15	Western Light & Power Co.	
50	Clark.....	Washougal River.....	5	4 E.	200	12-15	C. W. Cottrell.	
51	Lewis.....	Tilton River.....	4	1 N.	75	13	Morton Electric Co.	
52	Pierce.....	Paradise River.....	22	15 N.	1,329	190	Rainier National Park Co.	
53	Pierce.....	Evans Creek.....	34	18 N.	175	450	Montezuma Coal Mining Co.	
54	Mason.....	Nisqually River.....	32	16 N.	22,000	425	City of Tacoma.	
55	Mason.....	Skokomish River.....	5	22 N.	50,000	200	City of Tacoma.	
56	Mason.....	Goldsborough Creek.....	24	18 N.	189	15	Shelton Light and Power Co.	
57	Grays Harbor.....	Sylvia Creek.....	31	20 N.	268	65	Puget Sound Power and Light Co.	
58	Pacific.....	Elwha River.....	15	14 N.	200	500	Willapa Power Co.	
59	Challam.....	Elwha River.....	15	30 N.	16,000	100	Northwestern Power and Manufacturing Co.	
60	Challam.....	Bear Creek.....	17	29 N.	20,000	200	Northwestern Power and Manufacturing Co.	
61	Whatcom.....	Newhalem Creek.....	11	36 N.	2,700	420	Superior Portland Cement Co.	
62	Whatcom.....	Skagit River.....	28	37 N.	2,000	555	City of Seattle.	
63	Whatcom.....	Skagit River.....	21	37 N.	50,000	250	City of Seattle.	
64	King.....	Cedar River.....	3	22 N.	33,000	618	City of Seattle.	
65	King.....	Lake Union.....	.....	.....	2,000	410	City of Seattle.
66	Snohomish.....	McCoy Creek.....	7	27 N.	150	250	Puget Sound Power and Light Co.	
67	Snohomish.....	Pilchuck Creek.....	19	30 N.	80	18	Puget Sound Power and Light Co.	
68	Snohomish.....	Jim Creek.....	31	6 E.	268	65	Puget Sound Power and Light Co.	
69	Snohomish.....	Olney Creek.....	36	28 N.	550	152	Great Northern Power Company.	
70	Yakima.....	Reservation Canal.....	.....	.....	.....	.....	U. S. Indian Irrigation Service.
71	Total Developed Horsepower					708,435	21	

PARTIAL TABULATION OF UNDEVELOPED POWER SITES IN THE STATE OF WASHINGTON.

The following tabulation of potential power sites is by no means intended as a complete inventory of the State's power resources, but rather as a conservative enumeration of the principal sites which are known to exist and which have received sufficient investigation to indicate with a degree of certainty their potential value. There are, therefore, unquestionably many excellent sites not included in this tabulation, and likewise it may be found upon detailed study that any individual site or group of sites may be capable of developing a greater or lesser amount of power than here shown or may even for physical or economic reasons for the present, at least, prove entirely non-feasible. The definite determination of the physical and economic feasibility of a power project ordinarily requires a great deal of costly study, and such determination is not within the present scope of this office.

Note: Numbers refer to location on the map.

No.	STREAM	FLOW	COUNTY	Available Power
				50% of Time at 70% Efficiency H. P.
1	Nooksack River—South Fork.....	Regulated	Whatcom.....	22,000
2	Skagit River—			
3	Gorge Creek Site.....	Regulated.....	Whatcom.....	270,000
4	Ruby Creek and Diablo Canyon Sites.....	Regulated.....	Whatcom.....	520,000
5	County Line	Regulated.....	Whatcom.....	40,000
6	Below Baker River.....	Regulated.....	Skagit.....	60,000
7	Cascade River	Regulated.....	Skagit.....	50,000
8	Sauk River Water Shed.....	Unregulated.....	Snohomish.....	225,000
9	Stlagnamish—South Fork.....	Regulated.....	Snohomish.....	30,000
10	Pilchuck and Deer Creeks.....	Regulated.....	Snohomish.....	20,000
11	Sultan River and Wallace River.....	Regulated.....	Snohomish.....	80,000
12	Skykomish River—North and South Forks.....	Partly Regulated.....	Snohomish.....	45,000
13	Foss River	Regulated.....	King.....	25,000
14	Miller Creek	Regulated.....	King.....	15,000
15	Snoqualmie River—North Fork.....	Unregulated.....	King.....	20,000
16	Snoqualmie River—South Fork.....	Unregulated.....	King.....	15,000
17	White River—Upper River.....	Partly Regulated.....	King.....	75,000
18	Puyallup River (below Electron).....	Unregulated.....	Pierce.....	16,000
19	Nisqually River (below LaGrande).....	Unregulated.....	Pierce.....	10,000
20	Skokomish River, North Fork, Hoods Canal Plant.....	Regulated.....	Mason.....	111,000
	Skokomish River, South Fork (Developed in connection with North Fork).....	Regulated.....	Mason.....	35,000
21	Lilliwaup River	Regulated.....	Mason.....	1,500
22	Hamma Hamma River.....	Regulated.....	Mason.....	7,500
23	Dosewallips River	Partly Regulated.....	Jefferson.....	30,000
24	Dungeness River	Unregulated.....	Clallam.....	4,000
25	Elwha River (Glines Canyon Dev.).....	Regulated.....	Clallam.....	16,500
26	Lyre River	Partly Regulated.....	Clallam.....	6,500
27	Hoh River (Big Bend Site).....	Regulated.....	Jefferson.....	33,000
28	Hoh River, Upper Hoh.....	Partly Regulated.....	Jefferson.....	24,000
29	Queets River	Partly Regulated.....	Jefferson.....	16,000
30	Quinalt River	Partly Regulated.....	Grays Harbor.....	10,000
31	Wynooche River	Regulated.....	Grays Harbor.....	20,000
	Cowlitz River—			
32	Mayfield Site	Regulated.....	Lewis.....	33,000
33	Mossy Rock Site	Regulated.....	Lewis.....	80,000
34	Big Bend Site	Regulated.....	Lewis.....	16,500
35	Cispus River	Partly Regulated.....	{Skamania and Lewis.....	40,000
36	Toutle River (Silver Lake Plan).....	Regulated.....	Cowlitz.....	30,000
37	Lewis River (Various sites above Yale).....			60,000
38	Lewis River (Yale Site).....	Partly Regulated.....	Cowlitz.....	42,000
39	Lewis River (Ariel Site).....			20,000
40	Kalama River	Unregulated.....	Cowlitz.....	30,000
41	White Salmon River—Various Sites.....	Unregulated.....	Klickitat.....	70,000
42	Klickitat River—Lower eight miles.....	Unregulated.....	Klickitat.....	4,000
43	Snake River—Five Mile Rapids.....	Unregulated.....	{Walla Walla and Franklin.....	100,000
44	Yakima River—Union Gap		Yakima.....	30,000
45	Yakima River Water Shed (other sites doubtful due to regulation for irrigation).....			

PARTIAL TABULATION OF UNDEVELOPED POWER SITES IN THE STATE OF WASHINGTON—Continued.

Note: Numbers refer to location on map.

No.	STREAM	FLOW	COUNTY	Available Power
				50% of Time at 70% Efficiency H. P.
46	Icele Creek .....	.....	Chelan.....	.....
47	Chiwawa River	Regulated.....	Chelan.....	10,000
48	Railroad Creek and Dumpky Lake.....	Partly Regulated.	.....	.....
49	Clark Fork at Z Canyon.....	Regulated.....	Pend Oreille...	260,000
50	Sheep Creek	Regulated.....	Stevens.....	5,000
	Columbia River at—			
51	Little Dalles	Regulated.....	Stevens.....	242,000
52	Kettle Falls	Regulated.....	Stevens.....	323,000
53	Grand Coulee	Regulated.....	Grant.....	1,170,000
54	Foster Creek	Regulated.....	Douglas.....	873,000
55	Rock Island Rapids	Regulated.....	Douglas.....	400,000
56	Priest Rapids	Regulated.....	Yakima.....	508,000
57	*Umatilla Rapids	Regulated.....	Benton.....	263,000
58	*The Dalles	Regulated.....	Klickitat.....	489,000
59	*Cascade	Regulated.....	Skamania.....	230,000

NOTE.—In estimating power available from streams in Eastern Washington due regard is had to their present and future utilization for irrigation.

*H. P. shown represents one-half of that available at site; other half credited to Oregon.

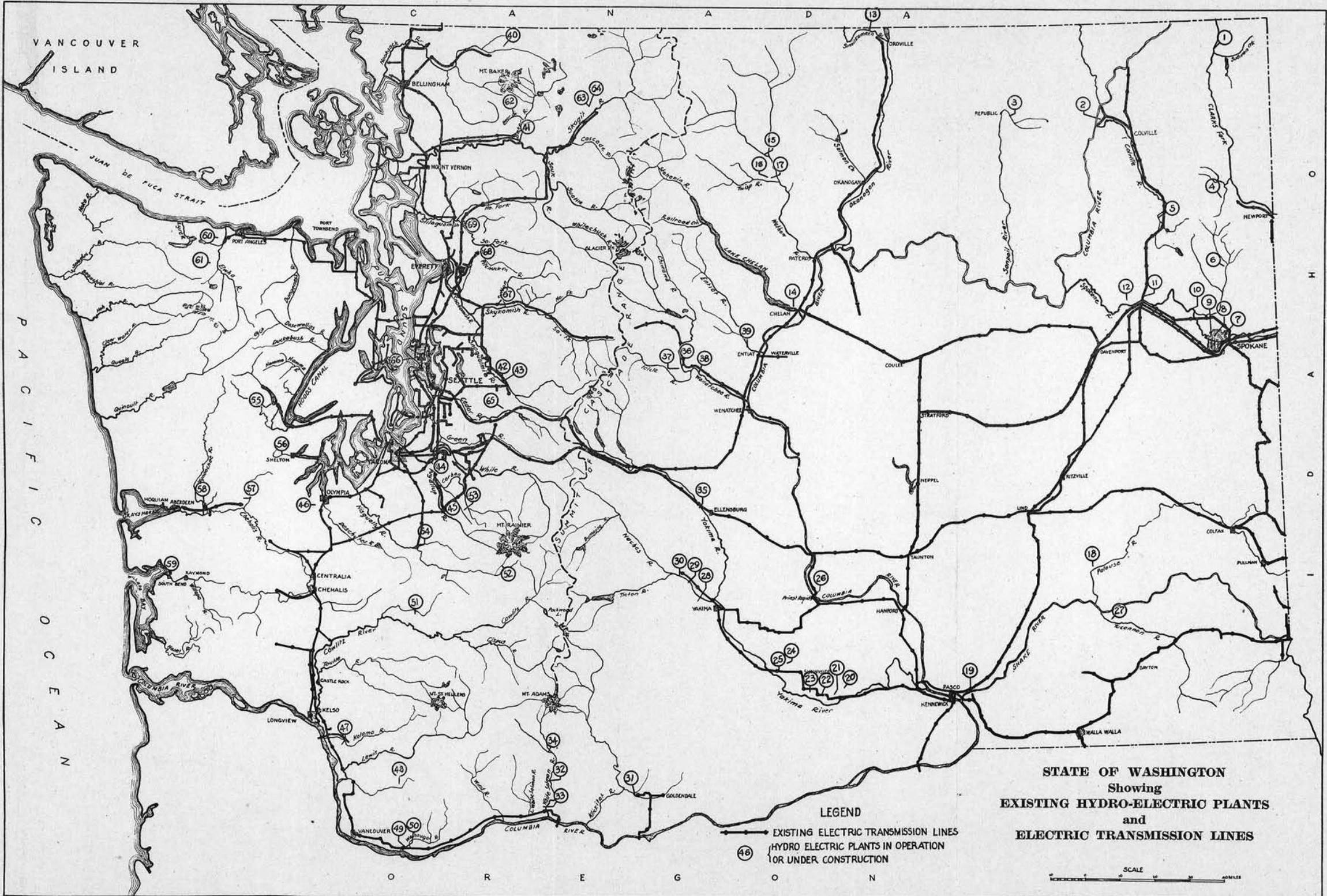
Recommended Legislation to Curb Speculative Power Filings.

It is believed that an annual license fee, which might be charged against all power projects, developed and undeveloped, would quickly eliminate most of the speculative power claims now remaining. Such a measure would produce an annual revenue of \$25,000 to \$50,000, which could be advantageously used for securing basic information in regard to the power resources of the state and other resources that might furnish industrial load for power development.

NEW WATER RIGHTS UNDER WATER CODE.

Any person who desires to initiate a right to appropriate or store water for a beneficial use may do so by filing an application in the office of the Supervisor, using the printed forms, which are furnished on request, together with a map showing points of proposed diversion and place of use. The applicant is required to publish notice of his proposed appropriation in a local newspaper and investigation is made on the ground by the Supervisor or his representative to determine whether there is public water available for appropriation, whether the appropriation sought is for a beneficial use and whether or not it will conflict with existing rights. This often entails a survey of the stream to determine what other uses are being made of its water.

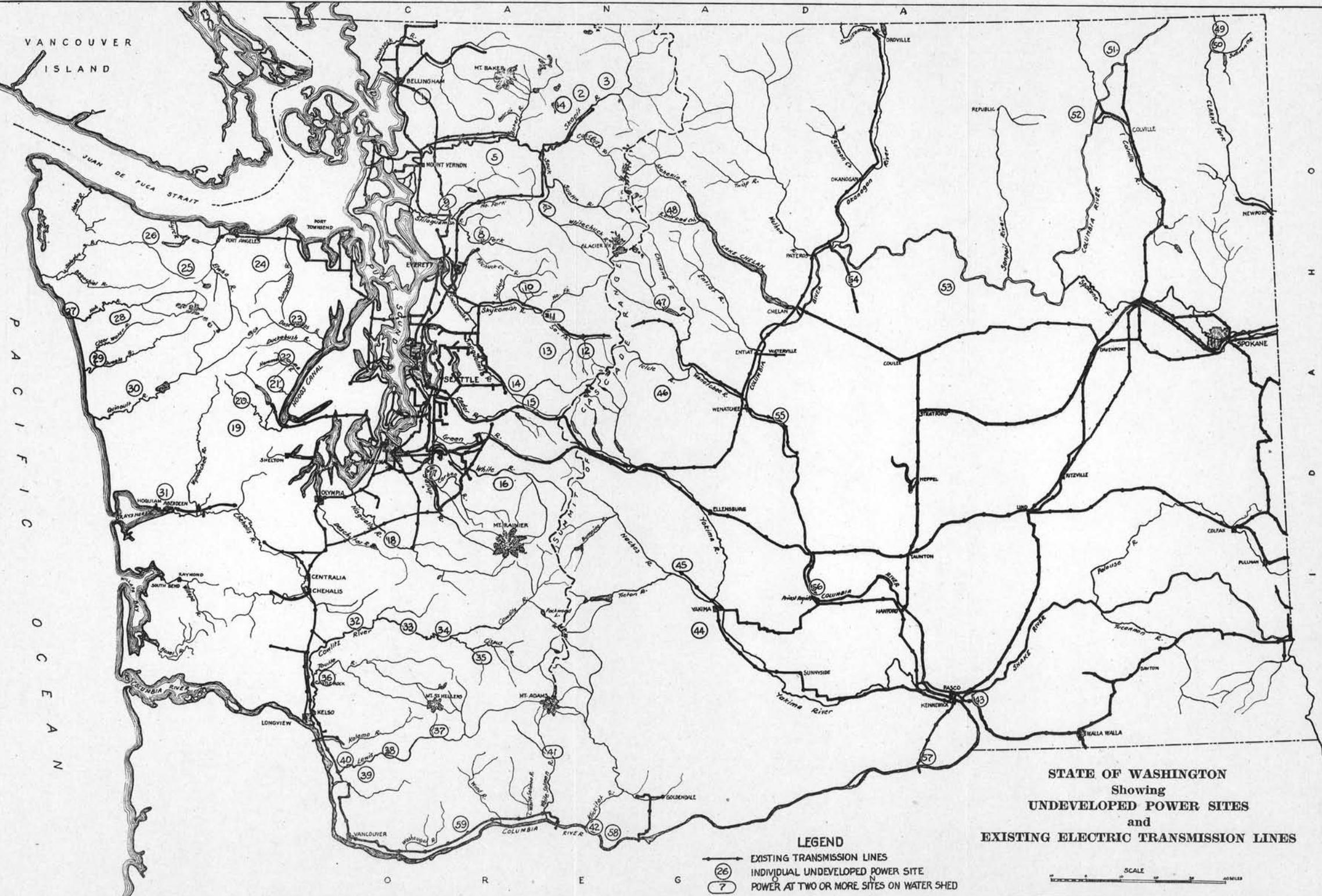
When large projects or streams of importance are involved, a careful study is made in order that the public interest may be protected. In case of two or more conflicting applications on the same stream, permit is issued to the applicant who proposes to make the highest feasible use of the public water, and it is within the discretion of the Supervisor to refuse to issue permit if the use proposed threatens to prove detrimental in any way to public interest,



STATE OF WASHINGTON
 Showing
 EXISTING HYDRO-ELECTRIC PLANTS
 and
 ELECTRIC TRANSMISSION LINES

LEGEND
 ———— EXISTING ELECTRIC TRANSMISSION LINES
 ○ 46 — HYDRO ELECTRIC PLANTS IN OPERATION
 OR UNDER CONSTRUCTION

SCALE
 0 10 20 30 40 MILES



STATE OF WASHINGTON
 Showing
 UNDEVELOPED POWER SITES
 and
 EXISTING ELECTRIC TRANSMISSION LINES

LEGEND
 ——— EXISTING TRANSMISSION LINES
 (26) INDIVIDUAL UNDEVELOPED POWER SITE
 (7) POWER AT TWO OR MORE SITES ON WATER SHED

SCALE
 0 10 20 30 40 50 MILES

having in mind the ultimate development of the highest feasible use of the waters belonging to the public.

If conditions warrant, permit is issued, fixing dates for beginning and completion of the project. These times may be extended for good reasons, but if the applicant does not show good faith, application or permit may be cancelled and the water then reverts to the State. On completion of the development and proof of application of water to beneficial use, a Certificate of Water Right is issued. This certificate is recorded in the office of the Supervisor and also of the Auditor of the County in which the project is located and is of similar effect to a land patent or deed.

Where prior appropriations of water are found, but it appears that some water at least is available for the use proposed, permits are sometimes issued, specifically subject to existing rights so that the permittee may not be misled.

RECORD OF APPLICATIONS AND PERMITS DURING THE BIENNIUM.

During the biennium 539 applications for permits to appropriate water have been received; 469 applications have been approved and permits issued, and development under 158 permits has been completed and final Water Right Certificates issued.

Since the office was established in 1917, 2,432 applications have been filed; 530 cancelled; 1,264 permits granted; 638 applications are now pending, and construction under 292 permits has been completed and final certificates issued thereunder.

WATER RIGHT APPLICATIONS, VARIOUS USES.

The amendment to the Water Code recommended by the Department and passed by the Legislature of 1925, requiring substantial examination fees based upon the amount of water applied for, accomplished two important results. First, it has very largely eliminated speculative power filings, of which there were always hundreds pending so long as the fee was fixed at \$5.00. Second, it has greatly increased the revenues of the division and so justified more careful and comprehensive study of important applications than was before possible.

Of the applications filed during the biennium 70 were for hydro-electric development and 28 permits have been issued for that purpose. Of these only 7 permits were for the development of over 100 horsepower. One of these permits was for a municipal project, two were issued to public utilities and the rest were issued to individuals and private corporations. Forty-four applications and 22 permits were for municipal water supply. Applications in these two classes are published in detail on the following pages.

For irrigation rights, amounting to 1 cubic foot per second or more, 72 applications were filed and 60 permits issued; for fish culture 12 applications and 12 permits.

Mining, manufacturing and miscellaneous uses accounted for 61 applications and 19 permits. Developments under these applications included hydraulic sluicing, milling of ore, washing sand and gravel, logging flumes, and paper and pulp mills.

The remaining 280 applications received during the biennium were mostly for private water supply systems for domestic and irrigation uses.

Note: In the tabulations on the following pages information is given regarding the more important applications for permits to appropriate and store water for power, municipal, irrigation and industrial uses. The less important applications for domestic and small irrigation use are omitted as they are not of general interest.

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER.
Power.

APP. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Estimated Theoretic H. F.	Per- mit No.	Cert. No.	REMARKS
				Sec.	Twp. R'ge					
33	City of Seattle.....	Skagit River	800	21	37 N. 12 E.	\$4,000,000	28,000	5	.....
36	Frank Leish.....	Company Creek	6	21	33 N. 17 E.	1,000	100	40	.....
212	Grant A. Stewart.....	Big Boulder Crk.....	50	35	36 N. 39 E.	1,000	124	83	.....
233	J. J. Hewitt.....	Puyallup River	400	33	18 N. 5 E.	750,000	12,700	77	.....
240	Western Wash. Land & Irrig. Co.	South Fork Jenkins Creek	50	31	22 N. 6 E.	50,000	100	339	.....
251	Peter Klavano, et al.....	Waits Lake	25	17	31 N. 40 E.	25,000	200	503	74	
326	Peter Klavano, et al.....	Waits Lake Res.....	600 a.f.	17	31 N. 40 E.	5,000	.....	R. 26	.....	Reservoir for storage of water under Permit 504. Exclusively for irrigation purposes. Wks. completed.
281	Methow Valley Irrig. Dist..	Methow River	150	25	34 N. 21 E.	20,000	375	113	.....
310	Nippon Lumber Co.....	Tye River	100	26	26 N. 12 E.	10,000	454	.....	.....
332	Good Hope Gold & Copper Mining & Developm't Co..	Silver Lake and E. Fork Silver Crk....	5	28	29 N. 11 E.	5,000	330	120	.....
353	Good Hope Gold & Copper Mining & Developm't Co..	Silver Lake Res.....	900 a.f.	28	29 N. 11 E.	3,000	.....	R. 6	.....	Reservoir for storage of water under Permit 120. First step of development completed—50,000 H. P.
353	City of Tacoma.....	Skokomish River	1,000	5	22 N. 4 W.	6,000,000	75,000	252	.....	Reservoir for storage of water under Permit 252.
354	City of Tacoma.....	North Fork Lake Cushman Res.	190,000 a.f.	5	22 N. 4 W.	1,768,000	.....	R. 18	.....	Reservoir for storage of water under Permit 252.
365	J. M. Reece.....	Dan's Creek	100	8	32 N. 10 E.	2,000	100	162	.....	Development completed.
394	City of Seattle.....	Newbalem Creek	150	28	37 N. 12 E.	200,000	145	38	.....	Development completed.
420	Callispel Lt. & Power Co..	Callispel Creek	20	27	32 N. 43 E.	40,000	680	158	35	
431	Callispel Lt. & Power Co..	North Fork	10,000 a.f.	27	32 N. 43 E.	80,000	.....	R. 13	.....	Reservoir for storage of water under Permit 158.
432	City of Seattle.....	Skagit R., Steftattle Crk & Thunder Crk	3,500	Unsurveyed	Unsurveyed	25,000,000	286,000	181	.....	First step of development completed—50,000 H. P.
433	City of Seattle.....	Skagit River	3,500	Unsurveyed	Unsurveyed	10,000,000	153,000	166	.....	Reservoir for storage of water under Per. 166 & 181
434	City of Seattle.....	Ruby Reservoir	1,000,000 a.f.	Unsurveyed	Unsurveyed	6,000,000	.....	R. 11	.....	Reservoir for storage of water under App. 433.
439	W. D. Shannon.....	Skykomish River	1,000	27	27 N. 10 E.	5,000,000	42,613	.....	.....	Reservoir for storage of water under App. 433.
440	W. D. Shannon.....	South Fork Lake Dorothy Res..	26,000 a.f.	Unsurveyed	Unsurveyed	.....	.....	.....	.....	Reservoir for storage of water under App. 433.
459	Mt. Spokane Power Co....	Otter Creek	50	24	29 N. 43 E.	4,600	369	.....	.....	Temporary permit issued.
466	Spirit Lake Ry. & Pr. Co..	Toutle River	10,000	15	9 N. 5 E.	3,000,000	732,954	.....	.....	.....
535	Big West Copper Syn.....	Litchy Creek	38	Unsurveyed	Unsurveyed	15,000	864	.....	.....	.....
536	Big West Copper Syn.....	Litchy Creek	100	Unsurveyed	Unsurveyed	100,000	4,545	.....	.....	.....
537	Big West Copper Syn.....	Big Western Creek..	38	Unsurveyed	Unsurveyed	15,000	864	.....	.....	.....

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER—Continued.
Power.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Estimated Theoretic H. P.	Permit No.	Cert. No.	REMARKS
				Sec.	Twp. R'ge					
546	Sam Samson	Falls Creek	25	14	5 N. 7 E.	.....	1,500	510	.....	To be operated in connection with existing plant on Rock Creek.
553	Riverside Irrig. Dist.....	Okanogan River ...	2,000	20	36 N. 27 E.	\$300,000	5,681	.....	.....	Plan to develop power for pumping water for irrigation.
560	Spirit Lake Ry. & Pr. Co...	Toutle River	1,300	20	10 N. 1 W.	.....	16,363	.....	.....	Temporary permit issued.
560a	Spirit Lake Ry. & Pr. Co...	Toutle River	600	16	10 N. 1 W.	1,500,000	16,363	.....	.....	Temporary permit issued.
560b	Spirit Lake Ry. & Pr. Co...	Toutle River	500	32	10 N. 3 E.	2,500,000	26,136	.....	.....	Temporary permit issued.
560c	Spirit Lake Ry. & Pr. Co...	Toutle River	400	2	9 N. 4 E.	3,000,000	36,363	.....	.....	Temporary permit issued.
560d	Spirit Lake Ry. & Pr. Co...	Green River	300	1	10 N. 2 E.	700,000	8,523	.....	.....	Temporary permit issued.
561	Spirit Lake Ry. & Pr. Co...	Spirit Lake Res.....	80,000 a.f.	15	9 N. 5 E.	.....	.....	.....	.....	Reservoir for storage of water under Apps. 466, 560, 560a, 560b, 560c and 560d.
577	James Campbell	Hoko River	550	12	31 N. 14 W.	250,000	6,375	.....	.....	Part of general scheme to divert Hoko River for power and log booming. Cont. let for construction.
590	Okanogan Pr. & Light Co..	Similkameen River..	500	20	40 N. 27 E.	280,000	3,409	.....	.....	Reservoir for storage of water under App. 500.
591	Okanogan Pr. & Light Co..	Similkameen R. Res.	2,500 a.f.	20	40 N. 27 E.	.....	.....	.....	.....
601	Fred M. Mitchell.....	Stranger Creek	10	12	32 N. 36 E.	10,000	275	259	.....
606	J. L. Keeler.....	Dungness River.....	.....	12	29 N. 4 W.	100,000	750	.....	.....
607	J. L. Keeler.....	Dungness River.....	.....	13	29 N. 4 W.	75,000	750	.....	.....
611	Peoples West Coast Hydro-Elec. Corp.	Naselle River.....	1,000	31	11 N. 8 W.	250,000	14,772	833	.....
646	City of Prosser.....	Yakima River.....	350	2	8 N. 24 E.	100,000	1,114	.....	.....	Temporary permit.
691	E. M. Chandler.....	Hamma Hamma R.	600	16	24 N. 3 W.	1,000,000	27,273	1015	.....	Reservoir for storage of water under App. 691.
1616	E. M. Chandler.....	Hamma Hamma Rs	100,000 a.f.	16	24 N. 3 W.	750,000	.....	.....	.....	Combined water supply and power development authorized and bonds voted.
693	City of Aberdeen.....	Wynooche River....	600	1	21 N. 8 W.	.....	25,000	247	.....	Reservoir for storage of water under Permit 247.
694	City of Aberdeen.....	Weatherwax Basin Res.....	80,000 a.f.	1	21 N. 8 W.	.....	.....	R. 16	.....	Project completed.
705	Upper Methow Valley Light & Power Co.....	Methow River.....	50	4	34 N. 21 E.	10,000	244	819	.....	Temporary permit issued.
708	Wash. Water Power Co.....	Columbia River.....	50,000 a.f.	2, 11	36 N. 37 E.	20,000,000	426,126	.....	.....	Reservoir for storage of water under App. 708.
709	Wash. Water Power Co.....	Kettle Falls Res....	60,000 a.f.	2, 11	36 N. 37 E.	.....	.....	.....	.....
811	C. H. Baskdull.....	Unnamed stream ..	8.13	19	39 N. 23 E.	5,000	1,169	.....	.....	Temporary permit issued.
822	Cascade Electric Co.....	Cowlitz River.....	1,000	6	11 N. 6 E.	2,000,000	22,727	.....	.....

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER—Continued.
Power.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Estimated Theoretic H. P.	Permit No.	Cert. No.	REMARKS
				Sec.	Twp. R'ge					
887	Delta Elec. & Water Co.....	Pilehuck Creek.....	650	15	32 N. 5 E.	\$200,000	553	388	.....	Company started construction work but went into hands of receiver. Feasibility of project doubtful. Reservoir for storage of water under Permit 388. Works completed. Power operates sawmill. Extensive surveys completed. plans in preparation under preliminary permit. Reservoir for storage of water under App. 885.
888	Delta Elec. & Water Co.....	Pichuck Creek Res.	14,000 a.f.	15	32 N. 5 E.	200,000	.....	R. 21	.....	Reservoir for storage of water under App. 887.
884	Palm & Son.....	Deep Creek.....	62	14	39 N. 40 E.	1,000	125	384	.....	Reservoir for storage of water under App. 886.
885	E. W. Backus.....	Cowlitz River.....	3,500	29	12 N. 2 E.	650,000	43,750	.....	.....	Extensive surveys completed. plans in preparation under preliminary permit. Reservoir for storage of water under App. 885.
1516	E. W. Backus.....	Mayfield Reservoir..	730,000 a.f.	29	12 N. 2 E.	.....	.....	.....	.....	Reservoir for storage of water under App. 887.
897	Stirling B. Hill.....	Nooksack River... S. Fork	1,000	27	37 N. 5 E.	2,000,000	32,954	.....	.....	Reservoir for storage of water under App. 887.
899	Stirling B. Hill.....	South Fork Res.....	30,000 a.f.	35	37 N. 5 E.	150,000	.....	.....	.....	Reservoir for storage of water under App. 886.
898	Stirling B. Hill.....	Whatecom Creek....	200	30	38 N. 3 E.	400,000	6,591	.....	.....	Reservoir for storage of water under App. 886.
900	Stirling B. Hill.....	Lake Whatcom Res	65,000 a.f.	28	38 N. 3 E.	100,000	.....	.....	.....	Reservoir for storage of water under App. 886.
916	Superior Portland Cement Co.	Jackman Creek....	55	8	35 N. 9 E.	175,000	4,250	.....	.....	First step of development completed—65,000 H. P. Reservoir for storage of water under Permit 413
956	Edward A. Smith.....	Twenty-five Mile Cr	10	33	29 N. 20 E.	2,000	170	.....	.....	First step of development completed—10,227 H. P. Encroachment under way to 16,500 H. P.
1010	Puget Sound P. & Lt. Co.	Sultan River.....	400	17	28 N. 8 E.	600,000	4,000	398	.....	Reservoir for storage of water under Permit 617.
1011	Puget Sound P. & Lt. Co.	Baker River.....	4,000	2	35 N. 8 E.	3,500,000	65,000	413	90	.....
1012	Puget Sound P. & Lt. Co.	Lower Baker Res...	50,000 a.f.	2	35 N. 8 E.	1,500,000	.....	R. 24	110	.....
1022	Northwestern Pr. & Lt. Co.	Elwha River.....	600	17	29 N. 7 W.	800,000	10,227	525	.....	Reservoir for storage of water under Permit 625 and Permit 688.
1287	Northwestern Pr. & Lt. Co..	Glines Canyon Res.	15,000 a.f.	17	29 N. 7 W.	800,000	.....	R. 27	.....	Reservoir for storage of water under Permit 617.
1031	Mrs. F. B. Denney.....	Boulder Creek.....	22	36	23 N. 14 E.	10,000	1,875	.....	.....	Power plant completed.
1038	Trout Lake Pr. & Lt. Co....	White Salmon River	350	24	6 N. 10 E.	3,000	300	416	.....	.....
1048	Fort of Kalama.....	Kalama River.....	520	36	7 N. 1 E.	750,000	10,341	.....	.....	.....
1049	Fort of Kalama.....	Swift Creek.....	180	16	7 N. 5 E.	1,300,000	16,363	.....	.....	.....
1050	Fort of Kalama.....	Kalama River.....	300	7	7 N. 4 E.	2,000,000	23,863	.....	.....	.....
1085	Sultan Electric Co.....	May Creek.....	25	36	28 N. 9 E.	500,000	5,000	617	.....	.....
1086	Sultan Electric Co.....	Lake Isabel Res...	10,000 a.f.	36	28 N. 9 E.	5,000	.....	R. 41	.....	.....

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER—Continued.
Power.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Estimated Theoretic H. P.	Permit No.	Cert. No.	REMARKS
				Sec.	Twp. Rge					
1126	Grays Hbr. Ry. & Lt. Co....	Quinnault River.....	500	24 N.	8 W.	.....	.....	.....	.....	Reservoir for storage of water under App. 1126.
1127	Grays Hbr. Ry. & Lt. Co....	N. Fork North Fork Res.....	30,000 a.f.	24 N.	8 W.	.....	.....	.....	.....	Reservoir for storage of water under App. 1128.
1128	Grays Hbr. Ry. & Lt. Co....	Quinnault R. E. Fork	500	24 N.	7 W.	.....	.....	.....	.....	Reservoir for storage of water under App. 1128.
1129	Grays Hbr. Ry. & Lt. Co....	East Fork Res.....	25,000 a.f.	24 N.	7 W.	.....	.....	.....	.....	Reservoir for storage of water under App. 1130.
1130	E. N. Sanderson.....	Queets River.....	3,000	36	24 N. 13 W.	\$1,000,000	23,181	.....	.....	Reservoir for storage of water under App. 1130.
1131	E. N. Sanderson.....	Fisher Rapids Res....	35,000 a.f.	36	24 N. 13 W.	1,000,000	.....	.....	.....	Reservoir for storage of water under App. 1133.
1132	Grays Hbr. Ry. & Lt. Co....	Queets R., Hee Hee Cr. & Felton Cr....	250	29.31	26 N. 8 W.	.....	.....	.....	.....	Reservoir for storage of water under App. 1133.
1133	Grays Hbr. Ry. & Lt. Co....	Hoh River.....	250	6	25 N. 8 W.	1,600,000	22,812	.....	.....	Reservoir for storage of water under App. 1161.
1134	Grays Hbr. Ry. & Lt. Co....	Lower Basin, Upper Hoh Res.	1,500 a.f.	11	27 N. 8 W.	3,250,000	33,806	.....	.....	Reservoir for storage of water under App. 1161.
1144	A. F. Horton et al.....	Bead Lake.....	150	9	32 N. 45 E.	25,000	2,556	.....	.....	Reservoir for storage of water under App. 1161.
1161	Port of Kalama.....	Kalama River.....	400	28	7 N. 2 E.	1,100,000	11,365	.....	.....	Plant will be operated with an existing plant on McCoy Creek.
1162	Port of Kalama.....	Kalama River.....	1,000 a.f.	36	7 N. 1 E.	250,000	.....	.....	.....	Reservoir for storage of water under Permit 618.
1167	Sultan Electric Co.....	Tomtit Lake, Roesiger Lake & McCoy Creek	6	7	27 N. 8 E.	.....	190	618	107	Plant completed.
1168	Sultan Electric Co.....	Tomtit & Roesiger Lake Reservoir	800 a.f.	21	27 N. 8 E.	.....	.....	R. 42	106	Reservoir for storage of water under App. 1161.
1178	C. W. Cottrell.....	Washougal River.....	300	5	1 N. 4 E.	7,000	250	465	121	Plant completed.
1237	E. N. Sanderson.....	Hoh River.....	2,500	27 N.	12 W.	3,000,000	46,875	.....	.....	Reservoir for storage of water under App. 1237.
1238	E. N. Sanderson.....	Big Bend Res.....	97,000 a.f.	.....	27 N. 12 W.	.....	.....	.....	.....	Reservoir for storage of water under App. 1237.
1255	L. J. Vogter.....	Dosewallips River.....	500	24	26 N. 4 W.	2,000,000	56,818	.....	.....	Reservoir for storage of water under App. 1255.
1256	L. J. Vogter.....	Jump Off Res.....	10,000 a.f.	24	26 N. 4 W.	200,000	.....	.....	.....	Temporary permit issued.
1282	Henry Waldo Coe.....	Tontle River.....	225	2	9 N. 4 E.	1,100,000	17,898	.....	.....	Reservoir for storage of water under App. 1282.
1283	Henry Waldo Coe.....	Spirit Lake Res....	16,125 a.f.	15	9 N. 5 E.	15,000	.....	.....	.....	Reservoir for storage of water under App. 1282.
1288	Chas. T. Wright.....	Kalama River.....	1,000	26	7 N. 2 E.	1,000,000	17,045	.....	.....	Two 34,000 h. p. units installed.
1307	H. L. Gilbert.....	Lewis River.....	2,000	24	7 N. 6 E.	3,000,000	86,363	.....	.....	.....
1324	H. L. Gilbert.....	Cispus River.....	600	8 or 9	10 N. 10 E.	.....	45,450	.....	.....	.....
1325	H. L. Gilbert.....	Cispus River.....	500	17	10 N. 9 E.	.....	58,818	.....	.....	.....
1365	Chelan Electric Co.....	Chelan River.....	4,000	13	27 N. 22 E.	10,000,000	100,000	584	.....	.....

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER—Continued.
Power.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Estimated Theoretic H. P.	Permit No.	Cert. No.	REMARKS
				Sec.	Twp. R'ge					
1366	Chelan Electric Co.	Chelan Lake Res...	640,000 a.f.	13	27 N. 22 E.	.....	.....	R. 37	.....	Reservoir for storage of water under Permit 584. Temporary permit issued.
1371	Startup Water System	Wallace Lakes & Olney Creek	10	20	28 N. 9 E.	.....	1,818	.....	.....	Reservoir for storage of water under App. 1371.
1373	Startup Water System	Startup Water System Res.	150 a.f.	25	28 N. 8 E.	.....	.....	R. 47	.....	Reservoir for storage of water under App. 1375.
1375	H. L. Gilbert	Walupt Lake Creek	1,000	20	11 N. 11 E.	.....	.....	.....	.....	Reservoir for storage of water under App. 1378.
1376	H. L. Gilbert	Walupt Lake Res.	50,000 a.f.	20	11 N. 11 E.	.....	.....	.....	.....	Reservoir for storage of water under App. 1379.
1378	H. W. Crozier	Cowlitz River	1,650	6	11 N. 6 E.	\$8,500,000	43,687	.....	.....	Reservoir for storage of water under App. 1380.
1382	H. W. Crozier	Big Bend Res	10,000 a.f.	6	11 N. 6 E.	50,000	.....	.....	.....	Reservoir for storage of water under App. 1380.
1379	H. W. Crozier	Cowlitz River	4,000	29	12 N. 2 E.	1,500,000	57,272	.....	.....	Reservoir for storage of water under App. 1380.
1381	H. W. Crozier	Mayfield Reservoir	25,000 a.f.	29	12 N. 2 E.	1,500,000	.....	.....	.....	Reservoir for storage of water under App. 1380.
1380	H. W. Crozier	Cowlitz River	4,000	8	12 N. 3 E.	6,000,000	147,727	.....	.....	Reservoir for storage of water under App. 1380.
1382	H. W. Crozier	Mossy Rock Res	25,000 a.f.	8	12 N. 3 E.	1,500,000	.....	R. 36	.....	Reservoir for storage of water under App. 1380.
1544	H. W. Crozier	Mossy Rock Res	1,000,000 a.f.	8	12 N. 3 E.	6,000,000	.....	.....	.....	Reservoir for storage of water under App. 1380.
1393	Lilliwaup Pr. & Water Co.	Lilliwaup River	250	13	23 N. 4 W.	200,000	4,261	.....	.....	Reservoir for storage of water under App. 1383.
1500	Lilliwaup Pr. & Water Co.	Lilliwaup Reservoir	50,000 a.f.	24	23 N. 4 W.	250,000	.....	.....	.....	Reservoir for storage of water under App. 1383.
1453	H. L. Gilbert	Meadow Creek	150	36	7 N. 7 E.	750,000	9,375	.....	.....	Reservoir for storage of water under App. 1453-1454. This project is an alternative to the project under Apps. 1453 and 1454.
1454	H. L. Gilbert	Rush & Hardtime Creeks	200	34	7 N. 7 E.	2,500,000	30,750	.....	.....	Reservoir for storage of water under App. 1457.
1455	H. L. Gilbert	Lone Butte Res	18,000 a.f.	13	7 N. 7 E.	800,000	.....	.....	.....	Reservoir for storage of water under App. 1461.
1455	H. L. Gilbert	Big Creek	150	36	7 N. 7 E.	2,600,000	32,386	.....	.....	Reservoir for storage of water under App. 1457.
1457	H. L. Gilbert	Lewis River	500	18	8 N. 8 E.	1,250,000	15,625	.....	.....	Reservoir for storage of water under App. 1457.
1458	H. L. Gilbert	Quartz Reservoir	84,000 a.f.	17	8 N. 8 E.	1,800,000	.....	.....	.....	Reservoir for storage of water under App. 1461.
1459	H. L. Gilbert	Little Creek	75	27	7 N. 7 E.	705,000	8,812	.....	.....	Reservoir for storage of water under App. 1461.
1460	H. L. Gilbert	Lewis River	300	33	8 N. 7 E.	450,000	6,000	.....	.....	Reservoir for storage of water under App. 1461.
1461	H. L. Gilbert	Muddy River	200	23	8 N. 6 E.	500,000	5,000	.....	.....	Reservoir for storage of water under App. 1461.
1462	H. L. Gilbert	Clearwater Res	12,000 a.f.	23	8 N. 6 E.	300,000	.....	.....	.....	Reservoir for storage of water under App. 1461.
1463	H. L. Gilbert	Cedar Flats Res	15,000 a.f.	24	7 N. 6 E.	300,000	.....	.....	.....	Reservoir for storage of water under App. 1461.

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER—Continued.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Estimated Theoretic H. F.	Permit No.	Cert. No.	REMARKS
				Sec.	Twp. R/ege					
1464	H. L. Gilbert.	Pine Creek.	200	14	7 N. 6 E.	\$300,000	5,000	.....	.....
1485	Lilliwaup Ld. & Resort Co.	Lilliwaup River.	250	19	23 N. 3 W.	500,000	21,306	.....	.....
1486	Lilliwaup Ld. & Resort Co.	Lilliwaup River.	250	19	23 N. 3 W.	250,000	.....	.....	.....
1487	Lilliwaup Ld. & Resort Co.	Milbourne Lk. Res.	2,000 a.f.	.....	23 N. 4 W.	5,000	.....	.....	.....	Reservoir for storage of water under Apps. 1485 and 1486.
1488	Lilliwaup Ld. & Resort Co.	Lilliwaup Swamp.	10,000 a.f.	.....	23 N. 4 W.	25,000	.....	.....	.....
1489	Lilliwaup Ld. & Resort Co.	Reservoir	2,000 a.f.	.....	23 N. 4 W.	5,000	.....	.....	.....
1495	Lilliwaup Pr. & Water Co.	Tucos Lake Res.	60	23	23 N. 4 W.	75,000	1,500	.....	.....
1522	Swank Mining & Dred'g Co.	Price's Lake.	150	.....	.....	.....	12,784	.....	.....
1529	Charles H. Ballard.	Ingauls Creek.	20	.....	.....	50,000	10,681	.....	.....
1541	Harold H. Hartman.	Canyon Creek.	3,500	29	12 N. 2 E.	8,200,000	119,318	.....	.....	Reservoir for storage of water under App. 1541.
1542	Harold H. Hartman.	Cowlitz River.	730,000 a.f.	29	12 N. 2 E.	.....	.....	.....	.....
1542	Harold H. Hartman.	Mayfield Res.	730,000 a.f.	.....	.....	.....	.....	.....	.....
1551	R. B. Metcalfe.	Hoffsteadt Cr. & Green River	1,000	6	10 N. 3 E.	1,500,000	56,818	.....	.....
1552	R. B. Metcalfe.	Toutle River.	500	2	9 N. 4 E.	1,500,000	38,352	.....	.....	Temporary permit issued.
1561	F. B. Allard.	Foss River.	300	28	25 N. 12 E.	1,000,000	34,091	.....	.....	Temporary permit issued.
1571	Pearl E. Richard.	Cle Elum River.	1,000	21	22 N. 14 E.	1,000,000	10,681	.....	.....	First step of development completed.
1591	City of Seattle.	Skagit River.	3,500	.....	Unsurveyed	8,000,000	120,000	.....	.....	Reservoir for storage of water under Permit 640.
1592	City of Seattle.	Diablo Reservoir.	90,000 a.f.	8	37 N. 13 E.	3,000,000	.....	R. 43	.....
1597	J. R. Snider.	North River.	5,000	.....	15 N. 9 W.	1,450,000	71,023	.....	.....	Reservoir for storage of water under App. 1597.
1598	J. R. Snider.	Reservoir.	272,000 a.f.	.....	15 N. 9 W.	.....	.....	.....	.....
1624	W. T. Batcheller and E. A. Olsen.	Miller R., E. Fork.	160	28	25 N. 11 E.	750,000	14,545	.....	.....
1625	W. T. Batcheller and E. A. Olsen.	Miller R., W. Fork	100	17	25 N. 11 E.	200,000	9,091	.....	.....
1626	W. T. Batcheller and E. A. Olsen.	Dorothy Lake Res.	45,000 a.f.	4	24 N. 11 E.	350,000	.....	.....	.....	Reservoir for storage of water under App. 1624. To be operated in connection with existing plant. Development contingent on release of waters withdrawn for use of U. S. Bureau of Reclamation.
1633	Mt. Spokane Power Co.	Jump Off Joe Cr.	10	35	31 N. 40 E.	15,700	250	721	.....	Development contingent on release of waters withdrawn for use of U. S. Bureau of Reclamation.
1634	H. Lloyd Miller.	Yakima River.	2,000	33	15 N. 19 E.	2,000,000	27,272	.....	.....	Raising of dam under way to provide increased storage capacity for present plant.
1635	H. Lloyd Miller.	Yakima River.	3,000	17	13 N. 19 E.	2,500,000	40,900	.....	.....
1638	Northwestern Pr. & Lt. Co.	Elwah River	200	17	29 N. 7 W.	1,000,000	16,500	683	.....

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER—Continued.
Power.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Estimated Theoretic H. P.	Permit No.	Cert. No.	REMARKS
				Sec.	Twp. R'ge					
1639	Northwestern Pr. & Lt. Co.	Gilnes Canyon Res.	50,000 a.f.	17	29 N. 7 W.			R. 45		Reservoir for storage of water under Permit 683.
1646	F. M. Mitchell	Hall Creek	50	1	32 N. 36 E.	\$10,000	539			
1657	Edward Fitzpatrick	Lapel Creek	30	Unsurveyed		50,000	4,091			
1658	W. E. Theodore	Eagle Creek	20	Unsurveyed		45,000	5,227			Completed.
1660	Royal Development Co.	Phelps Creek	30	15	30 N. 16 E.	40,000	1,080	696		
1661	Henry L. Gray	Naselle R., N. Br'ch	670	31	11 N. 8 W.	1,500,000	12,182			Reservoir for storage of water under App. 1661.
1662	Henry L. Gray	Naselle River Res.	20,000 a.f.	31	11 N. 8 W.	1,500,000				
1670	L. W. Johnson	Snoqualmie River, N. Fork	700	18	24 N. 9 E.	2,000,000	39,773			
1671	C. F. Uhden	Cross Creek	20	Unsurveyed			3,400			
1674	Verona Mining Co.	Bagley Creek	10	17	39 N. 9 E.	10,000	1,500			
1679	L. J. Vogter	Constance Creek	10	12	26 N. 4 W.		4,545			
1683	George E. Quinan	Deer Creek	2,000	7	33 N. 7 E.	2,500,000				
1684	George E. Quinan	Lake Cayanaugh, Reservoir	70,000 a.f.		33 N. 6 E.					Reservoir for storage of water under App. 1683.
1685	Henry A. Kell	Toutle River	2,500	14	10 N. 1 E.	6,000,000				
1686	Henry A. Kell	Silver Lake Res.	100,000 a.f.	25, 31	10 N. 1 W.	500,000				Reservoir for storage of water under App. 1685.
1708	Verona Mining Co.	Galena Creek	10	17	39 N. 9 E.	5,000	598			
1715	Miller & Aall	Clear Creek	100	6	31 N. 10 E.					
1723	Wallace Huntington	Doubtful Lake	41	Unsurveyed		100,000	3,028			
1724	City of Tacoma	Skokomish, R., S. Fork	600	10	22 N. 5 W.	5,000,000	46,364	940		
1725	City of Tacoma	South Fork Res.	220,000 a.f.	21	22 N. 5 W.			R. 60A		Reservoir for storage of water under App. 1724.
1726	Startup Water System	Ohney Creek	70	25	28 N. 8 E.	25,000	1,273	1069		
1727	Startup Water System	Ohney Reservoir	2,220 a.f.	25	28 N. 8 E.	25,000		R. 63		
1811	O. C. Carlson	Unnamed Stream, W. Fork	5	8	12 N. 5 E.	2,500	113	878		
1813	D. W. Stuver	Troublesome Creek, W. Fork	10	3	28 N. 11 E.	150,000	1,591			
1814	D. W. Stuver	Troublesome Creek, E. Fork	30	11	28 N. 11 E.	500,000	5,795			
1815	D. W. Stuver	Sultan River	5	35	29 N. 10 E.	50,000	568			Reservoirs in connection with Appropriation Apps. 1813, 1814 and 1815.
1816	D. W. Stuver	Twin Lakes Res.	7,500 a.f.	3	28 N. 11 E.	150,000				
1817	D. W. Stuver	Blanca Lake Res.	25,000 a.f.	11	23 N. 11 E.	500,000				
		Totals Storage	149,820 c.f.s. 6,255,295 a.f.			\$74,910,800	3,808,696			

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER—Continued.
Power.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Division Point		Estimated Cost	Estimated Theoretic H. P.	Per. mit No.	Cert. No.	REMARKS
				Sec.	Twp. E'g					
1882	W. G. Hufford.....	Wind River.....	300	16	3	\$250,000	6,818	.....	.....	.....
1918	City of Seattle.....	Skagit R. & trib..	3,300	2	37	16,000,000	187,500	.....	.....	.....
1917	City of Seattle.....	Ruby Res.....	3,800,000 a.f.	2	37	8,000,000	20	919	.....	.....
1937	B. C. Willey.....	Johns Creek.....	12	3	20	1,500	51,136	.....	.....	.....
1963	E. G. Hopson.....	Columbia River..	15,000	11	2	.....	.....	.....	.....	.....
1963	J. C. Oyer.....	Lacamas Creek..	10	14	12	1,500	4	883	.....	.....
1981	Pacific Hopkinson Co.....	Nisqually River..	1,050	26	16	2,000,000	33,469	.....	.....	.....
1982	W. H. Hopkinson.....	W. Fork.....	50	9	21	200,000	2,000	.....	.....	.....
1988	O. H. Babcock and Peter Jensen.....	Humtuplits River	5	8	30	1,500	10	1062	.....	.....
1988	Great Northern Power Co.....	W. Branch Cable... Creek	100	27	28	.....	.....	1076	.....	.....
2012	Great Northern Power Co.....	E. Fork Wallace R. Wallace Res.....	2,000 a.f.	27	25	.....	.....	R. 69	.....	.....
2020	Geo. T. Castle.....	Cranberry Creek..	10	36	21	2,000	20	929	.....	.....
2021	Miles H. Fuller.....	Fuller Creek.....	6	8	17	2,000	80	1129	.....	.....
2022	Startup Water System.....	Olney Creek.....	200	30	28	.....	16,382	.....	.....	Assigned to Great Northern Power Co.
2043	Joseph Roane.....	Toutle River.....	300	18	9	1,125,000	.....	.....	.....	.....
2044	Joseph Roane.....	Castle Creek Res..	36,000 a.f.	14	9	400,000	11,981	.....	.....	.....
2045	Joseph Roane.....	Cow Creek Res.....	15,000 a.f.	16-21	10	300,000	.....	.....	.....	.....
2046	Joseph Roane.....	Green River Res..	96,000 a.f.	5	10	800,000	.....	.....	.....	.....
2047	C. W. Cottrill.....	Washington River..	150	27	2	15,000	586	961	.....	.....
2051	Cascade Power Co.....	Lake Isabel.....	50	38	28	1,250,000	2,500	.....	.....	.....
2052	Cascade Power Co.....	Lake Isabel Res..	13,700 a.f.	38	28	100,000	.....	.....	.....	.....
2053	Cascade Power Co.....	Wenatchee River..	2,000	25	17	7,500,000	.....	.....	.....	.....
2054	Cascade Power Co.....	Wenatchee L.K. Res.	200,000 a.f.	25-26	27	750,000	90,969	.....	.....	.....
2054	H. C. Hansen.....	Johns River.....	20	17	16	250,000	500	.....	.....	.....
2077	E. A. Younglove.....	Cheadle Creek.....	10	11	21	1,000	.....	900	.....	.....
2095	L. E. Boswick.....	Noisy Creek.....	5	18	38	1,000	100	1162	.....	.....
2100	Sam Samson.....	Woodard Creek.....	10	28	2	4,000	.....	1029	.....	.....
2118	Walter Gilkey.....	E. Fork Nooka-champs Creek	5	5	33	.....	.....	.....	.....	.....
2119	Walter Gilkey.....	Big Lake.....	5	36	34	.....	.....	.....	.....	.....
2130	J. H. Adams.....	Alochoman River..	12	24	30	1,750	20	.....	.....	.....
2144	W. E. Mintzer.....	Ninety-Nine Creek	5	2	37	7,000	.....	1146	.....	.....
2152	Tor Power Co.....	Tilton River.....	30	5-25	13	.....	.....	.....	.....	.....
2165	H. D. Barto.....	Carbon River.....	225	22	18	.....	22,628	.....	.....	.....
2184	E. M. Chandler and Henry Gray.....	Dosewallips River...	150	28	26	1,250,000	.....	.....	.....	.....
2185	E. M. Chandler and Henry Gray.....	Dosewallips River...	26,000 a.f.	28	26	700,000	4,060	.....	.....	Temporary permit issued.

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER—Continued.
Power.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Estimated Theoretic H. P.	Permit No.	Cert. No.	REMARKS
				Sec.	Twp. R. 'ge					
2191	Hugh L. Cooper	Clark Fork	8,500	14	40	43 E.	17,000,000	1059		
2192	Hugh L. Cooper	Clark Fork	6,000 a.f.	14-15	40	43 E.	.....	R. 67		
2207	Robert Boyd	State Creek	25	36	40	43 E.	200,000	.....	
2219	Sragt Valley Irr., Water & Power Co.	Deer Creek	67,500 a.f.	21	33	6 E.	471,000	.....	
2287	Northwestern Fr. & L.L. Co.	Eiwha River	1,200	33	29	7 W.	2,200,000	.....	
2288	Northwestern Fr. & L.L. Co.	Eiwha River	65,000 a.f.	33	29	7 W.	2,000,000	.....	
2242	D. J. Becker	Alockoman River	5	30	10	4 W.	5,000	40,909		
2243	D. J. Becker	Alockoman River	5	30	10	4 W.	5,000	110		
2244	D. J. Becker	Alockoman River	5	36	10	4 W.	10,000	80		
2245	City of Port Angeles	Eiwha River	650	16	29	7 W.	750,000	11,079		
2253	P. D. Jennings	Sultan River	700	29	29	9 E.	10,000,000	.....		Assigned to Washington Electric Co.
2254	P. D. Jennings	Sultan River	230,000 a.f.	29	29	9 E.	2,000,000	.....	
2259	J. E. Wickstrom	Skykomish River	2,000	29	27	10 E.	2,000,000	.....	
2290	J. E. Wickstrom	Skykomish River	.....	28	27	10 E.	500,000	38,636		
2291	Wm. E. Parker	One and A Half Mile Branch of E. Creek	20	2	26	2 W.	50,000	.....	
2309	H. S. Shorey	Satsop River	200	28	9	6 W.	100,000	.....	
2316	Pheam Boyle	N. Fork Sultan R.	110	17	29	10 E.	30,000	.....	
2329	Eugene Logan	Sheep Creek	50	23	40	39 E.	150,000	500		
2346	Eugene Logan	Sheep Creek	10,000 a.f.	19	40	39 E.	25,000	1,000	1183	
2347	Eugene Logan	Sheep Creek	1,000 a.f.	14	40	39 E.	25,000	.....	R. 76	
2366	E. J. Nixon	Kalalock Creek	8.4	3	24	13 W.	2,000	.....	R. 75	
2387	SKOOKUM LUMBER CO.	SKOOKUMCHUCK R.	125	.....	15	1 E.	230,000	.....	6.7	Power, manufacturing, irrigation and domestic use.
2405	H. O. Purell	Purell Creek	20	8	12	8 E.	2,000	.....	25	
2421	John H. Wallin	Ingalls Creek	5	26	23	17 E.	600	.....	8	
	Totals	Storage	36,648 c.f.s.	.....	.....	.....	\$49,268,850	842,036	.....
			4,568,200 a.f.	.....	.....	.....		.....	.....

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER (1927-1928).
Municipal Use.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Population to be Served	Per. mit No.	Cert. No.	REMARKS
				Sec.	Twp. Rge					
1894	Lake Forest Park W. Co...	Springs, Trib.	1	9	26	4 E.	30,000	2,000	810	
1906	City of Kent.....	Sunrise Creek	10	33	22	6 E.	200	3,500		
1921	Great Northern Power Co...	Trib. of Soos Cr.	10	23	28	9 E.	500			
1920	Great Northern Power Co...	Rose Lake	2,000 a.f.	15	28	3 E.				
1925	Thomas B. Allison.....	Wright Lake Res.	1	8	22	3 E.	3,000	100	841	
1930	Great Northern Power Co...	Trib. Puget Sound.	20,000 a.f.	20	28	9 E.			R. 96	
1933	Snoqualmie Falls Lbr. Co...	Cascade Reservoir.	15	20	24	8 E.	120,000	1,000	845	180
1934	City of Aberdeen.....	Tokul Creek	125	33	18	8 W.				
1968	City of Aberdeen.....	Wynooche River	5	36	18	8 W.			980	
1969	City of Aberdeen.....	Elliott Slough	5	29	18	8 W.	700,000	63,000	981	
1970	City of Aberdeen.....	Wedekind Creek...	5	23	18	8 W.			982	
1972	City of Aberdeen.....	Mooney Creek	110	29	18	8 W.			984	
1973	City of Aberdeen.....	Wynooche River	625	33	18	5 E.			916	
1974	City of Tacoma.....	Puyallup River	50,000 a.f.	5	17	5 E.	2,000,000	200,000	917	
1975	City of Tacoma.....	Kapowsin Reservoir	100	5	17	5 E.			R. 58	
1976	City of Tacoma.....	Voight Creek	30	2	18	5 E.	500,000		918	
1980	City of Port Townsend	Little Quilcene R.	30	32-33	28	2 W.				
1891	City of Port Townsend	Quilcene River	750 a.f.	4	26	3 W.	1,000,000			
1892	City of Port Townsend	Lords Lake Res.	10,000 a.f.	28	28	2 W.				
1894	City of Hoquiam.....	E. Humptulips Res.	100	24	21	9 W.	1,500,000			
2002	City of Hoquiam.....	E. Fk. Humptulips	100	24	21	9 W.				
2005	City of Hoquiam.....	East Fork Humptulips River	95	23	21	9 W.	300,000			
2006	City of Hoquiam.....	Humptulips Res.	700,400 a.f.	23	21	9 W.	130,000	50,000		
2010	City of Hoquiam.....	Chehalis River	300	9	17	7 W.	2,660,000	50,000		
2016	City of Hoquiam.....	Humptulips River.	200	28	19	11 W.	1,660,000		1051	
2039	Town of Redmond.....	Sidell Creek	13.33	23	26	6 E.		20,000	1066	
2057	City of Redmond.....	Redmond Res.	33 a.f.	23	26	6 E.	6,000		R. 68	
2058	City of Aberdeen.....	Van Winkle Basin.	600 a.f.	1	17	9 W.	1,000,000		R. 65	
2169	City of Hoquiam.....	Wishkah River	25	22	19	9 W.		35,000	1040	
2256	City of Hoquiam.....	Middle Fork Hoquiam River	10	14	10	10 W.	35,000			
2258	Preston Armstrong.....	Asmus Creek	2	17	20	8 W.	4,000	400	1125	Privately owned.
2280	City of Aberdeen.....	Wishkah River	40 a.f.	28	21	8 W.	6,000			
2281	Neil Gooney.....	Pallx River	60	18	13	9 W.	100,000			
2285	City of Aberdeen.....	West Fork of Wishkah River	12	35	20	9 W.	85,000	35,000		
2304	City of Centralia.....	Wishkah River	250	13	15	1 E.	300,000	18,000		
2343	F. L. Dorch.....	Skookumchuck R.	3	3	14	11 W.	15,000	400		
2351	C. E. Leonard.....	Unnamed Trib. Willapa	6	28	12	2 W.	5,000	800		

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER (1927-1928)—Continued.
Municipal Use.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.		Diversion Point		Estimated Cost	Population to be Served	Permit No.	Cert. No.	REMARKS
			Sec.	Twp.	R	Page					
2387	Skookum Lumber Co.....	Skookumchuck R...	125	15	1	E.	\$230,000	20,000	.....	.....	Supply Centralia, Chehalis and vicinity. To serve Stanwood, East Stanwood and vicinity.
2389	City of Aberdeen.....	Wynooche River ..	800	12	21	8	W.	5,200,000	35,000	.....
2432	Stanwood Water Co.....	Springs trib. Hat Slough	5	5	31	4	E.	50,000	3,500	.....
Totals.....			3,158 c.f.s. 783,823 a.f.	.....	.....	.....	\$8,289,700	537,700	.....	.....

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER (1927-1928)—Continued.
Irrigation.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Acreage	Permit No.	Cert. No.	REMARKS
				Sec.	Twp., R'ge					
1863	Tonasket-Okanogan Orchards, Inc.	Okanogan River	1.8	8	36	27 E.	\$1,800	90	856	
1864	Tonasket-Okanogan Orchards, Inc.	Okanogan River	1.7	6	36	27 E.	1,800	85	857	
1865	Tonasket-Okanogan Orchards, Inc.	Okanogan River	1.8	31	37	27 E.	2,500	90	858	
1868	Douglas Almond	Ross Lake	1	24	34	1 E.	1,000	60	1050	
1877	T. K. Manderscheid	Twisp River	1	20	33	20 E.		50	881	
1885	U. S. R. Okanogan Project	Okanogan River	40	34	34	26 E.	300,000	4,546		
1905	Edsall Cobb and L. L. Robinson	Davis Creek	3	20	32	44 E.	1,000	220	937	
1913	Kemmerick Bros.	Skagit River	1	3	35	7 E.	1,000	60	992	
1915	Schnyler A. Douglass	Okanogan River	1.25	8	33	26 E.	2,500	70	814	
1922	State Parks Committee	Pass Lake	1	23	34	1 E.	12,000	160		
1924	Icicle Irrigation Dist.	Square Lake Res.	2,000 a.f.	22	25	13 E.	6,000			
1929	Arcadia Holding Co.	Withy Creek	3	35	28	42 E.		150	950	
1927	J. J. Slack	Stuck River	10	30	21	5 E.	10,000	1,000		
1941	Chas. S. Lane et al.	Trib. of Burnt Bridge Creek	6	14	2	2 E.	2,000	33		
1942	Geo. A. and W. L. Davis	Okanogan River	1.6	30	32	25 E.	4,000	80	874	
1943	Henry Bechrig	Unnamed Spring	1	11	39	36 E.	500	70		
1856	Edna R. Hosor	Happy Hollow Ok.	2	22	22	2 W.		50	962	
2001	Wm. J. Dahlmeier	Quilceda Creek	1	9	30	5 E.		30		
2007	Fred Kopsland	Barneby Creek	1	9	34	36 E.		72	963	
2028	Geo. W. Knittel	Elder Creek and Nooksack River	3	33	40	3 E.	600	40	978	
2029	E. A. Knittel	Squaw Creek	2	12	40	3 E.	200	40	993	
2036	C. K. McMillan	Ten-Mile Creek	2	22	39	2 E.	1,500	50	971	
2050	Maimo & Company	White River	1.5	11	22	4 E.	10,000	74	983	
2069	Henry C. Pigott	Boetzke Creek	1	31	23	9 E.	750	40	1130	
2072	Wm. A. Joyce	Columbia River	4	30	13	28 E.	5,000	126		
2079	Leavenworth Kershaw	Patterson Lake	5	17	1	1 W.	12,000	400		
2082	City of Seattle, Park Com.	Jones Creek	1.3	20	26	4 E.	8,000	100	1014	
2084	Maimo & Company	O'Brien Creek	1	2	22	4 E.	5,000	74	984	
2091	Adolf Van Mechlen	Unnamed trib. of Demsey Creek	1	22	17	3 W.	20	40	1042	
2099	Sam Samson	Little Creek	1	26	2	6 E.	5,000	100	1028	
2101	Leroy Wright	Perrygin Creek	2	25	85	21 E.	1,000			
2167	Stratford Orchards Co.	Crab Creek	48 a.f.	24-36	32	28 E.				
2170	Otto Kempe	Colville River	5,000 a.f.	23	32	40 E.	1,000	80		
2171	Robert W. McCall	Methow River	1	22	31	22 E.	15,000	100	1035	
2177	Hugh Allen and Eric Munson	So. Br. Allen Cr.	2.5	22	31	22 E.		100		
			2	11	30	5 E.		200	1039	

Sub-Irrigation.
Flood Water.

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER (1927-1928)—Continued.
Irrigation.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Acreage	Per- mit No.	Cert. No.	REMARKS
				Sec.	Twp. R'ge					
2188	North Pacific Mortgage Co.	Lacamas Creek	2	6	17	3 E.	128	1087		
2189	Att Dixon	Falouse River	2	8	17	40 E.	500	200	1184	
2193	Bambo Bros. et al.	Van Valkenburg Ck.	3	33	41	4 E.	600	294		
2211	J. E. Thurman	Samish River	3	33	35	3 E.	250	40	1107	
2255	Harold C. Stimson	Samamish River	4.5	27	26	5 E.	2,500	570	1105	
2259	E. H. Adams	Stuckler Creek	3	2	6	1 W.	2,000	30	1098	
2262	H. K. Smith	Crab Creek	50,000 a.f.	2	5	18	28 E.	12,000	R. 71	
2275	A. W. Dressel	Ljme Creek	2	13	40	43 E.	2,000	40	1186	
2282	Justin K. Hill	Yelm Creek	1	32	17	2 E.	500	50	1174	
2283	D. O. Carter	Dickerson Creek	1	8	24	1 E.	400	20	1136	
2287	Lake Chelan Rec. Dist.	Trib. of Lk. Chelan	1,600 a.f.	35-36	25	21 E.	8,500	186		
2288	John P. Anderson	Dosewallips River	3.5	3	25	2 W.	500	50	1137	281
2298	Robt. J. Graham	Wenatchee River	1	31	24	19 E.	3,000	50	1137	281
2308	James H. Downey	White River	2	23	22	4 E.	500	34	1143	
2324	M. Kollock and E. J. Cummins	Unnamed stream	1	18	3	10 E.	1,500			
2345	Oroville-Tonasket Irr. Dist.	Whitestone Lake	10	20	38	27 E.	5,000	55		
2350	Tom Martin	Lacamas Creek	1	36	18	2 E.	300	40		
2353	Frank Therriault	Cub Creek	5	30	36	21 E.	7,000	85		
2358	Chelan Falls Irr. Dist.	Chelan River	15	13	27	23 E.	70,000	400	1176	
2361	John R. Holmes and Anna Holmes	Unnamed stream	1.5	15	21	3 E.				
2364	Titus Hale	No. Fork of 25-Mile Creek	4	34	29	20 E.	4,200	150		
2367	T. M. Hodgman	Deer Creek	2	34	28	43 E.		20		
2374	P. G. Pederson	Unnamed stream	1	15	22	1 W.	200	10		
2379	A. R. Countryman	Methow River	2	21	31	22 E.	1,200	40		
2380	J. A. Brackett	Jefferson Creek	1	3	20	44 E.	100	40		
2381	F. G. Hill	Green River	1	25	23	4 E.	500	71		
2382	N. H. Williams	Palouse River	2	8	13	37 E.	1,800	90		
2383	P. S. C. Wills	LeBon and Lindis Springs	3	34	3	7 E.	6,000			
2391	Ahtanum Irrigation Dist.	Ahtanum Creek	200	22	30	5 E.	1,000	60		
2392	Dinsmore Irr. Company	Altona Creek	1	14	18	5 W.	300	600		
2396	Karl Church	Wild Cat Creek	1	14	18	5 W.	200	200		
2400	Geo. Lavler	Town Creek	2	14	18	3 W.	500	40		
2403	R. M. Metcalf	Perry Creek	1	8	12	8 E.	2,000	14		
2405	H. O. Furell	Purell Creek	20	15	25	7 E.	20,000	2,000		
2406	C. Beadon Hall	Toit River	40	16	4	3 E.	500	30		
2411	Harry E. Caldwell	Basket Creek	1	20	20	14 E.	500	64		
2415	John Bosio	Little Creek	3	27	20	3 E.	500	64		
	Totals	Totals	454 c.f.s.				\$569,920	22,941		
	Storage		58,048 a.f.							

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER (1927-1928)—Continued.
Mining, Manufacturing and Miscellaneous Uses.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.	Diversion Point		Estimated Cost	Permit No.	Cert. No.	USE
				Sec.	Twp. R. & G.				
1936	Raymond Medley Andrus	Willapa River	13	36	13	8 W.			Manufacturing.
1944	Grays Harbor Pulp Co.	E. Br. Hoquiam R.	35	8	18	9 W.	1001		Manufacturing and Domestic Use.
1946	John C. Hogan	Chensis Creek	6	14	18	11 W.			Manufacturing.
1947	John C. Hogan	Grass Creek	5	36	18	11 W.			Manufacturing.
1948	John C. Hogan	Grass Creek Res.	100 a.l.	36	18	11 W.			Manufacturing.
1951	Grays Harbor Ry. & Lt. Co.	Fry Creek	10	6	17	9 W.	904		Manufacturing.
1952	Grays Harbor Ry. & Lt. Co.	Fry Creek Res.	30 a.l.	6	17	9 W.	R. 57		Manufacturing.
1952	Wm. H. Stock	Little North River.	20	28	17	8 W.			Manufacturing.
1951	W. H. Hopkinson	E. F. k Humptulps River	50	23-26	12	9 W.			Power, Domestic and Manufacturing.
1977	Stewart Dennis	Willapa Creek	30	1	21	8 W.			Manufacturing.
1979	Tom Mairs	Tailrace of White R	150	12	20	4 E.			(Manufacturing, Domestic and
1985	W. K. Tahot	Cedar River	5	17	23	4 E.	808	Mfg.	(Pulp and Paper Mills.
2013	J. E. Buckingham	Wilson Creek	25	23	14	8 W.			Manufacturing.
2014	J. E. Buckingham	Willapa River	40	35	14	8 W.			Manufacturing.
2015	J. E. Buckingham	Fairchild Creek	20	22	14	8 W.			Manufacturing.
2018	F. E. Bertrand	Diabase Creek	150	36	11	E.			Manufacturing.
2019	F. E. Bertrand	Bacon Creek	400	1	17	9 W.			Manufacturing.
2025	Jennie R. West	Van Winkle Creek	5						Manufacturing.
2042	Geo. W. Johnson	Lake Washington	300	24	20	4 W.	R. 59		Pulp Manufacturing.
2053	Rainier Pulp & Paper Co.	Goldsbrough Ck	150 a.l.	10	23	4 E.	988		Manufacturing.
2063	Dana Roberts	Green River	40	10	23	4 E.			Manufacturing.
2118	Walter W. Gilkey	East Fork							Manufacturing.
2119	Walter W. Gilkey	Nooksachamps	5	5	33	5 E.			Manufacturing and Domestic Use.
2125	D. Tomson	Big Lake	5	36	34	4 E.			Manufacturing and Domestic Use.
2126	Tacoma Land & Impr. Co.	Chambers Creek	20	28	20	2 E.			Industrial, Mfg. and Domestic Use.
2130	J. H. Adams	Clear Creek	10	13	20	3 E.			Manufacturing and Domestic Use.
2137	City of Fort Townsend	Aleochoman River	12	24	10	5 W.			Mining and Power.
2137	City of Fort Townsend	Elwha River	150	3	30	7 W.			Manufacturing.
2152	Tor Power Co.	Tilton Creek	30	5-25	13	5 E.			Manufacturing.
2159	City of Hoquiam	Wishkah River	25	92	19	9 E.	1040		Industrial
2174	Great Northern Power Co.	Sultan River	300	29	29	2 E.			Manufacturing, Mining and Power.
2178	Glacier Gravel Company	Chambers Creek	25	29	20	2 E.			Washing Sand and Gravel.
2186	Pioneer Sand & Gravel Co.	Chambers Creek	20	27	20	2 E.			Washing Sand and Gravel.
2206	Z. E. Scott	Touchar River	5	30	10	39 E.			Log Pond.
2213	Allen B. Engle	Duwamish River	16	30	23	4 E.	1088		Manufacturing Pulp and Paper.
2226	Grays Harbor Pulp Co.	Wishkah River	15	22	19	9 W.	1114		Manufacturing.
2270	Nell Cooney	N. Fk. Palix River	50	18	13	9 W.			Manufacturing and Domestic Use.
2303	F. W. Woodland	Lake Martha	5	18	31	4 E.			Manufacturing.
2332	Grays Harbor Pulp Co.	Unnamed trib. of E. Hoquiam River	5	7	18	9 W.	1173		Manufacturing.

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER (1927-1928)—Continued.
Mining, Manufacturing and Miscellaneous Uses.

App. No.	NAME OF APPLICANT	Source of Appropriation	Amount of Water C. F. S.		Diversion Point			Estimated Cost	Permit No.	Cert. No.	USE
			Sec.	Twp.	R	R	R				
2331	Grays Harbor Pulp Co.....	E. Hoquiam River..	20	7	18	9	W.	\$400,000	1181	Manufacturing. Power and Domestic Supply for Camp Site. Manufacturing and Domestic Use. Power, Domestic Supply and Washing Gravel.
2337	W. G. Hufford.....	Rock Creek	15	35	3	7	E.	.....	.....	.....
2401	A. H. Nettleton.....	Stranger Creek	10	3	32	35	E.	500	.....	.....
2407	F. A. Duncan and A. W. Hammond.....	Smith Creek	30	29	15	9	W.	200,000	.....	.....
2430	Hamma Hamma Log. Co....	Johns Creek	5	28	24	3	W.	10,000	.....	.....
	Totals.....	Totals.....	2,082 c.f.s. 280 a.f.					\$4,123,000			

METHODS AND EXTENT OF WATER SUPERVISION.

The fundamental idea of the Water Code is that all rights to the beneficial use of water in the State of Washington will be evidenced eventually by certificates of water right issued through this office and based upon either permits under the Water Code or determination of old rights under the court procedure authorized by the Code.

The office is charged with the regulation and control of the diversion of water in accordance with the rights thereto. Such regulation and control is undertaken only when the rights have been established by court decrees or by the procedure prescribed under the Code. Frequent requests are made for regulation, the rights to which have not been so determined. In such cases representatives of the office will give such information and advice as may seem appropriate, but will assume no authority.

The regulation of water is accomplished by means of water masters and stream patrolmen. Water masters are appointed upon proper showing of necessity, each to serve a certain definite district, usually a county. Compensation is paid for the time actually employed, by the county served.

When a given stream requires more time for its regulation than can be given by the water master, a stream patrolman may be employed upon request of interested parties, the cost of his services to be paid by those receiving water from the stream.

It is necessary that the office keep in close touch with the water masters, as they often seek advice on problems which constantly arise in connection with the distribution of water, and in many instances water users, aggrieved by decisions of water masters or stream patrolmen, appeal to the Supervisor. This frequently requires a visit on the ground to secure the information upon which a fair and intelligent ruling may be based.

The Water Code provides for appeals from the decision of the Supervisor by any party not satisfied with his rulings, but only one such appeal has been made during the biennium.

During the biennium the following water masters and stream patrolmen have been appointed to regulate the diversion of water in various parts of the state:

WATERMASTERS.

<i>1927</i>	<i>1928</i>	<i>County</i>
C. E. Anderson.....	C. E. Anderson.....	Douglas, Adams, Grant and Lincoln
Harlow Barney.....	Harlow Barney.....	Walla Walla and Columbia
O. M. Bise.....	O. M. Bise.....	Chelan
H. M. Dorman.....	C. A. Ledgerwood.....	Stevens
Lloyd F. Fairbrook.....	Lloyd F. Fairbrook.....	Yakima
A. G. Hanson.....	A. G. Hanson.....	Klickitat
M. McLain.....		Okanogan
J. E. Tupper.....		Asotin and Garfield
Ben Vaughn.....	Ben Vaughn.....	Kittitas

STREAM PATROLMEN.

1927	1928	Stream
E. J. Brown.....	E. J. Brown.....	North Fork Salmon Creek
Peter Caraher.....		Teanum Creek
Thos. H. Coon.....	Thos. H. Coon.....	Beaver and Frazier Creeks
W. H. Dunnagan.....	W. H. Dunnagan.....	Squillchuck and Stemilt Creeks
E. Hamlin.....	E. Hamlin.....	Squillchuck and Mission Creeks
H. H. Kelly.....	H. H. Kelly.....	Peshastin Creek
D. J. Klassen.....	Gerald Thompson.....	Ahtanum Creek
E. L. Laney.....	Amos Bourdon.....	Wenas Creek
H. R. Murray.....	H. R. Murray.....	Bird and Frazier Creeks
E. H. Smith.....	E. H. Smith.....	Colman Creek
Dick Shuey.....	Gil Pope.....	Nanum Creek
George Shuey.....	R. O. Woodiwis.....	Wilson Creek
A. J. Sutton.....	A. J. Sutton.....	Reecer Creek
J. H. Wetzel.....	J. H. Wetzel.....	Menastash Creek
Guy White.....	Guy White.....	Cowiche Creek
D. J. Wood.....		Myers Creek
Roy Grinrod.....		Cooke Creek

MISCELLANEOUS ACTIVITIES.

The Supervisor is charged with the responsibility of approving the plans and inspecting construction, operation and maintenance of dams and other hydraulic works so far as may be necessary for the protection of life and property. Owing to lack of funds, and pressure of routine work, this function had been in a large measure neglected until the failure of the San Francisquito Dam on March 14, 1928, which cost hundreds of lives and millions in property damage. This tragedy impressed upon us the seriousness of this responsibility and a thorough-going inspection of all dams in the state was made.

The owners of these properties welcomed the inspection and gave most hearty cooperation. The result of the inspection was most satisfactory in that not a single dam was found to be in dangerous condition. Some suggestions were made for minor repairs and improvements, most of which were promptly acceded to by the owners. The cost of the inspection was borne from our general appropriation, but the law provides that it shall be reimbursed by the property owners. Collections have been made already covering most of the inspections.

Following is a list of the dams examined:

DAM NAME	Type	Height	River or Lake	Ownership
Post Falls, Idaho.....	Concrete, gravity type.....	64 ft.	Spokane River.....	Washington Water Power Co.
Little Falls.....	Concrete, gravity overflow.....	74 ft.	Spokane River.....	Washington Water Power Co.
Long Lake.....	Concrete, gravity overflow.....	250 ft.	Spokane River.....	Washington Water Power Co.
Nine-Mile.....	Concrete, gravity section.....	58 ft.	Spokane River.....	Washington Water Power Co.
Cedar Lake.....	Concrete arch, constant angle.....	160 ft.	Cedar River.....	City of Seattle
Diablo.....	Concrete arch.....	325 ft.	Skagit River.....	City of Seattle
Elwha.....	Concrete arch.....	110 ft.	Elwha River.....	Northwest Power & Manufacturing Co.
Gilnes.....	Concrete arch.....	210 ft.	Elwha River.....	Northwest Power & Manufacturing Co.
Baker River.....	Concrete arch.....	247 ft.	Baker River.....	Puget Sound Power & Light Co.
Cushman.....	Concrete arch, constant angle.....	275 ft.	Lake Cushman.....	City of Tacoma
City of Spokane.....	Rock-fill crib.....	20 ft.	Spokane River.....	City of Spokane
Chelan.....	Concrete, gravity overflow.....	74 ft.	Chelan River.....	Washington Water Power Co.
Salmon Lake.....	Earth type, hydraulic.....	33 ft.	Salmon Lake.....	U. S. Reclamation Service
Concomully.....	Earth, hydraulic.....	63 ft.	Concomully Lake.....	U. S. Reclamation Service
Cle Elum.....	Rock-filled crib dam.....	192 ft.	Lake Cle Elum.....	U. S. Reclamation Service
Keechelus.....	Earth, rolled fill.....	100 ft.	Lake Keechelus.....	U. S. Reclamation Service
Bumping Lake.....	Earth.....	42 ft.	Bumping Lake.....	U. S. Reclamation Service
Tieton.....	Earth, hydraulically planed, with concrete core wall.....	232 ft.	Tieton River.....	U. S. Reclamation Service
Kachess.....	Earth.....	.....	Kachess Lake.....	U. S. Reclamation Service
Hunter Land Co.....	Earth.....	70 ft.	Hunter Creek.....	Hunter Land Company
Spring Hill Irrigation Co.....	Earth.....	65 ft.	Stemilt Creek.....	Spring Hill Irrigation Co.
Pleasant Valley Water Users' Ass'n.....	Earth.....	50 ft.	Loop I. oop.....	Pleasant Valley Water Users' Ass'n
Wenas Dam.....	Earth.....	60 ft.	Wenas Creek.....	Wenas Irrigation District
Stemilt Irrigation District.....	Earth.....	80 ft.	Stemilt Creek.....	Stemilt Irrigation Co.
Fancher Dam.....	Earth.....	60 ft.	Antwyne Creek.....	Robt. M. Fancher and F. A. Fancher

The Division is required to investigate as to the source and sufficiency of water supply for proposed new irrigation districts and report to the county commissioners in advance of the organization hearing. During the biennium investigation and favorable reports were made on the Moses Lake Irrigation District, Chelan Falls Irrigation District, and Gardena Farms Irrigation District No. 3, Walla Walla.

During the biennium no engineers have been regularly assigned for duty in the Division of Reclamation and the Columbia Basin Division and the work of these two divisions has been handled by the Supervisor and other office employees as described in the reports of the respective divisions.

LITIGATION.

Many of the transactions of the Division involve rulings of a quasi-judicial nature and all rulings are subject to appeal to the courts. With 712 decisions during the biennium, involving the granting or denying of permits and the cancellation of pending applications, only two appeals have been taken and prosecuted. Decisions in these cases have not been rendered.

In connection with the adjudication of water rights, 10 cases, involving 1,140 water rights, were handled during the biennium. These cases are initiated in the Superior Court by the Supervisor. One case only has been appealed to the Supreme Court, *State of Washington vs. Millerdale Irrigation District et al.*, involving the waters of Squillchuck Creek in Chelan County, Washington. This case is still pending.

During the biennium decision of the Supreme Court was rendered in the Hunter Creek case, *State of Washington vs. George F. Laugenour and Ellen Jane Laugenour, his wife et al.* in which proceeding a report of the referee was filed in the year 1921. This decision followed the old riparian doctrine, whereas other decisions of the Supreme Court during recent years have indicated that the riparian doctrine of English Common Law is not consistent with our conditions and institutions. A strict application of the riparian doctrine would upset water titles in practically all of our irrigated districts and would severely handicap, if not entirely prevent, future irrigation developments. The circumstances in the Hunter Creek case, however, were such that the riparian doctrine could be applied without substantial injury to any one and it was apparently the view of the court that this doctrine offered the most simple solution of the problems involved in this particular case.

DETERMINATION OF EXISTING RIGHTS.

In the irrigated sections of the state water problems have been the cause of long and costly litigation. The method for determination of old rights provided by the Water Code is intended greatly to reduce the amount and cost of such litigation. It does not attempt to create new rights or to abolish or modify old rights, but simply to determine the extent of each and the relative priority between all claimants on a stream system. The results are set out in a court decree which is the basis of water right certificates issued by the Division of Hydraulics, recorded in the respective counties and subject to sale, division, transfer, etc., in the same manner as land titles.

This determination work was undertaken shortly after the Code became effective and has been carried on steadily since that time. The first cases were purposely limited to small streams until methods and procedure were fairly

well developed. As most serious conflicts often occur on the smaller streams, this order of procedure offered relief where it was most needed.

Now that the waters of most of the small irrigation streams have been adjudicated, the work will be carried to the rivers on which there are serious conflicts in water rights. It is also quite probable that some of the streams which were adjudicated before the Water Code became effective will in time be readjudicated. This appears desirable for the reason that the decrees entered in many of these cases are difficult to administer owing to the fact that, in these earlier cases, little consideration was given to the practical use of water and engineering problems affecting its diversion and use.

EXTENT OF WATER RIGHT DETERMINATIONS UNDER THE WATER CODE.

From June 15th, 1917, the date when the Water Code became effective, to September 30th, 1926, twenty-eight cases were completed, involving 1,295 water rights for as many farms having a total area of 121,236 acres. Since that period or during this biennium reports have been filed in ten cases involving 1,140 water rights for the irrigation of 28,927 acres of land. In addition to the ten cases above mentioned, hearings have been held in three other cases involving 307 water rights.

The number of water rights adjudicated during this biennium is nearly equal to the total number of water rights which have been handled during the entire previous history of the office.

Sixty per cent of the field surveys preliminary to the institution of proceedings to determine the water rights of the Yakima River and its tributaries, have been made as compared with forty per cent on the Colville River and tributaries. On Eagle Creek in Chelan County these surveys have been completed.

FUTURE NECESSITY FOR DETERMINATION OF WATER RIGHTS.

During the biennium eight petitions have been filed with the Supervisor of Hydraulics for the determination of water rights, and the rights on eleven streams have been adjudicated.

Of the petitions on file for water right determinations there are several as to which it is believed the conditions do not warrant action at an early date. Eventually, however, the water rights on all streams East of the Cascades, except perhaps the Snake and Columbia Rivers, must be adjudicated as the available water is limited in quantity and a fair distribution can be had only after proper legal action to determine the extent and relative priority of the various rights.

**PETITIONS FOR DETERMINATION OF WATER RIGHTS FILED PRIOR TO
OCTOBER 1st, 1926, ON WHICH NO ACTION HAS BEEN TAKEN.**

<i>Name of Stream</i>	<i>County in Which Stream Is Located</i>
Antoine Creek.....	Chelan
Bonaparte Creek.....	Okanogan
Clugston Creek.....	Stevens
Colville River.....	Stevens
Cottonwood Creek.....	Stevens
Upper Crab Creek.....	Lincoln
Crosner Creek.....	Stevens
Deer Creek.....	Stevens
Dry Creek.....	Walla Walla
Duck Lake Creek.....	Okanogan
Duck Lake.....	Okanogan
East Chéwelah Creek.....	Stevens
Five-Mile Lake.....	King
French or Crab Creek.....	Okanogan
Helm Creek.....	Stevens
Jewett Creek.....	Okanogan
LeFleur Creek.....	Ferry
Marshall or Lake Creek.....	Spokane
Methow River and tributaries.....	Okanogan
Mosquito Creek.....	Okanogan
No Name, tributary Entiat River.....	Chelan
North Pine Creek.....	Okanogan
O'Brien Creek.....	Ferry
Snow Creek.....	Chelan
Sherwood Creek.....	Stevens
Twelve Mile Creek.....	Stevens
Tucannon River.....	Columbia
Wawawai Creek.....	Whitman
White Salmon River.....	Klickitat
Wilmott Creek.....	Ferry

**PETITIONS FOR DETERMINATION OF WATER RIGHTS RECEIVED DURING
BIENNIUM.**

<i>Name of Stream</i>	<i>County in Which Stream Is Located</i>
Bacon Creek.....	Klickitat
Bigelow Gulch Creek.....	Spokane
Deadman Creek.....	Garfield
Eagle Creek.....	Chelan
Gold Creek.....	Okanogan
Icicle Creek.....	Chelan
Sinlahekin Creek.....	Okanogan
Yakima River.....	Yakima

Streams Adjudicated.

Determination proceedings were completed or substantially so, on the following streams, prior to September 30, 1926.

<i>Name of Stream</i>	<i>County in Which Stream Is Located</i>
Ahtanum Creek.....	Yakima
Alder Creek.....	Stevens
Alpowa Creek.....	Garfield and Asotin
Beaver and Frazier Creeks.....	Okanogan
Big Creek.....	Kittitas
Bird and Frazier Creeks.....	Klickitat
Bull Dog Creek.....	Stevens
Chewaeka Creek.....	Stevens
Corus Creek.....	Stevens
Cooke Creek.....	Kittitas
Cowiche Creek.....	Yakima
Crab Creek and Moses Lake.....	Grant and Adams
Doan Creek.....	Walla Walla
Dungeness River.....	Clallam
Hunter Creek.....	Stevens
Libby Creek.....	Okanogan
McFarland Creek.....	Okanogan
Meadow Gulch Creek.....	Garfield
Johnson Creek.....	Okanogan
Roaring Creek.....	Chelan
Safety Harbor Creek and tributaries.....	Chelan
Similkameen River.....	Okanogan
Stemilt Creek.....	Chelan
Stone Creek.....	Walla Walla
Salmon Creek.....	Okanogan
Teanaway River.....	Kittitas
Thompson Creek.....	Okanogan
Wenas Creek.....	Yakima
Wolf Creek.....	Okanogan

DETERMINATION PROCEEDINGS HAVE BEEN COMPLETED ON THE FOLLOWING STREAMS DURING THE PRESENT BIENNIUM.

Name of Stream	County in Which It Is Located	No. of Water Rights Involved	Acreage
Antoine Creek.....	Okanogan.....	6	165
Bacon Creek.....	Klickitat.....	8	840
Bowman Creek.....	Klickitat.....	28	168
Bigelow Gulch.....	Spokane.....	12	117
Black Canyon Creek.....	Okanogan.....	7	116
Deadman Creek.....	Garfield.....	83	505
Johnson Creek.....	Chelan.....	3	16
Quillisascut Creek.....	Stevens.....	26	276
Squillehuck Creek.....	Chelan.....	81	1,500
Walla Walla River.....	Walla Walla.....	886	25,209
Totals.....		1,140	28,972

STREAMS ON WHICH DETERMINATION PROCEEDINGS ARE NOW PENDING.

Name of Stream	County in Which It Is Located	No. Water Rights Involved
Gold Creek.....	Okanogan.....	20
Icicle Creek.....	Chelan.....	12
Touchet River.....	Walla Walla and Columbia.....	275
Sinlahekin Creek.....	Okanogan.....	

NOTE—Hearings have been held on the first three streams above named and the report of the Referee is now being prepared.

RECEIPTS FOR THE BIENNIUM.

Receipts for the biennium are more than three times those for the preceding biennium and about five times greater than they were for a like period before the increase of fees.

Receipts, segregated according to the more important sources, for the biennium, with the receipts for twenty-two months of the last biennium prior to the amendment of the law are shown in parallel columns for comparison.

RECEIPTS.

RECEIPTS	Dec. 1, 1922, to Sept. 30, 1924	Oct. 1, 1926, to Sept. 30, 1928	
Examination fees	\$1,515 00	\$2,610 00	
Additional examination fees		14,742 80	
(Under amendment passed by 1925 Legislature)			
Filing and recording fees.....	2,376 93	11,944 81	(Permits) (Certificate) (Miscel.)
Miscellaneous copying	124 34	254 10	
Extension of time for beginning of construction.....		357 85	
(Under amendment passed by 1925 Legislature)		186 19	
Adjudication of water rights.....	2,709 02	976 99	
Dam inspections (incomplete returns).....		363 70	
Totals.....	\$6,725 29	\$31,544 34	

It will be noted that the receipts for examination fees proper show an increase from \$1,515.00 to \$2,610.00, indicating a growth in the number of applications from 303 to 522. Additional examination fees, provided for in the amendment to the Water Code, amount to \$14,742.80, this being an entirely new source of revenue to the division; and filing and recording fees, the schedule of which was increased in the 1925 amendment, increased from \$2,376.93 to \$12,306.81.

CHANGE OF POINT OF DIVERSION.

The Water Code provides that when a water user desires to change the point of diversion or place or purpose of use of water, he must first obtain a permit therefor from the Supervisor of Hydraulics. The object of this provision is to protect other vested rights which might be injured by such change. If necessary the Supervisor investigates on the ground and if protests are filed or other good cause appears, a hearing is held to obtain full information concerning the effect of the proposed change on other rights. Thirty applications

of this nature have been filed during the biennium and decisions made in twenty-four of these.

COOPERATIVE HYDROGRAPHIC WORK.

R. K. Tiffany, Supervisor, and G. L. Parker, District Engineer of Division of Water Resources United States Geological Survey, Tacoma, Wash., in charge of Cooperative Hydrographic Work.

Hydrographic work consists primarily of collecting daily records of stream flow at gaging stations located on many of the important streams of the state. Secondly it involves investigation of dam and reservoir sites, determination of power and irrigation possibilities, consideration of flood problems, and study of the best sources of water for municipal and industrial uses.

Daily records covering a period of fifteen to twenty years are necessary to design hydraulic structures intelligently and to plan economical operation. Other basic information, needed to appraise hydraulic projects, can be obtained within a relatively short time, but water-supply data must be accumulated many years in advance of development. Private and municipal capital is too impatient to wait for the collection of such records. Obviously hydrographic work is a governmental function. It builds for the future and encourages wise development, which, in course of time, creates taxable wealth.

This state has greater water resources than any other in the Union and a marked impetus toward utilizing these resources is being experienced. The hydrographic work should be increased four-fold to lay a stable foundation for development during the next twenty years.

The legislature appropriated \$10,000 for cooperative hydrographic work during the biennium. Arrangements were made to cooperate with the United States Geological Survey in order to insure that the work would be carried on by impartial and trained specialists in accordance with a standardized procedure, in order that the results would be universally available in published form, and in order that the data would be accepted with confidence by engineers in all parts of the country. The plan of cooperation is the same as that effective in other states. A program of activities is framed jointly by the Supervisor of Hydraulics and the District Engineer of the Geological Survey, whereupon supervision of the details is administered by the District Office of the Geological Survey located at Tacoma. Monthly progress reports are submitted to the Supervisor of Hydraulics and he is furnished with results as soon as they become available.

From the beginning of the biennium to September 30th, 1928, an average of eighty-one gaging stations were maintained, 816 measurements of flow were made, and the expenditures through the Tacoma District Office, including those charged to the cooperative state appropriation, amounted to \$47,301.96.

Where private corporations or individuals are cooperating, they are applicants or permittees for water or power rights from the state or federal government or both.

A number of organizations or individuals assist in carrying on the joint program as follows:

- U. S. Department of State.
- U. S. Corps of Engineers.
- U. S. Bureau of Reclamation.
- U. S. Forest Service.
- U. S. Indian Service.
- Dominion Water Power and Reclamation Service of Canada.
- Inter-County River Improvement Commission.

Jefferson County.
Skagit County.
City of Aberdeen.
City of Seattle.
City of Tacoma.
Backus-Brooks Company.
Chelan Electric Company.
Grays Harbor Railway and Light Company.
Henry Hewitt Land Company.
Hugh L. Cooper Company.
Interurban Band Company.
Methow-Okanogan Irrigation District.
Oroville-Tonasket Irrigation District.
Mount Baker Development Company.
Northwestern Electric Company.
Northwestern Power and Light Company.
Puget Sound Power and Light Company.
Royal Development Company.
Stevens County Power and Light Company.
Stone and Webster Engineering Corp.
Washington Irrigation and Development Company.
Washington Water Power Company.
Western Washington Electric Light and Power Company.
E. M. Chandler.
W. F. Crowe, Walla Walla, Chamber of Commerce.

During the past six months the joint stream-gaging program has been increased by 17 gaging stations constructed at the expense of the U. S. Corps of Engineers for getting stream-flow records needed for an investigation of Columbia, Skagit, Stilagumish, Snohomish, Puyallup and Chehalis drainage basins. The U. S. Department of State has also provided funds for installing 3 gaging stations along the International Border for accurately determining the rights of the United States in connection with anticipated water controversies.

MISCELLANEOUS STREAM MEASUREMENTS.

The Water Code further provides that the Supervisor shall determine the discharge of streams and the capacity of lakes and keep a record thereof. In addition to the cooperative work with the Water Resources Division of the U. S. Geological Survey on larger streams in the state, this office has independently measured the discharge of 133 small streams and has recorded such measurements in this office. Generally these miscellaneous measurements were made at or near low water stage as the minimum flow is critical for most small projects, whether power, irrigation, manufacturing or municipal water supply.

HYDROGRAPHIC SUMMARY.

In 1920 a hydrographic summary was published by the Division of Water Resources showing all available stream data on the more important streams of the state up to that date. Since 1920 there have been several unusually dry years culminating in the unusually low summer and fall run-off of 1926. It appears that we have now passed a definite low point in the climatic cycle and that a new hydrographic summary will be of great value to all prospective water users. Such a summary has therefore been prepared and will be available as soon as it can be printed.

DIVISION OF RECLAMATION.

C. W. Karney, Supervisor.

The biennium has shown but little activity in this division. No new projects were offered or urged for development by the state. At the present time there is little demand for new irrigated land. In fact some fairly good land under existing projects is being poorly farmed or not farmed at all. On the other hand there is some activity in irrigation as evidenced by the constant irrigation of new land under the Wapato Project, under pumping plants along the Okanogan and Columbia Rivers and in some other sections of the state.

Some progress was made toward salvaging projects initiated by the state prior to 1925 and in one case bonds of the district not heretofore aided by the state were purchased in order to help the district make essential improvements which could not otherwise be financed.

WHITESTONE RECLAMATION PROJECT, OKANOGAN COUNTY.

This district was obligated to the state under old contracts for advances and interest on account of construction work to the extent of over \$900,000. It had voted bonds to the amount of \$1,125,000, which it was assumed would cover the construction cost for an area of approximately 9,000 acres. A board of engineers having determined that not more than 2,500 acres could be furnished with full and dependable water supply, the directors of the district classified land and reduced the area to 2,207 acres and on March 31, 1926, a contract was closed with the district by which the district delivered to the state an entire new bond issue of \$253,805 in full payment for the construction of water rights for the 2,207 acres. These bonds bear interest at one per cent per annum for ten years and at six per cent per annum for the remaining twenty years, principal payments beginning in ten years. The state reserves the right to the use of any surplus water above the requirements of the 2,207 acres and the right also to use the canals of the district for the carriage of surplus water to several additional lands should it become feasible to irrigate them.

It was obvious on consideration of the fixed charges against the lands in this district that the land owners could not pay six per cent during the development period but it is hoped that with the interest reduced to one per cent the state may reduce its capital investment to the extent of the bond issue.

METHOW VALLEY IRRIGATION DISTRICT, OKANOGAN COUNTY.

The Methow Valley Irrigation District had an outstanding bond issue of \$165,150, these bonds having been purchased by the state. The interest and maintenance charges were more than the land of the district would bear. Instead of being developed and improved as was anticipated when the state purchased the bonds, the lands were being abandoned and are reverting to sage brush. In order to make it possible for the settlers on the land to meet their charges and to settle up the remaining land in the district, a refund issue of \$165,150 bearing one per cent interest was purchased by the state and the proceeds used to retire the outstanding bonds.

LAKE CHELAN RECLAMATION DISTRICT, CHELAN COUNTY.

The Lake Chelan Reclamation District is one of the most highly productive districts in the state. Its water supply is secured from tributaries of Lake Chelan through long and expensive pipe lines. The district first appealed to the state in 1925 but its financial condition at that time was deemed unsound. By means of heavy annual assessments, the directors were able to pay off nearly all of the warranted indebtedness but still could not sell bonds on the market necessary to finance additional storage essential to the full irrigation of the orchard area which has been steadily increasing. After careful investigation, the department purchased \$100,000 of the bonds of this district, the interest rate being fixed at one per cent, and with this assistance it is believed that the district will be able to carry through to a successful development.

The status of bonds, purchased, sold and on hand, are shown on the attached tabulation.

IRRIGATION AND DRAINAGE BONDS PURCHASED AND SOLD. Biennium October 1, 1926, to September 30, 1928.

Par Value.

	On Hand Oct. 1, 1926	Purchased	Sold	On Hand Sept. 30, 1928
Methow Valley Irrigation District.....	\$20,000 00	\$165,150 00	\$20,000 00	\$165,150 00
Kennewick Irrigation District.....	199,500 00			199,500 00
Spokane Valley Irrigation District.....	28,500 00			28,500 00
Burbank Irrigation District No. 4.....	44,000 00			44,000 00
Yelm Irrigation District.....	5,000 00			5,000 00
Franklin County Irrigation Dist. No. 1..	142,000 00			142,000 00
First Creek Irrigation District.....	22,500 00			22,500 00
Icicle Irrigation District.....	250,000 00		55,000 00	195,000 00
White Salmon Irrigation District.....	35,000 00			35,000 00
Wenatchee Heights Reclamation District..	20,000 00			20,000 00
Wolf Creek Reclamation District.....	100,000 00			100,000 00
Consolidated Drainage Improvement Dist. No. 101, Thurston.....	74,000 00			74,000 00
Drainage Improvement District No. 2, Thurston.....	5,500 00			5,500 00
Drainage Improvement District No. 3, Thurston.....		7,023 30	7,023 30	
Lake Chelan Reclamation District.....		100,000 00		100,000 00
Whitestone Reclamation District.....		253,805 00		253,805 00
Totals.....	\$946,000 00	\$525,978 30	\$82,023 30	\$1,389,955 00

LETTER OF TRANSMITTAL.

The Honorable Erle J. Barnes, Director,
Department of Conservation and Development,
Olympia, Washington.

Sir: I have the honor to submit herewith the biennial report of the Supervisor of Geology. The report covers the period from April 1, 1927, to September 30, 1928.

It is a pleasure to acknowledge the full measure of cooperation and support with which you have consistently aided the work of the Division of Geology. I wish to acknowledge also the services and interest of a large number of engineers and industrial operators in the preliminary study of the geologic and topographic needs of the state.

Respectfully,

HAROLD E. CULVER,

Supervisor.

Pullman, Washington.

BIENNIAL REPORT OF THE SUPERVISOR OF THE DIVISION OF GEOLOGY.

ACTIVITIES OF THE DIVISION.

The work of the Division of Geology readily falls into the following categories: (1) Geologic Studies, (2) Topographic Mapping, (3) Laboratory and Field Service, (4) Collection of Mineral Statistics.

GEOLOGIC STUDIES.

Several types of investigation are included in this phase of Divisional activities, but since the work involved in any one type merges into that of other types any classification of geologic studies will show certain apparent omissions and duplications. Geologic studies may be undertaken with any one of the following aims in view:

(1) To determine the commercial importance of specific deposits in a given district:

A study of this type serves to indicate the reserves and value of some mineral substance in a limited area. Such an investigation was reported in Bulletin 10 of the Division publications, "The Coal Fields of Pierce County."

(2) To estimate the resources of the entire state in any one mineral substance:

This sort of investigation unites the study of limited districts and furnishes a basis for reliable estimates of the state's wealth in certain lines. It is illustrated by Bulletin 27 of the Division publications, "Iron Ores, Fuels and Fluxes of Washington."

(3) The mineral resources of a limited area:

In this type of geologic work a unit area such as a quadrangle or county is selected and the relations of all geologic features determined. The report of such studies introduces the general geology of the area in full as a basis for the presentation of all available information as to mineral resources. This type has not been systematically undertaken by the Division of Geology, but it is exemplified by the U. S. Geological Survey Series of Folios and by the forthcoming report, "Geology and Resources of the Chewelah Quadrangle."

(4) The delineation of detailed structures and stratigraphic relations in limited areas:

Exploration and development of districts containing an important mineral deposit are often handicapped by complexity of structure or stratigraphy. In some cases detailed investigation of a deposit will reveal the fundamental relations and point the way to commercial development of the district. In many instances, however, this procedure cannot be followed on account of unfavorable conditions. In such instances, the desired result may be obtained by extending the investigation to areas of favorable exposures where accurate delineation of the complex relations is possible. The results of such studies, although often obtained in regions of no commercial importance, can be applied to the valuable mineral deposits, making plain the relations which are otherwise ob-

scure. Such reports may be in themselves largely of scientific importance but ultimately become immensely valuable in the production of mineral wealth.

(5) *Determination of regional or state-wide geologic relations:*

Like No. 2 above, this sort of investigation is state-wide in scope and serves to utilize in a broad and thorough manner the result of detailed studies in limited areas. It is only through these investigations of wide scope that the general relations controlling the origin and development of our mineral deposits can be understood. Hence, while primarily scientific in plan, this type of study has come to be recognized as of prime importance in the exploitation of mineral resources of a region. The report of the "Tertiary Formations of Western Washington," which appeared as Bulletin 13 of the Division publications, belongs in this category.

Studies belonging in one or another of the above groups have been undertaken in the past but attention has of necessity been centered on those investigations in which specific results could be obtained in the shortest possible time. As a result, the broader problems, the solution of which demands the accumulation of large amounts of data, have received little or no attention.

An inspection of the previous activities of the Division of Geology emphasized the need of a general survey of the state in an attempt to determine the proper fields for geologic studies by the Division in the future. First hand data being essential to a thorough understanding of the matter, most of the work of the Supervisor has been of reconnoissance character, devoted to the inspection of the whole state. In the course of the field seasons the details of structure and stratigraphy were observed in selected portions of practically every county of the state, and the general geologic relations noted over a much wider area. So far as time permitted, mines, quarries, and the many other industrial operations involving geology were visited. During the winter months, these data were organized, correlated, and to a considerable degree amplified through correspondence and conferences with industrial operatives and engineers throughout the state.

On the basis of this general investigation of the needs of the state it has been possible to arrange a general program of Divisional activities, with due regard to the character, extent, and approximate cost of the work to be undertaken.

In addition to the foregoing general investigation some detailed work of importance and far reaching character has been begun.

For more than a quarter century the northern part of the state has received considerable attention from prospectors, mining engineers, and geologists. While providing detailed facts of undoubted value in local areas, this work has served mainly to reveal the great complexity of the structure and stratigraphy of the region and to demonstrate the need for intensive study of the whole field.

It seemed desirable to initiate this work in a region where the natural conditions favored this detailed type of work and where the results could be utilized at an early date in the further study of the valuable mineral deposits. After inspection of several areas it was decided to begin work on the Chewelah quadrangle in Stevens county. The object of this study was to provide material for a comprehensive report on the geology and mineral resources of the region, introducing such facts as would be particularly useful in the commercial exploitation of the mineral resources. In the course of the first summer, Pro-

fessor R. H. B. Jones, with an assistant, completed the study of the northern half of the Chewelah quadrangle. During the present season this work has been carried to completion for the whole quadrangle and the results will be incorporated in a report now in course of preparation.

While the foregoing grouping adequately indicates the major lines of service of the Division, there are a number of important activities which are difficult of classification and which may be taken as part of the usual and routine work of such an organization. Among these may be mentioned the systematic collection of representative ores, rocks, mine maps, geologic maps, and reports which constitute part of the working equipment of an efficient geologic survey. Coincident with the reorganization of the survey during this biennium, these phases of survey work have been especially arduous, but from now on will take their proper subordinate position.

TOPOGRAPHIC MAPPING.

As early as 1893 topographic mapping had been begun in the State of Washington under the auspices of the Topographic Branch of the United States Geological Survey. Unappreciated at first, these maps passed almost unnoticed, but as soon as larger areas were covered the value of the maps became more and more apparent. Ultimately there was developed a real and specific demand for such maps and their preparation came to be recognized as one of the chief functions of the geologic organization.

About 1910 there was formulated an agreement between the Federal and state agencies whereby topographic mapping would be hastened, the cost being equally divided between the two. Until 1925 the State of Washington enjoyed this cooperation and a total of more than 11,600 square miles was mapped. Independent mapping by the U. S. Geological Survey, prior to and during the period of cooperative activity, covers an additional area of nearly 21,000 square miles. During the present biennium the cooperative agreement for topographic mapping between the Department of Conservation and Development and the United States Geological Survey has been renewed.

Earlier work has been terminated while the mapping of the Chewelah quadrangle, in Stevens county, was about half completed. The first work was therefore planned so as to avoid any further loss on that project. Effective field work permitted the completion of that quadrangle and the starting of work on the Colville quadrangle to the north. During the past season, 1928, this work has been continued through the activity of a precise-level party and two sketching parties. A line of levels was run from Colville to the International Boundary east of Columbia River, tying with pre-determined points on the general network for the state and giving adequate level control for the complete sketching of the area. By the close of this season the work will have been carried so far that a single month next season will serve to finish it.

The work of this biennium, together with some additional work by the Federal Government in connection with the National Forests brings the total area now mapped to about 35,000 square miles, slightly more than 51 per cent of the total area of the state.

LABORATORY AND FIELD SERVICE.

One of the incidental but potentially important activities of the Division of Geology is in response to the demand for assistance in determining the value of mineral deposits. This service involves both field and laboratory ex-

aminations and requires considerable time and equipment. In this way, however, invaluable service is rendered the state through the intelligent direction of prospecting for, and utilization of, our mineral wealth.

In the past this phase of Divisional work has received particular attention and during this present biennium it has been continued and amplified in certain respects involving the cooperation of various departments of the State College of Washington. The very limited time and funds available have precluded the possibility of meeting any but a very few of the requests for field examination.

COLLECTION OF MINERAL STATISTICS.

This phase of Divisional activities corresponds in character to the work of the Census Bureau and has for its object the collection and tabulation of all data relative to the actual production of mineral wealth within the state. Such data form the only practicable basis for the intelligent comparison and study of many phases of the mineral industry. For a number of years past this Division has cooperated with the Federal agency in charge of the collection of mineral statistics. By this means any duplication of effort is avoided and the state receives the full benefit of the compilation. This cooperation has been continued during the past biennium.

The appended table gives the mineral production for 1925 and 1926 as far as available. Although the figures are probably subject to some revision, they indicate with sufficient accuracy the importance of the mineral industry in the state. It is to be noted that of the total of \$23,804,577 production, more than \$11,000,000 are in the non-metallic group.

MINERAL PRODUCTION OF WASHINGTON FOR 1925 AND 1926.

PRODUCTS	1925		1926	
	Quantity	Value	Quantity	Value
Briquets, tons	① ②	① ②		
Cement, barrels	2,499,237	\$5,523,324	2,153,320	\$4,632,258
Clay products		2,619,250		
Clay, raw, tons	24,170	② 43,645	12,947	31,515
Coal, tons	2,537,890	9,176,000	2,586,568	9,350,000
Coke, tons	79,257	② 617,265	67,286	518,053
Copper, pounds	1,159,057	164,586		
Diatomaceous earth	①	①	①	①
Gold, troy ounces	11,138	230,253		
Gypsum, tons	①	①		
Iron ore, long tons	830	①	①	①
Lead, tons	2,814	489,570	2,273	②
Lime, tons	29,636	357,297	23,783	298,014
Magnesite, tons	56,060	560,600		
Magnesium sulphate (natural)	①	①		
Manganese ore, long tons	8,113	①	①	①
Mercury			①	①
Mineral waters, gallons sold ④				
Pulpstones, short tons			①	①
Rubbing stones, tons	①	①	①	①
Sand and gravel, tons			①	①
Silica (quartz), tons	4,197,660	1,763,153	3,910,577	1,704,234
Silver, troy ounces	①	①	①	①
Stone, tons	166,425	115,499		
Zinc, tons	576,690	1,042,165	818,390	1,318,228
Miscellaneous ③	609	92,556	522	②
		1,009,414		140,989
Total value		\$23,804,577		\$17,983,291

① Value included under "Miscellaneous."
 ② Value not included in total value for state.
 ③ Includes minerals indicated by ① above.
 ④ No canvass.

RECOMMENDATIONS.

Geologic Studies: For nearly a quarter century, under the appropriations made by the State Legislatures, geologic investigations in the state have been actively prosecuted, first by the State Geological Survey and later by the Division of Geology.

Of necessity much of the earlier work was of reconnoissance nature whereby relatively large areas were covered in short periods of time. In addition to these general studies, however, detailed reports of certain districts were prepared. Bulletins such as No. 1 on the Republic area, and No. 7 on the Index area show the results of these endeavors. These early activities served to bring out the major features of the rather complex geology of the state and the details of a few selected areas as well. Experience has shown, however, that only a certain amount of the general or reconnoissance character can be profitably undertaken. While of considerable value in formulating a general conception of mineral deposits, these general studies must be supplemented by detailed studies to greatly assist the exploration and exploitation of known resources. Hence it is obvious that a stage is reached when the emphasis of the work of the Geologic Survey must be laid upon the detailed studies if the maximum benefit of the investigations is to be obtained.

Inspection of the mineral industries of the state indicates that such a stage has now been reached in our investigations. It is therefore necessary for us to consider means by which we can be of further aid to those who are honestly endeavoring to develop the mineral resources of the state. With few exceptions the broader geologic relations of the known mineral deposits of the state are fairly well understood. By contrast, there is scarcely a district in which the prospectors and producers would not benefit if the details of structure and stratigraphy could be put at their command. We have already acquired and put into use the more general features but lack the details without which further progress is slow if not impossible.

Geologic problems are rarely simple. By their very nature they involve unknown relations underground and must be attacked by some indirect method. This is particularly true when details are sought, for in these cases the solution of a given problem frequently involves the correlation of many apparently unrelated data. It follows that such studies must progress slowly and may demand considerable time and effort.

The State of Washington appears to be entering upon a period of extensive industrial development. No one in touch with the trend of commercial affairs can doubt the probability of marked increase in general construction and the utilization of the power and other resources of the state. This movement is certain to result in a corresponding expansion in the mineral industry of the state and if it is to have the benefit of scientific direction it is necessary that there be made a thorough and comprehensive survey of the mineral resources of the state.

Knowledge must precede the application of knowledge in geology as well as in other matters and unless the development of the country's mineral resources be based upon and proceed from the scientific knowledge of its geology there must inevitably be waste of effort, loss of money, and delay of progress inseparable from haphazard methods.

Since the field to be studied is broad and complex, it is particularly desirable that the start should be made at an advantageous point. Two general

features of the work should be borne in mind: first, the investigations should be planned so that the results of the early studies will be of value for those undertaken later; and second, work should be begun and continued on both metallic and non-metallic deposits.

No attempt is made here to list the many investigations which are contemplated. The object is rather to indicate the nature and scope of the work so that its importance may be realized. Typical of the metallic deposits which seem to merit attention are the well known lead-silver ores of the northeastern part of the state, the copper ores in the Red Mountain and Sultan districts, the quicksilver deposits of Lewis and other counties, and the manganese ores of the Olympic belt. The non-metallic resources are in general simpler in their geologic relations and are consequently better understood. Among the outstanding exceptions to the general rule, however, may be noted the magnesite deposits of the Chewelah district, the artesian water supplies which constitute an important economic resource in various parts of the state, and the potential oil and gas pools for which a diligent search has been made in several localities during the past few years.

In connection with the non-metallic deposits, attention should be called especially to the relative importance of clays in the mineral industry of the state. It is not widely appreciated that clay constitutes one of Washington's most important resources at present, nor is it generally realized that on account of the immense deposits of valuable clays of great variety this is almost certain to become of even greater relative importance.

Under an agreement between the Engineering Experiment Station of the University of Washington, the United States Bureau of Mines, and the State Geological Survey, there was planned a comprehensive study of all phases of this very important industry in this state. The first product of this agreement was the report by Professor Hewitt Wilson of the University of Washington, published several years ago. Its popularity is attested by the fact that the issue has been out of print for about four years. The companion report on the geology of clay deposits was completed prior to April 1, 1921, but its publication has been delayed.

The seven-year interim has seen many changes in the clay industry in Washington. Further development of known deposits has revealed additional information as to their nature and mode of formation. Prospecting has shown the presence of deposits of unknown dimensions and value. By a rather complete revision of the existing report it can be made of immense value to the state in the further development of the clay industry.

The needs of the state for geologic work are too extensive and too important to permit any but the most effective use of scientifically trained men. Under the present arrangement geologists are working for the survey only during the summer season under temporary appointment with the concomitant delay and irregularity in the preparation of reports. In order to more effectively carry on the geologic work it is proposed to secure the services of a competent geologist to work under the direction of the Supervisor on a twelve-month basis. This man will have charge of investigations of non-metallic deposits and will be chosen on the basis of his demonstrated ability in that line. By this means it will be possible to avoid most of the losses due to a continual change of personnel and each investigation will have the benefit of the results of previous work.

Publication: The work of the survey is only partially done when field studies have been made and reports prepared. In order that the citizens of the state may receive the benefit due them from the prosecution of this work it is necessary that the reports of the results be published early and distributed as widely as can be done economically. One of the outstanding failures of many such organizations as the Division of Geology is the delay involved in the publication of reports. Many schemes such as the use of press notices and preliminary reports have been used to avoid this loss in time. This survey has begun a series known as "Reports of Investigations" through which it is planned to present such results of current investigations as cannot well be deferred until a complete report with engraved maps is off the press. After a piece of investigative work has been completed it should be possible to present the results to the people of the state with the least possible delay. With this as a fixed policy the field men are instructed to observe a rule widely followed by similar organizations throughout the world, that of withholding the results of current investigations until publication can be made. By this procedure all citizens of the state and other interested persons have an equal chance to benefit by investigations which have been undertaken and financed by this agency.

**DEPARTMENT OF CONSERVATION AND DEVELOPMENT.
FINANCIAL STATEMENT.**

From April 1, 1927, to September 30, 1928.

FUND	Appropriation	Expenditures	Balance
GENERAL FUND			
General Office	\$8,700 00	\$6,455 19	\$2,244 81
Forestry Division	160,000 00	142,735 49	17,264 51
Hydraulic Division	40,500 00	40,498 90	1 10
Hydrographic Survey	10,000 00	6,084 14	3,915 86
Geological Survey	5,000 00	4,705 98	294 02
Topographic Survey	10,000 00	7,598 19	2,401 81
RECLAMATION REVOLVING FUND			
Reclamation Division—Operations	33,500 00	17,506 55	15,993 45
Land Settlement, Kittitas Project, and/or Contract and Bond Purchases.....	400,000 00	298,866 95	101,133 05
Land Settlement, Kittitas Project.....	150,000 00	.....	150,000 00
Columbia Basin Survey (reappropriated).....	13,621 78	12,234 22	1,387 56
Reliefs	250 00	250 00	.....
State Forest Board.....	3,000 00	772 72	2,227 28
SPECIAL FUND (Chap. 161, Laws 1925)			
Hydraulic Division—Water Code.....	20,000 00	2,686 19	17,313 81
Totals.....	\$854,571 78	\$540,394 52	\$314,177 26