

purposes. In rejecting the Indians' contention that all waters of the stream in question were reserved for them by treaty, the court held that the State had the power to regulate according to State law those waters in the stream not used by the Indians to carry out the purposes for which the reservation was created, even though the waters were physically located within the exterior boundaries of an existing reservation.

John M. Kniseley vs. the State of Washington. Notice of appeal has been filed in the Superior Court of the State of Washington for King County and served upon the Supervisor with regard to the decision entered under Surface Water Application No. 15755, Della D. Randall. In this instance the applicant requested permit to appropriate a portion of the waters of an unnamed spring for domestic purposes. Objections to issuance of permit were recorded through counsel by John M. Kniseley. After full review of the circumstances involved, the Supervisor ruled in favor of the applicant and notice of appeal followed.

Hearing of the appeal before the court is being deferred pending possible settlement between the parties. Negotiations toward settlement are presently in progress.

Fixing the Level of Clear Lake in Skagit County, Washington. Chapter 90.24 RCW sets forth a procedure whereby the level of certain lakes within the state may be set by a superior court of the state. The supervisor has participated, as statutory party, in one such proceeding during the past two years. This is the case of *In the Matter of Fixing the Level of Clear Lake in Skagit Count, Washington*. Objectors to the setting of level for said lake have submitted arguments contending that Chapter 90.24 RCW, at least as applied to the facts before the court, is unconstitutional.

No decision has as yet been rendered by the court.

Walker vs. Biles-Coleman et. al. The first of a series of general water rights adjudications, also covered elsewhere in this report, was initiated by the Supervisor of Water Resources in the Case of *Walker vs. Biles-Coleman Lumber Company, et al.* This involves the waters of Chiliwist Creek in Okanogan County.

Among the defendants in this proceeding is the United States of America. Immediately after the filing of the case, the United States removed the entire action from the State Superior Court in Okanogan County to Federal District Court in Spokane.

Thereafter the supervisor moved to remand the "removed" case back to Okanogan County Superior Court. The Federal District Court found the action to have been improperly removed and granted the Supervisor's motion.

Presently pending before the Okanogan County Superior Court is a motion to dismiss the United States as a party to the action. This motion has not as yet been argued.

Determination of Existing Rights.

During the biennium, petitions were received from water users on seven streams for the adjudication of existing rights under the Surface Water Code. The streams involved and the date the petitions were received are as follows:

PETITIONS FOR ADJUDICATION RECEIVED DURING THE BIENNIUM

Stream	Tributary of	County	Date
1. Crab Creek	Columbia River	Adams, Lincoln	7-25-62
2. Ten Mile Creek	Nooksack River	Whatcom	8- 3-62
3. Unnamed stream	Duncan Creek	Skamania	3-25-63
4. Narcisse Creek	Little Pend Oreille	Stevens	4- 3-63
5. McGee Creek	Columbia River	Stevens	4-29-63
6. Blockhouse Creek	Klickitat River	Klickitat	12-20-63
7. Marshall Creek	Latah Creek	Spokane	3-20-64

Waters of many of the streams in the state have been appropriated to the point where controversies arise each year between individual holders of certificates of water right issued by this office, and claimants to senior rights allegedly established by prior appropriation or under the riparian doctrine. Under the Surface Water Code this office has no authority to regulate in favor of, or against prior claims, until the priority and extent of such claims are determined through adjudication proceedings. The existence of unadjudicated claims to water rights makes it extremely difficult to determine the quantity of water still available for appropriation, as well as any determination of the highest beneficial use of the State's remaining water resource.

Since the adoption of the State Water Code on June 7, 1917, fifty-seven streams have been adjudicated under the provisions set forth therein. Many of these adjudications encompassed only a portion of a particular stream, rather than its entire drainage area. Present policy is to include the complete drainage area of a stream in the adjudication proceedings, so that claims to the use of water from tributary streams may not arise at a future date.

A petition for adjudication raises the question of availability of water for further appropriation, accordingly, the supervisor does not approve further appropriative rights from a disputed source involved a petition for adjudication, until all claimed rights thereon have been judicially evaluated and determined. Presently 14 streams within the state are within this category awaiting initiation or completion of adjudication proceedings.

The need for additional water increases with, and is a reflection of, the economic growth of the state. Appropriative rights awarded to meet these needs correspondingly increasingly impinge upon claimed rights. Thus, each petition for adjudication, by causing suspension of issuance of further appropriative rights pending adjudication, in effect, reduces economic development in that particular area.

Plate I in the appendix to this report depicts the relatively few streams adjudicated, or in process of adjudication, in relationship to the number of streams within the state. It is inevitable that within the next few years, an acceleration of conflicts between known appropriative rights and unproven claims will cause a serious and increasingly restrictive slow down of agricultural, commercial and industrial development throughout the state.

During the biennium, personnel and funds were available only to commence adjudication proceedings in the Okanogan County Superior Court, on the Chiliwist Creek Petition; and to do preliminary field surveys on Stranger Creek; Cummings Canyon Creek and an unnamed stream in Chelan County.

The present back log of 13 petitions under which proceedings are to be initiated together with the inevitable increase in requests for additional adjudications, results in the request for substantial budget increases for the 1965-1967 biennium. However, it must be recognized that this activity is not an expanded service but is a necessary obligation and duty expressly set forth in the statutes.

GROUND WATER AND GEOLOGIC MAPPING PROGRAM

Statement. The State Division of Water Resources geologic mapping and ground water resource inventory program was continued through the biennium both as division projects and through the cooperative program with the ground water branch of the United States Geological Survey. In addition to the progress made on county-wide geohydrologic studies, Division of Water Resources personnel participated in a number of research projects designed to provide answers to specific problems and establish new parameters which will permit a better and more effective administration of the State's ground water resources.

With the exception of several local problem areas, where water levels continued to decline from over-pumping or where levels continued to rise as a result of return waters from project irrigation, water levels throughout the state were about average expressing only normal seasonal variations.

History of Ground Water Investigations.

Geologic mapping in conjunction with ground water investigations within the State of Washington had its beginning just prior to the turn of the century and for discussion purposes can be divided into two phases. The early phase covers the area from the 1890's to the late 1930's. During that period ground water studies were sporadic and no attempt was made to cover the state systematically by an organized series of investigations. Since about 1937, when State Division of Water Resources' (Division of Hydraulics) officials became actively interested in the proper development and management of the state's ground water resources, aerial studies of ground water have proceeded on a steady basis. This period consists of the current phase of ground water investigation.

Early Phase of Ground Water Investigation. The first recorded investigation of the water resources in the State of Washington was made by I. C. Russell in 1893. According to him,

"An examination of the country . . . was ordered by the United States Geological Survey at the request of persons interested in the development of the State of Washington, for the purpose of ascertaining how far the geological structure of the state favored the hope of obtaining artesian wells for irrigation."

Russell's investigation dealt chiefly with the Yakima and tributary valleys and secondarily with the basalt plateau in the central and southern parts of Douglas County. In the Yakima Valley, Russell found that development of ground water already had begun and that the valley had definite promise for extensive development of ground water from flowing wells. The outlook for the Douglas County area was, on the other hand, bleak.

The foregoing viewpoint concerning the difficulty in developing ground water in basalt also was held by F. H. Newell. He reported in 1894 that the question of obtaining ground water on the plains of the Columbia River was still unsettled because attempts at drilling deep wells had been prevented by the great thickness of lava underlying the plains and by the expense involved.

In the summer of 1896, I. C. Russell made an investigation of the geology of the southeast portion of the State of Washington "For the purpose of

ascertaining how far the nature and position of the rocks of that region favor the hope of obtaining ground water." He restricted his investigation to the part of the state south of the Snake River comprising Walla Walla, Columbia, Garfield and Asotin Counties, an area of about 4,000 square miles.

The Yakima Valley in the vicinity of Yakima was investigated again in 1900 by G. O. Smith. In the eight-year period following the original reconnaissance by Russell, considerable ground water development had taken place, which provided Smith with much more field information that was available to Russell. Smith described ground water conditions in the Ahtanum-Moxee, in the Wenas-Selah Basins and in Cowiche Valley.

The Columbia plateau was investigated again in 1902. F. C. Calkins, acting under instructions from Mr. F. H. Newell, made a re-examination of a portion of the plateau touched upon by Russell in his earlier work. During his investigation, Calkins traversed parts of Kittitas, Douglas, Lincoln, Adams and Franklin Counties. As in the earlier reports concerning ground water in eastern Washington, Calkins was primarily interested in the development of ground water by the construction of wells through which water flows at land surface.

The first study of ground water supplies for the state, as a whole, was made by Henry Landis in 1905. In his report, he listed the counties of the state in alphabetical order and described the more important water supply systems in each.

In 1907, G. A. Waring made a reconnaissance study of geology and its relation to the occurrence of ground water in an area of about 5,000 square miles comprising Benton County, the eastern parts of Yakima and Klickitat Counties and the western part of Franklin County. In Waring's report, he stated that the object of his investigation was to "Study the supply at present in use and the possibility of increasing it by sinking deep wells."

Beginning in about 1911, the geological survey conducted an inventory of wells in the vicinity of Moses Lake under the supervision of F. F. Henshaw. The data collection program, the results which were not published, was undertaken in cooperation with the Grant Realty Company of Moses Lake. The program was discontinued a year or so later and no records of the conclusions reached are available.

The first report, that deals primarily with the occurrence and availability of groundwater in the state on other than a reconnaissance basis, was prepared by Schwennesen and Meinzer (1918). The material for the report was collected by the authors from the Quincy Basin in Grant County and covered an area of about 600 square miles. From their study the writers were able to collect a large amount of information adequate to permit construction of a water table map, to draw geologic sections and to use as a basis from which a rough figure of annual recharge could be estimated.

From 1916 to about the late 1930's, at which time ground water investigation in the state was given great impetus by the interest of local agencies, progress in ground water investigation lay almost dormant. Only three investigations were made during this period, two with regard to obtaining a firm supply of water for the federal penitentiary on McNeil Island and one for the Walla Walla Basin. The first unpublished report for McNeil Island was written in 1924 by Kirk Brien; the second by A. M. Piper in 1930. The report on the Walla Walla area was published as a court document.

Current Phase of Ground Water Investigation. The current phase of investigation of ground water in the State of Washington began when the Division of Water Resources (Division of Hydraulics) initiated the policy, in 1937, of supplying funds each year to be matched by the Geological Survey to map geology and study ground water on a systematic schedule in several basins of the state. Although the State Division of Water Resources had participated in some previous cooperative ground water studies, the year 1937 marks the start of a continuing program which has increased in scope year after year. The following table lists the funds supplied by the State of Washington for cooperative ground water studies for the period 1937-1964.

Biennium	Total funds	Biennium	Total funds
1937-39	\$ 4,650	1951-53	32,670
1939-41	4,490	1953-55	34,170
1941-43	4,700	1955-57	38,400
1943-45	4,770	1957-59	53,600
1945-47	7,800	1959-61	68,500
1947-49	15,600	1961-63	85,000
1949-51	31,500	1963-64	46,000*

*One-half biennial commitment of \$93,000

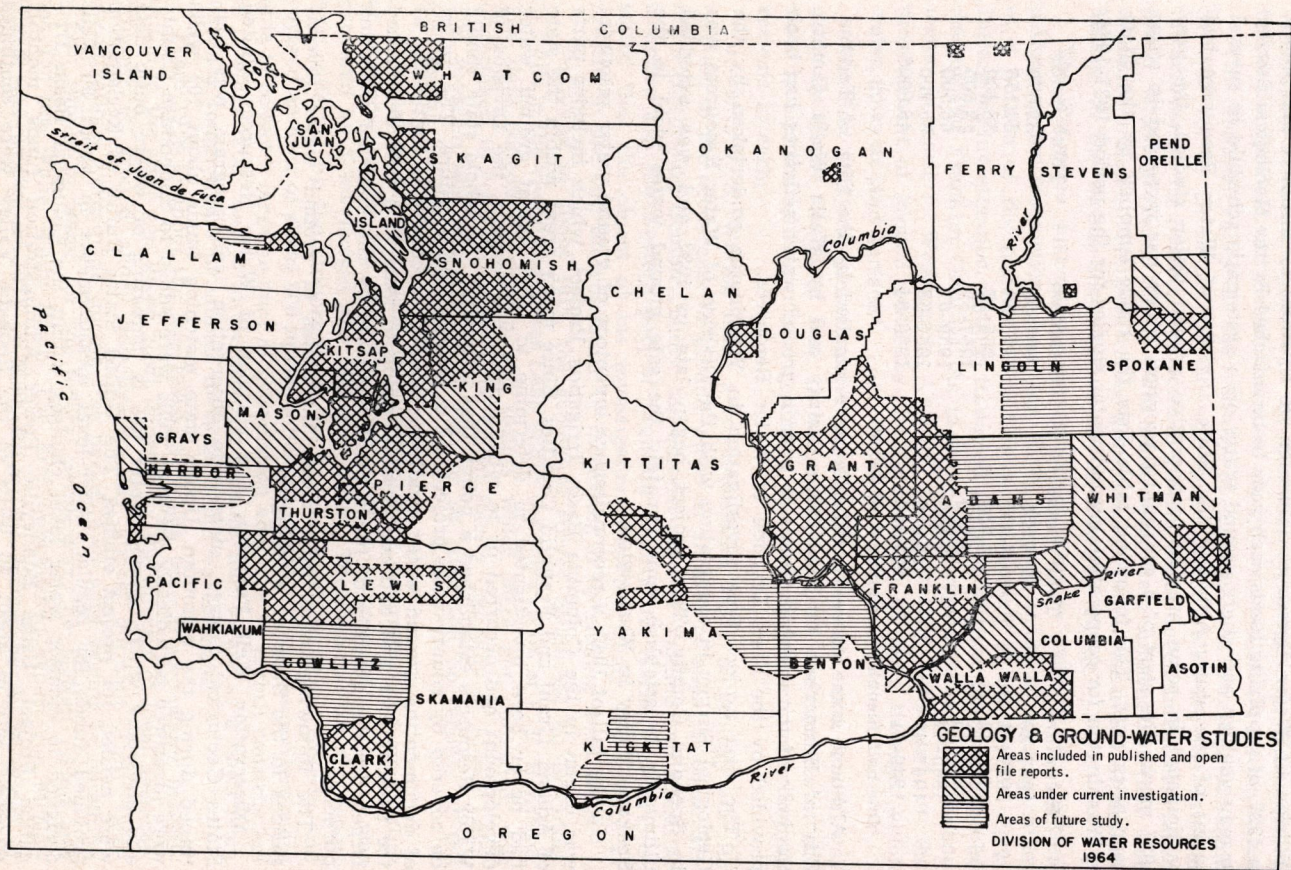
Although some cooperative funds were supplied by the City of Tacoma, City of Bremerton, by Snohomish County and by Walla Walla County, the bulk of the matching funds to sustain ground water activities has been provided by the State Division of Water Resources.

The first project type investigation in Washington undertaken by the Geological Survey in cooperation with the Division of Water Resources was in Spokane County. This project began late in 1937 and was extended ultimately to establish approximately the safe ground water yield in the Spokane Valley in Washington.

In the fall of 1940, a reconnaissance inventory of ground water resources was begun in the Columbia Basin Irrigation Project, which includes parts of Adams, Grant and Franklin Counties. Since many areas within the state had never been investigated to determine to what extent ground water development had occurred or to what extent was feasible, the Division of Water Resources established a policy that ultimately the whole state should be covered by county-wide projects of a reconnaissance nature. The policy of documenting ground water conditions county by county is continuing at the present time and will continue according to need at a rate determined largely by the quantity of funds made available by the state for matching purposes.

The following index map shows the status of ground water investigations in the State of Washington.

Observation Well Program. The Division of Water Resources—United States Geological Survey, state-wide observation well program was continued during the biennium. Under state matching funds about 105 wells were measured periodically. Several wells were added to Snohomish County and elsewhere where ground water use is increasing or where basic data were needed for project studies. The United States Bureau of Reclamation provided funds for regular water-level measurements in about 90 wells designed to monitor water level changes within the Columbia Basin Irrigation Project. Using Bonneville Power Administration funds, monthly measurements in about 20 wells in the Spokane Valley were continued through the biennium as a part of a program to determine the value of



ground water in storage in tributary valleys as a parameter for predicting the base flow of the Columbia River. Records of all these water level measurements are reported to the Division of Water Resources annually as well as to the other participating agencies.

Areas of Declining Water Levels.

1. Horse Spring Coulee-Aeneas Lake Area. An area of approximately 1800 acres located about 4 miles west of Tonasket, Okanogan County, Washington, is an area where water levels in wells and the water level of Aeneas Lake has been lowered nearly 14 feet since 1950. The Horse Spring Coulee-Aeneas Lake area is intensely farmed utilizing ground water being pumped from wells and water pumped directly from Aeneas Lake for irrigation purposes. It appears that the safe sustaining yield of the aquifers has been reached or is being exceeded.

A preliminary evaluation of the problem suggests that water from outside Horse Spring Coulee must be imported to compensate for the over-pumping from within the Coulee. Possible sources of exotic water are: (1) Aeneas Creek lying about a mile west of and roughly parallel to Horse Spring Coulee. (2) Okanogan River about two miles east of Aeneas Lake. (3) Surplus water from the Whitestone Irrigation District complex.

A meeting has been scheduled for August 17 which will be attended by Horse Spring Coulee ranchers, officials of the Town of Tonasket, representatives of the Department of Game and Division of Water Resources. The meeting has been called for the purpose of defining the problem and discussing possible solutions for the water level decline.

2. Odessa Area. Some wells in a 180 square mile area lying generally south and west of Odessa have experienced water level declines in recent years. It is an area where a number of large production wells have recently been completed or are in the process of being constructed. The problem is compounded because of the existence of two separate aquifer systems: one shallow aquifer from which many of the farmers obtain their domestic and stock water and a deeper aquifer or aquifers from which most of the irrigation water is pumped. In trying to preserve the shallow aquifer for domestic and stock water purposes, the Division of Water Resources has required that some irrigation wells penetrating to the deeper aquifers be cased with water tight casings which will prevent the shallow water from percolating to the deeper zones.

To keep abreast of water level changes that occur, the Division of Water Resources has established a net of observation wells from which regular periodic water level measurements are taken which will monitor water level changes and point out potential problems.

3. Pullman Area. Water levels in wells within the Pullman-Moscow Basin have continued to decline during the biennium. The decline has persisted at approximately one foot per year since about the turn of the century and the rate of decline has increased during the past few years.

4. College Place, Walla Walla County. Although water levels in observation wells within the Walla Walla Basin generally have more or less stabilized in recent years, water levels in the College Place area have continued to decline which points out the need for a remedial program.

The College Place water level decline problem was discussed with Mr. Anthony B. Barnes of the consulting firm Corell, Howland, Hayes and

Merryfield who are advising the City of College Place on their water resource development and distribution program. Mr. Barnes was fully aware of the declining water level problem and will present recommendations to the city officials for appropriate measures to deal with the problem.

Special Studies and Research Projects.

In addition to the Division's cooperative geohydrologic mapping program with the United States Geological Survey, the Division of Water Resources participated with other agencies in a number of special projects and research programs. Some of the more important are listed below:

1. Jackson Prairie Natural Gas Storage Project. The Division of Water Resources was commissioned by the Washington Water Power Company, Washington Natural Gas and El Paso Natural Gas, to coordinate a program to determine the effects of natural gas storage on the ground water resources which over-lie a geologic structure near Mary's Corner, Lewis County, Washington, into which natural gas is being artificially injected.

The water-quality monitoring program is being carried out jointly by the Division of Water Resources and the Quality Branch of the United States Geological Survey. Through the program, water samples from 134 water wells in the vicinity of the project were collected and analyzed chemically and for natural gas content. This is the most concentrated and complete ground water quality study ever made in the state.

In addition to the complete chemical and gas analyses of the 134 wells, 12 of the more representative wells were selected as monitors for continuing gas analyses to detect any changes in water quality or leakage of natural gas from the structure into the over-lying water bearing zones.

As of August 3, 1964, over 232 million cubic feet of natural gas had been stored in the naturally occurring geologic structure with no apparent adverse effect on the fresh water body over-lying the structure. The water quality monitoring program is being continued in conjunction with the participating agencies.

2. Pullman-Moscow Basin. Because of the concern of several agencies over the continuing water level decline in the Pullman-Moscow Basin, the Division of Water Resources, the City of Pullman, Washington State University, the City of Moscow, Idaho, and the University of Idaho, have co-sponsored a program with the Washington State University, Division of Industrial Research, whereby water samples will be collected and analyzed for tritium and/or carbon 14 content. In all, not less than 50 surface and ground water samples will be analyzed and the data used to define the movement pattern of the ground water and evaluate the water resource potential of the Pullman-Moscow geologic basin. The project will require from 12 to 18 months and it is anticipated that the final results will be published by the winter of 1965.

3. Artificial Recharge, City of Walla Walla. Artificial recharge through a well furnishing a part of the City of Walla Walla water supply was continued during the biennium. During the winter of 1962-1963, over a 15-week period, recharge was carried out at an average rate of about 600 gallons per minute for a total of approximately 74 million gallons for the season. Recharge was carried out for a 16-week period during the 1963-1964 winter and was started at 600 gallons per minute and gradually built up to about 1,000 gallons per minute. During the period, a total of approximately 98 million gallons were injected.

After completion of the 1963-1964 period, it was concluded that the recharge well would accept water at rates up to 1,000 gallons per minute without materially damaging the well or aquifer. The work is now being done entirely by the City of Walla Walla Water Department and has become a part of their overall water supply program.

4. Spokane Valley Irrigation Project. Actual drilling of production wells for the Spokane Valley Project got under way during 1964. The project is being constructed by the Bureau of Reclamation and involves the drilling of 33 wells to deliver 67,200 gallons of water per minute, 18,500 acre-feet per year for the irrigation of 7,140 acres of land in Washington and furnish domestic water for up to 38,000 people as of the year 2002. In years past, the lands within the project have been irrigated by waters diverted from the Spokane River, however, the canal system over the years has deteriorated to such an extent that it has become desirable to replace the gravity system from the river by pumping water directly from wells and delivered through closed systems.

The Division of Water Resources has worked closely with the Bureau of Reclamation and the City of Spokane in evaluating the availability of water for the project and its possible effect upon the aquifers from which the City of Spokane obtains its municipal water supply.

5. Hemlock-Looper Spray Project. A 70,000 acre area in Pacific and Grays Harbor Counties heavily infested with Hemlock looper was the site of a spray project designed to destroy the looper infestation. The spraying was done for the Washington State Department of Natural Resources and other land owners. The Washington State Pollution Control Commission coordinated a program to monitor the effects of the spray on the water resources of the area and established procedures to minimize side effects to other resources by the chemicals used.

Division of Water Resources personnel participated in the project to the extent of preparing basic information on the geology and hydrology of the project area.

6. North Cascade Wilderness Area Study. Division of Water Resources personnel participated in the North Cascade Wilderness Area Study and prepared geologic and hydrologic material which was incorporated in the task force report.

7. Wild River Study. Division of Water Resources personnel participated in the evaluation of the Skagit and several other Washington state rivers being considered as a part of a nationwide preliminary evaluation of 64 rivers from which a limited number may be selected and retained more or less in their natural state as wild rivers. The study is being made by the United States Bureau of Outdoor Recreation, Department of Interior, with assistance from state and local agencies.

8. Puget Sound Basin Study. Personnel of the Division of Water Resources have been assigned to task force committees making an evaluation of the quantity and quality of the water resources within the study area. The basin study will be a five-year project designed to inventory the water resources of 10 major and 12 minor streams tributary to Puget Sound. Interim reports will be made on planning studies in process. Scheduled completion of the overall report is 1969. The task force is co-chaired by Mr. John A. Richardson, Assistant Director, Department of Conservation; Mr. Robert H. Gedney, Department of Army, Corps of Engineers.

9. Ahtanum Creek Valley. Because there is a possibility that water users of the Ahtanum Irrigation District may lose a part of the water diverted from Ahtanum Creek through litigation now pending, the Division of Water Resources has received a number of applications for permits to drill deep wells from which water will be pumped to replace the Ahtanum Creek water should it be lost to the district.

Observation well measurements taken during the past several years have indicated that the safe sustaining yield of the basalt aquifers in the upper Ahtanum possibly is being approached and if so, the increased withdrawal from wells for which applications have been received could result in controversy among water users and an extremely difficult administrative problem. Because of the potential problem, the Division of Water Resources has established an observation well program for the area designed to monitor any changes that occur as new wells are drilled and placed in use. Applicants planning to drill new wells have been alerted and the potential problem explained to them.

10. Town-City Water Supply Studies. Division geologists assisted the towns of Cashmere, Oroville, Orient and Starbuck, in evaluating the probability of obtaining additional water supplies from wells for their respective communities. Preliminary geologic and hydrologic reports were prepared for the towns of Cashmere and Oroville.

Cooperative Program With United States Geological Survey

Considerable progress was made during the biennium on county-wide geohydrologic studies and interpretations of data being carried out with the United States Geological Survey.

Investigations Started. During the biennium field work was started on three major projects, those being:

1. Spokane County. Northern part of Spokane Valley. Well Scheduling has been nearly completed and geologic mapping is well under way. The project is scheduled for completion in 1965.

2. East Central Mason County. Geologic mapping about 70% complete. Well scheduling about 85% complete. The project is scheduled for completion in 1965.

3. Island County, including Whidby and Camano Islands. Well scheduling 90% complete. Geologic mapping approximately 70% complete. Scheduled for completion in 1965.

Investigations Continuing.

1. The Whitman County investigation has been reactivated and a reconnaissance type report of the county, excepting the Pullman Basin which was covered by a previous report, is scheduled for completion in 1965.

2. Geologic mapping of southwest King County is continuing. An open file report of well schedules and basic data has been released. The comprehensive report is scheduled for completion during the 1965-1966 period.

3. Geologic mapping of the Columbia Basin Project area has been completed and the text on the geology and hydrology is in the final stages of preparation. The report includes parts of Grant, Franklin and Adams Counties.

Investigations Completed. Reports awaiting approval.

1. Bingham, J. W., Columbia Basin Irrigation Project Well Records, Supplement 5, U. S. Geological Survey open file report.

2. Grolier, M. J. and Bingham, J. W., Geological Map and Cross Sections for parts of Grant, Franklin and Adams Counties, U. S. Geological Survey open file report.

3. Noble, J. B. and Wallace, E. F., Geology and Ground-Water Resources of Thurston County, Washington, Volume 2, Washington State Water Supply Bulletin No. 10.

4. Walters, K. E. Ground Water Occurrences and Structure of Unconsolidated Deposits, Central Pierce County, Washington, Washington State Water Supply Bulletin No. 22.

Reports Published. 1963-1964. Data from which the following reports were prepared were compiled entirely or in part with cooperative funds furnished by the Division of Water Resources and U. S. Geological Survey, Ground-Water Branch.

Holmberg, Glen, "Status of Ground Water Storage in 1963". Minutes, 26th Annual Meeting, Columbia River Basin Water Forecast Committee.

Kimmel, G. E., 1963, "Contamination by Sea Water Intrusion along Puget Sound, Washington," an area having abundant precipitation, Article 50, U. S. Geological Survey Professional Paper, 475 B., p. 182-185.

Liesch, B. A., Price, C. E., and Walters, K. L., 1963, "Geology and Ground-Water Resources of Northwestern King County, Washington," Washington State Water Supply Bulletin No. 20, 241 p., 9 figs.

Luezier, J. E., 1964, "Ground Water Data for Southwestern King County, Washington," U. S. Geological Survey open file report.

Mundorf, M. J., 1964, "Geology and Ground-Water Conditions of Clark County, Washington, with a description of a major alluvial aquifer along the Columbia River," Washington State Water Supply Bulletin No. 9, U. S. Geological Survey Water Supply Paper No. 1600, 268 p., 46 figs.

Kinnson, H. B. and Sceva, J. E., 1963, "Effects of Hydrologic and Geologic Figures on Streamflow of the Yakima River Basin, Washington," U. S. Geological Survey Water Supply Paper No. 1591, 134 p., 21 figs., 3 pls.

Walters, K. E., 1963, "High Productive Aquifers in the Tacoma Area, Washington," Article 227 in the U. S. Geological Survey Professional Paper, 450 E 157-158.

Wolcott, E. E., 1964, "Lakes of Washington, Volume 2, Eastern Washington," Water Supply Bulletin No. 14.

Areas to be Studied. As projects now under way are completed, starts on new projects for several areas will be made and in some cases where original evaluations were of a reconnaissance or preliminary nature, investigations will be reactivated and updated. Areas on which new starts will be made include:

1. Adams County, eastern part.
2. Lincoln County, southern part.
3. Klickitat County, Goldendale area.
4. Grays Harbor County, central part.
5. Yakima County.
6. Cowlitz County.

Areas in Need of Updating.

1. Whatcom County, western part.
2. Skagit County, western part.

Water Resources Inventory.

The water resource inventory program started in July, 1959, was continued through the biennium but on a somewhat reduced scale since some of the personnel originally assigned to the inventory project were required for other Division of Water Resource administrative programs. If adequate funds and personnel are made available for the 1965-1967 period, the program will be resumed on a more active schedule. Three river basins have been scheduled for starts during the next biennium. Those include (1) the Chehalis River Basin (lower reaches), (2) Deschutes River Basin, and (3) Snohomish River Basin. It is possible that plans for the latter two may be changed in view of the Puget Sound Basin water resource study recently started by the Corps of Engineers, the Department of Conservation and other state and federal agencies.

During the biennium an inventory of the Water Resources and Geology of the Kitsap Peninsula and Certain Adjacent Islands was completed and the geologic and hydrologic maps published. Publication of the text is being held up because funds are not available.

"Lakes of Washington, Volume 2, Eastern Washington" was completed and published which brings to a close the current lake inventory phase of the overall water resource inventory program. "Lakes of Eastern Washington" presents basic data for 4,051 lakes lying east of the crest of the Cascade Mountain range and contains 220 photographs and 190 bathymetric (depth contour) charts of popular fishing lakes. The total of lakes listed in Volume 2 represents 436,662 surface acres of water.

COOPERATIVE DATA COLLECTION PROGRAM**Snow Surveys and Water Supply Forecasts.**

Cooperative snow surveys and water supply forecasts continue to show growth in the State of Washington as the need for additional information is known. In the past two years, the number of basic data stations has increased until there are now 159 snow courses in the state, 9 soil moisture stations and 35 aerial snow survey stadia markers. Two hundred and seventy-seven forecasts were made and released for 32 river gage stations. A total of 785 individual snow measurements were made during the winter of 1963-64.

Reports entitled "Water Supply Outlook and Federal-State-Private Cooperative Snow Surveys for Washington" are prepared by the Soil Conservation Service and issued cooperatively by the Department of Conservation, Division of Water Resources and the Soil Conservation Service monthly during the late winter and early spring. Five such reports, February through June, are sent to the water users, managers and interested parties each year. During 1964, 2250 reports were mailed. In addition to the state report, 6 individual watershed reports are sent to 1830 recipients 4 times each season, February through May. These six watershed reports cover the following areas: Yakima River; Chelan, Entiat and Wenatchee Rivers; Okanogan and Methow Rivers; Colville, Kettle and Sanpoil Rivers; Walla Walla River; and Lower Columbia from Bonneville to mouth.

In the State of Washington, snow surveys were started in 1915 by the Bureau of Reclamation and in 1927 by Washington Water Power. It was not until 1935 that the Department of Agriculture, working with the State of Washington, was assigned by Congress the responsibilities of coordinating all snow surveys. Since that time, the growth of snow surveys and the resultant water supply forecasts has been steady in order to meet the needs of all the water users in the state.

The present network of snow courses will probably not be increased by any large extent in the near future. As happened during the last two years, there were 14 snow courses that were dropped from the network and 14 new courses located to give broader coverage over the state. The increased use of helicopters has made a more efficient type of operation, reducing the number of snow survey shelters needed and permitting the establishment of some snow courses at better and more inaccessible locations. It has always been a problem of balancing the cost of measuring a snow course with the value of data obtained. Expensive shelter cabins can now be replaced by emergency caches and hazardous avalanche terrain can be flown over instead of crossed on foot.

The facilities of the Computing Center at Washington State University at Pullman have been utilized for the analysis of basic data. By using the computers, a large number of different pieces of data can be studied singly or in different combinations to give the best possible forecast of seasonal runoff. All of the forecasts issued by the Department of Conservation and Soil Conservation Service have been subjected to computer analysis.

The Soil Conservation Service and the Department of Conservation, with the assistance of the Weather Bureau, have installed three precipitation storage gages on the east side of the Cascade Range. These are the first mountain storage gages that have been installed in eastern Washington. The reading of these 42-inch storage gages will be at least once a month and will be conducted by Wenatchee Heights Irrigation District, Okanogan Irrigation District and United States Forest Service, Okanogan National Forest.

In addition to these three storage gages, there are three new soil moisture stations at the same location. All of these installations are at established snow courses where in the future all the precipitation that falls in the area will be sampled. This is to determine if it evaporated, percolated into the soil or ran off into the reservoir for later use. By studying all the precipitation and knowing how much is needed to satisfy the soil moisture conditions, a better understanding of the runoff—when and how much—can be gained.

For the past three winters, there has been work going on at Mt. Hood on the development of a remote snow sensor, a device that weighs the snow in place. This device, a pressure pillow, has now proved satisfactory enough for field use. The Pacific Power and Light Company is planning on installing one or two of these pressure pillows on the Lewis River watershed. In all probability, the pillows will be located at existing snow courses and the information telemetered out to either the power plants or the Portland headquarters of the Utility. The installation of these pillows will be a cooperative venture but the telemetry will be the responsibility of the Utility alone. Public Utility District No. 1 of Chelan County is also studying the pillow system for possible establishment in the Chelan Lake watershed.

WASHINGTON SNOW SURVEY PERFORMANCE RECORDS

	PAST				PROPOSED	
	1955-56	1957-58	1959-60	1961-62	1963-64	1965-66
Snow Courses (No.)	83	88	122	159	159**	165
Snow Surveyors (No.)	96	87	120	121	135	120
Man-Miles Traveled Over Snow	2,305	2,994	6,601	8,100	8,000	8,000
Over-Snow Machines	4	4	7	10	12	14
Miles by Over-Snow Machines	940	788	1,152	1,200	1,500	1,800
Aircraft (No.)	2	3	3	4	6	7
Snow Survey Measurements	235	281	462	713	785	820
Miles by Aircraft	1,410	1,710	2,925	5,200	5,600	6,000
Shelter Cabins (No.)	23	23	29	32	28	25
Forecasts Made (No.)	61	95	110	199	277	300
Soil Moisture Stations (No.)	2	2	10	9*	11	15
Aerial Markers	4	12	26	27	35	42

* One station destroyed by vandals

** 14 courses relocated

The measurement of snow courses is a cooperative venture. Of the 135 snow surveyors who measured the snow courses during the winter of 1963-64, 56 were employees of the Forest Service, 5 of the Bureau of Reclamation, 5 of the National Park Service, 33 of the United States Geological Survey, with the rest Soil Conservation Service and others. In every case, the most qualified men in their respective locations are doing the job. Some of these men have been trained at West-Wide Training Conferences, the last of which was held at Squaw Valley, California in January 1964, some at local training workshops and some on the job. In many cases the training is given by an experienced snow surveyor on the way to and at the snow course while making the actual snow survey.

SURFACE WATER RESOURCES INVESTIGATION

The Need for Hydrographic Data. The waters of our rivers and creeks cannot be managed properly and fairly without knowledge of the amount available, its distribution areally, and the variations from day to day, month to month, and year to year. It is for this reason that the State Water Code directs the Supervisor of Water Resources to "determine the discharge of streams and springs and other sources of water supply and the capacities of lakes and reservoirs whose waters are being or may be utilized for beneficial purposes." The low-flow yield of streams in cubic feet per second per square mile varies greatly even in short distances owing to the effects of precipitation, geology, topography, elevation, slope and vegetal cover.

Competition for unappropriated water is increasing. Generally speaking, those interested in fisheries, pollution prevention or prevention or abatement, recreation, and navigation want water left in the streams whereas those interested in municipal supply for industrial and domestic use, and irrigation want water diverted from the streams. Hydroelectric power and flood control developments may be either beneficial or detrimental to any of the other uses of water, depending upon the nature of the individual development. Since the state has no set water policy, the Supervisor of Water Resources must consider all aspects of each water right application very carefully before acting upon it.

The Cooperative Program. For more than a century the state has carried on a cooperative surface-water investigation program with the United States Geological Survey, Tacoma, which since 1940 has been under the direction of Fred M. Veatch, District Engineer. Cost of the program is shared equally by the two agencies and the work is performed by engineering personnel of the Survey under nationwide technical standards. Detailed results are published by the Geological Survey but compilations or summary reports are published by both the Survey and the State. The cooperative program includes both the collection of basic data and the preparation of analytical and interpretive reports.

In the collection of basic data, records are obtained of the amount of water in the rivers and creeks, and of the stages of lakes and reservoirs. A summary of the number of gaging stations or sites at which these data are collected in the state during the period July 1, 1962 to June 30, 1964 follows:

	Daily discharge	Daily stage	Flood peak	Low flow	Total
In operation July 1, 1962.....	326	62	150	16	554
Established during the biennium.....	50	5	33	0	88
Discontinued during the biennium.....	24	0	0	0	24
In operation June 30, 1964.....	352	62	183	16	618

In addition to the above, 1,230 discharge measurements were made at miscellaneous sites.

In the analytical and interpretative studies, the records are appraised and analyzed so that the basic information is presented in forms convenient for use by other agencies and the public.

The following studies were completed during the biennium:

1. Magnitude and frequency of floods in the United States, Part 12, Pacific slope basins in Washington and the upper Columbia River basin by G. L. Bodhaine and D. M. Thomas. U.S. Geological Survey Water Supply Paper No. 1687.
2. Drainage-area data for eastern Washington, by J. R. Williams. To be an open-file release.
3. Compilation of miscellaneous discharge measurements. To be published by the State as one of the series of Water Supply Bulletins of the Department of Conservation.

The following other reports, prepared in cooperation with several State and municipal agencies including the Department of Conservation, are in various stages of completion:

1. Water resources of King County.
2. Surface water hydrology of the upper Cedar River basin.
3. Cedar Lake loss study.
4. The effect of logging on runoff in the upper Green River basin.
5. Effect of wind and barometric pressure on Franklin D. Roosevelt Lake.
6. Water resources of Kitsap peninsula and certain adjacent islands.†
7. Water resources of Chehalis River basin.†
8. Magnitude and frequency of floods in small drainage basins in eastern Washington.
9. Areal hydrology of the Flett Creek basin.

Funds. During this two-year report period the total moneys contributed by State agencies in Washington for these records and studies were \$283,435 of which \$179,500 was by the Department of Conservation, \$347,725* was by county, city, and district agencies, and \$658,795 was from Federal sources.

The Need to Enlarge the Program. The growth of population and industry, and the rising standards of living with its greatly increased per capita consumption of water, bring about increasing and sometimes competing demands on the total water supply. For this reason our water problems are rapidly becoming more numerous and complex, and require more detailed information than heretofore. A well-planned program of an increasing rate of gathering water resources data should be entered upon before the various problems become more critical. More extensive and detailed data, vital to the solution of these problems, is needed for determining the quantity, areal distribution, and time variations of the surface waters.

The Proposed Program. The stream gaging network, consisting of records of natural runoff and runoff as modified by man, is the foundation upon which are based special investigations of areas where there are existing

*Of this, \$80,000 was contributed through the Department of Conservation's stream gaging fund.

†Under preparation by the Department of Conservation, with contributions on surface-water supply and floods by the U. S. Geological Survey.

water problems. More gaging stations of all types, including some to collect hydrologic data where water resources probably will not be affected by the works of man, are needed so that records will be available to evaluate the changes that occur through the increased use of the water. More than ever it is necessary to consider the relations of surface water to ground water and their effect on each other.

The number of gaging stations located on streams draining small areas should be increased so that valuable information will be provided for operational and management purposes. It is proposed that the net work be increased at a gradual rate of 10 to 15 stations per year.

Areal and interpretative studies of smaller river basins with emphasis on a definition of the entire system of water movement both above and below ground, with descriptions of the local situation, would be of value in problem areas such as the Ahtanum and Beaver Creek areas in the Yakima and Methow basins.

The results of low flow frequency and durations studies would be used for estimating the future availability of water supplies when granting water rights. Such low flow information is especially important in connection with the propagation of fish and the control of pollution. This type of study would be invaluable to the state in the management of its available water.

Benefits to be Derived. Wise conservation and utilization of the water supplies remaining unused in the state can be accomplished only by maintaining an adequate inventory of the resource.

Water Quality Program.

During the past year water quality data have been collected at 94 sampling sites on the rivers and streams of Washington under a cooperative program with the United States Geological Survey. These sites are selected to furnish information on the natural quality of Washington's waters and to determine changes in quality produced by man's use of the watershed or the waters themselves. Thus, data are available to guide the development of the water resources and to provide information on changing water quality characteristics before the conditions become detrimental to the best utilization of this resource. A report is being prepared containing a general description of the quality of Washington's surface waters, and also including two years of data collected under this program.

Studies of the quality of ground water were also continued. A report has been completed on the chemical character of ground water throughout the state. This report includes more than 1000 representative chemical analyses of water samples collected from wells tapping the many diverse aquifers in the state. The report will be published by the Department of Conservation when funds become available.

During the year more than 125 samples of ground water were analyzed for chemical quality. This program is being continued to provide data on ground water quality in areas where such data are not now available and to provide information on specific aquifers so that general water quality conditions will be known prior to the development of new wells.

Expenditures July 1, 1962 — June 30, 1964

Administration of Water Codes (Salaries & Operation)		\$299,273
Surface Water Surveys (Stream & Lake Gaging)		
General Fund	\$132,249	
Reclamation Revolving Account	39,376	
Stream Gaging Fund	80,000	
Total		251,625
Ground Water Surveys		
Reclamation Revolving Account	72,625	
Total		72,625
River Surveys		
Reclamation Revolving Account	2,310	
Total		2,310
Snow Surveys		
Reclamation Revolving Account	19,031	
Total		19,031
Water Quality		
Reclamation Revolving Account	58,875	
Reclamation Revolving Account		
—unanticipated receipts	6,388	
Total		65,263
Total Expenditures		\$710,127
Receipts		
General Fund		\$237,551
Reclamation Revolving Account		
Power License Fees	199,953	
Unanticipated Receipts	10,343	
Stream Gaging Fund	78,607	
Total		288,903
Total Receipts		\$526,454
Net Burden to General Fund		\$183,673

RECOMMENDATIONS FOR LEGISLATION

The department will present bills to the forthcoming legislature seeking to amend the sections concerning watermasters, changing the fee schedule to help offset the additional costs of administration, adding a forfeiture clause to the water codes and requiring the registration of all vested claims to the use of water within a five-year period. The texts of the four bills to be presented follow:

AN ACT Relating to regulation of waters in the State of Washington; authorizing the appointment of water masters, and the creation of water master districts; amending section 9, chapter 117, Laws of 1917, as last amended by section 2, chapter 123, Laws of 1947, and RCW 90.03.060; amending section 10, chapter 117, Laws of 1917 and RCW 90.03.070.

Be it enacted by the Legislature of the State of Washington:

Section 1. Section 9, chapter 117, Laws of 1917, as last amended by section 2, chapter 123, Laws of 1947, and RCW 90.03.060 are each amended to read as follows:

Water masters shall be appointed by the supervisor of water resources [upon application by interested parties making a reasonable showing of the necessity therefor,] at such time, for such districts, and for such periods of service, as [local] conditions may indicate **to the supervisor** to be necessary to provide the most practical supervision on the part of the state and to secure to water users and owners the best protection in their rights. The districts for or in which the water masters serve shall be designated water **master** districts, which shall be fixed from time to time by the supervisor, as required, and they shall be subject to revision as to boundaries or to complete abandonment as local conditions may indicate to be expedient, the spirit of this provision being that no districts [need] be created **or exist** [or maintained or water masters appointed therefor,] where the need for the same does not exist. Water masters shall be under the supervision of the supervisor of water resources, **shall be compensated for services from funds of the department of conservation, division of water resources**, and shall be technically qualified to the extent of understanding the elementary principals of hydraulics and irrigation, and of being able to make water measurements in streams and in open and closed conduits of all characters, by the usual methods employed for that purpose. **Counties, municipal and public corporations of the state are authorized to contribute moneys to the department of conservation to be used as compensation to water masters in carrying out their duties. All such moneys received by the department of conservation shall be used exclusively for said purpose.** [Each water master shall, if employed by the day, receive a wage per day for each day he shall be actually employed in the duties of his office, or, if employed by the month, he shall receive a salary per month, which wage or salary shall be fixed in the manner provided by law for the fixing of the salaries or compensation of other state officers or employees, to be paid by the county in which the work is performed. In case the service extends over more than one county each county shall pay its equitable part of such wage to be apportioned by the supervisor. He shall be reimbursed for actual necessary expenses when absent from his designated headquarters in the performance of his duties, such expense to be paid by the county in which he renders the service. The accounts of the water master shall be audited and certified by the supervisor and the county auditor shall issue a warrant therefor upon the current expense fund.]

Sec. 2. Section 10, chapter 117, Laws of 1917, and RCW 90.03.070 are each amended to read as follows:

It shall be the duty of the water master, acting under the direction of the supervisor of water resources, to divide in whole or in part, the water supply of his district among the several water conduits and reservoirs using said supply, according to the right and priority of each, respectively. He shall, as near as may be, divide, regulate and control the use of water within his district by such closure or partial closure of headgates as will prevent its use in excess of the amount to which the owner of the right is lawfully entitled. He shall as may be required in times of scarcity of water, and in respect of priorities of rights, shut and fasten or cause to be shut and fastened the headgates of water conduits, and shall regulate or cause to be regulated the controlling works of reservoirs. Whenever, in the pursuance of his duties, the water master regulates a headgate of a water conduit or the controlling works of a reservoir, he shall attach to such headgate or con-

trolling works a written notice, properly dated and signed, stating that such headgate or controlling works has been properly regulated and is wholly under his control and such notice shall be a legal notice to all parties. He **shall perform such other duties related to the office of the division of water resources of the department of conservation** and shall enforce such rules and regulations as the supervisor shall from time to time prescribe. **The county or counties in which water master districts are established shall without charge provide to each water master suitable office space, supplies and equipment, and clerical assistance as are necessary to the water master in carrying out his duties.**

NEW SECTION. Sec. 3. There is hereby appropriated from the general fund for the ensuing biennium ending June 30, 1967 the amount of thirty-six thousand dollars to carry out the provisions of the act.

AN ACT Relating to fees collected by the supervisor of water resources; amending section 44, chapter 117, Laws of 1917, as last amended by section 5, chapter 57, Laws of 1951, and RCW 90.03.470.

Be it enacted by the Legislature of the State of Washington:

Section 1. Section 44, chapter 117, Laws of 1917, as last amended by section 5, chapter 57, Laws of 1951, and RCW 90.03.470 are each amended to read as follows:

The following fees shall be collected by the supervisor in advance:

(1) For the examination of an application for permit to appropriate water **or an application to change point of diversion, withdrawal, purpose or place of use**, a minimum of ten dollars, to be paid with the application. For each second foot between one and five hundred second feet, two dollars per second foot; for each second foot between five hundred and two thousand second feet, fifty cents per second foot; and for each second foot in excess thereof, twenty cents per second foot. For each acre foot of storage up to and including one hundred thousand acre feet, one cent per acre foot, and for each acre foot in excess thereof, one-fifth cent per acre foot. Then ten dollar fee payable with the application shall be a credit to that amount whenever the fee for direct diversion or storage totals more than ten dollars under the above schedule and in such case the further fee due shall be the total computed amount less ten dollars.

Within five days from receipt of an application the supervisor shall notify the applicant by registered mail of any additional fees due under the above schedule and any additional fees shall be paid to and received by the supervisor within thirty days from the date of filing the application, or the application shall be rejected.

(2) For filing and recording a permit to appropriate water for irrigation purposes, [twenty] **forty** cents per acre for each acre to be irrigated up to and including one hundred acres, and [ten] **twenty** cents per acre for each acre in excess of one hundred acres up to and including one thousand acres, and [five] **ten** cents for each acre in excess of one thousand acres; and also twenty cents for each theoretical horsepower up to and including one thousand horsepower, and four cents for each theoretical horsepower in excess of one thousand horsepower, but in no instance shall the minimum fee for filing and recording a permit to appropriate water be less than [four] **five** dollars. For all other beneficial purposes the fee shall be twice the amount of the examination fee except that for individual household and

domestic use, which may include water for the irrigation of a family garden, the fee shall be [four] **five** dollars.

(3) For filing and recording any other water right instrument, [two] **four** dollars for the first hundred words and [twenty] **forty** cents for each additional hundred words or fraction thereof.

(4) For making a copy of any document recorded or filed in his office, [twenty] **forty** cents for each hundred words or fraction thereof, but when the amount exceeds [ten] **twenty** dollars, only the actual cost in excess of that amount shall be charged.

(5) For certifying to copies, documents, records, or maps, two dollars for each certification.

(6) For blueprint copies of a map or drawing, or, for such other work of a similar nature as may be required of his office, at actual cost of the work.

(7) For granting each extension of time for beginning construction work under a permit to appropriate water, an amount equal to one-half of the filing and recording fee, **except that the minimum fee shall be not less than five dollars for each year that an extension is granted**, and for granting an extension of time for completion of construction work or for completing application of water to a beneficial use, [two] **five** dollars **for each year that extension is granted**.

(8) For the inspection of any hydraulic works to insure safety to life and property, the actual cost of the inspection, including the expense incident thereto.

(9) For the examination of plans and specifications as to safety of controlling works for storage of ten acre feet or more of water, a minimum fee of ten dollars, or the actual cost.

(10) For recording an assignment either of a permit to appropriate water or of an application for such a permit, a fee of [four] **five** dollars.

(11) For [issuing a certificate for change of point of diversion, place or purpose of use, ten] **preparing and issuing all water right certificates, five** dollars.

(12) For filing and recording a protest against granting [an] **any** application [for a permit to appropriate water for any purpose], two dollars.

AN ACT Relating to the registration of claims to withdraw and make use of waters.

Be it enacted by the Legislature of the State of Washington:

NEW SECTION. Section 1. It is the sense of the legislature that, due to the many and differing means whereby the state has authorized persons to withdraw and make use of the waters of the state, there presently exists a great uncertainty as to the extent of such water users' authority to use the waters of the state. Because this grave uncertainty does not inure to the proper and beneficial development of the water resources for the benefit of the citizens of the state, this chapter is enacted to assist in extinguishing this uncertainty, and otherwise, to promote the general welfare of the citizens of the state.

NEW SECTION. Sec. 2. All persons claiming the right to withdraw and make use of ground or surface waters of the state, either as an owner of lands riparian to a stream, lake or watercourse, or other water source, or as one relying upon legislative enactments authorizing the use of waters of the state for beneficial purpose, or by custom, or by court decree, or

otherwise, shall file with the supervisor of water resources prior to July 1, 1970, a statement of claim on a form to be provided by the supervisor. The statement of claim shall contain the following:

- (1) The name and address of the claimant,
- (2) The name of the water course or water source, from which the right to divert or make use of water is claimed,
- (3) The location, with reasonable certainty, of the points of diversion and place of use of waters, and purpose of use and
- (4) The approximate volume of water and times of use claimed.

NEW SECTION. Sec. 3. Filing of a statement of a claim shall take place and be completed upon receipt thereof by the supervisor of water resources at his office in Olympia of an original signed by the claimant or his authorized agent, and two copies thereof. Immediately upon receipt of any statement of claim, the supervisor shall acknowledge receipt by a notation on one copy indicating receipt thereof the date of receipt and assign a control number thereto, and return said copy by certified or registered mail to the claimant at the address set forth in the statement of claim.

NEW SECTION. Sec. 4. Any person claiming the right to withdraw waters of the state as set forth in section 2 hereof, who fails to submit a statement of claim as provided in said section, shall be conclusively deemed to have waived and relinquished any right, title or interest in said right.

NEW SECTION. Sec. 5. The filing of a statement of claim under the provisions of this act does not constitute an adjudication of any claim to the right use of waters as between the water use claimant and the state, or as between one water use claimant and another.

NEW SECTION. Sec. 6. To insure that all persons claiming the right to use the waters of the state are given notification of the provisions of this act, the supervisor of water resources is directed to give notice as follows:

(1) He shall cause said notice to be placed in a prominent and conspicuous place in all newspapers of the state having a circulation of more than 20,000 copies for each week day, and in at least one newspaper in each county of the state, at least once every three months for five consecutive years.

(2) He shall cause said notice to be broadcast by the radio and television stations which are heard or seen in the state, as designated by the supervisor, on at least six occasions a year.

(3) He shall cause said notice to be placed in a prominent and conspicuous location in each county court house in the state.

(4) He shall furnish to the county treasurer of each county, before the fifteenth of February of each year through 1970, a quantity of written notices sufficient so that each taxpayer receiving a statement of taxes due as provided by RCW 84.56.050, will together therewith receive a notice of the provisions of this act, and every county treasurer shall enclose said notice with the statement of taxes due submitted to each taxpayer.

(5) He may give notice in any other manner which in his discretion will carry out the purposes of this section.

(6) Where notice is directed to be given in writing by this section, sections 2 and 4 shall be set forth and quoted in full.

NEW SECTION. Sec. 7. The supervisor of water resources is directed to establish in the division of water resources of the department of conservation, a registry entitled the "Water Rights Claims Registry." All claims, set forth in accordance with section 3 hereof, shall be filed in the registry both alpha-

betically and consecutively by control number, and deemed public documents.

NEW SECTION. Sec. 8. There is hereby appropriated from the general fund for the ensuing biennium ending June 30, 1967, the amount of dollars to carry out the provisions of this act.

AN ACT Relating to the relinquishment of rights to withdraw and make use of waters of the state; adding new sections to chapter 117, Laws of 1917 and to Chapter 90.03 RCW; and making an effective date.

Be it enacted by the Legislature of the State of Washington:

NEW SECTION. Section 1. Any water user entitled to withdraw and make use of waters of the state through any appropriation authorized by enactments of the legislature prior to enactment of chapter 117, Laws of 1917, or by custom, or through any appropriation authorized by chapter 117, Laws of 1917, or general adjudication, who abandons the same, or who voluntarily fails, without sufficient cause, to beneficially use all or any part of his right to withdraw for a period of five successive years, shall forfeit its right, and said right shall revert to the state, and the water affected thereby shall become available for appropriation in accordance with RCW 90.03.250.

NEW SECTION. Sec. 2. Any water user entitled to withdraw and make use of waters of the state by virtue of its ownership of land abutting a stream, lake, watercourse, or water source, who abandons the same, or who voluntarily fails, without sufficient cause, to beneficially use all or any part of his right to withdraw for a period of five successive years shall forfeit such right, and such right shall revert to the state, and the water affected thereby shall become available for appropriation in accordance with the provisions of RCW 90.03.250.

NEW SECTION. Sec. 3. Any water user hereafter entitled to withdraw and make use of waters of the state through an appropriation authorized under this chapter, who abandons the same, or who voluntarily fails, without sufficient cause, to beneficially use all or any part of his right to withdraw for a period of five successive years shall forfeit its right, and the waters affected thereby shall become available for appropriation in accordance with RCW 90.03.250. All certificates hereafter issued by the supervisor of water resources pursuant to RCW 90.03.330, shall expressly incorporate this section by reference thereto.

NEW SECTION. Sec. 4. When the supervisor of water resources is informed that a person entitled to the use of water as described in sections 1, 2 and 3 hereof has or may have abandoned, or forfeited his right or portion thereof, and the same has reverted to the state, the supervisor shall notify such person to show cause to the supervisor why his rights should not be declared abandoned or forfeited. The notice shall contain, (1) the time and place of hearing as determined by the supervisor, (2) a description of the water right in question, (3) the substantial location of the point of diversion, (4) the general description of the lands or places where such waters were used, and (5) a statement that unless sufficient cause be shown the water right will be held abandoned or terminated, and shall be served by registered or certified mail and be posted at least sixty (60) days before the hearing and sent to the last known address of the holder of the water right in question. The supervisor shall, as soon as practicable after such hearing, make an order determining whether such water right has been abandoned or terminated, and give notice to the holder of the contents thereof in the same manner as

in the notice procedure as hereinbefore set forth. For the purpose of this act, "sufficient cause" shall be defined as the unavoidable non-use of water by a water user for five years arising from drouth, active service in the armed forces of the United States during military crisis, non-voluntary service in the armed forces of the United States, severe financial or military crisis or economic depression throughout the state, operation of legal proceedings, or other similar causes.

NEW SECTION. Sec. 5. Any person feeling aggrieved by any order of the supervisor of water resources may have the same reviewed by superior court of the county in which the waters in question are situated. In any review by the courts, the findings of fact as set forth in the report of the supervisor of water resources shall be prima facie evidence of any abandonment or forfeiture of water right.

NEW SECTION. Sec. 6. All matters relating to the operation of this act shall be carried out in accordance of Chapter 34.04 RCW, except where the provisions of this expressly conflict therewith.

NEW SECTION. Sec. 7. The provisions of this act shall also apply to all rights to withdraw ground waters of the state, whether authorized by Chapter 90.44 RCW or otherwise.

NEW SECTION. Sec. 8. No rights to the use of waters of the state affecting either appropriated or unappropriated waters thereof, may be acquired by prescription or adverse use.

NEW SECTION. Sec. 9. The provisions of this act shall be effective beginning July 1, 1965.

NEW SECTION. Sec. 10. If any provisions of this chapter or the application thereof to any person or circumstance is held invalid, the chapter which can be given effect without the invalid provision or application; and to this end the provisions of this act are declared to be severable.

DIVISION OF MINES AND GEOLOGY

MARSHALL T. HUNTTING, Supervisor

BIENNIAL REPORT NO. 10

PART I

ADMINISTRATION

The following report applies to the organization and activities of the Division of Mines and Geology, Department of Conservation, for the period July 1, 1962 to June 30, 1964.

INTRODUCTION

The Division of Mines and Geology is a service agency; its function is to promote maximum utilization of the State's mineral resources. Its only regulatory activities are those in administering the Oil and Gas Conservation Act. It acts as a clearing house of information on the geology and mineral resources of the State. Known mineral deposits are evaluated through field and office research, and through geologic mapping the basic information is provided that is needed in the search for new ore deposits. The Division collects statistics concerning the occurrence and production of minerals economically important in Washington; publishes bulletins on the geology, mineral resources, and mineral statistics of the State; maintains a collection of rock and mineral samples (at least 5,200 specimens) with special emphasis on those of economic importance or potential; maintains a library (approximately 13,000 volumes) of books, reports, records, and maps on geology, mineralogy, and mining, with special emphasis on material that pertains to Washington; and makes them available to the public for reference in the Division office. The Division also identifies samples of ores and minerals sent in by the public.

The Division is building up a collection of oil well cores and cuttings that are extensively used by oil companies in exploring, both in Washington and as far as 50 miles offshore. More than 200 oil test wells are represented by these samples. Increasing work is being done to build up the Division's collection of slides of microscopic-size fossils for use in oil exploration work. This is a collection of about 3,000 slides.

The Division issues permits and regulates the drilling for oil and gas and the development of underground gas storage areas. It provides observers to enforce regulations of offshore drilling, an activity that first started in 1963 and has increased considerably in 1964. Three ships required four observers in 1963; seven ships required eight observers in 1964.

Geologic maps are made and geologic and mineral-resource reports are published and sold. Sales are increasing each year. Most of the reports are written by the Division's staff geologists, but some manuscripts are obtained

free or at small cost from specialists other than those on the staff. Reports published include technical reports; directories of mineral producers; and popular reports on rocks, minerals, fossils, geology, prospecting, and archeology. Sets of rocks and minerals are prepared in cooperation with the State Department of Public Instruction and are sold to Washington schools.

Numerous requests from individuals, from large and small companies, and from other State agencies for information regarding the availability and quality of Washington mineral commodities for use in expanding existing production and for the establishment of new industries have shown the immediate need for surveys of the State's mineral resources, including but not limited to: sand and gravel, bauxite, aggregates for radiation shielding, olivine, and building stone. There is also a demand for complete mineral-resource surveys for many of the counties of the State.

In 1964 the Division made a small start on a new program—geochemical prospecting, in which thousands of stream sediment samples are collected and analyzed in the search for ore bodies and mineralized areas.

Geologic mapping to provide a basis for further mineral-resource studies is under way in the Grays River area in Wahkiakum County, the Chewelah area in Stevens County, the Kelso area in Cowlitz County, the Wynoochee quadrangle in Grays Harbor and Mason Counties, and in two areas near Colville in Stevens County. The first three of these areas are being mapped in cooperation with the U.S. Geological Survey in projects that were started in 1963.

The Division matches funds with the U.S. Geological Survey for topographic mapping. Areas to be mapped are selected by the Division, and the mapping is done by the Federal agency. In 1963, mapping was started on three new quadrangle maps of about 600 square miles of area near Leavenworth, in Chelan County.

The Division is called upon to advise and assist in formulating policy and legislation—at county, state, and federal levels—regarding mineral industries and oil and gas exploration. For example, the Federal Area Re-development Administration depends upon the Division for advice and assistance in its program in this State, and the Division recently assisted in revising the zoning code for King County.

STAFF

Marshall T. Huntting.....	Supervisor
Vaughn E. Livingston.....	Assistant Supervisor
W. A. G. Bennett.....	Geologist IV
Weldon W. Rau.....	Biostratigrapher
Wayne S. Moen.....	Geologist III
William H. Reichert.....	Geologist-Librarian
Gerald W. Thorsen.....	Geologist II
Nancy Maschner.....	Cartographer
Dorothy Rinkenberger.....	Secretary-Editor
Gloria DeRossitt.....	Secretary
Sandra Anderson.....	Clerk-Typist

Dr. Joseph W. Mills, chairman of the Department of Geology at Washington State University, was hired for 3 months during the summer of

1962 and again in 1963 to map the geology and examine the mineral deposits in an area in Stevens County. Several temporary field or laboratory assistants worked for short periods during the biennium. Four offshore drilling observers were hired in 1963 and eight in 1964.

The present technical staff of 6 geologists compares with a total of 4 geologists and 1 mining engineer comprising the Division staff 16 years ago, at a time when the demands for services were substantially less than they are now.

HISTORY OF THE DIVISION

Geologic investigations as a function of the State Government were established by the first State Legislature and began with the appointment of George A. Bethune as State Geologist in 1890, with office in Tacoma. After 2 years this early work was discontinued for lack of further appropriation. It was resumed in 1901 with the establishment of the Board of Geologic Survey and the appointment, by the Board, of Henry Landes as State Geologist. For 20 years the office of the Washington Geological Survey was maintained at the University of Washington, Seattle. On April 1, 1921, the Administrative Code was adopted by the Legislature, and the duties and functions of the Board of Geologic Survey devolved upon the Director of the Department of Conservation and Development, the activities to be carried on by the Division of Geology. The first supervisor of this newly formed Division was Solon Shedd. He retired in 1925, to be succeeded by Harold E. Culver, but throughout the whole 24-year period from 1921 to 1945 the Divisional office was maintained at the State College of Washington, Pullman.

In 1935 the Legislature passed the Mines and Mining Act, whereby the Director of the Department of Conservation and Development was given the duty, through an appointed supervisor, of carrying on what, in effect, were nearly the identical activities of the original State Geologic Survey and its successor agency the Division of Geology. The first supervisor of the Division of Mines and Mining was Thomas B. Hill; the office was in the quarters of the Department of Conservation and Development, Olympia. In 1941 he was succeeded by Sheldon L. Glover, formerly the assistant supervisor of the Division of Geology, and the Olympia office and staff were enlarged to carry on the activities specifically authorized by the Mines and Mining Act.

For four years thereafter (from November 1, 1941 to October 1, 1945) these two divisions of the Department of Conservation and Development were concurrently engaged in the investigation of the State's mineral resources, studying all phases of geology that were prerequisites to a proper understanding of our mineral deposits, preparing reports for publication, and aiding in every possible way in the development and utilization of these natural resources. Through careful collaboration and coordination of activities the two supervisors prevented a duplication of field investigations and a waste of funds. However, it was impossible to operate the separate offices without considerable duplication in the matter of files, records, library, and laboratory facilities, and without some inconvenience to the public who were unaware of which office had the particular data desired.

On October 1, 1945, therefore, the two divisions were combined by administrative order. All files, records, field notes, reports, maps, library volumes, and bulletins of the Division of Geology were moved to Olympia and there added to the similar material of the Division of Mines and Mining. The supervision of the combined Division of Mines and Geology was given to Sheldon L. Glover. Upon Mr. Glover's retirement in February 1957, Marshall T. Huntting was appointed supervisor.

DUTIES OF THE DIVISION

The Division of Mines and Geology is a service agency that has the responsibility of compiling and distributing information on the mineral resources, mineral industries, and geology of Washington. Regulatory activities of the Division are limited to those in the field of oil and gas exploration and production, as required under the Oil and Gas Conservation Act of 1951 (RCW 78.52.001 to 78.52.550).

The Division has the following duties and responsibilities, as set out in RCW 43.21.070 and 43.92:

- (1) To examine the metallic and nonmetallic mineral deposits of the State.
- (2) To prepare and distribute, at cost of printing, geologic and mineral-resource reports and maps.
- (3) To collect, compile, publish, and disseminate statistics and information about mining, milling, and metallurgy.
- (4) To collect and assemble an exhibit of mineral specimens.
- (5) To assemble a library pertaining to mining, milling, metallurgy, and geology.
- (6) To make determinative examinations of ores, minerals, and rocks for the public.
- (7) To administer the Oil and Gas Conservation Act, regulating drilling and production of oil and gas.
- (8) To cooperate with the U. S. Geological Survey in making topographic and geologic maps and to cooperate with the U. S. Bureau of Mines and with all departments of the State Government.

ACTIVITIES OF THE DIVISION

The Division is engaged in fundamental and applied research, the purpose of which is to serve the mineral industries and the public in developing a better knowledge and understanding of the geology and a more complete utilization of the mineral resources of the State.

The statutory duties are broadly defined, providing the flexibility necessary for the proper functioning of the Division in accordance with changing economic conditions, new trends in minerals utilization, and changing demands for mineral-resource and geologic information. In formulating plans for the Division's investigative programs, it is always helpful to have the suggestions and recommendations of professional and technical people in the minerals industries. Especially valuable during the past biennium have been the recommendations of the Industrial Raw Materials Advisory Committee to the Washington Department of Commerce and Economic Development. Some

of the recommendations of this committee, although directed to the Commerce Department, were for mineral resource surveys, which are a function of the Division of Mines and Geology of the Department of Conservation. A program that was proposed by the committee and was carried on by the Division during the biennium was that of mapping and sampling to determine the location, size, and quality of barite deposits in the State.

The activities of the Division in fulfilling its statutory duties are described in the following paragraphs.

MINERAL DEPOSIT EXAMINATIONS

Division geologists during the biennium continued to acquire information on the metallic and nonmetallic mineral deposits in the State. Field studies were made of known mineral deposits, new deposits were sought out, and reported occurrences were investigated. Field examinations were made of deposits of copper, gold, iron, lead, mercury, nickel, uranium, zinc, barite, bauxite, black sand, clay, coal, diatomite, limestone, olivine, peat, pumice, saline compounds, sand and gravel, and silica. Most field studies served the dual purpose of adding to our fund of information on the State's mineral resources and aiding the prospector or owner of the claim on which the mineral deposit was located. Most of the examinations were of a preliminary nature, but some were in more detail. In examining mineral deposits at the request of their owners, Division geologists take great care not to encroach upon the field of the consulting engineer or geologist. In accordance with this policy, oral advice is given but written reports are not made for individual claim owners.

MINING AND MILLING STATISTICS

The Division cooperates with the U. S. Bureau of Mines in collecting production data on all minerals produced in Washington. These data are published in the annual Minerals Yearbooks of the Bureau of Mines. Preprints of the Washington chapter on mineral production are available from the Bureau.

At least once in each 2 years, Division geologists visit the State's active mining operations—metallic, nonmetallic, and sand and gravel—in order to compile the Directory of Washington Mining Operations. These directories are among the most popular reports published by the Division.

MINERAL EXHIBITS

A rather complete labeled collection of all the metallic and nonmetallic minerals of known economic importance is maintained in the Division office for the use of prospectors, miners, and industrialists. Also included in the display are mineral substances that may have future value but that are not now being mined.

Characteristic samples from mineral deposits and geologic formations throughout the State are collected during the course of field work. In the office they are classified and added to an extensive collection of several thousand specimens that is maintained for staff reference and for the use of visiting geologists who may be working in the State. An attractive col-

lection of fluorescent minerals and a small collection of agates and other specimens of interest to hobbyists are on display for anyone wishing to refer to them. A special display of uranium minerals is maintained. Two sets of minerals and rocks are kept in special traveling cases for occasional display at expositions or to illustrate talks made before various groups and organizations. A supply of bulk minerals and rocks is used to fill requests for samples.

Samples of cuttings and cores from oil and gas test wells are collected, examined, labeled, and added to an extensive collection of similar materials maintained for study and reference. These samples are of particular value to the geologists of companies exploring for oil in the State.

LIBRARY

A fairly large, specialized, reference library of approximately 13,000 publications is maintained for the use of the staff, other State agencies, and for public reference. It includes authoritative texts on mining, metallurgy, mineral resources, and geology, and nearly complete collections of the reports of the U. S. Geological Survey and U. S. Bureau of Mines. Included also are pertinent reports of the U. S. Atomic Energy Commission and other Federal agencies, as well as the publications of Canadian and other foreign geological surveys and the reports of other state geological surveys and mining bureaus. The U. S. Geological Survey and the U. S. Bureau of Mines place unpublished reports on Washington areas and mineral deposits on open file for public inspection in the Division library. The Division subscribes to a number of geology, mining and metallurgy, and oil periodicals to assist staff members in keeping informed of current developments in those fields and for the benefit of anyone else who may wish to consult the publications in the Division offices.

Full sets of all topographic maps of Washington are maintained for the use of the staff and for public reference. Similarly available are aerial mosaics, planimetric maps, special geologic maps, mine maps, and various other maps. The Division's map collection is constantly being enlarged.

Most of the library material is acquired without cost on an exchange basis from other State and Federal agencies and from educational institutions. A few volumes are acquired by private donations, and a few texts and reports of especial interest are purchased through limited funds available for the purpose. Library acquisitions are increasing rapidly as a result of increased mineral-resource exploration activity nationally and publication of the results of these studies, and as a result of greatly increased numbers of publications distributed by the Federal agencies and other state geological surveys.

MINERAL IDENTIFICATION SERVICE

The Division provides a free mineral identification service for the public. Samples of ores, rocks, minerals, and clays from Washington localities are examined and identified. The senders are advised of the possible value of submitted samples, and suggestions are given for further prospecting or analysis whenever such action appears warranted. Through this service new occurrences of potential value are occasionally found and brought to the attention of those who are seeking new sources of mineral raw materials in the State. Sample identification does not include assays or quantitative chemical analyses, as these services are available from commercial concerns.

During the biennium the Division of Mines and Geology received and reported upon 1,398 samples. This indicates a very large interest in Washington's mineral resources and shows increased public dependence upon help and advice from the Division in developing these resources.

The laboratory of the Division is equipped for most of the mineralogical studies required. Equipment consists of a diamond saw and laps for making thin sections and polished sections of rocks and ores; binocular, petrographic, and metallographic microscopes; a small laboratory electric furnace for high-heat tests; an electric drying oven; a spectrograph and densitometer for qualitative and quantitative examinations of rock and mineral specimens; blow-pipe equipment for qualitative tests; sieves for making screen analyses of sands; laboratory crusher and grinder; a Superpanner; Geiger counters and a scintillation detector for radiometric tests of uranium-bearing samples; ultraviolet lamps for fluorescence tests; and a high-intensity magnetic separator.

A piece of equipment greatly needed for use in identification of minerals and rocks is an X-ray diffractometer. This tool is especially useful in identifying small grains of intermixed minerals in ore, mill concentrates, drilled cores, and exploration samples.

OIL AND GAS

Since the early 1930's the Division has collected and cataloged all available information on the progress and results of oil and gas test drilling. These data are on open file for all geologists and oil men who desire to see or copy them.

In 1951 the Oil and Gas Conservation Act was passed by the Legislature. The Act and the rules and regulations drawn up under its authority govern the drilling, testing, and other operations that comprise exploration and production of oil and gas in Washington. In January 1954 the Oil and Gas Conservation Committee appointed the Supervisor of the Division of Mines and Geology to be Oil and Gas Supervisor for the State and gave him the duty of administering the Act.

From January 18, 1954, through June 30, 1964, a total of 194 drilling permits were issued, of which 28 were issued during the 1962-64 biennium. This is an increase of two permits over those of the preceding biennium.

The Oil and Gas Conservation Act and rules and regulations require that all logs, drilling histories, cuttings and core descriptions, and records of tests that are made for each well must be filed with the Oil and Gas Supervisor (who is Supervisor of the Division of Mines and Geology) within 30 days after completion or abandonment of the well (6 months are allowed for filing electric logs). These logs are kept confidential for a period of 1 year after the filing deadline, after which they are released for public inspection.

No new personnel were hired when the administration of the Oil and Gas Conservation Act was turned over to the Division in 1954. In order to provide some of the greatly increased services demanded by oil and gas exploration groups, the Division needs funds to hire a laboratory helper full time rather than part time as at present. Also needed is a petroleum geological engineer to assist in the administration of the Oil and Gas Conservation Act and to help develop information that will be useful to oil and gas exploration groups.

As required by law and rules and regulations, the Division furnishes State drilling observers to work on oil company ships that drill holes as much as

1,000 feet deep to obtain bottom samples for study in connection with off-shore oil and gas exploration. In 1963 four observers served on ships working for three oil companies. In 1964 eight observers worked on ships that were used by seven companies or groups of companies.

REPORTS PUBLISHED

Geologic investigations are of little value to the public unless the results are made easily available. The demand is increasing each year for information on geology, mineral resources, and the status of the mining industry of Washington. This information is dispensed through office and field conferences, by correspondence, and, most effectively, through distribution of published reports. Most of the Division's reports are written by staff geologists, but some manuscripts are obtained free or are purchased from specialists other than those on the staff. As required by law, the entire cost for printing of reports will eventually be returned to the State's General Fund through income from sale of the reports.

During the biennium the following reports were published and made available for distribution:

- High-Calcium Limestones of Eastern Washington, by Joseph W. Mills, Bulletin 48, 268 pages, 7 plates, 64 figures, \$4.00.
- Saline Lake Deposits in Washington, by W. A. G. Bennett, Bulletin 49, 129 pages, 35 figures, \$1.50.
- Geology and Mineral Deposits of the North Half of the Van Zandt Quadrangle, Whatcom County, Washington, by Wayne S. Moen, Bulletin 50, 129 pages, 4 plates, 41 figures, \$1.50.
- Barite in Washington, by Wayne S. Moen, Bulletin 51, 112 pages, 2 plates, 37 figures, \$1.00.
- Preliminary Geologic Map of the Hobart and Maple Valley Quadrangles, King County, Washington, by James D. Vine, Geologic Map GM-1, 75¢.
- Preliminary Geologic Map of the Cumberland Quadrangle, King County, Washington, by A. A. Wanek and H. D. Gower, Geologic Map GM-2, \$1.00.
- Introduction to Washington Geology and Resources, by Charles D. Campbell, Information Circular 22R, 44 pages, 5 figures, 25¢. (Reprinted)
- Fossils in Washington, by Vaughn E. Livingston, Jr., Information Circular 33, 35 pages, 1 plate, 17 figures, 25¢. (Reprinted)
- 1962 Directory of Washington Mining Operations, by Gerald W. Thorsen, Information Circular 37, 81 pages, 2 maps, Free.
- A Geologic Trip Along Snoqualmie, Swauk, and Stevens Pass Highways, by University of Washington Geology Department Staff, revised by Vaughn E. Livingston, Jr., Information Circular 38, 51 pages, 50¢.
- Marketing of Metallic and Nonmetallic Minerals, by Donald L. Anderson, Information Circular 39, 39 pages, 2 figures, Free.
- Caves of Washington, by William R. Halliday, Information Circular 40, 132 pages, 9 plates, 92 figures, \$1.00.
- Tertiary Geologic History of Western Oregon and Washington, by Parke D. Snively, Jr. and Holly C. Wagner, Report of Investigations 22, 25 pages, 23 figures, 25¢.
- Mineralogy and Geochemistry of the Read Magnetite Deposit, Southwestern Stevens County, Washington, by W. A. G. Bennett; and Ludwigite from the Read Magnetite Deposit, Stevens County, Washington, by Waldemar

T. Schaller and Angelina C. Vlisidis, Reprint No. 7, reprinted from *Economic Geology*, 1962, 13 pages, 2 figures, 25¢.

Emplacement of the Twin Sisters Dunit, Washington, by Donal M. Ragan, Reprint No. 8, reprinted from *American Journal of Science*, 1963, 17 pages, 1 plate, 1 figure, 25¢.

A publications list is available from the Division. Listed are all the Bulletins, Reports of Investigations, Information Circulars, administrative reports, and Reprints that have been published by the Division of Mines and Geology and its predecessor agencies.

PROJECTS IN PROGRESS

During the biennium the following projects were in progress and reports on most of these were in preparation:

Limestone in Washington—an investigation to determine the size and quality of stone available in the largest and most accessible deposits in both eastern and western Washington. The deposits are concentrated in the northern tier of counties from San Juan to Pend Oreille. Two geologists and five field assistants were assigned to the job. The western Washington survey was supervised by Dr. W. R. Danner, professor of geology at the University of British Columbia, and the eastern Washington survey by Dr. Joseph W. Mills, Chairman, Department of Geology at Washington State University. Topographic and geologic maps of the best deposits were made. About 750 samples were taken for complete chemical analysis. Field work was done in 1959 and was continued and completed in the fall of 1960. The results of the survey will be published in two reports. The first of these reports, "High-Calcium Limestones of Eastern Washington," by Joseph W. Mills, was published during the biennium. The western Washington report is in preparation and should be ready to print some time in 1965.

Ferruginous Laterite in the Kelso-Cathlamet Area, by Vaughn E. Livingston, Jr. A mineral resource not now being utilized but having very great potential value is the iron-rich bauxite that occurs in northwestern Oregon and in the Kelso-Cathlamet area in Washington. Geologic mapping to outline the areas that are favorable for the occurrence of this material was conducted and ten core holes were drilled during the previous biennium. Preparation of the report of this work was continued during this biennium, and the report should be ready to send to the printer some time during 1965.

Geology and Mineral Resources of the South Half of the Colville Quadrangle, Stevens County, Washington, by W. A. G. Bennett. Field work for this study was essentially completed during the last biennium. A small amount of additional field work was accomplished during this biennium. It is expected that the geologic map and report will be completed and published during the next two years.

Bibliography and Index of the Geology and Mineral Resources of Washington, 1957-1962, by William H. Reichert. This is part of a continuing project to maintain an up-to-date bibliography and index to articles, both published and unpublished, on geology and mineral resources of the State. This report will be completed and published during the next 2 years.

Black Sand at Grays Harbor, by Gerald W. Thorsen. Numerous inquiries about black sands, both as a possible source of iron and as a source of titanium, have emphasized the need for detailed information on the mineralogic composition of these sands. Laboratory analyses of samples from the mouth of Grays Harbor have been completed, and a report is in preparation.

Geology of the Northern Cascade Mountains, by Peter Misch, professor of geology at the University of Washington. Dr. Misch, in a period of about 20 years, has mapped, almost singlehandedly, an area of more than 2,000 square miles in the northern Cascades, the most rugged and inaccessible terrain in the State. The Division is pleased to have arranged to publish his maps and a report describing the rocks in this area. The report and maps are in preparation and should be ready for publication some time during the 1964-66 biennium.

Geology and Mineral Resources of the Methow Quadrangle, Okanogan County. Dr. Julian D. Barksdale, professor of geology at the University of Washington, has devoted many years to the study of the geology of a large area in Okanogan County, including the area within the Methow quadrangle, and the Division has made arrangements to publish his geologic map and report on the geology of the area. In 1959, G. W. Thorsen examined most of the known mineral deposits in the area, and the results of his examinations also will be published. The U. S. Bureau of Mines has cooperated by compiling a record of production for all the mines in the area.

Geology of the Wynoochee Area, Grays Harbor County, Washington, by Weldon W. Rau. Field and laboratory studies of the rocks and their contained fossils were continued throughout the biennium. A geologic map and report should be ready for publication in 1965.

Geology and Mineral Resources of the East Half of the Kettle Falls Quadrangle, Stevens County, Washington, by Joseph W. Mills. Field work was commenced in 1961 and continued through 1964. A geologic map and report of this work should be completed and ready to print some time in 1965.

Introduction to Washington Geology and Resources, by Charles D. Campbell, Information Circular 22R, 44 pages, 5 figures, 25¢. This popular report, which was reprinted once during the biennium, went out of print again and had been sent to the printer to be reprinted again at the biennium's end. It was ready for distribution again early in the following biennium.

Stone in Washington, by Wayne S. Moen. Decorative stone for use in buildings, floors, patios, etc., has become more and more popular in recent years, and the need for information about the sources of such stone in Washington has become quite apparent. An appraisal of the building and decorative stone industry in the State and an examination of Washington stone deposits were essentially completed during the biennium. A report of this work should be published some time in 1965.

Mineral Resources of King County, by Vaughn E. Livingston, Jr. Mineral production in King County leads that for all other counties in Washington. An investigation of these resources was started during the biennium, but because of other demands on the investigator's time it may be several years before the project is completed.

Geochemical Investigations in Washington, by Wayne S. Moen. Late in the biennium a small start was made on a proposed reconnaissance geochemical survey to determine the copper, lead, zinc, and molybdenum contents of stream sediment samples in the areas of the State in which it is expected that ore deposits may be found.

Mineral Resources in the North Cascade Mountains, by Marshall T. Hunting, Vaughn E. Livingston, Jr., and Wayne S. Moen. During the biennium a study was made of the North Cascade mineral resources and the potential for their development. This was done in cooperation with the U.S. Geological Survey and was part of a larger study of all the resources of this area being conducted by a five-man study team made up of representatives of the U.S. Departments of Interior and Agriculture. A report was written, but, although the possibility of publishing the report was discussed, no definite plans have yet been made for its publication.

Pegmatites in Washington, by Ted Ross. All the known pegmatite deposits in the State were being examined in detail in the field and in the laboratory in 1963 and 1964 by Mr. Ross, a candidate for the degree of Doctor of Philosophy in Geology at Washington State University. The field examinations were financed in part by the Division, and a detailed report is expected to be ready for publication some time in 1965.

COOPERATIVE PROJECTS

Topographic Mapping

The Division continued to cooperate with the U. S. Geological Survey in topographic mapping within the State. The mapping is conducted by the Survey, the State contributing half of the funds through a cooperative, matching agreement. Additional topographic mapping is carried on and paid for solely by the Federal agency.

As a part of our continuing cooperative topographic mapping program with the U.S. Geological Survey, work was continued during the biennium on two 15-minute quadrangles, the mapping of which was started during the previous biennium. Three new map projects were started in July 1963. The names, locations, and estimated publication dates of these maps are:

<i>Names of quadrangles</i>	<i>Counties in which located</i>	<i>Estimated publication date</i>
Mazama	Okanogan	July 1964
Doe Mountain	Okanogan	December 1964
Chiwaukum 4	Chelan	June 1966
Chiwaukum 3	Chelan	June 1967
Chiwaukum 2	Chelan	June 1967

Also during the biennium sixteen 7½-minute quadrangles and ten 15-minute quadrangles were completed and published by the U.S. Geological Survey using Federal funds only.

The first topographic quadrangle map in Washington was published in 1895 by the U. S. Geological Survey. In order to speed up the mapping program, the State Legislature of 1903 authorized expenditure of State funds on a 50-50 matching basis, and the Legislature of 1909 appropriated \$10,000 for this purpose. Since that time the State has provided matching funds almost every year. The total amount expended from 1909 through 1964 is

\$452,217, and 78 quadrangle maps have been completed or are in progress under this cooperative program. In spite of greatly increased mapping in recent years by the U. S. Geological Survey independent of the cooperative program, there still remain large areas in the State for which no topographic maps are available, and there are other large areas for which the available maps are of inadequate scale or accuracy.

The Industrial Raw Materials Advisory Committee has pointed out that topographic maps are an indispensable tool for the development of Washington's natural resources and are an important aid in overall economic development in the State. These maps are required by planners, builders, engineers, geologists, foresters, farmers, soil conservationists, hydrologists, river-resource developers, and hunters and fishermen. The committee has recommended that greatly increased funds be made available to augment the cooperative program so that topographic mapping of the State may be completed in the next 10 years.

It has been recommended that eighty-seven 15-minute quadrangles (of 200 square miles each) be mapped. This, in addition to areas already being mapped, would give complete coverage of the State with topographic maps published since 1945. At an estimated cost of \$20,000 per quadrangle, this would be a total cost of \$1,790,000 to the State, which would be matched by the Federal government.

Geologic Mapping

An agreement was first made with the U. S. Geological Survey to conduct geologic mapping in Washington on a cooperative basis in 1958. The work was done by geologists of the Federal agency, and the cost was shared equally by the State and the Federal government.

The first year's contract provided for mapping that was used in the compilation of the State Geologic Map that was published in 1961. Later contracts initiated studies that resulted in the publication by the Division of Mines and Geology of a bulletin detailing the coal reserves of Washington, a report on the stratigraphy of coal-bearing rocks in King County, and two geologic maps with brief texts describing coal- and clay-producing areas in King County.

In July 1963 three new geologic mapping projects were started—the Grays River quadrangle in Pacific County (an area of interest primarily for its potential for oil and gas and nonmetallic mineral development), the Loomis quadrangle in Okanogan County, and the Chewelah quadrangle in Stevens County. The last two areas were chosen for investigation because of the diverse, widespread mineralization present in these areas. These are 3-year projects; the geologic maps and reports of this work should be completed by July 1966.

By making use of expert geologists from the Federal Geological Survey staff and 50 percent Federal matching funds, we have been able to complete much more work of excellent quality than we could have accomplished without this help.

Geologic mapping is needed as a foundation from which private industry can extend its search for mineral resources, is needed to evaluate fully the State's mineral-resource potential, is needed in order to appraise water resources and to locate such construction materials as sand, gravel, and

stone, and is needed to provide information on which to select, plan, and design sites for engineering structures and highways and to evaluate such natural hazards as landslides and earthquakes.

The Industrial Raw Materials Advisory Committee, recognizing these needs in 1958, recommended a program of geologic mapping and mineral resource investigations and recommended that \$500,000 be appropriated for such work in the following biennium. In 1960 the Committee again recommended a major program of geologic mapping in cooperation with the U. S. Geological Survey and recommended the appropriation of \$450,000 for that purpose during the next biennium. In 1962 the Committee once more recommended cooperative geologic mapping that was estimated to cost \$382,000 annually for a period of 10 years. In 1964 the Committee still was convinced of the value of geologic mapping as a vital part of the State's economic development program and again recommended a very large increase over the current rate of mapping.

Other Cooperative Projects

Cooperation is maintained with the U. S. Bureau of Mines in the collection of mineral production statistics in Washington. Information on mining operations and mineral producers, obtained separately by the Bureau and the State Division of Mines and Geology, is exchanged in the interest of complete coverage. Assistance is given the Bureau in exchange for copies of detailed production records. The Bureau has tested samples of clay and bauxite collected by Division geologists in conjunction with geologic mapping projects described on previous pages.

The Division cooperates with the U. S. Coast and Geodetic Survey by maintaining in Olympia for the Survey a strong-motion accelerograph. Periodic checks are made to be sure that the instrument is in good operating condition and to determine whether or not the instrument has recorded any strong-motion earthquakes.

Cooperation with the U. S. Atomic Energy Commission is maintained through distribution of A. E. C. literature by the Division. The A. E. C. has provided the Division with a "radiometric assayer" instrument for the purpose of making quantitative analyses of uranium ores.

During the past biennium the Division has had occasions to provide information and be of assistance to the U. S. Forest Service and other Federal agencies as well as such State agencies as the Department of Commerce and Economic Development, Department of Highways, Commissioner of Public Lands, Pollution Control Commission, Department of Employment Security, Tax Commission, and Department of Licenses.

In 1962 and 1963 Division geologists devoted about 3.6 man-months in working with the King County Planning Department and with representatives of King County sand, gravel, stone, and clay industries in developing a new county zoning code. This code provides some protection from the encroachment of other industrial and housing developments that would destroy valuable deposits of sand, gravel, stone, and clay that will be critically needed as construction materials in the years to come.