KLAMATH BASIN

STATE WATER RESOURCES BOARD
SALEM, OREGON
June 1971

The preparation of this document was financially aided by a federal grant from the Water Resources Council under authorization of Title III, P.L. 89-80, the "Water Resources Planning Act of 1965."

COVER PICTURE

Upper Klamath Lake with Mt. McLoughlin in background. Oregon State Highway Division Photo.

Price $2.50

TABLE OF CONTENTS

TABLE OF CONTENTS

PAGE

PART II WATER SUPPLY

TABLE OF CONTENTS

TABLE OF CONTENTS

PAGE

APPENDIX II

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

LIST OF PLATES

Note: Plates appear at the back of the report.

PURPOSE AND INTRODUCTION

The purpose of this report is to set forth in a condensed form the data compiled and conclusions reached by the State Water Resources Board as the result of an inventory study of the Klamath Basin.

The study was instituted at the request of the Klamath Basin Water Users Protective Association and was conducted under the broad guidelines of three major objectives. These objectives are as follows:

1. Determine the availability of water resources.
2. Update the California Department of Water Resource's Bulletin No. 83, "Klamath River Basin Investigation" as it pertains to Oregon.
3. Collect, correlate, and publish existing data.

The Board's investigation, completed July 1971, was conducted in compliance with ORS 536.300 which states:

> "The board shall proceed as rapidly as possible to study: existing water resources of this state; means and methods of conserving and augmenting such water resources; existing and contemplated needs and uses of water for domestic, municipal, irrigation, power development, industrial, mining, recreation, wildlife, and fish life uses and for pollution abatement, all of which are declared to be beneficial uses, and all other related subjects, including drainage, reclamation, flood plains and reservoir sites."

The Klamath River Basin Compact, an interstate agreement between Oregon and California and consented to by the U. S. Congress, established the Klamath River Compact Commission and designated it as the official body for establishing the use and control of the water resources of the Upper Klamath River Basin. Due to this designation, the State Water Resources Board does not have authority to formulate an integrated, co-ordinated water resource program as required in ORS 536.300 (2) which states:

> "Based upon said studies and after an opportunity to be heard has been given to all other state agencies which may be concerned, the board shall progressively formulate an integrated, coordinated program for the use and control of all the water resources of this state and issue statements thereof."

A summary of the basic data and factors examined in the study are contained in this report. Detailed information is available for examination in the files of the Board in Salem, Oregon.

FINDINGS AND CONCLUSIONS

1. The total basin yield is adequate on an average annual basis to supply all presently existing and some contemplated needs and uses of water, but some shortages exist each year in most areas, because of the seasonal and geographical yield distribution pattern.

2. The basin's average annual yield, from streams and ground water, supplies water to irrigate 269,000 acres in the Oregon portion of the basin, supplies all other consumptive uses, and supplies an outflow of 1,205,000 acre-feet to the Klamath River.

3. Natural flows are not sufficient in some areas during low flow months to meet existing or future demands.

4. Flows at or near the zero level also occur under natural conditions on some streams having little water under appropriation.

5. Major contributions to surface water yields are made directly from spring flows. Major development of the ground water resource without proper regulation could affect these contributions.

6. Simultaneous use of a major portion of the existing consumptive water rights results in flows at or near the zero level in many streams during the summer and early fall months.

7. Available data indicate that the ground water resource is of major significance and represents an important source for domestic, livestock, municipal, irrigation, and industrial needs, both present and future.

8. Augmentation of the water supply in periods of need can come through storage of surplus runoff and through more efficient use of presently appropriated water.

9. Further knowledge of the quantity of surface flows is required. Reestablishment of inactive gages and establishing stations at new sites is needed to record inflows to Upper Klamath Lake from its western and northwestern drainage areas, inflows to Swan Lake, and flows in the Sprague and Sycan Rivers above Beatty. A program to establish specific locations should be undertaken.

FINDINGS AND CONCLUSIONS

10. General studies of ground water occurrence and yield capabilities are presently being carried out by the State Engineer and the U. S. Geological Survey. Detailed investigations are limited and should be expanded.

11. The Klamath River Basin Compact between the States of Oregon and California establishes an agency with responsibility to manage the use and control of the waters of the basin.

12. The Compact establishes a priority of use as follows: domestic and irrigation; recreational use, including fish and wildlife; industrial use; generation of hydroelectric power; and other uses as the state may recognize.

13. The priority of use for irrigation is limited to lands irrigated at the time of Compact ratification and an additional 200,000 acres in Oregon and 100,000 acres in California.

14. Waters of the Lake of the Woods and tributaries have been withdrawn from future appropriation by ORS 538.190.

15. There is an estimated total of 200 cfs allowed for out-of-basin diversions for irrigation, power, domestic, and municipal uses. An effort is needed to evaluate if these rights are being fully utilized.

16. There are consumptive water rights for 2,878 cfs within the basin. Irrigation rights account for the greatest consumptive use with 2,754 cfs. These rights do not include those rights to use water for irrigation claimed by the U. S. Bureau of Reclamation.

17. There are sufficient ground and surface water resources to supply supplemental water to the presently irrigated acreage, increase the irrigated acreage within the Klamath Compact limitation, plus supplying some additional needs for domestic, municipal, industrial, and recreation uses.

18. Water for increased domestic supply probably will be supplied by ground water sources.

19. Of the total water consumption in the basin, irrigation use consumes about 98 percent.

FINDINGS AND CONCLUSIONS

20. Most of the presently irrigated lands have an adequate water supply during the June through September portion of the irrigation season in average water years and experience some shortages in critically low water years.

21. Pollution of ground and surface water is a problem in the basin and is due, to a large extent, to natural causes.

22. Summer flows recommended by the Oregon State Game Commission are in excess of available flows on some of the Klamath Basin stream systems.

23. To satisfy documented fish life needs in lower basin streams would require approximately 250,000 acre-feet of annual outflow from the basin.

24. Priority of use established by the Compact and the available water resource may prohibit the Commission from restricting further appropriation of natural streamflow to protect fish and wildlife. A few streams would be benefited by such restrictions.

25. Further studies are needed as to possible means of furnishing flow requirements for production and rearing of fish life.

26. Waterfowl habitat will continue to be an important user of water in the basin. Conservation of the basin's natural lakes and marshes would help protect fish life and waterfowl habitat, and would increase recreational potential.

27. Competition for water exists among irrigation, recreation, pollution abatement, and fish and wildlife uses.

28. Flooding and streambank erosion are serious local problems on about 68,000 acres of valley land and where the streams pass through urban areas. Erosion is a major problem on about 70 percent of the land in the basin.

29. Flood damage benefits are not great enough to justify large single-purpose structures.

30. Small reservoirs on important tributaries could reduce local flooding and erosion and provide late season water for irrigation, livestock, and fish life.

FINDINGS AND CONCLUSIONS

31. The surface water supply as now developed is inadequate in some areas to provide enough water for the basin needs. Therefore, coordinated development of ground and surface water supplies is essential for total development of the basin within the Klamath Compact limitations.

32. There are few feasible potential reservoir sites in the major watersheds.

33. There are over 980,000 acres of mapped irrigable land within the basin.

34. Further agricultural development throughout the basin is limited to a certain extent by climatic conditions.

35. To accomplish irrigation development up to the limit of the Compact, regulation of the annual yield will be necessary.

36. Utilization of available ground water for additional irrigation development may allow management of unappropriated surface water for uses with an inferior priority.

37. The Klamath Basin Compact Commission should undertake a multipurpose basin planning program. There is need to coordinate individual project plans into basinwide plans.

38. Feasibility studies of future development in the basin either for large reclamation projects or for waterfowl enhancement projects should include objective analysis of land quality, water supply, climatic conditions, economic returns, and impacts on wildlife habitat.

KLAMATH BASIN

PART I THE BASIN

NATURAL FEATURES

Location and Description

The Klamath Drainage Basin is located in south central Oregon and northwestern California. This report is concerned with the area upstream of the point where the Klamath River passes from Oregon into California as shown in Figure 1 with study areas tabulated in Table 1.

TABLE 1

KLAMATH BASIN AREAS

STUDY AREA		ACRES	SQUARE MILES
1. Williamson River		950,900	1,485.8
2. Sprague River		1,013,400	1,583.4
3a. Wood River		208,600	325.9
3b. Upper Klamath Lake		256,400	400.6
4a. Swan Lake		84,700	132.3
4b. & c. Lost River	(Oregon portion)	755,500	1,180.5
	(California portion)	1,092,100	1,706.4
5. Klamath River	(Oregon portion)	363,600	568.1
	(California portion)	396,700	619.8
TOTAL		5,121,900	8,002.8

Data Source: Klamath River Basin Compact, California Department of Water Resources Bulletin No. 83, USDA, SCS River Basin Survey Staff, State Water Resources Board.

This drainage area, essentially as defined by the Klamath River Compact, also includes two closed basins contiguous to the natural drainage basin of the Klamath River. These closed basins are the Lost River drainage in the eastern extremity and the Meiss Lake drainage in the southwestern section of the basin. The portion of the basin in Oregon, as delineated by the State Water Resources Board, measures about 85 miles from north to south and averages about 70 miles from east to west. The basin in Oregon, about 3,633,100 acres, encompasses the major portion of Klamath County and smaller parts of Jackson, Josephine, and Lake Counties and lies almost entirely within

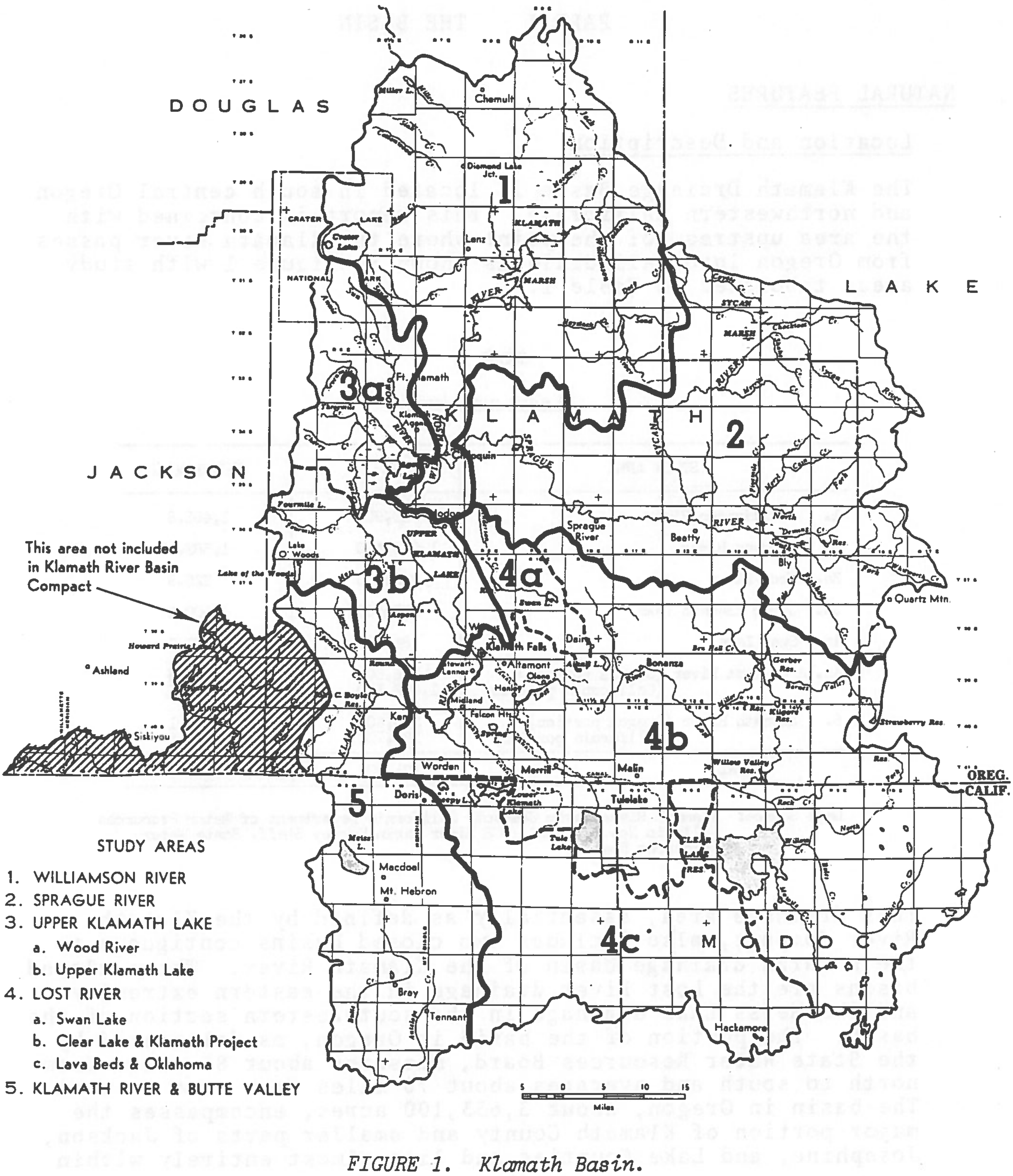


FIGURE 1. Klamath Basin.

the State of Oregon's eleventh Administrative District. The California portion of the basin comprises about 1,488,800 acres and encompasses major portions of Modoc and Siskiyou Counties.

For study purposes the basin has been broken down into five major study areas as shown in Figure 1 and Table 1. Study Area 1, Williamson River, is situated in the northern portion of the basin and forms the major tributary to Upper Klamath Lake. Study Area 2, Sprague River, forms the northeastern portion of the basin and is tributary to the Williamson River. Study Area 3 comprises the drainage into Upper Klamath Lake along the western side of the basin, which is the eastern slope of the Cascade Range. Study Area 4 is comprised of the Lost River and Klamath River drainages above Keno in the southeastern portion of the basin. It also encompasses the closed Swan Lake Basin. In this Study Area lies the Klamath Project, one of the larger irrigation developments in the State of Oregon. Study Area 5 is comprised of the area tributary to the Klamath River downstream from Keno, north of the Oregon-California state line, and the closed basin of Meiss Lake in California.

Stream Systems

Plates 1 and 1a of the Appendix illustrate the stream systems and locate all known water features including streams, springs, lakes, marshes, reservoirs, canals, and major wells.

Crater Lake, lying in the caldera of collapsed Mount Mazama, is a major water feature of the basin and is the principal attraction of the only National Park within the State of Oregon. Located along the crest of the Cascade Range, it has no visible inlet or outlet. On a long-term basis, precipitation and snowmelt on the crater walls are balanced by seepage and evaporation from the lake surface. The lake has a surface area of approximately 13,200 acres.

Upper Klamath Lake, the largest natural lake within the state, is another outstanding water feature of the basin. It is fed by both surface water entering from the north and west and large springs and seeps located in the lake bed.

Upper Klamath Lake receives surface inflows from the Williamson and Wood Rivers, its major tributaries. The Williamson River rises in large springs along the toe of Booth Ridge in the northeasterly portion of the basin. It flows northward for some distance before turning to the west and entering Klamath Marsh. From Klamath Marsh it flows southerly into Upper Klamath Lake. Between Klamath Marsh and Upper Klamath Lake, the Williamson has two tributaries that are significant. The first, Spring Creek, which enters the Williamson above the town of Chiloquin, exhibits almost constant flow; the second, Sprague River, joins the Williamson just south of Chiloquin.

The Sprague River has its headwaters on the westerly slopes of Coleman Rim and Gearhart Mountain in the eastern extremity of the basin. It is joined in the central portions of the Sprague River Valley by a major tributary, the Sycan River. The headwaters of the Sycan are on Winter Ridge in the extreme easterly portion of the basin. The river flows in a north-westerly direction until it enters Sycan Marsh. From the marsh it flows southwesterly to its confluence with the Sprague. The Sprague then flows generally westerly until it merges with the Williamson River near the town of Chiloquin.

Wood River rises from Wood River Springs. The springs are located about 17 miles due north of Agency Lake. Wood River drains into Agency Lake, the shallow, marshy, northerly arm of Upper Klamath Lake.

Drainage from the easterly slopes of the Cascade Mountains provides surface inflows on the west side of Upper Klamath Lake. Within this western drainage, many small high altitude lakes exist in small natural pockets. One of these, Fourmile Lake, provides storage for releases into Cascade Canal, one of two systems that export water from the Klamath Basin for use in the Rogue Basin to the west. The other system utilizes water from Howard Prairie Lake and transfers it via the Howard Prairie Canal to the Rogue Basin.

Prior to modification by man, the outlet of Upper Klamath Lake was over a basalt dike located at the extreme southern end of the lake. This dike, which formed natural falls, is the head-waters of a short stream, Link River. Link River discharges into Lake Ewauna, which during peak floods overflowed into Lower Klamath Lake.

Historically, flood overflows from Lake Ewauna fed this large natural marsh known as Lower Klamath Lake. The area inundated extended from Klamath River into California and covered approx-imately 94,000 acres, as indicated on an old 1905 map. It was in this old lake bed that some of the early private irrigation development occurred. The area in Oregon has now been almost entirely reclaimed for agricultural purposes.

THE BASIN

As the Klamath River leaves Lake Ewauna, it flows in a generally southerly and westerly direction. Near Keno the stream narrows and enters a precipitous gorge from which it enters John C. Boyle Reservoir, a facility of Pacific Power and Light Company. After release through a power generation facility, it leaves the state, flowing in a southwesterly direction for about 208 miles where it reaches its estuary at the town of Klamath, California.

The Lost River drainage east and south of the city of Klamath Falls includes areas both in Oregon and California and constitutes a naturally closed basin. The river originates at the outlet of Clear Lake, which is located in Modoc County in northeastern California. Clear Lake receives inflows from Willow Creek, which drains the southeasterly portion of the basin. Upon leaving Clear Lake, Lost River flows northerly for some distance into Oregon through Langell Valley. In the central part of the valley, flows from Miller Creek enter from the east, after regulation in Gerber Reservoir. Near the town of Bonanza, the river turns to the west. In this area large springs contribute substantial inflows to the shallow, sluggish stream. Upon flowing through Olene Gap, some 10 miles east of Klamath Falls, the river turns to the southeast, flowing through the Klamath Valley and eventually discharging into Tule Lake, which is located in Modoc and Siskiyou Counties in California. Historically, Tule Lake was a large natural sump, which at times reached a water surface of about 90,000 acres. At this extreme the lake covered the sites of the existing towns of Tulelake, California and Malin, Oregon. During periods of high runoff, flows from Lost River would raise Tule Lake to its highest elevation. The lake would then slowly recede during the summer and fall months due to evaporation. During construction of the Klamath Project, one of the first facilities built was a diversion canal connecting the Lost and Klamath Rivers, which provided for diversion of Lost River flood flows into Klamath River, thus allowing the reclamation of the bed of Tule Lake. Tule Lake Tunnel was also constructed between Tule Lake and Lower Klamath Lake so that excess water could be pumped to Lower Klamath Lake and ultimately to the Klamath River.

In the southwest portion of the basin, lies the naturally closed basin of Meiss Lake, fed by Butte Creek. This intermittent creek has its headwaters in the northerly slopes of Horse Ridge and flows northerly into Butte Valley, in which the towns of Doris and Macdoel are located. Historically, the lake had no outlet, relying on summer evaporation to dispose of flood flows entering the lake.

THE BASIN

Topography

The Klamath-Siskiyou section of the Pacific Border province, the Cascade Mountains province, and the Basin and Range province make up the physiographic units forming the Klamath Drainage Basin.

The Klamath-Siskiyou section physiographic unit, forming the extreme southwest corner of the basin, is noted for its rugged steep slopes, deeply dissected canyons, and turbulent streams. Mount Ashland, 7,533 feet above sea level, is the highest elevation in the unit and has been developed into one of the most spectacular skiing areas in the state. The entire unit is heavily timbered, principally with fir. The lower valleys have been developed for a variety of agriculture.

The Cascade Mountains physiographic province, comprising most of the western boundary of the basin, is made up of the Western and High Cascades units. The province is characterized by snow-capped volcanic peaks, rough steep slopes, and a heavy growth of high-grade timber, predominantly pine on the lower levels and fir on the higher elevations. Numerous small streams and springs contribute large quantities of crystal clear water to surface flows in this province.

World-renowned Crater Lake, lying in the caldera of a volcano on the crest of the High Cascades unit, is unique for its depth, deep blue color, high precipitous walls, size, and scenic grandeur. It is one of the most spectacular topographic features in Oregon. The lake is 4½ to 6 miles in diameter and 1,932 feet deep, making it the deepest lake in the United States. The caldera was created approximately 6,600 years ago by the collapse of an erupting volcano, now named Mount Mazama, which geologists estimate to have been nearly 12,500 feet high.

The Basin and Range province, comprising the majority of the basin area, has a variety of terrain formed by block faulting of large land masses and differential erosion. Extensive pumice plains and marshlands occur in the northern and western parts of the basin. The uplands and broad flat valleys in the central area support pine timber in the higher elevations. Lower elevation valleys in the northern portion of the basin are generally devoid of timber and are covered with native grasses and sagebrush where not under agricultural development. The eastern portion of the basin is mountainous and well timbered with both pine and fir. The low-lying flat southern portion is under intensive agricultural development. Those areas in the southern portion not under agricultural development are generally covered with native grasses and are used primarily for pasturelands.

This province is also characterized by parallel fault-formed mountains and valleys, generally trending northwesterly. Steeply dipping cliffs and scarps front the many tilted fault-block mountains, some of which have vertical displacements of more than 1,400 feet. One of these scarps, located south of Algoma adjacent to U. S. Highway 97, forms Oregon's longest exposed slickenside, a polished and striated fault surface.

Drainage is poor in the flat-lying valleys, as evidenced by the meandering courses of three of the four major river systems.

Valley floor elevations range from the 5,000-foot elevation Sycan Marsh area in the northern portion of the basin to the 4,030-foot Tule Lake Sump area in the south. Maximum peak elevation on the eastern border is 8,364-foot Gearhart Mountain, whereas 9,495-foot Mount McLoughlin, highest peak in the basin, crests the western border formed by the Cascade Range. Maximum relief in the basin is approximately 6,745 feet, ranging from Mount McLoughlin to about 2,750 feet elevation where the Klamath River leaves the basin at the Oregon-California boundary, 25 miles southwest of Klamath Falls.

Climate

The climate of the Klamath Drainage Basin is generally characterized by relatively dry summers with high temperatures and wet winters with moderate to low temperatures. The geographical differences of the Klamath Drainage Basin contribute to a large variety of climatic conditions. Annual precipitation and native vegetation indicate the climate is semiarid.

This subject is covered more extensively under the section titled Climatology in Part II of this report.

CULTURAL DEVELOPMENT

History

The history and settlement of the Klamath Basin typifies the settlement of the American West. First, came trappers and explorers followed by more formal military exploration parties, which led to later settlement by immigrants. The Applegate Trail, the southern route to Oregon, crossed the basin and traffic was heavy. In the early 19th Century the basin was within the area in dispute between Spain and the United States concerning the northern boundary of the Spanish claim. The resulting negotiated settlement established a boundary at 42 degrees latitude. The present state line between Oregon and California was surveyed and established in the 1850's.

In the early 1820's Hudsons Bay Company trappers, led by Peter Skene Ogden in particular, traveled through the area trapping and exploring. These early parties named two mountain peaks, Mount McLoughlin and Mount Shasta, which still carry those names. In the 1840's General John C. Fremont made two expeditions through the basin. The second occurred in May of 1846. He and his party traveled up the western side of Upper Klamath Lake looking for a wagon pass through the Cascades.

Again in 1846 a party led by Levi Scott and including the Applegate brothers laid out a trail from Oregon to the east passing through the Klamath Lake country over to Goose Lake and through Nevada's northwest corner. This was to become the Applegate Trail, the southern route to Oregon.

Early in the 1850's the first agricultural use was made of the basin when Wallace Baldwin pastured 50 head of horses in the lower Klamath country. It was not until 1866, however, that the first permanent settler, Wendelin Nuss, arrived. Very shortly thereafter, Orson Stearns, the first homesteader, arrived. He was followed by Steven Stukel. Prior to this time, in the middle 1850's, a military survey party involved in the Pacific Railroad survey under the command of Lieutenants Williamson and Abbot, with a military escort led by Lieutenant Phil Sheridan, passed through the Klamath Basin exploring for a railroad route from the Sacramento Valley to the Columbia River. The report prepared at the conclusion of this journey has recently come into a measure of importance due to the references it contains concerning the potability of water in Upper Klamath Lake.

The 1870's saw the first water rights for irrigation established in the basin. These were for irrigation of lands in Swan Lake Valley, filed by Lucien Applegate, and for irrigation of lands along Lost River, filed by Silas Kilgore. This decade also saw the advent of the Modoc Indian war. Even today, along the northern boundary of the Lava Beds National Monument, the siege ground may be visited with essentially little change having occurred since the battle raged.

THE BASIN

In 1867 George Nurse, a storekeeper at Fort Klamath, saw commercial possibilities in the area and established a store and ferry at the base of Klamath Falls, which grew into the first town in the basin, Linkville. Some ten years later the Linkville Ditch Company was in operation delivering water for irrigation of town lots.

Some time prior to this, water rights had been established for irrigation along the Sprague River. The Moore Ditch, which ran down Link River for the purpose of powering a sawmill, also had been constructed. The decade of the 1880's saw the construction of the Van Brimmer Ditch and the beginning of irrigation development in the Wood River Valley. About 1886, 4,000 acres were under irrigation near Merrill, being served by the Van Brimmer Ditch, which was soon to be extended via the Adams Canal to irrigate additional lands farther east. About 1892 the Moore Ditch was enlarged for irrigation of additional town lots, and it was within this decade that Linkville was renamed Klamath Falls.

In 1902 passage of the Reclamation Act foretold a development, which through the years, has become significant not only to the Klamath Basin but also the States of Oregon and California. About a year after passage of the Act, a reconnaissance survey was conducted in the basin by Messrs. Whistler and Green, engineers from the U. S. Reclamation Service. About this time the construction of the Modoc Point Irrigation System was begun; and a general investigation of that area was conducted by T. H. Humphreys, also of the U. S. Reclamation Service. The Klamath Water Users Association was formed in 1905, the same year that approval of the Klamath Project was received from the Secretary of the Interior. This year was of further significance because Oregon, by Legislative action for the purpose of irrigation and reclamation, authorized the United States to (1) lower the water level of Upper Klamath Lake, (2) lower and drain Lower Klamath Lake and Tule Lake in Klamath County, (3) use the beds of said lakes for storage, and (4) ceded to the United States any lands uncovered by the lowering or drainage of said lakes. Also in this year the first contract was awarded for the construction of "A" canal.

In 1907 the Southern Pacific Railroad in reaching Klamath Falls constructed a railroad embankment between the Klamath River and Lower Klamath Lake. At this time the U. S. Reclamation Service had structures installed in the embankment at the Klamath Straits crossing so that the Klamath River overflow into the Lower Klamath Lake area could be controlled. The structures were installed by the railroad company and are maintained and operated by the Bureau of Reclamation.

In 1908 Executive Order Number 924, by Theodore Roosevelt, established the Klamath Lake Reservation upon lands in the Lower Klamath Lake area, subject to the provisions of the Reclamation Act. This was the first national wildlife refuge established for waterfowl in the nation. This action initiated recognition of this important natural resource, which is presently protected by five national wildlife refuges within the Klamath Basin, four of which are superimposed upon lands under the primary jurisdiction of the Bureau of Reclamation. In 1964 Public Law 88-567 stabilized the ownership, administration, and management of these four refuges.

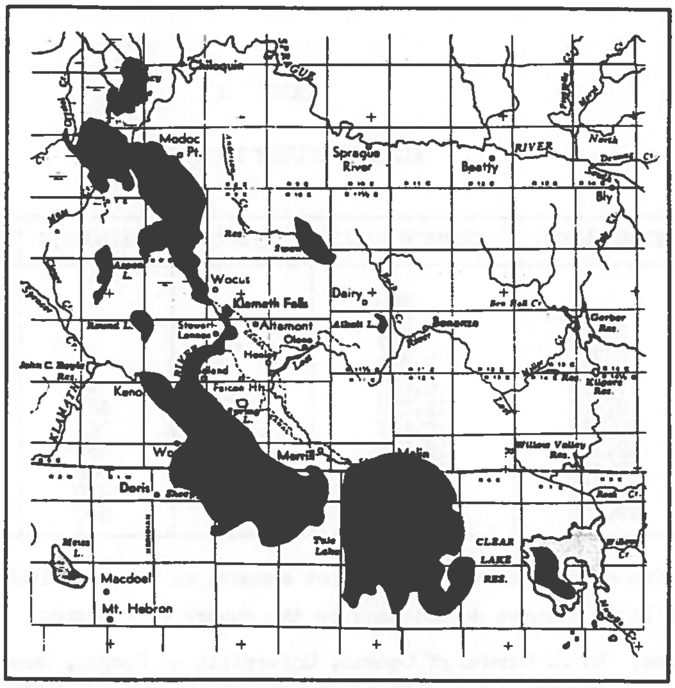
On September 11, 1957, the Klamath River Basin Compact between the states of Oregon and California became effective. This followed ratification by both states in April of 1957 and Congressional consent in August 1957. The document is unique in Oregon and establishes the administrative framework under which future development of the water resources of the basin may be carried out.

The significant impact of development is illustrated in Figure 2, which shows the basin in about its natural state and the rearrangement of lake and water surface features as they are today.

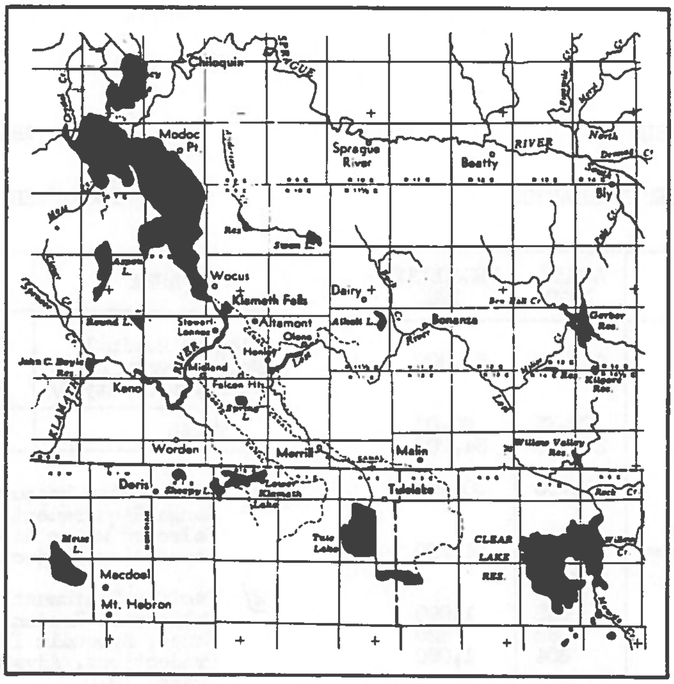
Population

The population of the area encompassed by the Klamath River Basin Compact amounted to nearly 54,100 people in 1960. Of this amount a little over 88 percent or nearly 47,800 people resided in Klamath County in Oregon. The remainder, about 6,300, resided in Modoc and Siskiyou Counties in California. The major urban center within the Compact boundary is the city of Klamath Falls, whose 1960 population amounted to almost 17,000 people.

Tables 2 and 3 show tabulations of historical growth and present data obtained from various projections cited in appropriate locations. Within the basin the most rapid growth occurred from 1910 through 1930, during the period when development of the Klamath Project was under way. A like but less significant growth rate occurred in the Project portion of Siskiyou County. The portion of Modoc County within the Compact boundary has exhibited a slow but relatively steady rate of growth throughout the recorded census period.



CIRCA 1905



1970

FIGURE 2. Comparative Water Surface Areas.

THE BASIN

TABLE 2

KLAMATH COUNTY POPULATION

YEAR	KLAMATH CO.	KLAMATH FALLS	BONANZA	CHILOQUIN	MALIN	MERRILL
1880	-	250	-	-	-	-
1890	2,444*	364	-	-	-	-
1900	5,106	447	-	-	-	-
1910	8,553	2,758	-	-	-	-
1920	11,413	4,801	77	-	-	237
1930	32,407	16,093	141	481	215	306
1940	40,497	16,497	233	741	535	648
1950	42,150	15,875	259	668	592	835
1960	47,475	16,949	297	945	568	804
1965	48,100	17,600	287	910	560	848
1968	49,100	18,200	250	890	570	850

*Population of Indian Reservations not enumerated prior to 1890.

Klamath Falls figures do not include the suburb of Altamont.

Data Source: U. S. Bureau of Census, University of Oregon, Bureau of Municipal Research, Portland State College, Center for Population Research and Census.

TABLE 3

PROJECTED POPULATION

KLAMATH BASIN IN OREGON	ACTUAL 1960	PROJECTED 1980
Total Population	46,780	57,900
Urban Population		
Percent	59.3%	60.0%
Number	27,760	34,700
Rural Population	16,703	20,400
Major Urban Places		
Klamath Falls Area*	27,760	34,700
Other Communities		
Chiloquin	945	1,090
Malin	568	620
Merrill	804	1,090

*Includes Klamath Falls and Altamont.

Data Source: U. S. Bureau of Census, State Water Resources Board.

TABLE 4

PROJECTED POPULATIONS

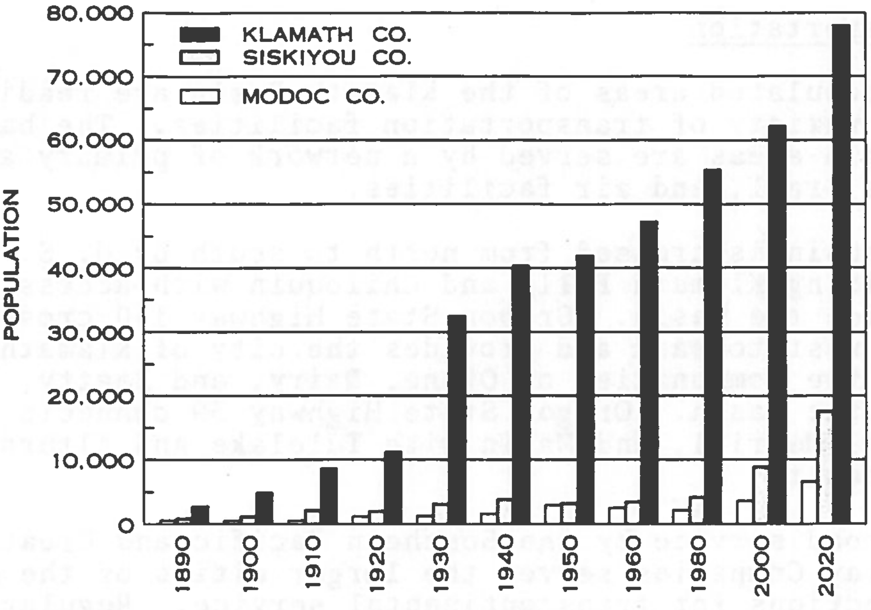
AREA	1980	2000	2020
Klamath Basin 1/	57,900	64,800	78,300
Modoc County 2/	1,800	3,700	6,900
Siskiyou County 3/	4,900	8,800	17,800
TOTAL	64,600	77,300	103,000

1/ State Water Resources Board's Oregon's Long-Range Requirements for Water, Appenidx III, Selected Major Water Using Industries and Population Projections, 1969

2/ Pacific Southwest Interagency Committee, California Region, Comprehensive Framework Study, Appendix IV, Economic Base and Projections, Advanced Preliminary Field Draft, 1970

3/ Ibid. adjusted to area of county included in Compact boundary on basis of populations contained in California Department of Water Resources Bulletin No. 83.

Projections of future population, Table 4 and Figure 3, indicate that within 50 years the population of Klamath County



DATA SOURCES:
1890–1960 – U.S. Bureau of Census
1980–2020 – Oregon's Long-Range Requirements for Water, SWRB 1969
California Region Comprehensive Framework Study 1970 (Draft)

FIGURE 3. Historic and Projected Populations of Klamath Basin Compact Area.

will increase more than one and one-half times to over 78,000 people. The portion of this population allocated to the Klamath Falls area (Klamath Falls and Altamont) amounts to 50,100. Projection data for Modoc and Siskiyou Counties, obtained from the ongoing California Region studies, indicate a population of 6,900 people in Modoc County and 17,800 people in Siskiyou County. These projections are for those portions of the counties within the Compact boundaries. The total population for the year 2020 within the area encompassed by the Klamath Compact would amount to about 103,000 people, almost double today's level.

The levels of population in 1957, the year of the Compact ratification, were derived by straight-line interpolation for the various governmental components of the area. Based on this estimate, the 1957 population of the entire area was 52,450. The estimate indicated 45,900 people residing in

Oregon and the remainder in the California portion, with 2,775 in Modoc County and 3,775 in Siskiyou County.

Transportation

The populated areas of the Klamath Basin are readily accessible by a variety of transportation facilities. The basin's metropolitan areas are served by a network of primary and secondary roads, rail, and air facilities.

The basin is crossed from north to south by U. S. Highway 97, providing Klamath Falls and Chiloquin with access to points outside the basin. Oregon State Highway 140 crosses the basin from west to east and provides the city of Klamath Falls along with the communities of Olene, Dairy, and Beatty, egress outside the basin. Oregon State Highway 39 connects Klamath Falls, Merrill, and Malin with Tulelake and Alturas to the southeast.

Railroad service by the Southern Pacific and Great Northern Railway Companies serves the larger cities of the basin with connections for transcontinental service. Regular bus and truck freight service is available to all larger and most smaller communities.

Klamath Falls is the only city in the basin served by a scheduled airline. The airport, Kingsley Field, is operated jointly by the city of Klamath Falls and the Air Force. Numerous other airports accommodate small private aircraft and governmental air traffic to the outlying communities.

Telephone service is provided primarily by Pacific Northwest Bell throughout the basin.

Land Use and Ownership

Due to the complexity and lack of current data on land use and ownership in the California section of the Klamath Basin, only that portion of the basin lying within Oregon will be discussed in this section. The Oregon section of the basin contains approximately 3,633,100 acres. The largest landowner is the Federal government, which owns 1,830,500 acres or approximately 50 percent of the Oregon portion of the Klamath Basin. Private, municipal, county, and state ownerships amount to 1,661,100 acres or approximately 46 percent of the Oregon portion of the basin. The balance, approximately 4 percent, is made up of Indian Trust lands.

Approximately 273,600 acres of the federally-owned lands are public domain, which are administered by the Bureau of Land Management. About 1,417,600 acres are included in the Fremont, Winema, Deschutes, Rogue River, and Klamath National Forests. Other Federal ownerships include the Bureau of Reclamation and the Department of Defense. About 141,500 acres are Indian Trust lands managed by the U. S. National Bank of Portland.

Table 5 shows the status of land use and ownership broken into four major categories. These categories are range and

TABLE 5

LAND USE AND OWNERSHIP
KLAMATH BASIN, OREGON, 1970
Acres

OWNER	USE					PERCENT OF TOTAL BASIN
	Range and Pasture	Crop	Forest	Other	Total	
FEDERAL						
Forest Service	76,100	-	1,332,500	9,000	1,417,600a/	39
Bureau of Land Management	102,400	-	170,800	400	273,600b/	7
Other Federal	-	2,700	73,200	63,400	139,300b/	4
Subtotal	178,500	2,700	1,576,500	72,800	1,830,500	50
INDIAN TRUST	7,200	2,300	131,900	100	141,500	4
STATE, COUNTY, MUNICIPAL and OTHER	373,100	296,500	428,000	123,500	1,221,100c/	34
LARGE TIMBER INDUSTRY	16,000	-	421,800	2,200	440,000	12
TOTAL	574,800	301,500	2,558,200	198,600	3,633,100	100
Percent of Basin	16	8	71	5	100	

a/ Includes O and C lands.

b/ Includes Bureau of Sports Fisheries and Wildlife, National Park Service, Bureau of Reclamation and U. S. Air Force.

c/ Includes state administered lands on Klamath and Agency Lakes and small private lands.

Data Source: USDA, SCS River Basin Survey Staff.

pasture, crops, forest, and other. The other category includes lands which are unsuitable or unavailable for use within the other three categories. Examples are urban lands, roadways, and open water areas. As can be seen in this table, the largest portion of land use is made up of forest land, which comprises approximately 71 percent of the basin in Oregon. These are lands that are forested to an extent of at least 10 percent or lands from which timber has been harvested.

The next largest category of land use is the range and pasture category. This category includes primarily those areas of grassland or other long-term forage that have less than 10 percent timber coverage. Although the basin sustains an agricultural industry, the total cropland within the Oregon portion of the basin amounts to only 8 percent of the basin area, with the remaining 5 percent made up of other uses.

Figure 4 is a generalized land use map. It should be noted on this figure that the other lands category not only comprises those gray areas shown but also the white open-water areas.

ECONOMY AND RELATED NATURAL RESOURCES

General

The two most important contributors to the economy of the Klamath Basin traditionally have been the agricultural and the timber industries. However, the recreational industry is the fastest growing industrial enterprise within the basin and may soon become one of the major contributors to the economy of the basin. Other types of economic activity include the various retail and wholesale trades, service trades, and nonwood products manufacturing to a limited extent.

There were approximately 530 retail establishments in Klamath County in 1967. Of these, 118 were classified as eating and drinking places. Although the total number of retail establishments decreased by approximately 5 percent during the 9-year period from 1958 to 1967, the gross value of sales for the retail trades increased by about 24 percent.

Manufacturing can be considered one of the major sources of economic activity in the basin, due to its relation to the timber industry. Fifty-eight firms were classified as manufacturing establishments in 1968. The largest single category, 25 firms, dealt with wood products processing. The mineral processing industry in the Klamath Basin is minor and is limited to the extraction of sand, gravel, stone, and pumice,

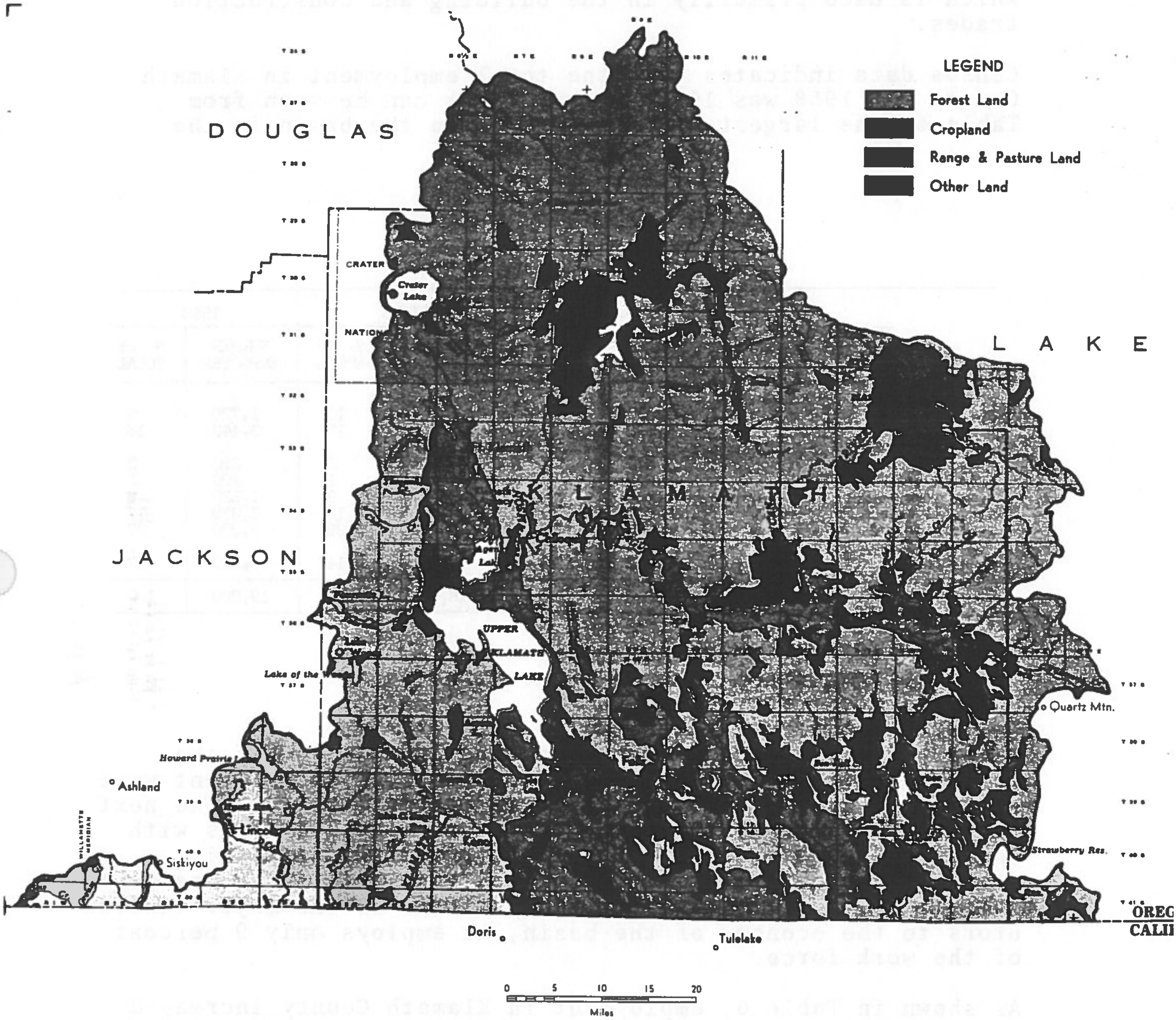


FIGURE 4. Generalized Land Use.

which is used primarily in the building and construction trades.

Census data indicates that the total employment in Klamath County for 1968 was 19,000 people. As can be seen from Table 6, the largest single employer in the basin is the

TABLE 6

KLAMATH COUNTY EMPLOYMENT

INDUSTRY	1958		1963		1968	
	NUMBER EMPLOYED	% of TOTAL	NUMBER EMPLOYED	% OF TOTAL	NUMBER EMPLOYED	% OF TOTAL
Agriculture	2,030	12	1,620	10	1,720	9
Lumber and wood products manufacturing	3,360	19	2,680	17	3,440	18
Other manufacturing	570	3	390	2	380	2
Contract construction	1,050	6	370	2	400	2
Transportation	1,580	9	1,460	9	1,530	8
Wholesale and retail trades	2,670	15	2,880	18	3,230	17
Service, self-employed, and miscellaneous a/	4,370	25	4,620	28	5,090	27
Government	1,910	11	2,240	14	3,210	17
TOTAL	17,540	100	16,260	100	19,000	100

a/ Includes unpaid and domestic.

Data Source: USDA, SCS River Basin Survey Staff.

lumber and wood products manufacturing industry. Of the 19,000 people employed in 1968, approximately 18 percent were employed by lumber and wood products manufacturing. The next two largest employers were wholesale and retail trades with approximately 17 percent and various government agencies, federal, state, county, and municipal with another 17 percent. Although the agricultural industry is one of the major contributors to the economy of the basin, it employs only 9 percent of the work force.

As shown in Table 6, employment in Klamath County increased from 17,540 people in 1958 to 19,000 people in 1968. During this same period from 1958 to 1968, unemployment varied from a high of 7.4 percent in 1961 to a low of 4.7 percent in 1968. Unemployment in the county not only varies from year to year but varies from month to month within the year.

Unemployment has reached as high as 10 percent during the months of January, February, and March and averages around

4 to 5 percent during the months of September and October. The lower unemployment rates in the summer months are due to the seasonal characteristics of the lumber and agricultural industries.

Median family income within Klamath County for 1960 was $5,922, exceeding median family income in both Oregon and United States. The value within Oregon for 1960 was $5,892 and was $5,660 for the entire United States.

The Timber Industry

The economic potential of the timber resource of Klamath County was first evidenced in 1863, with the building of the first sawmill at Fort Klamath. Today, approximately 350 million board feet of lumber is processed annually within the basin.

Table 7 shows the available commercial forest acreage within

TABLE 7

COMMERCIAL FOREST LAND
1968

OWNER	AVAILABLE		MILLED IN BASIN	
	Acres	% of Total	MM Board Feet	% of Total
U. S. Forest Service	1,125,300	52	108.0	29
Bureau of Land Management	74,100	3	30.8	8
National Park Service	-		-	
Trust	131,900	6	30.0	8
Forest Industry	421,800	20	113.0	30
State	34,000	2	10.0 1/	3
Other	363,800	17	80.0 1/	22
TOTAL	2,150,900	100	371.8	100

1/ Estimated from USDA records.

Data Source: USDA, SCS River Basin Survey Staff.

the Oregon portion of the basin. Most of the commercial forest land in the basin is managed under a sustained yield program. Approximately 2,151,000 acres are classified as available commercial forest land, consisting primarily of ponderosa and sugar pine. Other species classified as commercial forest include Douglas-Fir, lodgepole pine, incense cedar, western larch, shasta fir, true fir, mountain hemlock, and Englemann Spruce. As can be seen from Table 7, approximately 52 percent of the available commercial timber within the basin is managed by the U. S. Forest Service. The U. S. Bureau of Land Management, the Forest Industry, the State, and Indian Trust lands constitute most of the remaining ownership. Unavailable commercial forest land, lands dedicated by Congressional action to recreation and wildlife uses, totals 142,600 acres of which 56,600 acres are managed by the National Park Service.

There are 10 lumber processing mills within the basin with a capacity of 380 million board feet. Peak production occurred during 1941 in which there was a total of 808.6 million board feet processed within the basin boundaries. At that time there were 22 lumber processing mills in the basin. The recent trend has been toward larger mills with greater processing capacity. Approximately 90 percent of the timber cut in the basin is milled into lumber and plywood, and the remaining 10 percent is processed for plywood core stock and box shook.

The total annual cut within the basin in 1968 was 398.5 million board feet. This total annual cut has been on an increasing trend in recent years from a low of 182 million board feet in 1957. Table 7 shows the distribution of the total annual cut milled within the basin for the year 1968. The largest portion cut was harvested from privately owned land. In addition to the 371.8 million board feet cut and milled within the basin in 1968, an additional 57.7 million board feet was shipped outside the basin boundaries for milling.

TABLE 8

TIMBER IMPORTS
1968

OWNER	MM BOARD FEET
Oregon	
Fremont National Forest	33.2
California	
Modoc National Forest	19.0
Klamath National Forest	20.0
Private Ownership	12.0
TOTAL	84.2

Data Source: USDA, SCS River Basin Survey Staff.

Table 8 shows the total annual amount imported into the basin for processing in 1968. The majority of this timber was cut from the Modoc and Klamath National Forests and private lands in California.

Using 18 sample sales within the national forest boundary, the average stumpage value of timber cut was $20.22 per thousand board feet as compared to the milled lumber value of the 18 sample sales of $95.05 per thousand board feet. If these rates were applied to the 1968 level of production within the basin, the 371.8 million board feet would produce approximately $7,518,000 at stumpage value and approximately $35,340,000 for the milled lumber value.

Agriculture

Within Klamath County approximately 270,000 acres of privately owned land is utilized for production of agricultural products, using various methods of irrigation. In 1964, 86 percent of total cropland harvested was irrigated, compared to 78 percent ten years earlier. Types of crops include potatoes, grains, peas, grass and legume seed, alfalfa hay, grass hay, and pasture.

In 1945 there were 1,421 farms in Klamath County that averaged slightly in excess of 980 acres in size. By 1959 the number of farms had declined to 1,089 but had increased in average size to 1,390 acres. Most recent census data indicate that there are approximately 1,072 farms averaging in excess of 1,450 acres in size. Included in the number of farms are 98 farms that are less than 10 acres in area and 101 farms that are in excess of 2,000 acres.

In 1964 of the 1,072 farms classified within Klamath County, 48 percent were classed as general, which includes all farms not specializing in any particular crop or livestock operation. Eighteen percent were classed as specialized farms, which is any farm specializing in the production of a single crop such as potatoes, hay, or cash grains; and the remaining 34 percent were classed as predominately livestock operations, including cattle, sheep, dairy products, and poultry.

Table 9 indicates the tenure of farms in Klamath County for the period of 1954, 1959, and 1964. This table indicates 61 percent of the total farms within Klamath County were operated by the owner in 1964. This percentage has decreased from 1954, when 65 percent of the farms were owner operated. During the same period the percentage of part owners increased from 25 to 29 percent of total number of operators. It can also be

TABLE 9

NUMBER OF FARMS
KLAMATH COUNTY

TENURE	NUMBER		
	1954	1959	1964
Fully Owned	839	701	657
Partly Owned	330	290	316
Managed	7	8	13
Tenant Farmed	121	90	86
TOTAL	1,297	1,089	1,072

Data Source: USDA, SCS River Basin Survey Staff.

seen from this table that tenant farmers make up only 8 percent of all operators.

Table 10 shows the average value of land and facilities per farm and per acre within Klamath County for the years 1949,

TABLE 10

VALUE OF LAND AND BUILDINGS
KLAMATH COUNTY
Dollars

STATE AND COUNTY	1949	1954	1959	1964
Average Per Farm				
Klamath County	35,977	62,910	58,625	108,113
Oregon	19,963	27,798	43,608	59,079
Average Per Acre				
Klamath County	54	59	76	106
Oregon	62	76	87	115

Data Source: USDA, SCS River Basin Survey Staff.

1954, 1959, and 1964. The average value of land and facilities per farm has been consistently higher in Klamath County than the average for the state, although the value per acre has been lower than the statewide average. This is due to the many large cow-calf operations that are typical within the basin. This table also shows that total value per farm has increased 200.5 percent from 1949 to 1964, whereas the total per acre value has increased 96 percent.

Table 11 shows the major crops grown in the Klamath Basin: alfalfa and other hay crops, potatoes, and small grains.

TABLE 11

ACREAGE HARVESTED
KLAMATH COUNTY
Acres

CROP	1954	1959	1964	PERCENT 1964
Small Grains				
Wheat	12,822	7,836	6,930	4.1
Barley	54,353	46,530	31,613	18.7
Oats	32,463	30,012	26,219	15.5
Rye and other grains	4,692	1,706	3,751	2.2
Subtotal	104,330	86,084	68,513	
Hay Crops				
Alfalfa	29,420	32,471	45,511	26.9
Clover	4,237	8,057	8,734	5.2
Oats, wheat, barley, and other grains	11,923	11,521	14,930	8.8
Wild hay	24,128	18,610	15,439	9.1
Other hay	4,479	3,765	4,132	2.4
Subtotal	74,187	74,424	88,746	
Silage Crops	1,913	790	981	.6
Seed Crops a/	6,755	5,953	1,548	.9
Potatoes	10,998	8,032	9,275	5.5
Miscellaneous Crops b/	243	41	207	.1
Subtotal	19,909	14,816	12,011	
TOTAL	198,426	175,324	169,270	100

a/ Grass and hay seeds.

b/ Includes vegetables, berries, orchards, and other crops.

Data Source: USDA, SCS River Basin Survey Staff.

Approximately 27 percent of the total cropland harvested in 1964 was devoted to the production of alfalfa. The next two largest crops were barley and oats, which consisted of approximately 19 and 16 percent of the total croplands, respectively. Clover hay, small grains, and wild and other hay were grown on approximately 25 percent of the total harvested cropland.

TABLE 12

MAJOR CROP PRODUCTION
KLAMATH COUNTY
Thousands

CROP	UNIT	1954	1959	1964	1968
Small Grains					
Wheat	Bushel	272	167	239	360
Barley	"	2,097	1,926	1,888	2,121
Oats	"	888	1,558	1,633	1,404
TOTAL		3,257	3,651	3,760	3,885
Hay					
Alfalfa	Ton	95	111	163	NA
Clover	"	6	14	15	"
Small grains	"	14	15	25	"
Wild hay	"	25	17	18	"
Other hay	"	5	4	7	"
TOTAL	"	145	161	228	
Silage	Ton	6,765	5,971	5,664	NA
Potatoes	CWT	2,171	2,255	1,954	2,856

Data Source: USDA, SCS River Basin Survey Staff.

TABLE 13

AVERAGE MAJOR CROP YIELDS PER ACRE
KLAMATH COUNTY

CROP	UNIT	1954	1959	1964	1968
Small Grains					
Wheat	Bushel	21	21	34	40
Barley	"	39	41	60	53
Oats	"	27	52	62	54
Hay					
Alfalfa	Ton	3.2	3.4	3.6	NA
Clover	"	1.4	1.7	1.8	"
Small grains	"	1.2	1.3	1.6	"
Wild hay	"	1.0	0.9	1.2	"
Other hay	"	1.2	1.6	5.8	"
Silage	Ton	3.5	7.6	5.8	"
Potatoes	CWT	197	281	211	280

Data Source: USDA, SCS River Basin Survey Staff.

Potato production utilized only 6 percent of the total croplands as of 1964. A trend in the basin in crop production in recent years has been to decrease acreages of small grains and to increase production of alfalfa.

Total production of the major crops grown in Klamath County is shown in Table 12. Increases in production have occurred in all the small grains and potatoes from 1954 through 1968 and in most hay crops from 1954 to 1964. Table 13 shows the average unit yields of all major crops, indicating significant increases in all crops in recent years. Yields in wheat and oats increased about 90 and 100 percent respectively from 1954 through 1968. During the same period, potato yields have increased approximately 42 percent.

Table 14 shows the total value of sales of the major crops grown within Klamath County. As can be seen from this table,

TABLE 14

MAJOR CROP VALUE
KLAMATH COUNTY
Thousands of Dollars

CROP	1959-1964	1965	1965
Small Grains			
Wheat	419	495	483
Barley	1,616	1,660	1,817
Other	-	1,221	958
All Hay	1,702	1,859	2,308
All Seed	396	281	212
Specialty Crops	13	30	34
Vegetables	5	5	5
All Potatoes	5,003	3,770	4,818
Other Crops	-	290	139
TOTAL		9,611	10,774

Data Source: USDA, SCS River Basin Survey Staff.

potatoes are the most important crop in terms of the total value of sales. Potatoes grown in the basin are sold primarily for fresh market consumption. The smaller sized potatoes that would normally be suited for processing are generally used locally for livestock production within the basin as there are no potato processing facilities within the area. In recent years the barleys that were originally grown for sale to the eastern breweries have been shifted to the production of higher yielding feed barleys.

The predominant type of livestock enterprise in the basin is cow-calf ranching. A few of the feeder cattle and calves produced in these operations are fattened in local feed lots, but the greater percentage is shipped out of the basin to feed lots in California and western Oregon. The cow-calf operation accounted for approximately 90 percent of the total sales of livestock and livestock products within the basin for the year 1968. The total sales for livestock and livestock products for this year were $16,794,000.

A great deal of the area within the basin is used for pasturelands. Significant amounts are used for large numbers of cattle from California ranches brought into the basin for summer grazing. Approximately 70,000 head were pastured in the basin during the summer of 1969.

Table 15 indicates the livestock numbers in Klamath County for the years 1954, 1959, and 1964. It can be seen from

TABLE 15

LIVESTOCK NUMBERS
KLAMATH COUNTY

STOCK	1954	1959	1964
Cattle and Calves			
Cows and heifers calved	48,752	37,744	55,082
Heifers and heifer calves	30,507	30,855	42,852
Steers and bulls, including calves	40,037	30,351	42,283
TOTAL	119,296	98,950	140,217
Sheep and Lambs			
Lambs under a year	23,531	22,853	9,539
Ewes	31,004	32,754	29,763
Rams and wethers	1,098	917	1,079
TOTAL	55,633	56,524	40,381
Hogs and Pigs	4,244	4,218	1,958
Chickens	54,531	47,819	34,603

Data Source: USDA, SCS River Basin Survey Staff.

this table that the number of cattle and calves has increased significantly. The trend in hogs and chicken production has decreased sharply over the same period. Sheep have decreased somewhat but continue to be the second largest livestock industry within the basin.

It is interesting to note that the 1930 census indicated there were 36,000 head of cattle in Klamath County, whereas the 1964 census indicated 140,217 head. Contrasted to this, the number of sheep in 1930 was some 140,000 head as compared to 1964 when approximately 40,400 head of sheep grazed within the basin.

The dairy industry in Klamath County has followed similar trends as those throughout the United States. The 1940 census indicated that there were approximately 8,000 dairy cows within the county as compared to the 1964 census figures that indicated only 2,100. Although the total number of dairy cows has declined, production has not declined proportionately. Presently there are approximately 15 commercial milk producers operating within Klamath County; and, while the number of cows may further decline, an increase in county population will require greater yields, thus insuring the continuance and probable expansion of the dairy industry.

The stability of the agriculture economy within the Klamath Basin is best represented by the success of the Bureau of Reclamation's Klamath Project. Costs of the Project since 1905 amount to a total of approximately $20,000,000, of which about 87 percent has been repayed to date. The balance of about $2,700,000 is contracted for repayment, with all contract payments current.

In addition to repayments, approximately $120,000 per year received from leasing government-owned lands in the refuges is used to pay in lieu taxes to Klamath, Siskiyou, and Modoc Counties.

Mineral Industry

Mineral production in Klamath County amounted to $2,139,000 in 1969, according to the U. S. Bureau of Mines. This is an increase of more than a million dollars over the prior year, due principally to an increased use of pumice and volcanic cinders for road construction and maintenance by governmental agencies.

The minerals produced, in descending order of value, were stone, sand and gravel, pumice and volcanic cinders, and clay.

The term "stone" designates any consolidated rock. Stone suitable for construction purposes is available throughout much of the Klamath Basin, as are volcanic cinders. Good quality sand and gravel are not abundant. Pumice occurs predominantly in the northern portion of the basin. Clay is excavated north of Klamath Falls for brick and tile manufacture.

The principal use of water in the production of these minerals is that required to wash sand and gravel aggregate for concrete. Much of this water is reused.

In the Klamath Falls area, stone is currently produced at two quarries within seven miles of the city. Sand and gravel comes from two large deposits within nine miles of the city limits. Upon exhaustion of these deposits, a very large quantity of sand and gravel is available west of Ball Bay, a hauling distance of less than 20 miles to Klamath Falls.

Diatomite underlies much of the southern portion of the basin and is presently being deposited in Klamath Lake, Agency Lake, and the Klamath Marsh. Except for a few carloads from a site west of Keno used as a concrete additive for dam construction, the diatomite is generally too high in volcanic ash and other impurities to have commercial value at this time.

The State Department of Geology and Mineral Industries reports (1970) that there is little or no evidence to indicate the presence of commercial quantities of oil or gas in the Klamath Basin. This finding is based on the results of geologic studies and the drilling logs of five exploratory wells.

Geothermal steam, a mineral resource having a high potential for development in the basin, is discussed in Part III, Water Use and Control.

Recreation

The Klamath Basin is a land of wide diversity of both flora and fauna and is utilized by outdoor recreationists throughout the entire year. Recreation is the third largest contributor to the basin economy and is the fastest growing industry within the basin.

Outdoor recreation includes such activities as camping, picnicking, fishing, hunting, natural and historic sightseeing, vacation ranching, and outdoor winter sports. Facilities for all these activities are available within the basin.

THE BASIN

Numerous parks and recreation facilities exist throughout Klamath Basin, having been developed by federal, state, county, and city agencies. The major park facility in Klamath County is Crater Lake National Park, which consists of some 250 square miles of federally owned land and is totally situated within county boundaries. Crater Lake is recognized as one of the natural scenic phenomena of the western United States and annually attracts in excess of 500,000 visitors.

The United States Forest Service provides recreational conveniences, which include riding and hiking trails, camping and picnicking areas, boating areas, fishing and hunting facilities, and, in general, open natural spaces for public use. There are two wilderness areas in the basin, Mountain Lakes and Gearhart Mountain, comprising a total of 65 square miles.

The four state parks within the Klamath Basin are Collier, 349.03 acres; Jackson F. Kimball, 19.44 acres; Klamath Falls-Lakeview Forest Wayside, 80 acres; and Tubb Springs Wayside, 40 acres. These facilities afford the visitor camping, picnicking, and fishing opportunities. Collier State Park is the site of the largest museum of pioneer logging equipment in the United States.

There are seven county-operated parks within Klamath County that represent a total of 622 acres. These provide facilities for fishing, camping, and picnicking in addition to boat launching facilities for water-based recreational sports.

Particular credit must be given to the city of Klamath Falls, which provides an all year recreational program on some 463 acres to the benefit of the residents of the Klamath Falls area. Also the city of Malin has gained recognition as having one of the most outstanding community parks in the state available to the general public.

A winter sports facility has been provided on national forest land on Mount Ashland for skiing, sledding, etc. Tomahawk Ski Bowl operates some 25 miles northwest of Klamath Falls.

Water-related recreational activities are enjoyed extensively on Upper Klamath Lake, and, to a more limited extent, on Lake Ewauna.

The total recreational use of various outdoor activities is shown in Table 16 and is enumerated in terms of visitor-day use. Sightseeing and other miscellaneous uses were the most

TABLE 16

RECREATION USE
KLAMATH BASIN
VISITOR-DAY 1/

RECREATION USE	FOREST SERVICE	BUREAU OF LAND MANAGEMENT	PARK SERVICE	LARGE TIMBER INDUSTRY	BUREAU OF RECLAMATION'S PROJECT AREAS				
					Lower Klamath Lake	Clear Lake	Tule Lake	Gerber Reservoir	Upper Klamath Lake 2/
Wilderness Travel	4,000	-	-	-	-	-	-	-	-
Camping	210,700	6,500	231,300	13,000	8,300	-	3,500	5,300	4,000
Picnicking	26,100	3,300	-	-	-	-	-	1,000	2,000
Fishing	44,100	4,900	1,200	20,300	-	-	-	4,700	20,000
Big Game Hunting	164,000	3,400	-	20,100	-	-	-	-	-
Small Game Hunting	8,400	-	-	2,000	-	-	-	-	-
Waterfowl Hunting	-	-	-	-	39,900	400	27,700	900	9,000
Water Sports	33,500	100	1,000	-	1,100	40	1,900	800	18,000
Winter Sports	19,500	-	500	-	-	-	-	-	-
Sightseeing and Other	172,000	1,000	474,100	26,800	3,400	1,100	8,500	700	21,000

1/ One visitor-day is equivalent to eight hours of recreation use by one person for a specific activity or an equivalent.

2/ The numbers for Upper Klamath Lake are conservative estimates due to the unlimited and unmonitored access to the lake.

Data Source: USDA, SCS River Basin Survey Staff; U. S. Bureau of Reclamation.

TABLE 17

DEER HARVEST
KLAMATH BASIN

	UNIT	1964	1965	1966	1967	1968	AVERAGE
Hunters	Number	24,013	25,075	23,220	25,690	26,655	24,931
Hunter-day a/	Days	127,915	132,452	122,757	128,720	146,315	131,632
Harvest	Number	14,401	14,398	13,627	15,640	12,845	14,180
Hunter Success	Percent	60	57	59	61	48	57

a/ A hunter-day is one person hunting for any portion or portions of any one day.

Data Source: USDA, SCS River Basin Survey Staff.

popular recreational activities in terms of visitor-days in 1968. Camping ranked second as the most popular recreational activity with big game hunting ranking third.

Table 17, Deer Harvest, shows Klamath Basin as one of the most successful areas for deer hunters in the state.

Pheasant, valley quail, and dove are the most heavily hunted small game in the basin. Table 18, Small Game Harvest, gives

TABLE 18

SMALL GAME HARVEST
KLAMATH BASIN

GAME SPECIES	1966			1967		
	HUNTERS	HUNTER-DAYS a/	HARVEST	HUNTERS	HUNTER-DAYS a/	HARVEST
Pheasant	2,647	10,049	6,548	2,594	13,316	6,681
Quail	712	2,229	3,854	1,152	5,698	12,904
Dove	959	3,257	10,647	753	3,279	8,207
Grouse	91	162	113	304	573	418
Silver Gray Squirrel	156	501	229	224	973	950
TOTAL	4,565	16,198	21,391	5,027	23,839	29,160

a/ A hunter-day is one person hunting for any portion or portions of any one day.

Data Source: USDA, SCS River Basin Survey Staff.

the figures on small game harvest in the basin for the 1966 and 1967 seasons.

The greatest waterfowl concentrations in North America occur in the Klamath Basin. Approximately 80 percent of the waterfowl in the Pacific Flyway pass through the basin during spring and fall migrations.

Waterfowl hunters from several states expend an estimated 65,000 to 80,000 hunter-days annually in the Klamath area. Oregon accommodates about 40 percent of this use with the remainder occurring in the California portion of the basin.

Trends of recreational visits and activities to Crater Lake National Park and national forest lands are shown in Figure 5. As can be seen, the trends are on an ever-increasing basis.

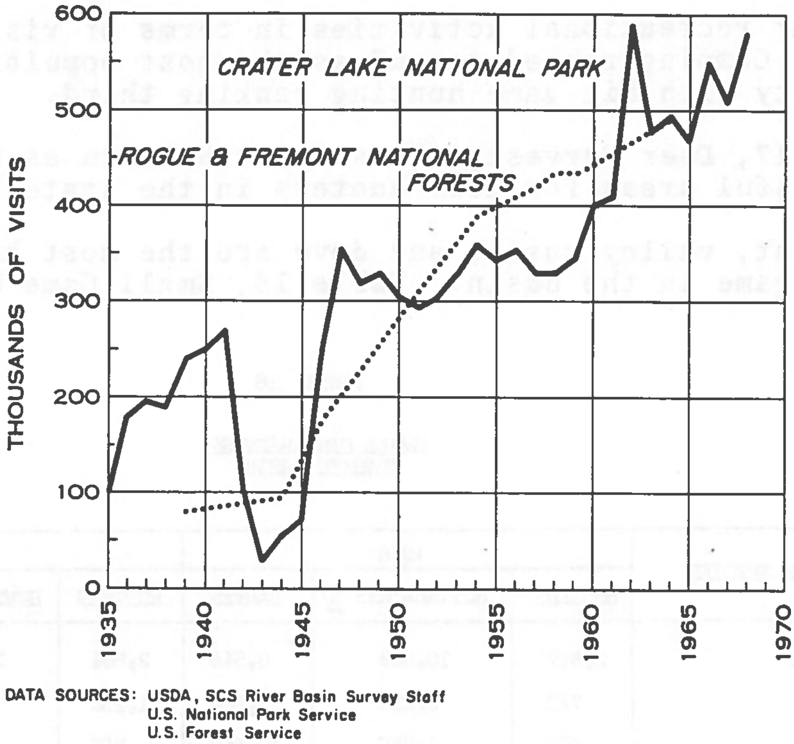


FIGURE 5. Recreational Trends.

Fish Life

Fish resources of Klamath Basin are an important part of the recreational industry. The basin is generally noted for its excellent fish populations, which attract sportsmen from considerable distances. Four species of trout, two of landlocked salmon, and nine species of warm-water game fish inhabit streams and lakes in the Oregon portion of the Klamath Basin.

According to the Oregon State Game Commission, the distribution of resident trout and warm-water game fish populations is concentrated in those streams and impoundments maintaining the most favorable perennial water quality and quantity conditions. The upper Williamson, Sprague, and Wood Rivers in addition to the various high lakes, support the highest trout populations along with Upper Klamath Lake.

Rainbow trout are the most important game fish, and fish over 30 inches in length are not uncommon. Other popular species of trout are brook, brown, and Dolly Varden, with the latter being the least common and more restricted in distribution. Kokanee and coho salmon have been introduced recently into Lake of the Woods, Fourmile Lake, and other high mountain lakes. Lost River is the basin's only major stream that has no trout fishery.

Warm-water game fish include black crappie, largemouth bass, yellow perch, bluegill, pumpkinseed, and brown bullhead and are confined to the warm, lower elevation streams, lakes, and reservoirs. Popular warm-water game fisheries exist in Agency Lake, Gerber, J. C. Boyle, Willow Valley, and Bumpheads Reservoirs. Lost, Klamath, and Sprague Rivers in their lower reaches also have good warm-water game fisheries. Mullet, or Lost River Sucker, are unique to the Klamath Basin and attain lengths up to 36 inches. Mullet fishing activity occurs during the spring spawning migrations from Upper Klamath Lake into the Wood River system, lower Williamson, and lower Sprague Rivers.

Nongame or rough fish are established throughout most of the basin. Sucker, dace, cottid, roach, redside shiner, and lamprey are found in Klamath and Agency Lakes, the lower Sprague, Williamson, Klamath, and Lost Rivers.

Streams draining the eastern slope of the Cascades generally have excellent perennial flows. Elsewhere, streamflows are normally acceptable for fish life but become critically low during July, August, and September. Streams experiencing seasonal low flows are the Williamson River between Klamath Marsh and Spring Creek, tributaries of the upper Williamson River, lower South Fork Sprague River, Sycan River and its tributaries below Sycan Marsh, the Lost River system, and Jenny Creek.

Water quality in Klamath Basin streams is generally acceptable for fish propagation, although temperature is a problem in many cases for salmon and trout. Klamath River, lower Williamson River, Lost River, and Sprague River frequently carry high concentrations of organic nutrients. Klamath Basin streams are generally noted for their fertility and ability to produce large fish.

Continual accumulation of organic nutrients in Klamath Lake has several significant effects on fish, the most desirable of which is the rapid growth and large size of trout. Less desirable, however, is a loss of dissolved oxygen as water temperatures rise and organic constituants increase, contributing to the heavy blooms of phytoplankton or algae. Figure 6 shows the general distribution of game fish in the basin. The salmonoids refer to all salmon-like fish that include all

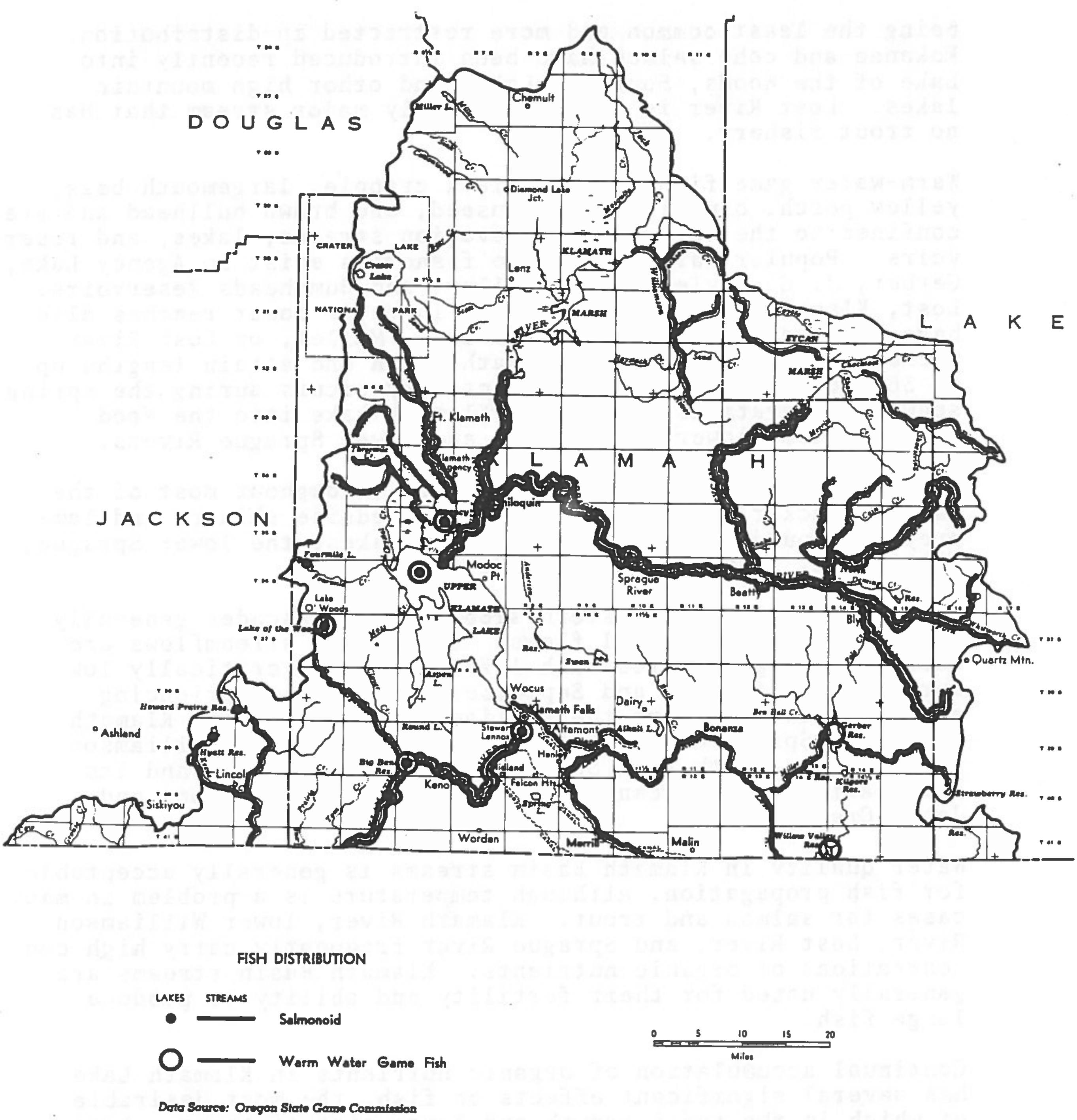


FIGURE 6. General Distribution of Game Fish.

species of trout, coho, and kokanee.

It should be noted that a species of mosquito fish was recently introduced into the Lost River drainage to provide mosquito control.

On the Klamath River a project developed jointly with the Oregon State Game Commission and the California Department of Fish and Game resulted in planting of mature steelhead trout on the Oregon side, upstream of the Copco Dam. This established a steelhead fishery on the upper river for the first time since 1916.

Wildlife

According to the Oregon State Game Commission, the Klamath Basin has excellent wildlife populations that attract hunters from every part of the state.

Big game within the Klamath Basin include mule and black-tailed deer, elk, pronghorn antelope, black bear, and cougar. Approximately 85 percent of the land in the basin is utilized by deer populations for at least a portion of the year. Black-tailed deer are generally found in the southwest corner of the basin during the summer months and move to the Rogue River Basin during the winter. Herds of mule deer occupy major parts of the basin throughout the entire year. Many of these have summer ranges in the Klamath Basin and migrate out of the basin during winter. Some herds use winter ranges around Swan Lake, east of Bly, north of Bonanza, and along lower Sprague River. Some winter range is used in the area southwest of Klamath Falls.

A small number of elk are present in the basin. The majority use summer range in the southwest portion of the basin, migrating from their winter ranges in the Rogue River Basin. Herd numbers are expected to increase due to the light hunting pressure in this portion of the basin and the closed season in the eastern portion of the basin.

A small herd of pronghorn antelope summer in the southeast portion of the basin, migrating from their winter range in California. Although there is no open season, the numbers within this herd have been on a continual decline.

Small numbers of black bear and cougar are scattered throughout the mountainous areas of the basin.

Small game species are an important segment of the basin wildlife resource. These include 10 separate species of upland game birds plus the silver gray squirrel. Bird species include mourning dove, ring-neck pheasant, valley quail, mountain quail, blue grouse, ruffed grouse, sage grouse, Hungarian partridge, chukar partridge, and wild turkey. Populations of upland species vary significantly, generally coinciding with land-use patterns. Increases occur in areas of new cropland development. Generally, decreases occur as dry farmed lands are converted to alfalfa and potato production. There have been attempts to establish chukar, wild turkey, and Hungarian partridge, which have met with limited success.

Ruffed and blue grouse are generally found in the western portion of the basin along the Cascade Range. Dove and sage grouse populate the north central and south central sections of the basin. Valley quail and pheasant are found in the south central section of the basin, with some populations of quail in the Sprague River Valley.

The greatest waterfowl concentrations in North America occur in the Klamath Basin. Approximately 80 percent of the waterfowl in the Pacific Flyway pass through and spend some time resting and feeding in the basin during spring and fall migrations. The greatest concentrations generally occur in November. During this period waterfowl numbers often exceed 5 million, including about 50 percent of the goose population in the Pacific Flyway. Although most species of waterfowl are present in the basin at one time or another, Pintail and mallard ducks comprise approximately 70 percent of the total. Other waterfowl species common to the basin include widgeon, shoveler, redhead, canvasback, ring-necked, and goldeneye ducks, and white-fronted, snow, cackling, Canada, and Ross's geese.

Other migratory waterfowl not classified as game birds are found in the Klamath Basin in large numbers. These birds are important to the wildlife resource for aesthetic and natural heritage values. A few examples of these species are loon, white pelican, cormorant, heron, egret, sandhill crane, sandpiper, gull, and tern.

The Bureau of Sport Fisheries and Wildlife presently maintains five national wildlife refuges within the Klamath Basin. These are Upper Klamath, Klamath Forest, Tule Lake, Lower Klamath, and Clear Lake. They are primarily managed for preservation of waterfowl habitat and encompass an area of approximately 190 square miles. These refuges are shown on Plate 1 in the Appendix. In addition the Oregon State Game Commission operates a management area in the basin along the Klamath River in the Miller Island area along with management areas in the Shoalwater Bay and Squaw Point areas on Upper Klamath Lake.

There are many fur bearing animals within the basin. Their populations are concentrated along the marshy areas in the Williamson, Sprague, and Upper Klamath Lake areas. Some of these fur bearers include beaver, otter, mink, muskrat, racoon, marten, skunk, fox, wildcat, and coyote. The majority of the furbearers taken by local trappers are muskrat, beaver, and mink. In 1965-66, 11,272 muskrat were taken as compared to 108 mink and 189 beaver.

Diking and reclamation of marshland for agricultural purposes have had some impact on the fur bearers' habitat; especially mink, beaver, otter, and muskrat. Water quality and quantity are important limiting factors in habitat of these species whose requirements are similar to waterfowl. Predatory fur bearers such as wildcat, coyote, and fox are also affected by reclamation of marshlands, due to the fact that these areas are the major producers of their prey.

PART II

WATER SUPPLY

SURFACE WATER

Introduction

Flow characteristics of the Klamath Basin streams are typical of semiarid regions. Normally these streams would exhibit extreme differences in both seasonal flows and annual yield; however, because of the numerous springs contributing to relatively large base flows and manipulation by storage of other basin streams relatively small diversity occurs. The following text, graphics, and tables present information defining these parameters.

Source of Data

Published U. S. Weather Bureau station records are the source of all climatological data used herein. Surface water data were obtained from U. S. Geological Survey water supply papers and Oregon State Engineer's records. Special reference should be given to Klamath Project reports prepared by the U. S. Bureau of Reclamation and Appendix D, titled "Water Supply," from the report "Upper Klamath River Basin-Oregon-California," March 1959. Additional sources are listed in the bibliography in the Appendix. Table A in the Appendix includes a complete tabulation of all hydrological and climatological stations in the basin. The location of all stations is shown on Plates 2 and 2a, titled "Hydrological Stations and Average Annual Precipitation." Correlations were performed where inadequate data exists.

It should be noted that the availability of hydrological records is extremely limited in Study Areas 1, 2, and 3; and much more extensive monitoring of surface water flows is needed for complete evaluation of the water resource in these areas. Climatological records also are limited throughout the basin.

Base Period

The base period used in this report is from October 1929 through September 1968. This 40-year period presents the majority of recorded data available and includes both the "dry cycle" of the 1930 decade and the "wet cycle" of the 1950's.

WATER SUPPLY

Mean annual streamflow at the station "Klamath River at Keno" for the base period is 1,205,700 acre-feet per year. For the entire period of record, 48 years, the average annual flow is also 1,205,700.

Climatology

The Klamath Basin is characterized by local microclimates. Conditions vary in severity, even though separated by only a few miles. In keeping with the nature and scope of this report, this section will deal with climatology on a generalized basis.

The climate of the Klamath Basin is generally characterized by dry summers with high temperatures and wet winters with moderately low temperatures. Annual precipitation as reflected by the vegetation indicates the climate may be classified as semiarid.

The basin, due to its location just east of the Cascade Mountain Range between the Pacific Coast and the inland plateaus, is in the path of many cyclonic storms originating in the north Pacific. Practically all winter precipitation is derived from these storms traversing the basin in an easterly direction from the west and southwest. Precipitation amounts in the basin are greatest along the eastern slope of the Cascades. The area is subject to residual precipitation from primary uplifting of storms passing over the Cascade Range. The areas in the central and eastern portion of the basin receive relatively minor amounts, although secondary uplifting of these storms over the divide between the Klamath and Goose and Summer Lakes Basins results in release of much of the remaining moisture. Plates 2 and 2a, prepared in the office of the State Water Resources Board, depict the distribution of average annual precipitation over the basin.

Most winter precipitation falls as snow, particularly at higher elevations. Total average annual snowfall at Klamath Falls weather station is approximately 41 inches and at Crater Lake National Park Service headquarters approximately 521 inches. Midwinter rains are frequent in the lower elevation areas. Maximum precipitation and minimum temperatures generally occur in December and January. Minimum precipitation and maximum temperatures generally occur in July, August, and September.

WATER SUPPLY

Figures 7 through 11 illustrate the annual precipitation for the 40-year base period at the four selected stations in the basin. Approximately 60 to 70 percent of the total average annual precipitation occurs in the months October through March.

Table 19 shows average monthly precipitation in both inches of rainfall and percent of average annual precipitation for

TABLE 19

MONTHLY DISTRIBUTION OF AVERAGE PRECIPITATION AT SELECTED STATIONS 1929-1968

MONTH	CHILOQUIN		KLAMATH FALLS 2SSW		ROUND GROVE		TULELAKE 1/	
	Monthly Average Inches	Percent of Total	Monthly Average Inches	Percent of Total	Monthly Average Inches	Percent of Total	Monthly Average Inches	Percent of Total
January	2.65	15.7	2.01	14.8	1.90	11.1	1.02	9.8
February	1.82	10.8	1.36	10.0	1.78	10.3	0.99	9.6
March	1.44	8.5	1.13	8.3	1.67	9.7	0.88	8.5
April	1.04	6.1	0.83	6.1	1.35	7.9	0.78	7.5
May	1.24	7.3	1.04	7.6	1.78	10.3	1.21	11.7
June	0.99	5.9	0.90	6.6	1.42	8.2	1.03	9.9
July	0.29	1.7	0.26	1.9	0.41	2.4	0.25	2.4
August	0.32	1.9	0.44	3.2	0.53	3.1	0.28	2.7
September	0.58	3.4	0.53	3.9	0.68	4.0	0.45	4.3
October	1.42	8.4	1.15	8.5	1.56	9.1	0.95	9.2
November	2.20	13.0	1.65	12.1	1.76	10.2	1.14	11.0
December	2.91	17.3	2.30	17.0	2.36	13.7	1.39	13.4
TOTAL	16.90	100.0	13.60	100.0	17.20	100.0	10.37	100.0

1// Tulelake Period of Record 1933 - 1968.

Data Source: U. S. Weather Bureau.

various Weather Bureau stations throughout the basin. During the growing season, April through September, precipitation amounts to approximately 4 inches. It is apparent that in order for successful agricultural enterprises to be carried out in the basin an irrigation program must be conducted.

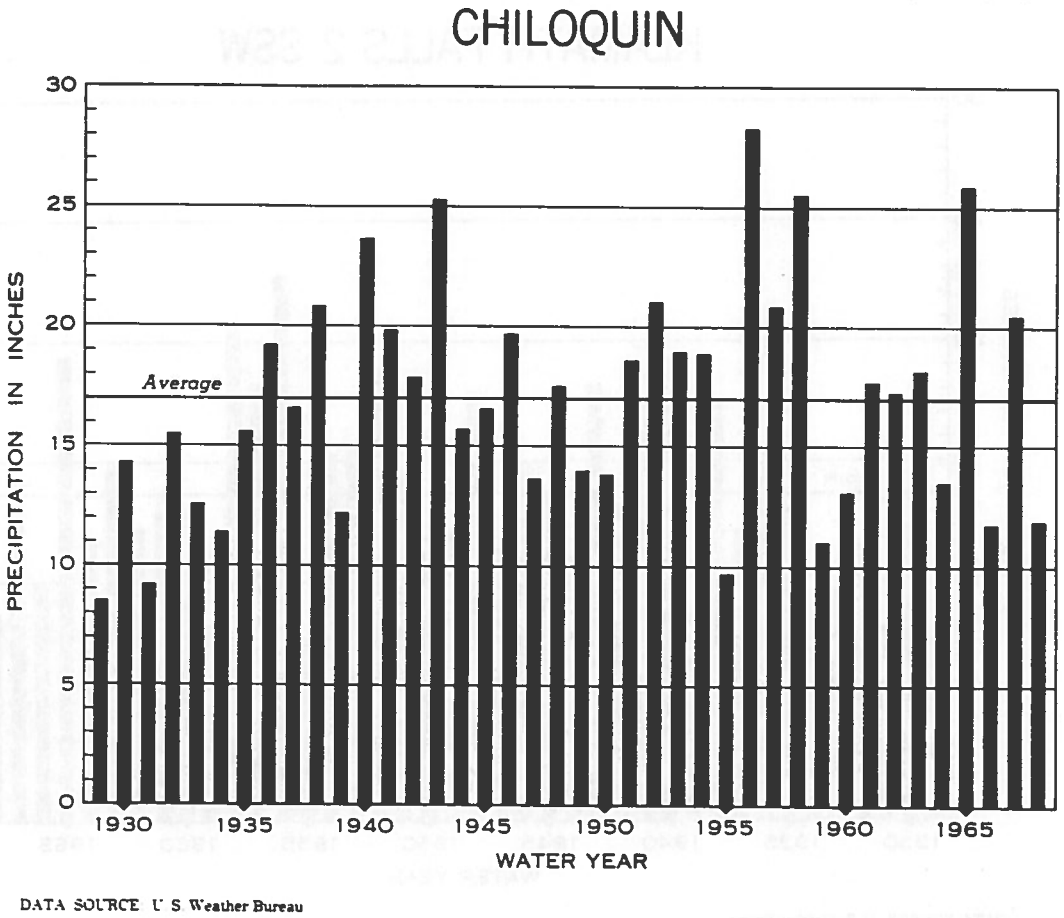


FIGURE 7. Annual Precipiation - Chiloquin.

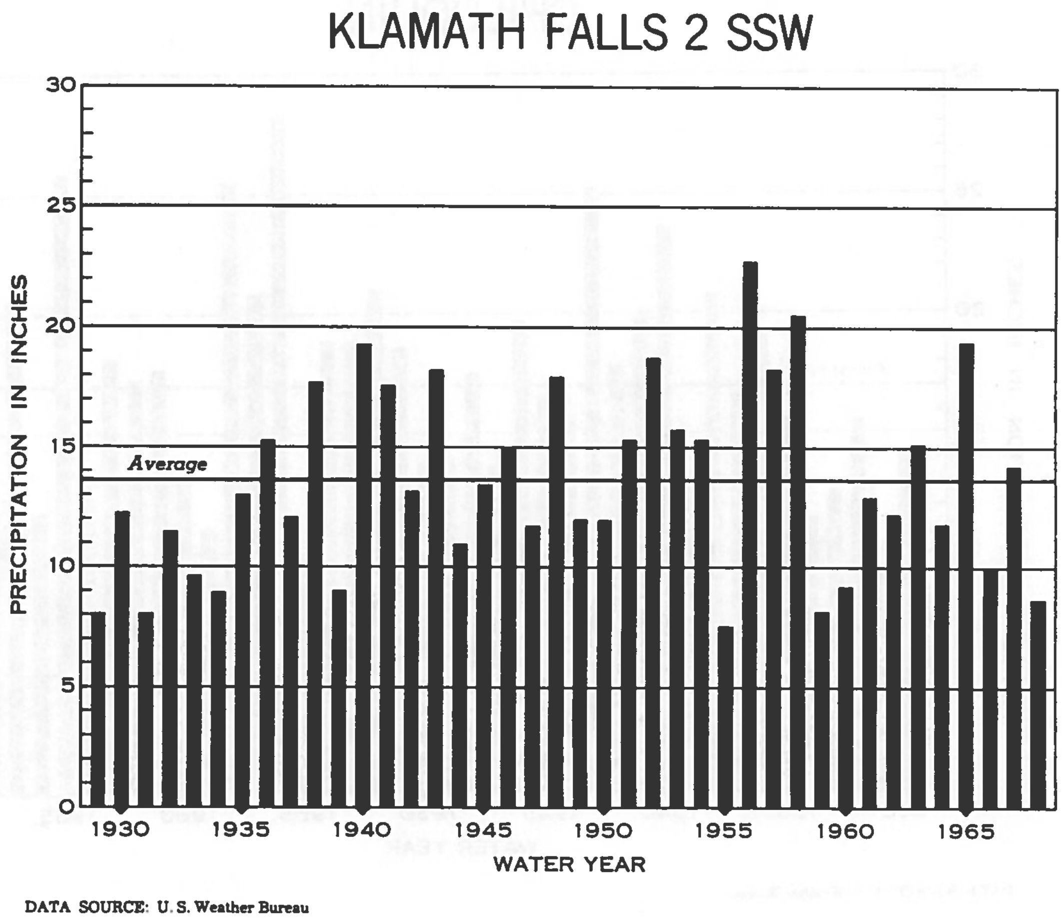
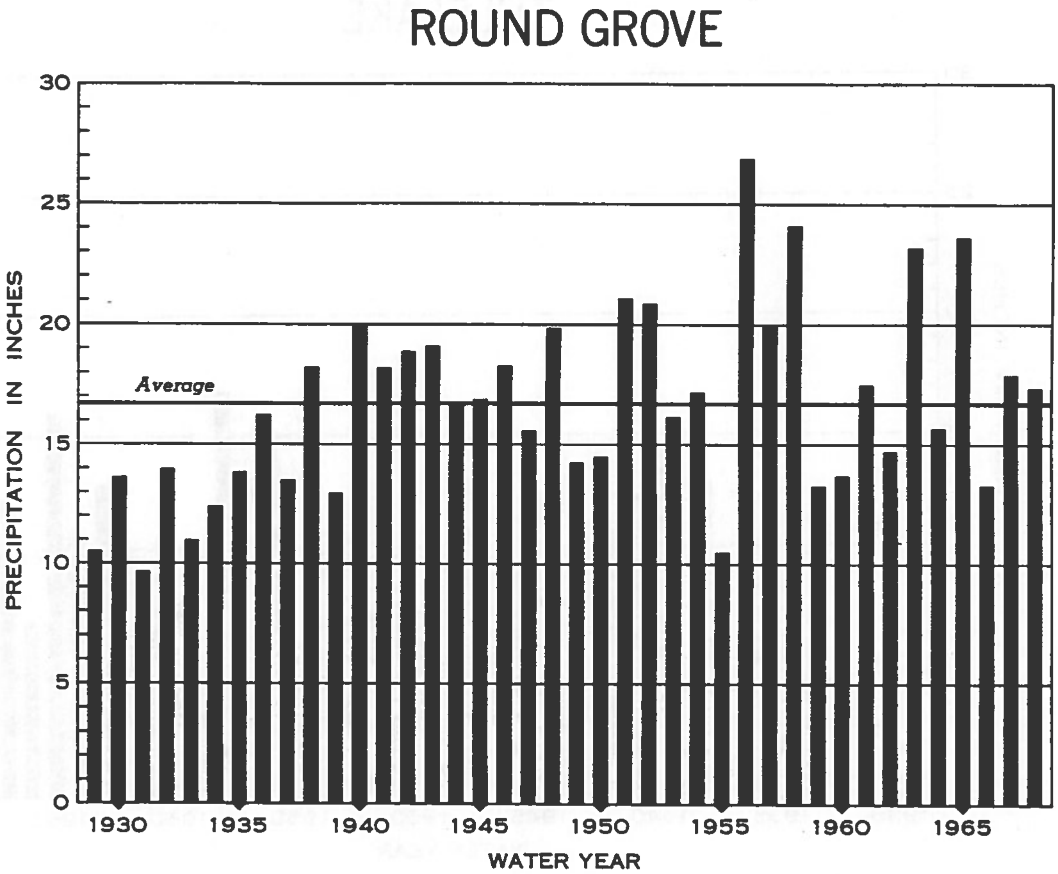


FIGURE 8. Annual Precipiation - Klamath Falls.



DATA SOURCE: U. S. Weather Bureau

FIGURE 9. Annual Precipitation - Round Grove.

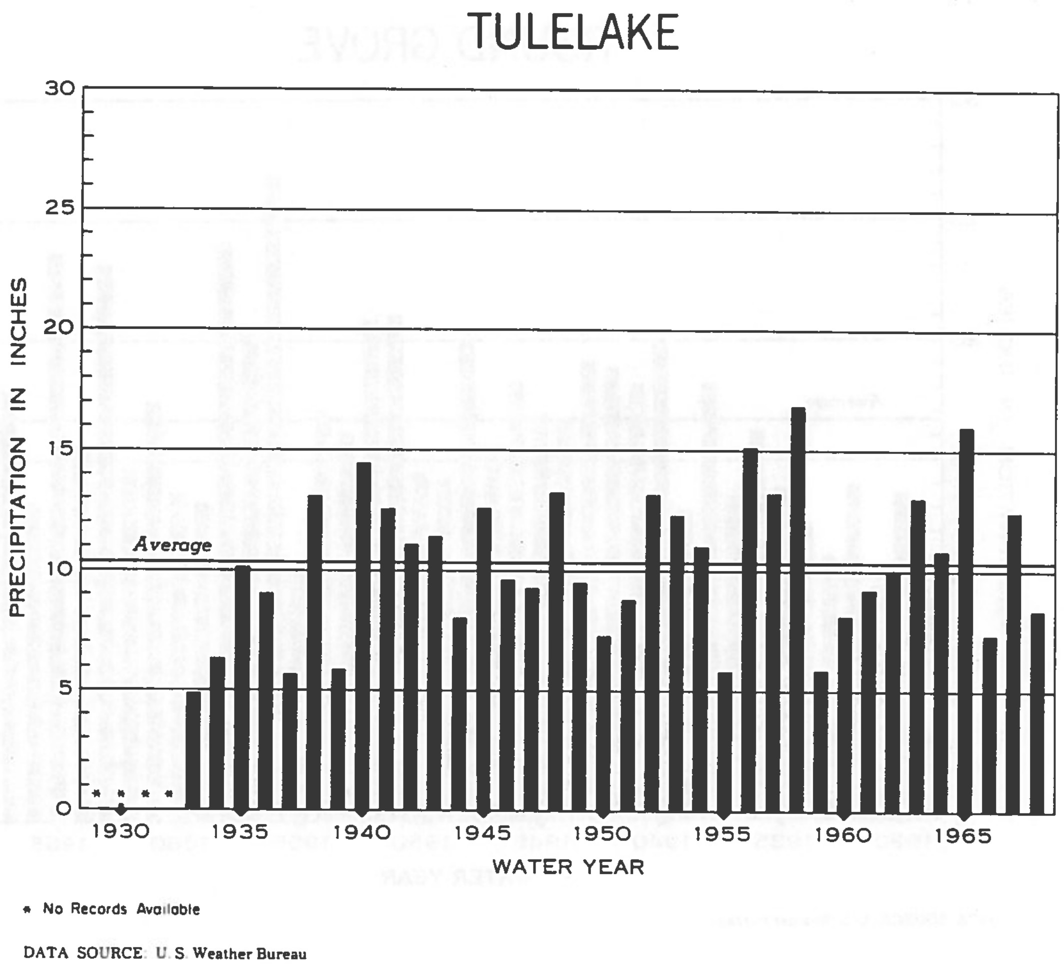


FIGURE 10. Annual Precipitation - Tulelake.

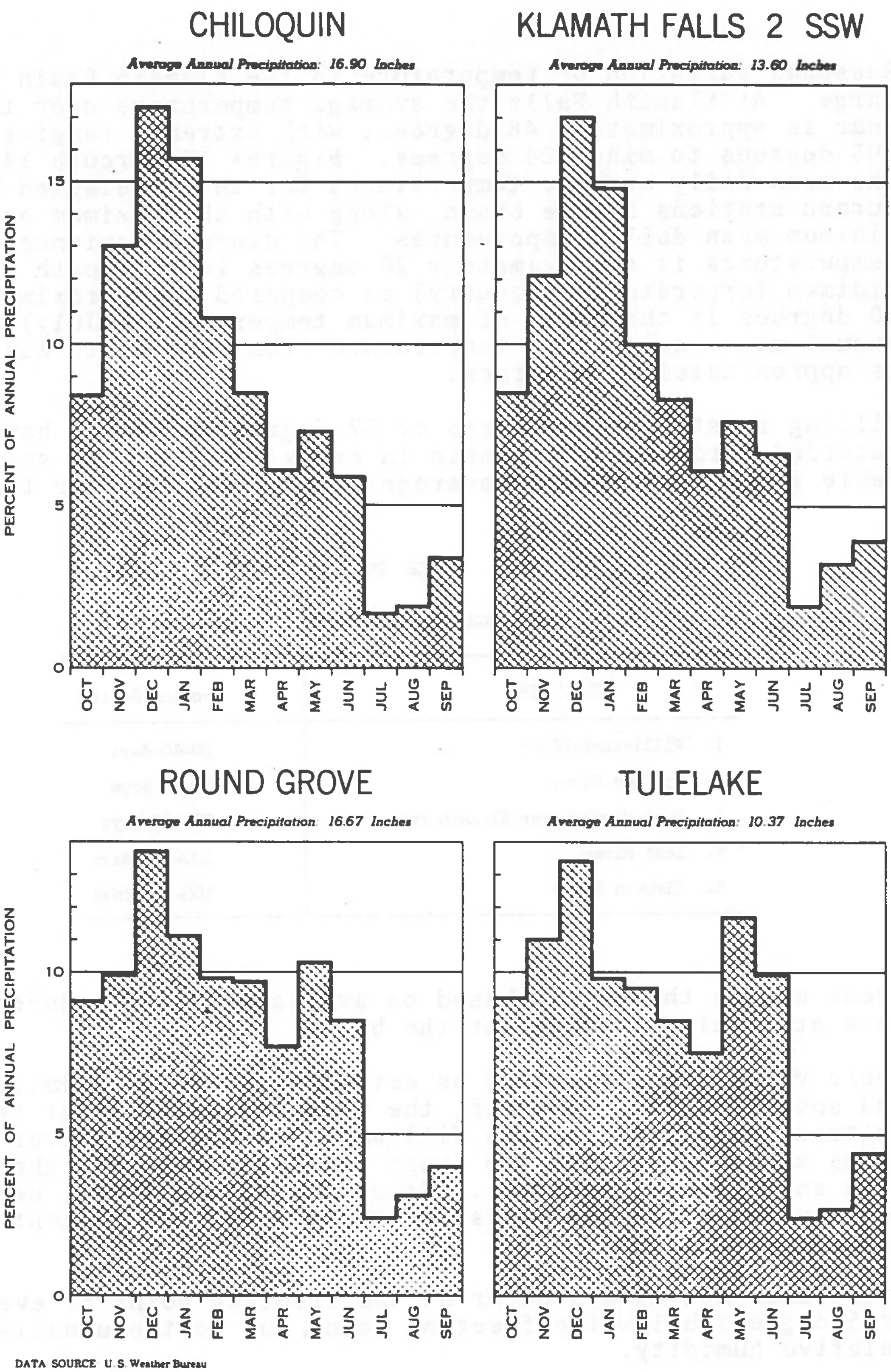


FIGURE 11. Monthly Distribution of Annual Precipitation.

Seasonal variation of temperature in the Klamath Basin is large. At Klamath Falls the average temperature over the year is approximately 48 degrees, with extremes ranging from 105 degrees to minus 24 degrees. Figures 12 through 14 show the mean daily average temperatures for three selected Weather Bureau stations in the basin, along with the maximum and minimum mean daily temperatures. The diurnal variance in temperatures is approximately 20 degrees in the month of minimum temperatures (January) as compared to approximately 40 degrees in the month of maximum temperatures (July). The annual mean variance in temperature from maximum to minimum is approximately 65 degrees.

Killing frosts, temperatures of 32 degrees or less, have been recorded throughout the basin in every month of the year. Table 20 shows estimated average growing seasons for the study areas within the basin, based on available Weather Bureau data at stations throughout the basin.

TABLE 20

AVERAGE FROST-FREE SEASON

STUDY AREA	Growing Season
1. Williamson River	20-40 days
2. Sprague River	30-50 days
3. Wood River-Upper Klamath Lake	90-100 days
4. Lost River	100-125 days
5. Klamath River	100-125 days

These values are presented as estimates, based on limited and sporadic data. However, the table indicates that agricultural operations in the Williamson and Sprague River Study Areas should be limited to frost resistant crops or those with short growing seasons. Generally, agricultural development in the entire basin is limited to a certain extent by climatic conditions.

Frost does not always occur at the freezing point or even 4 or 5 degrees below the freezing point, due to the usually low relative humidity.

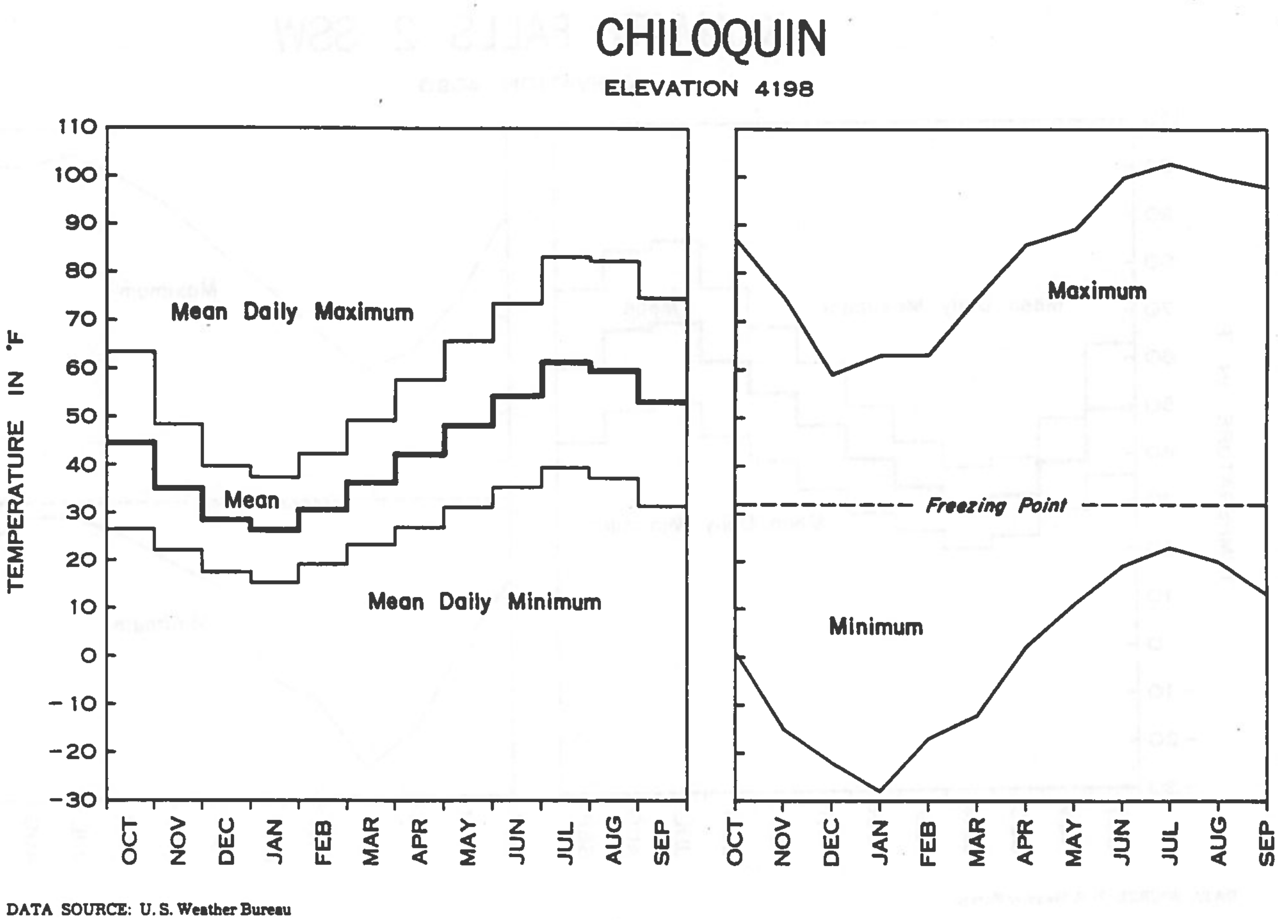


FIGURE 12. Maximum, Minimum, and Mean Daily Average Temperatures - Chiloquin.

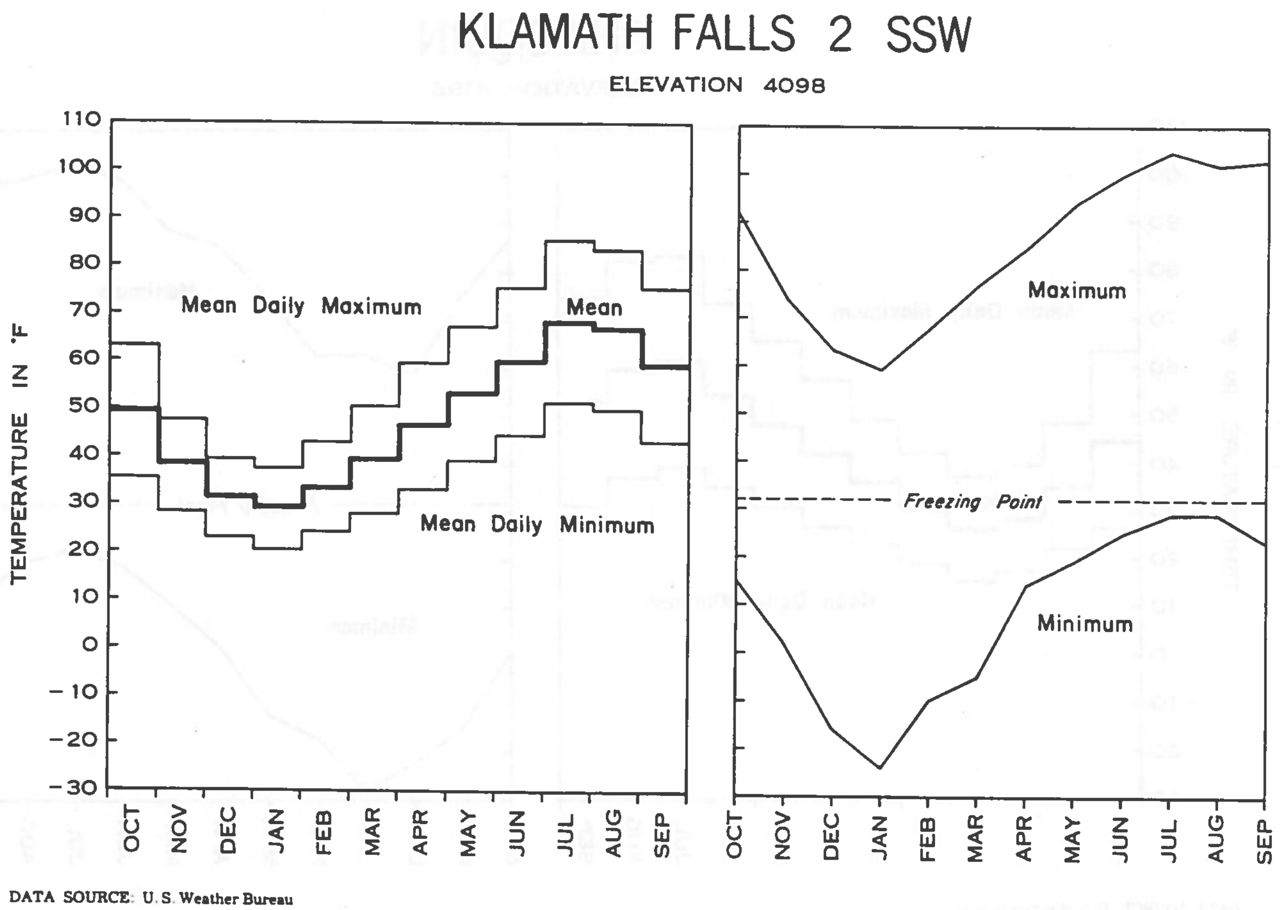
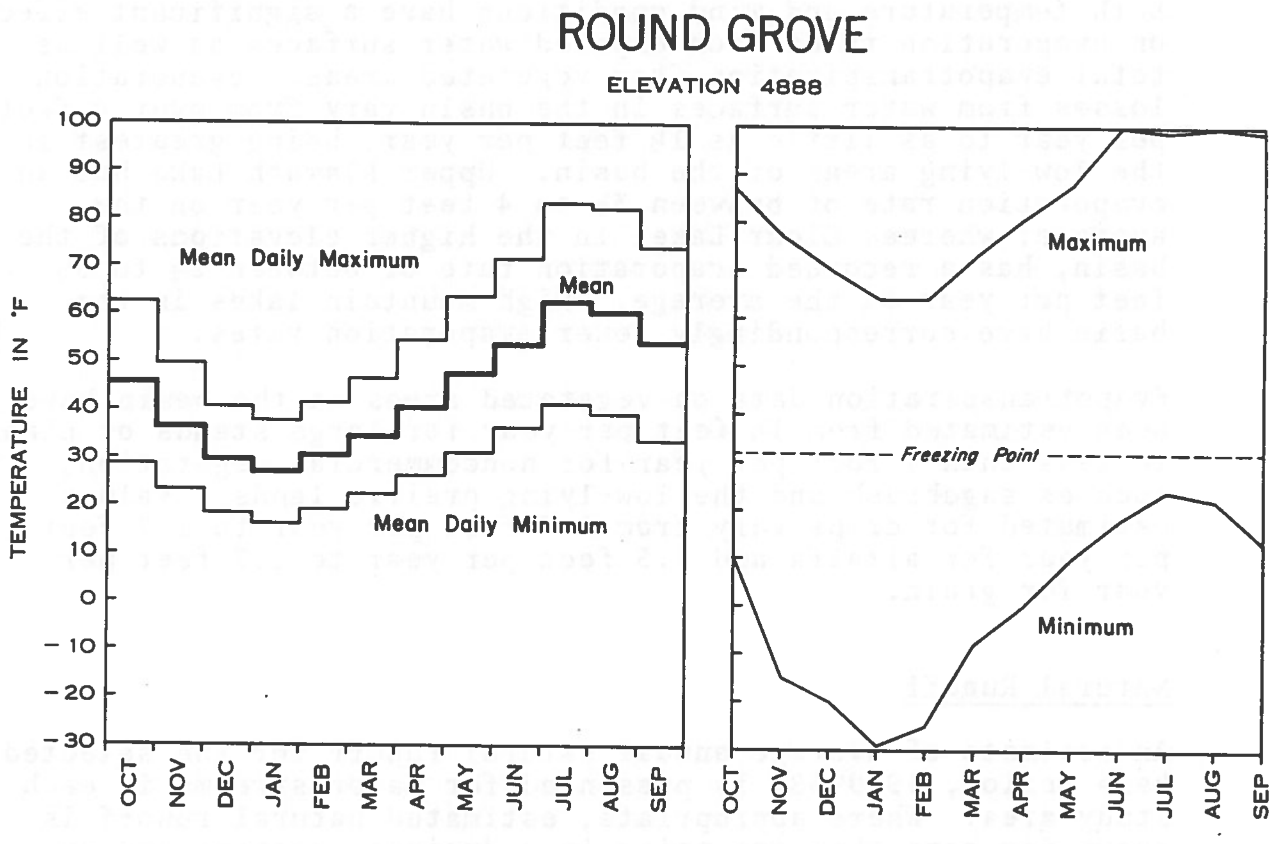


FIGURE 13. Maximum, Minimum, and Mean Daily Average Temperatures - Klamath Falls.



DATA SOURCE: U. S. Weather Bureau

FIGURE 14. Maximum, Minimim, and Mean Daily Average Temperatures - Round Grove.

Prevailing winds in the basin are from the west and southwest. Average recorded wind velocity in the basin is approximately 6 miles per hour on a long-term basis, but localized surface wind patterns vary throughout the basin, due to the irregular topography. Severe wind storms are not uncommon, and in May 1962 a small tornado was recorded in the southern portion of the basin.

Both temperature and wind conditions have a significant effect on evaporation rates from exposed water surfaces as well as total evapotranspiration from vegetated areas. Evaporation losses from water surfaces in the basin vary from over 4 feet per year to as little as 1½ feet per year, being greatest in the low-lying areas of the basin. Upper Klamath Lake has an evaporation rate of between 3½ to 4 feet per year on the average; whereas Clear Lake, in the higher elevations of the basin, has a recorded evaporation rate of between 2½ to 3½ feet per year on the average. High mountain lakes in the basin have correspondingly lower evaporation rates.

Evapotranspiration data on vegetated areas in the basin have been estimated from 1½ feet per year for large stands of pine to less than 1 foot per year for noncommercial vegetation, such as sagebrush and the low-lying prairie lands. Values estimated for crops vary from 2.7 feet per year to 1.7 feet per year for alfalfa and 1.5 feet per year to 1.7 feet per year for grain.

Natural Runoff

An estimate of average annual natural runoff for the selected base period, 1929-68, is presented for major streams in each study area. Where appropriate, estimated natural runoff is shown for more than one point in a drainage system; and an average monthly distribution of runoff for the 40-year base period also is shown. The estimate was derived by adjusting gaging station records for significant depletions where possible.

Some minor consumptive uses are not accounted for in the calculations. The results are, however, the best estimates of natural flows obtainable within the limitations of time and scope of this study.

Study Area 1, Williamson River, has some development that consumptively uses water for irrigation. However, irrigated land is mostly reclaimed marshland. Consequently, recorded flows are felt to be fair representations of natural flows

TABLE 21

SUMMARY OF NATURAL RUNOFF
MAXIMUM, AVERAGE, AND MINIMUM
ANNUAL RUNOFF AT SELECTED STATIONS
Water Years 1929 through 1968

STATION	RUNOFF Thousands of Acre-Feet			DRAINAGE AREA Sq. Mi.
	Maximum	Average	Minimum	
Williamson River above Spring Creek	417.3	126.7	16.5	1,377
Williamson River above Sprague R.	628	336.4	227	1,417
Sycan River near Beatty	286.5	89.9	5.8	540
Sprague River near Beatty	467.1	199.7	88.9	513
Sprague River near Chiloquin	1,012	414.3	170	1,583
Williamson River below Sprague R.	1,587	751.2	397	3,076
Wood River at Fort Klamath	258.0	171.8	102.4	90
Surface Inflow to Upper Klamath Lake	2,574	1,420.4	796	3,796
Klamath Lake Outflow 1/	2,346	1,249.6	639	3,796
Klamath River Inflow below Keno (Study Area 5)	650.3	249.0	155.3	450
Recorded Flow, Klamath River at Keno	2,600.0	1,205.7	395.0	3,920

Project Seasonal Supply (April - September)	
1929 - 1944	285.8
1951 - 1967	367.9

1/ Including irrigation and power diversions.

Data Source: U. S. Geological Survey and SWRB Computations.

TABLE 22

MAXIMUM, MINIMUM, AND AVERAGE ANNUAL RECORDED RUNOFF

STREAM	USGS GAGE NO.	DRAINAGE AREA SQ. MI.	PERIOD OF RECORD	COMPLETE WATER YEARS OF RECORD	ANNUAL RUNOFF ACRE-FEET			RECORDED RUNOFF CFS	
					Minimum	Maximum	Average	Minimum	Maximum
Williamson R. nr. Klamath Agency	4935	1,290	1908*,10,55-68	15	76,800	339,500	160,000	0	1,590
Williamson R. below Sprague R. nr. Chiloquin	5025	3,000	1917-68	52	396,000	1,587,000	733,000	320	16,100
Sprague R. nr. Beatty	4975	513	1914*,26,54-68	18	97,700	467,100	218,600	57	6,980
Sycan R. nr. Beatty	4990	540	1912*,16,17-25	9	16,300	139,000	70,400	1	9,250
Sprague R. nr. Chiloquin	5010	1,580	1920-21,11-68	48	187,000	1,012,000	402,200	50	14,900
Wood R. nr. Fort Klamath	5040	90	1911*,22,23-36	18	102,000	225,000	155,700	84	520
"A" Canal at Klamath Falls	5060	-	1911-68	58	35,700	293,900	180,000	0	1,180
Link R. at Klamath Falls	5075	3,810	1904-68	66	639,000	2,030,000	1,153,000	17	9,400
Diversion from Klamath R. to Lost R. near Olene	5085	-	1931-68	38	91	53,400	25,400	0	719
Klamath R. at Keno, Ore.	5095	3,920	1904-14,30-68	48	395,000	2,600,000	1,205,700	26	9,250
Klamath R. below Fall Cr. nr. Copco, Calif.	5125	4,370	1924-61	38	550,000	2,905,100	1,306,400	10	12,000
Howard Prairie Lake nr. Pinehurst, (Content)	5129	28	1958-68	10	16,700	29,200	24,300	0	61
Keene Cr. near Ashland	5145	12	1917*,22,49-67	20	2,000	12,300	9,400	0	751
Lost R. at Clear Lake, Calif.	4830	550	1904-9,18-50	36	3,700	247,000	35,200	2	3,020
Miller Cr. at Gerber Res. near Lorella	4835	220	1904-09,25-50	29	17,000	110,600	42,700	0	6,730
Lost R. Diversion Canal near Olene	4860	-	1912-15,16*,19,20-68	52	21,900	396,800	117,600	-	-
Lost R. at Wilson Bridge near Olene	4870	1,620	1912-20	8	5,700	121,000	45,200	0	2,920

* Unpublished Records

Data Source: U. S. Geological Survey.

on an annual basis. Flows estimated for Study Area 2, Sprague River, were determined in the same manner.

Measurable consumptive use occurs in Study Area 3a, Wood River; but the amount is small compared to the overall inflow into Upper Klamath Lake. Recorded flow data are sparse, which required the use of correlation techniques. The results can be considered good estimates of the natural occurrence.

Study Area 4, Lost River, is not included in natural runoff calculations. The area is almost entirely within the boundary of the Bureau of Reclamation's Klamath Project, and project facilities have significantly altered volumes and schedules of flow within the area over the entire base period. Consequently, data are presented that indicate the impact of Klamath Project operation on the water resources of the basin.

Data for Upper Klamath Lake are separated under a special heading, due to the complexities of lake level manipulation for irrigation diversion to the Klamath Project and for power generation at downstream plants.

Table 21 is a summary of all the calculated average annual natural flows, maximum and minimum calculated flows for the base period, and calculated Project seasonal supply. Table 22 is a summary of recorded data from gaging stations used in study calculations. Figure 15 is a flow diagram, which will aid the reader in visualizing the relative yields of the stream system.

ANNUAL RUNOFF AND MONTHLY DISTRIBUTION

Study Area 1 - Williamson River

The natural average annual runoff of the study area is 751,200 acre-feet and comprises the total inflow into Klamath Lake from Study Areas 1 and 2. At a point immediately above Spring Creek, the average is 126,700 acre-feet. Immediately above Sprague River, the average is 336,800 acre-feet, which represents the total annual flow from the Williamson River drainage area. Annual flows at these three points are shown in Figure 16. Average annual flow over the base period is also shown. The majority of the Williamson River drainage area is upstream of Spring Creek; however, the surface water contribution is only 17 percent of the total flow of the Williamson River into Upper Klamath Lake. The majority of the annual

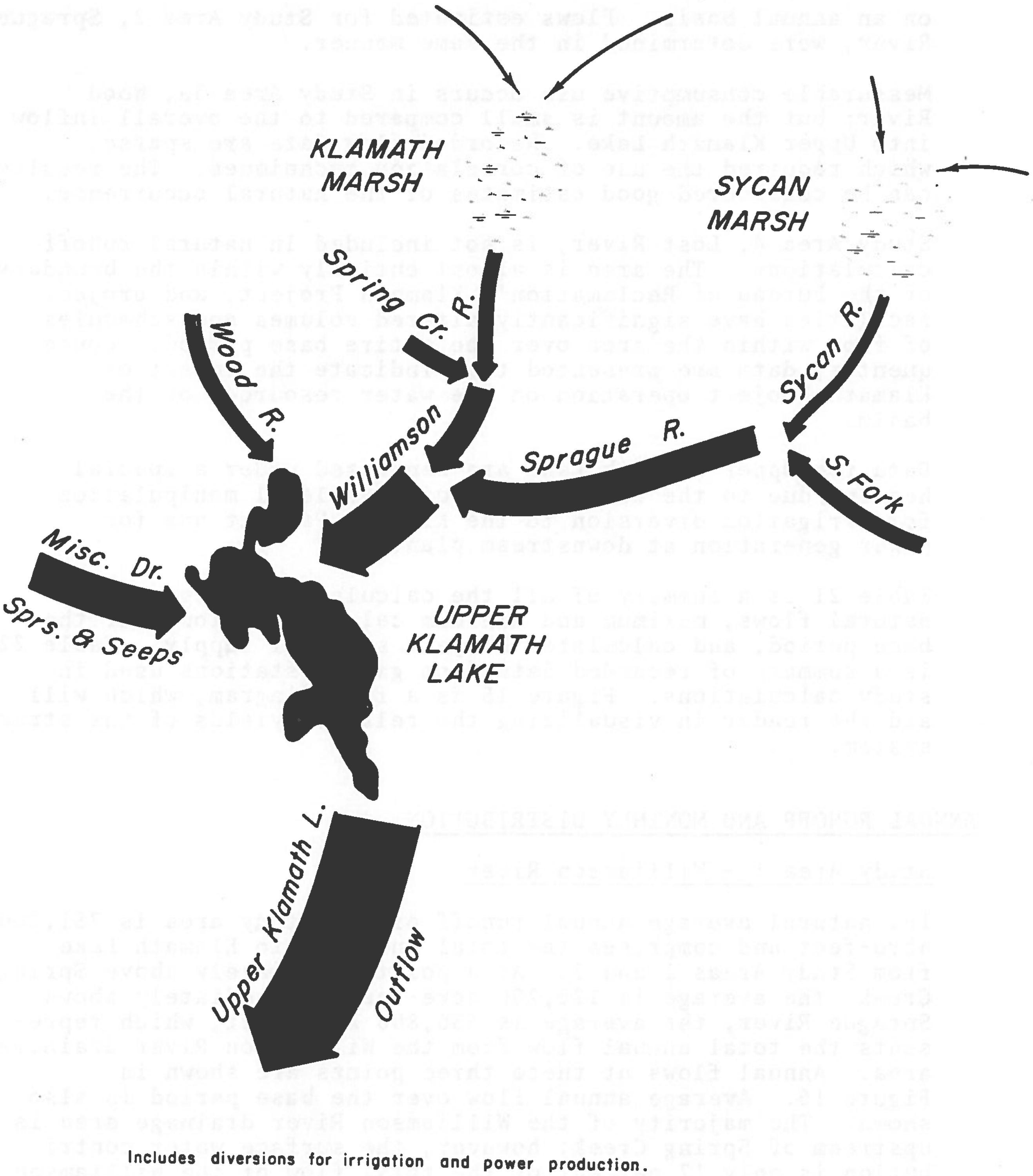


FIGURE 15. Relative Yields of Stream System.

yield, about 210,000 acre-feet per year, of the Williamson River above Sprague River is contributed by Spring Creek, a stream which is largely spring fed. Spring Creek's drainage area is small, only 9 square miles, yet it contributes approximately 28 percent of the total flow of the Williamson River into Upper Klamath Lake and during low flow months contributes almost the entire flow of the river.

The average monthly distribution for the three points discussed is shown in Figure 16. Months of maximum flow are March and April, with minimum flows occurring in August and September. The monthly distribution is nearly the same for streams in Study Areas 1 and 2. The Williamson River below Spring Creek has higher minimum flows, due to the relatively continuous flows of Spring Creek.

Study Area 2 - Sprague River

The natural average annual runoff of the study area is 414,300 acre-feet and contributes about 55 percent of the total flow of the Williamson River into Upper Klamath Lake. About 70 miles above its mouth, the Sprague River is joined by the Sycan River. The yields of each of these streams at Beatty are shown in Figure 17. The combined flows of the Sprague and Sycan Rivers at their confluence comprise 70 percent of the total flow of the Sprague River at its mouth. Of the combined flows the Sycan River contributes only 30 percent. Although the Sycan River has a relatively large drainage area, Sycan Marsh consumes significant quantities of the stream's yield. The total surface flow of Study Area 2 is shown in Figure 17, Sprague River near Chiloquin.

The monthly distribution of flows based on the 40-year average for the three locations discussed is shown in Figure 17. Runoff patterns for these streams are very similar in nature to those of the Williamson drainage above Spring Creek. There is a large variance between yields during wet and dry years, which lessens the reliability of the long-term average value.

Study Area 3a - Wood River

The natural average annual runoff of the Wood River at Fort Klamath is 171,800 acre-feet. Figure 18 shows the calculated annual runoff for the Wood River at Fort Klamath some 15 miles upstream from its mouth.

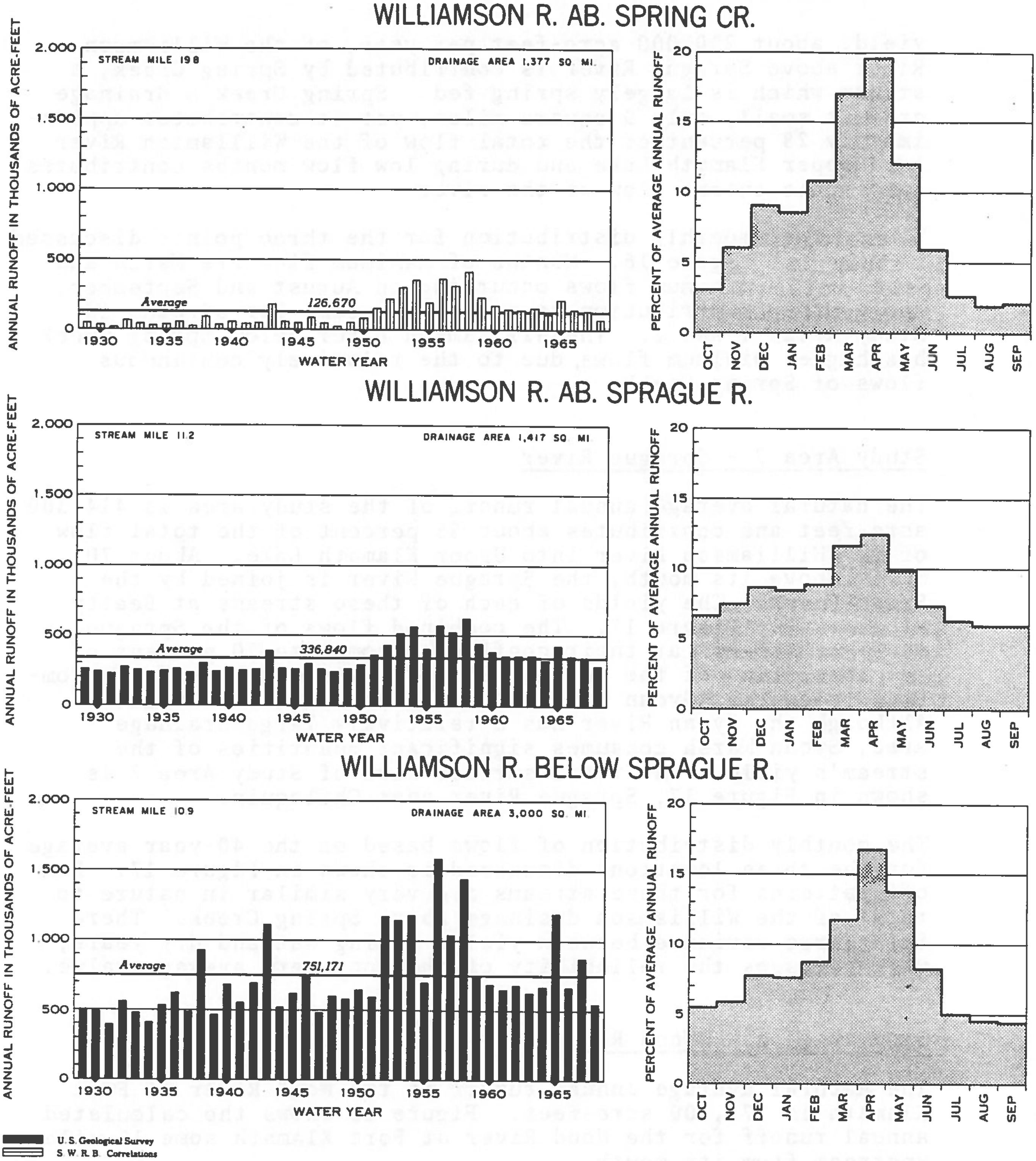


FIGURE 16. Annual Runoff and Monthly Distribution - Study Area 1.

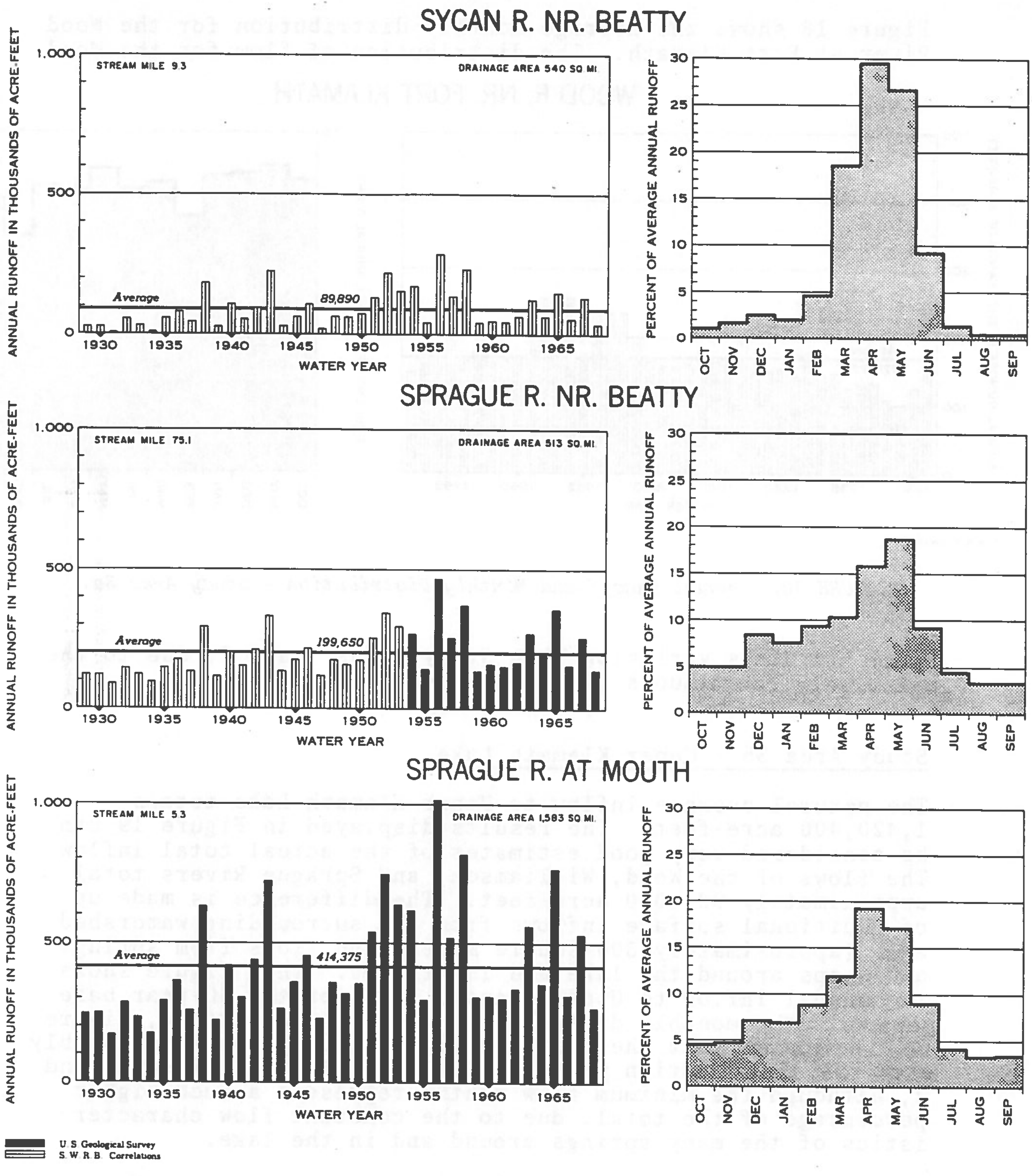


FIGURE 17. Annual Runoff and Monthly Distribution - Study Area 2.

Figure 18 shows the average monthly distribution for the Wood River at Fort Klamath. The distribution of flow for the Wood

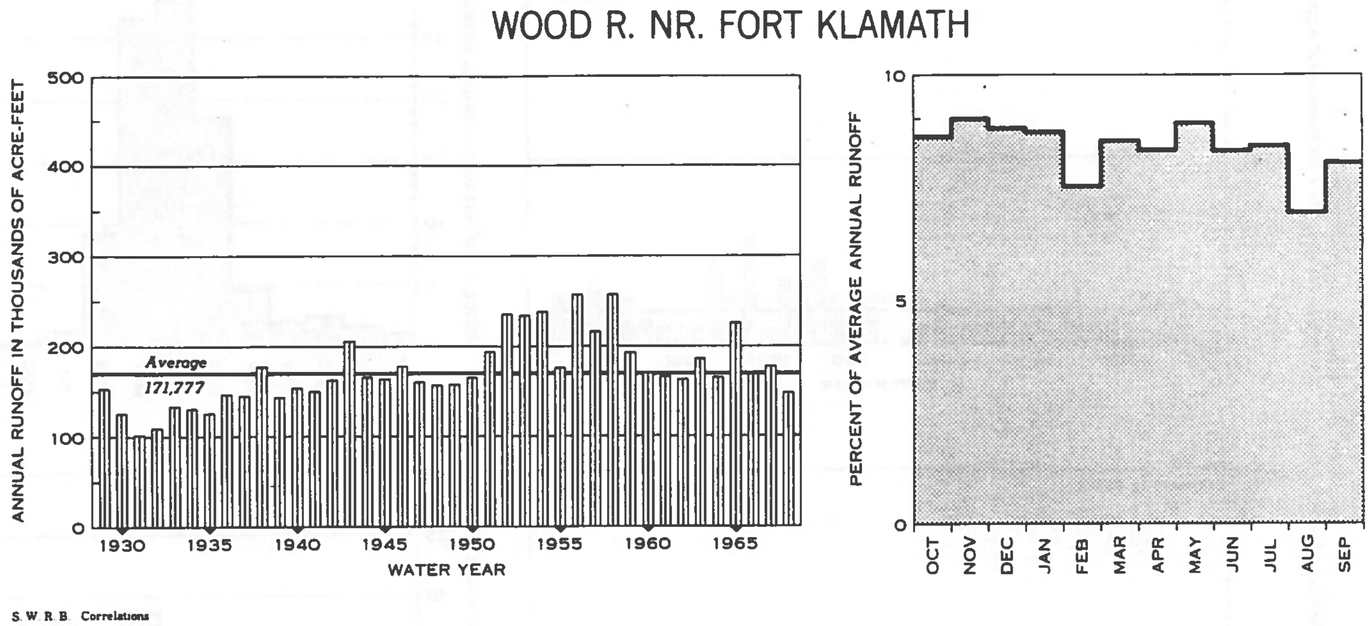


FIGURE 18. Annual Runoff and Monthly Distribution - Study Area 3a.

River has less variation than Study Areas 1 and 2, due to the relatively continuous flows of Wood River Springs.

<u>Study Area 3b - Upper Klamath Lake</u>

The natural average inflow to Upper Klamath Lake totals 1,420,400 acre-feet. The results displayed in Figure 19 can be considered very good estimates of the actual total inflow. The flows of the Wood, Williamson, and Sprague Rivers total approximately 923,000 acre-feet. The difference is made up of additional surface inflows from the surrounding watershed area (approximately 300 square miles) and flows from springs and seeps around the lake and in its bed. This figure shows the annual inflow to Upper Klamath Lake for the 40-year base period. The monthly distribution of the total inflow, Figure 19, indicates that the distribution patterns compare favorably with the distribution patterns displayed in Study Areas 1 and 2, although the minimum flow months represent a much higher percentage of the total, due to the constant flow characteristics of the many springs around and in the lake.

Figure 19 also shows the outflow from Upper Klamath Lake is

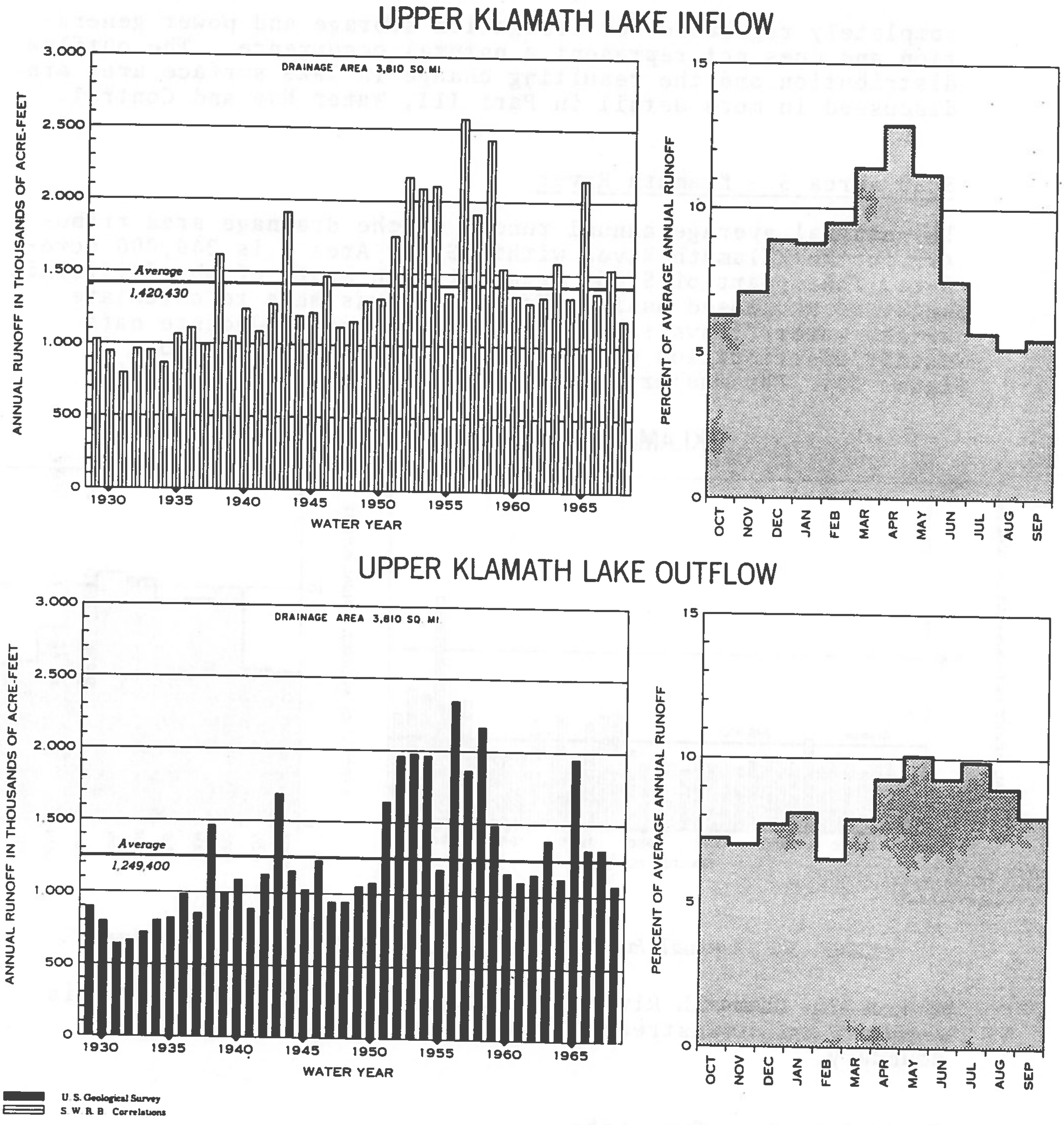


FIGURE 19. Annual Runoff and Monthly Distribution - Study Area 3b.

completely regulated for irrigation storage and power generation and does not represent a natural occurrence. The outflow distribution and the resulting change in lake surface area are discussed in more detail in Part III, Water Use and Control.

Study Area 5 - Klamath River

The natural average annual runoff of the drainage area tributary to the Klamath River within Study Area 5 is 249,000 acre-feet. That part of Study Area 5 to the south of the California border is a closed basin. No attempt was made to calculate surface water flows in the area because of inadequate data. Monthly distribution of the runoff from Oregon is shown in Figure 20. The majority of runoff from the Oregon portion

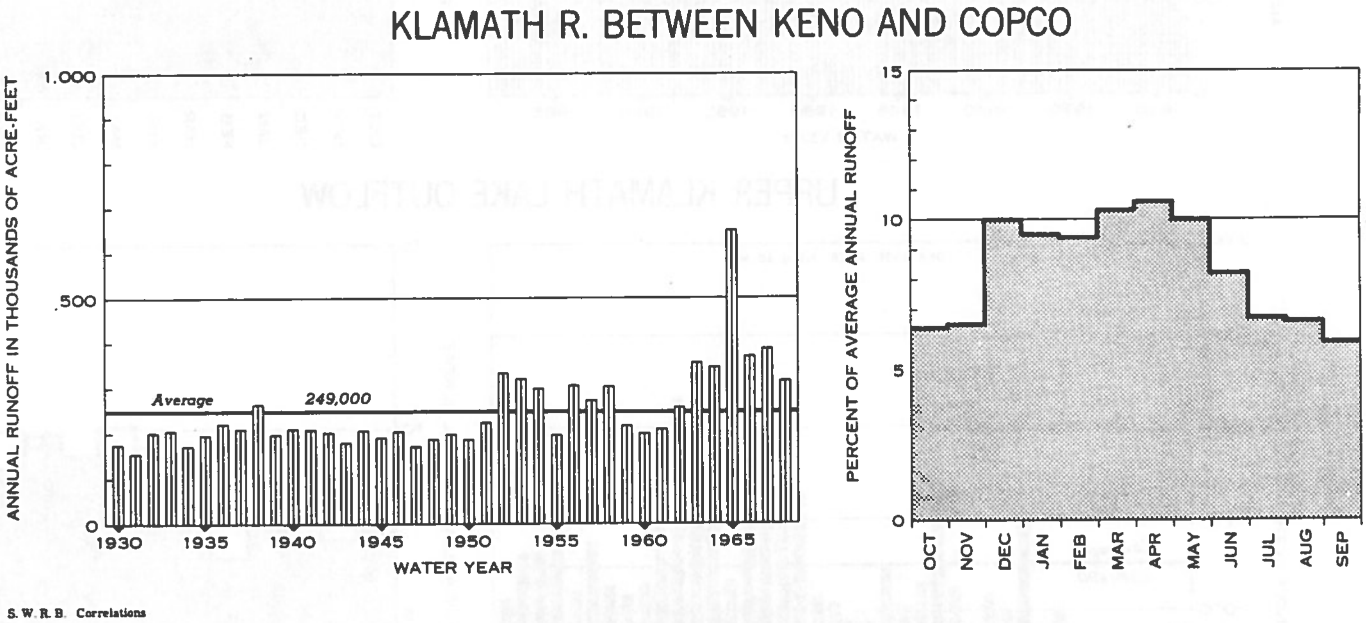
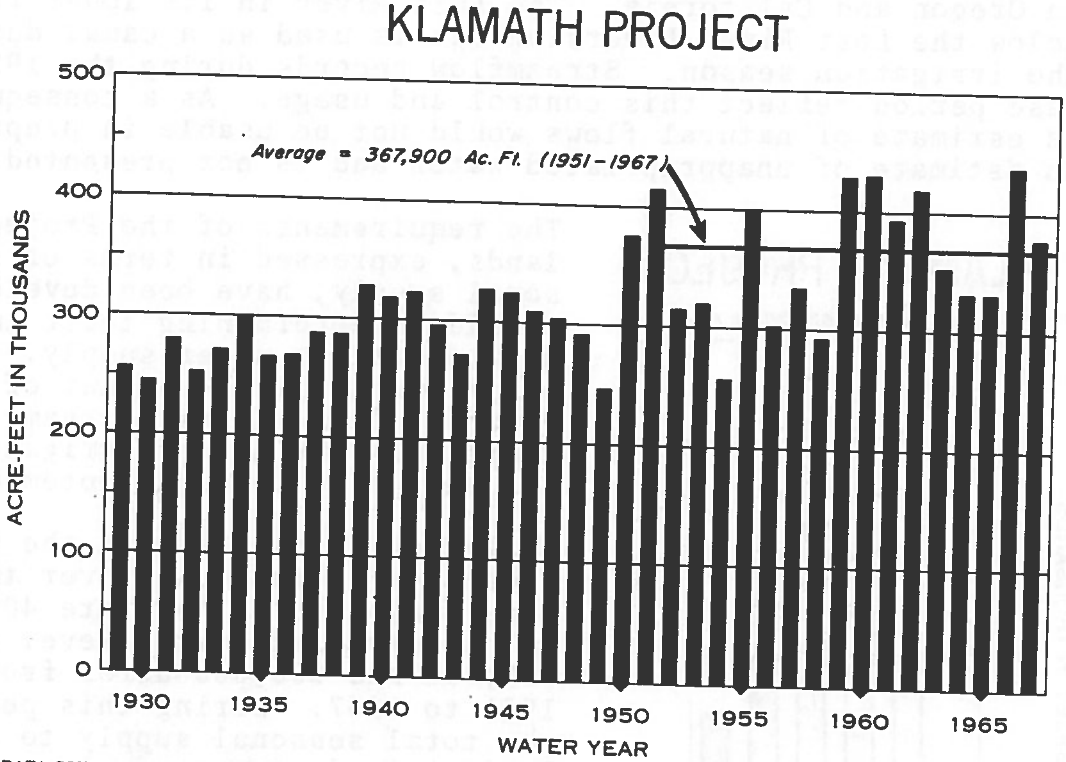


FIGURE 20. Annual Runoff and Monthly Distribution - Study Area 5.

enters the Klamath River downstream of the Oregon-California boundary and downstream of the Klamath River Basin Compact Boundary.

Study Area 4a - Swan Lake

The Swan Lake Study Area constitutes a closed basin. Surface runoff flows into Swan Lake or is diverted for irrigation, and flows reaching Swan Lake are consumed by evaporation or



DATA SOURCE: U. S. Bureau of Reclamation

FIGURE 21. Klamath Project Seasonal Supply.

deep percolation. No recorded surface water measurements are available, and no climatological data are recorded. Consequently, no estimates are presented in this report.

Study Area 4b & c - Lost River

The annual yield in the Lost River Study Area is, to a large extent, controlled for irrigation of Klamath Project lands in Oregon and California. The Lost River in its lower reaches below the Lost River Diversion Dam is used as a canal during the irrigation season. Streamflow records during the 1929-68 base period reflect this control and usage. As a consequence an estimate of natural flows would not be usable in preparing an estimate of unappropriated water and is not presented.

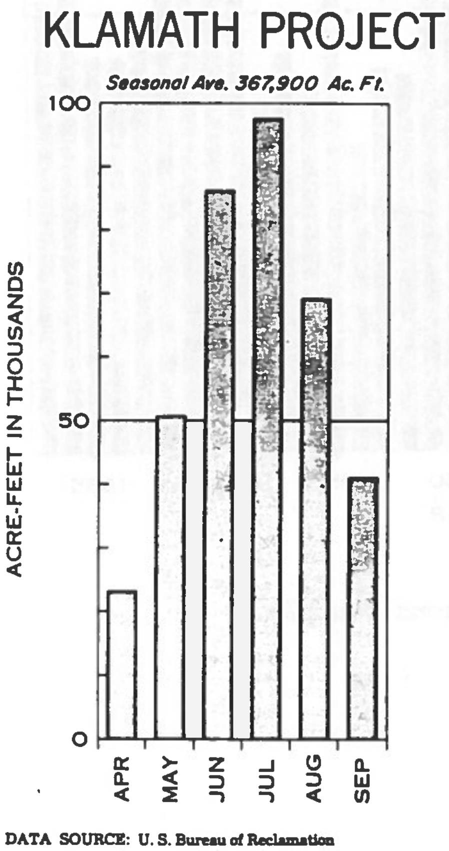


FIGURE 22. Monthly Distibution of Average Seasonal Supply.

The requirements of the Project lands, expressed in terms of seasonal supply, have been developed to aid in determining their impact on the basin's water supply. Seasonal supply is the amount of water diverted from various streams and facilities during the irrigation season, April through September.

Irrigated acreage within the Project increased sporadically over the base period until the late 40's. It has stabilized at a level between 190,000 and 200,000 acres from about 1951 to 1967. During this period the total seasonal supply to the Project lands averaged almost 368,000 acre-feet per year. Figure 21 illustrates fluctuations in Project seasonal supply over the base period. Figure 22 shows the monthly distribution of Project seasonal supply.

About 266,000 acre-feet per year is estimated to have been the average diversion from Upper Klamath Lake and Klamath River during the 1951-67 period. This represents about 20 percent of the total average inflow to Upper Klamath Lake over the base period and amounts to about 73·

percent of the total Project supply. The great majority, 66 percent of the total, is delivered via "A" canal, with the remaining 7 percent being diverted from Klamath River via the Lost River diversion canal. Figure 23 shows the monthly

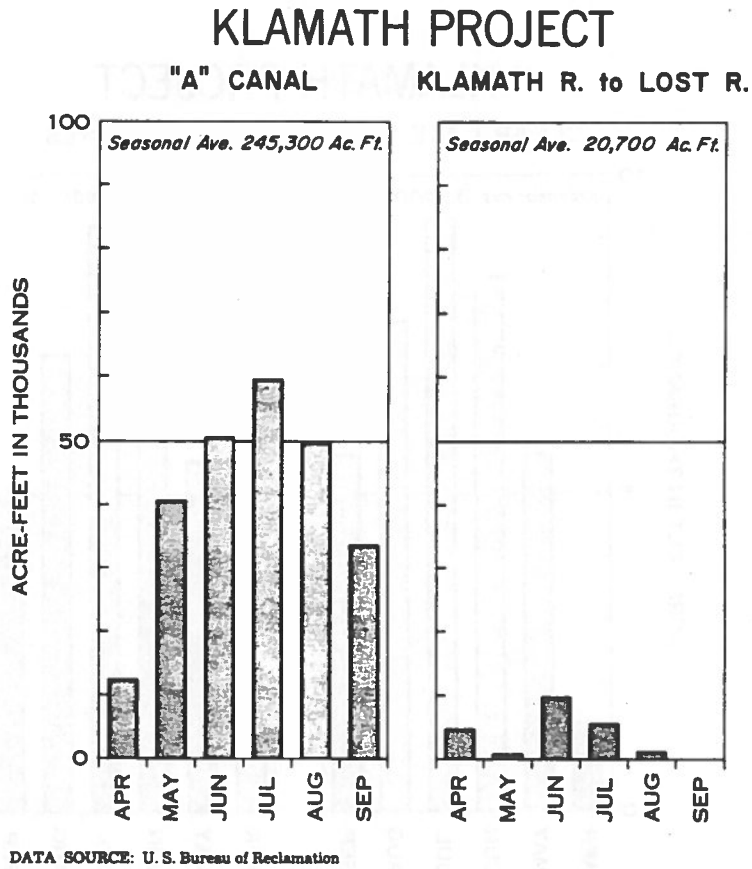


FIGURE 23. Monthly Distribution of Supply from Selected Sources.

distribution of diversions at these sources.

Runoff from the Lost River system yields the remaining 102,000 acre-feet per year.

Estimated average seasonal releases from Clear Lake and Gerber Reservoirs amount to 38,000 acre-feet and 35,800 acre-feet, respectively. The flow of Bonanza-Big Springs is estimated to average 34,800 acre-feet per season, based on little recorded data. The monthly distribution of reservoir releases is shown in Figure 24.

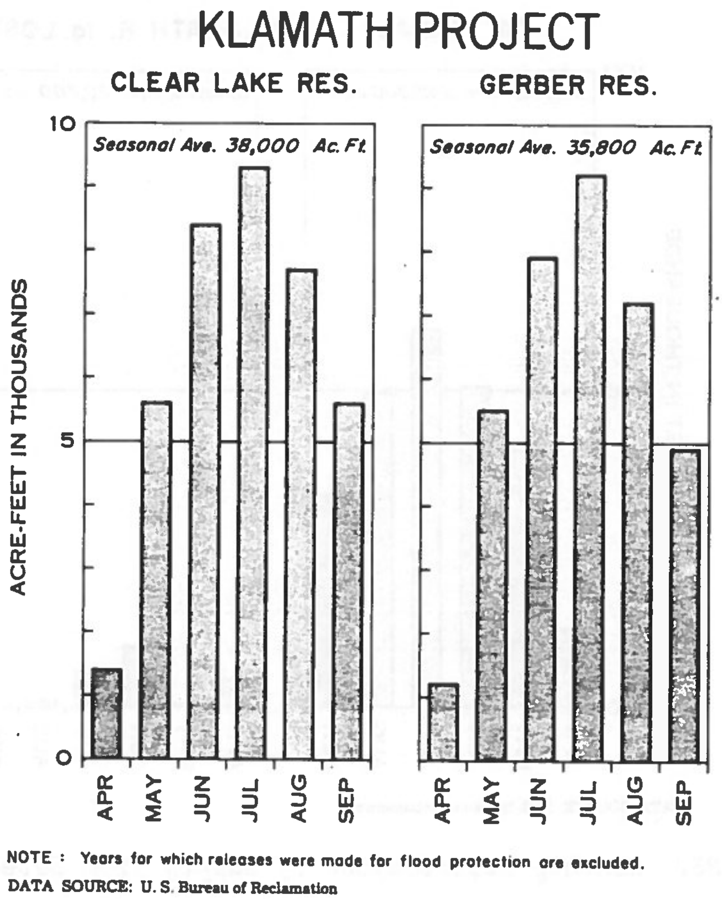


FIGURE 24. Monthly Distribution of Reservoir Releases.

WATER SUPPLY

WATER QUALITY

Introduction

Material for this section is abstracted from a report prepared by the River Basin Survey Staff of the U. S. Soil Conservation Service. A complete summary of quality standards also may be found in their "Klamath Drainage Basin Report."

Surface and ground water of the Klamath Drainage Basin has a wide quality range. The drainage system includes broad, shallow lakes and reservoirs, sluggish rivers, and extensive irrigation facilities. Nowhere else in the state are surface waters more manipulated and reused than in the Klamath Project irrigation system.

Water quality in the basin is generally suitable for most uses common to the region. Standard treatment measures are used to attain acceptable standards of quality in some areas. Quality standards quoted in this section are those decreed by the State of Oregon, Department of Environmental Quality, adopted July 1967. The quality of surface and ground water is summarized in the following text. Tabular data detail the chemical, biological, and physical characteristics.

Drainage to Upper Klamath Lake

The water quality of the springs and streams draining into Upper Klamath Lake is generally adequate for most uses, as listed in Table 23.

Iron occurs throughout the Sprague River Valley in concentrations higher than the allowable maximum of 0.3 parts per million (ppm) for domestic and municipal uses. The level of coliform organisms in the lower five miles of the Williamson River exceeds the permissible limit of 1,000 per 100 milliliter (ml) for public health and water-contact recreation purposes. A rapid increase in the coliform count for the Williamson River near Chiloquin indicates one or more localized sources of coliform pollution. The high coliform concentration entering the lake is diluted to acceptable levels before passing from the lake to the Link River. Turbidity in the lower reaches of the Sprague and Williamson Rivers exceeds the 10 Jackson Turbidity Unit (JTU) limit desirable for fish and other aquatic life during the winter months.

The major water quality problem in Upper Klamath Lake is a

TABLE 23

WATER QUALITY
DRAINAGE TO UPPER KLAMATH LAKE
AND ASSOCIATED GROUND WATER+

CONSTITUENTS	QUALITY
INORGANIC CHEMICAL CHARACTERISTICS	
1. Dissolved oxygen	1. Suitable for all uses.
2. Hardness*	2. Suitable for most uses.
3. Iron*	3. Relatively high concentrations throughout the Sprague River Valley.
4. Nitrogen	4. High concentration from Williamson River.
5. p^{H}*	5. Suitable for all uses.
6. Phosphates*	6. High concentration from Williamson River.
7. Sodium adsorption ratio*	7. Excellent for irrigation.
8. Specific conductance*	8. Excellent for irrigation.
9. Total dissolved solids, including boron, chloride, sodium, sulfates*	9. Suitable for all uses, excellent for irrigation.
10. Total solids	10. Suitable for most uses.
11. Water type: calcium-sodium bicarbonate	11. Suitable for most uses.
MICROBIOLOGICAL CHARACTERISTICS	
12. Coliform organisms	12. Adequate for public health and recreational purposes except lower Williamson River.
PHYSICAL CHARACTERISTICS	
13. Temperature	13. Generally suitable for aquatic life.
14. Turbidity	14. Undesirable during winter for aquatic life in lower reaches of Williamson and Sprague Rivers.

+ See Figure 1 for location of area.
* Includes ground water.

Data Source: USDA, SCS River Basin Survey Staff.

deficiency of dissolved oxygen, due to the introduction of phosphates and other chemical constituents by influent streams and springs. These nutrients produce an excessive growth of algae, called algal blooms, which depletes the dissolved oxygen content of the water. The dissolved oxygen content is below acceptable limits (6 milligrams per liter) for fish life in Ball, Howard, and Shoalwater Bays, and creates taste, odor, and coloration problems throughout the lake. The deficiency of dissolved oxygen is further increased by the decay of dead algal matter within the lake.

Algal blooms in the outflow from the lake are seriously detrimental to the quality of water in Link and Klamath Rivers.

Upper Klamath Lake is one of the eutrophic lakes (rich in dissolved nutrients and deficient in oxygen) studied by the Federal Water Pollution Control Administration to determine the significance of its watershed as a source of algal nutrients. It was reported (1967) that the principal nutrients; phosphates, nitrogen, and iron as well as various trace elements are supplied through natural geologic environments in quantities fully sufficient to maintain algal blooms. Man's contaminating contributions, although accelerating the eutrophication process, are minor in comparison.

Excerpts from the 1854 diary of Lt. Henry L. Abbott, leader of a railroad survey party, attest to the condition of the lake water being due to natural causes: "The water from the lake had a dark color, and a disagreeable taste occasioned apparently by decayed tule." And, "The taste of the water was so disagreeable that several vain attempts were made to discover a spring in the vicinity." (of what is now named Cove Point near the south end of the lake).

Crater Lake, an inclosed basin

The water of Crater Lake, derived from precipitation, is low in total dissolved solids (TDS) including chloride, fluoride, nitrates, and sulfates. Their concentrations are suitable for all uses, based on a 1964 water analysis.

Drainage between Link River Dam and Klamath Strait Drain

The major water quality problem in Link River, Lake Ewauna, and Upper Klamath River is a severe dissolved oxygen deficiency during summer months. This is caused by large algae populations passing from Upper Klamath Lake. Effective atmospheric reaeration is prevented by the regulated low water velocities, which in much of the reach approximate standing water conditions. Water quality analyses are shown in Table 24.

Irrigation return flows and flows from the Lost River Diversion Channel contribute additional pollutants, along with sanitary and industrial wastes from the city of Klamath Falls. The man-made wastes, however, are secondary in detrimental effect to those introduced by natural agents. The Federal Water Pollution Control Administration reports (1969) that the biological oxygen demand (BOD) of both sanitary and industrial wastes discharged into the reach is only 9 percent of BOD required by the outflow of Upper Klamath Lake when its release is 700 cubic feet per second (CFS).

Dissolved oxygen in the reach from Lake Ewauna to Keno fell to near zero during August 1968, causing a large fish kill. State of Oregon water quality standards in this area require a dissolved oxygen concentration of not less than 5 milligrams per liter for aquatic life unless lowered by natural condition.

Iron concentrations not only are high for domestic use but along with nitrogen and phosphates enhance algal bloom in this reach.

Excessive alkalinity in Link River is recorded with hydrogen ion concentration (p^H) readings as high as 9.6 at the Fremont Bridge. A p^H higher than 8.5 exceeds the concentration deemed desirable for irrigation. State water quality standards for this reach prescribe a p^H range of 7.0 to 9.0 for fish and other aquatic life.

Coliform counts are twenty times above acceptable limits for public health and recreational purposes. In the spring coliform counts of the outflow from Upper Klamath Lake averaged 49 at the Link River-Fremont Bridge and increased to 20,285 at the Klamath River-Highway 97 bridge, about 5½ miles downstream. Coliform counts in this area exceed 5,000 during most seasons, well above the safe limit of 1,000 per milliliter.

The high coliform count reflects the concentration of discharges from sewage treatment facilities and industries along this reach of river. The condition is aggravated by the extremely low velocities and warm temperatures experienced in this reach.

WATER SUPPLY

TABLE 24

WATER QUALITY - DRAINAGE INTO KLAMATH RIVER BETWEEN LINK RIVER DAM AND KLAMATH STRAIT DRAIN AND ASSOCIATED GROUND WATER+

CONSTITUENTS	QUALITY
INORGANIC CHEMICAL CHARACTERISTICS	
1. Dissolved oxygen	1. Deficient for aquatic life.
2. Iron	2. Undesirably high for domestic, municipal, and industrial uses.
3. Nitrogen	3. High concentration which enhances algae growth.
4. pH*	4. Alkalinity sometimes undesirably high for irrigation and aquatic life.
5. Phosphates	5. High concentration which enhances algae growth.
6. Sodium adsorption ratio	6. Generally adequate for irrigation
7. Specific conductance*	7. Generally adequate for irrigation Some thermal ground water is undesirable for sensitive crops.
8. Total dissolved solids, including boron, chloride, sodium, sulfates. Thermal wells yield all of the above plus fluoride.*	8. Suitable for all uses, except water from thermal wells which may be unsuitable for domestic use and irrigating sensitive crop
9. Water types: varies from calcium-sodium bicarbonate to sodium-calcium bicarbonate	9. Both types are adequate for most uses. Calcium-sodium bicarbonate type is better quality.
MICROBIOLOGICAL CHARACTERISTICS	
10. Biological oxygen demand	10. Unsuitable for aquatic life.
11. Coliform organisms	11. Too high for public health and water-contact recreation without treatment.
PHYSICAL CHARACTERISTICS	
12. Temperatures	12. Detrimental for fish life during summer months.
13. Turbidity	13. Exceeds levels desirable for aquatic life.

\+ See Figure 1 for location of area.
* Includes ground water.

Data Source: USDA, SCS River Basin Survey Staff.

WATER SUPPLY

Water temperatures as high as 77° F. have been recorded in this reach, well above the 72° F. maximum recommended for fish life by state water quality standards. As water temperatures increase, the dissolved oxygen content decreases.

Turbidity readings as high as 80 JTU have been recorded below the Link River-Main Street Bridge, far above the 10 JTU maximum level prescribed for fish and other aquatic life.

This high turbidity level reflects the quality of water from Upper Klamath Lake along with contributing factors of irrigation return flows and effluents from domestic and industrial uses.

Wells located along fault zones in the Klamath Falls and Klamath Hills thermal ground water zones yield water up to 235° F. and 200° F., respectively. Some thermal wells produce fluoride in concentrations marginal or detrimental for domestic use and boron in concentrations excessive for irrigating sensitive crops.

Drainage Area of Lost River, Tule Lake and Lower Klamath Lake, Klamath Strait Drain, and Klamath River below Klamath Strait Drain to Keno

Lost River in Oregon

The Lost River, as a principal source of water for the more than 200,000 acres cultivated in the U. S. Bureau of Reclamation's Klamath Project, is essentially an irrigation channel. As such, the mineral and nutrient constituents from the geologic environment and the agriculture return flows increase downstream to progressively degrade the water quality.

Dissolved oxygen in the lower reaches of the river is deficient during summer months for fish and other aquatic life, due to the combined effects of low flows, massive algal blooms, and high temperatures. These constituents are listed in Table 25. Turbidity counts as high as 123 JTU (a count not greater than 10 is desirable for fish life) have been recorded 5 miles southeast of Bonanza, well upstream from heavy irrigation use. Iron concentrations are excessively high for domestic, municipal, and industrial uses. The surface water TDS count is suitable for all uses. However, ground water from thermal

TABLE 25

WATER QUALITY
DRAINAGE IN LOST RIVER AREA IN OREGON AND ASSOCIATED GROUND WATER, TULELAKE IRRIGATION DISTRICT AND LOWER KLAMATH LAKE WILDLIFE REFUGE IN CALIFORNIA AND KLAMATH STRAIT DRAIN AREA TO KENO+

CONSTITUENTS	QUALITY
INORGANIC CHEMICAL CHARACTERISTICS	
Oregon Portion	
(Lost River Area)	
1. Dissolved oxygen	1. Below concentration desirable for aquatic life in lower Lost River.
2. Iron	2. Exceeds level desirable for domestic, municipal, and industrial uses.
3. p^H	3. Alkalinity often exceeds levels desirable for aquatic life.
4. Specific conductance*	4. Higher than desirable in some ground waters for sensitive crops.
5. Total dissolved solids, including boron, chloride, sodium, sulfates.*	5. Generally suitable for all uses.
6. Water types: varies from calcium-sodium bicarbonate to sodium-calcium sulfate bicarbonate.	6. Calcium-sodium bicarbonate type is suitable for most uses. Sodium-calcium sulfate bicarbonate type may be of poor quality for domestic, municipal, and irrigation uses.
California Portion	
(Tulelake Irrigation District and Lower Klamath Lake Wildlife Refuge)	
7. Boron	7. Suitable for all uses.
8. Chloride	8. Suitable for all uses.

TABLE 25 - Continued

CONSTITUENTS	QUALITY
9. Dissolved oxygen	9. Below levels desirable for aquatic life and prevention of botulism in waterfowl.
10. Iron	10. Higher than desirable for domestic municipal, and industrial uses.
11. p^H	11. Generally higher than desirable for aquatic life.
12. Specific conductance	12. Progressively increases, becoming less desirable for irrigation downstream.
13. Total dissolved solids	13. Frequently exceeds concentration desirable for irrigation.
14. Water type: sodium-calcium sulfate bicarbonate	14. Poor quality for domestic, municipal, and irrigation uses.

Oregon Portion

(Klamath Strait Drain Area, including Outflow from Lower Klamath Lake Wildlife Refuge in California)

15. Boron^x	15. Exceeds levels desirable for irrigating sensitive crops.
16. Chloride	16. Suitable for all uses.
17. Dissolved oxygen	17. Lower than desirable for aquatic life.
18. Iron	18. Higher than desirable for domestic municipal, and industrial uses.
19. p^H	19. Alkalinity exceeds levels desirable for aquatic life.
20. Specific conductance	20. Exceeds levels desirable for irrigation.
21. Total dissolved solids	21. Above levels desirable for irrigation.

Klamath River between Klamath Strait Drain and Keno

22. Dissolved oxygen	22. Occasionally below levels desirable for aquatic life.
23. Iron	23. Higher than desirable for domestic municipal, and industrial uses.

TABLE 25 - Continued

CONSTITUENTS	QUALITY
24. p^H	24. Alkalinity occasionally exceeds value desirable for irrigation and aquatic life.
25. Total dissolved solids, including boron, chloride, sodium, sulfates	25. Suitable for all uses.
26. Water type: sodium-calcium bicarbonate	26. Generally adequate for most uses.

MICROBIOLOGICAL CHARACTERISTICS

Oregon Portion

Klamath River between Klamath Strait Drain and Keno

27. Coliform organisms (No other tests made)	27. Occasionally too high for public health and water-contact recreation without treatment.

PHYSICAL CHARACTERISTICS

Oregon Portion

(Lost River Area)

28. Temperature	28. Frequently exceeds levels desirable for aquatic life.
29. Turbidity	29. Often exceeds levels desirable for aquatic life.

CALIFORNIA PORTION

(Tulelake Irrigation District and Lower Klamath Lake Wildlife Refuge)

30. Temperature	30. Generally higher than desirable for aquatic life.

TABLE 25 - Continued

CONSTITUENTS	QUALITY
OREGON PORTION	
(Klamath Strait Drain, including Outflow from Lower Klamath Lake Wildlife Refuge in California)	
31. Temperature	31. Detrimental for fish life during summer months.
32. Turbidity	32. Exceeds levels desirable for aquatic life.
Klamath River between Klamath Strait Drain and Keno	
33. Temperature	33. Detrimental for fish life during summer months.
34. Turbidity	34. Periodically exceeds levels desirable for aquatic life.

+ See Figure 1 for location of area.
* Includes ground water.
x Boron concentration is higher in Klamath Strait Drain area than in any other part of Klamath Basin.

Data Source: USDA, SCS River Basin Survey Staff.

zones and alkaline areas is generally too high in TDS to be potable or used for irrigating sensitive crops.

Tule Lake and Lower Klamath Lake Areas

These areas are essentially natural evaporation basins in which sodium salts have probably been accumulating throughout recent geologic time. Irrigators make the soil suitable for raising medium salt-tolerant crops, such as potatoes, onions, peas, and alfalfa, by preleaching the top soil. This procedure causes a high salinity concentration to appear in any water quality samples from the channels, drainage ditches, or in either of the Tule Lake Sumps. It follows that these salts are carried on to the wildlife refuges and to the downstream irrigated areas in Oregon.

The incremental effects of TDS are illustrated as the water moves through the reclaimed irrigated area. Analyses show that the TDS concentration during the irrigation season increased from 290 at the lower Lost River diversion dam to 2,509 at Pump 9 near the southwest margin of Tule Lake. The TDS concentration then drops slightly, probably due to ground water intrusion, as the water moves to the head of the Klamath Strait Drain at the California state line.

Iron concentrations are too high for domestic, municipal, and industrial uses. Both temperature and p^H levels are unsatisfactorily high. The level of total dissolved oxygen in these waters is important because oxygen is needed to prevent botulism in waterfowl. Botulism usually occurs during warm weather when alkaline water fluctuates over the mudflats of the wildlife refuges.

Klamath Strait Drain Area in Oregon

Much of this area receives water reportedly (1966) reused at least 2½ times on fertilized cropland during its long course through the Klamath Project. The very poor quality of the water is shown by the TDS and sulfate concentrations, which respectively increase from 940 ppm and 951 ppm at the head of the Klamath Strait Drain to 1,730 ppm and 1,521 ppm at its outlet in the Klamath River. Boron concentrations near the outlet are 0.78 ppm, the highest in the Klamath Basin. Again, the salt content problem in part of the area is resolved by growing medium salt-tolerant crops and by preleaching the soils.

Iron concentrations are too high for domestic, municipal, and industrial uses. Water in the drain has high turbidity, p^H, and temperature, as well as deficiency in dissolved oxygen.

Klamath River between Klamath Strait Drain and Keno

Analyses of water samples taken at Keno show enough quality improvement to indicate a probable significant dilution by ground water intrusion in the reach.

The water is a sodium-calcium bicarbonate type, and TDS concentrations are suitable for most uses. Iron remains higher than desirable for domestic, municipal, and industrial uses; and the coliform concentration is above levels for public health and recreational uses. Turbidity, dissolved oxygen, temperature, and p^H are occasionally undesirable for fish life. The p^H concentration occasionally is too high for irrigation use.

Klamath River between Keno and California Border

The water quality of the Klamath River below Keno is markedly improved by turbulent reaeration, caused by the steeper channel gradient and by considerable ground water intrusion. The quality has improved to such a degree that only water temperatures remain intermittently high. However, this is undesirable to fish and other aquatic life in this reach. The constituents and qualities are listed in Table 26.

LEGAL RESTRICTIONS AND LIMITATIONS ON WATER USE

Klamath River Basin Compact

The Klamath River Basin Compact was ratified by the States of Oregon and California in April of 1957 and consented to by an Act of Congress of the United States in August of 1957. The Compact became effective September 11, 1957. It is unique in Oregon and provides a legal basis for the use of surface waters of the Klamath River Basin between the two states.

WATER SUPPLY

TABLE 26

WATER QUALITY - KLAMATH RIVER
BETWEEN KENO AND CALIFORNIA BORDER+

CONSTITUENTS	QUALITY
INORGANIC CHEMICAL CHARACTERISTICS	
1. Dissolved oxygen	1. Essentially no problem.
2. Iron	2. Essentially no problem.
3. pH	3. Essentially no problem.
4. Total dissolved solids including boron, chloride, sodium, sulfates	4. Essentially no problem.
5. Water type: calcium-sodium bicarbonate	5. Generally adequate for most uses.
MICROBIOLOGICAL CHARACTERISTICS	
6. Coliform organisms	6. Generally no problem.
PHYSICAL CHARACTERISTICS	
7. Temperature	7. Marginal for fish life.
8. Turbidity	8. Generally no problem.

+ See Figure 1 for location of area.

Data Source: USDA, SCS River Basin Survey Staff.

WATER SUPPLY

The purposes as stated in Article I of the Compact are:

"A. To facilitate and promote the orderly, integrated and comprehensive development, use, conservation and control thereof for various purposes, including, among others: the use of water for domestic purposes; the development of lands by irrigation and other means; the protection and enhancement of fish, wildlife and recreational resources; the use of water for industrial purposes and hydroelectric power production; and the use and control of water for navigation and flood prevention.

"B. To further intergovernmental cooperation and comity with respect to these resources and programs for their use and development and to remove causes of present and future controversies by providing (1) for equitable distribution and use of water among the two states and the Federal Government, (2) for preferential rights to the use of water after the effective date of this compact for the anticipated ultimate requirements for domestic and irrigation purposes in the Upper Klamath River Basin in Oregon and California, and (3) for prescribed relationships between beneficial uses of water as a practicable means of accomplishing such distribution and use."

Article II contains definitions to aid in interpretation of Compact language. The most significant are subsections B and G.

Subsection B defines the boundaries of the area included under the Compact as follows:

"B. 'Upper Klamath River Basin' shall mean the drainage area of the Klamath River and all its tributaries upstream from the boundary between the States of California and Oregon and the closed basins of Butte Valley, Red Rock Valley, Lost River Valley, Swan Lake Valley and Crater Lake, as delineated on the official map of the Upper Klamath River Basin approved on September 6, 1956, by the Commissions negotiating this compact."

Subsection G defines the resource with which the Compact is concerned, to wit:

"G. 'Water' or 'waters' shall mean waters appearing on the surface of the ground in streams, lakes or otherwise, regardless of whether such waters at any time were or will become ground water, but shall not include water extracted from underground sources until after such water is used and becomes surface return flow or waste water."

Article III of the Compact recognizes vested water rights validly established under respective state law as of its effective date. The article then establishes a priority of beneficial use to govern further appropriation of unappropriated waters within the basin. The ranking is quoted below:

"(a) Domestic use,
(b) Irrigation use,
(c) Recreation use, including use for fish and wildlife,
(d) Industrial use,
(e) Generation of hydroelectric power,
(f) Such other uses as are recognized under the laws of the state involved."

Subsection 2 of Article III stipulates there shall be no diversion of water from the Upper Klamath River Basin except for waters originating within the drainage area of Fourmile Lake. All surface return flows and waste waters from diversions within the basin must be returned to the Klamath River above Keno, Oregon. This condition applies to all waters diverted for use in either Oregon or California and was included to minimize potential effects of further development on power generation facilities downstream of Keno.

Subsection C of Article III states that rights acquired after the effective date of the Compact for domestic and irrigation purposes in the Upper Klamath River Basin in either state are superior to any other right acquired after the effective date. Rights for those purposes are superior regardless of their priority in time and may be exercised with respect to inferior rights without compensation. "But such superior rights to use water for use (b) in California shall be limited to the quantity of water necessary to irrigate 100,000 acres of land, and in Oregon shall be limited to the quantity of water necessary to irrigate 200,000 acres of land."

Subsection C also provides for storage of water "as long as the storing of waters.....does not interfere with direct diversion or storage of such waters for use (a) or (b) in the Upper Klamath River Basin."

Article IV requires that each state in planning for and developing their respective areas will "provide for the most efficient use of available power head" in order to reasonably minimize power rates associated with "irrigation and drainage pumping, including pumping from wells."

Article V provides that each state grants to the other the right to construct and operate facilities for measurement, diversion, storage, and conveyance of water in one state for use in the other. The commission has approval authority over the location of these facilities. The article also provides for establishment and operation of permanent gaging stations as required by the commission in regard to the involved interstate water transfers.

Article VI provides the means for one state to acquire property in the other for water diversion purposes. It also stipulates the amount of in lieu taxes to local governments. These amount to "a sum of money equivalent to the average annual amount of taxes assessed against those rights during the 10 years preceding the acquisition."

Pollution control is considered in Article VII. It recognizes the potential harmful effects on the health, welfare, and economic development of the basin. Subsection B assigns the Compact Commission duties and powers to cooperate with the states and United States in promoting effective laws and adopting regulations to abate and control pollution in the basin. The commission also is instructed to intermittently recommend to the affected governments reasonable minimum water quality standards. It is also charged with disseminating information to the public concerning pollution abatement and control.

Subsection C assigns to each state primary responsibility to take action to abate and control interstate pollution and defines the procedure by which an affected state may process a complaint through the commission concerning pollution that originates in the other state. The commission is directed to investigate and recommend corrective action. The commission may hold hearings and issue orders if the recommended actions are not taken by the offender. This subsection also specifies the courts having jurisdiction in the event further enforcement or appeals become necessary.

Article VIII provides that no further diversions except those allowed by the commission may be made from the waters of Jenny Creek and that necessary re-regulation of water shall be accomplished after its use for power generation.

Article IX deals with administration of the Compact. It creates a commission composed of representatives from the State of California, the State of Oregon, and the United States. Oregon's representative is the State Engineer who serves as ex officio representative of the State Water Resources Board of Oregon. Both state representatives have one vote. The representative of the United States serves as the commission chairman and has no vote.

The article requires the commission to employ an executive director and to establish its office containing the commission's "records, files and documents" within the Upper Klamath Basin. The article provides the methods of arbitration in case of disagreement between state representatives. It also sets forth the mechanics of budgeting and fiscal management of commission funds.

The status of Indian rights is provided for in Article X. The Article states that Compact provisions shall not adversely affect present (1957) rights of any individual Indian, tribe, band, or community of Indians to use the waters of the Klamath River Basin for irrigation or deprive them of any rights, privileges, or immunities afforded under Federal treaty, agreement, or statute. The Compact does not amend or alter provisions of the Act of August 13, 1954 (68 Stat. 718)1/. Lands within the Klamath Reservation are to be accounted for in the 200,000-acre limitation if developed after the effective date of the Compact.

Article XI, the provision regarding Federal rights, states that nothing in the Compact will impair or affect any rights, powers or jurisdictions of Federal agencies to the waters of the Klamath River Basin nor impair those agencies from implementation of the Compact. The article prohibits any adverse effects on the existing areas of Crater Lake National Park or Lava Beds National Monument and adverse effects on water use, as of the effective date (1957), within designated waterfowl management areas. The Compact recognizes obligations under the Migratory Bird Conservation Act (45 Stat. 1222).

1/ Titled: "To provide for the termination of Federal supervision over the property of the Klamath Tribe of Indians located in the State of Oregon and the individual members thereof."

General provisions are contained in Article XII. These provide that all water users in the basin are subject to Compact terms, that either state has recourse to a court of competent jurisdiction to protect its rights, that remaining Compact terms will be effective if one is found unconstitutional by a state or the United States, and that the terms of the Compact are based on the peculiar physical conditions of the basin and are not precedent setting regarding other interstate streams.

Under Article XIII, by ratifying the Compact, Congress agreed that:

1. The United States recognizes and will be bound by Subdivision A of Article III.
2. The United States will not impair any water rights within the Compact boundary by use of waters of the upper basin outside the upper basin or those of any user in the entire Klamath Basin other than domestic or irrigation without just compensation. Uses for (a) domestic and (b) irrigation may not cause an annual depletion greater than 340,000 acre-feet in any calendar year.
3. The United States is subject to limitation on diversions of water from the Jenny Creek Basin.
4. The United States will comply with certain limitations in Article III.
5. The United States must cause return flows from irrigation development in California to enter the Klamath Basin above Keno, except where the Secretary of the Interior finds this would be detrimental to development feasibility. In that case return flows must be returned to the Klamath River above Copco Lake.

Article XIV provides the means by which the Compact may be terminated.

A complete copy of the Klamath River Basin Compact is included in the Appendix.

Legislative Withdrawals

ORS 538.190, the only legislative withdrawal of water within the basin, is quoted below:

> "ORS 538.190 Lake of the Woods and tributaries, Klamath County; diversion, interruption or appropriation of waters prohibited; excepted uses.

In order to maintain, increase and perpetuate game fish and game fish propagation within Oregon, the waters or use of the waters of Lake of the Woods and its tributaries, situated in Klamath County, not already appropriated, shall not be diverted, interrupted or appropriated for any purpose whatsoever, except for domestic use on contiguous and surrounding land."

WATER RIGHTS AND DEPLETIONS

Water rights data for the Klamath Basin are summarized from State Engineer's records and contain water rights by stream diversion point, quantity, priority date, and use. The data are restricted to surface water rights and exclude those for the Klamath Project. In total, surface water rights would permit an annual maximum legal depletion of 3,451,548 acre-feet per year from the surface waters of the basin.

Table 27 presents the limitations and irrigation seasons that have been set.

TABLE 27

ADJUDICATED LIMITATIONS

STREAM	IRRIGATION SEASON	IRRIGATION DUTY
Sprague R.	Mar. 1 to Oct. 1 1/	1/40 cfs/Ac. to June 15 & 1/80 cfs/Ac. thereafter up to 3 Ac.Ft./Ac.
Wood R.	Apr. 1 to Oct. 1	1/50 cfs/Ac. to July 20 & 1/80 cfs/Ac. thereafter up to 50 5 Ac.Ft./Ac.
Anna (Annie) Cr.	May 1 to Nov. 1	1/80 cfs/Ac. up to 3 Ac-Ft./Ac.
Swan Lake	Mar. 15 to Sept. 30	1/40 cfs/Ac. to June 15 & 1/80 cfs/Ac. thereafter up to 3 Ac.Ft./Ac.
Lost R.	Mar. 1 to Sept. 31	1/80 cfs/Ac. up to 2-1/2 Ac.Ft./Ac.

Note: All tributaries of adjudicated streams come under the main stem limitations.

1/ Adjudicated outside old Indian Reservation Boundary.

Data Source: State Engineer.

Depletions due to surface water rights for irrigation are based on limitations of flow, quantity, and season for those streams which have been adjudicated.

Basin surface rights total 6,676 cfs, of which 2,878 cfs are for consumptive uses (domestic, municipal, industrial, and irrigation) and 3,788 cfs are for nonconsumptive uses (power, mining, and fish life). In addition there are exports from the basin in the amount of about 200 cfs.

Rights other than those for irrigation are continuous throughout the year. The rights prior to the Klamath Compact are ranked in order of priority; first in time, first in right. Rights issued after the Klamath Compact are contingent upon priority of use.

The State Water Resources Board prepared and has on file separate Klamath Basin water rights compilation sheets that list all rights by stream, diversion point, priority date, and use.

Due to the complexity of the water rights situation within the Project area, it has been presented separately under the heading of Klamath Project. The tabulation of water rights for the study areas does not include the Project area.

A summary of the total legal depletions in acre-feet for all the study areas is shown in Table 28. A summary of the total legal annual diversions on each stream in cfs is shown in Table 29. A more detailed compilation of existing water rights is included in Table B of the Appendix.

The following is a detailed description of the total water rights for each specific use by study area.

Study Area 1 - Williamson River

The data for the Williamson River and Sprague River study areas are of limited reliability, since both of these streams flow through the now dissolved Klamath Indian Reservation. Adjudication proceedings forthcoming on both streams will change the present condition to a large extent.

The largest consumptive surface water rights from the Williamson River are for irrigation in the amount of 424.560 cfs, for a potential depletion of 91,192 acre-feet. Other consumptive rights include domestic, 0.120 cfs or 86 acre-feet per year; municipal, 4.205 cfs or 3,045 acre-feet per

TABLE 28

LEGAL ANNUAL SURFACE WATER RIGHTS DEPLETIONS SUMMARY
Acre-Feet

STUDY AREA	CONSUMPTIVE						NONCONSUMPTIVE					
	Dom.	Mun.	Ind.	Irr.	Acres	Total	Pwr.	Fish & Wildlife	Mining	Rec.	Total	Total Rights
1. Williamson River	86	3,045	45,972	91,192	30,397.70	140,295	0	0	0	0	0	140,295
2. Sprague River	1,513	0	1,687	82,203	27,400.50	85,403	0	724[F]	0	0	724	86,127
3. Wood River												
(a) Wood River	4,007	1,332	0	211,840	53,611.49	217,179	0	14,479[F]	0	0	14,479	231,658
(b) Upper Klamath Lake	152	51 1/	0 1/	33,848	11,282.60	34,051 1/	7,240	0	0	0	7,240	41,291
4. Lost River												
(a) Swan Lake	87	0	0	14,803	4,934.40	14,890	0	0	0	0	0	14,890
(b) Lost River 3/	4,610	232	16,289	72,653	27,536.83	93,784	727,590	290[F]	0	0	727,880	821,664
5. Klamath River	829	51	854	6,086	2,029.00	7,820	1,986,573 2/	2,695[F]	10,136	0	1,999,404	2,007,224
BASIN TOTAL	11,284	4,711	64,802	512,625	157,192.52	593,422	2,721,403	18,188	10,136	0	2,749,727	3,343,149

F Fish life.

1/ Excludes out-of-basin diversion.

2/ Includes out-of-basin power diversion.

3/ Excluding the Project rights.

Data Source: Oregon State Engineer

TABLE 29

LEGAL ANNUAL SURFACE WATER RIGHTS SUMMARY
Cubic Feet per Second

STUDY AREA	CONSUMPTIVE						NONCONSUMPTIVE					
	Dom.	Mun.	Ind.	Irr.	Acres	Total	Pwr.	Fish & Wildlife	Mining	Rec.	Total	Total Rights
1. Williamson River	0.120	4.205	63.500	424.560	30,397.70	492.385	0	0	0	0	0	492.385
2. Sprague River	2.091	0	2.330	544.385	27,400.50	548.806	0	1.000[F]	0	0	1.000	549.806
3. Wood River												
(a) Wood River	5.535	1.840	0	757.939	53,611.49	765.314	0	20.000[F]	0	0	20.000	785.314
(b) Upper Klamath Lake	0.210	0.070 1/	0 1/	144.560	11,282.60 1/	144.840	10.000	0	0	0	10.000	154.840
4. Lost River												
(a) Swan Lake	0.120	0	0	88.611	4,934.40	88.731	0	0	0	0	0	88.731
(b) Lost R. 2/	6.364	0.320	22.500	350.216 2/	27,536.83 2/	379.400	1,005.000	0.400[F]	0	0	1,005.400	1,384.800
5. Klamath River	1.145	0.070	1.180	30.185	2,029.00	32.580	2,744.000	3.750[F]	14.000	0	2,761.750	2,794.330
BASIN TOTAL	15.585	6.505	89.510	2,340.456	157,192.52	2,452.056	3,759.000	25.150	14.000	0	3,788.150	6,240.206

1/ Excludes out-of-basin diversion.

2/ Excluding Project rights.

F Fish life.

Data Source: Oregon State Engineer.

year; and industrial 63.500 cfs or 45,972 acre-feet per year. There are no recorded surface water rights in the Williamson River Study area for other beneficial uses.

Figure 25 illustrates the total legal annual depletion of Study Area 1.

Study Area 2 - Sprague River

As for the Williamson River, the largest surface water rights for the Sprague River are for irrigation in the amount of 544.385 cfs for a potential depletion of 82,203 acre-feet per year. Other consumptive rights include domestic, 2.091 cfs or 1,513 acre-feet per year; and industrial, 2.330 cfs or 1,687 acre-feet per year. A single nonconsumptive right is recorded for 1.000 cfs for fish life. Figure 25 illustrates the total legal annual depletion of Study Area 2.

Study Area 3a - Wood River

The largest surface water rights are for irrigation in the amount of 757.939 cfs, for a potential depletion of 211,840 acre-feet per year. Other consumptive rights include domestic, 5.535 cfs or 4,007 acre-feet per year; municipal, 1.840 cfs or 1,332 acre-feet per year; and a nonconsumptive fish life right for 20.000 cfs.

Figure 26 illustrates the total legal annual depletions by stream mile.

Study Area 3b - Upper Klamath Lake

The largest consumptive surface water rights are for irrigation purposes in the amount of 557.750 cfs, for a potential depletion of 133,013 acre-feet per year. Other consumptive rights include domestic, 0.210 cfs or 152 acre-feet per year; municipal, 0.825 cfs or 597 acre-feet per year; and a nonconsumptive power right for 10.000 cfs.

There is an out-of-basin diversion to the Rogue Basin from Fourmile Lake in the amount of about 30 cfs. Recorded amounts have ranged from 0 to about 11,000 acre-feet per year for irrigation, 6.000 cfs for municipal, and 6.000 cfs for industrial purposes. Final determination is pending.

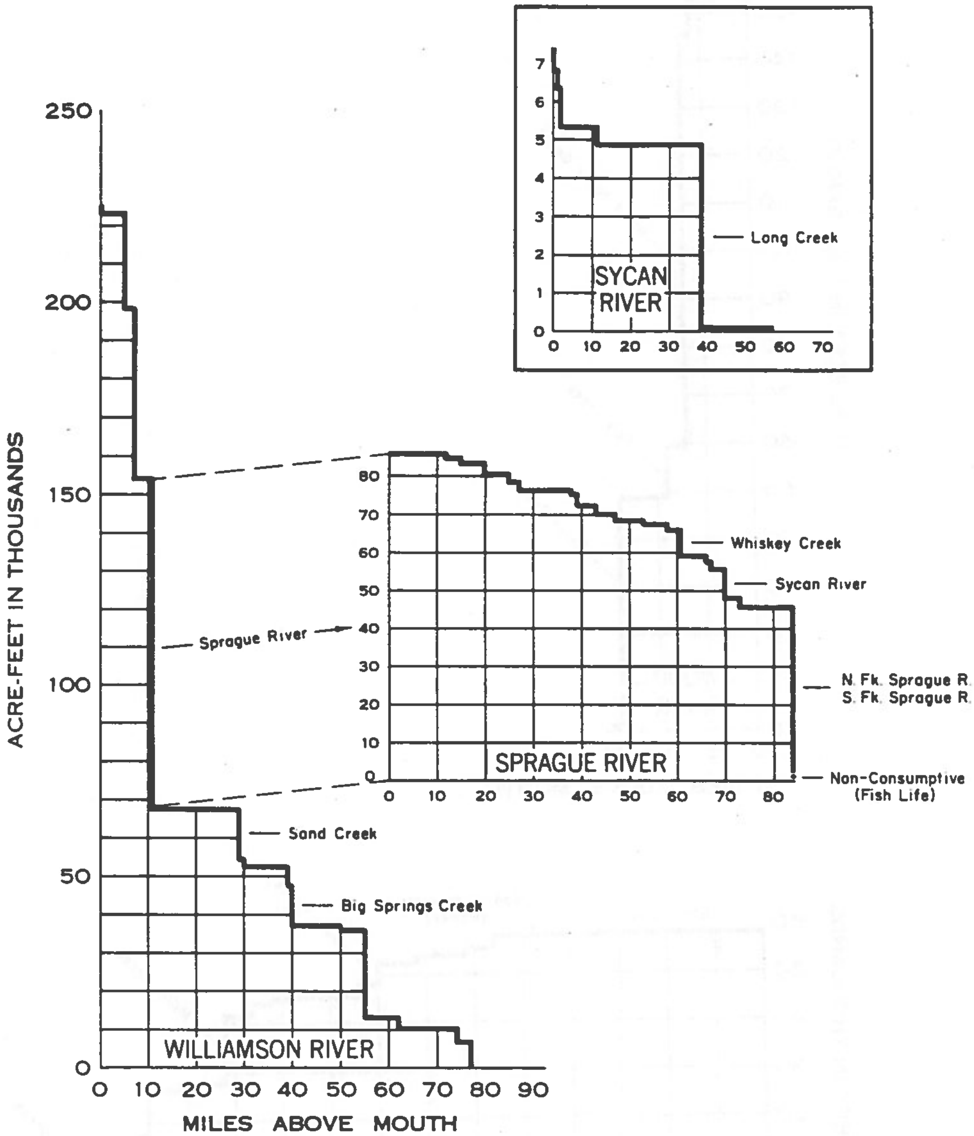


FIGURE 25. Legal Depletions - Study Areas 1 & 2.

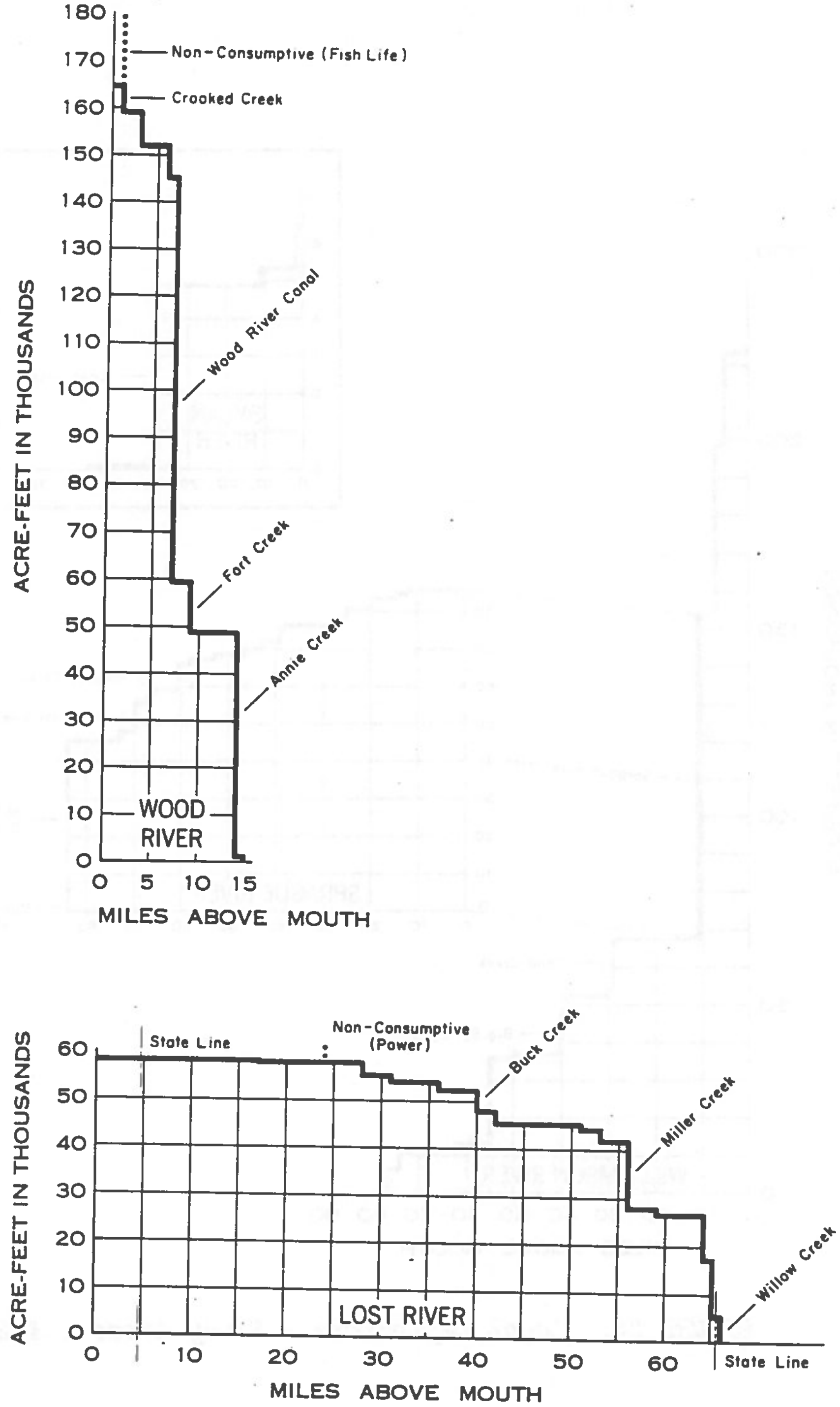


FIGURE 26. Legal Depletions - Study Areas 3a & 4b.

WATER SUPPLY

Study Area 4a - Swan Lake

The largest surface water rights are for irrigation purposes in the amount of 88.611 cfs or 14,803 acre-feet per year. Surface water rights for domestic uses in the study area total 0.120 cfs or 87 acre-feet per year.

Study Area 4b - Lost River

The largest consumptive surface water rights, excluding the Project Area, are for irrigation in the amount of 350.216 cfs, for a potential depletion of 72,653 acre-feet per year. Other consumptive use rights include domestic, 6.364 cfs or 4,610 acre-feet per year; municipal, 0.320 cfs or 232 acre-feet per year, and industrial, 22.500 cfs or 16,289 acre-feet per year. Nonconsumptive uses include power, 1,005.000 cfs and fish life in the amount of 0.400 cfs.

Figure 26 illustrates the total legal annual depletions by stream mile, excluding the Project area.

Study Area 5 - Klamath River

The largest consumptive surface water rights are for irrigation in the amount of 30.185 cfs, for a potential depletion of 6,086 acre-feet per year. Other consumptive rights include domestic, 1.145 cfs or 829 acre-feet per year; municipal, 0.070 cfs is 51 acre-feet per year; and industrial, 1.180 cfs or 854 acre-feet per year. Of the nonconsumptive rights, power is the largest at 2,744 cfs. Others are for fish life in the amount of 3.750 cfs and mining in the amount of 14.000 cfs.

There is an out-of-basin transfer through the Keene Creek Canal for export of 160.000 cfs or 115,835 acre-feet per year.

Water Rights within the Klamath Project

Water supplies for the adjudicated segment of the Klamath Project within the Lost River drainage are somewhat complicated, from the legal as well as the operational standpoint.

Most of the irrigators within the Project receive their water supplies as members of water districts that have contractual agreements with the United States. A few, however, have legal individual irrigation rights that are not a part of the Project rights.

WATER SUPPLY

In 1905 Oregon authorized the appropriation of water by the United States for use within the Klamath Project. Pursuant to this action, the United States filed its intention to utilize all the waters of the Klamath Basin in Oregon under the provisions of the Reclamation Act. In 1950 the Attorney General of Oregon ruled that the United States, when appropriating water under the Reclamation Act, was controlled by the beneficial use doctrine. He further ruled that any surplus water was subject to appropriation in the Klamath Basin. The Bureau of Reclamation is in the process of filing water-use maps of the Klamath Project with the State Engineer, and a final water right has not been issued by the State of Oregon. However, since an agreement has been reached between the affected states and the federal government in the form of the Klamath Compact, the Project still has the right to use waters of the Upper Klamath Basin within the limits of the Compact.

TABLE 30

SUMMARY OF LANDS BENEFITTED BY KLAMATH PROJECT OREGON 1/

AREA	ACRES
Horsefly Irrigation District	9,943
Klamath Falls Area	28,709
Langell Valley	18,246
Lower Klamath Basin	28,726
Malin Area	16,782
Merrill Area	22,679
Poe Valley	10,645
Upper Klamath Lake Area - North	8,818
Upper Klamath Lake Area - South	9,103
Oregon Total	153,650

1/ Lands benefited in California = 118,098 Acres

Data Source: Bureau of Reclamation.

Table 30 summarizes the lands benefited by Project works. According to data supplied by the Bureau of Reclamation, there are approximately 153,400 acres benefited by the Klamath Project in Oregon. Of this total acreage, only about 31,000 acres are within areas that have been adjudicated. Within the Project boundary, there are some 4,600 acres that have water rights decreed to individuals.

Water Rights in California

A description of the water law of California, which varies from Oregon water law, is beyond the scope of this report.

Table D of the Appendix is a brief summary of the water rights in the California portion of the basin, supplied by the California State Water Resources Control Board, Division of Water Rights.

Imports and Exports

There are two interbasin transfers of water from the Klamath Basin. Both transport water to the Rogue Basin. The Cascade Canal takes water from Fourmile Lake in Study Area 3a into Fish Lake in the Rogue Basin. The canal, under a water right allowing about 40 cfs to be diverted, usually operates only during the irrigation season, April through September. Diversions from the Klamath Basin have ranged from zero to 11,600 acre-feet per season and have averaged 4,500 acre-feet annually over 42 years of operation. The diversion is made from Fourmile Creek, a tributary of Upper Klamath Lake.

The other export system is relatively complex. Plate 1 illustrates the arrangement. Howard Prairie Lake receives water from two facilities, South Fork Little Butte Collection Canal and Dead Indian Collection Canal. These conveyances divert water from the Little Butte Creek drainage in the Rogue Basin into the lake. Water is transported from Howard Prairie Lake via Howard Prairie Canal to its terminous at Keene Creek dam. Flows in Keene Creek are fed by releases from Hyatt Reservoir and combine with water from Howard Prairie Canal. Water leaves the Klamath Basin via Cascade Divide Tunnel.

For the 5-year period, 1961 through 1965, delivery to the Rogue Basin averaged 34,100 acre-feet per year under a water right providing 160 cfs. Over the same period, imports to Howard Prairie Lake averaged 15,700 acre-feet per year, leaving an average of 18,400 acre-feet per year actually exported from the Klamath Basin. Both storage facilities are located in the upper portion of the drainage area of Jenny Creek.

PART III

WATER USE AND CONTROL

WATER USE AND ASSOCIATED PROBLEMS

General

Irrigation, recreation, fish and wildlife propagation, and power production are the major uses of surface water in the Oregon portion of the Upper Klamath River Basin. Specific uses in the California portion are not discussed except under irrigation where the Klamath Project is considered as a whole.

Domestic, municipal, and industrial uses are vital to the economy of the basin but are small in relation to basin yield. The major use of water has been for irrigation, but emphasis on recreation and fish and wildlife uses recently has been increasing. Water used for power generation is of significance in evaluating water use in the basin. A short evaluation of geothermal uses is included because of its apparent potential. There is little or no use of surface or ground water for mining purposes.

The water use information supplied in this section generally represents present conditions and includes an estimate of the 1957 level of irrigation.

Domestic and Municipal

Domestic and municipal requirements, in the great majority, are supplied from ground water sources, according to Klamath County's "Water and Sewerage Comprehensive Plan Report," 1970. Most ground water supplies yield an abundant supply of relatively good quality water, but localized problem areas are beginning to appear.

Eight wells, owned by the Oregon Water Corporation, supply the city of Klamath Falls, Kingsley Field Air Force Base, and surrounding areas. The Henley area, a residential suburb southeast of Klamath Falls, is supplied mostly by private wells. It is likely that a community water supply and distribution system will be required within the next five to ten years.

The cities of Malin and Merrill have active programs, assuring them of continued adequate municipal water supply. Although the city of Bonanza is presently adequately supplied by private wells, the city has had the foresight to have an engineering investigation to determine its future water needs.

Because of low population densities and the availability of a satisfactory water supply, no foreseeable water problems within the next decade exist for the following unincorporated communities: Beatty, Beaver Marsh, Midland, Modoc Point, Odessa Creek-Rocky Point area, Olene, and the Worden area southwest of Fairhaven. The community of Dairy has no anticipated water problems within the next 10 to 20-year period.

Due to anticipated population growth, the need for community or district type water supply systems will probably occur within the next decade for the following unincorporated communities: Agency Lake, Chemult, Fort Klamath, Keno, Sprague River, and Wocus.

The city of Chiloquin and the unincorporated communities of Bly and Stewart Lennox are in urgent need of rehabilitating and expanding their water systems. However, all three have extremely limited local financial capability and may be unable to undertake adequate programs without outside assistance.

Development of surface water in the basin for domestic or municipal purposes is unlikely, due to water quality and attendant costs of treatment.

Table 31 summarizes available information on domestic and municipal water supplies for most of the major communities within the basin. Approximate individual daily uses for selected communities are tabulated below.

MUNICIPAL CONSUMPTIVE USE
(Gallons per capita per day)

COMMUNITIES	USE
1. Chiloquin	184
2. Klamath Falls	199
3. Altamont	200
4. Malin	225
5. Merrill	206

Industry

Industrial water use in the Klamath Basin amounts to about 23,000 acre-feet per year and is concentrated in Klamath Falls

TABLE 31

DOMESTIC AND MUNICIPAL WATER SUPPLY+

COMMUNITY	OWNERSHIP	POPULATION SERVED (APPROX.)	SOURCE	QUALITY*	TEMPERATURE (APPROX.)	TREATMENT	ANNUAL CONSUMPTION IN 1,000 GALS.	RESTRICTIONS ON USE	PLAN TO INCREASE SUPPLY
Beatty#	Individual	85	Wells	Soft	Cold	None	Unknown	None	No
Bly#	Bly Water Co.	400^x	1 Well	Soft	Cold	Clorox	Unknown	Summer shortage	No
Bonanza	Individual	230	Wells	Soft	52°	None	Unknown	None	No
Chemult#	Individual	180	Wells	Soft	46°	Chlorine	Unknown	Summer shortage	No
Chiloquin	Municipal	826	1 Well	Soft	50°	None	55,500	Summer shortage	No
Dorris	Municipal	1,000	2 Wells	Alkali	70°	Chlorine	Unknown	None	Additional well
Ft. Klamath#	Individual	220	Wells	Soft	Cold	None	Unknown	None	No
Keno#	Individual	200	Wells	Med. hard	Cold	None	Unknown	None	No
Klamath Falls & Altamont#	Oregon Water Co.	15,775 15,746	8 Wells	Soft	67°	Chlorine (2 wells)	2,300,256	None	No
Macdoel#	Macdoel Hotel Co.	125^x	1 Well	Med. hard	52°	None	Unknown	None	No
Malin	Municipal	486	2 Wells	Soft	48°	None	40,000	None	Additional well
Merrill	Municipal	722	2 Wells	Soft	70°	None	54,385	None	No
Sprague River#	Sprague River Water Assn.	100^x	1 Well	Soft	Cold	None	Unknown	None	No
Tulelake	Municipal	1,600	2 Wells	Soft	72°	None	110,259	None	No

\+ Most communities having commercial wells also have some private wells.

\# Unincorporated.

x Estimated.

* Fort Klamath and Macdoel wells yield traces of iron and hydrogen sulfide.

Data Source: SWRB

or its environs. The majority of this demand is supplied by wells, with minor surface water diversions supplying the remainder.

The largest user of water for industrial purposes is the Weyerhaeuser Company. Approximately 22,400 acre-feet is used annually at the company's wood products plant, which is supplied by three wells, a spring, and direct diversions from the Klamath River. Within the plant, water is used for wood processing, cooling, domestic purposes, and steam generation of electric power. This is the only steam generation plant in the basin.

Besides the wood products industry, water is used for the production of ice, dairy processing, sand and gravel processing, meat packing, and laundry establishments.

The majority of water diverted for industrial purposes is not consumed, and effluents from industries located within Klamath Falls are treated by the city's sewerage treatment facilities. The Weyerhaeuser plant provides filtration and aeration of their industrial wastes prior to discharge to the Klamath River.

Irrigation

The great majority of water consumed in the basin is for irrigation. On the 380,000 acres irrigated, about 908,000 acre-feet are required annually. Consumption is estimated to be about 496,000 acre-feet.

Irrigated lands in the basin are classed as surface irrigated or subirrigated in this report. Surface irrigated lands are those to which water is applied artificially and includes areas in which the ground water table is manipulated to supply water to crops. Subirrigated lands essentially are natural wetlands, such as the basin's extensive marshlands. High meadowlands grazed by livestock also are included in the sub-irrigated category where appropriate. About 269,000 acres are surface irrigated in the basin, with almost 111,000 being classed as subirrigated. The surface irrigated lands require 764,000 acre-feet annually, with consumption estimated to amount to almost 353,000 acre-feet per year. Subirrigated lands consume nearly 144,000 acre-feet per year. The above data are shown by study area in Table 32, Irrigated Area; Table 33, Estimated Mean Seasonal Water Requirement; and Table 34, Estimated Mean Seasonal Consumptive Use of Applied Water.

TABLE 32

IRRIGATED AREAS
KLAMATH BASIN
Thousands of Acres

STUDY AREA	IRRIGATED AREA											
	SWRB DATA (1957)				CALIF. BUL. 83 DATA				SCS DATA (Present)			
	Irr.	Sub. Irr.	Total Irr.	% of Total	Irr.	Sub Irr.	Total Irr.	% of Total	Irr.	Sub Irr.	Total Irr.	% of Total
1. Williamson River	24.2	80.3	104.5	24	10.2	50.8	61.0	21	23.9	48.2	72.1	19
2. Sprague River	24.4	45.8	68.2	16	15.1	21.9	37.0	13	22.6	29.4	52.0	14
3a. Wood River	38.4	22.3	60.7	14	32.7	8.0	40.7	14	38.0	11.3	49.3	13
3b. Upper Klamath Lake	13.1	10.5	23.6	5	9.3	1.7	11.0	4	12.2	9.1	21.3	6
4a. Swan Lake	9.5	1.8	11.3	3	7.3	0	7.3	2	11.0	1.0	12.0	3
4b. Lost River (Oregon only)	150.8	16.3	167.1	38	129.6	4.9	134.5	46	160.6	11.6	172.2	45
5. Klamath River (Oregon only)	0	0.7	0.7	-	0.1	-	0.1	-	1.1	0.1	1.2	-
TOTAL	258.4	177.7	436.1	100	204.3	87.3	291.6	100	269.4	110.7	380.1	100

Data Source: SWRB, USDA, SCS River Basin Survey Staff.

TABLE 33

ESTIMATED MEAN SEASONAL
WATER REQUIREMENT
KLAMATH BASIN
Acre-Feet

STUDY AREA	WATER REQUIREMENT		
	SURFACE IRRIGATION REQUIREMENT	SUB IRRIGATION REQUIREMENT	TOTAL
1. Williamson River	77,300	56,400	133,700
2. Sprague River	94,400	44,900	139,300
3a. Wood River	104,600	11,700	116,300
3b. Upper Klamath Lake	29,000	12,700	41,700
4a. Swan Lake	31,000	1,900	32,900
4b. Lost River	422,000	15,800	437,800
5. Klamath River	5,700	200	5,900
TOTAL	764,000	143,600	907,600

Data Source: USDA, SCS River Basin Survey Staff.

TABLE 34

ESTIMATED MEAN SEASONAL CONSUMPTIVE
USE OF APPLIED WATER
KLAMATH BASIN
Acre-Feet

STUDY AREA	CONSUMPTIVE USE					
	SURFACE IRRIGATED	% OF TOTAL	SUB IRRIGATED	% OF TOTAL	TOTAL IRRIGATED	% OF TOTAL
1. Williamson River	23,200	7	56,400	39	79,600	16
2. Sprague River	28,300	8	44,900	31	73,200	15
3a. Wood River	41,800	12	11,700	8	53,500	11
3b. Upper Klamath Lake	11,600	3	12,700	9	24,300	5
4a. Swan Lake	15,500	4	1,900	1	17,400	3
4b. Lost River	230,700	65	15,800	11	246,500	49
5. Klamath River	1,700	1	200	1	1,900	1
TOTAL	352,800	100	143,600	100	496,400	100

Data Source: USDA, SCS River Basin Survey Staff.

Bulletin No. 83, "Klamath River Basin Investigation," July 1964, contains data based on land use surveys conducted in 1953. Due to limited access to lands within the Klamath Indian Reservation during the study, the values published should not be considered conclusive. Later work was accomplished in the Reservation during the period of Compact ratification. Because of the impact on future development, an estimate of lands irrigated in 1957 within the Compact boundary in Oregon was considered necessary. Staff limitations, however, required that this effort be only a cursory examination and compilation of previously collected data. About 436,000 acres are estimated to have been irrigated in 1957. Of this amount, 258,000 are tabulated as surface irrigated, with almost 178,000 acres being subirrigated. The results of this estimate are shown on Plate 3, and values are presented in Table 32. Bulletin No. 83 data shows a total of about 292,000 acres being irrigated in 1953.

Differences between values tabulated as "Present" and "1957" are due primarily to differing data interpretation techniques utilized by the performing agencies. Variation in subirrigated areas is a function of water table elevation and can differ substantially, depending on annual precipitation. The tabulated 1957 values also were not adjusted to allow for exclusions of land use for nonagricultural purposes such as roads, railroads, farmsteads, etc. No significant decreases in irrigated acreage over the long term are apparent.

Of the 380,000 acres presently irrigated, about 63 percent is utilized for pasture. Alfalfa is produced on 19 percent, with hay and grain accounting for 15 percent. Potatoes were grown on only 2 percent of the basin's irrigated land. Normal crop rotations would modify these values somewhat, varying with the particular year in which data were collected. Table 35, Estimated Present Water Service Areas, contains the above data, presented by study area.

Estimated Mean Seasonal Unit Values of Consumptive Use are presented in Table 36. The total seasonal consumptive use value for crops noted varies throughout the basin, due to differences in climatic and soil conditions. The most extreme example of this is alfalfa, which varies from as low as 1.7 feet per acre in the Williamson drainage to as high as 2.7 feet per acre in the Lost River drainage. Effective precipitation occurring during the growing season supplies some of the needed water for plant growth. Thus, the required applications for irrigation are somewhat less than the total consumptive use of the plant. Effective precipitation is that

TABLE 35

ESTIMATED PRESENT WATER
SERVICE AREAS (1969-70)
KLAMATH BASIN
Acres

STUDY AREA	WATER SERVICE AREAS								
	Alfalfa	Pasture			Grain Harvested and Hay	Grass Seed	Potatoes	Total Net Irrigated	
		Improved	Marginal	Meadow					
1. Williamson River	4,000	17,400	12,500	35,700	2,000	-	500	72,100	19%
2. Sprague River	2,100	17,600	3,600	25,800	2,900	-	-	52,000	14%
3a. Wood River	200	46,400	2,500	-	200	-	-	49,300	13%
3b. Upper Klamath River	1,000	7,700	-	9,100	1,400	2,000	100	21,300	6%
4a. Swan Lake	4,200	2,000	-	1,000	4,600	-	200	12,000	3%
4b. Lost River (Oregon only)	59,700	40,800	10,500	3,800	47,100	1,500	8,800	172,200	45%
5. Klamath River (Oregon only)	-	1,100	-	100	-	-	-	1,200	-
TOTAL	71,200	133,000	29,100	75,500	58,200	3,500	9,600	380,100	
% of Net Irrigated	19	35	8	20	15	1	2	100	

Data Source: USDA, SCS River Basin Survey Staff.

TABLE 36

ESTIMATED MEAN SEASONAL UNIT VALUES
OF CONSUMPTIVE USE, KLAMATH BASIN
Feet per Acre

STUDY AREA	ALFALFA			IMPROVED PASTURE			CLOVER			HAY AND GRAIN			POTATOES			GRASS SEED		
	Applied Water	Precipitation	Total	Applied Water	Precipitation	Total	Applied Water	Precipitation	Total	Applied Water	Precipitation	Total	Applied Water	Precipitation	Total	Applied Water	Precipitation	Total
1. Williamson River	0.9	0.8	1.7	1.0	0.9	1.9	0.8	0.9	1.7	0.8	0.7	1.5	1.1	0.6	1.7	-	-	-
2. Sprague River	1.2	0.8	2.0	1.3	0.9	2.2	1.1	0.8	1.9	1.0	0.7	1.7	-	-	-	-	-	-
3. Upper Klamath Lake	1.1	0.8	1.9	1.1	0.8	1.9	-	-	-	0.9	0.7	1.6	1.1	0.6	1.7	0.3	0.8	1.1
4. Lost River	1.8	0.9	2.7	1.5	0.9	2.4	1.5	0.9	2.4	1.0	0.6	1.6	1.3	0.7	2.0	0.3	0.8	1.1
5. Klamath River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Data Source: USDA, SCS River Basin Survey Staff.

which reaches the plant and does not equal total precipitation recorded for the growing season.

Irrigation efficiencies vary throughout the basin. In the study areas upstream of Upper Klamath Lake, efficiencies are about 30 percent. A significant portion of the acreage is irrigated by wild flooding when water is available from streamflows. In the Klamath Project or Lost River study area, because of more sophisticated equipment and techniques, on-farm irrigation efficiency is about 55 percent. Significant quantities of land are being converted from gravity to sprinkler irrigation methods. As a consequence, on-farm efficiencies will continue to improve.

Table 37 presents the major water districts in the Oregon portion of the basin.

TABLE 37

MAJOR WATER DISTRICTS
KLAMATH BASIN IN OREGON

IRRIGATION DISTRICTS	IRRIGABLE ACREAGE
Enterprise	2,981
Horsefly	10,250
Keno	4,113
Klamath	39,798
Langell Valley	22,000
Malin	3,452
Modoc Point	5,200
Pine Grove	523
Shasta View	4,048
Sunnyside	595
Upper Klamath Lake Contractors	7,904
Van Brimmer Ditch Co.	4,083
Willow Valley	2,117
DRAINAGE DISTRICTS	**ASSESSED ACREAGE**
Klamath	24,817
Lakeshore Gardens	96
Meadows	22,851
Upper Van Brimmer	1,121
Wocus	3,176
DISTRICT IMPROVEMENT COMPANIES	**IRRIGABLE ACREAGE**
Ady	435
Emmitt	424
Klamath Basin	10,282
Midland	581
Plevna	523
Poe Valley	2,636
Wood River	2,150

Data Source: State Engineer, U. S. Bureau of Reclamation.

The Klamath Project as a whole, however, is extremely efficient from the point of view of water use. Table 30, Page 90, Summary of Lands Benefited by Project Works, shows about 154,000 acres in Oregon. The amount supplied to the entire Project, both in Oregon and California, over the period 1951-1967 averaged 368,000 acre-feet per season. The average consumption over this period amounted to about 328,000 acre-feet, for an efficiency of about 89 percent. The consumption value includes evaporation and seepage losses in the distribution system and from Tule and Lower Klamath Lakes. These losses are considered to be significant values.

Conflicts have existed in the past in regard to operation of Tule Lake. This body of water serves as a waterfowl refuge and as a sump and regulating facility for irrigation. Adequate capacity to discharge flows from Lower Klamath Lake and from lands irrigated in that area does not exist. The need to remove water from Lower Klamath Refuge and adjacent project areas occurs at about the same part of the season. As a result, opportunities to manage the refuges to their maximum potential have been limited. However, improved drainage facilities are planned.

Hydroelectric Power

There are three hydroelectric powerplants in the basin. A license has been obtained from the Federal Power Commission and State Engineer for a fourth plant. The Eastside and Westside plants are along the Link River between Upper Klamath Lake and Lake Ewauna. The John C. Boyle plant is on the Klamath River about nine miles downstream from Keno. The licenses allow construction of a plant at Keno Dam sometime in the future.

Out-of-basin powerplants that use water directly from the basin are Copco Numbers 1 and 2 on the Klamath River in California and Greensprings on Emigrant Creek in the Rogue Basin. This plant uses water from the interbasin diversion from Howard Prairie Lake and Hyatt Reservoir.

Two in-basin plants have "power claims" established prior to May 1905. These amount to 150 cfs and 205 cfs for the Eastside and Westside plants, respectively. Subsequent claims for these and other plants are subject to two contracts between the U. S. Bureau of Reclamation and Pacific Power and Light Company.

A renegotiated contract dated January 31, 1956, with a term of 50 years, between the United States (U. S. Bureau of Reclamation) and Pacific Power and Light Company (previously the California Oregon Power Company), the present owners of the plants, specifies that the power company may regulate the water level of Upper Klamath Lake between elevations 4143.3 and 4137 (Reclamation Service datum). Without express permission from the Bureau of Reclamation, the limits may not be exceeded. The contract further specifies that the Bureau of Reclamation may set a higher minimum elevation than 4137 in order to protect irrigation and reclamation requirements of project lands. The contract also provides for favorable power rates for irrigation.

The above material is summarized in Table 38, General Data, Hydroelectric Plants on the Klamath River.

TABLE 38

GENERAL DATA
HYDROELECTRIC PLANTS ON THE
KLAMATH RIVER

PLANT	STREAM	POWER CLAIM CFS	GROSS STATIC HEAD FEET	INSTALLED CAPACITY KW
Eastside	Link River	1,150	49	3,200
Westside	Link River	205	48	660
*Keno	Klamath River	5,000	270	NA
John C. Boyle	" "	2,500	463	80,000
COPCO No. 1	" "	3,750	125	20,000
COPCO No. 2	" "	3,750	152	27,000

* Licensed but not constructed.

Data Source: U. S. Bureau of Reclamation, Federal Power Commission, State Engineer.

Except for water rights prior to 1905, the power company may not use water for power generation that is required by the United States for waterfowl conservation in quantities utilized, as of the effective date of the contract. Damages resulting from operation of the Link River Dam or regulation and control of water level in Upper Klamath Lake are a liability of the power company.

The power claim at Keno, also held by Pacific Power and Light Company, is regulated by an additional Federal contract.

Recreation

Water-based recreation activities consist of lake fishing, boating, water skiing, and swimming. All or some of these may be accomplished on major streams in the basin, on the high mountain lakes, Upper Klamath Lake, and Lake Ewauna. Interest in recreational use on Upper Klamath Lake has increased significantly in recent years, but data enumerating actual use are not available.

Two problems impede utilization of the entire lake surface for recreation. The first is the natural configuration of the lake, which averages only 10 feet in depth. A small area between Eagle Ridge and Bare Island is about 40 to 50 feet deep, but a significant portion has a depth of less than 10 feet. Consequently, fluctuations in lake level cause large changes in water surface area.

Average end of month water surface areas during the period 1951 through 1967 vary from a maximum of 89,500 acres in May to a minimum of 71,400 acres in September. The decrease in surface area, slightly over 18,000 acres, occurred as the level of the lake decreased less than three feet. For the period 1929 through 1944, like data show a maximum average area of 87,200 acres in May and a minimum average 62,900 acres in October. The difference in area, over 24,000 acres, is the result of a decrease in lake level of a little over 2½ feet. The two periods are considered representative of a relatively wet period, 1951 through 1967, versus a relatively dry period, 1929 through 1944. Fluctuations during the dry period would probably be more severe under present levels of development. Average end of month areas are illustrated in Figure 27.

Lake levels are fluctuated within contract limits in response to the needs of irrigation on Klamath Project lands, requirements for power generation, and minimum fish flows at downstream power generation plants. Maintenance of maximum water surface elevation in the lake would require reduction of releases for those purposes and also would result in an increase in evaporation losses from the larger water surface area.

The second problem is one of aesthetics caused by algal blooms during the recreation season. Surface inflows to the lake are rich in nutrients and organic matter. The majority of nutrients present in the lake inflows are from natural sources, although irrigation return flows contribute minimal amounts. The majority of organic matter enters the lake from marshlands via the Williamson River. These constituents have been present for many years and coupled with deposits of dead tule on the lake bed, provide an environment ideally suited to the proliferation of these algal blooms.

Fish and Wildlife

The Oregon State Game Commission has provided recommended minimum flows at various locations in the basin. These are summarized in Table E in the Appendix. The recommendations

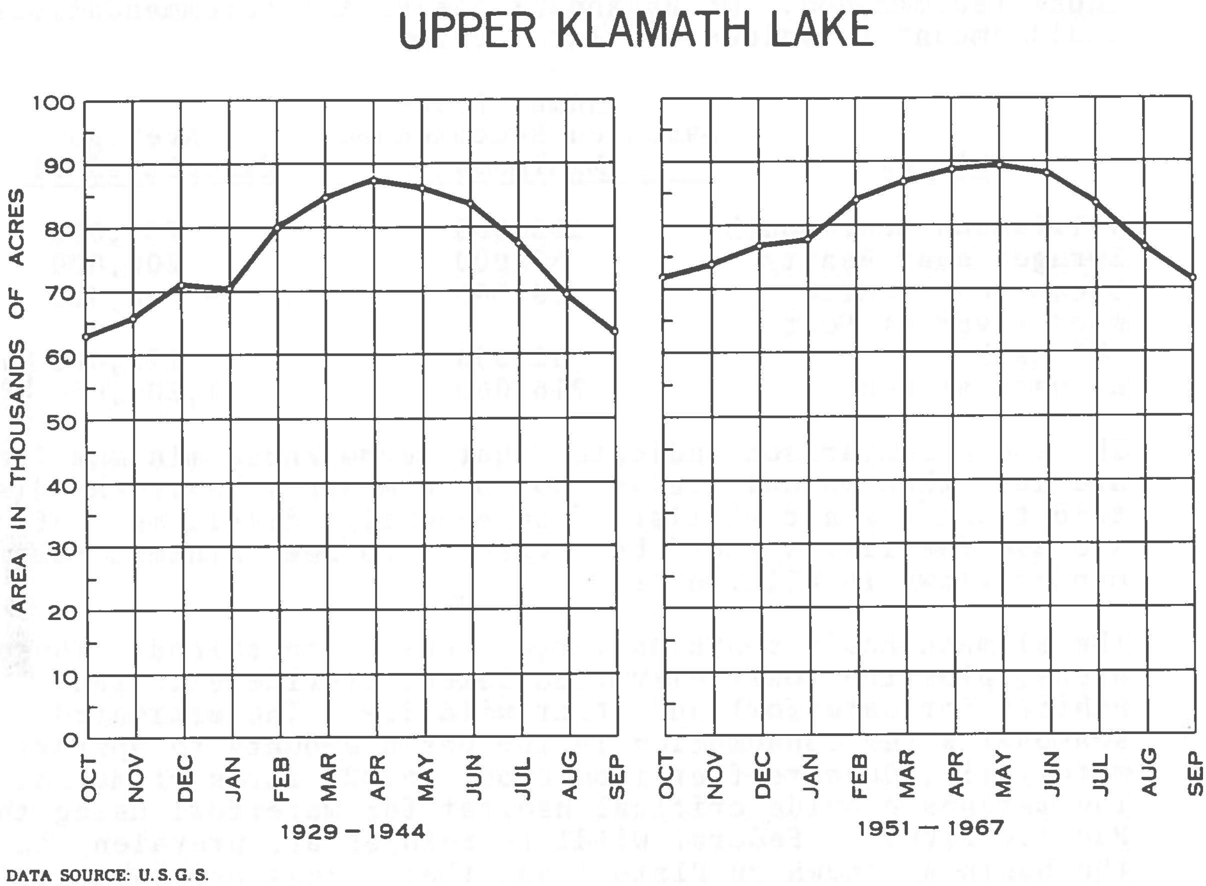


FIGURE 27. Average End of Month Areas - Upper Klamath Lake.

require a much lesser variation in monthly distribution than is normally present in streams above Upper Klamath Lake.

Streams in which zero flow has been recorded or observed are the Sycan River, the Williamson River above Spring Creek, and the upper reaches of the Sprague River. Other streams in the basin have experienced instantaneous minimum flows lower than those recommended. On an annual basis, the recommendations would amount to values tabulated below:

Stream	Annual Flow Based on Recommended Minimums	Average Calculated Flows
Williamson near mouth	192,000	751,000
Sprague near Beatty	62,000	200,000
Sycan near Beatty	29,000	90,000
Wood River at Fort Klamath	52,000	172,000
Klamath at Keno	216,000	1,206,000

The above comparison indicates that recommended minimum flows are less than annual yields, but on a monthly basis the distributions are not similar. Consequently, development of storage facilities would be necessary to meet minimum recommended flows in all months.

The Klamath Basin contains large areas of marshland. These areas, plus the lower elevation lakes, provide excellent habitat for waterfowl and other wildlife. The estimated seasonal water consumption in the basin amounts to approximately 130,000 acre-feet from about 36,000 acres of marsh. The marshes provide critical habitat for waterfowl using the Pacific Flyway. Federal wildlife refuges are prevalent in the basin as shown on Plate 1, and their areas are tabulated below.

FEDERAL WILDLIFE REFUGES

	Area (Acres)
Lower Klamath	22,800
Clear Lake	33,500
Tule Lake	37,000
Upper Klamath	12,700
Klamath Forest	15,200
Total	121,200

Table 39, Estimated Present Water Surface Areas and Mean Season Requirements, presents these data by study area.

TABLE 39

ESTIMATED PRESENT WATER SURFACE AREAS AND MEAN SEASONAL REQUIREMENTS

STUDY AREAS	SURFACE AREAS		REQUIREMENT	
	MARSH ACRES	PRINCIPAL RESERVOIRS AND LAKES ACRES	MARSH AC-FT	PRINCIPAL RESERVOIRS AND LAKES AC-FT
1. Williamson River	12,600	16,000	45,400	57,700
2. Sprague River	7,600	650	27,400	2,300
3a. Wood River	13,000	9,500	46,800	34,200
3b. Upper Klamath Lake	1,400	62,600	5,000	225,400
4a. Swan Lake	-	1,300	-	5,000
4b. Lost River	1,600	9,200	5,800	33,100
5. Klamath River	-	3,620	-	13,000
TOTAL	36,200	102,870	130,400	370,700

Data Source: USDA, SCS River Basin Survey Staff.

Upper Klamath and Sycan Marshes also sustain large populations of a variety of species of bird and small animal life. These are extremely important areas from a biological point of view, in that they provide habitat and are the generating points for food webs that affect wildlife throughout the entire basin. Although these marshes consume a large amount of water, consideration should be given to their value before any large-scale reclamation projects are undertaken. The principal lakes and reservoirs that sustain large water-oriented recreational use and provide habitat for waterfowl propagation are also relatively large water users.

Upper Klamath Lake loses approximately 225,000 acre-feet of water in evaporation when its surface area is 63,000 acres. Hence, the demand for large surface water areas for recreational and wildlife use results in a direct consumption of water.

WATER USE AND CONTROL

Geothermal Energy

Geothermal energy was first used to generate electricity in Italy in 1904. Natural steam powerplants also operate in New Zealand, Japan, Russia, Mexico, and in The Geysers area 85 miles north of San Francisco. Iceland has long made large-scale use of natural hot water for heating residential and other buildings. Many other countries of the world are presently engaged in exploring and developing their geothermal resources.

Much of the following data on the two thermal zones is abstracted from publications of the State Department of Geology and Mineral Industries.

The city of Klamath Falls has for many years used hot water wells to heat structures situated within the boundaries of its thermal zone. As of 1970, approximately 350 thermal wells have been drilled, mostly for space-heating requirements of more than 450 residences, a number of apartments, seven schools, several businesses and commercial firms, and the Oregon Technical Institute. The city school system saves an estimated $22,500 annually in heating costs by using thermal wells.

The Klamath Falls thermal zone trends northwesterly and encompasses what is presently the northeast portion of the city. A fault along the east side of the zone likely provides the conduit for the rise of the hot ground water from depth. Present knowledge shows that water hotter than 140 degrees F. extends from the Oregon Technical Institute campus in the northwest part of the zone to the Mazama School in the southeast, a distance of about 4.5 miles. Temperatures of the thermal wells, 100 to 1,800 feet deep, range from 140° F. to 235° F. A broad area of warm water extends beyond the hot wells.

Several ranchers in the Klamath Hills thermal zone use the hot water for irrigation purposes, after ponding the water several days to allow cooling. At least one sand and gravel processor uses the hot water to wash aggregate and finds it superior as a cleaning agent.

The Klamath Hills thermal zone is about 10 miles south of the Klamath Falls zone and has a similar geologic environment. It trends northwesterly along the west escarpment of the fault block forming the Hills, is narrow and about 4 miles long. Large volumes of 200° F. water are encountered by wells of shallow depths. It is likely that the thermal zone extends for some distance southward beneath the alluvium of Lower Klamath Lake Basin.

WATER CONTROL

Flood Control

The occurrence of flooding within the Klamath Basin is widespread, ranging from annual over-bank flooding along the Sprague River and Fishhole Creek to rare occurrences of over-bank flooding along the Klamath River between Klamath Falls and Keno. Flooding in the basin occurs from two causes, rapid spring snowmelt and severe winter storms. The most severe floods that have occurred in the basin in recent times are those due to the winter storms of December 1955 and December 1964, the most severe in recent times. Major floods within the basin are generally of short duration, with over-bank flooding in intervals of 24 to 48 hours in length.

Damages reported due to the 1964 flood are tabulated below.

APPROXIMATE 1964 FLOOD DAMAGES

Timber and Rangeland Damage	$ 722,000
Agricultural Damage	2,000,000
Industrial Damage	100,000
Commercial Facility Damage	100,000
Flood fighting, rescue operations, and repair of flood control works	400,000

The land inundated due to over-bank flooding was reported to be approximately 67,600 acres. Flooded areas were along the Sprague River, Fishhole Creek, lower Williamson and Wood Rivers, and along the Klamath River between Klamath Falls and Keno. Several campgrounds and recreational sites were damaged, especially along the Sprague River.

Minor flooding occurs annually in the upper Sprague River Valley along Fishhole Creek and the South Fork Sprague River. Damage primarily occurs from loss of agricultural production with some localized municipal and industrial damage.

Erosion and Sedimentation

Damages resulting from erosion and sedimentation are significant within the basin, although somewhat difficult to evaluate.

Within the Oregon portion of the Upper Klamath River Basin, over 73 percent of the land area is subject to severe erosion hazard potential. Moderate erosion hazard potential is present in soils comprising 11 percent of the basin area.

Some erosion and sedimentation occurs, due to geologic causes and is the natural degradation of the earth's crust. The largest areas subject to geologic erosion lie within the National Forest boundaries, and resulting sedimentation generally does not reach major drainage systems.

Serious erosion and sedimentation problems have been caused by logging and road building practices which have not provided for soil stabilization. Some of these practices have eliminated vegetative cover from much of the volcanic ash and pumice type soils, which when exposed or disturbed are highly susceptible to erosion. Improper farming methods, overgrazing of rangeland, and poor water management also have been responsible for erosion. The resulting sedimentation deposits have caused problems in irrigation structures, canals, waterways, and reservoirs and accelerate the eutrophication process in streams and lakes. Many salts and nutrients, especially phosphorous, are added to surface water. These salts and nutrients are contained in the soils and are dissolved during heavy sediment loading.

Sedimentation also causes some damage to game fish habitat and spawning areas.

Drainage

Approximately 10 percent of the land area in the basin has major drainage problems, due mainly to high ground water tables. In some areas irrigation has resulted in raising the ground water table to within the root zone of normally well-drained soils. Marshlands have been drained by diking and reclaimed for agricultural use, with significant concentrations around Upper Klamath Lake and within the old lakebed of the Lower Klamath Lake. Pastureland has been improved to a limited extent in the Sprague and Sycan valleys.

Pollution

Pollution from domestic, municipal, and industrial waste discharges are concentrated mainly in Lake Ewauna and Klamath River downstream to Keno. Domestic and municipal wastes from

Klamath Falls and surrounding suburban areas and discharges from industrial plants have caused water quality degradation in the reach. However, in relation to the quality of water discharged from Upper Klamath Lake, the added pollutants are of secondary importance.

Elimination of a major source of pollution in the Klamath River is being accomplished by various lumber companies by relocation of their log storage operation from the river to a dryland decking and sorting system. These companies, in accomplishing this task, have also removed some sunken logs, bark, and other residue. Presently, log storage in the reach from Klamath Falls to Keno has been reduced by more than 50% and will be further reduced within the next two years.

In the drainage to Upper Klamath Lake, the contribution of dissolved salts and nutrients, due to irrigation return flows, is minor compared to the natural contribution. Constituents from both sources add to the eutrophication process in Upper Klamath Lake.

In the lower Lost River drainage, return flows of the Main and Tule Lake Divisions of the Klamath Project contribute heavily to the nutrient and alkalinity problems in Tule and Klamath Lakes and Klamath Strait Drain.

There is also a substantial thermal pollution problem in this area, partly contributed by the irrigation return flows and by the many warm-water springs that make up the Lost River flow along its lower drainage. Due to the increasing use of the geothermal resource in Klamath Falls and the Lower Lost River drainage area, thermal pollution may become a more substantial water quality problem in the future.

PART IV

AVAILABLE RESOURCE AND DEVELOPMENT POTENTIAL

Previous sections of the report have dealt with water supply and water use and control. This section will present estimates of the water supply available to meet needs of the development potential in the basin. Under the Compact, priority of right is assigned to domestic and irrigation uses.

The major consumptive use of water in the basin both presently and in the foreseeable future is for irrigation. Compared thereto, consumptive use water requirements for industrial, domestic, and municipal development, although vital to the basin's economy, will be insignificant. Consequently, development potential in the basin can be defined in terms of irrigation requirements compared to water supply. Although regulation of the flood waters of the upper Lost River watershed is needed, the primary source of surface water available for further development in the basin are the inflows to Upper Klamath Lake. This body of water can be considered as a "central reservoir" for scoping development potential. Inflows to Upper Klamath Lake are estimated during a simulated wet and dry period based on previous occurrence. The estimates are shown below and would be available for future development and to meet downstream demands on flows in the Klamath River:

a. Wet period (similar to 1951-67 period)
   The available resource above present levels of development and consumptive uses is approximately 1,150,000 acre-feet annually.

b. Dry period (similar to 1929-44 period)
   The available resource above present levels of development and consumptive uses is approximately 530,000 acre-feet annually.

The above values have been adjusted to take into account present demands and uses within the basin, including present levels of evapotranspiration from wildlife refuges and marshes and net evaporation from the lake surface. They do not take into account present downstream demands such as power generation along the Klamath River.

In assigning superior priority to irrigation use, the Compact established a limitation on the additional acreage that could be developed under this priority after its effective date. This limitation is 300,000 acres, of which 200,000 acres is assigned to the Oregon portion of the basin and 100,000 acres assigned to the California portion. Hence, including the estimated 1957 level of development of 258,000 acres, a total of about 458,000 acres could be irrigated in Oregon, with superior water rights under the Compact.

The U. S. Department of Agriculture, in its "Klamath Basin Survey" report, estimates the total irrigable acreage within the Oregon portion of the basin to be about 984,000 acres. The distribution of this acreage is shown in Figure 28, with evaluation by suitability in Table 40, Estimated Irrigation Suitability.

TABLE 40

ESTIMATED IRRIGATION SUITABILITY
KLAMATH BASIN 1970

GROUP	DESCRIPTION	AMOUNT ACRES
Excellent	Soils with only slight limitation	42,500
Good	Soils with only moderate limitations	148,200
Fair	Soils with two or more deficiencies of moderate degree	759,300
Poor	Soils with severe limitations	34,600
	Total potentially irrigable land	984,600
Very Poor or Nonirrigable	Soils with very severe limitations considered as nonirrigable	2,532,800
Presently Irrigated Land	Land now developed for irrigation	380,000
	Total land area	3,517,500
	Water area	115,600
	Total Basin	3,633,100

Data Source: USDA, SCS River Basin Survey Staff; Appendix I-14, Oregon's Long-Range Requirements for Water, SWRB.

Irrigable land is available to achieve the total acreage that may be irrigated with superior rights.

Development of the additional 300,000 acres of land for irrigation in both Oregon and California would consume an additional 400,000 acre-feet annually. This estimate is based on present unit rates of consumption for irrigation.

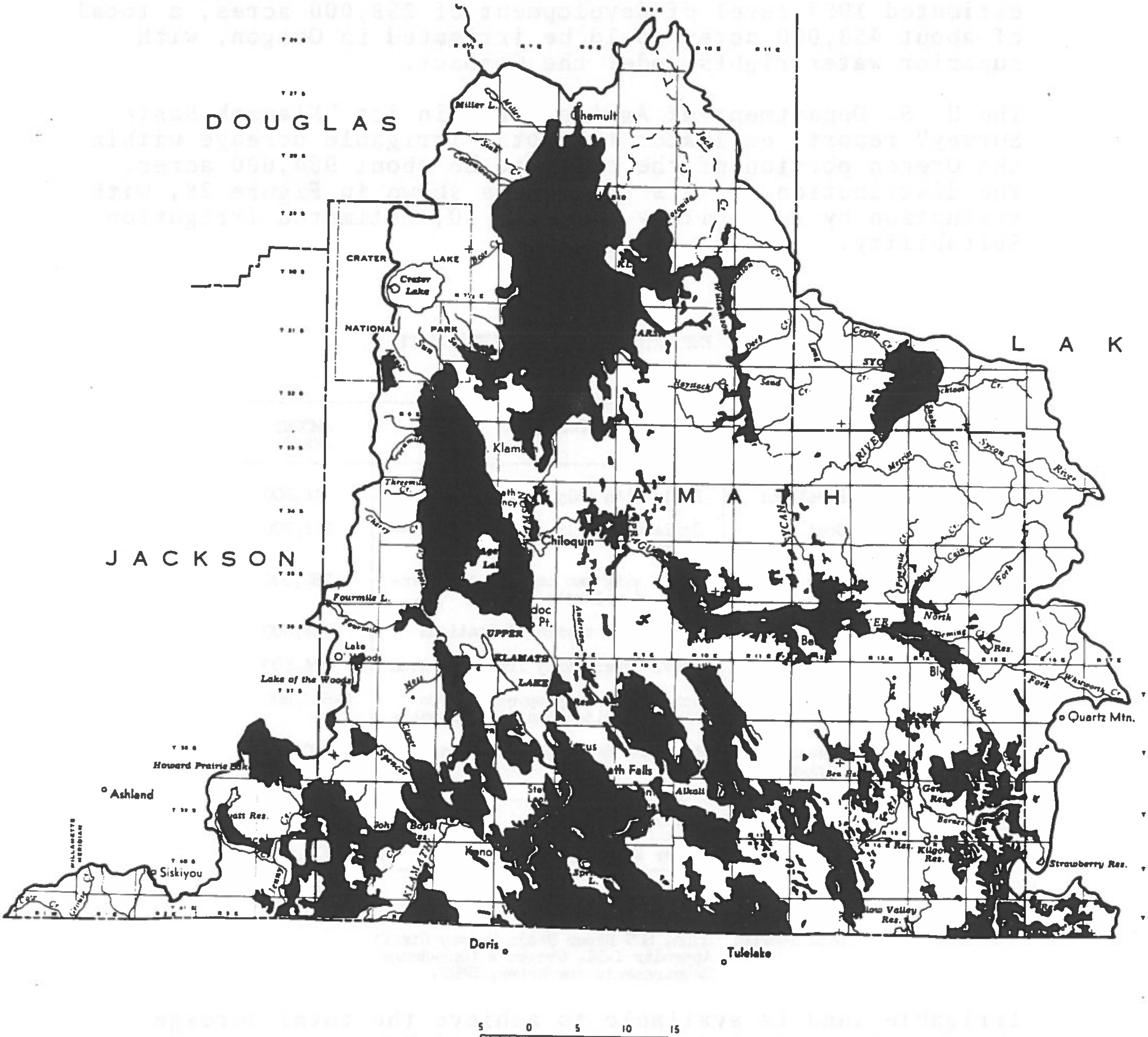


FIGURE 28. *Irrigable Land.*

Flows in the Klamath River would be reduced by that amount if return of all waste waters to the Klamath River, near Lake Ewauna, were accomplished and would reduce flows out of the basin by that amount.

During the wet period, about 750,000 acre-feet annually or about 62 percent of present outflows would be available for other uses, both in the basin and downstream. During the dry period, only 130,000 acre-feet annually or 11 percent would be surplus to irrigation needs. Consequently, storage capacity sufficient to regulate annual runoff on a cyclic basis would be necessary to achieve major additional development of irrigation. No economic data are developed by this study on the feasibility of such large storage facilities. However, previous studies have shown that adequate on-stream storage sites are limited, both by site geology and/or water supply.

A large volume of ground water appears to be available. If borne out by more detailed ground water investigations, this resource should be considered in future development plans for the basin. Although it would appear that the Compact limits development only from surface water supply, depletion of ground water to the extent that it would adversely affect streamflow might be found to violate the terms of the Compact. This point should be clarified, since it poses a possible limitation on the extent of ground water development. Regardless of the legal determination, more detailed information on recharge capability and the relationship of source of recharge to specific ground water aquifers should be developed. Conceivably, utilization of the ground water resource for development of irrigation might allow some use of surface waters of the basin for providing adequate fish flows for management of upper basin wildlife refuges and for improved operation of Upper Klamath Lake for recreation purposes, as well as for aesthetic purposes throughout most basin streams.

AVAILABLE RESOURCE AND DEVELOPMENT POTENTIAL

Flows in the Klamath River would be reduced by that amount [illegible] return of [illegible] waste waters to the Klamath River. [illegible] Lake [illegible] were accomplished and would reduce flows out of the basin by that amount.

During the [illegible] period, about 350,000 acre-feet annually [illegible] percent of [illegible] would be available [illegible] both in the basin and downstream. During the [illegible] period, only 700,000 acre-feet annually, [illegible] would be required for irrigation needs. Consequently, storage [illegible] to regulate [illegible] would be necessary to [illegible] additional development [illegible] irrigation. [illegible] land are developed [illegible] however, [illegible] have shown that [illegible] water [illegible].

[illegible] ground water [illegible] should be continued [illegible] the basin. Although [illegible] ground water [illegible] [illegible] as well as for [illegible].

APPENDIX I

AUTHORITY

The authority for the preparation and presentation of this report is set forth in ORS 536.300. The Legislative Assembly recognizes and declares in ORS 536.220 (1) that:

"(a) The maintenance of the present level of the economic and general welfare of the people of this state and the future growth and development of this state for the increased economic and general welfare of the people thereof are in large part dependent upon a proper utilization and control of the water resources of this state, and such use and control is therefore a matter of greatest concern and highest priority.

"(b) A proper utilization and control of the water resources of this state can be achieved only through a coordinated, integrated state water resources policy, through plans and programs for the development of such water resources and through other activities designed to encourage, promote and secure the maximum beneficial use and control of such water resources, all carried out by a single state agency.

"(c) The economic and general welfare of the people of this state have been seriously impaired and are in danger of further impairment by the exercise of some single-purpose power or influence over the water resources of this state or portions thereof by each of a large number of public authorities, and by an equally large number of legislative declarations by statute of single-purpose policies with regard to such water resources, resulting in friction and duplication of activity among such public authorities, in confusion as to what is primary and what is secondary beneficial use or control of such water resources and in a consequent failure to utilize and control such water resources for multiple purposes for the maximum beneficial use and control possible and necessary."

The authority for the report, the study on which it is based, and the actions effected are specifically delegated to the State Water Resources Board in ORS 536.300 (1) and (2) which state:

"(1) The board shall proceed as rapidly as possible to study: existing water resources of this state; means and methods of conserving and augmenting such water resources; existing and contemplated needs and uses of water for domestic, municipal, irrigation, power development, industrial, mining, recreation, wildlife, and fish life uses and for pollution abatement, all of which are declared to be beneficial uses, and all other related subjects, including drainage, reclamation, flood plains and reservoir sites."

"(2) Based upon said studies and after an opportunity to be heard has been given to all other state agencies which may be concerned, the board shall progressively formulate an integrated, coordinated program for the use and control of all the water resources of this state and issue statements thereof."

Within the limits of existing data and knowledge, the study has taken into full consideration the following declarations of policy under ORS 536.310:

"(1) Existing rights, established duties of water, and relative priorities concerning the use of the waters of this state and the laws governing the same are to be protected and preserved subject to the principle that all of the waters within this state belong to the public for use by the people for beneficial purposes without waste;

"(2) It is in the public interest that integration and coordination of uses of water and augmentation of existing supplies for all beneficial purposes be achieved for the maximum economic development thereof for the benefit of the state as a whole;

"(3) That adequate and safe supplies be preserved and protected for human consumption, while conserving maximum supplies for other beneficial uses;

"(4) Multiple-purpose impoundment structures are to be preferred over single-purpose structures; upstream impoundments are to be preferred over downstream impoundments. The fishery resource of this state is an important economic and recreational asset. In the planning and construction of impoundment structures and mill dams and other artificial obstructions, due regard shall be given to means and methods for its protection;

"(5) Competitive exploitation of water resources of this state for single-purpose uses is to be discouraged when other feasible uses are in the general public interest;

"(6) In considering the benefits to be derived from drainage, consideration shall also be given to possible harmful effects upon ground water supplies and protection of wildlife;

"(7) The maintenance of minimum perennial streamflows sufficient to support aquatic life and to minimize pollution shall be fostered and encouraged if existing rights and priorities under existing laws will permit;

"(8) Watershed development policies shall be favored, whenever possible, for the preservation of balanced multiple uses, and project construction and planning with those ends in view shall be encouraged;

"(9) Due regard shall be given in the planning and development of water recreation facilities to safeguard against pollution;

"(10) It is of paramount importance in all cooperative programs that the principle of the sovereignty of this state over all the waters within the state be protected and preserved, and such cooperation by the board shall be designed so as to reinforce and strengthen state control;

"(11) Local development of watershed conservation, when consistent with sound engineering and economic principles, is to be promoted and encouraged; and

"(12) When proposed uses of water are in mutually exclusive conflict or when available supplies of water are insufficient for all who desire to use them, preference shall be given to human consumption purposes over all other uses and for livestock consumption, over any other use, and thereafter other beneficial purposes in such order as may be in the public interest consistent with the principles of this Act under the existing circumstances."

BIBLIOGRAPHY

I. KLAMATH BASIN - GENERAL

1971 - Oregon Blue Book, Secretary of State (Current year)

1970 - The Klamath County Manpower Resource Study, State Employment Division

Public Land Statistics, U. S. Department of the Interior, Bureau of Land Management (Current year)

1968 - Federal Outlays in Oregon, U. S. Office of Economic Opportunity (Current year)

Fifth Long-Range Planning Conference, Klamath County Planning Conference

Oregon Employment and Payrolls by Industry and County, State Department of Employment, Research & Statistics Division (Current year)

Timber Harvest by Ownership in the State of Oregon, U. S. Department of Agriculture, Forest Service (Current year)

1967 - BLM Facts, Oregon and Washington, U. S. Department of the Interior, Bureau of Land Management (Current year)

Community Planning in Oregon / A List of Publications, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

Issues in the Community / An Annotated Bibliography of Selected Community Problems in Oregon, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

Population Bulletin, State Board of Higher Education, Portland State University, Center for Population Research & Census

Summary of Federal Programs - Oregon, U. S. Office of Economic Opportunity

1966 - Pacific Northwest Economic Base Study for Power Markets, Volume II, Part 1 - Population, U. S. Department of the Interior, Bonneville Power Administration

BIBLIOGRAPHY

KLAMATH BASIN - GENERAL (Continued)

1965 - Certificate of Population / Enumerations and Estimates of Incorporated Cities and Counties of Oregon, State Board of Higher Education, Portland State University, Center for Population Research & Census

1965 - Revenue Sources of Oregon Counties, 1963-64 / Information Bulletin No. 147, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

1964 - Census of Agriculture, U. S. Department of Commerce, Bureau of the Census

Oregon Comprehensive Statewide Planning Study / Summary Report, State Department of Commerce, Division of Planning and Development

Pacific Northwest Economic Base Study for Power Markets, Volume II, Part 4 - Personal Income by Counties, 1950-1961, U. S. Department of the Interior, Bonneville Power Administration

Property Tax Levies in Oregon Counties / Information Bulletin No. 143, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

1963 - Climate of Crater Lake National Park, Crater Lake Natural History Association, National Park Service

Klamath Falls Urban Area Development Plan, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

Planning by Local Government in Oregon, State Department of Commerce, Division of Planning and Development

Summary Development Plan, Klamath Falls Urban Area, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

Temperature and the Water Balance for Oregon Weather Stations / Special Report 150, State Board of Higher Education, Oregon State University, Agricultural Experiment Station

KLAMATH BASIN - GENERAL (Continued)

1961 - Estimating Dates for Low Temperatures in Oregon / Station Bulletin 581, State Board of Higher Education, Oregon State University, Agricultural Experiment Station

Land Use in 33 Oregon Cities / Planning Bulletin No. 2, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

1960 - A Bibliography of Klamath Basin Anthropology with Excerpts and Annotations, Swartz, B. K., Klamath County Museum Research Papers

Agriculture in Oregon, State Department of Agriculture

Census of Population, U. S. Department of Commerce, Bureau of the Census

Climatic Summary of the United States, 1951-1960, U. S. Department of Commerce, Weather Bureau

The Samuel A. Clarke Papers with an Appendix Compiled from Material in Clarke's Scrapbook, Klamath County Museum Research Papers

1959 - An Act to Amend the Klamath Termination Act, Public Law 86-247, U. S. Congress

An Act to Authorize the Use of the Revolving Loan Funds for Indians to Assist Klamath Indians during the Period of Terminating Federal Supervision, Public Law 86-40, U. S. Congress

Historic Water Levels of Tule Lake, California - Oregon and their Relations to the Petroglyphs, Klamath County Museum Research Papers, Cleghorn, John C.

Oregon Geography, Dicken, Samuel N.

1958 - Census of Manufactures, U. S. Department of Commerce, Bureau of the Census

Land Use in Klamath Falls, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

BIBLIOGRAPHY

GENERAL

1958 - Population Trends, Klamath Falls, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

Population Trends in Klamath Falls, State Board of Higher Education, University of Oregon, Bureau of Municipal Research & Service

1957 - O & C Counties: Population, Economic Development, County Finances, State Board of Higher Education, University of Oregon, Bureau of Municipal Research & Service

1956 - Facts About Klamath County and Klamath Falls (also 1948 & 1955), Klamath County Chamber of Commerce

The Basin's 1956 Historical Event Annual Report, Klamath County Chamber of Commerce

1952 - 50 Years of Reclamation, 1902-1952 / Financial Report to the Nation's Stockholders, U. S. Department of the Interior, Bureau of Reclamation

Oregon Geographic Names, McArthur, Lewis A.

1946 - Landownership Survey on Federal Reclamation Projects, U. S. Department of the Interior, Bureau of Reclamation

1943 - Federal Reclamation Laws, Annotated, U. S. Department of the Interior, Bureau of Reclamation

1941 - History of Klamath County, Oregon / Its Resources and Its People, Sisemore, Linsey, Editor-in-Chief

1931 - Crater Lake in Klamath County, Klamath County Chamber of Commerce

1900 - Klamath County, Oregon: Its Resources and Advantages, Pierce, J. G.

II. GEOLOGY & MINERALS
(Geology)

1970 - Bibliography of the Geology and Mineral Resources of Oregon (Fourth Supplement), January 1, 1956 to December 31, 1960; Roberts, Miriam, 1970, Bulletin 67, State Department of Geology and Mineral Industries

BIBLIOGRAPHY

GEOLOGY & MINERALS
(Geology)

1970 - Cenozoic Ash-Flow Tuffs of Oregon, The Ore Bin, Volume 32, No. 6, Walker, George W., State Department of Geology & Mineral Industries

The Reconnaissance Geology and Mineral Resources of Eastern Klamath County and Western Lake County, Oregon / Bulletin 66, Peterson, Norman V. and McIntyre, James R., State Department of Geology & Mineral Industries

1968 - Index to Published Geologic Mapping in Oregon, 1898-1967 / Miscellaneous Paper 12, Corcoran, R. E., State Department of Geology & Mineral Industries

State Soil Survey Plan of Operations, U. S. Department of Agriculture, Soil Conservation Service

1966 - Bibliography of Theses and Dissertations on Oregon Geology from January 1, 1959 to December 31, 1965, Roberts, Miriam (Supplement to Miscellaneous Paper 7, 1959), State Department of Geology & Mineral Industries

1965 - Geologic Map of Southwestern Oregon West of Meridian 122° West and South of Parallel 43° North / Mineral Investigations Field Studies Map MF-38 / Preliminary, Wells, Francis G., U. S. Department of the Interior, Geological Survey

1964 - Geology of Oregon, Baldwin, Ewart M.

1963 - Maars of South-Central Oregon, The Ore Bin, Vol. 25, No. 5, Peterson, Norman J. and Groh, Edward A., State Department of Geology & Mineral Industries

Reconnaissance Geologic Map of the Eastern Half of the Klamath Falls (AMS) Quadrangle, Lake and Klamath Counties, Oregon / Mineral Investigations Field Studies Map MF-260, Walker, George W., U. S. Department of the Interior, Geological Survey

1962 - Geology of Collier State Park Area, Klamath County, Oregon / The Ore Bin, Volume 24, No. 6, Peterson, Norman V., State Department of Geology & Mineral Industries

BIBLIOGRAPHY

GEOLOGY & MINERALS

(Geology)

1962 - Oregon Soil and Water Conservation Needs Inventory, The Oregon Conservation Needs Committee (Published cooperatively by Oregon State University, Extension Service; and U. S. Department of Agriculture, Soil Conservation Service)

1961 - Geologic Map of Oregon West of 121st Meridian / Miscellaneous Geologic Investigations Map I-325, Peck, Dallas L., U. S. Department of the Interior, Geological Survey

1959 - Bibliography of Theses on Oregon Geology, Miscellaneous Paper No. 7, Schlicker, Herbert G., State Department of Geology and Mineral Industries

(Minerals)

1970 - Klamath Falls Iron Meteorite / The Ore Bin, Volume 32, No. 2, Lange, E. F., State Department of Geology & Mineral Industries

1969 - Mineral and Water Resources of Oregon, U. S. Department of the Interior, Geological Survey; and State Department of Geology and Mineral Industries

The Mineral Industry of Oregon, Preprint from the 1969 Bureau of Mines Minerals Yearbook / U. S. Department of the Interior, Bureau of Mines

1967 - Geothermal Potential of the Klamath Falls Area, Oregon / A Preliminary Study / The Ore Bin, Volume 29, No. 11, Peterson, Norman V. and Groh, Edward A., State Department of Geology & Mineral Industries

1966 - Geothermal Energy Potential in Oregon / The Ore Bin, Volume 28, No. 7, Groh, Edward A., State Department of Geology & Mineral Industries

1961 - Perlite Occurrences in Southeastern Klamath and Southwestern Lake Counties, Oregon / The Ore Bin, Volume 23, No. 7, Peterson, Norman V., State Department of Geology & Mineral Industries

BIBLIOGRAPHY

GEOLOGY & MINERALS
(Minerals)

1956 - A Mineral Resource Survey of the Klamath Indian Reservation, Beatty, William B., Stanford Research Institute, Menlo Park, California

1951 - Lightweight Aggregate Industry in Oregon / GMI Short Paper No. 21, Mason, Ralph S., State Department of Geology & Mineral Industries

III. SURFACE WATER & ASSOCIATED USES

A. General Planning Studies & Hydrology

1971 - Basin Data, State Water Resources Board

California Region Comprehensive Framework Study - Type I / Preliminary Draft, 1970-1971, Pacific Southwest Inter-Agency Committee

Klamath River (Presently being conducted), U. S. Department of the Army, Corps of Engineers

Soils Survey / Southeastern Klamath County (Presently being conducted), U. S. Department of Agriculture, Soil Conservation Service

Streamflow Records / Klamath River Basin, State Water Resources Board

Upper Klamath River Basin Reconnaissance Investigation (Presently being published), U. S. Department of the Interior, Bureau of Reclamation

Upper Lost River Division (Presently being conducted), U. S. Department of the Interior, Bureau of Reclamation

Water & Related Land Resources / Klamath Drainage Basin, Oregon (Presently being conducted), U. S. Department of Agriculture, Soil Conservation Service

1970 - Climatological Data, 1931 to date, U. S. Department of Commerce, Weather Bureau (1837-1930, Department of Agriculture)

Minutes of Meetings, Klamath River Compact Commission (Aug. 11, 1964 to current)

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

A. General Planning Studies & Hydrology

1970 - Snow Survey and Soil Moisture Measurements / Basic Data Summary for Western United States, U. S. Department of Agriculture, Soil Conservation Service (Current)

Surface and Precipitation Records of Oregon, to 1970, State Engineer

Thirty-third Biennial Report of the State Engineer, July 1, 1968 to June 30, 1970, State Engineer

Water Budget of Upper Klamath Lake, Southwestern Oregon, Hydrologic Investigations Atlas HA-351, Hubbard, Larry L., U. S. Department of the Interior, Geological Survey

Water Resources Data for Oregon / Part 1 - Surface Water Records / Part 2 - Water Quality Records, U. S. Department of the Interior, Geological Survey (Current)

Water Rights in the Upper Klamath River Basin, Jackman, David, Stanford Law School

Water Supply Outlook and Snow Surveys for Oregon, U. S. Department of Agriculture, Soil Conservation Service (Current)

1969 - Mineral and Water Resources of Oregon, U. S. Department of the Interior, Geological Survey; and State Department of Geology & Mineral Industries

Oregon's Long-Range Requirements for Water, State Water Resources Board

Oregon's Long-Range Requirements for Water / Summary Report, State Water Resources Board

Upper Klamath River Basin, Oregon-California / An Interim Report on Certain Possibilities for Future Development, U. S. Department of the Interior, Bureau of Reclamation

1968 - Hydrology of Crater, East, and Davis Lakes, Oregon / Water Supply Paper 1859-E, Van Denburgh, A. S., U. S. Department of the Interior, Geological Survey

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

A. General Planning Studies & Hydrology

1968 - Interim Report, Upper Klamath River Basin, U. S. Department of the Interior, Bureau of Reclamation

Land and Water Areas, Pacific Southwest Inter-Agency Committee, California Region Framework Study Staff

Precipitation Stations - Oregon / Monthly Precipitation Records on Punch Cards by Calendar and Water Year through September 1967, State Water Resources Board

Surface Water Gaging Stations - Oregon / Monthly Runoff Records on Punch Cards as of September 1966 and July 1967, State Water Resources Board

Upper Lost River Division, Klamath Project, Oregon-California / A Status Report on Water Resources in the Upper Lost River Watershed, U. S. Department of the Interior, Bureau of Reclamation

Water Resources Investigations in Oregon, (Also 1962 and 1965), U. S. Department of the Interior, Geological Survey

1967 - A Hydrologic Model for the Lost River System, U. S. Department of the Interior, Federal Water Pollution Control Administration (Prepared by Water Resources Engineers, Inc., Walnut Creek, California)

Biennial Report, State Water Resources Board

Hydrologic and Related Characteristics of Three Small Watersheds in the Oregon Cascades, Rothacker, Jack; Dyrness, C. T.; Fredriksen, Richard L., U. S. Department of Agriculture, Forest Service, Pacific Northwest Forest & Range Experiment Station

1966 - California Water Projects, Feather River Project Association

Klamath River Hydrology, State of California, The Resources Agency, Department of Water Resources

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

A. General Planning Studies & Hydrology

1966 - The California State Water Project in 1966 / Bulletin No. 132-66 / Appendix C: Facility Descriptions, California Department of Water Resources

Water Laws of Oregon, State Engineer

1965 - Feasibility Study of Mainland Shelf Undersea Aqueducts / Coastal Delivery of Waters of the Eel, Klamath, and Rogue Rivers to Central and Southern California, U. S. Department of the Interior, (Prepared by National Engineering Science Company, Pasadena, California)

Land and Water Use in Lost River-Butte Valley Hydrographic Unit / Bulletin No. 94-9 / Preliminary Edition, California Department of Water Resources

Undersea Aqueduct System for Coastal Delivery of Waters of the Eel, Klamath, and Rogue Rivers to Central and Southern California, Lee, Fred C., National Engineering Science Company, Pasadena, California

Water for Oregon, Water Supply Paper 1649; Phillips, K. N., et al., U. S. Department of the Interior, Geological Survey

1964 - Klamath River Basin Investigation / Bulletin No. 83 / California Department of Water Resources

Resources for Development, State Department of Commerce, Division of Planning & Development

Results of Public Hearing on Preliminary Edition of Bulletin No. 83, Klamath River Basin Investigations, California Department of Water Resources

Shasta Valley Investigation / Bulletin No. 87, California Department of Water Resources

1963 - Climate of Crater Lake National Park, The Crater Lake Natural History Association, in cooperation with the National Park Service

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

A. General Planning Studies & Hydrology

1963 - Observations or Analysis of Necessary Programs in the 2nd Congressional District, State Water Resources Board

1962 - Atlas of Pacific Northwest Resources and Development, State Board of Higher Education, Oregon State University, Department of Natural Resources

Oregon Soil and Water Conservation Needs Inventory, U. S. Department of Agriculture, Soil Conservation Service

Project Feasibilities and Authorizations and Cumulative Supplements, 1949-1962, U. S. Department of the Interior, Bureau of Reclamation

Publications and Graduate Theses in Water Research at Oregon State University, 1961 and 1962, State Board of Higher Education, Oregon State University, Water Resources Research Institute

Streams and Lakes Withdrawn by State Engineer's Order; Withdrawn from Appropriation by Legislative Act; Withdrawn from Appropriation by the State Water Resources Board, State Engineer

1960 - Water - White Gold of California / Biennial Progress Report, July 1, 1958 to June 30, 1960, California Department of Water Resources

1957 - Klamath River Basin Compact between the States of Oregon and California, State Engineer, Klamath River Compact Commission

1955 - Report of Water Resources Committee, submitted to Forty-Eighth Legislative Assembly, Water Resources Committee

1954 - Interim Report on Klamath River Basin Investigation, Water Utilization and Requirements, California State Water Resources Board

Upper Klamath River Basin, Oregon-California / Appendices A through H, U. S. Department of the Interior, Bureau of Reclamation

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

A. General Planning Studies & Hydrology

1954 - Upper Klamath River Basin, Oregon-California / A Comprehensive Departmental Report on the Development of Water and Related Resources, U. S. Department of the Interior, Bureau of Reclamation

Water Right Investigations, Upper Klamath River Basin, U. S. Department of the Interior, Bureau of Reclamation

1953 - Water Resources Development by the Corps of Engineers in Oregon, U. S. Department of the Army, Corps of Engineers

1948 - The Lahontan Basin, Project Planning Report No. 4-6.0-1, U. S. Department of the Interior, Bureau of Reclamation

1928 - Forecasting Runoff in the Klamath Basin, Oregon, Partridge, John F.

1922 - Klamath River and Its Utilization, LaRue, E. C.

B. Domestic & Municipal

1970 - Municipal Water Supply in the Upper Klamath Basin, mail questionnaire survey (Unpublished), State Water Resources Board

Water and Sewerage Comprehensive Plan Report, Klamath County Planning Commission

1966 - Sewerage System Financing and Service Practices / Information Bulletin No. 155, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

Survey of Water Rates, Financing Policies, and Water Districts / Information Bulletin No. 154, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

B. Domestic & Municipal

1965 - Municipal Water Needs in Pacific Northwest to Year 2,000 / Working Paper No. 54, U. S. Department of Health, Education & Welfare, Public Health Service

1963 - Klamath Falls Urban Area Service Needs, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

Municipal Water Facilities, U. S. Department of Health, Education & Welfare, Public Health Service

1962 - Planning for Public Buildings, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

1960 - Census of Population, U. S. Department of Commerce, Bureau of the Census

1959 - Major Streets in Klamath Falls, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

1958 - Population of Oregon Cities, Counties and Metropolitan Areas, 1850 to 1957 / Information Bulletin No. 106, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

1956 - Problems of the Urban Fringe, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

1954 - Water Supply Sources and Water Use in 187 Oregon Cities, Bureau of Municipal Research and Service, University of Oregon, Oregon State Water Resources Committee

C. Irrigation

1970 - Crop Report and Related Data, Federal Reclamation Projects, 1962 to date, U. S. Department of the Interior, Bureau of Reclamation

Klamath Project, Oregon-California / Clear Lake Watershed Report, U. S. Department of the Interior, Bureau of Reclamation, Region 2, Division of Project Development

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

C. Irrigation

1970 - Klamath Project, Oregon-California / Gerber Watershed Report, U. S. Department of the Interior, Bureau of Reclamation, Region 2, Division of Project Development

Klamath Project, Oregon-California / Malone Watershed Report, U. S. Department of the Interior, Bureau of Reclamation, Region 2, Division of Project Development

1969 - Oregon's Long-Range Requirements for Water / General Soil Map Report with Irrigable Areas / Klamath Drainage Basin, Appendix I-14, State Water Resources Board

Oregon's Long-Range Requirements for Water / Irrigation & Food Products Projections / Appendix II, State Water Resources Board

Upper Klamath River Basin, Oregon-California / Interim Report on Future Development, U. S. Department of the Interior, Bureau of Reclamation

1968 - Annual Report, Tulelake Irrigation District

Consumptive Use and Net Irrigation Requirement Estimates for Oregon / Circular of Information 628, State Board of Higher Education, Oregon State University, Agricultural Experiment Station

Irrigable Area Report - Klamath Reservation, Oregon, U. S. Department of the Interior, Bureau of Indian Affairs

1967 - Programs of the Bureau of Reclamation in the Pacific Northwest, 1957-1967, U. S. Department of the Interior, Bureau of Reclamation

1966 - Appropriation Acts and Allotments / Statistical Supplement, U. S. Department of the Interior, Bureau of Reclamation

Klamath Project, California-Oregon / U.S.B.R. Exhibits / In support of U. S. protest to applications R 40004 through R 40010. Filed by Willow Valley Irrigation District & Johnson Stock Company, U. S. Department of the Interior, Bureau of Reclamation

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

C. Irrigation

1965 - Consumptive Use and Net Irrigation Requirement Estimates of Monthly Values for Oregon / Special Report 194, State Board of Higher Education, Oregon State University, Agricultural Experiment Station

1962 - Atlas of Oregon Agriculture, 1958 / Supplement / 1962, State Board of Higher Education, Oregon State University, Department of Natural Resources

Clear Lake Unit, Klamath Project, Oregon-California, U. S. Department of the Interior, Bureau of Reclamation

1961 - Feasibility Report on Klamath Project Extensions, Oregon, Klamath Basin Improvement District (Prepared by Clair A. Hill & Associates, Redding, California)

1960 - Agricultural Geography of the Klamath Basin in Oregon, Jack, James T., Thesis, Oregon State University

Butte Division, Klamath Project, Oregon-California / A Report on the Feasibility of Irrigation Development, U. S. Department of the Interior, Bureau of Reclamation

1959 - Feasibility Report on Klamath Project Extension, Oregon, Klamath Basin Improvement District (Prepared by Clair A. Hill & Associates, Redding,California)

The Reclamation Program, 1953-1959, U. S. Department of the Interior, Bureau of Reclamation

1958 - Reclamation Project Data, 1948 and 1958, U. S. Department of the Interior, Bureau of Reclamation

1957 - Granting the Consent of Congress to the Klamath River Basin Compact between the States of California and Oregon, Public Law 85-222, U. S. Congress

1954 - Upper Klamath River Basin, Klamath Project, Oregon-California / Appendix B - Water Supply, Part 1 - Surface Water Resources, Part 2 - Ground Water Geology and Resources, U. S. Department of the Interior, Bureau of Reclamation

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

C. Irrigation

1953 - Klamath Project Extensions, Klamath Project, Oregon-California, U. S. Department of the Interior, Bureau of Reclamation

Reclamation Accomplishments, 1950-1953, Klamath Project, Oregon-California, U. S. Department of the Interior, Bureau of Reclamation

1947 - Project Repayment Histories and Payout Schedules with History of Crop Production, U. S. Department of the Interior, Bureau of Reclamation

1941 - Irrigation Requirements of Arable Oregon Soils / Station Bulletin 394, State Board of Higher Education, Oregon State College, Agricultural Experiment Station

1938 - Klamath County Agricultural Economic Conference (also 1927 and 1936), State Board of Higher Education, Oregon Agricultural College (OSU), Extension Service

1927 - Farming in Oregon, Klamath County, Klamath County Chamber of Commerce

1911 - Disposition of Surplus Water and Cooperation in Irrigation Work / The Warren Act / An act to authorize the government to authorize for impounding, storing, and carriage of water, and to cooperate in the construction and use of reservoirs and canals under reclamation projects, and for other purposes, U. S. Department of the Interior, Bureau of Reclamation

1908 - Klamath Irrigation Project, U. S. Department of the Interior, Reclamation Service

D. Recreation

1970 - An Appraisal of Potential Outdoor Recreation Developments in Klamath County, Oregon, U. S. Department of Agriculture, Soil Conservation Service (Unpublished)

Public Hearing Notice - Park Wilderness Proposal, Crater Lake National Park, Oregon, U. S. Department of the Interior, National Park Service

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

D. Recreation

1970 - Winema National Forest, Annual Report, U. S. Department of Agriculture, Forest Service (Current)

1969 - Master Plan for Crater Lake National Park, U. S. Department of the Interior, National Park Service

Oregon's Long-Range Requirements for Water / Forest Products Projections & Recreation Projections - Appendices IV & V, State Water Resources Board

The Estimation of Recreational Benefits Resulting from an Improvement of Water Quality in Upper Klamath Lake: An Application of a Method for Evaluating the Demand for Outdoor Recreation, Gibbs, Kenneth C., Thesis, Oregon State University

1968 - Individual County Reports and Directory, Oregon County Parks Association

Principal Lakes of the United States / Circular 476, U. S. Department of the Interior, Geological Survey

1967 - National Forest Campground Directory, Oregon-Washington, U. S. Department of Agriculture, Forest Service

Oregon Outdoor Recreation and Supplements, State Highway Department, Parks & Recreation Division

1966 - Pleasure Boating in Oregon, State Marine Board

1965 - History of the Oregon State Parks, Armstrong, Chester H., State Highway Department, Parks & Recreation Division

1962 - Planning for Park and Recreation Facilities in Klamath Falls, Oregon, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

1957 - A Half Century of Progress on the Klamath Federal Reclamation Project / Committee Print No. 7, U. S. House of Representatives, 85th Congress, 1st Session

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

E. Fish & Wildlife

1971 - Amino Acid Flux in a Naturally Eutrophic Lake, Burnison, Kent, Thesis, Oregon State University, Fish & Game Department

1970 - Bacteria-Phosphate Interactions in Upper Klamath Lake Sediments, Harrison, Michael J., Thesis, Oregon State University

Basin Investigations, Klamath Basin, Oregon State Game Commission

Fish and Wildlife Resources of the Klamath Basin, Oregon, and their Water Requirements, Oregon State Game Commission

Fishery Division, Annual Reports, 1952 to date, State Game Commission

Game Division, Annual Reports, 1951 to date, State Game Commission

Limnology of Upper Klamath Lake, Oregon, with Emphasis on Benthos, Hazel, Charles R., Thesis, Oregon State University, Geology Dept.

Upper Klamath Basin Investigation - Oregon and California, U. S. Department of Commerce, Bureau of Sports Fisheries & Wildlife

Vitamin B12 Production and Depletion in a Naturally Eutrophic Lake, Gillespie, Paul, Thesis, Oregon State University

Winema National Forest, Annual Report, U. S. Department of Agriculture, Forest Service (Current)

1968 - Fish and Wildlife Resources of the Klamath River Drainage, California and Oregon, U. S. Department of Commerce, Bureau of Sports Fisheries and Wildlife

Master Plan for Angler Access and Associated Recreational Uses / Oregon Lakes and Reservoirs, Klamath County, Oregon, State Game Commission

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

E. Fish & Wildlife

1968 - The Influence of Some Environmental Factors on the Distribution of Fishes in Upper Klamath Lake, Vincent, David T., Thesis, Oregon State University, Fish & Game Department

1967 - Hunting in Oregon, State Game Commission

1966 - Feasibility Study to Establish Salmon and Steelhead in the Upper Klamath Basin, Fortune, John D.; Gerlach, Arthur R.; & Hanel, C. J., Oregon State Game Commission & Pacific Power & Light Company

1964 - An act to promote the conservation of the Nation's wildlife resources on the Pacific Flyway in the Tule Lake, Lower Klamath, Upper Klamath, and Clear Lake National Wildlife Refuges in Oregon and California and to aid in the administration of the Klamath Reclamation Project, Public Law 88-567, 88th Congress

1961 - Keys to Oregon Freshwater Fishes / Technical Bulletin 58, Bond, Carl E., State Board of Higher Education, Oregon State University, Agricultural Experiment Station

1956 - Plan for Wildlife Use of Federal Lands in the Upper Klamath Basin, Oregon-California, U. S. Department of the Interior, Fish & Wildlife Service

1954 - A Special Report on Fish and Wildlife Resources Affected by Developments Proposed for the Upper Klamath Basin, Oregon and California, U. S. Fish & Wildlife Service, Division of River Basin Studies

Water Resources and their Relationships to Fish and Wildlife, Oregon State Game Commission

1952 - Special Report on Waterfowl Requirements / Tule Lake and Lower Klamath National Wildlife Refuges, Klamath Basin, U. S. Fish & Wildlife Service, Division of River Basin Studies

1949 - Hank's Marsh Project, Upper Klamath Lake, Oregon, U. S. Fish & Wildlife Service, Division of River Basin Studies

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

E. Fish & Wildlife

1948 - Fish Management Problems of Lake of the Woods, Oregon, Bond, Carl E., Thesis, Oregon State University, Fish & Game Department

Trout Studies and a Stream Survey of Crater Lake National Park, Oregon, Wallis, Orthello L., Thesis, Oregon State University, Fish & Game Department

1943 - Klamath Basin National Wildlife Refuges, Oregon and California, Jewett, Stanley G.

1938 - A Census of Water Bird Life on Upper Klamath Lake, Coopey, Raymond W., Thesis, Oregon State University, Fish & Game Department

F. Industrial

1971 - Industrial Water Use in the Upper Klamath Basin, mail questionnaire survey, State Water Resources Board (Unpublished)

1970 - Directory of Oregon Manufacturers, State Department of Commerce, Division of Planning and Development

1969 - Oregon's Long-Range Requirements for Water / Selected Major Water Using Industries and Population Projections - Appendix III, State Water Resources Board

1968 - Approximate Acres Logged and MBF Volume Removed Including Hazard Status of Certain Cutover Land, 1948-1968, State Board of Forestry

Timber Resource Statistics for Central Oregon / Bulletin PNW 24, U. S. Department of Agriculture, Forest Service

1963 - Oregon Industrial Fact File, State Department of Commerce, Division of Planning & Development

1956 - Klamath Falls Urban Area Commercial Study, State Board of Higher Education, University of Oregon, Bureau of Governmental Research & Service

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

G. Power

1970 - Independent Hydroelectric Resources in the Pacific Northwest, Pacific Northwest River Basins Commission

1964 - Hydroelectric Power Resources of the United States, Developed and Undeveloped, Federal Power Commission

Klamath River Basin, Oregon-California / Planning Status Report / Water Resources Appraisals for Hydroelectric Licensing, Federal Power Commission, Bureau of Power

1963 - Gross Theoretical Waterpower, Developed and Undeveloped, Part 1 - Basin Summaries, Part 2 - List of Power Sites, U. S. Department of the Interior, Geological Survey

1961 - Iron Gate, An Important Unit in the Klamath River Project, Pacific Power & Light Company

Plant Data Sheets of Hydroelectric and Steam-Electric Plants of the Pacific Northwest, Columbia Basin Inter-Agency Committee, Power Planning Subcommittee

1960 - Annual Reports, 1931-1960, State Engineer, Hydroelectric Commission of Oregon

1954 - Upper Klamath River Basin, Oregon-California / Appendix D, Volume 9 - Power Development, U. S. Department of the Interior, Bureau of Reclamation

1927 - Series of Articles on the Looting of the Water Power Resources of the Klamath Irrigation District and the State of Oregon, October 11-15, 17, Portland Telegram Newspaper

H. Flood Control

1969 - Streambank Erosion Study - Pacific Southwest Area, U. S. Department of the Army, Corps of Engineers

1968 - Crest-Stage Gaging Stations in Oregon, U. S. Department of the Interior, Geological Survey

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

H. Flood Control

1967 - Magnitude and Frequency of Floods in the United States / Part II - Pacific Slope Basins in California, Volume 2 - Klamath and Smith River Basins and Central Valley Drainage from the East, Water Supply Paper 1686, U. S. Department of the Interior, Geological Survey

Project and Index Maps / River and Harbor and Flood Control, U. S. Department of the Army, Corps of Engineers

1965 - Floods of December 1964 in the Far Western States, Open-file Report, U. S. Department of the Interior, Geological Survey

High Water Mark Data for Klamath River Upper Portion - Flood of December 1964, U. S. Department of the Army, Corps of Engineers, San Francisco Region

Plan of Development for Flood Control and Allied Purposes, Northern California Streams, California and Oregon, U. S. Department of the Army, Corps of Engineers

Report on Floods of December 1964 in Northern California Coastal Streams, Volumes I, II, III, U. S. Department of the Army, Corps of Engineers, San Francisco Region

1956 - Floods of December 1955 to January 1956 in Far Western States, Peak Discharges / Circular 380, U. S. Department of the Interior, Geological Survey

I. Water Quality

1971 - Environmental Quality in Oregon, A Summary of Current and Future Problems, Advisory Committee on Environmental Science and Technology, Environmental Science Information Coordinator, Oregon State University (Unpublished)

Klamath Basin Comprehensive Study, U. S. Department of the Interior, Federal Water Quality Administration (Presently being published)

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

I. Water Quality

1971 - The Estimation of Regional Secondary Benefits Resulting from an Improvement in Water Quality of Upper Klamath Lake, Oregon; an Interindustry Approach, Reiling, Stephen D., Thesis, Oregon State University

Water-Sediment Nutrient Studies, U. S. Department of the Interior, Federal Water Quality Administration (Presently being conducted)

1970 - Klamath Basin Study / Pesticide Investigation, U. S. Department of the Interior, Federal Water Quality Administration, Pacific Southwest Region (Unpublished)

Status Report and Recommendations for the Sanitary Sewer System, City of Klamath Falls, Office of the City Engineer

1969 - Oregon's Long-Range Requirements for Water / Water Quality Control Projections, Appendix VI, State Water Resources Board

Water-Resources Appraisal of Crater Lake National Park, Oregon / Open-file Report, Frank, F. J., and Harris, A. B., U. S. Department of the Interior, Geological Survey

1968 - Water Quality Control Policy for the Lost River in California, California Water Quality Control Board

1967 - Implementation and Enforcement Plan for the Waters of the State of Oregon, State Sanitary Authority (now Department of Environmental Quality)

Interim Report, Upper Klamath Lake Studies, Oregon, U. S. Department of the Interior, Federal Water Pollution Control Administration

Interim Report, Upper Klamath Lake Studies, Oregon / Water Pollution Control Research Series Publication No. WP-20-8, U. S. Department of the Interior, Federal Water Pollution Control Administration

Pacific Northwest Water Temperature Inventory as of September 1966, Pacific Northwest River Basins Commission, Hydrology Subcommittee

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

I. Water Quality

1967 - Proposed Water Quality Standards for the Public Waters of Oregon, State Sanitary Authority (now Department of Environmental Quality)

1966 - Water Quality Standards, Klamath River, Klamath County, Oregon, State Sanitary Authority (now Department of Environmental Quality)

1965 - Municipal Water Needs in the Pacific Northwest to the Year 2020 / Columbia River Basin Comprehensive Project for Water Supply and Pollution Control, U. S. Department of Health, Education & Welfare, Public Health Service

1964 - Compilation of Water-Temperature Data for Oregon Streams, Open-file Report, U. S. Department of the Interior, Geological Survey

Quality of Klamath Basin Waters in Oregon, July 1959 to December 1963, State Sanitary Authority (now Department of Environmental Quality)

1963 - The Humic Water of Klamath Marsh and Its Effect on the Growth of Anabaena cylindrica Lemm. in Culture, Peak, Chester A., Thesis, Oregon State University

1962 - Investigation into Methods to Control Algae in the Klamath River Basin, State Engineer, Klamath Compact Commission

1961 - Guide to Scheduled Water Sampling Activities and the Types of Resulting Data, State Sanitary Authority (now Department of Environmental Quality)

1957 - Water Quality Data Inventory, Bulletin 1 - 1956, Bulletin 2 - 1957, State Water Resources Board

1956 - Inventory of Published and Unpublished Chemical Analysis of Surface Waters in the Western United States, 1947-55, Bulletin No. 9, U. S. Inter-Agency Committee on Water Resources, Subcommittee on Hydrology

BIBLIOGRAPHY

SURFACE WATER & ASSOCIATED USES

I. Water Quality

1914 - Quality of Surface Waters of Oregon / Water Supply Paper 363, U. S. Department of the Interior, Geological Survey

IV. GROUND WATER

1970 - Ground Water Levels, 1967-68 / Ground Water Report No. 15, State Engineer

1967 - Estimated Existing and Potential Ground-Water Storage in Major Drainage Basins in Oregon / Open-file Report, Robison, James H., U. S. Department of the Interior, Geological Survey

1965 - List of Reports Pertaining to Ground Water in Oregon, Johnson, Nyra A., U. S. Department of the Interior, Geological Survey

1963 - Role of Ground Water in the National Water Situation / Water Supply Paper 1800, U. S. Department of the Interior, Geological Survey

1958 - Preliminary Report on the Ground-Water Resources of the Klamath River Basin, Oregon, Newcomb, R. C., and Hart, D. H., U. S. Department of the Interior, Geological Survey

1957 - Bibliography and Index of Publications Relating to Ground Water / Water Supply Paper 1492, U. S. Department of the Interior, Geological Survey

1955 - Water Levels and Artesian Pressures in Observation Wells in the United States / Part 5 - Northwestern States / Water Supply Papers, 1940 to 1955, U. S. Department of the Interior, Geological Survey

1952 - Geology and Ground-Water Resources of the Swan Lake-Yonna Valleys area, Klamath County, Oregon, Meyers, Joseph D., and Newcomb, R. C., U. S. Department of the Interior, Geological Survey

BIBLIOGRAPHY

GROUND WATER

1951 - Ground-Water Situation in Oregon, Newcomb, R. C., U. S. Department of the Interior, Geological Survey

1947 - Bibliography and Index of Publications Relating to Ground Water / Water Supply Paper 992, U. S. Department of the Interior, Geological Survey

CHRONOLOGY OF IMPORTANT EVENTS*
KLAMATH PROJECT
1903 To 1968

1903

Reconnaissance trips and reports made by Reclamation Service Engineers John T. Whistler and H. E. Green. (Oct.-Nov.)

1904 T. H. Humpherys appointed Project Engineer

General investigation made by Reclamation Service Engineer T. H. Humpherys.

Public lands withdrawn from entry (1,000,000 acres), consisting of Clear Lake and Horsefly reservoir sites, power sites on Klamath River, and other areas containing irrigable lands. (July-Aug.)

1905

Acts passed by Oregon and California Legislatures ceding to the United States rights in Tule, Lower Klamath, and Upper Klamath Lakes. (Jan. & Feb.)

Water Users' Association incorporated. (March)

Project approved by the Secretary of the Interior. (May)

Contract awarded to construct the "A" Canal. (Dec.)

1906 D. W. Murphy appointed Project Engineer

Keno Reef cut investigated to determine effect on Klamath River grades. (March)

Construction of "B," "E," and "F" Canals begun by force account. (July)

McCormick Tract purchased for Keno cut and tunnel. (Nov.)

1907

First irrigation from Project works. (May)

Main ("A" and "B") Canal completed to Olene.

1908

Clear Lake Dam construction begun by force account. (Sept.)

*DATA SOURCE: Bureau of Reclamation

CHRONOLOGY OF IMPORTANT EVENTS

1908 (cont.)

Keno Canal completed.

First public notice for homesteading on Klamath Project. (Nov.)

1909 W. W. Patch appointed Project Engineer

"C" Canal construction completed. (March)

Lower Klamath Lake separated from Klamath River by completion of the Southern Pacific railroad dike.

Van Brimmer Ditch Company repayment contract executed. (Nov.)

1910

Clear Lake Dam completed. (Jan.)

1911

Lost River Diversion Dam and Channel construction begun. (March)

1912

Klamath Straits closed.

Lost River Diversion Dam and Channel completed. (April & June)

1913 J. G. Camp appointed Project Manager

Hearings on adjudication of Lost River water. (Oct.-Nov.)

1914

Leasing of Government lands in Tule Lake bed authorized by Chief Counsel. (March)

Extension of time on operation and maintenance charges authorized by Comptroller (provided applicant agrees to pay a penalty of 1% per month). (May)

Horsefly Irrigation District enters into a cooperative contract for investigations. (June)

Gates installed in Klamath Straits at Ady. (Sept.)

CHRONOLOGY OF IMPORTANT EVENTS

1915

Secretary of the Interior approves restoration of withdrawn lands not included in approved construction and development plans. (Oct.)

Van Brimmer Canal first received water from Project works. (July)

Exploratory shafts dug in attempting to find and enlarge the supposedly existing outlet of Tule Lake into the Lava Beds. (Aug.)

Topographic survey to locate Tule Lake shore line begun.

Topographic surveys of Upper Klamath Lake completed.

Exploratory work on Tule Lake outlet into lava rock discontinued. (Dec.)

"G" Canal construction completed.

1916

Landowners in Lower Klamath Lake area disagree on closure and operation of Klamath Straits slough.

1917 J. D. Bond appointed Project Manager

Homestead entry of 11,800 acres in Main Division.

Contract executed with The California Oregon Power Company for the lease of the Keno Canal and construction of a dam on Link River. (Feb.)

Lost River Diversion Channel unable to carry flood flow of Lost River for two weeks; Clear Lake reservoir filled to within 0.1 foot of the top of spillway. (Dec.)

Klamath Drainage District repayment contract executed. (Nov.)

1918

An office study contemplated construction of Horsefly (Gerber) Storage Dam and a diversion dam on Miller Creek to serve about 17,400 acres in Langell Valley.

Labor shortage; wage rates increased from $2.70 to $3.50 per day.

CHRONOLOGY OF IMPORTANT EVENTS

1918 (cont.)

Klamath Irrigation District repayment contract executed. (July)

Pine Grove Irrigation District repayment contract executed. (Dec.)

1919 Herbert J. Newell appointed Project Manager

Construction of temporary dam on Link River for the regulation of Upper Klamath Lake completed by The California Oregon Power Company.

Horsefly Irrigation District repayment contract executed for water supply from Lost River for 4,400 acres. (July)

1920

Soil survey made on northerly side of Tule Lake. (Jan. & Feb.)

Langell Valley Irrigation District issued bonds for $900,000. (July)

Van Brimmer Ditch Company repayment contract completed for drainage ditch construction. (July)

Construction of Link River Dam outlet to Upper Klamath Lake begun by The California Oregon Power Company. (July)

Enterprise Irrigation District repayment contract executed and amended to include rights-of-way, drainage service, etc. (Oct.)

Klamath Irrigation District contract amended changing the semiannual dates of payment, and for additional construction work.

E. Debler report on reclamation of Tule Lake completed.

1921

Klamath Drainage District contract executed for the sale of irrigation water to an area not to exceed 27,500 acres. (Aug.)

Link River Dam completed by The California Oregon Power Company. (Oct.)

Lower Diversion Dam on Lost River completed. (Dec.)

CHRONOLOGY OF IMPORTANT EVENTS

<u>1922</u>

Allen L. Darr report on Tule Lake reclamation completed.

Horsefly Irrigation District contract amended to include 2,100 acres to be irrigated from Clear Lake, and 1,500 acres to be irrigated from Lost River. (Mar. & Oct.)

Langell Valley Irrigation District repayment contract executed, and amended to cover costs of topographic surveys. (Oct. & June)

Klamath Irrigation District voted to assume cost of delivery of water to Van Brimmer Ditch Company; contract also amended to clarify the meaning and intent of certain portions thereof and set penalties and revised certain construction costs. (April)

Malin Irrigation District repayment contract executed. (Sept.)

Shasta View Irrigation District repayment contract executed. (Oct.)

Sunnyside Irrigation District repayment contract executed. (Oct.)

Homestead entry of 9,680 acres in Tule Lake Division, Part 1. (Oct.)

C-G Cutoff Canal construction completed. (Nov.)

<u>1923</u>

Tule Lake Division lateral system completed for the first 10,000 acres. (April)

Water spilled from Lost River to Tule Lake. Maximum flow 400 c.f.s. (Mar. & Apr.)

Langell Valley West Canal construction begun. (May)

Malone Diversion Dam completed. (May)

Langell Valley Irrigation District repayment contract executed for construction charges for Gerber Dam, etc. (June)

Horsefly Irrigation District contract amended to include additional 4,532 acres to be irrigated from Clear Lake. (Oct.)

1923 (cont.)

Allen L. Darr report on reclamation of Lower Klamath Lake completed.

Tule Lake Sump almost dry; total water area about 2,000 acres.

D. G. Henry and James Munn report on Tule Lake reclamation completed.

1924

Langell Valley West Canal completed. (April)

Langell Valley North Canal construction begun by Government forces. (June)

California Oregon Power Company's Link River power plant placed in operation.

E. C. Koppen report on distribution of construction costs approved by Secretary of the Interior. (Sept.)

E. C. Koppen report on reclamation of Tule Lake completed.

1925

Gerber Dam completed. (June)

Langell Valley Eastside Canals completed. (July)

Langell Valley Irrigation District supplemental contract completed for repayment of cost of construction of canals. (Oct.)

Miller Creek Diversion Dam completed.

1926

"J" Canal construction completed.

Southern Pacific railroad provides first passenger service between Klamath Falls and Eugene, Oregon. (Aug.)

E. B. Debler, J. L. Lytel and A. W. Walker report on Tule Lake reclamation completed.

1927

Langell Valley Irrigation District contract amended for

1927 (cont.)

repayment of drainage works and to extend repayment period for construction charges. (Jan.-July)

Homestead entry of 145 farm units in Tule Lake Division. (March)

Shasta View Irrigation District contract amended to extend repayment period for construction charges. (June)

Sunnyside Irrigation District contract amended to extend repayment period for construction charges. (June)

Klamath Irrigation District contract amended to suspend certain construction charges, exclude certain areas, and reduce penalties. (June)

Malin Irrigation District contract amended to extend repayment period for construction charges. (July)

1928

Great Northern railway branch line between Bend and Klamath Falls opened. (May)

Klamath Irrigation District contracts amended and supplemented to establish sums to be expended by the U. S., determine costs of studies, and provide drainage works. (Nov.)

J. R. Iakisch report on drainage, Klamath Irrigation District, completed.

1929 B. E. Hayden appointed Superintendent

Homestead entry of 28 farm units in Tule Lake Division, under Public Order No. 23. (Feb.)

Horsefly Irrigation District contract amended to revise repayment schedule. (May)

Van Brimmer Ditch Company contract amended to extend repayment period for construction charges. (July)

Central Pacific railroad from Klamath Falls, Oregon, to Alturas, California, first opened to traffic. (Sept.)

Tule Lake Division report on drainage and sump arrangement

1929 (cont.)

prepared (contained in Chapter IV of 1929 Project History).

1930

Clear Lake water entirely depleted. (July)

Lost River Diversion Channel enlarged from 250 c.f.s. to 1,200 c.f.s. (Nov.)

1931

Clear Lake Reservoir Channel construction begun. (March)

Horsefly Irrigation District contract amended to cover costs of Clear Lake Channel construction. (April)

1932

Malin Irrigation District contract executed for construction of culvert under Adams Canal.

Field classification of irrigable lands made in Klamath Irrigation District. (Oct.)

All Project construction stopped due to lack of funds. (Nov.)

Repayment moratoriums granted due to financial failures. (See Chapter IV, page 51, of 1932 Project History.)

1933

Additional moratoriums on payments to the Government requested. (See pages 7 and 8 and Chapter IV, page 48, in 1933 Project History.)

All Project work on construction stopped due to lack of funds. (Nov.)

Langell Valley Irrigation District contract amended for extension of time for repayment of construction charges. (Dec.)

1934

Horsefly Irrigation District contract amended to decrease repayment obligation of Clear Lake storage by the amount of 4,864 acre-feet, and to grant adjusted deferment of construction charges. (Jan.)

1934 (cont.)

Clear Lake Reservoir water depleted. (July)

Langell Valley Irrigation District contract amended to suspend certain construction charges under the Act of Congress, June 27, 1934. (July)

1935

Pine Grove Irrigation District contract amended to exclude railroad lands. (Jan.)

Enterprise Irrigation District contract amended to adjust construction charges due to economic conditions. (May)

Malin Irrigation District contract amended to cover construction of a second culvert under the Adams Canal. (May)

Melhase-Ryan Sump drainage pumping plant placed in operation. (June)

Langell Valley Irrigation District contract amended to exclude 6,271 acres as nonproductive. (Nov.)

1936

Sale of lots in Tulelake Townsite. (April)

Malin Irrigation District contract amended to increase annual water delivery from 2 to 2½ acre-feet per acre. (May)

Sunnyside Irrigation District contract amended to increase annual water delivery from 2 to 2½ acre-feet per acre. (June)

Shasta View Irrigation District did not operate as a district due to financial conditions.

1937

Town of Tulelake, California, voted to incorporate. (Feb.)

Construction work in Tule Lake Division discontinued due to lack of funds. (June)

Enterprise Irrigation District contract amended, granting a license to construct, operate and maintain a power plant at "C" Canal drop. (Sept.)

1937 (cont.)

Malone Diversion Dam washed out, causing $10,000 damage. (Dec.)

Lost River flow exceeds capacity of Diversion Channel for first time since 1930 enlargement. (Dec. 13)

1938

Homestead entry on 69 farm units in Tule Lake Division. (April)

J. R. Iakisch "Report on Pumping from Tule Lake Sump," including "Memorandum on Wild Life Refuge Development," completed. (April)

Langell Valley Irrigation District contract amended to cover repayment of construction work done by Civilian Conservation Corps. (May)

Enterprise Irrigation District power plant at "C" Canal drop placed in operation. (June)

1939

Raising of Clear Lake Dam completed.

1940

Plevna Improvement District executes first repayment contract. (April)

Klamath Drainage District contract amended to cover water conveyance rights-of-way, drainage, etc. (May)

Lost River exceeds capacity of Lost River Diversion Channel. (Feb. 29, March 4, and April 1-4)

1941

Naval Air Base construction started. (June)

Tule Lake Tunnel completed. (Nov.)

1942

Fish and Wildlife Service original agreement executed to

1942 (cont.)

integrate and regulate certain features and functions of the Klamath Project in relation to operation of Tule Lake, Lower Klamath Lake, and Upper Klamath Lake Wildlife Refuges. (Jan.)

Pumping Plant "D" placed in operation. (May)

Japanese Relocation Center at Newell, California, construction completed. (May)

Langell Valley Irrigation District contract amended to exclude certain lands. (Oct.)

1943

Van Brimmer Ditch Company contract amended for inclusion of lands. (Feb.)

Klamath Drainage District contract amended to supersede and replace contracts in 1917, 1921, and 1929. (April)

Ady Pumping Plant placed in operation. (July)

1944

Deferred Project Charges, under Congressional Acts of 1932 to 1937, summarized as of December 31, 1944. (See 1944 Project History, Part 3, page 7.)

Klamath Project transferred from Region 1 to Region 2. (July)

1945 E. L. Stephens appointed Superintendent

Water shut out of the "A" and "J" Canals until about June 7 due to heavy rains, for the first time in Project History.

"A," "B," and "C" dikes in Tule Lake Sump enlarged to substantially present size by lessees. (May)

Klamath Straits Drain and appurtenant works completed. (Dec.)

1946 R. R. Best appointed District Manager

Memorandum report completed to justify opening for entry of additional lands in Tule Lake area.

Boundary Damsite core drilling started. (May)

CHRONOLOGY OF IMPORTANT EVENTS

1946 (cont.)

Homestead entry on 86 farm units in Tule Lake Division, Public Notice No. 43. (Dec.)

Langell Valley Irrigation District reclassification of about 12,500 acres of land approved by Commissioner. (Dec.)

Upper Klamath River Basin Investigation begun.

1947

Naval Air Station turned over to City of Klamath Falls. (April)

Homestead entry on 44 farm units made under Public Notice No. 45 (in Part 2 of Tule Lake Division). (Oct.)

Klamath Drainage District contract of 1943 amended to cover repayment of construction and operation and maintenance of certain works operated by the Government. (Oct.)

Emmitt District Improvement Company first repayment contract executed. (Oct.)

1948 E. L. Stephens appointed Project Manager

Homestead entry on 86 farm units (in Parts 1 and 2 of Tule Lake Division) and Narrative History report for Public Notice No. 47 prepared.

Shasta View Irrigation District repayment contract superseded previous contracts. (Aug.)

Construction of "M" Canal system completed.

1949

Crater Lake frozen over for the first time of record. (Feb.)

Lost River Diversion Channel enlarged second time, from 1,200 c.f.s. to 3,000 c.f.s. (March)

Lost River Channel improvements in Langell and Poe Valleys completed.

1950

Tulelake Irrigation District formation approved by a vote of

1950 (cont.)

115 to 15.

Legal decision, concerning the filing of the United States for all waters of the Klamath River, rendered by Attorney General George Neuner for the State of Oregon, reversing a former decision relative to certain water rights of Klamath Project.

1951

Lower Lost River Channel and Tule Lake dikes "A," "B," and "North Main" improved.

The California Oregon Power Company applied for license to build Big Bend No. 2 diversion dam and power plant on Klamath River. (April)

Oregon passed law prohibiting diversion of water from State without special legislation. (May)

Langell Valley Irrigation District contract amended to include certain lands in South Langell Valley. (May)

The California Oregon Power Company water right at Keno extended for 50 years by the State Engineer.

Newell Townsite lots sold.

1952

Midland District Improvement Company first repayment contract executed. (Feb.)

Report entitled "History of Tule Lake Division, including Modoc Unit," prepared. (Feb.)

Tulelake Irrigation District formed. (March)

Thirty leases in Tule Lake Division cancelled due to violation of lease provisions. (Sept.)

Construction of "N" Canal system completed.

1953

Poe Valley Improvement District first repayment contract executed. (July)

1953 (cont.)

Langell Valley Irrigation District contract amended for repayment of construction of pumping plants. (Nov.)

1954 J. Pitts Elmore appointed Project Manager

Ady District Improvement Company first repayment contract executed. (Aug.)

Klamath Irrigation District contract amended to transfer the operation and maintenance of Main Division to the District effective January 1, 1955. (Nov.)

Upper Klamath Basin Investigation proposed report and appendices completed and reproduced.

Butte Valley Feasibility Investigation resumed.

1955

Klamath Irrigation District takes over operation and maintenance of Main Division. (Jan.)

Klamath Project Extensions Feasibility Report completed.

Clear Lake bottom sounded as part of Lost River Storage Unit Feasibility Investigation.

Lost River flood flows exceed Diversion Channel capacity; 4,990 acre-feet spilled to Tule Lake Sumps. (Dec.)

1956

Fish and Wildlife Service agreement of 1942 amended and supplemented. (Jan.)

Lost River flood flows exceed Diversion Channel capacity; 3,450 acre-feet spilled to Tule Lake Sumps. (Jan.)

Flashboards placed in Clear Lake spillway to prevent spilling, this being the first time water surface reached spillway crest.

Inflow to Project reservoirs set an all-time record during the 1955-56 stream year.

The Oregon and California Klamath River Commissions drafted

1956 (cont.)

a water use priority agreement, for submittal to the respective legislatures in 1957.

Enterprise Irrigation District power plant at the head of the "C" Canal damaged by fire. (Oct. 10)

Link River Dam contract with The California Oregon Power Company, covering the operation and maintenance of the dam and operation of Upper Klamath Lake and Link River, executed for 50-year period, effective date April 16, 1956, superseding 1917 contract.

Tulelake Irrigation District repayment and operation and maintenance contract executed. (Sept.)

Project headquarters moved to new office building at Washburn Way and Joe Wright Road in Klamath Falls; displaced by Air Force.

1957 D. A. Gray appointed Project Manager

Tulelake Irrigation District began operation of Tule Lake Division under terms of 1956 contract. (Jan. 1)

Horsefly Irrigation District contract amended to include water service for 1,843 additional acres. (Sept.)

50th Anniversary celebration of water delivery to the Klamath Project sponsored by the Klamath Basin Water Users Protective Association. (May 24)

Klamath River Basin Compact, apportioning the waters of Klamath River, its tributaries, and other streams between the States of Oregon and California, ratified by the respective State Legislatures. (April 17)

Klamath River Basin Compact ratified by United States Congress. (Aug. 29)

CHRONOLOGY OF IMPORTANT EVENTS

1958

Enterprise Powerplant conversion to a canal drop. Bids opened for Specifications No. 200C-373. Donald Francis Hastings low bidder for $9,322.00 (January 23). Work started under Contract No. 14-06-200-6941 (February 3); completed (April 9).

Tule Lake Tile Drain Experiment on Lot No. 23 of Lease Area B-1. Bids opened for Specifications No. 200C-376 for the excavation of trenches and installation of closed drains (March 21). Construction work started (April 22); completed (May 12). Drainage experiment conducted jointly by Bureau and University of California during irrigation season.

Homestead-lease Controversy Announcement. Press release from Secretary of the Interior offering a general plan for resolving this controversy (April 1). Meetings held to discuss this matter with local representatives of water users, wildlife interests, and governmental agencies (April 1) and (September 22-23).

Pumping Plants U and V Construction. Bids opened under Specifications No. DC-5030. Low bid $53,210; engineer's estimate $47,404. All bids rejected (April 22).

Bids opened under Specifications No. 200C-393. Low bid of $28,355 awarded to George R. Stacy, Oregon, Ltd. Engineer's estimate $26,574 (August 26). Work begun under Contract No. 14-06-200-7360 (September 19).

Gerber Dam. Water spilled over the spillway for the first time since the dam was constructed (April 12-24).

1959

March 7. Regional Director, Project Manager, and Vernon Ekedahl, Manager, Tule Lake and Lower Klamath Wildlife Refuges, met with landowners and others interested in the proposed Lower Klamath land exchange.

July 17. Fuller Brasher, Watermaster of the Tulelake Irrigation District, was fatally burned in an electrical accident at Pumping Plant D, which put the plant out of operation for eight days.

October 9. Bureau of Prisons area at Newell was sold to H. A. Fletcher, Lamont, California, after the lease was not renewed.

October 17-29. The Lost River Diversion Channel was closed

October 17-29. (cont.)

and drained for inspection and rehabilitation, and for repair of the turnout at Station 48.

October 28. Regional and Project personnel inspected the outlet gates at Clear Lake Dam.

November 1. An appraisal of the Suty excess lands in Langell Valley was made by an appraisal board.

December 3. Gerber Reservoir had only 2,700 acre-feet of storage, which is the lowest since March 1932. Water surface was at elevation 4800.49.

December 8. Regional Director H. P. Dugan, Regional Supervisor of Irrigation and Power M. H. Blote, and Project Manager D. A. Gray attended a meeting at Tulelake, California, with Congressman Johnson, representatives of the Tulelake Irrigation District, Fish and Wildlife Service, and various other agricultural and wildlife interests, for discussing the operation of Tule Lake Sump and several matters concerned in the coordination and development of wildlife and agricultural lands in the Klamath Basin.

1960

January 6-7. Project Manager D. A. Gray at meeting in Washington, D. C., with representatives of the Bureaus of Reclamation and Wildlife and the Tulelake Irrigation District to discuss with the office of the Secretary of the Interior the controversy over water levels to be maintained in the Tule Lake Sump.

January 1-31. Draft of revised Rules and Regulations, operation of Pumping Plant D and the Tule Lake Sump, prepared and reviewed by the Regional and Denver offices.

February 11. On the basis of telegraphic assurance by the District that it would operate in accordance with modified Rules and Regulations (Feb. 10, 1960) furnished to the District on that day, the Secretary's office advised the District that Plant D and related works would not be taken from the District on February 14. This was the take-over date set by the Secretary's notice of December 11, 1959.

March 16. Contract executed for one year with the Newell County Water District, covering O&M of the water and sewage disposal systems, Newell, California.

CHRONOLOGY OF IMPORTANT EVENTS

April 4. Pumping Plant 9, built by George R. Stacy, transferred from Construction to O&M status and, also, transferred to the Tulelake Irrigation District for O&M.

May 22. John S. Hamilton, Regional office, Sacramento, California, appointed as Project Manager to fill vacancy created by transfer of Donald A. Gray to the office of the Assistant Commissioner and Chief Engineer, Denver, Colorado.

June 2. Contract for construction of Contract Unit 2, Sump 2, awarded to John M. Keltch, Pasco, Washington.

July 1-31. During July a record water delivery of 66,750 acre-feet was made through the A Canal.

July 26-27. Butte Division Feasibility Report mailed or delivered to interested agencies and individuals for review and comment.

August 30. Contracts for construction of Pumping Plants W, X, and Y awarded to Patterson Construction Co., Klamath Falls, Oregon, for Schedules 1 and 2, and to William S. Shedd, Berkeley, California, for Schedule 3.

October 5. Construction contract, Earthwork and Structures for Laterals and Drains, Sump 3, Contract Unit 1, awarded to M. J. Coleman, Inc., Paradise, California.

October 17-19. Regional, Project and District personnel made periodic examination of Transferred Works--Klamath, Tulelake, and Langell Valley Irrigation Districts.

November 17. Meeting of water users' attorney, representatives of the Regional Solicitor, and Regional and Project officials to discuss the legal problems involved in the formation of a district which would contract with the Government for repayment of construction costs of the Klamath Project Extensions.

1961

February 13. Project Manager J. S. Hamilton transferred to office of Secretary of the Interior, Washington, D. C., as special Assistant to the Under Secretary.

March 7. Construction contract, Earthwork and Structures for Laterals and Drains, Sump 2, Contract Unit 3, awarded to George W. Lewis, Kennewick, Washington.

March 11. Landowners under proposed Klamath Basin Improvement

March 11. (cont.)

District voted to request a Small Projects Loan from Congress to finance construction of the Klamath Project Extensions.

May 9-23. Congressional representatives and interested agencies informed that work on Butte Division Investigation and Report was being discontinued until water users resolved local problems of organization and indicated a strong interest in development.

June 29. Hearing in Circuit Court at Klamath Falls, Oregon, on temporary order to restrain State Engineer and Watermaster from releasing stored water from private reservoirs to Gerber Reservoir.

July 14. Meeting involving representatives of the Regional Solicitor, Langell Valley Irrigation District, Bureau of Reclamation, and water users to discuss Department's program for gathering data for action to protect Project water rights.

August 21. Contract for construction of Pumping Plants 10 and 11 awarded to Klamath Plumbing and Heating Company, Klamath Falls, Oregon.

August 25. Contract for construction of Contract Unit 2, Sump 3, awarded to Kenneth E. Beck, Moses Lake, Washington.

September 15. Application for Small Projects Loan by Klamath Basin Improvement District approved by Department and forwarded to Congress for approval.

October 15. C. D. Lawrence appointed Project Manager.

November 16. Meeting at Tulelake, California, conducted by Congressman Bizz Johnson of California with representatives of the Tulelake Irrigation District, Bureau of Sport Fisheries and Wildlife, Modoc and Siskiyou Counties, Regional and Project offices to discuss Senate Bill 1988 concerning administration of public lands in the Tule Lake area.

December 6. Construction contract, Laterals and Drains, Sump 3, Contract Unit 3, awarded to John M. Keltch, Inc., Pasco, Washington.

1962

February 1. Meeting of Regional and Project representatives of Bureau of Reclamation with Bureau of Land Management in

February 1. (cont.)

Portland, Oregon, to determine position on each of many water-right applications by Bureau of Land Management on reservoirs and stockwater ponds in the Lost River watershed.

February 13-16. Contracts awarded February 13 to Patterson Construction Company, Klamath Falls, Oregon, for relocating the 101-C-1 Drain and repairing the N-1 Lateral, and to Washington Construction Company, Redding, California, on February 16 for leveling some existing laterals, both part of the Tule Lake lateral and drain construction program.

March 29. Meeting in Portland, Oregon, of Bureaus of Reclamation and Sport Fisheries and Wildlife, to discuss fishery benefits associated with reconnaissance report on proposed Clear Lake Unit.

April 10. Meeting at Klamath Falls, Oregon, of Bureaus of Reclamation and Sport Fisheries and Wildlife and Oregon and California Departments of Fish and Game, to review wildlife and fishery benefits of Clear Lake Unit and expedite preparation of Wildlife Bureau companion report.

April 25. Executed water service and Small Reclamation Projects loan repayment contract between the United States and the Klamath Basin Improvement District to finance construction of Klamath Project Extensions. Also signed was an amendment to the operation and maintenance contract between the United States and the Klamath Irrigation District.

October 7-14. October precipitation greater than any previous amount recorded for that month in the Klamath Basin, principally due to the very heavy wind-and-rain storm occurring throughout the Northwest on October 12. Mean daily flow through the Lost River Diversion Channel on October 14 was 3,050 c.f.s., exceeding the design capacity of 3,000 c.f.s. No spills through the Diversion Dam to Lower Lost River were necessary, although the Diversion Channel was at peak capacity for several days.

December 12. Acting Commissioner approved distribution of Clear Lake Unit reconnaissance report, which summarizes possible plan for further water resource development on the Lost River watershed.

1963

February 12. Meeting at Klamath Falls, Oregon, of Bureaus

February 12. (cont.)

of Reclamation and Indian Affairs and Interior Solicitor, on possibility of transfer of Klamath Indian irrigation projects to Bureau of Reclamation.

May 6-7. Biennial examination of maintenance on major Project facilities. Representatives of Region, Project, and Districts participated. Examination at Clear Lake, inaccessible in May, deferred and completed July 2.

May 11. Explosion, of unknown origin, blasted large hole in Olene Flume.

June 10-14. Drainage review by Denver and Regional office specialists.

August 9. Klamath Project Extensions dedicated by Commissioner of Reclamation Floyd E. Dominy.

September 4-6. U. S. Court of Claims hearing in Klamath Falls on lawsuit, Tulelake Irrigation District v. United States, on allocation of O&M costs, Klamath Straits Drain.

October 5. Klamath Straits Drain cleaning completed. Work was done by joint participation of Tulelake Irrigation District, Bureau of Sport Fisheries and Wildlife, Klamath Drainage District, and Bureau of Reclamation as defined in a special contract.

October 28. Agricultural leases, 185 in number, were cancelled and rewritten to include language prohibiting participation in any acreage-diversion program established by the Agricultural Stabilization and Conservation Service Program.

December 16. Meeting of representatives of the Bureau and five principal districts involved toward negotiation of contracts for transfer of Reserved Works to water users for operation and maintenance.

1964

January 28. Contract awarded to George R. Stacy, Klamath Falls, Oregon, for relocating the 101-C-1 Drain in Sump 3, part of the Tule Lake lateral and drain construction program.

July 15. Brief of exceptions of United States filed in case entitled "Tulelake Irrigation District v. United States, Court of Claims Civil No. 445-60," on allocation of O&M costs, July 15. (cont.)

Klamath Straits Drain.

September 2. Public Law 88-567 (Kuchel Bill) passed by Congress and signed by the President. This law applies to conservation of wildlife resources and administration of public-land areas of the Klamath Reclamation Project in the Upper Klamath Basin.

September 10. Contract for closed drain construction, Tule Lake area--Sump 2, awarded to D. J. Hallgren, Carmichael, California.

October 12-16. Biennial examination of minor Project facilities, with representatives of Region, Project, and Districts participating.

November 12. Meeting at Klamath Falls, Oregon, of Bureaus of Reclamation and Sport Fisheries and Wildlife to discuss implementation of Public Law 88-567 (Kuchel Bill).

December 22-31. Heavy precipitation and runoff caused localized flooding and record-breaking streamflow in the Basin, resulting in considerable damage to District and Bureau properties. Flow at Harpold Bridge was about 6,900 c.f.s. Flow in excess of capacity of the Lost River Diversion Channel was passed to lower Lost River, and flow over Lower Diversion Dam was 3,800 c.f.s. Christmas morning. All Project reservoirs held back flood water to minimize flooding downstream.

1965

January 26-29. Inspection of damage and appraisal of emergency repairs to irrigation and related Project facilities, with representatives of Districts, Project, and Region participating.

February 11. Contract negotiated with Sierra Pacific Construction Company, Sacramento, California, for emergency repairs to Tule Lake Sump dikes.

March 12. U. S. Court of Claims issued decision in favor of Tulelake Irrigation District in court action, Civil No. 445-60, which involved allocation of O&M costs of the Klamath Straits drainage system.

March 18. Contract awarded to Patterson Construction Company, Klamath Falls, Oregon, for emergency flood rehabilitation of

March 18. (cont.)

Lower Lost River Diversion Dam and Spillway and J Canal.

March 20. Keno Reef By-pass Channel cut through by Pacific Power & Light Company to expedite removal of remaining flood water and start, as the first step, a major job of increasing discharge capacity of Klamath River upstream from the canyon.

April 19. Payment to Klamath Drainage District for proportion of costs of constructing irrigation and drainage facilities as defined by Public Law 88-567, September 1964.

April 21. Contract for flood-damage repair in Langell Valley awarded to Patterson Construction Company, Klamath Falls, Oregon.

May 17. Contract awarded to Francis D. Brown & Son, Fort Klamath, Oregon, for flood-damage repair--cleaning flood-damaged drain ditches in the Tule Lake Southwest Sump area.

June 16-17. Hearings conducted by Corps of Engineers in Yreka, California, and Klamath Falls, Oregon, on flood control--Klamath River Basin.

July 7. Contract between the Bureau of Reclamation and Siskiyou County, California, executed for improving the "Hill Road" along the west side of Tule Lake.

July 16-19. Biennial examination of maintenance on major Project facilities and inspection of possible alternate sites for Clear Lake Spillway. Representatives of Denver, Region, Project, and Districts participated.

July 29. Amendatory contract with Langell Valley Irrigation District executed, which provides for irrigation service from Gerber and Clear Lake Reservoirs to 16,299.7 acres of land.

September 16. Examination of Tule Lake Tunnel, with representatives of Region, Project, and Tulelake Irrigation District participating.

1966

February 15-17. Underwater examination, by diving team made up of volunteers from the Regional office, of trashracks at Gerber Dam, spillway section of Lost River Diversion Dam, and float well at Pumping Plant F.

CHRONOLOGY OF IMPORTANT EVENTS

April 19 and May 26. Hearings by Oregon State Engineer at Klamath Falls, Oregon, on applications by Willow Valley Irrigation District and Johnson Stock Company to appropriate water from streams tributary to Lost River, and protested by the United States of America (through the Bureau of Reclamation), Langell Valley Irrigation District, and Tulelake Irrigation District.

June 15. Cooperative agreement between Bureau of Reclamation and University of California executed for study and control of root-knot nematode, which attacks wide variety of crops.

September 1. First payments in lieu of taxes, under Public Law 88-567 (September 2, 1964), from public-land revenue, made to Klamath ($5,823), Modoc ($14,667), and Siskiyou ($53,034) Counties.

September 26-30. Biennial examination of minor Project facilities, with representatives of Region, Project, and Districts participating.

November 30. Contract for closed drain construction, Tule Lake area--Sump 3, awarded to Lawrence L. Jaeger, Yuba City, California.

December 15. Upper Klamath River water quality hearing held at Klamath Falls, Oregon, by Oregon Sanitary Authority to permit interested parties to comment on proposed standards.

1967

January 17. First formal meeting with Pacific Power & Light Company on draft of amendatory contract for operation of Keno Development (new dam and channel improvement).

February 9. Public hearing held at Eureka, California, by North Coastal Regional Water Quality Board on proposed water-quality standards for the Klamath River.

April 10. Transfer of finance records and integration of Klamath Project accounts in Regional office completed.

May 23. Hearing before Oregon State Sanitary Authority, following which Oregon adopted water-quality standards for the Klamath River.

June 15. Drafts of contracts for transfer of O&M of Reserved Works presented to Klamath Drainage District, Klamath Irrigation District, Langell Valley Irrigation District, and

June 15. (cont.)

Tulelake Irrigation District.

June 29. Construction contract for rehabilitation of Pumping Plant C awarded to Patterson Construction Company, Klamath Falls, Oregon.

June 30. Contract with Pacific Power & Light Company for operation of Keno Development approved by the Secretary of the Interior.

July 1. Extension of cooperative agreement between Bureau of Reclamation and University of California at Davis for study and control of nematode, Sump 2, Tule Lake area.

September 18-22. Biennial examination of major irrigation structures, with representatives of Region, Project, and Districts participating.

September 20. Rehabilitation and betterment contract between United States and Langell Valley Irrigation District executed.

October 1. Second payments in lieu of taxes, under Public Law 88-567 (Sept. 2, 1964), from public-land revenues, made to Klamath ($6,061), Modoc ($15,738), and Siskiyou ($88,000) Counties.

November 15 and November 29. Public hearings held in Klamath Falls, Oregon, and Yreka, California, before representatives of Federal Water Pollution Control Administration, Oregon State Sanitary Authority, California Department of Water Resources, and other agencies on planning for water-pollution control in Klamath River Basin.

1968

April 12. Klamath River Compact Commission meeting at Klamath Falls, Oregon, for detailed review of water-quality control programs as they relate to water use in the Klamath Basin.

May 9. Public hearing at Tulelake, California, by North Coastal Regional Water Quality Control Board on proposed water-quality policy for Lost River in California.

June 17. Installation and impact testing of techite pipe in east bank of Klamath Straits Drain under joint program of United Technology Center, Sunnyvale, California, and Bureau of Reclamation.

CHRONOLOGY OF IMPORTANT EVENTS

July 29-August 2. Biennial examination of reserved works (minor), with representatives of Region, Project, and Districts participating.

July 31. Meeting at Sacramento, California, of Regional and Project officials with representatives of Pacific Power & Light Company, Federal Power Commission, California Department of Fish and Game, and Bureau of Sport Fisheries and Wildlife on Upper Klamath Lake-Klamath River operations water supply, at which agreement was reached on reduced downriver fishery flows during August and September due to drouth conditions and short water supply.

August 27-29. Field inspection of Klamath drainage area above Link River Dam by representatives of Regional and Denver officies for reevaluation of inflow spillway design flood, Link River Dam.

October 17. Third payments in lieu of taxes, under Public Law 88-567 (Sept. 2, 1964), from public-land revenues, made to Klamath ($10,696), Modoc ($16,987), and Siskiyou ($88,615) Counties.

KLAMATH RIVER BASIN COMPACT

BETWEEN THE STATES OF

OREGON AND CALIFORNIA

Ratified by

STATE OF OREGON, APRIL 17, 1957

(Chapter 142, Oregon State Laws, 1957)

and

STATE OF CALIFORNIA, APRIL 17, 1957

(Chapter 113, California Statutes, 1957)

Consented to by

THE UNITED STATES CONGRESS

ACT OF AUGUST 30, 1957 (71 STAT. 497)

Effective September 11, 1957

KLAMATH RIVER BASIN COMPACT

After negotiations participated in by the following duly appointed Compact Commissioners of the State of California and Oregon, acting pursuant to authorizations of their respective legislatures and the Act of Congress of August 9, 1955 (69 Stat. 613):

FOR OREGON

NELSON REED, Chairman
Klamath Falls, Klamath County

JAMES KERNS, Jr., Vice Chairman
Klamath Falls, Klamath County

RALPH E. KOOZER, Commissioner
Ashland, Jackson County

HARRY PEARSON, Commissioner
Chiloquin, Klamath County

GEORGE E. STEVENSON, Commissioner
Olene, Klamath County

FOR CALIFORNIA

BERT A. PHILLIPS, Chairman
Douglas City, Trinity County

JAMES G. STEARNS, Vice Chairman
Tulelake, Modoc County

NELSON C. BOWLES, Secretary
Eureka, Humboldt County

HARVEY O. BANKS, Director of
Water Resources, Sacramento

ELLIS J. LOUIE, Commissioner
Gazelle, Siskiyou County

and by Frank A. Banks, representative of the United States of America, the States of California and Oregon have agreed on the compact articles hereinafter set out which were approved by the Klamath River Commissions of Oregon and California on November 17, 1956, and ratified by the Legislatures of Oregon (Chap. 142, Oregon State Laws 1957) and California (Chap. 113, Calif. Statutes 1957) on April 17, 1957. This compact was consented to by Act of Congress (71 Stat. 497) on August 30, 1957, and became effective on September 11, 1957.

KLAMATH RIVER BASIN COMPACT

TABLE OF CONTENTS

KLAMATH RIVER BASIN COMPACT

ARTICLE I

PURPOSES

The major purposes of this compact are, with respect to the water resources of the Klamath River Basin:

A. To facilitate and promote the orderly, integrated and comprehensive development, use, conservation and control thereof for various purposes, including, among others: the use of water for domestic purposes; the development of lands by irrigation and other means; the protection and enhancement of fish, wildlife and recreational resources; the use of water for industrial purposes and hydroelectric power production; and the use and control of water for navigation and flood prevention.

B. To further intergovernmental cooperation and comity with respect to these resources and programs for their use and development and to remove causes of present and future controversies by providing (1) for equitable distribution and use of water among the two states and the Federal Government, (2) for preferential rights to the use of water after the effective date of this compact for the anticipated ultimate requirements for domestic and irrigation purposes in the Upper Klamath River Basin in Oregon and California, and (3) for prescribed relationships between beneficial uses of water as a practicable means of accomplishing such distribution and use.

ARTICLE II

DEFINITION OF TERMS

As used in this compact:

A. "Klamath River Basin" shall mean the drainage area of the Klamath River and all its tributaries within the States of California and Oregon and all closed basins included in the Upper Klamath River Basin.

B. "Upper Klamath River Basin" shall mean the drainage area of the Klamath River and all its tributaries upstream from the boundary between the States of California and Oregon and the closed basins of Butte Valley, Red Rock Valley, Lost River Valley, Swan Lake Valley and Crater Lake, as delineated on the official map of the Upper Klamath River Basin approved on September 6, 1956, by the commissions negotiating this compact and filed with the Secretaries of State of the two states and the General Services Administration of the United States, which map is incorporated by reference and made a part hereof.

C. "Commission" shall mean the Klamath River Compact Commission as created by Article IX of this compact.

D. "Klamath Project" of the Bureau of Reclamation of the Department of the Interior of the United States shall mean that area as delineated by appropriate legend on the official map incorporated by reference under subdivision B of this article.

E. "Person" shall mean any individual or any other entity, public or private, including either state, but excluding the United States.

F. "Keno" shall mean a point on the Klamath River at the present needle dam, or any substitute control dam constructed in Section 36, Township 39 South, Range 7 East, Willamette Base and Meridian.

G. "Water" or "waters" shall mean waters appearing on the surface of the ground in streams, lakes or otherwise, regardless of whether such waters at any time were or will become ground water, but shall not include water extracted from underground sources until after such water is used and becomes surface return flow or waste water.

H. "Domestic use" shall mean the use of water for human sustenance, sanitation and comfort; for municipal purposes; for livestock watering; for irrigation of family gardens; and for other like purposes.

I. "Industrial use" shall mean the use of water in manufacturing operations.

J. "Irrigation use" shall mean the use of water for production of agricultural crops, including grain grown for feeding wildfowl.

ARTICLE III

DISTRIBUTION AND USE OF WATER

A. There are hereby recognized vested rights to the use of waters originating in the Upper Klamath River Basin validly established and subsisting as of the effective date of this compact under the laws of the state in which the use or diversion is made, including rights to the use of waters for domestic and irrigation uses within the Klamath Project. There are also hereby recognized rights to the use of all waters reasonably required for domestic and irrigation uses which may hereafter be made within the Klamath Project.

B. Subject to the rights described in subdivision A of this article and excepting the uses of water set forth in subdivision E of Article XI, rights to the use of unappropriated waters originating within the Upper Klamath River Basin for any beneficial use in the Upper Klamath River Basin, by direct diversion or by storage for later use, may be acquired by any person after the effective date of this compact by appropriation under the laws of the state where the use is to be made, as modified by the following provisions of this subdivision B and subdivision C of this article, and may not be acquired in any other way:

1. In granting permits to appropriate waters under this subdivision B, as among conflicting applications to appropriate when there is insufficient water to satisfy all such applications, each state shall give preference to applications for a higher use over applications for a lower use in accordance with the following order of uses:

(a) Domestic use,
(b) Irrigation use,
(c) Recreational use, including use for fish and wildlife,
(d) Industrial use,
(e) Generation of hydroelectric power,
(f) Such other uses as are recognized under the laws of the state involved.

These uses are referred to in this compact as uses (a), (b), (c), (d), (e) and (f), respectively. Except as to the superiority of rights to the use of water for use (a) or (b) over the rights to the use of water for use (c), (d), (e) or (f), as governed by subdivision C of this article, upon a permit being granted and a right becoming vested and perfected by use, priority in right to the use of water shall be governed by priority in time within the entire Upper Klamath River Basin regardless of state boundaries. The date of priority of any right to the use of water appropriated for the purposes above enumerated shall be the date of the filing of the application therefor, but such priority shall be dependent on commencement and completion of construction of the necessary works and application of the water to beneficial use with due diligence and within the times specified under the laws of the state where the use is to be made. Each state shall promptly provide the commission and the appropriate official of the other state with complete information as to such applications and as to all actions taken thereon.

2. Conditions on the use of water under this subdivision B in Oregon shall be:

(a) That there shall be no diversion of waters from the Upper Klamath River Basin, but this limitation shall not apply to out-of-basin diversions of waters originating within the drainage area of Fourmile Lake.

(b) That water diverted from Upper Klamath Lake and the Klamath River and its tributaries upstream from Keno, Oregon, for use in Oregon and not consumed therein and appearing as surface return flow and waste water within the Upper Klamath River Basin shall be returned to the Klamath River or its tributaries above Keno, Oregon.

3. Conditions on the use of water under this subdivision B in California shall be:

(a) That the water diverted from the Klamath River within the Upper Klamath River Basin for use in California shall not be taken outside the Upper Klamath River Basin.

(b) That substantially all of the return flows and waste water finally resulting from such diversions and use appearing as surface waters in the Upper Klamath River Basin shall be made to drain so as to be eventually returned to the Klamath River upstream from Keno, Oregon.

C. 1. All rights, acquired by appropriation after the effective date of this compact, to use waters originating within the Upper Klamath River Basin for use (a) or (b) in the Upper Klamath River Basin in either state shall be superior to any rights, acquired after the effective date of this compact, to use such waters (i) for any purpose outside the Klamath River Basin by diversion in California or (ii) for use (c), (d), (e) or (f) anywhere in the Klamath River Basin. Such superior rights shall exist regardless of their priority in time and may be exercised with respect to inferior rights without the payment of compensation. But such superior rights to use water for use (b) in California shall be limited to the quantity of water necessary to irrigate 100,000 acres of land, and in Oregon shall be limited to the quantity of water necessary to irrigate 200,000 acres of land.

2. The provisions of paragraph 1 of this subdivision C shall not prohibit the acquisition and exercise after the effective date of this compact of rights to store waters originating within the Upper Klamath River Basin and to make later use of such stored water for any purpose, as long as the storing of waters for such later use, while being effected, does not interfere with the direct diversion or storage of such waters for use (a) or (b) in the Upper Klamath River Basin.

ARTICLE IV

HYDROELECTRIC POWER

It shall be the objective of each state, in the formulation and the execution and the granting of authority for the formulation and execution of plans for the distribution and use of the waters of the Klamath River Basin, to provide for the most efficient use of available power head and its economic integration with the distribution of water for other beneficial uses in order to secure the most economical distribution and use of water and lowest power rates which may be reasonable for irrigation and drainage pumping, including pumping from wells.

ARTICLE V

INTERSTATE DIVERSION AND STORAGE RIGHTS; MEASURING DEVICES

A. Each state hereby grants for the benefit of the other and its designees the right to construct and operate facilities for the measurement, diversion, storage and conveyance of water from the Upper Klamath River Basin in one state for use in the other insofar as the exercise of such right may be necessary to effectuate and comply with the terms of this compact. The location of such facilities shall be subject to approval by the commission.

B. Each state or its designee, exercising within the jurisdiction of the other a right granted under subdivision A of this article, shall make provision for the establishment, operation and maintenance of permanent gaging stations at such points on streams or reservoir or conveyance facilities as may be required by the commission for the purpose of ascertaining and recording the volume of diversions by the streams or facilities involved. Said stations shall be equipped with suitable devices for determining the flow of water at all times. All information obtained from such stations shall be compiled in accordance with the standards of the United States Geological Survey, shall be filed with the commission, and shall be available to the public.

ARTICLE VI

ACQUISITION OF PROPERTY FOR STORAGE AND DIVERSION; IN LIEU TAXES

A. Subject to approval of the commission, either state shall have the right (1) to acquire such property rights in the other state as are necessary for the diversion, storage, conveyance, measurement and use of water in conformity with this compact, by donation or purchase, or (2) to elect to have the other state acquire such property rights for it by purchase or through the exercise of the power of eminent domain. A state making the latter election shall make a written request therefor and the other state shall expeditiously acquire said property rights either by purchase at a price satisfactory to the requesting state, or, if such purchase cannot be made, then through the exercise of its power of eminent domain, and shall convey said property rights to the requesting state or its designee. All costs of such acquisition shall be paid by the requesting state. Neither state shall have any greater power to acquire property rights for the other state through the exercise of the power of eminent domain than it would have under its laws to acquire the same property rights for itself.

B. Should any diversion, storage or conveyance facilities be constructed or acquired in either state for the benefit of the other state, as herein provided, the construction, repair, replacement, maintenance and operation of such facilities shall be subject to the laws of the state in which the facilities are located, except that the proper officials of that state shall permit the storage, release and conveyance of any water to which the other state is entitled under this compact.

C. Either state having property rights other than water rights in the other state acquired as provided in this article shall pay to each political subdivision of the state in which such property rights are located, each and every year during which such rights are held, a sum of money equivalent to the average annual amount of taxes assessed against those rights during the 10 years preceding the acquisition of such rights in reimbursement for the loss of taxes to such political subdivisions of the state. Payments so made to a political subdivision shall be in lieu of any and all taxes by that subdivision on the property rights for which the payments are made.

ARTICLE VII

POLLUTION CONTROL

A. The states recognize that the growth of population and the economy of the Upper Klamath River Basin can result in pollution of the waters of the Upper Klamath River Basin constituting a menace to the health and welfare of, and occasioning economic loss to, people living or having interests in the Klamath River Basin. The states recognize further that protection of the beneficial uses of the waters of the Klamath River Basin requires cooperative action of the two states in pollution abatement and control.

B. To aid in such pollution abatement and control, the commission shall have the duty and power:

1. To cooperate with the states or agencies thereof or other entities and with the United States for the purpose of promoting effective laws and the adoption of effective regulations for abatement and control of pollution of the waters of the Klamath River Basin, and from time to time to recommend to the governments reasonable minimum standards for the quality of such waters.

2. To disseminate to the public by any and all appropriate means information respecting pollution abatement and control in the waters of the Klamath River Basin and on the harmful and uneconomic results of such pollution.

C. Each state shall have the primary obligation to take appropriate action under its own laws to abate and control interstate pollution, which is defined as the deterioration of the quality of the waters of the Upper Klamath River Basin within the boundaries of such state which materially and adversely affects beneficial uses of waters of the Klamath River Basin in the other state. Upon complaint to the commission by the state water pollution control agency of one state that interstate pollution originating in the other state is not being prevented or abated, the procedure shall be as follows:

1. The commission shall make an investigation and hold a

conference on the alleged interstate pollution with the water pollution control agencies of the two states, after which the commission shall recommend appropriate corrective action.

2. If appropriate corrective action is not taken within a reasonable time, the commission shall call a hearing, giving reasonable notice in writing thereof to the water pollution control agencies of the two states and to the person or persons which it is believed are causing the alleged interstate pollution. Such hearing shall be held in accordance with rules and regulations of the commission, which shall conform as nearly as practicable with the laws of the two states governing administrative hearings. At the conclusion of such hearing, the commission shall make a finding as to whether interstate pollution exists, and if so, shall issue to any person or persons which the commission finds are causing such interstate pollution an order or orders for correction thereof.

3. It shall be the duty of the person against whom any such order is issued to comply therewith. Any court of general jurisdiction of the state where such discharge is occurring or the United States District Court for the district where the discharge is occurring shall have jurisdiction, on petition of the commission for enforcement of such order, to compel action by mandamus, injunction, specific performance, or any other appropriate remedy, or on petition of the person against whom the order is issued to review any order. At the conclusion of such enforcement or review proceedings, the court may enter such decree or judgment affirming, reversing, modifying, or remanding such order as in its judgment is proper in the circumstances on the basis of the rules customarily applicable in proceedings for court enforcement or review of administrative actions.

D. The water pollution control agencies of the two states shall, from time to time, make available to the commission all data relating to the quality of the waters of the Upper Klamath River Basin which they possess as the result of studies, surveys and investigations thereof which they may have made.

ARTICLE VIII

MISCELLANEOUS

A. Subject to vested rights as of the effective date of this compact, there shall be no diversion of waters from the basin of Jenny Creek to the extent that such waters are required, as determined by the commission, for use on land within the basin of Jenny Creek.

B. Each state shall exercise whatever administrative, judicial, legislative or police powers it has that are required to provide any necessary re-regulation or other control over the flow of the Klamath River downstream from any hydroelectric power plant for protection of fish, human life or property from damage caused by fluctuations resulting from the operation of such plant.

ARTICLE IX

ADMINISTRATION

A. 1. There is hereby created a commission to administer this compact. The commission shall consist of three members. The representative of the State of California shall be the Department of Water Resources. The representative of the State of Oregon shall be the State Engineer of Oregon who shall serve as ex officio representative of the State Water Resources Board of Oregon. The President is requested to appoint a federal representative who shall be designated and shall serve as provided by the laws of the United States.

2. The representative of each state shall be entitled to one vote in the commission. The representative of the United States shall serve as chairman of the commission without vote. The compensation and expenses of each representative shall be fixed and paid by the government which he represents. Any action by the commission shall be effective only if it be agreed to by both voting members.

3. The commission shall meet to establish its formal organization within 60 days after the effective date of this compact, such meeting to be at the call of the governors of the two states. The commission shall then adopt its initial set of rules and regulations governing the management of its internal affairs providing for, among other things, the calling and holding of meetings, the adoption of a seal, and the authority and duties of the chairman and executive director. The commission shall establish its office within the Upper Klamath River Basin.

4. The commission shall appoint an executive director, who shall also act as secretary, to serve at the pleasure of the commission and at such compensation, under such terms and conditions and performing such duties as it may fix. The executive director shall be the custodian of the records of

the commission with authority to affix the commission's official seal, and to attest to and certify such records or copies thereof. The commission, without regard to the provisions of the civil service laws of either state, may appoint and discharge such consulting, clerical and other personnel as may be necessary for the performance of the commission's functions, may define their duties, and may fix and pay their compensation. The commission may require the executive director and any of its employees to post official bonds, and the cost thereof shall be paid by the commission.

5. All records, files and documents of the commission shall be open for public inspection at its office during established office hours.

6. No member, officer or employee of the commission shall be liable for injury or damage resulting from (a) action taken by such member, officer or employee in good faith and without malice under the apparent authority of this compact, even though such action is later judicially determined to be unauthorized, or (b) the negligent or wrongful act or omission of any other person, employed by the commission and serving under such officer, member or employee, unless such member, officer or employee either failed to exercise due care in the selection, appointment or supervision of such other person, or failed to take all available action to suspend or discharge such other person after knowledge or notice that such other person was inefficient or incompetent to perform the work for which he was employed. No suit may be instituted against a member, officer or employee of the commission for damages alleged to have resulted from the negligent or wrongful act or omission of such member, officer or employee or a subordinate thereof occurring during the performance of his official duties unless, within 90 days after occurrence of the incident, a verified claim for damages is presented in writing and filed with such member, officer or employee and with the commission. In the event of a suit for damages against any member, officer or employee of the commission on account of any act or omission in the performance of his or his subordinate's official duties, the commission shall arrange for the defense of such suit and may pay all expenses therefor on behalf of such member, officer or employee. The commission may at its expense insure its members, officers and employees against liability resulting from their acts or omissions in the performance of their official duties. Nothing in this paragraph shall be construed as imposing any liability upon any member, officer or employee of the commission that he would otherwise not have.

7. The commission may incur obligations and pay expenses which are necessary for the performance of its functions.

But it shall not pledge the credit of any government except by and with the authority of the legislative body thereof given pursuant to and in keeping with the constitution of such government, nor shall the commission incur any obligations prior to the availability of funds adequate to meet them.

8. The commission may:

(a) Borrow, accept or contract for the services of personnel from any government or agency thereof, from an intergovernmental agency, or from any other entity.

(b) Accept for any of its purposes and functions under this compact any and all donations, gifts, grants of money, equipment, supplies, materials and services from any government or agency thereof or intergovernmental agency or from any other entity.

(c) Acquire, hold and dispose of real and personal property as may be necessary in the performance of its functions.

(d) Make such studies, surveys and investigations as are necessary in carrying out the provisions of this compact.

9. All meetings of the commission for the consideration of and action on any matters coming before the commission, except matters involving the management of internal affairs of the commission and its staff, shall be open to the public. Matters coming within the exception of this paragraph may be considered and acted upon by the commission in executive sessions under such rules and regulations as may be established therefor.

10. In the case of the failure of the two voting members of the commission to agree on any matter relating to the administration of this compact as provided in paragraph 2 of this subdivision A, the representative from each state shall appoint one person and the two appointed persons shall appoint a third person. The three appointees shall sit as an arbitration forum. The terms of appointment and the compensation of the members of the arbitration forum shall be fixed by the commission. Matters on which the two voting members of the commission have failed to agree shall be decided by a majority vote of the members of the arbitration forum. Each state obligates itself to abide by the decision of the arbitration forum, subject, however, to the right of each state to have the decision reviewed by a court of competent jurisdiction.

11. The commission shall have the right of access, through its authorized representatives, to all properties in the Klamath River Basin whenever necessary for the purpose of

administration of this compact. The commission may obtain a court order to enforce its right of access.

B. 1. The commission shall submit to the governor or designated officer of each state a budget of its estimated expenditures for such period and at such times as may be required by the laws of that state for presentation to the legislature thereof. Each state pledges itself to appropriate and pay over to the commission one-half of the amount required to finance the commission's estimated expenditures as set forth in each of its budgets, and pledges further that concurrently with approval of this compact by its legislature the sum of not less than $12,000 will be appropriated by it to be paid over to the commission at its first meeting for use in financing the commission's functions until the commission can prepare its first budget and receive its first appropriation thereunder from the states.

2. The commission shall keep accurate accounts of all receipts and disbursements, which shall be audited yearly by a certified public accountant, and the report of the audit shall be made a part of its annual report. The accounts of the commission shall be open for public inspection during established office hours.

3. The commission shall make and transmit to the legislature and governor of each state and to the President of the United States an annual report covering the finances and activities of the commission and embodying such plans, recommendations and findings as may have been adopted by the commission.

C. 1. The commission shall have the power to adopt, and to amend or repeal, such rules and regulations to effectuate the purposes of this compact as in its judgment may be appropriate.

2. Except as to matters involving exclusively the management of the internal affairs of the commission and its staff or involving emergency matters, prior to the adoption, amendment or repeal of any rule or regulation the commission shall hold a hearing at which any interested person shall have the opportunity to present his views on the proposed action in writing, with or without the opportunity to present the same orally. The commission shall give adequate advance notice in a reasonable manner of the time, place and subject of such hearings.

3. Emergency rules and regulations may be adopted without a prior hearing, but in such case they may be effective for not longer than 90 days.

4. The commission shall publish its rules and regulations in convenient form.

ARTICLE X

STATUS OF INDIAN RIGHTS

A. Nothing in this compact shall be deemed:

1. To affect adversely the present rights of any individual Indian, tribe, band or community of Indians to the use of the waters of the Klamath River Basin for irrigation.

2. To deprive any individual Indian, tribe, band or community of Indians of any rights, privileges, or immunities afforded under Federal treaty, agreement or statute.

3. To affect the obligations of the United States of America to the Indians, tribes, bands or communities of Indians, and their reservations.

4. To alter, amend or repeal any of the provisions of the Act of August 13, 1954, (68 Stat. 718) as it may be amended.

B. Lands within the Klamath Indian Reservation which are brought under irrigation after the effective date of this compact, whether before or after Section 14 of said Act of August 13, 1954, becomes fully operative, shall be taken into account in determining whether the 200,000 acre limitation provided in paragraph 1 of subdivision C of Article III has been reached.

ARTICLE XI

FEDERAL RIGHTS

Nothing in this compact shall be deemed:

A. To impair or affect any rights, powers or jurisdiction of the United States, its agencies or those acting by or under its authority, in, over and to the waters of the Klamath River Basin, nor to impair or affect the capacity of the United States, its agencies or those acting by or under its authority in any manner whatsoever, except as otherwise provided by the federal legislation enacted for the implementation of this compact as specified in Article XIII.

B. To subject any property of the United States, its agencies or instrumentalities, to taxation by either state or any subdivision thereof, unless otherwise provided by act of Congress.

C. To subject any works or property of the United States, its agencies, instrumentalities or those acting by or under its authority, used in connection with the control or use of waters which are the subject of this compact, to the laws of any state to an extent other than the extent to which those laws would apply without regard to this compact, except as otherwise provided by the federal legislation enacted for the implementation of this compact as specified in Article XIII.

D. To affect adversely the existing areas of Crater Lake National Park or Lava Beds National Monument, or to limit the operation of laws relating to the preservation thereof.

E. To apply to the use of water for the maintenance, on the scale at which such land and water areas are maintained as of the effective date of this compact, of officially designated waterfowl management areas, including water consumed by evaporation and transpiration on water surface areas and water used for irrigation or otherwise in the Upper Klamath River Basin; nor to affect the rights and obligations of the United States under any migratory bird treaty or the Migratory Bird Conservation Act (45 Stat. 1222), as amended to the effective date of this compact.

ARTICLE XII

GENERAL PROVISIONS

A. Each state and all persons using, claiming or in any manner asserting any right to the use of the waters of the Klamath River Basin under the authority of either state shall be subject to the terms of this compact.

B. Nothing in this compact shall be construed to limit or prevent either state from instituting or maintaining any action or proceeding, legal or equitable, in any court of competent jurisdiction for the protection of any right under this compact or the enforcement of any of its provisions.

C. Should a court of competent jurisdiction hold any part of this compact to be contrary to the Constitution of either state or the United States, all other provisions shall continue in full force and effect, unless it is authoritatively and finally determined judicially that the remaining provisions cannot operate for the purposes, or substantially in the manner, intended by the states independently of the portions declared unconstitutional or invalid.

D. Except as to matters requiring the exercise of discretion by the commission, the provisions of this compact shall be self-executing and shall by operation of law be conditions of the various state permits, licenses or other authorizations relating to the waters of the Klamath River Basin issued after the effective date of this compact.

E. The physical and other conditions peculiar to the Klamath River Basin constitute the basis for this compact, and neither of the states hereby, nor the Congress of the United States by its consent, considers that this compact establishes any general principle or precedent with respect to any other interstate stream.

ARTICLE XIII

RATIFICATION

A. This compact shall become effective when ratified by the legislature of each signatory state, and when consented to by an act of Congress of the United States which will, in substance, meet the provisions hereinafter set forth in this article.

B. The act of Congress referred to in subdivision A of this article shall provide that the United States or any agency thereof, and any entity acting under any license or other authority granted under the laws of the United States (referred to in this article as "the United States"), in connection with developments undertaken after the effective date of this compact pursuant to laws of the United States, shall comply with the following requirements:

1. The United States shall recognize and be bound by the provisions of subdivision A of Article III.

2. The United States shall not, without payment of just compensation, impair any rights to the use of water for use (a) or (b) within the Upper Klamath River Basin by the exercise of any powers or rights to use or control water (i) for any purpose whatsoever outside the Klamath River Basin by diversions in California or (ii) for any purpose whatsoever within the Klamath River Basin other than use (a) or (b). But the exercise of powers and rights by the United States

shall be limited under this paragraph 2 only as against rights to the use of water for use (a) or (b) within the Upper Klamath River Basin which are acquired as provided in subdivision B of Article III after the effective date of this compact, but only to the extent that annual depletions in the flow of the Klamath River at Keno resulting from the exercise of such rights to use water for uses (a) and (b) do not exceed 340,000 acre-feet in any one calendar year.

3. The United States shall be subject to the limitation on diversions of waters from the basin of Jenny Creek as provided in subdivision A of Article VIII.

4. The United States shall be governed by all the limitations and provisions of paragraph 2 and subparagraph (a) of paragraph 3 of subdivision B of Article III.

5. The United States, with respect to any irrigation or reclamation development undertaken by the United States in the Upper Klamath River Basin in California, shall provide that substantially all of the return flows and waste water finally resulting from such diversions and use appearing as surface waters in the Upper Klamath River Basin shall be made to drain so as to be eventually returned to the Klamath River upstream from Keno, unless the Secretary of the Interior shall determine that compliance with this requirement would render it less feasible than under an alternate plan of development, in which event such return flows and waste waters shall be returned to the Klamath River at a point above Copco Lake.

C. Upon enactment of the act of Congress referred to in subdivision A of this article and so long as such act shall be in effect, the United States, when exercising rights to use water pursuant to state law, shall be entitled to all of the same privileges and benefits of this compact as any person exercising similar rights.

D. Such act of Congress shall not be construed as relieving the United States of any requirement of compliance with state law which may be provided by other federal statutes.

ARTICLE XIV

TERMINATION

This compact may be terminated at any time by legislative consent of both states, but despite such terminations, all rights then established hereunder or recognized hereby shall continue to be recognized as valid by the states.

TABLE A

HYDROLOGICAL STATION SUMMARY

KLAMATH DRAINAGE BASIN

OREGON

MAP INDEX NO.	NAME	STATION NO.	LOCATION Twp.	LOCATION Rng.	LOCATION Sec.	STREAM MILE	DRAINAGE AREA Sq.Mi.	ELEVATION Feet	TYPE	ACTIVE 1969	WATER YEARS OF RECORD	COMPLETE WATER YEARS	SOURCE
	STREAM GAGES												
1	Miller Creek at Gerber Res. near Lorella	4835	39S	13E	12	12.0	220	4800	Staff		1904-09, 25-50	29	USGS
2	Miller Creek near Lorella	4840	40S	14E	7	2.3	270	4200	Recorder		1909* 20	5	USGS
3	Lost River above Olene	4845	39S	11½E	21	34.4	1410	4100	Staff		1915-17	0	USGS
4	Lost River at Olene	4850	39S	10E	14	29.3	1590	4100	Staff		1904, 07-11	4	USGS
5	Lost River at Wilson Bridge	4870	39S	10E	30	25.1	1620	4005	Recorder		1912-20	8	USGS
6	Lost River near Merrill	4875	40S	10E	28	16.2	1670	4000	Staff		1904-07	2	USGS
7	Lost River at Merrill	4880	40S	10E	34	13.2	1680	4000	Recorder		1916	0	USGS
8	Williamson River near Silver Lake	4915	30S	10E	14	61.3	220	4550	Staff		1917-21	0	USGS
9	Miller Creek near Crescent	4920	28S	7E	2		23.7	4700	Staff		1912-14	1	USGS
10	Sand Creek near Fort Klamath	4925	31S	7E	29		35	4700	Recorder		1917-22	0	USGS
11	Scott Creek near Fort Klamath	4930	31S	7E	18		10	4700	Staff		1917-20	0	USGS
12	Williamson River near Klamath Agency	4935	33S	7E	1	27.1	1290	4500	Recorder	X	1908*, 10, 55-	15	USGS
13	Williamson River above Spring Creek, near Klamath Agency	4940	34S	7E	2	19.8	1330	4190	Recorder		1912* 13, 1917-25	1	USGS
14	Williamson River at Chiloquin	4945	35S	7E	3	11.2	1400	4170	Staff		1911-17	5	USGS
15	South Fork Sprague River near Bly	4955	37S	15E	6	9.7	110	4500	Staff		1925-26	0	USGS
16	North Fork Sprague River near Bly	4965	36S	14E	2	10.2	45	4600	Staff		1917-18, 25-26	0	USGS
17	Fivemile Creek near Bly	4970	35S	13E	34		40	4300	Staff		1917-20	2	USGS
18	Sprague River near Beatty	4975	36S	12E	13	75.1	513	4350	Staff Recorder	X	1914* 26, 1954-	18	USGS
19	Sycan River near Silver Lake	4980	32S	14E	21	46.4	100	5000	Recorder		1918-22	0	USGS
20	Sycan River at Sycan Marsh near Silver Lake	4981	32S	14E	19	43.3	220	5000	Staff		1905-06	0	USGS
21	Long Creek near Silver Lake	4985	32S	13E	6		40	5100	Recorder		1918* 24,1927* 29	2	USGS
22	Sycan River near Beatty	4990	35S	12E	8	9.3	540	4400	Recorder		1912* 16,1917-25	9	USGS
23	Whiskey Creek near Beatty	4995	36S	12E	19		51	4300	Staff		1917-19	1	USGS
24	Sprague River near Yainax	5000	36S	10S	11	50.8	1270	4300	Staff		1904-05	0	USGS
25	Sprague River near Chiloquin	5010	34S	7E	35	5.3	1580	4202	Recorder	X	1920-21,1921-	48	USGS
26	Sprague River near Chiloquin	5020	35S	7E	3	0.6	1600	4180	Recorder		1911-16, 17-19, 1923* 25	7	USGS
27	Williamson River below Sprague River near Chiloquin	5025	35S	7E	4	10.9	3000	4156	Recorder	X	1917-	52	USGS
28	Anna Creek near Fort Klamath	5035	32S	6E	36	5.3	40	4300	Staff		1923-27	3	USGS
29	Sun Creek at Ranger Station near Fort Klamath	(8323)	32S	7½E	29				Staff		1927	0	OSE
30	Sun Creek at Dixon's Ranch	(8330)	33S	7½E	4				Staff		1927	0	OSE
31	Wood River at Cardwell Ranch near Fort Klamath	(8324)	33S	7½E	3	16.4		4912	Staff		1927-28	0	OSE
32	Wood River near Fort Klamath	5040	33S	7½E	22	12.5	90	4167	Staff		1911* 22,23-36	18	USGS
33	Fort Creek near Fort Klamath	(8328)	33S	7½E	27				Staff		1927*	0	OSE
34	Wood River at Loosley Ranch near Fort Klamath	(8325)	33S	7½E	34	7.5			Staff		1927*	0	OSE
35	Wood River at Wood Ranch near Fort Klamath	(8329)	34S	7½E	3	6.3			Staff		1927*	0	OSE
36	Wood River near Fort Klamath	5041	34S	7½E	10	5.7	88	4150	Recorder		1964-67	2	USGS
37	Crooked Creek near Fort Klamath	5042	34S	7½E	13		6	4150	Staff		1964-67	2	USGS
38	Sevenmile Creek at Ranger Station near Fort Klamath	(8331)	33S	6E	11	17.3			Staff		1927*	0	OSE
39	Sevenmile Creek at Loosley Ranch near Fort Klamath	(8322)	34S	6E	1	10.8			Staff		1927*	0	OSE
40	Crane Creek at Loosley Ranch near Fort Klamath	(8326)	34S	6E	1				Staff		1927*	0	OSE
41	Fourmile Creek near Odessa	5055	36S	5E	9	10.1	11	5730	Recorder		1912* 17	3	USGS
42	Fourmile Creek near Rocky Point	5056	36S	6E	9	2.1	105	4150	Staff		1964-67	0	USGS
43	Varney Creek near Rocky Point	5057	36S	6E	9		7	4150	Staff		1964-67	0	USGS
44	Link River and "A" Canal at Klamath Falls	(833-b)	38S	9E	30				Recorder		1924-41	18	OSE
45	Link River at Klamath Falls	5075	38S	9E	32		3810	4084	Recorder	X	1904-	66	USGS
46	Link River and Keno Canal at Klamath Falls	(833-a)	38S	9E	32		3800		Recorder		1924-41	18	OSE
47	Klamath River at Keno	5095	39S	7E	35	231.4	3920	3970	Recorder	X	1904-14,1930-	64	USGS
48	Spencer Creek near Keno	5100	39S	7E	20	0.5	90	3820	Staff		1929-32	3	USGS
49	Klamath River at Spencer Bridge near Keno	5105	39S	7E	31	225.3	4050	3775	Recorder		1914-31	18	USGS
50	Klamath River below John C. Boyles Power Plant near Keno	5107	40S	6E	14	19.1	4080	3275	Recorder	X	1959-	10	OSE
51	Grizzly Creek near Lilyglen	5130	38S	4E	33	2.2	30	4407	Recorder		1916*-19, 31* 42-43, 50-53	22	USGS
52	Little Beaver Creek at Pinehurst	5135	40S	4E	4	13.3	13	3349	Recorder		1944-48	5	USGS
53	Keene Creek near Ashland	5145	39S	3E	21	10.6	12	4706	Recorder		1917* 22,1949-65	18	USGS
54	Keene Creek at Keene Ranch near Ashland	5155	39S	3E	29	8.6	18	4588	Recorder		1918-19	0	USGS
55	Keene Creek near Lincoln	5160	39S	3E	33	7.6	19	4420	Recorder		1944 - 48	5	USGS

TABLE A
HYDROLOGICAL STATION SUMMARY
KLAMATH DRAINAGE BASIN
OREGON
(continued)

MAP INDEX NO.	NAME	STATION NO.	LOCATION Twp.	Rng.	Sec.	STREAM MILE	DRAINAGE AREA Sq.Mi.	ELEVATION Feet	TYPE	ACTIVE 1969	WATER YEARS OF RECORD	COMPLETE WATER YEARS	SOURCE
	STREAM GAGES												
56	Anderson Creek near Klamath Falls	(8216)	37S	9E	23		30		Recorder		1946-49	0	OSE
	CREST STAGE GAGE												
57	Mosquito Creek near Shevlin	4918	28S	10E	32		2	4920		X	1965-	0	USGS
58	Brownsworth Creek near Bly	4948	36S	16E	28		2	5480		X	1965-	0	USGS
59	Currier Creek near Paisley	4978	33S	16E	18					X	1965-	0	USGS
60	Crystal Creek near Chiloquin	5013	35S	7E	2		6	4190		X	1965-	0	USGS
61	Threemile Creek near Crystal	5044	34S	6E	3		10	4570		X	1965-	0	USGS
62	Lost Creek near Rocky Point	5055.5	35S	5E	26		13	5320		X	1965-	0	USGS
63	Klamath River Tributary near Keno	5094	39S	7E	35		1	4240		X	1963-	0	USGS
	CANAL GAGES												
64	South Fork Little Butte Canal near Pinehurst	3394	38S	4E	7			4640	Recorder	X	1959-68	9	OSE
65	Dead Indian Canal near Pinehurst	3404	38S	3E	15			4540	Recorder	X	1958-68	4	OSE
66	Olene Westeway at Olene	4855	39S	10E	14			4100	Staff		1915-18	0	USGS
67	Lost River Diversion Canal near Olene	4860	39S	10E	29			4080	Staff		1912-15, 16-19, 20-69	53	USGS
68	"G" Canal near Olene	4865	39S	10E	29			4080	Recorder		1912-18	0	USGS
69	Ady Pumps to Klamath River at Ady (Pump "F")	4910	40S	8 E	23			4082	Pump Records	X	1943-	19	USGS
70	Bly Canal near Bly	4950	37S	15E	8			4500	Staff		1925-26	0	USGS
71	Sprague River Irrigation Company's Canal near Bly	4960	36S	14E	10			4600	Staff		1918, 25-26	0	USGS
72	Modoc Point Canal near Chiloquin	5015	35S	7E	3			4200	Staff		1915" 21,1923" 27	0	USGS
73	Melhase Ditch near Fort Klamath	(8327)	33S	7½E	15				Staff		1927	0	OSE
74	Cascade Canal at Fourmile Lake near Lakecreek	5046	36S	5E	9			5744	Staff	X	1923-31, 33-43, 45-54, 57-68 68-	5	OSE
75	Cascade Canal near Fish Lake	5050	36S	5E	30			5235	Recorder	X	1924" 1925-	0	OSE
76	"A" Canal at Klamath Falls	5060	38S	9E	30			4126	Recorder	X	1911-	0	USGS
77	Keno Canal at Klamath Falls	5065	38S	9E	32				Staff		1923-50,50-52	18	USGS
78	Diversion from Klamath River to Lost River near Olene	5085	39S	10E	31			4080	Staff		1931-69	29	OSE
79	Diversion from Klamath River to Midland Canal near Midland	5091	40S	8E	1			4100	Staff		1947-69	23	USGS
80	Diversion from Klamath River at Ady	5090	40S	8E	23			4082	Staff		1943-69	26	USGS
81	Keene Creek Canal near Ashland	5150	39S	3E	29			4706	Recorder		1923-28,1929" 31	14	OSE
82	Diversion near Ashland Diversion from Klamath River	5161	39S	3E	32			2162	Meter		1960-65	5	USGS
	RESERVOIR GAGES												
83	Gerber Res. near Lorelle	4834	39S	13E	12	12	220	4800	Staff	X	Feb. 1925 Sept. 1968	44	OSE
84	Crater Lake nr. Crater Lake	4922	30S	6E	12		26.2	6163	Recorder	X	1961-	9	USGS
85	Fourmile Lake near Recreation	5045	36S	5E	9	10.1	10.6	5980	Staff	X	1923-	36	OSE
86	Upper Klamath Falls near Klamath Falls	5070	38S	9E	19		3810	4098	Recorder	X	1904-23,1923-	47	OSE
87	Howard Prairie Lake near Pinehurst	5129	38S	4E	32	3	27.6	4503	Mercury Staff	X	1958-	10	USGS OSE
88	Howard Prairie Lake near Pinehurst	5129.2	38S	4E	32	3			Meter	X	1959-	10	USGS OSE
89	Hyatt Reservoir near Ashland	5140	39S	3E	16	11	11.2	5016	Staff	X	1922-	42	OSE
	WATER TEMPERATURE GAGES												
(84)	Crater Lake near Crater Lake	4922	30S	6E	12		26.2		Recorder		1963-64	1	USGS (1964)
(12)	Williamson River near Klamath Agency	4935	33S	7E	1	27.1	1290		Spot		1954-62		USGS
(18)	Sprague River near Beatty	4975	36S	12E	13	75.2	513		Spot		1953-62		USGS
(25)	Sprague River near Chiloquin	5010	34S	7E	35	5.4	1580		Spot		1947-58,1960-62		USGS
(27)	Williamson River below Sprague River near Chiloquin	5025	35S	7E	4	10.8	3000		Spot		1941-62		USGS
90	Crooked Creek near Klamath Agency		34S	7½E	1				Daily		1943-45	1	USGS
(77)	Keno Canal at Klamath Falls	5065	38S	9E	32				Spot		1947" 62		USGS
(45)	Link River at Klamath Falls	5075	38S	9E	32		3810		Spot		1947-62		USGS
(47)	Klamath River at Keno	5095	39S	7E	35	231.4	3920		Spot		1947-57,1958" 62		USGS
(53)	Keene Creek near Ashland	5145	39S	3E	21	10.6	12		Spot		1948-58,1959-65		USGS
	WATER QUALITY												
91	Lost River at Harpold Dam		39S	11E	9	40.7				X	1968-		DEQ
92	Lost River at Merrill Road Bridge		40S	10E	34	13.2				X	1969-		DEQ
93	Lost River at Diversion Dam near Malone		41S	11E	7	7.7				X	1968-		DEQ
94	Lost River Diversion Channel below Wilson Bridge		41S	11E	8	7.0				X	1968-		DEQ

TABLE A

HYDROLOGICAL STATION SUMMARY

KLAMATH DRAINAGE BASIN

OREGON

(continued)

MAP INDEX NO.	NAME	STATION NO.	LOCATION Twp.	LOCATION Rng.	LOCATION Sec.	STREAM MILE	DRAINAGE AREA Sq.Mi.	ELEVATION Feet	TYPE	ACTIVE 1969	WATER YEARS OF RECORD	COMPLETE WATER YEARS	SOURCE
	WATER QUALITY												
95	Williamson River 1½ miles above Chiloquin	K-2	34S	7E	27	12.8				X	1959-61,1967-		DEQ
96	Sprague River ½ mile above Chiloquin	K-1	35S	7E	3	0.5				X	1959-		DEQ
97	Williamson River at Highway 97 Bridge		35S	7E	21	7.1				X	1959-		DEQ
98	Williamson River at Williamson River Store	K-3	35S	7E	30	4.8					1959-61		DEQ
99	Exit of Klamath Lake at Fremont Street Bridge, Klamath Falls	K-4	38S	9E	30	254.2				X	1959-		DEQ
100	Link River Highway 97 Bridge 3½ miles South of Klamath Falls	K-5	39S	9E	18	248.3				X	1959-		DEQ
(69)	Klamath Straight at Pumping Plant "F"	4910	10S	8E	23	1.7				X	1968-		DEQ
101	Klamath River at Keno (above dam)		40S	8E	6	234.9				X	1959-		DEQ
102	Klamath River at Keno Bridge	K-6	39S	8E	31	234.4					1959-61		DEQ
103	Klamath River below Big Bend Powerhouse	K-7	40S	6E	14	219.9				X	1959-		DEQ
	CLIMATOLOGICAL STATIONS												
104	Bly Ranger Station	0853	36S	14E	34			4360	P	X	1948° 53,53-62, 1962, 63, 63-	13	USWB
105	Bryant Mountain	1087	40S	13E	19			5720	SGP		1968-		OSE
106	Chemult	1546	27S	8E	21			4760	P,T	X	1937-	32	USWB
107	Chiloquin	1571	34S	7E	34			4198	P,T	X	1884-88, 96-98, 1908° 10,1911-	65	USWB
108	Crater Lake National Park Headquarters	1946	31S	6E	8			6475	P,T	X	1931-	39	USWB
109	Crater Lake (North Rim) Crater Lake 7 NNE	1951	30S	6½E	(UNS.)			6800	SGP SGP	X	1963-68 1965-66		USWB USWB
110	Dairy 3 NE (Yonna)	2018	38S	11E	19			4150	P,T		1931-44,1945° 53	15	USWB
111	Fish Lake	2928	37S	4E	3			4840	P,T		1918-65	46	USWB
112	Fort Klamath		33S	7E	35			4160	P,T		1865° 66, 72° 75, 75-89, 1896-98	15	USWB
113	Fort Klamath 7 SW	3022	34S	6E	11			4160	P,T		1953-60	7	USWB
114	Gerber Dam	3232	39S	13E	12			4850	P	X	1926-57, 58-60 60-	39	USWB
115	Green Springs Power Plant	3509	40S	2E	3			2435	P	X	1961-	9	USWB
116	Howard Prairie Dam	4060	38S	4E	32			4567	P,T	X	1961-	9	USWB
117	Keno	4403	39S	7E	36			4116	P	X	1928-	42	USWB
118	Klamath Falls	4506	38S	9E	32			4098	P,T		1884-89, 94° 95, 1898° 1903, 1904-	72	USWB
119	Klamath Falls Airport	4511	39S	9E	22			4065	P,T		1948,1948-59	9	USWB
120	Lilyglen		38S	3E	15			4537	P		1908-09° 1910-20	11	USWB
121	Malin	9964	41S	11E	16			4050	P,T	X	1925-46,1968-	23	USWB
122	Merrill 2 NW	5505	40S	10E	34			4080	P,T		1906-17, 1927° 28, 1949° 52, 1952-68	36	USWB
123	Paisley (Near)		33S	17E	5			4209	P,T		1892, 1906-12, 1913-19	10	USWB
124	Quartz Mountain Summit	6948	37S	16E	33			5630	SGP	X	1963-		OSE USWB
125	Rocky Point 3 S	7285	36S	6E	14			4150	P,T	X	1967-	3	USWB
126	Round Grove	7354	37S	15E	25			4888	P,T	X	1920-	50	USWB
127	Sand Creek	7533	32S	7E	6			4682	P,T		1929-46, 1946, 1947-48	17	USWB
128	Seven Lakes	7687	34S	5E	3			5980	SGP	X	1965-		OSE
129	Silver Creek	7804	29S	13E	25			4900	SGP	X	1963-		OSE USWB
130	Silver Lake 1 SW	7815	28S	11E	36			4996	P,T		1967° 68		USWB
131	Siskiyou Summit WB	7850	40S	2E	20			4125	P,T	X	1899-1900,1912-30, 35-48	31	USWB
132	Sprague River	8007	36S	10E	14			4360	P,T	X	1953-54, 54-65, 65-67, 1967	12	USWB
133	Strawberry Snow Course	8155	40S	16E	4			5760	SGP	X	1964		OSE USWB
134	Summer Lake 1 S	8173	31S	16E	3			4192	P,T	X	1957-	12	USWB
135	Summer Rim Snow Course	8177	33S	16E	15			7200	SGP	X	1963-		OSE USWB
136	Taylor Butte	8357	33S	11E	21			5040	SGP	X	1964-		OSE
137	Tule Lake		41S	11E	6			4055	P		1915-23	7	USWB
138	Yamsey Mountain	9570	30S	12E	28			7380	SGP	X	1967-		OSE
	SNOW SURVEY COURSES												
139	Annie Spring	22G6	31S	6E	19			6018	SS	X	1929-		SCS
140	Beatty	1FP&L	36S	12E	22			4300	SS	X	1927-		SCS
141	Billie Creek Divide	22G13	36S	5E	30			5300	SS	X	1929-		SCS
142	Bly Mountain	21G8M	37S	11E	15/22			5090	SS,SM	X	1957-		SCS
143	Bly 101 Ranch	10FP&L	35S	14E	22			4800	SS	X	1927-		SCS

TABLE A

HYDROLOGICAL STATION SUMMARY

KLAMATH DRAINAGE BASIN

OREGON

(continued)

MAP INDEX NO.	NAME	STATION NO.	LOCATION Twp.	LOCATION Rng.	LOCATION Sec.	STREAM MILE	DRAINAGE AREA Sq.Mi.	ELEVATION Feet	TYPE	ACTIVE 1969	WATER YEARS OF RECORD	COMPLETE WATER YEARS	SOURCE
	SNOW SURVEY COURSES												
(106)	Chemult	21F11	27S	8E	21			4760	SS	X	1937-		SCS
(107)	Chiloquin	3PP&L	34S	7E	34			4187	SS	X	1927-		SCS
144	Chemult	2PP&L	27S	8E	21			4760	SS		1927-66		SCS
145	Cold Springs Camp	22G24	35S	5E	12			6100	SS	X	1959-		SCS
146	Crazyman Flat	20G12a	34S	15E	9			6100	ASD	X	1958-		SCS
147	Crystal	4PP&L	34S	6E	26			4200	SS	X	1930-		SCS
148	Diamond Lake	13PP&L	27S	6E	29			5200	SS		1929-37, 1937-50		SCS
149	Diamond Lake Junction 97	21F18	29S	7E	1			4600	SS	X	1959-		SCS
150	Diamond-Crater Summit	22F19	28S	6E	34			5800	SS	X	1959-		SCS
151	Dog Hollow	21G6a	40S	14E	1			4900	ASD	X	1958-		SCS
152	Finley Corrals	20G14a	36S	16E	11			6000	ASD	X	1958-		SCS
153	Fort Klamath	5PP&L	33S	7½E	22			4150	SS	X	1927-		SCS
154	Fourmile Lake	22G12	36S	5E	9			6000	SS	X	1930* 1950-		SCS
(114)	Gerber Dam	21G4P	39S	13E	12			4850	SS,P	X	1949-		SCS
155	Harriman Lodge	8PP&L	36S	6E	3			4200	SS	X	1927-		SCS
156	Howard Prairie	22G26	38S	4E	32			4500	SS	X	1959-		SCS
157	Hyatt Prairie Reservoir	22G16	39S	3E	15			4900	SS	X	1929* 32, 1935-		SCS
158	Kirk	6PP&L	33S	7E	1			4533	SS		1927-66		SCS
159	Lake of the Woods	22G15	37S	5E	11			4960	SS	X	1937-		SCS
160	Lake of the Woods	7PP&L	37S	5E	15			4960	SS		1927-51		SCS
(108)	Park Headquarters	22G5	31S	6E	8			6450	SS	X	1943-		SCS
161	Pelican Guard Station	22G25	36S	6E	9			4150	SS	X	1959-		SCS
162	Quartz Mountain	20G6MP	38S	16E	2			5320	SS,SM,P	X	1929* 38, 1938		SCS
(124)	Quartz Mountain Summit	9PP&L	37S	16E	33			5500	SS	X	1930-		SCS
163	Rocky Point	11PP&L	35S	6E	26			4150	SS		1927-42		SCS
(133)	Strawberry	20G9AP	40S	16E	4			5760	SS,P	X	1938-		SCS
(135)	Summer Rim	20G2AP	33S	16E	15			7200	P, ASD	X	1936-		SCS
164	Seven Lakes No. 1	22G10P	34S	5E	3			6800	SS		1936-69		SCS
165	Seven Lakes No. 2	22G11	33S	5E	26			6200	SS	X	1936-		SCS
166	Sun Mountain	21G2	32S	7½E	22			5350	SS	X	1937-		SCS
167	Sycan Flat	20G13a	31S	14E	25			5500	ASD	X	1958-		SCS
(136)	Taylor Butte	21G3AP	33S	11E	16 & 31			5100	ASD,P	X	1937* 54, 1955-		SCS
168	Yamsey	12PP&L	31S	11E	20			4600	SS		1929-65, 65-69		SCS
169	Yamsey Mountain	21G1	30S	12E	10			6500	SS		1929* 34		SCS

Notes: Map index numbers refer to SWRB Hydrological Station Map.

Station numbers in parenthesis refer to numbering system prior to September 30, 1951.

* Denotes incomplete years of record

ABBREVIATIONS

DEQ = Department of Environmental Quality
OSE = Oregon State Engineer
SCS = Soil Conservation Service
USGS = U. S. Geological Survey
USWB = U. S. Weather Bureau

ASD = Aerial Snow Depth Gage
P = Precipitation
SGP = Storage Gage Precipitation
SM = Soil Moisture
SS = Snow Survey Course
T = Air Temperature

TABLE A

HYDROLOGICAL STATION SUMMARY

UPPER KLAMATH DRAINAGE BASIN

CALIFORNIA

MAP INDEX NO.	NAME	STATION NO.	LOCATION Twp.	Rng.	Sec.	STREAM MILE	DRAINAGE AREA Sq.Mi.	ELEVATION Feet	TYPE	ACTIVE 1969	WATER YEARS OF RECORD	COMPLETE WATER YEARS	SOURCE
	STREAM GAGES												
1	Lost River at Clear Lake California	4834.2	47N	8E	8		550	4460	Staff		1904-09, 18-50	44	USGS
2	Willow Creek nr. Dorris		46N	2E	9						1953-54		USBR
3	Cottonwood Creek nr. Dorris		47N	2E	18						1953-54		USBR
4	Hot Creek nr. Dorris		47N	1E	3						1953-54		USBR
5	Sheepy Creek nr. Dorris		48N	1E	35						1953-54		USBR
6	Antelope Creek nr. Tennant	4895	43N	1W	25		18.6	5080	Recorder	X	1952-	17	USGS
7	Antelope Creek nr. Macdoel	4900	43N	1W	12		30	5080	Weir & Recorder		1921-22*		USGS
8	Butte Creek nr. Macdoel	4905	45N	1W	30		178	4300	Recorder		1921-22, 51-60	8	USGS
9	Prather Creek nr. Mt. Hebron		45N	2W	5		4				1951-54		USBR
10	Muskgrave Creek nr. Macdoel		46N	2W	8		3				1953-54		USBR
11	Harris Creek nr. Macdoel		46N	2W	6		2				1953-54		USBR
12	Ikes Creek nr. Macdoel		46N	2W	6		4				1953-54		USBR
	CLIMATOLOGICAL STATIONS												
13	Beswick 7S	0715	47N	3W	33			6140	P, T	X	1952	17	DWR
14	Bray 10 WSW	1050	43N	3W	24			5759	P, T	X	1951-	18	USWB
									SGP		1966-67	1	DWR
(1)	Clear Lake Dam	1805	47N	8E	8			4500	P, T		1907-13, 23-55	38	DWR
15	Crowder Flat	2188	47N	11E	20			5175	P, T	X	1958-	11	Private
									SGP		1966-67	1	DWR
16	Dorris Inspect Sta.	2480	48N	1W	36			4240	P, T	X	1959-	10	Private
17	Grass Lake HMS	3564	44N	3W	28			5080	P, T	X	1954-	15	USWB
18	Lava Beds National Mon.	4838	45N	4E	28			4770	P, T	X	1940-	29	USWB
19	Medicine Lake	5505	43N	3E	10			6660	P, T	X	1946-	23	USWB
									SGP		1966-67	1	DWR
20	Mount Hebron R. S.	5941	46N	1W	32			4250	P, T	X	1942-	27	USWB
21	Mount Hebron SE	5940	45N	1E	11			4396	P		1952		USWB
22	Steele Swamp		47N	9E	33			5000	P		1923-49	26	USWB
(7)	Tennant	8860	43N	1W	12			4750	P		1952		USWB
23	Tulelake	9053	47N	5E	6			4035	P, T	X	1932-	37	USWB
24	Tulelake		48N	4E	26			4036	P		1932-54	22	USWB
25	Tulelake 5 WSW	9056	47N	4E	7			4033	P, T		1943-51	8	USWB
26	Tulelake Insp. Sta.	9057	44N	7E	31			4408	P, T	X	1953-	16	Private
27	Willow Creek Ranch	9691-92	46N	11E	6			5200	P, T	X	1960-	9	USGS
	SNOW SURVEY COURSES												
28	Crowder Flat	20H2a	47N	11E	30			5200	ADS	X	1939-44, 46-53 1958-		SCS
29	State Line	20H1a	48N	11E	21			5750	ADS	X	1958-		SCS

Notes: Map index numbers refer to SWRB Hydrological Station Map.

* Denotes incomplete years of record

ABBREVIATIONS

DWR = Department of Water Resources, Northern District
SCS = Soil Conservation Service
USBR = U. S. Bureau of Reclamation
USGS = U. S. Geological Survey
USWB = U. S. Weather Bureau

ASD = Aerial Snow Depth Gage
P = Precipitation
SGP = Storage Gage Precipitation
T = Air Temperature

TABLE B

SURFACE WATER RIGHTS SUMMARY
in Cubic Feet per Second

SUBBASIN	CONSUMPTIVE						NONCONSUMPTIVE					
	Dom.	Mun.	Ind.	Irr.	Acres	Total	Pwr.	Fish	Mining	Rec.	Total	Total Rights
1. Williamson River												
Williamson R.	0.100	4.055	63.500	282.290	21,324.70	349.945	0	0	0	0	0	349.945
Haystack Draw & Misc.	0	0	0	2.950	236.00	2.950	0	0	0	0	0	2.950
Sand Cr. & Misc.	0	0	0	3.260	227.10	3.260	0	0	0	0	0	3.260
Deep Cr. & Misc.	0	0	0	17.500	700.10	17.500	0	0	0	0	0	17.500
Jackson Cr.	0.020	0	0	25.780	1,173.40	25.800	0	0	0	0	0	25.800
Big Springs Cr. & Misc.	0	0	0	36.390	2,910.90	36.390	0	0	0	0	0	36.390
Sand Cr. & Misc.	0	0.150	0	50.840	3,408.60	50.990	0	0	0	0	0	50.990
Scott Cr. & Misc.	0	0	0	4.790	383.20	4.790	0	0	0	0	0	4.790
Spring Cr.	0	0	0	0.320	16.10	0.320	0	0	0	0	0	0.320
Sprague R. (Part, Mi. 0-5)	0	0	0	0.440	17.60	0.440	0	0	0	0	0	0.440
East Upper Klamath Lake	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0.120	4.205	63.500	424.560	30,397.70	492.385	0	0	0	0	0	492.385
2. Sprague River												
Sprague R. (-)	0.020	0	0	132.028	8,043.90	132.048	0	0	0	0	0	132.048
South Fork Sprague R.	0.600	0	0.450	123.998	5,283.50	125.048	0	0	0	0	0	125.048
Fishhole Cr.	0.510	0	0.900	47.602	2,228.10	49.012	0	1.000	0	0	1.000	50.012
Deming Cr.	0	0	0	28.513	1,270.90	28.513	0	0	0	0	0	28.513
North Fork Sprague R.	0.500	0	0	99.110	4,121.00	99.610	0	0	0	0	0	99.610
Meryl Cr.	0.340	0	0	16.128	821.30	16.468	0	0	0	0	0	16.468
Fivemile Cr.	0.016	0	0.020	16.696	942.10	16.732	0	0	0	0	0	16.732
Sycan R.	0	0	0.150	15.135	820.90	15.285	0	0	0	0	0	15.285
Long Cr. &	0	0	0.810	24.630	1,410.20	25.440	0	0	0	0	0	25.440
Snake Cr.	0.005	0	0	0.055	3.00	0.060	0	0	0	0	0	0.060
Whiskey Cr.	0	0	0	38.750	2,316.60	38.750	0	0	0	0	0	38.750
Trout Cr.	0.100	0	0	1.740	139.00	1.840	0	0	0	0	0	1.840
TOTAL	2.091	0	2.330	544.385	27,400.50	548.806	0	1.000	0	0	1.000	549.806
3a. Wood River												
Wood River	0.500	0	0	302.892	22,266.15	303.392	0	0	0	0	0	303.392
Annie Cr. & Misc.	2.810	1.260	0	120.465	10,003.79	124.535	0	0	0	0	0	124.535
Sun Cr. & Misc.	0.400	0.580	0	20.535	1,026.74	21.515	0	0	0	0	0	21.515
Fort Cr. & Misc.	0	0	0	40.124	2,159.55	40.124	0	0	0	0	0	40.124
Crooked Cr.	0.100	0	0	20.760	1,076.75	20.860	0	20.000	0	0	20.000	40.860
Sevenmile Cr.	1.225	0	0	206.783	13,371.28	208.008	0	0	0	0	0	208.008
Fourmile Cr.	0	0	0	27.750	2,216.63	27.750	0	0	0	0	0	27.750
Threemile Cr.	0.500	0	0	5.230	421.50	5.730	0	0	0	0	0	5.730
Cherry Cr.	0	0	0	13.400	1,069.10	13.400	0	0	0	0	0	13.400
West Upper Klamath Lake	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	5.535	1.840	0	757.939	53,611.49	765.314	0	20.000	0	0	20.000	785.314
3b. Upper Klamath Lake												
Fourmile Cr.	0.210	0 1/	0 1/	0 1/	0 1/	0.210	0	0	0	0	0	0.210
Moss Cr.	0	0	0	1.500	93.66	1.500	0	0	0	0	0	1.500
Aspen Lake & Misc.	0	0	0	29.200	2,104.74	29.200	10.000	0	0	0	0	39.200
E&W Upper Klamath Lake	0	0.070	0	113.860	9,084.20	113.930	0	0	0	0	0	113.930
TOTAL	0.210	0.070	0	144.560	11,282.60	144.840	10.000	0	0	0	10.000	154.840
4a. Swan Lake												
Swan Lake & Misc.	0.120	0	0	88.611	4,934.40	88.731	0	0	0	0	0	88.731
TOTAL	0.120	0	0	88.611	4,934.40	88.731	0	0	0	0	0	88.731
4b. Lost River												
Lost R.	5.194	0	0	148.368	12,263.60	153.562	5.000	0	0	0	5.000	158.562
Willow Cr. & Misc.	0.050	0	0	10.100	1,296.90	10.150	0	0	0	0	0	10.150
Rock Cr.	0	0	00	7.340	523.30	7.340	0	0	0	0	0	7.340
Miller Cr. & Misc.	0.400	0	0	61.507	4,681.40	61.907	0	0	0	0	0	61.907
Buck Cr. & Misc.	0.370	0	0	8.791	601.32	9.161	0	0	0	0	0	9.161
Mills Cr. & Misc.	0.010	0	0	6.930	552.68	6.940	0	0	0	0	0	6.940
West Upper Klamath Lake	0	0	0	15.680	1,136.00	15.680	0	0	0	0	0	15.680
East Upper Klamath Lake	0.100	0.320	1.510	0.510	24.75	2.030	1,000.000	0	0	0	1,000.000	1,002.030
Klamath R. (Part, Str. Mi. 250-233)	0.240	0	21.400	90.990	6,456.88	112.630	0	0.400	0	0	0.400	113.030
TOTAL	6.364	0.320	22.500	350.216	27,536.83	379.400	1,005.000	0.400	0	0	1,005.400	1,384.800
5. Klamath River												
Klamath R. (-)	0.280	0	0	5.030	380.40	5.310	2,500.000	0	0	0	2,500.000	2,505.310
Spencer Cr. & Misc.	0	0	0.300	0	0	0.300	0	3.000	0	0	3.000	3.300
Jenny Cr.	0.040	0.070	0	14.890	845.90	15.000	0	0	0	0	0	15.000
Grizzley Cr.	0.070	0	0	5.685	450.60	5.755	60.000	0	0	0	60.000	65.755
Beaver Cr.	0.210	0	0	1.710	124.20	1.920	24.000	0	0	0	24.000	25.920
Keene Cr.	0.365	0	0.570	2.320	185.00	3.255	160.000 2/	0.750	0	0	160.750	164.005
Cottonwood Cr. & Misc.	0.180	0	0.310	0.550	42.90	1.040	0	0	3.000	0	3.000	4.040
Indian Cr.	0	0	0	0	0	0	0	0	11.000	0	11.000	11.000
TOTAL	1.145	0.070	1.180	30.185	2,029.00	32.580	2,744.000	3.750	14.000	0	2,761.750	2,794.330
BASIN TOTAL	15.585	6.505	89.510	2,340.456	157,192.52	2,452.056	3,759.000	25.150	14.000	0	3,798.150	6,250.206

1/ Excludes out of basin diversion.

2/ Out of basin power diversion.

TABLE C

LEGAL SURFACE WATER RIGHTS DEPLETIONS
Acre-Feet

SUBBASIN	CONSUMPTIVE						NONCONSUMPTIVE					
	Dom.	Mun.	Ind.	Irr.	Acres	Total	Pwr.	Fish & Wildlife	Mining	Rec.	Total	Total Rights
1. Williamson River												
Williamson R.	72	2,936	45,972	63,974	21,324.70	112,954	0	0	0	0	0	112,954
Haystack Draw & Misc.	0	0	0	708	236.00	708	0	0	0	0	0	708
Sand Cr. & Misc.	0	0	0	681	227.10	681	0	0	0	0	0	681
Deep Cr. & Misc.	0	0	0	2,100	700.10	2,100	0	0	0	0	0	2,100
Jackson Cr.	14	0	0	3,519	1,173.10	3,533	0	0	0	0	0	3,533
Big Springs Cr. & Misc.	0	0	0	8,733	2,910.90	8,733	0	0	0	0	0	8,733
Sand Cr. & Misc.	0	109	0	10,226	3,408.60	10,335	0	0	0	0	0	10,335
Scott Cr. & Misc.	0	0	0	1,150	383.20	1,150	0	0	0	0	0	1,150
Spring Cr.	0	0	0	48	16.10	48	0	0	0	0	0	48
Sprague R. (Part Mi. 0-5)	0	0	0	53	17.60	53	0	0	0	0	0	53
East Upper Klamath Lake	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	86	3,045	45,972	91,192	30,397.70	140,295	0	0	0	0	0	140,295
2. Sprague River												
Sprague R. (-)	14	0	0	24,132	8,043.90	24,146	0	0	0	0	0	24,146
South Fork Sprague R.	434	0	326	15,851	5,283.50	16,611	0	0	0	0	0	16,611
Fishhole Cr.	369	0	652	6,684	2,228.10	7,705	0	724	0	0	724	8,429
Deming Cr.	0	0	0	3,813	1,270.90	3,813	0	0	0	0	0	3,813
North Fork Sprague R.	362	0	0	12,363	4,121.00	12,725	0	0	0	0	0	12,725
Meryl Cr.	246	0	0	2,464	821.30	2,710	0	0	0	0	0	2,710
Fivemile Cr.	12	0	14	2,826	942.10	2,852	0	0	0	0	0	2,852
Sycan R.	0	0	109	2,463	820.90	2,572	0	0	0	0	0	2,572
Long Cr.	0	0	586	4,231	1,410.20	4,817	0	0	0	0	0	4,817
Snake Cr.	4	0	0	9	3.00	13	0	0	0	0	0	13
Whiskey Cr.	0	0	0	6,950	2,316.60	6,950	0	0	0	0	0	6,950
Trout Cr.	72	0	0	417	139.00	489	0	0	0	0	0	489
TOTAL	1,513	0	1,687	82,203	27,400.50	85,403	0	724	0	0	724	86,127
3a. Wood River												
Wood R.	362	0	0	111,331	22,226.15	111,693	0	0	0	0	0	111,69[illegible]
Annie Cr. & Misc.	2,034	912	0	30,011	10,003.79	32,957	0	0	0	0	0	32,957
Sun Cr. & Misc.	290	420	0	3,080	1,026.74	3,790	0	0	0	0	0	3,790
Fort Cr. & Misc.	0	0	0	10,798	2,159.55	10,798	0	0	0	0	0	10,798
Crooked Cr.	72	0	0	5,384	1,076.75	5,456	0	14,479	0	0	14,479	19,935
Sevenmile Cr.	887	0	0	40,114	13,371.28	41,001	0	0	0	0	0	41,001
Fourmile Cr.	0	0	0	6,650	2,216.63	6,650	0	0	0	0	0	6,650
Threemile Cr.	362	0	0	1,265	421.50	1,627	0	0	0	0	0	1,627
Cherry Cr.	0	0	0	3,207	1,069.10	3,207	0	0	0	0	0	3,207
West Upper Klamath Lake	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4,007	1,332	0	211,840	53,611.49	217,179	0	14,479	0	0	14,479	231,658
3b. Upper Klamath Lake												
Fourmile Cr.	152	0 1/	0 1/	0	0 1/	152	0	0	0	0	0	152
Moss Cr.	0	0	0	281	93.66	281	0	0	0	0	0	281
Aspen Lake & Misc.	0	0	0	6,314	2,104.74	6,314	7,240	0	0	0	7,240	13,554
E. & W. Upper Klamath Lake	0	51	0	27,253	9,084.20	27,304	0	0	0	0	0	27,304
TOTAL	152	51	0	33,848	11,282.60	34,051	7,240	0	0	0	7,240	41,291
4a. Swan Lake												
Swan Lake & Misc.	87	0	0	14,803	4,934.40	14,890	0	0	0	0	0	14,890
TOTAL	87	0	0	14.803	4,934.40	14,890	0	0	0	0	0	14,890
4b. Lost River												
Lost R.	3,760	0	0	360,659	12,263.60	34,419	3,620	0	0	0	3,620	38,039
Willow Cr. & Misc.	36	0	0	3,242	1,296.90	3,278	0	0	0	0	0	3,278
Rock Cr.	0	0	0	1,310	523.90	1,310	0	0	0	0	0	1,310
Miller Cr. & Misc.	290	0	0	11,704	4,681.40	11,994	0	0	0	0	0	11,994
Buck Cr. & Misc.	268	0	0	1,503	601.32	1,771	0	0	0	0	0	1,771
Mills Cr. & Misc.	7	0	0	1,382	552.68	1,389	0	0	0	0	0	1,389
West Upper Klamath Lake	0	0	0	3,408	1,136.00	3,408	0	0	0	0	0	3,408
East Upper Klamath Lake	72	232	796	74	24.75	1,174	723,970	0	0	0	723,970	725,144
Klamath R. (Part, Str. Mi. 250-233)	177	0	15,493	19,371	6,456.88	35,041	0	290	0	0	290	35,331
TOTAL	4,610	232	16,289	72,653	27,536.83	93,784	727,590	290	0	0	727,880	821,664
5. Klamath River												
Klamath R. (-)	203	0	0	1,141	380.40	1,344	1,809,925	0	0	0	1,809,925	1,811,269
Spencer Cr. & Misc.	0	0	217	0	0	217	0	2,172	0	0	2,172	2,389
Jenney Cr.	29	51	0	2,536	845.90	2,616	0	0	0	0	0	2,616
Grizzley Cr.	51	0	0	1,352	450.60	1,403	43,438	0	0	0	43,438	44,841
Beaver Cr.	152	0	0	373	124.20	525	17,375 2/	0	0	0	17,375	17,900
Keene Cr.	264	0	413	555	185.00	1,232	115,835 2/	523	0	0	116,358	117,590
Cottonwood Cr. & Misc.	130	0	224	129	42.90	483	0	0	2,172	0	2,172	2,655
Indian Cr.	0	0	0	0	0	0	0	0	7,964	0	7,964	7,964
TOTAL	829	51	854	6,086	2,029.00	7,820	1,986,573	2,695	10,136	0	1,999,404	2,007,224
BASIN TOTAL	11,284	4,711	64,802	512,625	157,192.52	593,422	2,721,403	18,188	10,136	0	2,749,727	3,343,149

1/ Excludes out-of-basin diversions

2/ Out-of-Basin Power Diversion

Data Source: State Engineer Records

TABLE D

NOTE: Appropriative rights initiated prior to December 19, 1914, and riparian rights are not included in this list. However, statements of water diversion and use for many of these rights are on file as required by Water Code Sections 5100-5108.

STATE OF CALIFORNIA
RESOURCES AGENCY
STATE WATER RESOURCES CONTROL BOARD

DIVISION OF WATER RIGHTS

MEMORANDUM CONCERNING APPLICATIONS TO APPROPRIATE WATER

CLOSED BASINS IN UPPER KLAMATH RIVER BASIN

DATE PREPARED JUNE 4, 1969

APP No.	DATE FILED	APPLICANT	SOURCE	POINT OF DIVERSION			AMOUNT		USE	STATUS
				SECTION	TWP & RANGE	B&M	CFS OR GPD	ACRE-FEET		
2234	022821	BUTTE VALLEY IRRIGATION DISTRICT	BUTTE SLOUGH	SWNW17	45N1W	M	30c	8000	I	L
11090	062245	ROBERT C LYNN	ANTELOPE CREEK	SESE07	44N1E	M	3c		IS	L
15881	0521[illegible]4	ROBERT C LYNN	ANTELOPE CREEK	SESE07	44N1E	M	3c		IS	L
19521	070760	U S KLAMATH NATL FOREST	TAMARACK SPRING	NWNW05	43N2E	M	2900G		DE	L
19523	070760	U S KLAMATH NATL FOREST	UNNAMED SPRING	SESW15	43N1W	M	1800G		DZ	L
19524	070760	U S KLAMATH NATL FOREST	UNNAMED STREAM	SWNW31	45N2E	M		0.09	SW	L
19525	070760	U S KLAMATH NATL FOREST	BAIRD SPRINGS	NESW15	43N1E	M	1400G		DZ	L
19526	070760	U S KLAMATH NATL FOREST	UNNAMED STREAM	SWNW35	45N2E	M		2	SW	L
19527	070760	U S KLAMATH NATL FOREST	ANTELOPE WELL UNDERFLOW	SESW04	44N2E	M	1200G		S	L
19807	101060	JAMES D ELLIS	ANTELOPE CREEK	NENE18	44N1E	M	1.5c	20	KS	P
20038	031661	U S BUREAU OF LAND MANAGEMENT	UNNAMED STREAM	SENE24	46N1E	M		0.5	SW	L
20038	031661	U S BUREAU OF LAND MANAGEMENT	UNNAMED STREAM	SENW25	46N1E	M		3.0	SW	L
20670	032162	U S SHASTA-TRINITY NATL FORESTS	BELNAP SPRING	SESE13	41N1E	M	1300G		DZ	L
20671	032162	U S SHASTA-TRINITY NATL FORESTS	HARRIS SPRING	NENW30	42N2E	M	1400G		DU	L
20959	092862	U S KLAMATH NATL FOREST	MUSKGRAVE CREEK	NESW18	46N2W	M	0.40c	*340	R	L
20959	092862	U S KLAMATH NATL FOREST	SEIKEL CREEK	NENE19	46N2W	M	0.13c	*340	R	L
20959	092862	U S KLAMATH NATL FOREST	3 UNNAMED SPRINGS	SENE19	46N2W	M	#0.03c	*340	R	L
20959	092862	U S KLAMATH NATL FOREST	UNNAMED STREAM	NWNW20	46N2W	M	#0.03c	*340	R	L
22982	021368	COUNTY OF SISKIYOU	MEISS LAKE	SWSW21	47N2W	M	41.25c		I	
22983	021368	ROSE M SAMMIS	SAMS NECK DRAINAGE CANAL	NWNW16	47N2W	M	4c		I	
22984	021368	ROSE M SAMMIS	MEISS LAKE	SWSW16	47N2W	M	4c		I	
22985	021368	DELLA M LUZZI	SAMS NECK DRAINAGE CANAL	NENE04	47N2W	M	4c		I	
22986	021368	DELLA M LUZZI	MEISS LAKE	NWSW21	47N2W	M	4c		I	
22998	022868	KEN-DEL RANCH A PARTNERSHIP	3 UNNAMED SPRINGS	SESE26	43N1W	M	0.085c		DZ	P
23023	040868	PAUL R & FRANCES P CAVENER	MEISS LAKE	NWNW21	47N2W	M	*4c		I	
23023	040868	PAUL R & FRANCES P CAVENER	MEISS LAKE	SWNW21	47N2W	M	*4c		I	
23025	041068	BUTTE VALLEY IRRIGATION DISTRICT	BUTTE CREEK	NWSE10	44N1W	M		10000	ID	
23076	070168	ESTATE OF CLARENCE E BULLOCK	ANTELOPE CREEK	SWSW24	43N1W	M	0.25c		M	P
22912	092767	BETTY M & J STANLEY MCCLUSKEY	SAMS NECK DRAINAGE CANAL	NENW09	47N2W	M	5.5c		I	
22912	092767	BETTY M & J STANLEY MCCLUSKEY	UNNAMED SPRING	NENE09	47N2W	M	0.25c		I	
22912	092767	BETTY M & J STANLEY MCCLUSKEY	UNNAMED SPRING	SENE09	47N2W	M	0.25c		I	
23024	040868	PAUL R & FRANCES P CAVENER	SAMS NECK DRAINAGE CANAL	SESW09	47N2W	M	*4c		I	
23024	040868	PAUL R & FRANCES P CAVENER	SAMS NECK DRAINAGE CANAL	NESW09	47N2W	M	*4c		I	

TABLE D

(Continued)

NOTE: Appropriate rights initiated prior to December 19, 1914, and riparian rights are not included in this list. However, statements of water diversion and use for many of these rights are on file as required by Water Code Sections 5100-5108.

STATE OF CALIFORNIA
RESOURCES AGENCY
STATE WATER RESOURCES CONTROL BOARD

DIVISION OF WATER RIGHTS

MEMORANDUM CONCERNING APPLICATIONS TO APPROPRIATE WATER

TULE LAKE SUMP DATE PREPARED JUNE 4, 1969

APP No.	DATE FILED	APPLICANT	SOURCE	POINT OF DIVERSION			AMOUNT		USE	STATUS
				SECTION	TWP & RANGE	B&M	CFS OR GPD	ACRE-FEET		
4159	081424	JOHNSON STOCK COMPANY	RUSSELL CANYON	NWSE20	48N6E	M		15	S	L
8925	032537	FRANK J JR & CORINNE SULLIVAN	UNNAMED STREAM	SESE35	48N6E	M		5	IS	L
8925	032537	FRANK J JR & CORINNE SULLIVAN	UNNAMED STREAM	SESW26	48N6E	M		10	IS	L
10078	112840	LOVENESS LUMBER COMPANY	BULL SPRING	NWSW20	48N6E	M	0.2C		IS	L
10078	112840	LOVENESS LUMBER COMPANY	WOODEN CREEK	SWSW20	48N6E	M	0.3C		IS	L
12840	120148	FRANK J JR & CORINNE SULLIVAN	UNNAMED STREAM	SESW26	48N6E	M		40	IX	L
12840	120148	FRANK J JR & CORINNE SULLIVAN	UNNAMED STREAM	NWNE35	48N6E	M		20	IX	L
15267	033153	FRANK J JR & CORINNE SULLIVAN	UNNAMED STREAM	NWNE35	48N6E	M		50	I	P
15268	033153	FRANK J JR & CORINNE SULLIVAN	UNNAMED STREAM	NENE35	48N6E	M		50	I	P
15269	033153	FRANK J JR & CORINNE SULLIVAN	UNNAMED STREAM	NWSW26	48N6E	M		25.75	I	P1
15269	033153	FRANK J JR & CORINNE SULLIVAN	UNNAMED STREAM	SESE35	48N6E	M		64.25	I	P
21527	110863	STANLEY JOHNSON	UNNAMED STREAM	NENW16	46N6E	M		2	SQ	P
21527	110863	STANLEY JOHNSON	UNNAMED STREAM	SWNW15	46N6E	M		2	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	NWSW08	47N6E	M		3	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	NESE08	47N6E	M		0.5	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	NWSW09	47N6E	M		5	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	SWNE09	47N6E	M		1	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	NWSE17	47N6E	M		0.5	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	SWSW16	47N6E	M		1.5	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	SESE17	47N6E	M		3	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	NWNE17	47N6E	M		1	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	NWNW17	47N6E	M		1	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	NENE19	47N6E	M		0.5	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	SWSW15	47N6E	M		1.5	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	NENW15	47N6E	M		1	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	NWSE08	47N6E	M		1	SQ	P
21529	110863	STANLEY JOHNSON	UNNAMED STREAM	NENW16	47N6E	M		1.5	SQ	P
21530	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	NENE20	48N6E	M		4	SQ	P
21530	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	NENE32	48N6E	M		2	SQ	P
21530	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	SENW32	48N6E	M		3	SQ	P
21530	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	NESE05	47N6E	M		1	SQ	P
21530	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	NESW04	47N6E	M		3	SQ	P
21530	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	SWSE21	48N6E	M		0.5	SQ	P
21530	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	NWSW21	48N6E	M		3	SQ	P
21530	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	NENW28	48N6E	M		2.5	SQ	P
21531	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	SESE14	48N6E	M		6	SE	P
21532	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	NESE33	47N6E	M		1.5	SQ	P
21532	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	SWNE33	47N6E	M		3	SQ	P
21532	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	NWNW04	46N6E	M		2.5	SQ	P
21532	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	SWNE28	47N6E	M		0.7	SQ	P
21532	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	SESW03	46N6E	M		2	SQ	P
21534	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	SESE09	46N6E	M		0.5	SQ	P
21										
21535	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	NESE21	47N6E	M		2	SQ	P
21535	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	SESW05	47N6E	M		1	SQ	P
21820	061864	MICHAEL H & MARY L FAYNE	UNNAMED STREAM	NWSE03	46N6E	M		1	SE	P
22241	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	SENE10	47N6E	M		5	S	P
22241	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	NESE03	47N6E	M		1	S	P2
22241	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	SENE04	47N6E	M		0.5	S	P
22241	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	NWSE33	48N6E	M		0.5	S	P
22242	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	SWSW24	48N6E	M		1.5	S	P
22242	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	SESW23	48N6E	M		1	S	P
22243	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	NENW27	48N6E	M		5	S	P
22243	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	SWNW27	48N6E	M		5	S	P
22243	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	NWSW27	48N6E	M		0.3	S	P
22243	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	SESE16	48N6E	M		0.5	S	P
22243	072665	JOHNSON STOCK COMPANY	UNNAMED STREAM	NESW21	48N6E	M		6	S	P

TABLE D

(Continued)

NOTE: Appropriative rights initiated prior to December 19, 1914, and riparian rights are not included in this list. However, statements of water diversions and use for many of these rights are on file as required by Water Code Sections 5100-5108.

STATE OF CALIFORNIA
RESOURCES AGENCY
STATE WATER RESOURCES CONTROL BOARD

DIVISION OF WATER RIGHTS

MEMORANDUM CONCERNING APPLICATIONS TO APPROPRIATE WATER

CLEAR LAKE RESERVOIR IN MODOC COUNTY — DATE PREPARED JUNE 4, 1969

APP No.	DATE FILED	APPLICANT	SOURCE	POINT OF DIVERSION			AMOUNT		USE	STATUS
				SECTION	TWP & RANGE	B&M	CFS OR GPD	ACRE-FEET		
594	022317	BIDART BROTHERS INCORPORATED	JANES FLAT DRAINAGE AREA	SESE27	47N10E	M		1408	I	L
1474	100619	ELSIE EVERLY & RALPH RENNER	FLETCHER CREEK	SWSW15	47N12E	M		600	I	L
1880	062320	CARLTON O & ETHEL A ROUSE	WILLOW CREEK	L1 03	45N10E	M		400	A	L
3432	052223	BIDART BROTHERS INCORPORATED	JANES FLAT DRAINAGE AREA	SESE25	47N10E	M		335	I	L
3531	071423	BIDART BROTHERS INCORPORATED	DRY VALLEY CREEK	SWSW07	46N11E	M		200	I	L
5312	121626	CARLTON O & ETHEL A ROUSE	WILLOW CREEK	L1 03	45N10E	M		400	I	L
9551	040739	STANLEY JOHNSON	UNNAMED SPRING	SENW06	47N7E	M	2200G		S	L
12708	092348	U S MODOC NATL FOREST	BOTTLE SPRING	NENE27	45N10E	M	*400G		S	L
12708	092348	U S MODOC NATL FOREST	BOTTLE CREEK FROM	NENE27	45N10E	M	*400G		S	L
12708	092348	U S MODOC NATL FOREST	BOTTLE CREEK TO	SWSE22	45N10E	M	*400G		S	L
13193	063049	U S MODOC NATL FOREST	QUAKING ASPEN SPRING	NWSE11	46N9E	M	1800G		DS	L
16346	042755	STANLEY JOHNSON	UNNAMED CREEK	SWNW06	47N7E	M		500	I	P
21528	110863	STANLEY JOHNSON	UNNAMED STREAM	NESE01	47N6E	M		2	SE	P
21528	110863	STANLEY JOHNSON	UNNAMED STREAM	SWNE07	47N7E	M		1	SE	P
21528	110863	STANLEY JOHNSON	UNNAMED STREAM	NENE12	47N6E	M		1	SE	P
21533	110863	JOHNSON STOCK COMPANY	UNNAMED STREAM	NENE03	47N7E	M		2	SE	P

EXPLANATION OF ENTRIES

DATE FILED: First two digits are month; next two digits are day of month; last two digits are year.

POINT OF DIVERSION:

SECTION: Forty acre subdivision of the section in which the point of diversion is located:

NWNW	NENW	NWNE	NENE
SWNW	SENW	SWNE	SENE
NWSW	NESW	NWSE	NESE
SWSW	SESW	SWSE	SESE

TWP & RANGE: Numbers preceding N or S are township number north or south of base line. Numbers preceding E or W are range numbers east or west of meridian.

B & M: H is Humboldt Base and Meridian
M is Mt. Diablo Base and Meridian
S is San Bernardino Base and Meridian

AMOUNT: A symbol (*, #, %, ¢, =, ", etc.) preceding an amount entry indicates that there are alternate points of diversion under this application and the amount listed may be diverted from this or other point or points of diversion identified by the same symbol under this application number. cfs and gpd are abbreviations for cubic feet per second and gallons per day, respectively. Following an amount entry they are further abbreviated c for cubic feet per second and g for gallons per day.

USE:
- A Agricultural
- B Mining
- C Milling
- D Domestic
- E Fire protection
- F Flood control
- G Dust control
- H Fish culture
- I Irrigation
- J Industrial
- K Irrigation, domestic
- L Salinity control
- M Municipal
- N Navigation
- O Stockwatering, fish culture
- P Power
- Q Recreational, fire protection
- R Recreational
- S Stockwatering
- T Recreational, fire protection, fish culture
- U Stockwatering, fire protection
- V Recreational, fish culture
- W Wildlife propagation
- X Recreational, stockwatering
- Y Recreational, stockwatering, fish culture
- Z Uses too numerous to list or not included in code

STATUS: No entry—Application
P —Permit
L —License

TABLE D

(Continued)

TABULATION OF STATEMENTS OF WATER DIVERSION AND USE

For Streams Tributary to Clear Lake Reservoir, Lost River in California and Streams in the Butte Valley Area

Statement Number	Applicant	Source	Point of Diversion Section	Township	Range		Amount Acre-Feet
			T U L E L A K E S U M P				
S 622	Paul Tschirky	Bloody Pt. Creek	7	47N	6E	MDB&M	entire flow
			M E I S S L A K E				
S 734	Ellis Louie	Rose Spring	3	43N	2W	MDB&M	50
S 735	Ellis Louie	Unnamed Springs	3, 10	43N	2W	MDB&M	175
S 736	Ellis Louie	Butte Creek	10	43N	2W	MDB&M	425
S 737	Ellis Louie	Double Spring	10	43N	2W	MDB&M	100
S 738	Ellis Louie	Spring	15	43N	2W	MDB&M	500
S 739	Ellis Louie	Butte Creek	22, 15	43N	2W	MDB&M	850
S 740	Ellis Louie	Butte Creek	22, 15	43N	2W	MDB&M	1,200
S 741	Ellis Louie	Alder Creek	26	43N	2W	MDB&M	700
S 742	Ellis Louie	Spring	26	43N	2W	MDB&M	400
S 743	Ellis Louie	Alder Creek	26	43N	2W	MDB&M	1,600
S 744	Ellis Louie	Unnamed Stream	27	43N	2W	MDB&M	1,000
S 745	Ellis Louie	Pomeroy Creek	27	43N	2W	MDB&M	225
S 746	Ellis Louie	Unnamed Spring	34,27	43N	2W	MDB&M	225
S 747	Ellis Louie	Unnamed Spring	34,27	43N	2W	MDB&M	100
S 748	Ellis Louie	Butte Creek	10	43N	2W	MDB&M	15
S 1028	Walter Ralphs, Jr.	Prather Creek	5	45N	2W	MDB&M	6,000
S 2387	Cline C. Soule	Butte Creek	23, 24	44N	2W	MDB&M	3,200
S 4348	Meiss Ranch Company	Prather Creek	14	46N	2W	MDB&M	entire flow
S 4349	Meiss Ranch Company	Musgrave Creek	8	46N	2W	MDB&M	entire flow
S 4350	Meiss Ranch Company	Harris Creek	5, 6	46N	2W	MDB&M	entire flow
S 4351	Meiss Ranch Company	Ike's Creek	6	46N	2W	MDB&M	entire flow
			K L A M A T H R I V E R				
S 4910	U. S. Bureau of Reclamation	Lost River	8	47N	8E	MDB&M	234,010
S 4911	U. S. Bureau of Reclamation	Lost River	7	41S	11E	WB&M	167,870

TABLE E

OREGON STATE GAME COMMISSION RECOMMENDED MINIMUM FLOWS FOR FISH LIFE, KLAMATH BASIN 1/ 2/

STREAM	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	LOCATION
Klamath River	250	300	400	400	400	300	250	250	250	250	250	250	USGS Gage #11-5107
Klamath River	250	300	400	400	400	300	250	250	250	250	250	250	USGS Gage #11-5095
Jenny Cr.	8	12	16	16	16	10	8	5	4	5	5	8	Pinehurst, Oregon
Keene Cr.	6	8	12	12	12	8	5	5	4	4	5	6	Mouth
Spencer Cr.	16	16	20	20	20	20	20	12	12	12	12	16	Mouth
Link River	60	60	80	80	80	60	50	40	30	30	30	50	USGS Gage #11-5075
Cherry Cr.	10	10	15	15	15	10	5	3	3	15	10	10	Mouth
Sevenmile Cr.	15	15	15	15	15	12	10	10	8	15	15	15	Just above Dry Cr.
Short Cr.	8	8	10	10	10	8	8	8	8	10	8	8	Mouth
Crane Cr.	3	3	6	6	6	5	5	3	3	6	3	3	Mouth
Wood River	80	80	80	80	80	60	60	60	60	60	80	80	USGS Gage #11-5041
Wood River	80	80	80	80	80	60	60	60	60	80	80	80	Below Wood R. spring
Crooked Cr.	15	15	25	25	25	15	15	15	15	25	15	15	Hwy 232 crossing
Fort Cr.	20	20	30	30	30	20	20	20	20	30	20	20	Hwy 232 crossing
Annie Cr.	40	40	40	40	40	30	20	20	20	40	40	40	Just above Sun Cr.
Sun Cr.	10	10	10	10	10	10	8	8	8 15	15	15 10	10	Mouth
Williamson River	300	300	300	300	300	250	200	200	200	200	300	300	USGS Gage #11-5025
Williamson River	300	300	300	300	300	250	200	200	200	200	300	300	Below Spring Cr.
Williamson River	60	60	60	60	60	40	25	25	20	20	60	60	Above Spring Cr.
Williamson River	20	30	40	40	40	30	20	20	15	15	15	15	USGS Gage #11-4935
Williamson River	30	40	50	50	50	40	30	30	30	50	30	30	Rocky Ford
Sprague River	150	150	150	150	150	120	100	100	100	100	150	150	USGS Gage #11-5010
Sprague River	120	120	120	120	120	100	80	80	80	80	120	120	Lone Pine
Sprague River	100	100	100	100	100	80	60	60	60	60	100	100	USGS Gage #11-4975
Sycan River	50	50	50	50	50	40	30	20	20	20	50	50	Mouth
Sycan River	35	35	35	35	35	30	20	15	15	15	35	35	R. M. 23.0
Sycan River	15	15	20	20	20	15	10	5	5	20	15	15	2 miles above Merritt Cr.
Sycan River	15	15	20	20	20	15	12	10	10	20	15	15	0.4 mile below Paradise Cr.
Sycan River	10	10	15	15	15	12	12	10	10	15	10	10	Below S. Fk. Sycan River
Crazy Cr.	3	3	6	6	6	3	1	1	1	6	3	3	Mouth
Paradise Cr.	3	3	6	6	6	4	2	2	2	6	3	3	Above Crazy Cr.
Skull Cr.	3	3	5	5	5	3	1	1	1	5	3	3	Mouth
Long Cr.	3	3	6	6	6	3	1	1	1	6	3	3	Mouth
N. Fk. Sprague River	50	50	50	50	50	40	20	15	15	50	50	50	3.0 miles below Yeden Cr.
N. Fk. Sprague River	30	30	30	30	30	20	10	10	10	30	30	30	2.0 miles above Gearhart Cr.
Meryl Cr.	15	15	15	15	15	10	8	5	5	15	15	15	Mouth
Long Cr.	6	6	6	6	6	3	1	1	1	3	6	6	Mouth
S. Fk. Sprague River	50	50	50	50	50	30	15	15	15	15	50	50	Mouth
S. Fk. Sprague River	45	45	45	45	45	30	15	15	15	15	45	45	1.0 mile below Ish-Tish Cr.
S. Fk. Sprague River	40	40	40	40	40	20	10	10	10	40	40	40	2.0 miles below Whitworth Cr.
S. Fk. Sprague River	6	6	10	10	10	7	4	4	4	10	6	6	Below Corral Cr.
Fishhole Cr.	10	10	10	10	10	5	3	1	1	3	10	10	Above Devil Lake Cr.
Brownsworth Cr.	10	10	10	10	10	6	3	1	1	3	10	10	Mouth
Whitworth Cr.	8	8	8	8	8	5	3	1	1	8	8	8	Mouth
Deming Cr.	10	10	10	10	10	5	1	1	5	10	10	10	Above Rocky Flat Cr.
Spring Cr.	300	300	300	300	300	300	300	300	300	300	300	300	Mouth
Sand Cr.	10	10	15	15	15	10	10	10	10	15	10	10	Hwy 232
Scott Cr.	5	5	8	8	8	6	4	4	4	8	5	5	Hwy 232
Miller Cr.	15	15	15	15	15	10	5	5	5	5	15	15	3.0 miles above Beaver Marsh
Jackson Cr.	5	5	8	8	8	5	5	5	5	8	5	5	Mouth
Deep Cr.	3	3	5	5	5	3	1	1	1	5	3	3	Mouth
Aspen Cr.	4	4	7	7	7	3	1	1	1	7	4	4	Mouth
Lost River	30	30	30	50	50	50	20	15	15	15	15	20	Merrill, Oregon
Lost River	25	30	30	35	35	35	10	10	10	10	10	15	Bonanza, Oregon
Lost River	15	15	15	20	20	20	10	5	5	5	5	10	R. M. 64.0
Miller Cr.	30	30	30	50	50	50	30	15	15	15	15	20	Below Gerber Reservoir

1/ Flows are expressed in cubic feet per second.

2/ The recommended flows should arrive at the point of recommendation and continue to the mouth of the stream or to the next point for which a different flow is recommended.

ACKNOWLEDGMENTS

The State Water Resources Board expresses grateful appreciation to those organizations which have permitted the use of material from their publications listed under Bibliography in this report. In accordance with cooperative agreements, the U. S. Department of Agriculture supplied agricultural, economic, and water use data which was used extensively throughout this report. The Oregon State Game Commission and the U. S. Bureau of Sport Fisheries and Wildlife supplied the basic data for fish and wildlife water uses.

Several other agencies and organizations provided direct assistance in the preparation of this report. Among others, these included the U. S. Army, Corps of Engineers; U. S. Geological Survey; U. S. Bureau of Reclamation; U. S. Soil Conservation Service; U. S. Forest Service; U. S. Bureau of Land Management; Parks and Recreation Division, State Highway Division; Klamath County Board of Supervisors; Klamath County Chamber of Commerce; Izaak Walton League; and various city officials of the communities within Klamath County.

The State Engineer has provided direct assistance by preparing the Ground Water Appendix. The following technical staff prepared the Appendix under the direction of Chris L. Wheeler, State Engineer:

William S. Bartholomew, Chief, Ground Water Section

Joseph R. Illian, Hydrogeologist

Special acknowledgment is given to the following local residents of the Klamath Basin who provided valuable assistance in the report preparation:

John Stewart, Jr., Secretary-Treasurer, Klamath Basin Water Users Protective Association

George Proctor, Attorney, Klamath Falls

Cecil Hunt, President, KBWUPA

Jim Ottoman, Shasta View Irrigation District

Ray L. Roberts, Klamath Irrigation District

Fred Fehner, Tulelake Irrigation District

Don Macken, Tulelake Irrigation District

Glen Bowen, Oregon Water Corporation

ACKNOWLEDGMENTS

James Flowers, KBWUPA

John Marshall, KBWUPA

James Bunker, Langell Valley Irrigation District

Irvine Tipping, Pacific Power & Light

William Burk, Klamath County Museum

Donald D. Todd, City Engineer, Klamath Falls

William Wales, Consulting Engineer, Klamath Falls

Robert Bond, Executive Secretary, Klamath Compact Commission

Dan Eastman, Izaak Walton League

Dick Wylie, Soil Conservation Service

Norman McGourty, Soil Conservation Service

Walt Jendrzejewski, Extension Agent, Klamath County

Ken Baghatt, Farm Advisor, Tulelake

Cliff Lawrence, U. S. Bureau of Reclamation

Tom Roston, U. S. Bureau of Reclamation

The report was prepared and edited by the following technical staff of the State Water Resources Board:

Tucson H. Myers, P. E., Chief, Area Planning and Development Division

Albert E. Wright, P. E., Study Manager

Melvin R. Casselman, Planning Assistant

Robert S. Sparks, Planning Assistant

Gordon W. Olcott, Geologist

Gerald N. Holman, Chief Draftsman

Franklin P. Hopkins, Data Engineer

ABBREVIATIONS AND SYMBOLS

Ac.	Acre	MBF	Million Board Feet
Ac-ft	Acre-feet	Mdw.	Meadow
AUM	Animal unit month	Mgd	Million gallons per day
Ave.	Average	Mi.	Mile
Can.	Canyon	Mtn.	Mountain
cfs	Cubic feet per second	Mun.	Municipal
Co.	County	ORS	Oregon Revised Statute
Cr.	Creek	OSHC	Oregon State Highway Commission
D.	Ditch	Pt.	Point
Dom.	Domestic	R., Rng.	Range
DR.	Drainage	Rec.	Recreation
°F	Degrees Fahrenheit	Res.	Reservoir
Fk.	Fork	RRA	Roadside Rest Area
Ft.	Foot, Feet	Sec.	Section
G.	Gulch	Spr.	Spring
gpd	gallons per day	Sta.	Station
gpm	gallons per minute	SWRB	State Water Resources Board
Ind.	Industrial	T., Twp.	Township
Irr.	Irrigation	Temp.	Temperature
kw	kilowatt	USDA	United States Department of Agriculture
L.	Lake, Little	USGS	United States Geological Survey
Ls., Lks.	Lakes		
Max.	Maximum		

APPENDIX II

STATE ENGINEER'S

INTERIM REPORT

ON THE GROUND WATER IN THE KLAMATH BASIN

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

Note: Plates appear at the back of the report.

ABSTRACT

The Klamath Basin is divided into four major drainage areas. These areas are individually described and are the Williamson River Sub-basin, the Sprague River Sub-basin, the Upper Klamath Lake Sub-basin, and the Lost River Sub-basin. This report on ground water within the Klamath Basin:

(1) identifies numerous recharge and discharge areas,

(2) interprets the general directions of ground-water movement,

(3) describes principal aquifers and their water yielding characteristics,

(4) lists existing ground-water rights,

(5) presents water level measurements from observation wells, and

(6) estimates the average annual amount of ground-water recharge and discharge for each sub-basin.

Number values used in approximating the total amount of precipitation, evaporation and transpiration losses, surface water outflow, and ground-water underflow should be regarded as gross approximations. The quantity of annual ground-water recharge which approximates the amount of ground water available within each sub-basin is presented as a rough estimate for planning the future development of ground-water resources in the Klamath Basin. As new information becomes available, better estimates may be made so that the final solutions may be closer to the natural values.

INTRODUCTION

This investigation was conducted by the State Engineer's Office in cooperation with the U. S. Geological Survey and the Oregon State Water Resources Board. The report defines the general ground-water conditions of the Klamath Basin in south central Oregon. Basin recharge boundaries are shown in Figure 1.

Ground water beneath the 5,700 square miles of the Klamath Basin is one of southern Oregon's most valuable resources. The management of this resource will require detailed knowledge of the basin's hydraulic characteristics. Ground-water occurrence within the Klamath Basin is controlled by

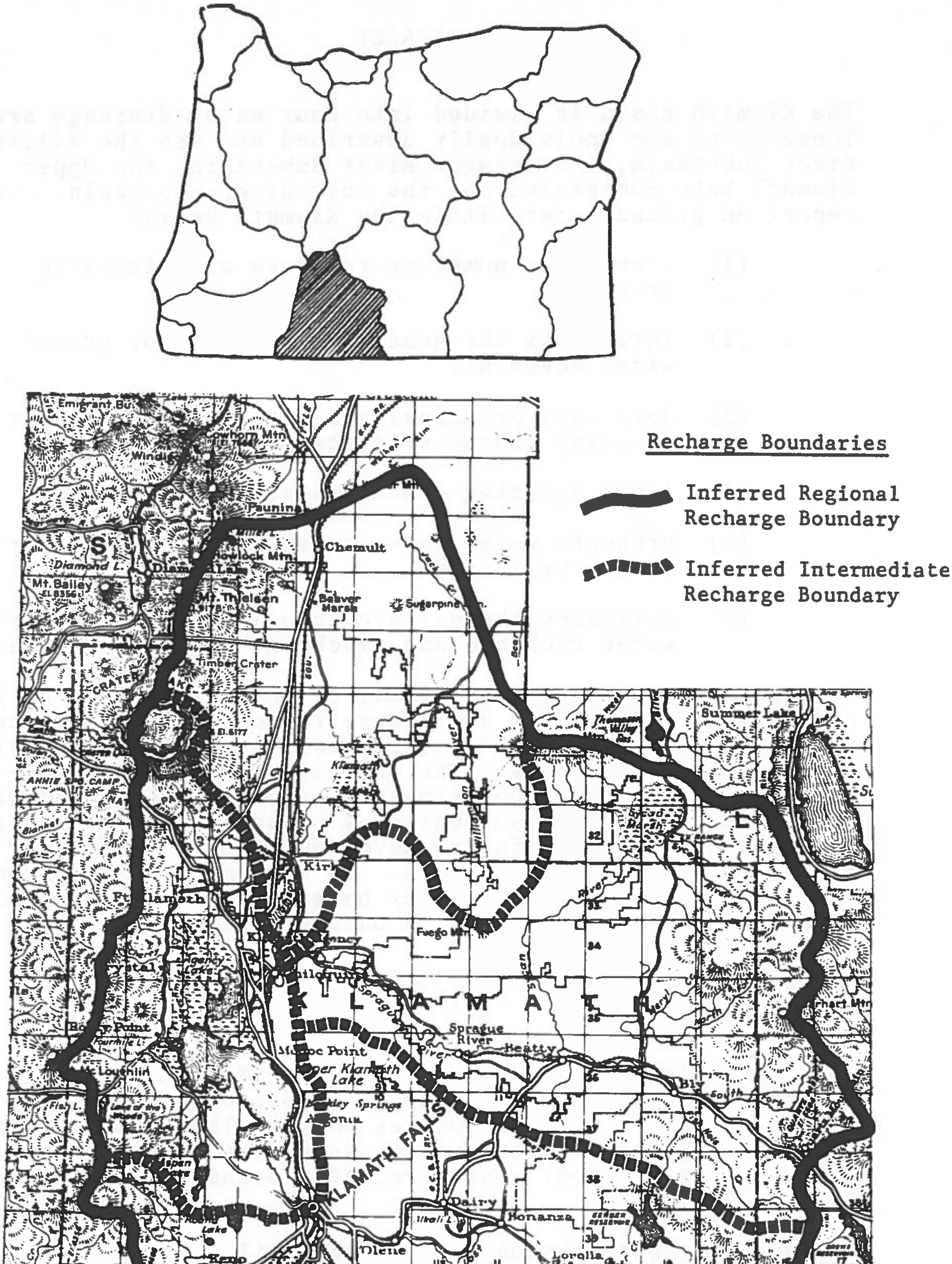

Recharge Boundaries
Inferred Regional Recharge Boundary
Inferred Intermediate Recharge Boundary
Emigrant Bu.
Paunina
Chemult
Diamond L.
Mt. Bailey
Howlock Mtn.
Mt. Thielsen
Beaver Marsh
Sugarpine Mtn.
Timber Crater
CRATER
Summer Lake
Kirk
Ft. Klamath
Fuego Mtn.
Chiloquin
K L A M A T H
Sprague River
Beatty
Modoc Point
Upper Klamath Lake
Algoma
Bly
KLAMATH FALLS
Dairy
Bonanza
Olene
Keno
Midland
Pinehurst
Worden
Merrill
Malin

FIGURE 1.

INTRODUCTION

a variety of complex climatic, topographic, and geologic factors. A better understanding of these interrelated factors and their effect on the ground-water system will assist in the long-range planning and optimum use of ground-water resources.

The purpose of this report is to: (a) delineate ground-water recharge and discharge areas, (b) interpret the general directions of ground-water movement, (c) describe principal aquifers and their water yielding characteristics, (d) report existing ground-water rights, and (e) estimate the average annual amount of ground water available. This is an interim report; a more detailed U. S. Geological Survey-State Engineer's cooperative report on the Geology and Ground-Water Resources of the Klamath Basin is scheduled for completion in 1972.

SUMMARY AND CONCLUSIONS

The direction of ground-water movement within the Klamath Basin is controlled by major topographic boundaries and related ground-water divides. The general trend of ground-water movement is to the south and southwest toward the lowest point in the Klamath Basin at the Klamath River exit. The direction of ground-water movement is always away from recharge areas that receive higher amounts of annual precipitation and toward discharge areas at lower elevations. The recharged water enters the ground-water body and becomes a part of a shallow, local flow system; an intermediate system; or a long, deep-seated, regional flow system. Ground water may, at times, move uphill but it will always move down gradient. The major recharge and discharge areas of the basin have been identified on Plate 5.

Wells constructed in recharge areas will experience declining water levels as the wells are deepened. Annual water level fluctuations are usually greater in wells located in recharge areas. Discharge area wells will experience less drawdown effects and will have lower ranges of annual water level fluctuation. Ground water in the recharge areas is generally colder and of better quality than ground water discharged from regional flow systems, such as the Lower Klamath Lake area.

SUMMARY AND CONCLUSIONS

Four main aquifer units have been defined:

Map Symbol	Name	Lithologic Units	Waterbearing Characteristics
SA	Sedimentary Aquifer	Sand, Clay, Shale, Gravel Sediments	Poor
VCA	Volcanic Centers Aquifer	Lava Flows and Cinders	Moderate to High
LBA	Lower Basalt Aquifer	Basalt	High
VAA	Volcanic Ash Aquifer	Volcanic Ash and Sediments	Poor

A tabulation of 226 ground-water right applications and permits is presented in Table 25, page 265. The accumulative amount of ground water allowed under these water rights for the Klamath basin is 347,000 acre-feet per year.

The Klamath Basin covers an area of about 5,700 square miles. Precipitation over this area supplies about 6,700,000 acre-feet of water to the basin each year. Estimates of evaporation and transpiration losses indicate that approximately 5,048,000 acre-feet is transpired by plants or lost by evaporation each year. An additional 347,000 acre-feet is consumptively used as ground-water pumpage from wells. Surface water outflow from the basin measured on the Klamath River at Keno, Oregon, is approximately 1,205,000 acre-feet per year. Therefore, if 6,700,000 acre-feet represents the total annual amount of water added to the Klamath Basin, then the loss of 5,048,000 acre-feet due to evapotranspiration, plus the consumptive use of 347,000 acre-feet by wells, and the surface outflow of 1,205,000 acre-feet in the Klamath River indicates a ground-water underflow of about 100,000 acre-feet exiting the Klamath Basin.

To reiterate, the above quantities of average ground-water recharge are given as an estimate of the amount of ground-water resource available in the sub-basins of the Klamath Basin. These values are presented in the hope that as more refined estimates of the variables become available the budget can be updated and improved. Thus, the values reported are first estimates and it is expected that they will change with time.

SUMMARY AND CONCLUSIONS

Recharge balances with discharge for the Klamath Ground-Water Basin. This is evidenced by the fact that observation wells in the basin do not indicate any significant change in ground-water storage. Hydrographs in Figure 7, on pages 268 through 288, indicate uniform water level fluctuations. A few artesian wells located in the Sprague River Sub-basin do show a decline in head of about 1½ to 2 feet per year. This is a local water level decline due to pumping and does not represent a material change in ground-water storage.

6,700,000	Total Precipitation
5,048,000	Evapotranspiration
1,652,000	
347,000	Ground-Water Pumpage
1,305,000	
1,205,000	Surface Water Outflow
100,000	Ground-Water Outflow

A large portion of the Klamath Basin ground-water resources are discharged in the lowland areas of the basin. Much of this water is derived from regional flow systems which contribute ground water of poor chemical quality. Much of Lower Klamath Lake is occupied by nonproductive alkali flats and marsh brines. Excessive amounts of sodium and related chemical constituents are brought to land surface by the rising ground-water discharge.

If ground water could be pumped from the upland recharge areas where it is still relatively fresh water and the highly mineralized brines in the alkaline soil areas could be drained or pumped to waste, it might then be possible to flush the upper few feet of the alkaline soils with fresh water and reclaim these areas for productive agricultural use. Increased ground-water withdrawals in the recharge areas would intercept fresh ground water and would reduce the amount of ground water entering the regional flow system. A great deal more hydrologic and geologic information will be required to evaluate and design such a large scale program of land and water reclamation.

A very large amount of ground water must be intercepted to effect the desired changes. It is estimated that at least 500,000 to 800,000 acre-feet per year of additional ground water can be appropriated from the Klamath Ground-Water Basin provided pumping centers are properly designed and spaced. However, physical limitations may restrict actual withdrawals to possibly one-half this amount. Local sub-basins may be approaching adequate development at the present time, and additional wells in these areas could initiate declining water levels.

Future ground-water development will require proper siting and development of well fields to fully utilize the Klamath Basin's ground-water resources.

PART I LAND AND PEOPLE

MAJOR LAND FORMS

Two physiographic provinces of the Western United States are joined within the Klamath Basin of Oregon. These two provinces, separated by topographic and climatic divisions, are the Basin and Range and the Sierra-Cascade Provinces.

Basin and Range Province

The Basin and Range Province extends from southern Oregon through several western states into Mexico. It is characterized by roughly parallel down-faulted valley areas separated by fault block mountains and interior surface drainage. The Basin and Range Province terminates against the north-south trending Sierra-Cascade Mountain Province and forms the western margin of the Klamath Basin.

Most of the valleys within or adjacent to the Lost River Drainage, such as Langell, Poe, Yonna, and Swan Lake, lie within the Basin and Range Province. Internal drainage is the typical drainage pattern for these local basins. The flat, debris-filled playa valleys of this province are separated by discontinuous fault block mountains such as Swan Lake Rim, Stukel, and Bryant Mountains. Streams carrying surface runoff from this area terminate in lowland areas such as Swan Lake and Tule Lake.

Sierra-Cascade Province

The Sierra-Cascade Mountain chain, which extends from southern Canada to the Mojave Desert in California, is cut by three large rivers, the Columbia, the Pitt, and the Klamath Rivers. The Klamath River and its tributaries drain the Klamath Basin portion of the Sierra-Cascade Province. Waters of the Williamson and Sprague Rivers drain southward through Link River on the southern end of Upper Klamath Lake into the Klamath River. The Klamath River cuts its way through both the Cascade Range and the Coast Range mountains in reaching the Pacific Ocean south of Crescent City, California.

POPULATION AND LAND USE

Of the 50,021 inhabitants of Klamath County (1970 census), 31,521 people live in the cities of Klamath Falls and Altamont. The remaining 18,500 residents live in rural areas around the communities of Bly, Bonanza, Chiloquin, Fort Klamath, Henley, Malin, and Merrill.

LAND AND PEOPLE

Land use in the Klamath Basin is distributed between forest land (about 70 percent), rangeland (about 17 percent), cropland (about 8 percent), and other land use (about 5 percent).

PART II GEOLOGIC HISTORY

OLDEST KNOWN EVENTS

The oldest rocks exposed in the Klamath Basin are found in the east central part of the basin near Quartz Mountain north of Drews Reservoir. These rocks are dacitic lava flows, which poured onto land surface, cooled, and solidified 30 to 60 million years ago. The base of this unit is not exposed in this area, therefore, its thickness is unknown.

The dacitic lava flows were subsequently covered by deposits which reflect the explosive volcanic activity that occurred between 20 to 30 million years ago. These deposits consist of particle fragments derived from the older dacitic lava flows, volcanic eruptions, and older terrain which now lie buried. Following the deposition of sands, muds, and volcanic ash, a series of thinly layered basalt and andesite lava flows covered parts of the area. The combined thickness of these rock units is believed to be highly variable and is presently unknown. However, oil exploration wells near the eastern shore of Goose Lake in Lake County suggest these deposits could reach 13,000 feet in thickness.

BASALT LAVA FLOWS

Following an extended period of erosion, a series of volcanic eruptions sent forth basaltic lava flows from several vents located along the eastern margin of the Klamath Basin. The lavas filled erosional depressions in earlier land forms. These basaltic rocks form the most permeable aquifer unit in the Klamath Basin. The aquifer unit varies from 20 to 600 feet in thickness and is encountered in many of the deep irrigation wells in the Sprague River, Yonna, Swan Lake, Langell, Poe, and Lost River Valleys.

YONNA FORMATION DEPOSITION

The basaltic rocks described above were then covered by a highly varied group of rocks. During the period between 3 and

10 million years ago, lakes occupying lowland areas were filled by streams issuing from the volcanic highlands. Volcanic eruptions created great clouds of ash and cinders, which covered the ground and settled to lake bottoms. Old stream channels were cut and refilled by meandering streams. Lavas were erupted at irregular intervals and occasionally poured down canyons and valleys, forcing streams to cut new channels.

Lake water during that period of time was occupied by an abundant supply of microscopic plants called diatoms, which thrived on the silica-charged water issuing from the volcanic terrain. As these small plants died, their siliceous shells settled to lake bottoms and built up thick deposits of diatomite (chalk). Muds and fine sands, contributed by streams flowing into the lakes, also accumulated as impermeable beds on lake bottoms. Today the chalk, clay, and fine, unsorted sand layers of this group of rocks yield little or no water to wells.

Waves continually beating against shorelines of these ancient lakes were winnowing fine-grained material from coarse-grained material and redepositing the fines in deeper, quiet water areas. The coarse, well-sorted, gravelly cinders and black sands, which were deposited along ancient shorelines, yield moderate to large quantities of ground water where they are encountered beneath the water table by present day wells.

The group of rocks described above has been called the Yonna formation by Newcomb and Hart. The formation was named for Yonna Valley where extensive outcrops are exposed. The thickness of this unit is quite variable and may reach a maximum thickness of 1,000 feet.

LATEST GEOLOGIC EVENTS

Toward the final stages of deposition of the Yonna formation, land surface had been nearly leveled by erosion. Renewed volcanic activity sent a flood of lava from fissures in the underlying rocks. Several flows of this type can be seen in the slopes of Winter Ridge east of Sycan Marsh. The best exposure of one of these thin (20 to 30 feet) basaltic units is located along the southern and eastern rims of Knot Tableland in north central Sprague River Valley. This formation is the "Cap Rock" and is seldom found below the water table.

Less than 3 million years ago, faulting activity began to divide the Klamath Basin into smaller sub-basins such as the Williamson, Sprague, and Lost River sub-basins. Uplift along fault planes has rejuvenated the erosional process; and alluvial materials, sands, gravels, silts, peat, and chalk are being eroded, reworked, and deposited at the present time.

A famous event occurred about 6,600 years ago. Ancient Mount Mazama (present day site of Crater Lake) exploded violently, forcing clouds of pumice into the air. The pumice rained to land surface over most of the Klamath Basin, Central, and Eastern Oregon. Closely following the explosion, Mount Mazama Collapsed, forming the basin which now accommodates Crater Lake.

A surface geology map and cross section of geologic units in the Klamath Basin was compiled by Roger Paul, Geologist, with the Soil Conservation Service, Salem, Oregon. This map is presented in Figure 2.

PART III WATER IN THE KLAMATH BASIN

HYDROLOGIC CYCLE

Ground water is a part of the earth's continuous hydrologic cycle. The earth's water supply circulates endlessly from the ocean, to the sky, to the lands, and finally returns again to the ocean. The ocean is the center of the hydrologic cycle; however, evaporation from other open bodies of water is important. The sun distills water vapor from the ocean brine and from lakes, swamps, and rivers. Winds carry the water vapor over land; the vapor condenses and falls to the earth's surface. After reaching land some water runs off, some water evaporates, and some water seeps into the ground. Eventually all water is returned to the ocean.

The Klamath Basin receives over 6½ million acre-feet per year from precipitation. Precipitation rates within the basin range from less than 15 inches per year on the valley floors to over 60 inches per year in the Cascade Range near Crater Lake. The majority of the precipitation falls during the period of October through March. Upon reaching land surface, the precipitation may be divided into three categories: (1) surface water runoff, (2) evaporation and transpiration losses, and (3) seepage into the ground (ground-water recharge).

PART IV GROUND WATER IN THE KLAMATH BASIN

INFILTRATION AND RECHARGE

A portion of the precipitation that seeps into the ground in the Klamath Basin may be absorbed by water-deficient soil and plants. The remaining water percolates vertically downward to the water table (top of the saturated zone). Downward percolating water in the Klamath Basin (ground-water recharge) may cause a slight rise in the water table elevation, resulting in an increase in ground-water storage. If there is an increase in the quantity of ground-water recharge, there will also be an increase in the quantity of natural ground-water discharge from the basin. If the total amount of downward percolating recharge is insufficient to maintain a balance with the total basin discharge, then the water table elevation will decline. Large quantities of ground water artificially discharged by wells may also cause water table elevations to decline. To date, no serious water level declines have occurred in the Klamath Basin. Observation well net data are presented in Figure 7, page 268.

The areas in which ground-water recharge is taking place within the Klamath Basin are the Cascade Mountains, Yamsay Mountain, Winter Rim, and similar elevated areas possessing permeable soil and receiving large amounts of rainfall. Well log information is sparse in mountainous areas; therefore, it is difficult to accurately locate recharge boundaries. In the Klamath Basin it is assumed that ground-water boundaries will lie beneath topographic divides.

Deep wells must be constructed in order to withdraw water from ground-water recharge areas. Such wells experience progressive declines in water levels as the wells are deepened. They are subject to large pumping declines and slow recovery rates. Water from wells drilled in recharge areas is usually of excellent chemical quality, having low temperatures 40° to 50° (°F) Fahrenheit and small quantities of dissolved chemical constituents. The total dissolved solids are usually less than 100 (ppm) parts per million.

WATER BEARING FORMATIONS

Ground water moves through spaces between rock particles or fractures in solid rock. Rarely are these spaces larger than a fraction of an inch. Reports of underground rivers encountered by wells are usually based on misinterpretations of permeable aquifer materials. Lava tubes are present within the Klamath Basin, but only rarely do wells encounter these structures.

GROUND WATER IN THE KLAMATH BASIN

Ground-Water Units of the Klamath Basin

For the purposes of this report, the varied rock units described in the Klamath Basin by previous investigators have been grouped together into four main groups, each having unique water-bearing properties. These four groups represent the general hydraulic characteristics of each of the lithologic units present within each group.

Sedimentary Aquifer (SA)

The first aquifer unit is designated SA (Sedimentary Aquifer) on Plate 4. This water-bearing formation is composed of alluvium, alluvial terrace, and shallow lake deposits; and some interbedded basalt, rhyolite ash deposits, and pumice. The sedimentary aquifer is found throughout the Klamath Basin, and the thickest deposits are in the major valleys. A survey of water wells completed in this aquifer unit indicated that specific capacities range from .01 to 5 (gpm/ft.) gallons per minute per foot of drawdown and averages about .45 gpm/ft. A black sand or gravel layer, when it is encountered in this unit, may yield from 2 to 10 gpm/ft. Generally, these sedimentary beds yield only sufficient quantities of water for domestic purposes.

Volcanic Centers Aquifer (VCA)

The second aquifer unit is designated VCA (Volcanic Centers Aquifer) on Plate 4. This unit is composed of basalt and volcanic ejecta, consisting of ash, cinders, and agglomerate. These units represent eruptive centers of old volcanoes. The Volcanic Centers Aquifer is most commonly located in mountainous areas; however, a few local exposures are found on the valley floors. Their water-yielding characteristics are excellent, due to well-sorted coarse cinders, highly fractured lava rock, and scoriaceous interbeds. Water wells constructed in these rock types demonstrate a wide range in specific capacity, varying from less than 1 to over 100 gpm/ft. Large yielding wells can be constructed in this aquifer unit.

Lower Basalt Aquifer (LBA)

A third aquifer unit labeled LBA (Lower Basalt Aquifer) on Plate 4 is the Lower Lava Unit described by Newcomb and Hart (1958). It is composed primarily of basaltic lava flows. This unit underlies the Yonna Formation and is the aquifer which yields large amounts of water to irrigation wells in the Klamath Basin. Surface exposures of the Lower Basalt Aquifer are found in the Quartz Mountain - Winter Rim areas. Well logs report it at depths exceeding 1,000 feet below land surface in most of the valleys of the Klamath Basin. The aquifer's high permeability is the result of weathered surfaces, open scoriaceous zones between flows, and fractures in the basalt flows. The Lower Basalt Aquifer has specific capacities, which range from 33 to 500 gpm/ft. and averages about 145 gpm/ft. Large yielding wells can be constructed in this rock unit.

Volcanic Ash Aquifer (VAA)

A fourth ground-water unit shown on Plate 4 is labeled VAA (Volcanic Ash Aquifer). This unit is composed of volcanic ash, tuff, breccia, related sedimentary materials, and occasional basalt flows. This formation is similar to the Sedimentary Aquifer previously described. Little is known of the hydrologic characteristics of this unit. It underlies the LBA unit. Few wells have been constructed into these tuffaceous sediments. Well logs indicate that this formation lies at considerable depth and has been penetrated by few wells in the Klamath Basin. The cost of drilling deep wells (in excess of 1,000 feet in depth) to encounter this formation would generally discourage attempts to develop ground water from this unit. East of the Klamath Basin, in Lake County, where this formation outcrops extensively, well yields are moderate to low and comparable to the sedimentary aquifer described above.

GROUND-WATER DISCHARGE

Ground water from the mountainous recharge areas flows downward through diverse geologic materials toward lowland areas where it reappears as ground-water discharge. A large amount of ground water is forced to land surface as natural discharge within the lowlands of the Klamath and Sycan Marshes and the valleys of the Williamson, Sprague, Lost, and Klamath Rivers. Numerous springs, such as Big Spring and Bonanza Springs, and marshlands of Upper and Lower Klamath Lakes also serve as major ground-water discharge areas in the Klamath Basin. Nature's balance between natural recharge and discharge is altered by man's use of wells. This use constitutes an artificial discharge of ground water to which nature must adjust.

GROUND WATER IN THE KLAMATH BASIN

GEOTHERMAL GROUND WATER

Geothermal ground water occurs at several localities within the Klamath River Basin. Some local development of low and moderate temperature ground water has been made in two main areas of the basin. The larger, more developed area is located in a northeastern residential district within the city of Klamath Falls. This area extends about 4½ miles along the western margin of a faulted area near upper Klamath Lake. A second thermal area occurs near the southwestern flank of the Klamath Hills in a similar geologic environment. Thermal springs and wells have also been located in other portions of the regional discharge area within the Klamath Basin. Hot springs at Olene flow into Lost River; and in Langell Valley thermal springs occur 1½ miles south of Lorella. In northeastern Klamath Falls, approximately 350 wells have been drilled to extract thermal ground water for use in heating requirements for residences, schools, swimming pools, and business establishments. The Klamath Falls' city school system estimates an annual savings of about $23,000 in heating costs per year. Thermal ground water, 140° to 192° F., is also used to heat the new (O.T.I.) Oregon Technical Institute campus. The O.T.I. wells are the deepest thermal wells of the area, ranging between 1,150 and 1,805 feet in depth.

Hot water wells in the northeastern residential district of Klamath Falls vary greatly in depth and temperature between closely spaced, neighboring wells. The highest temperature of record is 238° F., developed in the Ponderosa Nursing Home well located in SE¼ of the SE¼ of Section 28 of Township 38 South, and Range 9 East, W.M. The majority of domestic heating wells vary in temperature from 90° to 214° F., with the average well temperature being generally less than 190° F. The depths at which hot water is encountered in these wells varies between 100 and 1,100 feet. The great variation in both depth and temperature is probably due to: (1) the proximity of the well location to ascending thermal ground water, (2) the relative permeability of the water-bearing formations at the different well sites, and (3) the variable mixing of cold water in shallow aquifers with ascending thermal waters.

Thermal ground water near the Klamath Hills has not been fully developed to date. Wells on the Liskey Ranch and the Otis Osborn Ranch produce 200° and 186° F. water from wells 285 feet and 418 feet in depth, respectively. Additional wells will be needed to fully define the potential and areal extent of the Klamath Hills thermal area.

GROUND WATER IN THE KLAMATH BASIN

Most of the geothermal areas in the United States believed to be capable of development for geothermal power generation are associated with Cenozoic volcanic rock units similar to the volcanic rocks exposed in the Klamath Basin. The heat source for these geothermal areas is believed to be deeply buried, hot, volcanic rocks. In areas of known volcanic activity, magma may be injected between near-surface layers of rock where it may then begin to cool very slowly. These hot rocks are usually located within the zone of deep, regional ground-water flow systems. Therefore, ground water in the regional discharge areas is usually thermal ground water, having temperatures higher than the normal ground-water body.

Both the northeast Klamath Falls area and the Klamath Hills area are in the regional ground-water discharge area of the Klamath Basin. Block faulting has developed a fractured and broken rock mantle overlying the deep-seated rock formations. The fracture zones along major block movements serve as nearly vertical vent areas through which higher temperature ground water can move toward regional discharge areas within the basin. Similar geothermal areas are known to occur in a number of other faulted areas in Oregon, such as the Goose Lake Basin and Warner Valley in Lake County. The normal regional flow system, with its natural upward movement in discharge areas, is augmented by thermal gradients and permeable zones associated with zones of faulting within the Klamath and Goose Lake Basins.

Geothermal investigations in areas such as Steamboat Springs, south of Reno, Nevada, indicate that less than 5 percent of the ground water discharged from thermal springs is from direct volcanic origin. Chemical analysis indicates that over 95 percent of the thermal water tested is meteoric; i.e., water derived directly from precipitation. Chemical analysis of thermal water from the Klamath Basin indicates that it is also derived from precipitation. For a discussion of the methods by which ground water picks up heat, see the section on <u>Ground-Water Flow Systems</u>.

To date, drilling in the Klamath Basin has not located the depth or position of any buried or cooling magmatic rock body. Deep drilling and geophysical exploration techniques may prove more successful at some future date in identifying a usable thermal energy source for electrical power generation in the Klamath Basin. The main problem of prospecting for geothermal power is locating an adequate heat source near enough to land surface and obtaining a sufficient amount of very high temperature water (in excess of 300° to 350° F.) to generate electric power on a sustained basis. There are also a number of attendant problems; such as water quality of waste water discharge, noise pollution problems, equipment maintenance, and ground-water interference problems. A great deal of time, effort, and money will be required to clarify the true potential of geothermal power generation in the Klamath River Basin.

GROUND-WATER FLOW SYSTEMS

Between closely spaced wells of the Klamath Basin, variations in chemical quality, temperature, and water-level fluctuations are all due to changes in depth, distance, and geologic materials through which the ground water moves. The ground-water body is divided on the basis of size, flow distances, and common water characteristics into three types. These are described as local, intermediate, and regional ground-water flow systems. See Figure 3.

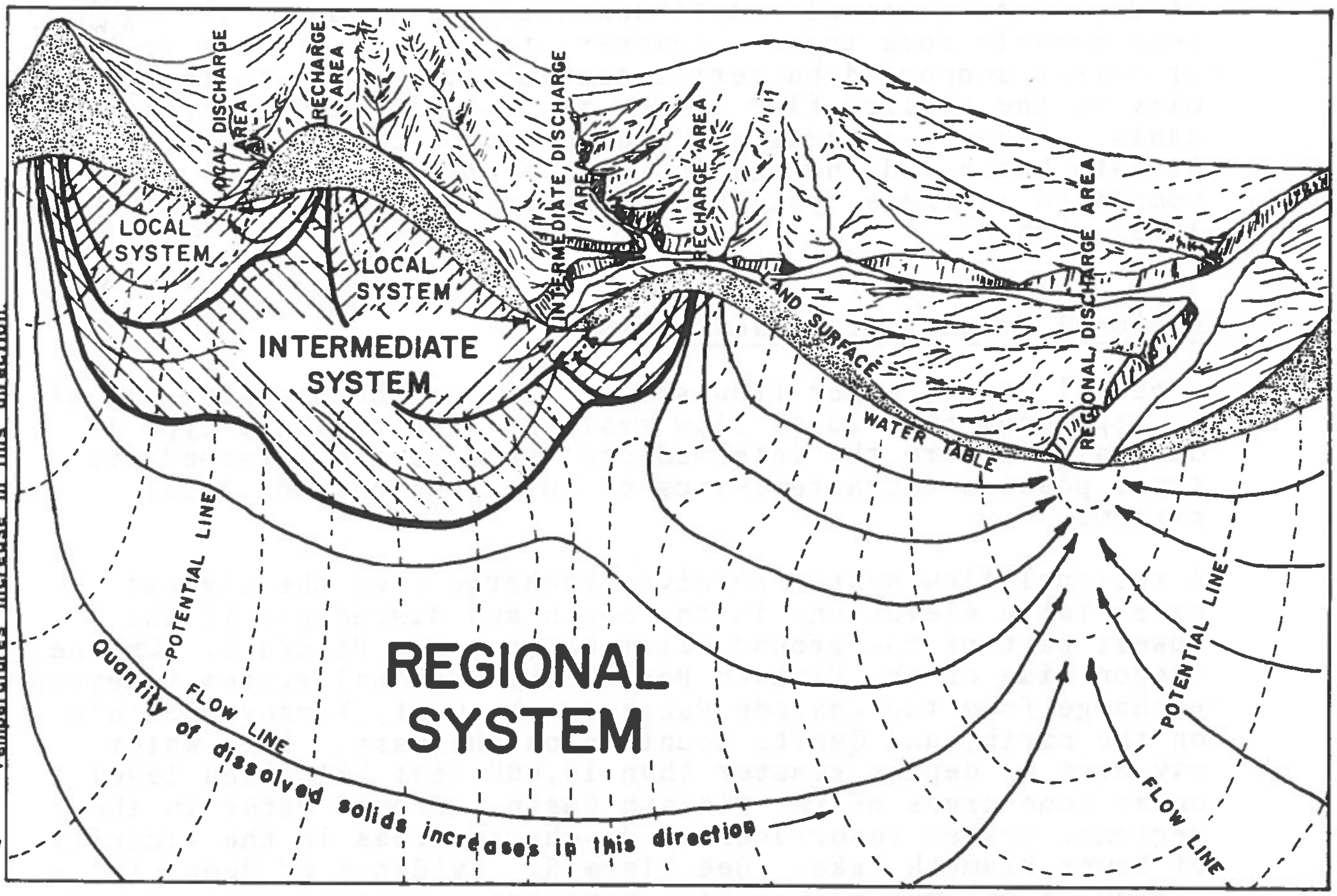


FIGURE 3. Salient features of local, intermediate, and regional ground-water flow systems.

GROUND WATER IN THE KLAMATH BASIN

Local Ground-Water Flow Systems

Ground water discharged from local ground-water flow systems, such as those shown in Figure 3, are recharged in an immediately adjacent recharge area. The local flow systems may cover only a few acres, and the water may circulate to depths of less than 100 feet below the water table. Discharge areas of local systems, such as Meadow Lake west of Swan Lake Valley, the upper reaches of the Sycan River east of Sycan Marsh, and Williamson River Springs north of Fuego Mountain, all have characteristic low ground-water temperatures ranging from 35° to 50° F. These low temperatures are indicative of shallow circulation. Natural heat flow emanating from the interior of the earth causes rock temperatures to rise an average of about 1° F. for every 50 to 60 feet below the first 100 feet below the land surface. For this reason ground water having high temperatures generally indicates deep circulation.

Water from local systems generally contains low concentrations of dissolved chemical constituents unless it moves through very soluble rock types. However, there is a greater risk of oxygen-supported bacterial contamination, due to the proximity of the shallow flow system to possible surface contaminants. Because of seasonal precipitation cycles in the Klamath Basin and the shallow nature of local systems, wells completed in these systems usually exhibit seasonal water-level changes.

Regional Ground-Water Flow Systems

Regional ground-water flow systems lie at the opposite end of the spectrum from local flow systems. The regional type is discussed before the intermediate, because the intermediate types possess characteristics of both regional and local systems.

A regional flow system receives recharge from the highest water table elevations in the basin and discharges in the lowest part of the ground-water basin. See Figure 3. On the Oregon side of the Klamath Basin, the regional system receives recharge from the Cascade Range on the west, Yamsay Mountain on the north, and Quartz Mountain on the east. This water may move to depths greater than 10,000 feet below sea level under some areas of the Klamath Basin. Ground water in the regional system resurfaces in discharge areas in the vicinity of Lower Klamath Lake. See Plate 5. Evidence of deep circulation is offered by the high-temperature waters encountered in wells in the discharge area. The water temperature encountered in the John Liskey well located in Section 4, Township 40 South, Range 9 East, is 200° F. In the Otis Osborn well located in Section 27, Township 40 South, Range 9 East, the temperature is 186° F. Long travel distances also result in relatively high concentrations of chloride (50 ppm), sodium (200 ppm), sulphate (400 ppm), and silicate (80 ppm) for waters of the Lower Klamath Lake discharge area. Because waters of local and intermediate flow systems also discharge within the regional discharge areas, the local water temperatures and chemical characteristics can be expected to show appreciable variation between closely spaced wells.

Intermediate Ground-Water Flow Systems

As the name "intermediate" implies, waters of intermediate flow systems lie between the other systems in their size, position, chemical character, and degree of seasonal water-level fluctuation.

Ground-water flow systems of intermediate size are exemplified by waters discharging near the bottoms of the Sprague, Williamson, and Lost River drainage basins. Waters of these discharge areas are characterized by temperatures which range from 45° to 85° F. The quantity of total-dissolved solids range from 100 to 800 ppm and average 100 to 200 ppm. Included in this figure are values for sodium (10 to 200 ppm), chloride (5 to 50 ppm), sulphate (10 to 350 ppm), and silicate (30 to 80 ppm). Most of the water pumped from wells in the Klamath Basin is found to lie somewhere between these extremes. Because of the nature of intermediate-size discharge areas, some variation in the chemical character of water pumped from adjacent wells can be expected.

Water levels which are undisturbed by pumping effects in nearby wells can be expected to show some slight seasonal variation, due to seasonal nature of ground-water recharge to the system.

PART V THE DIVISIONS OF THE KLAMATH GROUND-WATER BASIN

GENERAL

The Klamath Basin can be divided into four sub-basins. These are the Williamson River, Sprague River, Upper Klamath Lake, and Lost River Sub-basins. Boundaries are indicated on Plate 4. A ground-water budget has been estimated for each sub-basin on the basis of annual precipitation, estimated annual evaporation and transpiration, and annual surface water runoff records.

Care should be exercised in relying upon the estimates of average annual ground-water recharge to sub-basins of the Klamath Basin. The estimates reported on the following pages are based upon records of sparsely located precipitation gages and streamflow gaging stations, with a great deal of interpretation exercised in extrapolating between points of measured data. These estimates provide a rough guide toward determining whether or not a sufficient quantity of ground water is present to warrant expenditures on additional research. That research effort should be directed toward answering the question of how best to develop the resource.

WILLIAMSON RIVER SUB-BASIN

The Williamson River Sub-basin covers 1,450 aquare miles in the northwestern portion of the Klamath Basin. Recharge boundaries of this sub-basin are formed by ground-water mounds of sufficient magnitude to cause large quantities of ground water to move away from the boundary areas. The sparsity of well log information in the mountainous areas prohibits the precise location of the ground-water boundaries. Therefore, it is assumed that the regional ground-water boundaries lie beneath the major topographic divides. Regional boundaries, as shown in Figure 4 and Plates 4 and 5, extend from Miller Mountain to Little Walker Mountain on the north, from Tea Table Mountain to Yamsay Mountain on the east, and from Crater Lake along the Klamath County-Douglas County line to Miller Mountain on the west. Intermediate boundaries within the Klamath Basin separate the Williamson Sub-basin from the other sub-basins. These boundaries follow the divides from Crater Lake to Chiloquin along Sand Ridge on the west, and from Yamsay Mountain to Fuego Mountain, to Solomon Butte, and to Chiloquin on the east and south.

Land surface elevations range from the highest point of 9,178 feet at Mt. Thielsen in the Cascade Range to the west, and 8,196 feet Yamsay Mountain on the east; to a low elevation of 4,180 feet near the confluence of the Williamson and Sprague Rivers at the lower southern end of the sub-basin. Principal features within the Williamson River Sub-basin are: the bordering Cascade Range to the west, the Klamath Marsh near the center of the sub-basin, and the Williamson River. The Williamson River flows northward on the far eastern side of the basin and then swings abruptly southward through Klamath Marsh on its way to Upper Klamath Lake.

THE DIVISIONS OF THE KLAMATH GROUND-WATER BASIN

Water in the Williamson River Sub-basin

Estimates of the total annual water supplied to the Williamson River Sub-basin were made for the purpose of arriving at a value for annual ground-water recharge. Precipitation is considered the only source of water to this sub-basin, and available precipitation data was used in the analysis. A portion of the total average annual precipitation falling in the ground-water recharge area infiltrates into the ground-water system. The remaining portions are evaporated, transpired by forest cover, or contribute to surface water runoff. Precipitation falling in ground-water discharge areas cannot enter the ground-water system, because in these areas ground water is moving toward land surface.

Based upon a 40-year average of surface water records, evapotranspiration estimates of various types of forest cover, and the above-mentioned precipitation data, we have estimated that approximately 900,000 acre-feet per year is recharged to the ground-water system in the Williamson River Sub-basin.

Ground Water in the Williamson River Sub-basin

The 900,000 acre-feet per year of annual recharge to the ground-water system enters the ground in the recharge areas. The water percolates downward through the geologic materials and resurfaces in ground-water discharge areas.

Ground-Water Recharge Areas

Downward percolating ground water forms regional boundaries under the Cascade Range and Yamsay Mountain. It also may form mounds of smaller dimension under other elevated areas containing permeable soils such as Fuego Mountain and Calimus Butte. The regional ground-water mounds form effective hydraulic barriers against waters which might otherwise enter from adjoining basins. The intermediate ground-water mounds form effective barriers only to waters of intermediate depth and not to the very deep waters of the regional system. Figure 4 shows four interpretive profiles which indicate the relative depth and direction of ground-water movement in portions of the Williamson River Sub-basin. A map indicating the directions of ground-water movement for the Williamson River Sub-basin and other sub-basins of the Klamath Basin is shown on Plate 5.

Geology and Aquifer Units

The materials through which ground water flows on its way from recharge areas to discharge areas are described and reported on well drillers' logs filed in the State Engineer's Office, Salem, Oregon. Well logs for wells located in the Williamson River Sub-basin are sparse. The majority of these wells are located in or near Chemult, Beaver Marsh, Klamath Marsh, Collier Park, and Chiloquin.

Chemult

Shallow wells located in or near Chemult generally yield approximately 20 (gpm) gallons per minute, with little drawdown. Static levels for these shallow, water-bearing units are usually 10 to 30 feet below land surface. These wells develop water from sands, clays, and cemented and uncemented gravels. Most of the wells in the Chemult area are deep wells cased below the shallow water and completed in broken lavas at depths of 230 to 270 feet. Water levels in these deeper wells range from 210 to 230 feet below land surface. These wells produce from 20 to 175 gpm, with little or no drawdown. See Table 1.

TABLE 1

REPRESENTATIVE WELLS FOR CHEMULT

Sections 20 & 21, Township 27 South, Range 8 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
262	0	150	Pm, Cl, Sd, Gl					
	150	198	Cemented Sd & Gl	SA				
	198	262	Lava, Ci	VCA	225	175	10	
65	0	65	Soil, Pm, Gl	SA	28	15	0	

Abbreviations: Pumice (Pm), Clay (Cl), Sand (Sd), Gravel (Gl), Cinders (Ci), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

The difference in elevation between water levels for the shallow wells and water levels for the deeper wells indicate a decrease in water level elevation with increasing depth. This evidence indicates that this area is acting as a recharge area. Shallow water levels stand at elevations of about 4,750 feet. Deeper water levels stand at elevations of about 4,550 feet above sea level. See Table 2.

TABLE 2

REPRESENTATIVE WELLS FOR BEAVER MARSH

Sections 5, 17, 18, 19, & 20, Township 28 South, Range 8 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
181	0 136	136 181	Pm, Sd, Cl, Gl Lava	SA VCA	126	30	0	50
392	0 303	303 392	Pm, Sd, Cl, Gl Ci, Lava	SA VCA	175	27	0	
202	0 24 148	24 148 202	Pm Cemented Gl Gl, Bo	SA	150	18	5	

Abbreviations: Pumice (Pm), Sand (Sd), Clay (Cl), Gravel (Gl), Cinders (Ci), Boulders (Bo), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

Diamond Lake Junction

Deep wells located near Diamond Lake Junction penetrate pumice, sand, and gravel to depths of approximately 300 feet. Well log information for this area is not available for depths greater than 300 feet. The majority of wells at Diamond Lake Junction are generally 150 feet in depth and produce water from sands, gravels, and pumice. The gravels usually produce from 10 to 30 gpm, with very little drawdown. Static water levels range from 85 to 105 feet below land surface.

Lenz

In the vicinity of Klamath Marsh near Lenz, wells usually encounter pumice, sand, clay, shale, and gravel to at least

73 feet below land surface. Depth to the base of the volcanic rocks which underlie the sedimentary materials is unknown. Those wells completed in the basalt units yield several thousand gpm, with 5 to 50 feet of drawdown. Water levels are very shallow in this area, and many wells flow at rates of a few gallons to 120 gpm. Artesian pressures of these flowing wells vary from 1 to 5 pounds per square inch. These pressures are sufficient to cause water to rise 2.31 to 11.5 feet above land surface. See Table 3.

TABLE 3

REPRESENTATIVE WELLS FOR KLAMATH MARSH AT LENZ

Township 30 South, Range 7 & 8 East, W.M.

Township 31 South, Range 7 & 8 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
110	0 40 73	40 73 110	Pm, Sd Sd, Gl Lava	SA SA VCA	12	2400	49	42
150	0 68	68 150	Pm, Sd, Gl Ash, Sd, Gl	SA SA	3	4000	6	
462	0 14	14 462	Peat Pm, Cl, Sd, Gl	SA SA	1.5 psi	flow 120 pump 275	3	42
131	0	131	Same as above	SA	5 psi	flow 12.5		51
274	0 112	112 274	Pm, Cl, Sd Lava, Basalt	SA VCA	5	3500	55	43
160	0 4 156	4 156 160	Peat Pm, Cl, Sd, Gl Lava	SA SA VCA	2 psi	flow 7 pump 1500	7	42

Abbreviations: Pumice (Pm), Sand (Sd), Clay (Cl), Shale (Sh), Gravel (Gl), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

Collier Park

Near Collier Park and Spring Creek, wells up to 638 feet deep have encountered pumice, clay, sand, and gravel. No well logs

TABLE 4

REPRESENTATIVE WELLS FOR COLLIER PARK AND SPRING CREEK

Township 33 South, Range 7 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, IBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
77	0	77	Pm, Cl, Sd, Gl	SA	15	45	0	
638	0	638	Pm, Cl, Sd, Gl, BSd	SA	6.5 psi	flow 20		46
125	0	125	Cl, BSd	SA	F	flow pump 30	40	48

Abbreviations: Pumice (Pm), Sand (Sd), Clay (Cl), Shale (Sh), Gravel (Gl), Black Sand (BSd), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (IBA)

TABLE 5

REPRESENTATIVE WELLS FOR SOUTH OF COLLIER PARK

Sections 9, 10, 15 & 16, Township 34 South, Range 7 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, IBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
100	0	100	Pm, Sd, Cl, Gl	SA	18 @ 67* 6 @ 100	20	12	
110	0	110	Same as Above	SA	15 @ 78* 8 @ 110	20	5	
500	0	500	Same as Above	SA	110 @ 168* 100 @ 198 78 @ 335 68 @ 343 61 @ 426	13 169	169	
270	0	270	Same as Above	SA	40 @ 231* 20 @ 242 7 @ 262	20	65	

Abbreviations: Pumice (Pm), Sand (Sd), Clay (Cl), Gravel (Gl), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (IBA)

* Rising water level as well is deepened.

from this area have reported encountering consolidated volcanic rocks. Tables 4 and 5 indicate that water levels in many of the wells rise as the wells have been deepened. Flowing wells are also common in this area. Rising water levels with increasing depth indicate that the area is a ground-water discharge area.

Pine Ridge

In the vicinity of Pine Ridge, near Chiloquin, water levels may decline slightly as wells are drilled through the shallower portions of the Sedimentary Aquifer. Table 6 shows

TABLE 6

REPRESENTATIVE WELLS FOR PINE RIDGE NEAR CHILOQUIN

Sections 22 & 27, Township 34 South, Range 7 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
403	0	403	Pm, Cl, Sd, Gl	SA	40 @ 189 8 @ 355 2 @ 375 flow 403	15	180	
365	0	348	Pm, Cl, Sd, Gl	SA	9.6	110	40	52
	348	365	BLa, Sd	VCA				
352	0	348	Pm, Cl, Sd, Gl	SA	4 @ 245*	30	73	
	348	352	Lava	VCA	13.5 @ 285 flow 352			

Abbreviations: Pumice (Pm), Sand (Sd), Clay (Cl), Gravel (Gl), Black Lava (BLa), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)
* Decline followed by rise in water level as well was deepened. Two systems encountered.

the water levels usually rise when the wells are drilled below 200 feet. This evidence suggests that a local recharge mound lies beneath Pine Ridge. The influence of this mound, however, does not extend to great depths. Water from the deeper ground-water flow system is moving upward in this area, as indicated by rising water levels in the deeper wells. Yields up to 110 gpm have been reported from the deeper Volcanic Centers Aquifer.

THE DIVISIONS OF THE KLAMATH GROUND-WATER BASIN

Chiloquin

Near Chiloquin, pumice, clay, sand, and gravel are encountered to depths of 250 feet. Below this depth, red and black volcanic rocks are encountered by wells that yield 10 to 110 gpm, with 10 to 80 feet of drawdown. See Table 7.

TABLE 7

REPRESENTATIVE WELLS FOR CHILOQUIN

Sections 33 & 34, Township 34 South, Range 7 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
480	0	402	Pm, Cl, Sd, Gl	SA	9.6	110	40	52
	402	480	BLa	VCA				
290	0	250	Pm, Cl, Sd, Gl	SA	20 @ 260*	60	5	44
	250	290	Red & BLa	VCA	17 @ 290			
151	0	151	Pm, Cl, Sd, Gl	SA	12 @ 93* 6 @ 131	12	28	
280	0	264	Pm, Cl, Sd, Gl	SA	0	10	78	
	264	280	BLa	VCA				

Abbreviations: Pumice (Pm), Clay (Cl), Sand (Sd), Gravel (Gl), Black Lava (BLa), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

* Rise in water level as well was deepened.

Ground-Water Discharge Areas

Ground-water discharge in the Williamson River Sub-basin moves upward toward low-lying discharge areas such as Klamath Marsh, Solomon Flat, and the Williamson River and its tributaries. The direction of ground-water movement within the Williamson River Sub-basin is toward Klamath Marsh and then south to Upper Klamath Lake as shown in Figure 4.

It has been estimated that 900,000 acre-feet per year enters the ground-water flow system in the Williamson River Sub-basin. Of this amount, 500,000 acre-feet per year appears to resurface within the boundaries of the sub-basin. This water is: (1) used by plants (transpired) in low-lying grass and marsh-lands, (2) evaporated, (3) exiting the sub-basin as baseflow in the Williamson River, or (4) extracted from wells. The remaining 400,000 acre-feet per year moves beneath the southern boundary on its way toward the Upper Klamath Lake and Lost River Sub-basins.

Ground-water pumpage accounts for approximately 25,000 acre-feet per year. This figure is derived by assuming that irrigation wells within the basin are used at the maximum allowable rate of 3 acre-feet per acre per year. Therefore, ground-water irrigation rights under permit account for about 23,500 acre-feet per year from the Williamson River Sub-basin. Other permitted ground-water rights, assuming they are used at the maximum allowable rate, would account for 1,500 acre-feet per year. Water uses included in this category are industrial, municipal, domestic, stock water, heating, air conditioning, and road sprinkling. Therefore, allowable ground-water rights, if used to the maximum, would account for about 25,000 acre-feet per year. Ground-water rights are listed in Table 25, under Williamson River.

Well Hydrographs

Figure 7, pages 268 and 269 shows quarterly, water-level measurements in observation wells in the Williamson River Sub-basin. Locations of observation wells are shown on Plate 5.

SPRAGUE RIVER SUB-BASIN

The northeastern subdivision of the Klamath Basin is the 1,580 square mile Sprague River Sub-basin. Boundaries are formed by water-table mounds of sufficient magnitude to cause significant quantities of ground water to move away from boundary areas. Regional boundaries for the Sprague River ground-water system as shown in Figure 5 extend from Yamsay Mountain to Ritter Ridge on the north along Winter Ridge to Gearhart Mountain and then to Barnes Rim on the east. Intermediate boundaries extend from Barnes Rim to Yainax Butte to Edgewood Mountain on the south, from Edgewood Mountain to Chiloquin to Solomon Butte on the west, and from Solomon Butte to Fuego Mountain to Yamsay Mountain on the north. Presently available data does not permit delineating local flow system boundaries.

Elevations in the Sprague River Sub-basin are 8,390 feet at Gearhart Mountain, 8,196 feet at Yamsay Mountain, 7,226 feet at Yainax Butte; and range to a low of 4,183 feet at the confluence of the Williamson and Sprague Rivers near Chiloquin.

Principal features within the Sprague River Sub-basin are Yamsay Mountain, Gearhart Mountain, Yainax Butte, Sycan Marsh, Sycan River and Sprague River.

Water in the Sprague River Sub-basin

Estimates of the total annual water supplied to the Sprague River Sub-basin were made for the purpose of arriving at a value for annual ground-water recharge. Precipitation is considered the only source of water to this sub-basin, and available precipitation data was used in this analysis. A portion of the total average annual precipitation flowing to the ground-water recharge area infiltrates into the ground-water system. The remaining portions are evaporated, transpired by forest cover, or contributed to surface water runoff. Precipitation falling in ground-water discharge areas cannot enter the ground-water system, because in these areas ground water is moving toward land surface.

Based upon a 40-year average of surface water records, evapotranspiration estimates of various types of forest cover, and the above-mentioned precipitation data, we have estimated that approximately 650,000 acre-feet per year is recharged to the ground-water system within the Sprague River Sub-basin.

Ground Water in the Sprague River Sub-basin

The 650,000 acre-feet per year assumed to reach the ground-water system infiltrates in recharge areas, flows downward through geologic materials acting as aquifer units, and resurfaces in ground-water discharge areas.

Ground-Water Recharge Areas

Regional ground-water mounds produced by downward percolating water can be found under Yamsay Mountain, Winter Rim, and Quartz Mountain. Intermediate ground-water mounds can be expected to form under other elevated areas, with permeable soils and high rainfall such as Yainax Butte and Swan Lake Point. Figure 5 shows four profiles which indicate an interpretation of the relative depth and direction of ground-water movement beneath portions of the Sprague River Sub-basin. Plate 5 shows a map view of the directions of ground-water movement for the Sprague River Sub-basin as well as other sub-basins of the Klamath Basin.

THE DIVISIONS OF THE KLAMATH GROUND-WATER BASIN

Geology and Aquifer Units

A large number of well logs for the Sprague River Sub-basin are on file in the State Engineer's office. A high percentage of these wells are large, high-yielding irrigation wells. A list of wells and their characteristics will be presented in the more-detailed U. S. Geological Survey-State Engineer joint report to be published at a later date. A few selected wells are presented in Tables 8 through 10 and indicate what can be expected of wells in several of the areas of the Sprague River Sub-basin.

Sprague River

Near the community of Sprague River, most wells are less than 450 feet deep and encounter sand, clay, gravel, shale, and chalk. These wells usually yield less than 25 gpm, unless black sand or other permeable units are encountered. The basalt rock units are usually encountered at depths greater than about 550 feet in the center of the valley and at shallower depths on the flanks of the valley. This aquifer can be expected to yield more than 100 gpm and in some cases up to 1,350 gpm. See Table 8.

TABLE 8

REPRESENTATIVE WELLS FOR THE CITY OF SPRAGUE RIVER

Township 36 South, Range 10 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, IBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
200	0	200	Sd, Cl, Gl, Sh	SA	9.75	25	70	
527	0 446	446 527	Sd, Cl, Ck Broken lava, Ck	SA VCA	16	1350	81	
385	0	385	Alternating lava & Sh	VCA	181	100	80+	

Abbreviations: Sand (Sd), Clay (Cl), Gravel (Gl), Shale (Sh), Chalk (Ck), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (IBA)

Beatty and Bly

Much the same conditions exist around Beatty. Deeper wells of 950 feet in depth have encountered large yields and artesian pressures. Flows in excess of 1,000 gpm have been reported. Some large-yielding wells have been reported on the flanks of the valleys at shallower depths. In the vicinity of Bly, shallow wells encounter the lower basalt aquifer. Well yields in excess of 2,000 gpm are not uncommon in the Sprague River Sub-basin. See Tables 9 and 10.

TABLE 9

REPRESENTATIVE WELLS FOR BEATTY

Township 36 South, Range 12 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, IBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
280	0	280	Sd, Sh, Ck	SA	37	10	63	60
950	0 890	890 950	Pm, Sd, Cl, Sh Gl	 SA	+	flow 700		56
960	0 470 490 900	470 490 900 960	Ck Lava Ck, Pm Basalt	SA VCA SA IBA	+	flow 900		
180	0 115	115 180	Sd Lava	SA VCA	7	110	0.33	
524	0 420	420 524	Ck, Sd Basalt	SA IBA	8 psi	flow 1800		

Abbreviations: Sand (Sd), Shale (Sh), Chalk (Ck), Pumice (Pm), Clay (Cl), Gravel (Gl), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (IBA)

TABLE 10

REPRESENTATIVE WELLS FOR BLY

Township 36 South, Range 14 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
110	0 12	12 110	Sd, Gl Red & Black Lava	SA VCA	35	30	0	52
376	0 94 180 280	94 180 280 376	Sd, Gl Lava Cl Lava	SA VCA SA LBA	80	2350	7	60
485	0 20 152 443	20 152 443 485	Sd, Cl Lava, Bt Sh, Gl Bt, Lava	SA VCA SA LBA	42.5	2300	108	58
708	0	708	Lava, Ci, Cl	VCA and LBA	9.5	2360	97	62
143	0 41	41 143	Sd, Cl Lava, Ci, Bt	VCA and LBA	28	3500	0	56

Abbreviations: Sand (Sd), Gravel (Gl), Clay (Cl), Shale (Sh), Basalt (Bt), Cinders (Ci)
Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

Ground-Water Discharge Areas

The major intermediate-size discharge areas for the Sprague River Sub-basin are Sycan Marsh, Sycan River, and Sprague River. The direction of ground-water movement as shown in Figure 5 and Plate 5 is generally toward Sycan Marsh, then southward toward Sprague River, and westward through the central portions of the sub-basin.

Of the estimated 650,000 acre-feet per year assumed to reach the ground-water system, 500,000 acre-feet per year resurfaces within the boundaries of this sub-basin. This water is: (1) used by plants (transpired) in low-lying grass and marsh-lands, (2) evaporated, (3) exiting the sub-basin as baseflow to Sprague River, or (4) extracted from wells. The remaining 150,000 acre-feet per year leaves the sub-basin as regional underflow beneath the southern or western intermediate boundaries. The question of direction of regional ground-water movement can be answered with either a southerly movement toward Lost River or a westerly movement toward Upper Klamath Lake. With present day information, south or west directions of movement are equally strong possibilities. Thus, the final disposition of the 150,000 acre-feet of estimated ground-water underflow leaving the Sprague River Sub-basin has not yet been determined.

The ground-water extractions are accounted for as pumping withdrawals. Assuming that irrigation wells are used at the maximum allowable rate of 3 acre-feet per acre per year, ground-water rights under permit account for 59,700 acre-feet per year. Other permitted water rights, assuming they are used at the maximum allowable rate, would account for 300 acre-feet per year. Included in this category are industrial, municipal, domestic, stock watering, and road sprinkling. Therefore, local water rights, if used to the maximum, would account for 60,000 acre-feet per year. Ground-water rights are listed in Table 25, under Sprague River.

Well Hydrographs

Figure 7, pages 270 through 274 shows quarterly, water-level measurements in 15 observation wells in the Sprague River Sub-basin. Locations of observation wells are shown on Plate 5. Some water level decline has been recorded in observation wells near Sprague River. These minor declines of 1½ to 2 feet per year are due to pumping effects during the irrigation season and are to be expected in a developing well field.

UPPER KLAMATH LAKE SUB-BASIN

The Upper Klamath Lake Sub-basin covers 790 square miles in the west central portion of the Klamath Basin. Recharge boundaries of this sub-basin are formed by ground-water mounds that cause ground water to move away from the boundary areas. See Figure 4, following page 238 and Figure 6, following page 252. Regional boundaries extend along the crest of the Cascade Range from Crater Lake to Brown Mountain, which lies just south of Mt. McLoughlin.

Intermediate boundaries which separate the Upper Klamath Lake Sub-basin from other sub-basins of the Klamath Basin extend from Crater Lake to Brown Mountain along the Cascades on the west, from Brown Mountain to Aspen Butte to Klamath Falls on the south, from Klamath Falls along Naylox Mountain and Chiloquin Ridge to Chiloquin on the east, and from Chiloquin along Sand Ridge to Crater Lake on the northeast.

Mt. McLoughlin, at an elevation of 9,495 feet above sea level, is the highest point in the sub-basin. Klamath Lake, at 4,139 feet above sea level, is the lowest portion of the Upper Klamath Lake Sub-basin. Principal features within the Upper Klamath Lake Sub-basin are Crater Lake, 6,176 feet; Agency Lake and Upper Klamath Lake, 4,139 feet; Aspen Lake, 4,319 feet; and Lake of the Woods, 4,960 feet. Notable peaks are Pelican Butte, 8,036 feet; Aspen Butte, 8,208 feet; and the Chiloquin Ridge-Naylox Mountain chain, near 6,000 feet. Aside from Williamson River, which flows into the sub-basin from the north, the principal stream in the Upper Klamath Lake Sub-basin is Wood River. This stream issues from springs at the base of Sun Mountain and flows southward to Agency Lake.

Water in the Upper Klamath Lake Sub-basin

Estimates of the total annual water supply to the Upper Klamath Lake Sub-basin were made for the purpose of arriving at a value for average annual ground-water recharge. Precipitation records, surface water inflow records, and estimates of the ground-water underflow from the Williamson River Sub-basin were used in the analysis. A portion of the total, annual, average precipitation falling in the ground-water recharge area infiltrates into the ground-water system. The remaining portions are evaporated, transpired by forest cover, or contributed to surface water runoff. Precipitation falling in ground-water discharge areas cannot enter the ground-water system, because in these areas ground water is moving toward land surface.

Based upon a 40-year average of surface water records, evapotranspiration estimates of various types of forest cover, and the above-mentioned precipitation data, we have estimated that approximately 800,000 acre-feet per year is recharged to the ground-water system within the boundaries of the Upper Klamath Lake Sub-basin.

Ground Water in the Upper Klamath Lake Sub-basin

The 800,000 acre-feet per year that seeps into the ground-water system enters the ground in the recharge areas. The water percolates downward through the geologic materials and resurfaces in ground-water discharge areas.

THE DIVISIONS OF THE KLAMATH GROUND-WATER BASIN

Ground-Water Recharge Areas

Downward percolating ground water beneath elevated areas, such as the Cascade Range from Crater Lake to Aspen Butte, forms mounds of a regional scale. Recharge mounds of smaller dimension can be expected to form under other elevated areas which receive high rainfall and possess permeable soils such as Naylox Mountain, Chiloquin Ridge, and Sand Ridge. Regional ground-water mounds form effective hydraulic barriers against waters which might otherwise enter from adjoining basins. Intermediate ground-water mounds form effective hydraulic barriers only to waters of intermediate depth and not to the very deep waters of the regional system. Figure 6, following page 252, shows two interpretive profiles which indicate the relative depth and direction of ground-water movement beneath portions of the Upper Klamath Lake Sub-basin. A map indicating the directions of ground-water movement for the Upper Klamath Lake Sub-basin and other sub-basins of the Klamath Basin is shown on Plate 5.

Geology and Aquifer Units

The representative materials through which ground water moves on its way from recharge areas to discharge areas are described and reported on well drillers' logs which are filed in the State Engineer's Office, Salem, Oregon. Well logs on file for wells located in the Upper Klamath Lake Sub-basin are sparse. The majority of these logs are located in or near the communities of Fort Klamath, Klamath Agency, Algoma, Shady Pine, Wocus, and Rocky Point.

Fort Klamath

In the vicinity of Fort Klamath, in the Upper Klamath Lake Sub-basin, typical wells vary from less than 50 feet to 350 feet in depth and encounter pumice, sand, clay, gravels, and cinder to at least 335 feet. Static water levels vary from 35 feet below land surface to artesian pressures equivalent to 14 feet above land surface (psi) pounds per square inch. Shallow flowing wells are very common in this area. Ground-water temperatures range from 40^{o} to 53^{o} F. See Table 11.

TABLE 11

REPRESENTATIVE WELLS FOR FORT KLAMATH

Township 33 South, Range 7½ East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
103	0	103	Pm, Sd, Cl, Ci	SA	35	30	35	52
136	0	136	Pm, Sd, Cl, Gl, Ci	SA	+ 6 psi	flow 20 pump 80	6	
335	0	335	Same as above	SA	+	flow 10		40

Abbreviations: Pumice (Pm), Sand (Sd), Clay (Cl), Cinder (Ci), Gravel (Gl), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

TABLE 12

REPRESENTATIVE WELLS FOR KLAMATH AGENCY

Township 34 South, Range 7½ East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
55	0	55	Pm, Sd, Ch, Gl	SA	3	40	7	50
256	0	256	Peat, Sd, Pm, Sh	SA	+ 9.60 psi	flow 50		
363	0 186	186 363	Pm, Sd, Cl Interbedded lava & Sd	SA SA	3	1200	92	50

Abbreviations: Pumice (Pm), Sand (Sd), Chalk (Ck), Gravel (Gl), Shale (Sh), Clay (Cl), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

Klamath Agency

Water wells near Klamath Agency are similar to those in the Fort Klamath area, with the deepest reported well being 363 feet. This well encounters lavas from 186 to 363 feet below land surface. Water levels of the area are shallow. Some artesian wells report pressures of 9.6 psi or water levels 22 feet above land surface. The highest reported production is from the Lower Basalt Aquifer which yields 1,200 gpm, with 92 feet of drawdown. See Table 12.

Rocky Point

Dozens of shallow wells, 35 to 60 feet deep, are reported in the Rocky Point area. These wells are completed in sands, gravels, and clays of the Sedimentary Aquifer. Static water levels are generally less than 10 feet below land surface, and wells can be expected to produce quantities of about 30 gpm. Temperatures range from 47° to 51° F. See Table 13.

TABLE 13

REPRESENTATIVE WELLS FOR ROCKY POINT

Township 36 South, Range 6 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
39	0	39	Sd, Cl	SA	6	30	6	51
40	0	40	So, Cl, Sd, Gl	SA	2	25	10	47
115	0	115	Sd, Cl, Gl	SA	6	30	2	47

Abbreviations: Sand (Sd), Clay (Cl), Soil (So), Gravel (Gl), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

Algoma and Shady Pine

In the Algoma and Shady Pine areas, wells encounter sand, clay, gravel, and chalk of the Sedimentary Aquifer to depths between 100 and 350 feet below land surface. Below these materials lava, cinders, and basalt of the Volcanic Centers

Aquifer are encountered. Water levels are generally less than 40 feet. Well capacities range from 12 gpm, with 30 feet of drawdown from the Sedimentary Aquifer, to 3,175 gpm, with 12 feet of drawdown from the Volcanic Centers Aquifer and the Lower Basalt Aquifer. Temperatures range from 54° to 61° F. See Table 14.

TABLE 14

REPRESENTATIVE WELLS FOR ALGOMA AND SHADY PINE

Sections 6, 7, 18 & 31, Township 37 South, Range 9 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
110	0 95	95 110	Sd, Cl, Gl Sd, Lava	SA	10	25	15	58
419	0 340	340 419	Sd, Cl, Gl BLa, Ci	SA LBA	40	3175	12	61
43	0 41	41 43	Bo, Sd, Cl Basalt		6 @ 20 8 @ 41	12	30	54

Abbreviations: Sand (Sd), Clay (Cl), Gravel (Gl), Basalt Lava (BLa), Cinders (Ci), Boulder (Bo), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

Wocus

Near Wocus most water wells yield more than 20 gpm. These wells encountered sand, clay, gravel, shale, and chalk of the Sedimentary Aquifer to depths of 80 to 160 feet below land surface. Water production comes from porous lava of the Volcanic Centers Aquifer underlying these sediments. The porous lavas may be only 20 feet thick, with shale and sand underlying it to depths of at least 260 feet. No wells greater than 260 feet in depth have been reported in this area. See Table 15.

TABLE 15

REPRESENTATIVE WELLS FOR WOCUS

Sections 1, 12, & 13, Township 38 South, Range 8 East, W.M.

Section 7, Township 38 South, Range 9 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
232	0	232	Cl, Sh, Pm, Sd	SA	124	10	15	61
125	0 114	114 125	Chalk Lava	SA VCA	114	42	2	
165	0 143	143 165	Chalk, Cl, Sh Lava	SA VCA	48	15	40	
257	0 180 200	180 200 257	Cl, Sd, Gl, Sh Basalt, Sh Sh, Ss	SA VCA	90	20	0	53

Abbreviations: Clay (Cl), Shale (Sh), Pumice (Pm), Sand (Sd), Gravel (Gl), Sandstone (Ss), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

Ground-Water Discharge Areas

Ground water recharged in the highland areas of the Upper Klamath Lake Sub-basin as well as portions of the ground-water underflow from the Williamson River Sub-basin moves downward toward low lying ground-water discharge areas such as Aspen, Agency, and Upper Klamath Lakes. Annie Creek, Sevenmile Creek, Fourmile Creek, Crooked Creek, and Wood River also receive ground-water discharge. The direction of ground-water movement within the Upper Klamath Lake Sub-basin is shown in Figures 4 and 6 and Plate 5. Ground water in this sub-basin generally moves toward Upper Klamath Lake then south toward Lower Klamath Lake.

It is estimated that 800,000 acre-feet per year enters the ground-water system within the boundaries of this sub-basin.

In addition, approximately 400,000 acre-feet per year enters as ground-water inflow from the Williamson River Sub-basin, bringing the total to nearly 1,200,000 acre-feet per year. Of this amount, 1,000,000 acre-feet per year appears to resurface within the boundaries of the sub-basin. This water is: (1) used by plants (transpired) in low lying grass and marshlands, (2) evaporated, (3) exiting the sub-basin as baseflow in Link River, or (4) extracted from wells. The remaining 200,000 acre-feet per year moves beneath the southern boundary on its way toward the Lost River Sub-basin.

The 27,000 acre-feet per year accounted for as pumpage from the Upper Klamath Lake Sub-basin is estimated by assuming that irrigation wells are used at the maximum allowable rate of 3 acre-feet per acre per year. Ground-water irrigation rights under permit would account for 4,000 acre-feet per year. Other permitted ground-water rights, assuming they are used at the maximum allowable rate, would account for 23,000 acre-feet per year. Included in this category are industrial, municipal, domestic, stock water, heating, air-conditioning, and road sprinkling. Therefore, allowable ground-water rights, if used to the maximum, would account for 27,000 acre-feet per year.

Well Hydrographs

Figure 7, page 269 shows quarterly, water-level measurements in the observation well located in Section 34, T. 35S., R. 7E., of the Upper Klamath Lake Sub-basin. Locations of observation wells are shown on Plate 5.

LOST RIVER SUB-BASIN

The Lost River Sub-basin covers 3,019 square miles in the southern portion of the Klamath Basin. Of that total, 1,315 square miles lies in Oregon, and the remaining 1,704 square miles lies in California. It is assumed that ground-water boundaries of the sub-basin lie beneath topographic divides. See Figure 6 and Plate 5. Regional boundaries extend along topographic divides from Quartz Mountain southward into California. The boundary extends along the drainage divide between the Lost River-Klamath River Drainage and the Pitt River Drainage to the south. The boundary extends eastward to Mt. Shasta, then northward through Whaleback, Deer, and Goosenest Mountains and re-enters Oregon in the vicinity of Secret Spring Mountain and Hamaker Mountain. Intermediate boundaries which separate the Lost River Sub-basin from the other sub-basins of the Klamath Basin on the Oregon side of the Oregon-California state line extend from the Cascade Divide to Aspen Butte, thence to Klamath Falls, thence northward along Naylox Mountain, Bly Mountain, Yainax Butte, and Juniper Mountain. Principal features within Oregon's Lost River Sub-basin are Langell, Yonna, Poe, and Swan Lake Valleys; plus Lower Klamath Lake and Tule Lake, which extend into California. Hogback Mountain, Moyina Hill, Stukel Mountain, and Bryant Mountain are notable topographic highs in the central portion of the sub-basin. Principal streams are Lost River, which drains into Tule Lake; and Klamath River, which cuts its way through the Cascades on its way to the Pacific Ocean.

Water in the Lost River Sub-basin

Estimates of the total annual water supply to the Lost River Sub-basin were made in the same manner as the estimates for the other sub-basins. On the basis of a water budget analysis, we estimate that approximately 550,000 acre-feet per year recharges the ground-water basin. In addition to ground water being recharged within the boundaries of the Lost River Sub-basin, 200,000 acre-feet per year enters the sub-basin as ground-water inflow from the Upper Klamath Lake Sub-basin; and an additional 150,000 acre-feet enters as ground-water underflow from the Sprague River Sub-basin. The total, average, quantity of ground water moving through the Lost River Sub-basin is approximately 900,000 acre-feet per year.

Ground Water in the Lost River Sub-basin

The 550,000 acre-feet per year that seeps into the ground-water system enters the ground in the recharge areas. The water percolates downward through the geologic materials and resurfaces in ground-water discharge areas.

Ground-Water Recharge Areas

Recharge areas for ground water entering the Oregon side of the Lost River Sub-basin are the Cascade Range and Aspen Butte on the west; Naylox Mountain, Edgewood Mountain, Yainax Butte, and Horsefly Mountain on the north; Quartz Mountain on the east; and Goodlow, Bryant, Stukel, and Hogback Mountains within the sub-basin.

Downward percolating water beneath ground-water recharge areas can be expected to form mounds of a regional scale.

These mounds act as boundaries and extend along the Cascade Range from Brown Mountain to Buck Mountain on the west, and from Juniper Mountain to Strawberry Butte, and south into California on the east. Recharge mounds of smaller dimension can be expected to form under other elevated areas which receive high rainfall and possess permeable soils such as Hogback Mountain, Bryant Mountain, Edgewood Mountain, and Yainax Butte. Regional ground-water mounds form effective hydraulic barriers against water which might otherwise enter from adjoining basins. Intermediate ground-water mounds form effective hydraulic barriers only to water of intermediate depth and not to the very deep waters of the regional system. Figure 6 shows five interpretive profiles which indicate the relative depth and direction of ground-water movement beneath portions of the Lost River Sub-basin. A map indicating the directions of ground-water movement for the Lost River Sub-basin and other sub-basins of the Klamath Basin is shown on Plate 5.

Geology and Aquifer Units

Materials through which ground water flows on its way from recharge areas to discharge areas within the Lost River Sub-basin are described on well drillers' logs filed in the State Engineer's Office, Salem, Oregon. Wells located in the Lost River Sub-basin are numerous and will be tabulated in the U. S. Geological Survey-State Engineer cooperative report, which will present more detailed tables of well logs in the Langell, Yonna, Poe, and Swan Lake Valleys. For this reason, more emphasis in this report will be placed on well logs from the vicinity of Malin, Merrill, Midland, Keno, and Henley.

Keno

Table 16 lists several wells in the Keno area which were selected to show the variation in ground water which might be expected in the area. These wells usually encounter clay and gravel for the first 10 to 150 feet, with lava, basalt, and cinders underlying these sediments. They produce from 7 gpm, with 60 feet of drawdown, to 20 gpm, with no observable drawdown. Ground-water temperatures range from 42° to 57° F. The deeper water levels are experienced in wells located in the hills above the valley floor.

TABLE 16

REPRESENTATIVE WELLS FOR KENO

Township 39 South, Range 7 & 8 East, W.M.

Township 40 South, Range 7 & 8 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
220	0 42	42 220	Cl, Gl Lava, Bt, Ci	SA VCA	136	10	16	
175	0 110	110 175	Soil, Bo Lava	SA VCA	74	10	12	
293	0 52	52 293	Cl, Bo Lava, Bt, Ci	SA VCA	270	20	0	42
383	0 105	105 383	Cl, Bo Lava, Bt, Ci	SA VCA	308	10	10	57
234	0 95	95 234	Cl, Bo Lava, Sd, Sh, Ci	SA VCA	145	20	0	
179	0 28	28 179	Sd, Bo Lava, Bt	SA VCA	68	20	20	
197	0 10	10 197	Sd, Cl Lava, Bt, Ci	SA VCA	146	10	0	
250	0 30	30 250	Sd, Cl Lava, Bt, Ci	SA VCA	97	7	60	
205	0 95	95 205	Sd, Cl, Bo Sd, Ci, Lava	SA VCA	98	30	60	53
152	0 22	22 152	Cl Lava, Bt, Ci	SA VCA	47	25	18	

Abbreviations: Clay (Cl), Gravel (Gl), Basalt (Bt), Cinders (Ci), Boulders (Bo), Shale (Sh), Sand (Sd), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

Henley

In the area around Henley, wells encounter sand, clay, gravel, and shale near the center of the valley to depths of 1,180 feet. Several well logs report lava, basalt, and cinders of the Volcanic Centers and Lower Basalt Aquifers below depths ranging from 300 to 600 feet closer to the margins of the valley. The Sedimentary Aquifer in this area contains a black sand and gravel member which yields up to 1,000 gpm.

Some mineralized water has been encountered in the area, and one well contained alkali water which is reportedly unfit to drink. Temperatures range from 52° to 86° F. See Table 17.

TABLE 17

REPRESENTATIVE WELLS FOR HENLEY

Township 39 South, Range 9 & 10 East, W.M.

Township 40 South, Range 9 & 10 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGICAL MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
135	0	135	Sd, Cl, Sh	SA	15	50	30	54
113	0	113	Sd, Cl, Gl, Sh	SA	11	20	3	
185	0 182	182 185	Sd, Cl, Sh Black Sd	SA SA	97	30	53	58
165	0	165	Sd, Cl, Gl	SA	8	30	8	56
342	0	342	Ck, Sh, Sd	SA	8.5	40	0	68
565	0	565	Sd, Ck, Sh	SA	5	7	17	65
495	0 485	485 495	Sh, Sd Lava	SA VCA	2.5	50	12	83
392	0 317	317 392	Sd, Sh, Bo Lava	SA VCA	132	200	2	86
756	0 660	660 756	Sd, Ck, Sh Lava, Bt, Ci	SA VCA	17	700	73	
170	0 135	135 170	Sd, Sh, Cl Gl	SA SA	35	1000	69	56
100	0	100	Sd, Cl	SA	0	25	10	52
801	0	801	Same as above	SA	0*	25	10	52
1210	0	1210	Sd, Cl, Ck	SA	+ 10 psi	flow 45		84

Abbreviations: Sand (Sd), Clay (Cl), Shale (Sh), Gravel (Gl), Chalk (Ck), Boulders (Bo), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

* Unfit to drink.

Lower Klamath Lake

In the Klamath Hills, which lie along the northern edge of Lower Klamath Lake, wells yield up to 3,500 gpm, with 83 feet of drawdown from the Lower Basalt Aquifer. The more permeable lavas, basalt, and cinders have been encountered at depths as shallow as 174 feet and as deep as 702 feet below land surface. The Sedimentary Aquifer typically yields less than 30 gpm.

Of special interest are the water temperatures for this area, especially, because of recent efforts to harness geothermal energy in the production of electrical power. Temperatures as high as 200° F. have been encountered in the John Liskey well. Average temperatures for wells in this area are above 70° F. See Table 18.

TABLE 18

REPRESENTATIVE WELLS FOR LOWER KLAMATH LAKE

Township 40 South, Range 9 East, W.M.

Township 41 South, Range 9 & 10 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, IBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
200	0 174	174 200	Cl, Sh Lava, Sh	SA VCA	104	15	16	108*
418	0 395	395 418	Cl, Sh, Bo Bt, Lava	IBA	32	450	2	186*
128	0	128	Sd, Cl, Ck, Gl	SA	45	30	2	72
155	0	155	Sh, Gl	SA	75	20	20	74
770	0 702	702 770	Cl, Sh Lava, Sh	SA IBA	40.5	3500	83	99
888	0 651	651 888	Ck, Lava, Sh, Sd Lava, Cinders	SA IBA	140*	2600	35	86

Abbreviations: Sand (Sd), Clay (Cl), Shale (Sh), Boulders (Bo), Basalt (Bt), Chalk (Ck), Gravel (Gl) Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (IBA)

* High temperature indicates deep circulation.

The high temperatures characteristic of this region are indicative of deep ground-water circulation, which is to be expected in a regional ground-water discharge area. In this area ground water moves upward toward the shallow water table near land surface bringing with it heat and mineral constituents which the water has acquired during its long, deep flow path. Therefore, sodium brought to the surface in discharge areas by ground-water movement causes alkali soils and brines to develop in Lower Klamath Lake.

Merrill Area

Table 19 shows well data for a number of wells in the vicinity of Merrill. The Sedimentary Aquifer may yield from as little as 5 gpm, with 163 feet of drawdown, to as much as 40 gpm, with 9 feet of drawdown. The sedimentary materials of this aquifer can be expected to range in depth from 35 to 1,000 feet below land surface. The more permeable lavas, basalts, and cinders of the Volcanic Centers Aquifer and the Lower Basalt Aquifer underlie the Sedimentary Aquifer. Yields from the underlying lavas range up to 2,450 gpm, with 19 feet of drawdown; and ground-water temperatures generally range from 54° to 78° F. Shallow water levels, flowing wells, moderate to high concentrations of total-dissolved solids, and moderate to high water temperatures indicate the Merrill area is also a ground-water discharge area.

Malin Area

Well yields typical of the Sedimentary Aquifer in the Malin area range from 2½ gpm, with 53 feet of drawdown, to 25 gpm, with no apparent drawdown. Higher yields from this unit are reported from gravel and black sand layers. Typical well yields from the Volcanic Centers Aquifer average 24 gpm, with 20 feet of drawdown. The top of the Volcanic Centers Aquifer may outcrop at land surface or be found at depths in excess of 500 feet below land surface. Well yields of 1,200 gpm, with 1 foot of drawdown, have been developed from the Lower Basalt Aquifer. Reported temperatures range from 54° to 73° F. See Table 20.

Swan Lake, Poe, Yonna, and Langell Valleys

Tables 21, 22, 23, and 24 list wells in the Swan Lake, Yonna, Poe, and Langell Valleys, which have been selected as representative of these areas. Detailed information on wells and their locations in these areas will be presented in the U.S. Geological Survey-State Engineer cooperative report.

TABLE 19

REPRESENTATIVE WELLS FOR MERRILL

Township 40 South, Range 10 East, W.M.

Township 41 South, Range 10 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, IBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
260	0	260	Sd, Gl, Ck	SA	6 @ 31* flow @ 220 2 psi @ 260	flow 3 bail 40	10	54
250	0 35	35 250	Cl, Sd Red & BLa	SA VCA	55	12	100	64
263	0 119	119 263	Cl, Ck Lava	SA VCA	90	515	7	78
165	0	165	Sd, Cl, Ck	SA	7	30	13	56
152	0 136	136 152	Sd, Cl, Gl, Sh Lava, Sd	SA VCA	112	750	34	61
552	0	552	Cl, Sh	SA	17	5	163	61
125	0	125	Cl, Sd, Gl	SA	15	40	20	56
335	0 328	328 335	Ck, Cl, Sd Lava	SA VCA	43	100	10	68
330	0	330	Cl, Sh, Sd, Ck	SA	5	33	17	50
1088	0 897	897 1088	Cl, Sh, Sd, Ck Lava, Ci	SA VCA, IBA	47.5	325	5	74
732	0	732	Cl, Sh, Sd, Ck	SA	9	35	61	54
1128	0 1001	1001 1128	Cl, Sh, Sd, Ck Lava	SA IBA	+ 4 psi	flow 420 pump 1300	27	76
50	0	50	Ck, Sd, Gl	SA	3	40	9	56
1012	0 900	900 1012	Sd, Ck Lava	SA IBA	33	2450	19	74

Abbreviations: Sand (Sd), Gravel (Gl), Chalk (Ck), Clay (Cl), Black Lava (BLa), Shale (Sh), Cinders (Ci) Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (IBA)
Note: * Rising water level as well was deepened.

TABLE 20

REPRESENTATIVE WELLS FOR MALIN

Township 40 South, Range 12 East, W.M.

Township 41 South, Range 12 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
1198	0 154 463 979	154 463 979 1198	Sd, Cl Lava, Gl, Sd Cl, Sd, Gl Lava, Bt	SA VCA SA LBA	210	700	72	58
248	0 57	57 248	Sd, Cl, Ck Lava, Ci	SA LBA	162*	1150	46	55
222	0 202	202 222	Cl, Sd, Ck Lava	SA LBA	120	10	0	
391	0 179	179 391	Sd, Cl Lava, Bt, Ci	SA VCA, LBA	249	1060	6	73
302	0 8	8 302	Sd Bt, Lava, Ci	VCA LBA	186	1200	1	68
650	0 457	457 650	Sd, Cl, Ck Lava, Cl	SA VCA	58	80	42	
101	0	101	Sd, Cl	SA	2	10	13	55
273	0 217	217 273	Lava, Sd, Ci Cl, Sh	VCA SA	133	12	27	56
202	0	202	Sd, Cl, Gl, Ck	SA	35	20	35	54
156	0 88	88 156	Sd, Cl, Gl Lava, Ci	SA VCA	22	24	20	56
70	0	70	Sd, Cl, Gl	SA	12	25	0	
380	0 100	100 380	Sd, Cl Lava, Sd	SA LBA	21	532	10	
245	0	245	Sd, Cl, Sh	SA	7.5	18	45	57
95	0	95	Sd, Cl	SA	7	2.5	53	57

Abbreviations: Sand (Sd), Clay (Cl), Gravel (Gl), Chalk (Ck), Cinders (Ci), Basalt (Bt), Shale (Sh), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

* Water level raised while deepening.

Swan Lake Valley

Typical wells in the Swan Lake Valley encounter sands, shales, clays, chalk, and gravel to depths greater than 130 feet. Yields from the Sedimentary Aquifer are generally less than 30 gpm. Underlying the Sedimentary Aquifer are extensive deposits of lava, basalt, and cinders which yield up to 2,150 gpm, with 90 feet of drawdown. These units, which include the Volcanic Centers Aquifer and the Lower Basalt Aquifer, are the principal water producing formations for irrigation wells. As noted in Table 21, the decline in

TABLE 21

REPRESENTATIVE WELLS FOR SWAN LAKE VALLEY

Township 38 South, Range 10 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
850	0	70	Sd, Sh, Cl, Gl	SA				
	70	850	Lava, Bt	VCA, LBA	58	2150	90	50
243	0	70	Sd, Sh, Cl, Gl	SA	62 @ 67*	30 +	0	58
	70	243	Lava, Bt	VCA, LBA	87 @ 195 138 @ 228			
221	0	31	Yellow Cl	SA	75	1600	19	65
	31	221	Lava, Ci, Bt	VCA, LBA				
129	0	129	Sd, Cl, Ck, Gl	SA	11	30	50	64

Abbreviations: Sand (Sd), Shale (Sh), Clay (Cl), Gravel (Gl), Basalt (Bt), Cinders (Ci), Chalk (Ck) Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

* Note decline in water level as well was deepened indicating recharge area.

water level as wells are deepened in the southern portions of Swan Lake Valley indicate that this is a ground-water recharge area.

Yonna Valley

In the vicinity of Yonna Valley, wells encounter sand, shale, clay, and gravel in the Sedimentary Aquifer to depths up to 857 feet below land surface. Wells in this unit generally yield about 20 gpm, whereas wells extending into the Volcanic Centers Aquifer or the Lower Basalt Aquifer yield up to 3,200 gpm. A number of flowing wells have been constructed in this area. Water temperatures range from 58° to 63° F. See Table 22.

TABLE 22

REPRESENTATIVE WELLS FOR YONNA VALLEY

Township 38 South, Range 11½ East, W.M.

Township 39 South, Range 11½ East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPER-ATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
583	0 556	556 583	Sd, Cl, Ck Bt	SA LBA	70	3200	23	
280	0 271	271 280	Sd, Cl, Sh Bt	SA LBA	65	1500	0.5	
996	0 857	857 996	Sd, Sh, Cl, Gl Lava, Bt	SA LBA	53	2000	26	
348	0 310	310 348	Sd, Cl, Ci Red & BLa	SA LBA	+ 2	flow ? pump 1500	55	63
209	0 207	207 209	Sd, Ck, Sh BLa	SA LBA	21	20		58
395	0 365	365 395	Sd, Cl, Sh Red & BLa	SA LBA	20	1900	103	58

Abbreviations: Sand (Sd), Clay (Cl), Chalk (Ck), Basalt (Bt), Shale (Sh), Gravel (Gl), Black Lava (BLa), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

Poe Valley

Sands, shales, clays, cinders, and chalk of the Sedimentary Aquifer have been encountered to depths up to 650 feet beneath land surface in Poe Valley. Yields from this formation are generally sufficient only for domestic purposes. Underlying the Sedimentary Aquifer are the basalts and volcanic materials of the Lower Basalt and Volcanic Centers Aquifers. Some well logs report flows of 600 gpm at land surface from these aquifers. Temperatures range from 53° to 73° F. See Table 23.

TABLE 23

REPRESENTATIVE WELLS FOR POE VALLEY

Township 39 South, Range 11½ & 11 East, W.M.

Township 40 South, Range 11 & 12 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, IBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
582	0	582	Sd, Sh, Cl, Ci	SA	12	24	70	64
682	0	643	Sd, Sh	SA				
	643	682	Lava, Bt	IBA	59	23	55	
510	0	510	Sd, Sh, Cl, Gl, Ck	SA	14	6	46	58
689	0	87	Sd, Sh, Cl, Gl, Ck	SA		flow 600		
	87	459	Lava, Bt	VCA		pump		73
	459	643	Sd, Sh	SA	+	800	53	
	643	689	Bt	IBA				
410	0	302	Sd, Sh, Cl, Ck	SA				
	302	410	Lava, Bt	VCA, IBA		1200	40	53

Abbreviations: Sand (Sd), Shale (Sh), Clay (Cl), Cinders (Ci), Basalt (Bt), Gravel (Gl), Chalk (Ck), Sedimentary Aquifer (SA), Volcanic Centers Aquifers (VCA), Lower Basalt Aquifer (IBA)

Langell Valley

The few well logs available from the Langell Valley area suggest that the Sedimentary Aquifer extends to depths of at least 110 feet below land surface on the fringes of the valley and are underlain by the Volcanic Centers and Lower Basalt Aquifers. Well yields from these aquifers reach 1,400 gpm, with 60 feet of drawdown. A number of flowing wells have been reported in Langell Valley, and thermal springs indicate that ground water discharges in the central part of the valley. See Table 24.

TABLE 24

REPRESENTATIVE WELLS FOR LANGELL VALLEY

Township 39, 40, & 41 South, Range 12 & 13 East, W.M.

DEPTH OF WELL (FEET)	GEOLOGIC MATERIALS				WATER LEVEL	WELL PERFORMANCE		TEMPERATURE (°F)
	DEPTH FROM (FEET)	DEPTH TO (FEET)	CHARACTER OF MATERIAL	AQUIFER UNIT (SA, VCA, LBA)	FEET BELOW LAND SURFACE	YIELD (GPM)	DRAWDOWN (FEET)	
257	0 112	112 257	Ck Lava	SA LBA	84	1050	16	
203	0 110	110 203	Sd, Cl, Gl Bt, Cl	SA LBA, VCA	80	100	0	58
130	0	130	Lava, Bt	VCA	22	40	3	
102	0	102	Sd, Cl, Gl	SA	+ 3	flow 1 bail 27	27	60
75	0	75	Sd, Gl	SA	18	40	12	
210	0 70	70 210	Unreported Bt	Unknown LBA	17	1400	60	

Abbreviations: Chalk (Ck), Sand (Sd), Clay (Cl), Gravel (Gl), Basalt (Bt), Sedimentary Aquifer (SA), Volcanic Centers Aquifer (VCA), Lower Basalt Aquifer (LBA)

Ground-Water Discharge Areas

Ground water recharged in the elevated areas of the Lost River Sub-basin along with portions of the ground-water underflow from the Upper Klamath Lake and Sprague River Sub-basins moves toward low lying ground-water discharge areas such as Tule Lake, Lower Klamath Lake, Lost River, and Klamath River. The direction of ground-water movement within the Lost River Sub-basin is shown in Figure 6 and Plate 5. Ground water generally moves from the north and east toward Lost River, thence east and south toward Lower Klamath Lake and the Klamath River.

It is estimated that 550,000 acre-feet per year enters the ground-water system within the boundaries of this sub-basin. In addition, 350,000 acre-feet per year enters as ground-water inflow from the Upper Klamath Lake and Sprague River Sub-basins.

Of the 900,000 acre-feet per year flowing through the Lost River Sub-basin, 800,000 acre-feet per year appears to resurface within the boundaries of the sub-basin. This water is: (1) used by plants (transpired) in lower Klamath Lake and Tule Lake, (2) evaporated, (3) exiting the sub-basin as baseflow to the Klamath River, or (4) extracted from wells. The remaining 100,000 acre-feet per year leaves the Lost River Sub-basin as ground-water underflow beneath the southwestern boundary on its way to discharge points in the Klamath River canyon.

Pumping withdrawals are based upon total acreages under a duty of 3 acre-feet per acre per year. Ground-water irrigation rights on the Lost River Sub-basin, if used at the maximum allowable rate, would account for 206,000 acre-feet per year. Other permitted ground-water rights, assuming they are used at the maximum allowable rate, would account for 29,000 acre-feet per year. Included in this category are industrial, municipal, domestic, stock water, and road sprinkling. Therefore, ground-water withdrawals account for about 235,000 acre-feet per year.

Well Hydrographs

Figure 7, pages 275 through 288 shows quarterly, water-level measurements in observation wells in the Lost River Sub-basin. Locations of observation wells are shown on Plate 5.

PART VI WATER WELL HYDROGRAPHS

WELL HYDROGRAPHS

A network of observation wells was established in 1961 for monitoring water well changes within the Klamath Basin. A total of 65 observation wells in Klamath County are now measured four times per year.

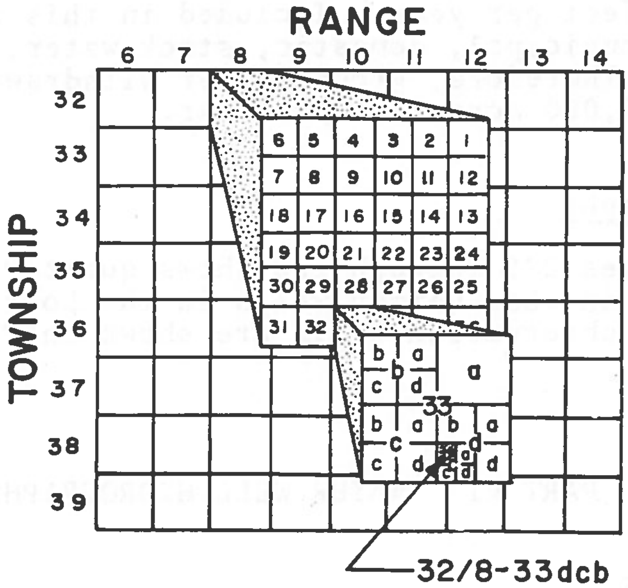
Figure 7 lists the observation wells by township, range, and section. Each measurement designated by a circle on the hydrograph represents the depth to water below land surface at a particular time. Depths are indicated (in feet below land surface) on the left hand margin and dates of measurement (in months and years) are indicated at the bottom of the hydrograph.

WATER WELL HYDROGRAPHS

Annual fluctuations of the water table are shown on the hydrograph and are related to the seasonal recharge and discharge of the ground-water body. Changes in ground-water storage are indicated by a progressively changing rise or decline of the water table. Usually the highest water level position is noted during the early spring months of March and April.

The lowest water levels occur during the late summer or early fall; October 15 is considered the end of the water year.

Designations of wells discussed in this report are based upon official systems for rectangular subdivision of public lands. The numbers indicate the location of the well by township, range, section, and position within the section. A graphic illustration of this method of well location is shown below. The first numeral indicates the township south



of the Willamette Baseline. The second number separated from the first by a slash (/) indicates the range east of the Willamette Meridian. The third number indicates the section in which the well is located, and the letters following the section number locate the well within the section. The first letter denotes the quarter-section (160 acres); the second, the quarter-quarter section (40 acres); and the third, the quarter-quarter-quarter section (10 acres). If two or more wells were located in the same 10-acre tract, the tract could be further divided into 2½-acre tracts of 5/8-acre tracts and so on, until the wells could be distinguished. For example, the well designated by 32/8-33dcb is located in the northwest quarter of the southwest quarter of the southeast quarter, Section 33, Township 32 South, Range 8 East, of the Willamette Baseline and Meridian.

TABLE 25

ABSTRACT OF GROUND-WATER FILINGS IN KLAMATH BASIN

DIVERSION Sec.	Twp.	Rge.	AREA	FILING DATE	PERMIT NO.	APPL. NO.	CERT. NO.	QUANTITY Applied for	Allowed	USE	REMARKS
7	29S	8E	Williamson River	7-2-57	G-615	G-698	24505	15000 gpd	0.06 cfs	Road Sprinkling	
5	29S	9E	Williamson River	7-2-57	G-615	G-698	24505	-	-	Road Sprinkling	
27	28S	10E	Williamson River	7-2-57	G-615	G-698	24505	-	-	Road Sprinkling	
25	30S	8E	Williamson River	7-5-67	G-3581	G-3404	-	0.50 cfs	0.27 cfs	133.30 Ac	
25	30S	8E	Williamson River	12-28-60	G-1756	G-1901	33061	2.00 cfs	1.00 cfs	189.10 S Ac	
32	30S	8E	Williamson River	8-3-66	G-3319	G-3527	-	8000 gpm	7.15 cfs	571.72 Ac	
6	31S	8E	Williamson River	8-3-66	G-3319	G-3527	-	-	-	-	
1	31S	7E	Williamson River	9-4-62	G-2243	G-2434	34992	11.10 cfs	10.52 cfs	841.80 S Ac	
7	31S	8E	Williamson River	5-21-62	G-2152	G-2328	33062	1300 gpm	2.90 cfs	307.40 Ac	
10	31S	8E	Williamson River	7-29-63	G-2475	G-2670	36514	10.00 cfs	4.60 cfs	368.30 Ac	
33	31S	8E	Williamson River	10-15-62	G-2303	G-2470	33522	10.00 cfs	10.00 cfs	1524.20 S Ac	
9	33S	11E	Williamson River	12-23-66	G-3774	G-3760	-	28.50 cfs	28.50 cfs	39.70 Ac	
										2246.70 S Ac	
1	34S	6E	Upper Klamath Lake	4-23-45	U-160	U-169	19944	0.45 cfs	0.17 cfs	13.60 Ac	
30	34S	7E	Upper Klamath Lake	11-22-55	G-122	G-185	30880	500 gpm	0.37 cfs	29.60 Ac	
28	34S	8E	Sprague River	8-22-67	G-3796	G-4046	-	2700 gpm	3.02 cfs	188.30 Ac	
										52.90 S Ac	
7	35S	7E	Williamson River	2-15-68	G-3865	G-4233	-	230 gpm	0.20 cfs	Domestic	
28	35S	7E	Williamson River	1-10-57	G-467	G-539	27529	2.22 cfs	2.22 cfs	Mfg.	
34	35S	7E	Williamson River	8-22-50	U-357	U-386	24677	1.00 cfs	0.70 cfs	94.80 Ac	
12	35S	9E	Sprague River	5-11-70	-	G-5190	-	8.00 cfs	-	286.00 Ac	
4	35S	12E	Sprague River	9-7-56	G-350	G-472	33169	-	1.98 cfs	158.10 S Ac	Assigned
22	35S	12E	Sprague River	6-21-68	G-4199	G-4456	-	7.99 cfs	7.90 cfs	631.80 Ac	
23	35S	12E	Sprague River	3-25-66	G-3217	G-3431	-	1.75 cfs	1.75 cfs	140.00 Ac	
26	35S	12E	Sprague River	11-30-67	G-3893	G-4146	-	-	1.40 cfs	112.00 Ac	
22	35S	12E	Sprague River	9-16-65	G-3115	G-3236	-	23.70 cfs	11.86 cfs	948.50 Ac	
27	35S	12E	Sprague River	9-16-65	G-3115	G-3236	-	-	-	-	
27	35S	12E	Sprague River	8-29-61	G-1946	G-2108	34991	1600 gpm	0.98 cfs	171.10 Ac	
34	35S	12E	Sprague River	1-23-61	G-1763	G-1918	33928	4.09 cfs	1.72 cfs	137.50 Ac	
13	36S	10E	Sprague River	5-19-55	U-705	U-832	27232	1.82 cfs	0.20 cfs	106.30 Ac	
8	36S	11E	Sprague River	4-23-47	U-216	U-240	19830	12.00 cfs	9.40 cfs	706.10 Ac	Assigned
										45.40 S Ac	
16	36S	11E	Sprague River	4-23-47	U-216	U-240	19830	-	-	-	
13	36S	11E	Sprague River	8-1-62	G-2231	G-2407	-	1.00 cfs	1.00 cfs	79.90 Ac	
14	36S	11E	Sprague River	9-18-58	G-1156	G-1255	31062	1.28 cfs	1.09 cfs	87.40 Ac	
14	36S	11E	Sprague River	6-26-68	G-4207	G-4464	-	1780 gpm	1.98 cfs	158.70 Ac	
14	36S	11E	Sprague River	9-17-69	G-4605	G-4599	-	1.34 cfs	0.13 cfs	10.50 Ac	
15	36S	11E	Sprague River	12-12-69	G-4692	G-4976	-	1.05 cfs	1.05 cfs	84.00 Ac	
15	36S	11E	Sprague River	4-10-53	U-534	U-585	20319	1.27 cfs	1.26 cfs	100.70 Ac	Assigned
15	36S	11E	Sprague River	3-4-64	G-2588	G-2722	-	1600 gpm	2.00 cfs	160.00 Ac	
16	36S	11E	Sprague River	8-6-52	U-463	U-515	27806	5.00 cfs	5.00cfs	93.00 Ac	
										326.60 S Ac	
17	36S	11E	Sprague River	4-3-52	U-439	U-485	24679	2.00 cfs	1.97 cfs	157.20 Ac	Assigned
18	36S	11E	Sprague River	9-20-48	U-254	U-244	20314	5.00 cfs	1.50 cfs	90.40 Ac	
										209.20 S Ac	
20	36S	11E	Sprague River	2-1-60	G-1538	G-1673	36067	6.50 cfs	4.23 cfs	59.90 Ac	
										278.40 S Ac	
23	36S	11E	Sprague River	2-25-58	G-773	G-876	34893	-	1.95 cfs	155.70 Ac	
26	36S	11E	Sprague River	4-18-68	G-4089	G-4334	-	3.87 cfs	1.81 cfs	145.00 Ac	
35	36S	11E	Sprague River	8-7-68	G-4307	G-4538	-	3200 gpm	0.26 cfs	Rec.	
36	36S	11E	Sprague River	7-11-49	U-289	U-315	20320	5.00 cfs	4.06 cfs	186.30 Ac	
										138.40 S Ac	
2	36S	12E	Sprague River	4-2-63	G-2392	G-2580	34898	2200 gpm	4.10 cfs	327.60 Ac	
3	36S	12E	Sprague River	5-31-60	G-1602	G-1752	33170	2.61 cfs	2.24 cfs	205.30 Ac	Assigned
4	36S	12E	Sprague River	5-31-60	G-1602	G-1752	33170	-	-	-	
5	36S	12E	Sprague River	7-5-66	G-7818	G-3472	-	2250 gpm	1.88 cfs	150.00 S Ac	
6	36S	12E	Sprague River	5-16-67	G-3632	G-3932	-	3.08 cfs	3.08 cfs	246.30 Ac	
8	36S	12E	Sprague River	3-5-57	G-491	G-571	31167	-	1.99 cfs	159.40 Ac	
9	36S	12E	Sprague River	8-13-56	G-368	G-444	29622	2.00 cfs	1.85 cfs	148.20 Ac	
14	36S	12E	Sprague River	6-24-59	G-1396	G-1510	30970	1440 gpm	0.55 cfs	43.60 Ac	Assigned
15	36S	12E	Sprague River	2-16-61	G-1779	G-1936	33417	661.98 gpm	0.93 cfs	74.40 Ac	
16	36S	12E	Sprague River	4-29-66	G-3275	G-3471	-	-	1.90 cfs	151.80 Ac	
23	36S	12E	Sprague River	6-26-68	G-4208	G-4465	-	0.78 cfs	0.78 cfs	62.30 Ac	
22	36S	12E	Sprague River	12-19-66	G-3547	G-3758	-	4500 gpm	4.00 cfs	320.00 Ac	
23	36S	12E	Sprague River	4-2-62	G-2051	G-2174	33615	1600 gpm	1.43 cfs	114.00 Ac	
34	36S	12E	Sprague River	1-29-68	G-3969	G-4205	-	3550 gpm	3.96 cfs	281.30 Ac	
										35.20 S Ac	
3	37S	12E	Sprague River	1-29-68	G-3969	G-4205	-	-	-	-	
22	36S	13E	Sprague River	2-17-65	G-2820	G-3033	-	10.97 cfs	10.97 cfs	878.00 Ac	
5	36S	14E	Sprague River	3-18-69	G-4537	G-4817	-	16.57 cfs	8.28 cfs	512.50 Ac	
										150.20 S Ac	
7	36S	14E	Sprague River	11-28-61	G-1999	G-2168	-	3.38 cfs	3.39 cfs	94.66 Ac	
										176.26 S Ac	
25	36S	14E	Sprague River	5-9-61	G-1795	G-1911	33926	2500 gpm	4.46 cfs	454.10 S Ac	
27	36S	14E	Sprague River	10-4-55	G-53	G-145	27098	3000 gpm	6.44 cfs	23.50 Ac	
										491.60 S Ac	
29	36S	14E	Sprague River	9-4-70	G-4835	G-5309	-	-	6.20 cfs	249.20 Ac	
										244.80 S Ac	
30	36S	14E	Sprague River	3-1-66	G-3192	G-3402	-	5.53 cfs	2.77 cfs	221.20 Ac	
34	36S	14E	Sprague River	5-21-70	-	G-5195	-	200 gpm	-	-	
35	36S	14E	Sprague River	8-4-60	G-1673	G-1817	33171	10.00 cfs	8.77 cfs	701.90 Ac	
35	36S	14E	Sprague River	9-26-61	G-1964	G-2122	-	10.00 cfs	0.10 cfs	Road Sprinkling	
35	36S	14E	Sprague River	6-23-66	G-3337	G-3548	-	-	1.50 cfs	124.20 S Ac	
29	37S	8E	Upper Klamath Lake	6-6-61	G-1875	G-2040	36369	4000 gpm	3.25 cfs	259.90 Ac	
36	37S	9E	Swan Lake	1-30-52	U-465	U-457	29529	6.60 cfs	2.02 cfs	199.20 Ac	
8	37S	10E	Swan Lake	12-24-51	U-486	U-453	29530	29.00 cfs	15.50 cfs	1127.10 Ac	
										558.10 S Ac	
9	37S	10E	Swan Lake	12-24-51	U-486	U-453	-	-	-	-	
18	37S	10E	Swan Lake	6-3-66	G-3317	G-3525	-	1.52 cfs	1.52 cfs	121.90 Ac	
18	37S	10E	Swan Lake	5-28-52	U-585	U-501	30572	4.50 cfs	0.96 cfs	76.80 Ac	
30	37S	10E	Swan Lake	8-2-48	U-250	U-279	22847	3.00 cfs	1.95 cfs	156.00 Ac	
15	37S	11½E	Yonna Valley	3-8-61	G-1790	G-1948	-	3.20 cfs	2.97 cfs	237.70 Ac	
36	37S	11½E	Yonna Valley	1-14-52	U-563	U-456	29620	4.37 cfs	2.92 cfs	233.40 Ac	
1	37S	14E	Sprague River	9-3-68	G-4309	G-4579	-	0.36 cfs	0.18 cfs	14.60 Ac	
2	37S	14E	Sprague River	5-29-68	G-4164	G-4418	-	450 gpm	0.42 cfs	33.20 Ac	
6	37S	15E	Sprague River	5-8-68	G-4119	G-4367	-	23.28 cfs	11.69 cfs	410.70 Ac	
										524.40 S Ac	
6	37S	15E	Sprague River	9-18-69	G-4718	G-5000	-	1.08 cfs	1.08 cfs	86.30 Ac	
12	38S	8E	Upper Klamath Lake	9-23-55	G-76	G-138	29531	0.90 cfs	0.26 cfs	20.80 Ac	
33	38S	8E	Upper Klamath Lake	10-31-67	G-3878	G-4122	-	3350 gpm	7.40 cfs	93.70 Ac	
										505.60 S Ac	
7	38S	9E	Upper Klamath Lake	4-14-58	G-832	G-933	30573	0.33 cfs	0.03 cfs	2.67 Ac	
17	38S	9E	Upper Klamath Lake	5-17-63	G-2387	G-2511	-	500 gpm	2.46 cfs	Heating, Domestic, Garden	
20	38S	9E	Upper Klamath Lake	5-17-63	G-2378	G-2511	-	-	-	and Irrigation	
28	38S	9E	Upper Klamath Lake	12-24-41	U-137	U-145	15540	0.22 cfs	0.14 cfs	Domestic, Heating Medicinal	
										0.70 S Ac	
28	38S	9E	Upper Klamath Lake	7-30-38	U-108	U-115	12507	0.30 cfs	0.30 cfs	Heating	
28	38S	9E	Upper Klamath Lake	3-11-54	U-617	U-675	24682	0.25 cfs	0.25 cfs	Swim Pool	

TABLE 25

ABSTRACT OF GROUND-WATER FILINGS IN KLAMATH BASIN

DIVERSION Sec.	Twp.	Rge.	AREA	FILING DATE	PERMIT NO.	APPL. NO.	CERT. NO.	QUANTITY Applied for	Allowed	USE	REMARKS
32	38S	9E	Upper Klamath Lake	2-15-60	G-1541	G-1679	32193	17.80 cfs	12.20 cfs	Municipal	
32	38S	9E	Upper Klamath Lake	10-17-34	U-84	U-89	11582	-	0.20 cfs	Industrial	Assigned
32	38S	9E	Upper Klamath Lake	2-13-58	G-756	G-861	32192	7.80 cfs	4.00 cfs	Municipal	
36	38S	9E	Upper Klamath Lake	9-12-62	G-2265	G-2443	-	250 gpm	0.56 cfs	Domestic	
36	38S	9E	Upper Klamath Lake	9-7-56	G-349	G-470	32191	400 gpm	0.25 cfs	Municipal	
36	38S	9E	Upper Klamath Lake	5-19-55	U-740	U-831	26371	0.49 cfs	0.03 cfs	2.00 Ac	
36	38S	9E	Upper Klamath Lake	3-8-67	G-3613	G-3833	-	3.00 cfs	2.38 cfs	Municipal	
1	39S	9E	Upper Klamath Lake	3-8-67	G-3613	G-3833	-	-	-	-	
5	38S	10E	Swan Lake	2-10-58	G-764	G-856	34519	15.99 cfs	3.23 cfs	624.30 Ac	
5	38S	10E	Swan Lake	12-9-65	G-3088	G-3316	-	7650 gpm	17.00 cfs	695.00 Ac 1881.30 S Ac	
16	38S	10E	Swan Lake	12-9-65	G-3088	G-3316	-	-	-	-	
9	38S	10E	Swan Lake	10-12-51	U-411	U-440	24678	5.20 cfs	4.23 cfs	415.00 Ac	Assigned
9	38S	10E	Swan Lake	3-23-66	G-3214	G-3428	-	4.23 cfs	0.50 cfs	40.00 Ac	
16	38S	10E	Swan Lake	9-20-57	G-700	G-762	31518	4770 gpm	5.04 cfs	555.70 Ac	
16	38S	10E	Swan Lake	3-6-69	G-4529	G-4804	-	1850 gpm	0.91 cfs	73.00 Ac	
23	37S	10E	Swan Lake	7-19-49	U-343	U-319	35150	61.00 cfs	6.31 cfs	505.10 Ac	
22	37S	10E	Swan Lake	7-19-49	U-343	U-319	35151	-	5.21 cfs	416.50 Ac	
6	38S	11½E	Swan Lake	7-19-49	U-343	U-319	35152	-	26.56 cfs	2124.90 Ac	
7	38S	11½E	Swan Lake	7-19-49	U-343	U-319	-	-	-	-	
30	38S	11½E	Swan Lake	7-19-49	U-343	U-319	-	-	-	-	
13	38S	10E	Swan Lake	7-19-49	U-343	U-319	35152	-	-	-	
23	38S	10E	Swan Lake	7-19-49	U-343	U-319	35152	-	-	-	
25	38S	10E	Swan Lake	10-13-49	U-307	U-333	26511	-	1.90 cfs	152.00 Ac	
25	38S	10E	Swan Lake	10-19-65	G-3060	G-3262	36370	450 gpm	0.29 cfs	23.10 Ac	
26	38S	10E	Swan Lake	8-24-49	U-298	U-323	22854	-	1.97 cfs	157.70 Ac	
1	38S	11½E	Yonna Valley	2-23-66	G-3092	G-3396	-	6.39 cfs	6.39 cfs	511.00 Ac	
2	38S	11½E	Yonna Valley	2-19-52	U-565	U-464	27015	3.25 cfs	2.45 cfs	196.30 Ac	
3	38S	11½E	Yonna Valley	5-13-49	U-279	U-306	26510	5.50 cfs	3.50 cfs	283.30 Ac	
11	38S	11½E	Yonna Valley	1-23-48	U-230	U-259	19993	6.00 cfs	2.50 cfs	200.00 Ac	Assigned
12	38S	11½E	Yonna Valley	2-27-48	U-235	U-265	22843	3.00 cfs	2.00 cfs	159.00 Ac	
12	38S	11½E	Yonna Valley	11-16-51	U-401	U-446	22875	3.13 cfs	3.12 cfs	250.00 Ac	
12	38S	11½E	Yonna Valley	4-16-48	U-244	U-272	19655	3.00 cfs	1.50 cfs	120.00 Ac	
13	38S	11½E	Yonna Valley	11-3-49	U-295	U-258	20315	3.600 cfs	3.60 cfs	235.50 Ac 84.40 S Ac	
13	38S	11½E	Yonna Valley	4-20-48	U-245	U-273	19749	3.50 cfs	1.76 cfs	140.70 Ac	
15	38S	11½E	Yonna Valley	3-18-48	U-237	U-268	20316	4.00 cfs	2.80 cfs	280.00 Ac	
15	38S	11½E	Yonna Valley	11-26-51	U-700	U-448	34168	3.00 cfs	2.35 cfs	48.90 Ac 138.80 S Ac	
20	38S	11½E	Yonna Valley	3-11-69	G-4552	G-4812	-	9.11 cfs	4.56 cfs	346.70 Ac 17.80 S Ac	
30	38S	11½E	Yonna Valley	3-11-69	G-4552	G-4812	-	-	-	-	
23	38S	11½E	Yonna Valley	2-27-48	U-234	U-264	19748	5.00 cfs	1.17 cfs	93.50 Ac	
24	38S	11½E	Yonna Valley	2-18-52	U-564	U-463	27012	1.87 cfs	1.13 cfs	90.40 Ac	
24	38S	11½E	Yonna Valley	12-15-49	U-314	U-341	20707	2.80 cfs	2.79 cfs	222.70 Ac	
25	38S	11½E	Yonna Valley	7-12-49	U-290	U-316	22851	1.50 cfs	1.50 cfs	133.00 Ac	
25	38S	11½	Yonna Valley	11-26-52	G-179	G-14	27209	1.50 cfs	0.90 cfs	72.00 Ac	
26	36S	11½	Yonna Valley	9-20-48	U-263	U-289	19750	3.50 cfs	3.50 cfs	287.40 Ac	
28	38S	11½E	Yonna Valley	4-18-49	U-275	U-300	26807	3.50 cfs	2.10 cfs	214.00 S Ac	
29	38S	11½E	Swan Lake	7-19-49	U-402	U-318	29619	4.00 cfs	2.87 cfs	229.70 Ac	
29	38S	11½E	Yonna Valley	11-6-68	G-4401	G-4673	-	2.87 cfs	0.76 cfs	60.60 Ac	
30	38S	11½E	Yonna Valley	4-14-49	U-272	U-299	27302	4.00 cfs	2.13 cfs	171.00 Ac	
30	38S	11½E	Swan Lake	11-6-68	G-4400	G-4672	-	4.95 cfs	0.82 cfs	65.50 Ac	
31	38S	11½E	Swan Lake	9-15-66	G-3446	G-3670	-	1500 gpm	2.65 cfs	212.10 Ac	
5	39S	11½E	Yonna Valley	4-13-48	U-243	U-271	28200	12.00 cfs	7.00 cfs	567.60 Ac	
32	38S	11½E	Yonna Valley	4-13-48	U-243	U-271	28200	-	-	-	
33	38S	11½E	Yonna Valley	9-16-49	U-302	U-328	27006	3.00 cfs	2.46 cfs	196.60 Ac	
34	38S	11½E	Yonna Valley	6-2-49	U-281	U-309	23135	3.00 cfs	0.80 cfs	63.60 Ac	
34	38S	11½E	Yonna Valley	6-7-51	U-399	U-424	34894	5.07 cfs	3.18 cfs	239.50 Ac 15.50 S Ac	
35	38S	11½E	Yonna Valley	8-12-65	G-2996	G-3193	-	1.38 cfs	1.38 cfs	110.80 Ac	
36	38S	11½E	Yonna Valley	4-26-67	G-3670	G-3906	-	10.00 cfs	9.36 cfs	144.50 Ac 568.31 S Ac	
5	38S	11E	Yonna Valley	3-22-48	U-238	U-269	22844	4.00 cfs	3.00 cfs	241.40 Ac	
5	38S	11E	Yonna Valley	4-10-58	G-809	G-927	29623	0.50 cfs	0.24 cfs	18.80 Ac	
5	38S	11E	Yonna Valley	2-8-51	U-377	U-407	22870	1.00 cfs	0.86 cfs	68.70 Ac	
5	38S	11E	Yonna Valley	2-7-69	G-4503	G-4781	-	0.44 cfs	0.44 cfs	35.30 Ac	
8	38S	11E	Yonna Valley	2-7-69	G-4503	G-4781	-	-	-	-	
7	38S	11E	Yonna Valley	12-18-68	G-4448	G-4728	-	-	0.21 cfs	16.40 Ac	
6	38S	11E	Yonna Valley	7-14-47	U-219	U-245	31455	9.00 cfs	2.92 cfs	233.70 Ac	
6	38S	11E	Yonna Valley	2-19-52	U-566	U-465	29621	2.00 cfs	1.87 cfs	149.20 Ac	Assigned
6	38S	11E	Yonna Valley	8-30-66	G-3427	G-3648	-	0.48 cfs	0.48 cfs	38.40 Ac	
7	38S	11E	Yonna Valley	8-30-48	U-260	U-286	22848	3.00 cfs	1.78 cfs	142.10 Ac	
7	38S	11E	Yonna Valley	10-29-48	U-265	U-292	20706	3.00 cfs	1.45 cfs	115.50 Ac	
5	38S	11E	Yonna Valley	3-20-67	G-3653	G-3856	-	3.43 cfs	7.50 cfs	274.50 Ac 415.10 S Ac	
8	38S	11E	Yonna Valley	3-20-67	G-3653	G-3856	-	-	-	-	
18	38S	11E	Yonna Valley	7-26-48	U-249	U-278	23380	3.50 cfs	1.13 cfs	68.90 Ac	Assigned
19	38S	11E	Yonna Valley	4-26-67	G-3671	G-3907	-	8.00 cfs	5.95 cfs	122.82 Ac 353.20 S Ac	
19	38S	11E	Yonna Valley	9-14-66	G-3443	G-3667	-	2.82 cfs	2.62 cfs	209.80 Ac	
31	38S	11E	Yonna Valley	12-6-51	U-540	U-451	26812	4.44 cfs	0.80 cfs	64.30 Ac	
1	39S	8E	Lower Klamath Lake	6-21-48	U-247	U-275	27226	1.00 cfs	1.00 cfs	80.00 Ac	
6	39S	8E	Lower Klamath Lake	5-17-65	G-2907	G-3112	-	16.78 cfs	16.78 cfs	250.30 Ac 1092.40 S Ac	
7	39S	8E	Lower Klamath Lake	5-17-65	G-2907	G-3112	-	-	-	-	
12	39S	8E	Lower Klamath Lake	2-20-67	G-3597	G-3812	-	0.48 cfs	0.48 cfs	38.10 Ac	
18	39S	9E	Lower Klamath Lake	8-1-56	G-342	G-437	27805	1270 gpm	0.97 cfs	Dom. & Mfg.	
28	39S	8E	Lower Klamath Lake	2-3-53	U-508	U-560	27011	2.67 cfs	1.36 cfs	108.70 Ac	
36	39S	8E	Lower Klamath Lake	9-3-47	U-224	U-249	16615	150.00 cfs	0.90 cfs	35.98 Ac	
1	39S	9E	Lower Klamath Lake	4-5-54	U-630	U-687	27807	0.20 cfs	0.05 cfs	4.40 Ac	
7	39S	9E	Lower Klamath Lake	2-7-66	G-3011	G-3017	-	350 gpm	0.50 cfs	Domestic	
18	39S	9E	Lower Klamath Lake	9-22-64	G-2758	G-2967	37576	0.66 cfs	0.67 cfs	Mfg.	
6	39S	10E	Lost River	9-30-49	U-303	U-329	22856	0.90 cfs	0.44 cfs	35.20 Ac	
6	39S	10E	Lost River	8-15-63	G-2491	G-2684	-	0.97 cfs	0.50 cfs	10.00 Ac & Dom.	
7	39S	10E	Lost River	5-22-61	G-1939	G-2028	30574	250 gpm	0.65 cfs	39.10 Ac 13.00 S Ac	
8	39S	10E	Lost River	4-11-52	U-469	U-487	27309	50 gpm	0.08 cfs	6.10 Ac	
9	39S	10E	Lost River	6-3-69	G-4646	G-4899	-	330 gpm	0.57 cfs	46.10 Ac	
18	39S	10E	Lost River	7-15-63	G-2468	G-2662	34768	-	0.41 cfs	32.40 Ac	
18	39S	10E	Lost River	11-9-60	G-1712	G-1832	33378	300 gpm	0.07 cfs	5.80 Ac	

TABLE 25

ABSTRACT OF GROUND-WATER FILINGS IN KLAMATH BASIN

DIVERSION Sec.	Twp.	Rge.	AREA	FILING DATE	PERMIT NO.	APPL. NO.	CERT. NO.	QUANTITY Applied for	Allowed	USE	REMARKS
28	39S	10E	Lost River	10-10-47	U-240	U-250	22845	0.11 cfs	0.07 cfs	5.60 Ac	
29	39S	10E	Lost River	4-25-61	G-1833	G-1994	31063	100 gpm	0.05 cfs	4.00 Ac	
2	39S	11½E	Yonna Valley	7-16-47	U-220	U-246	27121	7.00 cfs	1.36 cfs	108.90 Ac	
5	39S	11½E	Pine Flat	11-25-49	U-310	U-338	28335	3.60 cfs	1.36 cfs	108.50 Ac	
6	39S	11½E	Pine Flat	8-30-49	U-299	U-324	23382	4.10 cfs	3.20 cfs	259.60 Ac	
6	39S	11½E	Pine Flat	1-23-57	G-468	G-550	24698	0.61 cfs	0.48 cfs	38.40 Ac	
10	39S	11½E	Yonna Valley	11-1-48	U-266	U-293	27122	9.00 cfs	4.00 cfs	583.70 S Ac	
10	39S	11½E	Yonna Valley	8-14-58	G-1002	G-1195	34894	5.00 cfs	5.00 cfs	505.40 S Ac	
13	39S	11½E	Yonna Valley	4-2-69	G-4555	G-4832	-	2600 gpm	5.80 cfs	466.30 Ac	
22	39S	11½E	Poe Valley	9-28-50	U-362	U-394	27007	2.00 cfs	0.46 cfs	36.60 Ac	
2	39S	11E	Langell Valley	2-24-67	G-3602	G-3819	-	1.75 cfs	1.75 cfs	109.10 Ac 31.40 S Ac	
3	39S	11E	Langell Valley	8-6-70	-	G-5276	-	300 gpm	-	15.00 Ac	
7	39S	11E	Yonna Valley	2-27-68	G-4054	G-4252	-	3000 gpm	5.83 cfs	185.50 Ac 280.50 S Ac	
10	39S	11E	Yonna Valley	3-24-70	G-4873	G-5140	-	1.10 cfs	-	87.50 Ac	
22	39S	11E	Yonna Valley	3-24-70	G-4873	G-5140	-	-	-	-	
10	39S	11E	Yonna Valley	4-17-52	U-440	U-488	27425	0.15 cfs	0.13 cfs	10.30 Ac	
14	39S	11E	Langell Valley	3-7-63	G-2371	G-2561	34897	0.61 cfs	0.31 cfs	24.60 Ac	
20	39S	11E	Yonna Valley	4-23-51	U-384	U-420	27228	2.00 cfs	1.82 cfs	145.30 Ac	
21	39S	11E	Yonna Valley	2-26-51	U-368	U-411	27656	1.77 cfs	1.77 cfs	141.20 Ac	
16	39S	11E	Yonna Valley	2-26-51	U-368	U-411	-	-	-	-	
7	39S	12E	Langell Valley	12-27-55	G-108	G-194	33419	1050 gpm	0.61 cfs	48.40 Ac	
16	39S	12E	Langell Valley	4-25-61	G-1834	G-1996	-	4.60 cfs	4.57 cfs	365.60 Ac	
17	39S	12E	Langell Valley	4-25-61	G-1834	G-1996	-	-	-	-	
21	39S	12E	Langell Valley	6-12-69	G-4549	G-4907	-	1200 gpm	2.50 cfs	200.00 Ac	
29	39S	13E	Langell Valley	3-19-69	G-4539	G-4819	-	9.12 cfs	4.56 cfs	335.40 Ac 29.40 S Ac	
31	39S	13E	Langell Valley	1-7-48	U-228	U-256	27224	2.50 cfs	0.16 cfs	12.80 Ac	
11	40S	7E	Lower Klamath Lake	7-29-63	G-2476	G-2671	33275	0.05 cfs	0.06 cfs	Keno AFB	
23	40S	7E	Lower Klamath Lake	6-26-57	G-614	G-693	30370	25 gpm	0.01 cfs	Dom. & Fire	
1	40S	8E	Lower Klamath Lake	6-27-55	U-744	U-848	26901	0.56 cfs	0.44 cfs	2.50 Ac 32.70 S Ac	
24	40S	9E	Lower Klamath Lake	5-9-57	G-557	G-641	31787	3.25 cfs	1.00 cfs	122.00 Ac	
24	40S	9E	Lower Klamath Lake	3-17-65	G-2844	G-3048	37578	0.52 cfs	0.52 cfs	122.00 Ac	
32	40S	10E	Lost River	6-19-67	G-3465	G-3971	-	750 gpm	1.67 cfs	152.00 Ac	
1	40S	11E	Poe Valley	9-16-58	G-1080	G-1252	27002	600 gpm	0.60 cfs	88.00 Ac	
1	40S	11E	Poe Valley	12-7-65	G-3004	G-3311	-	1200 gpm	2.66 cfs	198.70 Ac 88.00 S Ac	
11	40S	11E	Poe Valley	7-26-62	G-2210	G-2397	34896	500 gpm	0.20 cfs	49.30 Ac	
12	40S	11E	Poe Valley	11-30-64	G-2789	G-2992	-	1.98 cfs	1.98 cfs	158.60 Ac	
12	40S	11E	Poe Valley	10-25-61	G-1975	G-2138	34767	3.15 cfs	3.15 cfs	252.00 Ac	
13	40S	11E	Poe Valley	3-4-59	G-1296	G-1404	33258	2.75 cfs	0.42 cfs	33.80 Ac	
13	40S	11E	Poe Valley	5-8-52	U-457	U-502	27016	3.12 cfs	3.88 cfs	310.80 Ac	
14	40S	11E	Poe Valley	5-8-52	U-457	U-502	-	-	-	-	
29	40S	11E	Lost River	1-19-68	G-3957	G-4192	-	1200 gpm	2.67 cfs	266.00 Ac	
32	40S	11E	Lost River	3-14-66	G-3204	G-3418	-	400 gpm	0.19 cfs	15.00 Ac	
32	40S	11E	Lost River	9-19-58	G-1157	G-1257	27330	640 gpm	0.76 cfs	61.00 Ac	
7	40S	12E	Poe Valley	10-15-65	G-3057	G-3259	-	5.21 cfs	5.21 cfs	376.60 Ac 40.00 S Ac	
18	40S	12E	Poe Valley	9-2-49	U-301	U-326	26808	3.00 cfs	2.50 cfs	199.30 Ac	Assigned
18	40S	12E	Poe Valley	10-30-52	U-650	U-534	26809	1.15 cfs	1.26 cfs	101.10 Ac	
28	40S	12E	Lost River	5-10-68	G-4125	G-4373	-	1400 gpm	2.00 cfs	160.00 Ac	
28	40S	12E	Lost River	5-28-56	G-255	G-379	27103	1.48 cfs	1.40 cfs	112.20 Ac	
33	40S	12E	Lost River	6-1-56	G-365	G-387	27317	1.00 cfs	1.00 cfs	79.10 Ac	
33	40S	12E	Lost River	2-23-66	G-3104	G-3397	36946	1.13 cfs	0.98 cfs	78.20 Ac	
34	40S	12E	Lost River	12-11-57	G-730	G-819	30279	3.00 cfs	2.20 cfs	232.20 S Ac	
34	40S	12E	Lost River	9-26-50	U-361	U-393	27304	3.00 cfs	2.20 cfs	232.20 Ac	
5	41S	8E	Lower Klamath Lake	4-8-69	G-4343	G-4835	-	1850 gpm	4.11 cfs	356.20 Ac	
5	41S	8E	Lower Klamath Lake	4-8-69	G-4342	G-4834	-	1200 gpm	2.66 cfs	212.60 Ac	
12	41S	9E	Lost River	5-1-69	G-4578	G-4861	-	6.77 cfs	6.77 cfs	541.60 Ac	
2	41S	10E	Lost River	12-16-57	G-731	G-821	27530	230 gpm	0.51 cfs	Mun.	
4	41S	10E	Lost River	1-12-53	G-63	G-15	26814	2.88 cfs	1.00 cfs	138.40 Ac	
4	41S	10E	Lost River	7-3-67	G-3735	G-3978	-	1000 gpm	1.20 cfs	95.80 Ac	
7	41S	10E	Lost River	6-19-64	G-2684	G-2902	-	3.67 cfs	3.67 cfs	293.55 Ac	
9	41S	10E	Lost River	3-25-60	G-1564	G-1704	29725	0.69 cfs	0.69 cfs	55.20 Ac	
9	41S	10E	Lost River	7-26-50	U-354	U-379	27303	1.00 cfs	0.63 cfs	50.20 Ac	
9	41S	10E	Lost River	3-7-67	G-3611	G-3831	-	1.62 cfs	1.62 cfs	129.50 Ac	
9	41S	10E	Lost River	1-3-58	G-759	G-837	29724	1.60 cfs	1.60 cfs	127.70 Ac	
10	41S	10E	Lost River	7-26-50	U-353	U-378	27531	2.50 cfs	2.27 cfs	181.50 Ac	
10	41S	10E	Lost River	2-20-69	G-4521	G-4796	-	0.63 cfs	0.32 cfs	25.30 Ac	
1	41S	12E	Lost River	3-27-52	U-468	U-483	27308	2.50 cfs	1.45 cfs	116.00 Ac	
1	41S	12E	Lost River	1-26-56	G-138	G-221	27312	3.72 cfs	2.25 cfs	179.40 Ac	
2	41S	12E	Lost River	1-26-56	G-138	G-221	27312	-	-	-	
15	41S	12E	Lost River	10-0-31	-	GR-4060	GR-2895	-	-	350 gpm Mun.	
15	41S	12E	Lost River	8-4-58	G-1107	G-1167	-	375 gpm	0.84 cfs	Mun.	
7	41S	13E	Lost River	12-26-52	U-503	U-551	27010	4.00 cfs	1.98 cfs	41.80 Ac 116.40 S Ac	
17	41S	13E	Lost River	5-25-66	G-3102	G-3506	-	50 gpm	0.11 cfs	Dom., Air Cond., & Landscape	
2	41S	16E	Willow	8-15-68	G-4280	G-4556	-	-	1.27 cfs 4.18 cfs	101.90 Ac 334.40 S Ac	

Abbreviations: Acres (AC), Cubic feet per second (cfs), Domestic (Dom.), Gallons per minute (gpm), Manufacturing (Mfg.), Municipal (Mun.), Recreation (Rec.), Supplemental Acres (S Ac)

Footnote: For current status of Ground-Water Rights, contact OFFICE OF THE STATE ENGINEER, SALEM, OREGON 97310.

OBSERVATION WELLS
WILLIAMSON RIVER SUB-BASIN

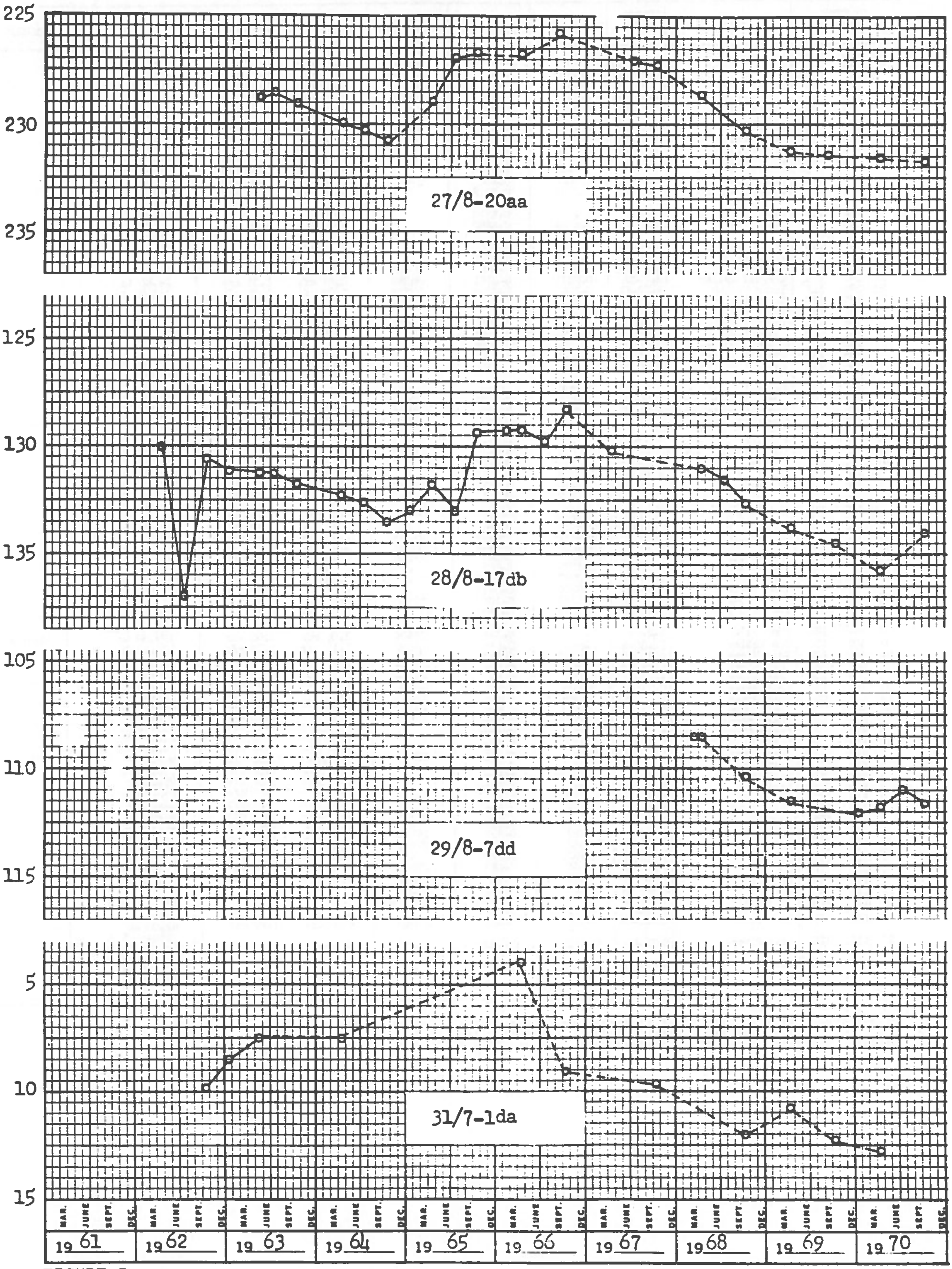


FIGURE 7.

OBSERVATION WELLS
WILLIAMSON RIVER SUB-BASIN

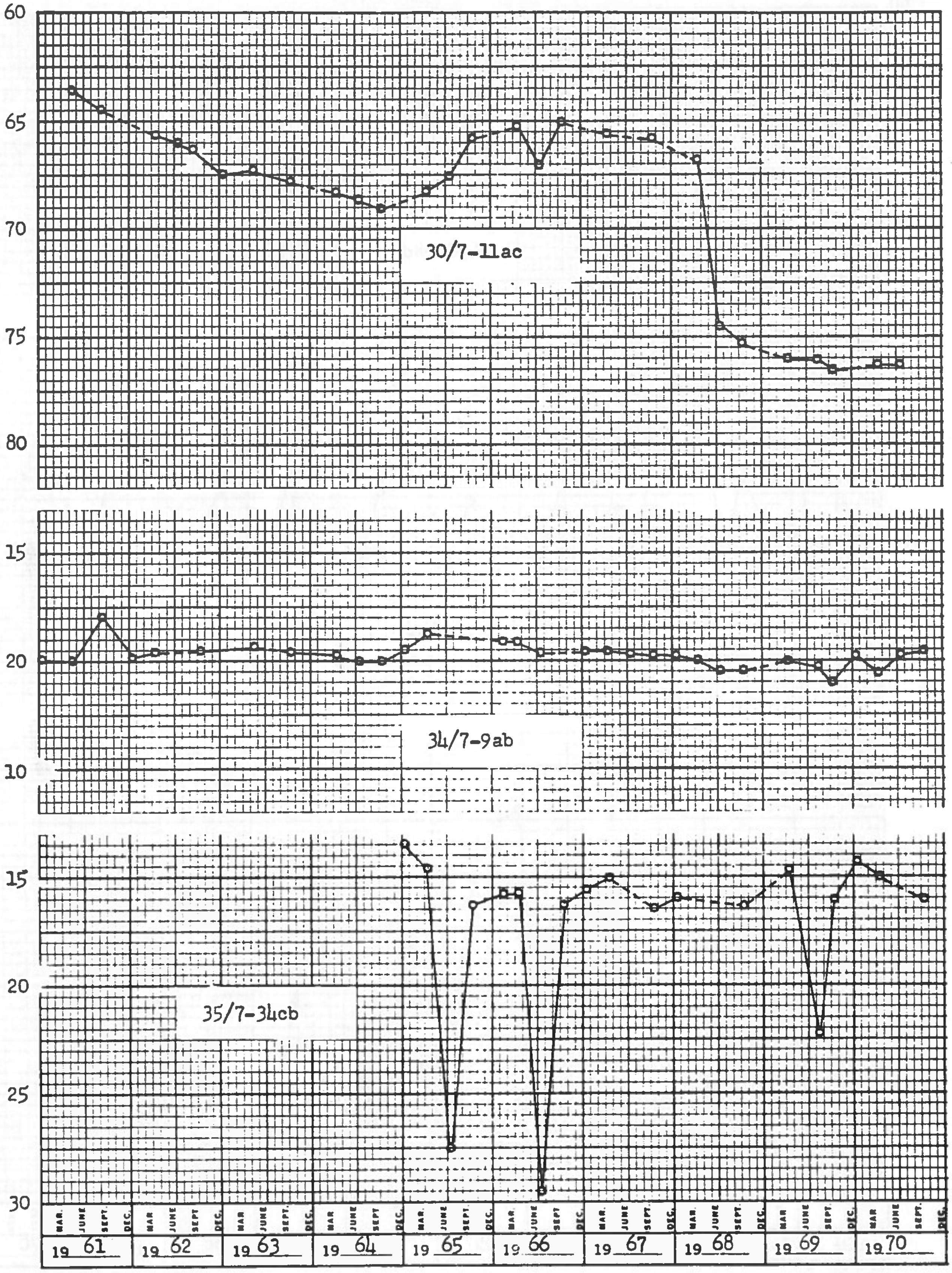


FIGURE 7.

OBSERVATION WELLS
SPRAGUE RIVER SUB-BASIN

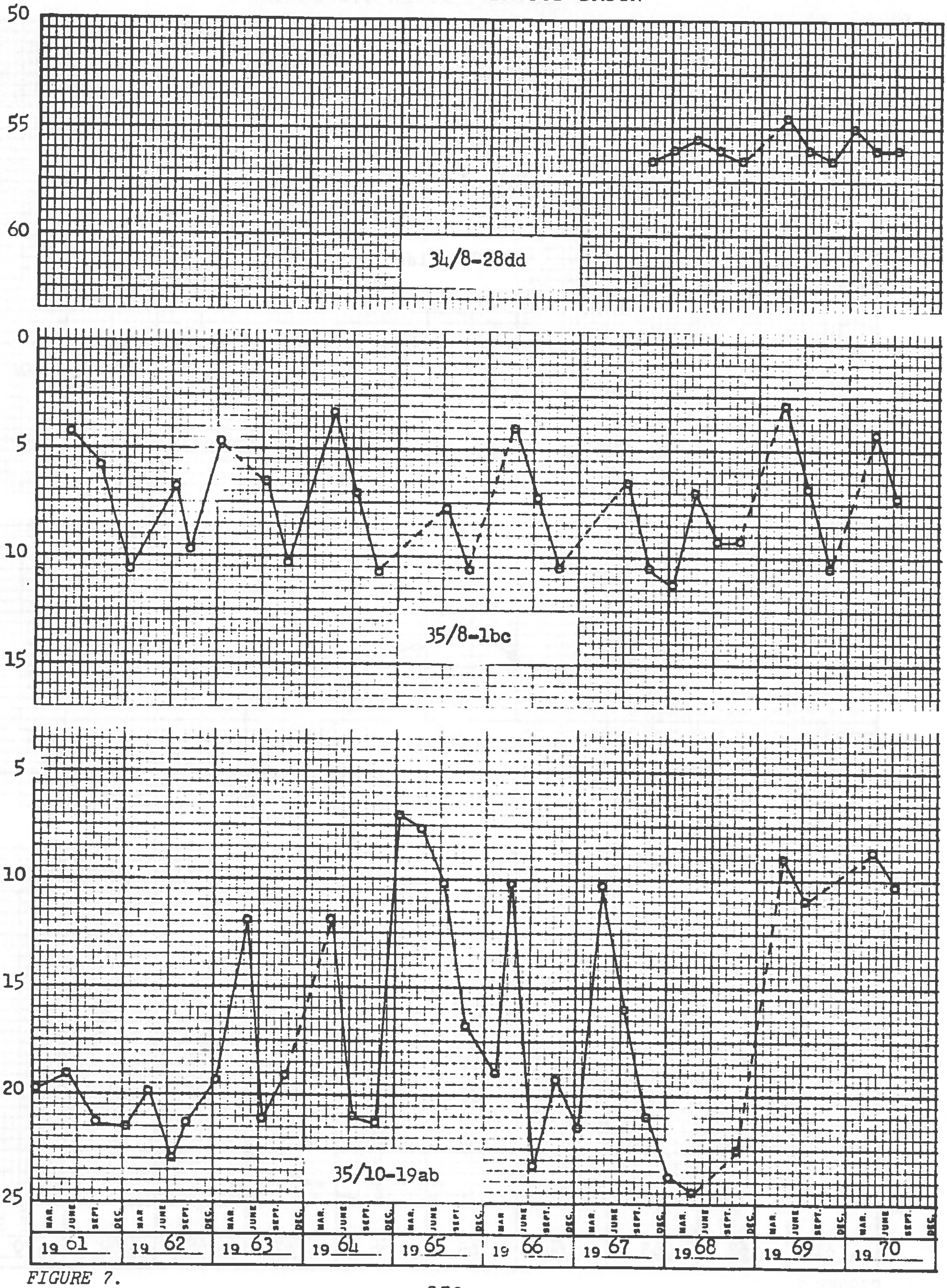


FIGURE 7.

OBSERVATION WELLS
SPRAGUE RIVER SUB-BASIN

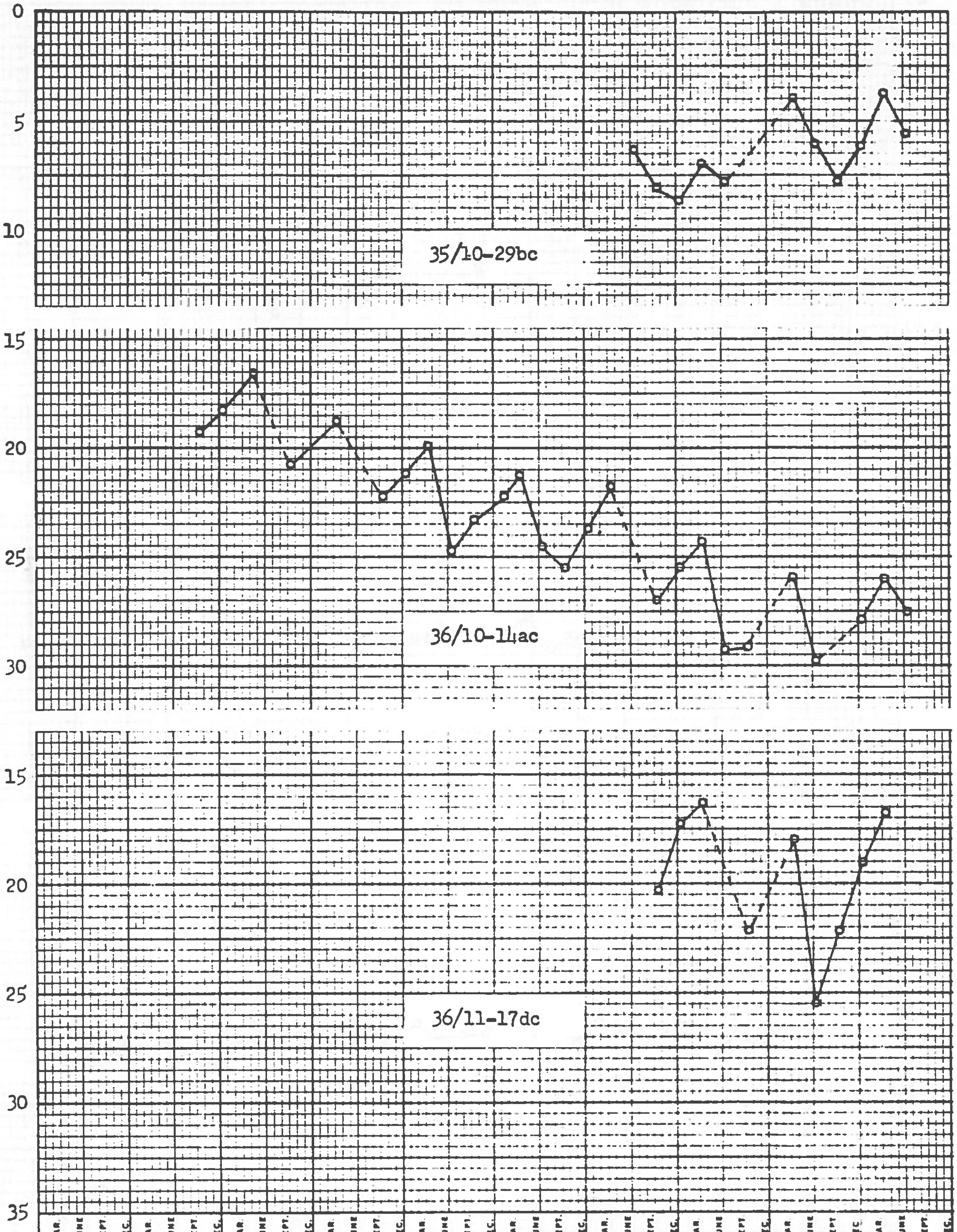


FIGURE 7.

OBSERVATION WELLS
SPRAGUE RIVER SUB-BASIN

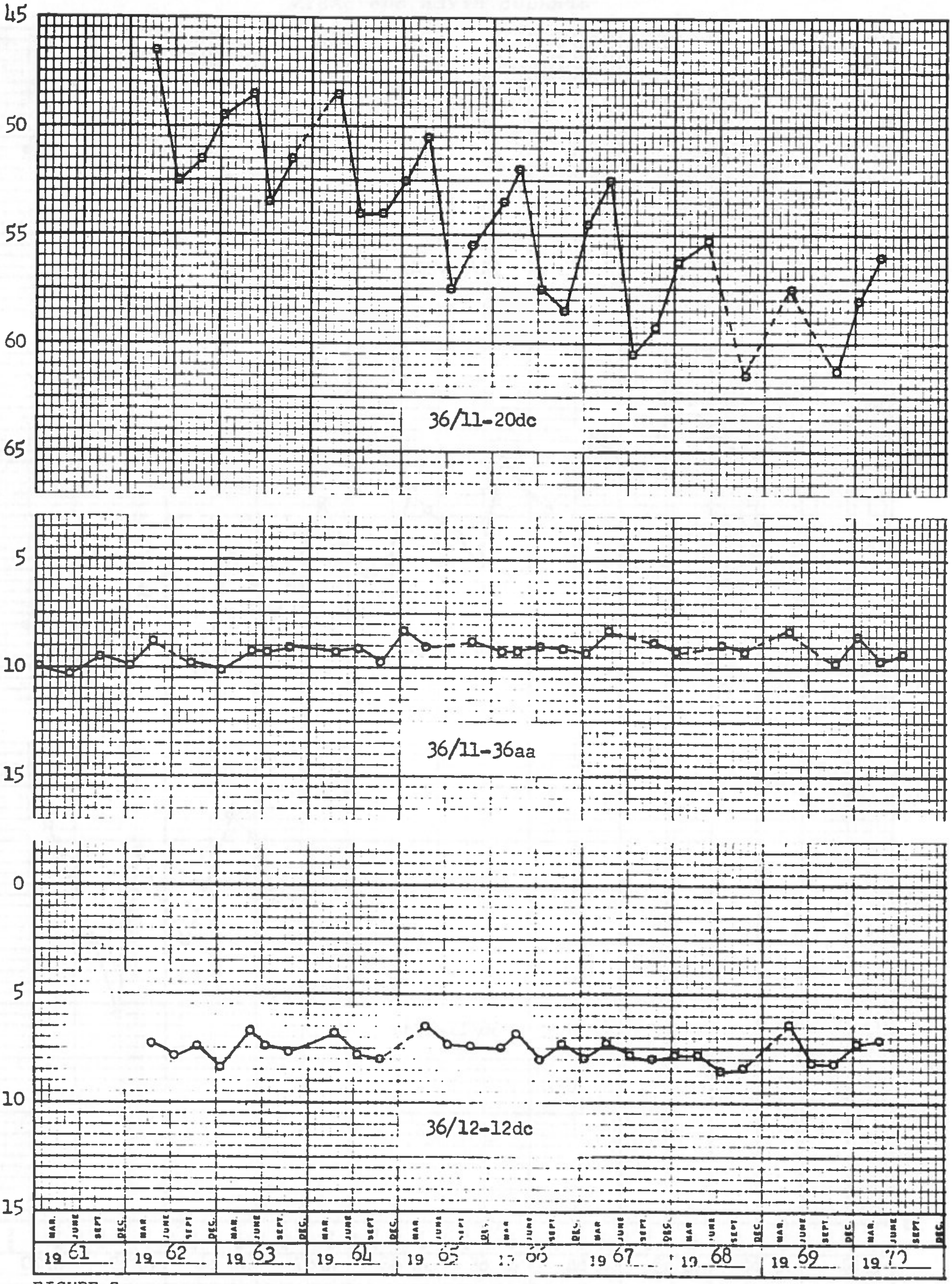


FIGURE 7.

OBSERVATION WELLS
SPRAGUE RIVER SUB-BASIN

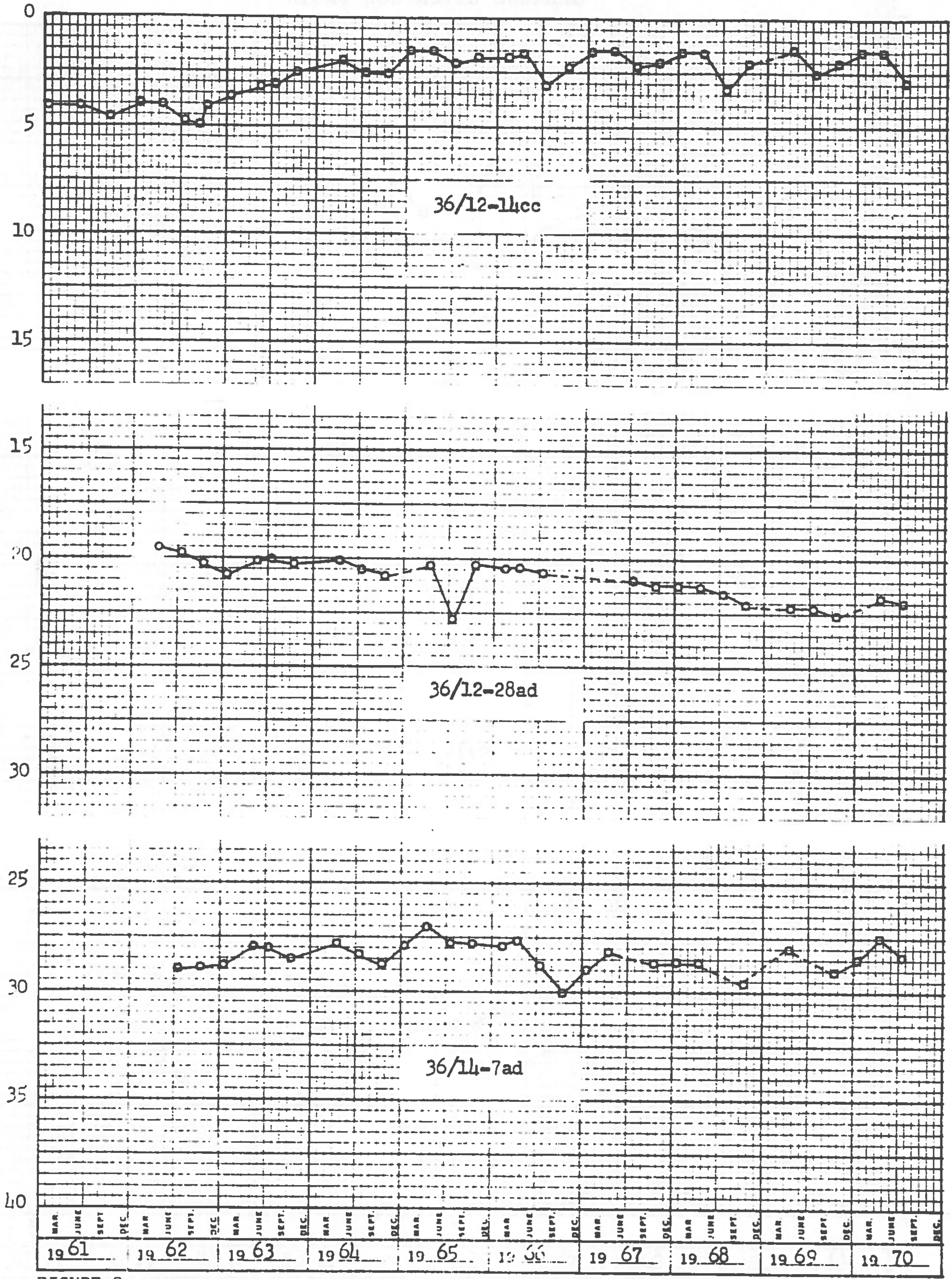


FIGURE 7.

OBSERVATION WELLS
SPRAGUE RIVER SUB-BASIN

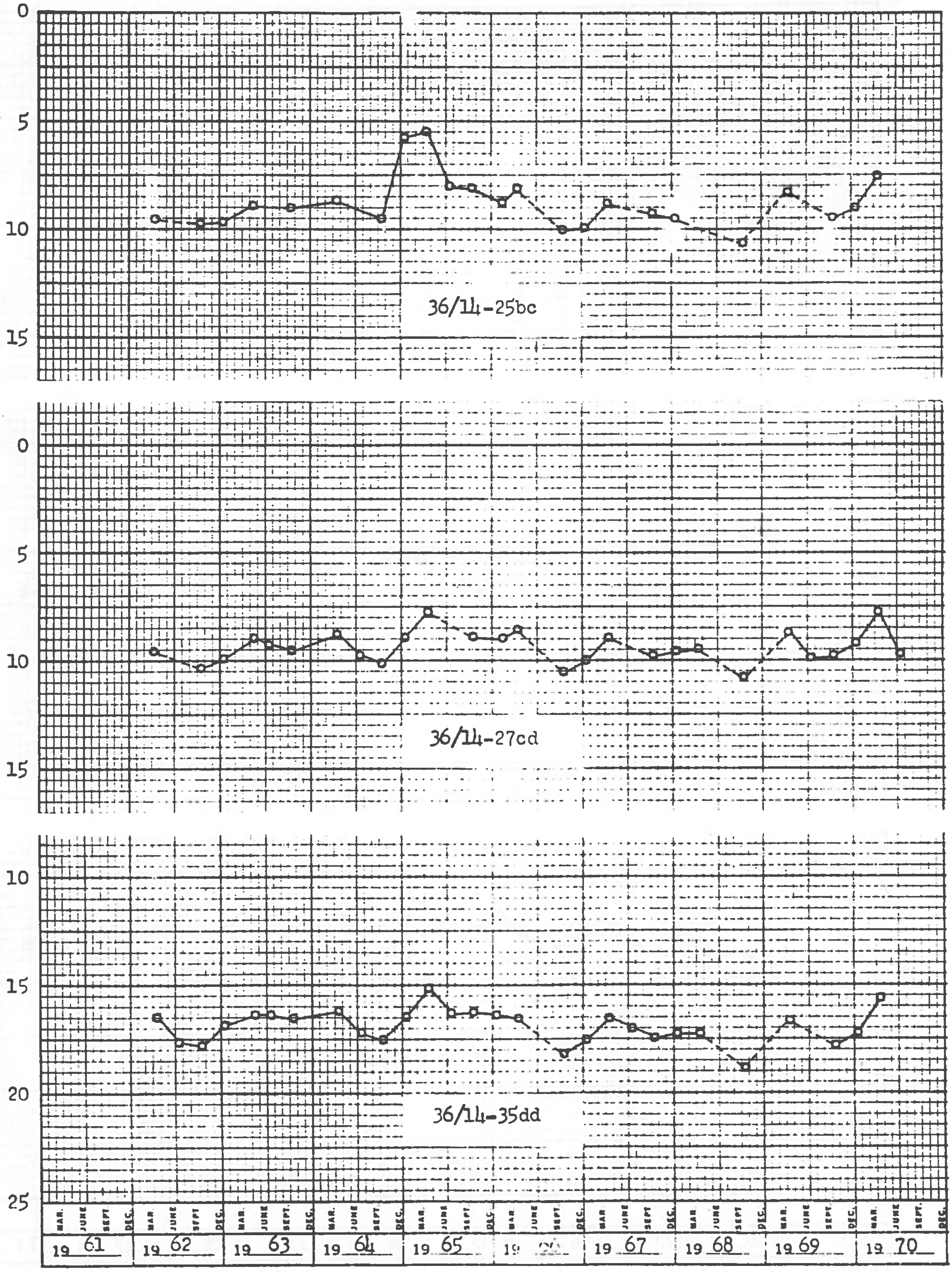


FIGURE 7.

OBSERVATION WELLS
SWAN LAKE VALLEY

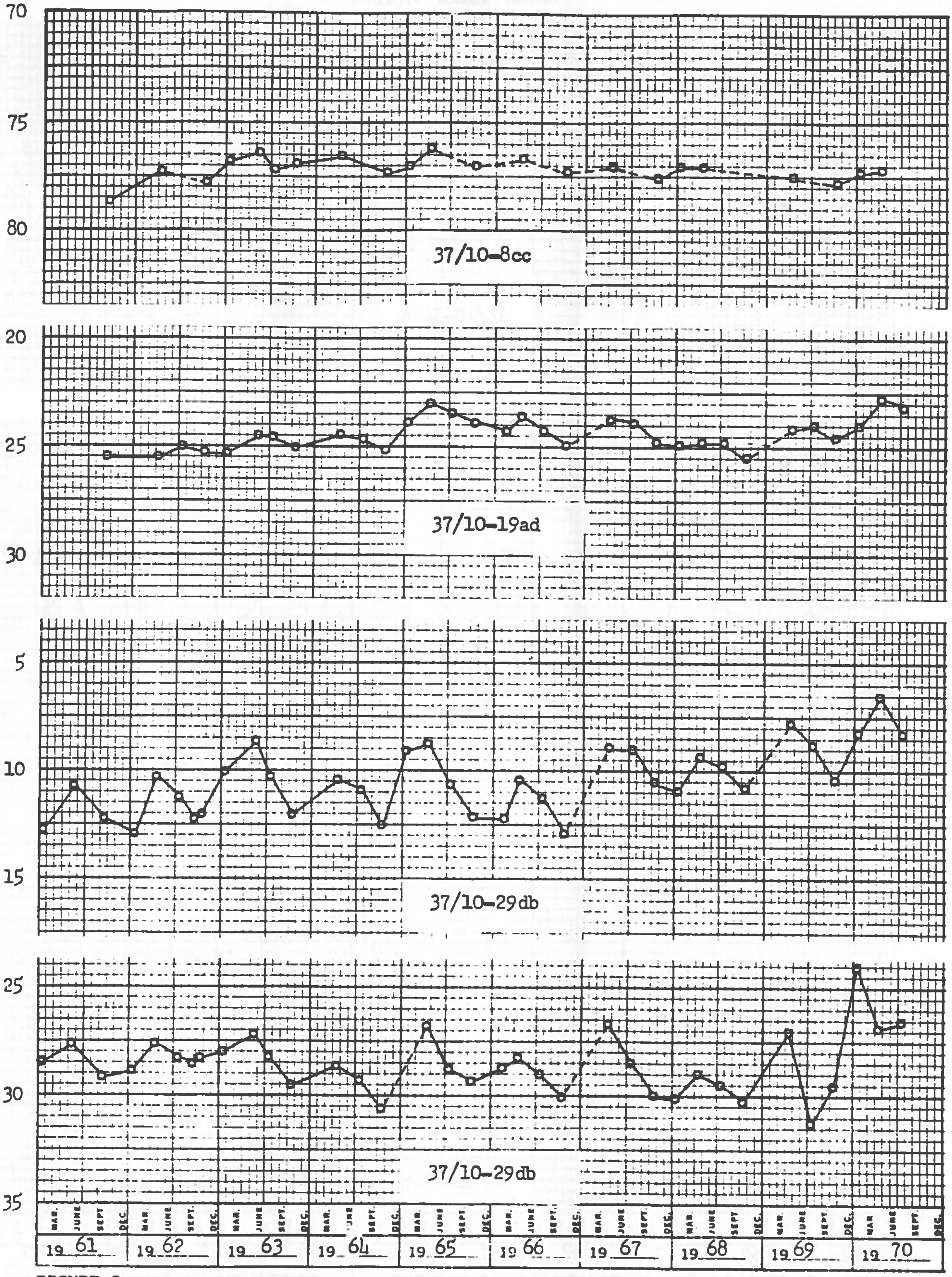


FIGURE 7.

OBSERVATION WELLS
SWAN LAKE VALLEY

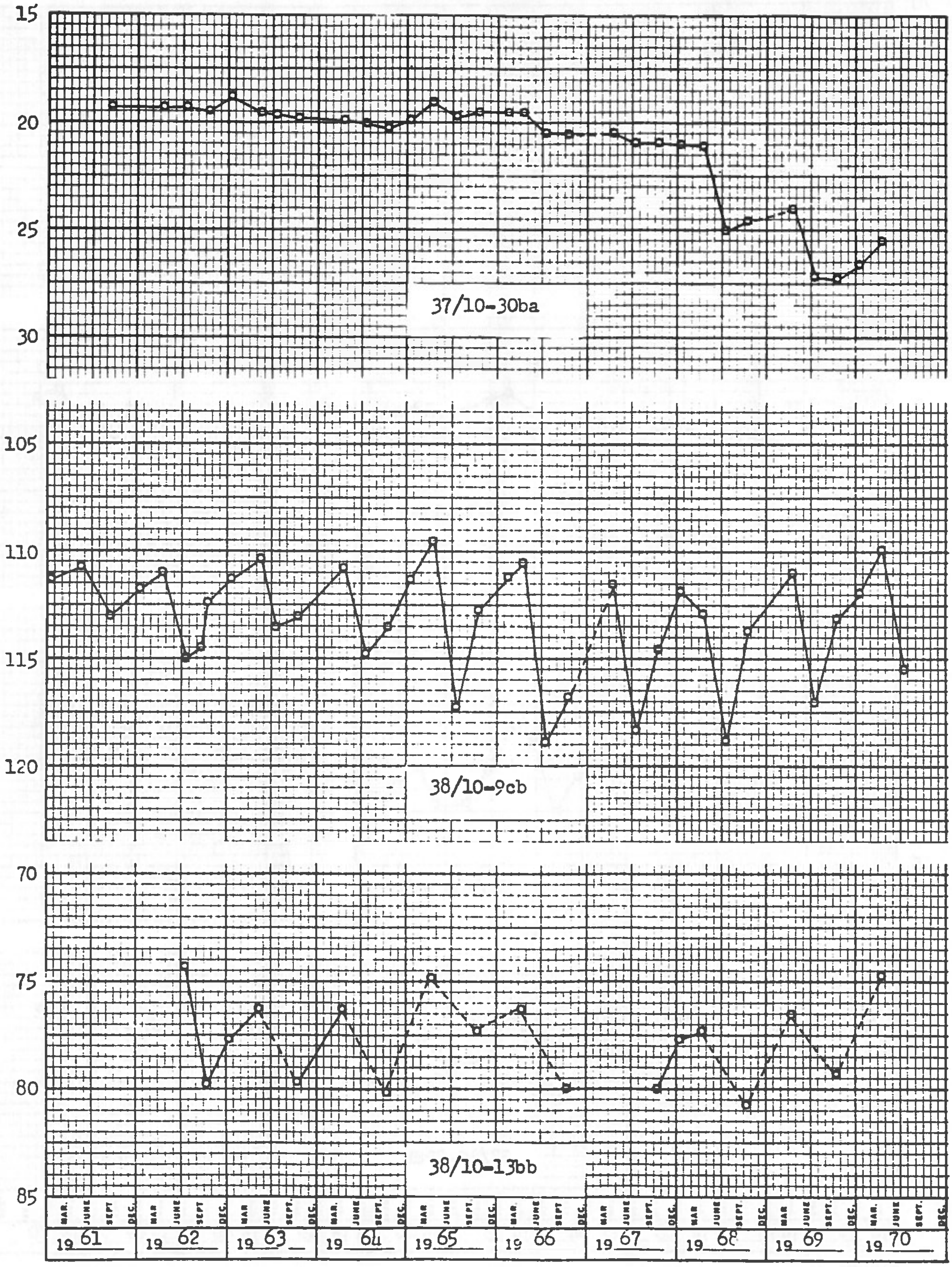


FIGURE 7.

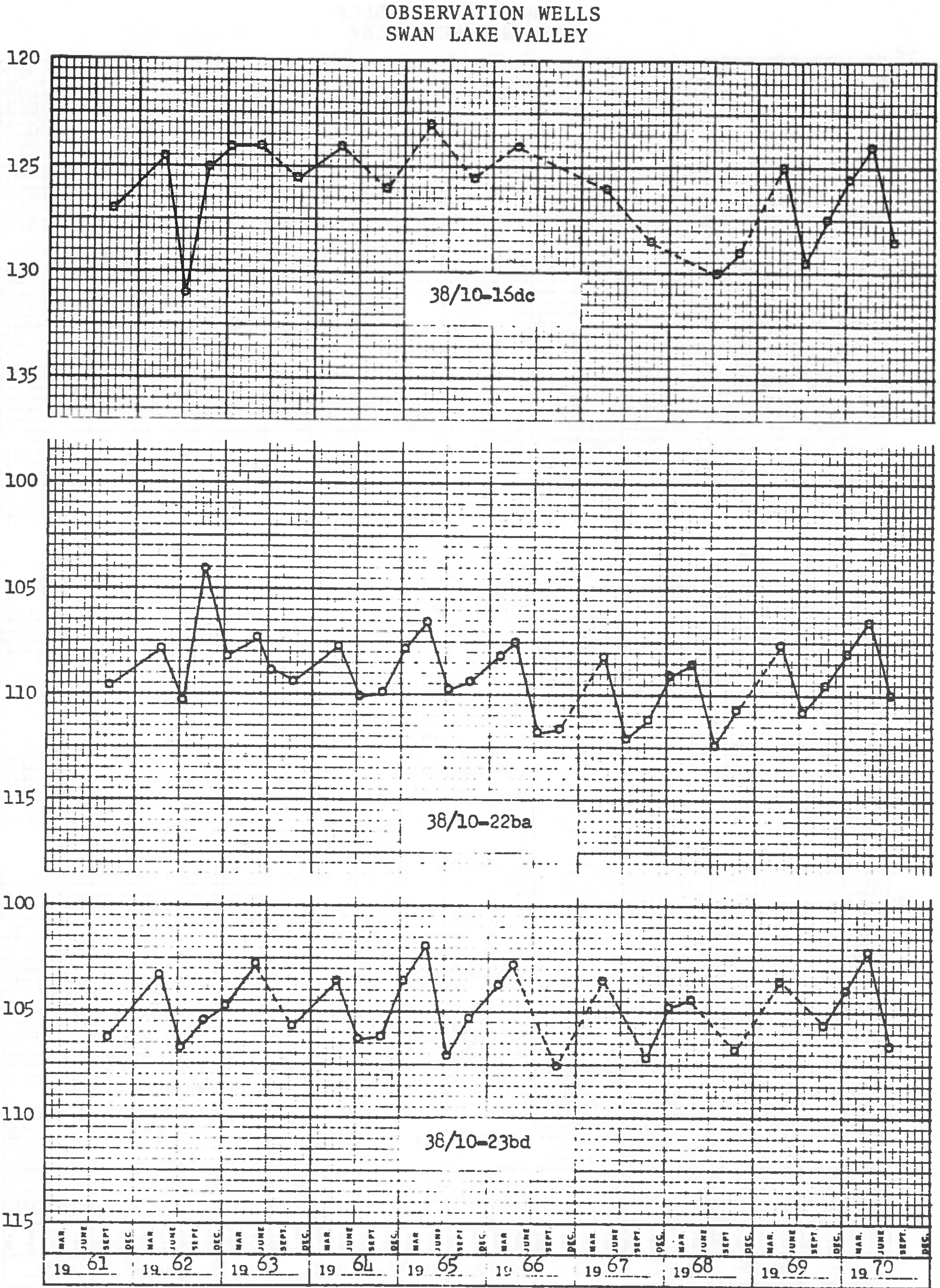

OBSERVATION WELLS
SWAN LAKE VALLEY
120
125
130
135
38/10-16dc
100
105
110
115
38/10-22ba
100
105
110
115
38/10-23bd
MAR.
JUNE
SEPT.
DEC.
19 61
19 62
19 63
19 64
19 65
19 66
19 67
19 68
19 69
19 70

FIGURE 7.

OBSERVATION WELLS
SWAN LAKE VALLEY

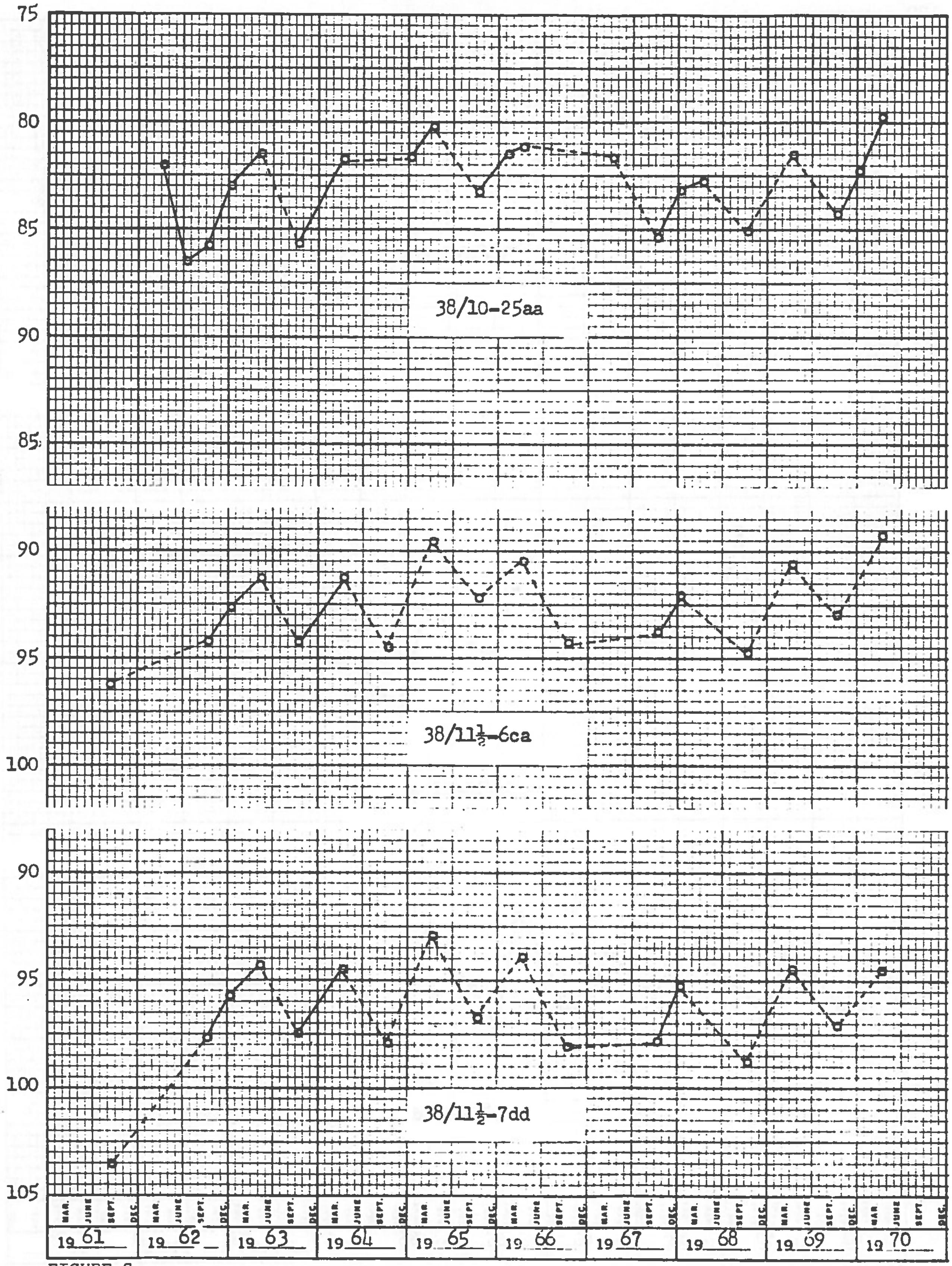


FIGURE 7.

OBSERVATION WELLS
SWAN LAKE VALLEY

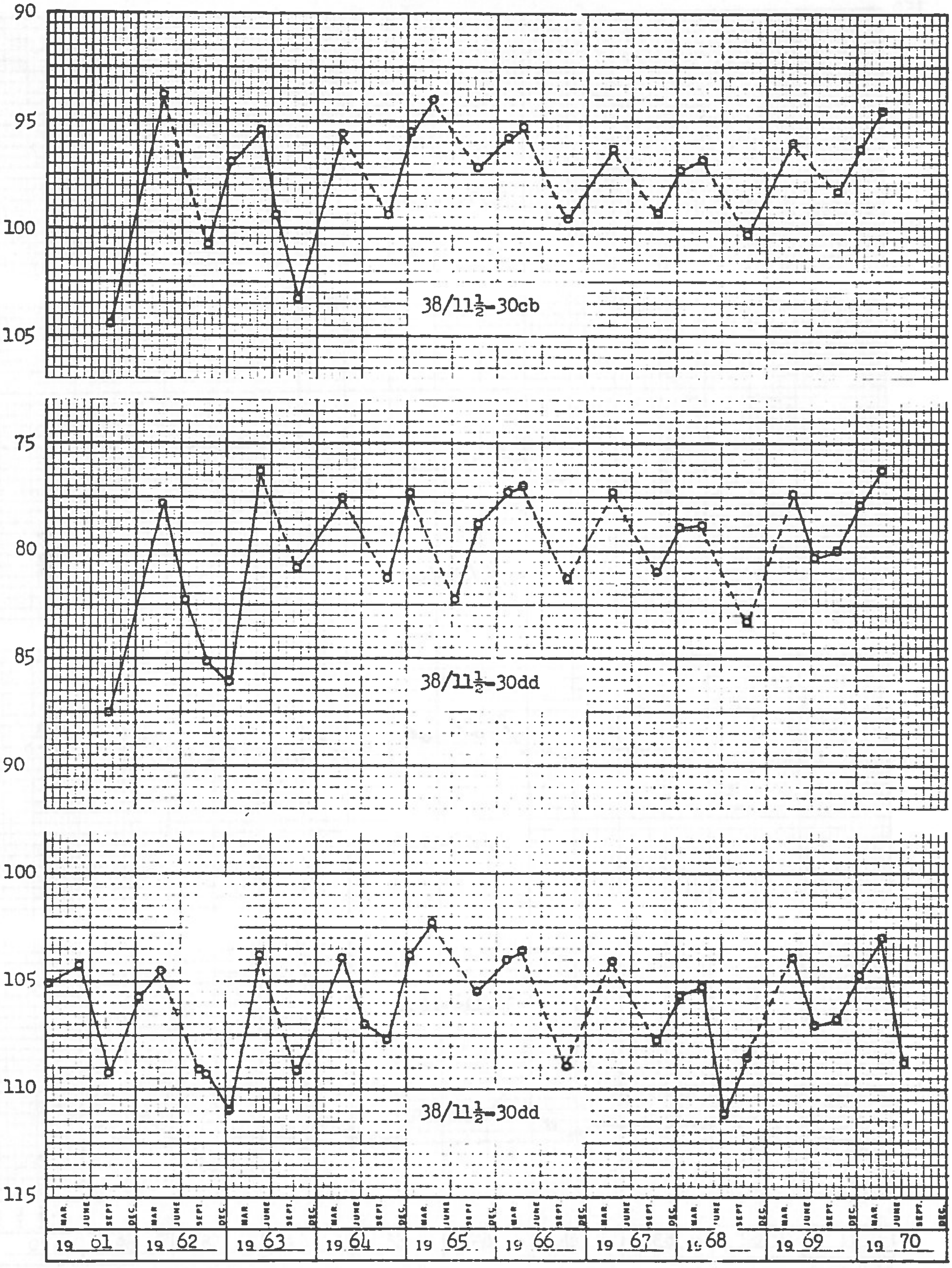


FIGURE 7.

OBSERVATION WELLS
YONNA VALLEY

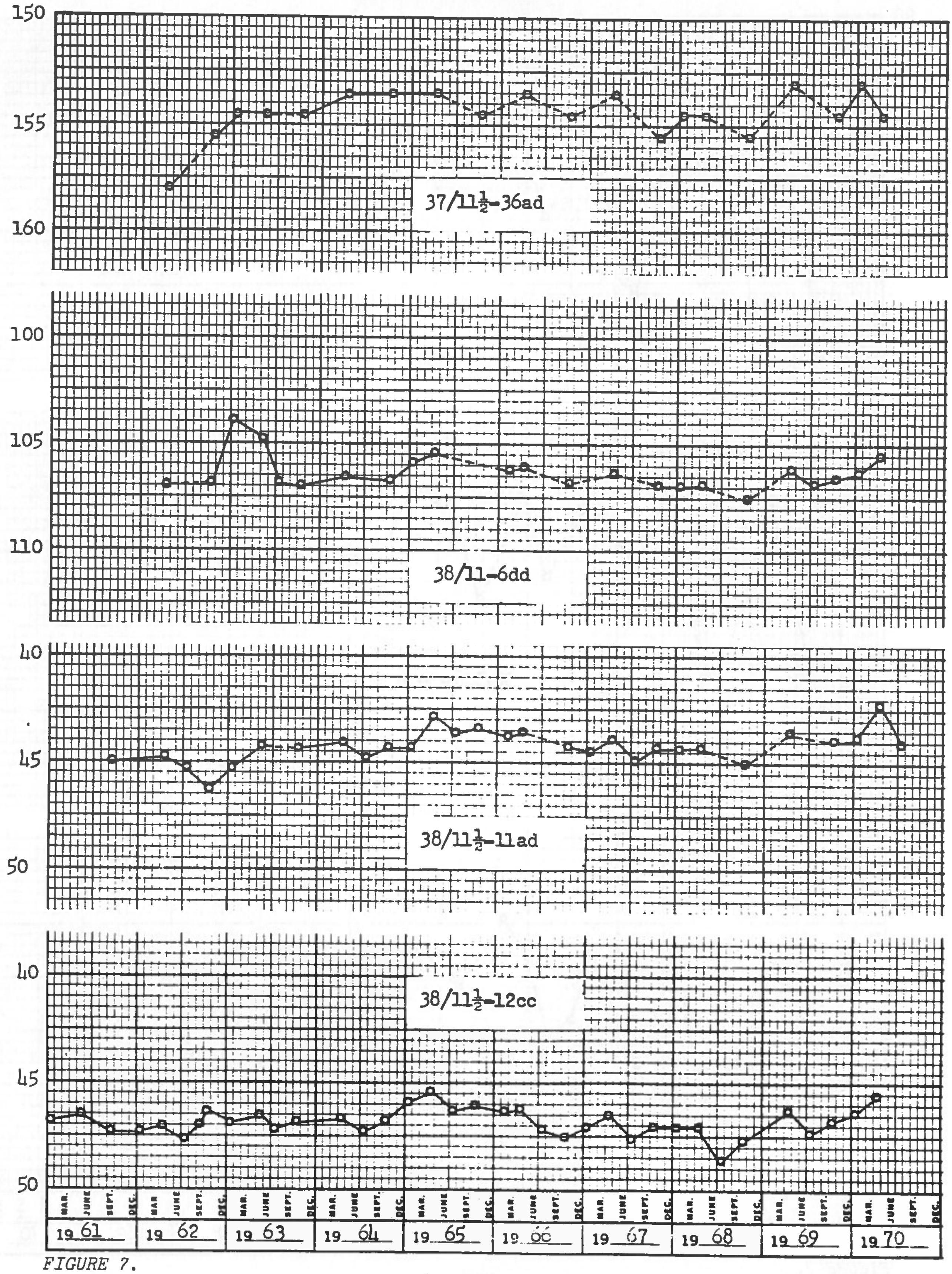


FIGURE 7.

OBSERVATION WELLS
YONNA VALLEY

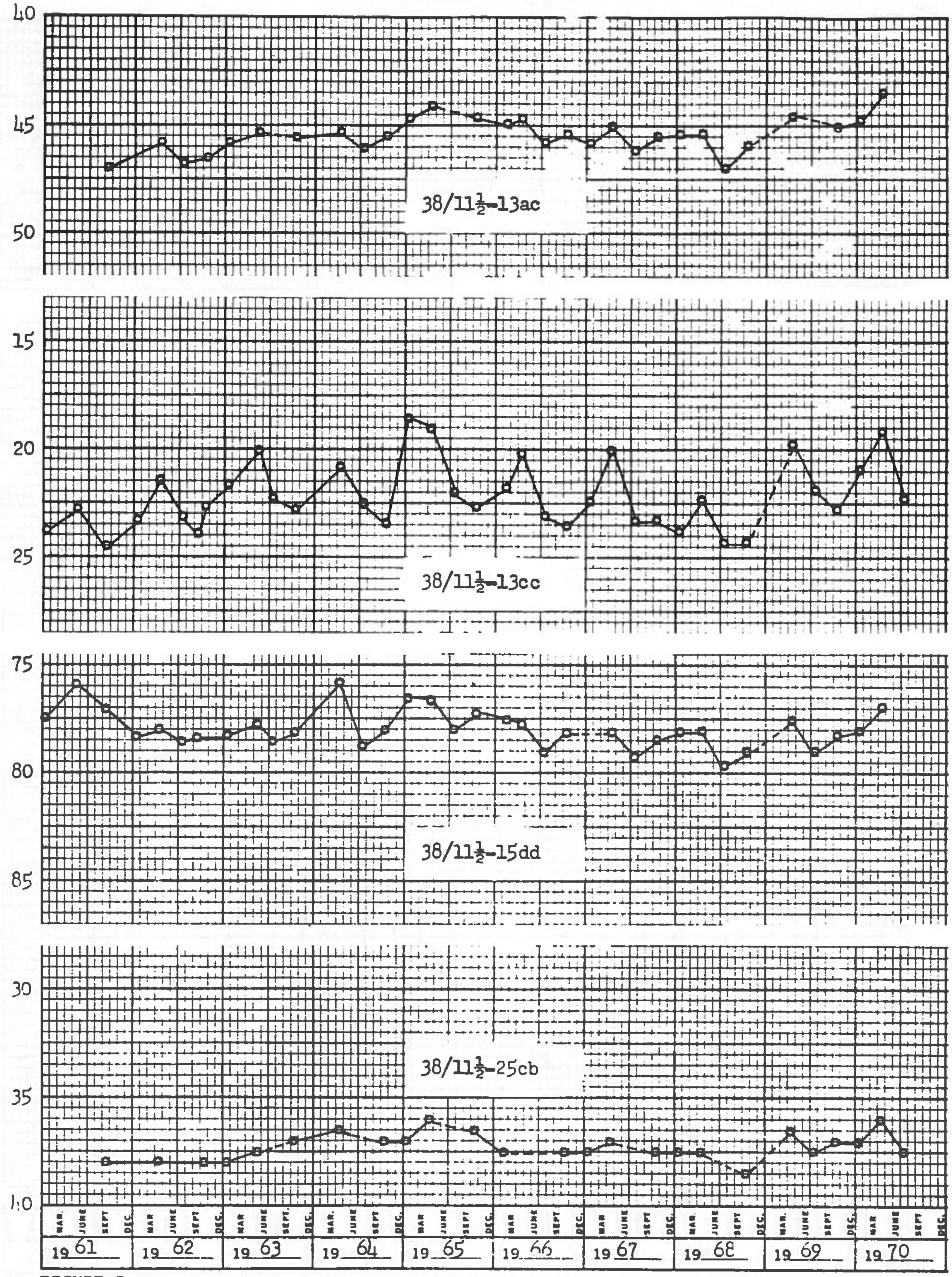


FIGURE 7.

OBSERVATION WELLS
LOST RIVER SUB-BASIN

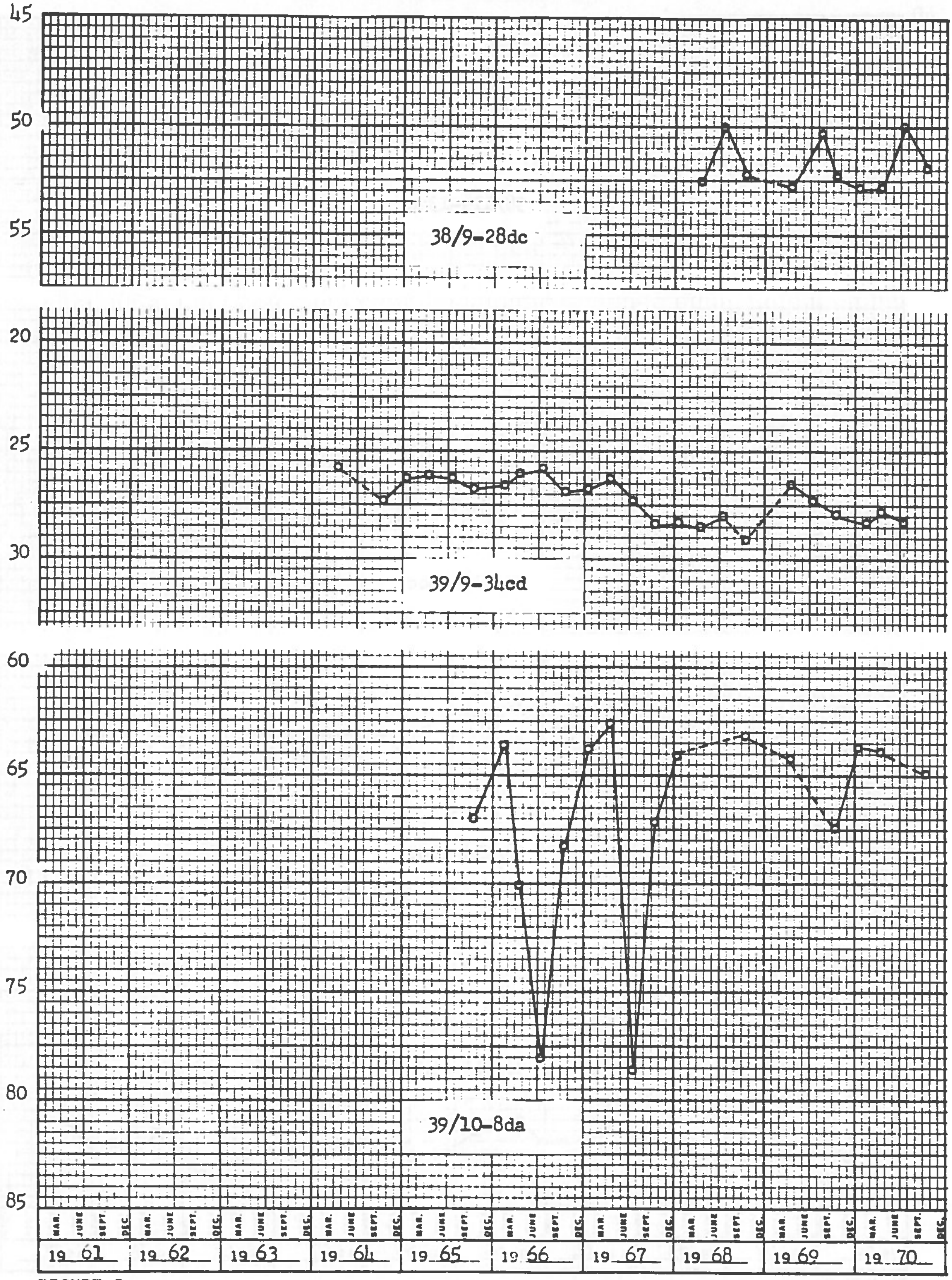


FIGURE 7.

OBSERVATION WELLS
LOST RIVER SUB-BASIN

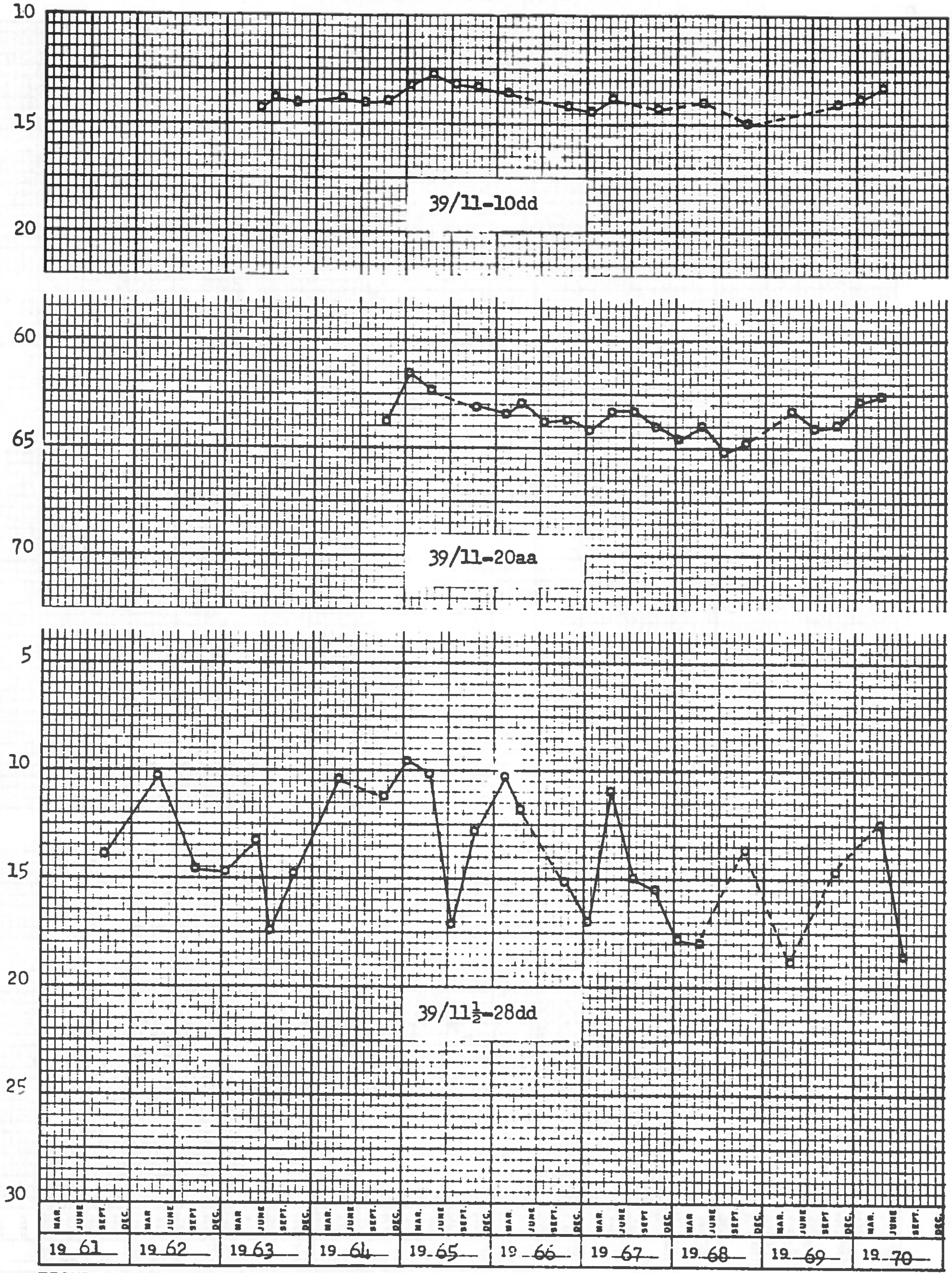


FIGURE 7.

OBSERVATION WELLS
LOST RIVER SUB-BASIN

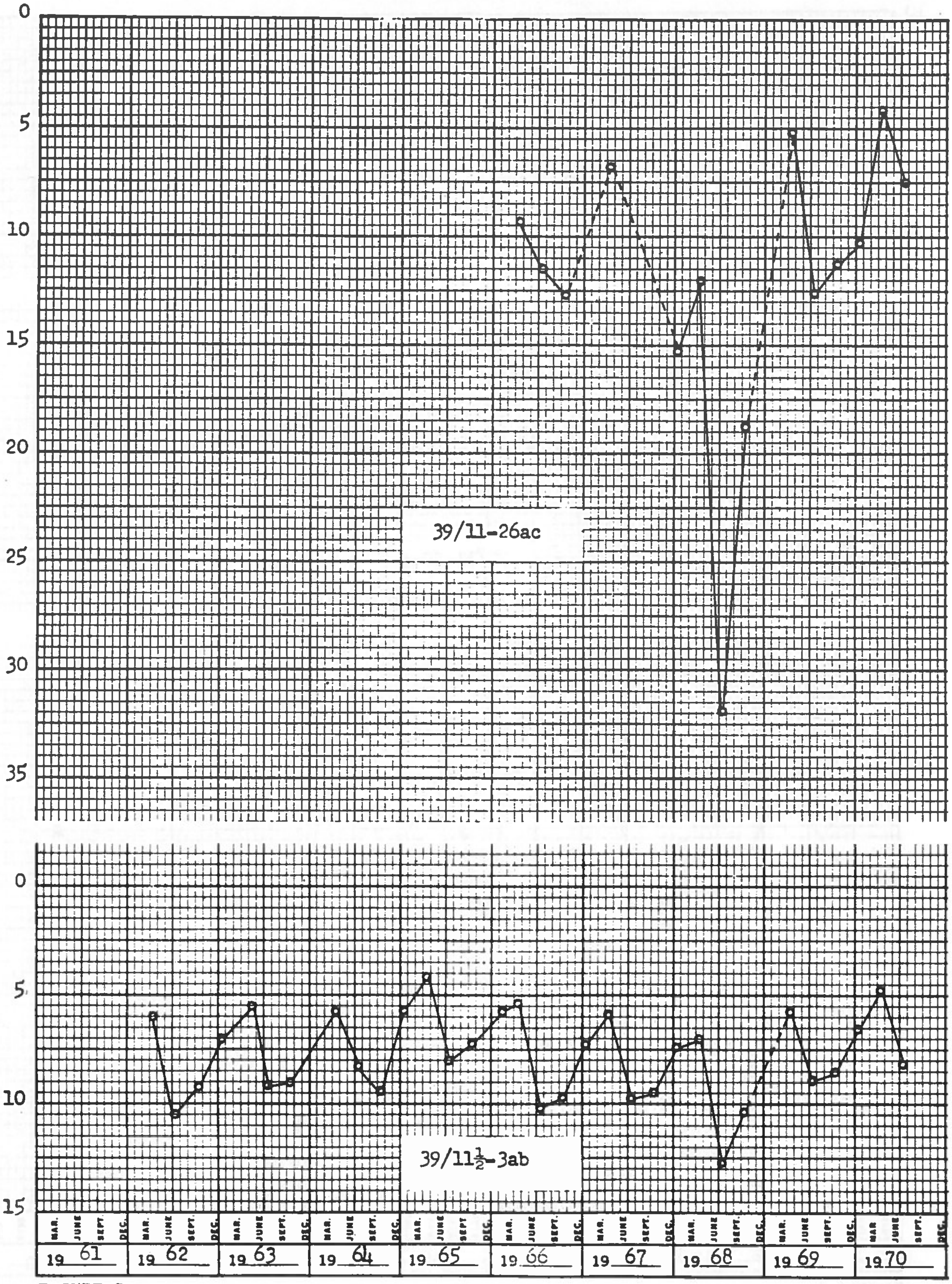
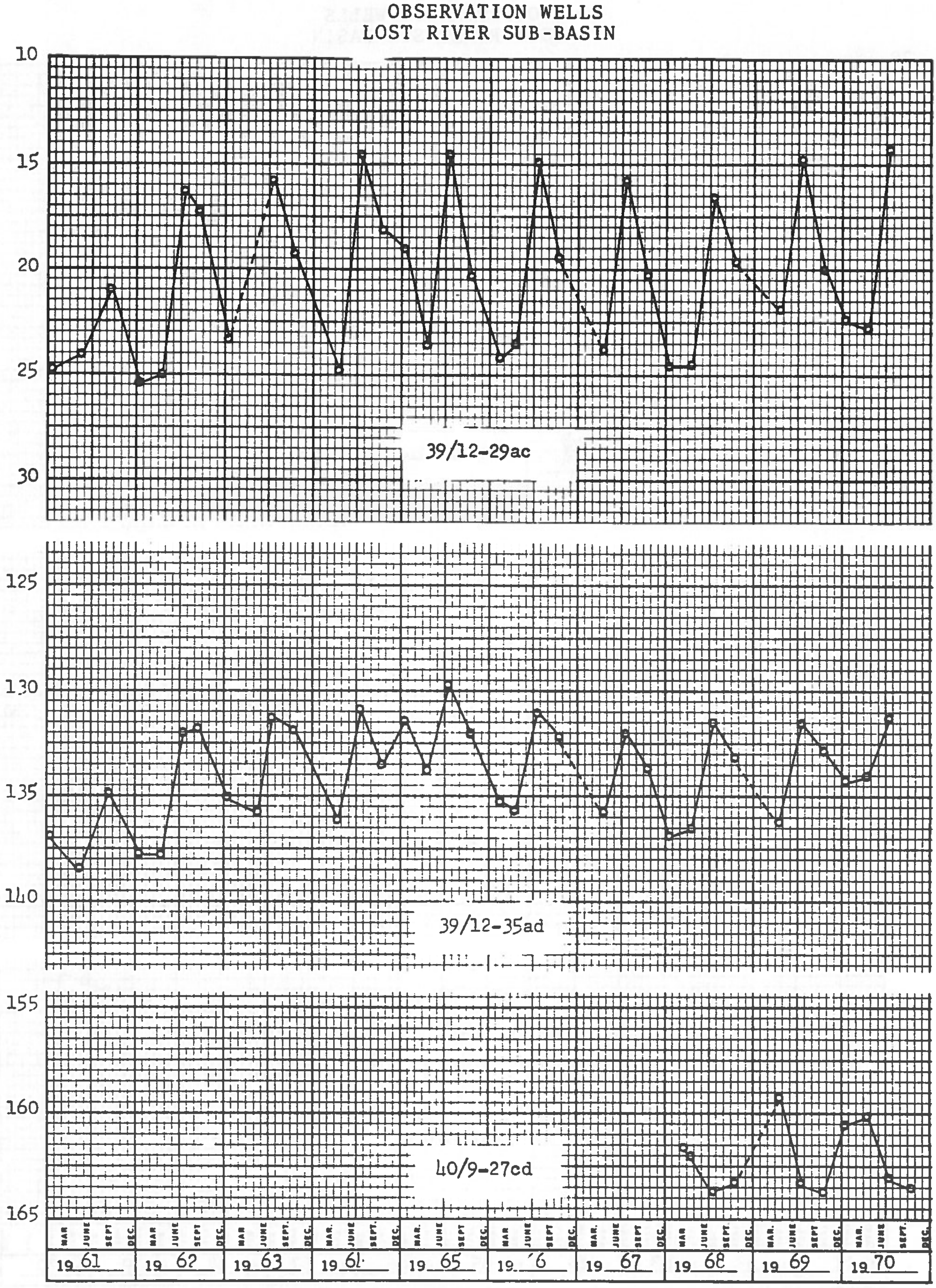


FIGURE 7.



OBSERVATION WELLS
LOST RIVER SUB-BASIN
10
15
20
25
30
39/12-29ac
125
130
135
140
39/12-35ad
155
160
165
40/9-27cd
MAR.
JUNE
SEPT.
DEC.
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970

FIGURE 7.

OBSERVATION WELLS
LOST RIVER SUB-BASIN

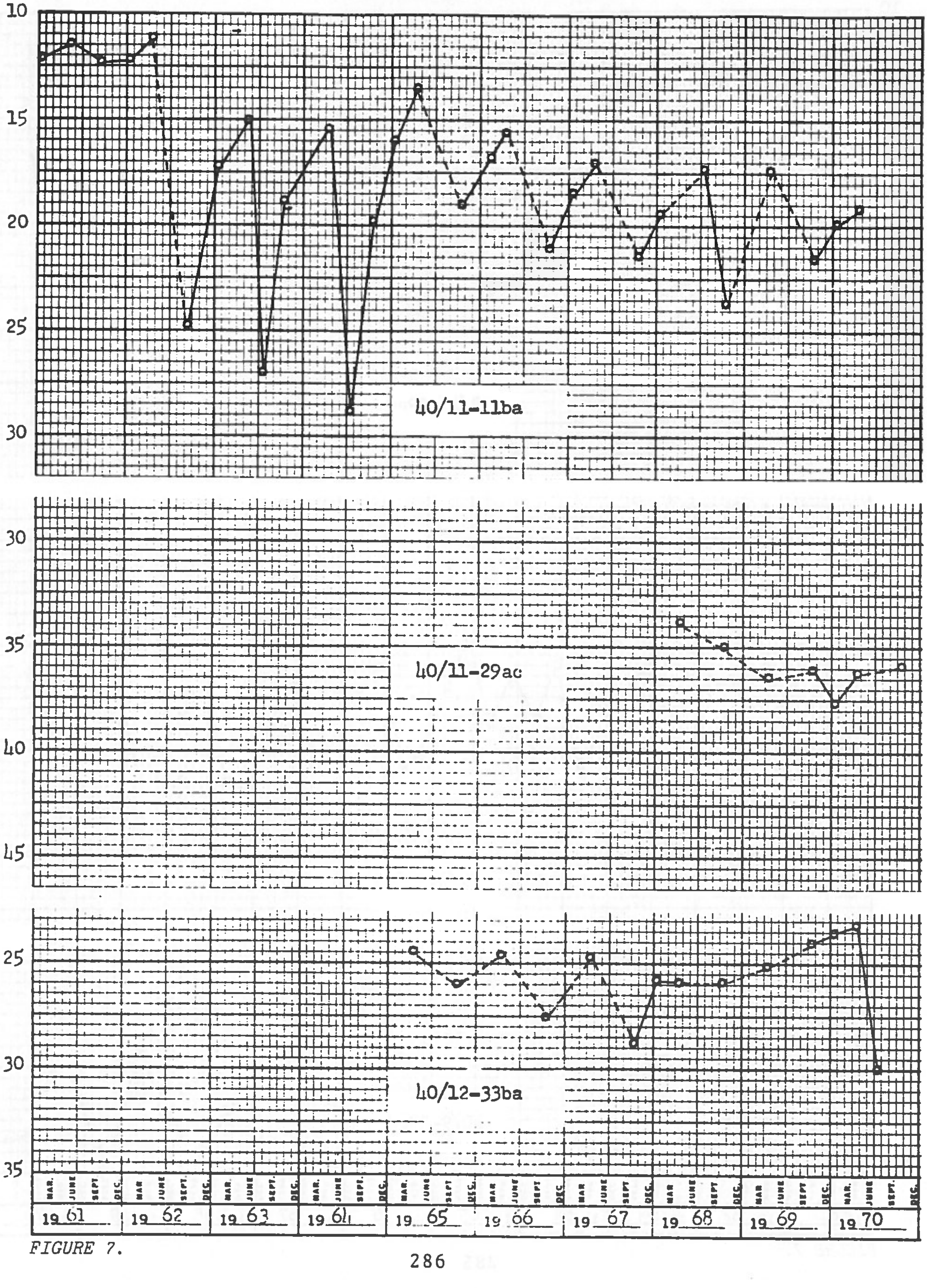


FIGURE 7.

OBSERVATION WELLS
LOST RIVER SUB-BASIN

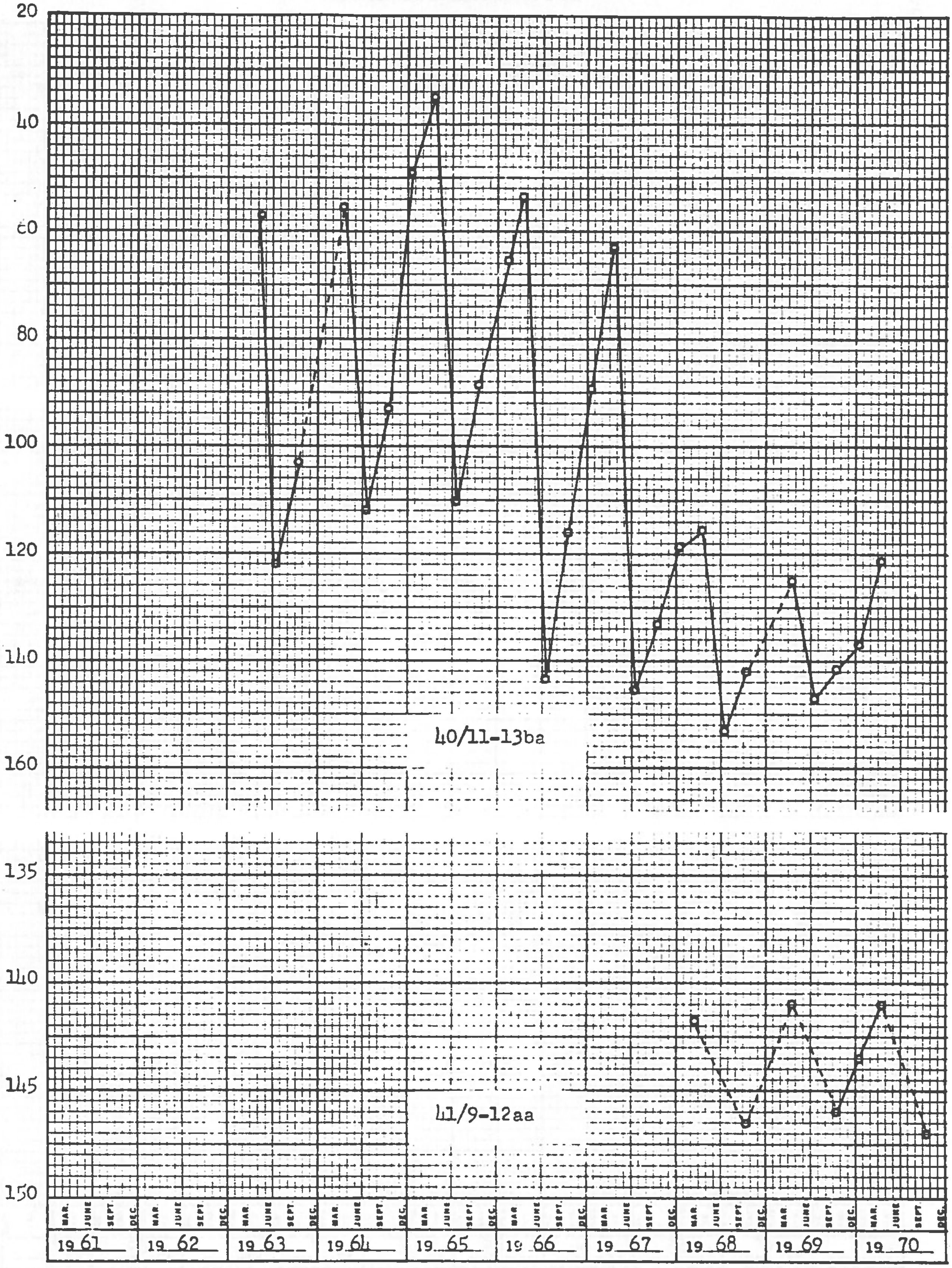


FIGURE 7.

OBSERVATION WELLS
LOST RIVER SUB-BASIN

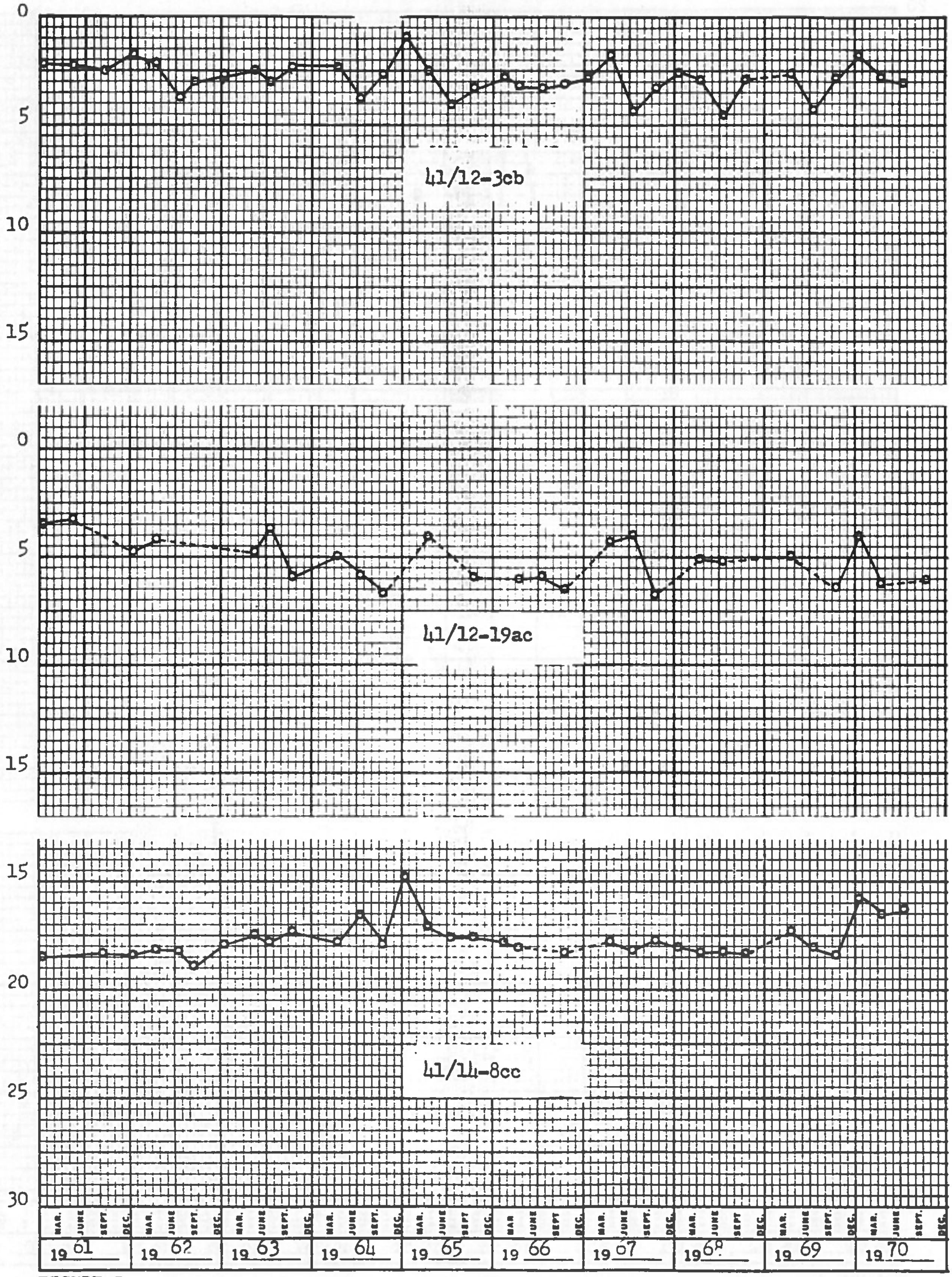


FIGURE 7.

STRATIGRAPHIC SECTION

Geologic Time Scale (Age in millions of years) — Periods	Epochs	Rock Units		Description of Materials
Quaternary 0-1m	Recent 0-0.025m	Qal	Qal	**Quaternary Alluvium** — ALLUVIUM: stream and lake deposited silt, sand, clay, gravel, peat, diatomite and ash.
		Qp	Qp	PUMICE: airborne and flow pumice of dacitic composition. Originating primarily from ancestral Mount Mazama, present location of Crater Lake.
	?	Qls	Qls	LANDSLIDE DEBRIS: associated with fault scarps exposing basaltic flows underlain by tuffaceous sediments. More extensive immediately east of study area.
	Pleistocene 0.025m-1m	Qlo	Qlo	OLDER ALLUVIUM: fluvial, terrace and lacustrine deposits of higher lake levels including pumice, coquina, conglomerate and fine grained tuffaceous sediments.
		Qvu	Qvu	**Pliocene-Pleistocene Volcanics** — PLIOCENE-PLEISTOCENE VOLCANICS UNDIFFERENTIATED: lava flows and pyroclastic materials of andesitic, dacitic and basaltic composition.
		Qb	Qb	PLIOCENE-PLEISTOCENE BASALTS: multiple, thin flows of basaltic composition deposited on erosional surface of pliocene sediments. Includes eruptive centers.
		Qa	Qa	PLIOCENE-PLEISTOCENE ANDESITES: numerous flows of both massive and platy andesite. Contains few if any interbeds.
		UNCONFORMITY		
Tertiary 1m-60m	Pliocene 1m-12m	Tpu	Tpu	**Pliocene Sediments and Volcanics** — PLIOCENE SEDIMENTS AND VOLCANICS UNDIFFERENTIATED: basaltic flows, pyroclastics and associated fluvial and lacustrine sediments undifferentiated.
		Ts	Ts	PLIOCENE SEDIMENTS: thin bedded lacustrine diatomites, tuffs, basaltic sandstones and siltstones. Contains local contemporaneous basaltic flows.
		Tb	Tb	PLIOCENE BASALTS: numerous individual flows of two distinct series. Overlain by late Pliocene sediments.
		UNCONFORMITY		
	Miocene 12m-30m	Tv	Tv	**Miocene-Pliocene Volcanics** — Predominantly massive beds of light colored rholitic and dacitic ash-flow tuff. Contains subordinate basalt flows and tuffaceous sediments.
	Oligocene 30m-40m	Twc	Twc	**Eocene-Oligocene Rocks** — VOLCANIC ROCKS OF WESTERN CASCADES: partially altered lava flows with interbedded tuffs.
	Eocene 40m-60m	Teu	Teu	UMPAQUA FORMATION: sandstones, shales and conglomerates of Eocene Age.
		UNCONFORMITY		
Cretaceous 60m-115m and older		pTu	pTu	**Pre-Tertiary Rocks Undifferentiated** — Metamorphic, igneous and sedimentary rocks of Mesozoic and earlier age.

Legend

Contact - Dashed where location inferred.

Fault - Dashed where location inferred. Bar and bar on downthrown side.

Source of Information:

1. West of 122° longitude, "Preliminary Report on the Ground-Water Resources of the Klamath River Basin, Oregon" by R.C. Newcomb and D. H. Hart.

2. East of 122° longitude, "The Reconnaissance Geology and Mineral Resources of Eastern Klamath County and Western Lake County, Oregon" by Norman V. Peterson and James R. McIntyre.

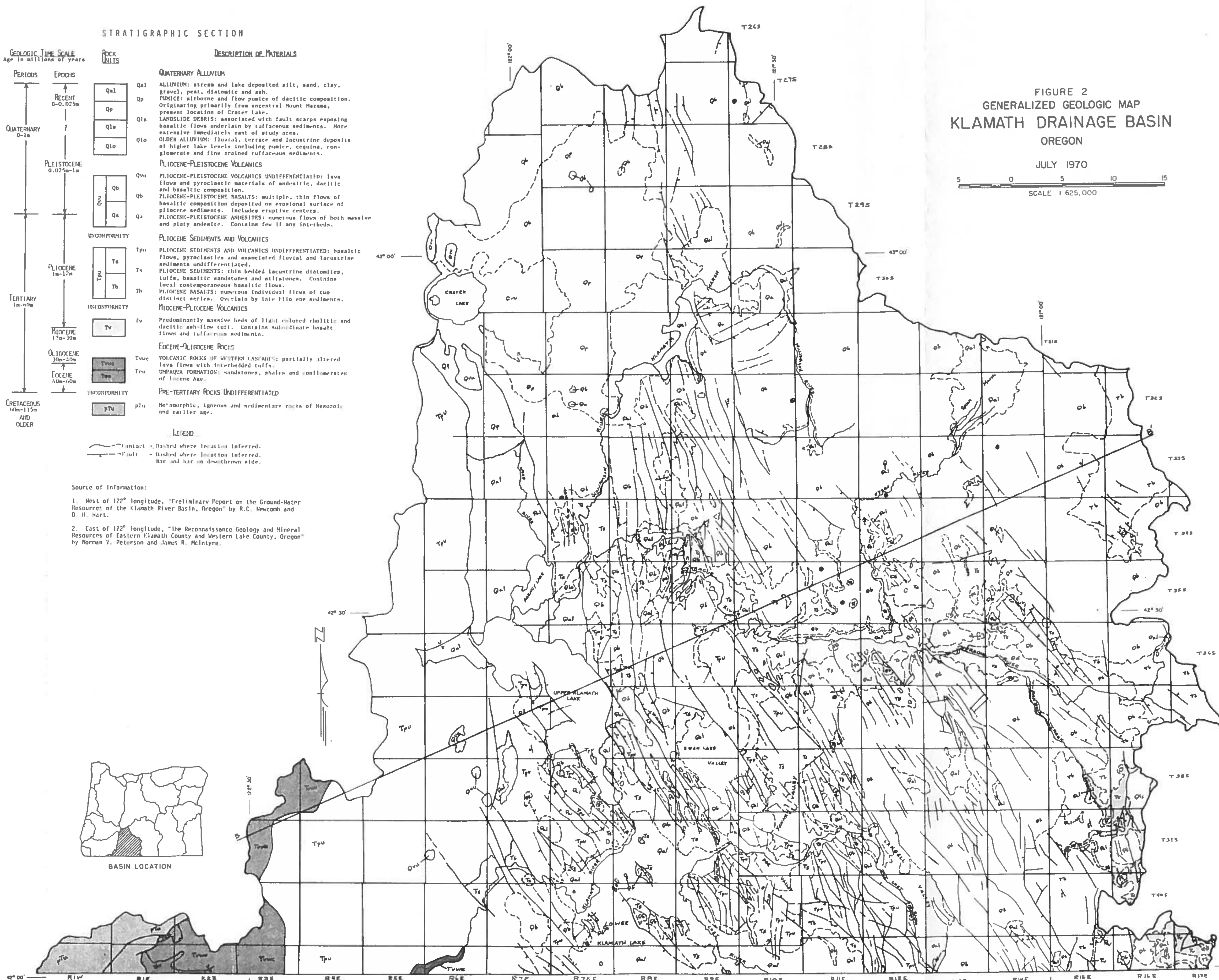
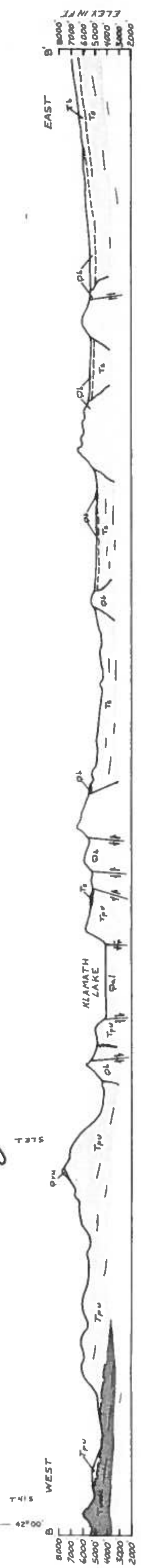


FIGURE 2
GENERALIZED GEOLOGIC MAP
KLAMATH DRAINAGE BASIN
OREGON
JULY 1970
SCALE 1:625,000



U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

M7-S-21691-N

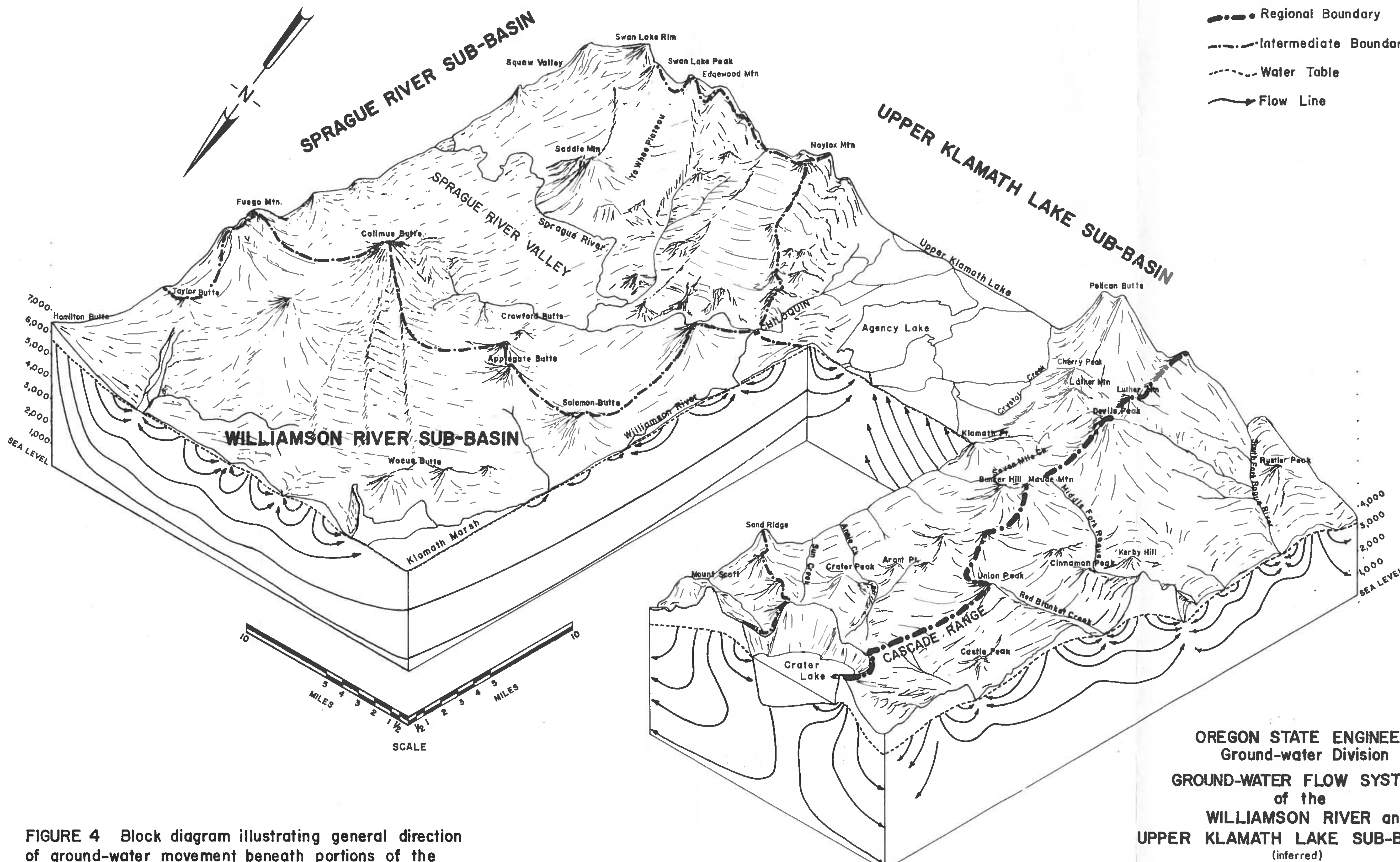


FIGURE 4 Block diagram illustrating general direction of ground-water movement beneath portions of the Williamson River and Upper Klamath Lake Sub-basins.

OREGON STATE ENGINEER
Ground-water Division

GROUND-WATER FLOW SYSTEMS
of the
WILLIAMSON RIVER and
UPPER KLAMATH LAKE SUB-BASINS
(inferred)
KLAMATH BASIN, OREGON

Joseph R. Illian, Hydrogeologist   Nov., 1970

FIGURE 4

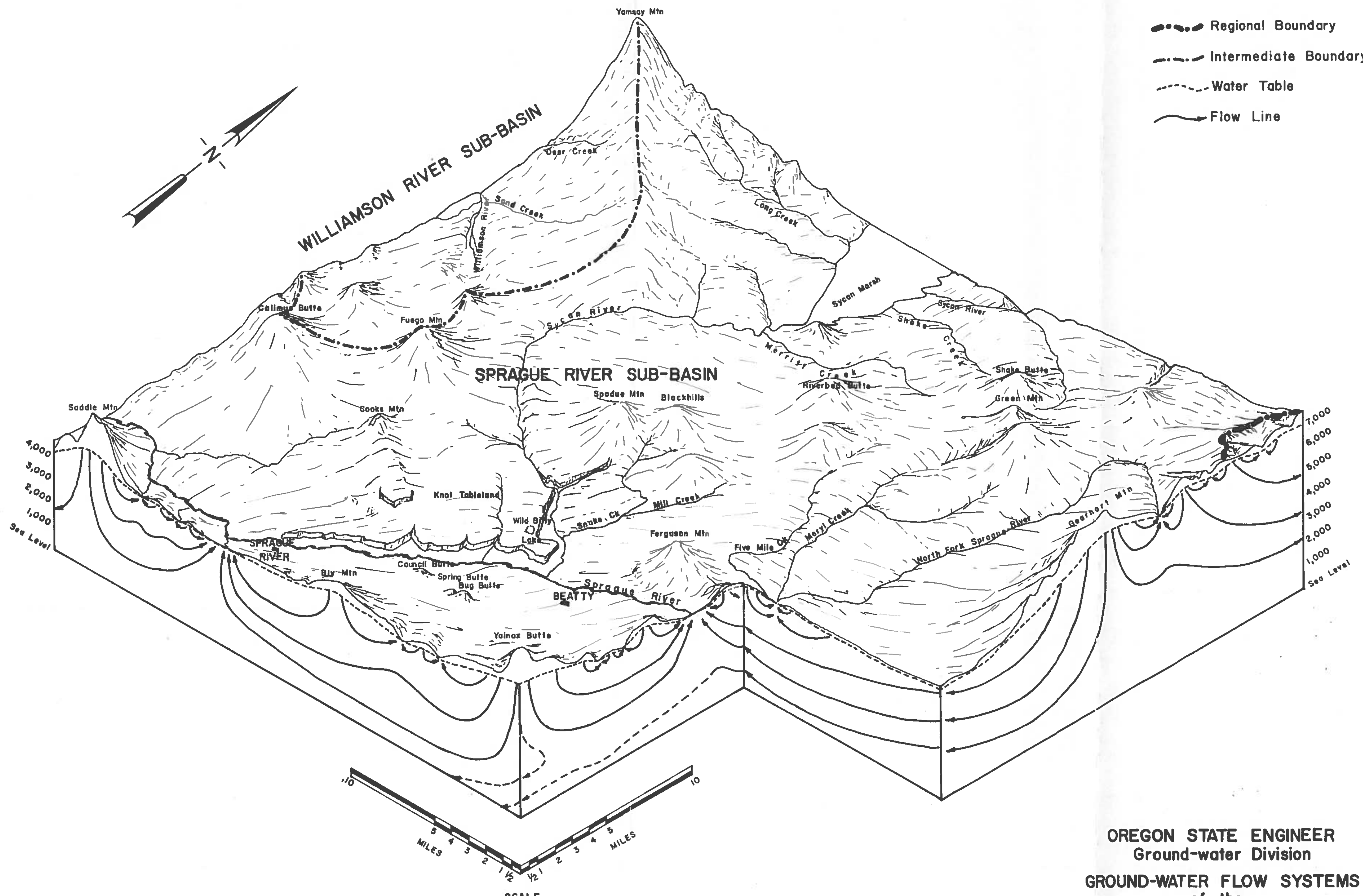


FIGURE 5 Block diagram illustrating general direction of ground-water movement beneath portions of the Sprague River Sub-basin.

OREGON STATE ENGINEER
Ground-water Division

GROUND-WATER FLOW SYSTEMS
of the
SPRAGUE RIVER SUB-BASIN
(inferred)
KLAMATH BASIN, OREGON

Joseph R. Illian, Hydrogeologist Nov., 1970

FIGURE 5

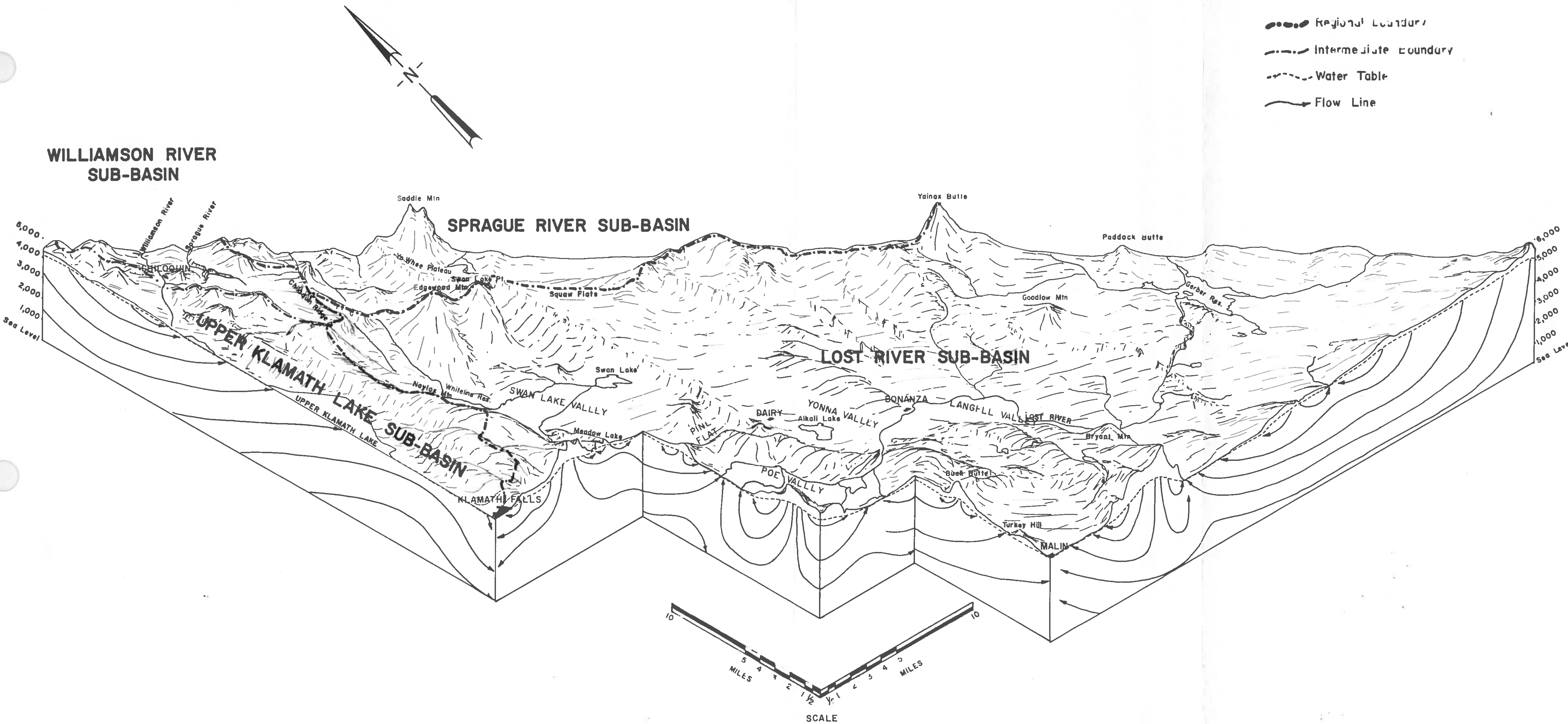


FIGURE 6 Block diagram illustrating general direction of ground-water movement beneath portions of the Lost River Sub-basin.

OREGON STATE ENGINEER
Ground-water Division

GROUND-WATER FLOW SYSTEMS
of the
LOST RIVER SUB-BASIN
(inferred)
KLAMATH BASIN, OREGON

Joseph R. Illian, Hydrogeologist Nov., 1970

FIGURE 6