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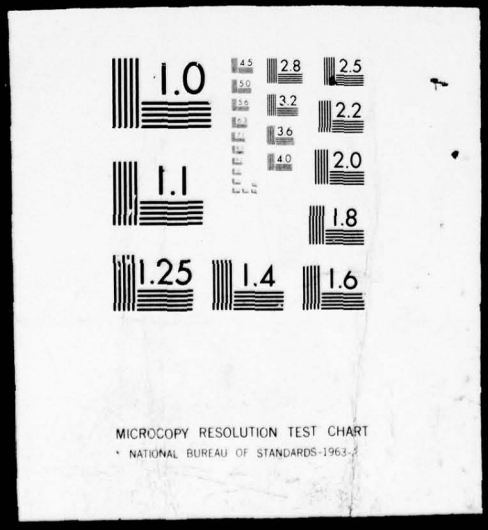

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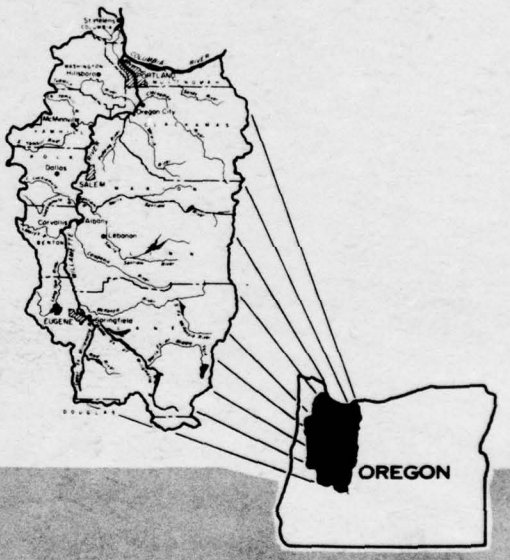

APPENDIX A

STUDY AREA

WILLAMETTE BASIN TASK FORCE - PACIFIC NORTHWEST RIVER BASINS COMMISSION

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CREDITS

This is one of a series of appendices to the Willamette Basin Comprehensive Study main report. Each appendix deals with a particular aspect of the study. The main report is a summary of information contained in the appendices plus the findings, conclusion, and recommendations of the investigation.

This appendix was prepared under the general supervision of the Willamette Basin Task Force and by the Study Area Committee. The Committee was chaired by the State Water Resources Board and included representation from the following agencies:

Bonneville Power Administration

Bureau of Land Management

Bureau of Mines

Bureau of Outdoor Recreation

Bureau of Reclamation

Bureau of Sport Fisheries and Wildlife

Corps of Engineers

Economic Research Service

Federal Water Pollution Control Administration

Forest Service

Geological Survey, Ground Water Branch

National Park Service

Soil Conservation Service

Oregon State University

State Department of Commerce

State Department of Forestry

State Department of Geology and Mineral Industries

State Soil and Water Conservation Committee

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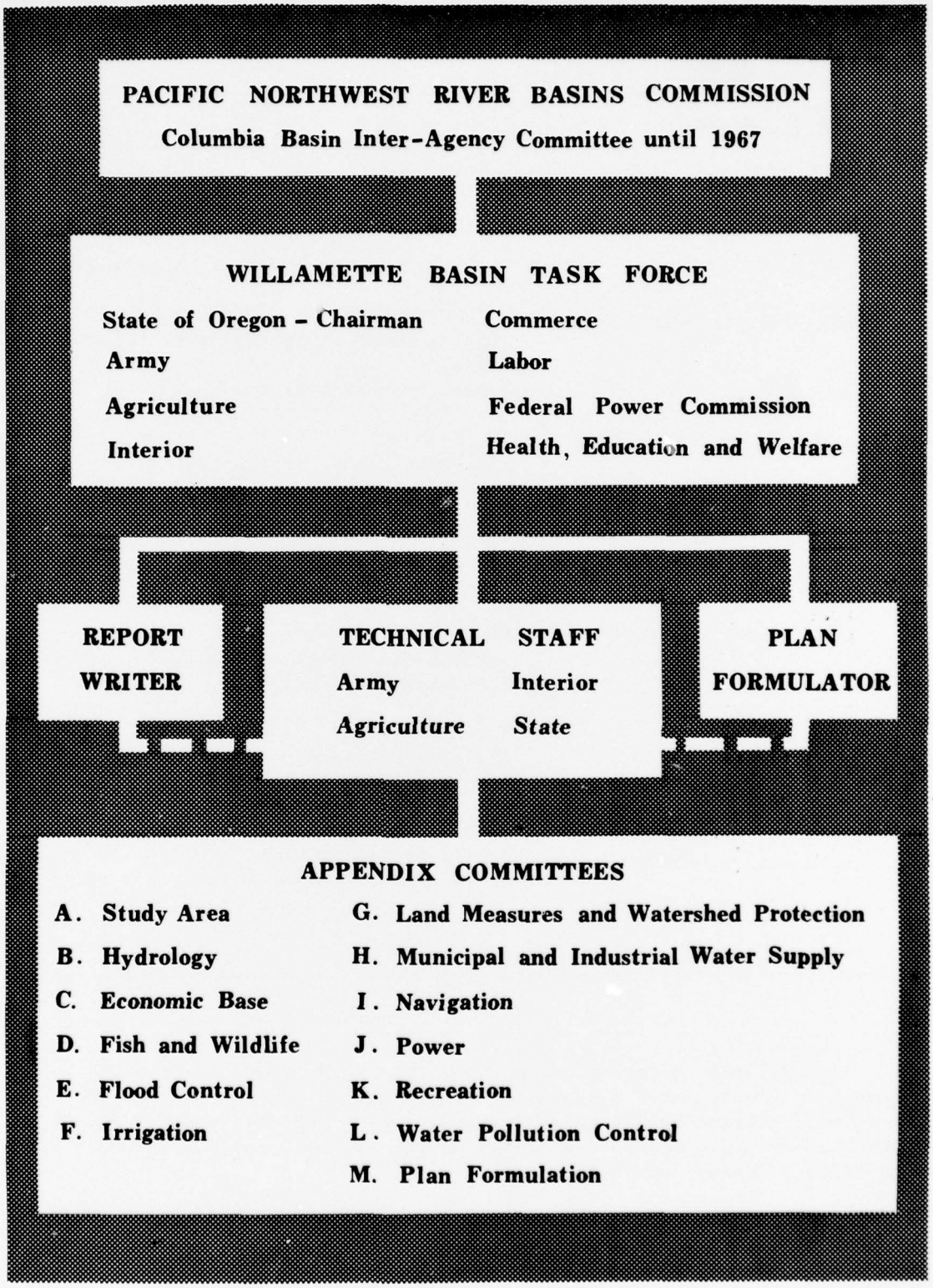

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Department of Interior	John F. Mangan Area Engineer, Lower Columbia Development Office Bureau of Reclamation
Department of Agriculture	Oke Eckholm Assistant State Conservationist Soil Conservation Service
Department of Commerce	David J. Bauman Hydrologist, Weather Bureau Forecast Center
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Department of Labor	Horace Harding Regional Economist Bureau of Employment Security
Department of Health, Education & Welfare	Francis L. Nelson Public Health Service Water Supply and Sea Resources Program

The Willamette Basin Comprehensive Study has been directed and coordinated by the Willamette Basin Task Force listed above. The Task Force has been assisted by a technical staff, a plan formulator and a report writer. Appendix committees listed on the following page, carried out specific technical investigations.

APPENDIX COMMITTEES

Appendix-Subject		
A - Study Area	OSWRB - Chairman:	FWPCA, USBPA, USBLM, USBM, USBOR, USBR, USBSF&WL, USCE, USERS, USFS, USGS, USNPS, USSCS, OSDC, OSDF, OSDG&MI, OSS&WCC, OSU
B - Hydrology	USGS - Chairman:	FWPCA, USBPA, USBR, USCE, USSCS, USWB, OSE, OSWRB
C - Economic Base	USCE - Chairman:	FWPCA, USBPA, USBCF, USBM, USBOR, USBR, USSF&WL, USDL, USERS, USFS, OSDC, OSU, UOBGRS
D - Fish & Wildlife	USBSF&WL - Chairman:	FWPCA, USBCF, USBLM, USBOR, USCE, USDA, USFS, USGS, USSCS, OSFC, OSGC, OSWRB , USHEW
E - Flood Control	USCE - Chairman:	FWPCA, USBR, USDA, USGS, USSCS, USWB, OSDC, OSE, OSWRB, UOBGRS
F - Irrigation	USBR - Chairman:	USSCS, OSDC, OSWRB, OSU
G - Land Measures and Watershed Protection	USSCS - Chairman:	FWPCA, USBCF, USBLM, USBOR, USBR, USSF&WL, USFS, OSU
H - M&I Water Supply	FWPCA - Chairman:	USBR, USBSF&WL, USGS, USSCS, OSBH, OSDC, OSWRB, USHEW
I - Navigation	USCE - Chairman:	OSDC, OSMB, POP, OSU
J - Power	USBPA - Chairman:	FPC, FWPCA, USBCF, USBR, USCE, USFS, USGS, OSE, OSWRB
K - Recreation	USBOR - Chairman:	FPC, FWPCA, USBLM, USBSF&WL, USCE, USFS, USNPS, USSCS, OSBH, OSDC, OSFC, OSGC, OSHD-PD, OSMB, OSWRB, LCPD, OCPA , USHEW
L - Water Pollution Control	FWPCA - Chairman:	USBCF, USBLM, USBOR, USBR, USBSF&WL, USGS, USSCS, OSBH, OSE, OSFC, OSGC, OSWRB, OSU , USHEW
M - Plan Formulation	Plan Formulator - Chairman:	USCE, USDA, USDI, OSWRB

FPC	- Federal Power Commission
FWPCA	- Federal Water Pollution Control Administration
USBPA	- Bonneville Power Administration
USBCF	- Bureau of Commercial Fisheries
USBLM	- Bureau of Land Management
USBM	- Bureau of Mines
USBOR	- Bureau of Outdoor Recreation
USBR	- Bureau of Reclamation
USBSF&WL	- Bureau of Sport Fisheries and Wildlife
USCE	- Corps of Engineers
USDA	- Department of Agriculture
USHEW	- Department of Health, Education and Welfare
USDI	- Department of Interior
USDL	- Department of Labor
USERS	- Economic Research Service
USFS	- Forest Service
USGS	- Geological Survey
USNPS	- National Park Service
USSCS	- Soil Conservation Service
USWB	- Weather Bureau
OSBH	- Oregon State Board of Health
OSDC	- Oregon State Department of Commerce
OSDF	- Oregon State Department of Forestry
OSDG&MI	- Oregon State Department of Geology and Mineral Industries
OSE	- Oregon State Engineer
OSFC	- Fish Commission of Oregon
OSGC	- Oregon State Game Commission
OSHD	- Oregon State Highway Department
OSHD-PD	- Oregon State Highway Department - Parks Division
OSMB	- Oregon State Marine Board
OSS&WCC	- Oregon State Soil and Water Conservation Committee
OSWRB	- Oregon State Water Resources Board
OSU	- Oregon State University
PSC-PR&C	- Portland State College - Center for Population Research and Census Service
UO	- University of Oregon
UO-BGRS	- University of Oregon - Bureau of Governmental Research and Service
LCPD	- Lane County Parks Department
OCPA	- Oregon County Parks Association
POP	- Port of Portland

BASIN DESCRIPTION

Between the crests of the Cascade and Coast Ranges in northwestern Oregon lies an area of 12,045 square miles drained by the Willamette and Sandy Rivers--the Willamette Basin. Both the Willamette and Sandy Rivers are part of the Columbia River system, each lying south and at right angles to the lower Columbia River.

With a 1965 population of 1.34 million, the basin accounted for 68 percent of the population of the State of Oregon. The State's 3 largest cities, Portland, Salem and Eugene, are within the basin boundaries. Forty-one percent of Oregon's population is concentrated in the lower basin subarea, which includes the Portland metropolitan area.

The basin is roughly rectangular, with a north-south dimension of about 150 miles and an average width of 75 miles. It is bounded on the east by the Cascade Range, on the south by the Calapooya Mountains, and on the west by the Coast Range. The Columbia River, from Bonneville Dam to St. Helens, forms its northern boundary. Elevations range from less than 10 feet (mean sea level) along the Columbia, to 450 feet on the valley floor at Eugene, and over 10,000 feet in the Cascade Mountains. The Coast Range attains elevations of slightly over 4,000 feet.

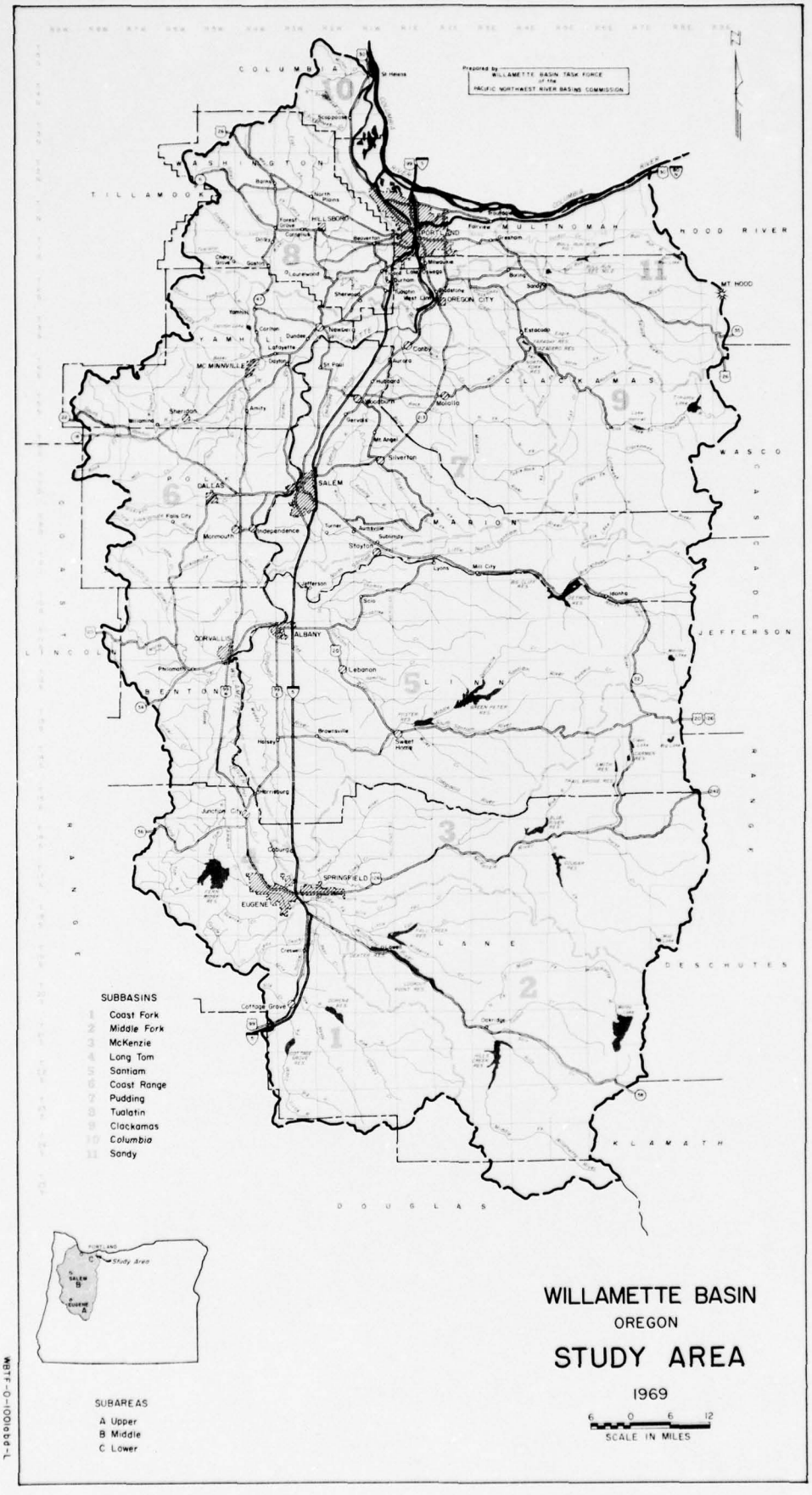
The Willamette Valley floor, about 30 miles wide, is approximately 3,500 square miles in extent and lies below an elevation of 500 feet. It is nearly level in many places, gently rolling in others, and broken by several groups of hills and scattered buttes.

The main stem Willamette River forms at the confluence of its Coast and Middle Forks near Springfield. It has a total length of approximately 187 miles, and in its upper 133 miles flows northward in a braided, meandering channel. Through most of the remaining 54 miles, it flows between higher and more well defined banks unhindered by falls or rapids, except for the basaltic intrusion which blocks the valley at Oregon City and creates Willamette Falls. The stretch below the falls is subject to ocean tidal effects which are transmitted through the Columbia River.

Most of the major tributaries of the Willamette River rise in the Cascade Range at elevations of 6,000 feet or higher and enter the main stream from the east. The Coast Fork Willamette River rises in the Calapooya Mountains, and numerous smaller tributaries rising in the Coast Range enter the main stream from the west.

In this study, the basin is divided into three major sections, referred to as the Upper, Middle, and Lower Subareas (see map opposite). The Upper Subarea is bounded on the south by the Calapooya Mountains and on the north by the divide between the McKenzie River drainage and the Calapooia and Santiam drainages east of the valley floor and by the Long Tom-Marys River divide west of it. The Middle Subarea includes all lands which drain into the Willamette River between the mouth of the Long Tom River and Fish Eddy, a point three miles below the mouth of the Molalla River. The Lower Subarea includes all lands which drain either into the Willamette River from Fish Eddy to its mouth or directly into the Columbia River between Bonneville and St. Helens; the Sandy River is the only major basin stream which does not drain directly into the Willamette River.

For detailed study, the three subareas are further divided into eleven subbasins as shown on the map.


Prepared by
WILLAMETTE BASIN TASK FORCE
of the
PACIFIC NORTHWEST RIVER BASINS COMMISSION
SUBBASINS
1 Coast Fork
2 Middle Fork
3 McKenzie
4 Long Tom
5 Santiam
6 Coast Range
7 Pudding
8 Tualatin
9 Clackamas
10 Columbia
11 Sandy
SUBAREAS
A Upper
B Middle
C Lower
Study Area
WILLAMETTE BASIN
OREGON
STUDY AREA
1969
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SCALE IN MILES
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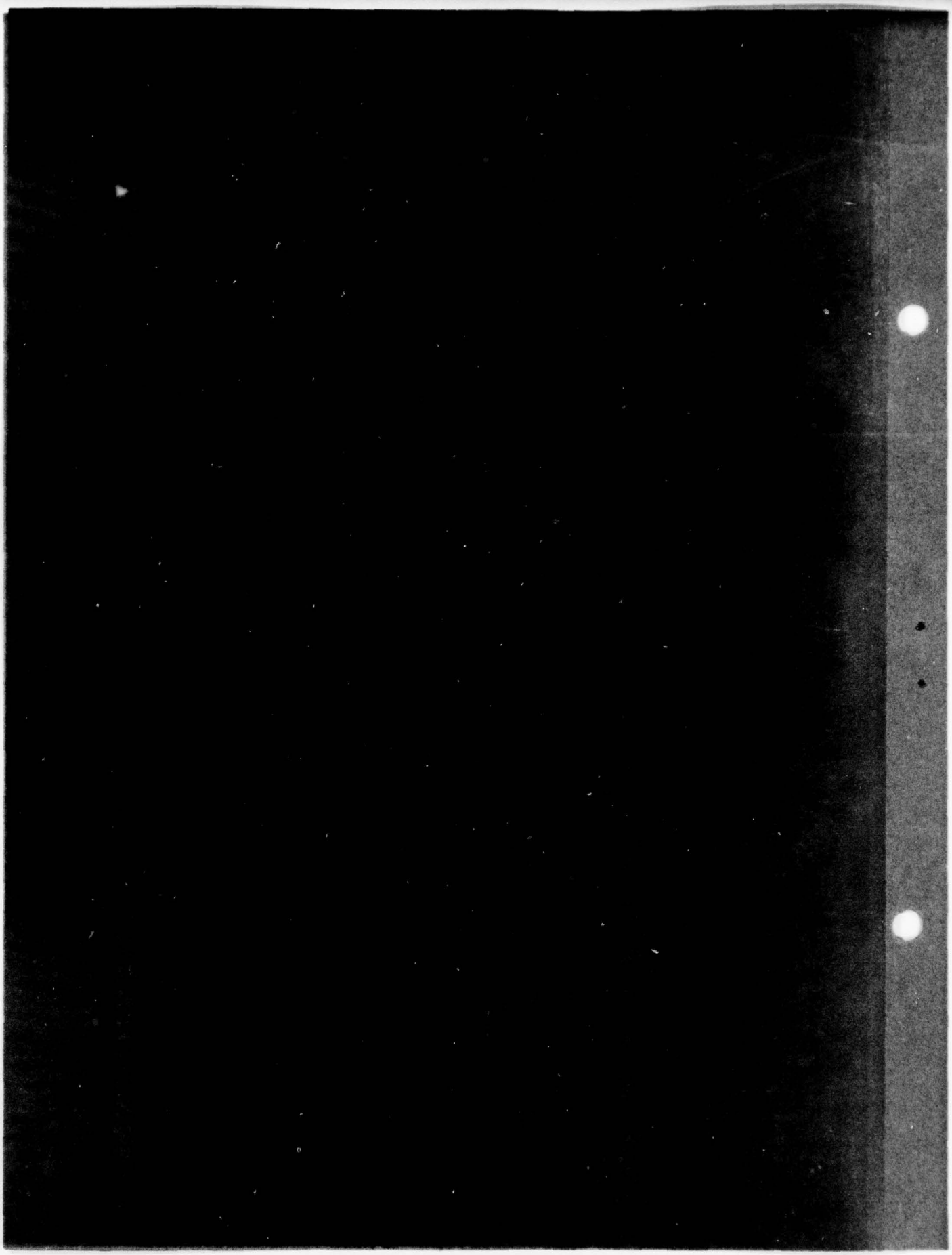
Formation of a provisional government on May 28, 1843, at Champoeg, led to territorial status and finally to statehood. Mural in the State Capitol. (O. S. Hwy. Photo)

INTRODUCTION



RELATIONSHIP TO OTHER PARTS OF THE REPORT

This appendix, together with Appendix B - Hydrology, and Appendix C - Economic Base, provides supporting data for the functional Appendices D through L. The general history and description of the basin, inventory of resources, and the broad relationship of those resources to use are discussed. The broad objectives of resource utilization and the pertinent physical, administrative, social, and legal aspects are contained in this appendix.

The sequence of Appendices D through L reflects the alphabetical arrangement of potential project functions and consideration.

Appendix D - Fish and Wildlife

E - Flood Control

F - Irrigation

G - Land Measures and Watershed Protection

H - Municipal and Industrial Water Supply

I - Navigation

J - Power

K - Recreation

L - Water Pollution Control

Parts I through V of the functional appendices on a single-purpose basis, establish: I, the background; II, present status; III, future demand; IV, alternative means to satisfy demands for specific functions, as supported by Appendices A, B, and C; and V, the summary. Appendix M - Plan Formulation, in addition to developing the multipurpose plan, evaluates the plan in relation to the functional proposals developed in Appendices D through L.

HISTORY OF WILLAMETTE BASIN

EXPLORATION

The early history of the Pacific Northwest and Willamette Basin is shrouded in myths, Indian legends, and folklore. The Indians told of landings by oriental ships before white explorers appeared. A very old Chinese bronze fan and brass coins estimated to be over 3,000 years old were discovered near Victoria, British Columbia.

The first Europeans in the region were Spanish, who explored the Oregon coast in the early part of the 16th century. Modern Oregon history started in 1775 when Heceta found and described the mouth of the Columbia River, although the actual discovery of the Columbia was credited to Captain Gray, an American, in 1792 when he entered and explored the lower reaches of the river. In October 1792, Broughton sailed about 120 miles up the Columbia as far as the present town of Corbett, Oregon. He identified the mouth of the Willamette River and named a number of familiar landmarks including Mt. Hood.

Members of the Lewis and Clark expedition were the first white men to record any information on the Willamette Valley. They entered the lower river in 1806. By 1813, the upper reaches of McKenzie and Willamette Rivers had been explored.

SETTLEMENT

Lewis and Clark, in 1806, estimated that 80,000 Indians lived along the Columbia River; about 10,000 of these lived in the Willamette Valley. Dr. McLoughlin of the Hudson's Bay Company estimated that nine-tenths of the Indians died in the "cold sick" epidemic of 1829, which also affected many whites. Although many Indians were still in the upper Valley in 1834, most historians agree that the reduction in Indian population from the epidemic made it easier for the white man to settle in the basin.

The first permanent white residents in the Willamette Valley were fur traders who began to settle in 1812. "A dwelling and trading house" were built very late in 1812 or early in 1813 about on the site of the present Salem by William Wallace and J. C. Halsey, two clerks associated with the Astor enterprise. Joseph Gervais and Etienne Lucier, formerly Astorians, are said to have had a camp, with their families, on Pudding River near its confluence with the Willamette. By 1831 the existence of at least three farms on the upper Willamette (above Willamette Falls) appears to be well documented (Hussey, 1967).

In June 1841, the white population of the Willamette Valley was 137 people. The westward migration of 1843 added 875 people. Further settlement swelled the population to 6,000 by 1845 and to 99,000 by 1880. By 1900, the population had reached 233,700 and the three principal population centers of the basin--Portland, Salem, and Eugene--had been firmly established.

Photo I-1 A wagon train rests at The Dalles before beginning the remaining miles over the Oregon Trail to the Willamette Valley, 1843. Mural in the State Capitol. (O. S. Hwy. Photo)

By 1965, the basin's population had grown to 1,338,900 with 82 incorporated cities; 45 cities had populations in excess of 1,000. Portland had 382,000, Eugene 72,600, and Salem 64,000.

GOVERNMENT

Dr. John Floyd, on January 18, 1822, presented a bill to Congress seeking to establish the Oregon Territory. This was the first use of the name "Oregon" in connection with the territory. This name had originally been applied to the Columbia River, but not to the surrounding country.

In 1818, the mutual occupancy treaty between Great Britain and the United States was signed and remained in effect until 1843. During this time, when neither government could take over jurisdiction, the Oregon Country had no organized government of its own. In 1843, a provisional government was established at Champoeg, the first capital of Oregon. In 1844, the provisional capital moved to Oregon City. In 1846, Great Britain and the United States accepted the 49th parallel as the dividing line between what is now Canada and the United States. The whole region was called, at that time, the Oregon Country. In 1849, a territorial government was formed and in 1850 the territorial legislature passed an act making Salem the Capital. However, it was not until 1864 that Salem actually became the state capital by popular vote.

Photo I-2 News reaches Salem that Oregon has been admitted as a state. State Capitol mural. (O. S. Hwy. Photo)

On February 14, 1859, Congress ratified the Oregon State Constitution and granted statehood to Oregon.

WATER AND RELATED LAND RESOURCE DEVELOPMENT

The gradual growth of settlements produced a demand for lumber, and in 1827 the first sawmill was established in the Pacific Northwest. Within 5 years, lumber production increased enough to enable the first export of lumber from Oregon.

In 1838, Dr. McLoughlin erected a sawmill at Oregon City, using a water wheel for power. Fifty years later, the Willamette Falls Electric Company was incorporated to harness the energy of Willamette Falls by water wheels driving electric dynamos. On June 3, 1889, street lighting circuits in Portland were lighted by electricity generated at the falls and transmitted to Portland by one of the Nation's first long distance (14 miles) transmission lines.

The demand for navigation mounted in the 1800's. In 1836, the Hudson's Bay Company introduced the first steamboat to the lower Willamette River. Four years later, in 1840, flatboats were operating above Willamette Falls and the first exportable surplus livestock was produced. A year later, the first shipments of butter, cheese, and hides were made to Russians in Alaska and to England.

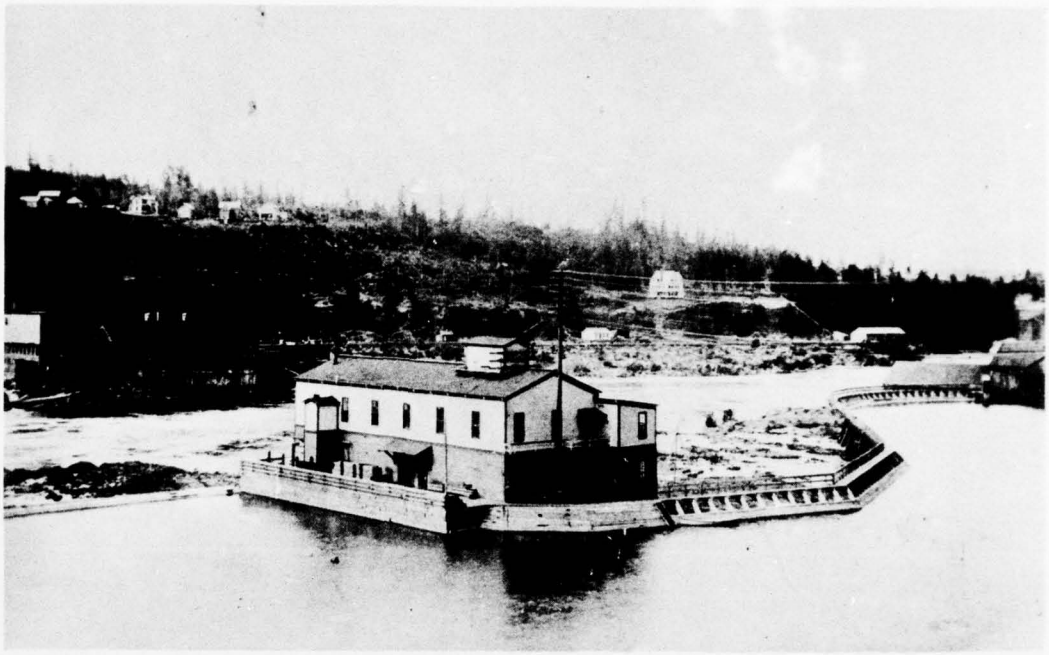


Photo I-3 The Willamette Falls at Oregon City was the site of the first hydroelectric plant in Oregon. (O. S. Library Photo)

From the outset, the basin's development reflected the impact of forest and agricultural products, and water for power and transportation. Navigation was supplemented later by rail connections to the east and by transcontinental highways. These are still important factors in the basin's development.

By the mid-1930's, the need for flood protection had become evident. Individual and small-group cooperative efforts to control floods, through construction of dikes and levees, were bolstered in 1938 when Congress authorized the Willamette Basin Project substantially as recommended in H. D. 544, 75th Congress, 3d Session. Additional elements have been added to the project as the result of subsequent studies. The present system of multiple-purpose reservoirs is described in Table III-3 of this appendix. Part II of the Flood Control Appendix describes these projects, plus the bank revetment and channel works.

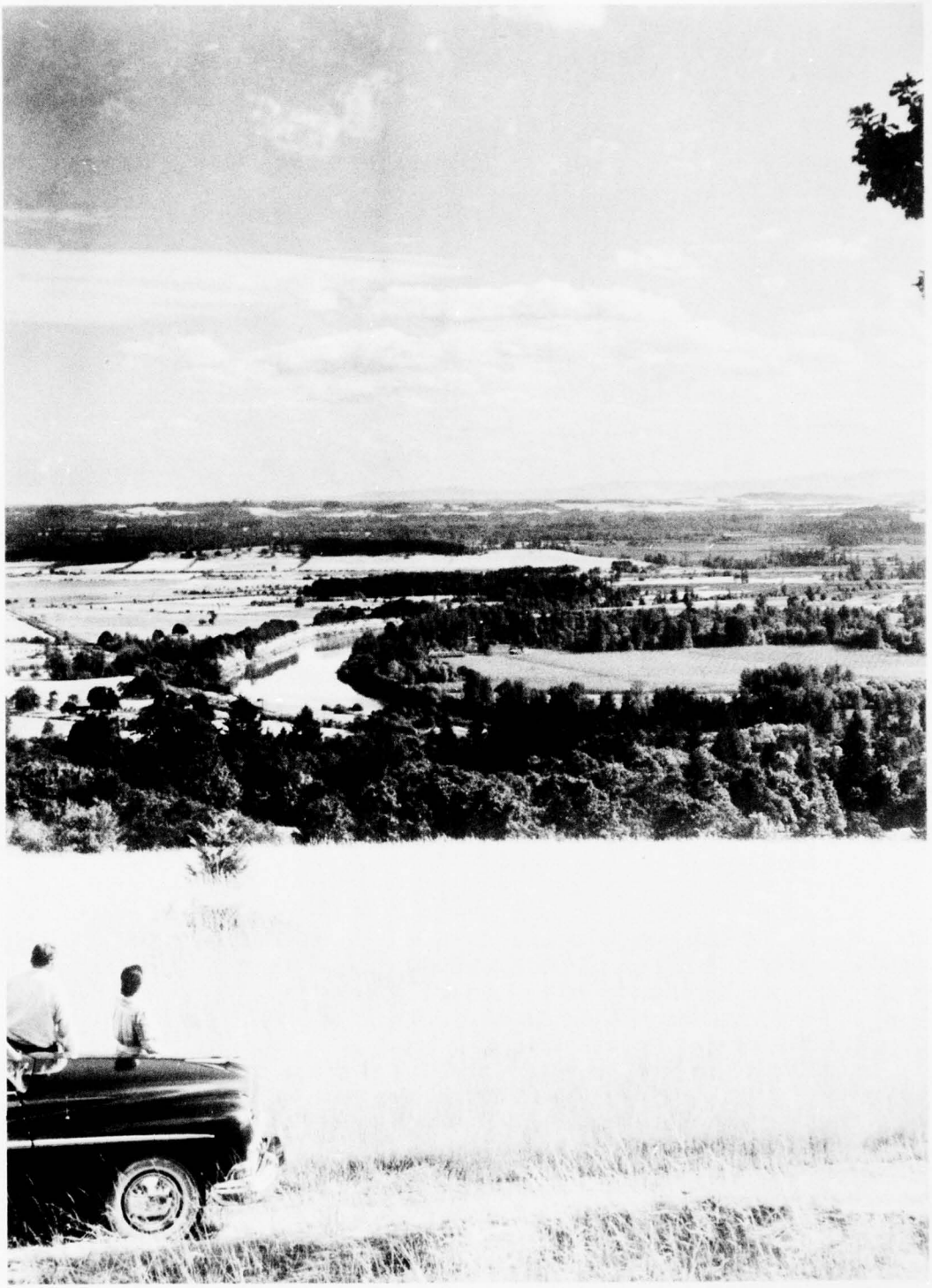


Photo I-4 The Willamette Basin as seen from Bunker Hill southwest of Salem. (O. S. Hwy. Photo)

BASIN DESCRIPTION

BASIN DESCRIPTION

GENERAL

The Willamette River and Sandy River drainages encompass 12,045 square miles in northwestern Oregon. This represents about one-eighth of the State's total area of 96,248 square miles. Oregon, in turn, represents about one-fortieth of the continental United States.

The basin is roughly rectangular in shape, with a north-south dimension of about 150 miles and an average width of 75 miles. It is bounded on the east by the Cascade Range, on the south by the Calapooya Mountains, and on the west by the Coast Range. The Columbia River from Bonneville to St. Helens forms the northern boundary of the area. Elevations range from less than 10 feet (mean sea level) along the Columbia to 400 feet on the valley floor at Eugene and over 10,000 feet in the Cascade Range. The highest elevation attained by the Coast Range is slightly over 4,000 feet. The basin includes all or major portions of Benton, Clackamas, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill Counties, and minor portions of Columbia, Douglas, Lincoln, and Tillamook Counties.

The valley floor, about 30 miles wide, is approximately 3,500 square miles in extent and lies below an elevation of 500 feet. It is nearly level in many places, gently rolling in others, and broken by several groups of hills and scattered buttes. The lower valley is bounded by a range of low hills through which the Willamette River flows to join the Columbia River.

In this study, the basin is divided into three major sections, referred to as Upper, Middle, and Lower Subareas (see frontispiece). Each Subarea has a city designated as a Standard Metropolitan Statistical Area, which serves as the focal point for economic activity. The Upper Subarea includes all lands which drain into Willamette River above the lower mouth of Long Tom River. The Upper Subarea is the site of the major part of the forest products industry. The Middle Subarea includes all lands which drain into Willamette River between the lower mouth of Long Tom River and Fish Eddy, a point 3 miles below the mouth of Molalla River. The Middle Subarea has a significant agricultural base. The Lower Subarea includes all lands which drain into Willamette River from Fish Eddy to the mouth of Willamette River and direct drainage into Columbia River between Bonneville and St. Helens. The Lower Subarea is dominated by the influence of the city of Portland.

Each subarea has one major center of population. Portland is the major population center of the Lower Subarea and of the state. Salem, the state capital, is the largest city in the Middle Subarea, ranking third in the state and in the Willamette Basin. Eugene is the major city in the Upper Subarea, ranking second in the basin and state.

For detailed study, the 3 subareas are further divided into 11 subbasins as shown on the frontispiece and listed in Table II-1.

Table II-1
Areas of Willamette Basin, by Subbasins

	Subbasin	Acres	Square Miles	Percent of Basin
1	Coast Fork	425,400	665	6
2	Middle Fork	866,400	1,354	11
3	McKenzie	859,100	1,342	11
4	Long Tom	336,800	526	4
	Upper Subarea	2,487,700	3,887	32
5	Santiam	1,561,600	2,440	20
6	Coast Range	1,148,200	1,794	15
7	Pudding	759,100	1,186	10
	Middle Subarea	3,468,900	5,420	45
8	Tualatin	455,100	711	6
9	Clackamas	649,000	1,014	8
10	Columbia	275,800	431	4
11	Sandy	372,500	582	5
	Lower Subarea	1,752,400	2,738	23
	Total	7,709,000	12,045	

The Willamette River forms at the confluence of its Coast and Middle Forks near Springfield. It has a length of approximately 187 miles, and flows northward in a braided, meandering channel for a distance of 133 miles. Through most of the remaining 54 miles, it flows between higher and more well-defined banks unhindered by falls or rapids, except for the basaltic intrusion which blocks the valley at Oregon City and creates Willamette Falls. The section below the falls is subject to ocean tidal effects which are transmitted through the Columbia River.

Most of the major tributaries of the Willamette River rise in the Cascade Range at elevations of 6,000 feet or higher and enter the main stream from the east. The Coast Fork Willamette River rises in the Calapooya Mountains, and numerous smaller tributaries rise in the Coast Range and enter the main stream from the west.

C L I M A T E

The Willamette Basin is characterized by dry, moderately warm summers and wet, mild winters. The average annual precipitation over the entire basin is approximately 63 inches, of which about 70 percent occurs during the months of November through March, 5 percent during the three summer months June, July, and August, and the balance during April, May, September, and October. The mean annual precipitation exceeds 200 inches over small areas in the Coast Range, decreasing to approximately 40 inches near the center of the valley floor, and thence gradually increasing to more than 130 inches over portions of the Cascade Range.

Temperatures of the basin are usually mild. Normal variation between the winter and the summer average is small, ranging at lower elevations from about 38 degrees Fahrenheit (°F.) in January, to 67° F. in July. Minimum temperatures rarely drop below zero and maximums seldom exceed 100 degrees. Temperature usually decreases at the rate of 3 to 5° F. per 1,000 feet of elevation. Table II-2 gives temperature data for representative stations in the Willamette Basin.

Table II-2
Temperature Data for Representative Basin Stations

Station	Elev. feet	Period of Record Years*	TEMPERATURE IN °F Annual Mean	Jan. Mean	July Mean	Max.	Min.
Eugene WB Airport	359	25	52.5	39.1	66.6	105	- 4
Oakridge	1,275	43	50.4	38.3	65.6	112	- 3
Portland WB Airport	21	24	52.9	38.4	67.2	105	- 2
Salem	196	72	52.4	38.5	66.1	108	-10
Vernonia	805	21	49.3	36.3	61.8	106	- 8

* *Based on U. S. Weather Bureau data through 1964*

Over the valley floor, the average growing season is a little over 200 days, decreasing to approximately 150 days at the 1,000-foot level. At the highest levels in the Cascades, frost may occur during any month of the year. Table II-3 shows average freeze data for selected stations in the valley.

Table II-3
Freeze Data for Selected Stations

Station	Period of Record Years*	Freeze Data 32° F. (Mean Dates) Last Occurrence in Spring	First Occurrence in Fall
Forest Grove (near Portland)	39	April 26	October 18
Salem	38	April 14	October 27
Eugene	39	April 9	October 31

* *Based on U. S. Weather Bureau data through 1964*

Surface winds are generally light to moderate. A notable exception to this was the violent Pacific storm which moved inland on Columbus Day of 1962. Gusts of over 90 miles per hour (MPH) were recorded at Salem and winds exceeded 100 MPH in the Portland and Corvallis areas. The prevailing direction of the winds during the summer is from the north to northwest, becoming west or southwest during the winter. Occasional gale-force east winds occur in the Columbia Gorge, particularly in the winter months.

Cloudiness is prevalent and relative humidity is high during the winter months. The percentage of possible sunshine experienced ranges from 20 percent in December to 65 percent in July and August. Fog rarely occurs in Willamette Valley during the summer months, but is common from October through February. Hail, thunderstorms, and sleet occur infrequently and seldom reach destructive proportions. A more detailed description of the basin's climate is presented in Appendix B - Hydrology.

PHYSIOGRAPHY

The Willamette Basin is composed of three distinct physiographic units: (1) Willamette Trough, (2) Coast Range, and (3) Cascade Range. These units, all oriented north-south, are integral parts of physiographic provinces extending far beyond the confines of the basin. The Willamette Trough lies between the two ranges (Figure II-1).

WILLAMETTE TROUGH

The Willamette Trough is bordered by the Coast Range, Calapooya Mountains, Cascade Range, and Columbia River. In its southern half, the Willamette Trough is a large, flat plain, broken only by isolated buttes. In its northern half, the trough is interrupted by east-west trending ridges that extend out, as salients from the mountains, across the valley floor. The intervening ridges or hills are the Salem-Eola Hills, the Chehalem Mountains, and the Portland Hills (Tualatin Mountains).

Roughly 30 percent of the Willamette Basin, or about 3,500 square miles, lies within the Willamette Trough. The trough is about 125 miles long, extending from Cottage Grove to Portland. It is up to 30 miles wide where lowland embayments extend up tributary valleys, as at Brownsville, but narrows to less than 1 or 2 miles wide where Willamette River cuts through the intervening ridges, as at Salem and Oregon City.

The Willamette Trough can be divided into four separate lowlands: (1) Southern Willamette Valley, (2) Northern Willamette Valley, (3) Tualatin Valley, and (4) Portland Basin. In general, each of these lowlands contains a main valley plain, remnants of at least one higher terrace, isolated hills or buttes within the plain, and incised trenches occupied by streams.

The general slope is northward in most of the Willamette Valley, but southeastward in the Tualatin Valley and westward in the Portland Basin. The elevation of the Willamette Valley floor is about 400 feet near Eugene, decreasing more or less evenly to about 150 feet near Champoeg; average elevation in both the Tualatin Valley and the Portland Basin is about 200 feet.

Southern Willamette Valley

The main valley plain in the Southern Willamette Valley begins near Eugene at an elevation of about 400 feet and extends northward about 60 miles to the Salem-Eola Hills, where its elevation is about 200 feet. The Willamette River flows north along the western part of the plain in a trench from 1 to 4 miles wide. This trench is just a few feet below the plain near Eugene but progressively deepens to nearly 50 feet below the plain at Albany. The Willamette River meanders within the trench, and many abandoned channels, oxbows, and other

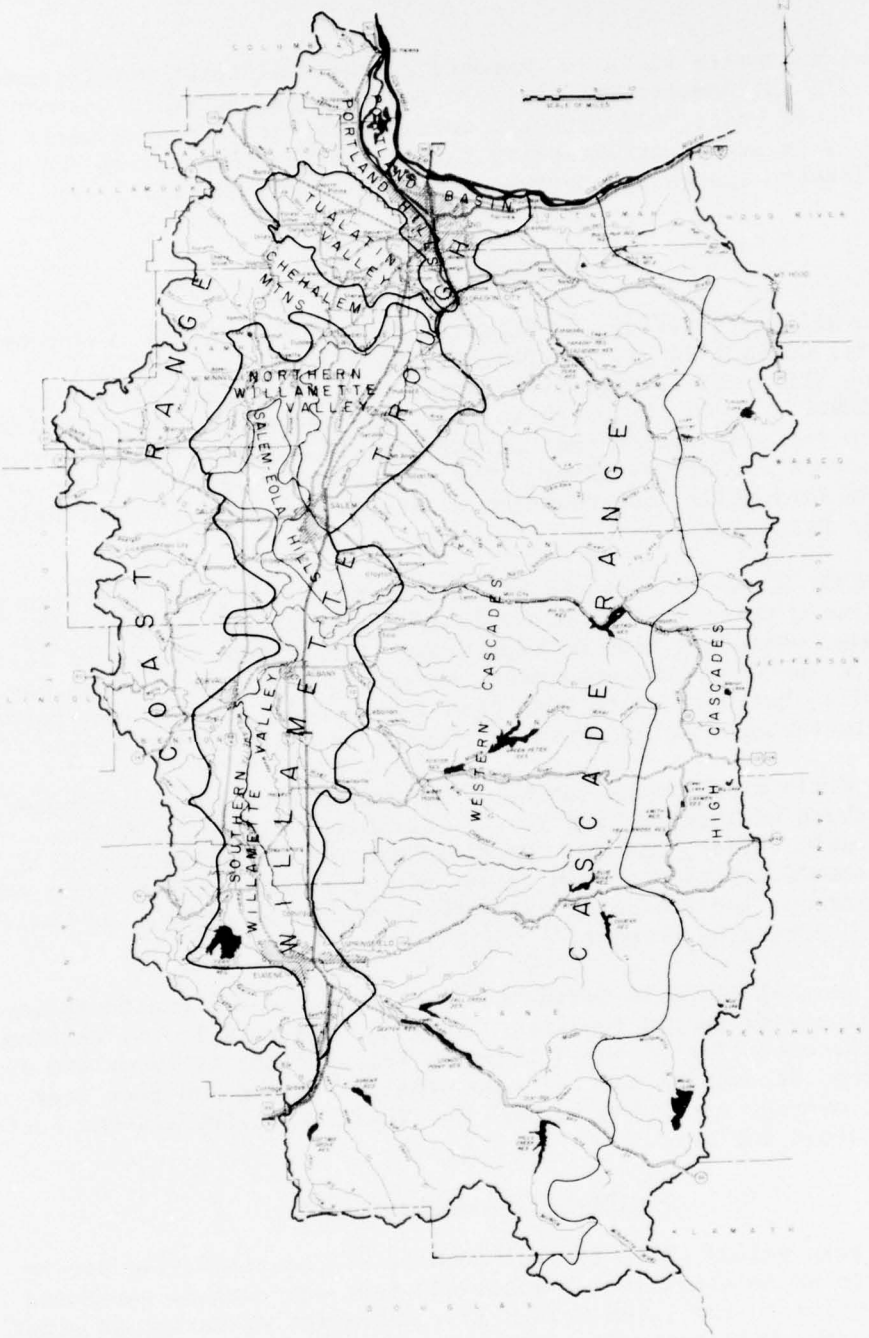


Figure II-1 Physiographic Subdivisions

Photo II-1 Willamette Valley north of Eugene. (Delano Photo)

flood-plain topographic features have formed on the lands immediately adjacent. On both sides of the Willamette trench, the main plain is occupied by braided, intermittent streams, in low swales. East of the trench, the plain is formed by a series of broad, interlaced alluvial fans.

Gravel-veneered terraces or pediments lying slightly higher than the main valley plain occur near the entrances of the South Santiam, Marys, and Long Tom Rivers. In addition, isolated buttes or hills are common east of the Willamette River, with Knox, Peterson, and Ward Buttes the most prominent.

The Southern and Northern Willamette Valleys are separated by the Salem-Eola Hills. Throughout the 25-mile reach of Willamette River between the mouth of the Santiam River and Salem, much of the main valley plain has been eroded away by the Willamette, which presently meanders in the broad, deeply entrenched flood plains.

Northern Willamette Valley

The Northern Willamette Valley extends north from the ridge of intervening hills south and west of Salem to the Chehalem Mountains and to Oregon City. French Prairie is the largest expanse of valley plain. Broad extensions of the valley floor also reach up the valleys of the North and South Yamhill Rivers. The main valley plain for the most part lies between 150 and 250 feet in elevation.

The Willamette River flows past French Prairie in a trench 1 to 4 miles wide and cut 50 to 100 feet below the valley plain. Several smaller tributaries drain the prairie. In contrast to the tributaries draining the valley floor in the Southern Willamette Valley, these streams are more deeply entrenched (up to 100 feet) in steep-walled but flat-floored valleys, as the Pudding River. Most of them flow northeastward, following the gradual slope of the plain. Divides between the tributaries are generally broad and lack relief, especially several large areas both west and east of the Willamette River trench between Salem and Newberg which lack even local stream-valley relief.

Extensive areas of terraces lie along the foothills on both sides of the valley and adjacent to the Molalla River. Isolated hills or buttes are also found; the largest, Mount Angel, rises 285 feet above the plain.

Tualatin Valley

The Tualatin Valley is separated from the other lowlands by the Chehalem Mountains and the Portland Hills. It is connected to the Willamette River Valley by two gaps, each less than 2 miles wide, the Tualatin River flowing through one and Lake Oswego occupying the other.

The Tualatin Valley is about 30 miles long and 10 miles wide, the longer dimension oriented northwest-southeast. It surrounds the Cooper-Bull Mountain highland, a domelike mass covering about 20 square miles near the center of the valley. The valley floor averages about 200 feet in elevation, but ranges from 120 to 250 feet. Narrow segments of the plain extending up tributary valleys slope more steeply than the main part of the valley.

The Tualatin River and its tributaries follow sinuous courses in entrenched valleys. In the western part, stream valleys are incised about 20 feet below the main plain, but in the southeastern part moving toward the mouth of the Tualatin River, the valley progressively deepens to 30-40 feet. On the Tualatin Valley's western edge, the frontage with the flanking hills is a sharp break in slope. In its eastern part, the alluvial lowland is rolling; and the change in slope between it and the surrounding hills is less abrupt.

Portland Basin

The Portland Basin, lying north of Oregon City and east of the Portland Hills, is bounded by the Willamette and Columbia Rivers and the rolling foothills of the Cascade Range.

It is comprised of a main valley plain, entrenched flood plains of the Willamette and Columbia Rivers, and terraces. The valley plain ranges in elevation from about 150 feet in north Portland to about 250 feet where it overlooks the Sandy River, east of Gresham. In contrast to the other valley areas, locally the valley plain rolls considerably; and channels have as much as 25 feet of relief. Johnson Creek, one of three perennial streams draining the Portland Basin, derives most of its runoff from the adjacent Boring Hills and skirts the southern boundary. The other perennial streams are Kellogg Creek and its tributary Mt. Scott Creek. Small, intermittent streams drain the escarpments fronting the Willamette and Columbia Rivers.

The flood plains of both the Willamette and Columbia Rivers range from 1 to 2 miles wide and lie 80 to 150 feet below the valley plain. At places, the Willamette River has recently undercut nearly vertical escarpments, as near Swan Island. The Columbia River escarpment is generally smoothly rounded and shows little evidence of recent undercutting.

Photo II-2 The Willamette River cuts through the City of Portland then flows into the Columbia River. (O. S. Hwy. Photo)

COAST RANGE

The Coast Range is the western rampart of Willamette Basin. As well as the long, main range whose summits lie roughly 25 miles inland from the Pacific Coast, the Coast Range also includes hilly and mountainous terrain in an arc lying southwest to northwest of Portland. In all, the Coast Range encompasses about 1,900 square miles--approximately 15 percent of Willamette Basin.

The Coast Range, although fairly low, is locally rugged with steep slopes. Marys Peak (elevation 4,097 feet) is the highest point, and numerous other peaks and sharp ridges attain elevations greater than 3,000 feet. Stream valleys are narrow and rather deep, their side slopes ranging from moderate to steep depending upon the hardness of the rock. The foothills and buttes fronting the Willamette Valley are rounded or rolling.

The major streams range from 26 to 60 miles in length, but their sources are only 10 or 12 miles from the western edge of the Willamette Valley floor. In headwater reaches, the streams have many rapids and waterfalls, but their gradients flatten as they emerge from the mountain front.

Photo II-3 Marys Peak, highest in the Coast Range, as seen from Kings valley. (O. S. Hwy. Photo)

CASCADE RANGE

The Cascade Range occupies about 7,600 square miles--almost two-thirds of Willamette Basin. Included in this province are the east-side tributaries of the Willamette, and the Sandy River, which empties directly into the Columbia River.

The Cascade Range is composed of two topographically distinct sub-provinces: (1) the High Cascades, and (2) the Western Cascades. The boundary between these two parts roughly parallels the summit of the Cascade Range (Map II-1), and is marked in its central portion by a well defined trench containing the upper McKenzie and North Santiam Rivers, and Clear Lake.

The High Cascades, the higher and easternmost part of the range, are a gently inclined plateau, 5 to 10 miles wide and about 130 miles long, with elevations ranging from 3,000 to 5,000 feet. The plateau is surmounted by numerous volcanic cones and mountains, the largest--Mt. Hood, Mt. Jefferson, and the Three Sisters--attaining elevations greater than 10,000 feet.

The Western Cascades, a ridge-and-valley region about 120 miles long, decrease in width from 50 miles in the south to 20 miles in the

Photo II-4 Looking north from Horsepasture Mountain trail into the McKenzie River Valley. (USFS Photo)

north. Elevations range from 300 feet where the foothills rise from the Willamette Valley floor to more than 5,000 feet at the crests of numerous ridges. The master drainage channels, flowing mostly west to northwest, are deeply incised with adjacent ridge tops rising as much as 3,500 feet above the valley floor.

Most of the principal tributaries draining the Cascade Range head in the High Cascades and traverse the Western Cascades for 40 to 80 miles. The upper tributary drainages of most of these streams are U-shaped, evidence that they were carved by glaciers. Some of the upper valleys have been overrun by very recent lava flows. All the major tributaries have rather steep gradients, descending 3,000 to 4,500 feet in their courses. The steepest gradients are in the upper (eastern) part of the Western Cascades where streams drop as much as 1,500 feet in 5 miles.

The principal tributaries with more sustained summertime flows--Middle Fork Willamette, McKenzie, North Santiam, Clackamas, and Sandy Rivers--originate in the High Cascades. Of the other major tributaries South Santiam and Molalla Rivers drain the Western Cascades, and Coast Fork Willamette River drains the Calapooya Mountains. The streams emanating from the High Cascades show 5 to 10 times more runoff per square mile during low flows than those draining the Western Cascades. In the High Cascades, winter snow persists later into the warm months and the highly porous lava gradually yields great quantities of ground water that sustains stream base flows.

G E O L O G Y

Two general types of rock compose the Willamette Basin--(1) volcanic rocks and (2) sedimentary rocks derived mostly from volcanic rocks. All the rocks exposed in Willamette Basin are of Tertiary and Quaternary age--that is, less than 60 million years old.

STRATIGRAPHIC RELATIONS

The oldest rocks in the basin, exposed in the Coast Range, are lava flows and volcanic breccias that are interbedded with marine sandstone and shale. Unconformably overlying these rocks, and partly equivalent in age to the oldest volcanic rocks in the Cascade Range, are marine sedimentary rocks. The latter are overlain by a succession of younger volcanic-and sedimentary-rock units, ending with the stream valley alluvium of Recent Age.

For this report about 50 geologic units, previously described and shown on the Geologic Map of Oregon west of the 121st meridian (Wells and Peck, 1961), have been grouped into 11 units that have distinctive geologic characteristics and hydrologic properties. The stratigraphic relation of these units is shown in the Legend of Map II-1, Generalized Geology. Included also is a brief statement of the potential ground water (well) yield and recharge capability for each unit. The unit locations are shown on Map II-1.

STRUCTURAL FEATURES

The geologic structure of Willamette Basin is oriented north-south, the structural axis roughly paralleling Willamette River. The physiographic provinces--Coast Range, Willamette Trough, and Cascade Range--are also structural provinces. The Coast Range is an anticlinal uplift, the Willamette Trough a sedimentary basin, and the Cascade Range is formed of great thickness of volcanic outpourings. The geologic structure of the basin is shown on Map II-1.

Coast Range

Deformation of the earth's crust has bowed the sedimentary beds and underlying volcanic rocks into a broad anticline. Numerous slumps and slides, and erosional dissection of the uplift have formed the present-day topography of rugged foothills and peaks. The forces of erosion have also removed much sediment from the Coast Range and deposited it on the Willamette Valley floor.

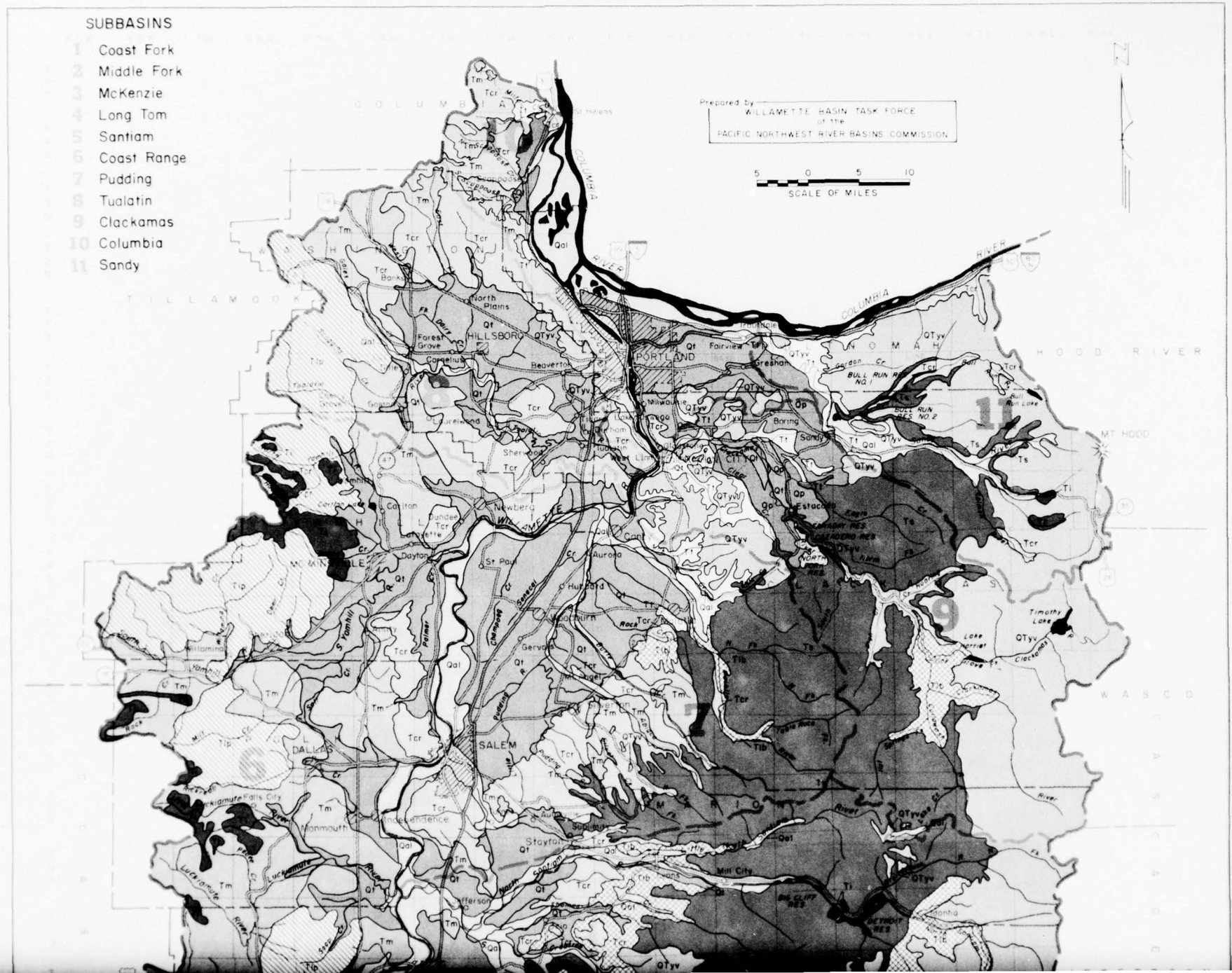
Principal geologic formations in the Coast Range, in order of oldest to youngest, are: Nestucca Formation; Tillamook Volcanic Series; Siletz River Volcanic Series; and the Fisher, Tyee-Burpee, Yamhill,

Photo II-5 The Coast Range comprises the oldest formations of the Willamette Basin. Uplifting & erosion through the ages have resulted in rugged foothills & peaks. (USSCS Photo)

Spencer, Keasey, Eugene, and Scappoose Formations. In addition, basalt and gabbro rocks were intruded into these formations after they were deposited. The Tyee-Burpee and Yamhill Formations together occupy about 60 percent of the Coast Range; the intrusives are exposed over only about 5 percent of this province.

The Coast Range was uplifted during the middle Miocene epoch and, after being eroded to a surface of low relief, was lowered to near sea level in the late Miocene. Rocks of the Columbia River group were then poured out on this planed surface. This group, made up of dark basalt flows up to 1,000 feet thick, persists as the primary rock unit in the northern Coast Range. Following the period of extrusion, the area was again warped upward to approximately its present elevation, accompanied by some minor folding such as the Portland Hills anticline. Following weathering and erosion of the Columbia River group, a thick, structureless, light-brown silt, known as the Portland Hills silt, was deposited on the Portland Hills to depths of 25 to 100 feet.

The areas of sedimentary rock are generally maturely dissected and have numerous slumps and slides. Areas of basic igneous rock are more rugged, steep, convex-sloped, and less dissected than the areas of sedimentary rock because of their greater resistance to weathering. The sills of intrusive rock and the extrusive flows of basalt are resistant to erosion and persist in some areas as gently sloping mountain tops such as Marys Peak.


SUBBASINS
1 Coast Fork
2 Middle Fork
3 McKenzie
4 Long Tom
5 Santiam
6 Coast Range
7 Pudding
8 Tualatin
9 Clackamas
10 Columbia
11 Sandy
Prepared by
WILLAMETTE BASIN TASK FORCE
of the
PACIFIC NORTHWEST RIVER BASINS COMMISSION
5 0 5 10
SCALE OF MILES
PORTLAND
SALEM
HILLSBORO
Forest Grove
Beaverton
Tigard
Lake Oswego
Oregon City
Gresham
Fairview
Troutdale
Milwaukie
Estacada
Sandy
Mt Hood City
Canby
Aurora
Donald
St Paul
Newberg
Dundee
Dayton
McMinnville
Amity
Sheridan
Willamina
Gervais
Monmouth
Independence
Falls City
Dallas
Stayton
Sublimity
Mill City
Lyons
Jefferson
Scio
Lebanon
Sweet Home
Harrisburg
Halsey
Brownsville
Shedd
Albany
Tangent
Scappoose
St Helens
Columbia City
Rainier
North Plains
Cornelius
Banks
Timber
Glaser
Garden Cr
Bull Run Lake
Timothy Lake
Lake Harriet
Detroit Res
Big Cliff Res
Green Peter Res
Foster Res
Hills Creek Res
Lookout Point Res
Dexter Res
Fall Creek Res
Cougar Res
Blue River Res
Trailbridge Res
Fern Ridge Res
Siltcoos River
Siuslaw River
Mohawk River
Long Tom River
Marys River
Calapooia River
Santiam River
North Santiam River
South Santiam River
McKenzie River
Middle Fork Willamette River
Coast Fork Willamette River
Willamette River
Columbia River
Clackamas River
Sandy River
Tualatin River
Yamhill River
Pudding River
Molalla River
Rock Creek
Scoggins Cr
Chehalem Cr
Palmer Cr
Abiqua Cr
Thomas Cr
Crabtree Cr
Thompson Cr
Lucktamute River
Santiam Canal
Qal
Qt
Qp
QTyv
Tcr
Tm
Tib
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Ts
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Tcg
Tcp
Tcb
Tmsc
Tmsr
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Tmsdd
Tmsee
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Tmsbbb
Tmsccc
Tmsddd
Tmseee
Tmsfff
Tmsggg
Tmshhh
Tmsiii
Tmsjjj
Tmskkk
Tmslll
Tmsmmm
Tmsnnn
Tmsooo
Tmsppp
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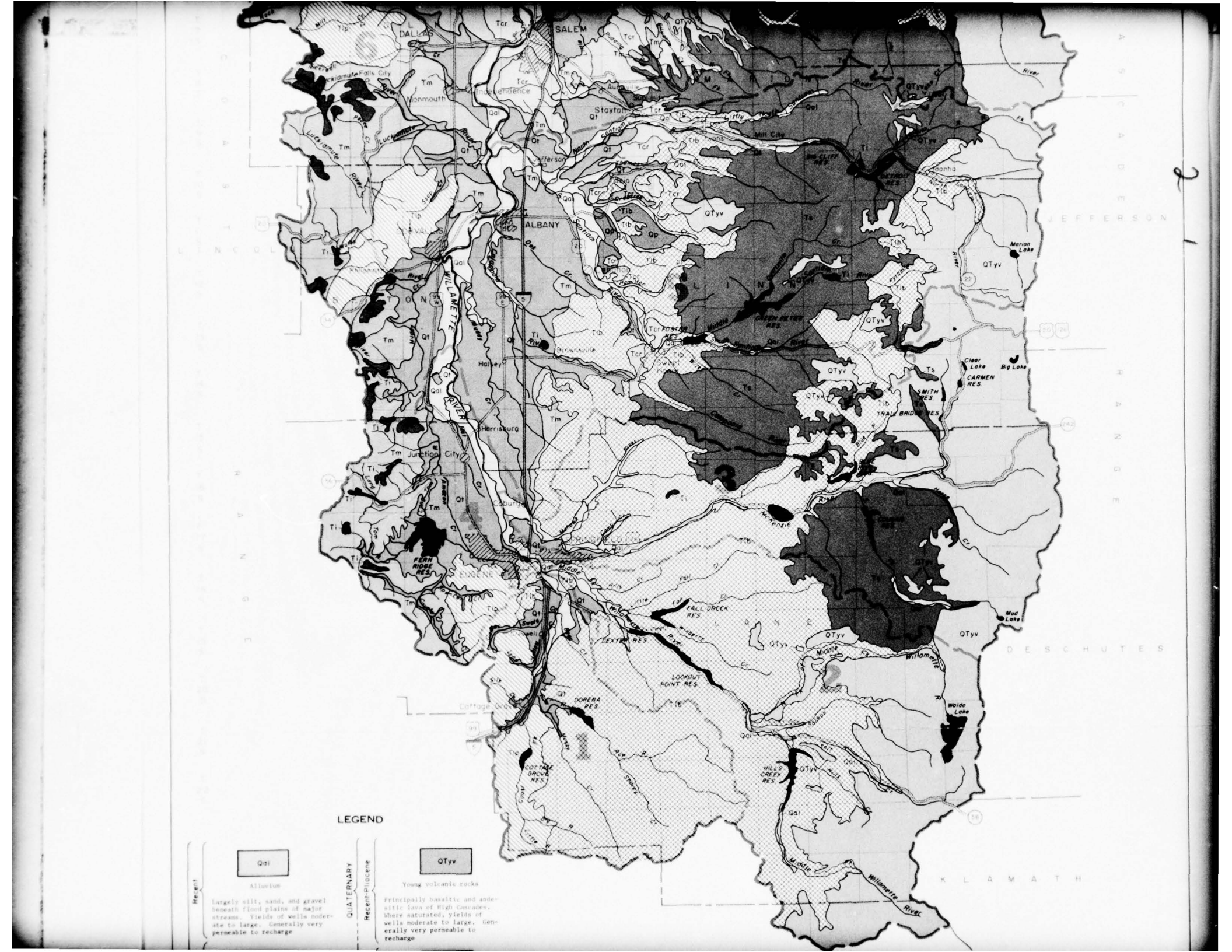

SALEM
ALBANY
Halsey
Harrisburg
Junction City
Stayton
Mill City
Lebanon
Sweet Home
Marion Lake
Clear Lake
Big Lake
Mud Lake
Waldo Lake
Detroit Res.
Big Cliff Res.
Green Peter Res.
Foster Res.
Smith Res.
Trail Bridge Res.
Fern Ridge Res.
Fall Creek Res.
Lookout Point Res.
Dorena Res.
Cottage Grove Res.
Hills Creek Res.
Willamette River
LEGEND
Qal
Alluvium
Largely silt, sand, and gravel beneath flood plains of major streams. Yields of wells moderate to large. Generally very permeable to recharge
QTyv
Young volcanic rocks
Principally basaltic and andesitic lava of High Cascades. Where saturated, yields of wells moderate to large. Generally very permeable to recharge
QUATERNARY
Recent
Recent-Pliocene

WBT-O-10016bb-LL

LEGEND

QUATERNARY — Recent

Qal — Alluvium

Largely silt, sand, and gravel beneath flood plains of major streams. Yields of wells moderate to large. Generally very permeable to recharge

QUATERNARY — Pleistocene

Qt — Terrace deposits

Silt, sand, and gravel; regularly to lenticularly bedded. Yields of wells small to large where saturated. Variably permeable to recharge

Piedmont deposits

Predominantly residual clay from weathered volcanic mudflow and sand and gravel. Yields of wells small where saturated. Poorly to moderately permeable to recharge

TERTIARY — Pliocene

Tt — Troutdale Formation

Conglomerate, sandstone, siltstone. Yields of wells from more permeable beds moderate to large. Permeable to recharge

QUATERNARY — Recent-Pliocene

QTyv — Young volcanic rocks

Principally basaltic and andesitic lava of High Cascades. Where saturated, yields of wells moderate to large. Generally very permeable to recharge

TERTIARY — Miocene

Sardine Formation

Andesitic lava, breccia, tuff. Yields of wells small. Moderately permeable to recharge

Tcr — Columbia River Group

Basaltic lava flows. Yields of wells in scoriaceous rubbly zones small to large. Moderately permeable to recharge

Intrusive rocks

Undifferentiated Tertiary intrusive rocks. Dense rock not known to yield water to wells

TERTIARY — Miocene-Oligocene

T(t) — Little Butte Volcanic Series

Tuff, breccia, basaltic andesite, basalt. Yields of wells generally small. Moderately to poorly permeable to recharge

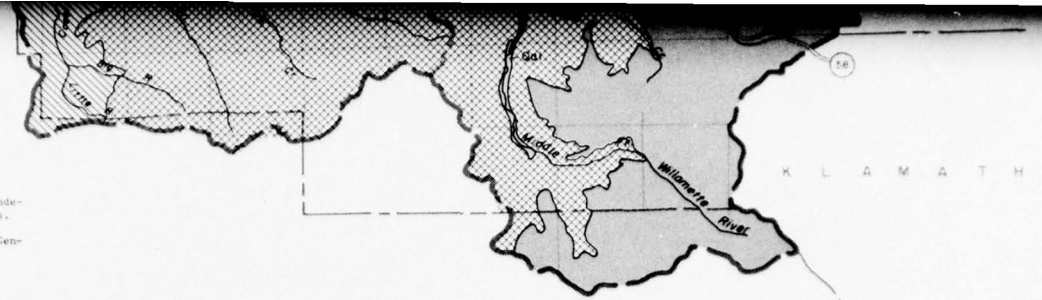
TERTIARY — Oligocene-Eocene

T(p) — Lavas, interbedded pyroclastic and sedimentary rocks

Basalt, andesite, tuff, interbedded with marine shale and sandstone. Yields of wells small. Generally poorly permeable to recharge

Tm — Marine rocks

Poorly permeable sandstone, shale, and mudstone. Yields of wells generally small; saline water in deeper zones. "Dry holes" common locally. Generally poorly permeable to recharge



MAP II - 1

WILLAMETTE BASIN STUDY

OREGON

GENERALIZED GEOLOGY

1967

6 0 6 12

SCALE IN MILES

2

Willamette Valley Trough

Coincident with the anticlinal upsweep in the Coast Range, the formations underlying the Willamette Valley trough were downfolded, forming an elongated basin (Willamette syncline) which has subsequently been filled with sediments from the Coast and Cascade Ranges. Bedrock is not generally exposed in the Willamette Valley; however, well logs have shown that the sedimentary formations exposed along the Coast Range are present beneath the valley alluvium. These formations probably interfinger with formations of equivalent age in the Cascade Range. In the northern portion of the valley, several large areas are covered with erosional remnants made up of Columbia River basalt. These remnants form prominent topographic features, such as the Chehalem Mountains and the Salem and Eola Hills.

During the late Pliocene and much of Pleistocene time (within the past 5 million years or less), there were at least three different actions which affected the basin's geology--uplift, glaciation, and deglaciation. Uplift, with associated erosion, caused cutting of the streams and alluviation of the valleys. Glaciation lowered the sea levels and stream cutting occurred as ice accumulated on the land. Deglaciation resulted in drowned streams, stream-cut terraces, and alluviation.

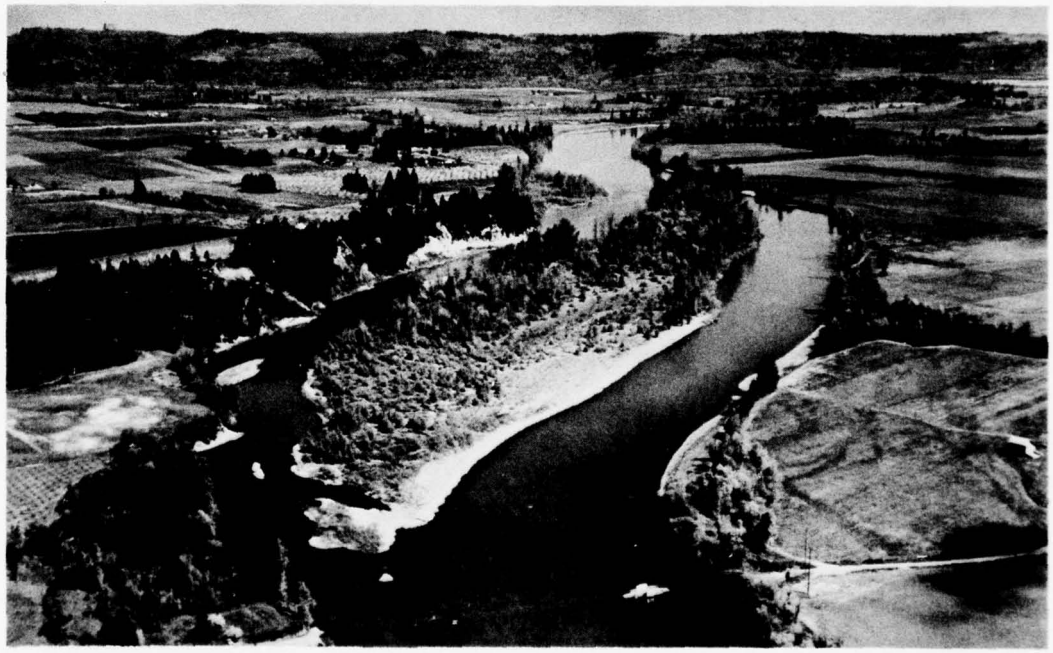


Photo II-6 Willamette River South of Salem Hills

Cascade Range

At least 7,500 feet of lava flows and pyroclastics (solid material ejected explosively from volcanic vents) and a small amount of marine sedimentary rocks are found in the Cascade Range.

Principal formations in the Western Cascades, in order of oldest to youngest, are: the Columbia River Group, previously mentioned; the Sardine Formation, composed of andesitic lavas and pyroclastics; and the Troutdale Formation, composed of coarse sandstone and conglomerate derived from erosion of the volcanic areas.

The High Cascades are made up of young volcanic lava flows believed to be of Pliocene to Recent age (12 million years ago to the present). These rocks, basaltic and andesitic, were erupted from central volcanic vents mostly lying within the area where the rocks are now exposed. Outliers of this formation (known as the Boring Lava) are exposed in the foothills near Portland.

Where exposed, the older flows are weathered to a reddish brown, rocky clay soil. The younger flows are not decomposed and have retained much of their surficial flow features, as exemplified in the vicinity of Clear Lake on the upper McKenzie River.

Studies conducted in the area indicate that soils such as Hambone, Denzer, Sisi, and Carpenter may be typical. A few series, of which McCully and Kinney may be typical, have been identified.

Photo II-7 Lava flow formation on the west slopes of Mt. Washington near headwaters of the McKenzie River. (OSG & MI Photo)

S O I L S

The purpose of this section is to briefly describe the soils in the Willamette Basin and to summarize their physical properties. More detailed information concerning agricultural and forestry uses is found in the Land Measures and Watershed Protection, Irrigation, and Hydrology Appendices.

MOUNTAIN RANGES

In the higher elevations of the Coast Range, soils were formed mostly on marine sedimentary rock under high rainfall and a coniferous forest cover.

In limited areas, similar soils developed from intrusive and extrusive volcanic rock. These are very porous, strongly acid soils with dark surface horizons high in organic matter. Subsoils are moderately fine or fine textured brown, and structurally porous. Bedrock is often deeply weathered. Soils on steep slopes are often unstable and mass soil movement is common. Variable amounts of coarse rock fragments may occur throughout the profile. Astoria and Bohannon are representative soil series.

On the western slope of the Cascade Range, soils were formed on dominantly steep slopes over various types of volcanic material and, at a few places, over glacial drift. Development was influenced by heavy snow and rainfall and a coniferous forest cover. The soils are generally weakly developed, dark colored, highly acid, stony, and porous. At higher elevations (above 3,500 feet), surface soils are thin and accumulations of iron oxide give a brownish color to the subsoil.

In both the Coast Range and the Cascades, there is little or no surface erosion in forested areas where the vegetative cover has not been disturbed. Erosion, however, can be serious for a few years following the removal of cover by fire or logging operations. In either case, runoff from comparatively small areas can contribute a substantial sediment load, especially the first year after disturbance. Productivity of the eroded soil likewise can be impaired.

Most of the surface soils in the mountainous areas absorb water rapidly and have relatively high water-holding capacity. Nevertheless, a high percentage of winter precipitation runs off quickly regardless of cover because of shallow soil depth, the presence of a restrictive subsoil or impermeable bedrock, and predominantly steep slopes. An important exception are those soils overlying porous volcanic rocks in parts of the Cascades.

Periodic saturation of surface and subsurface soils over impervious soils or bedrock leads to mass soil movement on sloping sites.

This phenomenon is quite general in the Coast Range area, but is less common in the Cascades. Major soil disturbance caused by road building or other excavations can aggravate the slippage problem.

FOOTHILLS

This section includes the foothills of the Coast and Cascade Ranges and the outlying Salem and Eola Hills. In the northern part of the valley, foothills of the Coast Range and the Cascades extend in some localities across the valley floor to near the Willamette River. At higher elevations, soils were formed under conditions of a coniferous forest cover and heavy precipitation. Soils in the lower elevations adjacent to the valley floor were largely formed under mixed hardwood forest interspersed with open prairies. In the intermediate elevations, soils were formed under various combinations of coniferous forest, hardwoods, and open prairies.

Most of the higher elevation foothills are forested. The lower foothills are primarily used for agricultural purposes, but include substantial areas of forest land, particularly on steep slopes and on soil too stony or otherwise unsuited for agricultural use.

Photo II-8 Typical foothill soils; Willakenzie on the far hills, Steiwer under the grass and oak on the right, and plowed Hazelair on the left. (USSCS Photo)

At the higher elevations, well developed soils overlie sedimentary or, in limited areas, basic volcanic rock. These soils have thin, moderately dark surface horizons and are acid with moderately fine textured reddish brown subsoils; Peavine is a typical series. At lower elevations, soils are similar except that they are generally less acid and subsoils are moderately fine, with only moderate depth; Willakenzie is a typical series. On the lower foothill slopes adjacent to the valley floor, prairie-like soils occur; Steiwer is a typical series. These soils have less horizon development and are browner than soils in the Willakenzie group. Soil depths at all elevations range from less than a foot to many feet, often within small localized areas.

In the northwest part of the basin, the foothills around the Tualatin Valley are covered by a mantle of silt; Laurelwood and Cascade soils are typical series. These soils are usually deeper than Willakenzie, Peavine, or Steiwer and have substantially less clay and more silt in the surface soil.

The Cascade foothills extend eastward from the outlying Eola and Salem Hills and rise gradually toward the west slope of the Cascade Range. The topography is gently sloping except for steep slopes adjacent to streams. Soils are commonly developed from deeply weathered tuffs and basic igneous rocks. Surface soils are commonly reddish brown, moderately acid, and high in clay. Subsoils are strongly acid and high in clay. Jory and Nekia are typical series. To the south, in Linn County, soils similar to those described for the Coast Range foothills are found over sedimentary rock.

As in the Coast Range foothills, soils to the north have been covered by a mantle of silt; Cascade is a typical series. At higher elevations in the forested area, reddish, clayey, strongly acid soils derived from volcanic debris and lava flows are common, McCully being a typical series.

Despite steep slopes and heavy rainfall, surface erosion generally is not a serious problem in the foothill area. The well-developed soil structure favors water infiltration and resists erosion. Most of the soils have a high clay content except soils developed from the silt overlying the northern portion of the valley.

In the forest areas, runoff waters from heavy rainfall carry practically no sediment except where the cover has been destroyed by logging or fire. Sediment loads can be heavy if the surface is badly disturbed, especially the first season after disturbance. There is little observable erosion from natural or artificially seeded grass lands.

Farming methods adopted in the area during the past 30 years have greatly reduced erosion, except in localized areas. Cropping patterns provide protective vegetative cover during the winter months. Substantial acreages of winter annuals and annual grass and legume crops, perennial forage crops, and winter grain are grown. Much of the basin's

tree fruit and nut crop is produced on hill land. These orchard areas, almost without exception, are protected by winter cover crops.

Localized areas, especially in the north end of the valley, devoted to the production of strawberries, cane fruits, and annual row crops are subject to severe erosion. Losses can be especially severe in the silt overlay areas.

Despite the favorable water absorption qualities of the surface soils and the general presence of a good vegetative cover, water usually runs off rapidly from the Willamette Basin hill lands during heavy rainy periods. On steep slopes, saturated surface and subsoils overlying clay or certain bedrock formations are subject to mass slippage. The slippage can be aggravated by road building or other excavation.

TERRACES AND FLOOD PLAINS

The main Willamette Valley floor includes broad areas of nearly level to gently sloping land, interrupted here and there by outlying foothills. The major part of the area is often termed the Willamette Silt terrace, thought to be a lacustrine deposit of the late Pleistocene Age. This terrace is dissected by the Willamette River and its tributaries, with recent alluvial flood plains and lower terraces lying at varying elevations below the main terrace level. In several locations, there are remnants of gravelly terraces much older than the valley floor terrace. These older terraces occur along the margins of the valley at slightly higher elevations.

Soils of the valley floor terrace developed under a grass cover with intermingled areas that developed under mixed hardwood forest. These soils have well developed profiles with characteristics varying according to natural drainage. Hillsboro and Willamette are examples of well drained soils which have no restrictions to root penetration or to the downward movement of water. These soils are limited in area.

Woodburn is the most extensive series in the valley. It is moderately well drained. Soils of the Amity series are second to Woodburn in extent. Amity subsoils are mottled below the 15-inch depth, indicating they are naturally saturated near the surface during the winter months. However, the texture and structure of the subsoil is such that properly installed tile can virtually eliminate the drainage problem. Intermingled with the Woodburn and Amity soils are areas of poorly drained soils belonging to the Dayton and related series that are difficult to reclaim with tile drainage. These poorly drained soils occur throughout the valley, though they typify extensive areas in the southern part of the valley, particularly in Linn and Benton Counties.

Most of the soils of the Willamette terrace naturally had a medium acid reaction. However, in many localized areas the reaction has been markedly changed by the removal of bases through years of cropping, by heavy applications of fertilizer, and by applications of liming material.

The recent alluvial flood plains and terraces include soils with characteristics determined by the source of the water laid material and type of deposition. The degree of drainage and susceptibility to seasonal flooding determine use capabilities.

Under natural conditions, the Newberg series is subject to frequent floods. It is underlain with a sandy subsoil that causes excessive drainage and limits its water-holding capacity. The Chehalis and Cloquato series are less subject to natural flooding than the Newberg. Both soils are underlain with subsoils which have excellent natural drainage along with good moisture-holding capacity.

The Maytown and Wapato series are likewise subject to occasional flooding. Both require artificial drainage, which is feasible because of favorable subsoil characteristics. In addition to being subject to major floods, the Wapato series is subject to inundation from local floods and ponded surface water. Usually associated with the Wapato are other poorly drained soils with tight clay subsoils that make drainage reclamation difficult. Bashaw has a heavy clay surface soil overlying a heavy clay subsoil; artificial drainage is not effective on this series.

Photo II-9 Typical flood plain soils are Chehalis-Cloquato-Newberg, pictured here extending from the Ash & Douglas-Fir growing on the banks of the Willamette River. (USSCS Photo)

Most soils of the recent flood plains and terraces are naturally medium acid in reaction. However, much of the area has been intensively farmed, often resulting in substantial changes in reaction.

Erosion from rainfall is generally not a problem on the valley floor soils, though there are some important local exceptions. The gently sloping or flat topography of the valley floor breaks to moderate or steeper slopes adjacent to stream channels. Included in the sloping areas are minor percentages of the Willamette, Woodburn, Hillsboro, and Salem series. Erosion can be serious, but only when the soils are left unprotected during the winter.

The soils of the older terraces are usually associated with the sloping topography and erosion is a problem if they are unprotected during the rainy season. Included are soils of the Veneta, Courtney, and Salkum series.

In a geographically separate terrace adjacent to the Columbia and Sandy Rivers in Multnomah County, moderate slopes are common, with localized areas of steeper slopes. The Powell series common to this area is quite erosive and requires special management measures to control erosion unless devoted to some type of permanent cover.

With the recent alluvial soils, surface and channel erosion resulting from stream overflow can be serious, depending on location, type of cover, and the nature of the overflow. Soils of the Newberg series are quite often exposed to erosion from overflow. Soils related to the Chehalis series lie at somewhat higher elevations and are less frequently subjected to erosive overflow. Wapato and related soils are ordinarily subjected to overflow by backwater, and erosion is seldom a problem.

Natural drainage is a major differentiating feature of the recent flood plains and older terrace soils. Drainage likewise is a major factor in determining types of land use. Included in the well drained grouping are Salem, Willamette, and Hillsboro in the terrace area and Chehalis, Cloquato, and Newberg in the recent alluvials.

Despite the nearly flat topography, surface runoff is substantial during periods of heavy rainfall on all but the best drained of the recent alluvial and older terrace soils. Even with adequately operating tile drainage, the outflow from the drainage systems makes an almost immediate contribution to the runoff from any area. In many areas where there are sizable contiguous areas of poorly drained soils, restricted outlets often result in ponded surface water and localized flooding that may or may not be related to major floods. This ponded surface runoff presents particular problems in the larger blocks of Wapato, Bashaw, and similar soils of recent alluvium, and with Dayton, Concord, and Amity soils in the terrace areas.

Restricted drainage and ponded surface water not only limit agriculture uses but also restrict other uses. Special measures are necessary to provide drainage for roadbeds and to provide protection from local flooding. Residential and industrial uses are restricted without special measures to provide drainage and adequate outlets for surface runoff and discharge from under drains.

With the relatively high percentage of runoff and almost immediate discharge from under drainage, waters flowing from the valley floor lands are naturally subject to contamination depending on the type of land use. Without special measures for disposal and treatment, the quality of runoff reaching major streams will be adversely affected by contaminants from intensive agricultural operations, rural and suburban residences, and different types of industrial operation.

Soils in the Bashaw series have inherent characteristics that cause them to shrink as they dry out and to swell as they become wet. This shrinking and swelling characteristic imposes limitations on its uses. Roadbeds are difficult to maintain and special measures are necessary to avoid disruption of foundations for dwellings and other buildings. Agricultural use is limited because the soils are extremely difficult to cultivate and drainage is not feasible.

Photo II-10 Poorly drained areas are subject to localized flooding, limiting agricultural and other uses. (USSCS Photo)

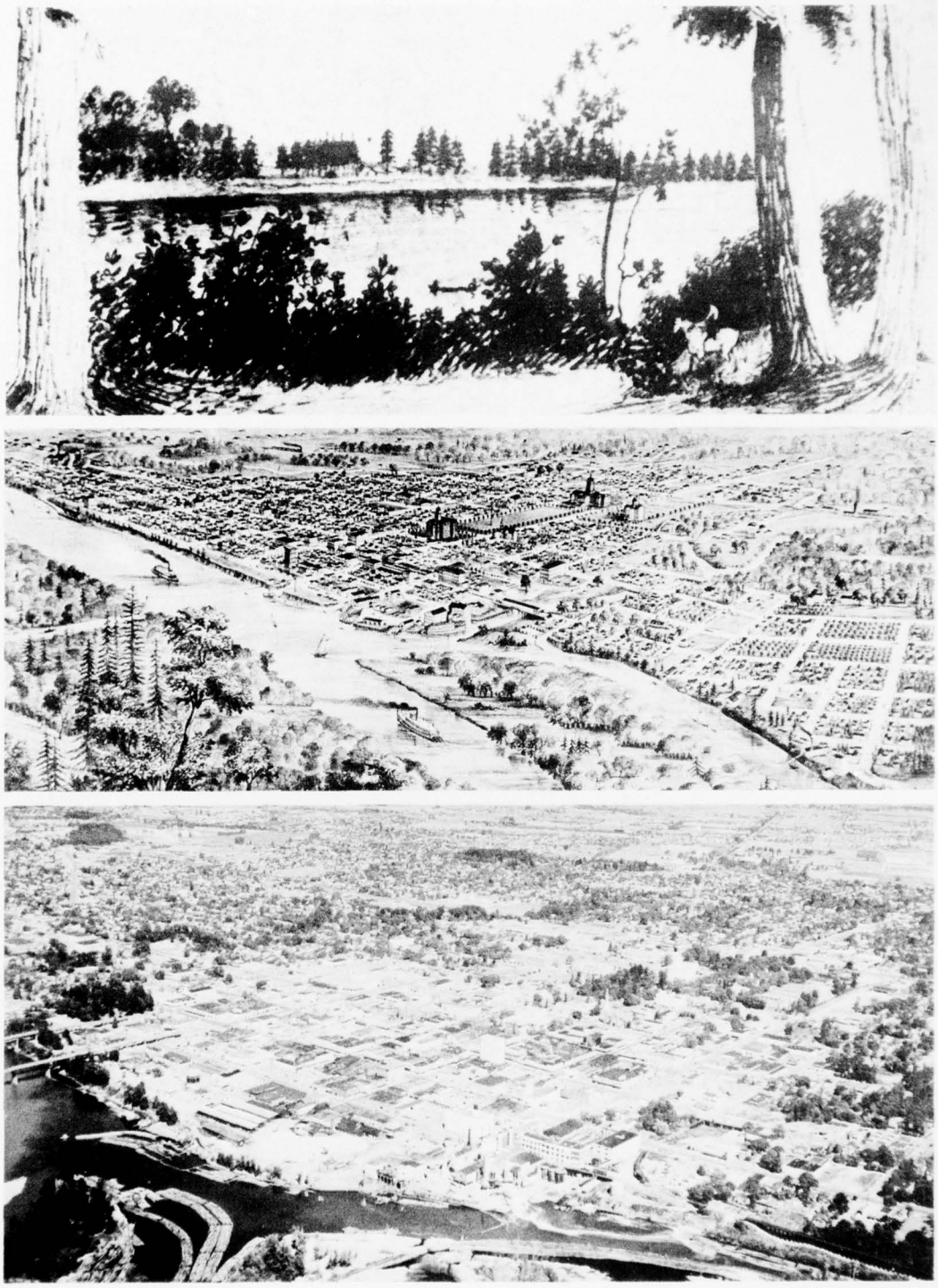


Photo II-11 A missionary encampment on the Willamette River-Salem in 1876-Salem in early 1960. (O. S. Library Photos, O. S. Hwy. Photo)

SOCIAL AND ECONOMIC DEVELOPMENT

Economic development of Willamette Basin has been directly related to its natural resources: water, land, forests, and, to a lesser extent, minerals. The aesthetic qualities of water, land, and forests combined with a bountiful supply of fish and game provide exceptional recreational resources. Utilization of the resources has provided transportation; power; agricultural, forest, and mineral products; and tourist attractions. These have led to supporting industries. Employment opportunities have resulted and, with those opportunities, increased population.

The economy of the Upper Subarea has centered about harvesting and processing timber, agriculture, and services, and that of the Lower Subarea about manufacturing, trades and services, with a declining emphasis on agriculture and lumber processing. Throughout the basin, recreation and tourism have surged ahead in recent years. For detailed analyses of association between resource development and the economy, see Appendix C - Economic Base, and the various functional appendices.

URBAN DISTRIBUTION

The Willamette Basin is the center of business, manufacturing, government, and learning in Oregon. Within its three distinct subareas, major population concentrations have formed specific patterns with distinctive urban forms and functions.

In the Upper Subarea, the Eugene-Springfield metropolitan area is the service center for a wide hinterland, is a center of lumber and wood products manufacturing, and is also the seat of the University of Oregon.

Metropolitan Salem and the Corvallis-Albany urban areas are situated in the Middle Subarea. Salem is the state capital and administrative headquarters for most state agencies. Albany serves as a manufacturing center and Corvallis is the seat of Oregon State University.

Portland, in the Lower Subarea, is a center of economic and cultural activity. The Portland tri-county urbanized area, made up of portions of Clackamas, Multnomah, and Washington Counties, straddles Willamette River from Oregon City to the Columbia River and occupies more than 300 square miles of land. This large metropolitan area is a regional distribution and administrative center for the Willamette Basin and the entire northwest.

Interspersed between these four major population areas are numerous lesser communities ranging from small rural service centers to incorporated areas of several thousand inhabitants.

POPULATION

The population of the Willamette Basin was 1.34 million in 1965 (Table II-4). Over 68 percent of the population of the State of Oregon lived within the boundaries of this basin; 41 percent of Oregon's population was concentrated in the Lower Subarea which includes the Portland metropolitan area. The population of each of the three subareas was concentrated in a city, 19% of the Middle Subarea in Salem, 37% of the Upper Subarea in Eugene. Urban fringe areas, satellite towns, and rural communities made up a large percentage of the remainder.

Table II-4
Population by County and Subarea, 1965

County and Subarea		Population
Lane County	198,000	
Upper		198,000
Benton	45,800	
Linn	65,000	
Marion	145,000	
Polk	34,200	
Yamhill	39,900	
Middle		329,900
Clackamas	134,000	
Multnomah	555,000	
Washington	122,000	
Lower		811,000
Total		1,338,900

SOURCE: Center for Population Research and Census

The 1965 population of the Upper Subarea was 198,000, resulting in an overall density of 50 persons per square mile. However, almost two-thirds of the population of this area was concentrated around the Eugene-Springfield area where the density of the urban area was about 3,000 persons per square mile. The population of the Middle Subarea, 329,900 in 1965, creates an average density of about 60 persons per square mile. About one-fourth of the population of the middle Willamette lived in Salem and the adjacent unincorporated suburban fringe area. Population density of urban areas in the Middle Subarea was about 2,600 persons per square mile. The Lower Subarea, the most densely populated area in Oregon, had 811,000 residents in 1965, about half of whom lived in Portland. The population density was 300 persons per square

mile for the Lower Subarea as a whole and about 3,400 for the urban parts.

Seventy-three percent of the total population of the Willamette Basin was urban in 1960. The remaining nonurban population included 21 percent nonfarm residents, and only 6 percent farm residents. These general percentage distributions have remained unchanged through 1965.

Eighty-two cities, listed in Table II-5, have been incorporated in the basin. The smallest incorporated community, Barlow in Clackamas County, had a population of 98 in 1965; Portland, the largest incorporated city, had a population of 382,000. Population changes since the 1950 Federal census also are indicated in the table.

Some cities have lost population within their corporate limits, others have had rapid increases. Those cities having a population loss generally are smaller centers located in the fringe areas of the valley where there has been a traditionally rural economic orientation. Many of the fringe cities are dependent on the forest products industry. A decline of small sawmill operations and the expansion of large corporations into integrated forest products industries have been responsible for the net decrease in population in most of these smaller communities. Several rural agricultural communities also have lost population. These losses might be attributed to changing economic and transportation characteristics of the surrounding area. Nevertheless, there seems to be a stabilization of population in contrast to the decrease which characterized these fringe communities during the decade of the fifties. Most of them have had slight increases since the 1960 census.

EMPLOYMENT

In 1964, there were about 503,300 persons employed in the Willamette Basin (Table II-6). This was 70 percent of the total employment in Oregon. About 39 percent of the population of the basin was in the labor force.

Jobs associated with manufacturing and the wholesale and retail trades were the most numerous in 1964. Some 20 percent of employment was in manufacturing and 19 percent in wholesale and retail trades, followed by employment in local, state, and Federal Government. Next were jobs of a service nature--business, household, recreation, education, and other types of service. Employment in agriculture accounted for only 5 percent of the total.

Location of the labor force and types of employment vary considerably among subareas. Almost 65 percent of the total jobs are found in the three counties of the Lower Subarea, another 21 percent are located in the Middle Subarea, and the remaining 14 percent are in the Upper Subarea. In total manufacturing employment, the Lower Subarea had about 60 percent of the jobs with the other two subareas almost equally dividing the remainder.

Table II-5

Population of Incorporated Cities

City	County	1950	Percent change 1950-60	1960	1965	Percent change 1960-65
Albany	Linn	10,115	+27.8	12,926	15,700	+21.5
Amity	Yamhill	672	-7.7	620	630	+1.6
Aumsville	Marion	281	+6.8	300	420	+4.0
Aurora	Marion	242	+12.4	272	336	+23.5
Banks	Washington	376	-7.7	347	411	+18.4
Barlow	Clackamas	75	+13.3	85	98	+15.3
Beaverton	Washington	2,512	+136.3	5,937	11,400	+92.0
Brownsville	Linn	1,175	-25.5	875	880	+0.6
Canby	Clackamas	1,671	+29.7	2,168	2,901	+21.7
Carlton	Yamhill	1,081	-11.3	959	1,060	+10.5
Coburg	Lane	693	+8.8	754	821	+8.9
Cornelius	Washington	998	+14.8	1,146	1,377	+20.2
Corvallis	Benton	16,207	+27.5	20,669	28,400	+37.4
Cottage Grove	Lane	3,535	+10.2	3,895	4,950	+27.1
Creswell	Lane	662	+14.8	760	964	+26.8
Dallas	Polk	4,793	+5.8	5,072	5,500	+8.4
Dayton	Yamhill	719	-6.4	673	1,044	+55.1
Detroit	Marion	-	-	206	250	+21.3
Donald	Marion	187	+7.4	201	217	+8.0
Dundee	Yamhill	308	+3.2	318	376	+18.2
Estacada	Clackamas	950	+0.7	957	1,002	+4.7
Eugene	Lane	35,879	+42.1	50,977	72,600	+42.4
Fairview	Multnomah	438	+31.9	578	759	+31.3
Falls City	Polk	853	-23.5	653	800	+22.5
Forest Grove	Washington	4,243	+29.6	5,628	6,550	+16.4
Gaston	Washington	368	-13.1	320	320	0.0
Gates	Marion	-	-	189	280	+48.1
Gervais	Marion	457	-4.2	438	480	+9.6
Gladstone	Clackamas	2,434	+58.3	3,854	4,950	+28.4
Gresham	Multnomah	3,049	+29.4	3,944	5,400	+36.9
Halsey	Linn	388	+4.1	404	450	+11.4
Harrisburg	Linn	862	+8.9	939	1,134	+20.8
Hillsboro	Washington	5,142	+60.1	8,232	11,000	+33.6
Hubbard	Marion	493	+6.7	526	720	+36.9
Idanha	Marion	442	-33.3	295	344	+16.6
Independence	Polk	1,987	-2.9	1,930	2,326	+19.3
Jefferson	Marion	636	+12.6	716	800	+11.7
Junction City	Lane	1,475	+9.4	1,614	1,990	+23.3
Lafayette	Yamhill	662	-19.5	533	632	+18.6
Lake Oswego	Clackamas	3,316	+168.6	8,906	12,200	+37.0
Lebanon	Linn	5,873	-0.3	5,858	6,200	+5.8
Lowell	Lane	-	-	503	620	+23.3
Lyons	Linn	-	-	463	590	+27.4
McMinnville	Yamhill	6,635	+15.4	7,656	8,600	+12.3
Mill City	Linn-Marion	1,792	-28.1	1,289	1,400	+8.6
Milwaukie	Clackamas	5,253	+73.2	9,099	14,200	+56.1
Molalla	Clackamas	1,497	+0.3	1,501	1,399	+6.5
Monmouth	Polk	1,956	+14.0	2,229	3,437	+54.2
Monroe	Benton	362	+3.3	374	387	+3.5
Mt. Angel	Marion	1,315	+8.5	1,428	1,857	+30.0
Newberg	Yamhill	3,946	+6.5	4,204	4,500	+7.0
North Plains	Washington		-	-	682	-
Oakridge	Lane	1,562	+26.3	1,973	2,360	+19.6
Oregon City	Clackamas	7,682	+4.1	7,996	8,300	+3.8
Philomath	Benton	1,289	+5.4	1,359	1,460	+7.4
Portland	Clack.-Mult.	373,628	-0.3	372,676	382,000	+2.5
St. Helens	Columbia	4,711	+6.6	5,022	5,380	+7.1
St. Paul	Marion	226	+12.4	254	250	-1.6
Salem	"-Polk	43,140	+13.9	49,142	64,000	+30.2
Sandy	Clackamas	1,003	+14.4	1,147	1,350	+17.7
Scappoose	Columbia	659	+40.1	923	1,000	+8.3
Scio	Linn	448	-1.6	441	494	+12.0
Scotts Mills	Marion	217	-28.6	155	190	+22.6
Sheridan	Yamhill	1,922	-8.3	1,763	1,800	+2.1
Sherwood	Washington	575	+18.3	680	770	+13.2
Silverton	Marion	3,146	-2.1	3,081	4,050	+31.5
Sodaville	Linn	157	-7.6	145	150	+3.4
Springfield	Lane	10,807	+81.5	19,616	23,500	+19.8
Stayton	Marion	1,507	+39.9	2,108	2,713	+18.7
Sublimity	Marion	367	+33.5	490	556	+13.5
Sweet Home	Linn	3,603	-6.9	3,353	4,050	+20.8
Tigard	Washington	-	-	-	2,203	-
Troutdale	Multnomah	514	+1.6	522	600	+15.0
Tualatin	Washington	248	+44.7	359	380	+5.8
Turner	Marion	610	+26.2	770	820	+6.5
Veneta	Lane	-	-	-	1,196	-
Waterloo	Linn	-	-	151	159	+5.3
West Linn	Clackamas	2,945	+33.5	3,933	4,600	+17.0
Willamina	Polk-Yamhill	1,082	-11.3	960	1,115	+16.1
Woodburn	Marion	2,395	+30.3	3,120	4,800	+53.8
Wood Village	Multnomah	-	-	822	900	+9.5
Yamhill	Yamhill	539	-24.5	407	506	+24.3

SOURCES: Center for Population Research and Census
U. S. Census of Population, 1950 and 1960

Income per recipient varies considerably among counties and is generally larger in the counties with larger proportions of urban population. Average income for recipients in the Middle Subarea is significantly lower than for the Upper or Lower Subareas. The average income for all basin counties was $3,691 per recipient; the total income was about $2.4 billion in 1959.

Table II-6
Average Annual Employment, 1964

Industry	1964 (Thousands)
Agriculture	27.3
Construction	21.5
Finance, insurance, & real estate	22.6
Government	76.7
Manufacturing:	
Food & kindred products	14.4
Lumber, wood products, furniture	35.9
Paper and allied products	5.2
Other	43.4
Mining	.7
Services	57.5
Trade, Wholesale & Retail	95.4
Transportation & utilities	33.0
Other	69.7
Total	503.3

SOURCE: Oregon State Department of Employment

TRANSPORTATION

Highway System

The Willamette Basin is served by an extensive road and highway system, shown on Map II-2. Two interstate highways allow rapid travel. Interstate Highway 5 runs in a north-south direction, serving as a vital connecting link between the major population centers in the valley and with Washington and California points. Within the basin, Interstate Highway 5 connects the cities of Cottage Grove, Eugene-Springfield, Albany, Salem, and metropolitan Portland. Corvallis, the fourth largest city in Oregon, has easy access to the highway. The other major interstate highway, Interstate 80 North, follows the Columbia Gorge from Portland east to points outside the basin.

In addition to the interstate highways, five U. S. and state highways serve the basin north-south, and nine serve it east-west. Several of these highways cross the Cascade and Coast Ranges.

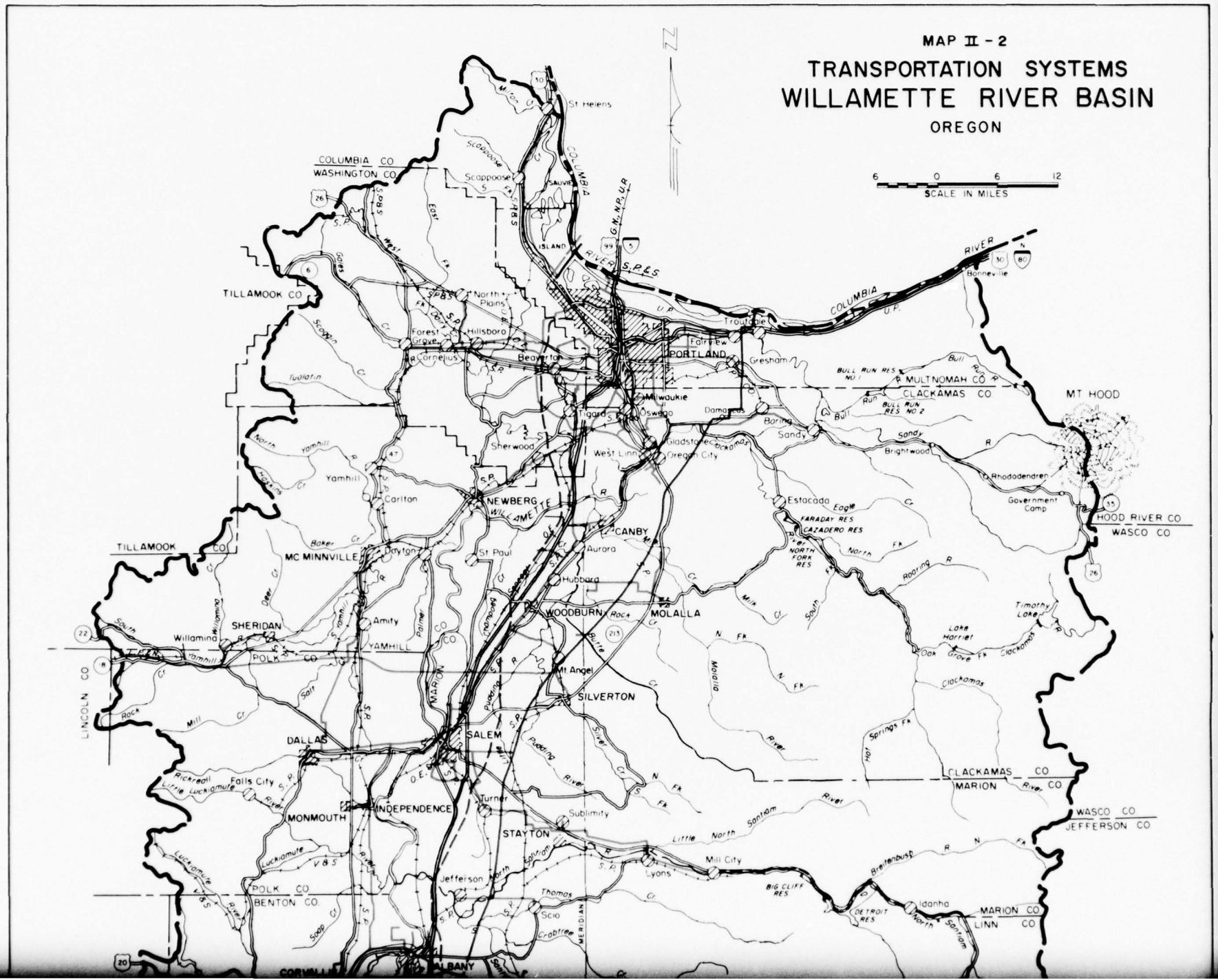
Photo II-12 The Hayesville interchange north of Salem is typical along the interstate route. (O. S. Hwy. Photo)

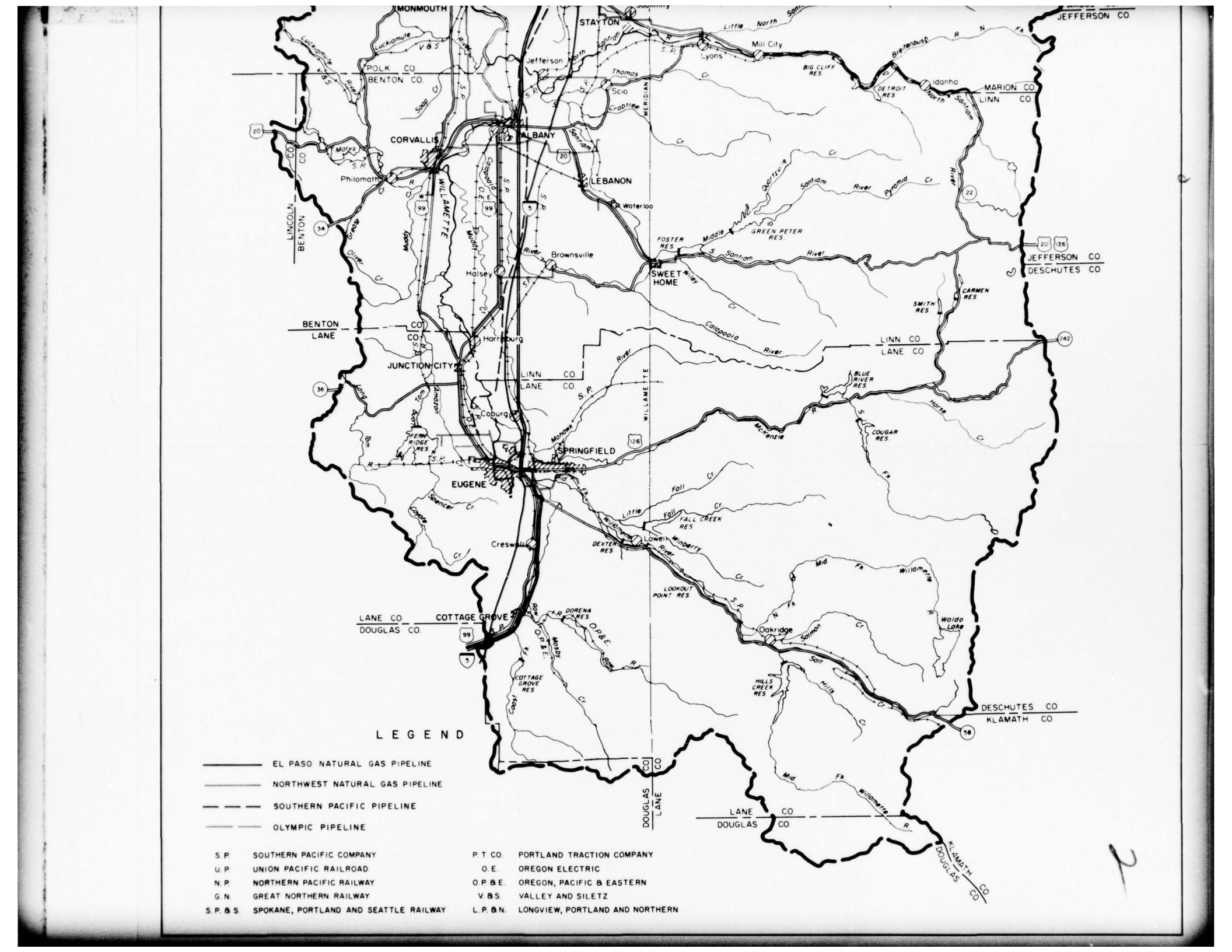
Secondary hard-surface roads provide a dense highway network serving most semirural and rural areas. These county road systems allow intrarural and urban fringe travel as well as access to major highways. The concentration of secondary roads increases northward with an extremely dense network in the Portland metropolitan area.

Waterways

The Columbia River and its Willamette River tributary form one of the Nation's most important inland waterways. Deep-draft ships travel 101 miles up the Columbia, enter the Willamette and continue 11.6 miles to Portland's upper waterfront docking facilities. A shallow-draft channel, used for downstream movement of logs, is maintained from the locks at Willamette Falls upstream to Corvallis.

Navigation channels are maintained by the U. S. Army Corps of Engineers. These facilities are discussed in the Navigation Appendix.


MAP II - 2
TRANSPORTATION SYSTEMS
WILLAMETTE RIVER BASIN
OREGON
SCALE IN MILES
6 0 6 12
COLUMBIA CO
WASHINGTON CO
TILLAMOOK CO
CLACKAMAS CO
MULTNOMAH CO
MARION CO
POLK CO
BENTON CO
LINN CO
LINCOLN CO
YAMHILL CO
HOOD RIVER CO
WASCO CO
JEFFERSON CO
PORTLAND
SALEM
ALBANY
CORVALLIS
MC MINNVILLE
NEWBERG
CANBY
SILVERTON
WOODBURN
MOLALLA
DALLAS
INDEPENDENCE
MONMOUTH
STAYTON
SHERIDAN
St Helens
Scappoose
Hillsboro
Forest Grove
Cornelius
North Plains
Beaverton
Tigard
Tualatin
Sherwood
Lake Oswego
Milwaukie
Gresham
Troutdale
Fairview
Wood Village
Damascus
Boring
Sandy
Estacada
Oregon City
West Linn
Gladstone
Carlton
Yamhill
Dayton
Amity
Willamina
Sheridan
St Paul
Aurora
Hubbard
Mt Angel
Woodburn
Jefferson
Scio
Crabtree
Turner
Sublimity
Lyons
Mill City
Idanha
Detroit
Brightwood
Rhododendron
Government Camp
Bonneville
Columbia River
Willamette River
Santiam River
North Santiam River
South Santiam River
Little North Santiam River
Clackamas River
Molalla River
Pudding River
Rickreall
Little Luckiamute River
Luckiamute River
Yamhill River
Rock Creek
Mill Creek
Scoggin Creek
Gales Creek
West Fork
East Fork
North Yamhill River
South Yamhill River
Baker Creek
Deer Creek
Palmer Creek
Abiqua Creek
Butte Creek
Silver Creek
Hot Springs Fork
Oak Grove Fork
Roaring River
Timothy Lake
Lake Harriet
Faraday Res
Cazadero Res
North Fork Res
Big Cliff Res
Detroit Res
Bull Run Res No 1
Bull Run Res No 2
Bull Run River
Eagle Creek
Breitenbush River
Thomas Creek
Soap Creek
Falls City
Monmouth
Independence
Stayton
Sublimity
Lyons
Mill City
Idanha
Scio
Crabtree
Jefferson
Turner
Aurora
Hubbard
Mt Angel
Silverton
Woodburn
Molalla
Dallas
Salem
Albany
Corvallis
Newberg
Canby
McMinnville
Sheridan
Willamina
Dayton
Carlton
Yamhill
Amity
St Paul
Oregon City
West Linn
Gladstone
Milwaukie
Lake Oswego
Tigard
Tualatin
Sherwood
Beaverton
Hillsboro
Forest Grove
Cornelius
North Plains
Scappoose
St Helens
Columbia River
Willamette River
Santiam River
Clackamas River
Molalla River
Pudding River
Rickreall
Little Luckiamute River
Luckiamute River
Yamhill River
Rock Creek
Mill Creek
Scoggin Creek
Gales Creek
Abiqua Creek
Butte Creek
Silver Creek
Hot Springs Fork
Oak Grove Fork
Roaring River
Timothy Lake
Lake Harriet
Faraday Res
Cazadero Res
North Fork Res
Big Cliff Res
Detroit Res
Bull Run Res No 1
Bull Run Res No 2
Bull Run River
Eagle Creek
Breitenbush River
Thomas Creek
Soap Creek
Falls City
Monmouth
Independence
Stayton
Sublimity
Lyons
Mill City
Idanha
Scio
Crabtree
Jefferson
Turner
Aurora
Hubbard
Mt Angel
Silverton
Woodburn
Molalla
Dallas
Salem
Albany
Corvallis
Newberg
Canby
McMinnville
Sheridan
Willamina
Dayton
Carlton
Yamhill
Amity
St Paul
Oregon City
West Linn
Gladstone
Milwaukie
Lake Oswego
Tigard
Tualatin
Sherwood
Beaverton
Hillsboro
Forest Grove
Cornelius
North Plains
Scappoose
St Helens


MONMOUTH
STAYTON
JEFFERSON CO.
Little North Santiam R.
Mill City
Lyons
Breitenbush R.
N. Fk.
POLK CO.
BENTON CO.
Luckiamute River
V. & S.
Jefferson
Thomas Cr.
Scio
Crabtree
BIG CLIFF RES.
DETROIT RES.
Idanha
MARION CO.
LINN CO.
North Santiam
CORVALLIS
ALBANY
LEBANON
Waterloo
Quartzville
Santiam River
Pyrmid Cr.
Marys R.
Philomath
Calapooia
Willamette
Middle
GREEN PETER RES.
FOSTER RES.
Brownsville
Halsey
SWEET HOME
Wiley
CARMEN RES.
SMITH RES.
LINCOLN CO.
BENTON CO.
Oliver Cr.
Muddy
Crabtree Cr.
Harrisburg
JUNCTION CITY
LINN CO.
LANE CO.
BLUE RIVER RES.
Coburg
Long Tom
Amazon
FERN RIDGE RES.
SPRINGFIELD
McKenzie
COUGAR RES.
Horse Cr.
EUGENE
Spencer Cr.
Coast Fk.
Fall Cr.
Little Fall Cr.
FALL CREEK RES.
Willamette
Lowell
DEXTER RES.
Creswell
Winberry Cr.
Mid Fk. Willamette
LOOKOUT POINT RES.
Oakridge
Salmon Cr.
Waldo Lake
DORENA RES.
COTTAGE GROVE
COTTAGE GROVE RES.
Mosby Cr.
O.P.&E. ROW
HILLS CREEK RES.
Hills Cr.
DESCHUTES CO.
KLAMATH CO.
DOUGLAS CO.
LEGEND
EL PASO NATURAL GAS PIPELINE
NORTHWEST NATURAL GAS PIPELINE
SOUTHERN PACIFIC PIPELINE
OLYMPIC PIPELINE
S.P. SOUTHERN PACIFIC COMPANY
U.P. UNION PACIFIC RAILROAD
N.P. NORTHERN PACIFIC RAILWAY
G.N. GREAT NORTHERN RAILWAY
S.P.&S. SPOKANE, PORTLAND AND SEATTLE RAILWAY
P.T.CO. PORTLAND TRACTION COMPANY
O.E. OREGON ELECTRIC
O.P.&E. OREGON, PACIFIC & EASTERN
V.&S. VALLEY AND SILETZ
L.P.&N. LONGVIEW, PORTLAND AND NORTHERN

Rail Transportation

The Willamette Basin is served by 10 railway companies, six Class I and four Class II railways.

Class I	Class II
Great Northern Railway Co.	Longview, Portland and Northern Railroad Co.
Northern Pacific Railway Co.	Oregon, Pacific & Eastern Railway Co.
Oregon Electric Railway Co.	
Southern Pacific Co.	Pottland Traction Co.
Spokane, Portland & Seattle Railway Co.	Valley & Siletz Railway Co.
Union Pacific Railroad Co.	

The Southern Pacific, the most important railway for the basin, operates 215 miles of main line stretching from Portland in the north to Willamette Pass in the south, and 476 miles of branch lines serving all major population centers. Portland acts as the central transfer and terminal point for the Great Northern; Northern Pacific; Southern Pacific; Spokane, Portland & Seattle; and the Union Pacific railway companies. Connections between Portland and points north, such as Seattle and Spokane, are provided by the Great Northern, Northern Pacific, and their subsidiary, the Spokane, Portland & Seattle Railway.

Photo II-13 Pacific Coast expeditor--high speed S. P. freight which operates southward to California. (S. P. Photo)

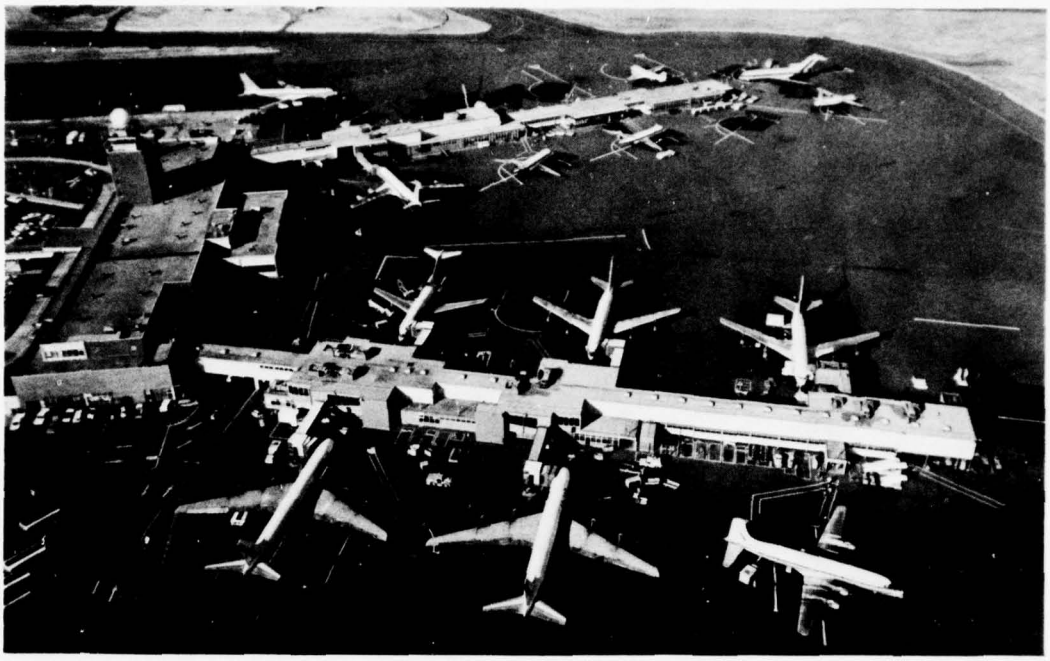


Photo II-14 Portland International Airport

Air Transportation

The Willamette Basin has 21 airports classified for public use, four of which are served by scheduled airlines. Portland International Airport is the largest field and provides main line service with Salem and Eugene. It also serves as one of the two principal Pacific Northwest airports for transcontinental and transocean flights. Eight scheduled airlines and one nonscheduled freight carrier connect Portland with all major cities in the world; these are Air West, Braniff, Continental, Eastern, Northwest Orient, Pan American, United, Western, and Flying Tiger.

Pipelines

Pipelines in the basin are used to move petroleum products and natural gas. Petroleum lines include a 14-inch facility serving Portland from Puget Sound, and an 8-inch facility from Portland to Eugene. Two natural gas lines, emanating from the El Paso Natural Gas Company's trunk line to the Pacific Northwest, serve Willamette Basin. For further details, see Part II, Appendix I - Navigation.

UTILITIES

Municipal Water Supply

Some 208 municipal water systems serve incorporated cities, water districts, water companies, water associations and cooperatives, and institutions. These systems supply water to approximately 714,000 people in the Lower Subarea, 288,000 in the Middle, and 156,000 in the Upper. These are about 88 percent, 87 percent, and 79 percent of the respective subarea populations.

The large population centers of Portland, Salem, and Eugene-Springfield have planned for future expansion of their systems to serve their outlying areas and no foreseeable problems exist. Most of the cities over 10,000 population, where the area lying outside the city limits is not densely populated, will be able to handle moderate growth with the present water supply.

The cities faced with inadequate future water supply are those lying along the Coast Range side of the basin. The long-range solution to the water supply needs of these as well as of most other small and large communities is the development of large supply systems with water treatment and storage facilities. For further, more detailed discussion, see Appendix H - Municipal and Industrial Water Supply.

Electric Power

Willamette Basin, with respect to power generation, is expected to remain a power-deficient area. Its greatest power-producing value is the contribution of its generating facilities toward meeting peak loads. Power generation in the basin is integrated into the Pacific Northwest power system, which covers Washington, Oregon, Idaho, and Montana west of the Continental Divide.

In 1965, the basin had 850,600 kilowatts of installed generating capacity. Of this total, hydroelectric capacity was 617,700 kilowatts and thermal capacity 232,900. For a full discussion of the basin's power resource and potential, see Appendix J - Power.

Sewerage

The first municipal sewage treatment plants on the Willamette River were placed in operation at Junction City and Newberg in 1949. This was the result of a concerted effort to have primary treatment of all sewage effluents before disposal into the river.

In 1957, after all cities on the Willamette River had installed primary treatment and many industries had installed some treatment facilities, a survey showed the need for secondary treatment for municipal waste plus treatment of pulp and paper mill waste.

For detailed information on activities of cities, sanitary districts, and industries related to sewage and industrial waste treatment, see Appendix L - Water Pollution Control.

Natural Gas

Natural gas is supplied by the Northwest Natural Gas Company, whose main lines within the basin are shown on Map II-2. Extensive natural gas service began in 1956 when the El Paso Natural Gas Company completed a pipeline to the Pacific Northwest from the San Juan Basin in New Mexico and Colorado. Subsequently, El Paso Natural Gas Company extended its facilities to the U. S.-Canadian border near Sumas, Washington and Kingsgate, British Columbia (north of the Idaho border) to receive natural gas from Westcoast Transmission Company, Ltd., from fields in northern British Columbia and Alberta.

INSTITUTIONS IN WILLAMETTE BASIN

Higher Education

Thirty-three of Oregon's 41 institutions of higher education are located in the highly urbanized areas of the Willamette Basin. Nineteen are in the Portland area. Two major universities and a state college, with enrollments over 9,000 each, are in Eugene, Corvallis, and Portland. The 33 institutions are listed in Table II-7, showing their location, fall 1965 enrollment, date of establishment, and fields of study. Enrollment totaled 65,942 in the fall of 1965.

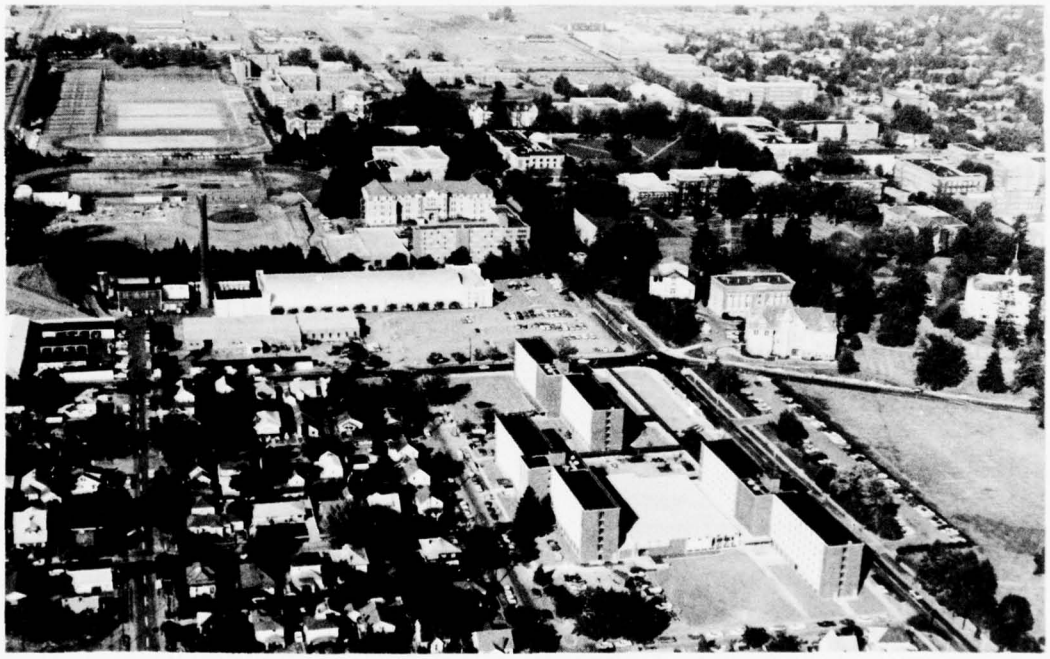


Photo II-15 Oregon State University at Corvallis.

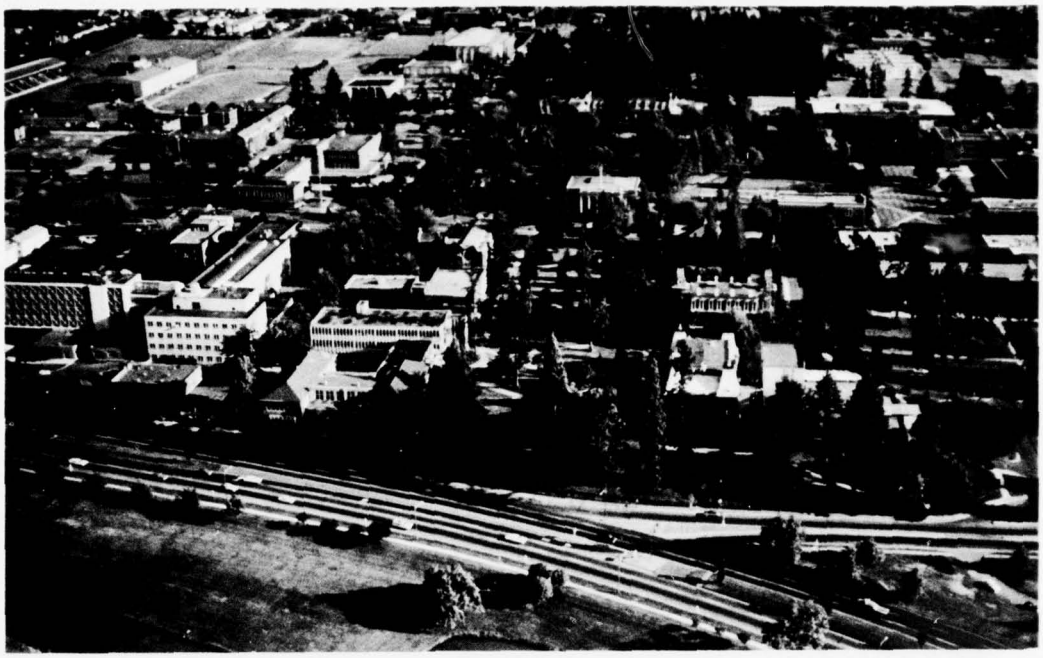


Photo II-16 University of Oregon at Eugene. (Western Ways Photo)

Libraries

Willamette Basin has 13 major libraries. These include the Oregon State Library at Salem and the libraries of the Oregon State Board of Higher Education, which are supported by state funds, as well as five locally supported libraries of regional importance.

Health, Welfare, and Correctional Institutions

Willamette Basin has 23 hospitals, with locations in every major population center in the valley. The greater portion of these are owned and operated by private groups and organizations. In addition to hospitals under the jurisdiction of the State Board of Health, the U. S. Veteran's Hospital is located at Portland.

There are 18 welfare institutions in the basin which are either aided or supported by the state. These include three schools for the handicapped, one home for the aged, one family rehabilitation center, and 13 infant and child-care institutions. The latter institutions are operated by nongovernment organizations. Seven are affiliated with religious organizations and six with nonprofit private associations.

The State of Oregon operates four correctional institutions within the basin.

Table II-7
Institutions of Higher Education, Willamette Basin

Institution	Location	Fall 1965 Enrollment		Date Established	Fields of Study
State System of Higher Education					
Oregon College of Education	Monmouth	2,067		1882	Education & Liberal Arts
Oregon State University	Corvallis	11,884		1868	General
Portland State College	Portland	9,089		1955	Liberal Arts
University of Oregon	Eugene	12,187		1872	General
University of Oregon Dental School	Portland	387		1945	Dentistry
University of Oregon Medical School	Portland	794		1887	Medicine
Subtotal			36,408		
Division of Continuing Education	Portland	11,000		1917	General
Total			47,408		
Community Colleges					
Lane Community College	Eugene	1,168		1965	Technical Liberal Arts
Portland Community College	Portland	2,500		1949	Technical Liberal Arts
Salem Technical Vocational Comm. College	Salem	501			Technical
Total			4,169		
Technical, Vocational Schools					
Oregon City Vocational School	Oregon City	117		1941	Technical
Total			117		
Independent Institutions					
Cascade College	Portland	336		1918	Liberal Arts, Science
Columbia Christian College	Portland	132		1956	Liberal Arts, Theology
Concordia College	Portland	156		1950	Liberal Arts, Theology
Conquerors Bible College	Portland	64		1954	Religion
George Fox College	Newberg	346		1885	Liberal Arts, Science
Judson Baptist College	Portland	122		1955	Liberal Arts, Theology
Lewis & Clark College	Portland	1,420		1867	Liberal Arts, Science
Linfield College	McMinnville	1,138		1849	Liberal Arts, Science
Marylhurst College	Marylhurst	750		1893	Liberal Arts, Science
Mt. Angel College	Mt. Angel	421		1888	Liberal Arts, Science
Mt. Angel Seminary	Mt. Angel	128		1889	Liberal Arts, Theology
Multnomah College	Portland	2,235		1897	Liberal Arts, Science
Multnomah School of the Bible	Portland	478		1936	Religion
Northwestern Christian College	Eugene	444		1895	Theology
Northwestern College of Law of Lewis & Clark College	Portland	271		1915	Law
Pacific University	Forest Grove	1,011		1849	Liberal Arts, Science
Reed College	Portland	1,050		1909	Liberal Arts, Science
University of Portland	Portland	1,822		1901	Liberal Arts, Science
Warner Pacific College	Portland	340		1940	Liberal Arts, Theology
Western Evangelical Seminary	Portland	59		1945	Religion
Western State College of Chiropractics	Portland	32		1907	Chiropractics
Willamette University	Salem	1,493		1842	Liberal Arts, Science
Total			14,248		
Total Enrollment			65,942		

PART III

RESOURCES

Photo III-1 (USFS, USSCS, & OS Department of Agriculture Photos)

SURFACE WATER SUPPLY

Annual Runoff

Annual runoff is the outflow or amount of water leaving a particular drainage area during a water year, which extends from October 1 of one year to September 30 of the next. This runoff is influenced by a number of variables, such as watershed characteristics, precipitation, evaporation, transpiration, use, and development. The major stream systems in the basin are gaged and fairly good records are available.

The estimated average annual runoff of the Willamette Basin is over 27 million acre-feet. Table III-1 shows the runoff for the major streams in each subbasin (except 10 - Columbia) at the lowest gaging station; the total runoff of each subbasin is therefore slightly more than the figures shown. Also presented are runoff averages for the Willamette River at various points.

Table III-1
Estimated Average Annual Runoff

Sub-basin	Stream and Location	Drainage Area (sq. mi.)	Avg. Ann. Runoff (ac. ft.)
1	Coast Fork Willamette River, near Goshen	642	1,220,000
2	Middle Fork Willamette River, at Jasper	1,340	2,870,000
3	McKenzie River, near Coburg	1,337	3,910,000
4	Long Tom River, at Monroe	391	565,000
5	Calapooia River, at Albany	372	659,000
5	Santiam River, at Jefferson	1,790	5,940,000
6	Marys River, near Philomath	159	333,000
6	Luckiamute River, near Suver	240	637,000
6	Yamhill River, at Lafayette	735	1,630,000
7	Molalla River, near Canby	323	818,000
7	Pudding River, at Aurora	479	883,000
8	Tualatin River, at West Linn	710	1,080,000
9	Clackamas River, near Clackamas	936	2,680,000
11	Sandy River, below Bull Run River	440	1,800,000
	Willamette River, at Springfield	2,030	4,180,000
	Willamette River, at Harrisburg	3,420	8,400,000
	Willamette River, at Albany	4,840	10,400,000
	Willamette River, at Salem	7,280	17,000,000
	Willamette River, at Wilsonville	8,400	18,900,000
	Willamette River, at Portland	11,100	24,900,000

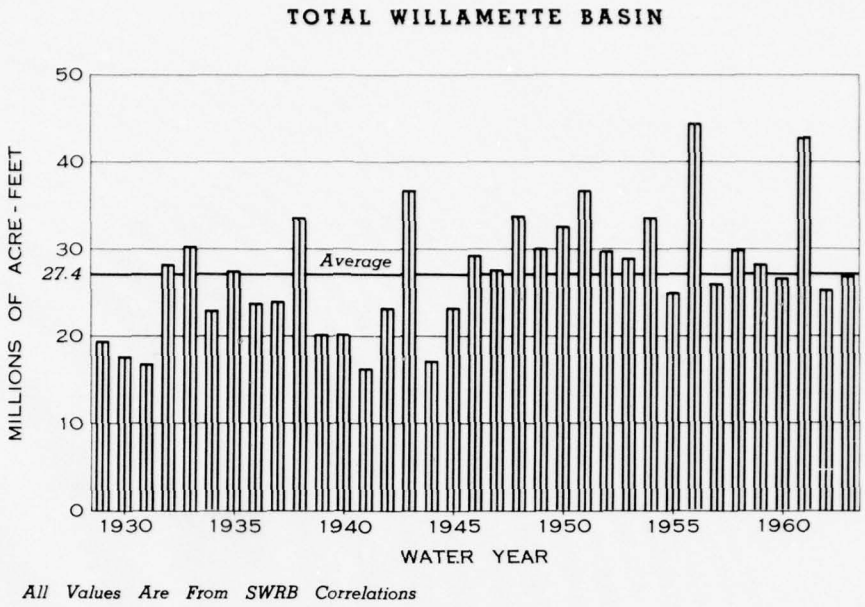


Figure III-1 Annual Water Yield, 1929-63

Figure III-1 illustrates the annual and average annual Willamette Basin runoff for the base period 1929 through 1963. This period was established as representative of the long-term mean. Streamflow records which did not cover the base period were extended by correlation to facilitate the comparison of the different systems in the basin.

Distribution

South Yamhill and Tualatin Rivers, typical of the streams originating in the Coast Range, rise abruptly starting in October, peak in January, then drop rather rapidly and uniformly through May to reach the low flow in August. This pattern closely reflects the precipitation pattern of the Coast Range, the precipitation occurring generally as rainfall. Approximately 93 percent of the annual outflow occurs during November through May, almost half of which runs off during December and January.

Streams that originate in the Cascade Range, such as the South Santiam, Clackamas, and Sandy Rivers, rise more slowly in the fall, peak initially in December, maintain high flows through May, then subside gradually. The yields of the Cascade stream thus reflect the impact of winter precipitation, occurring largely as snowfall. Generally, a secondary peak occurs when spring rains combine with snowmelt. The streamflows, generally, are better sustained throughout the year than those of the Coast Range.

The monthly percentage of average annual yield for selected streams in Willamette Basin is shown in Figure III-2.

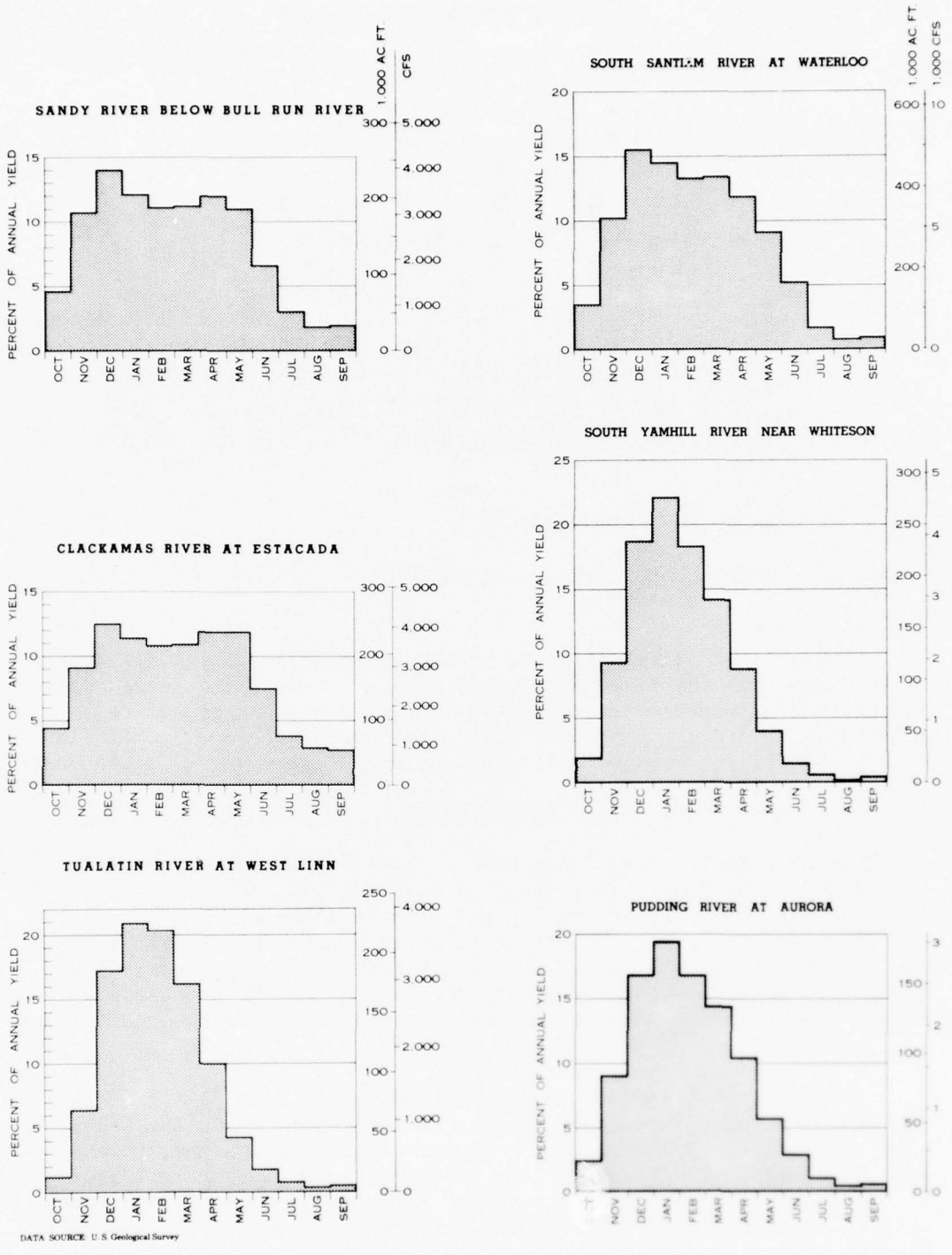


Figure III-2 Monthly distribution of annual water yield.

Streams originating in the foothills of the Cascades, such as the Pudding River, have streamflow patterns that closely resemble those of Coast Range streams.

Streamflow patterns have a significant bearing on water usage. Irrigation development, particularly on the west side of the basin, is adversely affected by the low flows which occur during the summer months. High water temperatures resulting from the low summer flows have an adverse effect on fish life. Pollution of many streams is a problem during periods of extremely low summer flows.

Storage reservoirs reduce peak discharge and augment low flows of the rivers which they control without much effect on the total annual runoff.

Extreme Discharges

Both the lowest and highest instantaneous unit-area discharges generally are observed on those streams originating in the Coast Range or in foothill areas of the Cascade Range. Less divergent extremes sustained in streams originating high in the Cascades reflect climatological and geological differences between the Coast and Cascade Ranges. These and other factors are discussed in detail in Appendix B - Hydrology.

Photo III-2 Willamette River at flood stage.

Quality

Waters from all the streams of Willamette Basin are suitable for most uses. Sodium and salinity concentrations are low so that the water is of excellent quality for irrigation. The water generally is suitable for most industrial uses but, because many streams have silica concentrations of more than 10 parts per million (ppm), may need treatment if water with low silica content is required. For some uses, the water also may need treatment for turbidity and color.

GROUND WATER SUPPLY

The occurrence, availability, movement, and sources, as well as quantity and quality of ground water, are closely controlled by the geology of the region. The three main physiographic and geologic divisions of Willamette Basin--the Cascade Range, the Coast Range, and the Willamette Trough between--were formed primarily by regional compression of the earth's crust. The Cascade Range is predominantly volcanic, the Coast Range is mostly sedimentary, and the Willamette Valley is partially filled with alluvium.

The porous volcanic rocks of the Cascade Range, particularly the younger lavas, store great quantities of infiltrating precipitation. This water is gradually released and makes possible the uniform base flows of the Cascade streams. Little ground water data is available for this area.

The sedimentary rocks of the Coast Range, most of which were deposited in a marine environment, generally are nonporous and impermeable. Well yields are poor. In local areas, wells from 100 to 200 feet in depth have encountered saline water, yet interspersed are wells yielding potable water. Wells tapping the marine sedimentary rocks yield water high in iron. Those tapping fine-grained claystone and mudstone frequently yield water having a strong sulfur odor or flat taste.

The coarse-sand and gravel lenses occurring in much of the alluvium in Willamette Valley yield moderate to large quantities of ground water to wells. The alluvium derived from Cascade Range volcanic rock is much more productive of ground water than that derived from the Coast Range sediments. The water quality generally is good. There appears to be sufficient recharge each winter to maintain the water table.

Rocks of the Columbia River Group (principally basalt) also are a source of ground water, although less prolific than the valley alluvium. This formation underlies the valley as far south as Salem. Because the overall porosity of these rocks is relatively low, the volume of stored water is small. Consequently, where there are a large number of high-yield wells as in some areas of the Tualatin Valley and in the Portland west side business district, it is possible to overpump the aquifer. Such overdraft permits infiltration of saline water from underlying marine rocks.

WATER USE

The laws of the State of Oregon identify 10 beneficial uses of water: domestic, municipal, irrigation, power generation, industrial, mining, recreation, wildlife, fish life, and pollution abatement. Only a small portion of the Willamette Basin stream systems have been adjudicated to date. Documentation of total existing legal rights to use of the basin's water has not been completed. Water rights established through the State Engineer, however, since enactment of the State Surface Water Code in 1909 and the Ground Water Act in 1955, reflect water use in the basin, and are summarized in Table III-2. Rights not yet adjudicated, such as the Willamette Falls power claims in the order of 30,000 cubic feet per second (cfs), are not included. For a more detailed breakdown showing use by subbasins, see Appendix B - Hydrology.

Table III-2

Water Rights Summary as of July 1965
CFS

Use	Surface Water	Ground Water	Total
Domestic	61.397	4.844	77.241
Irrigation	4,553.948	2,053.082	6,607.030
Municipal	955.833	226.437	1,182.270
Industrial	505.379	191.891	697.270
Power	22,039.724	0.400	22,040.124
Mining	6.500	0	6.500
Recreation	73.492	1.076	74.568
Wildlife	9.420	1.488	10.908
Fish Life	783.972	5.170	789.142
Total	28,989.665	2,484.388	31,474.053

Most of the existing water storage in the basin has resulted from the Corps of Engineers Willamette Basin Project system, of which the initial units were authorized in 1938. Authorized functions included flood control, irrigation, navigation, and power generation, where applicable. Since the initial projects, Federal policy as to beneficial use of water has been expanded to include the functions of municipal and industrial water supply, fish and wildlife enhancement, water quality control, and recreation. An important phase of the current study is to reevaluate existing, under construction, or presently authorized Federal projects (shown in Table III-3) to determine the desirability of modifying or adding to them to satisfy needs. All projects listed in Table III-3 were authorized for construction and operation by the Corps of Engineers, except Scoggins Reservoir, which was authorized for construction by the Bureau of Reclamation.

Table III-3

Major Federal Storage Projects

Project or Reservoir	Stream	River Mile 1/	Reservoir Normal or Max. Pool (Acres)	Total Capacity (Ac. Ft.)	Type of Dam 2/	Authorized Functions 3/	Year in Operation
			E X I S T I N G				
Fern Ridge	Long Tom River	25.7	10,400	116,200	E,CGSp.	FC,N,I	1941
Cottage Grove	Coast Fk. Willamette R.	29.7	1,158	33,060	E,CGSp.	FC,N,I	1942
Dorena	Row River	7.6	1,840	77,500	E,CGSp.	FC,N,I	1949
Detroit	N. Santiam River	49.2	3,580	455,000	CG	FC,N,P,I	1953
Big Cliff (Rereg.)	N. Santiam River	46.4	100	5,930	CG	P	1953
Lookout Point	Mid. Fk. Will. River	19.9	4,360	456,000	E,CGSp.	FC,N,P,I	1953
Dexter (Rereg.)	Mid. Fk. Will. River	16.8	1,025	27,500	E,CGSp.	P	1954
Hills Creek	Mid. Fk. Will. River	45.5	2,735	356,000	E,CGSp.	FC,N,P,I	1961
Cougar	S. Fk. McKenzie River	4.5	1,280	219,000	E,CGSp.	FC,N,P,I	1963
Fall Creek	Fall Creek	7.2	1,880	125,000	E,CGSp.	FC,N,I	1965
			U N D E R C O N S T R U C T I O N				
Green Peter	Mid. Santiam River	5.7	3,720	430,000	CG	FC,N,P,I	1967
Foster	S. Santiam River	37.7	1,220	61,000	E,CGSp.	P,FC	1967
Blue River	Blue River	1.7	975	89,000	E,CGSp.	FC,N,I	1968
			A U T H O R I Z E D				
Holley 4/	Calapooia River	45.5			E,CGSp.		-
Cascadia	S. Santiam River	46.7	1,700	160,000	E,CGSp.	FC,N,I	-
Gate Creek	Gate Creek	0.4	605	55,000	E,CGSp.	FC,N,I	-
Strube (Rereg.)	S. Fk. McKenzie River	2.5	230	5,900	E,CGSp.	P	-
Scoggins	Scoggins Creek	5.1	1,120	61,000	E,CGSp.	I,M,FC,R,FWL	-

1/ *CBIAC river mileage, June 1963*

2/ *E = Earthfill; CG = Concrete gravity; CGSp = Concrete gravity spillway.*

3/ *FC = Flood control; N = Navigation; P = Power; I = Irrigation; M = Municipal and Industrial; R = Recreation; FWL = Fish and Wildlife enhancement.*

4/ *Interim report dated FY 1969 recommends modification of the project authorized in 1959.*

F I S H A N D W I L D L I F E

Fish and wildlife of Willamette Basin are basic resources supporting many types of outdoor recreation and supplying commercially important food supplies.

FISHLIFE

Waters of the basin serve as spawning and rearing habitat for several species of anadromous fish that are harvested commercially in Columbia River and over a wide stretch of coastal waters from Alaska to California. These fish also support a sport fishery extending over a wide area of the ocean, in Columbia and Willamette Rivers, and in several Willamette tributaries.

Recent improvements in fish passage and pollution control in the lower river and in propagation and rearing techniques applicable to the basin indicate that the Willamette system will become one of the most important anadromous fish-producing rivers in the West when fisheries enhancement potentials are realized.

The basin contains thousands of miles of trout streams and many lakes and reservoirs that supply trout and warmwater fish.

WILDLIFE

Principal game species are Roosevelt elk, blacktailed deer, black bear, ring-necked pheasants, valley and mountain quail, ruffed and blue grouse, bandtailed pigeons, mourning doves, and several species of ducks and geese. Many other species of birds and mammals of less economic importance add interest and variety to camping, hiking, fishing, hunting, and other outdoor pursuits. A porcupine in a pup tent may lead to a never-to-be-forgotten experience.

Habitat for many species of wildlife is steadily declining under the pressures of increasing human populations, industrial and urban expansion, and other changes in the use and management of land. Since the biological potential of most game species is relatively low, forcing a strict rationing of the resources and limiting economic values, there is less potential for supplying the anticipated future needs for wildlife than for fish.

The basin contains nine Federal and state fish hatcheries, five state game management areas, one game farm, and three national wildlife refuges, as well as several private fish hatcheries, fee-fishing ponds, and duch clubs.

For additional information on Willamette Basin fish and wildlife resources, see Appendix D - Fish and Wildlife.

M I N E R A L S

The bulk of the mineral production in Willamette Basin goes to supply local demands of the construction industry and for roadbuilding and maintenance projects. Small quantities of metallic ores are mined and shipped to smelters in the other western states; mercury output also goes into national market channels. Location of mineral resources is shown on Map III-1.

The value of minerals produced in Willamette Basin totaled $23.1 million in 1964, or about 38 percent of the state total. Most of the mineral production value in 1964, as in earlier years, was in sand and gravel, stone, and cement; clays and lime also had significant value. Metal output has come largely from the Upper Subarea (Lane County), with most of the precious metals being produced in the Bohemia mining district. Mercury production in the basin has come mainly from the Black Butte mine in the southern part of Lane County. Metal mines in the Upper Subarea have supplied over 98 percent of the value of metals produced in Willamette Basin since 1900.

NONMETALS

The basin's nonmetal mineral resources--clay, limestone, sand and gravel, silica sand, trap rock (basalt), and miscellaneous stone--comprise over 95 percent of the total value of all minerals produced in the basin.

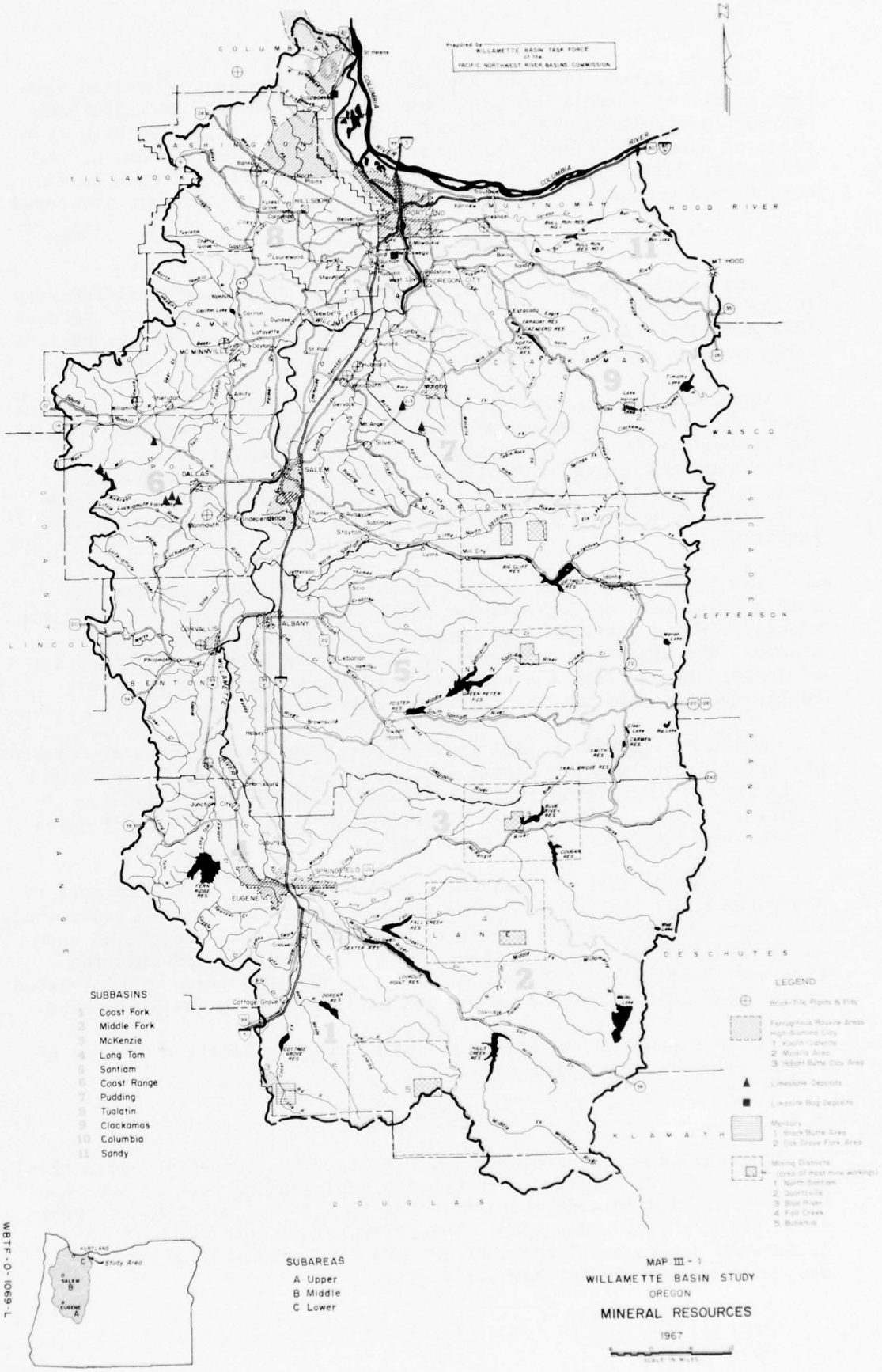
Clay

The miscellaneous clay classification includes both clay and shale. The clay is used almost entirely for manufacturing building brick, draintile, and other heavy clay products. Part of the shale mined is expanded into lightweight aggregate for use in concrete and other structural products. The location of firms manufacturing clay products is shown on Map III-1.

Kaolin-laterite zones surround and underlie the ferruginous-bauxite areas in Washington and Marion Counties. High alumina clays are formed in the Molalla area in Clackamas County and the Hobart Butte area in Lane County.

Limestone

A small number of limestone deposits occur in Clackamas and Polk Counties. Clackamas, Lane, Marion, Polk, and Yamhill Counties together have produced over two million short tons. The longest record of production has come from the Oregon Portland Cement Company's property about 3 miles southwest of Dallas in Polk County. Production started about 1911 and terminated in 1966 when, because of more rigid specifications, this high alkali limestone became unsuitable for use in cement.



WBTF-0-1069-L

MAP III - 1
WILLAMETTE BASIN STUDY
OREGON
MINERAL RESOURCES
1967

Several other limestone deposits in the area west of Dallas have been worked in a small way from time to time. Several quarries have provided agricultural limestone for local farms within a distribution range of about 20 miles. In general, the low calcium content of the Willamette Valley limestones has restricted and will continue to restrict this use unless new uses for low-grade limestones are developed.

Sand and Gravel

The production of sand and gravel is the leading mineral industry in the Willamette Basin, in terms of both quantity and value. Between 1940 and 1966, sand and gravel accounted for 48 percent of the basin's total mineral production value.

Sand and gravel, closely related to the erosive action of streams which are violent at times, are relatively abundant throughout most of the Willamette Basin. Considerable gravel, deposited during the Pleistocene and Recent epochs, is a component of the alluvium that makes up the terrace and flood plain deposits. This material generally requires screening and washing to remove the fine clay and silt particles.

The Willamette River channel from Portland to Oregon City has been a major source of gravel for the Portland area. In the past, the Clackamas River carried large quantities of gravel during floods; however, the migration of gravel is diminishing with the construction of large dams and with the commercial mining of upstream sources. Future requirements must be fulfilled from new sources.

Willamette River channel gravels are being dredged from the riverbed between Portland and Corvallis, under control of the Division of State Lands. Major tributaries, such as the Clackamas, Pudding, Molalla, Santiam, and McKenzie Rivers on the east and Rickreall Creek on the west also are sources of gravel.

The availability of sand and gravel will change as the effects of headwater flood control and power diversion dams become more pronounced. The upstream dams provide a positive block to channel passage of sand and gravel from upstream sources. Thus it is anticipated that the tributary Santiam and McKenzie Rivers may soon show signs of diminished gravel load as the present in-channel bars migrate to the Willamette.

Urban expansion has severely limited the exploitation of some of the basin's older alluvial deposits.

Silica Sand

Several deposits of high-purity silica sand, intermixed with clay, occur just west of Eugene. One deposit has produced over 10,000 tons of material used to make refractory brick; a lesser quantity was processed for use as foundry sand. The principal deposit has been engulfed and others are threatened by spreading urbanization so they, too, will be lost to further utilization.

Photo III-3 Sand and gravel being dredged from the Willamette River into barges.

Trap Rock

Basalt (trap rock) normally is crushed for various uses. It is widely distributed in the Cascade Range and occurs in buttes and hills throughout the Willamette Valley. Trap rock, ranging from basalt to gabbro, occurs as dikes and sills in many areas of the Coast Range.

Road construction and maintenance account for the greatest use of crushed rock. Where river gravels are not available, crushed rock also is used commercially in concrete.

Miscellaneous Stone

About 9.8 million tons of quartzite, granite, and tuffaceous rock were produced in the Willamette Basin between 1920 and 1966. These were used primarily for building purposes. This production is expected to continue as a small portion of the annual nonmetal output.

METALS

Metallic deposits include ferruginous bauxite, gold, silver, copper, lead, zinc, limonite bog ore, and mercury. Based on present knowledge, reserves and potentials for metallic ores in the Willamette Basin are limited.

Ferruginous Bauxite

Deposits of ferruginous bauxite occur in parts of northwestern Oregon, principally in Washington, Columbia, and Marion Counties. The largest known deposits are found in two main areas: Pumpkin Ridge - Dixie Mountain area in the Tualatin Mountains in northern Washington County, and the Salem Hills area in western Marion County. Other deposits are located in the Chehalem Mountains of Yamhill County, in the Mehama area of Marion County, and in the Estacada area of Clackamas County. Potential areas are outlined on Map III-1.

The Tualatin Mountain deposits, although the largest in northwestern Oregon, are too low grade to compete with imported bauxite ores. The Salem Hills bauxite apparently is not yet considered competitive with imported bauxite either, although it has a slightly higher alumina and lower iron and silica content than the Tualatin Mountain material.

The Aluminum Company of America carried on an extensive exploration program in the Tualatin Mountains during the late 1940's and reportedly discovered at least 25 million tons. From 1955 to 1962, several of the major aluminum companies conducted exploratory drilling programs in the Salem Hills. Reynolds Metal Company in 1966 owned approximately 2,000 acres of land in the area.

Gold, Silver, Copper, Lead, and Zinc

The base and precious metals mining districts and the Willamette Basin subareas and drainage systems that include them are:

1. North Santiam district - Middle Subarea, on the headwaters of Little North Santiam River.

2. Quartzville district - Middle Subarea, on Quartzville Creek.

3. Blue River district - Upper Subarea, on Quartz Creek.

4. Fall Creek district - Upper Subarea, on Christy Creek.

5. Bohemia district - Upper Subarea, on the headwaters of Champion Creek.

Recorded production value of gold, silver, copper, lead, and zinc since 1880 has been about $1.6 million, 85 percent from gold. The production value since 1940 has totaled $200,000, 61 percent from gold. The Bohemia and Blue River mining districts, in Lane County, have produced 97 percent of these metals. Some gold has been shipped from the Quartzville district, Linn County, and a few tons of base metal ore have been mined from the North Santiam district, Marion County. The Fall Creek district, Lane County, has mineralized structure but no recorded production.

During the late 1800's and early 1900's, emphasis was on gold mining. The production was mostly from the oxidized portions of the veins. Since about 1910, when complex sulfide ores could be concentrated, the districts sporadically produced copper, lead, and zinc. Most of the silver produced has been a byproduct of ore mined chiefly for other metal constituents.

Limonite Bog Ore

Bog iron deposits, generally small, are exposed in Clackamas and Washington Counties. Commercial production of the bog ore for making iron has been restricted to the Iron Mountain deposit at Lake Oswego, where the Prosser Mine operated from 1867 to 1894. Enough ore was mined to produce 93,404 tons of pig iron. A few small, isolated deposits are known in northern Washington County, but these are not considered even remotely economic.

Mercury

Two mercury producing areas--the Black Butte and Oak Grove Fork districts--are located in the basin. The Black Butte has been the more productive, accounting for 15 percent of Oregon's total mercury production. The district's mines, some of which lie just outside the Willamette Basin, still contribute to the Lane County economy. The Oak Fork area of Clackamas County has only produced a total of 200 to 400 flasks of mercury (one flask of mercury weighs 76 pounds).

FUELS

Coal

Six of the nine counties in Willamette Basin have coal deposits that were slightly developed many years ago. Very little information is available on volume or quality. Ranked as lignite or subbituminous coal, small quantities have been mined and marketed locally.

Petroleum and Natural Gas

Major periods of exploration for petroleum in Oregon occurred during the early and middle 1940's and, again, in and subsequent to 1949 Records of the State Department of Geology and Mineral Industries show that over 130,000 linear feet of exploratory drilling has been done in the Willamette Basin in search of oil and gas, but with negative results. There has been no commercial production of oil or gas in the basin.

FORESTS AND FOREST LANDS

Forests cover about three-quarters of Willamette Basin and are thus one of its major natural resources. Forests are the source of raw material for the basin's leading industry--timber and forest products. Most streams head on forest lands. The basin's forests provide a major wildlife habitat and are the main setting for outdoor recreation.

Forests vary widely within the basin. On the basis of ecology and climate, they can be divided into four zones: the valley woodland, the principal forest, the upper slope forest, and the subalpine forest. (Map III-2, Generalized Land Use.)

FOREST ZONES

Valley Woodland

The valley woodland generally lies below 1,000-foot elevation and has a relatively dry, warm climate. Forest stands are scattered between

Photo III-4 Typical valley woodland. (USFS Photo)

agricultural tracts and occupy less than 30 percent of the total area. They usually occur in blocks of less than 500 acres and are owned by farmers and ranchers. Hardwood stands flourish in this zone, both on bottom land flood plains and on dry sites. Cottonwood, alder, bigleaf maple, and willow are the most common species on bottom lands, oak on drier sites. Softwood stands grow on a variety of sites. The prevalent species is Douglas-fir. Other common species are grand fir, western hemlock, and western red cedar.

Principal Forest

The principal forest begins between elevations of 500 and 1,000 feet, and extends up to 4,000 feet. This zone produces the bulk of the basin's wood crops. Annual precipitation ranges from 60 to 140 inches. There is moderate winter snowfall and snowpack accumulation. Temperatures are cooler than those in the valley zone. Most of the zone contains forest cover. Douglas-fir forests often occur in pure stands over large areas. Other common species are western hemlock, western red cedar, and true firs with some ponderosa pine and sugar pine in the upper and middle elevations. The hardwoods consist of red alder, bigleaf maple, and Oregon white oak. Most forest lands in this zone are either in public ownership or are held by large timber companies.

Upper Slope Forest

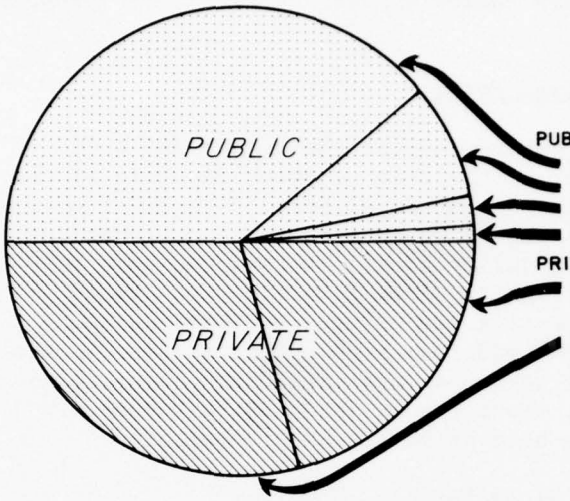
The upper slope forest extends from elevations of 3,000 to 4,000 feet upward to 6,000 feet. Upper slope forests exist only on the highest peaks on the west side of the basin but cover large areas in the Cascade Range. The climate is moderate except for brief periods of hot summer weather and cold winter weather. Precipitation ranges from 90 to 140 inches, and winter snowfall is heavy with significant snowpack accumulation. About 80 percent of the zone is forested; the remainder consists of rock outcrops, meadows, lakes, and noncommercial timber stands. True fir-mountain hemlock stands are predominant, but lodgepole pine stands occur on areas of recent fire or volcanic activity. Most of the land is in National forests.

Subalpine Forest

The subalpine forest zone begins at elevations of 5,500 to 6,000 feet in the Cascades and extends to timberline. It receives heavy snows and has a short growing season of about 30 days. The principal tree species are subalpine fir, mountain hemlock, whitebark pine, and ground juniper which occur in scattered stands mixed with meadows, barren areas, and lakes. A number of the Cascade peaks lie above timberline. Most of this zone is within National forests.

FOREST LANDOWNERSHIP

Forest land areas in the basin are divided equally between private and public ownerships (Figure III-3).



OWNERSHIP CLASS	1,000 ACRES	PER-CENT %
PUBLIC:		
NATIONAL FOREST	2,019	39
BLM ADMINISTERED LANDS	421	8
STATE	103	2
COUNTY & MUNICIPAL	27	1
PRIVATE:		
LARGE PRIVATE (OVER 5,000 ACRES)	1,070	21
OTHER PRIVATE (LESS THAN 5,000 ACRES)	1,454	29
TOTAL	5,094	100

Figure III-3 Forest Landownership, Willamette River Basin, Oregon, 1964.

Public Lands

Four national forests: Mt. Hood, Willamette, Umpqua, and Siuslaw, make up about 80 percent of the public land. Except for the Siuslaw, they generally cover the headwaters of the eastern tributaries of the Willamette Basin. An additional 16 percent of the public land is public domain and Oregon and California Railroad revested lands. These lands, administered by the Bureau of Land Management, occur in blocks of from less than one to several sections scattered throughout the Coast Range and foothills of the Cascades. Most of the remaining public land is state, county, and municipal lands distributed throughout the basin.

Most state-owned forest land, three-quarters of which lies in the Middle Subarea in well defined tracts, is managed by the Oregon State Department of Forestry. State lands at the eastern edge of the Tillamook Burn in Washington County are typical examples of state management areas. The rest of the state-owned forest land is in state parks administered by the Oregon State Highway Commission.

Some counties, particularly Clackamas, Lane, and Washington Counties, own significant forest land acreage and are attempting to bring it to intensive management levels. Lane County's plans for forest development are tied principally to their future needs for recreation expansion.

City forest land holdings represent less than one percent of the basin acreage; however, several cities such as Corvallis, Forest Grove, Portland, and Hillsboro own or control important parts of the watersheds that provide their municipal water.

Private Lands

Private forest lands, of which about 40 percent are in "large private" ownerships, are widely dispersed throughout the basin. More than half of the basins private forest holdings are in the Middle Subarea. It is significant to long-range wood fiber production that a majority of the large private holdings are in the principal forest area, while most of the small private holdings are in the valley woodland zone.

Farms often include woodlands. Small tract ownerships, the majority of which are less than 100 acres in size, create a complex pattern of intermingled forest woodlands. In the Upper Subarea, for example, 95 percent of the private forest owners (about 2,000) own only 25 percent of the private commercial forest.

There is a definite trend toward consolidation of forest ownerships into larger blocks. Medium and small nonfarm holdings are being merged into larger tracts. Small farm holdings, however, generally are resisting this trend.

Many full-time farmers recognize the business opportunity in farm forest management and are retaining their woodlands. Frequently, the farmer has had past association or working relationships in the logging or woods industry.

FOREST LAND USE

Classifications

Legislative authority and agency policies control public forest land use, while private forest land-use patterns usually stem from a large variety of personal, social, and economic factors. The major uses of forest land in the basin are water production, outdoor recreation, and wood fiber production. Other important uses are for botanical and ecological studies and wildlife habitat.

Land class and cover type for the Willamette Basin are shown in Tables III-4 and III-5. The land classification system is based primarily on four classes: commercial forest, noncommercial forest, reserved forest, and nonforest. Cover type indicates the specific class of vegetative cover.

About 65 percent (5 million acres) of the Willamette Basin is commercial forest land. Commercial forest land is forest land that is (a) producing, or physically capable of producing, usable crops of wood; (b) economically available, now or prospectively, for timber harvest; and (c) not withdrawn from timber harvest.

Publicly owned commercial forest land where timber harvesting is especially modified to protect or enhance recreational or watershed values, is called "modified-commercial" forest land. Commercial forest land is further divided by cover type.

Noncommercial forest land is incapable of producing usable crops of wood because it is an adverse site or is uneconomical due to physical location. Certain rugged, steep slopes of the Cascades may have merchantable timber stands that are barely able to hold the slope and site in a stable position. Conventional logging of the vegetative cover in such cases often destroys the site and triggers widespread land movement. For this reason, this land is often classified noncommercial. Future harvesting methods may make it possible to safely log these unstable slopes.

Reserved forest land is defined as land withdrawn from timber harvest (and often forest uses) through statute, ordinance, or administrative order.

Nonforest land includes all land that is less than 10 percent stocked with trees (except for nonstocked cutover forest land), such as cultivated land, pasture, lakes, streams, and urban areas.

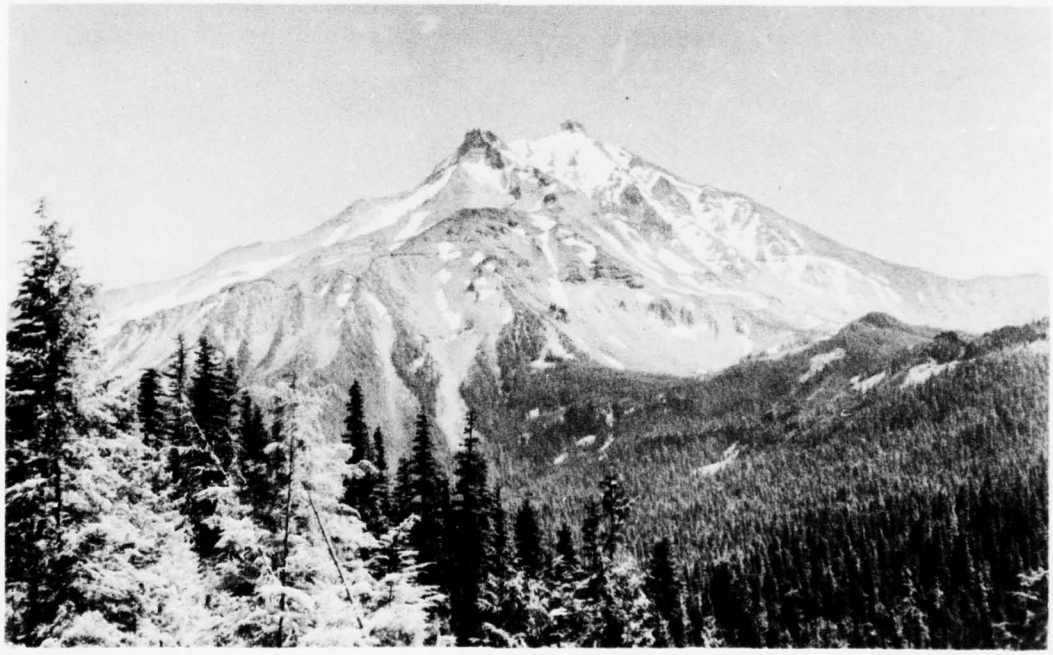


Photo III-5 Mt. Jefferson in the Willamette National Forest showing upper forest & Alpine zone (USFS Photo 483651).

Land Class and Cover Type	Upper Subarea 1/ 1 Coast Fork	2 Middle Fork	3 McKenzie	4 Long Tom	Total	5 Santiam
Conifers						
Above 90 Years						
BLM	27.8	9.4	13.2	7.3	57.7	16.0
State	0.1	0.2	0.4	0.4	1.1	2.6
Large Private	0.0	0.0	0.0	0.0	188.1	0.0
Other	0.0	0.0	0.0	0.0	24.9	0.0
Below 90 Years						
BLM	35.8	15.8	37.6	11.3	100.5	46.3
State	0.1	0.4	1.1	1.0	2.6	6.1
Large Private	0.0	0.0	0.0	0.0	238.2	0.0
Other	0.0	0.0	0.0	0.0	215.8	0.0
Hardwoods						
BLM	0.4	0.4	1.6	0.8	3.2	2.3
State	0.0	0.0	0.1	0.1	0.2	0.8
Large Private	0.0	0.0	0.0	0.0	39.5	0.0
Other	0.0	0.0	0.0	0.0	90.5	0.0
Nonstocked and Nonforest						
BLM	3.1	0.2	0.4	0.2	3.9	1.2
State	0.0	0.0	0.1	0.1	0.2	0.8
Large Private	0.0	0.0	0.0	0.0	20.7	0.0
Other	0.0	0.0	0.0	0.0	20.3	0.0
Total						
BLM	67.1	25.8	52.8	19.6	165.3	65.8
State	0.2	0.6	1.7	1.6	4.1	10.3
Large Private						466.5
Other						351.5
Other Public and Large Private					987.4	

1/ Large private and other ownership data is not broken down to subbasins due to accuracy lim

SOURCE: Bureau of Land Management, State Forester Inventories, Forest Survey, N. W. Oregon, and estimates by field party.

TABLE III-4

Land Class, Cover Type, Other Public and Privat

1,000 Acres

otal	Middle Subarea[1] 5 Santiam	6 Coast Range	7 Pudding	Total	Lower Subarea[1] 8 Tualatin	9 Clackamas	10 Columbia	11 Sandy	Total
57.7	16.0	43.1	25.7	84.8	1.6	3.8	1.0	3.1	9.5
1.1	2.6	3.3	1.8	7.7	0.7	0.0	0.0	0.0	0.7
38.1	0.0	0.0	0.0	242.2	1.1	1.8	0.7	2.0	5.6
24.9	0.0	0.0	0.0	24.2	5.0	17.5	0.0	6.9	29.4
00.5	46.3	48.1	10.0	104.4	7.9	5.6	4.7	4.7	22.9
2.6	6.1	26.4	10.7	44.2	20.1	0.0	0.0	0.0	20.1
38.2	0.0	0.0	0.0	399.6	28.0	12.4	11.3	4.0	55.7
15.8	0.0	0.0	0.0	164.0	123.4	56.0	36.0	14.0	229.4
3.2	2.3	5.2	1.5	9.0	0.6	1.0	0.4	0.8	2.8
0.2	0.8	0.6	0.6	2.0	0.1	0.0	0.0	0.0	0.1
39.5	0.0	0.0	0.0	203.2	4.9	3.6	3.3	8.0	19.8
90.5	0.0	0.0	0.0	114.0	22.9	15.8	11.0	27.1	76.8
3.9	1.2	6.2	2.2	9.6	0.6	1.0	0.4	0.8	2.8
0.2	0.8	2.5	0.7	4.0	7.3	0.0	0.0	0.0	7.3
20.7	0.0	0.0	0.0	32.2	0.0	1.2	2.7	0.0	3.9
20.3	0.0	0.0	0.0	10.1	0.0	13.3	8.4	0.0	21.7
55.3	65.8	102.6	39.4	207.8	10.7	11.4	6.5	9.4	38.0
4.1	10.3	32.8	13.8	56.9	28.2	0.0	0.0	0.0	28.2
	466.5			877.2	34.0	19.0	18.0	14.0	85.0
	351.5			312.3	151.3	102.6	55.4	48.0	357.3
87.4				1,454.2					508.5

due to accuracy limitations.

ey, N. W. Oregon,

TABLE III-4

...e, Other Public and Private Lands, 1964
1,000 Acres

...eal/ 10 ...olumbia	11 Sandy	Total	Total Willamette Basin
1.0	3.1	9.5	152.0
0.0	0.0	0.7	9.5
0.7	2.0	5.6	415.9
0.0	6.9	29.4	78.5
4.7	4.7	22.9	227.8
0.0	0.0	20.1	65.9
11.3	4.0	55.7	693.5
36.0	14.0	229.4	609.2
0.4	0.8	2.8	15.0
0.0	0.0	0.1	2.3
3.3	8.0	19.8	262.5
11.0	27.1	76.8	281.3
0.4	0.8	2.8	16.3
0.0	0.0	7.3	11.5
2.7	0.0	3.9	56.8
8.4	0.0	21.7	52.1
6.5	9.4	38.0	411.1
0.0	0.0	28.2	89.2
18.0	14.0	85.0	1428.7
55.4	48.0	357.3	1021.1
		508.5	2950.1

Land Class and Cover Type	Upper Subarea					Middle Subarea		
	1 Coast Fork	2 Middle Fork	3 McKenzie	4* Long Tom	Total	5 Santiam	6 Coast Range	7 Pudding
Sawtimber stands:								
Old-growth Douglas-fir	63.2	308.0	138.1	-	509.3	127.0	8.5	1.0
Other Douglas-fir	7.6	59.7	38.8	-	106.1	100.5	0.4	0.5
Western Hemlock	0.5	30.8	5.1	-	36.4	27.0	0.2	-
Western red cedar	-	12.2	5.7	-	17.9	1.0	-	-
True fir-mountain hemlock	1.2	109.1	29.3	-	139.6	31.5	-	-
Other conifers	-	12.8	7.0	-	19.8	3.3	0.7	0.4
Hardwoods	-	0.6	1.3	-	1.9	-	-	-
Poletimber stands:								
Douglas-fir	3.6	19.2	14.6	-	37.4	22.0	2.0	-
Western Hemlock	0.7	2.6	1.9	-	5.2	1.4	-	-
True fir-mountain hemlock	0.1	13.5	12.7	-	26.3	6.5	-	-
Other conifers	-	3.8	3.8	-	7.6	1.8	0.3	0.9
Hardwoods	0.1	-	-	-	0.1	-	-	-
Seedling-sapling stands:								
Douglas-fir	7.1	30.8	14.6	-	52.5	12.0	4.0	-
Western Hemlock	0.2	1.9	1.9	-	4.0	-	-	-
True fir-mountain hemlock	-	2.6	1.3	-	3.9	1.0	-	-
Other conifers	-	6.4	0.6	-	7.0	0.7	-	-
Hardwoods	-	-	-	-	-	-	-	-
Not stocked	1.4	11.6	3.2	-	16.2	7.3	-	-
Modified-commercial forest	-	-	-	-	-	32.0	0.6	-
Subtotal	85.7	625.6	279.9		991.2	375.0	16.7	2.8
Noncommercial and nonforest	1.4	40.4	21.6	-	63.4	21.0	0.3	0.2
Reserved forest land	-	-	-	-	-	55.0	-	-
Total	87.1	666.0	301.5		1,054.6	451.0	17.0	3.0

** Subbasins 4, 8, and 10 do not contain National Forest Lands.*

TABLE III-5

Land Class and Cover Type: National Forest Lands, 1964

(1,000 Acres)

Middle Subarea				Lower Subarea				
6	7		8*	9	10*	11		Total
Coast Range	Pudding	Total	Tualatin	Clackamas	Columbia	Sandy	Total	Willamette Basin
8.5	1.0	136.5	-	128.7	-	41.7	170.4	816.2
0.4	0.5	101.4	-	40.5	-	20.5	61.0	268.5
0.2	-	27.2	-	65.8	-	35.8	101.6	165.2
-	-	1.0	-	11.7	-	11.7	23.4	42.3
-	-	31.5	-	45.9	-	23.1	69.0	240.1
0.7	0.4	4.4	-	1.2	-	-	1.2	25.4
-	-	-	-	1.8	-	3.1	4.9	6.8
2.0	-	24.0	-	23.9	-	39.7	63.6	125.0
-	-	1.4	-	11.4	-	5.2	16.6	23.2
-	-	6.5	-	26.4	-	10.5	36.9	69.7
0.3	0.9	3.0	-	17.5	-	4.2	21.7	32.3
-	-	-	-	1.2	-	3.7	4.9	5.0
4.0	-	16.0	-	12.7	-	8.1	20.8	89.3
-	-	-	-	1.8	-	4.6	6.4	10.4
-	-	1.0	-	11.2	-	8.3	19.5	24.4
-	-	0.7	-	2.6	-	1.0	3.6	11.3
-	-	-	-	0.6	-	2.8	3.4	3.4
-	-	7.3	-	8.5	-	3.1	11.6	35.1
0.6	-	32.6	-	-	-	-	-	32.6
16.7	2.8	394.5		413.4		227.1	640.5	2,026.2
0.3	0.2	21.5	-	10.2	-	21.0	31.2	116.1
-	-	55.0	-	-	-	5.1	5.1	60.1
17.0	3.0	471.0		423.6		253.2	676.8	2,202.4

Levels of Management

Forest management techniques vary widely within the basin. On some private holdings, timber is harvested with little regard to other products, which the forest may be capable of producing or to other uses that can be made of the forest. On other private holdings, managers frequently apply intensive timber management practices (permanent road construction, fertilization, thinning, etc.) which result in increased productivity over the long run and opportunities for other successful land uses. Public forest lands are receiving more intensive management, which in turn, enables more extensive multipurpose use.

FOREST RESOURCES

The basin's forests are widespread and varied. In some ownerships, the forest consists mainly of young trees; in others, it may be principally old growth. Species of trees vary with geographical location. Precipitation and water yields vary in distribution. So, too, do uses related to forests and forest land vary. The remainder of this section summarized the principal uses of the forests and forest lands as related to fish and wildlife, grazing, recreation, timber, and water.

Fish and Wildlife

Fish and wildlife are integral parts of the forest environment and are basic resources upon which much of the recreational value of forests and woodlands depends. Forest watersheds furnish a large portion of the water flowing in Willamette Basin streams. Much of the spawning and rearing habitat for anadromous fish is in streams flowing through forest lands. Forests and woodlands are the principal habitat for all big game and for several upland game species. For a detailed discussion, see Appendix D - Fish and Wildlife.

Grazing

Most of the livestock grazing on forest land is on areas in and near the valley floor. Many forest stands are ongentle terrain, are relatively free of undergrowth, and have a ground cover of palatable forage plants.

Woodland grazing is extensive only on small private forest lands, mostly west of the Willamette River. After harvest of timber, owners often graze sheep and cattle on the stump land. The wetter sites gradually reforest on their own and animal food diminishes. Dry areas reforest very slowly, especially if the area is heavily grazed.

Some grazing is permitted on national forest land in the upper slope forest zone in the Cascades where there are small wet meadows and open timber stands. Present grazing by cattle totals less than 1,000 animal-unit months. At one time, sheep grazed large portions

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THE WILLAMETTE BASIN COMPREHENSIVE STUDY OF WATER AND RELATED L--ETC(U)
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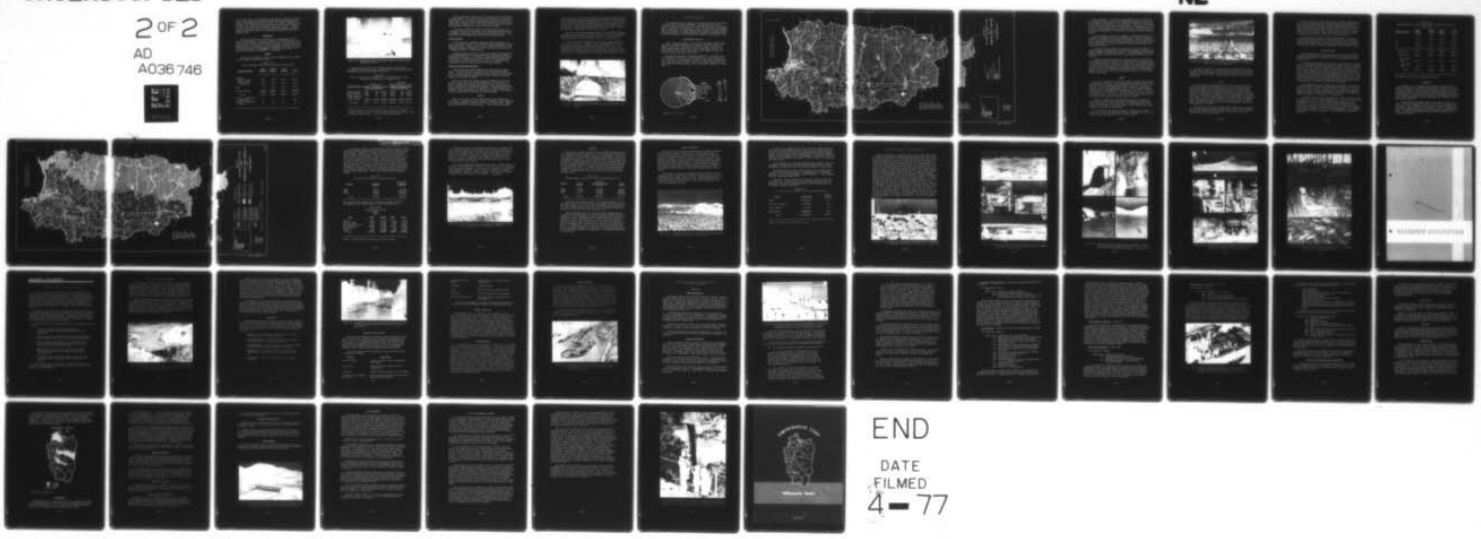

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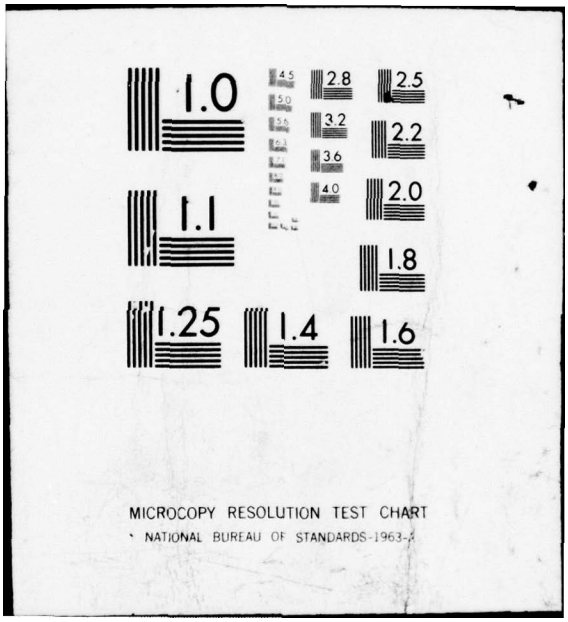
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

of the upper slope and subalpine zones and severely depleted the ground cover. Sheep grazing was gradually eliminated through administrative controls and changing economic conditions. The range is gradually recovering. Very little grazing is permitted on forest lands administered by other public agencies or managed by large forest owners. Changed economic and social desires have required greater emphasis on recreational and watershed values of the mountain areas and less emphasis on grazing values.

Recreation

Vast forest areas offer opportunity for a wide range of recreational opportunities. The general absence of stream pollution in the forest streams enhances their recreational values. The recreational opportunities, more particularly the increasing uses resulting from these opportunities, are placing more and more emphasis on the need for recreation-oriented forest land management, both public and private. For detailed information, see Appendix K - Recreation.

Timber

There are an estimated 5 million acres of commercial forest lands in the Willamette Basin (Table III-6).

Table III-6

Area of Commercial Forest Land, by Ownership Class, 1963

Ownership Class	Upper Subarea	Middle Subarea	Lower Subarea	Total
	Acreage (in thousands)			
Federal:				
National forest	9991.2	394.5	640.4	2,026.1
Bureau of Land Management	165.3	207.8	38.0	411.1
State	4.1	56.9	28.2	89.2
Private and other	818.0	1,189.5	442.3	2,449.8
Total	1,978.6	1,848.7	1,148.9	4,976.2
Percent of commercial forest land	40	37	23	100
Percent of Willamette Basin	26	24	15	65

Photo III-6 Hard-hatted logger, harvesting commercial timber forest. (Weyerhaeuser Photo)

These lands are stocked with about 120 billion board feet of merchantable and hardwood timber. Ninety percent of the hardwood timber is growing on private lands (Table III-7). 1/

Table III-7

Volume of Growing Stock and Sawtimber on Commercial Forest Lands, Softwoods and Hardwoods, by Ownership Class

Ownership Class	Growing Stock			Sawtimber (International 1/4" rule)		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
	Cubic Feet (million)			Board Feet (million)		
National Forest	16,154	136	16,290	95,464	385	95,849
Other Public 2/	3,083	165	3,248	18,455	488	18,943
Forest Industry	2,913	130	3,043	17,584	440	18,024
Farmer Owned and Misc. Private	2,092	847	2,939	10,706	2,595	13,301
All Owners	24,242	1,278	25,520	142,209	3,908	146,117

1/ *Timber volumes used in the narrative are in terms of log scale, Scribner rule, in trees 11 or more inches in diameter at breast height.*

2/ *Lands and Public Domain. Oregon and California Revested.*

The most productive timber areas in the basin are in the Cascade and Coast Ranges. In these areas of heavy precipitation and moderate temperatures, the site index for Douglas-fir averages from 130 to 170. (Site indices range from 80 to 200 for Douglas-fir, the larger figure representing a superior site. Site index is the height in feet that a given species is expected to attain at 100 years of age.)

Site quality generally decreases with increasing elevation and steepening terrain in the Cascades. Site indices between 100 and 125 are common on commercial forest lands in the national forests. Above 4,000 feet in the Cascades, the site index rarely exceeds 100.

Yield Potential

It is difficult to determine sustained yield potentials, since most of the forest stands in the basin are either young-growth or over-mature old-growth. However, after 1990, a continued reduction of the old-growth inventory is expected to result in lower total volume and a consequent reduction in timber harvest.

Although old-growth timber is still the dominant raw material for wood-using industries of the Willamette Basin, young-growth timber is increasing in importance. The remaining commercial old-growth timber probably will be completely harvested in about 90 years; therefore, the potential growth of the basin's forests is of importance in determining how much raw material will be available annually.

Logging and Wood-Using Industries

Timber harvest and lumber manufacturing reached their peaks at about 3.4 billion board feet annually in the late 1940's and early 1950's. Present sustained cutting trends and inventory available indicate that the harvest is leveling off at about 3 billion board feet annually for the 1960-70 decade.

There were about 250 primary wood-using industries in the basin in 1963. These industries use huge quantities of raw material. A high percentage of the sawdust and wood, which once was considered waste, is now used for wood residue products. The sawmills and plywood plants together have a capacity to use about 2.8 billion board feet annually. This estimate does not include wood residue, pulp and paper, and other miscellaneous wood fiber raw material needs.

Water

Most of the annual runoff in the Willamette Basin drains from forest land. Management of forest land is, therefore, vitally important in controlling quality, quantity, and timing of water runoff. Forest cover keeps the soil in stable position. Trees, brush, and organic

litter protect the soil from the eroding action of rainfall and facilitate water percolating into deep ground water storage for later gradual release instead of rapidly running off over the surface. At high elevations, forest cover helps to prolong melting of winter snowpacks, which provide much of the late spring and summer flows in streams rising in the Cascades. Trees provide shade along rivers and streams, helping to maintain water temperatures suitable for fish life.

Basic data concerning (evapotranspiration) the difference between total precipitation and actual water yields for the basin is fragmentary. Based on data from similar watersheds, however, it is estimated that evapotranspiration from forest lands is about 24 inches per year.

The use of forest lands generally involves some disturbance of forest soils and waters. Logging, road building, grazing, recreation, and other uses, as well as wildfires which occasionally occur, can temporarily or permanently affect water quality, color, taste, odor, temperatures, biological levels, and sedimentation. These water qualities, which are a vital consideration in all forest land use, are discussed more fully in Appendix G - Land Measures and Watershed Protection.

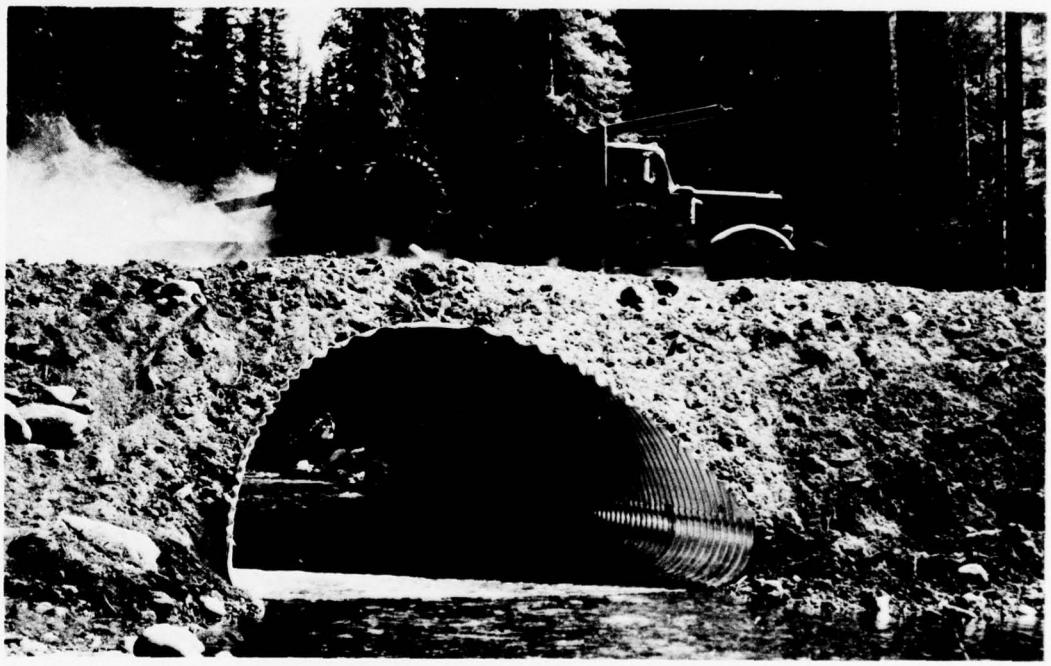


Photo III-7 Forest land use can disturb the natural watershed. (USFS Photo)

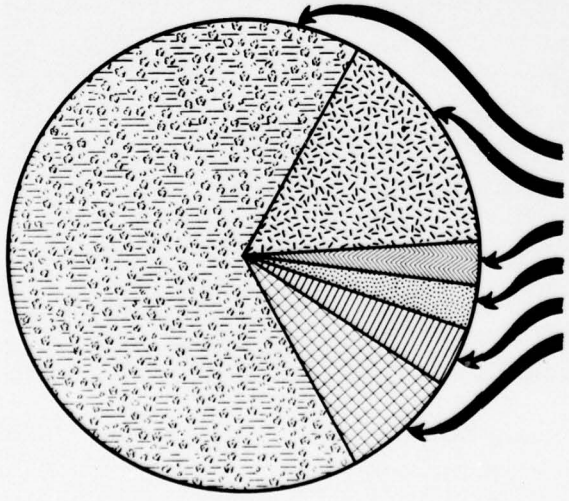
AGRICULTURE

The Willamette Basin is adapted to the production of a wide variety of agricultural crops and commodities. Contributing factors are a temperate climate, fertile soil with broad land capability, and abundant water. Each factor is responsible, in part, for the type of agriculture that has developed. The combination of these physical factors, together with the incentive of economic advantages, has made the Willamette Basin the Nation's leader in the production of a number of specialized crops.

AGRICULTURAL LAND USE

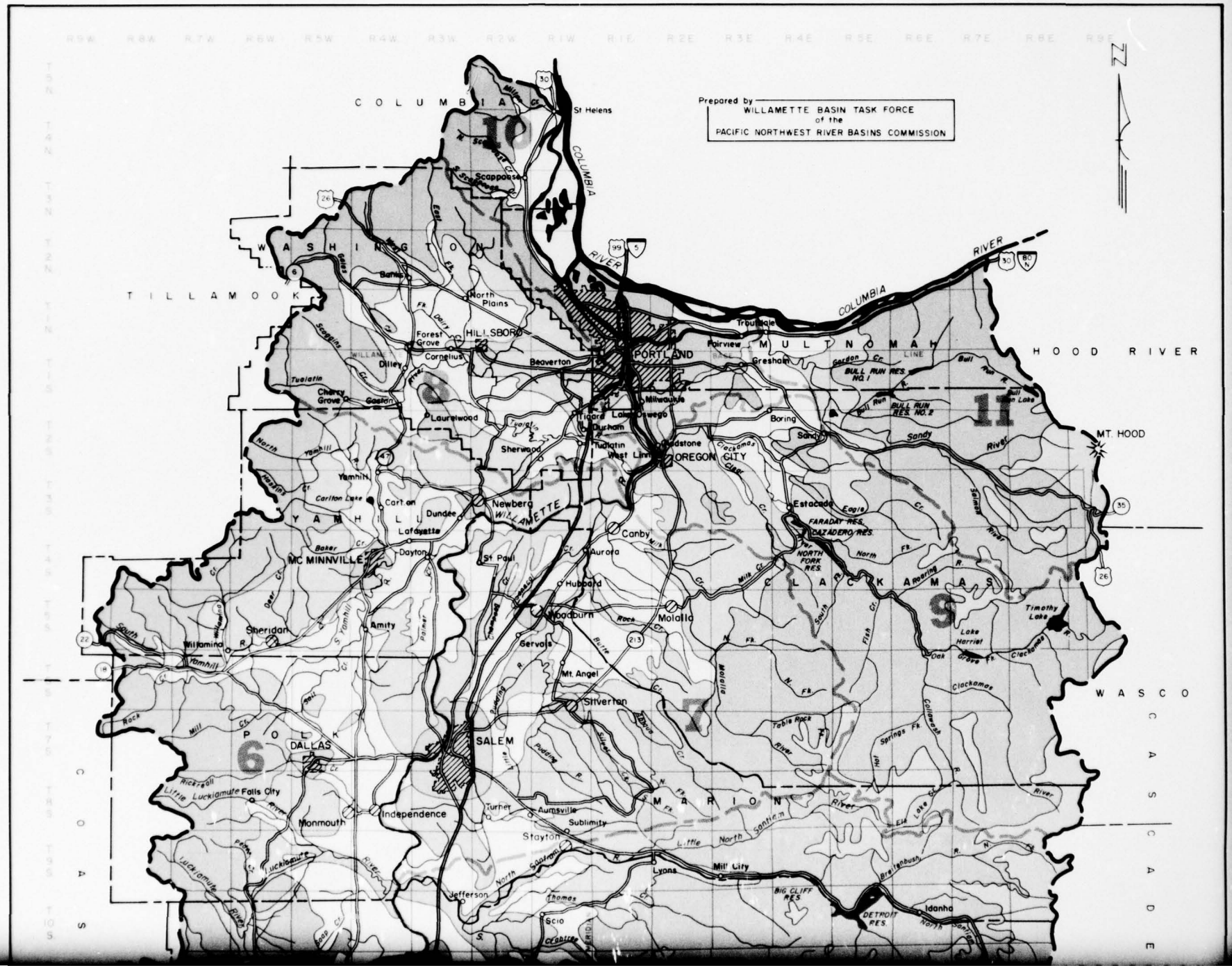
About 2.4 million acres, or 31 percent of Willamette Basin's land area, are in farms (see Figure III-4); about 4.8 million acres - 62 percent of the area - are forested land not in farms. Some forest land is grazed under permit, but is still classified as forest. An estimated 0.5 million acres are used for roads, highways, towns and cities, airports, and other similar uses.

The agricultural area is essentially limited to the valley floor at elevations of 1,000 feet or less (see Map III-2, Generalized Land Use). The bulk of the timberland is found on the strip of higher elevation slopes that ring the basin. Much of the "Other" land use is located around the urban population areas scattered throughout the valley floor.



LAND USE	1,000 ACRES	PERCENT %
FOREST & WOODLAND	5,101	66
DRY CULTIVATED LAND	1,212	16
IRRIGATED LAND	244	3
NATIVE PASTURE	237	3
URBAN	331	4+
"OTHER" USES	583	8
TOTAL	7,708	100

Figure III-4 Land use.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WILLAMETTE BASIN TASK FORCE
of the
PACIFIC NORTHWEST RIVER BASINS COMMISSION
COLUMBIA
WASHINGTON
TILLAMOOK
YAMHILL
POLK
MARION
CLACKAMAS
MULTNOMAH
HOOD RIVER
WASCO
CASCADE
St Helens
Scappoose
Banks
North Plains
HILLSBORO
Forest Grove
Cornelius
Dilley
Beaverton
PORTLAND
Troutdale
Fairview
Gresham
Milwaukie
Lake Oswego
Durham
Tualatin
West Linn
OREGON CITY
Boring
Sandy
MT. HOOD
Laurelwood
Sherwood
Cherry Grove
Gaston
Yamhill
Carlton
Dundee
Lafayette
Newberg
WILLAMETTE
Canby
Aurora
Hubbard
St Paul
Woodburn
Molalla
Estacada
FARADAY RES.
CAZADERO RES.
NORTH FORK RES.
Timothy Lake
Lake Harriet
MC MINNVILLE
Dayton
Amity
Sheridan
Willamina
Gervais
Mt. Angel
Silverton
SALEM
DALLAS
Monmouth
Independence
Falls City
Aumsville
Sublimity
Stayton
Turner
Mill City
Lyons
Jefferson
Scio
Idanha
DETROIT RES.
BIG CLIFF RES.
BULL RUN RES. NO. 1
BULL RUN RES. NO. 2
Bull Run Lake
Sandy River
Salmon River
Clackamas River
North Fk Santiam River
South Santiam River
Little North Santiam River
Breitenbush River
Table Rock
Molalla River
Pudding River
Willamette River
Yamhill River
Luckiamute River
Rickreall
Little Luckiamute River
Rock Creek
Mill Creek
Deer Creek
Baker Creek
Abiqua Creek
Butte Creek
Silver Creek
Thomas Creek
Crabtree Creek
Soap Creek
Scoggins Creek
Tualatin River
Gales Creek
Dairy Creek
Council Creek
Fern Hill Creek
Gordon Creek
Eagle Creek
Roaring River
Fish Creek
Oak Grove Fk
Hot Springs Fk
Collawash River
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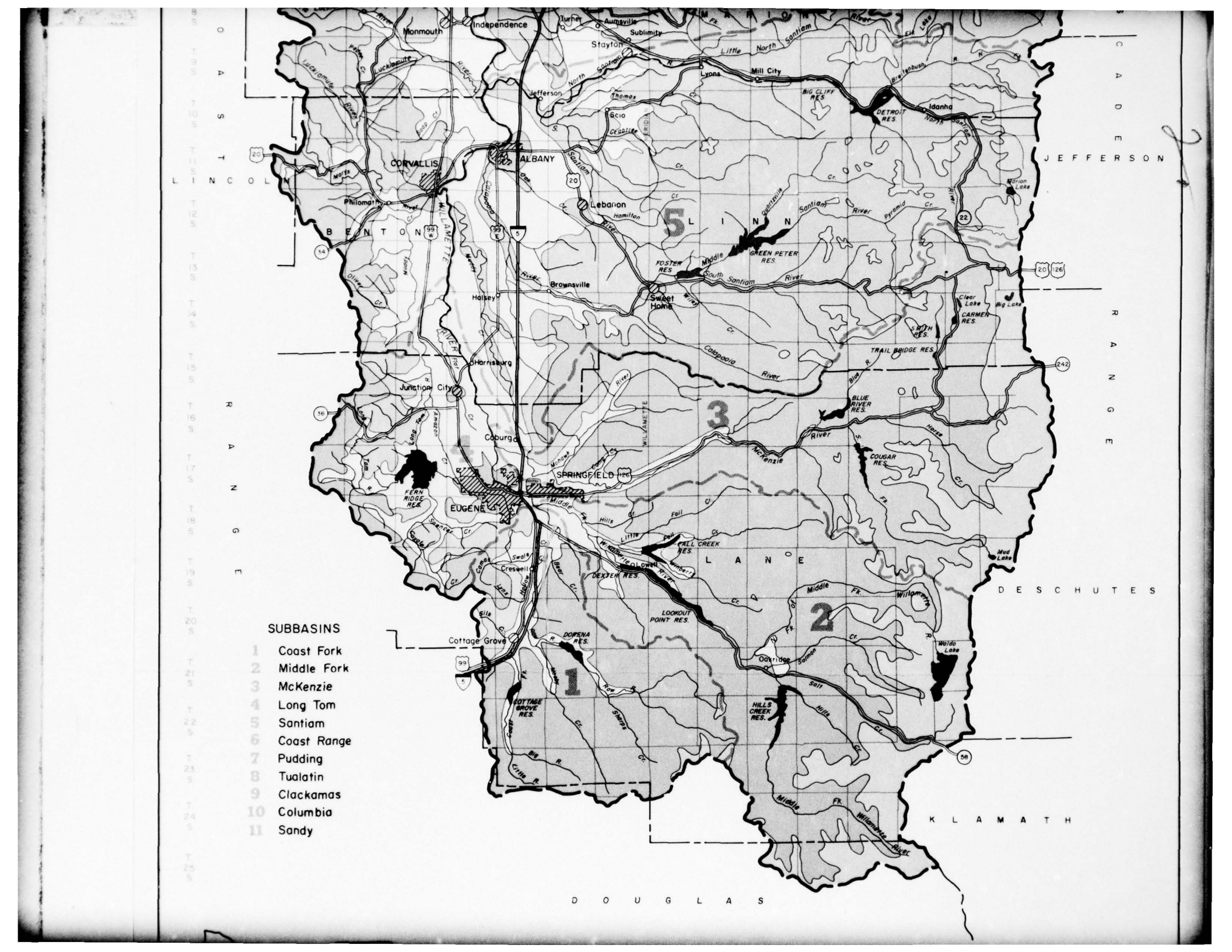
SUBBASINS
1 Coast Fork
2 Middle Fork
3 McKenzie
4 Long Tom
5 Santiam
6 Coast Range
7 Pudding
8 Tualatin
9 Clackamas
10 Columbia
11 Sandy
LINCOLN
BENTON
LINN
MARION
JEFFERSON
DESCHUTES
LANE
DOUGLAS
KLAMATH
COAST RANGE
CASCADE RANGE
Monmouth
Independence
Turner
Aumsville
Sublimity
Stayton
Lyons
Mill City
Jefferson
Scio
Idanha
CORVALLIS
ALBANY
Lebanon
Philomath
Brownsville
Halsey
Sweet Home
Harrisburg
Junction City
Coburg
SPRINGFIELD
EUGENE
Creswell
Cottage Grove
Oakridge
Dexter
Lowell
Detroit Res.
Big Cliff Res.
Green Peter Res.
Foster Res.
Fern Ridge Res.
Dorena Res.
Cottage Grove Res.
Lookout Point Res.
Fall Creek Res.
Hills Creek Res.
Blue River Res.
Cougar Res.
Trail Bridge Res.
Carmen Res.
Smith Res.
Clear Lake
Big Lake
Marion Lake
Mud Lake
Waldo Lake
Willamette River
Santiam River
North Santiam
South Santiam
Little North Santiam
McKenzie River
Calapooia River
Middle Fk. Willamette
Coast Fk.
Row River
Salt Creek
Hills Creek
Fall Creek
Dexter Res.
Lookout Point Res.
Green Peter Res.
Foster Res.
Detroit Res.
Big Cliff Res.
Blue River Res.
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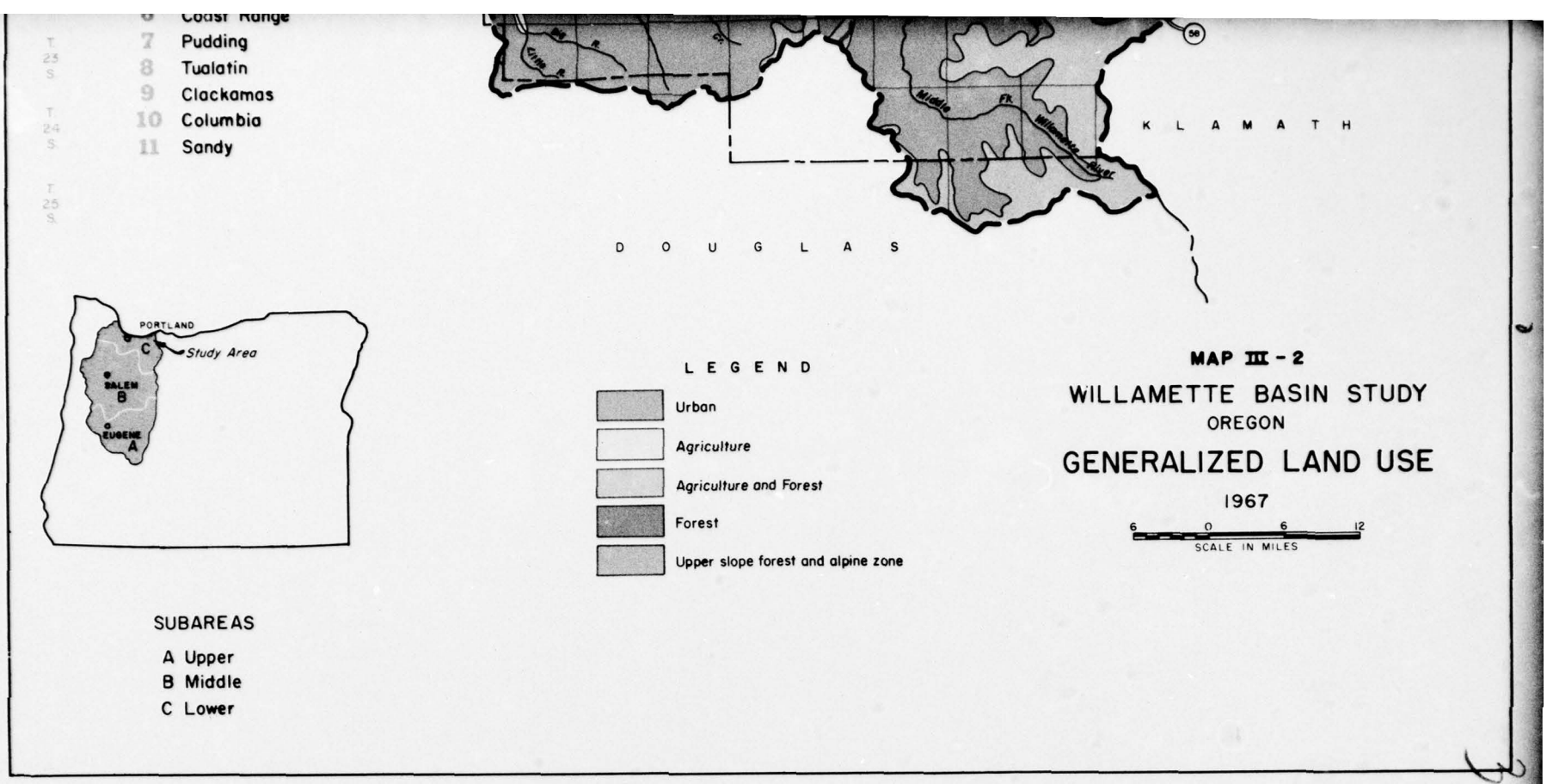
Trail Bridge Res.
Fern Ridge Res.
Dorena Res.
Cottage Grove Res.
Hills Creek Res.
Carmen Res.
Smith Res.



SUBAREAS

A Upper
B Middle
C Lower

LEGEND

- Urban
- Agriculture
- Agriculture and Forest
- Forest
- Upper slope forest and alpine zone

MAP III - 2

WILLAMETTE BASIN STUDY

OREGON

GENERALIZED LAND USE

1967

6 0 6 12

SCALE IN MILES

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Three breakdowns - farm timber land, grazing land, and cropland - may be made of the 2.4 million acres classified as land in farms. Much of the basin's grazing area is in a forest-crop transition zone located at the higher elevations and on steeper slopes. This area is often used as fall or early spring pasture in conjunction with improved land. Historically, forage yields have been quite low; yet, yields could double through proper management and quadruple by seeding to permanent improved species.

Of the cropland, 29 percent is devoted to improved pastures, hay, or forage, including both dry and irrigated land. Portions of this cropland are very productive and support a substantial livestock industry. Grain, mostly wheat and barley, and grass seed are closely related to the livestock industry in that grain supplies winter feed, and grass crops supply winter pasture.

The basin leads the Nation in production of such seed crops as Merion bluegrass, chewings fescue, red fescue, bentgrass, crimson clover, common ryegrass, and perennial ryegrass. It also ranks high in the production of many other seed crops and is an important producer of certified seed.

Although row crops and specialty crops are grown on a relatively small acreage, their contribution to the economy of the Willamette Basin is of major importance. Nearly all of these crops are processed locally. The Salem area is one of the largest centers in the Nation for the processing of fruits and vegetables. The Willamette Basin supplies about 14 percent of the Nation's processed snap beans and most of the superior-quality sweet corn. The basin also produces almost all of the filberts grown in the Nation.

CLIMATE

The basin's agricultural lands are favored by long periods without killing frosts or droughts. The growing season exceeds 200 days in the lower valleys and is approximately 150 days in the higher valleys and foothills. The long growing season enables commercial planting and growing of almost any temperate-zone crop, as well as double cropping in many cases. The January mean temperature is about 38° F.; the July mean temperature is about 67° F. On the average, 25 percent of the precipitation occurs in the fall, 45 percent in the winter, 24 percent in the spring, but only about 6 percent during the summer.

The wet, temperate fall-through-spring climate is conducive to winter growth of many crops, particularly to developing good stands of grass and legume seed crops which mature uniformly and produce high quality seed through the dry summer period. The Willamette Basin seed industry has an international market.

The climate further enhances maturity of high-quality, summer-grown crops. This gives the basin a quality advantage over some of the other vegetable-producing areas of the United States.

Photo III-8 A wide diversity of crops is possible in the Willamette Basin. (O. S. Dept. of Labor)

On the other hand, the climate has some undesirable influences on the agricultural resources. Excessive winter rainfall causes flooding, erosion, and drainage problems, which adversely affect crop selection, planting dates, and tillage. Summer drought necessitates irrigation of some crops.

SOILS

On the basis of parent material, there are two general groups of soils in the valley's agricultural areas. The first group, found in the Chehalem Mountains and Salem and Eola Hills, are residual soils formed from igneous rock and tuffaceous sandstone. The second group is the most extensive and the most important agriculturally. The parent material of these soils is composed of alluvial sediments of three geologic ages: (1) older gravelly deposits in varying stages of weathering in the higher terraces on the margins of the valley floor; (2) middle-aged silty deposits on the main valley floor, known as the Willamette Silts, covering the largest area; and (3) recent deposits on the flood plains adjacent to streams.

Soils formed on the older alluvial parent material are represented by the Pringle-Santiam-Golkey drainage catena. These soils are adapted and used for production of such crops as cereal grains, grass seed, strawberries, pasture, and timber.

Soils formed on the middle-aged alluvial sediments, depending on variations in amounts of silty or clayey material and in depths of profiles, in combination with their internal drainage characteristics, are represented by the Willamette-Amity-Dayton, and the less extensive Sifton-Salem-Clackamas-Courtney drainage catenas. These soils are adapted to a wide range of crops, such as hay, grass seed, row crops, pasture, and cereal grain. Nuts, tree fruits, berries, and alfalfa are produced on the better drained soils of these catenas.

Soils formed on the recent alluvial plain make up the Camas-Chehalis-Wapato drainage catena. They are adapted to the same crops as are the Willamette Silts: nuts, tree fruits, berries, and alfalfa on the better drained soils; and root crops, such as carrots, beets, turnips, and potatoes on soils of moderately coarse to medium texture.

LAND CAPABILITY

Closely associated with the basic soil resource are its inherent qualities and limitations for crop productivity. Classification according to capability is a measure of a soil's adaptability for agricultural use.

An interpretive grouping of soils into a "Land Capability Classification," developed by the Soil Conservation Service, shows, in a general way, how soils are suited for most kinds of farming. Soil Characteristics, such as depth, texture, wetness, permeability structure, reaction, water-holding capacity, and inherent fertility; land characteristics, such as slope, erosion hazard, and overflow hazard, and climatic conditions as they influence the use and management of land, are considered in grouping soils into eight land capability classes (Map III-3). The class numbers increase as hazards and limitations of group use increase. Class I land has no hazards or limitations, whereas Class VIII land is so limited that it is unfit for cultivation and grazing.

The classification can be broken into two divisions: (1) land in capability Classes I through IV is generally suited for cultivation and other uses; and (2) land in capability Classes V through VIII is best suited for range, forestry, and wildlife. The basin's land capability classes are further divided into subclasses to indicate the dominating physical limitation or hazard and soil limitations.

An estimate has been made of the amount of land in each capability class for each of the 3 subareas (Table III-8). About 2.8 million acres are adapted to cultivation in Willamette Basin according to this classification. This is 37 percent of the total land area and substantiates, in part, the claim of high agricultural land productivity in the basin. However, a significant portion of land in this category--about one-third million acres--is in urban developments. More detailed discussion is presented in Appendix G - Land Measures and Watershed Protection.

Table III-8

Estimated Acreage of Agricultural Land, by Capability Class, 1964
1,000 Acres

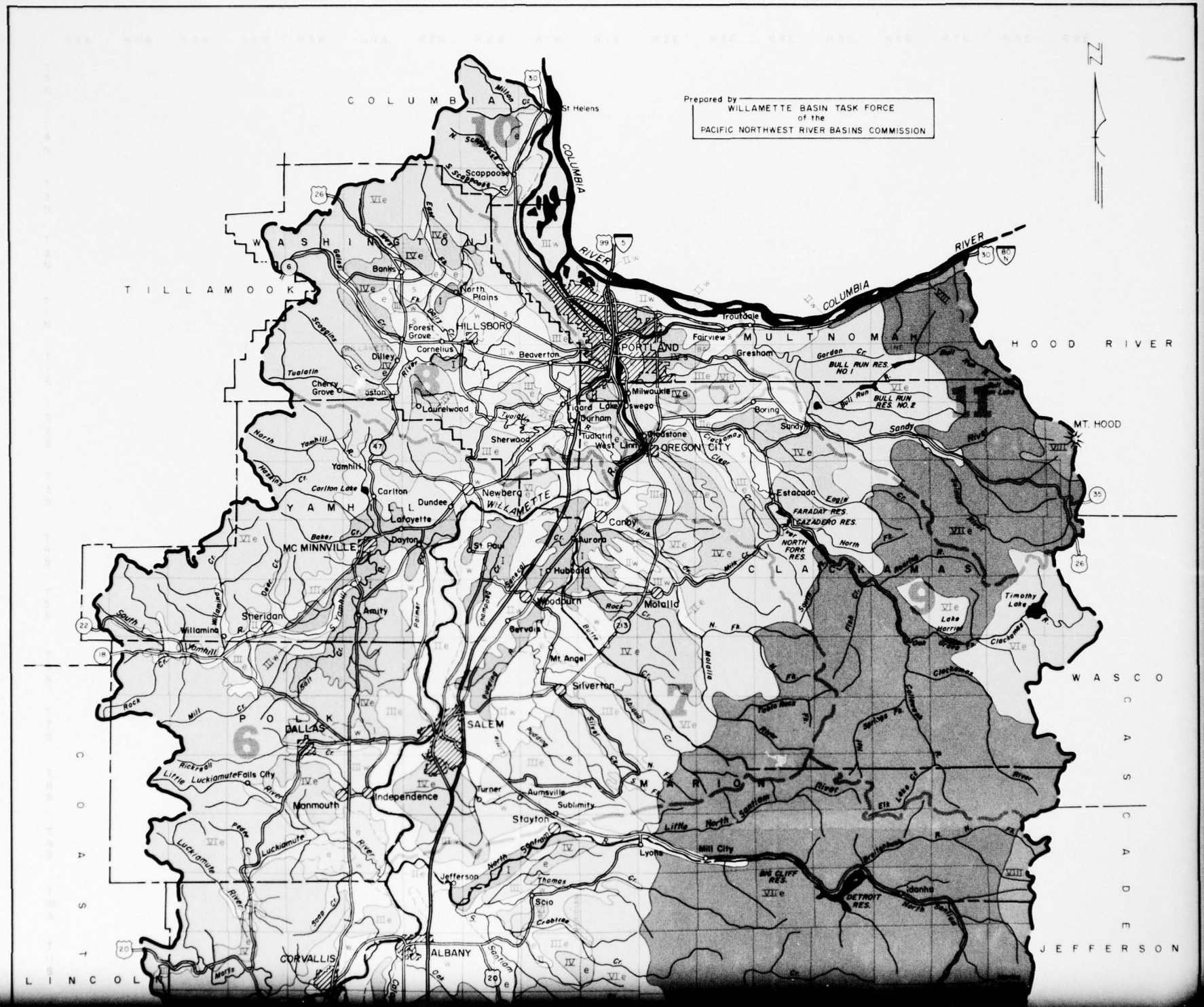
Capability Class	Upper Subarea	Middle Subarea	Lower Subarea	Total Basin
I	70.8	90.5	10.2	171.5
II	55.3	609.4	241.5	906.2
III	192.0	427.2	232.7	851.9
IV	239.0	486.7	146.5	872.2
Total I-IV	557.1	1,613.8	630.9	2,801.8
Total V-VIII	1,889.7	1,827.9	1,083.2	4,800.8
Total land area	2,446.8	3,441.7	1,714.1	7,602.6
Total water area	40.9	27.2	38.3	106.4
Total	2,487.7	3,468.9	1,752.4	7,709.0

Data Compiled by USDA, Soil Conservation Service

IRRIGATION

Irrigation is not a necessity for many basin crops, since the climate is favorable to a diversified agriculture. However, the trend in crop production is toward specialization and intensification, some of which is dependent upon irrigation. Farmers have found that substantially greater yields can be obtained with irrigation. Irrigation is so important to the quality and quantity of most vegetables and many fruits that food processors require irrigation as a condition to contracting with growers.

Irrigation did not develop rapidly in the basin until the late 1940's. From 1949 through 1964, about 112,000 acres of irrigated land were added. Most irrigation is practiced on the better soils on or near the Willamette River and its tributaries. Water is obtained primarily from streams or shallow wells, and usually is applied by sprinklers. Irrigation development has been acccmplished mostly on an individual farm basis.


Prepared by
WILLAMETTE BASIN TASK FORCE
of the
PACIFIC NORTHWEST RIVER BASINS COMMISSION
COLUMBIA
WASHINGTON
TILLAMOOK
YAMHILL
CLACKAMAS
MULTNOMAH
HOOD RIVER
WASCO
POLK
MARION
LINCOLN
JEFFERSON
CASCADES
St Helens
Scappoose
Banks
North Plains
Forest Grove
HILLSBORO
Cornelius
Dilley
Cherry Grove
Laurelwood
Beaverton
PORTLAND
Troutdale
Fairview
Gresham
Milwaukie
Oswego
Tigard
Durham
Tualatin
West Linn
OREGON CITY
Boring
Sandy
MT. HOOD
Estacada
Eagle
FARADAY RES.
CLEAZADERO RES.
NORTH FORK RES.
BULL RUN RES. NO. 1
BULL RUN RES. NO. 2
Gordon Cr.
Bull Run
Sherwood
Yamhill
Carlton
Carlton Lake
Dundee
Lafayette
Newberg
WILLAMETTE
Dayton
MC MINNVILLE
St Paul
Aurora
Canby
Hubbard
Woodburn
Molalla
Timothy Lake
Lake Harriet
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Silverton
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Mill City
BIG CLIFF RES.
DETROIT RES.
Idanha
CORVALLIS
ALBANY
Scio
Thomas Cr.
Soap Cr.
Mary's
Oak
Santiam
North Santiam
South Santiam
Little North Santiam
Clackamas
Molalla River
Pudding R.
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Willamina
Yamhill
Rock Cr.
Mill Cr.
Dairy Cr.
Baker Cr.
Palmer
Abiqua
Butte
Beaver
Berry
Chehalem
Hazelnut Cr.
Scoggins Cr.
Tualatin River
Gales Cr.
Dairy Cr.
Fern Cr.
Miller Cr.
Scappoose Cr.
Columbia River
Willamette River
Sandy River
Eagle Cr.
Clear Cr.
Deep Cr.
Hunter Cr.
Milk Cr.
Rock Cr.
Butte Cr.
Abiqua Cr.
Pudding R.
Silver Cr.
Beaver Cr.
Berry Cr.
Crabtree Cr.
Thomas Cr.
Jefferson
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Mill City
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Carlton
Yamhill
Newberg
Sherwood
Tualatin
West Linn
Oregon City
Gladstone
Milwaukie
Lake Oswego
Tigard
Durham
Beaverton
Hillsboro
Forest Grove
Cornelius
Dilley
Cherry Grove
Laurelwood
Banks
North Plains
Scappoose
St Helens
Troutdale
Fairview
Gresham
Boring
Sandy
Estacada
Eagle
Faraday Res.
Clazadero Res.
North Fork Res.
Bull Run Res. No. 1
Bull Run Res. No. 2
Gordon Cr.
Bull Run
Mt. Hood
Timothy Lake
Lake Harriet
Clackamas
Molalla
Woodburn
Hubbard
Aurora
Canby
St Paul
Gervais
Mt. Angel
Silverton
Big Cliff Res.
Detroit Res.
Idanha
Portland
Columbia River
Willamette River
Sandy River
Eagle Cr.
Clear Cr.
Deep Cr.
Hunter Cr.
Milk Cr.
Rock Cr.
Butte Cr.
Abiqua Cr.
Pudding R.
Silver Cr.
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Berry Cr.
Crabtree Cr.
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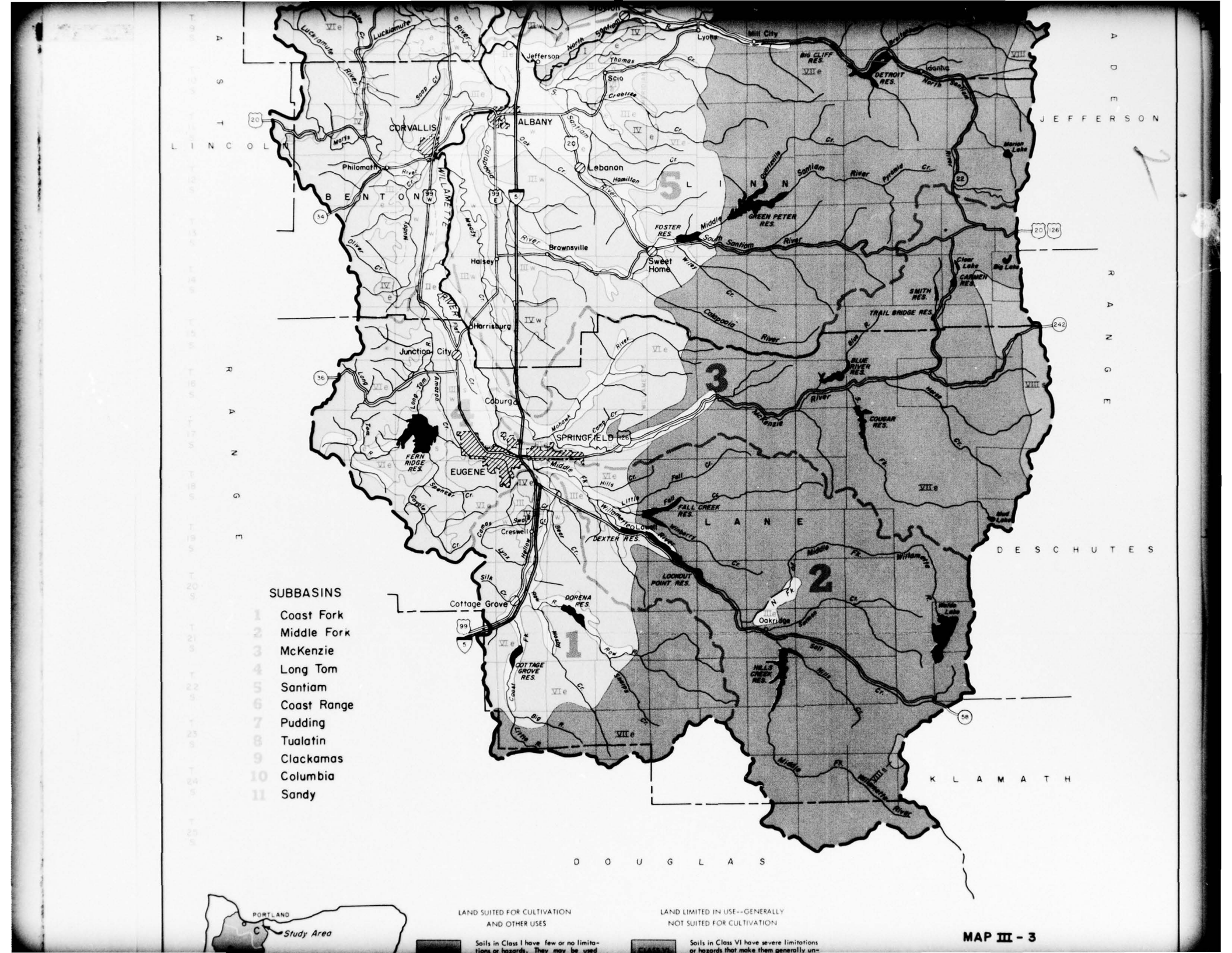
Gervais
Mt. Angel
Silverton
Big Cliff Res.
Detroit Res.
Idanha


SUBBASINS
1 Coast Fork
2 Middle Fork
3 McKenzie
4 Long Tom
5 Santiam
6 Coast Range
7 Pudding
8 Tualatin
9 Clackamas
10 Columbia
11 Sandy
LINCOLN
BENTON
LINN
JEFFERSON
DESCHUTES
LANE
DOUGLAS
KLAMATH
CORVALLIS
ALBANY
Lebanon
Brownsville
Halsey
Sweet Home
Harrisburg
Junction City
Coburg
SPRINGFIELD
EUGENE
Cottage Grove
Creswell
Oakridge
Lyons
Mill City
Scio
Jefferson
Philomath
FOSTER RES.
GREEN PETER RES.
DETROIT RES.
BIG CLIFF RES.
SMITH RES.
TRAIL BRIDGE RES.
BLUE RIVER RES.
COUGAR RES.
FALL CREEK RES.
DEXTER RES.
LOOKOUT POINT RES.
DORENA RES.
COTTAGE GROVE RES.
HILLS CREEK RES.
FERN RIDGE RES.
CARMEN RES.
Willamette River
Santiam River
McKenzie River
Coast Range
Cascade Range
PORTLAND
Study Area
LAND SUITED FOR CULTIVATION AND OTHER USES
Soils in Class I have few or no limitations or hazards. They may be used
LAND LIMITED IN USE--GENERALLY NOT SUITED FOR CULTIVATION
Soils in Class VI have severe limitations or hazards that make them generally un-

MAP III - 3

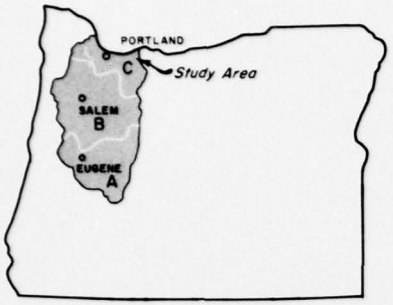
9 Clackamas
10 Columbia
11 Sandy

T 24 S

T 25 S

K L A M A T H

D O U G L A S



SUBAREAS

A Upper
B Middle
C Lower

LAND SUITED FOR CULTIVATION AND OTHER USES

CLASS I — Soils in Class I have few or no limitations or hazards. They may be used safely for cultivated crops, pasture, range, woodland, or wildlife.

CLASS II — Soils in Class II have few limitations or hazards. Simple conservation practices are needed when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

CLASS III — Soils in Class III have more limitations and hazards than those in Class II. They require more difficult or complex conservation practices when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

CLASS IV — Soils in Class IV have greater limitations and hazards than Class III. Still more difficult or complex measures are needed when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

LAND LIMITED IN USE--GENERALLY NOT SUITED FOR CULTIVATION

CLASS VI — Soils in Class VI have severe limitations or hazards that make them generally unsuited for cultivation. They are suited largely to pasture, range, woodland, or wildlife.

CLASS VII — Soils in Class VII have very severe limitations or hazards that make them generally unsuited for cultivation. They are suited to grazing, woodland, or wildlife.

CLASS VIII — Soils and land forms in Class VIII have limitations and hazards that prevent their use for cultivated crops, pasture, range, or woodland. They may be used for recreation, wildlife, or water supply.

SUBCLASSES

e- Erosion susceptibility and past erosion damage are major factors for placement in this sub class.

w- Wetness, high water table, poor soil drainage and overflow are major factors in this subclass.

s- Soils which have limitations such as shallowness, stoniness, low moisture-holding capacity, low fertility difficult to correct, salinity or alkalinity.

MAP III - 3

WILLAMETTE BASIN STUDY

OREGON

GENERALIZED LAND CAPABILITY

1967

6 0 6 12

SCALE IN MILES

WBTF-O-1042abc-LL

3

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The irrigated acreage in Willamette Basin varies from year to year. In the 1964 Census of Agriculture the land reported as irrigated totaled 188,323 acres. However, in accordance with the census instructions, this represented irrigation at a point in time, only land actually irrigated in 1964. Total irrigated acreage is felt better reflected in a field survey conducted by the Bureau of Reclamation representing later data than available for the 1964 census. The survey not only picked up land that may not have been irrigated in 1964 for crop rotation or other reasons but also land on which irrigation may have been initiated subsequent to 1964. According to this survey, there were an estimated 243,660 acres irrigated in the basin during 1965. About 142,260 acres were irrigated from surface water and the remaining 101,400 acres were irrigated from ground water. Table III-9 lists irrigated acreage by subarea.

Table III-9
Irrigated and Potentially Irrigable Lands 1965

Subarea	Irrigated (acres)	Potentially Irrigable (acres)
Upper	34,110	171,340
Middle	171,530	1,023,380
Lower	38,020	293,410
Total	243,660	1,488,130

The irrigated crops, grouped into six major categories, and their distribution in the three subareas are listed in Table III-10.

Table III-10
Irrigated Land Use 1965
Subarea
Acres

Crop	Upper	Middle	Lower	Total
Pasture	10,640	31,600	11,440	53,680
Hay and silage	9,300	27,070	8,380	44,750
Small grains and corn	1,830	10,810	1,380	14,020
Specialty crops	10,860	82,380	11,410	104,650
Field seeds	210	5,030	590	5,830
Others	1,270	14,640	4,820	20,730
Total	34,110	171,530	38,020	243,660

SOURCE: Prorated from 1964 Census of Agriculture, Oregon

In 1964, the Bureau of Reclamation initiated an irrigability land classification survey of the Willamette Basin, which was completed in 1966. Primary objectives of the survey were to determine the extent of potentially irrigable lands, and to classify these lands as to suitability for irrigation. Potentially irrigable lands were mapped as Classes 1, 2, or 3, depending on their relative suitability for irrigation development, with subclasses identified under Classes 2 and 3 to denote specific deficiencies.

The survey showed about 318,000 acres of Class 1; 529,000 acres of Class 2; and 641,000 acres of Class 3 lands, for a total of 1,488,000 acres potentially irrigable. This acreage is in addition to the 243,660 acres presently irrigated. Table III-9 gives estimates of irrigated and potentially irrigable acreage by subarea. For a more detailed discussion of the survey results, see Appendix F - Irrigation.

Photo III-9 Use of irrigation has increased the commercial potential of land for agricultural purposes. (ODA Photo)

DRAINAGE

More than 1.3 million acres have been classified as having restricted drainage under natural conditions. Some 466,000 acres have already been drained to various degrees and much of the remainder is expected to be improved by the year 2020. Drainage figures cited represent land requiring drainage before it can be used for more intense agricultural production. Of particular note is that some soils comprising this area do not need drainage themselves but are inclusions in larger areas that do have a wetness problem. The total drainage problem can be divided into two distinct types: (1) drainage that can be accomplished by an individual on his own farm, and (2) drainage that requires off-farm outlets. Drainage needs for the basin are shown by type and subarea in Table III-11.

Table III-11

Drainage Needs, by Subarea and Type of System Required, 1965

Subarea	On-Farm (acres)	Community Outlets + On-Farm (acres)	Total (acres)
Upper	79,500	113,900	193,400
Middle	156,300	827,700	984,000
Lower	-	125,000	125,000
Total	235,800	1,066,600	1,302,400

Individual farm drainage problems, and solutions thereof, are of only minor significance in the basin. Approximately 236,000 acres fall into this category. Most of this land is located on fans, footslopes, hill slopes, and isolated valley floor areas. Drainage improvement is expected to continue to be on an individual basis.

Off-farm drainage outlets are the major basin drainage problem. An estimated 1,066,000 acres are in need of channel improvements or new channels to permit landowners to apply drainage directly on the farm. The work is usually accomplished on a project basis requiring the cooperation of two or more individuals for the construction and mainenance of drainage outlets and facilities. The size of the project and number of landowners will depend upon the extent of the problem area. Much of the million-plus acres is included in large contiguous areas which will require community facilities to serve several thousand acres. For more detailed discussion, see Appendix G - Land Measures and Watershed Protection.

ECONOMIC STRUCTURE

Agriculture and the food processing industry it supports comprise one of the real economic growth factors left in Willamette Basin. Total harvested cropland is projected to decline from 931,000 acres in 1964 to 767,000 acres by the year 2020. Productivity, however, is expected to increase. Shifts in land use from less intensive to more intensive agriculture and increases in irrigated cropland will enhance productivity. Higher productivity will be essential to sustain the projected growth in export-oriented crops and increases in commodities now largely consumed within the region (Farness and Sitton, 1968). Land resources are sufficient to sustain the projected levels of production.

More than half the basin's agricultural land is farmed in units ranging from 140 to 1,000 acres. However, the median size of farms in Willamette Basin is small, about 119 acres. About three-fourths of the farms comprise only about one-fourth of the agricultural land area--53 percent being less than 50 acres. These, for the most part, comprise the noncommercial farms.

Photo III-10 A daffodil field near Popcorn School, in the Polk County hills west of Salem. (O. S. Hwy. Photo)

In 1964, of the basins 20,366 farms, only 8,016, about 40 percent, had a gross income exceeding $2,500. These were the commercial farms accounting for the bulk of the total farm production and agricultural income. The remaining 60 percent largely were part time and residential, reflective of the growth of off farm employment. From 1949 to 1964 the number of farms declined by 35 percent. Future decline is not projected to be this rapid.

Farm employment, too, has been declining while production has been increasing, following the national trend, since World War II. Farm employment is projected to fall from 26,300 in 1964 to 11,000 in 2020.

Long-term trends in values of sales indicate an increasing share of sales in crops and horticulture, a decreasing share in livestock products, and an increasing share in forest products. In 1964, average sales per farm were nearly $8,700.

Most basin farms are diversified, raising a variety of crops and some livestock. In 1964 about 64 percent of the farm production was for export. The value of products sold that year by major types for the basin is shown in Table III-12.

Table III-12

Value of Agricultural Products Sold, by Major Types, 1964

Product	Gross Value	Percent Of Total
Crops	$ 96,016,000	54.4
Livestock & products	63,187,000	35.8
Forest products	4,236,000	2.4
Horticultural	13,081,000	7.4
Total	$176,520,000	100.0

SOURCE: 1964 Census of Agriculture, Oregon

RECREATIONAL RESOURCES

Nature has favored the Willamette Basin with diverse land forms, an extensive stream system, numerous mountain lakes, and a wide variety of plant and animal life. This natural heritage provides both the livable environment that enriches the daily lives of basin residents and the proper setting for nearly every form of outdoor recreational pursuits. An office worker in Portland looks out at snow-capped Mt. Hood; a farmer near Salem stops his tractor beside the Willamette River to watch a doe and her fawn feeding along the river bank; a group of university students cut afternoon classes and head up the Santiam Highway for night skiing at Hoodoo Bowl; men stand on an Oregon City sidewalk beside a four-lane highway and fish for salmon; outdoor enthusiasts backpack to the mountain lakes in Jefferson Park, staying a week without seeing another person; a man living in a downtown apartment in Eugene skips supper and water skis till dark at a nearby reservoir; a college biology class field trips to Gold Lake Bog Research Natural Area to study its seven species of carnivorous plants; and a family picnics at Champoeg Park where settlers organized the Oregon Provisional Government in 1843. The recreational resources of the basin are thus important to its residents, both in their day-to-day lives and in their specific recreational pursuits. Moreover, these resources attract more and more tourists every year. The following photos illustrate some of the basin's varied recreational opportunities. The details of recreational development, use, demand, and value are included in Appendix K - Recreation.

Photo III-11 Mt. Hood, 11235 feet high, and 62 miles from Portland, is a year-around attraction for visitors. (O. S. Hwy. Photo)

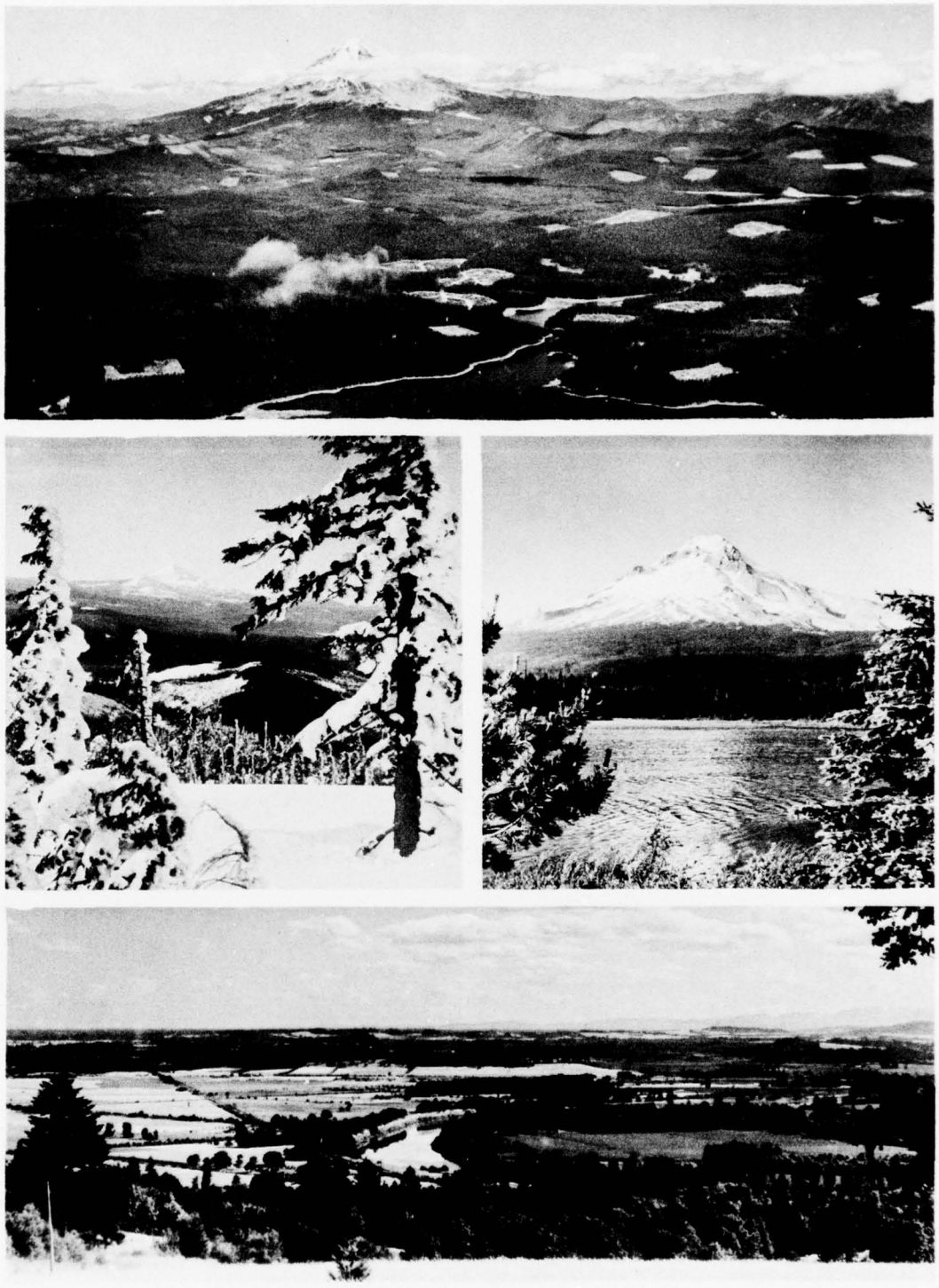


Photo III-12 *Mt. Hood and the fir forested slopes of Oregon's Cascade Mountains dominate the eastern portion of the Willamette Basin. (O. S. Hwy. Photos)*

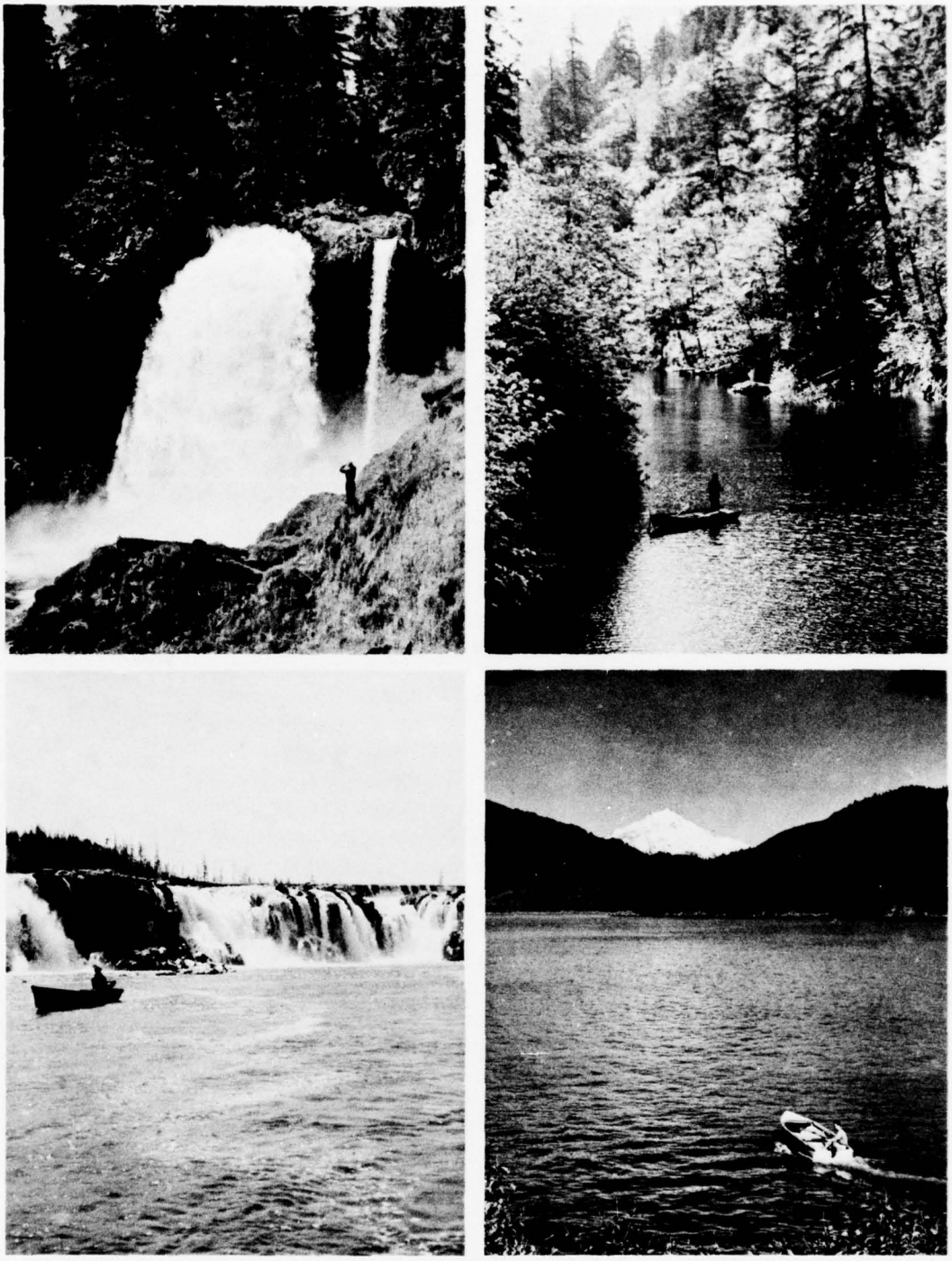


Photo III-13 Recreation areas are many and easily accessible. Sahalie Falls, Eagle Creek, Willamette Falls, and Detroit Lake lure men with their majesty and beauty. (O. S. Hwy. Photo)

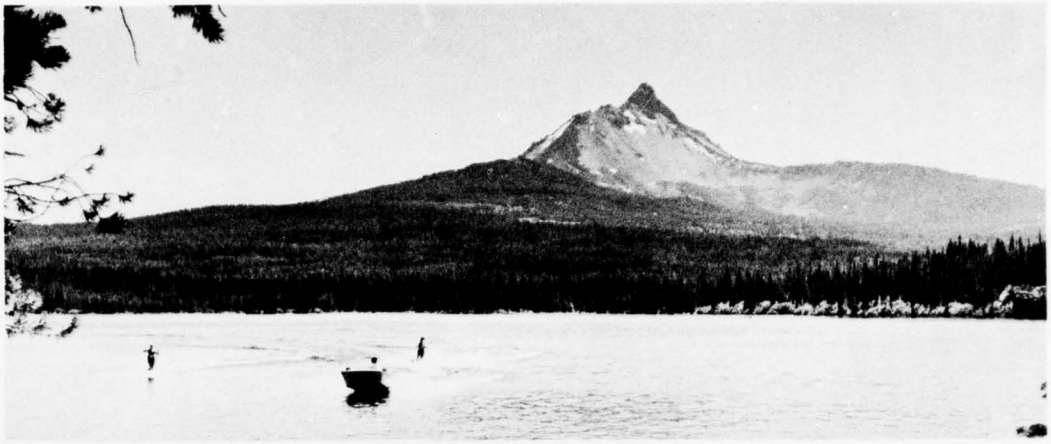


Photo III-14 Water skiing at Big Lake, camping at Scott Lake, back packing in the Three Sisters wilderness area, and picnicking at Champoeg. (USFS & OS Hwy. Photo)

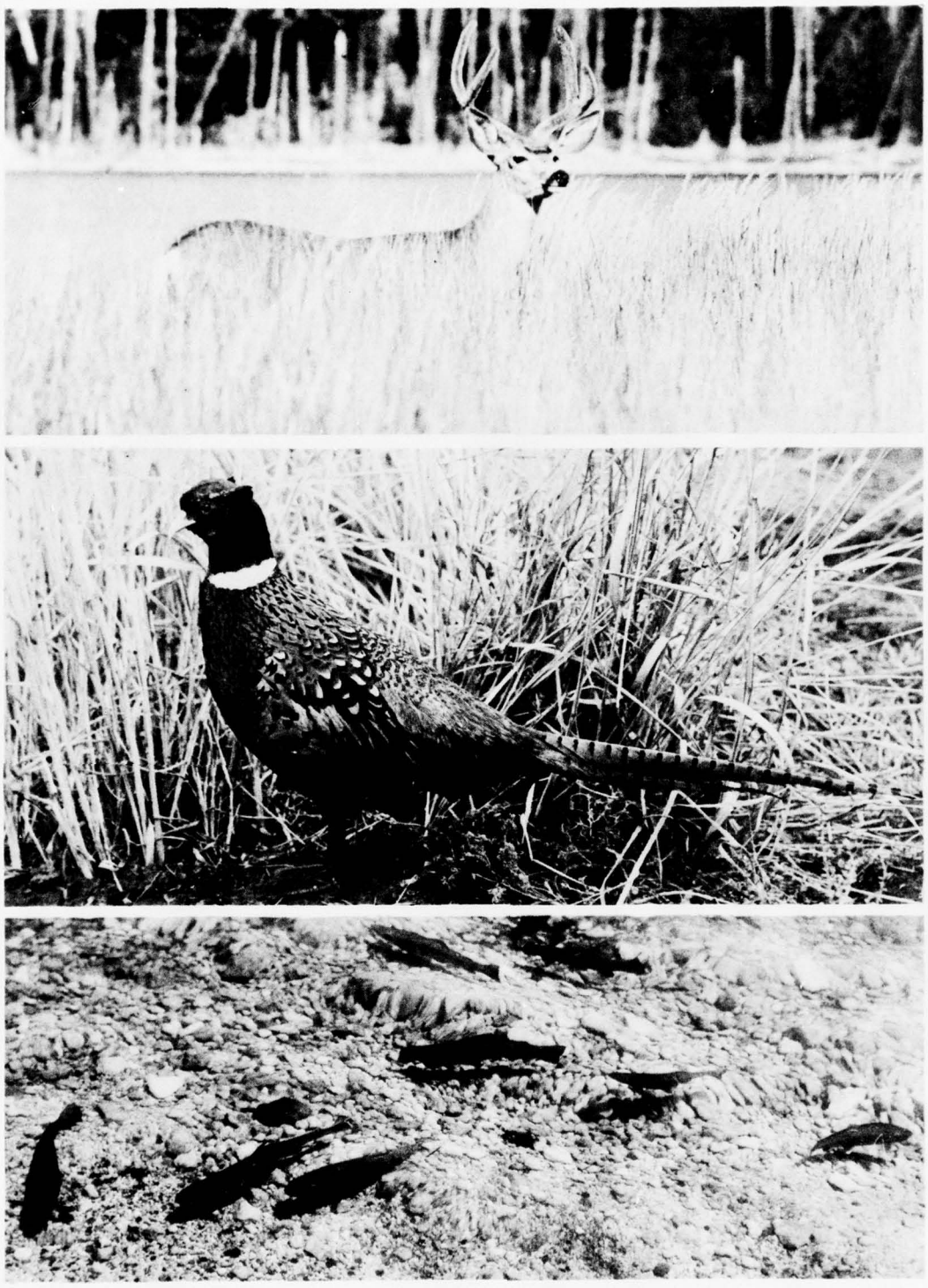


Photo III-15 Trout and other game fish are plentiful in the streams, rivers, and lakes of the Willamette Basin. Pheasant, wild duck, deer, and elk delight the hunter.

RESOURCE UTILIZATION

RESOURCE UTILIZATION

GOALS AND OBJECTIVES

This study and report is based on the overall concept that water, land, and all other resources and assets of the basin should be conserved and used for the well-being of people. In applying that concept, primary emphasis is placed on the needs for well-being of the people of the basin under current and foreseeable conditions. Regional and national aspects are considered on the basis that basin residents, as a group, are an integral segment of the Nation's total population, and that the well-being of the basin is reflected in the well-being of the Nation.

Broad goals stated herein are consistent with that overall concept. Those goals constitute a first-level statement of what water and related land resource development should provide. Appendix M, Plan Formulation, contains a statement of the overall mix of general and specific objectives embodied in the overall plan formulated to implement, to a maximum practicable degree, the above-stated concept.

The following tasks are considered necessary in developing an overall plan:

1. Inventory the water and related land resources currently available, and determine the extent of their utilization.

2. Project future resource needs, based on a reasonable balance between national, regional (state), and local requirements.

3. Define overall, long-range goals for development of all water and related land resources in the basin and derive specific goals for each water function.

4. Identify problems which can be alleviated by resource development, and determine the remaining opportunities for development.

5. Evaluate and present alternative means to meet the needs and overall goals, consistent with the availability of resources.

These considerations, as they relate to Federal and state laws, regulations, authorizations, and programs, establish the limits of the plan of resource development.

THE GOALS CONCEPT IN PLANNING

An essential step in water resource planning is the development of goals and objectives. Goals are stated in broad language, requiring refinement and definition in order to be useful in developing operational programs and/or orienting planning programs. Goals are statements which describe conditions, policies, or understandings which a program is intended to bring about. Goals can express the views of a group or groups as to what is considered economically, socially, or politically desirable of attainment for a geographic area and economy.

Plans and operating policies can be measured against goals. Goals also suggest the need for timely information. There is a strong interrelationship between goals, policy, and information. Information is needed to substantiate the need for action programs. Policy is needed to guide or develop the means through which goals are achieved. Problem descriptions help to identify the need for policy. The lack of information identifies the need for research. Sound goals are needed as an integral step in the whole process of planning.

Photo IV-1 Carefully planned and soon to be completed Green Peter Dam, and power plant on the Middle Santiam River. (O. S. Dept. of Planning and Development Photo)

Goals are not fixed or final but rather they are developmental. They are increasingly defined and detailed as programs evolve and as better information becomes available. Broad goals form a framework, with specific developmental objectives fitting in. There are always areas of conflict and needs for adjustment and compromise. There must be flexibility in programs, policies, and goals, so that there is room for new information, new concepts, and innovations. Feedback from programs as they advance will result in adjustment of goals. Sources of new concepts and new information must include the contribution of ideas from the public, business, research, and academic as well as governmental organizations.

On the basis of national policy and today's regional and local views, the suggested goals are more specific as to the needs of 1980 than as to those of the year 2000. However, because of the continuing expansion of population and resource requirements and the long advance periods involved in developing, conserving, and reserving the required water and land resources, attention must be given concurrently to identifying longer range needs and goals.

BROAD GOALS

Comprehensive planning of natural resource development recognizes public wants related to leisure, health and safety, economic growth, conservation of resources, environmental protection, and technological innovation; five broad goals for the development of water and related land resources for Willamette Basin, without reference to order of importance, are:

a. Leisure - To increase the choice of leisure time opportunity consistent with people's desires.

b. Health and Safety - To provide for the health and safety of the people and animal life of the basin.

c. Economic Growth - To insure production and economic growth consistent with efficient allocation of resources.

d. Conservation - To conserve land and natural resources and preserve and/or enhance their potential for future use.

e. Environment - To maintain a pleasant place for people to live.

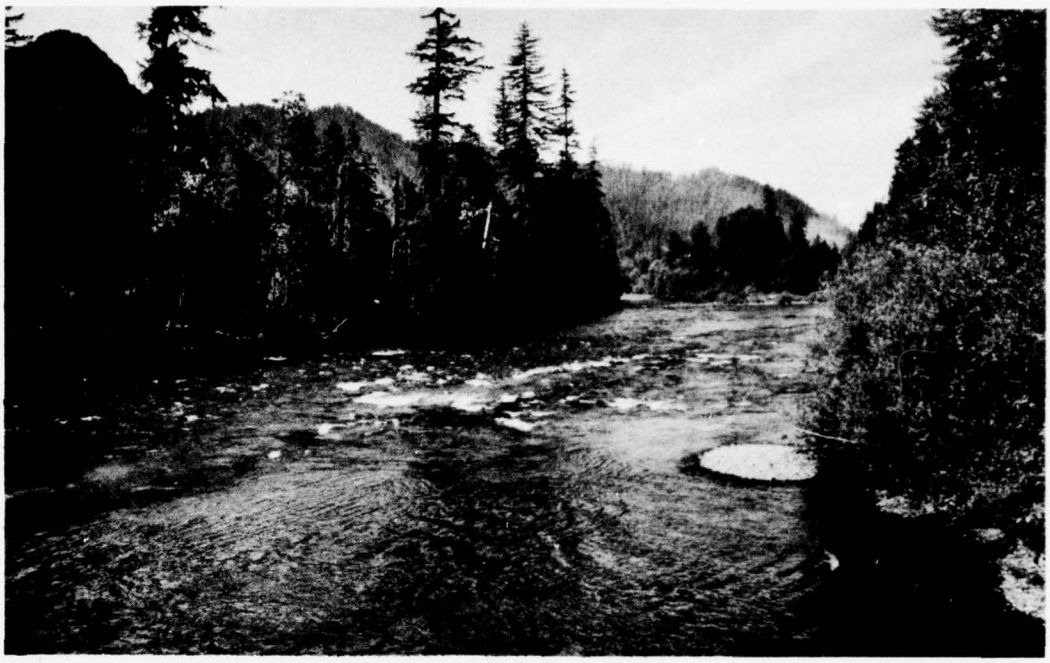


Photo IV-2 Development and use of our rivers and streams must reflect the future desires and needs of the public as a whole. (USFS Photo)

FUNCTIONAL RELATIONSHIPS

These goals are broad and all-inclusive; they represent wants and needs which should be considered in any program for development of the basin. Each of the functions discussed in the supporting appendices can contribute to the achievement of these goals. Fish and wildlife preservation and management, for example, is directly concerned with leisure, economic growth, resource conservation, and environmental protection, but is only indirectly related to health and safety.

Some relationship between the broad goals and the water functions is indicated as follows:

Function	Broad Goals
Fish and Wildlife	Leisure, Economic Growth, Conservation, Environment
Flood Control	Health and Safety, Economic Growth, Conservation
Irrigation	Economic Growth, Conservation, Environment
Land Measures & Watershed Protection	Leisure, Health and Safety, Economic Growth Conservation, Environment

Municipal and Water Supply	Health and Safety, Economic Growth, Environment
Navigation	Economic Growth
Power	Health and Safety, Economic Growth
Recreation	Leisure, Conservation, Environment
Water Pollution Control	Health and Safety, Economic Growth, Environment

Each functional Appendix (D through L) includes consideration of at least the above relationships between functions and broad goals.

GENERAL OBJECTIVES

The general objective is defined as a requirement or set of requirements which, when achieved, advances a system toward an overall goal. Each broad goal, then, is the basis for general objectives related to functional fields. Alternatively, it may be stated that objectives in functional fields are expressions of means of advancing toward achievement of one or more of the already stated broad goals. The general objective of fish and wildlife study, for example, is to provide a basis to maintain, restore, or enhance environmental conditions which would produce a fish and wildlife supply as demanded over a period of time. In a comprehensive planning effort, the objective should be broad enough to allow the flexibility and a significant range of alternatives to be considered. For this study of water and related land resources, most functional objectives can be categorized as land or water objectives.

Land Objectives

In some of the functions, the provision of the service or commodity entails a certain amount of land investments. In others, the provision of service does not directly use the land, but tends to alter the land-use pattern. Recreation management requires a certain amount of land and water. On the other hand, irrigation and flood control techniques tend to alter the pattern of land development. It is necessary, therefore, to consider the amount of land investment in both dollars and aesthetic values when utilizing a parcel of land for one purpose as opposed to another. Optimum use of the land for promotion of the economic and social welfare of people often will be difficult to discern. Choices among alternatives may have serious and permanent consequences on the overall environment of the basin. A question which arises is, "What should Willamette Basin look and be like?" Such factors as the conservation of open space, and preservation of the natural environment are significant imponderable objectives in planning both potential projects and development programs.

Water Objectives

The use of water to accomplish a desired output should not preclude the investigation of nonwater alternatives to achieve the same objective. Such considerations are important in allocating water to its highest use. Several alternatives may exist for accomplishing the desired objective; water itself may be involved as only one alternative among many. Certain water quality standards (objectives), for instance, may be achieved by providing water to dilute residual waste. The same standards quite possibly could be met through such preventive measures as addition to and/or intensification of treatment and the control of pollutants at the source. In general, specific water objectives are actually net water needs and are part of an optimum combination of alternatives for accomplishing a general objective.

Because discussion of objectives runs the risk of becoming unduly abstract, even academic, the generalizations herein are intended only to set the stage for the treatment of goals and objectives within the several functional appendices.

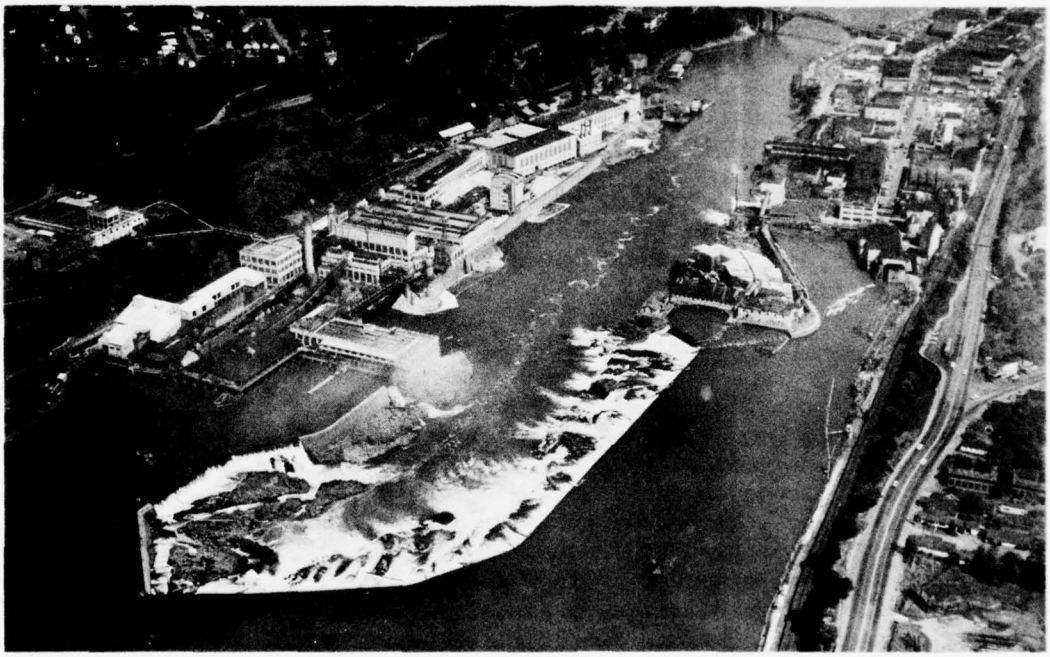


Photo IV-3 Water quality control at Willamette Falls at Oregon City is complicated by a concentration of industrial users. (Crown Zellerbach Photo)

STATE LAWS, POLICIES, AND PROGRAMS

STATE LAW

State Constitution

The Oregon Constitution is silent on water, but certain sections are applicable to the use and control of the State's waters. Article I, Section 18, provides that "private property shall not be taken for public use...without just compensation..; provided, that the use of all roads, ways, and waterways necessary to promote the transportation of the raw products of mine or farm or forest or water for beneficial use or drainage is necessary to the development and welfare of the state and is declared a public use."

A constitutional reference frequently cited is in Article XI, Section 7, with reference to debt limitation. According to an opinion of the Attorney General, this section would be violated were the state to agree to hold and save the United States free from damages due to the construction of certain works.

Article XI, Section 12, authorizes establishing Peoples' Utility Districts, one power of which is to acquire, develop, and/or otherwise provide for a supply of water, waterpower, and electric energy.

Article XI-D authorizes waterpower development by the state. To date, the legislature has not acted to provide means to implement this authority.

Statutes and Policy

Oregon's statutes relating to water use and control have evolved over a period of many years, progressively reflecting needs associated with the state's continuing growth. The Surface Water Code of 1909 reflected the need for orderly control of rights to the use of the water resources, a need identified during the first fifty years of statehood. Irrigation District laws were passed to meet the demands of reclamation. Subsequently, other special purpose laws were enacted.

Many of the laws have been visionary in scope. The legislature's recognition of ten beneficial uses of water in a law adopted in 1955, preceded by several years the Federal Government's recognition of beneficial functions other than power, navigation, and irrigation.

Most of Oregon's water laws have stood the test of time and provide a solid background for policies and programs relating to the use and control of the water resources. These laws are compatible with Federal legislation.

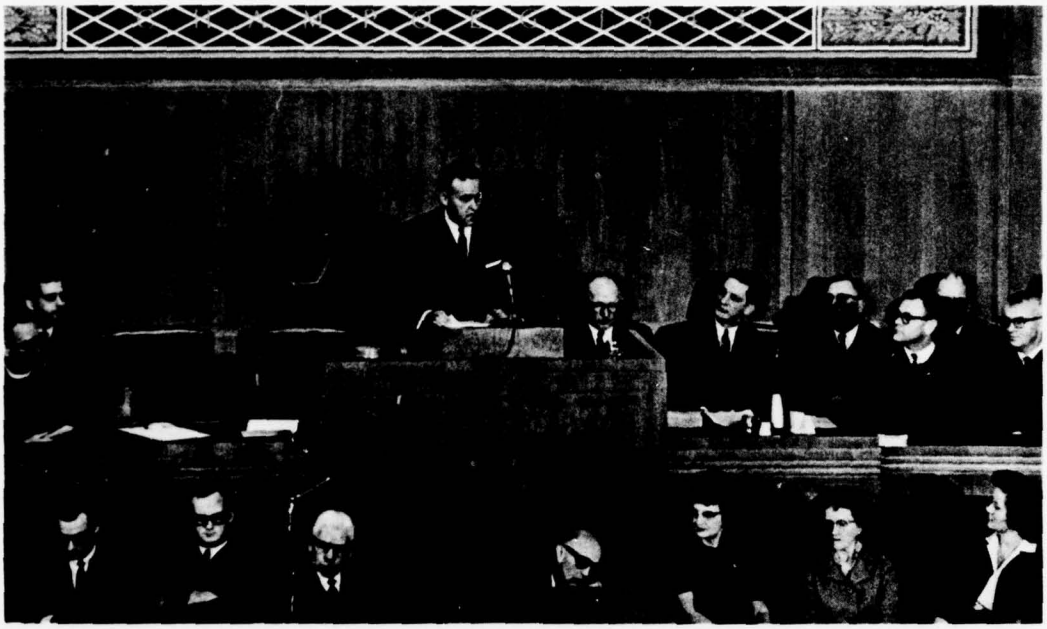


Photo IV-4 The control and use of our resources depend on the policies and implementing laws set down by those men elected to represent the people. (Oregon Truckers Assoc. Photo)

Legislative acts pertaining to the use and control of the waters of the state are embodied in Oregon Revised Statutes. The policies and programs pertaining to such use and control emanate from legislative policy declarations and from the authority vested in the various state boards, commissions, and departments created by those statutes.

In 1955, the legislative assembly made the following declaration of policy regarding water resources, as contained in ORS 536.220:

"(1) The Legislative Assembly recognizes and declares 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."

In conformance therewith, the State Water Resources Board was created and charged to progressively formulate an integrated, coordinated program for the use and control of all the water resources of the state, issue statements thereof, and devise plans and programs for the development and maximum beneficial use and control of the state's water resources.

The board's programs and orders have been issued classifying the unappropriated waters of the Willamette Basin as to the highest and best use, establishing numerous minimum perennial streamflows below which future appropriations shall not be made, and restricting appropriations from certain mountain lakes. Similar programs and orders have been issued for an additional 12 of the state's 18 basins.

The classification of sources of water as to use and quantities of use contained in the board's program statements has the effect of restricting the uses and quantities of uses to those specified by the board. The board's statements are binding on every state agency or public corporation in the exercise of any power, duty, or privilege affecting the water resources of the state.

A number of state agencies have statutory authority over specific users of the state's water resources, to wit: the State Sanitary Authority, the State Game Commission, and the Fish Commission of Oregon.

The major water-resource-oriented state agencies are listed below. Also listed are the statutes under which they operate or with which they are concerned, and statements of their primary responsibilities also are included. Except where otherwise specified, the chapter numbers cited refer to Oregon Revised Statutes.

State Water Resources Board: Chapter 536, specifically ORS 536.210 to 536.550.

Other pertinent statutes:

Chapter 543: Hydroelectric Power Projects
549: Drainage and Flood Control Generally
567 (Oregon Laws, 1967): Removal of Material from the Bed and Banks of the Waters of This State

The State Water Resources Board is responsible for progressively formulating a state water resources policy and for devising plans and programs for the development of, and to encourage, promote, and secure the maximum beneficial use of the state's water resources. Other activities carried on concurrently include commenting, on behalf of the state, on Federal project proposals; participating in Federal flood control projects; holding hearings and rendering decisions upon water use conflicts, upon proper referral; cooperating with and promoting coordination between local, state, and Federal water use plans, programs, and projects; approving applications for carrying out flood plain identification studies, identifying and studying methods of augmenting use of future reservoir sites; and representing the state on certain compacts of agreement authorized by the legislature concerning the state's water resources.

State Engineer: Chapter 536, specifically ORS 536.010 to 536.080.

Other pertinent statutes:

Chapter 537: Appropriation of Water Generally
538: Withdrawal of Certain Waters from Appropriation; Special Municipal and County Water Rights
539: Determination of Water Rights Initiated before February 24, 1909
540: Distribution of Water; Watermasters; Change in Use, Transfer, or Abandonment of Water Rights
541: Miscellaneous Provisions as to Water Rights and Uses
542: Water Resource Surveys and Projects; Compacts
543: Hydroelectric Power Projects
545: Irrigation Districts
547: Drainage Districts
548: Provisions Applicable Both to Drainage Districts and to Irrigation Districts
551: Diking Districts
555: Reclamation Projects
261: Peoples' Utility Districts

The State Engineer enforces laws relating to the appropriation, diversion, and use of the public waters of the state; accepts all applications for rights to appropriate water, including the generation

of hydroelectric power, and issues preliminary permits, licenses, permits, and certificates authorizing the use of public water; administratively determines the relative rights to the waters of any stream or ground water reservoir; promulgates regulation for fair distribution of water and appoints and instructs watermasters in said distribution; defines ground water reservoirs; determines critical ground water areas, lowest permissible water levels; and prohibits the pollution or impairment of quality of ground water bodies; examines plans for irrigation district works prior to construction; approves contract construction plans of drainage districts; exercises jurisdiction over many of the financial affairs of irrigation and drainage districts; exercises jurisdiction over proceedings for the formation of water conservation districts; cooperates with Federal, state, or local agencies in stream gaging, topographic mapping, snow surveys, and investigation of ground water resources, irrigation works, proposed dams, reservoirs, and hydraulic structures; inspects any hydraulic structure and orders modification or repairs necessary to prevent failure; examines petitions, investigates feasibility, and forms peoples' utility districts; represents Oregon on all matters pertaining to Public Law 566 and administers the Carey Act.

State Sanitary Authority: Chapter 449

The Sanitary Authority is responsible for the administration and enforcement of the laws of the state relating to air and water pollution control, and encourages voluntary cooperation by all persons in obtaining the greatest possible purity of air and water resources in the state; develops comprehensive plans and programs for air and water pollution control; makes field investigations and studies; establishes standards of quality and purity of air and water; examines and passes on plans for waste disposal works and air pollution control devices; issues waste discharge permits; receives complaints, petitions, and remonstrances; and holds hearings, enters orders, and enforces statutes relating to air and water pollution control.

State Game Commission: Chapter 496

Other pertinent statues:

Chapter 497: Licenses and Permits
498: Hunting and Fishing Regulations; Miscellaneous Wildlife Protective Measures
501: Hatcheries, Refuges, and Reservations; Shooting Preserves

The Game Commission formulates general policies and programs for management of game fish, game animals, furbearing animals, game birds, and nongame birds; establishes open seasons, bag limits, and methods of taking species; operates fish hatcheries, game farms, public shooting grounds, game management areas, and public access sites; and conducts research and field investigation of fish passageways, stream obstructions, environmental factors, and fish propagation.

Fish Commission of Oregon: Chapter 506.

Other pertinent statutes:

Chapter 507: Compacts with Other States
508: Licenses
509: General Protective Regulations
511: Local and Special Regulations
513: Packing Fish and Manufacture of Fish Products

The Fish Commission establishes policies in the administration of the commercial fishing and fisheries laws; declares open and closed seasons for commercial fishing in or on certain waters of the state; has been granted such further powers as may be necessary to carry out the purpose and intent of all laws pertaining to the protection, preservation, propagation, cultivation, development, and promotion of all fishes within the state and all living animals that reside intertidally on the bottom in Oregon waters except game fish; examines dams and artificial obstructions in rivers and streams of the state frequented by salmon or other anadromous fish to determine that free passageway is afforded.

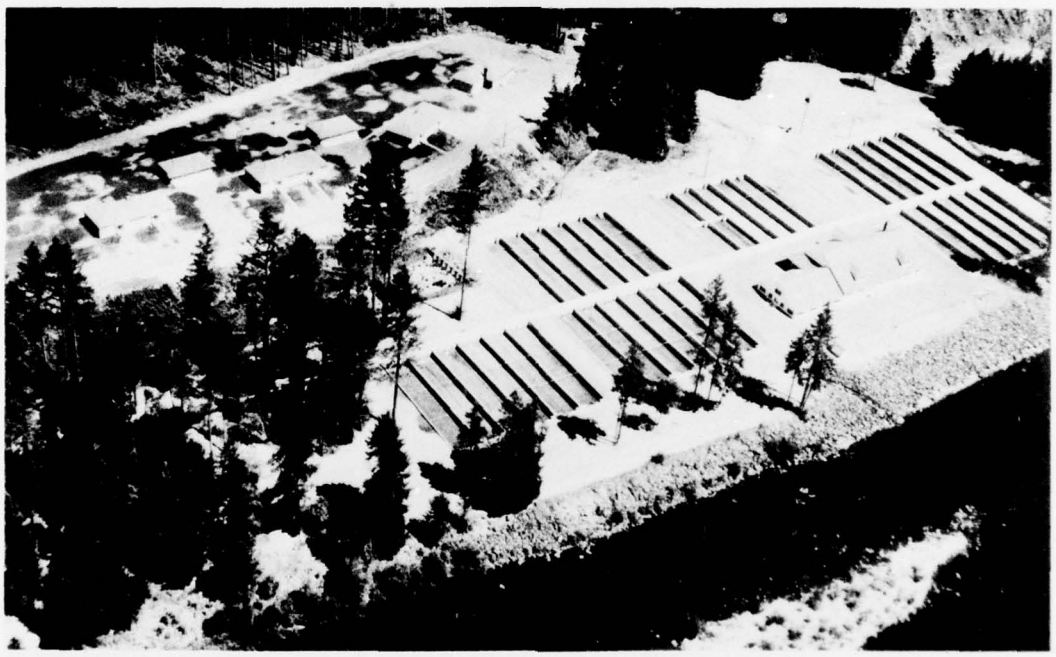


Photo IV-5 Oregon's commercial and game fishes are preserved and promoted through controlled propagation at State Fish Hatcheries such as that at Leaburg on the McKenzie River.

A number of other state agencies have interests vitally concerned with the state's water and related land resources:

State Land Board
State Marine Board
Parks and Recreation Division, State Highway Department
State Department of Agriculture
State Forestry Department
State Soil and Water Conservation Committee
Oregon State University
Economic Development Division, State Department of Commerce
Water Resources Research Institute, Oregon State University
Bureau of Governmental Research and Service, University of Oregon

In addition to the statutes related to the agencies cited above, there are several others of special significance:

Chapter	57:	Private Corporation Generally
	61:	Nonprofit Corporations
	62:	Cooperatives
	225:	Municipal Utilities
	264:	Domestic Water Supply Corporations
	274:	Tide, Swamp, and Submerged Lands; Stream and Lake Beds
	550:	Flood Control Districts (Island School Districts)
	552:	Water Conservation Districts
	553:	Water Control Districts
	554:	Corporations for Irrigation, Drainage, Water Supply, or Flood Control

The Water Control District law, currently is the best adapted for providing assurances relative to Federal flood control projects. Districts formed under this law have the authority to assess through ad valorem taxes and, thus, are fiscally capable of satisfactory operation and maintenance.

Corporations formed under Chapter 554, frequently referred to as Improvement Districts, also are capable, legally, of providing the necessary assurances but have an ineffective method of collecting revenue for flood control project operation.

Case Law and Attorney General's Opinions

A compilation of case law or Attorney General's opinions, specifically concerning water, is not available for inclusion in this report. Attorney General's opinions are published monthly, however, and are available through his office.

The State Engineer publishes "Water Laws of Oregon" which includes those statutes, involving the State Engineer and the State Water Resources Board, most frequently used by the public. He also compiles and publishes "Irrigation District Laws of Oregon" and "Peoples' Utility District Law." Each of these three publications contains miscellaneous annotations citing notes of decisions and Attorney General's opinions.

WATER RIGHTS

All waters within the State of Oregon from all sources (except a spring which does not flow into a well-defined channel and off the property of origin, under natural conditions) are declared by statute to belong to the public.

Subject to existing rights, all public waters within the state excepting those which may have been withdrawn by legislative action or by order of the State Engineer or the Water Resources Board may be appropriated for beneficial use by complying with the requirements of the Surface Water Code or the Ground Water Act, and not otherwise.

Doctrine

Oregon is essentially an appropriation-doctrine state, and the terminology "riparian rights" has become little more than legal fiction. In cases brought before the Oregon Supreme Court, it has held that the 1909 Water Code validly abrogated the common-law riparian rule except where the water had actually been applied to beneficial use prior to its enactment, which, in effect, makes it an appropriative right.

Surface Water

The appropriation of the surface waters of the State of Oregon--including the waters of rivers, lakes, streams, springs, waste waters, and waters stored in reservoirs and other surface sources--is governed by provisions of the Surface Water Code, adopted on February 24, 1909, and subsequent acts. Nothing in the code, however, is so construed as to take away or impair the vested right of any person, firm, corporation, or association to any right for surface waters which was initiated prior to February 24, 1909.

A legal right for any surface water appropriation initiated after February 24, 1909, can be established only through application of water to beneficial use under the terms of a water right permit issued by the State Engineer. A claim to a vested right by virtue of use prior to February 24, 1909, and continued use thereafter, can be determined and made a matter of record only through a legal proceeding, known as an adjudication. This proceeding involves several administrative steps by the State Engineer and is concluded by a decree of the circuit court.

Adjudication proceedings have been completed for most of the major stream systems in eastern and southern Oregon, but for only a few of the stream systems in the remainder of the state. A particular problem exists within the Willamette Basin with respect to power claims at Oregon City. This places a cloud upon all upstream water rights until adjudication. Figure No. IV-1 shows the stream systems that have been adjudicated in the Willamette Basin.

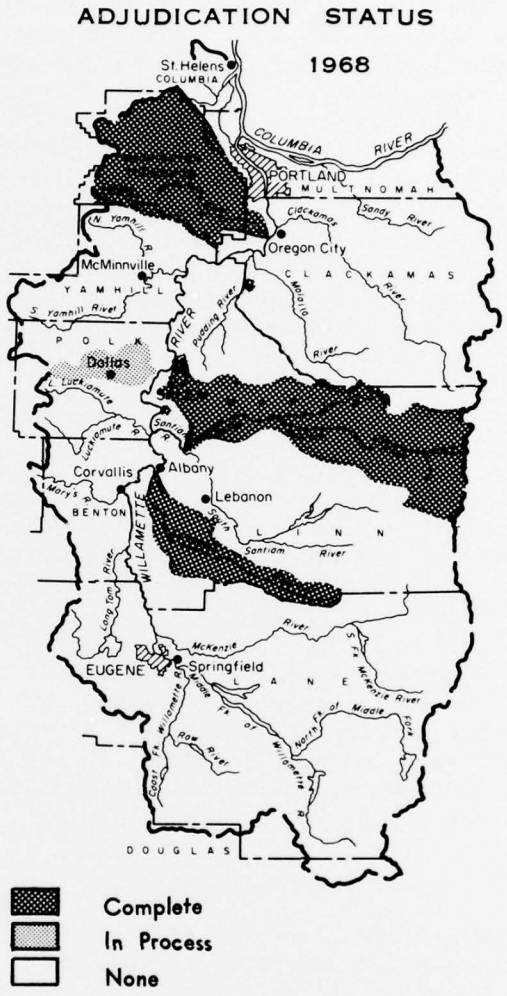


Figure IV-1 Adjudication

Ground Water

The appropriation of ground water, which is obtained only through an artificial opening or an artificially altered natural opening into the earth (not including a natural spring), is governed by the provisions of the Ground Water Act, adopted August 3, 1955.

The Ground Water Act of 1955, which applies to the entire State of Oregon, repealed the underground water laws which had been in effect in that part of Oregon east of the summit of the Cascade Range since 1927. It provided a means for registration of all claims of rights to appropriate ground water by virtue of use initiated before the effective date of the laws, and provides for later adjudication of the rights claimed to determine the extent and priority of each right.

A legal right for an appropriation of ground water initiated after August 3, 1955, can be established only through beneficial use under the provisions of a ground water permit issued by the State Engineer, except for the following uses: (1) stock watering purposes; (2) watering any lawn or noncommercial garden not exceeding 1/2 acre in area; (3) single or group domestic purposes in an amount not exceeding 15,000 gallons per day; or (4) for any single industrial or commercial purpose in an amount not exceeding 5,000 gallons per day. A permit is not necessary and cannot be issued for such exempted uses of ground water.

The prospective appropriator has the right to construct and test a water well for any purpose prior to applying for a permit to appropriate the water for beneficial use.

Change of Ownership

A completed and perfected water right as evidenced by a certificate of water right is appurtenant to the land on which the right was established and passes with the land through change of ownership, unless specifically reserved in the articles of conveyance. There is no statutory provision for transferring or assigning a completed and perfected water right from one owner to another.

An incomplete right under a water right permit or a ground water registration statement can be conveyed to a new owner only through the recording of an assignment in the office of the State Engineer. Forms for this purpose are supplied upon request. If the assignment is not recorded, it is not binding on anyone but the parties thereto and may result in cancellation of the water right.

Duration of a Right

A completed and perfected water right as evidenced by a certificate of water right remains valid and in force so long as it is not lost through intentional abandonment or through nonuse for a period of five successive years or more.

Access to Lakes and Streams

Authority of the State Engineer does not extend to matters of property rights; therefore, acceptance of an application or the issuance of a permit should not be construed in any sense as granting a right-of-access to a stream or any rights-of-way for construction or maintenance of works necessary to the use of the water.

All rights-of-access and rights-of-way must be obtained from the owner of the property involved.

Diversion between Basins

Diversion and use of waters out-of-state is forbidden except upon the express consent of the legislative assembly as provided in ORS 537.810 to 537.860.

Numerous diversions exist between watersheds within the state. Except where expressly forbidden by statute or order in conformance with a program adopted by the State Water Resources Board for the use and control of the waters involved, diversion between basins is permissible.

Eminent Domain

The right of eminent domain is provided under Chapter 772, Condemnation of Property by Private Corporation Generally; and Condemnation for Drainage, Irrigation, Water Systems, or Sewer Systems.

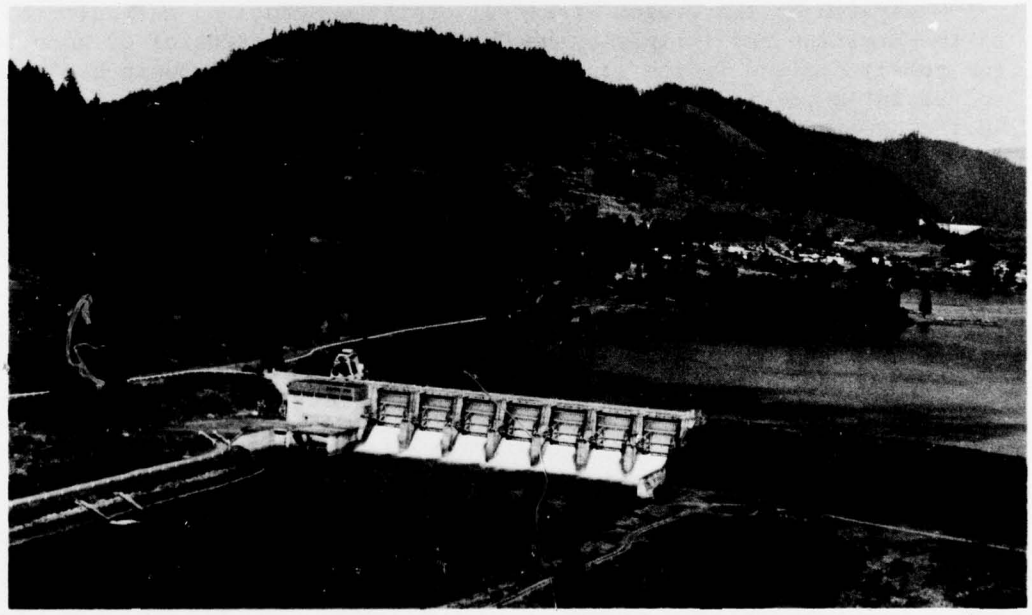


Photo IV-6 Dexter Dam on the Middle Fork of the Willamette River serves for flood control, water storage, and power generation.

STATE PROGRAMS

The large number of state agencies and statutes, directly or indirectly concerned with water and related land resources, is indicative of the wide variety of current programs. Oregon Revised Statute 536.470 provides that the State Water Resources Board "may consult and cooperate with any state agency or public corporation of this or any other state, any interstate agency or any agency of the Federal Government for the purpose of promoting coordination between local, state, interstate, and Federal plans, programs and projects for the use or control of the water resources of this state or to facilitate and assist the board in carrying out its functions as provided by law." Further coordination of programs is achieved through the Committee on Natural Resources which meets with the Governor on a regular schedule.

Generally, the various programs have been identified in the description of agency responsibilities.

The Willamette Basin project, as currently authorized by Congress, was an outcome of program activity by the former Willamette River Basin Commission. Upon dissolution of the commission as a legal entity of the state, the responsibility to foster and encourage the Willamette Basin project was assigned to the State Water Resources Board. The Willamette Basin Project Committee, formed prior to the commission, continues to serve as a driving force in coordination of planning and in maintaining active local interest in basin development.

Research by the Oregon State University's School of Agriculture on the drainage and irrigation needs and cropping potential of some of the poorly drained (white land) soils of the Willamette Basin has resulted in an upward adjustment of past estimates of irrigable acreage in the basin.

Studies undertaken through the Water Resources Research Institute have contributed important data needed for the comprehensive Willamette Basin Study: Willamette Basin General Soil Association Map and Report, Irrigation Water Requirements of Principal Crops in the Willamette Valley, and Trends and Anticipated Changes in Water Use in Practices for Irrigation in the Willamette Valley.

Much of the highly refined sprinkler irrigation equipment presently used was developed in Oregon following World War II, sparked by assistance and research at Oregon State University and through irrigation clinics sponsored by the University.

The state system of parks is one of the outstanding park systems in the Nation. Details as to state, as well as Federal parks, are provided in Appendix K - Recreation.

ROLE OF GOVERNMENTAL AGENCIES

The ultimate success of any major venture into the realm of comprehensive planning for and development of water and related land resources is highly interwoven with the efforts of numerous public agencies at all levels in addition to the private component. With the usual agency groupings of "Federal, state, and local" now appear specialized coordinating bodies that, hopefully, will enhance the quality and efficiency of the venture. What then are the roles of the different levels of government representation in Oregon with respect to current planning processes and future implementation of study plans?

Close cooperation of the State Game Commission with the State Water Resources Board in developing basic data as to streamflows, habitat, spawning, and rearing requirements has resulted in the board's reserving unappropriated streamflows sufficient to support aquatic life and for recreational purposes on many of the basin's streams.

It is anticipated that the various research activities of the several state agencies, jointly or individually, through coordination by the State Water Resources Board and the Committee on Natural Resources, will continue to develop technological improvements that will help the basin's growth and economy. More than technology is required, however. If water and land resource developments are to continue, the general public must accept the fact that strong, local financial support will be needed, particularly where recreation and sport fisheries are involved.

The principal entity in the highest level is the Pacific Northwest *River Basins Commission* whose purpose it is to stimulate, coordinate, and develop plans which seek to optimize benefits from the conservation, development, and utilization of the region's water and related land resources. This new State-Federal cooperative approach to planning by regions has entailed coordination of the Type II Willamette Basin Study and the provision of advice and assistance to the study as required. Other studies of the same nature are expected to occur in Oregon's future. Commission approval of the final study plan will go far toward ensuring authorization and funding of the plan's Federal project components.

At the state level, the Governor of the state of Oregon has established the Intergovernmental Coordination Committee for which one objective is to analyze the relations of Federal aid programs with state and local programs and to make recommendations to improve those programs financed by Federal aid. Such efforts, coupled with those of the State Water Resources Board, will serve to maximize the efforts of the state to successfully advance the planning and development phases within present legislative limitations and to assist in securing revised authority by legislative process when necessary.

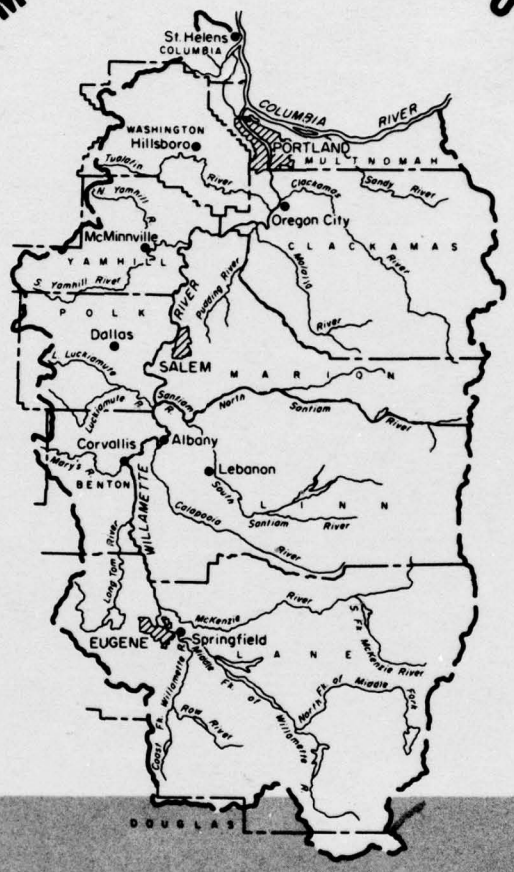
Local government - counties, cities, or quasi-municipalities such as irrigation, drainage, water control, and similar districts - will be directly involved in expressions of local interest, assurances of required financial participation and constructive communication concerning the needs and desires of the local citizenry. Along these lines, experience is proving that the task is becoming increasingly difficult for an entity to successfully pursue, particularly if it chooses to maintain an independent course of action.

At the local level, therefore, occur most of the specialized coordinating agencies. This is due, in part, to recognition of the fact that even with the great proliferance of existing special boards, commissions, councils, etc., each is relatively independent in its own field, yet each is dependent to some degree on the actions and decisions of the others. Truly comprehensive planning requires consideration and integration of all pertinent concerns of the citizenry such as transportation, drainage, sanitation, and education. To implement the comprehensive approach is and will continue to be the role of such organizations as the Columbia Region Association of Governments (CRAG), the Yamhill County Planning Commission (YCPC), the Mid-Willamette Valley Council of Governments (MWVCOG), the Linn-Benton Association of Governments (LBAG), and the Central Lane County Planning Commission (CLCPC) which, collectively, represent all of the principal counties and cities within the basin as well as School District 24J in the Marion-Polk County area. Although limited in authority and serving primarily in an advisory or staff capacity to their component entities, these associations are the primary representatives of local government in Willamette Basin.

With respect ot the future role of governmental agencies toward implementation of planning and development activities, the trend seems to indicate that the general task will only become more complex in keeping with the nature of our society's demands. The attitude of cooperation will be of paramount importance; and, hopefully, the formalized associations of governments will provide the instrument by which the mechanics of the attitude can be carried out.

Water, a basic necessity to life itself, in sufficient quantity and by wise use, can not only be enjoyed but can determine the prosperity of an area now and in the future. Silver Falls State Park. (O. S. Hwy. Photo)

COMPREHENSIVE STUDY



Willamette Basin

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