WORKING PAPER NO. 55

COLUMBIA RIVER BASIN COMPREHENSIVE PROJECT
For Water Supply and Pollution Control

AN ANALYSIS OF
MUNICIPAL AND INDUSTRIAL WATER SUPPLY
IN THE WILLAMETTE BASIN, OREGON

APRIL 1965

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Prepared by JEB	Project Staff ________
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U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Public Health Service
Region IX

Division of Water Supply and Pollution Control
570 Pittock Block
Portland 5, Oregon

This working paper contains preliminary data and information primarily intended for internal use by the Columbia River Basin Project staff and cooperating agencies. The material presented in this paper has not been fully evaluated and should not be considered as final.

PREFACE

This report was prepared with several thoughts in mind other than merely to present a numerical description of the present and projected municipal water supply situation in the Willamette River Basin, Oregon. Factors that influence development and utilization of the water resource were examined in an effort to identify the major influences within this basin. Many of the factors have been subjects of individual studies at various times and places with little success in arriving at a universal formula for applying the influencing factors.

Consideration of resource development resulted in several conclusions applicable to this basin at the present time. The major conclusion is that future source developments may not be defined by location. Civic pride and aesthetics have been inseparable major factors of source selection and have at various times over the years displaced economics as the deciding factor in source development. It was therefore realized that future sources cannot be readily defined just because they happen to be close and the least expensive of several alternates. Another major factor of future source identification easily recognized is that of availability of water. Definition of physically and legally available flow in most watershed areas is impossible. Gaging facilities in the upper reaches of most streams are non-existent. The appropriation of water by state water rights may be tabulated, but the total rights are not descriptive of the total user withdrawals. Installation of gaging facilities would cost approximately $4,000 per station for installation and $1,200 per year per station for operation and maintenance. Adjudication of water rights within each minor basin to determine the legally available flow is also expensive. As an example, the postage for mailing of adjudication notices of the Tualatin River amounted to about $20,000.

Water treatment practices vary at the present time, but it has been assumed that all surface water will be subject to complete treatment some time in the future. Complete treatment of water from closed watersheds may not be required by the Oregon State Board of Health, but closed watersheds are predicted to become a thing of the past.

Ground water is used in large quantities, primarily for heating or cooling, but not for typical municipal and industrial supplies. Only minor attention has been given to ground water in this paper because the quantity available and the quality vary throughout the basin. Only a small part of the population relies upon ground water and only a small part of the basin may place any reliance upon ground water as a major future source.

Factors of consumption were examined and several factors became apparent. Some of the factors could be considered as universal throughout the basin. The major factors which could influence per capita use rates as compared with other areas of the country include climate, urban development trends, and level of wet process industrialization. Soil moisture balance for this area accounts for most of added summer use. Examination of records of Willamette Basin municipal water systems indicated that the per capita use rates could best be correlated with community size. Generally speaking, a city of a given size requires a certain amount of industry and service trade to support the particular level of population.

Thus it is necessary to examine an entire metropolitan area and not each water system within the area. However, consideration of metropolitan areas is also necessary for distribution of projected population on a long term basis. It is neither practical nor possible to distribute population within a metropolitan area on a long term basis. Other factors such as social and economic conditions, water rates, and water quality which may be reflected in water use are assumed to be equal throughout the basin in consideration of the future.

Recognition is also given to the probable fact that new water service areas will be formed in areas where public supplies are now non-existent. In some cases these are identified and in other they are included only as miscellaneous facilities in the minor subbasin. Others will be formed throughout the projection period.

Typical patterns of man's progress became apparent early in the study. The major cities throughout the world are located on or adjacent to major waterways and the Willamette Basin conforms to this pattern. Conversely the smaller communities are frequently located in an area away from major waterways and therefore frequently experience a shortage of convenient water. The situation may be summed up by saying that generally the smallest communities have the biggest problem and the least money.

Acknowledgment for assistance is gratefully given to all of the cities of the basin, water districts, private water companies, county water resource groups, the Oregon State Board of Health, the Oregon State Water Resources Board, the Oregon State Engineer, and the Oregon Public Utilities Commission for their assistance in providing data.

J. E. Britton
Sanitary Engineer

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PURPOSE

This paper has been prepared to present data, observations, and a preliminary evaluation of the municipal and industrial water supply situation in the Willamette Basin, Oregon.

SCOPE

The study has been performed in sufficient detail to generally describe the situation in terms of watersheds and demand areas. The areas are described in enough detail to point out those watershed areas of obvious seasonal shortages and those demand areas of obvious needs. The final means of satisfying future demands will be dependent upon a detailed engineering analysis. Only general conclusions and recommendations are given. More detailed conclusions and recommendations may be reached for specific reports by examination of the detail and relating it to project needs.

CONCLUSIONS

1. The water supply situation may not be completely and accurately described until the status of existing streamflow is clearly understood.

2. There is a need for adjudication of all surface waters in and adjacent to the Willamette River Basin.

3. Seasonal deficiencies may limit development in the following subbasins until adequate storage or alternate provisions are a reality:

   a. Long Tom River

   b. Calapooia River

   c. South Santiam River

d. Luckiamute River

e. Rickreall Creek

f. Yamhill River

g. Pudding River

h. Tualatin River

Adjudication of water rights and state water policy will have a major bearing on the importance of developments of the watersheds listed.

4. Industries and water supply agencies must make feasibility studies in order to plan for the future.

5. Trans-basin diversions must be considered.

RECOMMENDATIONS

1. The State Engineer should initiate and complete adjudication of all surface waters in and adjacent to the Willamette River Basin as soon as possible.

2. All water supply agencies and industries should develop future water supply plans compatible with State of Oregon policy for development as needed.

3. The quality and quantity of legally available water should be described in order to better evaluate the need for and value of multiple purpose storage especially in those sub-basins having apparent seasonal deficiencies.

A. General

The use of water for municipal and industrial purposes within the Willamette Basin has increased at a more rapid rate than has the population of the area. There is neither sufficient past nor present data to statistically describe the increase in use of water. However, a review of increased industrial activity and housing trends typifies the increased demand for water.

Increased demands for municipally supplied water may be defined by a per capita demand increase as well as by the increase of the number of persons served. The number of persons served is increasing at a more rapid rate than the basin population. This is by reason of local ordinances which require public water supplies for new housing development and by the necessity for a reliable supply of safe water for household use in established suburban areas. In some suburban areas each household has been served by individual subsurface waste disposal and water supply until the situation became critical because of increased housing density and ground water pollution or contamination. When the situation becomes critical, the people residing in the area must take their choice of either forming a legal body such as a water district for the purpose of operating a public water system or of annexing to an adjacent community for municipal services. In some instances county or city land use control agencies recognize an area as unsuitable for individual water supply and will not permit development until a public water system is assured.

Other factors contributing to the increased demand for water include an increased number of modern home appliances that require more water than did their preceding counterparts, and larger yards both by choice and by ordinance. There is also a trend toward larger green areas around public buildings. Yards, green areas and parks require large amounts of water during the summer months.

Industrial use of municipally supplied water is also increasing, primarily for economic reasons. Industries, in some instances, have found it to be less expensive to purchase finished water than to develop an individual water system to supply the desired quantity and quality of water. The largest industrial group user of municipally supplied water is the food processing industry. By the nature of the industry, it is essential that large amounts of high quality water be available.

The supply of water within the Willamette River Basin, on an annual basis, is adequate for existing and projected municipal and industrial requirements. Some systems do experience short-term deficiencies due to seasonal streamflow deficiencies and transmission and treatment limitations; however, these may be overcome. Smaller communities are normally the ones with the most serious water supply problems and these problems are primarily financial. Most water supply problems within the basin may be solved by storage, transmission or treatment; however, small communities are seldom able to finance the required improvement projects.

Three major steps will have to be taken in order to satisfy future municipal water demands. (1) In some cases, upstream or out-of-basin storage must be acquired, preferably from a multiple-purpose development for use during periods of low natural stream flow. (2) Transmission line and distribution storage capacity must be sized to satisfy peak demands without imposing excessive hourly or daily demands from the source stream. (3) People must become willing to accept streams now considered to be of poor quality as a source for treatment plants. Use of reclaimed waste water may also occur in the future. Past experience, at places such as Salem and Eugene, indicate that the voters have been willing to pay a premium for water from a river of higher apparent quality in place of treating water to the same finished water standards from the more convenient stream, the Willamette River.

In most instances, it is not possible to arrive at a precise amount of stored water required for a given user because only few of the Willamette River tributary streams have been adjudicated and the status of existing rights is not certain. Water presently used in power claims in places such as Lebanon, Albany, Salem and Oregon City even further clouds the issue. The stream flow is not gaged near many of the withdrawal points, hence the flow and yield at sources is generally by estimate only.

B. Definition of Terms

1. Water Supply System

The works and auxiliaries for collection, treatment and distribution of the water from the source of supply to the free-flowing outlet of the ultimate consumer. (From PHS Drinking Water Standards)

2. <u>Municipal Water Supply or Municipal and Industrial Water Supply</u>

A water supply for a privately or publicly owned system which provides water within a service area for homes, businesses, industry and public facilities.

3. <u>Industrial Water Supply</u>

A water supply developed specifically for industrial use or that portion of a Municipal and Industrial supply used especially for industrial purposes.

4. <u>Domestic Water Supply</u>

A water supply developed specifically for normal home or residential use including drinking, bathing, cooking, lawn and family garden irrigation, and stock watering as incidental to a residence, or that portion of a municipal and industrial supply used for the above purposes.

5. <u>Irrigation Water</u>

Water distributed and used specifically for irrigation either from an irrigation system, a municipal system, or from an individual source. The quality may or may not be suitable for domestic use.

6. <u>Complete Treatment</u>

Water treatment consisting of at least flocculation, filtration, and disinfection. Other features may be included, such as pH or Flouride adjustment, mineral or gas removal, sedimentation, or taste, odor and color control measures.

7. Disinfection

Addition of chlorine or chlorine compounds to achieve a satisfactory degree of sanitary purity. Other means of disinfection are not presently used in the Willamette Basin.

C. Water Use Pattern

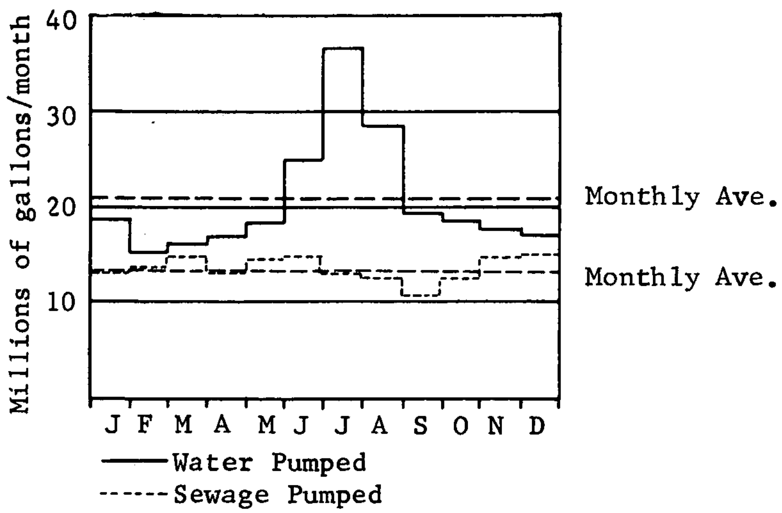
The seasonal pattern of water used by communities within the Willamette River Basin has very pronounced variations. Detailed analysis of daily water use compared with the day of the week, maximum and minimum daily temperature, precipitation, drought duration, and whether the day is a holiday or normal week day emphasizes the summer irrigation demand. The use of water for lawn and garden watering is a major influencing factor in the demand fluctuation. Seasonal industrial activity, primarily food processing, is another major factor.

An example of seasonal variation of water use where there is little fluctuation of industrial demands is Sweet Home. Nearly the same area is served both by the city water and sewer systems. Figure 1 shows, based on monthly figures from calendar year 1960, that the sewage pumpage is always less than the water pumpage.

A total of 248 MG of water was pumped and only 162 MG sewage during 1960. The most pronounced differential was during July when 36.5 MG water was pumped and only 13.2 MG sewage was pumped. This indicates that over one-half of the water was used for non-sewered uses during the month of July. On an annual basis at least 1/3 of the water is used for non-sewered purposes.

FIGURE 1

1960 WATER AND SEWAGE PUMPAGE, SWEET HOME, OREGON

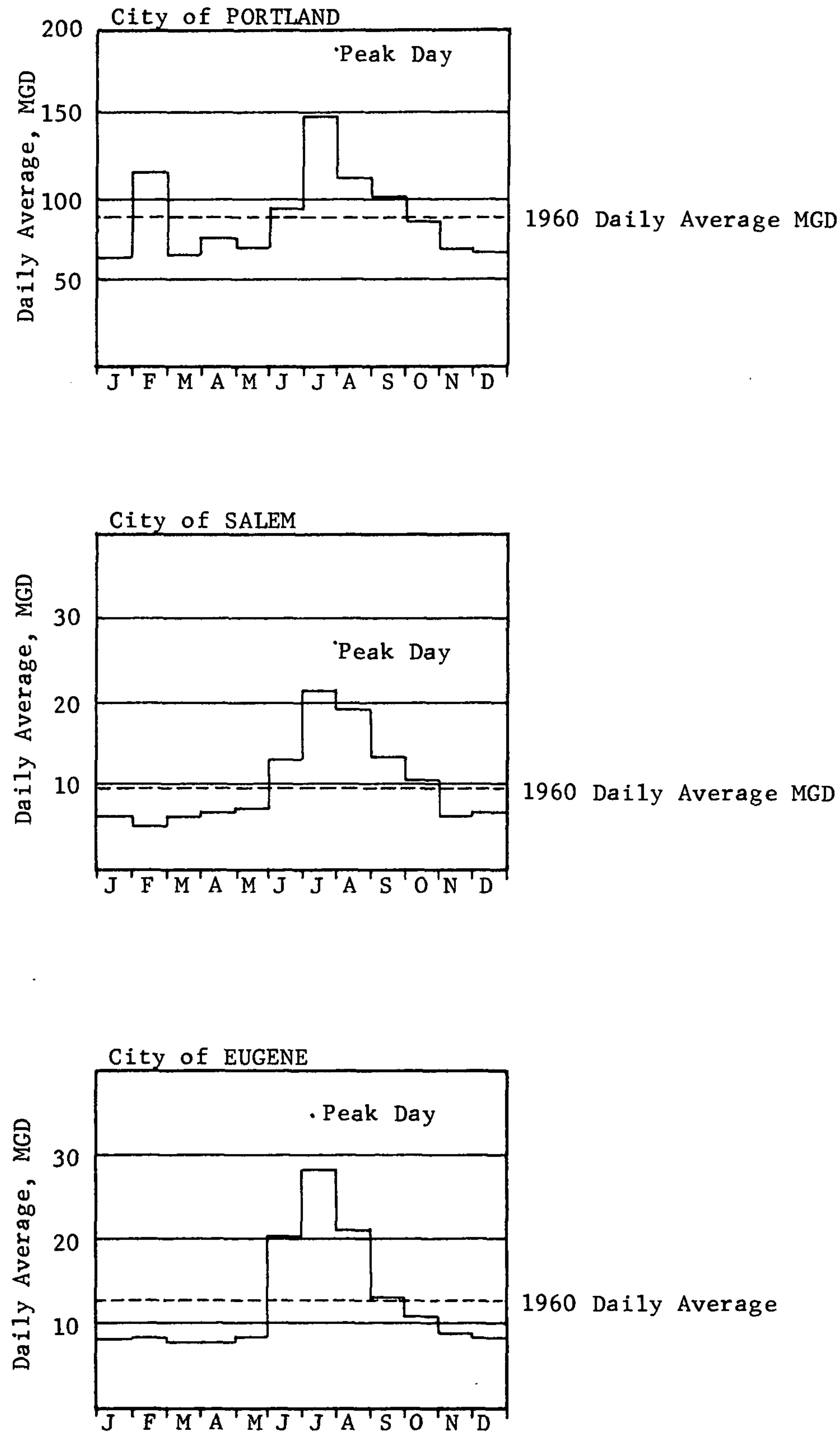


Other measures of the effects of seasonal use are portrayed in Figure 2, "Typical Water Use Patterns of Selected Willamette River Basin Communities" and Figure 3, "Monthly Municipal Water Consumption Characteristics - Willamette River Basin".

As might be expected, daily water use is high on exceptionally hot days, after prolonged drought and high temperature and on normal weekends. Demand drops appreciably on non-work holidays, both from plant shutdown and people leaving home for the day or long weekend. Demand also drops after precipitation, even if only negligible, and after a drop in temperature following an unusually warm succession of days.

FIGURE 2

TYPICAL WATER USE PATTERNS
AT SELECTED WILLAMETTE RIVER BASIN COMMUNITIES



MONTHLY MUNICIPAL WATER CONSUMPTION

CHARACTERISTICS - WILLAMETTE RIVER BASIN

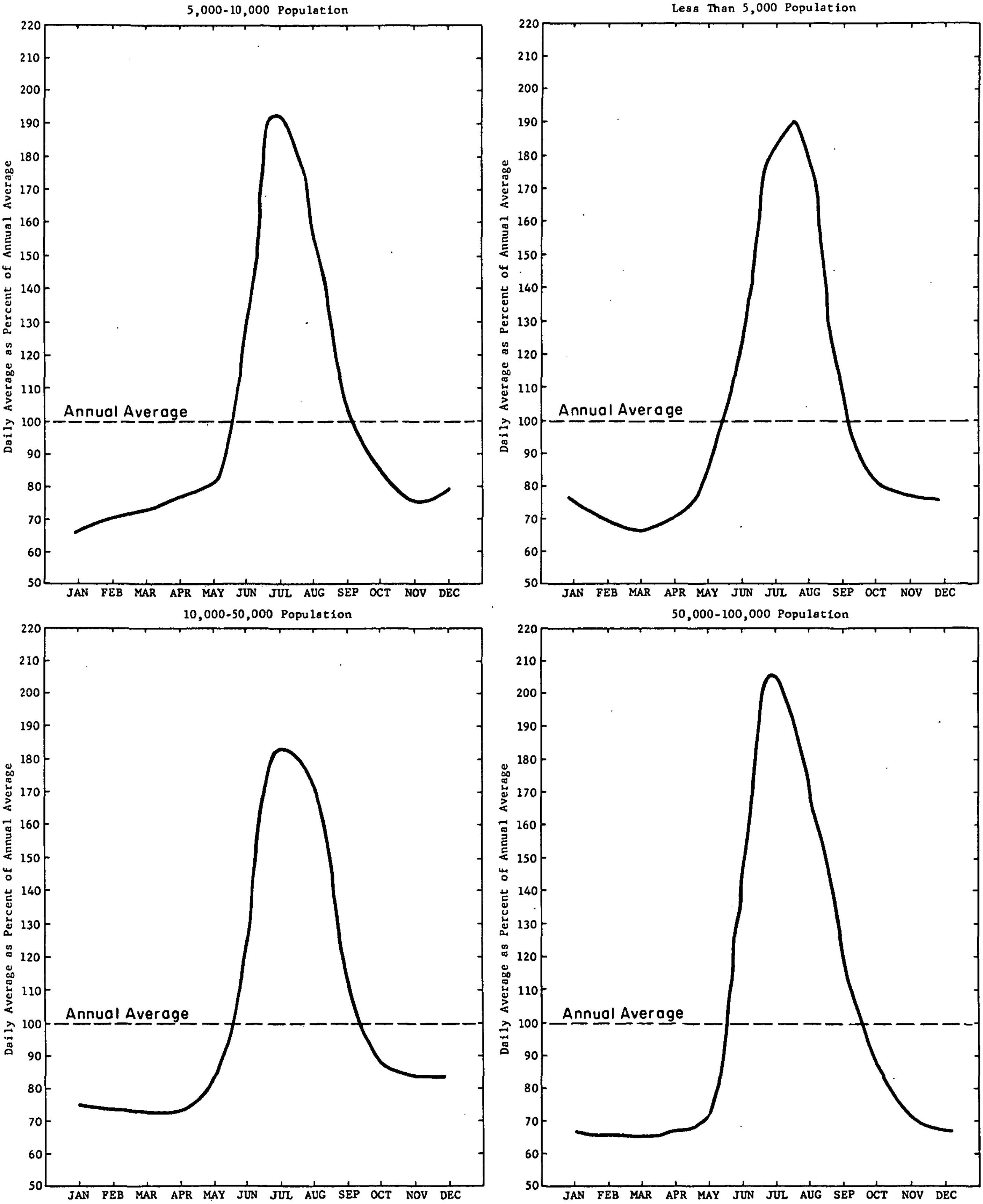
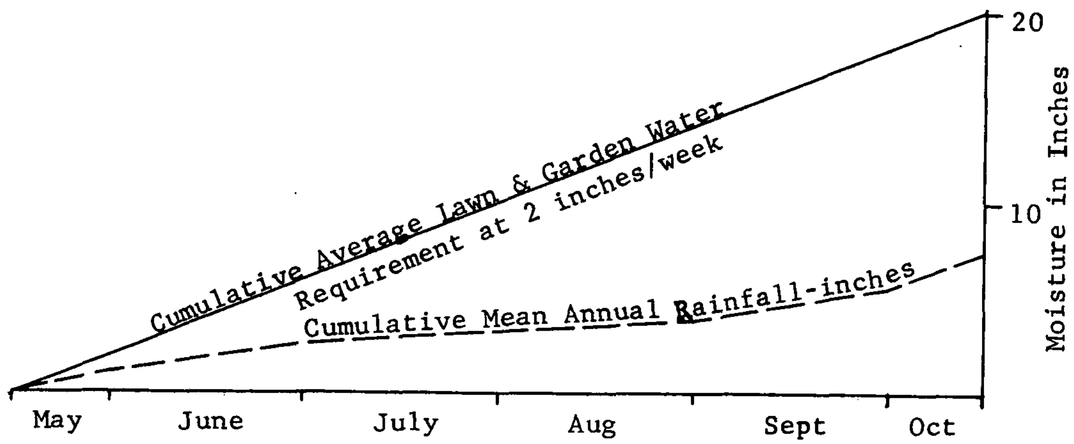


FIGURE 3

Projection of future demands has been based upon the growth pattern of cities of the size class that the subject community will have reached by the target year. This has been done in an attempt to allow for the changes which will occur in all but "bedroom" communities during their growth. Changes will include more green areas, more water-using industries and commercial establishments, and new housing. The monthly use patterns for communities of various sizes are illustrated by Figure 3.

FIGURE 4

LAWN WATER REQUIREMENT AND MEAN RAINFALL IN PORTLAND, OREGON



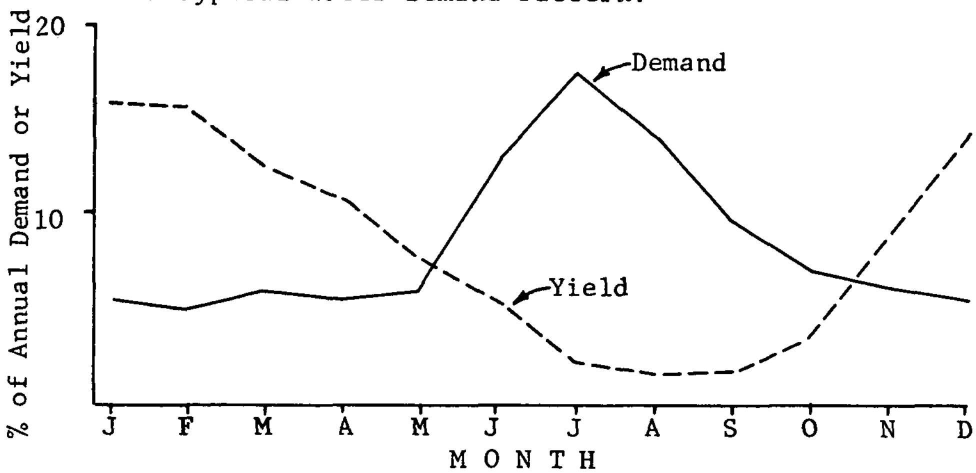
The effects of rainfall distribution on water demand is best shown by Figure 4, "Lawn Water Requirement and Mean Rainfall in Portland, Oregon".[1/] Even though the mean annual rainfall is in excess of 37 inches, the weekly deficit during the summer is 12.6 inches. Assuming average yard and green areas of only 5,000 square feet, this amounts to about 80 gallons per capita per day.

1/ USWB data.

The combined effects of high summer demand and low summer stream flow may be portrayed by comparing the demand and stream flow patterns. Figure 5, "Mean Stream Flow Distribution at Salem, Oregon and Typical Water Demand Pattern" shows that the period of high demand coincides with periods of low flow.

FIGURE 5

Mean Stream Flow Distribution at Salem, Oregon and Typical Water Demand Pattern.



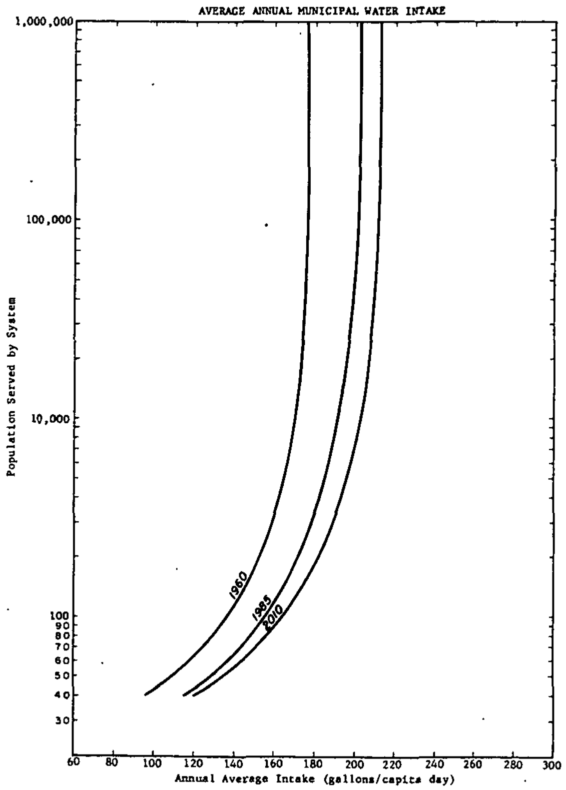
If it were possible to plot the actual legally available stream flow at present source points versus the projected demands in terms of MGD or cfs, the lines would probably cross and indicate a seasonal deficit. This, however, is not possible but the tendency for this to occur must be recognized for consideration in detailed planning.

D. Per Capita Consumption Rates

For the purpose of general evaluation of the municipal water supply situation in the Willamette Basin, a curve depicting per capita demand rates was constructed using weighted averages from selected communities. (Figure 6) The figures used depict gross system intake requirements and

FIGURE 6

AVERAGE ANNUAL MUNICIPAL WATER INTAKE



Explanation of Curves

The 1960 curve is the mean curve for all Willamette Basin communities with good records. If the points were shown, there would be a wide spread between the maximum and minimum values. It is assumed, for the sake of the projection, that all communities and cities will grow as average cities since the variables that will contribute to deveation may not be forecast.

If a city of 8,000 persons in 1960 used about 170 gallons per capita per day (or 1.36 MGD) grew to 10,000 persons in 1985, water would be used at the rate of 190 gallons per capita per day (or 1.9 MGD). If circumstances caused this city to require more water or to be above average, another city would be below average and balance the situation.

which include filter back washing and system losses as well as domestic, commercial and industrial, public institutional, and unaccountable use. The projected rates allow for community growth, including normal industrial-commercial expansion, new homes with large planted areas, new schools and other public buildings with increased summer irrigation requirements, and an increase in water-using home appliances. The rate has been projected to increase at an average rate of 0.5 percent annually from 1960 to 1985 and 0.2 percent annually from 1985 to year 2010. The per capita consumption rate of a given community will change in two ways. As the community grows the per capita demand rate increases to allow for the change in the character of the community and also by the annual per centage rate of increase.

The projected rates are not used for the "bedroom" communities surrounding Portland, because they do not support the normal distribution of water-using commercial and industrial establishments.

Inasmuch as the rates presented are averages, they may not be used as final design criteria for a specific system with relation to a particular source.

E. Quality of Water for Municipal and Industrial Purposes

The quality of surface water within the Willamette River Basin may be generally described as good. The primary deleterious constituents of the surface water supplies that must be removed or treated are sediment, taste and odor producing biological growths, and bacteria.

Sediment occurs in appreciable amounts in nearly every surface stream during periods of high runoff. Methods of control include sedimentation in reservoirs, flocculation and sedimentation, filtration, clarification, and combinations of the foregoing. There are also communities that do not specifically treat for sediment removal in any manner.

Control of obnoxious tastes and odors from biological organisms is also handled in a variety of manners. The City of McMinnville uses activated carbon and chemicals in their source impoundment. The City of Corvallis has experienced an increasing taste and odor problem from their Willamette River source, and the occurrence of certain algae in upstream impoundments has been labeled as the cause. Remedial treatment at the plant by super chlorination and addition of activated carbon has been used.

Bacterial pollution of nearly all surface water sources is treated by disinfection, primarily by chlorination, and in some cases by filtration as well as chlorination. Such disinfection is practiced both as a precautionary and as a remedial measure. The present trend indicates that filtration will eventually be required by the Oregon State Board of Health on all surface supplies except perhaps those in exceptionally well protected watersheds.

The mineral quality of water shown in Tables I, II and III for the cities of Portland, Salem and Eugene is typical of the major surface water supplies. Some specific uses of this water requires additional treatment. An example of additional treatment is boiler feed water conditioning; nearly all high temperature and high pressure boilers require feed water with scale and corrosion inhibitors added.

TABLE I

MINERAL ANALYSIS

OF PORTLAND CITY WATER

BY CHARLTON LABORATORIES

CONTENT		Parts Per Million	USPHS Recom. Limit ppm
Total Solids (Residue on Evaporation)		35.	500.
Volatile Solids (Loss on Ignition)		3.	
Fixed Solids (Residue after Ignition)		32.	
Alkalinity (as CaCO3)			
Carbonate		0.	
Bicarbonate		11.0	
Hardness (as CaCO3)		11.7	
Silica (SiO2)		8.0	
Calcium (Ca)		2.7	
Magnesium (Mg)		1.2	
Iron (Fe)		0.13	0.3
Aluminum (Al)		0.1	
Manganese (Mn)		0.00	0.05
Sodium (Na)		1.1	
Potassium (K)		0.5	
Chloride (Cl)		2.4	250.
Sulfate (SO4)		1.3	250.
Nitrate (NO3)		0.13	45.
Fluoride (F)		0.04	1.0
Phosphate (PO4)		0.0	
pH Value	7.30		
Turbidity	Less than 1.		5.0
Color	10.		15.0

From 70th Annual Report, Bureau of Water Works, Department of Public Utilities, Portland, Oregon

TABLE II

CITY OF SALEM MUNICIPAL WATER QUALITY

BACTERIOLOGICAL EXAMINATIONS
1961 - 1962

Bacteriological examinations were made of 1790 samples of water during the two years, taken at fixed sampling points and at random throughout the city. Results of these examinations far exceeded the required standards of the State Board of Health and the U. S. Public Health Service.

CHEMICAL ANALYSIS

Residents of Salem are fortunate in having a soft water, free of iron and other chemical compounds. The following results were secured from an analysis made on February 20, 1963.

pH Value 6.80

	Parts per Million	Grains per Million	USPHS Recom. Limit ppm
Total Solids (Residue on Evaporation)	35.0	2.04	500.
Volatile Solids (Loss on Ignition)	-	-	
Fixed Solids (Residue after Ignition)	-	-	
Alkalinity (as CaCO3)	-	-	
Carbonate	0.	0.	
Bicarbonate	15.0	0.87	
Hardness (as CaCO3)	15.5	0.91	
Silica (CiO2)	14.0	0.82	
Calcium (Ca)	3.8	0.22	
Magnesium (Mg)	1.5	0.09	
Iron (Fe)	0.07	0.004	0.3
Aluminum (Al)	0.3	0.02	
Manganese (Mn)	0.0	0.0	0.05
Sodium (Na)	2.0	0.12	
Potassium (K)	0.1	0.006	
Chloride (Cl)	3.0	0.18	250.
Sulfate (SO4)	1.2	0.07	250.
Nitrate (NO3)	0.0	0.0	45.
Fluoride (F)	0.0	0.0	1.

From Report of Water Department, City of Salem, Oregon
Calendar Years 1961-1962

TABLE III

MINERAL ANALYSIS

OF EUGENE CITY WATER

BY ANALYTICAL SERVICES, INC.

CONTENT	RAW WATER	FINISHED WATER	USPHS Recom. Limit ppm
pH	7.75	7.57	
Alkalinity (as CaCO3)			
Carbonate	0.	0.	
Bicarbonate	28.0	27.0	
Silica	21.6	23.4	
Calcium	6.7	8.7	
Magnesium	1.1	1.0	
Sodium	4.12	4.39	
Potassium	1.04	1.08	
Iron	0.26	0.20	0.3
Aluminum	0.028	0.114	
Iron & Aluminum as Oxides	0.42	0.50	
Manganese	<0.015	<0.015	0.05
Chlorides	1.59	3.77	250.
Sulfate	1.2	3.3	250.
Fluoride	0.08	0.13	1.
Nitrate	0.06	0.09	45.
Free CO_2	0.9	1.4	
Arsenic	0.010	<0.005	0.01
Copper	0.13	0.18	1.
Phosphate	0.125	0.125	
Total Solids	59.	68.	500.
Volatile Solids	28.	27.	

From letter report, September 12, 1962, from Analytical Services, Inc. to Eugene Water and Electric Board.

Ground water is of importance in the basin, but the quality frequently reduces the desirability of such a source. Hardness, salinity and iron-content are among those properties which have prevented extensive use of ground water in some areas.

The mineral water quality for the selected communities with ground water supplies is listed in Table IV. The recommended limit most commonly exceeded is for iron content. Excessive iron content is liable to impart tastes to beverages and cause staining in laundering and in fixtures. There is no significant toxological hazard from the excessive iron content.

The recommended manganese level is also exceeded but again the danger is economic and aesthetic, with staining the primary effect. There have not been any cases of neurologic effects on man resulting from oral ingestion of water with a manganese content above the recommended limit.[1/]

F. Municipal Water Facility Treatment Practices

The treatment afforded water prior to distribution by municipal water facilities is determined by the requirements of the Oregon State Board of Health and the desires of the consumer. In some instances treatment is provided to assure production of water of a satisfactory quality to meet the USPHS requirements as an interstate watering point, as well as to satisfy state requirements.

Table V provides a summary of treatment practiced in the Willamette River Basin. Recommended improvements to present systems include disinfection of all sources and filtration of most of the surface supplies.

1/ Public Health Service, Drinking Water Standards
1962

TABLE IV

MINERAL WATER QUALITY -- WILLAMETTE RIVER BASIN

Selected Communities -- All from Oregon State Board of Health Examinations

	Total Solids PPM	Sili-cone (SiO_2)	Chlor-ide (Cl)	Sul-fate (SO_4)	Cal-cium (Ca)	Magne-sium (Mg)	Alumi-num (Al)	Hardness (as $CaCO_3$)	Sodium (as Na)	Iron (Fe)	Mangan-ese (Mn)	Fluor-ide (F)	pH
U. S. Public Health Service 1962 Drinking Water Standards - Recommended Limits	500		250	250						0.3	0.05	1.0	
Clackamas Heights W.D.													
New Well 1-13-54	250	45	13	1.2	19.4	3.6	0	93	28	0.1	0.02	0.3	7.5
Dayton													
Well #1 4-20-54	101	3.2	3.5	3.8	4.5	4.5	0	23	7.4	5	0.1	0.2	7.4
Well #2 4-20-54	392	3.8	6.8	6.0	33	9.	0	116	8.6	NR	0.5	0.1	7.8
Fairview													
Well at City	165	28	5.9	2.6	16.2	16.7*	0.05	109.0	8.5	< 0.01	< 0.01	0.2	8.35
Independence													
System-4 wells 8-19-60	222	31.2	10.8	7.4	28.8	18.2*	0.05	146.7	NR	0.20	0.05	0.3	6.9
Jefferson													
Well #1 4-10-61	223.0	33.5	6.7	33.2	17.3	25.0*	< 0.05	146.0	8.0	0.08	< 0.05	0.1	7.30
Well #2 4-10-61	223.0	34.0	6.3	41.0	18.6	27.7*	< 0.05	160.0	7.0	0.58	< 0.05	0.1	7.40
Well #3 4-10-61	204.0	33.0	7.7	39.6	16.2	25.0*	< 0.05	143.0	9.0	1.78	< 0.05	0.1	7.50
Newberg													
System-Wells & Springs 7-14-60	163.0	49.0	4.7	4.6	15.1	13.4	0.08	92.8	7.8	3.0	0.14	0.05	7.8
Scio													
Well #1 4-10-61	101	27.0	6.3	16.8	13.7	8.5*	< 6.02	69.1	6.0	1.8	0.53	< 0.1	6.85
Well #2 4-10-61	155	25.0	27.2	5.0	11.9	9.2*	< 0.05	67.4	8.0	0.11	< 0.05	0.1	7.40
Springfield-PP&L System													
System-Wells 6-15-61	52.0	20.5	3.5	1.3	6.0	7.1*	0.05	44.2	3.8	6.08	< 0.05	< 0.05	6.6
Woodburn													
Well #1 2-9-54	155	41	0.2	1.4	15.4	12.4	0	91	5.3	4.	0	0.3	7.4
Well #2 2-9-54	165	41	0.2	0	15.6	13.3	0	87	5.2	1.5	0.05	0.3	7.5
Well #4 2-9-54	250	41	1.2	NR	22.0	11.3	0	91	5.0	0.6	0.05	0.3	7.8
Wood Village (Portland)													
Well 4-4-60	175	NR	.90	< 1.0	16.2	16.2*	NR	107.6	NR	0.05	0.23	< 0.01	7.48

NR -- Not Reported

* Calculated

Underlined figures exceed USPHS recommended limits.

Some communities without filtration plants have turbid water in the distribution system whenever the streams are turbid. Filtration also reduces the possibility of bacterial contamination of the source being carried into the distribution system. There are a few facilities that provide for mineral removal; however, this is the exception and they are not listed. Individual softeners are used in some areas. In some parts of the City of Lake Oswego softeners are used at a monthly cost of about $6.00.

TABLE V

SUMMARY OF SOURCES AND TREATMENT

WILLAMETTE BASIN, OREGON

Source & Treatment	Number of Municipal Facilities	Number of Developed Sources 1/	Population Served Thousands	Percent of Total
Surface, no treatment	12	22	6	0.6
Surface, Disinfection	42	61	750.5	75.1
Surface, disinfection & filtration	9	13	143	14.4
	63	96	899.5	90.1
Ground, no treatment	47	93	42	4.2
Ground, disinfection	25	66	57	5.7
Ground, disinfection & filtration	--	--	--	--
	72	159	99	9.9
Total All Sources			998.5	

1/ Facilities with sources other than water purchased from other systems, for distribution

It is expected that all surface water supplies will receive complete treatment by 1985. Well managed and protected watershed sources may be excepted. The treatment trends for ground water will show an increase of the number of facilities that provide chlorination.

G. The Cost of Water

Apparent costs of water vary according to the accounting procedure of the various agencies; however, several examples are given.

The City of Portland has experienced an increase of costs during the past eleven years that has essentially doubled the cost of delivered water. System improvements which benefit the user make up a substantial share of the increase. Increased source, transmission, and distribution storage capacity make it possible to provide better service, less danger of summer rationing and improved fire protection.

CITY OF PORTLAND
COST OF WATER DELIVERED 1/

Fiscal Year Ending	Cost Per MG
6-30-51	$103.81
6-30-52	110.62
6-30-53	104.07
6-30-54	122.38
6-30-55	138.94
6-30-56	128.66
6-30-57	133.73
6-30-58	140.81
6-30-59	175.82
6-30-60	192.78
6-30-61	183.17
6-30-62	193.05

1/ City of Portland, Bureau of Water Works Annual Reports

Addition of a complete treatment facility to the existing Portland system would increase the cost of water approximately $40/MG.

The City of Salem has a system of the same general nature as Portland, only they have not constructed upstream storage. The cost per million gallons sold in Salem was $119.59 in 1961 and $119.45 in 1962. In 1954 the cost per million gallons sold was $106.60. New facility construction and increased operations cost can be identified as the reason for the increase of about 11%.

The City of Corvallis operates two complete treatment plants. One of which is located on the Willamette River and used only during the summer months. The full time plant is located on Marys Peak, west of Corvallis, and utilizes natural flow and stored water in the Marys Peak watershed. The total cost of delivered water was $154.50 per million gallons during the fiscal year ending June 30, 1959. Treatment costs accounted for $41.00 per MG of the total. At Adair Air Force Station near Corvallis the total cost of $176.91 per million gallons during 1960 included full time use of a treatment plant using Willamette River water.

The City of Eugene operates a complete treatment plant at Hayden Bridge on the McKenzie River. The total cost of water has increased from $92.30 per million gallons in 1950 to $139 per million gallons delivered in 1960.

No conclusions may be drawn from this limited data except that costs are rising and storage of mountain watershed water to avoid treatment of nearby water may not be the least expensive alternate.

H. Present and Future Use and Supply

Table VI presents present and projected populations as well as average annual and peak month average water demands for Willamette River Basin water service areas. Areas having more than one source and distribution system are treated as a single service area with no attempt being made to project the individual systems requirements.

H-1. Sub-basin Discussion

1. Upper Portion of the Willamette River Basin

Main Stem Willamette River Sub-basin (1-A)

The major water use area in this sub-basin, the Eugene-Springfield Urban Area utilizes ground water from the McKenzie and Middle Fork Willamette River Sub-basins and surface water from the McKenzie River. No major use of the main stem of the Willamette River for municipal purposes in the Eugene-Springfield area is foreseen.

The other communities in the sub-basin rely upon ground water to satisfy their demands. Their future municipal demands will undoubtedly be satisfied from ground water.

Coast Fork Willamette River Sub-basin (2)

The supply of water within the basin appears to be adequate to satisfy future demands. The City of Cottage Grove relies upon flow from several watershed streams and provides flocculation, sedimentation and disinfection for treatment at the town end of the 23-mile transmission conduit as well as disinfection at the headworks end. Ground water is the source for Creswell and will continue as the source.

Middle Fork Willamette River Sub-basin (3)

The major water use area within this sub-basin is in the Oakridge area. There is ample water to satisfy future municipal requirements in this area.

The community of Lowell takes water from the river in the Dexter Reregulation Pool through an infiltration gallery. The pool is used extensively for recreation.

The water supply within the sub-basin is adequate for sub-basin requirements.

McKenzie River Sub-basin (4)

The supply of water within the sub-basin is adequate to satisfy foreseeable demands of sub-basin communities. The McKenzie River also is the primary source for the Eugene-Springfield Urban Area. Approximately 75% of the annual requirement for the Main Stem Sub-basin service area is supplied by the Eugene Water and Electric Board from its Hayden Bridge treatment plant. The existing resource and the existing and proposed storage will more than satisfy projected requirements in that area. The need for storage for municipal purposes will depend upon adjudication of existing water rights and power claims as well as the future water use policy of the State of Oregon.

Long Tom River Sub-basin (5)

The Long Tom River Sub-basin is not water deficient. However, the seasonal variation of the streamflow above Fern Ridge Reservoir and the apparent quality in the reservoir and downstream have delayed development of adequate water systems in the sub-basin communities.

The community area of Venita-Elmira is in need of a water system. Three alternates are apparent: (1) Install a transmission line to Eugene and purchase water from the Eugene Water and Electric Board. This has been contemplated and is presently considered as economically unfeasible. (2) Purchase storage space in Fern Ridge Reservoir if possible and treat water from the reservoir for distribution. (3) Construct single-purpose storage on a watershed stream for low flow period use and a treatment plant. A complete detailed study of the area by a consulting firm will be required before any progress toward a public water system may occur.

2. Middle Portion of the Willamette River Basin

Main Stem Willamette River Sub-basin (1-B)

The communities in this sub-basin utilize ground water, tributary streams, and the Willamette River to satisfy their needs. As previously stated, the means of satisfying their future requirements is somewhat dependent upon the results of an adjudication of the Willamette River and its tributaries. In all cases, there is sufficient water available on an annual basis, but the streams presently used as sources do not always have sufficient summer flow to satisfy the needs.

The City of Corvallis, after developing a watershed area on Marys Peak to its limit of economic feasibility, turned to the Willamette River as the next source. Water produced from this facility is generally satisfactory, except when the characteristics of the water change faster than adjustments in treatment techniques may be made. The City of Salem, which is also on a bank of the Willamette River, chose to take its water from the North Santiam River through a 20 mile transmission line. Complete treatment has been temporarily avoided by using this source. However, it is reasonable to assume that it will be required eventually.

The other communities of the sub-basin will satisfy their needs by storage, long transmission lines, or treatment of available water as Corvallis and Salem have done. The solution for each community will depend upon a detailed study near the time of need.

Calapooia River Sub-basin (6)

Upstream storage is the apparent means by which the City of Brownsville may satisfy their future demands. It has been necessary to alter the stream bed during summer periods of low flow in order to provide sufficient water to flood the cities infiltration gallery. Other development of water supplies within the basin will have to either utilize ground water or provide storage for use during periods of low flow. Two areas, Sodaville and Holley, are expected to have public water systems by 1985.

Santiam River Sub-basin (7)

The area along the North Santiam River should not experience any water supply problems nor should the City of Salem, which takes water from the river through an infiltration gallery.

The South Santiam River area may experience difficulty in supplying future demands from natural flow if all existing water rights and power claims are utilized. Upstream storage under consideration or under construction will have storage space which the cities, water companies, and industries may purchase if existing rights may not be satisfied from natural flow.

Marys River Sub-basin (8)

Present demands of the sub-basin are served from natural flow of Marys River and from a watershed on Marys Peak developed by the City of Corvallis. Storage for 100 MG has been built, but this will not satisfy present peak demands during dry years. The City of Corvallis has developed an additional source from the Willamette River. Additional water supply development in the sub-basin will be dependent upon upstream storage. However, most of the populated area is in the lower portion of the sub-basin and is convenient to the Willamette River as an alternate source.

Luckiamute River Sub-basin (9)

Only minor development has occurred within this sub-basin and no significant increase of municipal and industrial is projected. It is anticipated that the demands will be satisfied from the Luckiamute River and tributaries, the Willamette River, and ground water.

Yamhill River Sub-basin (10)

The total water resource of the Yamhill River sub-basin is adequate to satisfy projected demands, but seasonal deficiencies will make storage or trans-basin diversion necessary. The largest of the sub-basin communities, McMinnville, has had storage facilities for some time in order to satisfy peak summer demands. This city has also had alternate sources investigated. There are three major alternatives available: (1) transmission from the Willamette River, (2) single- or multi-purpose Yamhill Basin storage, or (3) trans-basin diversion from coastal streams. A final selection will, no doubt, reflect economic feasibility and aesthetic preference at the time of decision.

Other smaller sub-basin communities are faced with the same problem on a smaller scale. It is probable that participation in proposed upstream multiple purpose storage projects will provide a satisfactory solution for them.

<u>Pudding River Sub-basin</u> (11)

Season deficiencies of sub-basin stream flow have accelerated the consideration for upstream storage. Silverton is the largest community (4,000 served) that relies primarily upon surface water. The remainder of the communities rely primarily upon ground water.

<u>Molalla River Sub-basin</u> (12)

There is no storage indicated for municipal and industrial water supply within this sub-basin.

<u>Clackamas River Sub-basin</u> (13)

It is probable that the Clackamas River will be heavily used in the future for municipal water supply. A complete analysis of the resource of this river including adjudication of water rights and power claims and establishment of base minimum flows should be made. Determination of development requirements will not be clear nor will reliability be established until this is done.

The water resource of this sub-basin is adequate to satisfy projected demands, but future seasonal deficiencies and use conflicts must be overcome.

Tualatin River Sub-basin (14)

The Tualatin River sub-basin relies partially upon water from other sub-basins for municipal water supply at the present time and it is expected that a greater demand will be made on out-of-basin sources in the future. Alternatives available include coastal streams, the Willamette River, and the Columbia River. A complete evaluation must be made of the existing sub-basin resource and demands before a plan may be developed. Tualatin sub-basin communities have endorsed the USBR Tualatin Project which recommended storage in the amounts shown in the tabulation below.

USBR TUALATIN PROJECT RECOMMENDATIONS 1/

Participant	Allotment (Acre-feet)	Adequate to Year
Forest Grove	4,500	1998
Hillsboro	4,500	1986
Beaverton	1,500	1983
Tigard	2,500	1982
Lake Oswego Corporation	1,000	----
Total	14,000	

1/ Tualatin Project, Oregon Report, U. S. Department of Interior, Bureau of Reclamation, Boise, Idaho, May, 1963.

3. Lower Portion Main Stem Willamette River Sub-basin

This sub-basin is the most densely populated area in the Willamette River basin and also has the greatest demand for water. The supplies are many and varied, but the largest single source has been developed by the

City of Portland in the Bull Run watershed. The transmission facility is composed of three conduits about 25 miles long with a total capacity of 225 MGD. There is storage for 23,200 MG within the watershed with plans for an additional 11,150 MG by 1990. There has also been some planning for diversion from the Clackamas River sub-basin for future supply. The natural quality of the water and watershed management practices have made it possible to provide satisfactory water for distribution after treatment by simple chlorination only.

Other supplies in this sub-basin include ground water and the Clackamas River. Complete treatment is required of water from the lower reaches of the Clackamas River. Alternatives and additional sources include the Columbia and Willamette Rivers, the Clackamas River, and ground water.

Sandy River Sub-basin (15)

The water resources of this sub-basin are adequate for satisfaction of projected requirements.

I. Industrial Water Supply, Willamette Basin, Oregon

There are no industries that have located in the Willamette Basin solely because of water quality or quantity in recent years. During the initial development of the basin industrial sites were picked to take advantage of water power potential and available supplies for plant operation. However, the availability of large quantities of good water has continued to contribute to the industrial growth of the valley. Industries that are arbitrarily categorized as wet process industries are those that require large quantities of water in their particular process. Pulp and paper plants and food processing plants are the major wet process industries within the Willamette River Basin. There are other industries that rely upon water; however, the amount is not significant on an individual basis.

The only specific industry for which present and projected water requirements are stated is the pulp and paper industry. The majority of the food processing plants rely upon municipal systems for their supply and their requirement is an integral part of the projected municipal requirement. Other industries are mentioned, but only to show their existence and their relationship to the local water supply situation.

The quality of water used or available for industrial use in the Willamette Basin may best be described as good. Various users treat the water according to their needs with the degree of treatment ranging from none to complete treatment. Boiler feed water is nearly always conditioned regardless of the source. The most undesirable characteristic of surface water is fluctuation of chemical and physical parameters. Sediments transported in surface water fluctuate by season and effect more of the users than any other physical quality parameter. The expense incurred in coping with the sediments and silts has not been defined.

Intermittent discharges and accidental spills of strong wastes which cause a change in chemical quality cause operational problems at industrial treatment plants. The costs incurred in coping with changing chemical parameters has not been determined.

The most often stated quality requirement by industry is that the quality remain constant except for seasonal fluctuation.

The quantity of water generally assumed to be readily available would support virtually unlimited industrial development. However, the actual available supply for future industrial development is restricted. Water for industrial purposes may be limited in several ways. Many industrial water rights are of recent vintage and may be reduced by adjudication of the rights from a stream or may be reduced during an extreme low flow season. The State of Oregon may withdraw a portion of the natural flow of a stream from further appropriation in order to maintain at least a minimum desirable flow. From the foregoing, it becomes obvious that legally stored water will, in at least some areas, be the only reliable surface source for future industrial requirements.

I-1 Sub-basin Discussion

The following discussion of industrial water use in each of the sub-basins of the Willamette River Basin is directed toward the foreseeable future. In no case does this go past the level of development expected to occur by 1985.

1. Upper Willamette Basin

Main Stem Upper Willamette River (1-A)

There are no significant withdrawals of water from the main stem Upper Willamette River for industrial purposes. The two largest users in the City of Eugene, Eugene Fruit Growers and U. S. Plywood, used 175 and 133 million gallons respectively in 1960. Compared with the total city system intake from the McKenzie River, the Eugene Fruit Growers used 3.7 percent of the total and U. S. Plywood used 2.8 percent of the total. Other industrial uses in Eugene include a poultry packing plant, dairies, creameries, soft drink bottlers, an ice plant, steam plants, custom canners, and many other small users. The total commercial-industrial water sales in the City of Eugene total about 50 percent of the annual intake, or nearly 2,250 million gallons annually.

Coast Fork Willamette (2)

The largest industrial water user in the sub-basin is the Weyerhaeuser Timber Company mill at Cottage Grove. The average intake is 10 MGD, or 3,650 MG annually. Water is used primarily for steam production, hydraulic debarking and log pond filling. Other industrial uses include small saw mills and gravel washing. The existing sub-basin water supply is adequate in quantity and quality to fulfill projected needs.

Middle Fork Willamette (3)

Pope and Talbot, Inc., located near Oakridge, is the major industry of this sub-basin. An undetermined amount of water is used for plant operation in producing lumber, plywood and particle board. There are other smaller mills in the sub-basin, all of which have an adequate water supply. The water resources of the sub-basin are adequate in quantity and quality to satisfy all projected industrial requirements. A part of the industries in Springfield are supplied with water from the Pacific Power & Light Company water system. The water supplied by PP&L is produced from wells near the river which are artificially recharged with water from the Middle Fork Willamette River. The amount used by industry from PP&L totals approximately 250 MG annually, or less than one MGD.

McKenzie River (4)

The McKenzie River is the source of water for the majority of the industrial supply in the Eugene urban area. Most of the industries are served by city systems or water districts in the Eugene urban area. About 7 MGD withdrawn by municipal systems from the McKenzie River is used for commercial-industrial purposes.

The largest and only significant demand by a self-supplied industry is the Weyerhaeuser Timber Company plant in Springfield. This plant is used for production of lumber, plywood, pressed wood products and pulp. Current operations require an average withdrawal of 15 MGD, of which 10 MGD is required for operation of the pulp plant. The present capacity of the pulp plant is 400 tons/day and the anticipated 1985 capacity is 800 tons/day. The projected total plant water requirement is 30 MGD. The company holds a water right for 80 cfs (51 MGD). The quantity of water available in the basin is adequate to satisfy the foreseeable requirements of industry.

The quality of water is such that the Weyerhaeuser Company treats only about 6 MGD with an Accelator at the present time. During periods of heavy runoff, which results in high turbidity, the solids in the water cause excessive wear of the hydraulic debarker nozzles. It is presently economical for the company to buy water from the Rainbow Water District during this period instead of providing more treatment. Chemically, the water is always of satisfactory quality.

2. Middle Willamette Basin

Middle Portion Willamette Main Stem (1-B)

The use of water for industrial purposes from the middle portion of the Main Stem Willamette is primarily for pulp and paper manufacturing. Other uses include food processing, concrete products manufacturing, pressed wood products manufacturing, and the manufacture of bitumastic pipe.

Additional water is withdrawn from the Willamette River by the City of Corvallis and the Adair Air Force station which is ultimately used for industrial purposes. The majority of the water provided by the Air Force station and the City of Corvallis is for food processing. The present use in Corvallis by Blue Lake Packers, the major city-supplied industry, is about 30 MG annually; however, most of this is used between July and October.

In the vicinity of Albany, there are two major water users, Western Kraft Corporation and Wah Chang Corporation. Unbleached kraft liner board is produced at the Western Kraft Corporation plant. Present process techniques require about 4 MGD to satisfy the requirements for the ninety ton per day plant. There is no treatment except for the boiler feed water in order to control scale and corrosion. Their existing water right is for about 20 MGD. Based upon present State water allocation policy, the plant apparently will not be hampered by a lack of available water.

The second major water-using industry near Albany is the Wah Chang Corporation, manufacturers of rare metals. The output of the plant is not known. However, the average daily water use is 2.7 MGD, or 100 million gallons per year. Treatment has been limited to simple chlorination; however, turbidity is a wintertime problem.

The only other major withdrawal of water from the middle portion of the Willamette River is by the Spaulding Pulp and Paper Company at Newberg. The 160 ton per day plant produces unbleached pulp and requires about 5 MGD for plant operations. Their existing water right will provide about 13 MGD and is adequate for the foreseeable future.

The quality of the water is controlled by filtration, chlorination, and deionization. Their problems are typical of those normally found, primarily turbidity resulting from transport of silt and other floating material and changes in chemical quality. It is also necessary in this plant to supplant the river supply with City water during the summer when the river water temperature is higher than desirable for acid mixing. This amounts to about 0.1 MGD during August and September.

Long Tom River (5)

There is no present or projected significant industrial water demand in this sub-basin. There are several small sawmills and a clay products plant within the basin; however, the use of water is minor. The Long Tom River is not desirable either as a source of water for industrial purposes or as a receiving stream for large amounts of industrial wastes, and it is therefore not a likely location for any significant industrial development.

Calapooia River Basin (6)

There are no present or projected significant industrial uses of water in this basin. There are a few saw mills; however, their use is minor. The stream is not suitable for assimilation of large amounts of industrial wastes and is, therefore, not a likely location for industrial development.

Santiam River (7)

The Santiam sub-basin is most conveniently split into the South, North and mainstem sub-areas.

Present and programmed storage projects in this sub-basin will offer adequate opportunity for industries to contract for storage for future use, if required.

Industrial use of water withdrawn from the South Santiam by industries occurs in the Lebanon-Sweet Home vicinity. The major industrial withdrawal is for the Crown Zellerbach plant at Lebanon.

Crown Zellerbach operates a 90 ton per day sulphite process pulp and paper mill at Lebanon which requires about 7 MGD of water. The water is withdrawn from a canal which is a diversion from the South Santiam River above Lebanon. Future expansion of this plant is assumed to be minimal and the water supply for the foreseeable future is assumed to be adequate. The ultimate supply available will depend upon adjudication results and future State water policy.

The next largest user is Cascade Plywood Corporation at Lebanon which requires about 2 MGD. No shortage is foreseen.

There are other minor uses which are both self-supplied and supplied by the Sweet Home or Lebanon municipal water systems.

There is no appreciable industrial use of water along the North Santiam River. However, the Columbia River Paper Division of the Boise Cascade Corporation diverts water from the North Santiam through a canal to their Salem Mill.

The Columbia River Paper Division operates a 150 ton per day sulphite pulp and fine paper mill on the bank of the Willamette River in Salem. Approximately 16 MGD of water diverted from the North Santiam River is used daily. The water requires complete treatment prior to use. The paper mill shares in a right for 254 cfs (164 MGD) diversion from the North Santiam River for power and manufacturing purposes dated 1856 and subject only to a prior right of 50 cfs for the State Game Commission. The mill also shares in a 342.6 cfs right from Mill Creek which is subject to about 230 cfs of prior appropriation, and may not be satisfied during the summer. It is therefore assumed that sufficient water to meet foreseeable needs is available.

A portion of the water diverted by the City of Salem is also used for industrial purposes. Food processing is the major user with an annual average of about 1.5 MGD with 5 MGD peaks during the canning season.

There is no significant present or foreseeable industrial demand made upon the waters of the Main Stem Santiam River.

Marys River (8)

The only industrial use, existing or foreseen, made of water from the Marys River is for small saw mills. Any significant increase in industrial utilization of water within the sub-basin would be dependent upon either storage or trans-basin diversion.

Luckiamute River (9)

The existing and foreseeable industrial use of water in the Luckiamute sub-basin is minor. However, any major demands would best be satisfied from stored water.

Yamhill River (10)

Industrial use of water within the Yamhill sub-basin is presently limited primarily to a few saw mills, a plywood mill at Willamina and several industries using city water in McMinnville. No significant industrial supply is available without storage or trans-basin diversion. No appreciable increase in self-supplied industrial water demand is projected for the foreseeable future.

Pudding River (11)

There is no present or projected major industrial water supply demand within the Pudding River sub-basin in the foreseeable future. The largest single user, Birdseye Frozen Foods at Woodburn, relies upon ground water for its supply. This company was using about 2 MGD in 1961 and has since increased its use and supply. Ground water is satisfactory for the foreseeable future as its supply.

Molalla River (12)

Industrial use of water in this sub-basin is minor and is presently limited primarily to saw mill type operations. Most of that used is purchased from the City of Molalla. There is no foreseen demand for industrial process water in the area. However, any large demands would most probably have to be satisfied from storage.

3. Lower Main Stem Willamette River

Industrial utilization of water from the Lower Main Stem Willamette River is primarily for pulp and paper production at Oregon City.

At the Oregon City Falls, Publisher Paper Company operates a mill of 400 tons per day capacity. The mill requires approximately 30 MGD for sulphite and ground wood processing. About one-half, or 15 MGD, is given complete treatment at a total cost of about $33 per million gallons and used as process water. The remaining 15 MGD is used for non-process purposes such as flumes and the like. An additional quantity of water is used non-consumptively for power generation. The mill's right to use water in this manner dates prior to 1842 for 822 cfs. Based on projected expansion and present water policy, the mill should not experience a water shortage.

Crown Zellerbach operates a 600 ton per day plant at West Linn which is also at the Oregon City falls across the river from the Publishers Paper mill. The mill produces newsprint and printing paper from sulphite and ground wood processes. The water requirements are met by treating approximately 20 MGD of water from the river. The direct cost for treatment (chemicals and labor) is about $17.65 per million gallons.

Other uses of this portion of the basin are individually smaller in quantity. However, they are important to the basic economy. In some instances, it is more economical to purchase water from a municipal system for boiler use than to treat river water. Silt also poses a problem for boiler use in the lower reach of the river. The furthest downstream right is the Pennsylvania Salt Company's right for 8.90 cfs near the St. Johns Bridge in Portland.

A tremendous amount of ground water is used for industrial purposes in the area along the lower reach of the main stem Willamette River. The uses include heating and cooling, process water in food and kindred plants, fabricating plants, concrete plants and a host of other uses. It is impractical to attempt to determine a total, if not impossible, of the annual withdrawal. In 1959 there were over 500 wells listed in East Portland.[1] The capacity of these wells was over 82 MGD. The portion

[1]U. S. Geological Survey, Ground Water of East Portland. C. M. Hogensen, December 1959.

used is unknown. The present State policy has not restricted use in this area. However, it is reasonable to assume that restriction intended to maintain the ground water in a sufficient quantity and quality for beneficial uses will eventually be proposed.

Clackamas River (13)

Only minor use is made of water in the Clackamas River sub-basin for industrial purposes. Although there is no significant industrial use projected within the area, water in appreciable quantity would most probably be available only from storage or trans-basin diversion.

Tualatin River (14)

The effects of a shortage of water for industrial purposes have been felt in the Tualatin River sub-basin. One food processor moved to another area for a combination of reasons; the lack of additional water is alleged to have been one of the reasons.

The existing surface water sources within the sub-basin are presently appropriated to the limit. Further surface water utilization is possible only with storage and/or trans-basin diversion. A local committee stated at an Oregon State Water Resources Board public hearing that an additional 900 acre-feet will be required annually for food processing by 1975. It is reasonable to predict that an additional 1,000 acre-feet would be utilized, if available, by 1985. The present pattern of industrial water use within the sub-basin indicates that the need will be satisfied by municipal systems.

No major water-using industry is projected for location in the Tualatin River sub-basin and, therefore, water requirements for that purpose are not stated.

Lower Columbia River in Portland Vicinity and Sandy River Sub-basin (15)

The largest water user in the area of concern is Reynolds Metals Company at Troutdale. The plant is supplied by fourteen wells with an annual available yield of four billion gallons. During 1962, 2.4 billion gallons of water were used. The plant was not operating at full capacity; however, the water requirement does not vary directly with production. The majority of the water, 75-80 percent, is used for fume washing or scrubbing. The remainder is used for various purposes such as cooling bearings, casting, clean up, etc.

There are other industrial uses of water in the area. However, they are individually smaller and are able to satisfy their needs from public water supplies, ground water, or are close enough to the Columbia River to consider it as an alternate source. The projected industrialization of the area should not be short of water in the foreseeable future.

TABLE VI

WILLAMETTE RIVER BASIN MUNICIPAL WATER SERVICE AREAS
UPPER PORTION WILLAMETTE RIVER BASIN - COAST FORK SUBBASIN

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
1A - Main Stem Willamette River Subbasin					
Coburg and vicinity	1960	0.8	0.08	0.2	Wells are presently used and ground water should satisfy foreseeable requirements. Ground Water Rights = 1.4 MGD
	1985	3	0.54	1.1	
	2010	8	1.6	3.1	
Eugene Urban Area	1960	92.5	16.9	34.6	Eugene Water and Electric Board Surface Water (300.08 cfs), Pacific Power & Light Co. Ground Water (21.65 cfs), Springfield Utility Board-Rainbow Water District Ground Water (14 cfs) have rights totalling 335.75 cfs, or 217 MGD. This adequate for the foreseeable future. About 75% of the water is from the Eugene Water and Electric Board filtration plant (80 MGD capacity) on the McKenzie River at Hayden Bridge. The remainder is from ground water.
	1985	160	32.6	67.0	
	2010	280	59.4	122.0	
Junction City and vicinity	1960	1.6	0.45	0.9	Ground water (W.R. = 2.4 MGD) satisfies present and foreseeable requirements. Additional well development for 0.35 MGD is required to satisfy projected 1985 requirements.
	1985	6	1.1	2.1	
	2010	15	3	5.9	
Total	1960	94.9	17.43	35.7	
	1985	169	34.24	70.2	
	2010	303	64.0	131.0	

UPPER WILLAMETTE RIVER BASIN - COAST FORK SUBBASIN (Continued)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
2 - Coast Fork Willamette River Subbasin					
Cottage Grove and vicinity	1960	5	1	2.0	Upper tributary streams of the Coast Fork Willamette River are utilized by the city. (WR=9.7 MGD). Chlorine is added at the headworks of the 23 mile transmission conduit in order to provide service along the conduit. Treatment at the town end is limited to disinfection, flocculation, and sedimentation. Additional transmission capacity and filtration will be required in the future.
	1985	8	1.5	2.9	
	2010	17	3.5	5.3	
Creswell and vicinity	1960	0.8	0.08	0.2	Water is obtained from wells. Additional capacity will be required by 1985 for 0.4 MGD. Wells are the most likely source. Surface alternates include Coast Fork Willamette River and small tributary streams and springs.
	1985	2	0.3	0.6	
	2010	4	0.7	1.4	
Total	1960	5.8	1.08	2.2	
	1985	10	1.8	3.5	
	2010	21	4.2	6.7	
3 - Middle Fork Willamette River Subbasin					
Lowell and vicinity	1960	1	0.13	0.3	Water is taken from the Middle Fork Willamette R. through an infiltration gallery in the Dexter reregulation pool (surface water right, 0.65 MGD). Increased recreational use of the river and dam pools may make complete treatment necessary by 1985. Sufficient flow is present for future use; additional water right for 0.2 MGD needed by 1985.
	1985	2	0.34	0.7	
	2010	5	1.0	1.9	

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
3 - Middle Fork Willamette River Subbasin (Continued)					
Oakridge and vicinity	1960	4	0.6	1.2	The area if served by three systems using water from Salmon Creek and wells. There is sufficient flow to satisfy projected future requirements. Existing water rights total 4.5 MGD.
	1985	5	1.0	1.9	
	2010	11	2.2	4.1	
Total	1960	5	0.73	1.5	
	1985	7	1.34	2.6	
	2010	16	3.2	6.0	
4 - McKenzie River Subbasin					
Blue River and vicinity	1960	0	0	0	A public system does not now exist, but it is expected that there will be one by 1985. Water rights for 1 MGD and treatment for 0.90 MGD will be required to satisfy projected 1985 requirements. Sufficient water is available.
	1985	2	0.34	0.7	
	2010	5	1.0	1.9	
Marcola and vicinity	1960	0.5	0.05	0.1	Marcola is served by a well. Additional capacity of 0.4 MGD will be required by 1985. Ground water is the most probable source. The Mohawk River is an alternate.
	1985	1	0.16	0.3	
	2010	2	0.36	0.7	
Total	1960	0.5	0.05	0.1	
	1985	3	0.50	1.0	
	2010	7	1.36	2.6	

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
5 - Long Tom River Subbasin					
Elmira-Venita and vicinity	1960	0	0	0	There is not a public system at the present; however, one would be expected prior to 1985. Ground water development is not probable. Streamflows in the area frequently are zero during summer months. New single purpose storage or purchase of water from the C of E Fern Ridge Reservoir are alternates to purchasing water from the City of Eugene. A water right for 2 MGD, stream storage for 100 MG, and treatment for 1.5 MGD will be needed to satisfy projected 1985 requirements if a single purpose development is to be constructed.
	1985	4	0.74	1.4	
	2010	9	1.8	3.5	
Monroe and vicinity	1960	0.5	0.04	0.1	The present source on Muddy Creek tributaries has a 0.23 MGD water right. Further development of the existing source or treatment of Long Tom River water as an alternate supply is needed by 1985 in the amount of 0.5 MGD. A total of 2 MGD to satisfy peak demands will be required by 2010.
	1985	2	0.34	0.7	
	2010	5	1.0	1.9	
Total	1960	0.5	0.04	0.1	
	1985	6	1.08	2.1	
	2010	14	2.8	5.4	
Total Upper Portion Willamette River Basin	1960	106.7	19.33	39.6	
	1985	195	38.96	79.4	
	2010	361	75.6	151.7	

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
1-B Main Stem Willamette River Subbasin					
Albany and vicinity	1960	13	2.4	4.5	Status of water right is unknown. Pacific Power & Light Co. provides water from the power canal diverted as allowed by a power claim from South Santiam R. at Lebanon. This practice was started prior to adoption of Oregon Water Code and the river has not yet been adjudicated. An additional 10 MGD treatment facility will be required to meet projected 1985 requirements. The Calapooia and Willamette Rivers are alternate sources. Storage would be required to utilize the Calapooia River.
	1985	41	8.16	15.1	
	2010	91	19.3	39.6	
Aumsville and vicinity	1960	0.3	0.03	0.1	Ground water is the present source and it will satisfy projected 1985 requirements.
	1985	1	0.16	0.3	
	2010	2	0.36	0.7	
Corvallis and vicinity 1/	1960	24	4.03	7.4	The basic supply of 4.5 MGD is from the Marys River watershed--no expansion foreseen. Supplemental water supply is from the Willamette R. with 16 MGD water right and 9 MGD plant capacity. The peak 1985 requirement is estimated as 35 MGD. An additional 15 MGD water right and 22 MGD treatment capacity will be required. Additional water may come from the Willamette R. State water regulations may require upstream storage for summer water right satisfaction.
	1985	70	13.86	28.4	
	2010	132	28	57.5	

1/ Includes Marys River Subbasin, Philomath and vicinity and Corvallis suburban.

MIDDLE PORTION WILLAMETTE RIVER BASIN (Continued)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
1-B Main Stem Willamette River Subbasin (Continued)					
Dallas and vicinity	1960	7	1.49	2.9	The city holds a 9 MGD water right on Rickreall Creek which is adequate. Streamflow is low during summer months, but the city has 25 MG stream storage and will require an additional 250 MG by 1985. Complete treatment for 5 MGD will also be required to satisfy projected 1985 demands.
	1985	10	1.92	3.8	
	2010	14	2.9	5.4	
Dundee and vicinity	1960	0.5	0.08	0.2	The city supplies water from springs and wells with 1 and 0.1 MGD surface and ground water rights, respectively. The dependable well draft is 0.12 MGD. Additional ground water development for 1 MGD will be required to satisfy projected 1985 demands.
	1985	3	0.54	1.1	
	2010	6	1.2	2.4	
Halsey and vicinity	1960	0.2	0.02	0.1	Citizens Water and Light Company provides water from a well. Additional capacity of 0.1 MGD will be required by 1985 to satisfy projected requirements.
	1985	1	0.16	0.3	
	2010	2	0.4	0.8	
Harrisburg and vicinity	1960	1.2	0.17	0.3	The city uses wells rated at 0.7 MGD to satisfy requirements. Additional capacity of 1.8 MGD will be necessary to satisfy demand projected for 1985. Further ground water development is likely.
	1985	5	0.93	1.8	
	2010	11	2.25	4.2	
Independence and vicinity	1960	2.1	0.31	0.6	Pacific Power & Light Co. has ground water rights for 1.5 MGD (well capacity 3.2 MGD). An additional right for 1.5 MGD will be required by 1985 to satisfy projected demands.
	1985	6	1.12	2.2	
	2010	13	2.7	5.0	
Monmouth and vicinity	1960	2.5	0.39	0.8	The city has 2 MGD water rights on Teal Creek and springs. The system capacity is 0.5 MGD. Additional rights for 2 MGD, treatment for 4 MGD, and storage for 250 MG will be required to meet projected 1985 demands.
	1985	9	1.72	3.4	
	2010	19	3.9	7.2	

MIDDLE PORTION WILLAMETTE RIVER BASIN (Continued)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
1-B Main Stem Willamette River Subbasin (Continued)					
Newberg and vicinity	1960	5.5	0.71	1.4	City has water rights for 6.5 MGD surface water and 2.9 MGD ground water. Springs developed are for 1.37 MGD, wells for 2.1 MGD, or total of 3.47 MGD. Additional capacity of 4.5 MGD from existing rights is needed to satisfy the demands projected for 1985.
	1985	17	3.32	6.1	
	2010	38	7.9	14.6	
St. Paul and vicinity	1960	0.15	0.02	0.1	City has ground water rights for 0.4 MGD for two wells. Additional rights and well capacity for 0.8 MGD will be required by 1985.
	1985	3	0.54	1.0	
	2010	6	1.2	2.4	
Sublimity and vicinity	1960	0.4	0.05	0.1	The city uses 2 wells with a 0.13 MGD water right to satisfy present needs. Additional well capacity of 1.1 MGD will be required to meet peak demand projected by 1985.
	1985	3	0.54	1.0	
	2010	6	1.2	2.4	
Turner and vicinity	1960	--	--	--	The Turner area is supplied from the City of Salem transmission line. It is assumed that this practice will be continued.
	1985	3	0.54	1.0	
	2010	7	1.2	2.4	
Salem Urban Area	1960	78.6	12.67	26.0	The City of Salem provides the major portion of the water from rights for 85.3 MGD from the N. Santiam R. Keizer W.D. has 3.1 MGD ground water rights and Salem Heights W.D. ground water rights of 9.2 MGD. The total supply is 97.6 MGD. The amount is adequate for the foreseeable future. However, treatment for 80 MGD will be required by 1985 for the North Santiam supply.
	1985	178	36.13	74.0	
	2010	363	76.9	158.0	
Total Main Stem	1960	135.45	22.37	44.5	
	1985	350	69.64	139.5	
	2010	710	149.41	302.6	

MIDDLE PORTION WILLAMETTE RIVER BASIN (Continued)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
6 - Calapooia River Subbasin					
Brownsville and vicinity	1960	1	0.14	0.3	The city provides water from an infiltration gallery in the Calapooia River and has a 0.43 MGD water right. Additional rights for 0.8 MGD and treatment for 1.3 MGD will be required by 1985. Additional withdrawals from the Calapooia River will require purchase of prior rights or storage. Storage is the most likely source and 55 MG would be required to satisfy projected 1985 demands.
	1985	3	0.54	1.0	
	2010	6	1.9	3.7	
Holley and vicinity	1960	0	0	0	There is not a water system in the area at the present time, but one is expected by 1985. Ground water is a probable source with 0.4 MGD required by 1985.
	1985	1	0.16	0.3	
	2010	1	0.16	0.3	
Sodaville and vicinity	1960	0	0	0	There is not a water system in the area at the present time, but one is expected by 1985. Ground water is a probable source with 0.15 MGD required by 1985.
	1985	0.5	0.06	0.1	
	2010	1	0.16	0.3	
Total	1960	1	0.14	0.3	
	1985	4.5	0.76	1.4	
	2010	8	2.22	4.3	
7 - Santiam River Subbasin					
Detroit and vicinity	1960	0.2	0.02	0.1	Detroit utilizes a well and Mackey Creek with a 0.6 MGD water right. Existing facilities will satisfy projected requirements of 1985.
	1985	0.5	0.06	0.1	
	2010	0.5	0.07	0.2	
Gates and vicinity	1960	0.2	0.02	0.1	Gates is supplied with water with a 3.32 MGD surface water right and an infiltration gallery on the North Santiam R. The existing supply will satisfy projected requirements of 1985.
	1985	0.5	0.06	0.1	
	2010	0.5	0.06	0.2	

MIDDLE PORTION WILLAMETTE RIVER BASIN (Continued)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
7 - Santiam River Subbasin (Continued)					
Idanha and vicinity	1960	0.25	0.03	0.1	Idanha relies upon Idanha Creek as its water supply. The existing source and 1.77 MGD water right is adequate to satisfy projected 1985 requirements.
	1985	0.5	0.06	0.1	
	2010	0.5	0.07	0.2	
Jefferson and vicinity	1960	0.7	0.08	0.2	Three wells with ground water rights for 0.5 MGD provide the present supply of water for the system. Additional capacity of 0.35 MGD, from wells, will be required to meet projected 1985 demands.
	1985	2	0.34	0.7	
	2010	3	0.56	1.1	
Lebanon and vicinity	1960	6	1.05	2.1	Pacific Power & Light Co. serves water in this area. The water is taken from the South Santiam R. through the Lebanon-Albany power canal without a municipal water right. The right for such use was established prior to the establishment of the State Water Laws. Future rights will depend upon adjudication of the river. The existing source is adequate to satisfy projected demands. A 5 MGD treatment plant may be required prior to 1985 to meet demands of that period.
	1985	11	2.11	4.0	
	2010	17	3.5	7.2	
Lyons and vicinity	1960	0.5	0.06	0.1	Lyons receives water from an infiltration well in the North Santiam River. The water is withdrawn under a 0.775 MGD surface water right. The existing source and right will satisfy projected 1985 demands.
	1985	1	0.16	0.3	
	2010	2	0.36	0.7	
Mill City and vicinity	1960	1.5	0.11	0.2	The city withdraws water from the N. Santiam R. through an infiltration gallery under a 1.15 MGD surface water right. An additional right for 0.5 MGD will be required to satisfy 1985 demands.
	1985	3	0.54	1.0	
	2010	4	0.77	1.5	

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
7 - Santiam River Subbasin (Continued)					
Scio and vicinity	1960	0.5	0.06	0.1	Scio relies upon wells with ground water rights of 1.71 MGD and an auxiliary source in Thomas Creek with a 0.65 MGD surface water right. Existing sources and rights will satisfy projected 1985 requirements.
	1985	1	0.16	0.3	
	2010	2	0.36	0.7	
Scravel Hill and vicinity	1960	0.1	0.01	0.1	The Scravel Hill Water Co-op. utilizes a well for their supply. Ground water will satisfy their projected requirements through 1985.
	1985	0.5	0.06	0.1	
	2010	0.5	0.07	0.2	
Stayton and vicinity	1960	2.5	0.74	1.4	The city operates an infiltration well with ground water rights for 3.7 MGD. The existing source and water right will satisfy projected 1985 demands.
	1985	4	0.74	1.4	
	2010	6	1.19	2.3	
Sweet Home and vicinity	1960	3.4	0.68	1.3	The City of Sweet Home provides complete treatment of water from the South Santiam River and has surface water rights for 4.9 MGD. The source and rights are adequate for the projected 1985 requirement. About 1.5 MGD additional treatment plant capacity will be required by 1985.
	1985	8	1.52	3.0	
	2010	13	2.65	4.9	
Waterloo and vicinity	1960	0	0	0	It is expected that a water system will be in operation in this area by 1985. Ground water development and rights are assumed to satisfy the projected 1985 requirements. Development should be 0.15 MGD.
	1985	0.5	0.06	0.1	
	2010	0.5	0.07	0.2	
Total	1960	15.85	2.86	5.8	
	1985	32.50	5.87	11.2	
	2010	49.50	9.73	19.4	

MIDDLE PORTION WILLAMETTE RIVER BASIN (Continued)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
8 - Marys River Subbasin					
Corvallis Suburban					Supplied by City of Corvallis (See Corvallis, Main Stem).
Philomath and vicinity					Supplied by City of Corvallis (See Corvallis, Main Stem).
9 - Luckiamute River Subbasin					
Falls City and vicinity	1960	1	0.13	0.3	Falls City satisfies their present requirements from a 0.65 MGD water right on Teal Creek and from springs. Projected 1985 requirements may be satisfied from the present source with an additional 0.20 MGD water right.
	1985	2	0.34	0.7	
	2010	4	0.77	1.5	
10 - Yamhill River Subbasin					
Amity and vicinity	1960	0.7	0.07	0.2	Amity utilizes springs and a deep well for its water supply with surface and ground water rights of 0.47 and 0.29 MGD, respectively. Projected 1985 requirements may be met by existing sources.
	1985	1	0.15	0.3	
	2010	1	0.16	0.3	
Carlton and vicinity	1960	1	0.08	0.2	Carlton uses Panther Creek as its water source and has a 0.3 MGD water right. Additional water to satisfy the projected 1985 demand would require an additional water right of 0.5 MGD and 90 MG stream storage.
	1985	2	0.34	0.7	
	2010	3	0.56	1.1	
Dayton and vicinity	1960	0.8	0.11	0.2	Dayton utilizes wells and springs with surface and ground water rights of 0.32 and 0.87 MGD, respectively. Existing sources will satisfy projected 1985 demands.
	1985	1	0.15	0.3	
	2010	1	0.16	0.3	
Eola Village and vicinity	1960	1	0.08	0.2	The existing source, ground water, will satisfy the projected 1985 requirements.
	1985	1	0.15	0.3	
	2010	2	0.34	0.7	

MIDDLE PORTION WILLAMETTE RIVER BASIN (Continued)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
10 - Yamhill River Subbasin (Continued)					
Grande Ronde and vicinity	1960	0.3	0.03	0.1	Existing source is adequate in quantity to supply 1985 projected requirements. Treatment for 0.15 MGD will be required by 1985.
	1985	0.5	0.06	0.1	
	2010	0.5	0.07	0.2	
Hopewell and vicinity	1960	0	0	0	A ground water supplied system is expected to exist in this location by 1985. Well capacity of 0.15 MGD is recommended to supply projected 1985 needs.
	1985	0.5	0.06	0.1	
	2010	0.5	0.07	0.2	
Lafayette and vicinity	1960	0.6	0.08	0.2	The city has combined rights for 1 MGD from springs and a well. The system only yields 0.1 MGD. Additional well capacity of 0.3 MGD is recommended to satisfy projected 1985 requirements.
	1985	1	0.15	0.3	
	2010	1	0.16	0.3	
McMinnville and vicinity	1960	8.3	1.64	3.3	According to a 1960 consultant's report the city has developed the Haskins Creek source to the economic limit, except for transmission. The July-October 4-month's capacity is described as 435 MG. The projected July-October demand is 400 MG and would be satisfied by the existing source. Consideration for future expanded requirements has been directed towards storage and trans-basin diversion from the Nestucca River, a coastal stream. Consideration is also being given to the Willamette River as an alternate source. Storage on the S. Yamhill R. is also an alternate, but not actively considered. Treatment for 6 MGD is an expected requirement by 1985.
	1985	12	2.32	4.3	
	2010	18	3.71	6.9	

MIDDLE PORTION WILLAMETTE RIVER BASIN (Continued)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
10 - Yamhill River Subbasin (Continued)					
Sheridan and vicinity	1960	2	0.21	0.4	Sheridan utilizes springs as a water supply. Present reliable capacity is about 0.4 MGD. Projected 1985 demands exceed the annual supply of 146 MG by 60 MG. The peak 7-day demand exceeds the supply by 0.8 MGD. The projected 2010 demand, 281 MG, exceeds the supply by 135 MG annually. Alternate sources include additional springs, the S. Yamhill R. or tributary storage. The city has expressed interest in the USBR proposed Gorge Reservoir. Treatment for 1.5 MGD will be required for surface water utilization.
	1985	3	0.54	1.1	
	2010	4	0.77	1.5	
Willamina and vicinity	1960	1	0.26	0.6	Willamina has adequate water rights, 2 MGD, to satisfy the projected 1985 requirements. One right 0.65 MGD is dated 1909 and would be prior to most rights in the Yamhill River system.
	1985	1	0.16	0.3	
	2010	2	0.36	0.7	
Yamhill and vicinity	1960	1.2	0.26	0.5	Yamhill has a 0.8 MGD water right and a 0.4 MGD system on Lady Creek. The right and source are adequate to satisfy the projected 1985 demand.
	1985	1.5	0.16	0.3	
	2010	1.5	0.17	0.4	
Total Yamhill Basin	1960	16.90	2.82	5.9	
	1985	24.50	4.24	8.1	
	2010	34.50	6.53	12.6	
11 - Pudding River Subbasin					
Aurora and vicinity	1960	0.3	0.03	0.1	Aurora utilizes ground water, water right 0.3 MGD. Ground water will satisfy the projected 1985 demand.
	1985	0.5	0.06	0.1	
	2010	0.5	0.07	0.2	
Barlow and vicinity	1960	0.2	0.02	0.1	A 0.21 MGD provides ample water for present and projected requirements.
	1985	0.5	0.06	0.1	
	2010	0.5	0.07	0.2	

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
11 - Pudding River Subbasin (Continued)					
Donald and vicinity	1960	0.3	0.03	0.1	Two wells satisfy present requirements. Ground water will satisfy projected 1985 requirements.
	1985	0.5	0.06	0.1	
	2010	0.5	0.07	0.2	
Gervais and vicinity	1960	0.5	0.05	0.1	Ground water from two wells, 0.36 MGD capacity, satisfies present requirements. Projected 1985 requirements will be met from ground water.
	1985	1	0.16	0.3	
	2010	1	0.17	0.4	
Hubbard and vicinity	1960	0.6	0.07	0.2	Present and projected 1985 requirements will be satisfied from the ground water resource. Present capacity is 0.3 MGD. Additional 0.1 MGD capacity will be needed by 1985.
	1985	1	0.16	0.3	
	2010	1	0.17	0.4	
Mt. Angel	1960	1.5	0.18	0.4	Mt. Angel has ground water rights totalling 1.8 MGD and wells with a capacity of 0.7 MGD. Additional well capacity of 1.1 MGD will be required to meet projected 1985 demands.
	1985	4	0.74	1.4	
	2010	6	1.19	2.3	
Scotts Mills and vicinity	1960	0.2	0.02	0.1	Wells and springs are used to supply water to Scotts Mills. The city has a 0.16 MGD water right on Butte Creek which with treatment will supply its projected 1985 peak demand of 0.15 MGD. Seasonal deficiencies are now experienced.
	1985	0.5	0.06	0.1	
	2010	0.5	0.07	0.2	
Silverton and vicinity	1960	4	0.65	1.2	Silverton's system has an existing capacity of 4.65 MGD and surface and ground water rights of 9.7 and 0.7 MGD, respectively. Additional water may come from storage on Silver Creek. Storage of 32 MG will be needed by 1985 to satisfy peak demands during periods of low streamflow.
	1985	10	1.92	3.7	
	2010	16	3.28	6.1	

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
11 - Pudding River Subbasin (Continued)					
Woodburn and vicinity	1960	4	0.48	1.0	The city has 6 wells and is also connected with a well in the Woodburn Senior Estates for a total capacity of 4 MGD. Ground water rights total 3 MGD. The projected 1985 demand may be met from ground water. Additional capacity of 2.7 MGD will be required. Short-term deficiencies are now experienced because of high hourly demands. Birds Eye Frozen Foods is a large water user but is self-supplied.
	1985	11	2.11	3.9	
	2010	18	3.71	6.9	
Total Pudding River Basin	1960	11.6	1.53	3.3	
	1985	29.0	5.33	10.0	
	2010	44.0	8.80	16.9	
12 - Molalla River Subbasin					
Canby and vicinity	1960	2.2	0.26	0.5	Canby has developed 1.5 MGD well capacity from ground water rights of 2.5 MGD. Projected 1985 requirements may be met from ground water. Additional development of 1.8 MGD will be required.
	1985	7	1.32	2.6	
	2010	14	2.87	5.3	
Colton and vicinity	1960	0.4	0.04	0.1	An inadequate system which cannot supply summer demands uses water from a creek. Sufficient water is available to supply the projected 1985 demands. However, a satisfactory system must be built.
	1985	0.5	0.06	0.1	
	2010	1	0.16	0.3	
Molalla and vicinity	1960	1.3	0.18	0.4	The city takes water from the Molalla River through an infiltration gallery with a pumping capacity of 1.3 MGD. The surface water right is for 4.5 MGD. The source is adequate to satisfy projected 1985 demands with the addition of treatment for 2.5 MGD.
	1985	5	0.93	1.8	
	2010	10	2.03	4.0	
Mulino and vicinity	1960	0.5	0.05	0.1	The Mulino area is served from wells and springs having a combined capacity of 0.19 MGD. Additional capacity of 0.65 MGD from wells will be required by 1985 to meet projected demands.
	1985	2	0.34	0.7	
	2010	3	0.56	1.1	
Total Molalla Subbasin	1960	4.4	0.53	1.1	
	1985	14.5	2.65	5.2	
	2010	28.0	5.62	10.7	

MIDDLE PORTION WILLAMETTE RIVER BASIN (Continued)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD
Total Middle Portion Willamette	1960	186.2	30.38	61.2
	1985	457.0	88.83	176.1
	2010	878	183.08	368.0

LOWER PORTION WILLAMETTE RIVER BASIN

13 - Clackamas River Subbasin (outside of Portland Urban Area)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
Boring and vicinity	1960	0	0	0	It is expected that a public system will exist at Boring prior to 1985. The 1985 peak 7-day demand is estimated to be 2.1 MGD. Annual use is projected to be 340 MG. Location of the source would depend upon a feasibility study.
	1985	5	0.93	1.8	
	2010	11	2.24	4.2	
Estacada and vicinity	1960	1.2	0.27	0.5	The Clackamas River is the source of water for Estacada. The surface water right is 1.3 MGD. The 1985 projected peak demand of 3.42 MGD should be satisfied with a 3.5 MGD treatment plant, 2 MGD additional rights and 100 MG upstream storage, unless rights from natural flow will provide 3.3 MGD during periods of low flow.
	1985	8	1.52	2.9	
	2010	15	3.07	5.7	
Total	1960	1.2	0.27	0.5	
	1985	13	2.45	4.7	
	2010	26	5.31	9.9	

14 - Tualatin River Subbasin (outside of Portland Urban Area)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
Banks and vicinity	1960	0.6	0.07	0.2	The municipal water requirement is satisfied by flow from springs. Future projected demands may be met from storage on Dairy Creek in the amount of 60 MG, a 0.2 MGD water right and a 0.4 MGD treatment plant.
	1985	1	0.16	0.3	
	2010	2	0.36	0.7	

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
14 - Tualatin River Subbasin (outside of Portland Urban Area)(Continued)					
Forest Grove and vicinity	1960	7	1.16	2.3	Forest Grove has a system with a 6.53 MGD water right and 4 MGD capacity which may be reduced to 1.5 MGD during dry periods. Assuming a critical period from mid-June to mid-October storage of 775 MG will be required to meet projected demands. Additional treatment facilities for 7 MGD is indicated. The city has expressed an interest in the USBR Scoggins Creek Project and in single purpose diversion from coastal streams.
	1985	23	4.51	8.4	
	2010	43	9.00	16.7	
Hillsboro and vicinity	1960	18.5	1.93	3.6	Hillsboro takes water from Seine Creek and the Tualatin River to supply the city, and whole or partial supplies to Cornelius, Gaston and the Aloha-Huber Water District. Water rights total 9 MGD and July-October critical supply is 370 MG. Storage for 1,500 MG will be required to meet projected 1985 demands. Treatment capacity of 25 MGD will be required to meet peak demands. The city has expressed an interest in the USBR Scoggin Creek project and single purpose diversion from coastal streams in a joint study with the City of Forest Grove.
	1985	50	9.88	20.0	
	2010	93	19.49	40.0	
Sherwood	1960	0.7	0.08	0.2	Sherwood uses three wells with a combined dependable draft of 1.1 MGD. Ground water will satisfy projected 1985 requirements.
	1985	3	0.54	1.0	
	2010	6	1.19	2.3	
Total Non-urban Tualatin	1960	26.8	3.24	6.3	
	1985	77	15.09	29.7	
	2010	144	30.04	59.7	
15 - Sandy River Subbasin (outside of Portland Urban Area)					
Corbett and vicinity	1960	1.3	0.25	0.5	Corbett Water District provides water for the area from Gordon Creek. Surface water rights are 2.58 MGD. The present source is adequate but treatment for sufficient water to satisfy the projected 1985 demand will require 1.3 MGD treatment plant.
	1985	3	0.54	1.0	
	2010	6	1.19	2.3	

LOWER PORTION WILLAMETTE RIVER BASIN (Continued)

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
15 - Sandy River Subbasin (Outside of Portland Urban Area) (Continued)					
Sandy and vicinity	1960	1.5	0.21	0.4	The Sandy area relies upon water from Beaver Creek and from springs with a surface water right of 2.1 MGD. An additional water right of 0.25 MGD will be required to satisfy projected 1985 demands. Treatment for 2.3 MGD will also be required.
	1985	5	0.93	1.8	
	2010	8	1.19	2.3	
Total Non-urban Sandy River	1960	2.8	0.46	0.9	
	1985	8	1.47	2.8	
	2010	14	2.38	4.6	
Total Non-urban Lower Willamette River	1960	30.8	3.97	7.7	
	1985	98	19.01	37.2	
	2010	184	37.73	74.2	

PORTLAND URBAN AREA

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
1-C Main Stem Willamette					
Bull Run River (City of Portland operated)	1960	598	87.6	180	Projected 1985 population served includes: Portland City, 600,000; Gresham, 6,000; Beaverton, 17,000; Water Districts, 300,000; and Tigard, 8,000. The City of Portland, Bureau of Water Works, has made plans to develop the Bull Run watershed to provide an annual average of 185 MGD with 7-day peaks of 425 MGD. The supply is adequate to supply projected 1985 demands. The City of Portland and the U.S. Forest Service control the entire watershed and essentially all of the flow. Future plans include storage on the Little Sandy River and diversion to the Bull Run system. Industrial use of the present supply accounts for only about 1/5 of the annual sales.
	1985	931	185.3	364	
	2010	1563	327.6	645	

PORTLAND URBAN AREA (Continued)

	Years	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
1-C Main Stem Willamette (Continued)					
Lake Oswego	1960	12	1.1	2.1	The City of Lake Oswego does not now have a satisfactory source of their own. The present supply is from wells, not satisfactory, and the City of Portland. It is generally held that the Clackamas River is the most desirable source. Surface water rights to satisfy the projected 1985 demand would be 11 MGD, as would treatment facilities. Assuming low flow for two months upstream storage of 550 MG would be required, unless rights are available during periods of low streamflow.
	1985	40	4.4	8.2	
	2010	80	10.0	20.5	
Total Lower Willamette Main Stem (Portland Urban)	1960	610	88.7	182.1	
	1985	971	189.7	372.2	
	2010	1643	337.6	665.5	
13 - Clackamas River Subbasin (Portland Urban Area portion)					
South Fork Water Commission	1960	33.2	5.0	11.7	Water produced by the South Fork Water Commission supplies the following areas with projected 1985 populations: Oregon City, 20,000; West Linn, 11,000; Water Districts, 15,000. The commission holds a total of 75 MGD surface water rights on the Clackamas River, which are adequate to satisfy projected 1985 demands. Additional treatment capacity for 9 MGD is indicated.
	1985	46	7.7	14.2	
	2010	91	16.1	33.0	
Clackamas Water District	1960	9	0.8	0.2	The Clackamas Water District holds a 9.7 MGD surface water right on the Clackamas River which is adequate to satisfy projected 1985 demands. Additional treatment capacity of about 5 MGD will be required.
	1985	30	3.3	6.5	
	2010	60	7.5	15.4	

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
13 - Clackamas River Subbasin (Portland Urban Area portion) (Continued)					
Gladstone	1960	4	0.4	0.8	The surface water right of 2.6 MGD on the Clackamas River and ground water rights of 2.6 MGD will satisfy projected 1985 demands.
	1985	7	0.8	1.6	
	2010	13	1.6	3.0	
Milwaukie	1960	11.3	1.1	2.1	The city uses ground water with rights for 1.8 MGD. Satisfaction of projected 1985 demands will require an additional 6 MGD well capacity and rights.
	1985	26	2.9	5.4	
	2010	50	6.3	11.6	
Misc. Water Districts Self-Supplied	1960	2	0.26	0.5	New districts and expansion of small districts will account for this projected demand. It is anticipated that this will be satisfied primarily from wells.
	1985	41	4.5	8.6	
	2010	100	12.5	23.8	
Total Clackamas (Portland Urban)	1960	59.5	7.56	15.3	
	1985	150	19.2	36.3	
	2010	314	44.0	86.8	
14 - Tualatin River Subbasin (Portland Urban Area portion)					
Tualatin	1960	0.5	0.05	0.1	Tualatin uses ground water from two wells to satisfy the needs of the area. It is assumed that the projected 1985 requirements will be satisfied from ground water. Additional ground water of 0.1 MGD will be required.
	1985	1	0.1	0.2	
	2010	2	0.3	0.6	
Water District Self-Supplied	1960	2	0.2	0.4	It is assumed that many small water districts will be formed to supply water to this growing portion of the urban population. Most all of them will satisfy their 1985 requirements from ground water. A few of them will undoubtedly connect to existing systems with adequate water available to satisfy their requirements. Ground water development of 15 MGD will be required.
	1985	64	7.0	14.0	
	2010	154	19.3	36.6	
Total Tualatin (Portland Urban)	1960	2.5	0.25	0.5	
	1985	65	7.1	14.2	
	2010	156	19.6	37.2	

	Year	Popl. Serv. (Thou.)	Ann. Aver. MGD	Peak Month MGD	
15 - Sandy River Subbasin (Portland Urban Area portion)					
Fairview	1960	0.9	0.09	0.2	Fairview has ground water rights for 0.8 MGD which are adequate to satisfy projected 1985 demands.
	1985	1	0.1	0.2	
	2010	2	0.3	0.6	
Troutdale	1960	0.6	0.04	0.1	Troutdale has ground water rights for 0.4 MGD which is adequate to satisfy projected 1985 demands. Major industrial users are self-supplied.
	1985	1	0.1	0.2	
	2010	2	0.3	0.6	
Wood Village	1960	0.8	0.04	0.1	Wood Village uses wells with 0.3 MGD ground water rights to satisfy present requirements. Projected 1985 requirements may be satisfied by present rights.
	1985	1	0.1	0.2	
	2010	2	0.2	0.4	
Water Districts Self-supplied	1960	0.5	0.05	0.1	Expanding population in this portion of the urban area is assumed to be served from ground water. Expansion of existing small water districts and formation of new ones will require development of 4.8 MGD capacity to satisfy projected 1985 demands.
	1985	17	1.9	4.0	
	2010	33	3.8	8.0	
Total Sandy (Portland Urban)	1960	2.8	0.22	0.5	
	1985	20	2.2	4.6	
	2010	39	4.6	9.6	
Total Portland Urban Area	1960	674.8	96.73	198.4	
	1985	1206	218.2	427.3	
	2010	2152	405.8	799.1	
Total Lower Willamette	1960	705.6	100.70	206.1	
	1985	1304	237.21	464.5	
	2010	2336	443.53	873.3	

TABLE VII

SUMMARY OF TOTAL POPULATION AND POPULATION SERVED BY MUNICIPAL WATER SYSTEMS
WILLAMETTE RIVER BASIN, OREGON

Portion of Basin	Total Popl. (Thou.)	Popl. Serv. (Thou.)	% of Total Serv.	Ann. Aver. MGD	Peak Month MGD
1 9 6 0					
Upper Willamette	156	106.7	68.3	19.33	39.6
Mid. Willamette	288	186.2	64.6	30.38	61.2
Lower Willamette Non-urban	65	30.8	47.3	3.97	7.7
Lower Willamette Portland Urban	675	674.8	100	96.73	198.4
TOTAL WILLAMETTE	1,194	998.5	84.5	150.41	306.9
1 9 8 5					
Upper Willamette	237	195	82.2	38.96	79.4
Mid. Willamette	553	457	82.6	88.83	176.1
Lower Willamette Non-urban	145	98	67.5	19.01	37.2
Lower Willamette Portland Urban	1,206	1,206	100.0	218.20	427.3
TOTAL WILLAMETTE	2,141	1,956	91.3	364.95	720.0
2 0 1 0					
Upper Willamette	407	361	88.6	75.6	151.7
Mid. Willamette	1,024	878	85.7	183.08	368.0
Lower Willamette Non-urban	246	184	74.7	37.73	74.2
Lower Willamette Portland Urban	2,162	2,152	99.5	405.80	799.1
TOTAL WILLAMETTE	3,839	3,575	93.1	701.38	1,293.0

TABLE VIII

PROJECTED MUNICIPAL WATER FACILITY REQUIREMENTS BY 1985

	Surface Water Rights MGD	Filter Plant Capacity MGD	Storage MG	Well Capacity & Groundwater Right MGD
Upper Willamette				
1-A Upper Main Stem Subbasin				
Coburg	--	--	--	--
Eugene Urban Area	--	--	--	--
Junction City and vicinity	--	--	--	0.35
TOTAL	--	--	--	0.35
2 Coast Fork Willamette River Subbasin				
Cottage Grove	--	3.5	--	--
Creswell	--	--	--	0.4
TOTAL	--	3.5	--	0.4
3 Middle Fork Willamette River Subbasin				
Lowell and vicinity	0.2	1	--	--
Oakridge and vicinity	--	--	--	--
TOTAL	0.2	1	--	--
4 McKenzie River Subbasin				
Blue River and vicinity	1.0	0.9	--	--
Marcola	--	--	--	0.4
TOTAL	1.0	0.9	--	0.4
5 Long Tom River Subbasin				
Elmira-Venita and vicinity	2	1.5	100 1/	--
Monroe and vicinity	0.5	0.75	--	--
TOTAL	2.5	2.25	100	--
TOTAL UPPER WILLAMETTE	3.7	7.65	100	1.15

1/ Assuming watershed development.

FACILITY REQUIREMENTS BY 1985

	Surface Water Rights MGD	Filter Plant Capacity MGD	Storage MG	Well Capacity & Groundwater Right MGD
1-B Middle Willamette Main Stem				
Albany and vicinity	--	10	--	--
Aumsville and vicinity	--	--	--	0.1
Corvallis	15	22	--	--
Dallas and vicinity	--	5	250	--
Dundee and vicinity	--	--	--	1
Halsey and vicinity	--	--	--	0.1
Harrisburg and vicinity	--	--	--	1.8
Independence and vicinity	--	--	--	(1.5)*
Monmouth and vicinity	2	4	250	--
Newberg and vicinity	--	4.5	--	--
St. Paul and vicinity	--	--	--	0.8
Sublimity and vicinity	--	--	--	1.1
Turner and vicinity	--	--	--	--
Salem Urban Area	--	80	--	--
TOTAL	17.0	125.5	500	4.9
6 Calapooia Subbasin				
Brownsville and vicinity	0.8	1.3	55	--
Holley and vicinity	--	--	--	0.4
Sodaville and vicinity	--	--	--	0.15
TOTAL	0.8	1.3	55	0.55
7 Santiam Subbasin				
Detroit and vicinity	--	--	--	--
Gates and vicinity	--	--	--	--
Idanha and vicinity	--	--	--	--
Jefferson and vicinity	--	--	--	0.35
Lebanon and vicinity	--	5	--	--
Lyons and vicinity	--	--	--	--
Mill City and vicinity	0.5	--	--	--
Scio and vicinity	--	--	--	--
Scravel Hill and vicinity	--	--	--	--
Stayton and vicinity	--	--	--	--
Sweet Home and vicinity	--	1.5	--	--
Waterloo and vicinity	--	--	--	0.15
TOTAL	0.5	6.5	--	0.50

* Water right only.

ADDITIONAL FACILITY REQUIREMENTS BY 1985

System	Surface Water Rights MGD	Filter Plant Capacity MGD	Source Storage MG	Well Capacity & Groundwater Right MGD
8 Marys River				
See Corvallis, Main Stem				
9 Luckiamute River				
Falls City and vicinity	0.20	--	--	--
10 Yamhill River				
Amity and vicinity	--	--	--	--
Carlton and vicinity	0.5	--	90	--
Dayton and vicinity	--	--	--	--
Eola Village and vicinity	--	--	--	--
Grande Ronde and vicinity	--	0.15	--	--
Hopewell and vicinity	--	--	--	0.15
Lafayette and vicinity	--	--	--	0.3
McMinnville and vicinity	--	6	--	--
Sheridan and vicinity	--	1.5	60	--
Willamina and vicinity	--	--	--	--
Yamhill and vicinity	--	--	--	--
TOTAL	0.5	7.65	150	0.45
11 Pudding River				
Aurora and vicinity	--	--	--	--
Barlow and vicinity	--	--	--	--
Donald and vicinity	--	--	--	--
Gervais and vicinity	--	--	--	--
Hubbard and vicinity	--	--	--	0.1
Mt. Angel and vicinity	--	--	--	1.1
Scotts Mills and vicinity	--	0.15	--	--
Silverton and vicinity	--	--	32	--
Woodburn and vicinity	--	--	--	2.7
TOTAL	--	0.15	32	3.8
12 Molalla River				
Canby and vicinity	--	--	--	1.8
Colton and vicinity	--	--	--	--
Molalla and vicinity	--	2.5	--	--
Mulino and vicinity	--	--	--	0.65
TOTAL	--	2.5	--	2.45
TOTAL Mid-Willamette	19.0	143.6	737	12.65

FACILITY REQUIREMENTS BY 1985
LOWER PORTION OF WILLAMETTE RIVER BASIN

	Surface Water Rights MGD	Filter Plant Capacity MGD	Stream Storage MG	Well Capacity & Ground water Right MGD
13 Clackamas River Subbasin				
Boring and vicinity	--	--	--	2.1
Estacada and vicinity	2.0	3.5	100	--
TOTAL	2.0	3.5	100	2.1
14 Tualatin River Subbasin				
Banks and vicinity	0.2	0.4	60	--
Forest Grove and vicinity	--	7	775	--
Hillsboro and vicinity	--	25	1500	--
Sherwood and vicinity	--	--	---	--
TOTAL Non-urban	0.2	32.4	2335	--
Sandy River Subbasin (Non-urban)				
Corbett and vicinity	--	1.3	--	--
Sandy and vicinity	0.25	2.3	--	--
TOTAL Non-urban	0.25	3.6	--	--
TOTAL NON-URBAN LOWER WILLAMETTE	2.45	39.5	2435	2.1

PROJECTED MUNICIPAL WATER FACILITY REQUIREMENTS BY 1985
PORTLAND URBAN AREA

	Surface Water Rights MGD	Filter Plant Capacity MGD	Stream Storage MG	Well Capacity & Groundwater Right MGD
Bull Run River				
City of Portland System	--	--	11,000	--
Clackamas River				
South Fk. Water Commission	--	9	--	--
Clackamas Water District	--	5	--	--
Gladstone	---	1	--	--
Milwaukee	--	--	--	6
City of Lake Oswego	11	11	550	--
Misc. Water Districts	--	--	--	13
TOTAL	11	26	550	19
Tualatin River				
Tualatin	--	--	--	0.1
Water districts Self-supl.	--	--	--	7
TOTAL	--	--	--	7.1
Sandy River				
Fairview	--	--	--	--
Troutdale	--	--	--	--
Wood Village	--	--	--	--
Water districts Self-supl.	--	--	--	4.8
TOTAL	--	--	--	4.8
TOTAL Portland Urban Area	11	26	11,550	30.9

TABLE IX

SUMMARY
PROJECTED MUNICIPAL WATER FACILITY REQUIREMENTS BY 1985

Area	Surface Water Rights MGD	Filter Plant Capacity MGD	Stream Storage MG	Well Capacity & Ground Water Right MGD
Upper Willamette	3.7	7.65	100	1.15
Middle Willamette	19.0	143.6	737	12.65
Lower Willamette Non-urban	2.45	39.5	2435	2.1
Lower Willamette Portland Urban Area	11	26	11550	30.9
TOTAL	36.15	216.75	14822	46.80

TABLE X

SUMMARY

PULP AND PAPER MANUFACTURING WATER REQUIREMENTS

WILLAMETTE BASIN, OREGON

	1960	1985	Increase over 1960	2010	Increase over 1985	Increase over 1960
Upper Willamette						
Production--tons/day	400	800	400	1,500	700	1,100
Water--MG/ton	0.025	0.025	-	0.025	-	-
MGD	10	20	10	37	17	27
cfs	15.5	31	15.5	57.5	26.5	42
Annual MG	3,650	7,300	3,650	13,505	6,205	9,855
Annual Acre-feet	11,169	22,338	11,169	41,325	18,987	30,156
Middle Willamette						
Production--tons/day	660	1,110	450	1,760	650	1,100
Water--MG/ton	0.049	0.049	-	0.049	-	-
MGD	32	54	22	87	33	55
cfs	49.5	83.5	34	134.5	51	85
Annual MG	11,470	19,500	8,030	31,645	12,145	20,175
Annual Acre-feet	35,098	59,670	24,572	96,834	37,164	61,736
Lower Willamette						
Production--tons/day	1,000	1,300	300	1,500	200	500
Water--MG/ton	0.05	0.05	-	0.05	-	-
MGD	50	65	15	75	10	25
cfs	77.4	100.6	23.2	116.1	15.5	38.7
Annual MG	18,250	23,725	5,475	27,375	3,650	9,125
Annual Acre-feet	55,845	72,599	16,754	83,768	11,169	27,923
Total Willamette						
Production--tons/day	2,060	3,210	1,150	4,760	1,550	2,700
Water--MG/ton	0.045	0.043	(.0013)	.0418	-	-
MGD	92	139	47	199	60	107
cfs	142.42	215.17	72.75	308.05	92.88	165.63
Annual MG	33,370	50,525	17,155	72,525	22,000	39,155
Annual Acre-feet	102,122	154,606	52,494	221,926	67,320	119,814

TABLE XI

SUMMARY OF TOTAL POPULATION AND POPULATION SERVED BY MUNICIPAL WATER SYSTEMS, AND SELF-SUPPLIED INDUSTRY--WILLAMETTE RIVER BASIN, OREGON

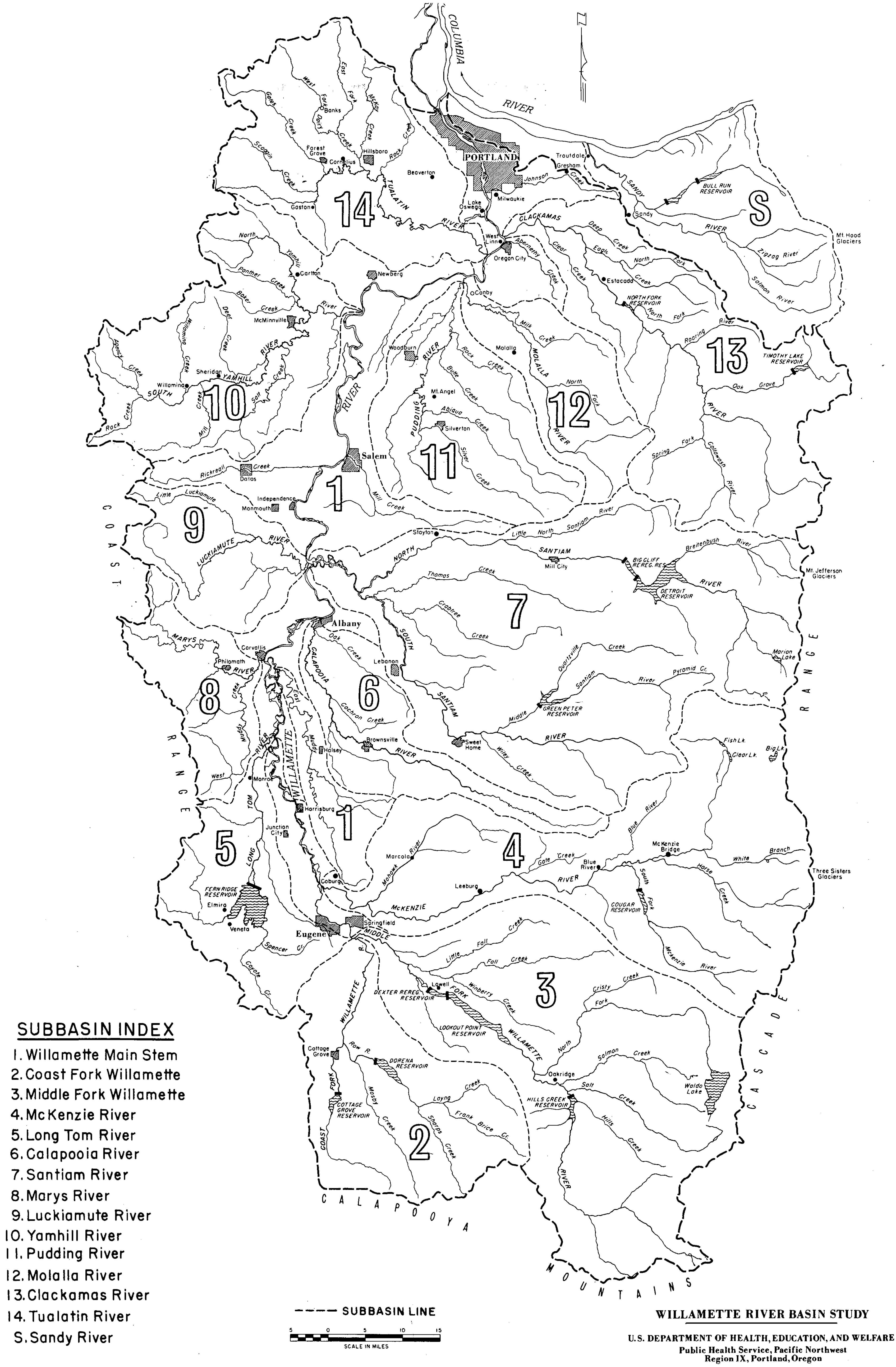
		Municipally Supplied				Self-Sup. Ind. Dem.			Tot. Mun. & Self-Sup. Ind.			
									Total M & I		Pop. Serv.	
Portion of Basin	Total Popl. Thou.	Popl Serv. Thou.	% of Total Serv.	Aver. Annual MGD	Peak Mo. Aver. MGD	P&P* Aver. MGD	Other MGD	Total MGD	Aver. MGD	Peak Mo. MGD	Aver. gpcd	Peak gpcd
1 9 6 0	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Upper Willamette	156	106.7	68.3	19.33	39.6	10.0	34.1	44.1	63.43	83.7	593	785
Mid. Willamette	288	186.2	64.6	30.38	61.2	35.0	29.8	64.8	95.18	126.0	510	676
Lower Willamette, Non-urban		30.8		3.97	7.7	--	8.9	8.9	12.87	16.6	418	538
Lower Willamette, Portland urban		674.8		96.73	198.4	50.0	48.3	98.3	195.03	296.7	289	441
Total Lower Will.	714	705.6	99.0	100.70	206.1	50.0	57.2	107.2	207.90	313.3	294	443
Total Willamette	1,158	998.5	86.2	150.41	306.9	95.0	121.1	216.1	366.51	523.0	368	525
1 9 8 5												
Upper Willamette	237	195	82.2	38.96	79.4	20.0	50.0	70.0	108.96	149.4	568	768
Mid. Willamette	553	457	82.6	88.83	176.1	58.0	72.6	130.6	219.43	306.7	480	673
Lower Willamette, Non-urban	145	98	67.5	19.01	37.2		21.1	21.1	40.11	58.3	410	595
Lower Willamette, Portland urban	1,206	1,206	100.0	218.2	427.3	65.0	109.9	174.9	393.10	602.2	326	500
Total Lower Will.	1,351	1,304	97.0	237.21	464.5	65.0	131.0	196.0	433.21	660.5	332	505
Total Willamette	2,141	1,956	91.3	365.00	720.0	143.0	253.6	396.6	761.6	1116.6	390	570
2 0 1 0												
Upper Willamette	407	361	88.6	75.56	151.7	37.0	85.5	122.5	198.06	274.2	548	760
Mid. Willamette	1,024	878	85.7	183.08	368.0	86.0	138.8	224.8	407.88	592.8	465	675
Lower Willamette, Non-urban	246	184	74.7	37.73	74.2	--	39.8	39.8	77.53	114.0	422	620
Lower Willamette, Portland urban	2,162	2,152	99.5	405.80	799.1	75.0	204.0	279.0	684.8	1078.1	317	501
Total Lower Will.	2,408	2,336	97.0	443.53	873.3	75.0	243.8	318.8	762.33	1192.1	327	510
Total Willamette	3,839	3,575	93.1	702.17	1393.0	198.0	468.1	666.1	1368.27	2059.1	383	575

*Pulp and paper.

Extention of above Table continued on next page

TABLE XI (Extended)

Portion of Basin	Rural Self-Supplied			Comb. Mun. & Self-Sup. Ind. & Rural				
	Rural Popl. Thou.	Annual Average MGD	Peak MGD	Total Average MGD	Peak Month MGD	Total Popl.	Average gpcd	Peak gpcd
1 9 6 0	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Upper Willamette	49.3	2.7	8.1	66.13	91.8	156	424	590
Middle Willamette	101.8	5.6	16.8	100.78	142.8	288	350	495
Lower Willamette, Non-urban	8.4	0.5	1.4	13.37	18.0	39.8	335	450
Lower Willamette, Portland urban	--	--	--	195.03	296.7	674.8	289	441
Total Lower Willamette	8.4	0.5	1.4	208.40	314.7	714	293	442
Total Willamette	159.5	8.8	26.3	375.31	549.3	1,158	324	474
1 9 8 5								
Upper Willamette	42	2.7	8.2	111.66	157.6	237	471	665
Middle Willamette	96	6.2	18.7	225.63	325.4	553	408	588
Lower Willamette, Non-urban	47	3.1	9.2	43.21	67.5	145	298	465
Lower Willamette, Portland urban	--	--	--	393.10	602.2	1,206	326	500
Total Lower Willamette	47	3.1	9.2	436.31	669.7	1,351	324	495
Total Willamette	185	12.0	36.1	773.6	1152.7	2,141	361	538
2 0 1 0								
Upper Willamette	46	3.4	10.3	201.46	284.5	407	495	700
Middle Willamette	146	11.0	32.9	418.88	625.7	1,024	408	612
Lower Willamette, Non-urban	62	4.6	14.0	82.13	128.0	246	334	520
Lower Willamette, Portland urban	10	0.8	2.3	685.60	1080.4	2,162	317	500
Total Lower Willamette	72	5.4	16.3	767.73	1208.4	2,408	319	502
Total Willamette	264	19.8	59.5	1388.07	2118.6	3,839	362	553


SUBBASIN INDEX
1. Willamette Main Stem
2. Coast Fork Willamette
3. Middle Fork Willamette
4. McKenzie River
5. Long Tom River
6. Calapooia River
7. Santiam River
8. Marys River
9. Luckiamute River
10. Yamhill River
11. Pudding River
12. Molalla River
13. Clackamas River
14. Tualatin River
S. Sandy River
SUBBASIN LINE
5 0 5 10 15
SCALE IN MILES
WILLAMETTE RIVER BASIN STUDY
U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Pacific Northwest
Region IX, Portland, Oregon
COLUMBIA RIVER
PORTLAND
Salem
Albany
Eugene
COAST RANGE
CASCADE RANGE
CALAPOOYA MOUNTAINS