Storm runoff as related to urbanization based on data collected in Salem and Portland, and generalized for the Willamette Valley, Oregon

By Antonius Laenen

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CONVERSION FACTORS

[For use of those readers who may prefer to use metric units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:]

Multiply	By	To obtain
	Length	
inch (in.)	25.40	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
Square mile (mi^2)	2.590	square kilometer (km^2)
acre	4,047	square meter (m^2)
	Specific combinations	
cubic foot per second (ft^3/s)	0.0283	cubic meter per second (m^3/s)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)

STORM RUNOFF AS RELATED TO URBANIZATION BASED ON DATA COLLECTED IN SALEM, AND PORTLAND, AND GENERALIZED FOR THE WILLAMETTE VALLEY, OREGON

By

Antonius Laenen

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ABSTRACT

Storm runoff as related to urbanization is defined by a series of regression equations for Salem and for the Willamette Valley, Oregon. In addition to data from 17 basins monitored in the Salem area, data from 24 basins gaged in a previous study in Portland, Oregon-Vancouver, Washington were used defining the Willamette Valley equations. Basins used to define equations ranged in size from 0.2 to 26 square mi. Rainfall intensity varied from 1.8 to 2.2 in. for the 6-hour, 0.02-exceedance probability. Sensitivity analyses of equations indicate that urbanization of an undeveloped basin can increase peak discharge more than three times and almost double runoff volume. Much of Portland and Vancouver are located on porous river terraces where dry wells are used to shunt runoff. Much of east Salem is located on previously farmed land where drain tiles used to dewater soils still connect directly to streams.

INTRODUCTION

With urban growth and development, there is an increasing need for flood information and techniques to evaluate effects of urbanization in areas where little or no data exist. Rainfall-runoff data have been collected in two urban areas in the Willamette Valley. During this project, data were collected in the Salem, Oregon area and are included in the supplemental tables in the back of this report. Data from the Portland, Oregon-Vancouver, Washington area have been included and interpreted in two previous reports (Laenen and Solin, 1978, and Laenen, 1980). The emphasis of this report is to evaluate both data sets and summarize a series of regression equations for estimating the magnitude and frequency of flood peaks and volumes for Salem alone, and for urban areas in the Willamette Valley (fig. 1).

Because there is a need to know what effect urban development has on flood peaks and volumes in Salem, and more generally the Willamette Valley, the objective of this report is to answer the following questions:

1) What are the flood peak and volume relations in Salem?
2) Are the urban areas of Portland-Vancouver and Salem statistically similar?
3) Can relations established in Portland-Vancouver and Salem be extended to include the entire urban Willamette Valley?

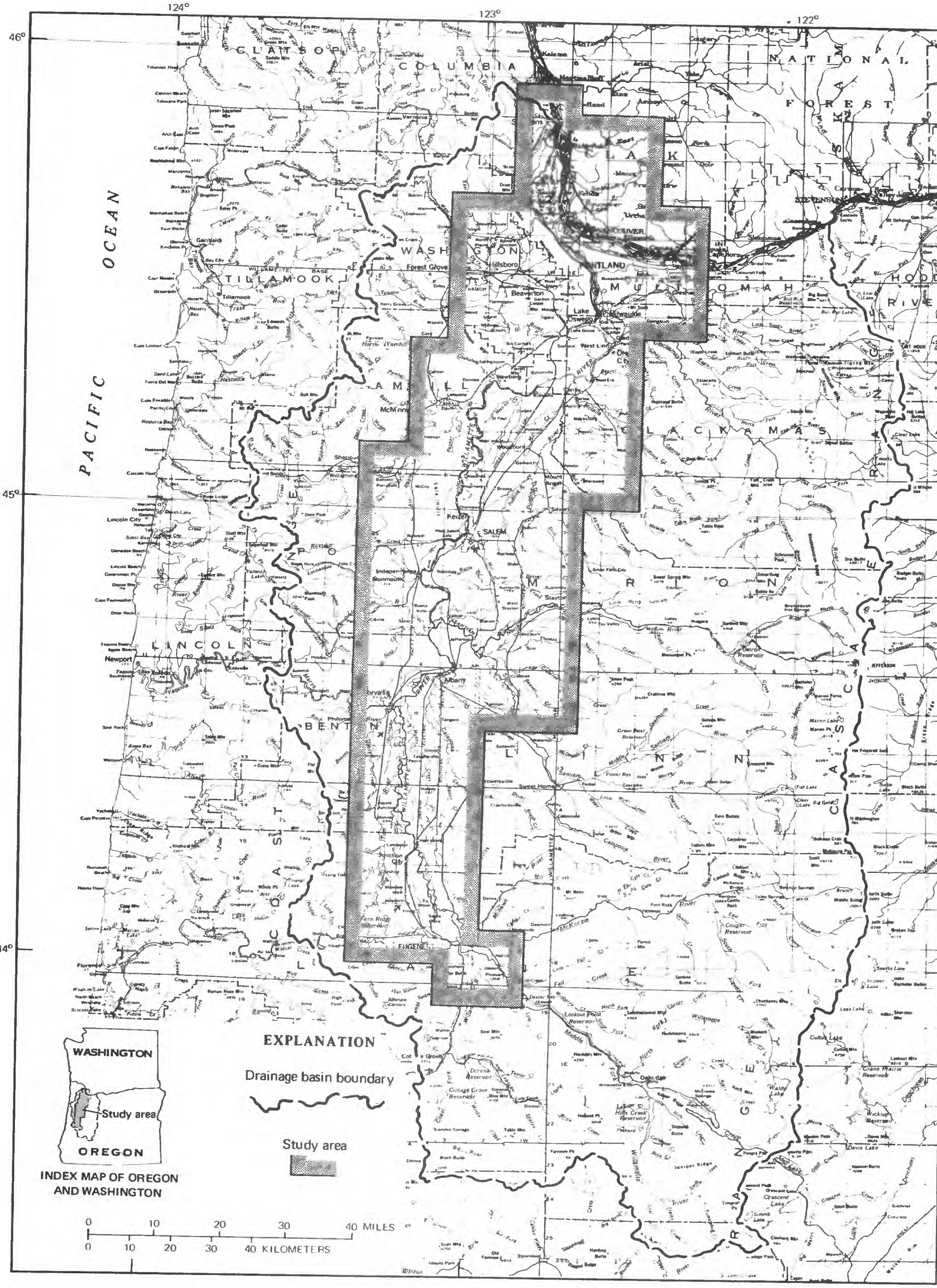


Figure 1. – Study area, Willamette River drainage basin, Oreg.

4) How do results from this study compare with other flood studies in the area and other urban studies outside the area?
5) 'To what degree does urbanization influence runoff in the area?

APPROACH

Peak-flow, storm-runoff, and rainfall-intensity information were used to define flood-frequency relations for specific gaged sites. In Portland and Vancouver, data from 24 streamflow and 24 rain-gage sites; and in Salem, data from 9 streamflow, 8 crest gage, and 14 rain-gage sites; were used to calibrate a digital rainfall-runoff model for each basin. Figure 2 shows the data collection network in Portland-Vancouver and figure 3 shows the data collection network in Salem.

The calibrated models were used to generate synthetic peaks from historic rainfall. National Weather Service records collected at the Custom's House in Portland (1903-73) and the airport in Salem (1938-80) were used as input to the models. Resulting annual peak flows and storm-runoff volumes were used in defining flood-frequency relations for each site.

Peak flows and runoff volumes from the flood-frequency relations in turn were regressed with physical basin characteristics to define equations for peak discharges and volumes for selected exceedance probabilities. Regression equations were defined independently for the Portland-Vancouver and Salem data sets, and for the combined data sets for the Willamette Valley.

Transferability between Portland-Vancouver and Salem was established by testing for differences between the two data sets. Transferability of equations that incorporate both data sets to the larger area of the Willamette Valley is implied because of the similarity of climatic and geomorphologic regimes. Data were also compared to results from a nationwide urban study (Sauer, and others, 1981).

In addition to digital modeling, a simple model (and regression equations) using only rainfall intensity to predict peak flow, was defined and evaluated for accuracy.

ACKNOWLEDGEMENTS

Data from the Salem area were collected with the direct cooperation of the city of Salem, Department of Public Works and especially Messrs. James V. Sears, Thomas L. Heinecke, and Jerry A. Wymore. The author also acknowledges the Mid-Willamette Valley Council of Governments and especially Messrs. John R. Russell and Timothy D. Goon for work defining basin characteristics.

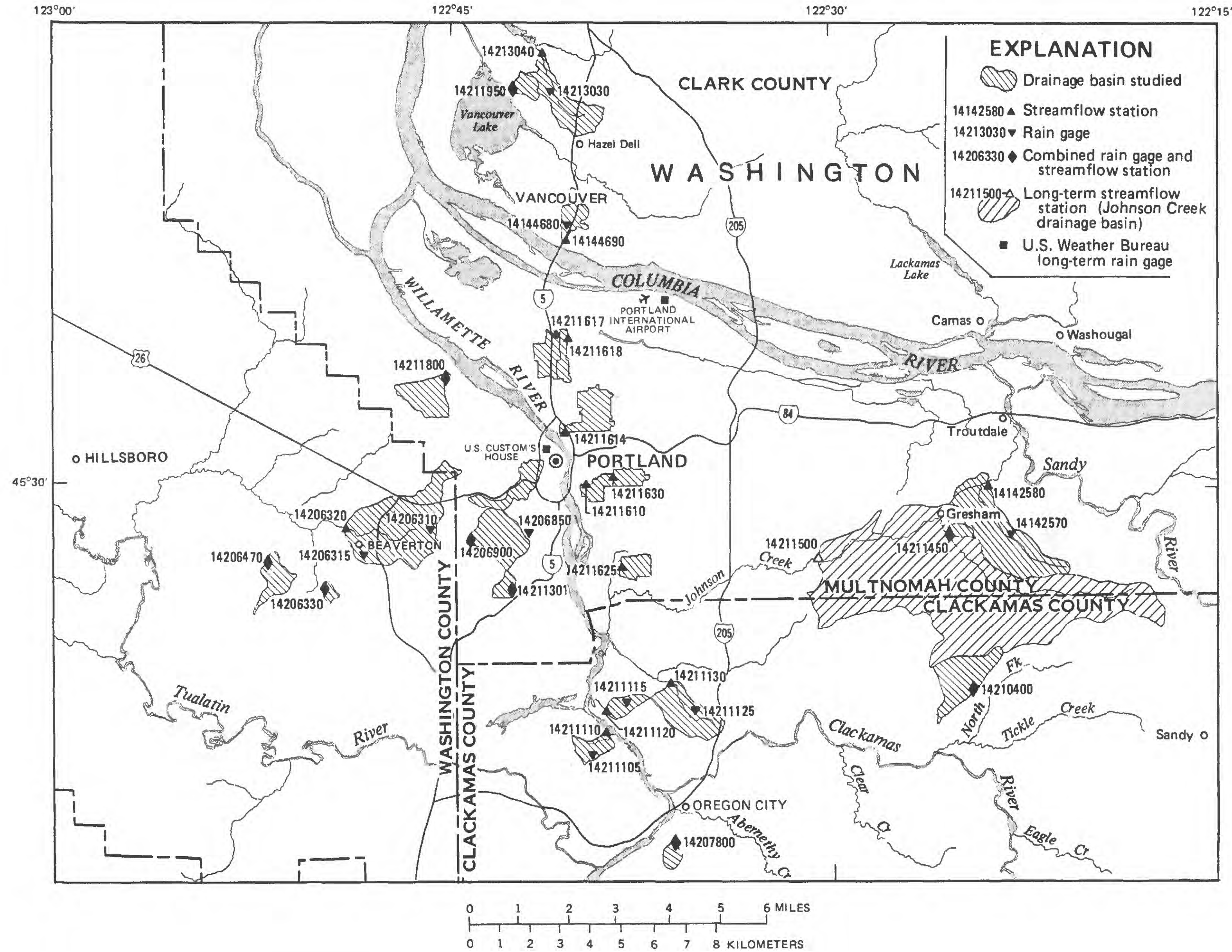


FIGURE 2. – Location of data collection network in Portland-Vancouver area.

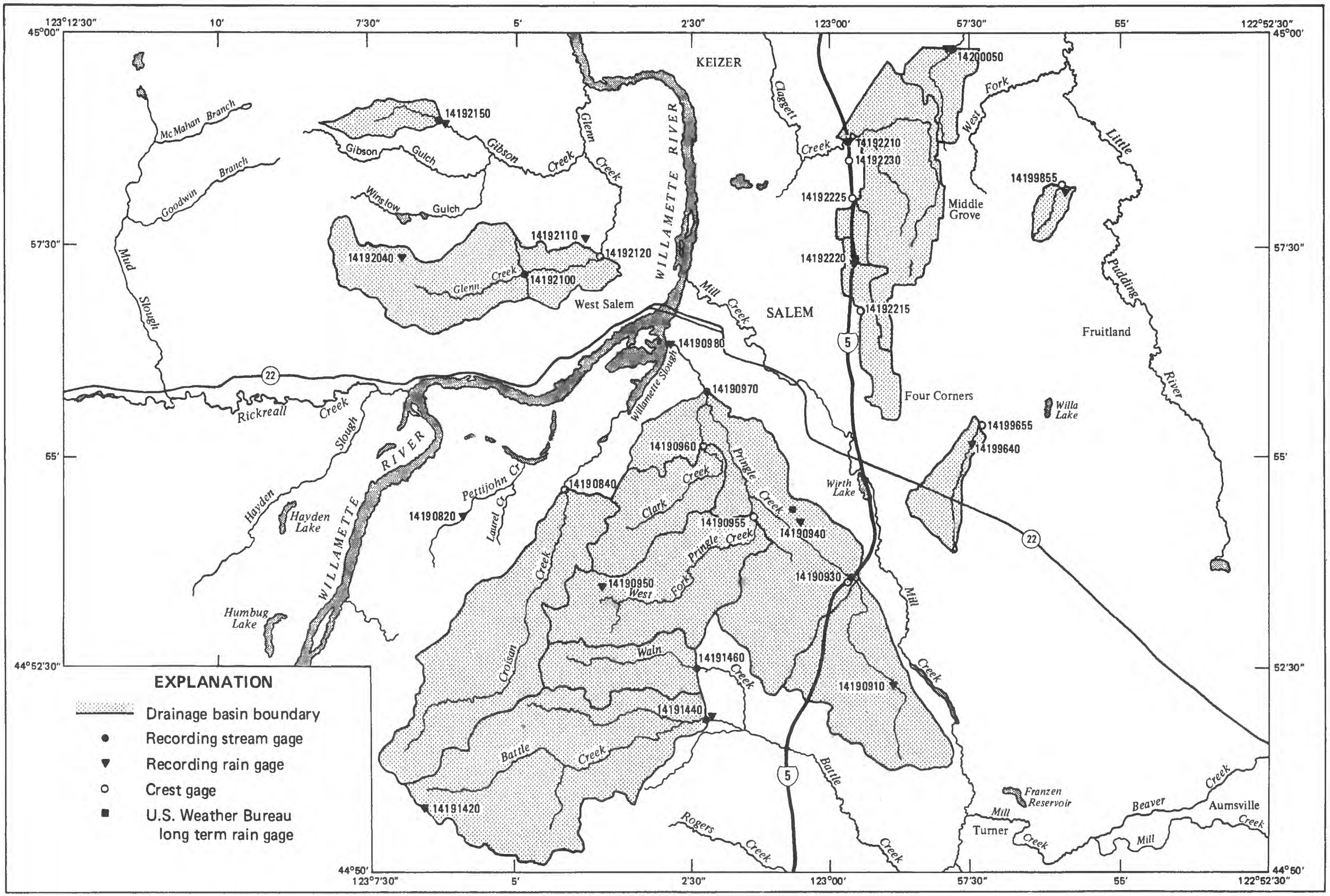


FIGURE 3. – Location of data collection network in Salem area.

PHYSICAL SETTING

Geography

The Willamette Valley occupies about 3,500 square mi in northwestern Oregon. It is approximately 30 mi wide, and extends about 125 mi from near Eugene-Springfield, northward to Portland, and the Columbia River. Salem is near the geographic center of the Willamette Valley. The valley is bounded on the west by the foothills of the Coast Range, on the south by the Calapooya Mountains, and on the east by the foothills of the Cascade Range. The extent of the valley is graphically portrayed in figure 4 which shows the surrounding topography in shaded relief.

The most predominent features within the valley are the Tualatin Mountains and the Chehalem Mountains near Portland, and Eola Hills near Salem. The valley surface is modified locally by alluvial fans that have formed where major streams emerge from the adjacent mountains. The valley plain slopes from elevations of about 500 ft near Eugene to about 150 ft near Canby to less than 50 ft at Portland.

In the upper 133 mi, the river's northward flow is in a braided, meandering channel. Throughout most of the lower 54 mi, it flows between high, well-defined banks entrenched 50 to 100 ft. Most main tributaries to the Willamette have narrow meandering channels entrenched 10 to 50 ft below the level of the valley plain.

Approximately 10 percent of the valley is now urbanized with the remaining 65 percent in agriculture and 25 percent in forest. About 67 percent of the agricultural land is devoted to cropland use. Drain tiles to dewater soil have been installed in cropland areas so that fields can be plowed early in the spring. Tiling especially affects the runoff characteristics of small basins.

The Willamette Valley contains approximately 60 percent of the population of the State of Oregon. The valley, with a 1980 population of 1.62 million, has experienced growth of 82 percent in the last 30 years, leveling off with growth of 24 percent in the last 10 years. The three largest metropolitan areas in Oregon; Portland, Salem, and Eugene-Springfield, lie within the valley. Table 1 shows populations for the state, valley and metropolitan areas for 1950, 1970, and 1980.

Table 1.--Population Statistics (city populations represent metropolitan areas)

	1950	1970	1980
Oregon	1,521,340	2,091,530	2,630,600
Willamette Valley	886,180	1,305,200	1,616,100
Portland	619,520	878,680	1,047,700
Vancouver (Wash.)	85,310	128,450	192,060
Salem	127,720	186,660	251,250
Eugene-Springfield	46,690	103,390	147,070

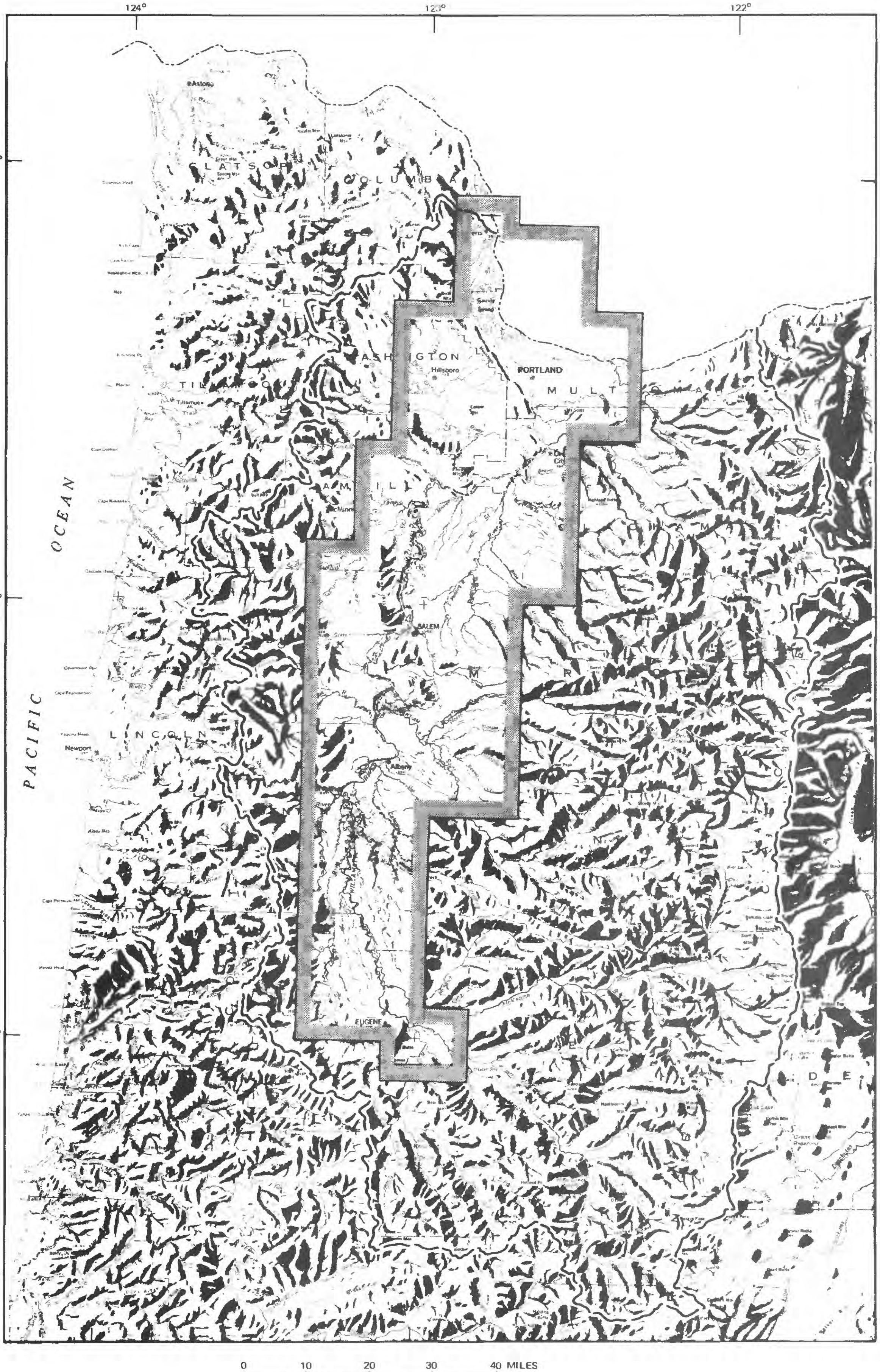


Figure 4. – Shaded relief map of the Willamette River drainage basin.

The metropolitan area of Vancouver, Washington, which lies just north of the Willamette Valley, is economically linked to the Portland area and is usually included in population statistics of metropolitan Portland (table 1 excepted). The Vancouver area is similar to the Willamette Valley in climate, topography, and geology, and can be considered a logical extention of the valley.

Geology

Geologically, Willamette Valley is part of a long, narrow lowland--the Puget-Willamette Trough--which extends from Eugene northward through Puget Sound (Pacific Northwest River Basins Commission, 1969). Willamette Valley is a syncline, or structural downwarp, partly filled with consolidated and unconsolidated alluvial deposits. The resistant rocks that frame the valley are primarily the marine rocks of the Coast Range and volcanic rocks of the Cascade foothills. These rocks extend beneath the alluvial deposits and, in places, protrude as hills above the valley floor.

Ridges of volcanic rock that extend across the valley south of Salem and near Oregon City divide the valley into four segments--southern Willamette Valley, northern Willamette Valley, Tualatin Valley, and Portland Basin.

The southern Willamette Valley surface is formed of sandy silt and is underlain by terrace deposits and alluvium that lie on marine and volcanic bedrock of low permeability. The valley fill is generally 30 to 130 ft thick.

Much of the surface in northern Willamette Valley is formed of sandy silt, which in places is 100 ft thick. Sand and gravel are found along the flood plain, and further upslope, the Troutdale Formation of Pliocene age is exposed and consists of up to 600 ft of stratified mudstone, sandstone, and conglomerate. Bedrock beneath the valley consists of marine and volcanic rocks, including the Columbia River Basalt Group of Miocene age.

The Portland Basin was formed by downwarping of the Troutdale Formation, Columbia River Basalt Group, and older rocks. The surface in the eastern part consists of clayey piedmont deposits and in other areas of bouldery gravel (terrace deposits). The valley fill, which includes these deposits and the underlying Troutdale Formation, ranges from 200 to 1,000 ft in thickness. The area adjacent to the Columbia and Willamette Rivers consists of terrace gravel deposited by the ancestral rivers. The Vancouver area can be considered part of this basin.

The terraces of the Portland Basin generally do not have a well-developed stream system, and although precipitation is fairly abundant, most water percolates down to the ground-water body leaving the area by underflow. Urban development capitalizes on the geology of the area by shunting considerable amounts of storm water into the terrace materials by means of dry wells.

Tualatin Valley also is a structural basin formed by downwarping of the Columbia River Basalt Group and underlying rocks. The valley fill generally consists of clay to fine sand ranging in thickness from a few feet to 1,500 ft.

RAINFALL CHARACTERISTICS

Climatic Elements

The Willamette Valley has a modified marine climate of relatively wet winters and clear, dry summers (Pacific Northwest River Basins Commission, 1969). This climate is a result of four major geographical features:

1) The Pacific Ocean, lies 40 to 50 mi to the west. Over the ocean, air becomes nearly saturated and air temperatures closely approach that of the ocean. From mid-October to early April, the ocean spawns storms that move onto the Oregon coast.

2) The Coast Range, is both a buffer protecting the valley from more violent aspects of most ocean storms, and a modifier of the incoming airmasses. In winter, air is cooled as it moves onto the land and up the slopes of the Coast Range thus stimulating rain. Because of this moisture release, the air that descends into the valley is much drier than marine air. In summer, the Coast Range effectively blocks the cool, moist air offshore.

3) The Cascade Range, blocks out great masses of continental air. As a result, extreme winter and summer temperatures that characterize areas 100 to 200 mi to the east rarely occur in the valley.

4) The Columbia Gorge, significantly affects the climate of the valley, especially the northern part, as it affords a nearly sea level passage through the mountains for marine air from the west and occasionally continental air from the east.

Most areal variations of precipitation (fig. 5) and temperature in the valley are a result of differences in altitude. However, differences in temperature, precipitation, and windspeed, also result from the proximity of areas to the Columbia Gorge. The meeting of cold air from the east with warm, moist, marine air from the west results in more severe winter weather for those areas close to the Gorge.

Several times each winter, severe storms cause moderate to heavy rain, strong winds, and occasionally snow in the valley. A long run of southwesterly winds aloft typically produces the heaviest rains. Winds originating near Hawaii, cross the Pacific and stream inland, carrying warm, moist air. This warm, moist air meets cold, northerly air from the Aleutian Islands to form a storm front. Warm, wet waves of air that form along the front move eastward for periods of several days.

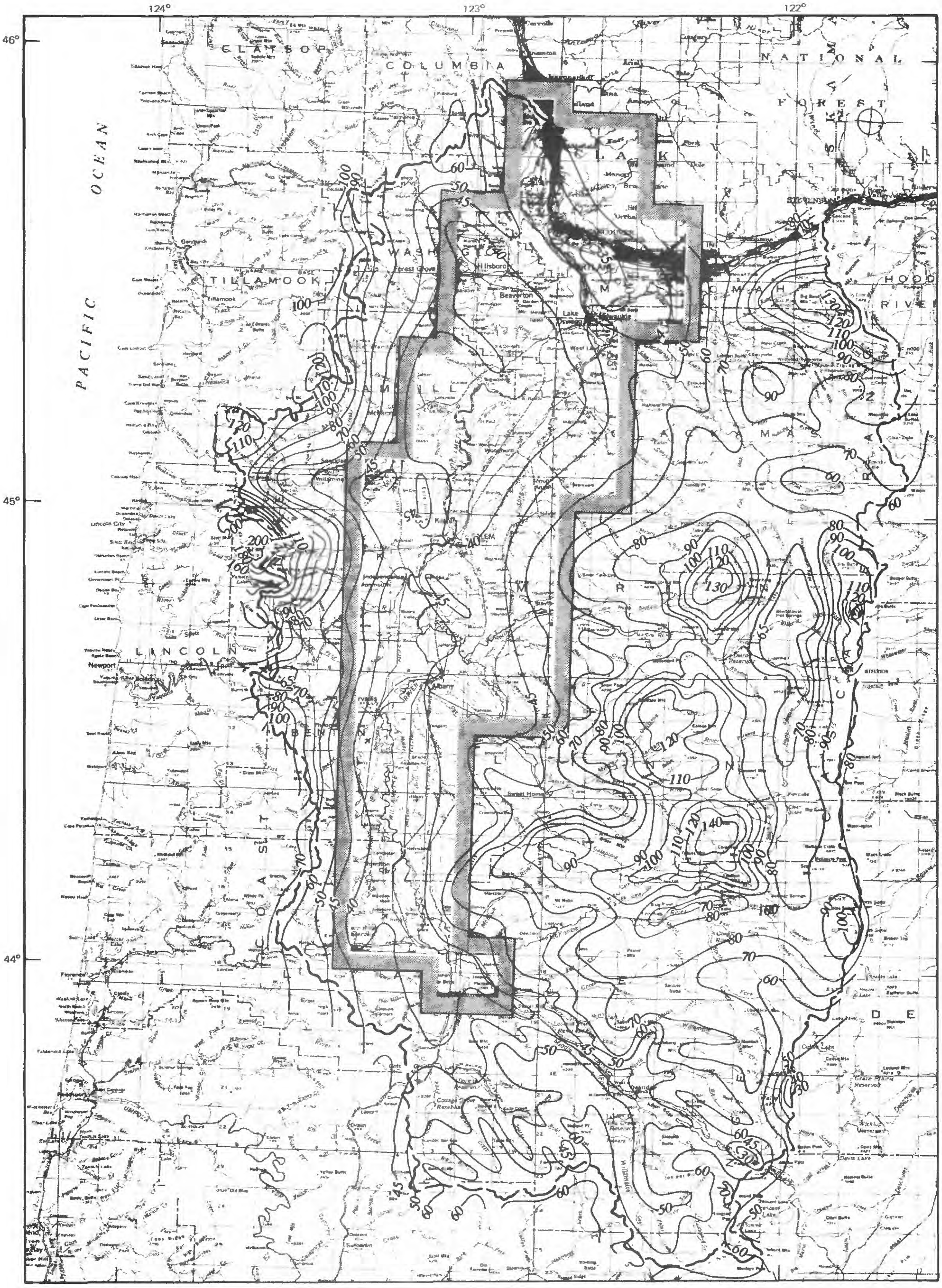


Figure 5. – Average annual precipitation, in inches

Temperatures remain well above freezing in the 1,000- to 2,000-ft altitudes of these frontal systems. Occasionally, a blanket of cold air covers the valley, and falling snow reaches the ground. Eventually, the cold, surface air is replaced by the warmer, marine air but sometimes not before freezing rain occurs.

A small percentage of annual rainfall occurs from May through September, generally from convective storms occurring on the average of one a month. These storms are not intense compared to storms in other parts of the United States, but are more intense for short durations than are the winter storms. Typically these storms will last less than an hour and deliver less that 1 in. of rain. This can be contrasted to frontal storms which can typically last 3 to 4 days and deliver 4 to 8 inches.

Rainfall-Intensity Duration

Cramer-Von Mises statistical tests (Conover, 1972) for identical distributions indicate that hourly rainfall amounts at the U.S. Custom's House in Portland and at the airport in Salem, are identical within the 95-percent confidence limits. All other rainfall amounts for other durations are identical within the 90-percent confidence limits. Figure 6 shows rainfall-exceedance probabilities for selected intensities at Portland, Salem, and Roseburg. A comparison of these curves indicates rainfall intensities are somewhat lower at the Salem Airport but not dissimilar to intensities at the Portland U.S. Custom's House.

The annual precipitation map (fig. 5) and the rainfall-intensity map (fig. 7) were used to adjust the input rainfall data for individual watershed models to compensate for differences in areal distribution of rainfall. The rainfall-intensity map for the 6-hour duration, 0.0.2-exceedance probability indicates intensities should be slightly lower at the Salem Airport than at the Portland U.S. Custom's House. Intensity at the Salem Airport is about 1.8 in. for a 6-hour duration compared to 1.9 in. for this same duration in Portland. This map (fig. 7), also indicated intensities to be slightly higher in the Eugene (2.1 in.) and Roseburg (2.2 in.) areas which are located just south of the project area. In fact, the rainfall-exceedance probabilities at Roseburg are very similar to that of Salem or Portland with the hourly duration curve almost exactly the same (fig. 6).

A further test for identical distributions was made whereby Portland rainfall data was used with Salem streamflow models and the results compared to Salem streamflow model with Salem rainfall data. Results showed the average deviation between the two data sets to be only 7 percent.

Because all tests indicate that rainfall statistics are similar for the entire valley, use of any of the available rainfall data regardless of location should not introduce significant bias to study results.

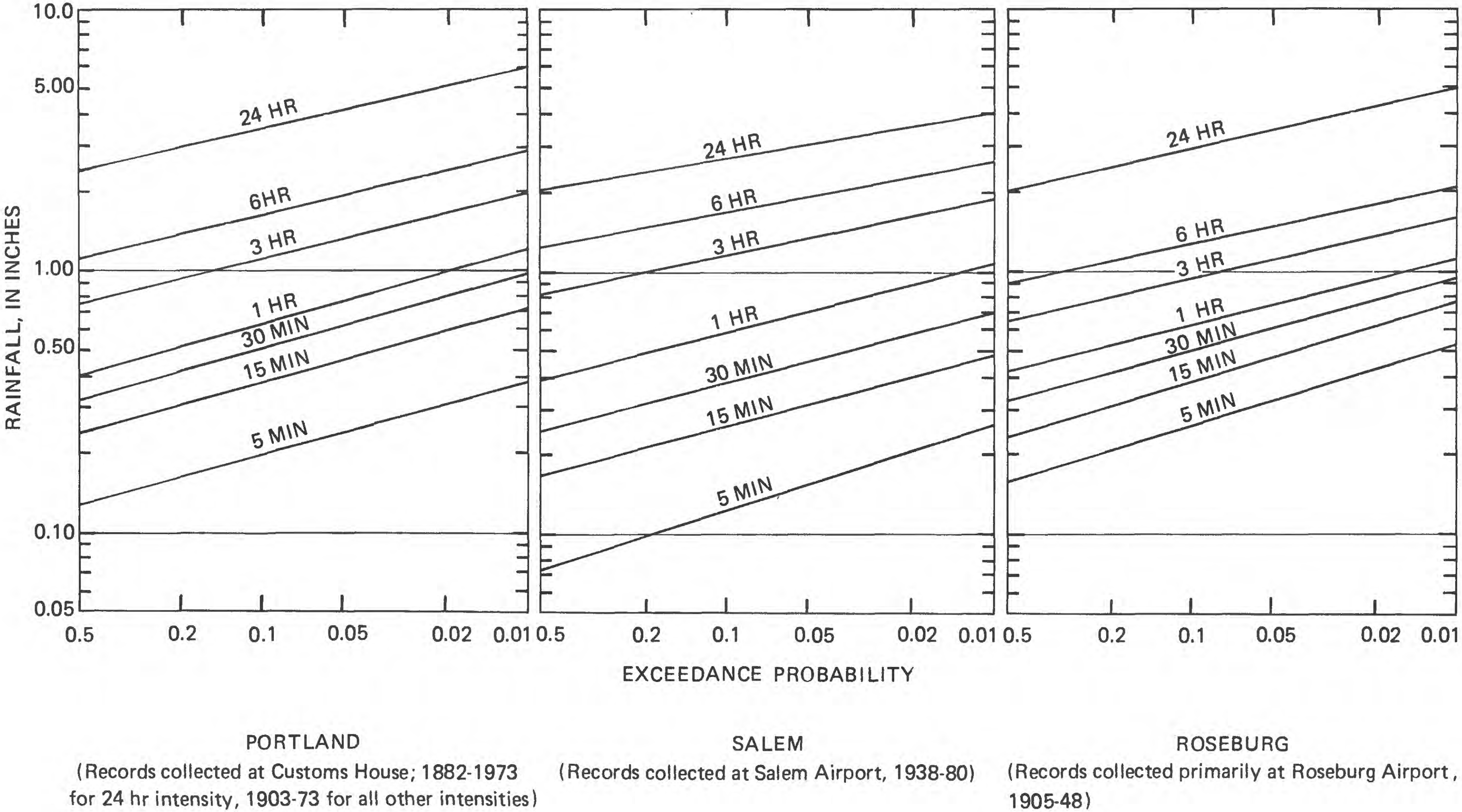


Figure 6. – Rainfall-exceedance probability for selected intensities for Portland, Salem, and Roseburg, Oregon.

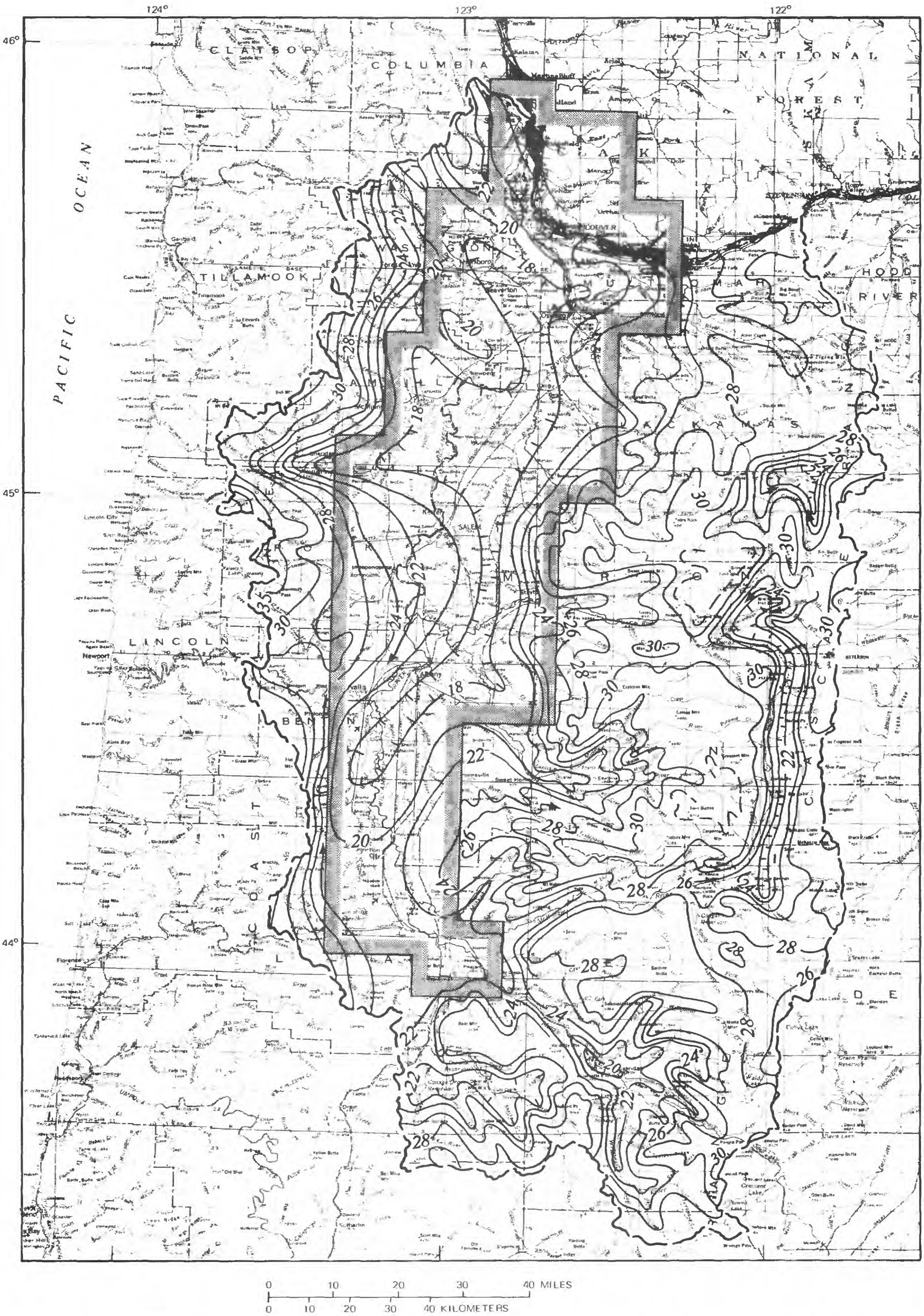


Figure 7. – Rainfall intensity, in tenths of inches, for 6 hour duration. 0.02 exceedance probability (National Oceanic and Atmospheric Administration, 1973)

Historic Rainfall

Rainfall data used with watershed models were collected at the U.S. Custom's House in Portland (1903-73) and at the Salem Airport (1938-80). However, prior to 1903 daily records of rainfall were collected in Portland and on December 12-13, 1882 and January 5-6, 1883, daily totals of 7.66 in. and 5.55 in., respectively, were recorded by the Weather Service at the U.S. Custom's House. From figure 6, these extreme events have estimated exceedance probabilities of 0.003 and 0.015 (recurrence intervals of 300 and 70 years), respectively. Work done in the companion study (Laenen, 1980) to this report showed that for basins of approximately 25 mi^2 or larger, the equations developed using only the 1903-73 rainfall data would predict the lower flood peaks; however, basins of approximately 6 mi^2 or smaller would not be affected.

DESCRIPTION OF HYDROLOGIC ANALYSES

Digital Modeling

The U.S. Geological Survey (USGS) rural rainfall-runoff model (A634) developed by Dawdy, Lichty, and Bergman (1972) was used for modeling and simulation. Data collected were entered into the model as daily rainfall and evaporation (to define antecedent moisture conditions) and as five-minute rainfall totals and peak-flow discharges (individual storm events). During the model-calibration phase for each basin, the various parameters were optimized to yield the best statistical results.

For this project, the model was used to optimize (estimate) effective impervious area (EIA), and the four interacting soil parameters of PSP, KSAT, RGF, and BMSM (see definitions in glossary) for each basin. All other model parameters were set to values computed from either regional data (Pacific Northwest River Basins Commission, 1969) or by graphical analysis of the observed data. Refer to Dempster (1974) or Laenen (1980) for detailed comments on model use and application. Calibration for basins in Salem was based on the period from February 1979 to May 1981, and storm information collected during this period are listed in tables 11 and 12 in the back of this report.

Determination of Effective Impervious Area

Effective impervious area (EIA) can be considerably different from that which may be mapped. To define effective impervious areas in ungaged basins, the hydraulic connections between the impervious areas and the stream would have to be cataloged, and then evaluated for their effectiveness. This is very time consuming and may be impractical for most studies.

If a stream is gaged, however, the effective impervious area can be estimated by using an optimal fitting technique with the USGS digital rainfall-runoff model. Although this technique lumps many soil and topographic characteristics together, including the impervious area, it still yields a reasonable estimate of the effectiveness of the hydraulic linkage in the system.

To verify the use of the model for estimating (optimizing) effective impervious area, field surveys of impervious area and hydraulic connections were undertaken for gaged sites in four basins; Beaverton Creek tributary near Portland (14206330) and Vancouver sewer outfall (14144690) in Vancouver, and Waln Creek (14191460) and Hawthorne Ditch (14192220) in Salem. Figure 8 shows how the standard error of estimate (SEE) for runoff volume computed by the model for Waln Creek and Vancouver sewer varies with effective impervious area. The field estimate of the effective impervious area and the mapped value of impervious area are also indicated in figure 8. The field estimate of effective impervious area for Waln Creek and Vancouver sewer-outfall basins showed that the optimized impervious area is a good estimate of the effective impervious area. For Waln Creek, most of the mapped impervious area was determined to be effective; however, for the Vancouver sewer-outfall basin, located on porous terrace gravel, there is a large difference between mapped impervious area and the computer-optimized or effective impervious area. The field survey showed that only the streets, the freeway, and some downtown buildings were directly connected to the Vancouver storm-sewer system. In most of the basin, residential dwellings and some downtown buildings had roof drains that were connected directly to dry wells. The only way to assess the effectiveness of this dry well area is through a basin by basin evaluation.

In Salem and parts of the Portland metropolitan area, such as Beaverton, drainage practices were similar (and relatively uniform) and a unique relation between mapped and effective impervious area could be established within reasonable limits. In these areas the following linear relation exists:

$$EIA = 3.6 + 0.43\ MIA \qquad (1)$$

where,

EIA = effective impervious area in percent of basin area, and
MIA = mapped impervious area in percent of basin area.

Data fits this curve with an R-square of .84 and a SEE of 27 percent. Drainage practices were too diverse in the terrace areas of Portland and Vancouver and no relation could be established there. Equation 1, however, may yield reasonable results for most urban areas in the Willamette Valley.

The intercept for equation 1 shows that there will always be some effective impervious area even though no impervious area may be mapped. This is not unusual for an area like the Willamette Valley where volcanic rock outcrops are sometimes abundant.

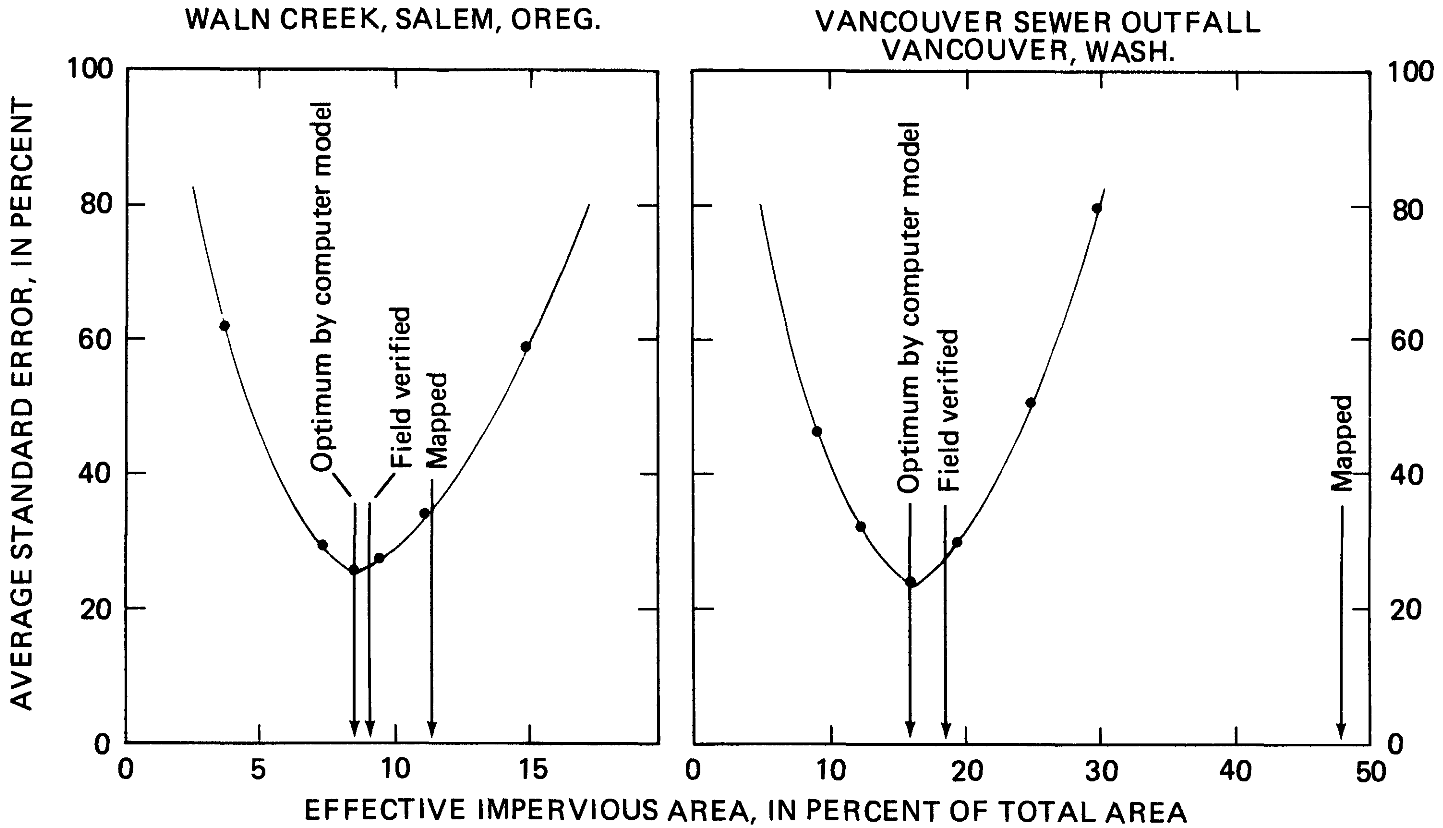


Figure 8. – Determination of effective impervious area by digital model.
(Volume phase of model used only, all parameters except impervious area held constant.)

Digital Model Simulation

Five-minute rainfall data for approximately five selected storms per year for Portland (1903-73) and Salem (1938-80) were obtained from records of the National Oceanic and Atmospheric Administration (NOAA). Storms were selected to include the maximum 24-hour to 5-day rainfall events plus at least one thunderstorm event per year. These were used as input data to the calibrated digital model for simulating a set of peak discharges for each basin studied. These peaks were then used in a flood-frequency analysis.

Additional input data to the simulation program were daily rainfall and evaporation (to determine antecedent moisture conditions), five-minute rainfall, and the calibrated model parameters. Only one rainfall and evaporation record was used in the simulation program. To account for areal variations, an annual rainfall adjustment was applied to daily rainfall values, and a rainfall-intensity adjustment was applied to five-minute rainfall values. Adjustments were determined from NOAA (1973 a, b) isohyetal and isopluvial maps (see fig. 5 and 7). Evaporation data were from the North Willamette Experimental Station near Canby, Oregon. Because the evaporation record was not as long as the rainfall record, evaporation was synthesized by harmonic analysis using existing data patterns. Evaporation data were not adjusted to account for areal variations.

Model Verification

Peak-flow data available for gaging stations on Johnson, Saltzman, and Glenn Creeks (14211500, 14211800, and 14192100) were compared with computer-synthesized peaks to evaluate the statistical reliability of the methods used in this report and to detect bias. The comparisons were made for periods outside the model calibration period and provided an independent verification of the model results. Glenn and Johnson Creek basins were essentially rural during the verification period, and the impervious values representing more urban conditions were reduced slightly to reflect more rural conditions. Saltzman Creek was rural for both calibration and verification periods.

Glenn Creek data (1952-77) exhibited excellent agreement between observed and simulated peaks (fig. 9). The scatter is random, which indicates little, if any, bias. The standard deviation is 30 percent from this relation. National Weather Service maps indicate that precipitation is 5 percent higher in the Glenn Creek basin than at the location of the rain gage used in synthesis. Factors based on figures 5 and 7 were used to adjust historical rainfall records for model synthesis. Peak-flow data for Johnson Creek (1949-73) and Saltzman Creek (1952-1973) were used in a similar verification. The scatter was random, and the standard deviations were 30 to 40 percent, respectively. Model calibration for Saltzman Creek is considered to be poor because of the small sample size available for calibration.

Split-sampling techniques were not used to verify model calibration because of the limited sample size.

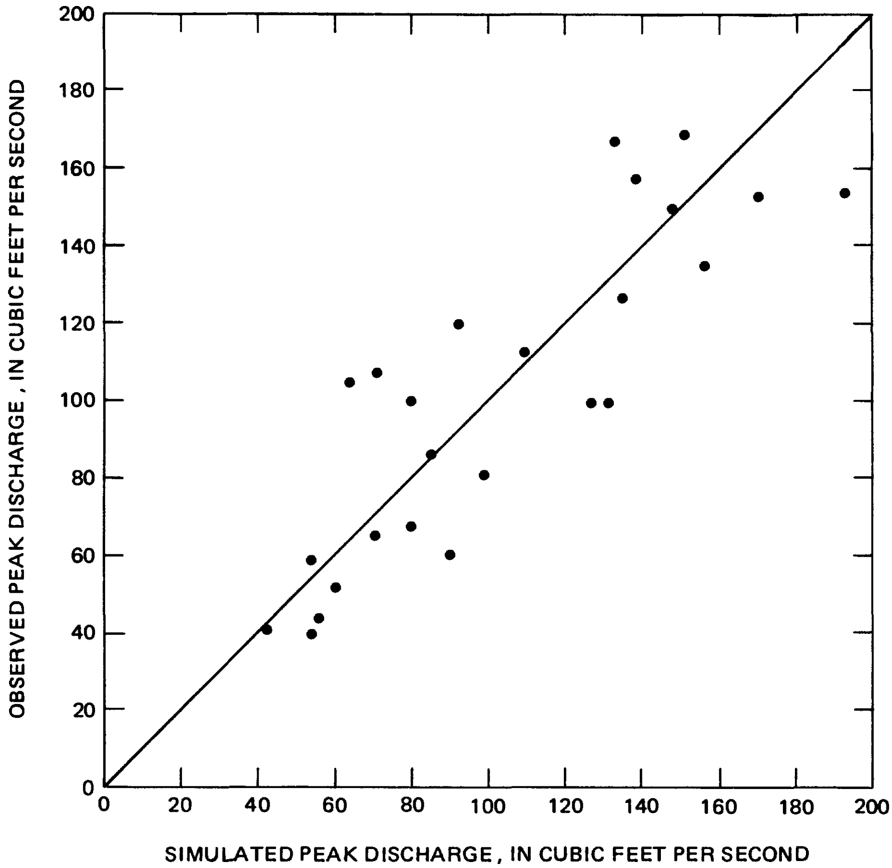


Figure 9. – Digital model verification for Glenn Creek (14192100), 1952-77.

Base Flow Determination

In this report, base flow during a storm is defined as that component of runoff not attributed to overland flow. It is highly variable from storm to storm, and from basin to basin. Base flow is influenced by antecedent conditions and can be attributed to the flow from ground water, interflow from the unsaturated zone or perched water table, and return flow from diversions.

For the individual model calibrations, base flows were determined graphically from the observed discharge hydrograph. Storm base flows for individual peaks were set equal to the average of flows prior to and after the storm event. In synthesis, base flow had to be estimated for the individual basins. Because only the large peaks defined the segment of the log-Pearson Type-III frequency curve used in the analysis, the average base flow for the higher peaks was used as the estimate. For peak discharge, base flows were normally less than 10 percent of the total flow in most basins. However, for a few streams at exceedance probabilities between 0.5 and 0.1, the base-flow component was higher than the runoff component from overland flow. Storm base-flow variability was analyzed, but no well-defined relation between basin parameters or antecedent conditions could be developed.

Table 2.--Summary of peak discharges for selected exceedance probabilities for urban stream-gage sites in the Willamette Valley

[Discharge in ft^3/s were obtained by fitting a log-Pearson Type-III frequency distribution of synthesized peak information by digital modeling.]

Portland-Vancouver basins (0.0 skew)							Salem basins (-0.4 skew)						
Station number	Exceedance probability .5	.2	.1	.04	.02	.01	Station number	Exceedance probability .5	.2	.1	.04	.02	.01
14142580	276	432	546	702	824	953	14190840	179	251	296	348	384	418
14144690	122	204	268	358	431	510	14190930	121	160	184	210	229	245
14206320	317	474	586	733	848	966	14190955	169	228	262	301	328	353
14206330	13	19	24	30	35	39	14190960	95	128	148	168	183	197
14206470	51	76	93	117	135	153	14190970	526	715	827	957	1040	1130
14206900	212	308	375	461	527	594	14191440	153	208	241	278	304	328
14207800	14	22	27	34	39	45	14191460	85	127	154	187	210	233
14210400	167	222	258	303	336	369	14192100	116	161	188	220	241	262
14211110	59	85	102	124	142	159	14192120	146	209	249	295	327	358
14211120	38	58	73	91	106	120	14192150	22	32	38	46	52	57
14211130	92	130	155	187	212	236	14192210	221	300	348	403	440	475
14211301	36	50	60	71	80	89	14192215	47	74	91	112	128	143
14211450	25	35	42	50	56	63	14192220	84	120	141	167	184	201
14211500	1310	1830	2180	2620	2960	3300	14192230	158	230	275	329	367	402
14211604	249	357	431	527	600	675	14199655	43	55	62	70	76	80
14211610	237	345	419	516	591	667	14199855	12	18	23	28	32	35
14211614	228	344	427	536	621	710	14200050	39	58	70	84	95	104
14211617	95	141	174	218	252	286							
14211618	51	88	118	162	198	237							
14211625	155	245	311	400	472	547							
14211630	102	167	216	285	341	400							
14211800	133	180	211	250	279	308							
14211950	16	25	31	40	47	54							
14213040	86	143	186	246	295	348							

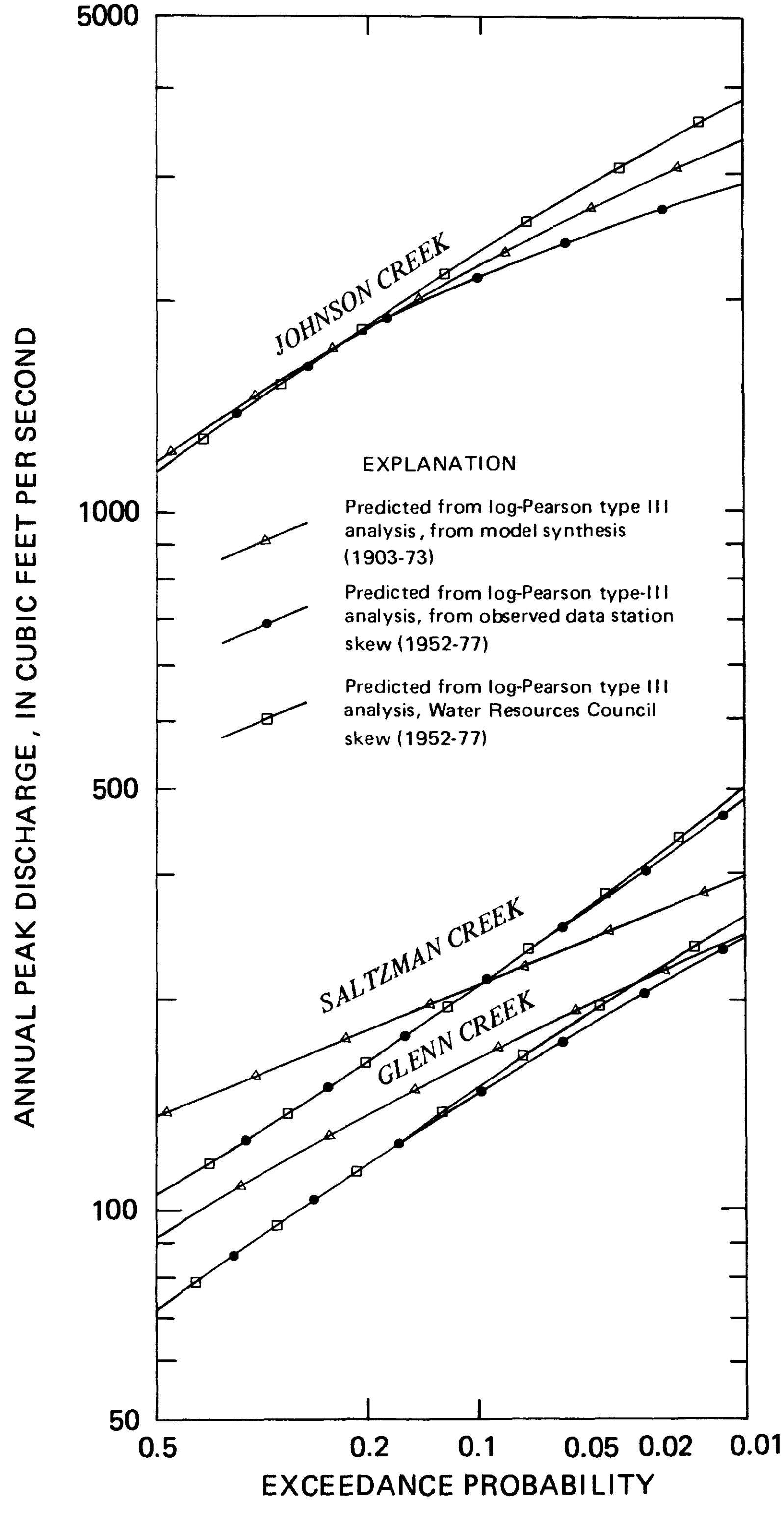


Figure 10. – Peak discharge frequency for Johnson, Saltzman, and Glenn Creeks, as determined from model synthesis and log-Pearson type-III analysis of observed peaks.

Peak and Storm-Runoff Frequency Analysis

Log-Pearson Type-III frequency analyses using various skew coefficients were performed on peak discharge simulated by the model for each basin. Analyses were made using zero skew, station skew, a weighted skew using U.S. Water Resources Council (WRC) guidelines (1977), and an average city skew.

WRC guidelines utilize a national map to generalize skew for local conditions. Average city skew was determined by averaging all station skews for the individual areas of Portland-Vancouver and Salem. Table 2 is a summary of peak discharges obtained by using the average city skew (zero for Portland, -0.4 for Salem) in the frequency analyses and used for regression analysis. Results of calculations using other skews can be found in the companion report by Laenen (1980) for Portland-Vancouver, and in table 15 for Salem located in the back of this report.

Observed peak information, from the three basins used to verify model calibration techniques, was used to verify frequency information. Figure 10 shows predicted frequency curves from digital model synthesis compared to frequency curves from actual peak information. The observed data were used to define two sets of frequency data; an actual station curve, and a weighted curve based on WRC guidelines. Data from both Glenn Creek and Johnson Creek show generally good agreement; however, Saltzman Creek shows the synthetic curve to have less slope and the .01-exceedance probability peak to be 23 percent lower than the actual station data defined peak. In general, these curves indicate synthetic peak predictions to be reasonable and within the average error (27 percent) of the digital model.

A general equation regressed from study data that may be used to predict station skew for the Willamette Valley has the form:

$$\text{Skew} = -2.0 + (.51\ \text{EIA}^{.24}\text{BSL}^{.13}\text{BSHP}^{-.09}) \qquad (2)$$

where,

EIA = effective impervious area, in percent,
BSL = basin slope, in feet per mile, and
BSHP = basin shape.

Basin characteristics are defined in the glossary. Equation 2 yields an R-square of 0.73 and a SEE of 19 percent, but offers little practical improvement over the use of a mean skew. All station skews synthesized for basins in the Salem area were negative (average -0.4) and for basins in the Portland area were both positive and negative (zero average). Average skews should be used for Salem and Portland instead of equation 2.

Equation 2 suggests that the differences in skew between the Portland-Vancouver and Salem areas may be caused by differences in methods used for routing storm discharge. EIA, which indirectly defines hyraulic linkages, was the most significant variable in the regression of this equation. The Portland-Vancouver area uses dry wells and Salem uses drain tiles to route storm discharges. EIA is also an indicator of urbanization. A nationwide urban study by Sauer, Thomas, and Stricker (1981), however, did not identify any relation between skew and urban factors. Instead the nationwide study showed a relation between skew and a soil parameter. No such relation coud be established for this study.

Thomas (1982) indicates that peak-discharge-frequency relations determined synthetically by digital modeling generally yield lower discharges than relations using observed peaks. His study which consisted of 97 rural basins from the eastern United States showed the synthetic peak estimate for the 0.01-exceedance probability to vary from 11 to 29 percent lower than the observed peak.

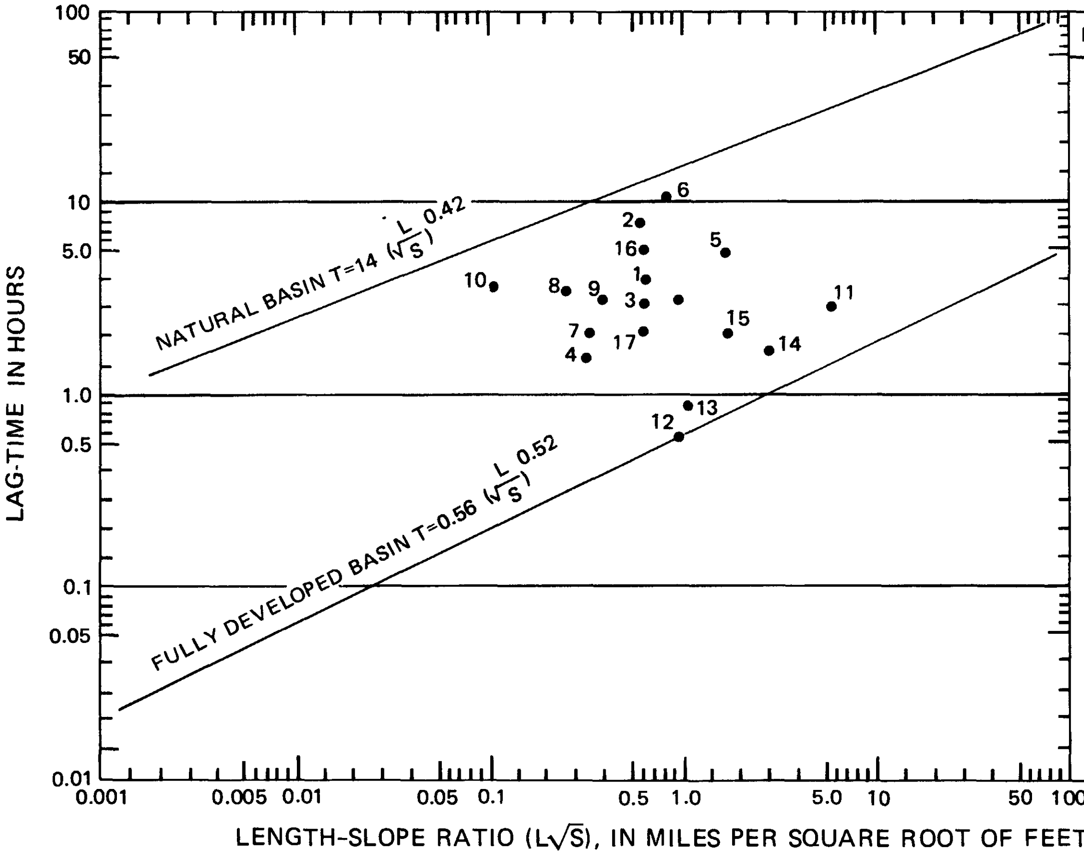
From data in figure 10, values computed by synthetic analysis were generally 9 percent lower than those values computed from the actual station record. The statistical sample compared in this report, however, is too small to allow for any adjustments.

Two sets of computations were made for storm-runoff volume, one including base flow and another excluding base flow. Storm runoff volume was determined by using the individual station skews defined by model synthesis. Results of runoff-volume computations for the Portland-Vancouver area can be found in the companion report by Laenen (1980), and for Salem in table 16 in the back of this report. WRC guidelines do not apply to runoff-volume data.

Lag-Time Analysis

Lag time can be defined as the time between the center of mass of rainfall and the center of mass of runoff for a basin. A report by Anderson (1970) has shown that lag time can be an excellent indicator of urban development. His report showed lag time to be a function of stream length and slope. For Portland-Vancouver (Laenen, 1980) and Salem (fig. 11), plots of lag time versus a length-to-slope ratio show no such relation.

In the Portland-Vancouver and Salem studies, plotted points scatter randomly with some highly developed urban basins showing response similar to natural basins. The cause of this random pattern is apparently from (1) large differences in impervious areas and their effectiveness, (2) differences in topographic relief which modify basin response, and (3) man's alterations which do not always improvė channel conditions. However, the limits shown in figure 11 have considerable value. They define the boundary between urban and natural lag time for basins in the area, and in addition are helpful in determining anomalies for specific basins. The lag-time relation for natural basins in this area is generally longer than that defined by Anderson (1970) for basins in northern Virginia.



Plot No.	Station number
1	14190840
2	14190930
3	14190955
4	14190960
5	14190970
6	14191440
7	14191460
8	14192100
9	14192120
10	14192150
11	14192210
12	14192215
13	14192220
14	14192225
15	14192230
16	14199655
17	14199855
18	14200050

Figure 11. – Relation of lag-time to length-slope ratio. Equations shown are from a report by Laenen, 1980. (Numbers refer to Salem basins, refer to table 12.)

Regression Analysis

Peak discharges and runoff volumes determined by log-Pearson Type-III frequency analysis of the computer-synthesized data were regressed against physical basin characteristics. The frequency analysis as defined by average city skew was used for regression analysis.

Multiple linear-regression analyses as described by Riggs (1968) were used to define the relation between the dependent variable (peak discharge or runoff volume) and one or more independent parameters. To obtain a linear-regression model as a matter of convenience, and to achieve equal variance about the regression line, the dependent and independent variables were transformed into logarithms.

A stepwise regression analysis of the logarithm of the variables was made using SAS (Statistical Analysis System) programming. The peak flow equation took the following form:

$$\mathrm{Log}Q_T = \mathrm{Log}K + a\mathrm{Log}C_1 + b\mathrm{Log}C_2 + c\mathrm{Log}C_3 \ldots\ldots + z\mathrm{Log}C_n \qquad (3)$$

which transformed becomes:

$$Q_T = K\ C_1^{a} C_2^{b} C_3^{c} \ldots\ldots C_n^{z} \qquad (4)$$

where,

Q_T = the peak discharge for the T exceedance probability,
K = a regression constant, the antilog of which becomes the equation constant,
C_1, C_2, C_3, and C_n = basin characteristics, and
a, b, c, and z = regression coefficients which become equation exponents when transformed.

The model used to define runoff volume has a similar form.

An evaluation of the various steps of the regression for both models of peak discharge and runoff volume was made based on the improvement of the SEE and R-square to select the most suitable relations.

Independent regression equations were developed for Portland-Vancouver, Salem, and the Willamette Valley (combined data). Because there are several forms of regression equations given in this report, table 3 is included to aid the reader in determining why certain equations were included and where they might be used. Selected results are shown in table 4, a summary of peak discharge equations, and table 5, a summary of runoff volume equations. R-square statistics shown in these tables refer to the log-transformed regression. SEE statistics have been transformed back from log to normal by methods described by Riggs (1968) and are reported in percent of the predicted value. Table 4 also contains the equation defined in the nationwide urban study by Sauer and others (1981).

Table 3.--Explanation of regression equation designations

Equation designation	Reason for regression	Urban area where best used
	Peak Discharge Equations	
P1	Best 3 parameter model from previous report on Portland	Portland area (superseded by W3)
P2	Best model using land-use parameters from Portland report	Portland area where land-use parameters are available
S1	Best 3 parameter model for Salem data	Salem area (superseded by W3)
S2	Best model using land-use parameters for Salem area	Salem area where land-use parameters are available
W1	Best 3 parameter model for Willamette Valley	Urban Willamette Valley exclusive of Portland and Salem areas
W2	Best model using land-use parameters for Willamette Valley	Urban Willamette Valley exclusive of Portland and Salem areas
W3	Best 4 parameter model for the Willamette Valley	Portland (skew = 0.0), Salem (skew = -0.4)
W4	Best model using basin development factor (BDF)	Urban Willamette Valley
W5	Best model using all parameter of the nationwide equations	Urban Willamette Valley
N5	Best 3 parameter model from nationwide study (Sauer, 1981)	All urban areas nationwide
	Runoff Volume Equations	
PV1	Best 3 parameter model without base flow from Portland study	Portland area
PVB1	Best 4 parameter model with base flow from Portland study	Portland area
WV1	Best 3 parameter model without base flow for Willamette Valley	Urban Willamette Valley excluding areas of excessive tiling
WVB1	Best 4 parameter model with base flow for Willamette Valley	Urban Willamette Valley excluding areas of excessive tiling
WV2	Best 3 parameter model without base flow using all data	Urban Willamette Valley
WVB2	Best 4 parameter model with base flow using all data	Urban Willamette Valley

Table 4.--Summary of regression equations for peak discharges for selected exceedance probabilities

[Form of general equation: $Q_T = a\ DA^b EIA^c LU12^d (GUTR+.1)^e (13\text{-}BDF)^f (ST+0.1)^g (SKEW+2)^h RQ_T^j$]

0.5-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg SEE pct
P1	25.6	.90	.32				-.28			24	.962	24
P2	79.4	.93		-.12	.05		-.27			24	.960	25
S1	26.1	.83	.37				-.07			17	.984	13
S2	107.0	.88		-.19	.07		-.08			17	.976	17
W1	26.8	.90	.34				-.20			41	.950	24
W2	86.0	.94		-.14	.06		-.19			41	.950	25
W3	32.0	.90	.34				-.20	-.26		41	.960	22
W4	107.0	.93				-.30	-.16			41	.936	28
W5	3.23	.004				-.43			1.01	41	.894	35
N5	13.2	.21				-.43			.73	269	.910	43

0.2-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg SEE pct
P1	34.6	.89	.36				-.27			24	.964	23
P2	127.0	.93		-.14	.06		-.26			24	.965	23
S1	37.7	.80	.37				-.09			17	.977	16
S2	148.0	.86		-.18	.08		-.10			17	.970	18
W1	37.0	.88	.36				-.21			41	.954	23
W2	134.0	.92		-.15	.07		-.20			41	.956	22
W3	39.1	.88	.36				-.21	-.10		41	.960	21
W4	170.0	.91				-.30	-.16			41	.942	26
W5	3.75	.004				-.43			.94	41	.902	33
N5	10.6	.17				-.43			.78	269	.920	40

0.1-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg SEE pct
P1	40.2	.89	.38				-.27			24	.964	23
P2	162.0	.94		-.16	.06		-.25			24	.965	22
S1	46.0	.79	.36				-.09			17	.972	16
S2	169.0	.84		-.17	.08		-.10			17	.966	19
W1	43.6	.87	.37				-.22			41	.953	23
W2	170.0	.92		-.17	.07		-.20			41	.957	22
W3	42.2	.87	.37				-.22	-.06		41	.960	22
W4	214.0	.90				-.30	-.17			41	.943	25
W5	3.89	.003				-.43			.98	41	.900	33
N5	9.51	.15				-.43			.79	269	.920	41

0.04-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg. SEE pct
P1	47.5	.88	.42				-.26			24	.962	23
P2	214.0	.94		-.17	.07		-.24			24	.967	22
S1	55.3	.78	.35				-.10			17	.967	17
S2	188.0	.83		-.16	.08		-.11			17	.961	20
W1	50.8	.86	.40				-.22			41	.950	24
W2	218.0	.91		-.18	.07		-.21			41	.955	22
W3	43.8	.86	.40				-.22	.23		41	.951	23
W4	274.0	.89				-.38	-.17			41	.941	26
W5	4.08	.003				-.52			.97	41	.896	34
N5	8.68	.15				-.34			.80	269	.920	43

0.02-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg. SEE pct
P1	53.0	.88	.44				-.25			24	.960	24
P2	256.0	.93		-.18	.07		-.23			24	.966	22
S1	62.6	.77	.35				-.11			17	.964	18
S2	202.0	.82		-.15	.08		-.12			17	.958	20
W1	56.1	.84	.41				-.22			41	.946	24
W2	259.0	.90		-.19	.07		-.21			41	.952	23
W3	45.3	.84	.41				-.22	.40		41	.950	23
W4	322.0	.88				-.40	-.17			41	.938	26
W5	4.23	.003				-.54			.96	41	.894	34
N5	8.04	.15				-.32			.81	269	.910	44

0.01-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg. SEE pct
P1	58.2	.88	.46				-.24			24	.957	25
P2	303.0	.94		-.19	.08		-.22			24	.965	23
S1	68.4	.77	.34				-.11			17	.961	19
S2	213.0	.82		-.14	.08		-.12			17	.956	21
W1	60.4	.84	.42				-.23			41	.942	25
W2	302.0	.90		-.20	.07		-.21			41	.948	24
W3	43.8	.84	.42				-.23	.57		41	.948	24
W4	372.0	.88				-.41	-.17			41	.933	27
W5	4.32	.003				-.55			.95	41	.889	35
N5	7.70	.15				-.32			.82	269	.910	46

1/ Explanation of equation designation: P = Portland, S = Salem, W = Willamette, N = Nationwide; The number indicates the individual parameter set, e.g. P1 and S1 use the same set of basin characteristics.

2/ R-square pertains to the log-transformed regression, but SEE is an average of the transformed-back from log to normal.

Table 5.--Summary of regression equations for runoff volume for selected exceedance probabilities

[Form of general equation: $V_T = a\ RI^b BSL^c EIA^d INFL^e Q_T^f DA^g LS^h (13\text{-}BDF)^j$]

0.5-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg. SEE pct
PV1	.100	.76	.43	.28						24	.624	36
PVB1	.025	.55	.50	.26	-.56					24	.667	44
WV1	.110	.43	.29	.30						35	.374	38
WVB1	.081	.46	.28	.09	-.78					35	.666	42
WV2	.034			.32		.44	-.60	.29	.52	41	.417	42
WVB2	.285					.21	.01		.43	41	.362	55

0.2-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg. SEE pct
PV1	.140	.64	.43	.27						24	.628	32
PVB1	.060	.54	.48	.25	-.44					24	.669	39
WV1	.200	.40	.28	.28						35	.370	36
WVB1	.166	.44	.28	.10	-.64					35	.658	38
WV2	.069			.30		.40	-.60	.22	.46	41	.370	36
WVB2	.468					.20	-.01		.37	41	.333	49

0.1-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg. SEE pct
PV1	.200	.64	.42	.27						24	.641	30
PVB1	.092	.54	.47	.25	-.38					24	.674	37
WV1	.320	.41	.26	.26						35	.357	37
WVB1	.237	.43	.27	.11	-.57					35	.654	36
WV2	.113			.33		.34	-.42	.18	.46	41	.327	30
WVB2	.534					.21	-.02		.35	41	.324	47

0.04-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg. SEE pct
PV1	.300	.63	.40	.26						24	.649	29
PVB1	.160	.55	.45	.23	-.31					24	.680	35
WV1	.370	.37	.26	.29						35	.355	34
WVB1	.350	.42	.27	.12	-.49					35	.649	33
WV2	.134			.35		.28	-.38	.13	.44	41	.417	35
WVB2	.610					.23	-.04		.33	41	.312	44

0.02-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg. SEE pct
PV1	.400	.62	.38	.26						24	.651	28
PVB1	.210	.56	.44	.23	-.27					24	.684	33
WV1	.400	.35	.27	.30						35	.347	34
WVB1	.450	.42	.26	.12	-.46					35	.643	32
WV2	.157			.37		.25	-.34	.10	.43	41	.345	38
WVB2	.632					.24	-.06		.32	41	.302	42

0.01-Exceedance probability (T)

Equation No. 1/	Constant a	Exponent b	c	d	e	f	g	h	j	Statistics 2/ Sample	R-sqr.	Avg. SEE pct
PV1	.500	.62	.37	.26						24	.650	28
PVB1	.290	.57	.44	.22	-.23					24	.688	32
WV1	.500	.35	.26	.30						35	.328	34
WVB1	.560	.42	.26	.13	-.40					35	.635	31
WV2	.171			.38		.25	-.32	.06	.42	41	.280	36
WVB2	.668					.26	-.07		.31	41	.297	41

1/ Explanation of equation designation: P = Portland, W = Willamette; V = volume without base flow, VB = volume with base flow. The number indicates the

2/ R-square pertains to the log-transformed regression, but SEE is an average of the transformed-back from log to normal.

Peak Discharge

The independent results shown in table 4 from regressions of the separate data sets can be used to make comparisions. Equations P1 and P2, which rely on two different sets of independent variables, were regressed from Portland-Vancouver area data. The data have been previously published in the companion report (Laenen, 1980). Two different regression equations were formulated to provide a choice to the user to be the most convenient set of variables for them. Equations S1 and S2, which rely on the same two sets of variables as P1 and P2, are regressed from Salem data. It can be seen that the exponents of S1 and S2 are generally similar to P1 and P2 except for a difference in the storage characteristic exponent. The extensive use of agricultural drain tile in east Salem probably accounts for this deviation in the storage exponent, and also the slightly lower value of the drainage-area exponent. An interesting exclusion should be noted in table 3. Rainfall intensity, which should be the driving force of a peak-discharge event, did not prove to be significant in any of the regression analyses. One explanation for this would be that the relatively small range of intensities sampled might not be significant.

Equations W1 and W2 represent regressions defined by data from the combined Portland-Vancouver and Salem areas. These equations fit the data well; however, for peak flow with a 0.5-exceedance probability, the mean of the residuals for the Salem data are 5 percent higher than for the Portland data. For the 0.01-exceedance probability (fig. 12), the mean of the residuals for Salem data is 14 percent lower than that for the Portland data. Combined data were additionally regressed to include individual station skew as an independent parameter. As a result, there was no difference in the means of the residuals for the two data sets when skew was included, and equations W3 logically has a smaller error.

For example, the set of equations W3 (table 3) is recommended when skew is defined as in the Portland-Vancouver and Salem areas. Equations W3 use the entire data set for both the Portland-Vancouver and Salem areas and in all probability are less biased than equations P1 and S1; therefore, equations W3 should be used for areas in Portland and Salem with skews of 0.0 and -0.4 respectively. The equation for the 0.5-exceedance probability takes the form:

$$Q_{0.5} = 32.0\ DA^{.90} EIA^{.34} (ST + 0.1)^{-.20} (SKEW + 2.0)^{-.26}$$

Definitions regarding all basin characteristics are discussed in the glossary.

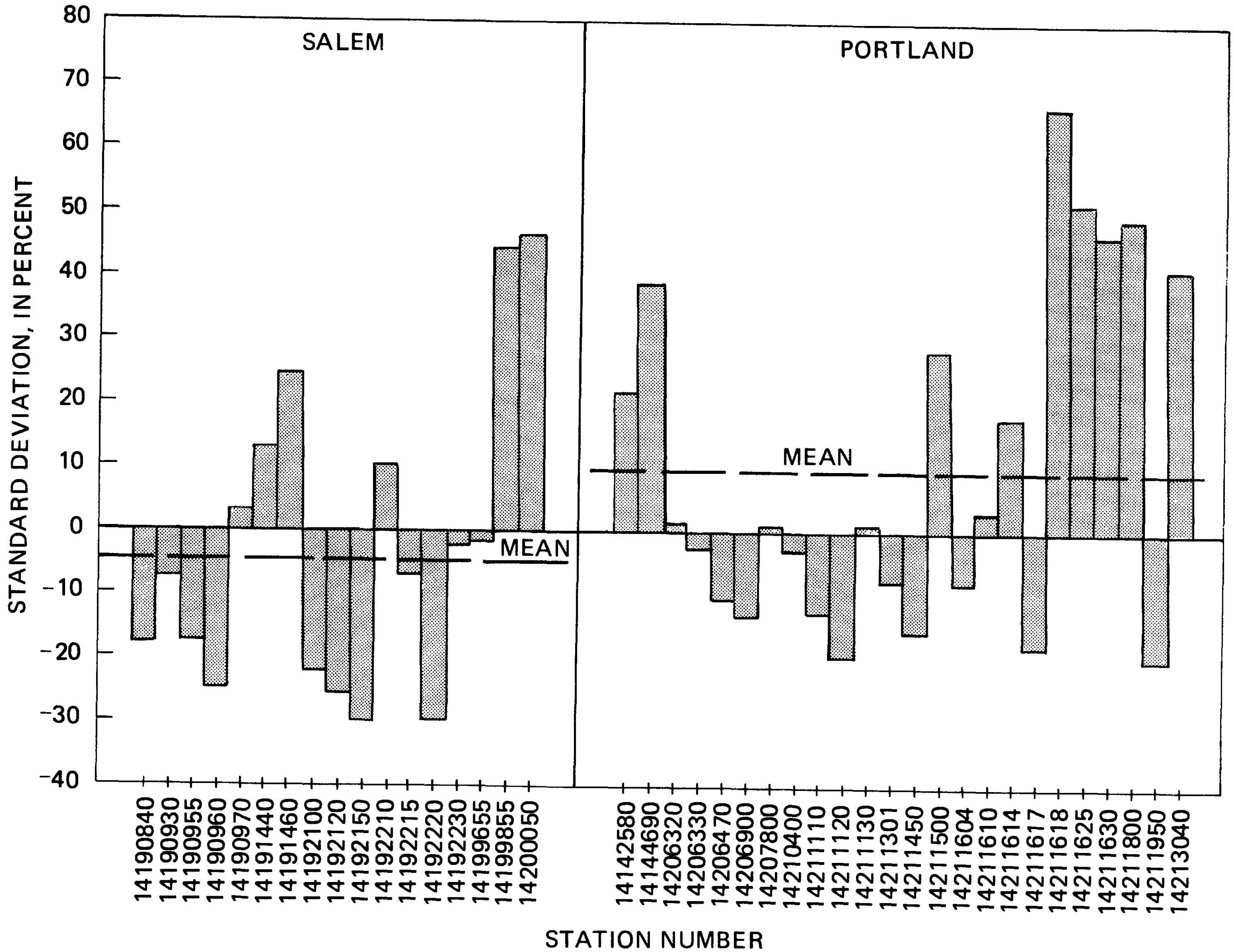


Figure 12. – Residual plot of peak discharge equation (W2) for the 0.01 exceedance probability

As another example, where skew cannot be defined in the Willamette Valley, equations W1 and W2 should be used. These equations for an exceedance probability of 0.5, are:

W1: $Q_{0.5} = 26.8\ DA^{.90} EIA^{.34} (ST + 0.1)^{-.20}$

and

W2: $Q_{0.5} = 86\ DA^{.94} LU12^{-.14} (GUTR + 0.1)^{.06} (ST + 0.1)^{-.19}$

Regressions were run and comparisons made with characteristics defined by the nationwide equations, where 24 of the 269 sites used in that analysis were from the Portland-Vancouver study. The nationwide equations N5 predict Portland-Salem peaks that are an average of 20 percent lower than peaks predicted by equations W1 and W2; however, the errors of the prediction are within the error of the equation. Equations W4 which use the characteristic of basin development (BDF) as described in the nationwide study, yield good results, but not quite as good as equations W1 and W2. A regression of only those characteristics used in the nationwide study yields equations W5 where the drainage area characteristic proved not to be significant. The drainage-area range sampled in Portland-Salem was considerably smaller than that sampled in the nationwide study which may account for this discrepancy. Equations W4 and W5 are left in table 4 only as a point of interest and comparison.

Nationwide equations (N5) are less accurate than W1 and W2 for Willamette Valley peak predictions, but they may be useful for other areas in Oregon, and especially areas where rainfall intensities are considerably different than those experienced in the valley. For example, used in conjunction with equations defined in a report by Harris, and others (1979), the national equations (N5) for the 0.5-exceedance probability have the form:

$$Q_{0.5} = 13.2\ DA^{.21} (13\text{-}BDF)^{-.43} (RQ_{0.5})^{.73}$$

The rural peak discharge ($RQ_{0.5}$) is defined by regional equations from Harris, and others (1979), in table 17 in the back of this report.

Results from the regional regression equations for western Oregon, as presented in the report by Harris and others (1979), generally compare favorably with equations developed in this report. Although it is difficult to compare methods that use substantially different data bases and different characteristics in analysis, the attempt was nevertheless made to demonstrate continuity.

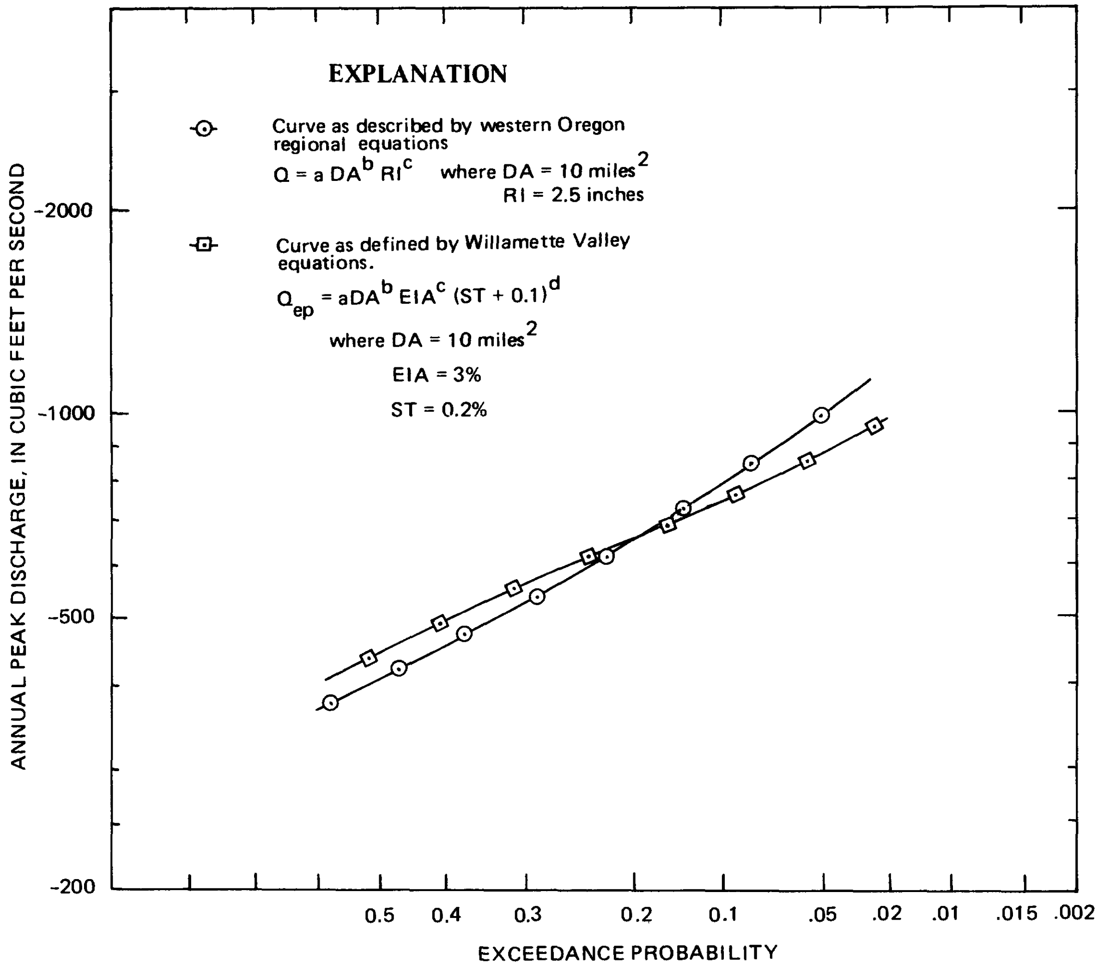


Figure 13. – Comparison of Willamette valley urban equations as presented in this report to Western Oregon regional equations from a report by Harris and others (1979).

Best judgement was used in the choice of independent characteristic values used in comparison. Results of this comparison are shown in figure 13. Peak discharges for the Willamette Valley were computed using the western Oregon equations (shown in table 17) for a drainage area (DA) of 10 mi^2 and a rainfall intensity (RI) of 2.5 in. for a 24-hour period. The curve defined by these discharges can be compared to the curve defined by peak discharges computed by the Willamette Valley equations (W1 in table 4) from this report. For the W1 equations, best judgement assumed the effective impervious area to be 3 percent and the storage coefficient to be 0.2 percent in order to define similar rural basin conditions as those used in the regression of the western Oregon equations. Rainfall intensity (RI) was not a significant characteristic in the regression of peak discharge for the W1 equations.

Runoff Volume

Two sets of regression equations are provided in this report to accommodate the separation of base flow for storms. Subtraction of volumes derived from these equations, however, is not considered a reliable means to determine base flow. Table 5 provides a summary of the regression equations for runoff volume.

Equations PVB1 and PV1, with and without base flow respectively, define runoff volume in the Portland-Vancouver area and were previously included in the companion report (Laenen, 1980). Using equation PV1 to predict both Salem and Portland-Vancouver volumes, yields the residual plot shown in figure 14. The figure shows an anomalous grouping of basins, all located in east Salem, which plot well outside the SEE of the predicting equation. Common to these basins is the extensive use of agricultural tile. The anomaly portrayed in figure 14 represents the return of water to the stream that would normally migrate to the water table approximately 20 to 30 ft below land surface. The amount of water returned to the stream is dependent on the density of the tile drainage system.

Regressing all Portland and Salem data, with the exception of those suspected of having agricultural tile, results in the equations WVB1 and WV1 (table 5). These equations, which best define runoff volume for untiled basins in the Willamette Valley, are also better than equations PV1 and PVB1 to determine volume in the Salem area. Equations WVB2 and WV2 include all Portland and Salem data and can also be used in the Willamette Valley; however, they yield a slightly higher SEE than WVB1 and WV1. Agriculturally tiled basins are not anomalous in equations WVB2 and WV2 because the predicted peak discharge (Q_n) and the lag time in equation WV2 as represented by the length-to-slope ratio (LS) defines the shape of the hydrograph, hence its volume.

Because the range of runoff volumes sampled was narrow, use of regressed equations to define runoff volume is of little improvement over use of the mean at the desired probability. Table 6 lists the means for runoff volumes at selected exceedance probabilities and their associated standard deviations.

Table 6.--Mean runoff volume for selected exceedance probabilities

Exceedance probability	Mean volume w/o base flow (inches)	Standard deviation about the mean (percent)	Mean volume w/ base flow (inches)	Standard deviation about the mean (percent)
0.5	.84	40	1.8	47
0.2	1.4	36	2.7	43
0.1	1.9	36	3.3	41
0.04	2.4	32	4.0	39
0.02	2.8	32	4.6	37
0.01	3.2	32	5.2	36

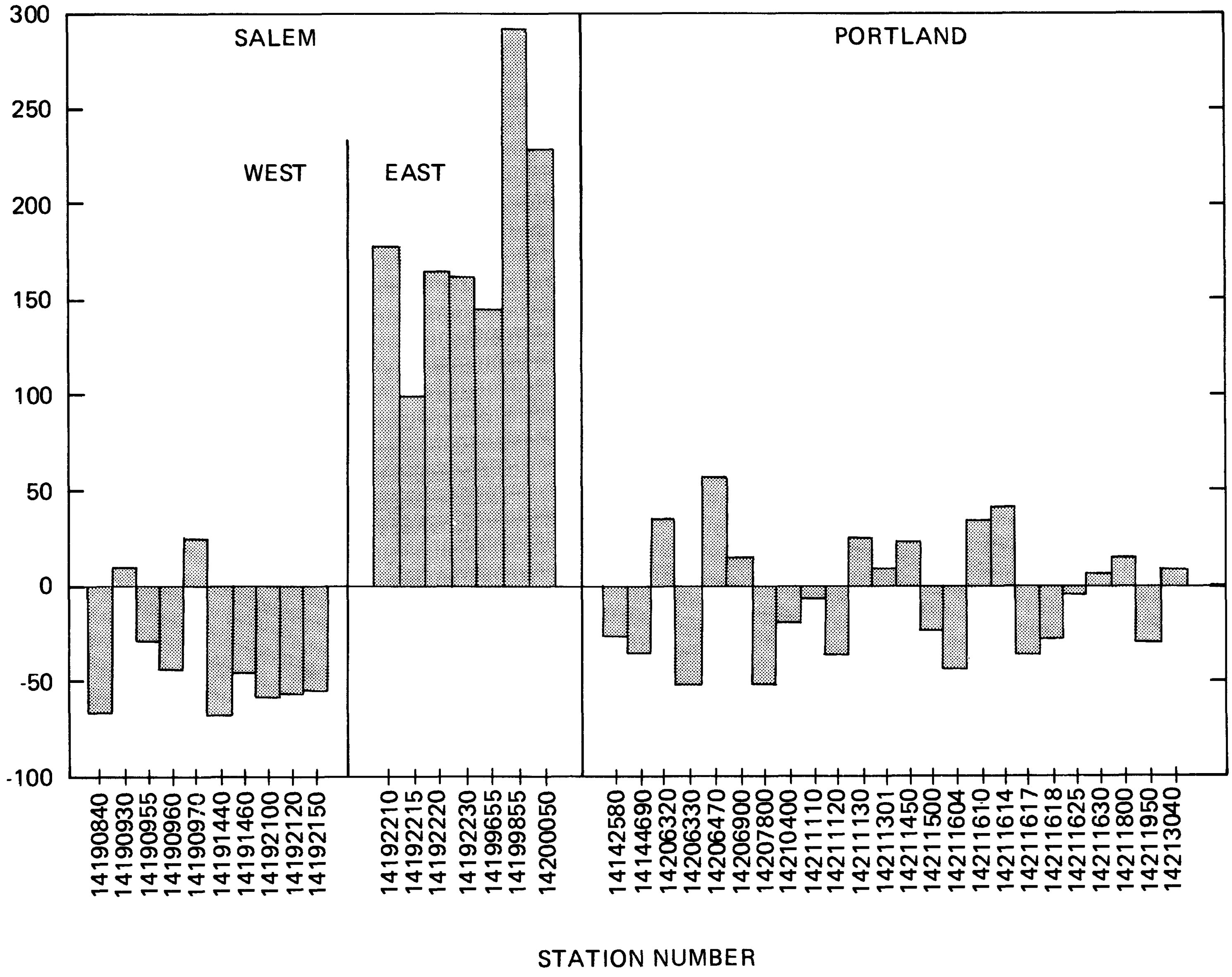


Figure 14. – Residual plot or runoff-volume equation (PV1) for the 0.5 exceedance probability

Sensitivity

Regression equations can be used to determine the sensitivity of peak discharge or runoff volume to physical basin characteristics in a study area. Specific characteristics are varied while all other characteristics are held constant. To examine the effect of each characteristic, realistic maximum and minimum characteristic values are substituted in the equations and the results compared. Table 7 shows results of sensitivity analysis for the equations in tables 4 and 5. This table can be roughly interpreted (by evaluating EIA, BDF, and the LU12 and GUTR characteristics) to show that the change, caused by urbanization, from a rural basin (minimum characteristic value) to a fully developed basin (maximum characteristic value) will increase peak discharge more than threefold, whereas, storm runoff will increase twofold.

The importance of basin storage can also be interpreted from equations shown in table 4. With one percent of a basin used in storage, peak flows will be reduced by approximately 40 percent and with 10 percent of the basin used in storage, peak flows may be reduced by approximately 70 percent. Remember, these are only estimates and the SEE associated with the equations used could result because of the uncertainty associated with the storage characteristic. Caution should be used in any sensitivity interpretation because of the generalities and limitations imposed by the predicting equations.

Limitations

Equations developed in this report are valid in the urban areas of the Willamette Valley within the range of parameter values used in the analysis. Figure 15 shows the range and distribution for selected characteristics used in analyses. Extrapolation beyond characteristic limits could produce erroneous results.

Uneven distributions, distributions with gaps in data, and distributions with narrow ranges cause weaknesses in analysis that could bias results. For example: For those basins analyzed, 39 had drainage areas of 10 mi^2 or less and 2 basins had areas greater; therefore, estimates for basins with drainages greater than 10 mi^2 could have an error larger than basins smaller than 10 mi^2. As another example: Rainfall intensity, which was expected to be a statistically significant characteristic in analysis, proved to be insignificant because of the small range sampled.

SIMPLIFIED MODEL

When modeling individual storms, rainfall intensity associated with basin lag time is the major driving influence on peak discharge. The Portland-Vancouver study by Laenen, (1980) showed that an excellent relation existed between lag-time intensities and peak discharges for both Johnson Creek and Fanno Creek, individually. Continuing along similar lines for this study, it was found that the relations between lag-time intensity and peak discharge were generally good for all basins in the Portland-Vancouver and Salem areas. It was also found that these relations could be extended to make frequency predictions.

Table 7.-- Sensitivity of peak discharge and runoff volume caused by varying selected basin characteristics in regression equations (from tables 4 and 5) through expected ranges

Peak discharge

Characteristic name	Acronym	Range of characteristics expected in area: Max	Min	Increase in discharge, in percent for specific characteristic range for selected exceedance probabilities: 0.5	0.2	0.1	.04	.02	.01	Average percent increase of discharge
Effective impervious area	EIA	50 percent	2 percent	280	320	340	390	410	440	360
Basin development factor	BDF	12	0	116	139	152	165	179	186	156
Land uses LU1 and LU2 and	1/ LU12	1 percent	99 percent	240	280	310	340	360	400	320
street-gutter density	GUTR	60 mi/mi²	0 mi/mi²							
Storage	ST	10 percent	.1 percent	-60	-61	-62	-63	-64	-65	-62
Drainage area	DA	25 mi²	0.2 mi²	1100	1100	1100	1100	1100	1100	1100

Runoff volume

Characteristic name	Acronym	Range of characteristics expected in area: Max	Min	Increase in volume, in percent for specific parameter range for selected exceedance probabilities: 0.5	0.2	0.1	.04	.02	.01	Average percent increase of volume
Effective impervious area	EIA	50 percent	2 percent	250	240	240	230	230	230	240
Rainfall intensity	RI	3.0 in./6hr	1.8 in./6hr	600	470	470	470	470	450	490
Basin slope	BSL	2000 ft/mi	80 ft/mi	300	350	350	340	330	320	330

1/ LU12 is an inverse indication of urbanization.

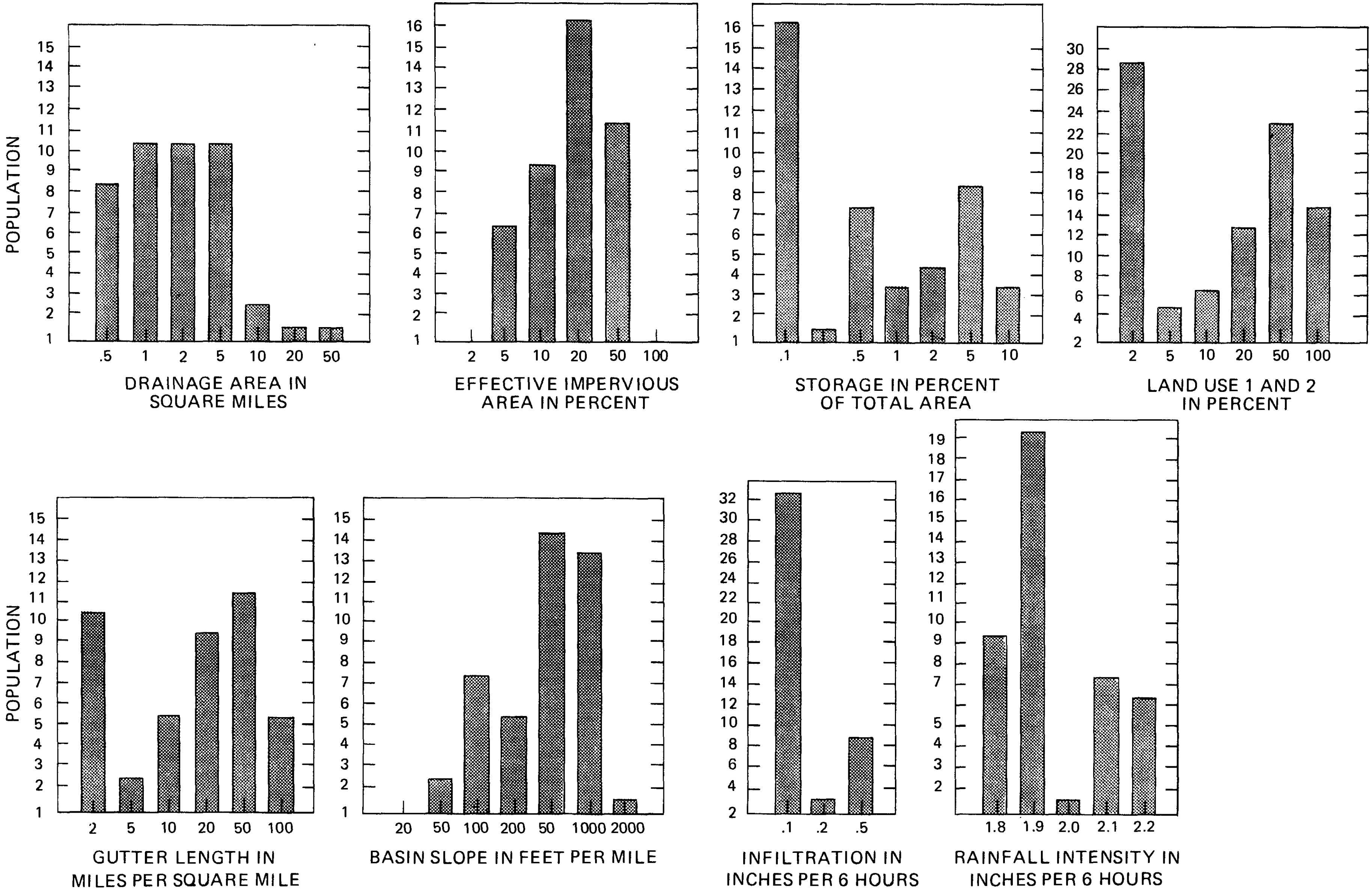


Figure 15. -- Distributions of selected parameters used in regression equations.

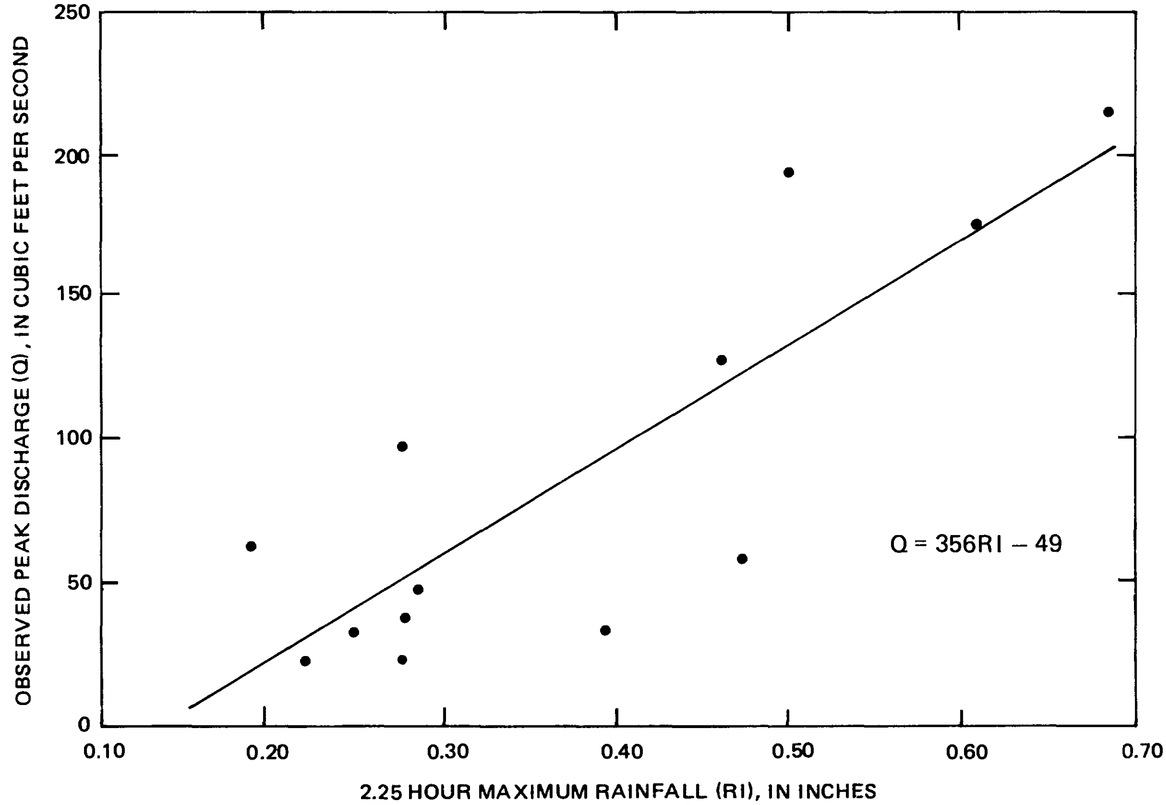


Figure 16. – Relation of rainfall intensity for average basin lag-time (2.25 hours) to peak discharge for Claggett Creek at Salem (1979-80).

This method of peak-flow determination which can be considered a simple model, was tested against peak-flow data obtained by digital modeling. The same peak discharge less base flow used in digital modeling was used to define equations shown in table 8. For a given storm, the maximum rainfall intensity that occurred over a time interval equal to the average basin lag time was related to the peak discharge for that storm. Figure 16 shows this relation for Claggett Creek in Salem. The average SEE for all basins modeled by the simple technique is approximately 40 percent as compared to the average SEE of 27 percent obtained in digital modeling.

The relations in table 8 were then used to estimate peak discharge for selected exceedance probabilities (table 9). Using basin lag time as the time duration, rainfall intensities were obtained from curves shown in figure 6 for the desired exceedance probability. For example, Claggett Creek with a lag time of 2.25 hours will have a rainfall intensity of 1.4 in./hr for a .01-exceedance probability. (Multiply by the same rainfall-intensity adjustment factor of 1.00 used in digital modeling.) Using this intensity in the formula given in table 8 yields a discharge of 513 ft^3/s. Adding the same base flow used in digital model synthesis yields a 0.01-exceedance probability peak that is comparable to digital modeling techniques.

Table 8.--Summary of rainfall-intensity basin equations defining peak discharge

Station number	Lag time	Intercept	slope	R-sqr.	SEE	Base flow	RI adj.
Portland equations							
14142580	5.00	-208	444	.889	37	30	1.10
14144690	0.35	-8.61	431	.670	33	0	.95
14206320	14.0	-47.7	203	.876	27	15	.98
14206330	0.43	-1.53	54.7	.860	24	1.5	.95
14206470	3.00	-13.9	73.2	.893	36	7.0	.95
14206900	1.87	-64.5	458	.769	36	30	1.00
14207800	4.20	-1.34	15.6	.671	44	2.5	1.05
14210400	4.75	-30.6	116	.924	23	60	1.10
14211110	4.55	-22.4	86.2	.619	59	15	1.05
14211120	2.12	-7.19	95.1	.729	36	5	1.02
14211130	10.7	-8.51	60.0	.798	32	25	.90
14211301	0.93	-2.99	77.8	.510	51	5	1.02
14211450	1.88	-3.59	39.1	.888	48	3	1.10
14211500	25.0	-626	745	.939	23	300	1.10
14211800	4.70	-65.7	222	.815	59	25	1.06
14211950	0.28	-6.26	55.5	.781	25	0	.90
14213040	3.83	-39.8	173	.586	45	12	.90
Salem equations							
14190930	7.00	-36.1	114	.934	31	60	1.02
14190970	5.17	-130	561	.831	30	150	1.02
14191440	9.67	-57.7	97.4	.819	43	100	1.05
14191460	2.33	-17.4	125	.621	50	30	1.05
14192100	3.50	-26.2	146	.665	63	40	1.05
14192150	2.50	-4.38	29.1	.586	64	8	1.05
14192210	2.25	-49.0	356	.700	47	20	1.00
14192220	0.85	-4.25	178	.558	41	3.5	1.00
14200050	3.08	-8.78	57.9	.846	48	1.5	1.00

Table 9.--Summary of peak discharges for selected exceedance probabilities defined by rainfall-intensity equations

Station number	Exceedance probability 0.5	0.2	0.1	.04	.02	.01	Percent difference for .01 probability[1/]
Portland basins							
14142580	310	432	550	726	896	1090	+14.4
14144690	126	167	204	226	327	397	-22.2
14206320	345	409	516	644	763	902	-6.6
14206330	19	25	31	40	48	59	+51.3
14206470	45	58	70	90	110	132	-13.7
14206900	222	291	359	469	579	689	+17.5
14207800	16	20	23	29	34	41	-8.9
14210400	154	185	214	260	303	353	-4.3
14211110	78	99	119	151	181	216	+35.8
14211120	57	69	88	113	136	163	+35.8
14211130	107	129	150	181	211	244	+3.3
14211301	34	43	52	67	81	98	+10.1
14211450	24	30	36	47	57	68	+7.9
14211500	1660	2150	2580	3290	3690	4100	+24.2
14211800	190	230	275	335	390	450	+46.1
14211950	28	32	38	48	57	67	+24.1
14213040	108	145	176	230	279	337	-3.2
Salem basins							
14190930	176	204	227	272	305	342	+39.6
14190970	678	798	901	1070	1200	1370	+21.2
14191440	196	223	247	283	313	349	+6.4
14191460	103	123	141	170	196	227	-2.6
14192100	152	179	204	242	274	313	+19.4
14192150	26	31	35	42	48	55	-3.5
14192210	209	263	309	384	452	533	+12.2
14192220	70	86	100	125	148	177	-11.9
14200050	41	51	60	74	86	100	-3.8

1/ Differences are between the .01-exceedance probability peak defined by rainfall-intensity equations and digital model synthesized log-Pearson Type-III frequency analysis (see table 2).

Table 9 lists peak flows for various exceedance probabilities that were estimated by the above method. The differences in table 9 are between the 0.01-exceedance probability discharge by rainfall-intensity modeling and the same discharge computed by frequency analysis of the digital model synthesized record. The simple modeling technique yields peak discharges that are on the average 11 percent higher than those obtained by digital modeling.

Another rainfall-intensity model was constructed using peak discharges with base flows and a split sample (half the data set was used in calibration and half was used in comparison). Slightly less accurate results were obtained with the equations having an average SEE of 44 percent. Rainfall intensities were obtained from U.S. National Oceanic and Atmospheric Administration maps (1973) instead of curves from figure 6.

UNIQUENESS OF BASINS IN THE SALEM AREA

Natural and manmade conditions in a basin make it unique in its response to any rainfall event. Each basin studied had to be scrutinized to define its hydraulic conditions to ensure that the analysis used would be valid. In planning this study, some basins were excluded because of unusual storage and urban development considerations. Even with this screening, many basin characteristics were less than ideal. This section is intended to help explain some basin conditions in Salem. Basin characteristics and model parameters are listed in tables 13 and 14, respectively, at the back of this report.

In addition to modeling all basins with the parametric USGS digital model, the USGS distributed routing model developed by Dawdy, Schaake, and Alley (1978) and Alley and Smith (1981) was used to investigate in detail runoff from several basins in Salem. This was done to provide the city of Salem with an additional planning tool and to help the USGS better understand the hydraulics of the individual basin. The distributed routing model was calibrated for 3 basins in the Salem area: Battle Creek (14191440), Waln Creek (14191460) and Glenn Creek (14192100). These models were used to define basin change, especially in impervious area and storage. The calibrated models were given to the city of Salem as part of a technical transfer of information.

Pringle Creek

Almost all of southeast Salem is drained by Pringle Creek and most of the drainage was measured by the gage located at Bush Park (14190970). During peak events, considerable water is stored in fields in the vicinity of Salem Airport. Two subbasins were also gaged during this study; Clark Creek (14190960) and the West Fork of Pringle Creek (14190955). Lag times for these basins indicate that some minor channel storage also occurs in the upper parts of the basin and is probably from man-made constrictions.

Battle Creek

Battle Creek (14191440) was gaged at a location in the basin where the drainage was primarily from rural land. The basin had considerable storage which should be expected in a primarily rural basin. The elimination of this storage would increase peak flows an average of 150 percent by model estimate. Waln Creek (14191460) is a developing basin in the Battle Creek drainage. During the period of study, the impervious area of the Waln Creek basin nearly doubled. Waln Creek is also unique in that it has a central band of undeveloped land influenced by a natural stream channel with small capacity. This central section retards water movement, thus attenuating peak flows. If the channel were to be improved, the 0.1-exceedance probability peak at the gage location would increase approximately 100 percent by model estimate.

Glenn Creek

Glenn Creek (14192100 and 14192120) drains a suburban basin with approximately 8 percent of its area urbanized. The impervious area within the basin increased 25 percent during the period of study. The basin has only a moderate amount of storage as estimated by lag time. To show how critical this moderate storage can be; however, in model simulation, elimination of storage by improving channels and draining topographic depressions would increase peak flows approximately 70 percent.

Claggett Creek

Flow in the upper part of Claggett Creek basin was gaged at locations on the main stem (14192210) and a tributary, Hawthorne Ditch (14192215, 14192220, 14192225, and 14192230). These drainages were the most urbanized basins studied in the Salem area. The use of tile to drain agricultural areas has been extensive in this and the adjacent areas. Tile systems in these basins exist in both active and deteriorated states. Both peak flows and runoff volumes are affected by the presence of tile systems. It is estimated that for basins greater than 3 mi^2, peak flows are higher because of tile systems. Figure 14 shows Hawthorne Ditch (14192220) runoff volume to be more than 100 percent greater than the volume estimated by the regression equation, and Claggett Creek (14192210) to be more than 180 percent greater.

Tile Study

An inquiry study done in 1982 by the city of Salem corroborates the deduction that tile systems in east Salem probably are a primary influence affecting the volume of storm runoff and peak flow for this area. Table 10 from the city's report (unpublished report by Timothy D. Goon) shows substantial tile fields in the area. This table, however, is incomplete and probably underestimates the tiled area because of recent deletions from Agricultural Conservation and Stabilization (ACS) and Soil Conservation and Stabilization (SCS) files. The only tiling contractor to respond to the Salem inquiry estimated that 50 percent of the indicated east Salem basins probably had been tiled by his firm (25 percent prior to 1928).

Table 10.--Area Tiled in East Salem

[Based on ACS and SCS files]

Station Number	Basin name	Total area (acres)	Tiled area (acres)
14199210	Clagget Creek	1971	20
14192215	Hawthorne Ditch at "D" St.	307	2
14192220	Hawthorne Ditch at Sunnyview Ave.	563	2
14192230	Hawthorne Ditch at Hyacynth St.	1126	3
14199655	L. Pudding R. Trib. at Cordon Rd.	505	13
14199855	L. Pudding R. Trib. at Lardon Rd.	172	137
14200050	L. Pudding R. Trib. at Kale Rd.	480	5

Probably a large part of east Salem had been tiled at one time. Changes in land use from mainly agricultural to rural and then to residential have caused existing tile within the study area to be destroyed and neglected; hence, the variability of deviation in the residual plots shown in figure 14. There is probably no good method to define the effectiveness of drain tile in east Salem.

CONCLUSIONS

Associated with urban development is elimination of much natural vegetation, compaction of natural soils, covering of area with impervious materials, and alteration of the storm-drainage systems. Man changes the surrounding environment to fit his purpose and to drain water from his property during storm events. His designs for accelerating storm-water runoff are varied, complex, and sometimes inadequate. Designs may include provision for storm-water storage, sometimes unintentionally.

In general, however, effects of urbanization on flood peaks and volumes for Salem and the Willamette Valley can be assessed by the use of a series of regression equations and other methods developed in this report. Basic questions asked in the introduction can now be answered.

1. What are the flood peak and volume relations in Salem?

   Equations S1 and S2 in table 3 estimate peak discharge with a SEE of 19 percent. Equations WV1 and WVB1 in table 4 estimate runoff volume with a SEE of 35 percent for basins where agricultural tiling practices are not extensively in use. In areas where tiles are extensively used, there are no good relations to determine runoff volume. Table 5, which lists mean volumes, can also be used to estimate runoff volume for the area.

2. Are the urban areas of Portland-Vancouver and Salem statistically similar?

Yes, the areas are similar with some minor differences. Statistical comparisons show rainfall-intensity for Portland, Salem, and even Roseburg to be essentially identical. However, peak-discharge-frequency information suggests that a zero skew is appropriate for the Portland area, and a -0.4 skew is appropriate for the Salem area. The difference in skew may be related to the differences in urban drain tile and dry-well systems in the two areas.

Effective impervious area can generally be predicted in all of the Salem area and some of the Portland area as a percent of the total mapped impervious area. Some of the areas in Portland and Vancouver located on the porous river terraces have used drainage practices whereby storm runoff is shunted into dry wells. For these areas, only detailed studies or modeling techniques may define the effective impervious area.

Farm lands in the Willamette Valley frequently contain drain tiles to dewater soil for early spring tillage. In the area of Salem, and more generally the area south of the Clackamas River, tiled fields are more predominant than the rest of the Willamette Valley. Runoff volume, and to some extent peak discharge, are affected by drain tiles. The effect of using tile in a basin cannot be predicted without adequate rainfall-runoff data for the basin.

3. Can relations established in Portland-Vancouver and Salem be extended to the urban Willamette Valley?

The logical area of application for equations derived for Portland-Vancouver and Salem areas is throughout the entire Willamette Valley. Rainfall statistics are similar for the entire valley and drainage practices, although varied, can be defined. Flood-peak equations W1 and W2 from table 4 can account for discharge within a SEE of 23 percent, and runoff volume equations from table 5 can account for volume within a SEE of 35 percent.

The simplified model, which uses the rainfall intensity associated with individual basin lag time, provides a reasonable means of obtaining a peak-frequency analysis without synthesis. This technique could be useful for determining flood-peak-frequency curves for streams throughout the Willamette Valley.

4. How do results from this study compare with other flood studies in the area and other urban studies outside the area?

   Comparison of flood frequencies from this study to the regional flood frequencies from the study by Harris, and others (1979), are good, although the two studies used different data bases and the developed equations used different basin characteristics.

   Comparison of flood frequencies from this study to a nationwide urban study show that the nationwide equations predict flood peaks 20 percent low, on the average; however, results are still within the 40 percent SEE of the nationwide predicting accuracy. These equations, listed as N5 in table 4, and other equations (listed as W5) can be used to predict urban peak flow in other areas of Oregon where precipitation intensities are greater than those experienced in Portland and Salem areas. Equations N5 and W5, which use discharge defined by western Oregon regional regression equations (Harris and others, 1979) as an independent characteristic, indirectly use rainfall intensity.

5. To what degree does urbanization influence runoff in the area?

   Analyses show that urbanization of an undeveloped basin can increase peak flows as much as three times and almost double runoff volume. However, manmade improvements do not always increase storm flows. Paradoxically, man's ability to divert and store water can nullify or reduce the effects of urbanization. Analyses of parameters in the regression equations show that storage will reduce peak flows. With 1 percent of a basin used in storage, peak discharge may be reduced approximately by half.

GLOSSARY OF SELECTED TERMS

Average annual precipitation (AAP).--The average annual precipitation, in inches, for the drainage area for the period 1941-70, estimated from National Oceanic and Atmospheric Administration isohyetal maps (scale 1:2,000,000).

Base flow.--During a storm is that component of runoff not attributed to overland flow.

Basin development factor (BDF).--An index of urbanization from a nationwide study (Sauer, Thomas, Stricker, 1981) which provides a measure of the efficiency of the drainage system. The basin is subdivided into three equal areas of upper, middle and lower sections. Then, within each section, four aspects of the drainage system are evaluated and assigned a code as follows:

1. Channel improvements.--If channel improvements such as straightening, enlarging, deepening, and clearing are prevalent for the main drainage channels and principal tributaries (those that drain directly into the main channel), then a code of one (1) is assigned. Any one, or all, of these improvements would qualify for a code of one (1). To be considered prevalent, at least 50 percent of the main drainage channnels and principal tributaries must be improved to some degree over natural conditions. If channel improvements are not prevalent, then a code of zero (0) is assigned.

2. Channel linings.--If more than 50 percent of the main drainage channels and principal tributaries have been lined with an impervious material, such as concrete, then a code of one (1) is assigned to this aspect. If less than 50 percent of these channels are lined, then a zero (0) is assigned. The presence of channel linings would obviously indicate the presence of channel improvements as well. Therefore, this is an added factor and indicates a more highly developed drainage system.

3. Storm drains, or storm sewers.--Storm drains are defined as enclosed drainage structures (usually pipes), frequently used on the secondary tributaries where the drainage is received directly from streets or parking lots. Quite often these drains empty into the main tributaries and channels which are either open channels, or in some basins are also enclosed as box or pipe culverts. When more than 50 percent of the secondary tributaries within a subarea (third of basin) consist of storm drains, then a code of one (1) is assigned to this aspect, and conversely, if less than 50 percent of the secondary tributaries consist of storm drains, then a code of zero (0) is assigned. It should be noted that if 50 percent or more of the main drainage channels and principal tributaries are enclosed, then the aspects of channel improvements and channel linings would also be assigned a code of one (1).

4. Curb and gutter streets.--If more than 50 percent of a subarea (third) is urbanized (covered by residential, commercial, and(or) industrial development), and if more than 50 percent of the streets and highways in the subarea are constructed with curbs and gutters, then a code of one (1) should be assigned to this aspect. Otherwise, assign a code of zero (0). Frequently, drainage from curb and gutter streets will empty into storm drains.

Items 1 through 4 are combined to obtain the total basin development factor (BDF).

Basin shape (BSP).--The ratio of the length to average basin width calculated by the formula:

$$BSP = L_c^2/DA$$

where,

L_c = straight-line distance from basin outlet to the point on the basin divide used to measure the main channel, and
DA = drainage area.

Basin slope (BSL).--The average slope for the basin, in feet per mile, computed from USGS topographic maps, using the formula described by Wisler and Brater (1959):

$$BSL = CL/DA$$

where,

C = contour interval, in feet,
L = total length of contours, in miles, and
DA = drainge area, in square miles.

The relation of basin slope to main channel slope differs considerably between basins in the project areas, probably reflecting basin-terrain characteristics.

Channel length (CL).--The channel length, in miles, for the basin as determined from USGS maps. It is defined as the distance from the gaged site upstream to the watershed divide along the most well-defined and longest channel.

Channel slope (CSL).--The channel slope, in feet per mile, for the basin as determined from topographic maps. It is defined as the difference in elevation, in feet, at points 10 percent and 85 percent of the distance upstream from the gaged site along the main channel (see channel length) divided by the distance, in miles, along the channel between the two points.

Confidence limit.--Is a means of indicating the reliability of an estimate. A 95-percent confidence limit means we are 95 percent sure the estimate lies within the prescribed confidence limits.

Detention storage.--Storage of storm runoff from roofs, parking lots, and other impervious surfaces especially designed to reduce peak flows. Detention-storage areas normally have constricted outlets so that water will flood designated areas and flow out slowly, thereby reducing the flood peak.

Digital Model Parameters.--The following selected acronyms pertain to parameters in the USGS rural and urban models and distributed flow routing model:

- IA -- impervious area in percent of total area.
- EVC -- pan coefficient that converts pan evaporation to potential evapotranspiration.
- RR -- coefficient that proportions the amount of daily rainfall that infiltrates into the soil.
- BMSM -- in inches, the maximum effective soil-moisture storage volume at field capacity.
- PSP -- in inches, the capillary potential, or soil suction, at wetted front for field-capacity conditions.
- RGF -- ratio that varies PSP over the soil moisture range from wilting point to field capacity.
- KSAT -- in inches per hour, the effective saturated value of hydraulic conductivity to determine infiltration rates.
- TC -- in minutes, the time characteristic for translation of rainfall excess by distance-area histograms.
- KSW -- in hours, the time characteristic for linear reservoir routing.

Effective impervious area (EIA).--The area, as a percentage of total drainage area, having a direct hydraulic link to the stream and impervious to the infiltration of rain.

Exceedance probability.--Probability that a random event will exceed a specific magnitude in a given time period. For example, a flood with a 0.01-exceedance probability is a flood that has one chance in a hundred of being exceeded in any one year. This is a 100-year flood under the "recurrence-interval" terminology. In this report, the term "exceedance probability" is used in preference to the term "recurrence interval."

Length of street gutters (GUTR).--In miles per square mile, defined by drainage maps showing curbs and catch basins, and by field delineation. Add 0.1 mile to this value to make it non-zero in regression equations. Multiply by 2 if both sides of the street have gutters.

Hydrologic soil group.--Soil group type A through D, as mapped by the U.S. Soil Conservation Service (SCS) in their county soil survey (1975) and unpublished soil maps. The range of infiltration rates, in inches per hour, is bracketed following each SCS definition:

A. (Low runoff potential). Soils having a high infiltration rate, when thoroughly wetted, and consisting chiefly of deep, well-drained to excessively-drained sand or gravel [0.45 to 0.30 in./hr].

B. Soils having a moderate infiltration rate when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well-drained soils with moderately fine to moderately coarse texture [0.30 to 0.15 in./hr].

C. Soils having a slow infiltration rate when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture [0.15 to 0.05 in./hr].

D. (High runoff potential). Soils having a very slow infiltration rate when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high-water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material [greater than 0.05 in./hr].

Lag time.--The time from beginning (or center of mass) of rainfall to peak (or center of mass) of runoff.

Land-use types.--Land uses in types 1 through 6, as mapped by Mid-Willamette Council of Governments (COG) and the USGS, and as defined as follows:

LU1 Parks, forests, and vacant lots
LU2 Agriculture
LU3 Light-to-normal residential
LU4 Dense residential
LU5 Apartments, commercial areas with some lawns, and industrial area with gravel parking lots
LU6 Downtown business, shopping centers, and industrial areas with paved parking lots

Note: LU12 is the sum of land-use types LU1 and LU2.

Mapped impervious area (MIA).--Drainage area, in percent of total drainage area, impervious to the infiltration of rain, including such areas as paved roads, paved parking lots, roofs, driveways, and sidewalks. Impervious area was determined from aerial photography by Mid-Willamette COG personnel. Mapping was on 1 in. = 600 ft black-and-white 1979 aerial photography. USGS mapping was at a scale of 1:24,000.

Overland flow.--The flow of rainwater over the land surface toward stream channels.

Rainfall intensity (RI).--Rainfall amount for a specified time duration. As used in this report, it is the 0.2-exceedance probability, 6-hour precipitation, in inches, for the drainage area, determined from isopluvial maps (scale 1:2,000,000) published by the National Oceanic and Atmospheric Administration (1973). Subtract 1.7 from this value in the regression equations.

Rural discharge (RQ_n).--The rural peak discharge as defined by regional regression equations developed in a report by Harris, and others (1979).

R-square.--The coefffficient of determination. It is a measure of variation in the dependent variable explained by the regression equation. R-square x 100 yields the percent of variation explained by the regression equation. If R-square = 1, then 100 percent of the variation is explained; if R-square = 0.75, then 75 percent of the variation is explained. It is a measure of the population scatter about a curve.

Sewered area (SA).--Area, in percent of total drainage area, serviced by storm sewers as taken from drainage maps supplied by various city and county agencies. To define the boundary of the sewered area, the distance of one city block was added to the outermost catch basins on the assumption that the outer catch basins, on the average, would drain approximately a one-block area. Add 0.1 percent to this value to make it non-zero in regression equations.

Skew.--A numerical measure or index of the lack of symmetry in a frequency distribution. Also called the coefficient of skewness. In this report it can be visualized as the upward (negative skew) or downward (positive) curvature of the log Pearson Type III frequency distribution curve.

Soil infiltration rate (INFL).--Average soil infiltration, in inches per hour, as determined by averaging ranges given for each soil group, types A-D, then weighting them by percent of total basin covered.

Standard error of estimate (SEE).--A statistical measure of accuracy based on population scatter about a curve. It is the square root of the variance and is graphically defined as having approximately two-thirds of the data points falling within its limits. This report normally presents the SEE as a value compared to the predicted value from the curve and is expressed in percent. The SEE reported with log-transformed regression equations is the average of the positive and negative antilog of the SEE in log units.

Storage (ST).--The surface area, in percent of the total drainage basin, where water can be stored during a storm event. This consists of lakes, ponds, marshes, flood plains, depressions, and detention-storage facilities. Add 0.1 percent to this value to make it non-zero in regression equations.

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SUPPLEMENTAL DATA TABLES

Table 11.--Daily precipitation for rain gages in the Salem, Oregon area

STATION NUMBER 14190820 ILLAHE HILL, SALEM, OR. (RG)
LATITUDE 445419 LONGITUDE 1230612

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.00	.17	.00	.00	.01	.00	.38
2					.00	.05	.02	.00	.00	.00	.00	1.62
3					.05	.46	.00	.00	.00	.00	.00	.05
4					.05	.21	.00	.86	.00	.00	.00	.00
5					.25	.18	.00	.84	.00	.00	.00	.05
6					.95	.09	.10	.59	.00	.00	.00	.01
7					.55	.00	.00	.10	.00	.00	.00	.16
8					.25	.00	.06	.07	.00	.14	.00	.09
9					.01	.00	.17	.01	.00	.02	.00	.01
10					1.12	.00	.19	.00	.00	.00	.00	.00
11					.28	.00	.07	.00	.00	.00	.00	.00
12					.33	.00	.54	.00	.00	.00	.00	.00
13					.05	.00	.17	.00	.00	.00	.11	.00
14					.00	.03	.02	.00	.13	.00	.14	.00
15					.11	.41	.03	.00	.00	.00	.29	.00
16					1.00	.15	.30	.00	1.01	.00	.06	.00
17					.25	.06	.29	.00	.00	.00	.00	.00
18					.09	.03	.19	.00	.00	.00	.09	.00
19					.23	.00	.01	.00	.00	.00	.24	.00
20					.23	.00	.01	.00	.00	.00	.00	.00
21					.00	.00	.01	.00	.00	.00	.93	.00
22					.29	.00	.01	.00	.00	.00	.02	.00
23					.27	.00	.46	.05	.00	.00	.00	.00
24					.36	.00	.00	.00	.00	.00	.00	.00
25					.13	.00	.00	.00	.00	.00	.00	.00
26					.02	.24	.00	.00	.00	.00	.00	.00
27					.65	.29	.31	.06	.00	.00	.00	.00
28					.18	.04	.01	.02	.00	.00	.00	.00
29					---	.04	.00	.00	.00	.00	.00	.00
30					---	.09	.00	.00	.14	.00	.00	.00
31					---	.03	---	.00	---	.00	.00	---
TOTAL					7.70	2.40	3.14	2.60	1.28	0.17	1.88	2.37

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.34	.08	1.17	.00	.00	.07	.08	.16	.00	.07
2	.00	.10	1.37	.17	.73	.01	.01	.08	.42	.00	.00	.23
3	.00	.14	.12	.06	.01	.01	.06	.16	.05	.20	.00	.00
4	.00	.31	.82	.65	.00	.08	.16	.17	.00	.04	.00	.00
5	.00	.06	.01	.30	.17	.39	.42	.14	.00	.00	.00	.00
6	.00	.00	.00	.03	.30	.01	.90	.02	.01	.00	.00	.00
7	.00	.00	.00	.08	.00	.07	.04	.08	.25	.00	.00	.00
8	.00	.00	.01	.36	.00	.01	.14	.24	.03	.00	.00	.00
9	.00	.00	.20	1.21	.00	.00	.70	.41	.02	.00	.00	.00
10	.00	.00	.03	.25	.00	.29	.06	.00	.00	.00	.00	.00
11	.00	.00	.02	.39	.00	.20	.00	.00	.00	.00	.00	.00
12	.00	.00	.06	1.18	.00	.45	.00	.00	.01	.00	.00	.16
13	.01	.00	.02	.62	.00	.87	.00	.00	1.06	.00	.00	.00
14	.03	.00	.00	1.07	.00	.21	.53	.00	.00	.00	.00	.04
15	.00	.04	.00	.04	.01	.16	.02	.00	.00	.00	.00	.00
16	.01	.24	.05	.33	.01	.01	.01	.00	.00	.00	.00	.00
17	.01	.56	1.19	.01	.56	.27	.00	.00	.00	.00	.00	.00
18	1.38	.53	.28	.00	.21	.01	.04	.00	.00	.00	.00	.19
19	.79	.00	.19	.00	.09	.00	.49	.00	.00	.00	.00	.12
20	.76	.00	.79	.00	.01	.21	.54	.00	.00	.00	.00	.20
21	.03	.02	.35	.00	.00	.02	.05	.05	.00	.00	.00	.00
22	.24	.97	.01	.00	.24	.00	.00	.18	.04	.00	.00	.00
23	.08	.29	.84	.00	.01	.00	.00	.12	.03	.00	.00	.00
24	.80	.40	.03	.00	.16	.00	.35	.02	.39	.00	.00	.00
25	.36	.27	.00	.00	.46	.00	.12	.04	.13	.00	.00	.00
26	.30	.07	.00	.00	.12	.25	.13	.43	.00	.00	.00	.00
27	.49	.00	.00	.01	.23	.01	.00	.01	.00	.00	.00	.00
28	.50	.00	.06	.02	.19	.00	.20	.00	.00	.00	.00	.00
29	.01	.00	.04	.00	---	.04	.12	.00	.00	.00	.00	.00
30	.36	.04	.23	.01	---	.01	.20	.00	.16	.00	.00	.00
31	.01	---	.87	.00	---	.19	---	.00	---	.00	.00	---
TOTAL	6.17	4.04	7.93	6.87	4.68	3.78	5.29	2.22	2.68	0.40	0.00	1.01

WTR YR 1980 TOTAL 45.07

Table 11.--Daily precipitation for rain gages in the Salem, Oregon area--Continued

STATION NUMBER 14190820 ILLAHE HILL, SALEM, OR. (RG)
LATITUDE 445419 LONGITUDE 1230612

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.44	.35	.00	.00	.00	.05	.00	.00	.00	.00	.04
2	.00	.07	1.86	.00	.00	.00	.09	.00	.00	.00	.00	.00
3	.00	.07	1.74	.00	.01	.88	.01	.02	.05	.00	.00	.00
4	.00	.01	.57	.00	.28	.08	.00	.36	.05	.00	.00	.00
5	.00	.37	.07	.00	.15	.00	.17	.03	.30	.00	.00	.00
6	.00	.40	.05	.00	.00	.00	.00	.03	.00	.09	.00	.00
7	.00	.88	.03	.00	.00	.08	.02	.04	1.10	.06	.00	.00
8	.00	.39	.08	.00	.00	.00	.36	.02	1.00	.00	.00	.00
9	.00	.11	.13	.00	.05	.00	.03	.00	.15	.00	.00	.00
10	.00	.00	.05	.01	.01	.00	.13	.00	.10	.00	.00	.00
11	.02	.01	.00	.00	.14	.00	1.13	.00	.00	.00	.00	.00
12	.75	.00	.00	.00	.00	.00	.02	.00	.25	.00	.00	.00
13	.35	.00	.00	.01	.96	.00	.00	.00	.50	.00	.00	.00
14	.15	.14	.00	.01	.07	.00	.00	.32	.01	.00	.00	.00
15	.00	.02	.00	.00	.23	.49	.03	.17	.01	.00	.00	.00
16	.00	.00	.00	.05	.24	.01	.00	.00	.60	.00	.00	.00
17	.00	.03	.01	.08	.27	.00	.00	.32	.00	.00	.00	.00
18	.00	.01	.02	.01	.40	.01	.00	.71	.15	.00	.00	.39
19	.00	.00	.20	.00	.36	.02	.00	.00	.05	.00	.00	.02
20	.00	.00	.19	.18	.01	.03	.05	.00	.00	.00	.00	.08
21	.00	1.19	1.15	.19	.00	.22	.00	.04	.00	.00	.00	.28
22	.00	.06	.31	.36	.00	.05	.02	.01	.00	.00	.00	.05
23	.00	.11	.01	.07	.10	.14	.09	.16	.00	.00	.00	.01
24	.23	.00	2.08	.01	.32	.29	.01	.25	.00	.00	.00	.01
25	.06	.16	1.83	.10	.00	.54	.00	.11	.00	.00	.00	.07
26	.46	.00	.14	.53	.09	.16	.00	.00	.00	.00	.00	1.24
27	.00	.38	.13	.41	.01	.00	.27	.00	.00	.00	.00	.32
28	.00	.05	.01	.32	.00	.01	.00	.00	.00	.00	.00	.01
29	.01	.66	.20	.01	---	.20	.00	.00	.00	.00	.00	.01
30	.00	.12	.01	.01	---	.05	.00	.02	.00	.00	.05	.00
31	.09	---	.00	.01	---	.49	---	.00	---	.00	.00	---
TOTAL	2.12	5.68	11.22	2.37	3.70	3.75	2.48	2.61	4.32	0.15	0.05	2.53

WTR YR 1981 TOTAL 40.98

STATION NUMBER 14190910 WILTSEY STREET, SALEM, OR. (RG)
LATITUDE 445106 LONGITUDE 1225843

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.07	.16	.00	.00	.05	.00	.33
2					.00	.02	.02	.00	.00	.03	.00	1.07
3					.05	.38	.00	.00	.00	.00	.00	.48
4					.05	.29	.00	.90	.00	.00	.00	.01
5					.25	.25	.03	.38	.00	.00	.00	.10
6					.95	.15	.23	.41	.00	.00	.00	.01
7					.55	.00	.00	.25	.00	.00	.00	.10
8					.15	.00	.17	.00	.00	.00	.00	.39
9					.06	.00	.21	.00	.00	.17	.00	.01
10					1.01	.00	.21	.00	.00	.02	.00	.00
11					.18	.00	.24	.00	.00	.00	.00	.00
12					.34	.00	.35	.00	.00	.00	.00	.00
13					.00	.00	.17	.00	.00	.00	.05	.00
14					.00	.06	.02	.00	.00	.00	.14	.00
15					.12	.36	.04	.00	.00	.00	.26	.00
16					.77	.19	.37	.00	.42	.00	.02	.00
17					.21	.01	.39	.00	.06	.00	.00	.00
18					.15	.02	.16	.00	.00	.00	.17	.00
19					.30	.00	.02	.00	.00	.00	.19	.00
20					.22	.00	.00	.00	.00	.00	.00	.00
21					.00	.00	.00	.00	.00	.00	.02	.00
22					.28	.00	.03	.00	.00	.00	.00	.00
23					.12	.00	.27	.03	.00	.00	.00	.00
24					.18	.00	.01	.00	.00	.00	.00	.00
25					.10	.00	.00	.00	.00	.00	.00	.00
26					.00	.20	.00	.00	.00	.00	.00	.00
27					.38	.27	.29	.00	.00	.00	.00	.00
28					.10	.06	.00	.00	.00	.00	.00	.00
29					---	.01	.00	.00	.00	.00	.00	.00
30					---	.05	.00	.00	.12	.00	.00	.00
31					---	.01	---	.00	---	.00	.00	---
TOTAL					6.52	2.40	3.39	1.97	0.60	0.27	0.85	2.50

STATION NUMBER 14190910 WILTSEY STREET, SALEM, OR. (RG)
LATITUDE 445106 LONGITUDE 1225843

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.32	.06	1.02	.00	.00	.05	.10	.00	.00	.05
2	.00	.07	1.38	.26	.64	.01	.01	.10	.40	.00	.00	.31
3	.00	.13	.13	.05	.01	.01	.04	.15	.05	.19	.00	.00
4	.00	.49	1.02	.75	.00	.07	.18	.15	.00	.09	.00	.00
5	.00	.03	.00	.24	.15	.33	.38	.15	.00	.00	.00	.00
6	.00	.00	.00	.02	.26	.01	.92	.02	.01	.00	.00	.03
7	.00	.00	.01	.12	.00	.10	.03	.10	.25	.00	.00	.02
8	.00	.00	.00	.72	.00	.12	.18	.25	.03	.00	.00	.01
9	.00	.00	.31	1.14	.00	.00	.57	.40	.02	.00	.00	.01
10	.00	.00	.06	.17	.00	.42	.02	.00	.00	.00	.00	.00
11	.00	.00	.01	.49	.00	.15	.00	.00	.00	.00	.00	.00
12	.00	.00	.03	1.21	.00	.33	.00	.00	.01	.00	.00	.19
13	.04	.01	.01	.63	.00	1.41	.00	.00	1.05	.00	.00	.00
14	.08	.01	.00	1.20	.00	.25	.26	.00	.00	.00	.00	.03
15	.00	.04	.01	.09	.01	.26	.01	.00	.00	.00	.00	.00
16	.03	.27	.03	.29	.01	.00	.00	.00	.00	.00	.00	.01
17	.00	.38	.86	.05	.49	.24	.00	.00	.00	.00	.00	.00
18	1.69	.61	.22	.00	.18	.01	.00	.00	.00	.00	.00	.10
19	.87	.01	.20	.00	.08	.00	.27	.00	.00	.00	.00	.12
20	1.14	.00	.32	.00	.01	.44	.70	.00	.00	.00	.00	.22
21	.02	.00	.38	.00	.00	.04	.11	.05	.00	.00	.00	.00
22	.15	.91	.01	.00	.21	.00	.00	.20	.00	.00	.00	.00
23	.10	.28	.87	.00	.01	.02	.00	.10	.00	.00	.00	.00
24	.66	.41	.10	.00	.14	.01	.35	.02	.27	.00	.00	.00
25	.42	.37	.00	.00	.40	.00	.10	.05	.05	.00	.00	.00
26	.21	.05	.00	.00	.11	.26	.15	.40	.00	.00	.00	.00
27	.45	.00	.00	.01	.20	.01	.00	.01	.00	.00	.00	.00
28	.53	.00	.03	.02	.17	.00	.20	.00	.00	.00	.00	.00
29	.01	.02	.05	.00	.00	.05	.10	.00	.00	.00	.00	.00
30	.46	.05	.40	.01	---	.01	.20	.00	.00	.00	.00	.00
31	.01	---	.41	.00	---	.24	---	.00	---	.00	.00	---
TOTAL	6.87	4.14	7.17	7.53	4.10	4.80	4.78	2.20	2.24	0.28	0.00	1.10

WTR YR 1980 TOTAL 45.21

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.31	.31	.00	.00	.00	.03	.00	.00	.00	.00	.04
2	.00	.06	2.09	.00	.01	.00	.04	.04	.00	.00	.00	.00
3	.00	.11	1.97	.00	.01	.90	.03	.03	.05	.00	.00	.00
4	.00	.01	.78	.00	.26	.09	.00	.30	.05	.00	.00	.00
5	.00	.44	.18	.00	.20	.00	.17	.12	.30	.00	.00	.00
6	.00	.78	.02	.00	.00	.00	.00	.10	.00	.10	.00	.00
7	.00	.87	.01	.00	.00	.17	.05	.01	1.10	.05	.00	.00
8	.00	.44	.09	.00	.00	.00	.66	.01	1.00	.00	.00	.00
9	.00	.30	.15	.00	.04	.01	.02	.01	.15	.00	.00	.00
10	.03	.00	.10	.00	.05	.00	.08	.00	.10	.00	.00	.00
11	.37	.01	.00	.00	.21	.00	.79	.00	.00	.00	.00	.00
12	.24	.00	.00	.00	.00	.00	.11	.00	.25	.00	.00	.00
13	.07	.00	.00	.00	1.02	.01	.00	.00	.50	.00	.00	.00
14	.02	.14	.00	.00	.10	.00	.01	.30	.01	.00	.00	.00
15	.00	.02	.00	.00	.34	.32	.02	.15	.01	.00	.00	.00
16	.00	.00	.00	.02	.29	.01	.01	.00	.60	.00	.00	.00
17	.00	.03	.01	.05	.34	.00	.00	.30	.00	.00	.00	.00
18	.00	.01	.01	.01	.47	.00	.00	.55	.15	.00	.00	.40
19	.00	.00	.20	.00	.43	.02	.00	.00	.03	.00	.00	.02
20	.00	.00	.26	.11	.00	.02	.02	.00	.00	.00	.00	.10
21	.00	1.21	.94	.20	.00	.14	.01	.02	.00	.00	.00	.30
22	.00	.09	.34	.38	.01	.03	.07	.00	.00	.00	.00	.05
23	.00	.11	.00	.09	.06	.28	.11	.15	.00	.00	.00	.01
24	.21	.01	2.23	.08	.40	.25	.01	.25	.00	.00	.00	.01
25	.25	.12	1.63	.03	.01	.59	.02	.10	.00	.00	.00	.05
26	.26	.00	.27	.44	.13	.04	.00	.00	.00	.00	.00	1.25
27	.01	.31	.23	.45	.01	.01	.25	.00	.00	.00	.00	.30
28	.00	.00	.00	.36	.01	.09	.00	.00	.00	.00	.00	.01
29	.00	.70	.20	.01	---	.18	.01	.00	.00	.00	.00	.01
30	.03	.13	.00	.01	---	.12	.00	.02	.00	.00	.05	.00
31	.30	---	.00	.00	---	.34	---	.00	---	.00	.00	---
TOTAL	1.79	6.21	12.02	2.24	4.40	3.62	2.52	2.46	4.30	0.15	0.05	2.55

WTR YR 1981 TOTAL 42.31

Table 11.--Daily precipitation for rain gages in the Salem, Oregon area--Continued

STATION NUMBER 14190940 SALEM AIRPORT SOUTH, SALEM, OR. (RG)
LATITUDE 445407 LONGITUDE 1230014

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.00	.06	.00	.00	.04	.00	.37
2					.00	.02	.01	.00	.00	.00	.00	1.56
3					.06	.61	.00	.00	.00	.00	.00	.10
4					.05	.22	.00	.79	.00	.00	.00	.00
5					.24	.21	.02	.59	.00	.00	.00	.04
6					.94	.10	.15	.48	.00	.00	.00	.02
7					.54	.00	.00	.08	.00	.00	.00	.09
8					.26	.00	.08	.19	.00	.00	.00	.25
9					.06	.00.	.22	.00	.00	.20	.00	.00
10					1.09	.00	.10	.00	.00	.01	.00	.00
11					.24	.00	.11	.00	.00	.00	.00	.00
12					.33	.00	.30	.00	.00	.00	.00	.00
13					.10	.00	.20	.00	.00	.00	.04	.00
14					.00	.04	.03	.00	.00	.00	.15	.00
15					.10	.27	.02	.00	.00	.00	.26	.00
16					.76	.20	.21	.00	.38	.00	.05	.00
17					.21	.00	.30	.00	.12	.00	.00	.00
18					.17	.01	.17	.00	.01	.00	.08	.00
19					.22	.00	.00	.00	.00	.00	.14	.00
20					.19	.00	.00	.00	.00	.00	.00	.00
21					.00	.00	.01	.00	.00	.00	.07	.00
22					.42	.00	.05	.00	.00	.00	.01	.00
23					.18	.00	.36	.00	.00	.00	.00	.00
24					.27	.00	.12	.00	.00	.00	.00	.00
25					.14	.00	.00	.00	.00	.00	.00	.00
26					.00	.17	.00	.00	.00	.00	.00	.00
27					.51	.26	.28	.07	.00	.00	.00	.00
28					.11	.02	.00	.00	.00	.00	.00	.00
29					---	.00	.00	.00	.00	.00	.00	.00
30					---	.04	.00	.00	.07	.00	.00	.00
31					---	.00	---	.00	---	.00	.00	---
TOTAL					7.19	2.17	2.80	2.20	0.58	0.25	0.80	2.43

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.42	.49	1.01	.00	.00	.00	.13	.00	.00	.09
2	.00	.10	1.35	.00	.73	.00	.01	.00	.36	.00	.00	.26
3	.00	.14	.12	.19	.00	.02	.04	.00	.01	.10	.00	.00
4	.00	.37	.92	.05	.00	.04	.18	.00	.00	.09	.00	.00
5	.00	.14	.00	.94	.15	.34	.38	.00	.00	.00	.00	.00
6	.00	.00	.00	.07	.20	.00	.86	.00	.00	.00	.00	.00
7	.00	.00	.01	.13	.00	.00	.04	.00	.18	.00	.00	.00
8	.00	.00	.00	.25	.00	.00	.17	.08	.16	.00	.00	.00
9	.00	.00	.33	1.52	.00	.00	.79	.29	.00	.00	.00	.00
10	.00	.00	.12	.21	.00	.24	.03	.12	.00	.00	.00	.00
11	.00	.00	.03	.51	.00	.16	.00	.00	.00	.00	.00	.00
12	.00	.00	.02	1.25	.00	.32	.00	.01	.02	.00	.00	.18
13	.01	.00	.01	.58	.00	1.00	.00	.01	.78	.00	.00	.00
14	.06	.03	.01	1.33	.00	.20	.33	.00	.00	.00	.00	.05
15	.00	.08	.00	.06	.00	.11	.00	.20	.00	.00	.00	.00
16	.02	.27	.00	.22	.01	.01	.01	.00	.03	.00	.00	.00
17	.01	.59	.67	.06	.49	.37	.00	.00	.00	.00	.00	.00
18	1.58	.50	.57	.05	.38	.00	.03	.00	.00	.00	.00	.14
19	.88	.00	.20	.04	.05	.00	.35	.00	.00	.00	.00	.08
20	.91	.00	.20	.02	.00	.28	.49	.00	.00	.00	.00	.19
21	.02	.01	.74	.02	.01	.01	.03	.09	.00	.00	.00	.00
22	.24	1.00	.05	.00	.16	.00	.00	.14	.00	.00	.00	.00
23	.10	.27	.54	.02	.00	.00	.00	.02	.01	.00	.00	.00
24	.76	.33	.43	.02	.14	.00	.03	.04	.21	.00	.00	.00
25	.42	.37	.00	.00	.53	.00	.00	.03	.19	.00	.00	.00
26	.32	.09	.00	.07	.16	.20	.00	.77	.00	.00	.00	.00
27	.51	.00	.01	.03	.20	.00	.00	.00	.00	.00	.00	.00
28	.41	.00	.02	.04	.07	.00	.00	.00	.00	.00	.00	.00
29	.01	.01	.11	.05	---	.00	.00	.00	.00	.00	.00	.00
30	.43	.03	.13	.03	---	.01	.00	.00	.00	.00	.00	.00
31	.01	---	.25	.02	---	.23	---	.00	---	.00	.00	---
TOTAL	6.70	4.33	7.26	8.27	4.29	3.54	3.77	1.80	2.08	0.19	0.00	0.99

WTR YR 1980 TOTAL 43.22

STATION NUMBER 14190940 SALEM AIRPORT SOUTH, SALEM, OR. (RG)
LATITUDE 445407 LONGITUDE 1230014

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.55	.30	.00	.01	.00	.02	.00	.00	.00	.00	.04
2	.00	.04	2.06	.00	.01	.00	.04	.00	.00	.00	.00	.00
3	.00	.08	1.87	.00	.00	.90	.01	.03	.05	.00	.00	.00
4	.00	.02	.58	.00	.21	.10	.00	.19	.05	.00	.00	.00
5	.00	.40	.13	.00	.18	.00	.30	.07	.30	.00	.00	.00
6	.00	.49	.06	.00	.00	.00	.00	.10	.00	.09	.00	.00
7	.00	.97	.00	.00	.00	.10	.04	.07	1.10	.06	.00	.00
8	.00	.25	.17	.00	.00	.00	.50	.01	1.00	.00	.00	.00
9	.00	.13	.21	.00	.01	.00	.03	.00	.15	.00	.00	.00
10	.00	.01	.02	.00	.02	.00	.14	.04	.10	.00	.00	.00
11	.02	.00	.01	.00	.16	.00	.93	.00	.00	.00	.00	.00
12	.47	.00	.00	.00	.01	.00	.04	.00	.25	.00	.00	.00
13	.26	.00	.03	.00	.91	.00	.00	.00	.50	.00	.00	.00
14	.08	.15	.01	.00	.07	.00	.00	.21	.01	.00	.00	.00
15	.08	.00	.01	.00	.29	.40	.01	.21	.01	.00	.00	.00
16	.00	.00	.00	.03	.32	.00	.00	.00	.60	.00	.00	.00
17	.00	.02	.02	.07	.30	.00	.00	.30	.00	.00	.00	.00
18	.00	.04	.01	.00	.39	.00	.00	.55	.15	.00	.00	.40
19	.00	.00	.16	.00	.25	.01	.00	.00	.03	.00	.00	.02
20	.00	.00	.21	.13	.01	.00	.03	.00	.00	.00	.00	.10
21	.00	1.60	1.07	.21	.00	.15	.00	.02	.00	.00	.00	.30
22	.00	.05	.30	.36	.00	.05	.00	.00	.00	.00	.00	.05
23	.00	.07	.01	.13	.05	.22	.10	.15	.00	.00	.00	.01
24	.17	.01	2.34	.01	.30	.25	.00	.25	.00	.00	.00	.01
25	.02	.12	1.69	.07	.01	.55	.00	.10	.00	.00	.00	.05
26	.41	.00	.20	.49	.15	.05	.00	.00	.00	.00	.00	1.25
27	.01	.29	.20	.45	.01	.00	.22	.00	.00	.00	.00	.30
28	.00	.00	.00	.31	.01	.05	.01	.00	.00	.00	.00	.01
29	.00	.77	.20	.01	---	.20	.00	.00	.00	.00	.00	.01
30	.01	.11	.00	.01	---	.08	.00	.02	.00	.00	.05	.00
31	.07	---	.00	.00	---	.50	---	.00	---	.00	.00	---
TOTAL	1.60	6.17	11.87	2.28	3.68	3.61	2.42	2.32	4.30	0.15	0.05	2.55

WTR YR 1981 TOTAL 41.00

STATION NUMBER 14190950 FIRE STATION, SALEM, OR. (RG)
LATITUDE 445325 LONGITUDE 1230332

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.00	.14	.00	.00	.04	.00	.38
2					.00	.04	.01	.00	.00	.00	.00	1.62
3					.05	.64	.00	.00	.00	.00	.00	.05
4					.05	.18	.01	.86	.00	.00	.00	.00
5					.25	.26	.01	.84	.02	.00	.00	.05
6					.95	.09	.14	.59	.00	.00	.00	.01
7					.55	.00	.00	.10	.00	.00	.00	.16
8					.25	.00	.04	.07	.00	.00	.00	.09
9					.05	.00	.16	.01	.00	.21	.00	.01
10					1.05	.00	.19	.00	.00	.01	.00	.00
11					.20	.00	.14	.00	.00	.00	.00	.00
12					.35	.00	.35	.00	.00	.00	.00	.00
13					.12	.00	.24	.00	.00	.00	.11	.00
14					.00	.04	.03	.00	.00	.00	.10	.00
15					.09	.32	.03	.00	.00	.00	.32	.00
16					.79	.34	.34	.00	.91	.00	.03	.00
17					.22	.01	.38	.00	.06	.00	.00	.00
18					.14	.02	.12	.00	.00	.00	.06	.00
19					.27	.00	.01	.00	.03	.00	.17	.00
20					.21	.00	.00	.00	.00	.00	.00	.00
21					.00	.00	.00	.00	.00	.00	.54	.00
22					.39	.00	.01	.00	.00	.00	.01	.00
23					.17	.00	.38	.05	.00	.00	.00	.00
24					.25	.00	.01	.00	.00	.00	.00	.00
25					.16	.00	.00	.00	.00	.00	.00	.00
26					.00	.22	.00	.00	.00	.00	.00	.00
27					.55	.31	.31	.06	.00	.00	.00	.00
28					.08	.03	.01	.02	.00	.00	.00	.00
29					---	.04	.00	.00	.00	.00	.00	.00
30					---	.13	.00	.00	.09	.00	.00	.00
31					---	.02	---	.00	---	.00	.00	---
TOTAL					7.19	2.69	3.06	2.60	1.11	0.26	1.34	2.37

STATION NUMBER 14190950 FIRE STATION, SALEM, OR. (RG)
LATITUDE 445325 LONGITUDE 1230332

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.34	.09	.94	.00	.00	.00	.12	.00	.00	.08
2	.00	.10	1.37	.20	.61	.00	.01	.00	.56	.00	.00	.24
3	.00	.14	.12	.05	.01	.02	.05	.00	.01	.20	.00	.00
4	.00	.31	.82	.70	.00	.04	.16	.00	.00	.08	.00	.00
5	.00	.06	.01	.26	.19	.31	.34	.00	.00	.00	.00	.00
6	.00	.00	.00	.02	.16	.00	.87	.00	.00	.00	.00	.00
7	.00	.00	.00	.07	.00	.00	.04	.00	.24	.00	.00	.00
8	.00	.00	.01	.49	.00	.00	.09	.17	.05	.00	.00	.00
9	.00	.00	.27	1.16	.00	.00	.73	.20	.00	.00	.00	.00
10	.00	.00	.05	.11	.00	.22	.03	.00	.00	.00	.00	.00
11	.00	.00	.00	.45	.00	.15	.00	.00	.00	.00	.00	.00
12	.00	.00	.05	1.11	.00	.29	.00	.01	.00	.00	.00	.16
13	.02	.00	.01	.59	.00	.94	.00	.01	.97	.00	.00	.00
14	.01	.00	.01	1.10	.00	.18	.39	.00	.00	.00	.00	.05
15	.01	.04	.00	.03	.14	.10	.00	.20	.00	.00	.00	.00
16	.02	.24	.04	.28	.01	.01	.01	.00	.03	.00	.00	.00
17	.00	.56	.98	.04	.57	.34	.00	.00	.00	.00	.00	.00
18	1.55	.53	.22	.00	.30	.00	.03	.00	.00	.00	.00	.19
19	.77	.00	.13	.00	.05	.00	.42	.00	.00	.00	.00	.12
20	.91	.00	.49	.00	.00	.26	.58	.00	.00	.00	.00	.22
21	.01	.02	.36	.00	.00	.01	.04	.09	.00	.00	.00	.00
22	.23	.97	.00	.00	.18	.00	.00	.16	.00	.00	.00	.00
23	.10	.29	.95	.00	.00	.01	.00	.08	.01	.00	.00	.00
24	.74	.40	.04	.00	.15	.00	.02	.05	.25	.00	.00	.00
25	.26	.27	.00	.00	.59	.00	.00	.14	.25	.00	.00	.00
26	.30	.07	.00	.01	.13	.26	.01	.34	.00	.00	.00	.00
27	.49	.00	.00	.03	.20	.00	.00	.00	.00	.00	.00	.00
28	.50	.00	.08	.00	.00	.00	.00	.01	.00	.00	.00	.00
29	.01	.00	.03	.01	.00	.00	.00	.00	.00	.00	.00	.00
30	.36	.04	.28	.00	---	.00	.00	.00	.00	.00	.00	.00
31	.01	---	.54	.02	---	.20	---	.00	---	.00	.00	---
TOTAL	6.30	4.04	7.20	6.82	4.23	3.34	3.82	1.46	2.49	0.28	0.00	1.06

WTR YR 1980 TOTAL 41.04

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.48	.33	.00	.00	.01	.02	.00	.00	.00	.00	.04
2	.00	.05	1.83	.00	.01	.00	.10	.00	.00	.00	.00	.00
3	.00	.05	1.69	.00	.00	.95	.01	.02	.05	.00	.00	.00
4	.00	.01	.51	.00	.26	.10	.00	.32	.05	.00	.00	.00
5	.00	.35	.08	.00	.15	.01	.22	.04	.30	.00	.00	.00
6	.00	.55	.04	.00	.00	.00	.00	.12	.00	.09	.00	.00
7	.00	.75	.01	.00	.00	.09	.03	.02	1.00	.06	.00	.00
8	.00	.30	.07	.00	.00	.00	.41	.01	1.00	.00	.00	.00
9	.00	.10	.02	.00	.00	.00	.02	.02	.15	.00	.00	.00
10	.00	.00	.02	.00	.00	.00	.15	.00	.10	.00	.00	.00
11	.02	.00	.00	.00	.15	.00	.95	.00	.00	.00	.00	.00
12	.60	.00	.00	.00	.00	.00	.05	.00	.25	.00	.00	.00
13	.36	.00	.00	.00	.82	.00	.00	.00	.50	.00	.00	.00
14	.12	.15	.00	.00	.06	.00	.00	.26	.01	.00	.00	.00
15	.00	.00	.01	.00	.19	.43	.02	.14	.01	.00	.00	.00
16	.00	.00	.00	.01	.24	.01	.00	.00	.60	.00	.00	.00
17	.00	.05	.00	.07	.22	.00	.00	.28	.00	.00	.00	.00
18	.01	.00	.02	.00	.40	.01	.00	.55	.15	.00	.00	.40
19	.00	.00	.24	.00	.28	.03	.00	.00	.03	.00	.00	.02
20	.00	.01	.20	.15	.01	.01	.05	.00	.00	.00	.00	.10
21	.00	1.28	.98	.22	.00	.21	.00	.00	.00	.00	.00	.30
22	.00	.06	.24	.35	.00	.07	.02	.01	.00	.00	.00	.05
23	.00	.09	.01	.07	.06	.18	.11	.13	.00	.00	.00	.01
24	.33	.01	2.58	.01	.25	.21	.00	.26	.00	.00	.00	.01
25	.02	.12	1.23	.06	.00	.52	.00	.09	.00	.00	.00	.07
26	.41	.00	.11	.45	.15	.16	.01	.00	.00	.00	.00	1.25
27	.00	.34	.18	.43	.01	.00	.22	.00	.00	.00	.00	.30
28	.01	.02	.00	.30	.01	.03	.01	.00	.00	.00	.00	.01
29	.00	.62	.20	.01	---	.20	.00	.00	.00	.00	.00	.01
30	.00	.15	.00	.00	---	.06	.00	.02	.00	.00	.05	.00
31	.07	---	.00	.01	---	.46	---	.00	---	.00	.00	---
TOTAL	1.95	5.54	10.60	2.14	3.27	3.75	2.40	2.29	4.20	0.15	0.05	2.57

WTR YR 1981 TOTAL 38.91

Table 11.--Daily precipitation for rain gages in the Salem, Oregon area--Continued

STATION NUMBER 14190980 SALEM CITY HALL, SALEM, OR. (RG)
LATITUDE 445611 LONGITUDE 1230225

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.14	.05	.00	.00	.01	.00	.34
2					.00	.00	.01	.00	.00	.00	.00	2.30
3					.05	.12	.00	.00	.00	.00	.00	.09
4					.05	.41	.00	.80	.00	.00	.00	.02
5					.25	.16	.00	.61	.05	.00	.00	.09
6					.95	.21	.11	.83	.00	.00	.00	.00
7					.55	.00	.00	.06	.00	.00	.00	.11
8					.15	.00	.05	.18	.00	.00	.00	.16
9					.06	.00	.19	.00	.00	.31	.00	.00
10					1.01	.00	.18	.00	.00	.00	.00	.00
11					.18	.00	.04	.00	.00	.00	.00	.00
12					.34	.00	.33	.00	.00	.00	.00	.00
13					.15	.00	.08	.00	.00	.00	.08	.00
14					.00	.03	.01	.00	.03	.00	.10	.00
15					.10	.23	.02	.00	.00	.00	.28	.00
16					.70	.02	.18	.00	1.01	.00	.03	.00
17					.22	.01	.00	.00	.05	.00	.00	.00
18					.10	.02	.25	.00	.00	.00	.07	.00
19					.14	.00	.00	.00	.00	.00	.15	.00
20					.16	.00	.00	.00	.00	.00	.00	.00
21					.00	.00	.00	.00	.00	.00	.66	.00
22					.28	.00	.02	.00	.00	.00	.00	.00
23					.12	.00	.44	.00	.00	.00	.00	.00
24					.18	.00	.00	.00	.00	.00	.00	.00
25					.10	.00	.00	.00	.00	.00	.00	.00
26					.00	.19	.00	.00	.00	.00	.00	.00
27					.38	.26	.34	.00	.00	.00	.00	.00
28					.10	.02	.00	.00	.00	.00	.00	.00
29					---	.02	.00	.00	.00	.00	.00	.00
30					---	.05	.00	.00	.12	.00	.00	.00
31					---	.00	---	.00	---	.00	.00	---
TOTAL					6.32	1.89	2.30	2.48	1.26	0.32	1.37	3.11

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.54	.04	.87	.00	.01	.00	.06	.00	.00	.09
2	.00	.12	1.32	.12	.64	.00	.00	.00	.17	.00	.00	.19
3	.00	.18	.09	.05	.00	.07	.03	.00	.00	.20	.00	.00
4	.00	.25	.64	.67	.01	.04	.14	.00	.00	.05	.00	.00
5	.00	.02	.01	.31	.26	.24	.29	.00	.00	.00	.00	.00
6	.00	.00	.00	.00	.20	.00	.92	.00	.00	.00	.00	.00
7	.00	.00	.00	.05	.00	.13	.01	.00	.15	.00	.00	.00
8	.00	.00	.01	.36	.00	.00	.14	.13	.08	.00	.00	.00
9	.00	.00	.22	1.31	.00	.00	.59	.22	.00	.00	.00	.00
10	.00	.00	.05	.22	.00	.31	.03	.04	.00	.00	.00	.00
11	.00	.00	.00	.55	.00	.05	.00	.00	.00	.00	.00	.00
12	.00	.00	.05	1.15	.00	.50	.00	.01	.01	.00	.00	.26
13	.02	.00	.01	.66	.00	.71	.00	.00	.99	.00	.00	.00
14	.00	.00	.00	1.25	.00	.12	.29	.00	.00	.00	.00	.03
15	.00	.05	.00	.03	.06	.17	.01	.38	.00	.00	.00	.00
16	.00	.18	.02	.32	.01	.00	.01	.00	.00	.00	.00	.00
17	.01	.49	1.09	.04	.54	.21	.00	.00	.00	.00	.00	.00
18	1.42	.36	.27	.00	.31	.00	.03	.00	.00	.00	.00	.25
19	.72	.00	.08	.00	.02	.00	.38	.00	.00	.00	.00	.09
20	.72	.00	.62	.00	.01	.15	.60	.00	.00	.00	.00	.10
21	.02	.01	.29	.00	.03	.00	.06	.07	.00	.00	.00	.00
22	.24	1.29	.01	.00	.13	.00	.00	.11	.00	.00	.00	.00
23	.04	.24	.82	.00	.00	.00	.00	.03	.01	.00	.00	.00
24	.73	.39	.05	.00	.12	.00	.00	.00	.30	.00	.00	.00
25	.29	.37	.00	.00	.56	.00	.00	.00	.27	.00	.00	.00
26	.24	.11	.00	.00	.20	.12	.00	.73	.00	.00	.00	.00
27	.57	.08	.00	.00	.19	.00	.00	.00	.00	.00	.05	.00
28	.38	.00	.03	.00	.16	.00	.00	.00	.00	.00	.00	.00
29	.00	.00	.06	.00	---	.05	.00	.00	.00	.00	.00	.00
30	.58	.01	.25	.00	---	.00	.00	.00	.00	.00	.05	.00
31	.00	---	.64	.04	---	.23	---	.00	---	.00	.00	---
TOTAL	5.98	4.15	7.17	7.17	4.32	3.10	3.54	1.72	2.04	0.25	0.10	1.01

WTR YR 1980 TOTAL 40.55

STATION NUMBER 14190980 SALEM CITY HALL,SALEM, OR. (RG)
LATITUDE 445611 LONGITUDE 1230225

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.49	.27	.00	.00	.00	.03	.00	.00	.00	.00	.05
2	.00	.04	2.11	.00	.00	.00	.07	.01	.00	.00	.00	.00
3	.00	.06	1.88	.00	.00	1.09	.00	.02	.05	.00	.00	.00
4	.00	.01	.42	.00	.25	.09	.00	.28	.05	.00	.00	.00
5	.00	.37	.06	.00	.14	.01	.18	.03	.24	.00	.00	.00
6	.00	.63	.03	.00	.00	.00	.00	.11	.00	.10	.00	.00
7	.00	.73	.01	.00	.00	.09	.01	.01	1.06	.05	.00	.00
8	.00	.32	.10	.00	.00	.00	.30	.02	.56	.00	.00	.00
9	.00	.09	.05	.00	.04	.00	.02	.00	.07	.00	.00	.00
10	.00	.00	.02	.00	.01	.00	.05	.00	.18	.00	.00	.00
11	.02	.00	.00	.00	.09	.00	1.02	.00	.00	.00	.00	.00
12	.72	.00	.00	.00	.00	.00	.01	.00	.21	.00	.00	.00
13	.31	.00	.00	.00	.95	.00	.00	.00	.40	.00	.00	.00
14	.08	.16	.00	.01	.05	.00	.00	.25	.00	.00	.00	.00
15	.00	.00	.01	.00	.20	.47	.00	.15	.00	.00	.00	.00
16	.00	.00	.00	.02	.27	.00	.00	.00	.60	.00	.00	.00
17	.00	.04	.01	.06	.28	.00	.00	.34	.00	.00	.00	.01
18	.00	.00	.01	.01	.50	.00	.00	.65	.11	.00	.00	.44
19	.00	.00	.16	.00	.34	.01	.00	.00	.03	.00	.00	.01
20	.00	.00	.20	.14	.00	.00	.01	.00	.00	.00	.00	.03
21	.00	1.26	1.20	.24	.00	.15	.00	.00	.00	.00	.00	.33
22	.00	.04	.28	.36	.00	.04	.01	.00	.00	.00	.00	.05
23	.00	.08	.00	.06	.06	.18	.09	.19	.00	.00	.00	.00
24	.15	.00	2.19	.00	.27	.29	.01	.32	.00	.00	.00	.00
25	.01	.12	1.95	.07	.00	.53	.00	.12	.00	.00	.00	.02
26	.40	.00	.10	.44	.12	.09	.00	.00	.00	.00	.00	1.25
27	.00	.29	.15	.45	.00	.00	.24	.00	.00	.00	.00	.32
28	.00	.02	.00	.32	.00	.03	.00	.00	.00	.00	.00	.00
29	.00	.61	.17	.02	---	.27	.00	.00	.00	.00	.00	.00
30	.00	.07	.01	.01	---	.02	.00	.02	.00	.00	.00	.00
31	.07	---	.00	.01	---	.51	---	.00	---	.00	.00	---
TOTAL	1.76	5.43	11.39	2.22	3.57	3.87	2.05	2.52	3.56	0.15	0.00	2.51

WTR YR 1981 TOTAL 39.03

STATION NUMBER 14191420 COLE RD., SALEM, OR. (RG)
LATITUDE 444724 LONGITUDE 1230636

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.00	.14	.00	.00	.06	.00	.45
2					.00	.04	.01	.00	.00	.02	.00	2.40
3					.05	.64	.00	.00	.00	.00	.00	.40
4					.05	.18	.01	.86	.00	.00	.00	.03
5					.25	.26	.01	.84	.00	.00	.00	.26
6					.95	.09	.14	.59	.00	.00	.00	.01
7					.55	.00	.00	.10	.00	.00	.00	.27
8					.25	.00	.04	.07	.00	.00	.00	.10
9					.05	.00	.16	.01	.00	.30	.00	.01
10					1.05	.00	.19	.00	.00	.00	.00	.00
11					.20	.00	.14	.00	.00	.00	.00	.00
12					.35	.00	.35	.00	.00	.00	.00	.00
13					.12	.00	.24	.00	.00	.00	.13	.00
14					.00	.04	.03	.00	.06	.00	.18	.00
15					.09	.32	.03	.00	.01	.00	.42	.00
16					.79	.34	.34	.00	.71	.00	.03	.00
17					.22	.01	.38	.00	.05	.00	.00	.00
18					.14	.02	.12	.00	.00	.00	.07	.00
19					.27	.00	.01	.00	.03	.00	.19	.00
20					.21	.00	.00	.00	.00	.00	.01	.00
21					.00	.00	.00	.00	.00	.00	1.10	.00
22					.39	.00	.01	.00	.00	.00	.01	.00
23					.17	.00	.38	.05	.00	.00	.00	.00
24					.25	.00	.01	.00	.00	.00	.00	.00
25					.16	.00	.00	.00	.00	.00	.00	.00
26					.00	.22	.01	.00	.00	.00	.00	.00
27					.55	.31	.41	.06	.00	.00	.00	.00
28					.08	.03	.01	.02	.00	.00	.00	.00
29					---	.04	.00	.00	.00	.00	.00	.00
30					---	.13	.00	.00	.17	.00	.02	.00
31					---	.02	---	.00	---	.00	.01	---
TOTAL					7.19	2.69	3.17	2.60	1.03	0.38	2.17	3.93

STATION NUMBER 14191420 COLE ROAD, SALEM, OR. (RG)
LATITUDE 444724 LONGITUDE 1230636

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.53	.11	1.30	.00	.01	.00	.18	.00	.00	.10
2	.00	.05	1.79	.43	.95	.00	.00	.00	.48	.00	.00	.40
3	.00	.33	.13	.06	.03	.02	.09	.00	.01	.22	.00	.00
4	.00	.47	1.02	.79	.27	.05	.19	.00	.00	.05	.00	.00
5	.00	.10	.00	.29	.41	.30	.48	.00	.03	.00	.00	.00
6	.00	.00	.04	.04	.00	.00	1.06	.00	.00	.00	.00	.00
7	.00	.00	.02	.28	.00	.00	.04	.00	.24	.00	.00	.00
8	.00	.00	.03	1.71	.00	.00	.11	.10	.17	.00	.00	.00
9	.00	.00	.59	1.97	.00	.00	.78	.42	.16	.00	.00	.00
10	.00	.00	.01	.09	.00	.45	.03	.01	.08	.00	.00	.00
11	.00	.02	.01	.30	.00	.24	.01	.00	.16	.00	.00	.00
12	.00	.00	.09	1.92	.00	.33	.00	.00	.25	.00	.00	.18
13	.02	.02	.03	.96	.00	1.36	.00	.02	1.26	.00	.00	.00
14	.04	.00	.01	1.18	.00	.35	.50	.00	.00	.00	.00	.02
15	.00	.07	.00	.03	.20	.40	.01	.00	.00	.00	.00	.00
16	.02	.26	.02	.44	.00	.00	.01	.00	.00	.00	.00	.00
17	.02	.44	1.29	.04	.60	.31	.00	.00	.00	.00	.00	.00
18	1.93	.93	.29	.00	.30	.01	.04	.00	.00	.00	.00	.26
19	1.28	.01	.17	.03	.05	.00	.51	.00	.00	.00	.00	.19
20	1.16	.01	.73	.00	.00	.31	.80	.00	.00	.00	.00	.31
21	.02	.01	.43	.00	.00	.00	.09	.22	.00	.00	.00	.00
22	.51	1.23	.01	.00	.20	.01	.00	.33	.02	.00	.00	.00
23	.13	.45	.90	.00	.00	.01	.00	.05	.10	.00	.00	.00
24	1.02	.39	.05	.00	.15	.01	.03	.33	.43	.00	.00	.00
25	.42	.57	.00	.00	.60	.00	.00	.07	.26	.00	.00	.00
26	.27	.07	.01	.03	.15	.24	.00	.57	.01	.00	.00	.00
27	.68	.01	.00	.01	.20	.01	.00	.27	.00	.00	.00	.00
28	.79	.00	.09	.00	.00	.00	.00	.09	.00	.00	.00	.00
29	.01	.02	.01	.01	.00	.05	.00	.00	.00	.00	.00	.00
30	.61	.03	.34	.09	---	.00	.00	.10	.00	.00	.00	.00
31	.01	---	1.05	.55	---	.28	---	.19	---	.00	.00	---
TOTAL	8.94	5.49	9.69	11.36	5.41	4.74	4.79	2.77	3.84	0.27	0.00	1.46

WTR YR 1980 TOTAL 58.76

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.64	.33	.00	.02	.00	.04	.00	.00	.00	.00	.04
2	.00	.08	1.83	.00	.02	.00	.19	.00	.00	.00	.00	.00
3	.00	.11	1.69	.00	.02	1.76	.02	.01	.05	.00	.00	.00
4	.00	.04	.51	.00	.28	.14	.00	.36	.05	.00	.00	.00
5	.00	.32	.01	.00	.10	.00	.27	.26	.30	.00	.00	.00
6	.00	.67	.06	.00	.00	.00	.00	.10	.00	.09	.00	.00
7	.00	.29	.09	.00	.00	.11	.03	.00	1.10	.06	.00	.00
8	.00	.11	.08	.00	.00	.00	.65	.04	1.00	.00	.00	.00
9	.00	.09	.03	.00	.00	.00	.05	.01	.15	.00	.00	.00
10	.00	.00	.05	.00	.00	.00	.05	.00	.10	.00	.00	.00
11	.02	.00	.00	.00	.21	.00	1.00	.00	.00	.00	.00	.00
12	.67	.00	.00	.00	.00	.00	.10	.00	.25	.00	.00	.00
13	.40	.00	.00	.00	1.02	.02	.00	.00	.50	.00	.00	.00
14	.09	.15	.00	.00	.10	.01	.01	.25	.01	.00	.00	.00
15	.00	.00	.00	.00	.39	.46	.04	.52	.01	.00	.00	.00
16	.00	.00	.00	.07	.72	.01	.00	.00	.60	.00	.00	.00
17	.00	.04	.01	.08	.38	.00	.00	.40	.00	.00	.00	.00
18	.00	.01	.03	.00	.74	.01	.00	1.03	.15	.00	.00	.40
19	.00	.00	.22	.00	.38	.02	.00	.00	.03	.00	.00	.02
20	.00	.03	.19	.18	.01	.07	.04	.05	.00	.00	.00	.10
21	.00	1.79	1.53	.21	.00	.25	.00	.05	.00	.00	.00	.30
22	.00	.07	.31	.36	.00	.06	.08	.00	.00	.00	.00	.05
23	.00	.14	.03	.11	.09	.25	.13	.33	.00	.00	.00	.01
24	.36	.02	2.48	.12	.48	.22	.00	.43	.00	.00	.00	.01
25	.16	.16	2.85	.06	.02	.76	.02	.14	.00	.00	.00	.05
26	.46	.01	.29	.48	.13	.16	.02	.00	.00	.00	.00	1.25
27	.00	.53	.24	.43	.00	.00	.32	.00	.00	.00	.00	.32
28	.01	.04	.04	.47	.00	.03	.01	.00	.00	.00	.00	.01
29	.00	.89	.26	.01	---	.26	.00	.00	.00	.00	.00	.01
30	.00	.16	.00	.03	---	.10	.00	.02	.00	.00	.05	.00
31	.05	---	.00	.02	---	.71	---	.00	---	.00	.00	---
TOTAL	2.22	6.39	13.16	2.63	5.11	5.41	3.07	4.00	4.30	0.15	0.05	2.57

WTR YR 1981 TOTAL 49.06

STATION NUMBER 14191440 BATTLE CREEK, SUNNYSIDE ROAD, SALEM, OR. (RG,SG)
LATITUDE 445035 LONGITUDE 1230157

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.03	.14	.00	.00	.10	.00	.30
2					.00	.00	.01	.00	.00	.02	.00	1.62
3					.05	.64	.00	.00	.00	.00	.00	.04
4					.05	.18	.01	.94	.00	.00	.00	.00
5					.25	.26	.01	.65	.00	.00	.00	.04
6					1.12	.09	.14	.66	.00	.00	.00	.00
7					.65	.00	.00	.22	.00	.00	.00	.12
8					.23	.00	.04	.05	.00	.00	.00	.00
9					.02	.00	.16	.01	.00	.15	.00	.00
10					1.26	.00	.19	.00	.00	.01	.00	.00
11					.40	.00	.14	.00	.00	.01	.00	.00
12					.32	.00	.35	.00	.00	.00	.00	.00
13					.11	.00	.24	.00	.00	.00	.06	.00
14					.01	.04	.03	.00	.00	.00	.13	.00
15					.10	.32	.03	.00	.00	.00	.34	.00
16					.91	.34	.34	.00	.57	.00	.04	.00
17					.20	.01	.38	.00	.05	.00	.00	.00
18					.31	.02	.12	.00	.00	.00	.07	.00
19					.34	.00	.01	.00	.00	.00	.15	.00
20					.23	.00	.00	.00	.00	.00	.00	.00
21					.01	.00	.00	.00	.00	.00	.62	.00
22					.53	.00	.04	.00	.00	.00	.02	.00
23					.28	.00	.32	.00	.00	.00	.00	.00
24					.26	.00	.01	.00	.00	.00	.00	.00
25					.16	.00	.00	.00	.00	.00	.00	.00
26					.02	.22	.01	.00	.00	.00	.00	.00
27					.55	.31	.25	.14	.00	.00	.00	.00
28					.19	.03	.00	.02	.00	.00	.00	.00
29					---	.04	.00	.01	.00	.00	.00	.00
30					---	.13	.00	.02	.00	.00	.00	.00
31					---	.02	---	.00	---	.00	.00	---
TOTAL					8.56	2.68	2.97	2.72	0.62	0.29	1.43	2.12

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.32	.10	1.00	.00	.00	.00	.11	.00	.00	.08
2	.00	.06	1.47	.35	.65	.00	.00	.00	.56	.00	.00	.26
3	.00	.15	.15	.05	.01	.02	.07	.00	.01	.28	.00	.00
4	.00	.56	1.03	.75	.00	.04	.20	.00	.00	.10	.00	.00
5	.00	.06	.01	.25	.20	.30	.44	.00	.00	.00	.00	.00
6	.00	.00	.00	.05	.30	.01	1.05	.00	.00	.00	.00	.01
7	.00	.00	.00	.20	.00	.12	.04	.00	.31	.00	.00	.01
8	.00	.00	.00	1.20	.00	.01	.13	.00	.06	.00	.00	.00
9	.00	.00	.40	1.55	.00	.00	.68	.06	.00	.00	.00	.00
10	.00	.00	.05	.15	.00	.08	.03	.38	.00	.00	.00	.00
11	.00	.00	.00	.40	.00	.25	.00	.11	.00	.00	.00	.00
12	.00	.00	.05	1.55	.00	.54	.00	.00	.01	.00	.00	.22
13	.04	.01	.00	.80	.00	1.20	.00	.00	.86	.00	.00	.01
14	.04	.01	.00	1.20	.00	.30	.28	.00	.00	.00	.00	.03
15	.01	.14	.00	.05	.10	.38	.02	.00	.00	.00	.00	.01
16	.00	.16	.00	.35	.01	.00	.00	.14	.00	.00	.00	.01
17	.00	.50	1.10	.00	.55	.30	.00	.01	.00	.00	.00	.01
18	1.74	.74	.25	.00	.25	.01	.00	.00	.00	.00	.00	.18
19	1.05	.01	.20	.00	.05	.00	.32	.01	.00	.00	.00	.13
20	1.20	.00	.50	.00	.00	.49	.61	.00	.00	.00	.00	.35
21	.01	.01	.40	.00	.00	.00	.06	.00	.00	.00	.00	.00
22	.40	1.01	.00	.00	.20	.01	.00	.18	.00	.00	.00	.00
23	.15	.34	.90	.00	.00	.01	.00	.13	.01	.00	.00	.00
24	1.00	.44	.10	.00	.15	.01	.00	.05	.24	.00	.00	.00
25	.22	.35	.00	.00	.55	.00	.00	.06	.15	.00	.00	.00
26	.25	.07	.00	.00	.15	.32	.00	.03	.01	.00	.00	.00
27	.52	.00	.00	.00	.20	.01	.00	.30	.00	.00	.00	.00
28	.62	.00	.05	.00	.10	.00	.00	.00	.00	.00	.00	.00
29	.01	.01	.05	.00	.00	.04	.00	.00	.00	.00	.00	.00
30	.49	.04	.35	.00	---	.00	.00	.00	.00	.00	.00	.00
31	.01	---	.75	.00	---	.21	---	.00	---	.00	.00	---
TOTAL	7.76	4.67	8.13	9.00	4.47	4.66	3.93	1.46	2.33	0.38	0.00	1.31

WTR YR 1980 TOTAL 48.10

STATION NUMBER 14191440 BATTLE CREEK, SUNNYSIDE ROAD, SALEM, OR. (RG,SG)
LATITUDE 445035 LONGITUDE 1230157

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.63	.40	.00	.00	.00	.05	.00	.00	.00	.00	.04
2	.00	.07	2.39	.00	.00	.00	.12	.02	.00	.00	.00	.00
3	.00	.12	1.90	.00	.01	.90	.01	.03	.05	.00	.00	.00
4	.00	.00	.87	.00	.29	.10	.01	.29	.05	.00	.00	.00
5	.00	.43	.25	.00	.16	.00	.24	.10	.30	.00	.00	.00
6	.00	.95	.05	.00	.05	.00	.00	.10	.00	.10	.00	.00
7	.00	.63	.00	.00	.09	.20	.08	.01	1.05	.05	.00	.00
8	.00	.46	.12	.00	.00	.00	.73	.03	.60	.00	.00	.00
9	.00	.23	.09	.00	.00	.00	.03	.01	.05	.00	.00	.00
10	.00	.00	.00	.00	.00	.00	.12	.00	.20	.00	.00	.00
11	.02	.01	.00	.00	.14	.00	1.20	.00	.00	.00	.00	.00
12	.55	.00	.00	.00	.01	.00	.14	.00	.20	.00	.00	.00
13	.26	.04	.00	.00	1.07	.00	.01	.00	.40	.00	.00	.00
14	.10	.14	.00	.00	.12	.00	.01	.25	.00	.00	.00	.00
15	.00	.02	.00	.00	.37	.44	.02	.35	.00	.00	.00	.00
16	.00	.02	.00	.04	.39	.01	.00	.01	.60	.00	.00	.00
17	.00	.08	.00	.06	.36	.00	.01	.25	.00	.00	.00	.00
18	.00	.00	.00	.00	.57	.00	.01	.50	.10	.00	.00	.45
19	.00	.00	.18	.00	.34	.04	.00	.00	.00	.00	.00	.00
20	.00	.00	.20	.13	.01	.05	.06	.01	.00	.00	.00	.02
21	.00	1.48	1.30	.22	.00	.25	.01	.03	.00	.00	.00	.30
22	.00	.05	.12	.36	.00	.07	.04	.00	.00	.00	.00	.05
23	.00	.11	.00	.05	.06	.31	.14	.18	.00	.00	.00	.00
24	.23	.01	2.58	.06	.29	.24	.01	.30	.00	.00	.00	.00
25	.05	.16	1.23	.05	.02	.70	.02	.16	.00	.00	.00	.02
26	.55	.00	.11	.61	.17	.07	.01	.00	.00	.00	.00	1.25
27	.02	.31	.18	.45	.01	.01	.31	.00	.00	.00	.00	.30
28	.00	.01	.00	.33	.01	.05	.01	.00	.00	.00	.00	.00
29	.00	.84	.20	.01	---	.16	.00	.00	.00	.00	.00	.00
30	.00	.18	.00	.00	---	.13	.00	.02	.00	.00	.05	.00
31	.06	---	.00	.01	---	.53	---	.00	---	.00	.00	---
TOTAL	1.84	6.98	12.17	2.38	4.54	4.26	3.40	2.65	3.60	0.15	0.05	2.43

WTR YR 1981 TOTAL 44.45

STATION NUMBER 14192040 BEST ORCHARDS, SALEM, OR. (RG)
LATITUDE 445706 LONGITUDE 1230658

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.01	.11	.00	.00	.02	.00	.48
2					.00	.02	.03	.00	.00	.01	.00	1.68
3					.05	.44	.00	.00	.00	.01	.00	.02
4					.05	.15	.00	.88	.00	.00	.00	.02
5					.25	.30	.00	.61	.03	.00	.00	.11
6					.95	.05	.06	1.30	.00	.00	.00	.01
7					.55	.00	.00	.00	.00	.00	.00	.23
8					.25	.00	.40	.00	.00	.00	.00	.09
9					.16	.00	.43	.00	.00	.11	.00	.00
10					1.12	.00	.34	.00	.00	.04	.00	.00
11					.42	.00	.04	.00	.00	.01	.00	.00
12					.43	.00	.47	.00	.00	.00	.00	.00
13					.03	.00	.09	.00	.00	.00	.14	.00
14					.00	.03	.04	.00	.05	.00	.11	.00
15					.08	.27	.10	.00	.00	.00	.29	.00
16					.78	.10	.36	.00	.88	.00	.06	.00
17					.32	.05	.13	.00	.05	.00	.00	.00
18					.12	.03	.09	.00	.01	.00	.10	.00
19					.20	.00	.00	.00	.00	.00	.17	.00
20					.19	.00	.01	.00	.00	.00	.01	.00
21					.01	.00	.01	.00	.00	.00	.74	.00
22					.41	.00	.03	.00	.00	.00	.01	.00
23					.15	.00	.38	.00	.00	.00	.01	.00
24					.31	.00	.01	.00	.00	.00	.00	.00
25					.21	.00	.01	.00	.00	.00	.00	.00
26					.01	.25	.01	.00	.00	.00	.00	.00
27					.60	.26	.42	.04	.00	.00	.00	.00
28					.34	.02	.01	.05	.00	.00	.00	.00
29					---	.10	.00	.00	.00	.00	.00	.00
30					---	.09	.00	.00	.04	.00	.00	.00
31					---	.00	---	.00	---	.00	.00	---
TOTAL					7.99	2.17	3.58	2.88	1.06	0.20	1.64	2.64

STATION NUMBER 14199640 MARY EYRE SCHOOL, SALEM, OR. (RG)
LATITUDE 445508 LONGITUDE 1225749

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.48	.02	1.00	.00	.00	.00	.19	.00	.00	.11
2	.00	.10	1.45	.18	.60	.00	.00	.00	.31	.00	.00	.29
3	.00	.13	.13	.06	.00	.05	.00	.00	.01	.20	.00	.00
4	.00	.33	.93	.66	.00	.05	.18	.00	.00	.05	.00	.00
5	.00	.04	.00	.29	.15	.20	.32	.00	.00	.00	.00	.00
6	.00	.00	.00	.05	.20	.00	.74	.00	.00	.00	.00	.06
7	.00	.00	.00	.09	.00	.10	.03	.00	.24	.00	.00	.01
8	.00	.00	.00	.44	.00	.00	.18	.19	.09	.00	.00	.00
9	.00	.00	.18	1.01	.00	.00	.69	.22	.00	.00	.00	.00
10	.00	.00	.00	.20	.00	.30	.02	.00	.00	.00	.00	.00
11	.00	.00	.00	.52	.00	.05	.01	.00	.00	.00	.00	.00
12	.00	.00	.03	1.22	.00	.50	.01	.00	.01	.00	.00	.14
13	.01	.00	.01	.68	.00	.65	.01	.00	.81	.00	.00	.02
14	.06	.01	.00	1.45	.00	.10	.27	.00	.00	.00	.00	.04
15	.01	.04	.00	.05	.00	.15	.01	.00	.00	.00	.00	.00
16	.02	.27	.03	.32	.00	.00	.01	.00	.00	.00	.00	.00
17	.01	.53	.83	.04	.50	.00	.00	.00	.00	.00	.00	.00
18	1.46	.37	.24	.01	.35	.00	.00	.00	.00	.00	.00	.13
19	.83	.01	.16	.00	.05	.00	.24	.00	.00	.00	.00	.05
20	.93	.00	.35	.00	.00	.15	.64	.00	.00	.00	.00	.21
21	.01	.01	.34	.00	.00	.01	.07	.13	.00	.00	.00	.00
22	.22	.81	.03	.00	.15	.00	.00	.09	.00	.00	.00	.00
23	.10	.19	.88	.00	.00	.01	.00	.06	.00	.00	.00	.00
24	.54	.37	.09	.00	.10	.00	.03	.00	.26	.00	.00	.00
25	.43	.44	.00	.00	.55	.00	.00	.00	.06	.00	.00	.00
26	.25	.08	.00	.01	.20	.24	.00	.59	.00	.00	.00	.00
27	.47	.00	.01	.05	.20	.00	.00	.00	.00	.00	.00	.00
28	.44	.00	.01	.00	.15	.00	.00	.01	.00	.00	.00	.00
29	.01	.01	.05	.00	---	.04	.00	.00	.00	.00	.00	.00
30	.35	.05	.39	.00	---	.00	.00	.00	.00	.00	.00	.00
31	.01	---	.37	.00	---	.22	---	.00	---	.00	.00	---
TOTAL	6.16	3.79	6.99	7.35	4.20	2.82	3.46	1.29	1.98	0.25	0.00	1.06

WTR YR 1980 TOTAL 39.35

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.51	.27	.00	.00	.00	.02	.00	.00	.00	.00	.04
2	.00	.04	2.25	.00	.01	.01	.05	.00	.00	.00	.00	.00
3	.00	.08	2.07	.00	.00	.92	.01	.04	.05	.00	.00	.00
4	.00	.01	.37	.00	.25	.10	.00	.19	.10	.00	.00	.00
5	.00	.37	.14	.00	.27	.00	.20	.05	.30	.00	.00	.00
6	.00	.51	.05	.00	.02	.00	.00	.11	.00	.10	.00	.00
7	.00	.85	.01	.00	.03	.10	.03	.06	1.10	.05	.00	.00
8	.00	.25	.11	.00	.00	.00	.45	.01	.60	.00	.00	.00
9	.00	.13	.09	.00	.00	.00	.02	.02	.20	.00	.00	.00
10	.00	.00	.05	.00	.00	.00	.15	.00	.30	.00	.00	.00
11	.02	.01	.00	.00	.10	.00	.75	.00	.00	.00	.00	.00
12	.49	.00	.00	.00	.01	.00	.03	.00	.20	.00	.00	.00
13	.21	.01	.00	.00	.88	.00	.00	.00	.30	.00	.00	.00
14	.06	.16	.00	.00	.04	.00	.00	.22	.01	.00	.00	.00
15	.01	.03	.00	.00	.31	.45	.01	.19	.01	.00	.00	.00
16	.00	.02	.00	.01	.30	.00	.00	.01	.50	.00	.00	.00
17	.00	.06	.05	.05	.27	.00	.00	.29	.01	.00	.00	.00
18	.00	.01	.01	.01	.39	.00	.00	.48	.10	.00	.00	.40
19	.00	.00	.16	.00	.32	.01	.00	.10	.00	.00	.00	.01
20	.00	.00	.21	.09	.01	.00	.02	.00	.00	.00	.00	.02
21	.00	1.74	1.23	.21	.00	.15	.00	.08	.00	.00	.00	.30
22	.00	.05	.29	.35	.00	.05	.05	.02	.00	.00	.00	.05
23	.00	.06	.01	.08	.07	.20	.13	.17	.00	.00	.00	.00
24	.15	.01	2.27	.01	.34	.30	.01	.30	.00	.00	.00	.00
25	.01	.06	2.02	.06	.01	.55	.00	.21	.00	.00	.00	.02
26	.35	.00	.11	.48	.13	.07	.01	.00	.00	.00	.00	1.25
27	.00	.32	.23	.44	.01	.00	.22	.00	.00	.00	.00	.30
28	.00	.01	.01	.34	.00	.05	.01	.00	.00	.00	.00	.00
29	.00	.72	.25	.01	---	.20	.00	.00	.00	.00	.00	.00
30	.00	.09	.01	.01	---	.03	.00	.02	.00	.00	.05	.00
31	.07	---	.00	.00	---	.50	---	.00	---	.00	.00	---
TOTAL	1.37	6.11	12.27	2.15	3.77	3.69	2.17	2.57	3.78	0.15	0.05	2.39

WTR YR 1981 TOTAL 40.47

Table 11.--Daily precipitetion for rain gages in the Salem, Oregon area--Continued

STATION NUMBER 14199855 LITTLE PUDDING RIVER TRIBUTARY, LARDON ROAD, SALEM, OR (RG,CG)
LATITUDE 445813 LONGITUDE 1225555

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.01	.10	.00	.00	.08	.00	.33
2					.00	.01	.04	.00	.00	.02	.00	1.05
3					.05	.42	.00	.00	.00	.00	.00	.11
4					.05	.21	.00	.68	.00	.00	.00	.01
5					.25	.00	.00	.69	.05	.00	.00	.08
6					.95	.07	.18	.62	.00	.00	.00	.02
7					.55	.01	.00	.11	.00	.00	.00	.08
8					.11	.00	.14	.13	.00	.00	.00	.39
9					.03	.00	.30	.04	.00	.17	.00	.00
10					.95	.00	.24	.01	.00	.01	.00	.00
11					.25	.00	.02	.00	.00	.01	.00	.00
12					.37	.00	.25	.00	.00	.00	.00	.00
13					.05	.00	.13	.00	.00	.00	.03	.00
14					.00	.00	.03	.00	.00	.00	.15	.00
15					.10	.23	.03	.00	.00	.00	.17	.00
16					.60	.14	.29	.00	.82	.00	.03	.00
17					.20	.00	.34	.00	.05	.00	.00	.00
18					.18	.00	.26	.00	.00	.00	.14	.00
19					.14	.00	.00	.00	.00	.00	.16	.00
20					.16	.00	.00	.00	.00	.00	.01	.00
21					.00	.00	.00	.00	.00	.00	.00	.00
22					.28	.00	.03	.00	.00	.00	.00	.00
23					.12	.00	.36	.00	.00	.00	.00	.00
24					.18	.00	.00	.00	.00	.00	.00	.00
25					.14	.00	.01	.00	.00	.00	.00	.00
26					.00	.17	.01	.00	.00	.00	.00	.00
27					.38	.29	.29	.00	.00	.00	.00	.00
28					.10	.04	.02	.18	.00	.00	.00	.00
29					---	.01	.01	.00	.00	.00	.00	.00
30					---	.03	.01	.00	.02	.00	.00	.00
31					---	.01	---	.00	---	.00	.00	---
TOTAL					6.19	1.65	3.09	2.46	0.94	0.29	0.69	2.07

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.58	.02	.88	.00	.00	.00	.13	.01	.00	.17
2	.00	.10	1.38	.16	.77	.00	.00	.00	.14	.00	.00	.25
3	.00	.24	.10	.06	.06	.09	.04	.00	.06	.24	.00	.00
4	.00	.35	.88	.69	.00	.06	.19	.00	.01	.04	.00	.00
5	.00	.11	.00	.32	.06	.29	.27	.00	.00	.00	.00	.00
6	.00	.00	.00	.01	.30	.00	.82	.00	.00	.00	.00	.01
7	.00	.00	.00	.13	.00	.19	.01	.00	.31	.00	.00	.00
8	.00	.00	.00	.46	.01	.01	.18	.00	.10	.00	.00	.00
9	.00	.00	.18	1.20	.00	.00	.56	.17	.00	.00	.00	.00
10	.00	.00	.00	.11	.00	.49	.04	.12	.00	.00	.00	.00
11	.00	.00	.00	.52	.00	.08	.01	.01	.00	.00	.00	.00
12	.00	.00	.05	.93	.01	.32	.01	.00	.08	.00	.00	.14
13	.04	.00	.00	.62	.00	.92	.00	.00	.90	.00	.00	.01
14	.11	.00	.00	1.34	.00	.12	.28	.01	.01	.00	.00	.06
15	.00	.04	.01	.04	.17	.26	.01	.01	.00	.00	.00	.00
16	.02	.29	.03	.37	.00	.00	.00	.00	.00	.00	.00	.00
17	.01	.47	.90	.03	.44	.30	.00	.00	.00	.00	.00	.00
18	1.46	.29	.23	.00	.38	.02	.00	.00	.00	.00	.00	.23
19	.83	.00	.09	.00	.05	.01	.32	.00	.00	.00	.00	.09
20	.76	.00	.46	.00	.00	.04	.63	.00	.00	.00	.00	.12
21	.01	.01	.31	.00	.00	.01	.07	.20	.00	.00	.00	.00
22	.22	.89	.00	.00	.14	.00	.00	.15	.00	.00	.00	.00
23	.10	.24	.88	.00	.01	.01	.00	.12	.00	.00	.00	.00
24	.54	.40	.08	.00	.13	.00	.03	.01	.29	.00	.00	.00
25	.28	.47	.00	.00	.52	.01	.00	.01	.13	.00	.00	.00
26	.25	.03	.00	.01	.16	.20	.00	.35	.01	.00	.00	.00
27	.47	.01	.01	.07	.20	.00	.00	.00	.00	.00	.00	.00
28	.44	.00	.02	.00	.16	.00	.00	.00	.00	.00	.00	.00
29	.01	.02	.09	.00	.01	.12	.00	.00	.00	.00	.00	.00
30	.35	.04	.35	.00	---	.01	.00	.01	.00	.00	.00	.00
31	.01	---	.39	.00	---	.25	---	.00	---	.00	.00	---
TOTAL	5.91	4.00	7.02	7.09	4.46	3.81	3.47	1.17	2.17	0.29	0.00	1.08

WTR YR 1980 TOTAL 40.47

STATION NUMBER 14199855 LITTLE PUDDING RIVER TRIBUTARY, LARDON ROAD, SALEM, OR (RG,CG)
LATITUDE 445813 LONGITUDE 1225555

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.43	.26	.00	.00	.00	.06	.00	.00	.00	.00	.04
2	.00	.05	1.87	.00	.00	.00	.08	.00	.00	.00	.00	.00
3	.00	.08	1.84	.00	.00	1.02	.01	.02	.05	.00	.00	.00
4	.00	.01	.36	.00	.20	.10	.01	.11	.10	.00	.00	.00
5	.00	.31	.05	.00	.25	.02	.16	.05	.30	.00	.00	.00
6	.00	.41	.02	.00	.00	.00	.14	.09	.00	.10	.00	.00
7	.00	.83	.00	.00	.00	.13	.05	.03	1.10	.05	.00	.00
8	.00	.36	.06	.00	.00	.00	.58	.00	.60	.00	.00	.00
9	.00	.11	.08	.00	.00	.00	.02	.00	.20	.00	.00	.00
10	.00	.00	.02	.00	.00	.00	.12	.00	.30	.00	.00	.00
11	.02	.02	.00	.00	.10	.00	.90	.00	.00	.00	.00	.00
12	.56	.00	.00	.00	.00	.00	.01	.00	.20	.00	.00	.00
13	.28	.00	.00	.00	.71	.00	.00	.00	.30	.00	.00	.00
14	.03	.17	.00	.00	.04	.00	.00	.23	.01	.00	.00	.00
15	.01	.00	.00	.00	.23	.41	.01	.21	.01	.00	.00	.00
16	.00	.00	.00	.03	.32	.00	.00	.01	.52	.00	.00	.00
17	.00	.05	.02	.05	.23	.01	.00	.26	.01	.00	.00	.00
18	.00	.00	.01	.00	.33	.00	.00	.40	.13	.00	.00	.40
19	.00	.00	.19	.00	.26	.03	.00	.00	.00	.00	.00	.02
20	.00	.00	.25	.15	.01	.01	.05	.00	.00	.00	.00	.10
21	.00	1.23	.96	.20	.00	.16	.00	.00	.00	.00	.00	.30
22	.00	.05	.44	.35	.00	.03	.07	.01	.00	.00	.00	.05
23	.00	.06	.00	.10	.08	.18	.20	.19	.00	.00	.00	.01
24	.28	.00	1.76	.05	.30	.30	.00	.36	.00	.00	.00	.01
25	.01	.14	1.51	.05	.01	.65	.00	.22	.00	.00	.00	.10
26	.39	.00	.25	.45	.13	.04	.01	.00	.00	.00	.00	1.25
27	.02	.32	.18	.40	.01	.00	.24	.00	.00	.00	.00	.30
28	.00	.01	.01	.40	.00	.04	.00	.00	.00	.00	.00	.01
29	.01	.57	.25	.01	---	.21	.00	.00	.00	.00	.00	.01
30	.00	.08	.00	.00	---	.04	.00	.02	.00	.00	.05	.00
31	.08	---	.00	.00	---	.42	---	.00	---	.00	.00	---
TOTAL	1.69	5.29	10.39	2.24	3.21	3.80	2.72	2.21	3.83	0.15	0.05	2.60

WTR YR 1981 TOTAL 38.18

STATION NUMBER 14200050 LITTLE PUDDING RIVER TRIBUTARY, KALE ROAD, SALEM, OR (RG,SG)
LATITUDE 445952 LONGITUDE 1225743

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.00	.13	.00	.00	.14	.00	.37
2					.00	.33	.01	.00	.00	.04	.00	1.62
3					.05	.18	.00	.00	.00	.00	.00	.33
4					.05	.21	.00	.62	.00	.00	.00	.01
5					.25	.00	.00	.71	.05	.00	.00	.15
6					.95	.07	.18	.77	.00	.00	.00	.00
7					.55	.01	.00	.15	.00	.00	.00	.06
8					.07	.00	.14	.03	.00	.00	.00	.11
9					.02	.00	.30	.02	.00	.12	.00	.00
10					1.01	.00	.24	.00	.00	.02	.00	.00
11					.24	.00	.02	.00	.00	.00	.00	.00
12					.33	.00	.25	.00	.00	.00	.00	.00
13					.04	.00	.13	.00	.00	.00	.02	.00
14					.02	.00	.03	.00	.00	.00	.08	.00
15					.10	.23	.03	.00	.00	.00	.11	.00
16					.70	.06	.29	.00	.65	.00	.03	.00
17					.17	.00	.34	.00	.03	.00	.00	.00
18					.18	.02	.26	.00	.00	.00	.07	.00
19					.14	.01	.00	.00	.00	.00	.18	.00
20					.27	.00	.00	.00	.00	.00	.01	.00
21					.00	.00	.00	.00	.00	.00	.03	.00
22					.26	.00	.03	.00	.00	.00	.01	.00
23					.12	.02	.36	.00	.00	.00	.00	.00
24					.18	.00	.01	.00	.00	.00	.00	.00
25					.12	.07	.01	.00	.00	.00	.00	.00
26					.00	.17	.01	.00	.00	.00	.00	.00
27					.38	.29	.29	.00	.00	.00	.00	.00
28					.10	.04	.02	.20	.00	.00	.00	.00
29					---	.01	.01	.00	.00	.00	.00	.00
30					---	.03	.01	.00	.12	.00	.00	.00
31					---	.01	---	.00	---	.00	.00	---
TOTAL					6.30	1.76	3.10	2.50	0.85	0.32	0.54	2.65

Table 11.--Daily precipitation for rain gages in the Salem, Oregon area--Continued

STATION NUMBER 14192040 BEST ORCHARDS, SALEM, OR. (RG)
LATITUDE 445706 LONGITUDE 1230658

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.41	.08	1.40	.00	.00	.00	.00	.00	.00	.03
2	.00	.24	1.34	.18	.67	.00	.00	.00	.05	.00	.00	.20
3	.00	.32	.18	.05	.01	.11	.03	.00	.20	.21	.00	.00
4	.00	.30	.58	.61	.00	.06	.18	.00	.01	.02	.00	.00
5	.00	.02	.01	.30	.29	.23	.34	.00	.01	.00	.00	.00
6	.00	.00	.00	.01	.19	.01	.92	.00	.02	.00	.00	.00
7	.00	.00	.00	.03	.00	.09	.03	.00	.00	.00	.00	.00
8	.00	.00	.02	.48	.00	.01	.13	.16	.25	.00	.00	.00
9	.00	.00	.20	1.09	.00	.00	.64	.30	.02	.00	.00	.00
10	.00	.00	.08	.22	.00	.06	.06	.22	.00	.00	.00	.00
11	.00	.00	.01	.70	.00	.18	.00	.01	.00	.00	.00	.00
12	.00	.00	.13	1.18	.00	.39	.00	.00	.00	.00	.00	.24
13	.02	.00	.01	.81	.00	.90	.00	.00	1.01	.00	.00	.01
14	.02	.00	.00	1.19	.00	.22	.31	.01	.00	.00	.00	.05
15	.01	.02	.01	.03	.15	.27	.01	.01	.00	.00	.00	.00
16	.02	.22	.04	.31	.02	.00	.00	.00	.00	.00	.00	.00
17	.00	.27	.86	.04	.54	.22	.00	.00	.00	.00	.00	.00
18	1.31	.55	.31	.02	.30	.01	.05	.00	.00	.00	.00	.34
19	.75	.00	.24	.00	.09	.00	.64	.00	.00	.00	.00	.18
20	.56	.00	.81	.00	.01	.14	.60	.00	.00	.00	.00	.09
21	.03	.02	.29	.00	.00	.01	.03	.12	.00	.00	.00	.00
22	.22	1.17	.01	.00	.15	.00	.00	.11	.01	.00	.00	.00
23	.03	.32	1.01	.00	.01	.01	.00	.11	.02	.00	.00	.00
24	.82	.50	.05	.00	.12	.00	.00	.01	.50	.00	.00	.00
25	.68	.25	.00	.00	.68	.01	.00	.02	.06	.00	.00	.00
26	.23	.11	.01	.02	.28	.17	.00	.71	.01	.00	.00	.00
27	.57	.00	.00	.01	.28	.01	.00	.01	.00	.00	.00	.00
28	.51	.00	.04	.00	.14	.00	.00	.00	.00	.00	.00	.00
29	.01	.01	.03	.01	.01	.09	.00	.00	.00	.00	.00	.00
30	.52	.01	.19	.00	---	.01	.00	.00	.00	.00	.00	.00
31	.00	---	.96	.00	---	.25	---	.00	---	.00	.00	---
TOTAL	6.31	4.33	7.83	7.37	5.34	3.46	3.97	1.80	2.17	0.23	0.00	1.14

WTR YR 1980 TOTAL 43.95

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.55	.30	.00	.00	.00	.06	.00	.00	.00	.00	.04
2	.00	.08	1.65	.00	.01	.00	.12	.00	.00	.00	.00	.00
3	.00	.08	1.64	.00	.04	1.15	.02	.01	.05	.00	.00	.00
4	.00	.01	.28	.00	.22	.29	.00	.19	.05	.00	.00	.00
5	.00	.35	.20	.00	.10	.00	.19	.04	.30	.00	.00	.00
6	.00	.44	.06	.00	.00	.00	.00	.12	.00	.10	.00	.00
7	.00	.99	.13	.00	.00	.27	.04	.01	1.10	.05	.00	.00
8	.00	.26	.12	.00	.00	.00	.60	.01	1.00	.00	.00	.00
9	.00	.13	.05	.00	.00	.00	.06	.01	.16	.00	.00	.00
10	.00	.00	.00	.00	.00	.00	.10	.00	.12	.00	.00	.00
11	.02	.01	.00	.00	.10	.00	.63	.00	.00	.00	.00	.00
12	.72	.00	.00	.00	.00	.00	.02	.01	.25	.00	.00	.00
13	.33	.00	.00	.00	.90	.00	.00	.00	.60	.00	.00	.00
14	.13	.15	.00	.00	.08	.00	.00	.20	.01	.00	.00	.00
15	.00	.02	.00	.00	.21	.47	.03	.26	.01	.00	.00	.00
16	.00	.00	.00	.05	.42	.01	.00	.01	.60	.00	.00	.00
17	.00	.07	.00	.09	.23	.00	.00	.42	.00	.00	.00	.01
18	.00	.00	.00	.03	.50	.02	.00	.73	.18	.00	.00	.40
19	.00	.00	.19	.00	.32	.01	.00	.00	.03	.00	.00	.01
20	.00	.00	.21	.19	.01	.05	.04	.00	.00	.00	.00	.02
21	.00	.86	1.10	.20	.00	.18	.01	.01	.00	.00	.00	.30
22	.00	.09	.25	.36	.00	.10	.02	.00	.00	.00	.00	.05
23	.00	.09	.01	.11	.11	.14	.11	.20	.00	.00	.00	.00
24	.26	.01	1.84	.09	.30	.34	.01	.25	.00	.00	.00	.00
25	.07	.12	2.21	.07	.01	.60	.00	.08	.00	.00	.00	.02
26	.34	.00	.12	.31	.06	.22	.00	.00	.00	.00	.00	1.25
27	.03	.46	.08	.42	.01	.00	.29	.00	.00	.00	.00	.32
28	.00	.08	.00	.45	.00	.00	.01	.00	.00	.00	.00	.00
29	.00	.59	.20	.04	---	.29	.00	.00	.00	.00	.00	.00
30	.00	.04	.01	.01	---	.02	.00	.02	.00	.00	.05	.00
31	.12	---	.00	.01	---	.41	---	.00	---	.00	.00	---
TOTAL	2.02	5.48	10.65	2.43	3.63	4.57	2.36	2.58	4.46	0.15	0.05	2.42

WTR YR 1981 TOTAL 40.80

STATION NUMBER 14192110 CHAPMAN HILL, SALEM, OR. (RG)
LATITUDE 445737 LONGITUDE 1230404

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.58	.25	.00	.00	.00	.08	.00	.00	.00	.00	.04
2	.00	.06	1.90	.00	.01	.01	.12	.00	.00	.00	.00	.00
3	.00	.09	1.70	.00	.01	1.08	.02	.01	.05	.00	.00	.00
4	.00	.01	.60	.00	.29	.08	.00	.26	.05	.00	.00	.00
5	.00	.40	.60	.00	.12	.00	.20	.02	.30	.00	.00	.00
6	.00	.44	.10	.00	.00	.00	.00	.12	.00	.09	.00	.00
7	.00	1.15	.00	.00	.00	.27	.05	.01	1.10	.06	.00	.00
8	.00	.35	.10	.00	.00	.00	.29	.01	1.00	.00	.00	.00
9	.00	.18	.05	.00	.00	.00	.04	.01	.15	.00	.00	.00
10	.00	.00	.00	.00	.00	.00	.09	.00	.10	.00	.00	.00
11	.02	.01	.00	.00	.10	.00	.83	.00	.00	.00	.00	.00
12	.72	.00	.00	.00	.00	.00	.02	.01	.25	.00	.00	.00
13	.33	.00	.00	.00	.82	.00	.00	.01	.60	.00	.00	.00
14	.09	.16	.00	.00	.08	.00	.00	.25	.01	.00	.00	.00
15	.00	.02	.00	.00	.20	.41	.02	.26	.01	.00	.00	.00
16	.00	.00	.00	.05	.47	.00	.00	.00	.60	.00	.00	.00
17	.00	.07	.00	.08	.26	.00	.00	.39	.00	.00	.00	.00
18	.00	.00	.00	.03	.45	.00	.00	.57	.18	.00	.00	.40
19	.00	.00	.20	.00	.35	.02	.00	.01	.03	.00	.00	.02
20	.00	.00	.20	.18	.00	.01	.02	.00	.00	.00	.00	.10
21	.00	1.35	1.10	.21	.00	.18	.01	.00	.00	.00	.00	.30
22	.00	.05	.25	.36	.00	.04	.02	.02	.00	.00	.00	.05
23	.00	.05	.01	.03	.08	.11	.14	.19	.00	.00	.00	.01
24	.22	.00	2.20	.00	.22	.32	.00	.26	.00	.00	.00	.01
25	.04	.10	2.12	.04	.00	.58	.00	.07	.00	.00	.00	.10
26	.36	.00	.10	.39	.08	.16	.00	.00	.00	.00	.00	1.25
27	.03	.30	.08	.40	.01	.00	.30	.00	.00	.00	.00	.30
28	.00	.00	.01	.31	.00	.01	.01	.00	.00	.00	.00	.01
29	.00	.70	.20	.01	---	.29	.00	.00	.00	.00	.00	.01
30	.00	.05	.01	.01	---	.02	.00	.02	.00	.00	.05	.00
31	.09	---	.00	.01	---	.40	---	.00	---	.00	.00	---
TOTAL	1.90	6.12	11.78	2.11	3.55	3.99	2.26	2.50	4.43	0.15	0.05	2.60

WTR YR 1981 TOTAL 41.44

STATION NUMBER 14192150 GIBSON CREEK TRIBUTARY, GIBSON ROAD (RG,SG)
LATITUDE 445859 LONGITUDE 1230617

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.01	.11	.00	.00	.06	.00	.26
2					.00	.02	.03	.00	.00	.01	.00	1.78
3					.05	.44	.00	.00	.00	.00	.00	.19
4					.05	.15	.00	.92	.00	.00	.00	.02
5					.25	.30	.00	.80	.00	.00	.00	.13
6					.95	.05	.06	1.47	.00	.00	.00	.01
7					.55	.00	.00	.00	.00	.00	.00	.22
8					.25	.00	.40	.00	.00	.00	.00	.15
9					.16	.00	.43	.00	.00	.11	.00	.00
10					1.12	.00	.34	.00	.00	.04	.00	.00
11					.42	.00	.04	.00	.00	.01	.00	.00
12					.43	.00	.47	.00	.00	.00	.00	.00
13					.03	.00	.09	.00	.00	.00	.17	.00
14					.00	.03	.04	.00	.00	.00	.15	.00
15					.08	.27	.10	.00	.00	.00	.22	.00
16					.78	.10	.36	.00	.96	.00	.09	.00
17					.32	.05	.13	.00	.02	.00	.00	.00
18					.12	.03	.09	.00	.00	.00	.27	.00
19					.20	.00	.00	.00	.00	.00	.11	.00
20					.19	.00	.01	.00	.00	.00	.00	.00
21					.01	.00	.01	.00	.00	.00	.36	.00
22					.41	.00	.03	.00	.00	.00	.02	.00
23					.15	.00	.38	.00	.00	.00	.01	.00
24					.31	.00	.01	.00	.00	.00	.00	.00
25					.21	.00	.01	.00	.00	.00	.00	.00
26					.01	.25	.01	.00	.00	.00	.00	.00
27					.60	.26	.42	.01	.00	.00	.00	.00
28					.34	.02	.00	.05	.00	.00	.00	.00
29					---	.10	.00	.00	.00	.00	.00	.00
30					---	.09	.00	.02	.04	.00	.00	.00
31					---	.00	---	.00	---	.00	.00	---
TOTAL					7.99	2.17	3.57	3.27	1.02	0.23	1.40	2.76

STATION NUMBER 14192110 CHAPMAN HILL, SALEM, OR. (RG)
LATITUDE 445737 LONGITUDE 1230404

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.01	.11	.00	.00	.03	.00	.30
2					.00	.02	.03	.00	.00	.01	.00	2.04
3					.05	.44	.00	.00	.00	.00	.00	.11
4					.05	.15	.00	.80	.00	.00	.00	.01
5					.25	.30	.00	.55	.03	.00	.00	.14
6					.95	.05	.06	.98	.00	.00	.00	.01
7					.55	.00	.00	.07	.00	.00	.00	.19
8					.25	.00	.40	.02	.00	.00	.00	.19
9					.16	.00	.43	.01	.00	.18	.00	.02
10					1.12	.00	.34	.01	.00	.02	.00	.00
11					.42	.00	.04	.00	.00	.01	.00	.00
12					.43	.00	.47	.00	.00	.00	.00	.00
13					.03	.00	.09	.00	.00	.00	.09	.00
14					.00	.03	.04	.00	.07	.00	.14	.00
15					.08	.27	.10	.00	.04	.00	.24	.00
16					.78	.10	.36	.00	.89	.00	.02	.00
17					.32	.05	.13	.00	.04	.00	.00	.00
18					.12	.03	.09	.00	.01	.00	.16	.00
19					.20	.00	.00	.00	.00	.00	.16	.00
20					.19	.00	.01	.00	.00	.00	.01	.00
21					.01	.00	.01	.00	.00	.00	.32	.00
22					.41	.00	.03	.00	.00	.00	.01	.00
23					.15	.00	.38	.00	.00	.00	.00	.00
24					.31	.00	.01	.00	.00	.00	.00	.00
25					.21	.00	.01	.00	.00	.00	.00	.00
26					.01	.25	.01	.00	.00	.00	.00	.00
27					.60	.26	.42	.04	.00	.00	.00	.00
28					.34	.02	.01	.05	.00	.00	.00	.00
29					---	.10	.00	.00	.00	.00	.00	.00
30					---	.09	.00	.00	.00	.00	.00	.00
31					---	.00	---	.00	---	.00	.00	---
TOTAL					7.99	2.17	3.58	2.53	1.08	0.25	1.15	3.01

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.45	.05	1.33	.00	.01	.00	.00	.00	.00	.04
2	.00	.21	1.35	.13	.67	.00	.00	.00	.00	.00	.00	.18
3	.00	.27	.12	.05	.01	.10	.02	.00	.18	.20	.00	.00
4	.00	.21	.63	.61	.00	.05	.14	.00	.01	.01	.00	.01
5	.00	.03	.00	.31	.21	.25	.36	.00	.01	.00	.00	.00
6	.00	.00	.00	.03	.23	.00	1.01	.00	.03	.00	.00	.00
7	.00	.00	.00	.11	.00	.03	.01	.00	.00	.00	.00	.00
8	.00	.00	.00	.49	.00	.01	.16	.00	.26	.00	.00	.00
9	.00	.00	.19	1.18	.00	.00	.66	.30	.04	.00	.00	.00
10	.00	.00	.05	.20	.00	.38	.02	.20	.00	.00	.00	.00
11	.00	.01	.01	.70	.00	.14	.00	.01	.00	.00	.00	.00
12	.00	.01	.08	1.20	.00	.49	.00	.00	.00	.00	.00	.17
13	.01	.01	.00	.82	.00	1.01	.00	.00	1.02	.00	.00	.00
14	.00	.00	.00	1.20	.00	.24	.46	.01	.00	.00	.00	.08
15	.01	.02	.01	.05	.01	.29	.01	.01	.00	.00	.00	.00
16	.01	.24	.02	.32	.00	.00	.01	.00	.00	.00	.00	.01
17	.00	.28	1.19	.00	.52	.25	.00	.00	.00	.00	.00	.00
18	1.55	.29	.31	.00	.32	.01	.03	.00	.00	.00	.00	.28
19	.72	.00	.16	.00	.07	.00	.49	.00	.00	.00	.00	.14
20	.56	.00	.75	.00	.00	.26	.53	.00	.00	.00	.00	.11
21	.02	.01	.36	.00	.00	.01	.03	.10	.00	.00	.00	.00
22	.19	1.19	.00	.00	.16	.00	.00	.10	.00	.00	.00	.00
23	.05	.30	.85	.00	.01	.01	.00	.10	.04	.00	.00	.00
24	.73	.41	.03	.00	.13	.00	.00	.01	.49	.00	.00	.00
25	.22	.29	.00	.00	.35	.01	.00	.02	.05	.00	.00	.00
26	.25	.12	.00	.00	.13	.20	.00	.70	.01	.00	.00	.00
27	.44	.00	.00	.00	.19	.01	.00	.01	.00	.00	.00	.00
28	.35	.00	.05	.00	.18	.00	.00	.00	.00	.00	.00	.00
29	.00	.01	.03	.00	---	.08	.00	.00	.00	.00	.00	.00
30	.44	.03	.18	.00	---	.00	.00	.00	.00	.00	.00	.00
31	.00	---	.77	.00	---	.22	---	.00	---	.00	.00	---
TOTAL	5.55	3.94	7.59	7.45	4.52	4.05	3.95	1.57	2.14	0.21	0.00	1.02

WTR YR 1980 TOTAL 41.99

Table 11.--Daily precipitation for rain gages in the Salem, Oregon area--Continued

STATION NUMBER 14192150 GIBSON CREEK TRIBUTARY, GIBSON ROAD (RG,SG)
LATITUDE 445859 LONGITUDE 1230617

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.41	.14	1.22	.00	.00	.00	.00	.00	.00	.03
2	.00	.24	1.09	.16	.75	.00	.00	.00	.05	.00	.00	.18
3	.00	.32	.18	.06	.01	.03	.02	.00	.17	.27	.00	.00
4	.00	.30	.58	.67	.00	.03	.11	.00	.01	.06	.00	.00
5	.00	.02	.00	.26	.27	.31	.21	.00	.00	.00	.00	.00
6	.00	.00	.00	.07	.18	.00	.57	.00	.01	.00	.00	.00
7	.00	.00	.00	.18	.00	.09	.02	.00	.01	.00	.00	.00
8	.00	.00	.00	.53	.00	.00	.08	.00	.27	.00	.00	.00
9	.00	.00	.22	1.24	.00	.00	.40	.22	.06	.00	.00	.00
10	.00	.00	.11	.35	.00	.04	.04	.21	.00	.00	.00	.00
11	.00	.00	.01	.76	.00	.11	.00	.01	.00	.00	.00	.00
12	.00	.00	.19	1.29	.00	.24	.00	.00	.00	.00	.00	.22
13	.01	.00	.02	.88	.00	.56	.00	.00	.00	.00	.00	.01
14	.02	.00	.00	1.21	.00	.14	.19	.01	1.03	.00	.00	.04
15	.01	.02	.01	.07	.16	.17	.01	.01	.00	.00	.00	.00
16	.06	.22	.03	.34	.02	.00	.00	.00	.00	.00	.00	.00
17	.00	.27	1.02	.05	.57	.14	.00	.00	.00	.00	.00	.00
18	1.51	.55	.36	.03	.35	.01	.03	.00	.00	.00	.00	.31
19	.99	.00	.25	.06	.12	.00	.40	.00	.00	.00	.00	.16
20	.61	.00	.92	.04	.01	.09	.37	.00	.00	.00	.00	.08
21	.03	.02	.40	.00	.00	.01	.02	.01	.00	.00	.00	.00
22	.28	1.17	.01	.00	.17	.00	.00	.09	.00	.00	.00	.00
23	.05	.32	1.14	.00	.01	.01	.00	.16	.04	.00	.00	.00
24	.76	.50	.08	.00	.12	.00	.00	.09	.49	.00	.00	.00
25	.68	.25	.00	.00	.64	.01	.00	.00	.05	.00	.00	.00
26	.23	.11	.00	.04	.36	.11	.00	.01	.01	.00	.00	.00
27	.57	.00	.01	.02	.33	.01	.00	.13	.00	.00	.00	.00
28	.51	.00	.05	.00	.22	.00	.00	.01	.00	.00	.00	.00
29	.01	.01	.04	.03	.02	.06	.00	.00	.00	.00	.00	.00
30	.52	.01	.19	.02	---	.01	.00	.00	.00	.00	.00	.00
31	.00	---	1.24	.00	---	.16	---	.01	---	---	.00	---
TOTAL	6.85	4.33	8.56	8.50	5.53	2.34	2.47	0.97	2.20	0.33	0.00	1.03

WTR YR 1980 TOTAL 43.11

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.50	.38	.00	.01	.01	.07	.00	.00	.00	.00	.04
2	.00	.05	1.85	.00	.00	.00	.23	.00	.00	.00	.00	.00
3	.00	.08	1.59	.00	.00	1.05	.02	.01	.05	.00	.00	.00
4	.00	.00	.39	.00	.26	.11	.01	.17	.05	.00	.00	.00
5	.00	.35	.27	.00	.08	.00	.25	.03	.31	.00	.00	.00
6	.00	.55	.07	.00	.05	.00	.00	.12	.00	.09	.00	.00
7	.00	.70	.07	.00	.00	.25	.02	.01	1.08	.06	.00	.00
8	.00	.25	.16	.00	.00	.00	.32	.01	1.08	.00	.00	.00
9	.00	.10	.13	.00	.00	.00	.06	.01	.16	.00	.00	.00
10	.00	.00	.00	.00	.00	.00	.14	.00	.12	.00	.00	.00
11	.03	.00	.00	.00	.10	.00	1.11	.00	.00	.00	.00	.00
12	.58	.00	.00	.00	.00	.00	.03	.01	.24	.00	.00	.00
13	.28	.00	.02	.00	.86	.00	.00	.00	.60	.00	.00	.00
14	.12	.15	.01	.00	.11	.00	.00	.25	.01	.00	.00	.00
15	.01	.00	.00	.00	.24	.46	.03	.25	.01	.00	.00	.00
16	.00	.00	.00	.01	.49	.01	.01	.00	.60	.00	.00	.00
17	.00	.05	.01	.09	.27	.00	.00	.45	.00	.00	.00	.00
18	.00	.00	.03	.04	.63	.01	.00	.64	.18	.00	.00	.40
19	.00	.00	.15	.00	.22	.02	.00	.01	.03	.00	.00	.01
20	.00	.02	.19	.18	.02	.03	.03	.00	.00	.00	.00	.10
21	.00	.99	1.40	.22	.00	.27	.00	.00	.00	.00	.00	.30
22	.00	.08	.23	.38	.00	.08	.02	.00	.00	.00	.00	.05
23	.00	.07	.01	.06	.09	.21	.16	.17	.00	.00	.00	.01
24	.20	.01	2.04	.33	.29	.40	.01	.23	.00	.00	.00	.01
25	.01	.13	2.43	.08	.01	.58	.00	.05	.00	.00	.00	.10
26	.40	.00	.15	.37	.07	.25	.00	.00	.00	.00	.00	1.25
27	.01	.50	.07	.42	.02	.01	.29	.00	.00	.00	.00	.30
28	.00	.10	.01	.39	.01	.00	.01	.00	.00	.00	.00	.00
29	.00	.78	.24	.00	---	.31	.00	.00	.00	.00	.00	.00
30	.00	.07	.00	.01	---	.05	.00	.02	.00	.00	.04	.00
31	.10	---	.00	.01	---	.52	---	.00	---	.00	.00	---
TOTAL	1.74	5.53	11.90	2.59	3.83	4.63	2.82	2.44	4.52	0.15	0.04	2.57

WTR YR 1981 TOTAL 42.76

Table 11.--Daily precipitation for rain gages in the Salem, Oregon area--Continued

STATION NUMBER 14192220 HAWTHORNE DITCH, OUTFLOW, SUNNYVIEW ROAD, SALEM, OR. (RG,SG)
LATITUDE 445720 LONGITUDE 1225921

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.14	.05	.00	.00	.03	.00	.40
2					.00	.00	.01	.00	.00	.01	.00	1.50
3					.05	.12	.00	.00	.00	.00	.00	.16
4					.05	.41	.00	.65	.00	.00	.00	.01
5					.25	.16	.00	.76	.00	.00	.00	.24
6					.95	.21	.11	.71	.00	.00	.00	.01
7					.55	.00	.00	.08	.00	.00	.00	.06
8					.15	.00	.05	.03	.00	.00	.00	.18
9					.06	.00	.19	.01	.00	.17	.00	.02
10					1.01	.00	.18	.00	.00	.02	.00	.00
11					.18	.00	.04	.00	.00	.00	.00	.00
12					.34	.00	.33	.00	.00	.00	.00	.00
13					.15	.00	.08	.00	.00	.00	.03	.00
14					.00	.03	.01	.00	.00	.00	.08	.00
15					.10	.23	.02	.00	.00	.00	.18	.00
16					.70	.02	.18	.00	.97	.00	.04	.00
17					.22	.01	.00	.00	.06	.00	.00	.00
18					.10	.02	.25	.00	.00	.00	.05	.00
19					.14	.00	.00	.00	.00	.00	.22	.00
20					.16	.00	.00	.00	.00	.00	.00	.00
21					.00	.00	.00	.00	.00	.00	.08	.00
22					.28	.00	.02	.00	.00	.00	.02	.00
23					.12	.00	.44	.00	.00	.00	.00	.00
24					.18	.00	.00	.00	.00	.00	.00	.00
25					.10	.00	.00	.00	.00	.00	.00	.00
26					.00	.19	.00	.00	.00	.00	.00	.00
27					.38	.26	.38	.00	.00	.00	.00	.00
28					.10	.02	.00	.39	.00	.00	.00	.00
29					---	.02	.00	.00	.00	.00	.00	.00
30					---	.05	.00	.00	.13	.00	.00	.00
31					---	.00	---	.00	---	.00	.00	---
TOTAL					6.32	1.89	2.34	2.63	1.16	0.23	0.70	2.58

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.62	.05	1.05	.00	.00	.00	.10	.00	.00	.04
2	.00	.12	1.21	.15	.62	.00	.00	.00	.15	.00	.00	.23
3	.00	.19	.09	.04	.00	.06	.03	.00	.00	.20	.00	.00
4	.00	.32	.74	.65	.00	.04	.15	.00	.00	.07	.00	.00
5	.00	.04	.00	.30	.15	.22	.28	.00	.00	.00	.00	.00
6	.00	.00	.00	.00	.20	.00	.80	.00	.00	.00	.00	.04
7	.00	.00	.00	.05	.00	.12	.01	.00	.24	.00	.00	.00
8	.00	.00	.00	.35	.00	.00	.15	.13	.07	.00	.00	.00
9	.00	.00	.21	.91	.00	.00	.55	.25	.00	.00	.00	.00
10	.00	.00	.06	.10	.00	.28	.02	.00	.00	.00	.00	.00
11	.00	.00	.00	.51	.00	.04	.00	.00	.00	.00	.00	.00
12	.00	.00	.06	1.11	.00	.45	.00	.00	.01	.00	.00	.15
13	.02	.00	.01	.89	.00	.64	.00	.00	.91	.00	.00	.00
14	.03	.00	.00	1.20	.00	.11	.35	.00	.00	.00	.00	.06
15	.01	.04	.00	.03	.00	.15	.00	.04	.00	.00	.00	.00
16	.00	.22	.04	.37	.00	.00	.00	.00	.00	.00	.00	.00
17	.01	.45	1.00	.02	.52	.19	.00	.00	.00	.00	.00	.00
18	1.24	.31	.25	.01	.33	.00	.01	.00	.00	.00	.00	.26
19	.73	.00	.07	.00	.03	.00	.40	.00	.00	.00	.00	.10
20	.66	.00	.47	.00	.00	.15	.59	.00	.00	.00	.00	.08
21	.02	.01	.31	.00	.00	.01	.04	.20	.00	.00	.00	.00
22	.20	.97	.00	.00	.13	.00	.00	.12	.00	.00	.00	.00
23	.06	.26	.87	.00	.00	.01	.00	.06	.01	.00	.00	.00
24	.67	.39	.04	.00	.12	.00	.00	.00	.26	.00	.00	.00
25	.28	.41	.00	.00	.55	.00	.00	.00	.25	.00	.00	.00
26	.18	.04	.00	.04	.20	.16	.00	.52	.00	.00	.00	.00
27	.55	.00	.01	.02	.20	.00	.00	.00	.00	.00	.00	.00
28	.39	.00	.01	.00	.15	.00	.00	.00	.00	.00	.00	.00
29	.00	.00	.05	.01	---	.11	.00	.00	.00	.00	.00	.00
30	.27	.03	.28	.00	---	.00	.00	.00	.00	.00	.00	.00
31	.01	---	.49	.00	---	.26	---	.00	---	.00	.00	---
TOTAL	5.33	3.80	6.89	6.81	4.25	3.00	3.38	1.32	2.00	0.27	0.00	0.96

WTR YR 1980 TOTAL 38.01

STATION NUMBER 14192220 HAWTHORNE DITCH, OUTFLOW, SUNNYVIEW ROAD, SALEM, OR. (RG,SG)
LATITUDE 445720 LONGITUDE 1225921 DRAINAGE AREA DATUM

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.53	.26	.00	.00	.00	.05	.00	.00	.00	.00	.03
2	.00	.07	1.92	.00	.00	.00	.08	.00	.00	.00	.00	.00
3	.00	.07	1.84	.00	.01	1.09	.01	.09	.05	.00	.00	1.00
4	.00	.01	.37	.00	.23	.11	.00	.24	.10	.00	.00	.00
5	.00	.36	.07	.00	.19	.01	.16	.10	.27	.00	.00	.00
6	.00	.42	.04	.00	.00	.02	.04	.10	.00	.10	.00	.00
7	.00	.93	.00	.00	.00	.11	.06	.03	1.01	.05	.00	.00
8	.00	.43	.06	.00	.00	.00	.37	.01	.60	.00	.00	.00
9	.00	.12	.04	.00	.00	.00	.03	.01	.22	.03	.00	.00
10	.00	.00	.01	.00	.00	.00	.06	.00	.32	.00	.00	.00
11	.02	.01	.00	.00	.10	.00	.87	.00	.00	.00	.00	.00
12	.62	.00	.00	.00	.00	.00	.02	.01	.20	.00	.00	.00
13	.28	.02	.00	.00	.38	.00	.00	.00	.30	.00	.00	.00
14	.09	.17	.00	.00	.08	.00	.00	.20	.01	.00	.00	.00
15	.00	.00	.00	.00	.25	.46	.02	.25	.01	.00	.00	.00
16	.00	.02	.00	.02	.31	.01	.00	.01	.52	.00	.00	.00
17	.00	.07	.01	.07	.26	.01	.00	.35	.01	.00	.00	.00
18	.00	.00	.01	.01	.36	.00	.00	.45	.13	.00	.00	.40
19	.00	.01	.20	.00	.34	.02	.00	.00	.03	.00	.00	.02
20	.00	.00	.22	.13	.01	.01	.02	.01	.00	.00	.00	.01
21	.00	1.17	1.08	.22	.00	.16	.01	.02	.00	.00	.00	.30
22	.00	.05	.40	.36	.00	.05	.05	.00	.00	.00	.00	.05
23	.00	.05	.01	.11	.07	.19	.12	.15	.00	.00	.00	.01
24	.23	.01	1.86	.01	.30	.29	.01	.25	.00	.00	.00	.01
25	.02	.05	1.62	.07	.01	.52	.00	.15	.00	.00	.00	.10
26	.35	.00	.24	.37	.15	.10	.00	.00	.00	.00	.00	1.25
27	.02	.36	.12	.43	.01	.00	.25	.00	.00	.00	.00	.30
28	.01	.02	.01	.36	.00	.03	.01	.00	.00	.00	.00	.01
29	.00	.67	.23	.02	---	.28	.00	.00	.00	.00	.00	.01
30	.01	.11	.01	.00	---	.03	.00	.02	.00	.00	.08	.00
31	.07	---	.00	.01	---	.38	---	.00	---	.00	.00	---
TOTAL	1.72	5.73	10.63	2.19	3.06	3.88	2.24	2.45	3.78	0.18	0.08	3.50

WTR YR 1981 TOTAL 39.44

STATION NUMBER 14199640 MARY EYRE SCHOOL, SALEM, OR. (RG)
LATITUDE 445508 LONGITUDE 1225749

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1					.00	.01	.11	.00	.00	.05	.00	.33
2					.00	.01	.04	.00	.00	.04	.00	1.05
3					.05	.42	.00	.00	.00	.00	.00	.11
4					.05	.21	.00	.74	.00	.00	.00	.01
5					.25	.00	.01	.47	.04	.00	.00	.08
6					.95	.07	.21	.58	.00	.00	.00	.02
7					.55	.01	.01	.14	.00	.00	.00	.08
8					.20	.00	.11	.10	.00	.00	.00	.39
9					.02	.00	.24	.00	.00	.15	.00	.01
10					1.01	.01	.12	.00	.00	.02	.00	.00
11					.29	.00	.05	.00	.00	.00	.00	.00
12					.32	.00	.33	.00	.00	.00	.00	.00
13					.14	.00	.21	.00	.00	.00	.03	.00
14					.00	.06	.02	.00	.00	.00	.15	.00
15					.11	.23	.32	.00	.00	.00	.17	.00
16					.64	.14	.28	.00	.39	.00	.03	.00
17					.20	.00	.28	.00	.04	.00	.00	.00
18					.18	.03	.17	.00	.00	.00	.14	.00
19					.16	.00	.01	.00	.00	.00	.16	.00
20					.21	.00	.00	.00	.00	.00	.01	.00
21					.00	.00	.00	.00	.00	.00	.00	.00
22					.46	.00	.03	.00	.00	.00	.00	.00
23					.12	.00	.36	.00	.00	.00	.00	.00
24					.18	.00	.01	.00	.00	.00	.00	.00
25					.14	.00	.01	.00	.00	.00	.00	.00
26					.00	.17	.01	.00	.00	.00	.00	.00
27					.44	.26	.29	.03	.00	.00	.00	.00
28					.15	.03	.02	.33	.00	.00	.00	.00
29					---	.00	.01	.00	.00	.00	.00	.00
30					---	.05	.01	.00	.03	.00	.00	.00
31					---	.00	---	.00	---	.00	.00	---
TOTAL					6.82	1.71	3.27	2.39	0.50	0.26	0.69	2.08

STATION NUMBER 14200050 LITTLE PUDDING RIVER TRIBUTARY, KALE ROAD, SALEM, OR (RG,SG)
LATITUDE 445952 LONGITUDE 1225743

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	.37	.10	1.23	.00	.00	.00	.10	.00	.00	.13
2	.00	.13	1.18	.14	.59	.00	.00	.00	.18	.00	.00	.23
3	.00	.14	.09	.07	.00	.03	.04	.00	.00	.17	.00	.00
4	.00	.19	.69	.69	.00	.06	.17	.00	.00	.05	.00	.00
5	.00	.03	.00	.31	.17	.30	.25	.00	.00	.00	.00	.00
6	.00	.00	.00	.04	.13	.00	.93	.00	.00	.00	.00	.07
7	.00	.00	.01	.07	.00	.11	.01	.00	.29	.00	.00	.00
8	.00	.00	.01	.35	.00	.02	.15	.00	.07	.00	.00	.00
9	.00	.00	.15	.96	.00	.00	.44	.32	.00	.00	.00	.00
10	.00	.00	.00	.10	.00	.35	.06	.12	.00	.00	.00	.00
11	.00	.00	.00	.51	.00	.09	.01	.01	.00	.00	.00	.00
12	.00	.00	.05	1.11	.00	.26	.01	.00	.08	.00	.00	.19
13	.02	.02	.00	.89	.00	.82	.01	.01	.89	.00	.00	.01
14	.04	.04	.00	1.20	.00	.10	.25	.01	.01	.00	.00	.06
15	.01	.01	.00	.08	.01	.15	.01	.00	.00	.00	.00	.00
16	.01	.01	.03	.34	.01	.00	.01	.00	.00	.00	.00	.00
17	.01	.18	.99	.02	.54	.24	.00	.00	.00	.00	.00	.00
18	1.51	.35	.25	.03	.24	.02	.02	.00	.00	.00	.00	.29
19	.71	.00	.09	.00	.04	.01	.42	.00	.00	.00	.00	.09
20	.53	.01	.40	.00	.01	.01	.65	.00	.00	.00	.00	.10
21	.00	.01	.26	.00	.00	.00	.04	.19	.00	.00	.00	.00
22	.05	.92	.00	.00	.14	.00	.14	.13	.00	.00	.00	.00
23	.01	.22	.89	.00	.01	.01	.01	.15	.00	.00	.00	.00
24	.59	.39	.04	.00	.12	.00	.03	.01	.26	.00	.00	.00
25	.19	.38	.00	.00	.56	.00	.00	.00	.24	.00	.00	.00
26	.19	.06	.00	.02	.18	.18	.00	.11	.00	.00	.00	.00
27	.52	.00	.01	.03	.17	.00	.00	.01	.01	.00	.00	.00
28	.30	.00	.03	.02	.19	.00	.00	.00	.00	.00	.00	.00
29	.00	.01	.09	.03	---	.08	.00	.00	.00	.00	.00	.00
30	.20	.04	.28	.02	---	.01	.00	.00	.00	.00	.00	.00
31	.01	---	.56	.02	---	.22	---	.00	---	.00	.00	---
TOTAL	4.90	3.14	6.47	7.15	4.34	3.07	3.66	1.07	2.13	0.22	0.00	1.17

WTR YR 1980 TOTAL 37.32

RAINFALL, ACCUMULATED (INCHES), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
SUMMATION VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.45	.28	.00	.00	.00	.04	.00	.00	.00	.00	.00
2	.00	.06	1.42	.00	.01	.00	.09	.00	.00	.00	.00	.00
3	.00	.08	1.76	.00	.01	.95	.01	.05	.05	.00	.00	.00
4	.00	.00	.22	.00	.21	.09	.00	.28	.10	.00	.00	.00
5	.00	.31	.14	.00	.25	.02	.18	.06	.30	.00	.00	.00
6	.00	.38	.02	.00	.00	.02	.04	.09	.00	.10	.00	.00
7	.00	1.12	.00	.00	.00	.08	.04	.01	1.10	.05	.00	.00
8	.00	.24	.06	.00	.00	.00	.36	.00	.60	.00	.00	.00
9	.00	.12	.07	.00	.00	.00	.01	.00	.20	.00	.00	.00
10	.00	.00	.05	.00	.00	.00	.03	.00	.30	.00	.00	.00
11	.02	.01	.00	.00	.10	.00	.68	.01	.00	.00	.00	.00
12	.61	.00	.00	.00	.00	.00	.01	.01	.20	.00	.00	.00
13	.25	.01	.00	.00	.68	.00	.00	.00	.30	.00	.00	.00
14	.03	.21	.00	.00	.06	.00	.00	.13	.01	.00	.00	.00
15	.01	.00	.00	.00	.22	.39	.01	.19	.01	.00	.00	.00
16	.00	.02	.00	.03	.36	.02	.00	.00	.50	.00	.00	.00
17	.00	.09	.02	.06	.23	.02	.00	.27	.01	.00	.00	.00
18	.00	.00	.01	.02	.22	.00	.00	.39	.13	.00	.00	.40
19	.00	.00	.16	.00	.25	.02	.00	.01	.00	.00	.00	.02
20	.00	.00	.26	.12	.01	.00	.02	.00	.00	.00	.00	.10
21	.00	1.20	.84	.23	.01	.15	.00	.00	.00	.00	.00	.30
22	.00	.09	.11	.36	.00	.05	.04	.00	.00	.00	.00	.05
23	.00	.06	.00	.09	.05	.15	.18	.16	.00	.00	.00	.01
24	.16	.00	1.68	.12	.28	.31	.00	.34	.00	.00	.00	.01
25	.02	.03	1.43	.07	.02	.57	.00	.17	.00	.00	.00	.07
26	.43	.00	.13	.27	.14	.06	.00	.00	.00	.00	.00	1.25
27	.02	.34	.13	.35	.02	.00	.22	.00	.00	.00	.00	.30
28	.01	.02	.01	.34	.01	.01	.00	.00	.00	.00	.00	.01
29	.00	.47	.22	.01	---	.19	.00	.00	.00	.00	.00	.01
30	.01	.06	.01	.00	---	.03	.00	.02	.00	.00	.05	.00
31	.07	---	.00	.01	---	.34	---	.00	---	.00	.00	---
TOTAL	1.64	5.37	9.03	2.08	3.14	3.47	1.96	2.19	3.81	0.15	0.05	2.53

WTR YR 1981 TOTAL 35.42

Table 12.--Selected storm data for basins in the Salem area

Station number and name: 14190930 - Upper Pringle Creek at Turner Road.
Location: Lat 44°53'35", long 122°59'21".
Control: a 4x6 ft box culvert.
Datum: Invert at -0.08 ft.
Rain gage (1) station No. 14190910.
Location: Lat 44°51'06", long 122°58'43", at Wiltsey Street.
Rain gage (2) station No. 14190940.
Location: Lat 44°54'07", long 123°00'14", Salem Airport south.
Rain gage (3) station No. 14190950.
Location: Lat 44°53'25", long 123°03'32", fire station on Liberty Road.

Storm Begin YR MO DAY HR	Storm End YR MO DAY HR	Rain gage No.	Precipitation (inches) Maximum intensities Minutes 5	15	30	Hours 1	6	24	Total	Discharge peak Time YR MO DAY HR MIN	Magnitude Gage height (ft)	Discharge (ft³/s)
79 05 06 06	79 05 07 11	1	.07	.12	.16	.16	.23	.41	.66	79 05 07 15 05	0.51	9.60
		2	-	-	-	-	-	-	-			
		3	.06	.10	.13	.13	.31	.59	.69			
79 11 22 01	79 11 23 24	1	.02	.04	.08	.12	.48	.91	1.19	79 11 23 00 05	.49	9.20
		2	.02	.05	.09	.14	.63	1.00	1.27			
		3	.02	.05	.08	.11	.55	.97	1.26			
79 12 17 01	79 12 17 24	1	.02	.06	.10	.18	.59	.86	.86	79 12 17 23 45	.46	8.50
		2	.04	.07	.14	.22	.47	.67	.67			
		3	.03	.07	.14	.25	.65	.98	.98			
80 01 09 01	80 01 09 20	1	.04	.06	.10	.14	.67	1.14	1.14	80 01 09 08 55	1.50	45.0
		2	.04	.07	.13	.18	.79	1.52	1.52			
		3	.03	.07	.12	.17	.84	1.16	1.16			
80 01 11 12	80 01 14 10	1	.08	.16	.26	.49	1.16	1.21	3.53	80 01 14 12 50	2.80	114
		2	.10	.22	.35	.60	1.28	1.33	3.67			
		3	.08	.17	.32	.45	1.07	1.11	3.25			
80 12 02 01	80 12 24 23	1	.07	.15	.25	.36	1.27	2.09	4.84	80 12 04 08 55	3.50	151
		2	.04	.09	.16	.30	1.20	2.06	4.47			
		3	.04	.08	.14	.26	1.07	1.83	4.03			
80 12 24 02	80 12 26 14	1	.05	.09	.17	.23	1.02	2.23	4.45	80 12 25 22 05	3.45	149
		2	-	-	-	-	-	-	-			
		3	.06	.11	.19	.31	1.55	2.58	3.10			

Table 12.--Selected storm data for basins in the Salem area--Continued

Station number and name: 14190970 - Pringle Creek at Bush Park, Salem, OR.
Location: Lat 44°55'45", long 123°01'53".
Control: Natural stream channel.
Datum: PZF at approximately 0.05 ft.
Rain gage (1) station No. 14190940.
Location: Lat 44°54'07", long 123°00'14", Salem Airport south.
Rain gage (2) station No. 14190950.
Location: Lat 44°53'25", long 123°03'32", fire station on Liberty Road.
Rain gage (3) station No. 14190980.
Location: Lat 44°56'11", long 123°02'25", Salem city hall.

Storm Begin YR MO DAY HR	Storm End YR MO DAY HR	Rain gage No.	Max. intensities Minutes 5	15	30	Hours 1	6	24	Total (inches)	Discharge peak Time YR MO DAY HR MIN	Gage height (ft)	Discharge (ft^3/s)
79 11 22 01	79 11 23 24	1	.02	.05	.09	.14	.63	1.00	1.27	79 11 22 13 00	2.36	249
		2	.02	.05	.08	.11	.55	.97	1.26			
		3	.04	.08	.10	.17	.77	1.29	1.53			
79 12 02 01	79 12 04 13	1	.04	.15	.21	.28	.90	1.35	2.39	79 12 02 04 00	2.47	282
		2	.07	.13	.24	.32	.88	1.37	2.32			
		3	.05	.12	.24	.37	.98	1.32	2.06			
79 12 17 01	79 12 17 24	1	.04	.07	.14	.22	.47	.67	.67	79 12 17 17 35	1.77	113
		2	.03	.07	.14	.25	.65	.98	.98			
		3	.05	.09	.13	.20	.69	1.09	1.09			
80 01 09 01	80 01 09 23	1	.04	.07	.13	.18	.79	1.52	1.52	80 01 09 05 40	2.40	260
		2	.03	.07	.12	.17	.84	1.16	1.16			
		3	.03	.06	.10	.19	.85	1.31	1.31			
80 01 11 12	80 01 14 21	1	.10	.22	.35	.60	1.28	1.33	3.67	80 01 14 09 40	3.12	602
		2	.08	.18	.32	.45	1.07	1.11	3.25			
		3	.05	.13	.23	.45	1.24	1.25	3.61			
80 11 21 06	80 11 21 19	1	.07	.12	.18	.30	1.37	1.60	1.60	80 11 21 16 40	1.92	138
		2	.05	.12	.20	.26	1.11	1.28	1.28			
		3	.08	.17	.25	.34	1.11	1.26	1.26			
80 12 02 01	80 12 04 22	1	.04	.09	.16	.30	1.20	2.06	4.47	80 12 04 00 55	2.65	359
		2	.04	.08	.14	.26	1.07	1.83	4.03			
		3	.04	.11	.17	.30	1.15	2.11	4.41			
80 12 24 01	80 12 27 01	1	-	-	-	-	-	-	-	80 12 26 02 20	3.48	697
		2	.06	.11	.19	.31	1.55	2.58	4.10			
		3	.05	.10	.19	.29	1.21	2.19	4.39			

Table 12.--Selected storm data for basins in the Salem area--Continued

Station number and name: 14191440 - Battle Creek at Sunnyside Road.
Location: Lat 44°50'35". long 123°01'57".
Control: A 7x10 ft box culvert.
Datum: Invert at -0.02 ft.
Rain gage (1) station No. 14191420.
Location: Lat 44°47'24", long 123°06'36", on Cole Road.
Rain gage (2) station No. 14191440.
Location: Lat 44°50'35", long 123°01'57", at Sunnyside Road.

Storm Begin YR MO DAY HR	Storm End YR MO DAY HR	Rain gage No.	Precipitation (inches) Maximum intensities Minutes 5	15	30	Hours 1	6	24	Total	Discharge peak Time YR MO DAY HR MIN	Magnitude Gage height (ft)	Discharge (ft^3/s)
79 10 20 03	79 10 20 24	1	.03	.07	.12	.19	.76	1.45	1.45	79 10 20 13 15	0.46	7.4
		2	.03	.08	.12	.20	.85	1.59	1.59			
79 10 24 20	79 10 25 24	1	.09	.23	.35	.44	.75	1.06	1.06	79 10 25 03 55	0.42	6.4
		2	.06	.10	.22	.40	.60	1.00	1.00			
80 01 09 01	80 01 09 23	1	.05	.11	.18	.31	1.45	1.97	1.97	80 01 09 11 40	3.03	97
		2	-	-	-	-	-	-	-			
80 01 11 01	80 01 14 10	1	.09	.22	.39	.56	1.34	1.92	4.36	80 01 14 12 45	5.22	220
		2	-	-	-	-	-	-	-			
80 03 13 15	80 03 14 05	1	.04	.08	.14	.19	.84	1.35	1.35	80 03 14 19 25	1.13	32.0
		2	-	-	-	-	-	-	-			
80 11 21 06	80 11 21 17	1	.06	.13	.20	.29	1.56	1.79	1.79	80 11 21 18 25	.50	8.5
		2	.05	.12	.16	.22	1.31	1.48	1.48			
80 12 02 01	80 12 04 22	1	.04	.08	.14	.24	1.24	1.82	4.03	80 12 03 21 25	3.05	108
		2	.05	.11	.17	.28	1.13	2.39	5.16			
80 12 24 01	80 12 27 10	1	.08	.16	.28	.54	1.83	2.85	5.86	80 12 25 21 30	5.33	272
		2	.06	.11	.19	.33	1.45	2.58	4.10			

Table 12.--Selected storm data for basins in the Salem area--Continued

Station number and name: 14191460 - Waln Creek at Sunnyside Road.
Location: Lat 44°52'27', long 123°02'07".
Control: A 6x10 ft box culvert.
Datum: Invert at -0.06 ft.
Rain gage (1) station No. 14190950.
Location: Lat 44°53'25", long 123°03'32", on fire station at Liberty Road.
Rain gage (2) station No. 14191440.
Location: Lat 44°50'35", long 123°01'57", Battle Creek at Sunnyside Road.

Storm Begin YR MO DAY HR	Storm End YR MO DAY HR	Rain gage No.	Precipitation (inches) Maximum intensities Minutes 5	15	30	Hours 1	6	24	Total	Discharge peak Time YR MO DAY HR MIN	Magnitude Gage height (ft)	Discharge (ft^3/s)
79 02 10 01	79 02 10 19	1	-	-	-	-	-	-	-	79 02 10 17 40	.90	25
		2	.03	.07	.13	.20	.64	1.26	1.26			
79 11 22 03	79 11 23 24	1	.02	.05	.08	.11	.55	.97	1.26	79 11 22 14 10	.58	12
		2	.02	.06	.09	.11	.47	1.01	1.35			
79 12 02 01	79 12 04 14	1	.07	.13	.24	.32	.88	1.37	2.32	79 12 04 08 30	.85	23
		2	.06	.14	.24	.36	.95	1.47	2.65			
80 01 09 01	80 01 09 23	1	.03	.07	.12	.17	.84	1.16	1.16	80 01 09 06 10	1.10	36
		2	-	-	-	-	-	-	-			
80 01 11 12	80 01 14 21	1	.08	.18	.32	.45	1.07	1.11	3.25	80 01 14 09 00	1.72	74
		2	-	-	-	-	-	-	-			
80 11 21 06	80 11 21 17	1	.05	.12	.20	.26	1.11	1.28	1.28	80 11 21 16 50	.85	23
		2	.05	.12	.16	.22	1.31	1.48	1.48			
80 12 02 01	80 12 04 22	1	.04	.08	.14	.26	1.07	1.83	4.03	80 12 03 16 25	1.27	47
		2	.05	.11	.17	.28	1.13	2.39	5.16			
80 12 24 01	80 12 27 10	1	.06	.11	.19	.31	1.55	2.58	3.10	80 12 25 18 35	2.05	96
		2	.06	.11	.19	.33	1.45	2.58	4.10			

Table 12.--Selected storm data for basins in the Salem area--Continued

Station number and name: 14192100 - Glenn Creek near Dokes Ferry Road.
Location: Lat 44°57'08", long 123°04'56".
Control: Twin 5-ft diameter concrete pipes with CMP extentions.
Datum: Invert changed several times.
Rain gage (1) station No. 14192040.
Location: Lat 44°57'06", long 123°06'58", at Best Orchards.
Rain gage (2) station No. 14192110.
Location: Lat 44°57'37", long 123°04'04", on Chapman Hill.

Storm Begin YR MO DAY HR	Storm End YR MO DAY HR	Rain gage No.	Precipitation (inches) Maximum intensities Minutes 5	15	30	Hours 1	6	24	Total	Discharge peak Time YR MO DAY HR MIN	Magnitude Gage height (ft)	Discharge (ft^3/s)
80 01 09 01	80 01 09 21	1	.02	.06	.09	.15	.61	1.09	1.09	80 01 09 05 45	1.47	30
		2	.03	.06	.10	.17	.62	1.18	1.18			
80 01 11 08	80 01 14 09	1	.08	.16	.20	.33	1.19	1.19	3.88	80 01 14 04 30	3.15	127
		2	-	-	-	-	-	-	3.91			
80 12 02 01	80 12 24 22	1	.03	.07	.12	.23	1.07	1.65	3.57	80 12 03 18 05	1.95	46
		2	-	-	-	-	-	-	-			
80 12 24 03	80 12 27 10	1	.06	.11	.20	.28	1.27	2.21	4.25	80 12 25 19 05	3.55	157
		2	.05	.10	.20	.29	1.28	2.12	4.21			
80 01 26 01	81 01 28 23	1	.02	.05	.10	.17	.39	.45	1.18	81 01 28 16 40	.92	14
		2	.05	.06	.08	.16	.36	.40	1.10			

Table 12.--Selected storm data for basins in the Salem area--Continued

Station number and name: 14192150 - Gibson Creek Tributary at Gibson Road.
Location: Lat 44°58'59", long 123°06'17".
Control: 2-ft diameter concrete pipe.
Datum: Invert at -0.13 ft.
Rain gage (1) station No. 14192150.
Location: Lat 44°58'59", long 123°06'17", Gibson Creek Tributary at Gibson Road.

Storm Begin YR MO DAY HR	Storm End YR MO DAY HR	Rain gage No.	Precipitation (inches) Maximum intensities Minutes 5	15	30	Hours 1	6	24	Total	Discharge peak Time YR MO DAY HR MIN	Magnitude Gage height (ft)	Discharge (ft^3/s)
79 12 02 01	79 12 04 13	1	.05	.11	.16	.20	.79	1.09	1.85	79 12 04 14 00	.73	3.3
80 01 09 01	80 01 09 21	1	.04	.09	.16	.24	.83	1.24	1.24	80 01 09 09 35	1.08	6.0
80 01 11 12	80 01 14 09	1	.06	.10	.21	.40	1.29	1.29	4.14	80 01 14 09 10	3.05	30.0
80 12 02 01	80 12 04 22	1	.03	.09	.14	.25	.91	1.85	3.83	80 12 03 17 55	1.19	7.0
80 12 25 03	80 12 27 01	1	.06	.14	.25	.36	1.34	2.43	4.69	80 12 25 19 05	3.65	37.0

Table 12.--Selected storm data for basins in the Salem area--Continued

Station number and name: 14192210 - Claggett Creek at Hiacynth.
Location: Lat 44°58'44", long 122°59'27".
Control: 7-ft CMP with mitered entrance.
Datum: Invert at -0.45 ft.
Rain gage (1) station No. 14192220.
Location: Lat 44°57'20", long 122°59'21", Hawthorne Ditch at Sunnyview Road.
Rain gage (2) station No. 14200050.
Location: Lat 44°59'52", long 122°57'36", Little Pudding River Tributary at Kale Road.

Storm Begin YR MO DAY HR	Storm End YR MO DAY HR	Rain gage No.	Precipitation (inches) Maximum intensities Minutes 5	15	30	Hours 1	6	24	Total	Discharge peak Time YR MO DAY HR MIN	Magnitude Gage height (ft)	Discharge (ft^3/s)
79 12 17 01	79 12 17 23	1	.03	.06	.11	.17	.56	1.00	1.00	79 12 17 17 30	2.05	44
		2	.04	.08	.12	.18	.58	.99	.99			
80 01 09 01	80 01 09 21	1	-	-	-	-	-	-	-	80 01 09 06 25	3.21	94
		2	.02	.05	.09	.16	.59	.96	.96			
80 01 11 10	80 01 14 10	1	-	-	-	-	-	-	-	80 01 14 10 30	5.25	212
		2	.11	.21	.26	.33	1.19	1.20	3.71			
80 12 02 01	80 12 04 22	1	.05	.10	.19	.32	1.18	1.92	4.13	80 12 03 16 45	3.93	124
		2	.03	.07	.13	.20	1.03	1.76	3.40			
80 12 24 02	80 12 27 01	1	.04	.09	.16	.26	.94	1.86	3.84	80 12 25 19 30	5.03	191
		2	.04	.08	.15	.25	.97	1.68	3.37			

Table 12.--Selected storm data for basins in the Salem area--Continued

Station number and name: 14192220 - Hawthorne Ditch at Sunnyview Road.
Location: Lat 44°57'20", long 122°59'21".
Control: A 4.5-ft concrete sewer pipe entrance.
Datum: Invert at -0.30 ft
Rain gage (1) station No. 14192220.
Location: Lat 44°57'20", long 122°59'21", Hawthorne Ditch at Sunnyview Road.

Storm								Rain gage No.	Precipitation (inches)							Discharge peak						
Begin				End					Maximum intensities						Total	Time					Magnitude	
									Minutes			Hours									Gage height (ft)	Discharge (ft³/s)
YR	MO	DAY	HR	YR	MO	DAY	HR		5	15	30	1	6	24		YR	MO	DAY	HR	MIN		
79	12	17	01	79	12	17	23	1	.03	.06	.11	.17	.56	1.00	1.00	79	12	02	01	05	2.65	51
80	01	09	01	80	09	01	21	1	.02	.05	.09	.16	.59	.96	.96	80	01	09	02	00	.98	7.7
80	01	11	10	80	01	14	10	1	.11	.21	.26	.33	1.19	1.20	3.71	80	01	14	06	30	.98	7.7
80	11	21	01	80	11	21	20	1	.12	.22	.27	.34	.87	1.17	1.17	80	11	21	16	05	2.49	45
80	12	02	01	80	12	04	22	1	.05	.10	.19	.32	1.18	1.92	4.13	80	12	03	16	25	3.10	63
80	12	24	02	80	12	27	01	1	.04	.09	.16	.26	.94	1.86	3.84	80	12	25	18	40	3.35	70

Table 12.--Selected storm data for basins in the Salem area--Continued

Station number and name: 14200050 - Little Pudding River Tributary at Kale Road.
Location: Lat 44°59'52", long 122°57'43".
Control: A 3x4.5 ft arch CMP.
Datum: Invert at -0.08 ft.
Rain gage (1) station No. 14200050.
Location: Lat 44°59'52", long 122°57'00", Little Pudding River Tributary at Kale Road.

Storm Begin YR	MO	DAY	HR	Storm End YR	MO	DAY	HR	Rain gage No.	Precipitation (inches) Maximum intensities Minutes 5	15	30	Hours 1	6	24	Total	Discharge peak Time YR	MO	DAY	HR	MIN	Magnitude Gage height (ft)	Discharge (ft^3/s)
79	05	06	01	79	05	07	11	1	.08	.14	.18	.25	.57	.77	.92	79	05	06	14	50	2.50	9.6
79	10	18	03	79	10	20	12	1	.02	.06	.11	.16	.55	1.51	2.75	79	10	18	16	05	1.75	3.8
79	12	02	01	79	12	04	12	1	.04	.11	.19	.23	.87	1.18	1.96	79	12	02	04	25	2.75	13.0
80	01	09	01	80	01	09	21	1	.02	.05	.09	.16	.59	.96	.96	80	01	09	07	10	2.82	14.0
80	01	11	10	80	01	14	10	1	.11	.21	.26	.33	1.19	1.20	3.71	80	01	14	10	20	3.80	43.0
80	02	01	05	80	02	02	20	1	.02	.06	.12	.23	.87	1.23	1.82	80	02	01	10	50	1.87	4.5
80	03	13	02	80	03	13	24	1	.03	.06	.10	.17	.53	.82	.82	80	03	13	23	05	2.53	10.0
80	11	05	09	80	11	07	22	1	.09	.14	.22	.34	.60	1.12	1.81	80	11	07	03	40	1.97	5.2
80	12	02	01	80	12	04	22	1	.03	.07	.13	.20	1.03	1.76	3.40	80	12	03	17	20	3.33	26.0
80	12	24	02	80	12	27	01	1	.04	.08	.15	.25	.97	1.68	3.37	80	12	25	19	25	3.61	36.0
80	01	26	01	81	01	28	17	1	.02	.05	.09	.14	.33	.35	.96	81	01	27	14	30	1.65	3.3

Table 13.--Characteristics of basins in the Salem, Oregon area

DA -- Drainage area, in mi^2.
MIA -- Mapped impervious area, in percent of total drainage area.
EIA -- Effective impervious area, in percent of total drainage area, as determined by field survey.
ST -- Storage, in percent of total drainage area, as defined by surface area in lakes, ponds, depressions, flood plains, and detention storage.
AAP -- Average annual precipitation, in inches.
RI -- Rainfall intensity, in inches, as defined by the 6-hour, 0.02-exceedance probability.
BSL -- Basin slope, in ft/mi.
BSHP -- Basin shape (dimensionless).
CSL -- Channel slope, in ft/mi.
CL -- Channel length, in mi.
LU -- Land-use categories, in percent of total drainage area.
01 - parks, forest, and vacant land
02 - agriculture
03 - light residential
04 - dense residential
05 - apartments, and commercial
06 - downtown, and industrial
SA -- Sewered area, in percent of total drainage area.
GUTR -- Gutter length density, in mi/mi^2.
BDF -- Basin developement factor, as classified into the upper, middle, and lower parts of the basin for four categories of urban developement. If developed in any of the following aspects, a value of one is assigned that part of the basin. A totally developed basin would have a BDF = 12 in the 05 column.
01 - sewers
02 - channel improvement
03 - channel lining
04 - curb and gutter
05 - total basin developement factor
HSG -- Hydrologic soil group, in percent of total dranage basin.
01 - soil group A, high infiltration rate
02 - soil group B, moderate infiltration rate
03 - soil group C, slow infiltration rate
04 - soil group D, very slow infiltration rate
INFL -- Soil infiltration rate, in in./hr.

Station											LU								BDF					HSG				
number	DA	MIA	EIA	ST	AAP	RI	BSL	BSHP	CSL	CL	01	02	03	04	05	06	SA	GUTR	01	02	03	04	05	01	02	03	04	INFL
14190840	4.54	4.0		0.9	42	2.2	807	3.9	118	5.21	53	35	10	1	1	0	7	0.8	001	000	000	001	2	0	0	98	2	.09
14190930	2.93	2.4		0.9	42	1.9	526	2.3	51	3.29	15	85	0	0	0	0	0	0.8	000	011	000	000	2	0	3	91	6	.10
14190955	3.16	30.0		2.5	40	2.1	317	3.1	78	3.90	2	25	51	5	9	8	44	28.0	011	010	000	110	5	0	1	96	3	.10
14190960	1.69	34.0		2.5	42	2.1	394	2.4	118	2.82	11	1	64	11	13	0	44	40.0	111	011	000	101	7	0	0	98	2	.09
14190970	12.6	22.0		4.5	40	2.0	151	1.8	30	6.38	32	23	26	3	7	9	21	17.3	001	011	000	011	5	0	3	90	7	.10
14191440	5.56	1.8		3.9	43	2.1	712	3.1	86	4.71	60	40	0	0	0	0	0	0.0	000	000	000	000	0	0	1	99	0	.10
14191460	1.47	12.0	9.2	1.5	44	2.1	500	2.7	70	2.27	67	10	22	0	1	0	34	18.5	100	100	000	101	4	0	1	99	0	.10
14192100	2.51	6.0		0.3	43	2.2	702	2.8	232	3.22	18	70	12	0	0	0	8	10.0	001	001	000	001	3	0	1	97	2	.09
14192120	3:31	8.0		0.3	44	2.1	926	4.0	180	4.43	19	61	18	1	1	0	11	15.9	011	010	000	011	5	1	2	93	4	.10
14192150	.54	1.7		0.1	45	2.2	622	5.2	360	1.85	26	74	0	0	0	0	0	0.0	000	000	000	000	0	0	1	99	0	.10
14192210	3.08	27.0		2.7	42	1.8	68	2.8	11	4.82	37	2	45	5	10	1	72	18.8	101	110	000	101	6	0	1	78	21	.08
14192215	.48	43.0	12.5	0.0	40	1.9	54	4.8	4.8	1.65	27	0	31	6	34	2	60	22.0	101	111	111	001	9					.09
14192220	.80	53.0	24.5	0.1	41	1.9	52	6.0	8.3	2.40	16	2	33	11	37	1	76	29.0	101	111	111	011	10	0	0	87	13	.09
14192225	1.40	45.0		0.4	41	1.9	55	6.6	9.8	3.40	15	1	35	12	35	2	86	30.0	101	111	110	110	9					.09
14192230	1.68	43.0		0.4	41	1.9	56	8.6	12	4.24	15	1	35	12	35	2	88	30.0	101	110	110	110	8					.09
14199655	.79	15.0		9.9	39	1.9	61	3.8	15	1.86	8	41	35	15	0	1	36	16.7	101	000	000	001	3	0	7	68	25	.09
14199855	.27	0.5		1.5	39	1.8	41	2.3	3.1	.84	1	99	0	0	0	0	0	0.0	000	010	000	000	1	0	0	87	13	.09
14200050	.75	20.0		7.4	38	1.8	29	2.2	5.0	1.57	6	36	57	1	0	0	66	15.6	100	100	000	110	4	0	0	85	15	.09

Table 14.--Model parameters and statistics for basins in the Salem, Oregon area

IA: Impervious area, in percent of total area, as optimized by digital model. Equivalent to effective impervious area (EIA).
Soil Parameters:
- PSP - Suction at wetting front for soil moisture at field capacity, in inches.
- KSAT - Effective saturated hydraulic conductivity, in in./hr.
- RGF - Ratio of suction at the wetting front between wilting point and field capacity.
- BMSM - Soil moisture storage at field capacity, in inches.

Timing:
- TC - Time characteristic, in minutes, for translation of rainfall excess by distance area histograms.
- KSW - Time characteristic, in hours, for linear reservoir routing.

Lag time: Time, in hours, from begining (or center of mass) of rainfall to peak (or center of mass) of runoff.
Rainfall adjustment: Adjustment to average annual precipitation (AAP) and rainfall intensity (RI) to correct for areal differences from long-term rain gage used in synthesis.
Statistics:
- Slope - The slope of the regression line for relation between predicted and observed peak discharges.
- R-square - The coefficient of determination for the relation.
- Avg SEE - The average standard error of estimate, in percent from the predicted, v = volume, p = peak.
- Max error - The greatest deviation, in percent from predicted, for any individual sample.
- Sample size - Number of samples used to calibrate the model.

Station number	Stream name	IA	Soil Parameters PSP	KSAT	RGF	BMSM	Timing TC	KSW	Lag time	Rainfall adjustment AAP	RI	Statistics Slope	R-sqr.	Avg SEE v	p	Max Error v	p	Sample size
14190840	Croisan Creek1/	8	2.50	0.120	20.0	8.00	90	5.0	4.0	1.08	1.10				16		42	9
14190930	Upper Pringle Creek	4	2.16	.095	16.7	4.86	150	9.0	7.0	1.08	1.02	1.08	0.968	63	39	225	89	12
14190955	W. F. Pringle Creek1/	18	2.00	.090	16.0	8.00	70	4.0	3.2	1.02	1.08				37		70	9
14190960	Clark Creek1/	20	2.00	.090	16.0	8.00	30	2.5	1.8	1.08	1.08				36		120	8
14190970	Pringle Creek	15	1.81	.105	15.9	6.10	100	7.0	5.2	1.02	1.05	.94	.937	72	28	330	53	12
14191440	Battle Creek	3	2.51	.147	27.2	8.30	220	12.0	9.7	1.10	1.08	1.00	.972	65	27	200	78	8
14191460	Waln Creek	9	2.92	.049	18.7	12.50	35	3.5	2.3	1.12	1.08	.91	.949	68	23	237	77	25
14192100	Glenn Cr at Doaks Fy Rd	6	2.25	.102	22.5	8.07	60	5.0	3.5	1.10	1.10	1.01	.964	63	27	186	76	17
14192120	Glenn Cr at Orchard Hts Rd1/	8	2.20	.100	20.0	8.00	40	5.0	3.2	1.12	1.08							4
14192150	Gibson Creek	3	2.26	.093	15.5	9.95	60	5.0	3.5	1.15	1.10	.81	.940	50	41	100	74	9
14192210	Claggett Creek	20	1.64	.039	24.8	6.98	60	2.5	2.2	1.08	.97	.96	.983	54	16	175	39	13
14192215	Hawthorne Ditch at D St1/	12	1.60	.090	20.0	7.00	10	0.7	0.5	1.02	1.00				34		44	5
14192220	Hawthorne D at Sunnyside Rd	28	1.02	.073	27.4	6.42	15	1.2	0.8	1.05	1.00	1.00	.954	27	21	78	50	18
14192225	Hawthorne D at Eastgate Pk1/	25	1.30	.040	25.0	7.50	40	1.4	1.4	1.05	1.00							
14192230	Hawthorne D at Hyacinth St	23	1.23	.043	25.3	7.56	60	1.5	1.8	1.05	1.00	1.10	.823	51	51	100	109	9
14199655	L Pudding R Tr at Cordon Rd1/	12	1.30	.070	25.0	6.50	80	8.0	5.3	1.00	1.00				25		40	11
14199855	L Pudding R Tr at Lardon Rd1/	2	1.30	.070	25.0	6.50	24	4.0	2.4	1.00	.97				84		233	6
14200050	L Pudding R Tr at Kale Rd	8	1.22	.081	13.2	5.67	80	3.5	3.1	.97	.97	1.10	.968	74	30	240	82	21

1/ Streams that were monitored with crest gages. Model parameters were estimated for these sites.

Table 15.--Peak discharges for selected exceedance probabilities as defined by log-Pearson Type-III frequency analysis of actual station data for various skew coefficients for basins in the Salem, Oregon area

[Discharge in ft^3/sec]

Station number	Station skew							Zero skew						WRC adjusted skew					
		Exceedance probability						Exceedance probability						Exceedance probability					
	skew	0.5	0.2	0.1	.04	.02	.01	0.5	0.2	0.1	.04	.02	.01	0.5	0.2	0.1	.04	.02	.01
14190840	-0.292	177	251	298	354	394	432	159	227	273	332	378	423	175	250	300	363	409	455
14190930	- .960	124	162	181	199	210	219	118	160	187	222	248	273	121	160	184	211	229	246
14190955	- .062	166	227	266	316	352	388	165	226	267	318	356	395	165	226	267	319	357	396
14190960	- .052	94	128	150	174	193	212	93	128	150	174	193	214	93	127	150	176	196	215
14190970	- .542	531	716	822	939	1020	1090	513	711	844	1010	1140	1270	522	714	833	975	1070	1170
14191440	- .448	154	208	240	276	300	323	149	207	245	294	331	368	152	208	243	285	315	344
14191460	- .274	84	127	156	192	218	244	82	126	158	202	236	271	83	127	157	197	228	258
14192100	- .305	115	161	189	223	247	269	113	160	192	233	264	296	114	160	191	228	256	283
14192120	- .452	147	210	248	292	323	352	130	190	231	286	327	370	144	209	251	304	342	379
14192150	- .564	22	32	38	45	50	54	19	29	37	47	55	64	21	32	39	47	54	60
14192210	- .391	218	303	355	416	458	497	215	299	355	426	480	534	215	299	355	426	479	532
14192215	- .499	46	75	94	117	133	148	44	74	98	131	158	187	45	73	94	123	146	170
14192220	- .305	84	120	142	169	189	207	82	119	144	178	203	229	83	119	143	174	196	219
14192230	- .742	160	238	282	332	363	391	149	260	347	473	578	691	153	229	283	357	415	476
14199655	- .301	43	55	63	71	77	82	42	55	63	74	81	88	43	55	63	72	79	86
14199855	-1.319	13	19	22	24	26	27	11	19	25	34	42	50	12	18	23	28	33	37
14200050	- .802	40	59	70	81	88	94	38	58	72	91	106	121	39	58	70	86	97	108

Table 16.--Runoff volume with and without base flow for selected exceedance probabilities as defined by log-Pearson Type-III frequency analysis for basins in the Salem, Oregon area

[Runoff volume, in inches]

Station number	With base flow							Without base flow						
	Station skew	Exceedance probability						Station skew	Exceedance probability					
		0.5	0.2	0.1	.04	.02	.01		0.5	0.2	0.1	.04	.02	.01
14190840	-0.291	2.26	3.21	3.81	4.53	5.04	5.54	-0.286	0.63	1.05	1.36	1.75	2.06	2.36
14190930	- .578	3.29	4.56	5.29	6.10	6.63	7.11	- .807	.68	1.15	1.43	1.75	1.95	2.14
14191955	- .144	2.59	3.67	4.37	5.25	5.90	6.54	- .268	1.01	1.58	1.97	2.47	2.84	3.21
14190960	- .161	2.50	3.55	4.22	5.05	5.65	6.24	- .222	.92	1.57	1.99	2.50	2.90	3.30
14190970	- .223	2.40	3.37	4.00	4.76	5.31	5.84	- .348	.93	1.45	1.80	2.22	2.54	2.85
14191440	- .409	2.68	3.71	4.33	5.05	5.54	6.01	- .490	.40	.73	.97	1.27	1.50	1.72
14191460	- .047	3.12	4.46	5.37	6.54	7.42	8.31	- .198	.75	1.41	1.93	2.67	3.27	3.91
14192100	- .317	2.72	3.82	4.51	5.33	5.91	6.46	- .381	.73	1.23	1.57	2.01	2.34	2.66
14192120	- .240	2.53	3.60	4.29	5.14	5.75	6.34	- .458	.69	1.19	1.53	1.97	2.28	2.60
14192150	- .263	2.38	3.39	4.03	4.80	5.36	5.90	- .619	.57	1.04	1.37	1.77	2.06	2.34
14192210	- .091	2.50	3.67	4.46	5.48	6.24	7.02	- .490	1.60	2.50	3.09	3.79	4.28	4.75
14192215	- .286	1.26	1.83	2.20	2.64	2.96	3.27	- .629	.90	1.39	1.69	2.03	2.26	2.48
14192220	- .157	2.00	2.98	3.65	4.50	5.14	5.77	- .275	1.48	2.30	2.84	3.54	4.05	4.56
14192230	- .274	1.72	2.64	3.27	4.06	4.65	5.23	- .705	1.46	2.32	2.85	3.44	3.84	4.19
14199655	- .359	3.56	4.96	5.82	6.84	7.55	8.22	- .609	1.17	1.86	2.28	2.78	3.13	3.44
14199855	-1.329	1.18	1.82	2.17	2.53	2.73	2.92	-1.329	.97	1.56	1.85	2.11	2.24	2.34
14200050	- .351	1.26	1.92	2.35	2.88	3.26	3.62	- .740	1.04	1.64	2.00	2.40	2.67	2.90

Table 17.--Western Oregon regional regression equations for peak discharge for the rural Willamette Valley based on peak information from 111 basins and the 0.2-exceedance probability, 24-hour rainfall intensity (from Harris and others, 1979).

[Basic equation: $Q_T = a\ DA^b RI^c$]

Exceedance probability (T)	Equation: Constant a	Equation: Exponents b	Equation: Exponents c	Average percent SEE
0.5	8.7	.87	1.71	33
0.2	15.6	.88	1.55	33
0.1	21.5	.88	1.46	33
0.04	30.3	.88	1.37	34
0.02	38.0	.88	1.31	36
0.01	46.9	.88	1.25	37