DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

WATER RESOURCES INVESTIGATIONS
REPORT 84-4090 (Sheet 1 of 6)

CONVERSION FACTORS, INCH-POUND TO METRIC

Multiply inch-pound units	By	To obtain SI units
inch (in.)	0.02540	meters (m)
	25.40	millimeters (mm)
foot (ft)	0.3048	meter (m)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
square mile (mi^2)	2.590	square kilometer (km^2)

Table 1.--Identification numbers and names of streamflow gaging stations that provided data for analysis

Gaging station Number	Name
12043300	Hoko River near Sekiu
12043400	East Twin River near Pysht
12044000	Lyre River at Piedmont
12045500	Elwha River at McDonald Bridge near Port Angeles
12047300	Morse Creek near Port Angeles
12047500	Siebert Creek near Port Angeles
12048000	Dungeness River near Sequim
12050500	Snow Creek near Maynard
12053000	Dosewallips River near Brinnon
12054000	Duckabush River near Brinnon
12054500	Hamma Hamma River near Eldon
12054600	Jefferson Creek near Eldon
12061500	Skokomish River near Potlatch
12063500	Union River near Belfair
12067500	Tahuya River near Belfair
12068500	Dewatto River near Dewatto
12069550	Big Beef Creek near Seabeck
12070000	Dogfish Creek near Poulsbo
12072000	Chico Creek near Bremerton
12073500	Huge Creek near Wauna
12076500	Goldsborough Creek near Shelton
12078400	Kennedy Creek near Kamilche
12080000	Deschutes River near Olympia
12081000	Woodland Creek near Olympia
12088400	Nisqually River above Powell Creek near Steilacoom
12090200	Muck Creek at Roy
12091500	Chambers Creek below Leach Creek near Steilacoom
12101500	Puyallup River at Puyallup
12113350	Green River at Tukwilla
12119000	Cedar River at Renton
12120000	Mercer Creek near Bellevue
12120500	Juanita Creek near Kirkland
12126500	Sammamish River at Bothell
12127100	Swamp Creek at Kenmore
1215080	Snohomish River near Monroe
12162500	S.F. Stillaguamish River above Jim Creek near Arlington
12164000	Jim Creek near Arlington
12167000	N.F. Stillaguamish River near Arlington
12168500	Pilchuck Creek near Bryant
12200500	Samish River near Mt. Vernon
12201500	Samish River near Burlington
12213100	Nooksack River at Ferndale

Base from U.S. Geological Survey
State base map, 1968

SHEET 1. Location of gaging stations that provided streamflow records for evaluation of inflow.

PRINCIPAL SURFACE-WATER INFLOW TO PUGET SOUND, WASHINGTON

by J. R. Williams

1981

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ABSTRACT

Estimates were made of the annual and seasonal mean discharges that have 10- (wet year), 50- (normal year), and 90- (dry year) percent chances of exceedence at the mouths of all streams in the Puget Sound area, Washington, that have a mean annual flow of 20 cubic feet per second or more. The information, an important factor in assessing the quality of water in Puget Sound and the Strait of Juan de Fuca, is presented on five map plates.

INTRODUCTION

In recent years there has been a growing concern about the quality of the waters of Puget Sound and the Strait of Juan de Fuca, and oceanographers and other scientists are undertaking increasingly complex studies of the factors that affect that quality. One important element that affects the quality is the volume of fresh surface water that flows into the Sound and Strait.

The purpose of this study was to estimate the annual and seasonal mean discharges that have 10-, 50-, and 90-percent chance of exceedence at the mouths of all streams in the region which have an annual mean flow of 20 ft^3/s (cubic feet per second) or more. These stream discharges are shown individually on five maps—one for the annual mean discharges and one for each of the months of December, March, June, and September.

METHOD OF ANALYSIS

The term regionalization has been used in hydrology to describe the modeling process by which streamflow data collected at gaging stations are transferred to sites where little or no actual data exist. For this study, relations between mean discharges at selected exceedence probabilities (dependent variable) and the basin drainage area and the mean annual precipitation on that drainage area (independent variables) for a group of gaging stations were used for the transfer. The relations were expressed as mathematical equations that were determined by multiple-regression analyses.

The streamflow data used in the regression analyses were obtained from records of daily mean discharges at stream gaging stations. The gaging stations chosen were those closest to the mouths of each river or stream for which 10 or more years of data have been collected through 1979. There are 42 gaging stations in the region which met those qualifications (table 1).

Frequency analyses of discharges at each station were made by the Log-Pearson Type III method to determine the annual and monthly mean discharges that could be expected to be exceeded 10, 50, and 90 percent of the time. These discharges represent values that might be expected for a normal year (50 percent), for a wet year (10 percent), and for a dry year (90 percent).

INFLOW ESTIMATES

Sheet 2 is a map of the region on which various-sized arrows have been placed at the mouths of 73 streams. The 73 streams are those which have an estimated annual mean discharge of 20 ft^3/s or more for the 50-percent exceedence probability, based on drainage basin size and precipitation. There are no such streams on any of the islands in Washington. The size of the arrows gives an indication of the discharge magnitude, but in addition to that, the numerical estimates of discharge for each stream are listed in a column behind each arrow. The discharge estimates are for the 10-, 50-, and 90-percent exceedence probabilities respectively, top to bottom.

Table 2 lists the three regression equations that were used to estimate annual mean discharges for the three exceedence probabilities for 73 streams in the region. Also shown with each equation is the correlation coefficient and standard error for the regression. These values are indicators of the quality of the regression. The closer the correlation coefficient is to 1.00 and the smaller the standard error is, the better the regression is. The user is cautioned about the reliability of the results if he uses independent variables outside the range of values used to define the regression equations in this report. The ranges of drainage areas and mean annual precipitation amounts used to define the regression equations are 5.01 to 3,093 mi^2 and 37 to 131 inches, respectively.

Table 3 lists the sums of the estimated annual mean discharges for the three exceedence probabilities for five selected areas of the Puget Sound region. These sums are of flows from streams having means greater than 20 ft^3/s; they are not estimates of total inflow.

To show the extent that stream discharges vary with the seasons of the year, the same types of regression analyses were made for the months of December, March, June, and September. The resulting regression equations (tables 4, 6, 8, and 10) were used to estimate monthly mean flows for those months. These data are shown in graphical and numerical form on sheets 3, 4, 5, and 6. Tables 5, 7, 9, and 11 present summations of estimated inflows from individual streams in five selected areas of the Puget Sound region and in the region as a whole, for each of the three selected probabilities. The summations are presented to provide information about general proportion within the region, not typical of any one year. In any year, the proportions of the sums of actual quantities may depart somewhat from the proportions presented because the simultaneous occurrence of actual quantities of exactly equal probability is unlikely.