Estimates of Ground-Water Recharge from Precipitation to Glacial-Deposit and Bedrock Aquifers on Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington

Prepared in cooperation with the
SAN JUAN COUNTY HEALTH AND COMMUNITY SERVICES

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 02-4114

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By Laura A. Orr, Henry H. Bauer, and J.A. Wayenberg

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Denver, CO 80225-0286

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
	Length	
inch (in)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
acre	4,047	square meter
square mile (mi^2)	2.590	square kilometer
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Temperature in degrees Fahrenheit (^oF) may be converted to degrees Celsius (^oC) as follows:

$^oC=(^oF-32)/1.8$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a feodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Altitude, as used in this report, refers to distance above or below sea level.

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

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ABSTRACT

An important source of fresh water on Lopez, San Juan, Orcas, and Shaw Islands in San Juan County off the northwestern coast of Washington is glacial-deposit and bedrock aquifers. Two methods were used to estimate recharge from precipitation to the water tables on the islands. A daily near-surface water-balance method, the Deep Percolation Model (DPM), was used to simulate water budgets for the period October 1, 1996, through September 30, 1998 (water years 1997-98) for six small drainage basins—three on Lopez Island and one each on San Juan, Orcas, and Shaw Islands. The calibrated soil and subsoil parameters from the DPM for each small basin were then used in island-wide applications of the DPM where the direct runoff component (which is not available on an island-wide basis) was simulated, rather than input, and calibration was not required. A spatial distribution of annual recharge was simulated for each island, with island averages of: Lopez Island, 2.49 inches per year; San Juan Island, 1.99 inches per year; Orcas Island, 1.46 inches per year; and Shaw Island, 1.44 inches per year.

A chloride mass-balance method that requires measurements of atmospheric chloride deposition, precipitation, streamflow, and chloride concentrations in ground water was used to estimate recharge to the glacial-deposit aquifers of Lopez Island. Only average recharge could be estimated using this method rather than area-specific recharge. Average recharge for Lopez Island estimated by this method was only 0.63 inch per year. The range of chloride concentrations in ground-water samples from selected wells indicates that the average recharge in areas of glacial deposits is between 0.29 and 1.95 inches per year. Recharge simulated using the DPM for two drainage basins on Lopez Island overlain by glacial deposits are 2.76 and 2.64 inches per year. Sources of chloride in ground water other than from the atmosphere would cause the recharge estimated by the chloride mass-balance method to be less than the actual recharge, therefore these estimates may represent lower limits which are, at least, consistent with the higher simulated recharge from the DPM.

The average island-wide recharge is most closely related to the amount of area overlain by glacial deposits. Thus, even though Lopez Island receives the least precipitation, it has the most recharge per square mile because it proportionally has the largest area overlain by glacial deposits. Recharge simulated by the DPM for areas of shallow to outcropping bedrock generally was less than 1.5 inches per year, but recharge simulated in areas of glacial deposits ranged from less than 0.5 to 3 inches per year, with recharge as high as 9 inches per year in some small areas.

INTRODUCTION

The islands that make up San Juan County, Washington, are located off the northwestern Washington coast (fig. 1). The islands are noted for their scenic beauty and low rainfall, and therefore are a popular location for residence and recreation. On the four largest islands—Lopez, San Juan, Orcas, and Shaw—the population and development are growing rapidly, and because an important source of fresh water for the islands is the glacial-deposit and bedrock aquifers, there is growing concern about the quality and availability of ground water. This is of particular concern on Lopez Island, which has the least precipitation, the lowest water levels, and, therefore, the greatest susceptibility to seawater intrusion. A key issue in assessing ground-water availability is to determine the amount of recharge to the aquifers from precipitation. Recharge is extremely difficult and costly to measure directly, and only very generalized and incomplete estimates of recharge are available for San Juan County.

In 1997, the U.S. Geological Survey (USGS), in cooperation with the San Juan County Health and Community Services, began a study of the quality and availability of ground water on Lopez, San Juan, Orcas, and Shaw Islands. The objective of the first phase of the study was to use chloride concentrations as an indicator to determine the present-day extent of possible seawater intrusion on Lopez Island (Orr, 2000) and then compare these findings with those from two previous USGS studies (Whiteman and others, 1983 and Dion and Sumioka, 1984).

The objective of the second phase of the study was to estimate recharge from precipitation to the glacial-deposit and bedrock aquifers on each of the four islands. Indirect recharge estimates can be subject to large errors, and therefore more than one method was used. The most direct, reliable method, assuming ground-water recharge is equal to ground-water discharge, is to measure the discharge. However, as indicated by ground-water levels (Whiteman and others, 1983), most ground water in the San Juan Islands probably discharges through the seabed, thus this method could not be used. Therefore, two indirect methods were used: a near-surface water-balance method and a chloride mass-balance method.

Purpose and Scope

The purpose of this report is to document estimates of ground-water recharge from precipitation to glacial-deposit and bedrock aquifers on Lopez, San Juan, Orcas, and Shaw Islands for water years 1997-98 using a near-surface water-balance method and a chloride mass-balance method.

The study included four steps:

1. Recharge was simulated using the Deep Percolation Model, a near-surface water-balance method, for six small drainage basins on the islands;
2. Calibration results from water-balance simulations from the near-surface water-balance method in the six small drainage basins were used to simulate ground-water recharge for the entire areas of the four islands;
3. Recharge was estimated using a chloride mass-balance method for the glacial-deposit aquifers of Lopez Island; and
4. Recharge estimates from the chloride mass-balance method were used to ascertain the reasonableness of the results from the near-surface water-balance method.

The near-surface water balance was simulated on a daily basis using a hydrometeorological model known as the Deep Percolation Model (DPM) (Bauer and Vaccaro, 1987; Bauer and Mastin, 1997) and the chloride mass-balance method used techniques documented by Eriksson and Khunakasem (1969) to estimate ground-water recharge. Since then, others (see, for example, Vacher and Ayers, 1980; Claassen and others, 1986; Dettinger, 1989; and Prych, 1998) have used this method for many different types of areas ranging from small oceanic islands to mountainous drainage basins that range in size from tens to thousands of square miles. Data needed to apply the methods were obtained from existing databases and collected as part of this study.

Data collected during water years 1997-98 included streamflow, precipitation, precipitation throughfall, solar shortwave radiation, temperature, and atmospheric-chloride deposition. Chloride concentrations in ground water were determined at selected locations throughout the study area in the spring of 1997 during the first phase of this study (Orr, 2000).

Figure 1. Location of Lopez, San Juan, Orcas, and Shaw Islands and the six study basins in San Juan County, Washington.

Previous Studies

The Washington State Department of Ecology inventoried the geology and surface- and ground-water resources of the islands of San Juan County in 1974 (Russell, 1975). In 1978, the USGS conducted a reconnaissance of seawater intrusion in coastal Washington, including San Juan County (Dion and Sumioka, 1984). Whiteman and others (1983) assessed the occurrence, quality, and use of ground water on Lopez, San Juan, Orcas, and Shaw Islands, including a description of the ground-water flow system and measurements of chloride concentrations in wells. The geology of the islands is described by Russell (1975) and Brandon and others (1988).

Well-Numbering System

The U.S. Geological Survey assigns numbers to wells and springs in Washington that identify their location in a township, range, and section. Well number 34N/01W-18K01 indicates, successively, the township (T. 34 N.) and range (R. 01 W.) north and west of the Willamette Base Line and Meridian (fig. 2). The first number following the hyphen indicates the section (18) within the township, and the letter following the section number gives the 40-acre subdivision of the section. The number (01) following the letter is the sequence number of the well within the 40-acre subdivision. This number indicates that the well was the first one inventoried by USGS personnel in that 40-acre tract. An "S" following the sequence number indicates that the site is a spring, a "D1" after the sequence indicates that the original reported depth of

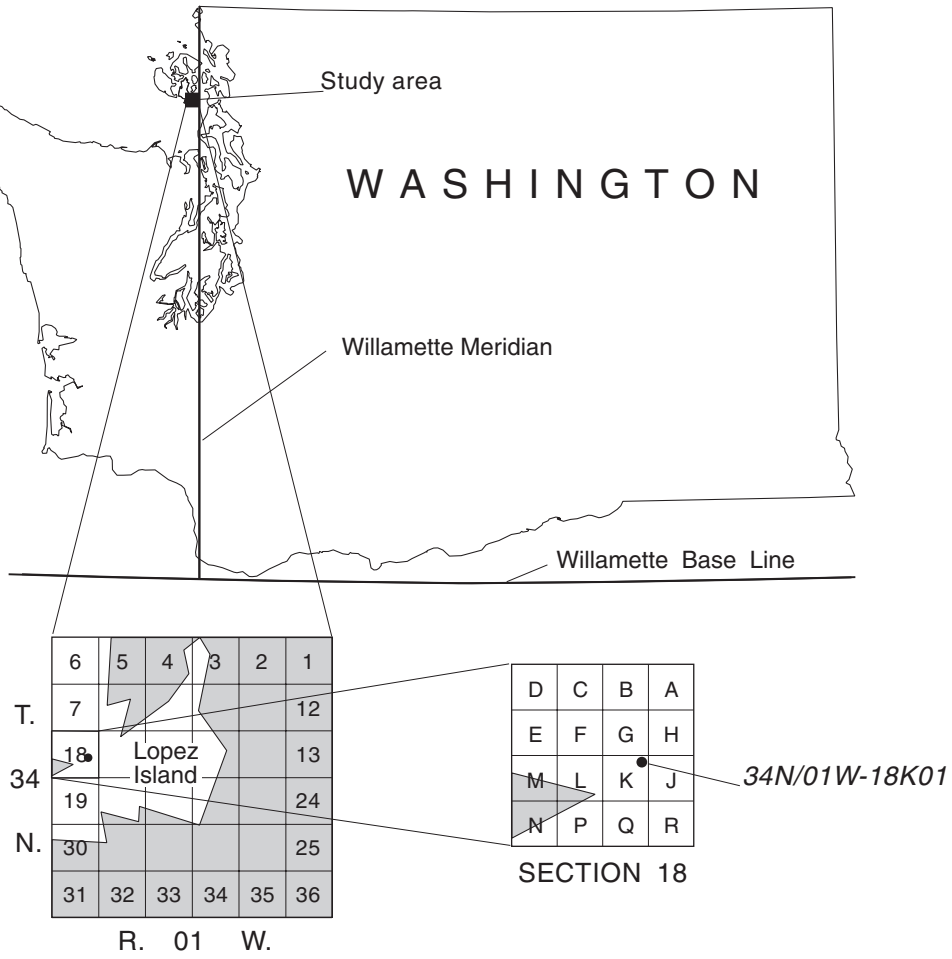


Figure 2. Well-number system used in Washington.

the well has been changed once, and successive numbers indicate the number of changes in the well depth.

Acknowledgments

The authors wish to express their gratitude to the many people in San Juan County who allowed access to their property for data collection for this study: Paul Atlas, David and Mary Fox, Walter Lease, Stanley Reitan, Sr., Charles Walker, Philip Weinheimer, John Willis, Laurence Wilmot, and Robert Winter, and a special thanks to Howard Cole, Gary Sale, Mother Therese and Mother Hildegard and their students at Our Lady of the Rock Priory, and Jan Helsell for the often difficult task of collecting the throughfall and(or) precipitation data. We also thank all USGS staff who collected data, and are especially grateful for the contributions of Karen Payne and C.G. Laird in processing the atmospheric chloride data.

DESCRIPTION OF STUDY AREA

San Juan County covers an area of 265 mi^2 off the coast of northwestern Washington State (fig. 1). About 172 mi^2 of the county is composed of islands that are part of the San Juan archipelago. The four largest islands make up 87 percent (149.4 mi^2) of the land area: Lopez, 18,847 acres (29.4 mi^2), San Juan, 35,448 acres (55.4 mi^2), Orcas, 36,432 acres (56.9 mi^2), and Shaw, 4,928 acres (7.7 mi^2). The population of the county in 2000 was 14,077, an increase of more than 40 percent since 1990 and the second largest population increase of counties in Washington (U.S. Census Bureau, 2001). The topography of individual islands varies (fig. 3). Orcas Island has the greatest relief, with land-surface altitudes ranging from sea level to 2,409 feet above sea level with seven peaks higher than 1,000 feet above sea level. One peak on San Juan Island is more than 1,000 feet above sea level and, along with Shaw Island, has a generally low, rolling landscape. Lopez Island is mostly flat or gently rolling, with a maximum altitude of 535 feet above sea level. The islands are composed of varying thicknesses of glacial deposits overlying bedrock that contain ground water that supplies most of the county's water needs. Most streams are intermittent and are usually dry between June and late October or November.

Climate and Precipitation

The maritime climate of San Juan County is typified by cool, dry summers and mild, moderately wet winters. At the National Oceanic and Atmospheric Administration (NOAA) weather station on Orcas Island, average temperatures for January and August were 39.5 and 60.2°F for 1961-90 (U.S. Department of Commerce, 1999). The islands lie in a rainshadow on the leeward side of the Olympic Mountains (fig. 1), resulting in much less precipitation than in other parts of western Washington. The rainshadow effect influences the distribution of precipitation across the islands as well. Mean annual precipitation (1961-90) at low to moderate altitudes ranges from about 26 inches in the southern part of the county to about 35 inches in the north, and is about 48 inches at the highest land-surface altitudes on Orcas Island (fig. 4). November is usually the wettest month and July is usually the driest month (Oregon Climate Service, 1999).

Hydrogeology

Unconsolidated glacial deposits overlie, to varying extents, a complex of sedimentary and volcanic bedrock that is metamorphosed in many areas of the islands (Russell, 1975, and Brandon and others, 1988). The glacial deposits, where saturated, generally yield large quantities of water to wells, but the bedrock generally yields only small quantities, usually sufficient only for single-family domestic use. Most of the bedrock is nonporous, and water occurs primarily in joints and fractures, often referred to as secondary permeability. Because most areas are not overlain by sufficient thicknesses of glacial deposits (fig. 5), most wells produce water from the bedrock.

About 80 percent of Lopez Island is overlain by saturated glacial deposits with thicknesses of as much as 250 feet. About 40 percent of San Juan Island is overlain by glacial deposits, but only as thin, discontinuous sheets, with thicknesses generally less than 30 feet. Although much of the glacial deposits on San Juan Island is not saturated, the extreme southern part is overlain by relatively thick saturated glacial deposits, as much as 100 feet.

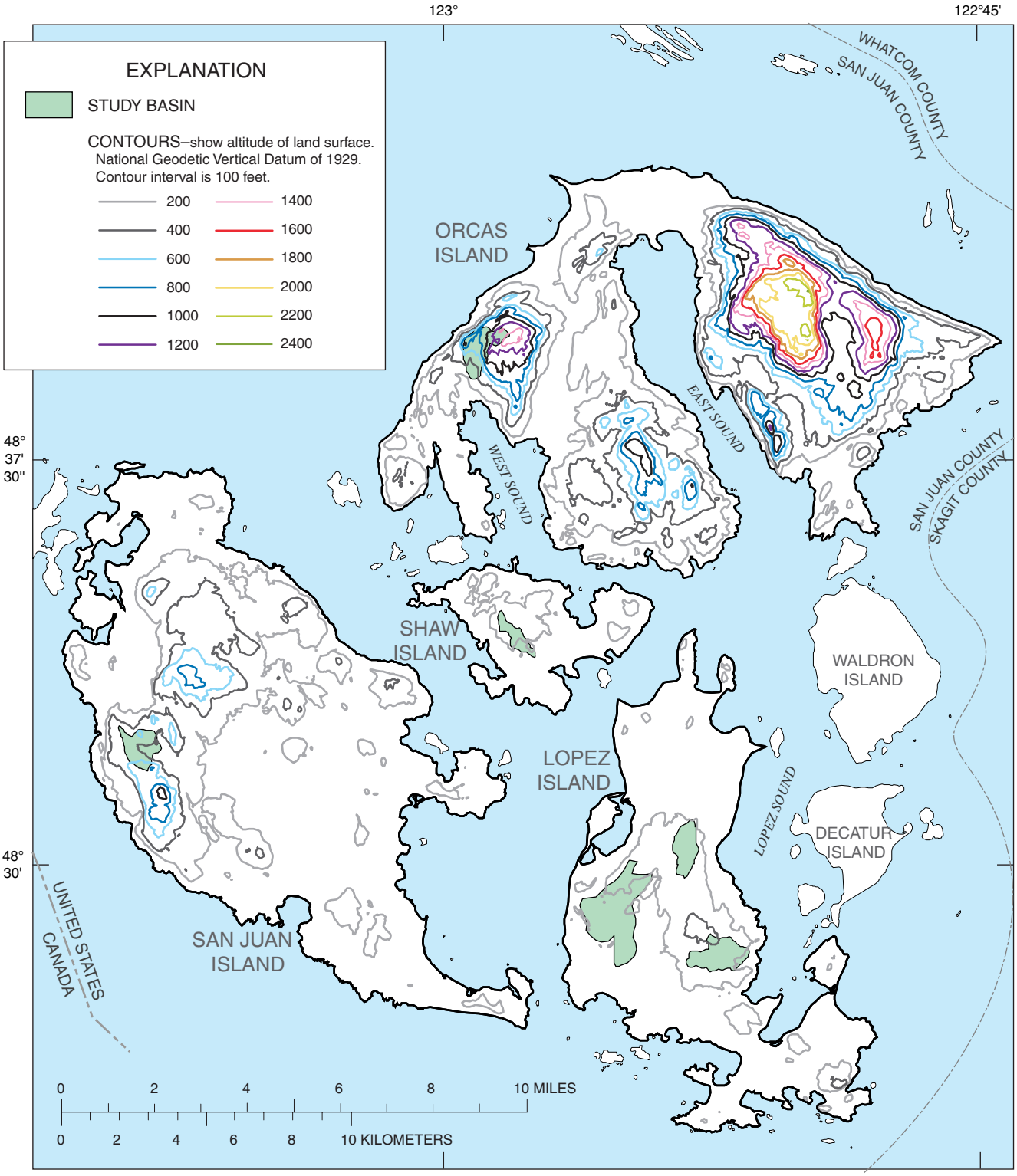


Figure 3. Topography of Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington.

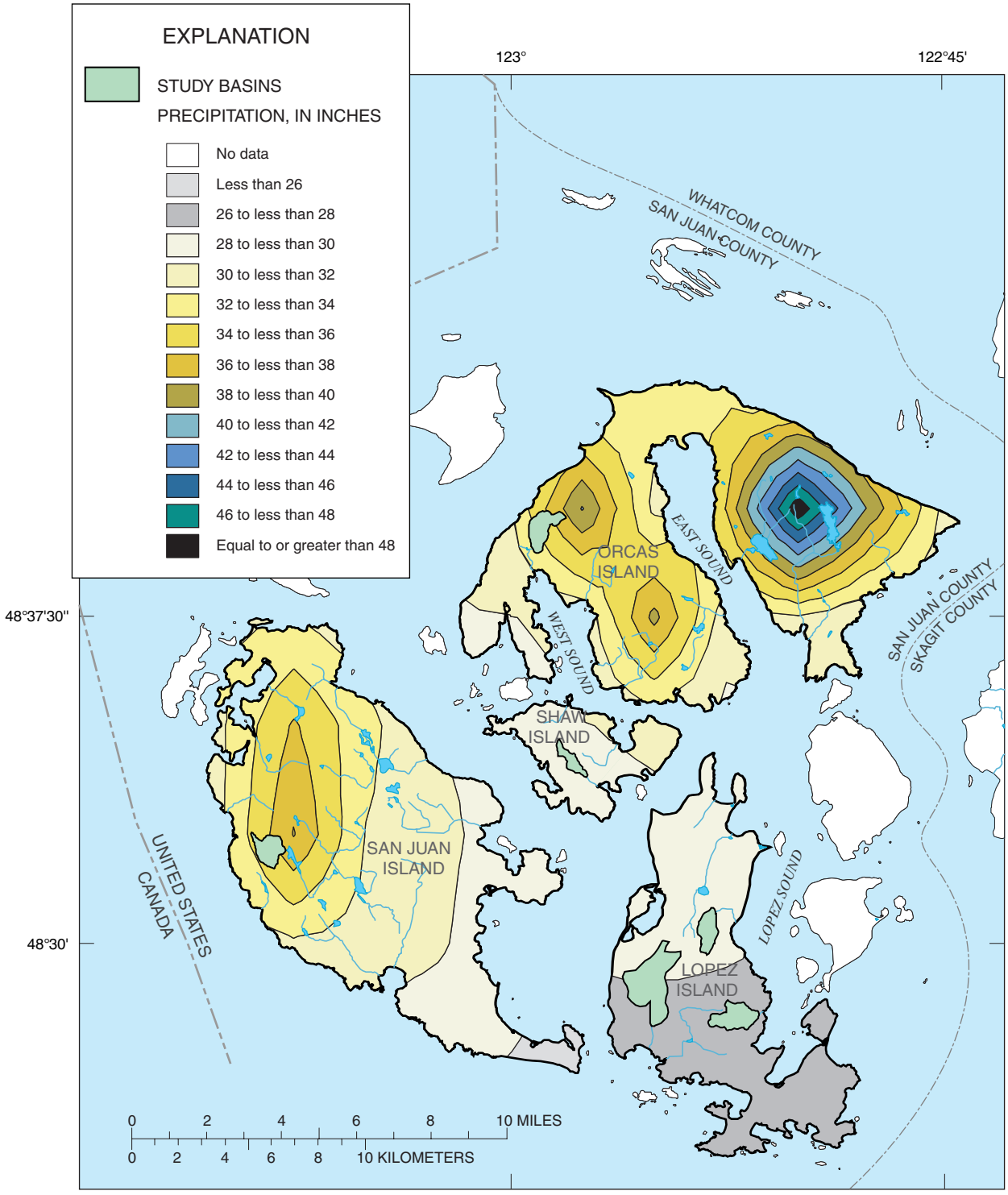


Figure 4. Mean annual precipitation for Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington, 1961-90.

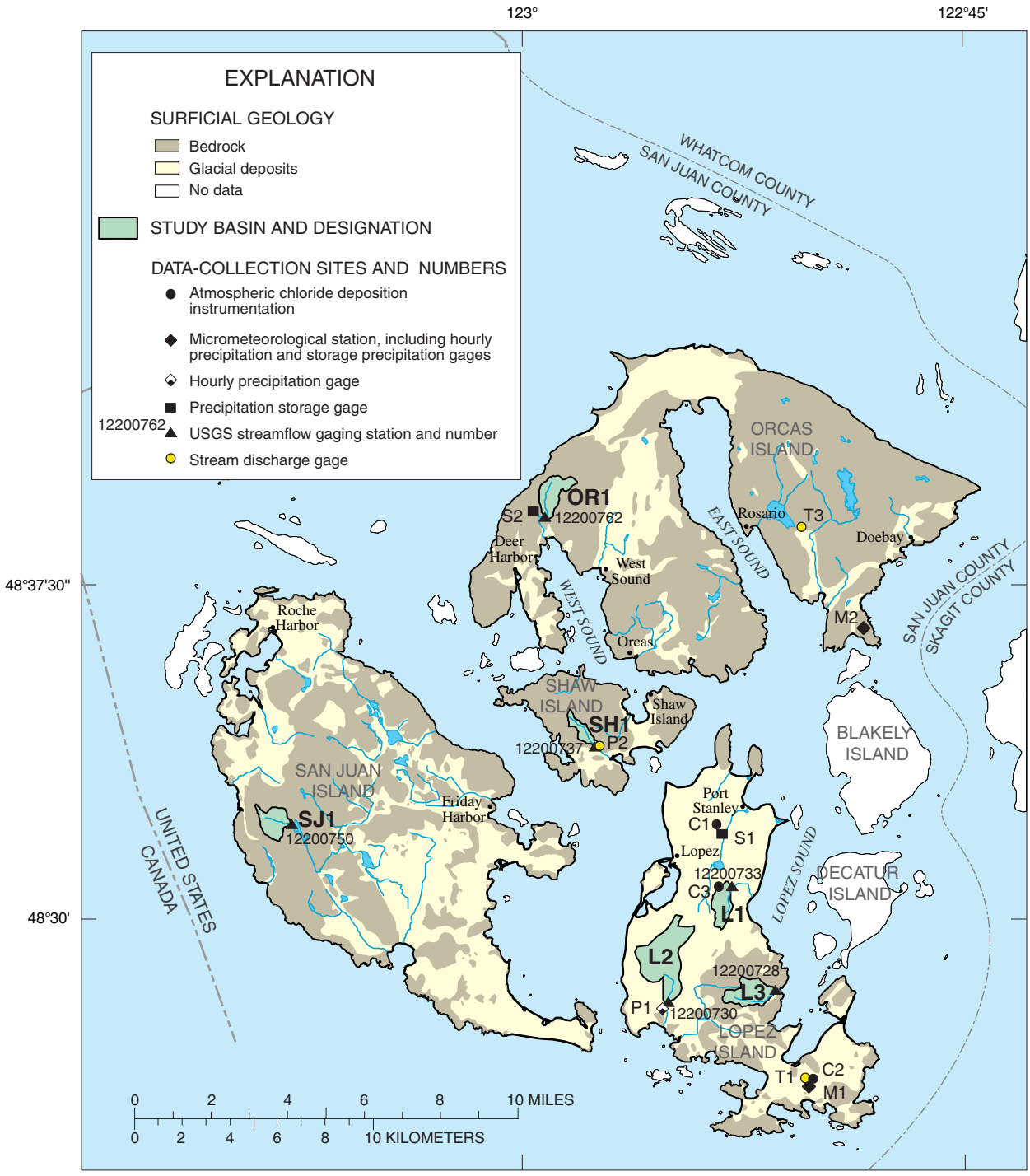


Figure 5. Generalized surficial geology and data-collection sites for Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington.

Surficial geology is modified from Jones (1999). Data-collection sites are summarized in table 2.

About 15 percent of Orcas Island (many small areas) is overlain by glacial deposits with thicknesses of as much as 300 feet at the northern end and in the central part, west of East Sound. Less than 10 percent of Shaw Island (only one small area) is overlain by glacial deposits. Additional information on the thicknesses of the glacial deposits on the islands is presented in Whiteman and others (1983).

Recharge and Evapotranspiration

Direct recharge to ground water from precipitation results from the infiltration of precipitation into the soil and below the root zone, hereafter referred to as "deep percolation": generally, the greater the precipitation, the greater the deep percolation and recharge. Factors that control evapotranspiration, namely temperature, solar shortwave radiation, wind, soil type, vegetation type, and land-surface slope, also directly affect deep percolation. The quantity of deep percolation in many areas is further limited by low-permeability materials underlying the soils. For a period of time during and following a storm, rainwater infiltrating the soil encounters low-permeability bedrock, glacial till, or clay, and some moves short distances horizontally through the soil to local drainages and discharges as surface water directly to the ocean, and thus is not available for recharging the ground-water system. Furthermore, not all of the deep percolation necessarily recharges the uppermost saturated zone from which water can be effectively withdrawn. For example, a thin saturated zone may exist above the zone(s) generally tapped by wells, and water in this thin zone may, in part, flow laterally and discharge to a stream or spring. Deep percolation and subsequent ground-water recharge from precipitation in San Juan County probably is less than in most of western Washington State because the rainshadow of the Olympic Mountains results in less precipitation.

Potential evapotranspiration (PET) is estimated to be about 25 inches per year (Russell, 1975). If soil-moisture holding capacities and root-zone depths are sufficiently large, potential recharge (rainwater not evapotranspired) could, in places, be nearly zero. Additionally, results from recent USGS studies in coniferous forested areas in the Puget Sound Lowland of western Washington have shown that measured daily evaporation frequently exceeds daily PET computed by traditional methods because large amounts of advective evaporation of intercepted precipitation (as much as 10 to 18 inches, annually) are not accounted for in the traditional methods (Bauer and Mastin, 1997; W.R. Bidlake, U.S. Geological Survey, written commun., 1998). In these areas, the quantity of recharge could be even less than would be expected using normal assumptions.

Ground-water recharge should not be equated with ground-water availability. Under natural conditions, ground-water recharge is balanced by subsurface flow to the ocean, to the lower reaches of streams, and, in areas of shallow water tables, to the roots of phreatophytes (these areas are collectively called discharge areas). Removal of ground water by wells will lower ground-water levels and diminish the outflow to one or more of these discharge areas. Where discharge to the ocean is diminished, seawater intrusion into wells may be induced. Diminished ground-water discharge to streams will reduce dry-season low flows, which could affect fish, wildlife, and surface-water right holders. Lowered water tables could transform wetlands and phreatophyte areas into drier environments. If all recharge were consumptively used, there would be no discharge to any of these areas.

Removal of ground water in rural and suburban non-irrigated areas generally is not all consumptive, but is accompanied by the return of a large fraction of this water as wastewater to the subsurface and eventually to the aquifers. Water-quality problems may therefore occur before significant problems in water levels or in ground-water discharge areas develop. These issues are most readily addressed using ground-water models for which the recharge estimates presented in this report will be essential.

ESTIMATES OF GROUND-WATER RECHARGE

Near-Surface Water-Balance Method

The primary method for estimating ground-water recharge from precipitation for this study was the near-surface water-balance method. A deep-percolation model (DPM), developed for eastern Washington (Bauer and Vaccaro, 1987) and modified for western Washington (Bauer and Mastin, 1997), was selected to estimate deep percolation from precipitation for this study. The DPM uses a daily water- budget approach to simulate deep percolation. In this method, the model computes daily fluxes of water into and out of a volume extending from the top of foliage to the bottom of the root zone and accounts for changes in water content. In most environments, deep percolation is destined to recharge the saturated systems that are tapped by wells. In some cases, ground-water recharge is less than deep percolation, and this is discussed later in the section "Sources of Uncertainty in the DPM Recharge Estimates." In this study, deep percolation is considered to be the best estimate of recharge.

Time-series data required for this application of the DPM include daily values of precipitation, precipitation throughfall, minimum and maximum air temperature, solar shortwave radiation, and "direct runoff." Direct runoff is herein defined as surface-water runoff plus water that drains from temporarily saturated soils to local drainage features. Spatial data required for the DPM include land-surface altitude, properties of soils, and land cover (vegetation type, surface water, or impervious surfaces). Areal variation in soils, vegetation, and land cover is accounted for in the DPM by dividing a drainage area into cells or polygons of any size and shape. Each cell is characterized by a single altitude (and optionally, surface slope and aspect), land cover, soil type, subsoil infiltration capacity, and climate regime. Areal variation in precipitation, air temperature, and solar shortwave radiation are accounted for by interpolation of data to each cell from data collected in or near the study basins.

Evapotranspiration depletes soil moisture and depends on soil-moisture content and meteorological conditions. Therefore, evapotranspiration and soil moisture must be calculated at sufficiently frequent intervals to accurately simulate changes. The DPM uses a daily time step, primarily because daily meteorological data generally are available. A daily time step is sufficiently short to ensure that soil-moisture variations are small enough to avoid significant error in the evapotranspiration calculations. For each day of a DPM simulation, deep percolation for each cell is computed as the residual of precipitation minus evapotranspiration minus direct runoff minus the change in soil moisture in the root zone.

Direct runoff for each cell is difficult to determine. Although the total direct runoff for the drainage basin can be readily estimated from streamflow measurements, the contributions from individual cells in the basin can vary greatly, depending on the soil and subsoil properties. For example, during a storm, a cell with a thick soil underlain by a permeable sand-and-gravel glacial outwash deposit may not contribute direct runoff, whereas a cell with thin soil overlying poorly permeable glacial till will contribute a large quantity of direct runoff. The DPM disaggregates the daily total measured direct runoff to the cells in proportion to a simulated daily direct runoff for each cell (for details, see Bauer and Mastin, 1997). A specified infiltration capacity beneath the root zone for each cell, based on the soil and subsoil properties, is incorporated into these calculations. By adjusting this parameter, a water balance (or calibration) is achieved. If the infiltration capacities are set mostly too large, too little water will be available to support the measured total direct runoff. This is indicated as a "negative deficit" in the DPM output; conversely, a "positive deficit" results when the infiltration capacities are mostly set too small.

Three steps were used to estimate recharge for all four islands using the DPM in this study: (1) the spatial data needed for applying the DPM to the entire study area were assembled, checked for accuracy, and divided into uniform cells; (2) the DPM was calibrated for each of the six study basins; and (3) the DPM was applied to each entire island using results of the calibrations of the six study basins.

In step 3, island-wide direct runoff data were not available. The DPM was, therefore, operated in a mode in which the simulated direct runoff for each cell is used in place of the disaggregated measured runoff.

During the calibration process of step 2, the simulated direct runoff was made to match the measured direct runoff as closely as possible so that the simulated island-wide direct runoff, using the calibrated input values and parameters from the study basins, produce a reasonable representation of the actual island-wide direct runoff.

Data Requirements

Data needed to estimate recharge were collected for water years 1997-98 from six surface drainage areas (herein called study basins) — one each on San Juan, Orcas, and Shaw Islands and three on Lopez Island (fig. 5). The criteria used to select each of the six study basins were based on

1. representativeness of the geologic materials;
2. ability to accurately gage streamflow; and
3. all or most of the streamflow in the basin was direct runoff (overland flow, or shallow subsurface flow through the soil) so that the amount of direct surface-water runoff to the ocean could be readily quantified. This was indicated by dry streambed or very small flow during field reconnaissance in late summer.

The principal characteristics of the study basins are summarized in table 1. In addition to the streamflow measurements, other data also were collected at various sites on the islands (see fig. 5). Two temporary micrometeorological stations were established to measure hourly precipitation, solar shortwave radiation, air temperature, wind speed, and relative humidity—one at the southeastern tip of Orcas Island and one at the southeastern end of Lopez Island. Precipitation throughfall data were collected on Orcas, Shaw, and Lopez Islands. Additional hourly precipitation data were collected on Lopez Island just south of the L2 study basin, and stored precipitation data were collected on Lopez, Orcas, and Shaw Islands. Atmospheric-chloride deposition data were collected at three sites on Lopez Island. Table 2 summarizes the type of data, frequencies of measurement, location of data, and landowners for the data-collection sites shown on figure 5.

Table 1. Principal characteristics of the six study basins on Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington, water years 1997-98

[**Study basin**: Location of study basins are shown in figure 5. **USGS streamflow-gaging station**: Data are retrievable from Web-served U.S. Geological Survey data base. Streamflow statistics are summarized in table 7. **Predominant soil group**: Letter corresponds to composite soil group shown in a tabular explanation in figure 7. **Predominant DPM land cover**: Classification of land use from original land-use data to the land-use categories used by the Deep Percolation Model (DPM) are shown in table 6. **Long-term average annual precipitation**: Data from Oregon Climate Service (1999). **Water years 1997 and 1998**: Interpolated from temporary USGS precipitation gages installed for the study. Abbreviations: USGS, U.S. Geological Survey; mi^2, square mile; in/yr, inch per year]

Island	Study basin (fig. 5)	USGS streamflow-gaging station No.	Drainage area (mi^2)	Geologic material beneath the soils (fig. 5)	Predominant soil group (fig. 7)	Predominant DPM land cover (table 6)	Precipitation (in/yr)		
							Water year 1997	Water year 1998	Long-term average annual (1961–90)
Lopez	L1	12200733	0.45	Glacial deposits	B, E	Pasture/hay and evergreen forest	30.04	20.54	28
	L2	12200730	1.63	Glacial deposits	A, E	Pasture/hay, grassland and evergreen forest	30.37	20.88	27.5
	L3	12200728	0.66	Bedrock	G	Evergreen forest	28.98	20.07	27
San Juan	SJ1	12200750	0.50	Bedrock	G, H	Evergreen forest	38.31	23.54	33
Orcas	OR1	12200762	0.57	Bedrock	D, H	Evergreen forest	34.90	21.44	34
Shaw	SH1	12200737	0.26	Bedrock	B, G	Evergreen forest	31.96	20.84	29

Table 2. Summary of type, frequency, and location of data collected at sites on Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington, water years 1997–98

[**Data-collection site No**: Location of data-collection sites are shown in figure 5]

Island	Data-collection site No. (fig. 5)	Land owner	USGS streamflow-gaging station No. or data location	Types of data collected	Frequency of measurement
Lopez	L1	Walter Lease	12200733	Streamflow	Hourly
	L2	Paul Atlas	12200730	Streamflow	Hourly
	L3	Laurence Wilmot	12200728	Streamflow	Hourly
	M1	Howard Cole	Project archives	Precipitation, solar shortwave radiation, air temperature, wind speed, humidity.	Hourly
				Stored precipitation	Approximately monthly
	P1	Paul Atlas	12200730	Precipitation	Hourly
	S1	Charles Walker	Project archives	Stored precipitation	Approximately monthly
	T1	Howard Cole	Appendix A	Throughfall	Daily
	C1	Charles Walker	483208122532401	Atmospheric chloride deposition, wet, dry, and composite	Approximately monthly
	C2	Howard Cole	482614122501701	Atmospheric chloride deposition, wet, dry, and composite	Approximately monthly
	C3	Philip Weinheimer	483044122532001	Atmospheric chloride deposition, composite only	Approximately monthly
San Juan	SJ1	Town of Friday Harbor	12200750	Streamflow	Hourly
Orcas	OR1	Robert Winter	12200762	Streamflow	Hourly
	M2	John Willis	Project archives	Precipitation, solar radiation, air temperature, wind speed, humidity, stored precipitation	Hourly
					Approximately monthly
	S2	Jan Helsel	Project archives	Stored precipitation	Approximately monthly
	T3	Environmental Learning Center Moran State Park	Appendix A	Throughfall	Multi-day to multi-week
Shaw	SH1	Our Lady of the Rock Priory	12200737	Streamflow	Hourly
	T2	Our Lady of the Rock Priory	Appendix A	Throughfall	Daily

Data Collection and Processing

In step 1 of the process, each of the six study basins was divided into a uniform grid of cells, each 98.4 feet (30 meters) on a side and with an area of 0.222 acre (900 square meters). This cell size was selected to match the resolution of the land-cover data, which was the lowest resolution of all the GIS coverages used. Each cell was assigned the predominant soil type and land cover that occurred in the cell. The percentage of total area assigned each predominant soil type and land cover for use in the DPM for each study basin are shown in table 3 and table 4. When the model was applied to the four islands, cell size was increased to 295 feet (90 m) on a side (about 2 acres) in order to reduce the number of cells to accommodate file-size limitations in the pre- and post-processing software. Grid characteristics for the six modeled study basins and islands are shown in table 5.

Daily values of precipitation, throughfall, solar shortwave radiation, air temperature, and stream-discharge data were collected by the USGS during water years 1997-98. Most properties of soils, vegetation, and land cover were compiled from published data or previous studies of San Juan County. DPM model parameters defining maximum clear-sky shortwave radiation, soil-limiting transpiration, and snowmelt and sublimation were compiled from values used in two previous applications of the DPM to areas of western Washington. Bauer and Mastin (1997) estimated recharge in till-covered areas, and W.R. Bidlake (U.S. Geological Survey, written commun., 1998) estimated recharge in areas covered by till and glacial outwash. These two studies used locally measured meteorological data and extensive calibration data, including direct stream runoff, soil-water content, soil saturation levels, and ground-water levels. Using parameter values from these previous two studies in this study is considered reasonable because all three study areas have a similar climate, vegetation cover, geology, and topography. The application of these parameters in the DPM is described in Bauer and Mastin (1997).

Precipitation

Three commercially available tipping-bucket-type precipitation gages were installed—one on Orcas Island and two on Lopez Island—and data were collected for water years 1997-98. The gages were connected to microloggers installed in clear areas at locations where precipitation is typical of the study basins (fig. 4 and fig. 5). Each bucket tip, representing 0.01 inch of precipitation, was counted and the total amounts were recorded in the data logger at 60-minute intervals. Data were retrieved from the data loggers at approximately 1-month intervals. Two of the tipping-bucket precipitation gages, the one at the southern end of Lopez Island and the one on Orcas Island, were part of two temporary micrometeorological stations that also collected air temperature, solar shortwave radiation, wind speed, and relative humidity data.

Several storage-type precipitation gages also were installed at various locations in the study area. A storage gage is a simple and reliable means of collecting precipitation that falls onto a funnel and directing it into a container where it is stored and later manually measured. Blowover and evaporation errors were minimized by placing the containers approximately flush with the ground surface where wind speed would be at a minimum and humidity at a maximum. A storage precipitation gage was installed at two of the tipping-bucket sites (see fig. 5 and table 2; sites M1 and M2) and the resulting data were used to provide correction factors to the hourly tipping-bucket data (see fig. 5 and table 2). Storage- precipitation data also were collected at two of the chloride-deposition data sites (see fig. 5; sites C1 and C2) and at the precipitation throughfall data-collection sites (see fig. 5; sites T1, T2, and T3). One of the data sets was used to provide correction factors to the tipping-bucket data used in the DPM for study basin SH1. Similarly, but not located within or adjacent to SH1, a storage precipitation gage was installed at study basin OR1 to provide correction factors to the tipping bucket data at M2 (see fig. 5) used for OR1.

Daily precipitation data, collected by Roche Harbor Water Systems (a privately owned company) and published weekly in the local newspaper "Journal of the San Juan Islands," were used to calculate a correction factor to the M2 tipping-bucket data used for drainage basin SJ1.

Table 3. Percentages of total basin area assigned soil types for use in the Deep Percolation Model for the six study basins, Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington

[**Soil group**: Letter corresponds to composite soil group shown in a tabular explanation in figure 7. All values rounded to two significant factors: Because of rounding, area totals may not agree exactly with other tables and percent values may not total 100 percent; Abbreviations: mi^2, square mile]

Soil group (fig. 7)	L1		L2		L3	
	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area
Bedrock						
A	0.00	0.00	0.00	0.00	0.00	6.2
B	0.00	0.00	0.00	0.00	0.04	6.2
C	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	0.00	0.00	0.00	0.00
E	0.00	0.00	0.00	0.00	0.12	18
F	0.00	0.00	0.00	0.00	0.00	0.00
G	0.00	0.00	0.00	0.00	0.48	74
H	0.00	0.00	0.00	0.00	0.00	0.00
I	0.00	0.00	0.00	0.00	0.00	0.00
J	0.00	0.00	0.00	0.00	0.00	0.00
K	0.00	0.00	0.00	0.00	0.01	1.5
Glacial Deposits						
A	0.01	2.2	0.82	50	0.00	0.00
B	0.14	31	0.07	4.3	0.00	0.00
C	0.00	0.00	0.07	4.3	0.00	0.00
D	0.00	0.00	0.00	0.00	0.00	0.00
E	0.27	60	0.44	27	0.00	0.00
F	0.02	4.4	0.04	2.5	0.00	0.00
G	0.00	0.00	0.00	0.00	0.00	0.00
H	0.00	0.00	0.00	0.00	0.00	0.00
I	0.00	0.00	0.00	0.00	0.00	0.00
J	0.00	0.00	0.12	7.4	0.00	0.00
K	0.01	2.2	0.07	4.3	0.00	0.00
Totals	**0.45**		**1.63**		**0.65**	

Table 3. Percentages of total basin area assigned soil types for use in the Deep Percolation Model for the six study basins, Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington—*Continued*

Soil group (fig. 7)	SJ1		OR1		SH1	
	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area
Bedrock						
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.11	41
C	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	0.47	82	0.00	0.00
E	0.00	0.00	0.01	1.8	0.00	0.00
F	0.00	0.00	0.00	0.00	0.00	0.00
G	0.29	57	0.00	0.00	0.15	56
H	0.22	43	0.09	16	0.00	0.00
I	0.00	0.00	0.00	0.00	0.00	0.00
J	0.00	0.00	0.00	0.00	0.01	3.7
K	0.00	0.00	0.00	0.00	0.00	0.00
Glacial Deposits						
A	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	0.00	0.00	0.00	0.00
E	0.00	0.00	0.00	0.00	0.00	0.00
F	0.00	0.00	0.00	0.00	0.00	0.00
G	0.00	0.00	0.00	0.00	0.00	0.00
H	0.00	0.00	0.00	0.00	0.00	0.00
I	0.00	0.00	0.00	0.00	0.00	0.00
J	0.00	0.00	0.00	0.00	0.00	0.00
K	0.00	0.00	0.00	0.00	0.00	0.00
Totals	**0.51**		**0.57**		**0.27**	

Table 4. Percentages of total basin area assigned land cover for use in the Deep Percolation Model for the six study basins, Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington

[**Land cover:** Distribution of land cover is shown on figure 8. All values rounded to two significant factors: Because of rounding, area totals may not agree exactly with other tables and percent values may not exactly total 100 percent. Abbreviations: mi^2, square mile]

Land cover (fig. 8)	L1		L2		L3	
	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area
Evergreen forest	0.25	54	0.33	20	0.49	75
Grassland	0.04	8.7	0.43	26	0.02	3.0
Orchard and deciduous forest	0.04	8.7	0.10	6.1	0.06	9.2
Pasture/hay	0.12	26	0.67	41	0.08	12
Row crops	0.00	0.00	0.01	0.61	0.00	0.00
Wheat	0.01	2.2	0.08	4.9	0.00	0.00
Surface water	0.00	0.00	0.01	0.61	0.00	0.00
Totals	**0.46**		**1.63**		**0.65**	

Land cover (fig. 8)	SJ1		OR1		SH1	
	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area
Evergreen forest	0.47	92	0.55	98	0.20	77
Grassland	0.00	0.00	0.00	0.00	0.00	0.00
Orchard and deciduous forest	0.03	5.9	0.00	0.00	0.05	19
Pasture/hay	0.00	0.00	0.00	0.00	0.00	0.00
Row crops	0.00	0.00	0.00	0.00	0.00	0.00
Wheat	0.00	0.00	0.00	0.00	0.00	0.00
Surface water	0.01	2.0	0.01	1.8	0.01	3.9
Totals	**0.51**		**0.56**		**0.26**	

Table 5. Grid characteristics for the six modeled basins and Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington

[**Area modeled**: Area modeled does not necessarily exactly equal the area of the basin because of model cell size. **Cell size used for gridding data**: Cell size means length of square cell. Abbreviations: mi^2, square mile]

Study basin or island (fig. 5)	Area modeled (mi^2)	Cell size used for gridding data		Number of gridded cells	Number of aggregated cells used in DPM simulation
		(feet)	(meters)		
L1	0.45	98.4	30	1,293	14
L2	1.63	98.4	30	4,683	not aggregated
L3	0.65	98.4	30	1,879	not aggregated
SJ1	0.50	98.4	30	1,451	not aggregated
OR1	0.57	98.4	30	1,637	7
SH1	0.26	98.4	30	761	not aggregated
Lopez Island	29.26	295	90	9,356	not aggregated
San Juan Island	55.01	295	90	17,589	not aggregated
Orcas Island	57.33	295	90	18,331	not aggregated
Shaw Island	7.54	295	90	2,410	not aggregated

Precipitation Throughfall

In forested areas of the Puget Sound Lowland, evaporation of precipitation intercepted and stored on the foliage, often referred to as interception loss, proceeds at considerably faster rates than transpiration, especially during the winter months, and annually has been determined to be from about 20 to 50 percent of the total precipitation (Bauer and Mastin, 1997 and Bidlake and Payne, 2001). During this investigation, throughfall (that part of precipitation not evaporated from foliage) was measured at three sites: a 15-to-30-year-old evergreen forest near the southern end of Lopez Island (site T1), an old-growth evergreen forest on Orcas Island (site T3), and a 50-to-100-year-old native evergreen forest on Shaw Island (site T2) (see fig. 5 for location of throughfall sites). At each throughfall data-collection site, several storage-type precipitation gages were installed at randomly selected locations within the forest and one was installed in an adjacent clear area. Following Hewlett (1982), seven gages were installed in forested areas at the sites on Shaw and Lopez Islands and six were installed in the forested area at the site on Orcas Island. Throughfall as a fraction of precipitation was calculated for the periods between site visits as the average of the forest gage totals divided by the clearing gage totals. All sites were monitored for the USGS by local residents. Daily measurements were collected at the Lopez and Shaw Island sites and approximately weekly measurements were collected at the Orcas Island site.

At the site on Orcas Island, data were not available for the periods October 1 to November 6, 1996; January 31 to May 13, 1998; and July 17 to September 30, 1998, because of the unavailability of gages or observers during those times. Therefore, data for those periods were estimated. All collected and estimated throughfall data are shown in tables 14-16 (at back of report).

Throughfall varied greatly from day to day primarily due to varying quantities, intensities, and durations of precipitation from day to day. Because measurement times were variable, a consistent basis was required to produce 24-hour values of throughfall for each site. This was done by calculating the average throughfall as a fraction of precipitation for the Shaw and Lopez Island sites for each rainy period, defined herein as a period of precipitation that is separated from the next rainy period by a period of 1 or more days of project-area-wide non-precipitation. For each site, the throughfall fraction for each rainy period was assumed to be the same for each of the days during the wet period.

This calculation could not be done for the Orcas site because of the long intervals between measurements. Therefore, daily throughfall data for the Orcas site were estimated by multiplying daily values from the Shaw site by correction factors based on the Orcas data.

Cumulative throughfall and precipitation at each of the three sites is shown in figure 6. For the 2-year period, the total throughfall was 86, 75, and 59 percent of precipitation, respectively, for the Lopez Island, Orcas Island, and Shaw Island sites. This large variability in throughfall probably is due mostly to the differences in the forest canopy. The Lopez Island site had the shortest trees, which therefore had the least storage capacity and the least advective evaporation. The "old growth" site on Orcas Island had the tallest trees, but they were more widely spaced than the "second growth" site on Shaw Island, thereby allowing greater quantities of precipitation to pass through the canopy without being intercepted by the foliage than the Shaw Island site. Interception loss in Puget Lowland forests was investigated in greater detail by Bidlake and Payne (2001), and Bauer and Mastin (1997).

Solar Shortwave Radiation and Meteorological Measurements

In addition to precipitation, daily incoming solar shortwave radiation, air temperature, relative humidity, and wind speed were measured during water years 1997-98 at the two temporary micrometeorological stations (see fig. 5). These stations were installed in pasture areas at least 500 feet from wooded areas. A pyranometer positioned about 10 feet above the ground measured incoming shortwave radiation. The pyranometer, air temperature, wind speed, and relative humidity probes were connected along with the precipitation gage to a micrologger, which sampled output from the sensors every 15 seconds and recorded the averages every 60 minutes.

Soil and Subsoil Properties

The soil properties needed for the DPM are depth, available water-holding capacity, horizontal hydraulic conductivity, specific yield, and texture. Only vertical hydraulic conductivity values were available in the soil surveys, and they were used only to estimate values of the horizontal conductivities. The soil cover information for the four islands and six study basins was obtained from the Washington State Department of Natural Resources Geographic Information System Division in the form of a digital coverage. The data were derived from the Private Forest Land Grading system (PFLG) and subsequent soil surveys, such as the U.S. Department of Agriculture Soil Conservation Service (SCS; the Soil Conservation Service is now known as the Natural Resources Conservation Service, but SCS is used in this report). The Geographic Information System (GIS) coverage was completed in 1990, and data from the coverage were checked against the most recent published soil survey of the area (Soil Conservation Service, 1962). The GIS coverage was in the form of variable size and shape polygons where each polygon represents an area covered by a particular SCS soil series mapped on a 1:24,000 scale.

The 65 soil series defined by SCS in the study area were grouped according to abundance and to properties important in DPM simulation. Most of the soil types occupied 4 percent or more of the study area (main soil series) or 2 percent or less (minor soil series). Eleven composite soil groups were formed from the main soil series on the basis of similarities of depths and available water-holding capacities (fig. 7). Areas of minor soil types were included into the major soil types according to closest similarity of available water-holding capacity and soil depth. Properties of each soil group were computed as area-weighted averages of the properties of the soil series in the group. Ranges of the properties of the soils composing the 11 composite soil groups are 0.06 to 0.36 inch per inch for available water capacity, 0.05 to 21 feet per day for hydraulic conductivity, 14 to 84 inches for depth, and silt loam to gravelly sandy loam for soil texture (see figure 7 explanation).

An important and usually unknown parameter used in the DPM is the infiltration capacity (or vertical hydraulic conductivity) of the subsoil, the geologic material underlying the soil. The values used to calibrate DPM simulations in Bauer and Mastin (1997) ranged from 4.0 to 40.0 inches per year for three glacial-till-covered drainage basins, and the values used to calibrate DPM simulations in Bidlake and Payne (2001) were 26.28 inches per year for glacial till and 876 inches per year for glacial outwash and other coarse-grained deposits. Determination of the values for this study area are presented in the section "Calibration of Deep Percolation Model for the Study Basins."

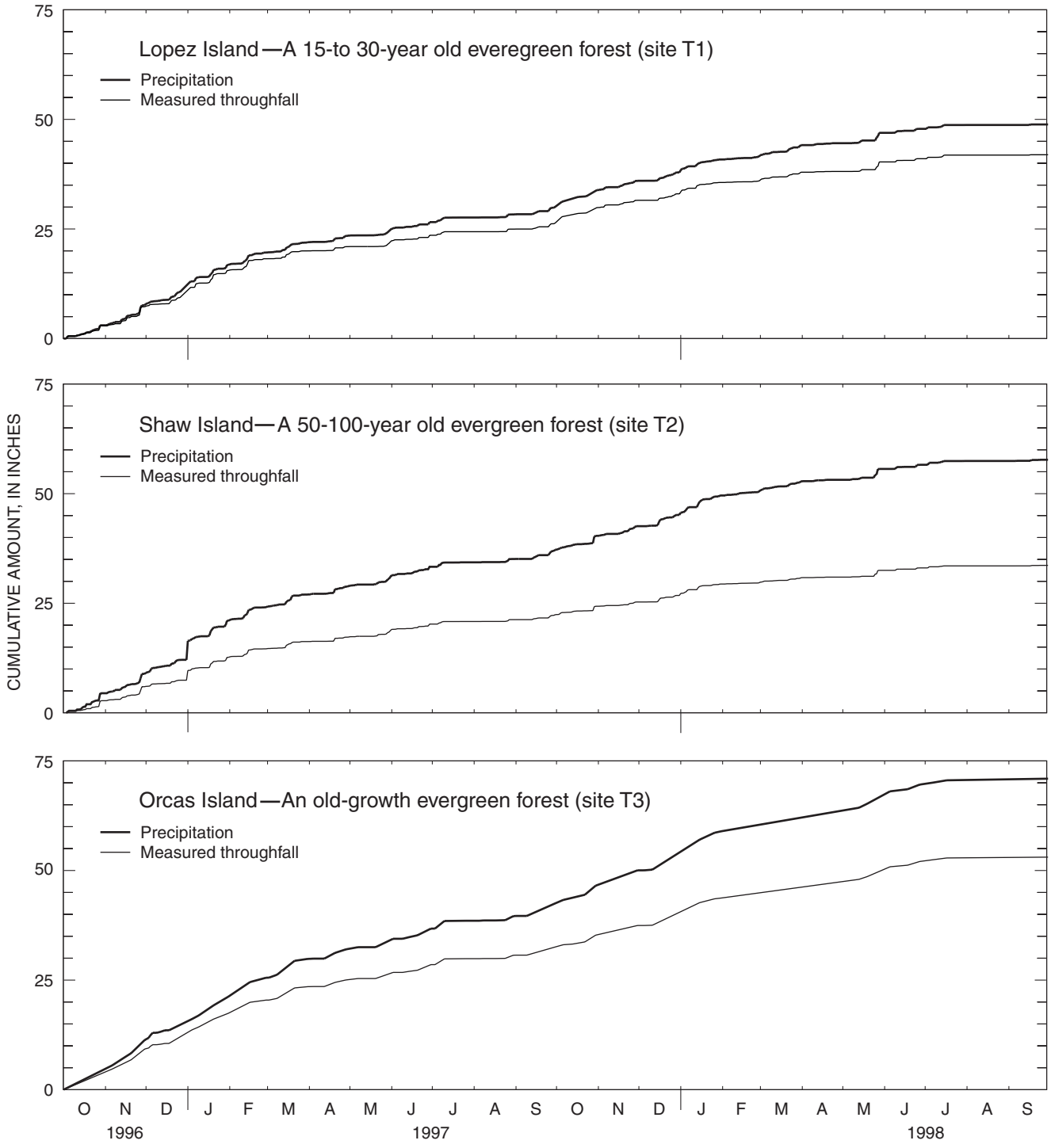


Figure 6. Cumulative precipitation and throughfall for three sites on Lopez, Orcas, and Shaw Islands, San Juan County, Washington.

(See figure 4 for location of throughfall sites.)

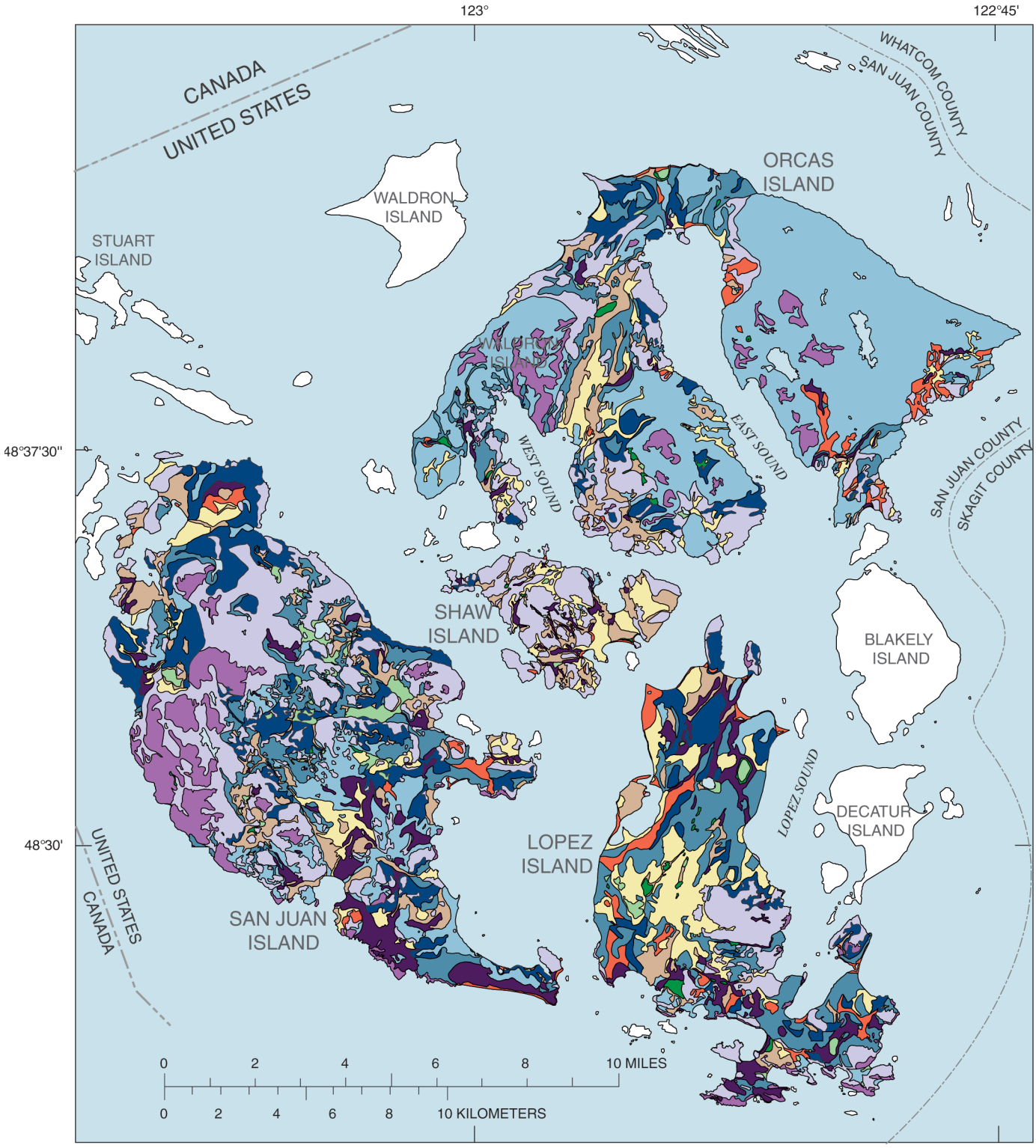


Figure 7. Distribution of soil groupings derived from Soil Conservation Service data for the Deep Percolation Model, on Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington.

Groupings and physical properties of Soil Conservation Service (SCS) soil series occurring on Lopez, Orcas, Shaw, and San Juan Islands, Washington

[--, not applicable]

Soil group and SCS soil series[1]	Area (square mile)	Depth from surface (inches)	Thickness-weighted average available water-holding capacity [2] (inch per inch)	Weighted average vertical permeability (feet per day)
Soil group A				
Bellingham clay loam	0.707	60	0.19	0.21
Bow gravelly silt loam	11.136	60	0.17	0.12
Soil group B				
Bellingham silt loam	1.794	51	0.18	0.13
Bow silt loam	5.586	50	0.19	0.16
Bow stony silt loam	2.672	50	0.15	0.52
Cloveland silt loam	0.972	48	0.19	0.27
Soil group C				
Coastal beaches	0.413	17	0.07	--
Everett gravelly sandy loam	3.576	24	0.08	18
Hovede loam	0.003	14	0.07	21
Neptune gravelly sandy loam	0.065	17	0.07	20
Tidal marsh	0.211	17	0.07	--
Soil group D				
Coveland gravelly silt loam	2.726	45	0.17	0.3
Coveland stony silt loam	1.087	45	0.14	0.5
Indianola-Roche complex	1.507	62	0.10	14
Norma loam	0.590	60	0.09	2
Norma loam, moderately deep	0.309	45	0.15	1.4
Pickett-Rock outcrop complex	27.962	40	0.13	3.3
San Juan gravelly sandy loam	2.890	36	0.15	1.6
San Juan loam	0.370	45	0.16	1.2
San Juan stony loam	0.362	50	0.12	1.2
Soil group E				
Alderwood gravelly sandy loam	0.931	50	0.08	5
Alderwood gravelly loam	1.392	42	0.10	3.7
Roche gravelly loam	14.430	48	0.08	0.18
Roche loam	0.791	48	0.08	0.33
Roche stony sandy loam	0.084	55	0.07	0.61
San Juan stony sandy loam	0.735	50	0.08	20
Soil group F				
Alderwood stony loam	2.366	45	0.08	1.2
Everett stony sandy loam	0.144	48	0.07	18
Roche gravelly sandy loam	0.451	48	0.07	0.52
Roche stony loam	10.250	60	0.06	0.14
Soil group G				
Roche-Rock outcrop complex	33.977	40	0.06	0.14
Soil group H				
Rock land, rolling and steep	8.016	40	0.06	0.14
Soil group I				
Active dune land	0.200	60	0.08	21
Indianola sandy loam	0.587	54	0.09	19
San Juan gravelly sandy loam	7.239	60	0.08	20
Soil group J				
Orcas peat	0.071	84	0.26	3.3
Semiahmoo muck	1.695	72	0.36	3.6
Soil group K				
Semiahmoo muck, shallow	0.565	60	0.22	0.05
Tanwax peat, alkaline variant	0.103	84	0.23	0.81

[1] Source: Soil Conservation Service, 1962, and digital coverages from the Washington State Department of Natural Resources Geographic Information System Division.

[2] When soil consists of more than one layer, the average property for the entire soil column is computed by weighting the property of each layer by the thickness of the layer.

Figure 7.—*Continued.*

Land Cover and Vegetation

Land-cover information for the study area was obtained from GIS coverages prepared by the USGS National Mapping Division for the Puget Sound NAWQA program. The coverages were developed from Landsat Thematic Mapper satellite data collected at a 30-meter resolution during the early 1990s (Vogelmann and others, 1998). There are 19 categories of land cover in the GIS data. Fourteen of those occur in the study area.

The DPM, however, does not allow all these categories. Therefore, each of the 14 GIS categories was approximated with seven of the most similar DPM categories (table 6 and fig. 8).

Table 6. Reclassification of original land-use data to land-cover categories used by the Deep Percolation Model (DPM) for Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington

[**Original classification of land-use categories**: Land-use data from GIS coverages derived from Landsat Thematic Mapper satellite data (Vogelmann and others, 1998)]

Original classification of land-use categories	Grouped land-cover categories used for DPM
Evergreen forest	Evergreen forest
Forest	Evergreen forest
Low intensity residential	Grassland
Natural grasslands	Grassland
Grasses, other (parks, lawns, golf courses)	Grassland
Wetlands (woody wetlands)	Grassland
Grass	Grassland
Deciduous forest	Orchard and deciduous forest
Natural shrubland, deciduous	Orchard and deciduous forest
Maple trees etc.	Orchard and deciduous forest
Grasses, pasture/hay	Pasture/hay
Row crops	Row crops
Small grains	Wheat
Surface water, developed commercial/industrial, transitional, quarries/strip mines/gravel pits, bare, rock/sand, planted, bare soil	Surface water[1]

[1]Land-cover categories allowed in DPM described in Bauer and Vaccaro (1987). The DPM computationally treats impervious surfaces the same as surface water.

The DPM contains default values of maximum foliar cover and maximum root depth, but these can be replaced with more appropriate values by the user (Bauer and Vaccaro, 1987). A 100-percent foliar cover value was used for all land uses, and maximum root depths were set at 5 feet for all non-agricultural, native vegetation land uses, 5 feet for alfalfa, and 3 feet for grasses and annual crops. The 5-foot depth for native vegetation and alfalfa generally corresponds with the deepest reported soil depths of the predominant soils, the 3-foot depth for grasses is from Bauer and Mastin (1997) and the 3-foot depth for annual crops is from James and others (1988). Where maximum root depths exceed the soil depth, the DPM automatically truncates the maximum root depth to the soil depth.

Land-Surface Altitude

Land-surface altitude data for the study basins were in the form of USGS 10-meter-resolution digital elevation models (DEMs) obtained from the University of Washington (2001). The DEMs were then converted into contour maps using GIS. The contour maps were checked for data reliability against USGS 7.5-minute quadrangle maps of the area. Average land-surface slope and aspect for model cells were not used in this application of the DPM.

Two other land-surface parameters that are used in the model for simulating direct runoff are a measure of the distance between the smallest drainage channels in the basin, and the slope between such channels and the drainage divides separating them (Bauer and Mastin, 1997). Values for these parameters were taken from Bauer and Mastin (1997) in their study in western Washington because both areas were subject to the last glaciation and their topographical features are similar.

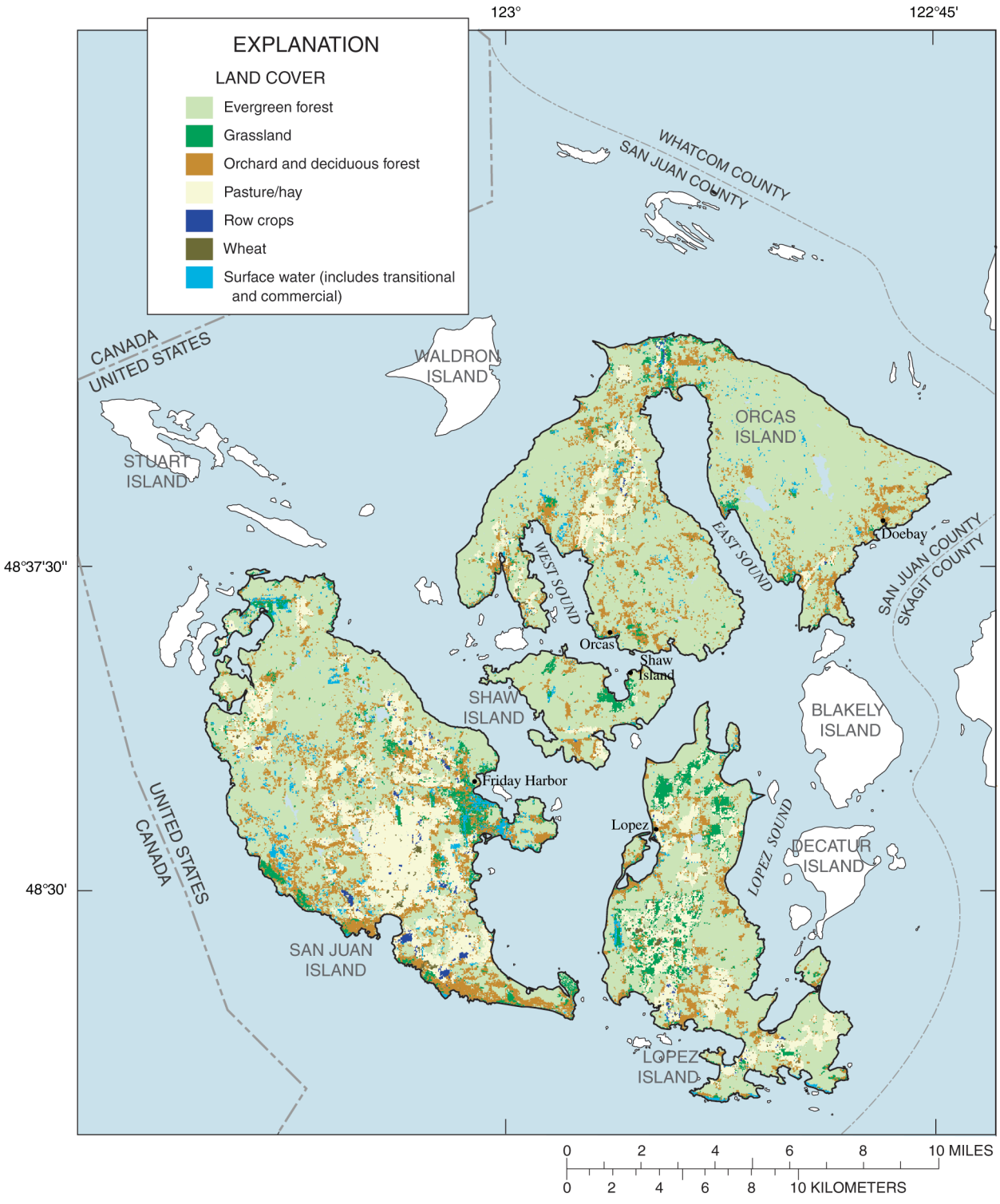


Figure 8. Areal distribution of land cover reclassified for the Deep Percolation Model for Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington.

Streamflow

Streamflow was measured during water years 1997-98 at the mouth of each of the six study basins using flow-control structures that provided accurate and constant stage-discharge relations. The streamflow measurements are summarized in table 7.

For basins L1, L3, OR1, and SH1, the flow-control structures consisted of pre-existing road culverts. For basin L2, a temporary V-notch weir was constructed by the USGS. For basin SJ1, a permanent V-notch weir was constructed by the Town of Friday Harbor Utilities Department according to specifications provided by the USGS. The V-notch weir for the SJ1 basin was not completed until December 1996, so the early 1997 water-year data for the basin were estimated using a regression relation developed from the available SJ1 data and data collected at the OR1 basin (streamflow pattern in OR1 basin is similar to that of SJ1).

The streamflow hydrographs reflect the distinct characteristics of the study basins (fig. 9). Basins L1 and L2 are entirely overlain by glacial deposits and total streamflow per unit area is less and streams are dry for longer periods than in the other four basins, which are underlain by bedrock just beneath the soil cover and have some exposed bedrock at the surface (see table 1). The characteristics of the basins with glacial deposits reflect, in part, the fact that the glacial deposits allow greater quantities of deep vertical infiltration of soil water that subsequently recharges the aquifers beneath the basin and flows out of the basin through the aquifers. Soils generally are thicker and have higher available water-holding capacities. As a result, more of the precipitation is temporarily stored in these soils, which subsequently results in greater amounts of evapotranspiration, which also causes less direct stream runoff.

Table 7. Summary of streamflow measured for the six study basins on Lopez, San Juan, Orcas, and Shaw Islands, water years 1997-98

[**Study basin**: Location of study basins are shown in figure 5. **Discharge**: Expressed as depth of water over the area of the study basin. **Annual discharge and mean daily discharge**: Values in these columns do not exactly agree with 1997 and 1998 values published by Wiggins and others (1998; 1999) due to refinements of study basin drainage area measurements made after 1996. Abbreviations: USGS, U.S. Geological Survey; mi^2, square mile]

Study basin (fig. 5)	USGS streamflow-gaging station No.	Basin area (mi^2)	Water year	Annual discharge (inch)	Mean discharge		Highest daily mean discharge	
					inch per day	cubic foot per second	inch per day	cubic foot per second
L1	12200733	0.45	1997	5.43	0.0149	0.18	0.760	9.2
			1998	0.51	0.0014	0.017	0.036	0.43
L2	12200730	1.63	1997	7.42	0.0203	0.89	0.386	16.9
			1998	0.57	0.0016	0.068	0.024	1.05
L3	12200728	0.66	1997	9.67	0.0265	0.47	1.465	26.0
			1998	2.47	0.0068	0.12	0.885	1.57
SJ1	12200750	0.50	1997	16.03	0.0439	0.59	1.101	14.8
			1998	7.61	0.0208	0.28	0.209	2.81
OR1	12200762	0.57	1997	16.20	0.0444	0.68	1.566	24.0
			1998	4.77	0.0131	0.20	0.134	2.06
SH1	12200737	0.26	1997	6.79	0.0186	0.13	0.744	5.20
			1998	2.40	0.0066	0.046	0.080	0.56

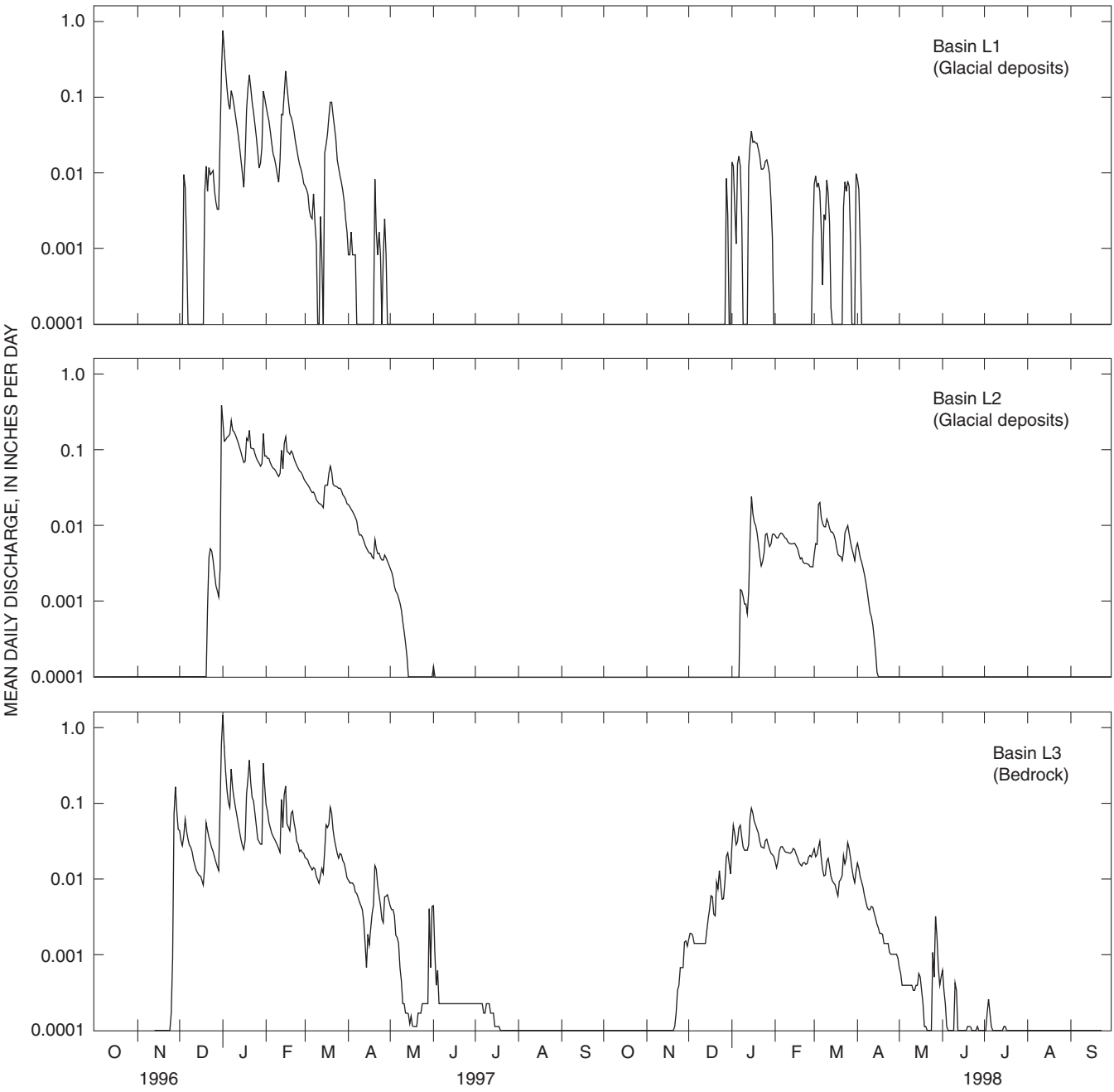


Figure 9. Streamflow for the six study basins on Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington, water years 1997-98.

Because of a lack of data, streamflow in basin SJ1 was estimated for October 1–November 31, 1996.

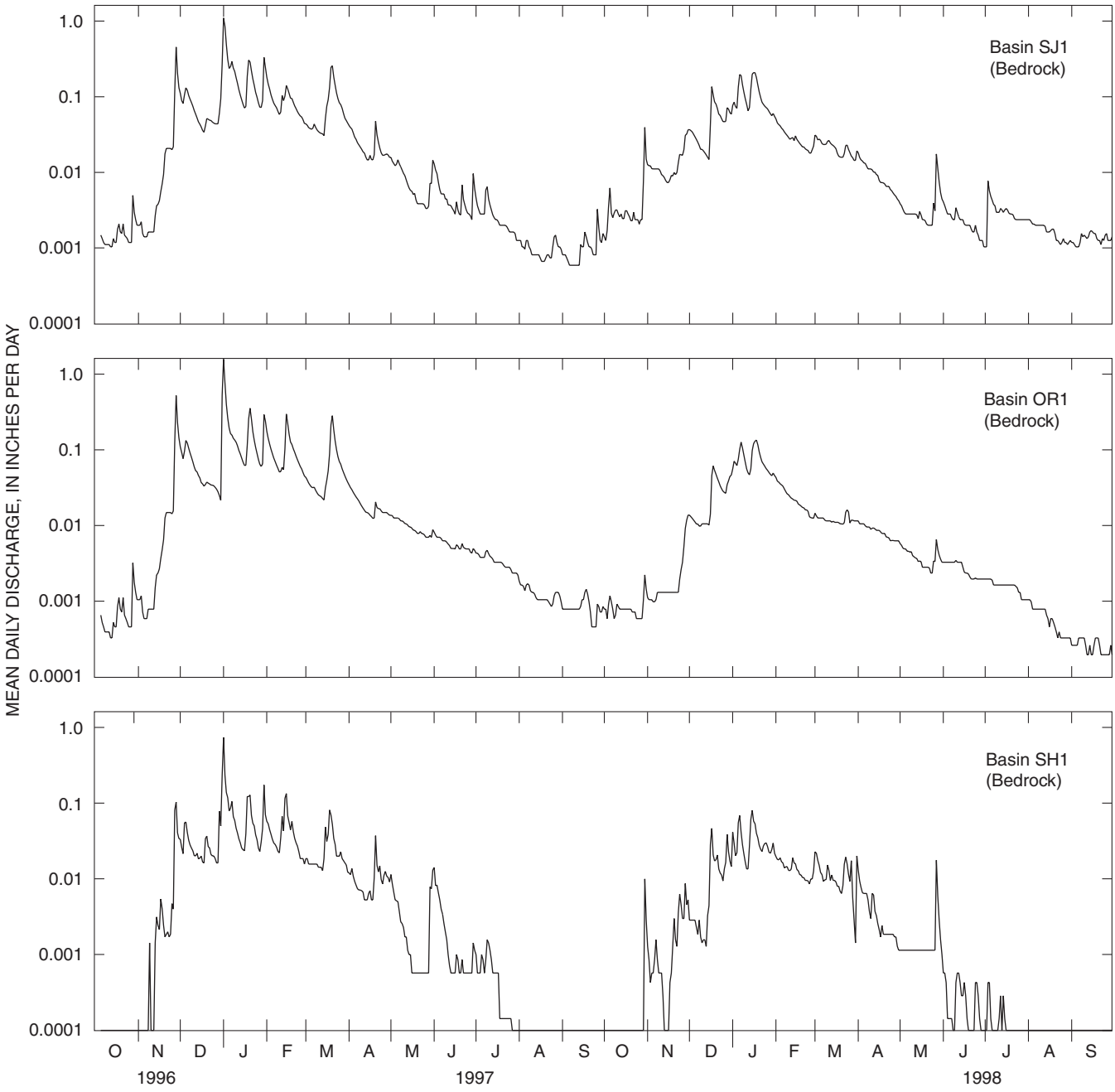


Figure 9.—*Continued*

Of the basins underlain by bedrock, L3 and SH1 have no streamflow during the driest months of the year, whereas basins SJ1 and OR1 have streamflow all year (fig. 9). Basins SJ1 and OR1 lie at higher altitudes than the other basins, have more rugged topography, and receive more precipitation. The more deeply incised stream channels for these two basins probably are draining part of the water table. Such drainage is commonly referred to as baseflow, which is defined as that part of streamflow coming from ground-water seepage into a stream (U.S. Geological Survey, 2001). Daily baseflow quantities for SJ1 and OR1 were estimated and used in the DPM as one of the time-series data inputs.

Baseflow was estimated by constructing a baseflow hydrograph from the hydrograph of the total streamflow. Total streamflow was assumed to be equal to baseflow during the summer seasons when precipitation was scarce and the soils were below field capacity, as evidenced by precipitation producing little or no streamflow response. A smooth baseflow curve was drawn for this period and then extended backward in time, using minimum wet-season flows from the total-flow hydrograph as maximum allowable baseflow values. The baseflow curve also was constrained to merge smoothly into the streamflow hydrograph of the previous dry season. Daily values were then read from the constructed baseflow curve.

Model Calibration

After the data were compiled, checked for accuracy, and assigned to the cells, the DPM was operated for each of the six study basins. For each study basin, various DPM parameters and an initial condition were adjusted in order to achieve a balance between the measured and simulated daily flows and fluxes of water (see "Near-Surface Water-Balance Method" section). Such a balance was achieved primarily by adjusting values assigned to the vertical hydraulic conductivity of the subsoil and less significantly to the soil properties and initial moisture conditions. Glacial deposits contain areas of three hydraulically distinct materials; clay, glacial till, and glacial outwash. All bedrock was assumed to be hydraulically similar. Soils underlain by bedrock or clay material generally allow less recharge because they have lower vertical hydraulic conductivities than soils underlain by glacial-deposit material. The subsoil material of each of the basins and islands was determined from the Soil Conservation Service (1962) and Jones (1999). Study basins L3, SJ1, OR1, and SH1 are underlain by bedrock beneath generally thin soils, whereas study basins L1 an L2 are underlain by glacial till, glacial outwash, and clay beneath thick soils.

The vertical hydraulic conductivities of subsoils composed of glacial till, glacial outwash, and clay were adjusted to 10, 100 and 4 inches per year, respectively. For bedrock, the vertical conductivity was adjusted to 1 inch per year except for study basin SH1, which required a value of 3 inches per year. The value used for till falls within the range used by Bauer and Mastin (1997). The value of 100 inches per year used for glacial outwash is smaller than typical published values for similar materials. Assuming a 100:1 anisotropy, the value used lies at the lower hydraulic conductivity range for a clean sand (Freeze and Cherry, 1979). However, if values for outwash materials commensurate with published values were used, a poorer DPM calibration resulted because simulated direct runoff would be zero for such areas, when, in fact, there was some runoff during periods of heavy precipitation. Probably, the overlying soils, which have smaller hydraulic conductivities than the subsoils in these areas, limit the downward movement of water, rather than the subsoil, and produce runoff during periods of heavy precipitation. Because this process is not explicitly simulated in the DPM, the assignment of an artificially lower infiltration rate to the subsoil was required to produce an equivalent result. The hydraulic conductivity used for bedrock is at the low end of typical published values for fractured igneous and metamorphic rocks (Freeze and Cherry, 1979). This is reasonable, considering that the uppermost few inches of fractures in the bedrock probably are filled with fine particulate material that would decrease the overall hydraulic conductivity of the near-surface bedrock.

Additional adjustments required to achieve calibration were as follows.

- Soil depths for the study basins with shallow bedrock generally decreased by as much as 25 percent from reported values. This adjustment also produced a better overall match between the quantities and timing of simulated and measured direct runoff.

- The horizontal hydraulic conductivities of the soils generally were set to as much as two orders of magnitude greater than the reported vertical hydraulic conductivities.
- To run the DPM, initial water contents of the soils must be specified. The amount of soil water is expressed as a fraction of the available water-holding capacity (unsaturated soil) and, for very wet conditions, as a fraction of specific yield (saturated soil). The start of the simulation for the six basins was October 1, 1996. In western Washington, non-irrigated soils are usually extremely dry by the first of October, and therefore, the initial soil moisture was first set to zero for all study basins. However, reasonable matches could not be obtained between the onset of simulated and measured direct stream runoff. The first simulated direct runoff for a basin typically would not occur until about a month after the first measured direct runoff. Inspection of precipitation records prior to October revealed that September had about twice the normal precipitation, suggesting that a non-dry initial soil moisture be used. A few trial-and-error DPM simulations revealed that an average initial unsaturated soil moisture of about 30 percent of available water-holding capacity gave a more reasonable match between the onset of simulated and measured direct stream runoff. Initial conditions errors may cause errors in the water budget, however such errors diminish as the simulation progresses. Tests have shown that after 1 year of simulation time, there are no subsequent errors due to incorrect initial conditions. Therefore, when parameter adjustments were made that could not satisfy the water balance of both water years, preference was given to the 1998 water year.
- A period of freezing temperatures limited infiltration of precipitation from December 26, 1996, to January 2, 1997, and for a short period before the ground thawed. To simulate these conditions, the hydraulic conductivity of the subsoils was set to 0 inches per year during that time. The freezing temperatures and a subsequent heavy snow storm also adversely affected the quality of the data during this period. This also was cause for bias toward the 1998 water year during calibration.

For two of the study basins, L1 and OR1, the water budgets (including the "deficit" term) simulated by the DPM did not achieve an accurate mass balance, due to accumulation of computational roundoff errors. Therefore, all cells with identical properties were aggregated into single cells for these two study basins, thereby reducing the number of cells to 18 and 7 for study basins L1 and OR1, respectively. Because proportionately fewer computations are executed, the mass-balance error was reduced to an insignificant amount. Each of these larger cells represents many of the original cells that may or may not be connected. The locations for the larger cells were computed by averaging the location of the smaller cells that they represent. Because of the small size of the study basin, any error resulting from the more approximate interpolation of weather station data to the cells was assumed to be insignificant.

After calibration, the average simulated annual deep percolation values for the six study basins from October 1996 to September 1998 were as follows.

L1	2.67 inches per year
L2	2.78 inches per year
L3	0.35 inch per year
SJ1	0.45 inch per year
OR1	0.27 inch per year
SH1	1.27 inches per year

The simulated annual water-budget components and the 2-year averages for each basin for the data-collection period are summarized in table 8. The output summary tables of the DPM simulations for the study basins, which present a more detailed breakdown of the simulated water-budget components on a monthly basis, are shown in tables 17-22 (at back of report).

Table 8. Summary of annual water-budget components using the Deep Percolation Model for the six study basins on Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington, water years 1997-98

[**Study basin–geologic material**: Location of study basins are shown in figure 5. **Interception loss**: May include small amounts of simulated snow evaporation. **Components of water budget**: Sum of interception loss, transpiration, direct runoff, deep percolation, change in soil moisture, and soil saturation deficit may not exactly equal precipitation because of roundoff errors]

Study basin – geologic material	Water year	Precipitation		Components of water budget (all values in inches)					
		Inches	Percentage of long-term average	Interception loss	Simulated transpiration	Direct runoff	Simulated deep percolation	Simulated change in soil moisture	Soil-saturation deficit
L1,	1997	30.04	107	7.13	14.38	5.53	3.29	-0.33	0.00
Glacial	1998	20.54	73	5.99	13.17	0.52	2.06	-1.20	0.02
deposits	avg	25.29	90	6.56	13.77	3.02	2.67	-0.77	0.01
L2,	1997	30.37	110	6.63	13.46	7.61	2.71	0.40	-0.50
Glacial	1998	20.88	76	5.48	13.14	0.58	2.86	-1.18	0.01
deposits	avg	25.63	93	6.06	13.30	4.10	2.78	-0.39	-0.24
L3,	1997	28.98	107	6.82	12.88	9.76	0.31	-0.08	-0.73
Bedrock	1998	20.07	74	6.12	11.92	2.54	0.40	-0.93	0.00
	avg	24.53	91	6.47	12.40	6.15	0.35	-0.50	-0.37
SJ1,	1997	38.31	124	10.70	10.20	15.90	0.43	0.25	0.54
Bedrock	1998	23.54	76	8.36	8.90	6.60	0.47	-0.88	-0.13
	avg	30.92	100	9.53	9.55	11.25	0.45	-0.31	0.21
OR1	1997	34.90	116	9.73	12.26	14.60	0.28	-0.47	-1.84
Bedrock	1998	21.44	71	7.48	10.70	3.88	0.26	-0.94	-0.17
	avg	28.17	94	8.60	11.48	9.24	0.27	-0.70	-1.01
SH1	1997	31.96	110	11.23	12.69	6.64	1.49	-0.25	0.15
Bedrock	1998	20.84	72	8.45	10.09	2.36	1.04	-1.08	-0.01
	avg	26.40	91	9.84	11.39	4.50	1.27	-0.66	0.07

As previously discussed, calibrating the water budgets for the study basins involves minimizing the soil-saturation deficit, which is the difference between precipitation and the sum of the other water-budget components (last column on tables 17-22). A zero deficit for all years for all basins was not possible to achieve because changing a parameter that is common to multiple basins often improves the water budget for one basin but worsens it in another. Similarly, improvement in one year often worsens the next or previous year. A considerable degree of "hydrologic judgment" is used during the calibration process, and results would probably vary slightly from one hydrologist to another.

The average annual absolute deficit for the two glacial drift study basins for water years 1997-98 is 0.12 inch, which compares favorably with the average simulated deep percolation 2.73 inches, suggesting an average uncertainty of about 4 percent.

The average annual absolute deficit for the four bedrock study basins for both years is 0.42 inch, which compares with an average annual deep percolation of 0.59 inch for these basins. Even though the values of these deficits are small in comparison to the main water-budget components, an uncertainty in deep percolation of about 72 percent is suggested. Given the accuracy of the data components and the small magnitude of the simulated deep percolation, however, it probably is not possible to achieve better accuracy using this method. Sources of error are discussed more fully in the section "Sources of Uncertainty in the DPM Recharge Estimates."

Recharge in relation to the other water-budget components on a monthly basis for each of the six study basins is shown in figure 10. Deep percolation primarily occurs from November through March, with minor amounts sometimes occurring into April and May. Although precipitation is relatively high in October, deep percolation does not occur because the soils absorb most of this moisture due to their dried out condition from the previous dry months.

During April through August, evapotranspiration greatly exceeds precipitation, thereby depleting the moisture in soils. The relation between runoff and deep percolation also is evident. After the soils accumulate sufficient moisture in the autumn, a small amount of deep percolation usually precedes the onset of runoff. Thereafter, a greater rate of monthly deep percolation ensues but remains steady even though the runoff may vary greatly. For example, the monthly deep percolation in study basin L1 is about the same from January through March 1997, but the monthly runoff varies by a factor of more than six. This is due to the fact that the infiltration capacity of the subsoil imposes an upper limit on the deep percolation rate. This process is even more pronounced for study basins L3, OR1, SJ1, and SH1, where soils are underlain by bedrock. The bedrock imposes an even smaller upper limit on the deep percolation rate, which remains nearly constant from November through March or April.

Estimating Island-Wide Recharge for Lopez, San Juan, Orcas, and Shaw Islands Using Deep Percolation Model and Results from Study Basins

After the DPM was calibrated for the six study basins, the modified input values and parameters were used in the DPM simulations of the entire areas of each of the four islands in the study area: Lopez, San Juan, Orcas, and Shaw Islands. Except for streamflow data (see “Near-Surface Water-Balance Method” section), input data for the island-wide DPM simulations were compiled in much the same manner as for the study-basin simulations. The 11 soil groups and seven land-use categories described earlier were used in the DPM in the distributions for each island shown in table 9 and table 10 and fig. 7 and fig. 8. On an island-wide basis, distance-interpolated precipitation from data collected would not be fully representative of certain areas, especially in the high, mountainous terrain of Orcas Island. However, if average annual precipitation values for cells and for data-collection sites are input, the DPM makes an additional correction to each daily distance-interpolated cell value based on the ratios of the average annual cell precipitation to the average annual precipitation data at the sites. Therefore, average annual precipitation data for the cells were estimated from the annual precipitation data averaged over the most recent climate normal period, 1961- 90 (Oregon Climate Service, 1999). Daily precipitation values were interpolated from the three tipping-bucket gages. Daily throughfall values were interpolated from all three data-collection sites, and daily solar shortwave radiation and air temperature values were interpolated from the temporary micrometeorological data stations on Lopez and Orcas Islands. The distance interpolations of these data across all cells are performed by the DPM. Calibrated vertical hydraulic conductivities of the subsoil, soil depth, and lateral permeability of the soil were taken from the six study basins for the corresponding subsoil materials and soil types.

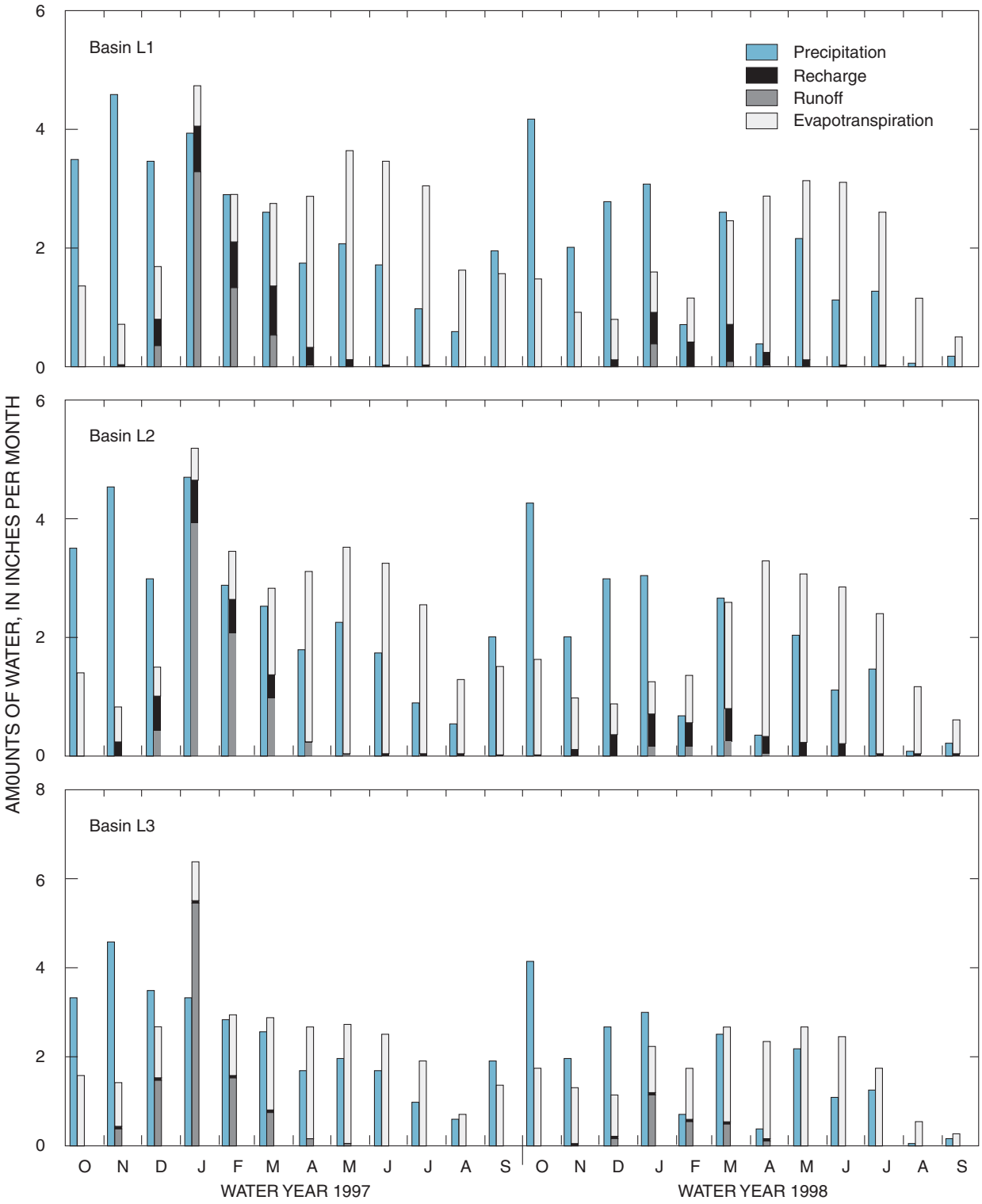


Figure 10. Monthly water-budget components for the six study basins on Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington, water years 1997-98.

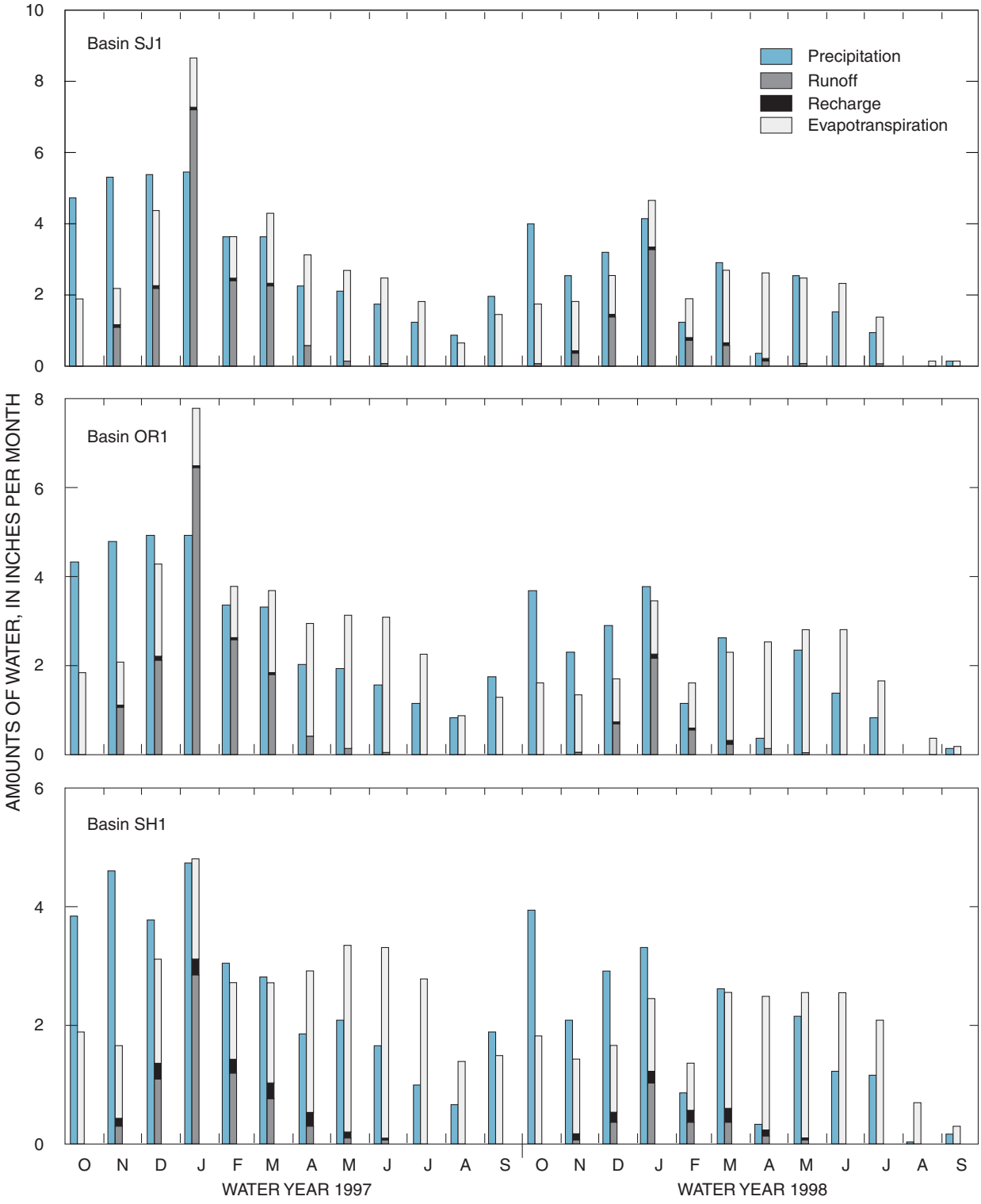


Figure 10.—*Continued.*

Table 9. Soil types assigned to Lopez, San Juan, Orcas, and Shaw Islands for use in the Deep Percolation Model, San Juan County, Washington

[**Soil type**: Letter corresponds to composite soil group shown in a tabular explanation in figure 7. All values rounded to two significant figures: Because of rounding, area totals may not agree exactly with other tables and percentage of values may not total exactly 100 percent. Abbreviations: mi^2, square mile]

Soil type	Lopez Island		San Juan Island		Orcas Island		Shaw Island	
	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area
Bedrock								
A	0.48	1.6	0.49	0.89	1.2	2.02	1.2	16
B	0.45	1.5	1.4	2.6	0.82	1.44	1.2	16
C	0.14	0.48	0.26	0.47	0.75	1.33	0.04	0.53
D	0.28	0.95	1.6	2.9	27	48	0.06	0.79
E	1.0	3.5	2.3	4.1	2.0	3.5	0.00	0.00
F	0.76	2.6	3.9	7.1	1.4	2.4	0.05	0.66
G	3.8	13	14	25	7.0	12	3.8	50
H	0.68	2.3	4.9	8.9	2.8	4.9	0.00	0.00
I	0.22	0.75	0.41	0.78	0.02	0.04	0.00	0.00
J	0.00	0.00	0.12	0.22	0.02	0.04	0.02	0.26
K	0.00	0.00	0.01	0.02	0.07	0.12	0.01	0.13
Glacial Deposits								
A	4.6	16	2.0	3.7	1.7	3.0	0.30	4.0
B	4.0	14	5.8	11	2.6	4.5	0.68	9.00
C	1.7	5.9	0.52	0.95	0.75	1.3	0.04	0.53
D	0.83	2.8	4.0	7.3	2.4	4.2	0.01	0.13
E	6.2	21	3.7	6.7	3.3	5.7	0.00	0.00
F	2.6	8.9	4.7	8.6	1.4	2.4	0.00	0.00
G	0.59	2.00	2.9	5.3	1.4	2.5	0.14	1.8
H	0.08	0.27	0.08	0.15	0.04	0.07	0.00	0.00
I	0.16	0.55	1.1	2	0.10	0.18	0.00	0.00
J	0.41	1.4	1.1	2	0.09	0.16	0.02	0.26
K	0.32	1.1	0.05	0.09	0.20	0.35	0.01	0.13
Totals	**29.19**		**54.88**		**57.19**		**7.52**	

Table 10. Land-cover groups assigned to Lopez, San Juan, Orcas, and Shaw Islands for use in the Deep Percolation Model, San Juan County, Washington

[**Land cover:** Distribution of land cover is shown on figure 8. All values rounded to two significant figures. Because of rounding, area totals may not agree exactly with other tables and percent values may not total exactly 100 percent. Abbreviations: mi^2, square mile]

Land cover (fig. 8)	Lopez Island		San Juan Island		Orcas Island		Shaw Island	
	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area	Area (mi^2)	Percentage of total basin area
Evergreen forest	17	58	29	52	46	79	6.2	81
Grassland	3.3	10	3.1	5.5	1.4	2.3	0.43	5.6
Deciduous forest and shrubland	3.1	10	8.9	16	6.1	10	0.59	7.7
Pasture/hay	5.2	18	11	21	2.6	4.6	0.25	3.2
Row crops	0.08	0.27	0.42	0.76	0.09	0.16	0.00	0.00
Wheat	0.19	0.64	0.26	0.47	0.12	0.21	0.01	0.13
Surface water	0.81	2.7	2.3	4.2	1.8	3.2	0.18	2.4
Totals	**30**		**55**		**58**		**8.7**	

The simulated average annual recharge for each island in the study area for water years 1997-98 was

Lopez Island	2.49 inches per year;
San Juan Island	1.99 inches per year;
Orcas Island	1.46 inches per year;
Shaw Island	1.44 inches per year.

The areal distribution of the simulated average annual recharge for each island (fig. 11) reflects not only the variation in the amount of precipitation (fig. 4) but also the different underlying materials, bedrock or glacial deposits (fig. 5). Recharge generally is greater in areas of glacial deposits than in areas of bedrock. Lopez Island, which receives the least precipitation, has the greatest amount of recharge per square mile because of the predominance of glacial deposits. Simulated reacharge in areas of shallow to outcropping bedrock generally is less than 1.5 inches per year. The DPM-simulated recharge on the glacial-deposit areas generally ranges from less than 0.5 to about 3 inches per year, but in some small areas where shallow sandy soils overlie permeable outwash deposits recharge is as high as 9 inches per year. This compares with generally greater estimates of recharge for glacial-deposit areas in the San Juan Islands presented in Vaccaro and others (1998, fig. 13) as broad ranges of values-from 1 to 11 inches per year.

In order to assess the validity of the island-wide simulations, the study-basin recharge quantities were compared with the island-wide recharge quantities in the comparable areas. The following is a comparison of the 2-year average recharge values from the study-basin DPM simulations and for the study-basin areas within the island-wide DPM simulations.

Study basin	Average annual recharge for water years 1997-98, in inches	
	Study basin simulated recharge	Study basin recharge from island-wide simulation
L1	2.67	3.35
L2	2.78	3.70
L3	0.35	0.86
SJ1	0.45	0.58
OR1	0.27	0.34
SH1	1.27	0.58

From these comparisons, recharge values from the island-wide recharge simulations appear to be somewhat greater than those from the study basins; about 23 and 1 percent, on average, for the glacial deposits and bedrock areas, respectively.

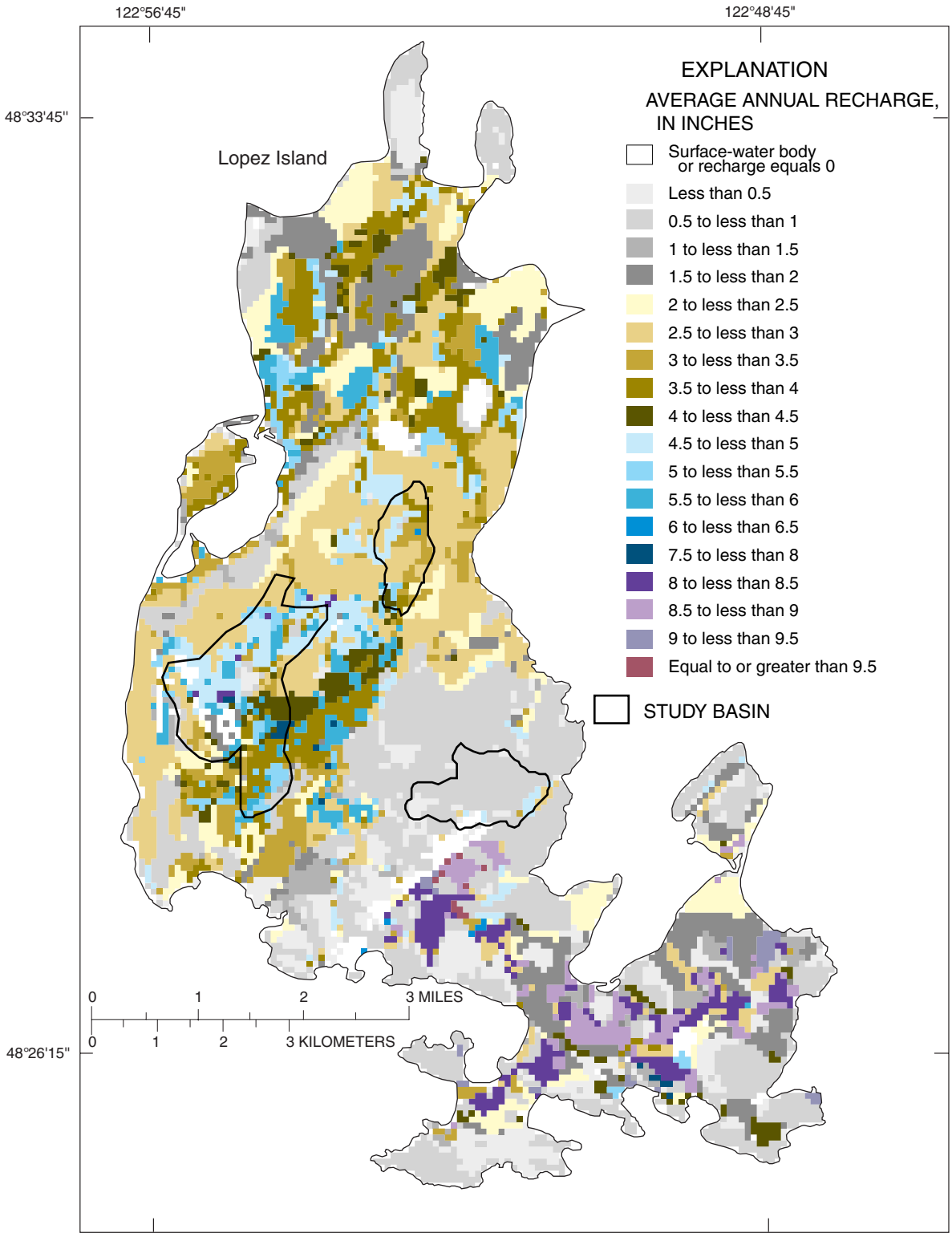


Figure 11. Areal distribution of simulated average annual recharge for Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington, water years 1997-98.

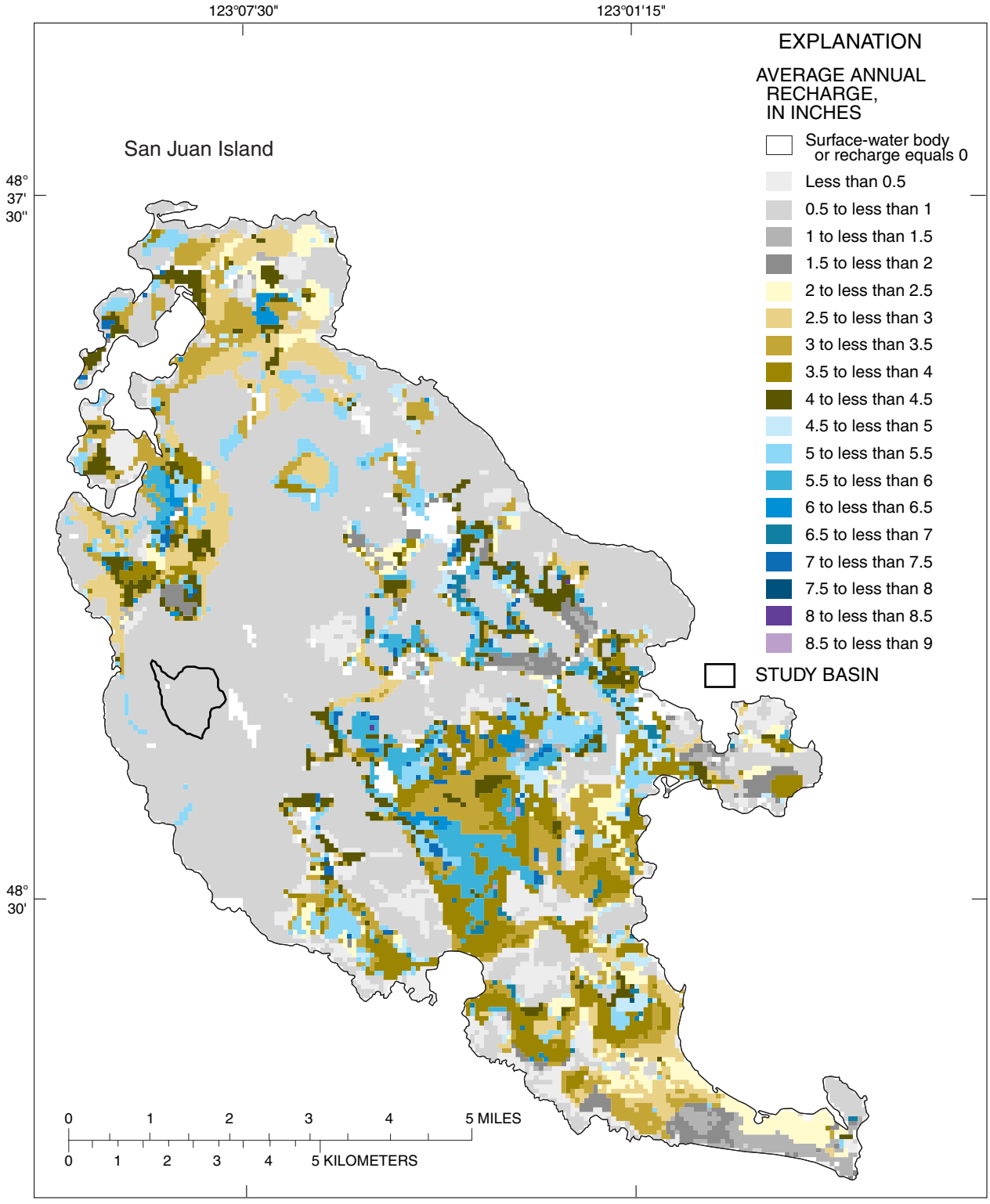
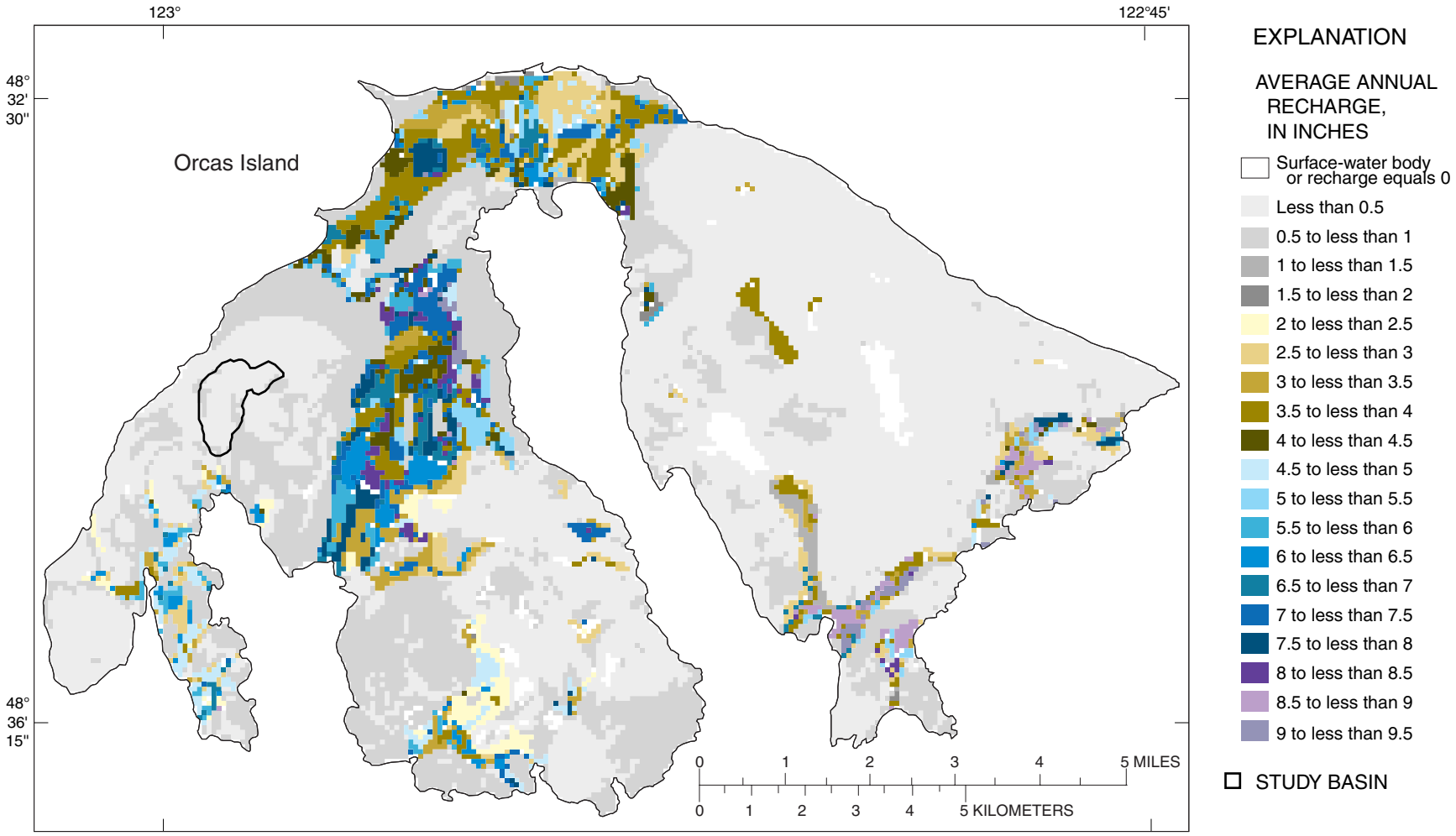


Figure 11.—*Continued*



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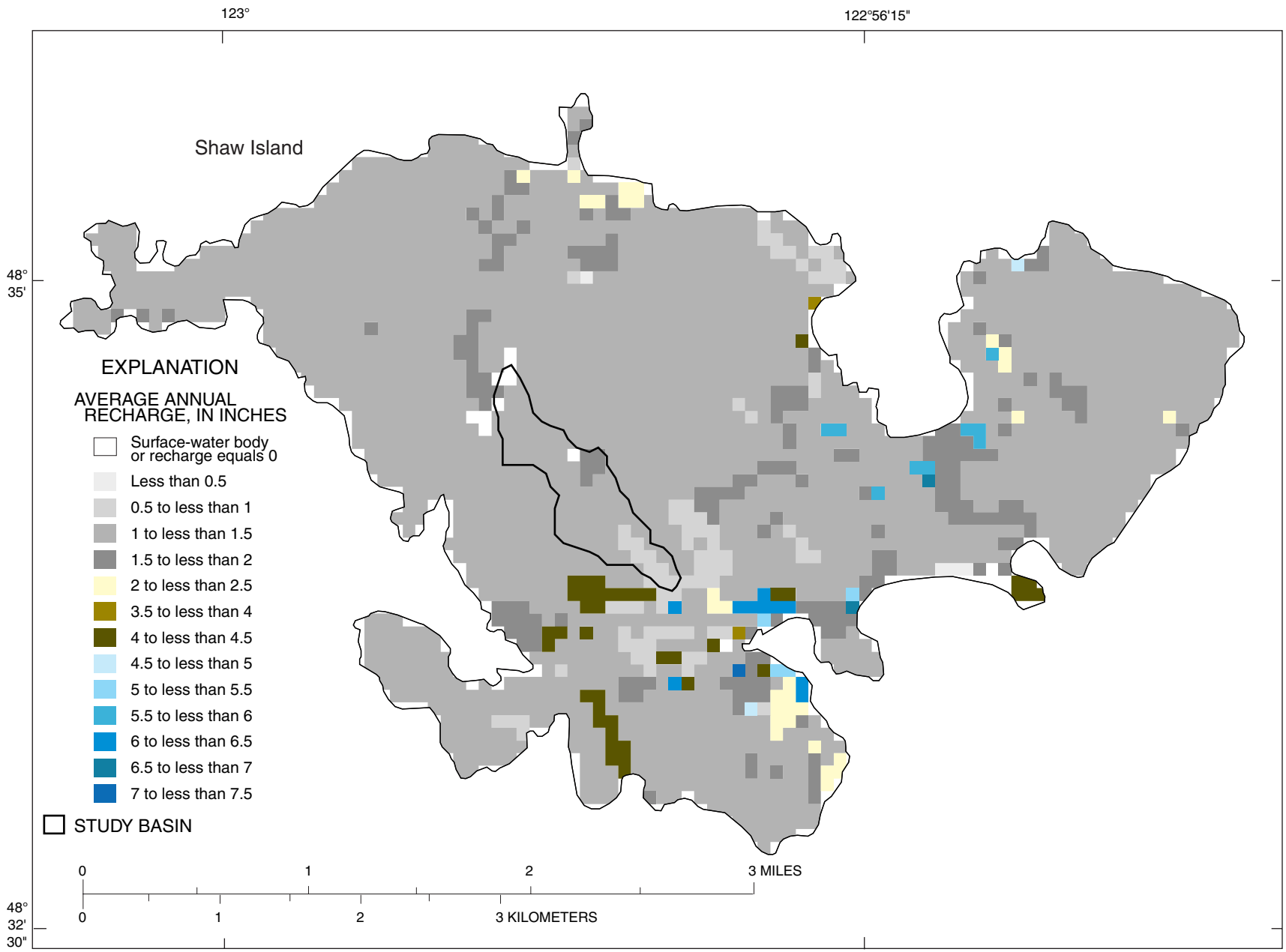

Figure 11.—*Continued*

The DPM simulated water-budget components for the 1997 and 1998 water years for each of the four main islands are summarized in table 11. Because water year 1997 was much wetter (from 9.6 to 14.8 inches more) than water year 1998, the DPM simulated recharge was greater on all islands for water year 1997 than for water year 1998. The differences in recharge were greater for Lopez and San Juan Islands (1.09 and 0.49 inches difference, respectively) than for Orcas and Shaw Islands (0.27 and 0.37 inches difference, respectively) because the mostly bedrock subsoils of Orcas and Shaw Islands impose smaller upper limits on the amount of deep percolation that can occur for a given period (see the section "Model Calibration" for discussion on limits on infiltration).

The question arises about how different the long-term recharge may be from this 2-year average recharge due to the difference in long-term precipitation from the 2-year average precipitation? The 2-year average precipitation for the four islands was only 6 to 10 percent less than the long-term average. If the ratio of the differences in recharge to the differences in precipitation from water year 1997 to water year 1998 is applied to the differences between long-term precipitation and the average 2-year precipitation for each of the main islands, then the long-term average annual recharge would be 0.26 inch (10 percent), 0.0 inch (0 percent), 0.04 inch (3 percent), and 0.01 inch (1 percent) more than the 2-year recharge values for Lopez, San Juan, Orcas, and Shaw Islands, respectively.

The output summary tables of the island-wide DPM simulations, which present a more detailed breakdown of the water-budget components on a monthly basis, are shown in tables 23-26 (at back of report).

Table 11. Summary of annual water-budget components using the Deep Percolation Model for Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington, water years 1997-98

[**Components of water budget**: Sum of interception loss, transpiration, direct runoff, deep percolation, change in soil moisture, and soil saturation deficit may not exactly equal precipitation because of roundoff errors. **Interception loss**: May include small amounts of simulated snow evaporation]

Island	Water year	Precipitation, inches	Water-budget components (all values in inches)				
			Interception loss	Simulated transpiration	Simulated direct runoff	Simulated deep percolation	Simulated change in soil moisture
Lopez	1997	30.65	6.73	14.22	5.59	3.03	0.68
	1998	21.05	5.86	12.20	2.15	1.94	-1.46
	avg	25.85	6.29	13.21	3.87	2.49	-0.39
San Juan	1997	34.99	8.24	13.40	9.77	2.24	0.48
	1998	23.59	6.73	11.65	4.10	1.75	-1.39
	avg	29.29	7.49	12.52	6.93	1.99	-0.46
Orcas	1997	40.37	9.64	13.48	14.50	1.60	0.59
	1998	25.53	7.62	11.61	6.08	1.33	-1.65
	avg	32.95	8.60	12.54	10.29	1.46	-0.53
Shaw	1997	34.12	10.79	13.06	8.52	1.62	-0.10
	1998	22.47	8.40	10.64	3.11	1.25	-1.14
	avg	28.29	9.59	11.85	5.81	1.44	-0.62

Sources of Uncertainty in the DPM Recharge Estimates

Although uncertainties in recharge estimates using the DPM could not be quantified, sources of uncertainty fall into three main groups:

1. errors in data and estimated parameters that affect reliability of estimates of downward drainage beneath the root zone as simulated by the DPM;
2. assumptions concerning equivalency of downward drainage from the root zone and recharge to ground water; and
3. assumptions involved with scaling up results from study basins to estimate annual recharge for the entire study area.

These are discussed as follows:

1. Several sources of error are associated with field-data collection of water-budget components for the study basins.

- Precipitation can vary greatly from one location to another for any particular storm. Therefore, an error in the water budget can develop when precipitation and throughfall data at one or two measuring points are used to represent the precipitation and throughfall for a drainage basin. Moreover, forest throughfall data are subject to additional error because of the wide variety of vegetation, age, density, and species in forested areas. The data-collection sites selected may or may not be fully representative of the larger forested areas.
- The best streamflow data, using the methods in this study, are considered accurate to only about 5 percent, and due to the small streamflow values measured in this study, probably only a 10-percent accuracy was achieved.
- A reliable means for computing direct runoff from total streamflow is not available, and subjective estimates of baseflow were used. This source of error only occurs for study basins SJ1 and OR1, which have baseflow. For the glacial-deposit study basins L1 and L2, there was no baseflow during the period of the study. This is because the water table on Lopez Island is mostly just a few feet above sea level (Orr, 2000, table 1), whereas land-surface altitudes of these study basins range upwards from about 120 feet above sea level. Baseflow for the bedrock study basins L3 and SH1 was assumed to be zero because total streamflow during the summer months was zero as for study basins L1 and L2.
- Errors in assignments to DPM parameters used to characterize soil and plant properties could have caused errors in the modeled partitioning of the water budget and ultimately recharge.
- Little published information exists concerning evapotranspiration in western Washington with which to verify the estimates in this study. Simulated transpiration in this study accounted for a substantial percentage (from 31 to 54 percent) of precipitation on an average annual basis. However, during the dormant winter periods, transpiration error relative to precipitation is small because transpiration is small. Moreover, even though daily simulations of evapotranspiration may contain error, the total seasonal evapo-transpiration error probably is small during summer and early autumn because nearly all precipitation and available soil moisture is transpired during this time. Error in transpiration during times when soil moisture is at field capacity during the growing season would result in the greater errors in simulated recharge. Therefore, the greater potential for error in simulated recharge is during the months of March through June.

2. Equating recharge to ground water to downward flow beneath the root zone also could lead to errors in recharge. In most environments, water that percolates below a few meters from the soil surface is destined to recharge a saturated system (arid environments can be an exception). However, a hydrogeologic system can contain multiple unsaturated zones that are separated by water-saturated zones. The arrangement and thicknesses of saturated and unsaturated zones in glacial-deposit areas may be complex. As a result, not all water that percolates downward beneath a root zone necessarily becomes recharge to the uppermost saturated zone that has been identified in the hydrogeologic framework. For example, water percolating through predominantly unsaturated materials beneath a root zone, upon meeting a layer of fine-grained sediments with low hydraulic conductivity, could recharge a thin saturated zone not tapped by wells, flow laterally, and discharge to a stream or spring.

The water in this example might not reach the saturated ground-water system that is used as a source of water to wells.

3. Error may result from extending the recharge results from the study basins to estimating the island-wide recharge. Parameters that control recharge and direct runoff were assumed to be identical for similar geologic, soil, land-cover, and precipitation conditions. Without measurements of streamflow for all drainage basins, this assumption could lead to errors, especially with regard to mapped geologic conditions, which generally are extrapolated from only a few observable locations. For example, an area that may be mapped as glacial till for the surficial deposits may, in part, be underlain by a channel deposit of clean sand and gravel. This would result in local recharge errors approximately comparable to the range in recharge depicted on figure 11.

Chloride Mass-Balance Method

The chloride mass-balance method was used as a second, independent means of estimating recharge in the study area. This method was used to estimate recharge only for Lopez Island, because the required chloride concentration data in ground water were not available for the other three islands. The chloride mass-balance method for estimating recharge is based on the principle that a known fraction of chloride in precipitation and dry atmospheric deposition is transported to the water table by the downward flow of liquid water. As water percolates downward, some evaporates directly or is taken up and transpired by plants. Where this occurs, the concentration of chloride in soil water increases with depth because little or no chloride is lost by these processes. At greater depths, where evapotranspiration does not occur, the chloride concentration should be uniform if climate, soil, and other conditions near the surface have been steady for a sufficiently long time.

The chloride mass-balance method uses the assumption that precipitation is the only source of chloride in ground water and in surface-water runoff. Human sources such as septic systems and animal sources such as cow manure contribute minimal amounts of chloride to the water in the study area, and natural sources such as evaporite rocks or connate seawater are not present in the hydrogeologic units above sea level. A mass balance of chloride in precipitation, surface runoff, and ground water is expressed in the following equation (Maurer and others, 1996; Prych, 1998):

$$P \times C_p = (GWR \times C_g) + (SWR \times C_p), \qquad (1)$$

where

P is annual precipitation, in inches;

C_p is concentration of chloride in precipitation, in milligrams per liter;

GWR is annual ground-water recharge, in inches;

C_g is concentration of chloride in ground water; and

SWR is annual surface-water runoff, in inches.

Rearranging the terms in equation 1 and solving for gives:

$$GWR = \frac{(P \times C_p) - (SWR \times C_p)}{C_g}. \qquad (2)$$

Implicit in the derivation and uses of equation 2 is the assumption of "plug flow" for which it is assumed that (1) the direction of water flow and chloride transport is vertical and downward, (2) areal distributions of the rate of percolation of water and of chloride on the local scale (a few tenths of a meter) are uniform (no preferred pathways), (3) all chloride is dissolved in soil water, and the distribution of the dissolved chloride in the soil water is relatively uniform within a pore (no solid chloride phase, sorption by soil, or anion exclusion), and (4) advection is the dominant mode of chloride transport, and dispersion is relatively unimportant. Additional assumptions are that (5) minerals in the soil are not a source of chloride-the only sources are precipitation and dry atmospheric deposition, (6) measured chloride concentrations are at depths great enough that seasonal variations in concentration are small, and (7) chloride concentrations in surface-water runoff are the same as those in precipitation. The method is still valid if chloride is taken up by growing vegetation as long as it is also released by decaying vegetation at the same rate.

Data Collection

Chloride concentrations from the atmosphere (precipitation and dry deposition), the water table, and(or) the unsaturated-zone soil moisture were determined from precipitation and dry atmospheric deposition samples collected during water years 1997-98, and from ground-water samples collected in spring 1997 on Lopez Island during phase 1 of the study (Orr, 2000) Three atmospheric-chloride deposition-collection sites were established on Lopez Island-one at the northern end of the island, one near study basin L1 near the center of the island, and one at the southern end at the location of a precipitation-throughfall data-collection site and a temporary micrometeorological station (see fig. 5). Wet- and dry-atmospheric chloride deposition samplers were installed at the northern and southern sites. The sampler consists of two buckets mounted on an electromechanical device that senses precipitation and automatically places a cover on one or the other of the buckets. During periods of precipitation the "dry" bucket is covered while the "wet" bucket collects precipitation. When it is not raining, the "wet" bucket is covered to prevent any influx from the dry atmosphere (including insects, bird droppings, and wind-blown ground debris) and to minimize evaporation. At the same time, the dry bucket is open to collect microscopic crystals of chloride salts that fall from the atmosphere. In addition to the wet and dry sampler at the northern and southern Lopez Island sites, one permanently open bucket was installed at each of these sites to collect a "composite" of the wet and dry deposition. At the central Lopez Island site, only a permanently open bucket was installed. The permanently open buckets were subject to more contamination from birds, insects, and so forth, and samples from them were used only to approximately check the values from the wet and dry samples. Data from these buckets also were used to estimate certain missing values from the wet and dry samples.

The sampling buckets were collected and replaced with clean buckets on a monthly basis. All bucket samples were weighed and filtered alloquots were sent to the USGS Central Laboratory for determination of low-level chloride concentrations. Alloquots from the dry buckets were collected by first rinsing with a known quantity of distilled water and sampling the rinse water.

Chloride concentrations in ground-water samples were determined colorimetrically using ferric thiocyanate (Friedman and Erdmann, 1982) at the Tacoma Field Services Unit of the USGS.

Recharge Estimates and Sources of Uncertainty Using Chloride Mass-Balance Method

In equation 2, all atmospheric chloride in soil water is assumed to be deposited by precipitation (wet deposition). However, about 37 percent of the total chloride deposition occurs as dry deposition. Equation 2 was therefore modified for this study to account for atmospheric chloride in terms of the total of the wet and dry chloride fluxes rather than just the concentration of chloride in precipitation. A summary of chloride concentrations in precipitation and dry deposition is shown in table 12.

The term $P \times C_p$ in equation 2, which represents the wet chloride deposition, is replaced by *FWD*, the total flux (mg/m^2) of the wet and dry chloride deposition. The term $SWR \times C_p$, which represents the outflow of atmospheric chloride through direct stream runoff, is replaced with the term $SWR \times FWD/P$, where FWD/P is the chloride concentration in stream water. This follows the assumption that the chloride in the stream water is a composite of the wet plus dry chloride deposition because precipitation, after falling on the ground, also dissolves and transports the chloride from the dry deposition as it moves to the stream channel. Equation 2 then becomes

$$GWR = FWD(1 - SWR/P)/C_g \qquad (3)$$

expressed in consistent units. In this study, *FWD* is expressed in mg/m^2, *Cg* in mg/L, and *GWR*, *SWR*, and *P,* in inches. Equation 3 then becomes

$$GWR = 0.0394FWD(1 - SWR/P)/C_g \; . \qquad (4)$$

Table 12. Summary of chloride concentrations in precipitation and dry chloride deposition observed at three locations on Lopez Island during October 1996 through September 1998

[**Location**: Location of precipitation throughfall sites are shown in figure 5. C1, site at north end of island; C2, site at south end of island; and C3, site at center of island. **Wet bucket**: Only composite samples were collected at site H. **Composite bucket**: Concentrations are affected by evaporation because the buckets remained uncovered at all times. In order to consistently compare composite and wet sample concentrations, the values presented are calculated assuming no evaporation; in other words, the calculated concentration is the concentration of the sample as if diluted by the difference in water content between the wet and composite buckets. **Atmospheric chloride flux in precipitation and total of wet+dry**: Only composite samples were collected at site H. — , no data]

Observation period (month-day-year)			Chloride concentration (milligrams per liter)		Atmospheric chloride flux (milligrams per square meter)			
From	To	Location	Wet bucket	Composite bucket	In precip-itation (wet)	As dry deposition (dry)	Total of wet+dry	Total from composite bucket
10-03-96	11-06-96	C1	1.9	4.8	205.59	7.68	213.27	521.61
		C2	11.0	2.4	[1]285.77	21.08	306.85	188.33
		C3	—	2.2	—	—	—	174.83
11-06-96	12-04-96	C1	1.4	1.7	158.30	48.44	206.74	203.89
		C2	2.1	2.9	222.05	68.00	290.05	306.83
		C3	—	2.0	—	—	—	191.07
12-04-96	12-31-96	C1	0.95	0.98	49.65	98.24	147.90	132.00
		C2	1.8	2.19	121.20	50.88	172.08	158.40
		C3	—	1.3	—	—	—	88.92
12-31-96	02-03-97	C1	0.82	1.0	95.51	28.32	123.83	127.34
		C2	1.70	2.08	170.68	49.51	220.19	209.03
		C3	—	1.0	—	—	—	97.07
02-03-97	03-20-97	C1	0.87	1.36	104.23	38.33	142.56	166.70
		C2	1.5	2.43	141.80	106.08	247.89	230.21
		C3	—	1.7	—	—	—	139.74
03-20-97	04-30-97	C1	1.07	1.66	48.44	30.13	78.56	76.71
		C2	2.80	7.30	73.74	160.75	234.49	192.62
		C3	—	3.45	—	—	—	83.72
04-30-97	06-02-97	C1	0.542	0.902	28.87	9.81	38.68	48.98
		C2	0.668	1.31	22.71	24.93	47.64	44.43
		C3	—	0.675	—	—	—	30.65
06-02-97	07-10-97	C1	0.372	1.29	10.81	14.87	25.69	40.52
		C2	0.756	1.66	44.05	30.03	74.08	97.88
		C3	—	4.098	—	—	—	68.03
07-10-97	08-14-97	C1	([2]—)	1.394	[2]7.81	19.99	27.80	28.07
		C2	([2]—)	4.231	[2]15.62	43.61	59.23	87.73
		C3	—	4.098	—	—	—	84.42
08-14-97	09-08-97	C1	0.12	0.59	1.62	5.20	6.82	7.72
		C2	0.17	0.81	2.63	16.52	19.15	12.25
		C3	—	0.23	—	—	—	3.43

Table 12. Summary of chloride concentrations in precipitation and dry chloride deposition observed at three locations on Lopez Island during October 1996 through September 1998—*Continued*

Observation period (month-day-year)		Location	Chloride concentration (milligrams per liter)		Atmospheric chloride flux (milligrams per square meter)			
From	To		Wet bucket	Composite bucket	In precip-itation (wet)	As dry deposition (dry)	Total of wet+dry	Total from composite bucket
09-08-97	10-08-97	C1	0.189	0.48	12.01	0.77	12.78	30.32
		C2	0.342	1.48	23.90	4.91	28.80	103.58
		C3	—	0.641	—	—	—	22.86
10-08-97	11-04-97	C1	1.434	1.80	92.73	49.85	142.58	118.31
		C2	([2]—)	([2]—)	[2]128.89	195.44	324.33	([1]—)
		C3	—	2.397	—	—	—	114.10
11-04-97	12-02-97	C1	0.709	1.12	28.50	19.34	47.85	47.02
		C2	1.029	1.81	39.58	27.39	66.98	69.47
		C3	—	1.596	—	—	—	52.99
12-02-97	01-08-98	C1	1.051	1.37	95.43	47.61	143.05	136.38
		C2	2.616	3.82	188.71	143.15	331.86	282.07
		C3	—	1.867	—	—	—	139.90
01-08-98	02-05-98	C1	1.615	2.28	72.25	24.02	96.27	103.25
		C2	2.945	4.25	86.19	61.03	147.22	125.33
		C3	—	3.702	—	—	—	98.72
02-05-98	03-11-98	C1	1.712	0.858	65.97	[1]33.32	99.29	26.83
		C2	2.533	([1]—)	72.78	[1]56.42	129.20	([1]—)
		C3	—	0.516	—	—	—	13.69
03-11-98	04-22-98	C1	0.511	1.37	14.72	10.37	25.10	39.69
		C2	0.729	1.78	26.39	25.45	51.84	64.34
		C3	—	([1]—)	—	—	—	([1]—)
04-22-98	06-02-98	C1	3.202	0.90	139.61	16.18	155.80	39.11
		C2	0.583	2.049	15.09	41.61	56.70	65.43
		C3	—	1.158	—	—	—	32.04
06-02-98	07-20-98	C1	0.223	2.37	8.36	22.47	30.83	89.30
		C2	0.425	([1]—)	15.41	34.97	50.39	([1]—)
		C3	—	3.216	—	—	—	87.48
07-20-98	09-09-98	C1	0.40	27.44	0.13	6.98	7.12	9.15
		C2	([2]—)	3.951	[2]5.45	53.83	59.28	51.10
		C3	—	0.828	—	—	—	10.81
09-09-98	10-06-98	C1	1.28	2.04	6.16	3.60	9.76	9.77
		C2	1.70	3.34	9.52	7.51	17.04	18.71
		C3	—	0.732	—	—	—	10.39

[1]Samples lost or destroyed or value deemed unreasonable. Value estimated by methods described in text, no estimates made for composite buckets.
[2]Very little or no water in wet bucket during this period. Chloride flux determined in same manner as for dry bucket.

For the 2-year data-collection period, *FWD* for the northern and southern Lopez Island sites was 1,782 and 2,935 mg/m^2 (table 12). These 2-year totals include a few estimated values where data were missing. Missing values were estimated by comparison with known values at the same site or with known values at the other site. Same-site comparison estimates were made by assuming that the wet-plus-dry value equaled the composite value. Different-site comparison estimates were made by assuming that the ratio of individual values between sites were the same as the ratio of the sums of all non-missing data values between sites. If data values were missing at both sites, an average deposition rate, determined from the other data values, was used to calculate missing values. For basins L1 and L2, the two basins lying within glacial deposits, *SWR* for this 2-year period totaled 6.05 and 8.19 inches, respectively. Precipitation for this period measured at three locations on Lopez Island (locations M1, P1, C1; fig. 5 and table 2) ranged from 44.85 to 50.69 inches.

For determining *Cg* in equation 4, ground-water samples must be from wells where the only source of chloride in the aquifer is from the atmosphere. Therefore, samples from any wells that may be intruded by seawater could not be used. One requirement that assures that there would be no seawater intrusion is that the bottoms of the wells be above sea level. For such wells, the water levels cannot be drawn down by pumping to below sea level, and therefore no potential gradient from seawater to the well could develop. The only potential migration of chloride from seawater would be by diffusion, which would only occur over distances that are small compared with distances to seawater. However, only 10 of the wells completed in the glacial deposits sampled on Lopez Island during 1977 met this bottom-altitude requirement. For those wells, the chloride concentrations ranged from 24 to 150 mg/L (Orr, 2000, table 1). In order to obtain a larger sample, wells also were selected from among those whose bottoms were below sea level but which did not appear to be intruded by seawater. Chloride concentrations in relation to well-bottom altitudes and distance from shore for all wells tapping glacial-deposit aquifers that were sampled during the spring of 1997 are shown in figure 12. Using figure 12, two conservative criteria were used in this selection. The wells had to be more than 2,000 feet from the shoreline and the well bottoms had to be higher than 15 feet below sea level. This produced a sample size of 27, all of which had chloride concentrations of less than 150 mg/L. The average chloride concentration for these wells is 63.6 mg/L. Locations of these wells and the chloride concentrations are shown on figure 13.

When the average values for the variables discussed above are used in equation 4, the average recharge is 1.25 inches for the 2-year period (0.63 inch annually), about 23 percent of the recharge estimated using the DPM. No attempt was made to estimate the distribution of recharge from the data used for this method. For any particular sampling point in the aquifer, ground water generally has a predominantly horizontal flow component. Therefore, any ground-water sample consists of an unknown mixture of water, consisting of water percolating vertically downward from recharge at the surface and from other upgradient areas. Recharge values calculated from chloride concentrations in single samples of ground water would therefore represent upgradient composite values.

Equation 4 and the data collected can be used to estimate certain limiting values of recharge. For example, areas with highly permeable subsoils would not produce direct runoff and therefore would have the largest amount of recharge and the lowest chloride concentrations. Selecting the lowest three chloride concentrations in ground water (approximately representing the lowest decile) from table 13, and setting *SWR* = 0 in equation 4, and maintaining the average value of atmospheric chloride deposition, yields a recharge value of 3.89 inches for the 2 years (1.95 inches annually). Conversely, using the three highest chloride concentrations from table 13 and using the larger of the two direct runoff values results in a recharge value of 0.58 inch for the 2 years (0.29 inch annually).

In the above analysis, it was assumed that there are no other sources of chloride to the aquifer, when in fact there are likely some anthropogenic chloride in the aquifers originating from septic systems and application of fertilizers, pesticides, and herbicides. Quantification of these sources was beyond the scope of this study, but such sources are thought to be minimal because of the low population density inland of 2,000 feet from the shore.

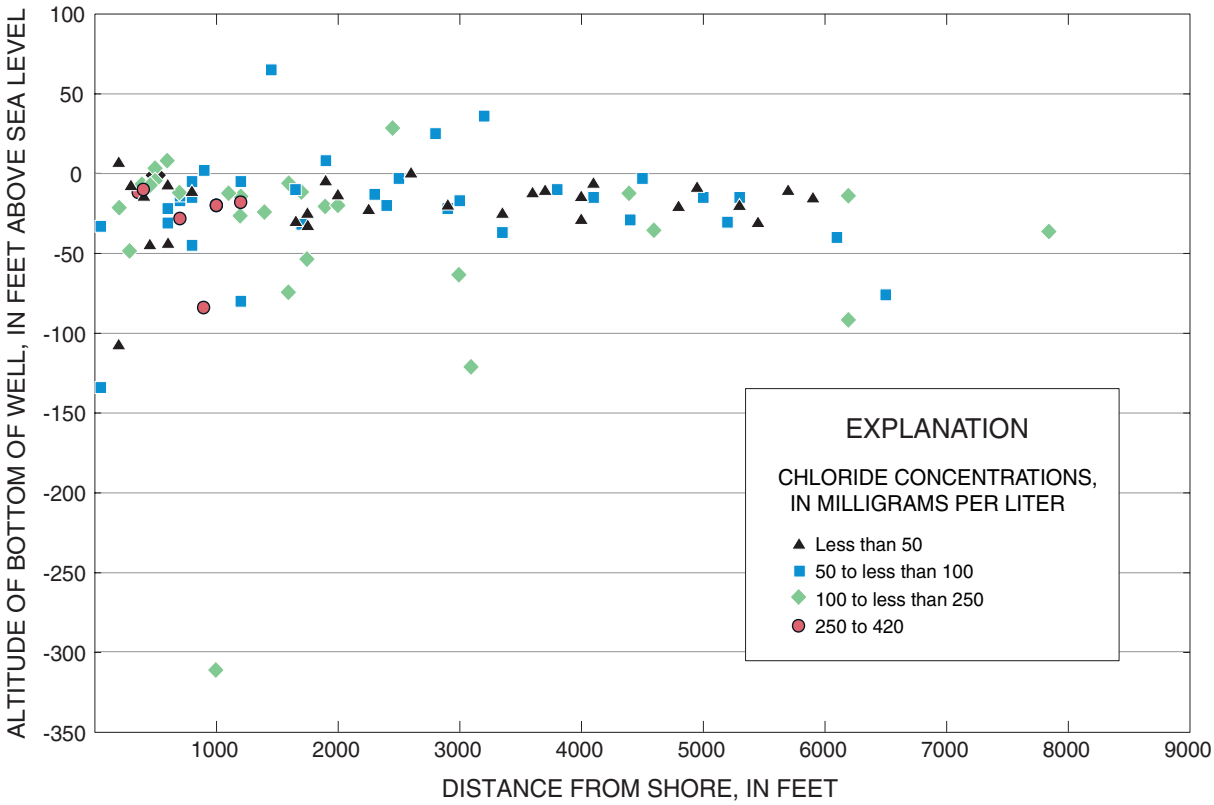

Figure 12. Relation between chloride concentrations and well-bottom altitudes and distances from shore for all wells tapping glacial-deposit aquifers that were sampled during spring 1997 on Lopez Island, San Juan County, Washington, water years 1997-98.

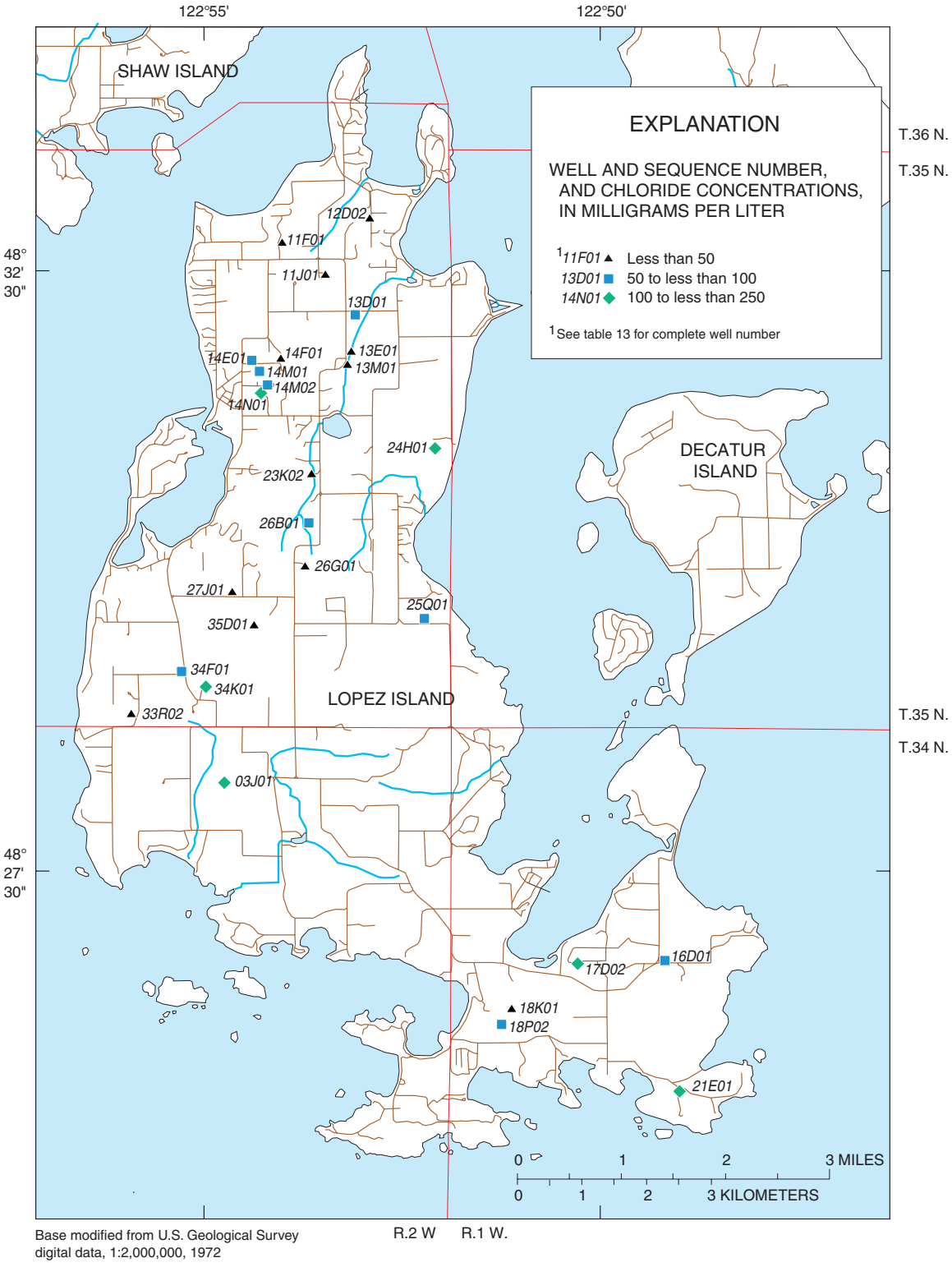

Figure 13. Locations and chloride concentrations for wells used in the chloride mass-balance method for estimating ground-water recharge, Lopez Island, San Juan County, Washington, spring 1997.

Table 13. Summary of chloride concentrations and selected physical and hydrologic data for wells used in the chloride mass-balance method for Lopez Island, San Juan County, Washington, spring 1977

[**Well No.:** The well-numbering system in Washington is described on page 4. **Altitude of land surface**: Estimated from 7.5-minute U.S. Geological Survey topographic maps. All listed wells are finished in glacial materials on Lopez Island and were sampled in spring 1997. Altitude refers to sea level, referenced to the National Geodetic Vertical Datum of 1929. Chloride rounded to two significant digits; all other data rounded to nearest foot. —, no data]

Well No.	Altitude of land surface (feet)	Altitude of well bottom (feet)	Well depth (feet below land surface)	Water-level altitude (feet)	Chloride concentration (milligrams per liter)
34N/01W-16D01	150	38	112	—	72
34N/01W-17D02	220	68	152	205	150
34N/01W-18K01	110	95	15	108	48
34N/01W-18P02	60	8	52	43	94
34N/01W-21E01	80	50	30	77	110
34N/02W-03J01	170	-11	181	—	100
35N/02W-11F01	130	-13	143	—	34
35N/02W-11J01	170	-15	185	4	34
35N/02W-12D02	90	-5	95	8	30
35N/02W-13D01	115	-10	125	6	78
35N/02W-13E01	100	-14	114	3	40
35N/02W-13M01	100	-14	114	3	48
35N/02W-14E01	100	-13	113	0	50
35N/02W-14F01	135	-7	142	10	32
35N/02W-14M01	110	-3	113	10	52
35N/02W-14M02	180	25	155	45	50
35N/02W-14N01	170	33	137	48	120
35N/02W-23K02	205	-6	211	5	30
35N/02W-24H01	120	20	100	110	130
35N/02W-25Q01	125	65	60	84	82
35N/02W-26B01	218	-2	220	9	64
35N/02W-26G01	265	-15	280	10	20
35N/02W-27J01	230	-11	241	102	28
35N/02W-33R02	190	0	190	16	24
35N/02W-34F01	180	-14	194	-1	68
35N/02W-34K01	190	-13	203	4	100
35N/02W-35D01	205	25	191	22	28

Another possible source of chloride is residual chloride from early post-ice-age seawater that may have intruded the glacial materials while the island was below sea level from the time after the glaciers retreated and before the island isostatically rebounded to above sea level. In areas of the northern Puget Sound region, there is evidence that chloride from this source has not yet been flushed from the aquifers (Halstead, 1986). Chloride concentrations in those areas, however, are much higher than those used in this analysis.

The net effect of sources of chloride other than from the atmosphere would be that the recharge values using the chloride mass-balance method are less than the actual recharge. This is evident from equation 3, in which the calculated recharge is inversely proportional to the chloride concentration in ground water, if the other variables remain unchanged. Therefore, the recharge estimates of from 0.29 to 1.95 inches per year calculated by the chloride-mass balance method may represent lower limits, which is consistent with the generally higher simulated recharge using the DPM (2.67 and 2.64 inches per year for the study basins L1 and L2).

The two methods also are representative of two different periods, which could be another cause for different results. The DPM simulations are for a specific 2-year period, but the chloride mass-balance method uses chloride concentrations in ground water that are the composite result of an unknown number of previous years during which chloride deposition, on average, may have been different from that measured during this study. The difference in annual chloride deposition between the 2 years that data were collected is about 32 percent of the annual average for the 2 years. This suggests that the uncertainty from this source in recharge estimated by this method could be of this magnitude.

SUMMARY

On Lopez, San Juan, Orcas, and Shaw Islands, the largest of the islands that make up San Juan County, Washington, population and development are growing rapidly. There is growing concern about the quality and availability of ground water because an important source of fresh water for the islands is the glacial-deposit and bedrock aquifers.

The amount of recharge available to the aquifers from precipitation, a key element in assessing ground-water availability, is extremely difficult and costly to measure directly, and only very generalized and incomplete estimates of recharge are available for San Juan County. In 1997, the U.S. Geological Survey, in cooperation with San Juan County Health and Community Services, began a study of the quality and availability of ground water on Lopez, San Juan, Orcas, and Shaw Islands.

Ground-water recharge from deep percolation of precipitation to the water tables on Lopez, San Juan, Orcas, and Shaw Islands was estimated using two independent methods. The first technique used a daily water and energy budgeting model, the Deep Percolation Model (DPM), to compute, simulate, and allocate daily moisture fluxes of precipitation, evapotranspiration, direct runoff, and deep percolation for any number of unique areas in a drainage basin. The DPM requires precipitation, streamflow, solar shortwave radiation, air temperature, soil-property, and vegetation-cover data. Precipitation throughfall data also were used for forested areas. The DPM was operated for six small study basins: three on Lopez Island and one each on San Juan, Orcas, and Shaw Islands. Various soil and subsoil parameters were estimated for the different geologic and soil conditions represented by each of the six study basins during a calibration process for each study basin. The process involved adjusting model parameters until the quantities and timing of measured precipitation, measured direct runoff (derived from streamflow data), measured evaporation (derived from throughfall measurements), computed transpiration, and computed vertical movement of soil water out of the bottom of the root zone (deep percolation) were reconciled into a water budget that minimized total water-balance error. The calibrated soil and subsoil parameters were then used in island-wide applications of the DPM where the direct-runoff component (which is not available on an island-wide basis) is simulated rather than input, and calibration is not required. A spatial distribution of recharge was simulated for each island.

The second technique used a chloride mass-balance method that requires measurements of atmospheric chloride deposition, precipitation, streamflow, and chloride concentrations in ground water.

Atmospheric chloride deposition data were collected as part of this study. Precipitation and streamflow data were available from the near-surface-water balance method used in this study and ground-water chloride concentration data were available from the earlier seawater-intrusion investigation phase of this project. Samples of atmospheric chloride deposition were collected at three sites on Lopez Island for the same 2-year period as for the time-series data collected for the near-surface water-balance method in this study. Recharge using this method was estimated only for the glacial deposits of Lopez Island and only average, rather than area-specific, values of recharge could be determined.

The study-basin recharge values estimated using the DPM for the two basins located on glacial deposits on Lopez Island were:

L1	2.67 inches per year
L2	2.64 inches per year

averaged over the 2-year period. This compares with an average value of only 0.63 inch per year based on the results of the chloride mass-balance method. The range of chloride concentrations in ground-water samples from the selected wells when used in the final equation indicates that average recharge ranges from 0.29 to 1.95 inches per year.

Sources of chloride in ground water other than from the atmosphere would cause the recharge estimated by the chloride mass-balance method to be less than the actual recharge. Therefore, the chloride mass-balance recharge estimates represent lower limits which are, at least, consistent with the higher recharge values from the DPM.

The other four study basins are all located on areas of shallow and outcropping bedrock, one on each of the four islands. Average recharge estimates using the DPM for these basins were:

L3 (Lopez Island)	0.35 inch per year
SJ1 (San Juan Island)	0.45 inch per year
OR1 (Orcas Island)	0.27 inch per year
SH1 (Shaw Island)	1.27 inches per year

The island-wide recharge estimates using the DPM were

Lopez Island	2.49 inches per year
San Juan Island	1.99 inches per year
Orcas Island	1.46 inches per year
Shaw Island	1.44 inches per year

The average island-wide recharge is most closely related to the amount of area covered by glacial deposits. Thus Lopez Island, with the most extensive area covered with glacial deposits, has the most recharge per square mile, even though it also has the least precipitation.

According to the DPM simulations, recharge in areas of shallow and outcropping bedrock generally is less than 1.5 inches per year. In areas underlain by glacial deposits, the DPM-simulated recharge generally ranges from less than 0.5 to about 3 inches per year, but in some small areas of sandy soils with highly permeable subsoils recharge is as great as 9 inches per year.

Ground-water recharge should not be equated with ground-water availability. Under natural conditions ground-water recharge is balanced by subsurface flow to the ocean, to the lower reaches of streams, and, in areas of shallow water tables, to the roots of phreatophytes. Removal of ground water by wells will lower ground-water levels and diminish the outflow to one or more of these discharge areas, inducing seawater intrusion into wells, reducing dry-season low flows in streams or transforming wetlands and phreatophyte areas into drier environments. If all recharge were consumptively used, there would be no discharge to any of these areas.

Removal of ground water in rural and suburban non-irrigated areas generally is not all consumptive, but a large fraction of this water is returned as wastewater to the subsurface and eventually to the aquifers. Water-quality problems may occur before significant problems in water levels or in ground-water discharge areas develop. These issues are most readily addressed using ground-water models for which the recharge estimates presented in this report will be essential.

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Tables 14 through 26

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98

[Values represent cumulative amounts from the data and time of the prior record to that of the current record. —, no data]

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
09-13-96	0000	—	—	—	—	—	—	—	—
09-14-96	1212	0.17	0.09	0.10	0.17	0.16	0.06	0.06	0.11
09-15-96	1630	0.52	0.38	0.63	0.53	0.77	0.53	0.41	0.40
09-16-96	1335	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-17-96	1250	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-18-96	1145	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-19-96	1900	0.18	0.21	0.17	0.13	0.20	0.08	0.25	0.15
09-20-96	1600	0.03	0.00	trace	0.01	trace	trace	0.01	trace
09-21-96	1615	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-22-96	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-23-96	1645	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-24-96	1345	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-25-96	1745	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-26-96	1730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-27-96	1330	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-28-96	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-29-96	1730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-30-96	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-01-96	1845	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-02-96	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-03-96	1700	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-04-96	1645	0.53	0.36	0.82	0.67	0.75	0.65	0.49	0.50
10-05-96	1800	0.005	0.015	0.05	0.01	0.02	0.01	0.02	0.02
10-06-96	1730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-07-96	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-08-96	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-09-96	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-10-96	1730	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-11-96	1930	0.18	0.07	0.03	0.24	0.23	0.14	0.15	0.13
10-12-96	1445	0.01	0.00	0.00	trace	trace	0.00	0.005	trace
10-13-96	1830	0.10	0.04	0.02	0.11	0.07	0.03	0.04	0.05
10-14-96	1745	0.15	0.10	0.15	0.30	0.15	0.16	0.15	0.20
10-15-96	1700	0.05	0.02	0.12	0.07	0.06	0.02	0.03	0.02
10-16-96	1715	0.01	trace	trace	trace	trace	trace	trace	trace
10-17-96	1730	0.17	0.05	0.05	0.05	trace	0.00	0.04	0.00
10-18-96	1800	0.22	0.16	0.32	0.31	0.20	0.21	0.12	0.23

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
10-19-96	1815	0.03	0.00	0.00	trace	trace	trace	trace	trace
10-20-96	1430	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-21-96	1800	0.10	0.05	0.05	0.15	0.09	0.13	0.10	0.10
10-22-96	1745	0.26	0.20	0.55	0.30	0.25	0.22	0.18	0.23
10-23-96	1700	0.10	0.04	0.02	0.10	0.07	0.05	0.08	0.05
10-24-96	1800	0.11	0.04	0.04	0.14	0.07	0.07	0.08	0.08
10-25-96	1800	0.15	0.05	0.02	0.09	0.12	0.04	0.05	0.02
10-26-96	1630	trace	0.00	0.00	trace	trace	0.03	trace	trace
10-27-96	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-28-96	1700	0.85	0.65	1.38	1.25	1.02	0.89	1.00	1.00
10-29-96	1700	trace	trace	trace	trace	trace	trace	trace	trace
10-30-96	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-31-96	1730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-01-96	1800	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-02-96	1630	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-03-96	1730	0.17	0.10	0.12	0.22	0.15	0.10	0.15	0.15
11-04-96	1700	0.18	0.07	0.03	0.16	0.15	0.05	0.13	0.10
11-05-96	1610	0.03	0.01	trace	0.03	0.02	0.01	0.02	0.01
11-06-96	1730	0.15	0.03	0.03	0.20	0.10	0.02	0.04	0.08
11-07-96	1530	0.01	trace	0.00	0.00	0.00	0.00	0.01	trace
11-08-96	1515	0.21	0.10	0.13	0.24	0.18	0.13	0.18	0.19
11-09-96	1610	0.01	0.00	0.00	trace	0.00	trace	trace	trace
11-10-96	1515	trace	0.00	0.00	0.00	0.00	trace	trace	trace
11-11-96	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-12-96	1545	0.03	0.00	0.00	0.01	trace	0.00	trace	0.00
11-13-96	1600	0.55	0.44	0.77	0.71	0.67	0.37	0.57	0.47
11-14-96	1500	0.05	0.05	0.02	0.13	0.10	0.05	0.14	0.05
11-15-96	1530	0.05	0.03	0.03	0.02	0.02	0.02	0.02	0.03
11-16-96	1630	0.13	0.03	0.02	0.09	0.11	0.04	0.05	0.02
11-17-96	1545	0.61	0.50	0.93	0.82	0.70	0.46	0.76	0.47
11-18-96	1500	trace	trace	trace	trace	0.00	trace	trace	trace
11-19-96	1515	trace	0.00	0.00	0.00	trace	trace	0.00	0.00
11-20-96	1615	0.19	0.18	0.26	0.22	0.32	0.22	0.25	0.35
11-21-96	1600	0.05	trace	0.01	0.01	0.01	0.01	0.03	0.01
11-22-96	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-23-96	1415	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
11-24-96	1430	0.03	0.01	trace	0.04	0.02	0.02	0.04	trace
11-25-96	1545	0.27	0.12	0.23	0.29	0.22	0.12	0.22	0.20
11-26-96	1330	0.05	0.03	trace	0.07	0.06	0.01	0.08	0.03
11-27-96	1745	1.42	1.15	2.72	1.87	1.37	1.30	2.17	1.45
11-28-96	1630	0.35	0.17	0.20	0.25	0.32	0.21	0.20	0.17
11-29-96	1630	0.01	trace	trace	0.01	trace	trace	0.01	trace
11-30-96	1615	0.05	0.02	0.01	0.04	0.02	0.02	0.01	0.02
12-01-96	1600	0.28	0.05	0.08	0.26	0.19	0.10	0.12	0.12
12-02-96	1845	0.15	0.05	0.08	0.18	0.15	0.06	0.09	0.12
12-03-96	1845	trace	0.00	trace	trace	trace	trace	trace	trace
12-04-96	1600	0.32	0.18	0.37	0.35	0.22	0.27	0.23	0.30
12-05-96	1630	0.04	0.00	trace	0.01	trace	trace	trace	trace
12-06-96	1530	0.05	0.02	0.01	0.05	0.03	0.02	0.02	0.03
12-07-96	1600	0.03	0.01	0.01	0.02	0.01	trace	0.01	trace
12-08-96	1545	0.05	0.01	trace	0.04	0.04	0.02	0.02	0.01
12-09-96	1745	trace	trace	trace	trace	trace	trace	trace	trace
12-10-96	1430	0.02	0.00	trace	0.01	0.00	trace	0.01	0.00
12-11-96	1545	0.10	0.03	0.02	0.12	0.09	0.03	0.06	0.04
12-12-96	1445	0.02	trace	trace	0.03	0.02	trace	trace	0.01
12-13-96	1515	0.10	0.01	0.02	0.07	0.03	0.02	0.02	0.02
12-14-96	1530	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-15-96	1630	0.02	0.00	0.00	trace	0.00	trace	0.01	trace
12-16-96	1530	0.03	0.01	0.01	0.03	0.02	0.02	0.03	0.02
12-17-96	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-18-96	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-19-96	1500	0.35	0.25	0.62	0.42	0.33	0.27	0.42	0.30
12-20-96	1530	0.38	0.22	0.80	0.51	0.32	0.31	0.39	0.34
12-21-96	1530	trace	trace	0.01	trace	trace	0.01	trace	trace
12-22-96	1430	0.04	0.02	0.01	0.02	0.01	0.01	0.03	0.01
12-23-96	1600	0.43	0.03	0.17	0.07	0.05	0.10	0.03	0.11
12-24-96	1545	0.35	0.42	0.56	0.30	0.45	0.23	0.26	0.23
12-25-96	1630	0.18	0.17	0.25	0.10	0.30	0.02	0.08	0.08
12-26-96	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-03-97	1530	[1]2.47	[1]2.50	[1]2.03	[1]3.25	[1]1.38	[1]1.65	[1]3.03	[1]2.65
01-04-97	1500	trace	trace	trace	trace	trace	trace	trace	trace

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
01-05-97	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-06-97	1500	0.06	0.02	0.01	0.06	0.02	0.03	0.02	0.02
01-07-97	1600	0.75	0.48	1.25	1.12	1.05	0.50	0.58	0.76
01-08-97	1615	0.03	0.01	0.01	0.01	0.01	0.01	0.02	0.01
01-09-97	1330	0.13	0.10	0.10	0.18	0.10	0.06	0.13	0.10
01-10-97	1615	0.02	0.01	0.01	0.01	trace	0.00	0.01	0.01
01-11-97	1700	0.01	0.01	trace	0.01	0.01	trace	0.01	trace
01-12-97	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-13-97	1613	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-14-97	1545	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-15-97	1600	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-16-97	1645	0.01	0.02	0.02	0.07	0.03	0.03	0.10	0.02
01-17-97	1500	0.16	0.08	0.09	0.20	0.10	0.10	0.17	0.12
01-18-97	1400	0.52	0.54	0.94	0.70	0.49	0.40	0.95	0.43
01-19-97	1530	0.20	0.16	0.27	0.35	0.16	0.12	0.14	0.20
01-20-97	1435	0.73	0.63	1.61	1.05	0.72	0.89	0.96	0.61
01-21-97	1515	trace	trace	trace	trace	trace	trace	trace	trace
01-22-97	1615	0.12	0.16	0.10	0.22	0.20	0.15	0.20	0.10
01-23-97	1430	0.15	0.03	0.04	0.16	0.10	0.04	0.04	0.09
01-24-97	1530	trace	trace	trace	trace	trace	trace	trace	trace
01-25-97	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-26-97	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-27-97	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-28-97	1730	0.04	0.01	0.01	0.03	0.01	0.01	0.03	0.01
01-29-97	1700	0.10	0.06	0.01	0.14	0.08	0.06	0.15	0.08
01-30-97	1600	0.72	0.42	0.98	0.89	0.45	0.46	0.41	0.62
01-31-97	1400	trace	trace	trace	trace	trace	trace	trace	trace
02-01-97	1445	0.16	0.11	0.07	0.17	0.12	0.10	0.17	0.12
02-02-97	1605	0.05	0.02	0.01	0.07	0.04	0.07	0.03	0.02
02-03-97	1700	0.04	0.02	0.01	0.05	0.04	0.02	0.04	0.02
02-04-97	1645	0.00	0.00	trace	trace	0.00	trace	trace	trace
02-05-97	1730	trace	0.00	0.00	0.00	0.00	trace	0.00	0.00
02-06-97	1530	trace	0.00	0.00	0.00	0.00	0.00	0.00	trace
02-07-97	1700	0.05	0.02	trace	0.04	0.05	0.03	0.03	0.02
02-08-97	1600	trace	trace	0.00	trace	trace	0.00	trace	trace
02-09-97	1430	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
02-10-97	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-11-97	1530	0.23	0.19	0.27	0.30	0.20	0.13	0.28	0.21
02-12-97	1730	0.38	0.25	0.52	0.57	0.37	0.25	0.40	0.27
02-13-97	1630	0.07	0.03	0.02	0.08	0.05	0.02	0.04	0.04
02-14-97	1600	0.51	0.41	0.93	0.87	0.49	0.35	0.53	0.54
02-15-97	1600	0.68	0.53	1.50	1.44	0.63	0.42	0.67	0.65
02-16-97	1530	trace	trace	trace	trace	trace	trace	trace	trace
02-17-97	1600	0.06	0.01	trace	0.04	0.04	0.01	0.01	0.01
02-18-97	1715	0.03	0.01	trace	0.01	trace	0.005	trace	trace
02-19-97	1700	0.23	0.06	0.12	0.19	0.19	0.10	0.12	0.18
02-20-97	1545	0.09	0.03	0.03	0.12	0.06	0.03	0.03	0.05
02-21-97	1815	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-22-97	1600	trace	trace	trace	trace	trace	trace	trace	trace
02-23-97	1615	trace	trace	trace	trace	trace	trace	trace	trace
02-24-97	1600	trace	0.00	0.00	trace	trace	0.00	trace	trace
02-25-97	1715	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-26-97	1645	0.22	0.21	0.10	0.27	0.22	0.20	0.20	0.13
02-27-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-28-97	1700	trace	trace	trace	trace	trace	trace	trace	trace
03-01-97	1500	0.05	trace	trace	trace	trace	trace	0.01	0.01
03-02-97	1645	0.02	0.00	trace	0.02	trace	trace	trace	trace
03-03-97	1400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-04-97	1730	0.02	0.00	0.00	0.01	trace	trace	0.00	0.00
03-05-97	1700	0.02	0.00	trace	0.005	0.00	trace	trace	0.00
03-06-97	1345	0.03	trace	trace	0.03	trace	0.01	0.01	trace
03-07-97	1630	0.10	0.03	0.04	0.13	0.07	0.05	0.05	0.07
03-08-97	1615	0.00	0.00	trace	trace	trace	0.00	trace	.06
03-09-97	1730	0.01	0.00	0.00	trace	0.00	trace	0.00	0.00
03-10-97	1530	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-11-97	1730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-12-97	1700	0.36	0.28	0.25	0.40	0.34	0.22	0.30	0.22
03-13-97	1730	trace	0.00	trace	trace	0.00	0.00	trace	trace
03-14-97	1730	trace	0.00	trace	0.00	0.00	0.00	0.00	0.00
03-15-97	1630	0.58	0.53	0.47	0.76	0.55	0.48	0.74	0.54
03-16-97	1630	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02
03-17-97	1830	0.18	0.15	0.12	0.25	0.17	0.13	0.15	0.14

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
03-18-97	1700	0.31	0.20	0.41	0.46	0.21	0.24	0.19	0.29
03-19-97	1645	0.22	0.13	0.20	0.29	0.16	0.11	0.12	0.15
03-20-97	1630	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02
03-21-97	1745	trace	0.00	trace	trace	0.00	0.00	trace	0.00
03-22-97	1730	0.04	trace	0.00	0.01	0.00	trace	trace	0.00
03-23-97	1730	0.01	0.00	0.00	trace	0.00	0.00	trace	0.00
03-24-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-25-97	1800	0.12	0.07	0.02	0.14	0.12	0.05	0.09	0.07
03-26-97	1645	0.13	0.08	0.09	0.14	0.10	0.07	0.10	0.09
03-27-97	1645	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-28-97	1700	0.03	0.00	trace	0.02	trace	trace	trace	trace
03-29-97	1530	0.01	0.00	0.00	trace	0.00	0.00	0.00	0.00
03-30-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-31-97	1745	0.10	0.00	0.00	0.02	trace	0.01	trace	trace
04-01-97	1700	trace	0.00	0.00	trace	trace	0.00	0.00	0.00
04-02-97	1650	trace	trace	0.00	0.00	0.00	0.00	0.00	0.00
04-03-97	1700	0.05	0.02	0.01	0.04	0.05	0.03	0.04	0.04
04-04-97	1645	trace	0.00	0.00	trace	0.00	0.00	trace	0.00
04-05-97	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-06-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-07-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-08-97	1650	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-09-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-10-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-11-97	1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-12-97	1610	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-13-97	1700	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-14-97	1800	0.07	0.03	0.01	0.05	0.04	0.02	0.04	0.02
04-15-97	1815	0.02	trace	0.00	0.02	0.01	trace	trace	trace
04-16-97	1800	0.08	0.01	trace	0.03	0.03	0.01	0.01	trace
04-17-97	1730	0.01	0.00	0.00	trace	0.00	0.00	trace	0.00
04-18-97	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-19-97	1800	0.17	0.10	0.10	0.20	0.14	0.12	0.16	0.15
04-20-97	1530	0.46	0.40	0.53	0.50	0.42	0.40	0.50	0.51
04-21-97	1745	trace	trace	0.00	0.00	trace	0.00	trace	trace
04-22-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
04-23-97	1700	0.05	trace	trace	0.04	0.01	trace	trace	0.01
04-24-97	1615	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-25-97	1600	0.02	trace	0.00	0.01	trace	trace	trace	0.00
04-6-97	1700	0.01	0.00	0.00	trace	0.00	0.00	trace	0.00
04-27-97	1730	0.38	0.24	0.12	0.26	0.34	0.23	0.23	0.12
04-28-97	1745	0.09	0.03	trace	0.07	0.05	0.03	0.06	0.03
04-29-97	1800	0.03	trace	0.00	0.02	0.01	trace	0.01	trace
04-30-97	1715	0.02	0.00	0.00	0.01	trace	trace	0.01	0.00
05-01-97	1745	0.07	0.02	0.00	0.03	0.04	0.02	0.02	0.01
05-02-97	1815	0.00	0.00	0.00	0.00	0.00	0.00	trace	0.00
05-03-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-04-97	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-05-97	1830	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-06-97	1845	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-07-97	2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-08-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-09-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-10-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-11-97	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-12-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-13-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-14-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-15-97	1800	0.01	0.00	0.00	trace	0.00	0.00	0.00	0.00
05-16-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-17-97	1845	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-18-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-19-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-20-97	1745	0.05	trace	0.00	0.03	0.01	0.00	0.01	0.00
05-21-97	2015	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-22-97	1930	0.02	trace	0.00	0.01	0.02	0.01	0.01	0.00
05-23-97	2000	0.09	0.03	0.00	0.06	0.07	0.03	0.03	0.02
05-24-97	2000	trace	0.00	0.00	trace	trace	0.00	trace	0.00
05-25-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-26-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-27-97	1900	0.15	0.10	0.05	0.13	0.13	0.08	0.11	0.10
05-28-97	1700	0.12	0.09	0.02	0.12	0.10	0.06	0.12	0.07

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
05-29-97	1830	0.28	0.25	0.28	0.40	0.32	0.25	0.31	0.35
05-30-97	1800	0.24	0.20	0.15	0.27	0.21	0.16	0.28	0.21
05-31-97	1800	0.33	0.27	0.42	0.43	0.32	0.21	0.34	0.42
06-01-97	1700	0.23	0.20	0.32	0.31	0.22	0.20	0.29	0.28
06-02-97	1800	0.01	trace	trace	trace	trace	trace	trace	trace
06-03-97	1745	0.20	0.16	0.12	0.20	0.19	0.15	0.25	0.18
06-04-97	1830	0.01	trace	trace	trace	trace	trace	trace	trace
06-05-97	1630	0.03	trace	0.00	0.01	0.01	trace	0.01	trace
06-06-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-07-97	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-08-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-09-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-10-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-11-97	1945	0.14	0.07	0.02	0.14	0.11	0.06	0.08	0.09
06-12-97	1915	0.03	0.03	0.01	0.04	0.03	0.01	0.03	0.05
06-13-97	1910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-14-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-15-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-16-97	1700	trace	trace	trace	trace	trace	trace	trace	trace
06-17-97	1800	0.16	0.05	0.01	0.12	0.11	0.05	0.09	0.05
06-18-97	1930	0.02	0.00	0.00	trace	trace	0.00	trace	trace
06-19-97	1915	0.01	0.00	0.00	trace	0.00	0.00	0.00	0.00
06-20-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-21-97	1930	0.35	0.30	0.30	0.41	0.39	0.38	0.32	0.27
06-22-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-23-97	1900	0.01	0.01	trace	0.03	0.04	trace	0.01	0.01
06-24-97	1830	trace	trace	0.00	trace	trace	trace	trace	trace
06-25-97	1900	trace	0.00	0.00	0.00	trace	trace	0.00	0.00
06-26-97	1800	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-27-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-28-97	1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-29-97	1630	0.52	0.36	0.63	0.68	0.55	0.30	0.36	0.60
06-30-97	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-01-97	1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-02-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
07-03-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-04-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-05-97	1900	0.32	0.22	0.22	0.35	0.28	0.15	0.20	0.25
07-06-97	1600	0.05	0.02	trace	0.03	0.01	0.01	0.02	trace
07-07-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-08-97	1830	0.32	0.25	0.32	0.41	0.35	0.25	0.40	0.31
07-09-97	1930	0.16	0.08	0.05	0.16	0.14	0.06	0.08	0.09
07-10-97	2045	0.16	0.09	0.13	0.20	0.17	0.10	0.14	0.14
07-11-97	1845	0.01	trace	trace	trace	trace	trace	trace	trace
07-12-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-13-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-14-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-15-97	1930	0.02	0.00	0.00	0.01	trace	0.00	0.00	0.00
07-16-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-17-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-18-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-19-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-20-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-21-97	1900	0.01	0.00	0.00	trace	0.00	0.00	0.00	0.00
07-22-97	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-23-97	1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-24-97	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-25-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-26-97	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-27-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-28-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-29-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-30-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-31-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-01-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-02-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-03-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-04-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-05-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-06-97	2000	0.02	0.00	0.00	trace	0.00	0.00	trace	0.00
08-07-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
08-08-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-09-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-10-97	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-11-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-12-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-13-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-14-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-15-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-16-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-17-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-18-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-19-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-20-97	1900	0.06	0.01	0.00	0.05	0.03	0.01	0.02	0.01
08-21-97	1900	0.01	0.01	0.00	0.01	0.01	trace	trace	trace
08-22-97	1945	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-23-97	2030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-24-97	1900	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-25-97	2130	0.06	0.02	0.00	0.05	0.03	0.01	0.04	trace
08-26-97	1930	0.49	0.37	0.77	0.51	0.41	0.39	0.55	0.48
08-27-97	1615	0.04	0.04	0.09	0.05	0.04	0.03	0.04	0.03
08-28-97	1800	0.01	trace	trace	0.00	trace	trace	0.00	0.00
08-29-97	1800	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-30-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-31-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-01-97	2000	0.05	0.02	0.00	0.04	0.03	0.01	0.02	0.01
09-02-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-03-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-04-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-05-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-06-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-07-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-08-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-09-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-10-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-11-97	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-12-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
09-13-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-14-97	1600	0.16	0.10	0.06	0.18	0.14	0.09	0.17	0.12
09-15-97	1630	0.08	0.01	0.00	0.05	0.05	0.01	0.07	0.07
09-16-97	1815	0.18	0.06	0.08	0.16	0.12	0.11	0.18	0.11
09-17-97	1800	0.14	0.08	0.15	0.15	0.12	0.12	0.16	0.11
09-18-97	1800	0.14	0.07	0.09	0.14	0.12	0.09	0.12	0.10
09-19-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-20-97	1700	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-21-97	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-22-97	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-23-97	1830	trace	trace	trace	0.00	0.00	0.00	trace	trace
09-24-97	1845	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-25-97	1830	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-26-97	1800	0.51	0.25	0.51	0.51	0.51	0.37	0.43	0.42
09-27-97	1730	0.26	0.19	0.40	0.36	0.29	0.20	0.20	0.22
09-28-97	1730	trace	0.00	trace	trace	trace	trace	trace	trace
09-29-97	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-30-97	1830	0.20	0.09	0.11	0.30	0.24	0.14	0.14	0.15
10-05-97	2400	[2]1.17	[2]1.08	[2]1.60	[2]1.99	[2]1.53	[2]1.05	[2]1.41	[2]1.37
10-17-97	2400	[2]1.10	[2]0.57	[2]0.84	[2]1.05	[2]0.81	[2]0.55	[2]0.74	[2]0.72
10-23-97	2400	[2]0.13	[2]0.08	[2]0.11	[2]0.14	[2]0.11	[2]0.07	[2]0.10	[2]0.10
10-31-97	2400	[2]1.44	[2]0.94	[2]1.39	[2]1.73	[2]1.33	[2]0.91	[2]1.23	[2]1.19
11-01-97	1745	0.01	trace	trace	trace	trace	trace	trace	trace
11-02-97	1700	trace	0.00	0.00	trace	0.00	0.00	0.00	0.00
11-03-97	1630	0.15	0.06	0.07	0.18	0.07	0.08	0.07	0.12
11-04-97	1645	trace	trace	trace	trace	trace	trace	trace	trace
11-05-97	1600	trace	0.00	0.00	0.00	0.00	0.00	trace	0.00
11-06-97	1430	0.42	0.32	0.65	0.57	0.37	0.42	0.37	0.51
11-07-97	1400	0.01	0.01	0.01	0.01	trace	trace	trace	0.01
11-08-97	1600	0.06	0.04	0.02	0.06	0.04	0.02	0.06	0.03
11-09-97	1530	trace	trace	trace	trace	trace	trace	trace	trace
11-10-97	1630	trace	0.00	0.00	0.00	0.00	trace	0.00	0.00
11-11-97	1615	trace	0.00	trace	0.00	0.00	0.00	0.00	trace
11-12-97	1645	trace	0.00	0.00	0.00	0.00	trace	0.00	trace
11-13-97	1745	trace	0.00	0.00	0.00	0.00	trace	0.00	trace

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
11-14-97	1845	trace	0.00	trace	trace	0.00	trace	0.00	trace
11-15-97	1700	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-16-97	1445	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-17-97	1700	0.23	0.18	0.21	0.03	0.15	0.14	0.16	0.19
11-18-97	1730	0.10	0.08	0.08	0.16	0.09	0.04	0.06	0.09
11-19-97	1630	0.04	trace	trace	0.03	trace	0.05	0.03	0.10
11-20-97	1630	0.32	0.17	0.31	0.45	0.25	0.17	0.20	0.33
11-21-97	1630	trace	trace	trace	trace	trace	trace	trace	trace
11-22-97	1615	0.05	0.05	0.01	0.04	0.02	0.01	0.03	0.01
11-23-97	1730	0.08	0.02	0.01	0.07	0.04	0.02	0.03	0.01
11-24-97	1630	0.04	0.005	0.01	0.06	0.02	trace	0.01	0.01
11-25-97	1600	0.12	0.07	0.05	0.15	0.07	0.07	0.08	0.09
11-26-97	1630	trace	trace	trace	trace	trace	trace	trace	trace
11-27-97	1700	0.05	0.01	0.01	0.05	0.02	0.01	0.02	0.02
11-28-97	1600	0.36	0.22	0.37	0.50	0.34	0.21	0.19	0.36
11-29-97	1530	0.01	trace	trace	trace	trace	trace	0.01	trace
11-30-97	1530	0.05	0.02	0.01	0.05	0.03	0.01	0.02	0.02
12-01-97	1645	trace	trace	trace	trace	trace	trace	trace	trace
12-02-97	1615	0.00	0.00	trace	0.00	0.00	0.00	0.00	0.00
12-03-97	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-04-97	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-05-97	1645	trace	0.00	trace	trace	0.00	0.00	0.00	trace
12-06-97	1700	0.005	0.00	0.00	trace	0.00	0.00	0.00	trace
12-07-97	1615	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-08-97	1630	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-09-97	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-10-97	1730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-11-97	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-12-97	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-13-97	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-14-97	1600	0.05	trace	0.01	0.01	0.02	0.01	0.01	0.02
12-15-97	1615	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-16-97	1615	0.45	0.38	0.07	0.75	0.45	0.41	0.32	0.60
12-17-97	1615	0.11	0.04	0.03	0.05	0.09	0.02	0.04	0.09
12-18-97	1600	0.02	trace	trace	trace	trace	.005	trace	trace
12-19-97	1745	0.05	0.02	0.01	0.03	0.01	0.02	0.03	0.01

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
12-20-97	1645	0.12	0.03	0.02	0.08	0.04	0.02	0.02	0.04
12-21-97	1545	0.26	0.18	0.08	0.17	0.21	0.15	0.15	0.11
12-22-97	1445	trace	trace	trace	trace	trace	trace	trace	trace
12-23-97	1600	0.18	0.10	0.15	0.22	0.15	0.10	0.12	0.16
12-24-97	1500	0.03	0.02	0.02	0.05	0.03	0.02	0.03	0.03
12-25-97	1630	trace	trace	trace	trace	trace	0.00	0.00	trace
12-26-97	1615	0.20	0.15	0.20	0.39	0.17	0.26	0.22	0.26
12-27-97	1530	0.04	0.04	0.06	0.05	0.03	0.03	0.02	0.03
12-28-97	1600	0.31	0.20	0.35	0.42	0.20	0.23	0.28	0.29
12-29-97	1700	0.07	0.05	0.04	0.10	0.05	0.04	0.04	0.06
12-30-97	1715	trace	trace	trace	trace	trace	trace	trace	trace
12-31-97	1645	trace	0.00	trace	trace	0.00	trace	trace	trace
01-01-98	1630	0.54	0.50	0.32	0.65	0.50	0.42	0.46	0.42
01-02-98	1645	0.32	0.31	0.65	0.55	0.32	0.27	0.28	0.37
01-03-98	1645	trace	trace	trace	trace	trace	trace	trace	trace
01-04-98	1715	0.05	0.01	trace	0.04	0.02	0.01	0.02	trace
01-05-98	1630	0.22	0.10	0.18	0.30	0.15	0.10	0.10	0.20
01-06-98	1600	0.22	0.14	0.15	0.32	0.17	0.09	0.14	0.20
01-07-98	1830	0.05	0.07	0.08	0.10	0.05	0.03	0.04	0.06
01-08-98	1700	trace	trace	trace	trace	trace	trace	trace	trace
01-09-98	1645	trace	trace	trace	trace	trace	trace	trace	trace
01-10-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-11-98	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-12-98	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-13-98	1615	0.45	0.43	0.75	0.58	0.60	0.40	0.72	0.55
01-14-98	1800	0.13	0.05	0.05	0.15	0.07	0.06	0.05	0.10
01-15-98	1745	0.23	0.13	0.15	0.36	0.20	0.07	0.08	0.24
01-16-98	1700	0.05	0.02	0.01	0.03	0.01	.015	0.02	0.02
01-17-98	1630	0.10	0.03	0.02	0.05	0.04	0.03	0.03	0.02
01-18-98	1630	0.01	0.00	trace	trace	trace	trace	trace	trace
01-19-98	1700	trace	trace	trace	trace	trace	trace	trace	trace
01-20-98	1800	0.13	0.07	0.05	0.16	0.10	0.06	0.08	0.08
01-21-98	1715	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-22-98	1645	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-23-98	1745	0.09	0.03	0.03	0.08	0.04	0.05	0.07	0.04
01-24-98	1745	0.011	0.03	0.02	0.11	0.07	0.04	0.03	0.07

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
01-25-98	1630	0.14	0.10	0.18	0.23	0.14	0.10	0.11	0.15
01-26-98	1745	0.06	0.03	0.02	0.06	0.03	0.04	0.02	0.02
01-27-98	1715	trace	0.00	0.00	0.00	trace	0.00	trace	trace
01-28-98	1700	0.05	0.02	0.01	0.03	0.01	0.01	0.03	0.01
01-29-98	1730	0.09	0.04	0.02	0.10	0.05	0.03	0.04	0.03
01-30-98	1645	0.01	0.01	trace	0.02	0.02	trace	0.01	0.02
01-31-98	1645	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-01-98	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-02-98	1645	0.01	0.00	0.00	0.005	trace	0.00	0.00	0.00
02-03-98	1715	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-04-98	1645	0.09	0.06	0.01	0.08	0.06	0.03	0.05	0.02
02-05-98	1730	trace	trace	0.00	trace	trace	trace	trace	trace
02-06-98	1645	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-07-98	1715	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-08-98	1515	0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-09-98	1715	0.09	0.04	0.03	0.10	0.08	0.03	0.04	0.06
02-10-98	1730	0.01	0.00	0.03	0.01	0.08	0.00	trace	trace
02-11-98	1915	0.01	0.00	trace	trace	trace	0.00	0.00	0.00
02-12-98	1915	0.07	0.02	0.02	0.05	0.03	0.02	0.02	0.01
02-13-98	1915	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-14-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-15-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-16-98	1700	0.05	0.02	trace	0.02	0.02	0.01	0.02	trace
02-17-98	1700	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-18-98	1400	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-19-98	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-20-98	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-21-98	1500	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-22-98	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-23-98	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-24-98	1530	0.16	0.05	0.07	0.16	0.13	0.05	0.06	0.14
02-25-98	1400	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-26-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-27-98	1800	0.10	0.05	0.03	0.10	0.03	0.04	0.06	0.05
02-28-98	1700	0.09	0.03	0.03	0.08	0.03	0.05	0.06	0.03

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
03-01-98	1600	0.29	0.17	0.27	0.35	0.23	0.18	0.23	0.25
03-02-98	1600	0.12	0.17	0.27	0.35	0.23	0.18	0.23	0.25
03-03-98	1700	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-04-98	1600	0.21	0.12	0.06	0.20	0.16	0.09	0.12	0.11
03-05-98	1600	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-06-98	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-07-98	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-08-98	1600	0.08	0.05	0.04	0.09	0.07	0.04	0.04	0.06
03-09-98	1600	0.16	0.10	0.19	0.21	0.15	0.09	0.10	0.17
03-10-98	1600	0.14	0.09	0.09	0.13	0.10	0.07	0.10	0.08
03-11-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-12-98	1600	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-13-98	1500	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-14-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-15-98	1530	0.07	0.03	0.02	0.09	0.04	0.03	0.04	0.03
03-16-98	1730	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-17-98	1530	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-18-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-19-98	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-20-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-21-98	1400	0.12	0.05	0.06	0.12	0.09	0.05	0.07	0.07
03-22-98	1600	0.40	0.16	0.30	0.38	0.30	0.11	0.18	0.29
03-23-98	1430	0.20	0.18	0.11	0.19	0.16	0.11	0.24	0.16
03-24-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-25-98	1700	0.26	0.18	0.12	0.29	0.26	0.12	0.16	0.16
03-26-98	1430	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-27-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-28-98	1930	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-29-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-30-98	1800	0.28	0.12	0.07	0.29	0.18	0.11	0.19	0.14
03-31-98	1500	0.25	0.17	0.29	0.33	0.26	0.15	0.24	0.21
04-01-98	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-02-98	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-03-98	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-04-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-05-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
04-06-98	1845	0.00	trace	trace	trace	trace	trace	trace	trace
04-07-98	1730	trace	0.00	0.00	trace	0.00	trace	trace	0.00
04-08-98	1730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-09-98	1800	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-10-98	1800	0.08	0.02	0.00	0.07	0.05	0.02	0.05	trace
04-11-98	1700	0.11	0.05	0.03	0.12	0.09	0.03	0.06	0.07
04-12-98	1500	0.06	0.01	trace	0.04	0.04	trace	0.02	0.02
04-13-98	1730	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-14-98	1800	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-15-98	1800	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-16-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-17-98	1830	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-18-98	1600	0.09	0.03	trace	0.08	0.06	0.03	0.06	0.02
04-19-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-20-98	1900	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-21-98	1700	trace	0.00	0.00	trace	0.00	0.00	0.00	0.00
04-22-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-23-98	1900	0.09	trace	0.00	0.06	0.03	trace	0.01	trace
04-24-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-25-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-26-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-27-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-28-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-29-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-30-98	1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-01-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-02-98	1700	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-03-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-04-98	1900	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-05-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-06-98	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-07-98	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-08-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-09-98	1700	0.06	trace	0.00	0.06	0.03	0.00	trace	0.02
05-10-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-11-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
05-12-98	1700	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-13-98	1900	0.06	0.00	0.00	0.03	0.01	0.00	trace	trace
05-14-98	1830	0.22	0.08	0.03	0.23	0.18	0.08	0.15	0.09
05-15-98	1700	0.27	0.21	0.27	0.34	0.29	0.20	0.29	0.29
05-16-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-17-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-18-98	1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-19-98	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-20-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-21-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-22-98	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-23-98	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-24-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-25-98	1800	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-26-98	1700	0.67	0.47	0.78	0.88	0.82	0.30	0.51	0.51
05-27-98	1800	0.27	0.14	0.06	0.27	0.26	0.09	0.14	0.16
05-28-98	2100	0.81	0.77	1.35	1.19	1.11	0.55	0.88	1.09
05-29-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-30-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-31-98	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-01-98	2030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-02-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-03-98	1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-04-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-05-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-06-98	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-07-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-08-98	1900	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.00
06-09-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-10-98	2030	0.36	0.24	0.30	0.46	0.49	0.22	0.34	0.30
06-11-98	1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-12-98	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-13-98	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-14-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-15-98	1700	0.08	trace	0.00	0.05	0.05	trace	trace	0.01
06-16-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
06-17-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-18-98	1730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-19-98	1730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-20-98	1545	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-21-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-22-98	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-23-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-24-98	1700	0.34	0.19	0.20	0.51	0.37	0.24	0.36	0.26
06-25-98	1830	0.07	0.08	0.04	0.09	0.11	0.06	0.08	0.07
06-26-98	1900	0.03	trace	0.00	0.02	trace	0.00	0.00	0.00
06-27-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-28-98	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-29-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-30-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-01-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-02-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-03-98	2100	0.34	0.20	0.30	0.43	0.51	0.12	0.26	0.37
07-04-98	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-05-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-06-98	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-07-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-08-98	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-09-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-10-98	1900	0.00	0.01	0.02	0.01	0.02	0.00	0.00	0.00
07-11-98	1900	0.05	trace	0.00	0.01	0.01	0.00	0.00	0.00
07-12-98	1900	0.06	0.03	0.00	0.06	0.09	0.03	0.10	0.00
07-13-98	1900	0.01	0.00	0.00	trace	trace	0.00	0.00	0.00
07-14-98	1900	0.24	0.18	0.04	0.27	0.24	0.15	0.24	0.17
07-15-98	1900	0.17	0.10	0.05	0.20	0.18	0.07	0.17	1.10
07-16-98	1800	trace	trace	trace	trace	trace	trace	trace	trace
07-17-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-18-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-19-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-20-98	2100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-21-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-22-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
07-23-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-24-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-25-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-26-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-27-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-28-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-29-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-30-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	trace	trace
07-31-98	1800	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
08-31-98	2400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-01-98	1730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-02-98	2030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-03-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-04-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-05-98	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-06-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-07-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-08-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-09-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-10-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-11-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-12-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-13-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-14-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-15-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-16-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-17-98	1700	0.12	0.26	0.00	0.10	0.07	0.03	0.06	0.03
09-18-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-19-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-20-98	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-21-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-22-98	1745	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-23-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-24-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-25-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-26-98	1830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Precipitation and throughfall in a predominantly evergreen forest located at the south end of Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
09-27-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-28-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-29-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-30-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-01-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-02-98	1730	0.15	0.03	0.03	0.06	0.12	0.02	0.04	0.05
10-03-98	1800	0.05	trace	0.00	0.02	0.01	trace	trace	trace
10-04-98	1730	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-05-98	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-06-98	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[1]Value subject to large error due to heavy snow storm during this period.

[2]Data not obtained. Value estimated from the average throughfall collected at the Shaw Island site for this period, multiplied by a factor equal to the sum of the throughfall quantities collected in this gage divided by the sum of the average throughfall collected in the Shaw Island gages over all periods with no missing data.

Table 15. Precipitation and throughfall in a predominantly evergreen forest located in Moran State Park, Orcas Island, San Juan County, Washington, water years 1997-98

[Values represent cumulative amounts from the data and time of the prior record to that of the current record. —, no data]

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)					
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)
10-01-96	0000	—	—	—	—	—	—	—
11-06-96	1500	[1]5.54	[1]4.76	[1]5.04	[1]6.31	[1]3.77	[1]4.24	[1]4.14
11-14-96	1600	1.60	1.00	1.34	1.60	1.10	1.03	1.10
11-20-96	1750	1.18	0.88	0.92	1.07	0.91	0.82	0.84
11-30-96	1700	3.00	2.80	2.07	2.86	2.00	2.70	2.29
12-03-96	1800	0.50	0.18	0.41	0.05	0.26	0.35	0.17
12-04-96	1400	0.50	0.33	0.31	0.50	0.35	0.18	0.37
12-06-96	1330	0.65	0.30	0.55	0.57	0.38	0.40	0.30
12-09-96	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-12-96	1600	0.25	0.06	0.20	0.24	0.03	0.12	0.04
12-15-96	1215	0.32	0.15	0.17	0.30	0.15	0.10	0.14
12-18-96	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-04-97	1030	[2]2.56	[2]3.57	[2]2.76	[2]3.70	[2]2.81	[2]3.26	[2]2.44
01-09-97	1510	0.82	0.77	0.75	0.80	0.56	0.55	0.57
01-20-97	1030	2.30	2.15	1.79	2.30	1.50	1.39	1.62
01-31-97	0800	2.00	1.55	1.35	1.44	1.27	0.90	1.50
02-16-97	1200	3.32	3.03	2.26	3.30	2.25	2.07	2.13
02-28-97	1130	1.00	0.30	0.65	0.91	0.35	0.50	0.30
03-02-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-08-97	1200	0.67	0.32	0.44	0.68	0.26	0.30	0.27
03-21-97	0930	3.18	2.61	2.63	3.17	2.00	1.58	2.37
03-31-97	1200	0.45	0.12	0.45	0.50	0.20	0.32	0.18
04-01-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-04-97	0930	0.05	0.01	0.04	0.05	0.01	0.03	0.01
04-12-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-20-97	1410	1.31	1.13	0.89	1.36	0.67	0.77	0.84
04-28-97	1730	0.80	0.43	0.70	0.86	0.36	0.55	0.42
05-07-97	1200	0.50	0.12	0.50	0.59	0.23	0.36	0.17
05-20-97	1430	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-02-97	1322	1.92	1.38	1.60	2.00	1.00	1.30	1.09
06-09-97	1945	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-14-97	1315	0.38	0.22	0.28	0.41	0.17	0.24	0.15
06-20-97	0910	0.41	0.24	0.23	0.43	0.16	0.22	0.21
06-30-97	0912	1.53	1.04	1.73	1.65	1.02	1.15	1.10
07-03-97	1740	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-10-97	1540	1.74	1.32	1.29	1.79	1.16	1.15	1.18
07-26-97	1600	0.05	0.03	0.06	0.08	0.02	0.05	0.04
07-31-97	1400	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 15. Precipitation and throughfall in a predominantly evergreen forest located in Moran State Park, Orcas Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)					
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)
08-01-97	0930	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-05-97	1640	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-08-97	1605	0.07	0.02	0.04	0.07	0.01	0.03	0.01
08-12-97	1545	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-17-97	1100	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-24-97	0945	0.06	0.03	0.04	0.07	0.00	0.06	0.01
08-30-97	1322	0.92	0.86	0.64	0.99	0.54	0.65	0.64
09-01-97	1015	0.05	0.01	0.02	0.05	0.00	0.02	0.00
09-06-97	0840	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-09-97	1045	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-30-97	1345	2.86	2.03	1.63	2.87	1.32	1.95	1.35
10-06-97	1615	0.79	0.48	0.80	0.81	0.00	0.57	0.44
10-13-97	1100	0.51	0.16	0.22	0.08	0.11	0.19	0.16
10-22-97	1730	0.67	0.50	0.50	[3]0.70	0.32	0.50	0.40
10-30-97	1300	2.07	1.60	1.67	2.00	1.22	1.34	1.43
11-30-97	1900	3.50	2.10	2.40	3.40	1.50	2.00	[3]1.83
12-01-97	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-05-97	1400	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-11-97	1300	0.16	0.05	0.08	0.17	0.02	0.03	0.02
01-15-98	1600	6.84	5.00	6.00	6.35	4.03	4.70	4.81
01-26-98	1330	1.57	0.76	1.00	1.54	0.59	0.70	0.65
01-31-98	1200	0.34	0.14	0.25	0.33	0.11	0.17	0.10
05-13-98	0910	[1]5.37	[1]4.29	[1]4.56	[1]5.65	[1]3.38	[1]3.49	[1]4.19
05-19-98	0930	0.90	0.58	0.73	0.81	0.52	0.58	0.47
06-05-98	1320	2.84	2.06	2.56	2.72	1.92	2.02	2.25
06-18-98	1105	[3]0.48	0.34	0.41	0.50	0.24	0.36	0.29
06-27-98	1415	[3]1.06	0.95	0.81	1.11	0.70	0.72	0.81
07-07-98	1200	0.46	0.44	0.42	0.48	0.34	0.39	0.35
07-17-98	1030	0.52	0.23	0.49	0.64	0.31	0.44	0.29
09-30-98	2400	[1]0.37	[1]0.19	[1]0.20	[1]0.25	[1]0.15	[1]0.17	[1]0.17

[1]Data not obtained. Value estimated from the average throughfall collected at the Shaw Island site for this period multiplied by a factor equal to the sum of the throughfall quantities collected in this gage divided by the sum of the average throughfall collected in the Shaw Island gages over all periods with no missing data.

[2]Value subject to large error due to heavy snow storm during this period.

[3]Data not obtained. Values estimated from the average throughfall collected in the other gages at this site, multiplied by a factor equal to the sum of throughfall quantities collected in this gage divided by the sum of the average throughfall collected in the other gages over all periods with no missing data.

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98

[Values represent cumulative amounts from the date and time of the prior record to that of the current record. —, no data]

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
09-11-96	1100	—	—	—	—	—	—	—	—
09-14-96	1005	0.31	0.15	0.08	0.13	0.18	0.18	0.27	0.12
09-15-96	0930	0.41	0.32	0.29	0.295	0.325	0.36	0.43	0.28
09-16-96	1005	0.01	0.00	0.00	0.00	0.00	trace	0.00	0.00
09-17-96	1015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-18-96	1015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-19-96	1015	0.22	0.16	0.10	0.13	0.15	0.15	0.27	0.11
09-20-96	1130	trace	trace	0.00	0.00	0.00	trace	trace	trace
09-21-96	1030	trace	0.00	0.00	0.00	trace	trace	trace	trace
09-22-96	0920	0.00	0.00	0.00	0.00	0.00	0.00	trace	0.00
09-23-96	0955	0.00	0.00	0.00	0.00	0.00	0.00	trace	0.00
09-24-96	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-25-96	0745	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-26-96	0710	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-27-96	0915	0.00	0.00	0.00	0.00	0.00	0.00	trace	0.00
09-28-96	0700	0.00	0.00	0.00	0.00	0.00	0.00	trace	0.00
09-29-96	0930	0.00	trace	0.00	0.00	0.00	0.00	trace	0.00
09-30-96	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-01-96	0915	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-02-96	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-03-96	1015	0.00	0.00	0.00	0.00	0.00	0.00	trace	0.00
10-04-96	1015	0.26	0.14	0.15	0.10	0.12	0.16	0.21	0.09
10-05-96	1015	0.22	0.17	0.25	0.18	0.22	0.23	0.23	0.20
10-06-96	0810	trace	trace	trace	trace	trace	trace	trace	trace
10-07-96	0910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-08-96	0735	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-09-96	0910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-10-96	0720	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-11-96	1000	0.29	0.14	0.22	0.12	0.145	0.19	0.25	0.24
10-12-96	0910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-13-96	0725	0.02	0.00	0.00	0.00	0.00	0.00	0.005	0.00
10-14-96	0900	0.12	0.01	0.01	0.00	0.02	0.02	0.05	0.01
10-15-96	0900	0.33	0.16	0.23	0.04	0.10	0.10	0.06	0.08
10-16-96	1620	0.16	0.08	0.05	0.06	0.07	0.11	0.14	0.07
10-17-96	0910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-18-96	0920	0.57	0.26	0.36	0.11	0.22	0.20	0.18	0.19
10-19-96	1015	trace	0.00	trace	0.00	0.00	0.00	0.00	0.00
10-20-96	0945	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-21-96	1015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-22-96	1030	0.48	0.33	0.34	0.20	0.33	0.29	0.28	0.26

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
10-23-96	1030	0.10	0.03	0.02	0.02	0.03	0.02	0.06	trace
10-24-96	1030	0.15	0.03	0.05	trace	0.04	0.03	0.02	0.01
10-25-96	1030	0.10	0.10	trace	0.07	0.10	0.07	0.17	0.07
10-26-96	1030	0.03	0.02	0.02	0.03	0.03	0.02	0.02	0.02
10-27-96	1015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-28-96	1030	1.50	1.00	1.20	1.10	1.50	1.00	0.90	2.00
10-29-96	1030	0.15	0.13	0.10	0.12	0.14	0.12	0.17	0.11
10-30-96	0930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-31-96	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-01-96	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-02-96	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-03-96	1000	0.19	0.15	0.09	0.09	0.13	0.15	0.20	0.10
11-04-96	0855	0.12	0.05	0.02	0.04	0.055	0.07	0.125	0.04
11-05-96	0930	0.04	0.03	trace	0.01	0.02	0.02	0.04	0.02
11-06-96	0850	0.05	0.00	trace	0.00	trace	trace	0.02	0.00
11-07-96	0900	trace	0.00	0.00	0.00	0.00	0.00	trace	0.00
11-08-96	0915	0.33	0.085	0.12	0.04	0.09	0.07	0.11	0.06
11-09-96	1130	0.03	trace	trace	trace	0.002	trace	0.025	0.01
11-10-96	1015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-11-96	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-12-96	1130	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-13-96	0920	0.38	0.27	0.28	0.28	0.31	0.30	0.41	0.32
11-14-96	1030	0.22	0.17	0.13	0.17	0.19	0.16	0.26	0.17
11-15-96	1030	0.00	0.00	0.00	0.00	0.00	0.00	trace	0.00
11-16-96	1030	0.16	0.06	0.10	0.05	0.08	0.07	0.11	0.04
11-17-96	0940	0.37	0.23	0.10	0.20	0.24	0.19	0.41	0.22
11-18-96	0910	0.02	0.05	0.06	0.13	0.10	0.04	0.07	0.06
11-19-96	0900	trace	trace	trace	trace	trace	trace	trace	trace
11-20-96	1500	0.17	0.11	0.15	0.11	0.11	0.09	0.12	0.11
11-21-96	0915	trace	trace	trace	trace	trace	trace	trace	0.00
11-22-96	0900	trace	trace	0.00	0.00	0.00	0.00	0.00	0.00
11-23-96	0915	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-24-96	1000	0.10	0.06	0.04	0.06	0.08	0.08	0.09	0.09
11-25-96	1000	0.15	0.10	0.05	0.07	0.09	0.08	0.09	0.10
11-26-96	1000	0.08	0.06	0.10	0.08	0.09	0.07	0.06	0.10
11-27-96	1000	1.00	0.83	0.70	0.72	0.72	0.70	1.00	1.02
11-28-96	1000	1.00	0.92	0.65	0.88	1.03	0.61	1.12	0.86
11-29-96	1000	0.00	0.00	0.00	0.00	trace	trace	0.00	0.00
11-30-96	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
12-01-96	0930	0.28	0.06	0.09	0.03	0.08	0.08	0.16	0.05
12-02-96	0910	0.07	0.01	0.01	0.00	0.005	trace	0.02	0.005
12-03-96	0905	0.09	0.025	0.03	0.02	0.02	0.03	0.05	0.02
12-04-96	0905	0.16	0.05	0.10	0.02	0.05	0.04	0.01	0.04
12-05-96	0855	0.63	0.40	0.48	0.27	0.49	0.40	0.37	0.34
12-06-96	0955	0.12	0.10	0.04	0.055	0.07	0.07	0.125	0.055
12-07-96	0955	0.02	trace	0.005	0.00	trace	trace	trace	trace
12-08-96	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-09-96	1000	0.09	0.02	0.02	0.01	0.02	0.03	0.05	0.02
12-10-96	1000	0.10	0.03	0.05	0.02	0.04	0.03	0.06	0.03
12-11-96	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-12-96	1000	0.05	0.00	0.00	0.00	0.00	trace	0.02	0.02
12-13-96	1000	0.08	0.00	0.02	0.00	0.03	0.00	0.02	0.01
12-14-96	1000	0.06	0.01	0.02	0.00	0.02	0.00	0.02	0.00
12-15-96	0925	trace	trace	0.00	0.00	trace	0.00	0.00	0.00
12-16-96	0910	0.125	0.08	0.07	0.04	0.055	0.04	0.07	0.075
12-17-96	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-18-96	0855	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-20-96	0835	0.49	0.37	0.31	0.32	0.40	0.32	0.41	0.34
12-21-96	0845	0.03	trace	0.005	trace	0.01	trace	0.015	trace
12-22-96	1000	trace	trace	trace	trace	trace	trace	trace	trace
12-23-96	1000	0.50	0.20	0.10	0.10	0.15	0.13	0.25	0.25
12-24-96	1000	0.20	0.10	0.05	0.05	0.08	0.07	0.15	0.12
12-25-96	1600	0.08	0.04	0.13	0.04	0.07	0.09	0.10	0.10
12-26-96	1100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-27-96	1100	0.03	0.00	0.00	0.00	0.00	0.04	0.00	0.00
01-01-97	1605	[1]4.31	[1]2.22	[1]1.45	[1]1.82	[1]2.28	[1]1.73	[1]2.94	[1]3.12
01-02-97	1555	0.10	0.005	0.04	0.02	0.02	0.015	0.03	0.02
01-03-97	0945	0.025	0.02	trace	0.01	0.02	0.022	0.04	0.02
01-04-97	0920	0.38	0.33	0.275	0.34	0.34	0.365	0.39	0.38
01-05-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-06-97	1000	0.20	0.05	0.10	0.02	0.09	0.09	0.20	0.06
01-07-97	1000	0.21	0.06	0.11	0.05	0.10	0.10	0.10	0.06
01-08-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-09-97	1000	0.04	0.04	0.03	0.04	0.05	0.05	0.08	0.05
01-10-97	1000	0.11	0.03	0.02	0.04	0.05	0.03	0.08	0.04
01-11-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-12-97	0935	trace	0.00	trace	0.00	0.00	trace	trace	trace
01-13-97	1300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-14-97	0910	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-15-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-16-97	0900	trace	0.00	0.00	0.00	0.00	trace	0.00	trace
01-17-97	0925	0.19	0.04	0.02	0.02	0.04	0.01	0.13	0.05

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
01-18-97	1540	1.00	0.91	0.63	0.92	0.94	0.63	1.04	0.81
01-19-97	1000	0.35	0.14	0.19	0.11	0.20	0.14	0.19	0.10
01-20-97	1000	0.47	0.38	0.31	0.40	0.39	0.35	0.50	0.36
01-21-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-22-97	1530	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-23-97	0910	0.16	0.09	0.06	0.07	0.085	0.10	0.14	0.07
01-24-97	1000	0.01	0.00	0.00	0.00	0.00	0.00	0.00	trace
01-29-97	1730	0.33	0.16	0.06	0.13	0.15	0.13	0.24	0.15
01-30-97	0930	1.03	0.79	0.91	0.55	0.85	0.65	0.52	0.54
01-31-97	0915	trace	trace	trace	trace	trace	trace	trace	trace
02-01-97	0920	0.14	0.12	0.07	0.09	0.11	0.10	0.15	0.07
02-02-97	0945	0.16	0.09	0.09	0.06	0.09	0.10	0.15	0.06
02-03-97	1000	0.04	0.01	0.02	0.01	0.02	0.01	0.03	0.01
02-04-97	1000	0.05	0.00	0.01	0.01	0.02	0.01	0.02	0.00
02-05-97	1000	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-06-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-07-97	1000	0.06	0.02	0.00	trace	0.02	0.02	0.05	trace
02-08-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-09-97	0940	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-10-97	0945	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-11-97	1020	0.14	0.12	0.03	0.09	0.095	0.095	0.16	0.105
02-12-97	0905	0.63	0.35	0.45	0.25	0.41	0.33	0.27	0.29
02-13-97	0945	0.06	0.02	0.01	0.005	0.015	0.015	0.04	0.01
02-14-97	0915	0.35	0.25	0.29	0.23	0.28	0.25	0.24	0.20
02-15-97	1030	0.83	0.69	0.84	0.64	0.81	0.75	0.81	0.66
02-16-97	1000	0.00	0.00	trace	0.00	0.00	0.00	0.00	0.00
02-17-97	1000	0.13	0.07	0.06	0.05	0.09	0.01	0.13	0.06
02-18-97	1000	0.19	0.08	0.11	0.06	0.08	0.09	0.11	0.06
02-19-97	1000	0.19	0.08	0.12	0.06	0.09	0.08	0.11	0.07
02-20-97	1420	0.03	trace	0.01	trace	trace	0.005	0.02	trace
02-21-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-22-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-23-97	1338	0.00	0.00	0.00	0.00	0.00	0.00	trace	trace
02-24-97	1100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-25-97	1430	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-26-97	0920	0.045	0.02	trace	0.01	0.02	0.02	0.05	0.02
02-27-97	0750	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-28-97	0915	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-01-97	1400	0.20	0.20	0.20	0.00	0.02	0.01	0.03	0.01
03-02-97	1000	0.00	0.02	0.03	0.00	0.01	0.01	0.02	0.01
03-03-97	1000	0.04	0.00	0.00	0.00	0.00	0.00	trace	0.00
03-04-97	1000	0.07	0.04	0.01	0.03	0.04	0.04	0.06	0.03

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
03-05-97	1100	0.02	0.00	trace	0.00	0.00	0.00	0.00	0.00
03-06-97	0935	0.13	0.01	0.04	trace	0.03	0.01	0.04	0.01
03-09-97	0920	0.18	0.04	0.09	0.03	0.06	0.06	0.09	0.03
03-10-97	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-11-97	1045	0.015	0.00	0.00	0.00	0.00	0.00	0.005	trace
03-13-97	0955	0.01	0.06	0.03	0.06	0.06	0.07	0.11	0.05
03-14-97	0910	0.005	trace	trace	trace	trace	trace	0.01	trace
03-15-97	1540	0.64	0.59	0.34	0.645	0.62	0.37	0.70	0.60
03-16-97	0945	0.12	0.14	0.13	0.14	0.14	0.11	0.155	0.12
03-17-97	0910	0.25	0.27	0.135	0.22	0.22	0.155	0.28	0.18
03-19-97	0915	0.80	0.31	0.44	0.17	0.33	0.25	0.25	0.19
03-20-97	0855	0.20	0.10	0.09	0.10	0.125	0.10	0.14	0.08
03-21-97	0935	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-23-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-24-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-25-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-26-97	1000	0.21	0.13	0.07	0.11	0.13	0.14	0.21	0.10
03-27-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-28-97	1000	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-29-97	1000	trace	0.00	0.00	0.00	0.00	0.00	trace	0.00
03-30-97	0905	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-01-97	1515	0.05	trace	trace	0.00	trace	0.00	0.02	trace
04-02-97	0815	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-03-97	0940	0.13	0.025	0.07	0.02	0.05	0.06	0.10	0.03
04-04-97	0915	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-05-97	0905	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-06-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-07-97	0915	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-08-97	0830	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-09-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-10-97	0945	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-11-97	0905	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-12-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-13-97	0900	0.02	0.00	0.00	0.00	trace	0.00	0.00	trace
04-14-97	0910	trace	0.00	0.00	0.00	0.00	0.00	trace	0.00
04-15-97	1630	0.08	0.01	trace	trace	0.02	trace	0.05	0.015
04-16-97	1640	0.07	0.015	trace	trace	0.02	0.01	0.04	0.01
04-17-97	1400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-18-97	0905	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-19-97	0900	0.02	trace	0.00	0.00	trace	0.00	0.02	trace
04-20-97	0710	0.87	0.74	0.68	0.55	0.72	0.70	0.65	0.57
04-21-97	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
04-22-97	0915	0.005	trace	trace	trace	trace	trace	trace	trace
04-23-97	1000	0.21	0.03	0.09	0.02	0.04	0.05	0.05	0.03
04-24-97	1445	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-26-97	0855	0.07	0.02	0.00	trace	0.02	0.01	0.05	0.015
04-27-97	0900	0.22	0.16	0.12	0.16	0.15	0.17	0.24	0.14
04-28-97	0940	0.08	0.04	trace	0.02	0.03	0.02	0.09	0.02
04-30-97	0900	0.09	0.005	0.005	trace	0.01	trace	0.05	0.01
05-01-97	1100	0.13	0.10	0.06	0.07	0.08	0.10	0.14	0.07
05-02-97	1005	0.01	0.005	0.00	trace	0.005	trace	0.01	trace
05-03-97	0900	0.03	trace	0.00	0.00	0.01	trace	0.02	0.01
05-04-97	0930	0.04	trace	0.005	0.00	trace	trace	trace	trace
05-05-97	0855	trace	0.00	0.00	0.00	trace	0.00	0.00	0.00
05-06-97	1010	0.15	0.08	0.05	0.07	0.10	0.08	0.16	0.06
05-07-97	0910	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-08-97	1015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-09-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-10-97	0910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-11-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-12-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-13-97	0700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-14-97	0740	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-15-97	0645	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-16-97	1005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-17-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-18-97	0905	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-19-97	0735	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-20-97	1800	0.15	0.09	0.07	0.05	0.10	0.01	0.14	0.06
05-21-97	1810	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-22-97	2035	0.37	0.27	0.26	0.29	0.43	0.35	0.40	0.33
05-23-97	0700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-24-97	1855	0.10	0.04	0.02	0.03	0.05	0.06	0.08	0.04
05-25-97	0910	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-26-97	0715	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-27-97	0730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-28-97	1005	0.14	0.07	0.03	0.06	0.09	0.09	0.12	0.07
05-29-97	0720	0.44	0.36	0.21	0.32	0.37	0.31	0.40	0.33
05-30-97	1015	0.10	0.11	0.09	0.07	0.11	0.10	0.09	0.05
05-31-97	1220	0.49	0.41	0.23	0.34	0.44	0.35	0.40	0.32
06-01-97	0940	0.35	0.36	0.19	0.30	0.33	0.25	0.30	0.25
06-02-97	0720	0.00	0.00	0.00	0.00	trace	0.00	trace	0.00
06-03-97	0715	0.03	0.02	0.00	0.01	0.03	0.01	0.04	0.02
06-04-97	2130	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
06-05-97	1900	0.24	0.14	0.03	0.12	0.14	0.11	0.17	0.12
06-06-97	1920	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-07-97	0900	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-08-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-09-97	0725	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-10-97	0700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-11-97	0730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-12-97	0725	0.12	0.07	0.01	0.04	0.07	0.05	0.06	0.03
06-13-97	0730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-14-97	0720	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-15-97	0905	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-16-97	0720	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-17-97	0930	0.24	0.10	0.09	0.09	0.09	0.10	0.17	0.07
06-18-97	1205	0.18	0.05	0.12	0.05	0.09	0.08	0.16	0.05
06-19-97	1840	0.01	0.00	0.00	0.00	0.00	0.00	trace	0.00
06-20-97	0755	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-21-97	1010	0.30	0.30	0.20	0.26	0.27	0.26	0.37	0.24
06-22-97	0730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-24-97	0925	0.08	0.02	0.02	0.02	0.03	0.04	0.07	0.02
06-25-97	0630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-26-97	1900	0.15	0.09	0.02	0.07	0.08	0.06	0.15	0.05
06-27-97	0740	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-28-97	0730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-29-97	1520	0.56	0.43	0.48	0.34	0.46	0.48	0.675	0.32
06-30-97	0630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-01-97	0730	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-02-97	0700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-03-97	0650	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-04-97	0745	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-05-97	0740	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-06-97	2050	0.42	0.26	0.18	0.22	0.29	0.25	0.47	0.17
07-07-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-08-97	1840	0.40	0.20	0.16	0.20	0.25	0.21	0.35	0.15
07-09-97	1840	0.11	0.09	0.07	0.08	0.10	0.09	0.13	0.06
07-10-97	2050	0.03	0.01	0.005	trace	0.02	trace	0.02	0.01
07-11-97	2030	0.01	trace	0.00	trace	trace	0.00	0.01	0.00
07-12-97	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-13-97	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-14-97	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-15-97	0720	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-16-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-17-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
07-18-97	0740	0.005	0.00	0.00	0.00	trace	0.00	trace	0.00
07-19-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-20-97	0840	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-21-97	0705	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-22-97	0720	0.04	0.005	trace	0.00	0.02	0.01	0.03	trace
07-23-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-24-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-25-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-26-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-27-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-28-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-29-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-30-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-31-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-01-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-02-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-03-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-04-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-05-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-06-97	0945	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-07-97	1000	0.05	0.01	trace	trace	0.025	trace	0.04	trace
08-08-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-09-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-10-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-11-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-12-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-13-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-14-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-15-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-16-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-17-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-18-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-19-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-20-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-21-97	1000	0.03	0.005	0.00	0.00	0.015	trace	0.02	0.00
08-22-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-23-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-25-97	1700	0.13	.055	trace	0.04	0.07	0.05	0.08	0.04
08-26-97	1300	0.16	0.08	0.04	0.065	0.08	0.08	0.18	0.08
08-27-97	1400	0.37	0.24	0.30	0.24	0.30	0.28	0.35	0.17
08-29-97	1400	0.02	.012	trace	trace	trace	trace	trace	0.01
08-30-97	1300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-31-97	1400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
09-01-97	1400	0.015	trace	trace	trace	trace	trace	0.01	trace
09-02-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-03-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-04-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-05-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-06-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-07-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-08-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-09-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-10-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-11-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-12-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-13-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-14-97	1400	0.29	0.21	0.10	0.17	0.17	0.20	0.26	0.13
09-15-97	1500	0.13	0.03	0.03	.025	0.05	0.06	0.09	0.045
09-16-97	1500	0.11	0.02	0.04	trace	0.02	0.01	0.02	0.05
09-17-97	1500	0.25	0.07	0.10	0.06	0.10	0.09	0.14	0.10
09-18-97	1500	0.08	0.03	0.03	0.04	0.03	0.03	0.06	0.05
09-19-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-20-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-21-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-22-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-23-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-24-97	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-25-97	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-26-97	1500	0.45	0.30	0.20	0.26	0.33	0.33	0.48	0.25
09-27-97	1600	0.37	0.22	0.22	0.20	0.29	0.25	0.32	0.18
09-28-97	1600	0.14	0.02	0.02	0.02	0.05	0.05	0.07	0.02
09-29-97	1500	trace	trace	trace	trace	trace	trace	trace	trace
09-30-97	1530	0.25	0.14	0.14	0.13	0.14	0.20	0.24	0.12
10-01-97	1545	0.08	0.05	0.02	0.02	0.05	0.05	0.06	0.025
10-03-97	1500	0.23	0.02	0.05	0.02	0.04	0.04	0.08	0.03
10-04-97	1530	0.05	0.28	0.22	0.22	0.35	0.30	0.42	0.20
10-05-97	1500	0.20	0.11	0.10	0.10	0.14	0.15	0.20	0.10
10-06-97	1500	trace	trace	trace	trace	trace	trace	trace	trace
10-07-97	1500	0.02	trace	trace	trace	0.01	trace	0.01	trace
10-08-97	1500	0.14	0.02	0.04	0.01	0.03	0.02	0.03	0.01
10-09-97	1500	0.11	0.03	0.05	trace	0.03	0.01	0.01	0.02
10-10-97	1530	0.02	trace	trace	trace	trace	trace	0.01	trace
10-11-97	1530	0.05	0.01	0.02	trace	0.01	0.02	0.03	0.01
10-12-97	1530	0.02	trace	trace	trace	0.01	trace	0.02	0.02
10-13-97	1530	0.17	0.15	0.10	0.15	0.15	0.11	0.20	0.15

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
10-14-97	1530	0.11	0.08	0.03	0.09	0.09	0.05	0.14	0.08
10-15-97	1500	0.01	0.04	0.02	0.00	0.01	0.01	0.01	0.01
10-16-97	1430	0.08	0.05	0.02	0.02	0.03	0.03	0.10	0.03
10-17-97	1630	trace	0.00	0.00	0.00	0.00	0.00	0.01	0.00
10-18-97	1530	0.00	trace	trace	trace	trace	trace	trace	trace
10-19-97	1530	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-20-97	1530	trace	trace	0.00	trace	trace	0.00	0.00	0.00
10-21-97	1530	0.06	0.02	0.04	0.05	0.03	0.03	0.05	0.03
10-22-97	1530	0.02	trace	trace	0.00	0.00	0.00	trace	trace
10-23-97	1530	trace	trace	trace	0.00	0.00	0.00	0.00	trace
10-24-97	1630	0.00	0.00	0.00	0.00	trace	0.00	0.00	trace
10-25-97	1530	0.05	0.02	trace	0.03	0.03	0.01	0.06	0.02
10-26-97	1530	0.03	0.01	trace	trace	trace	0.01	trace	trace
10-27-97	1530	0.07	0.01	0.02	trace	0.01	0.01	0.06	0.02
10-29-97	1530	1.50	1.25	1.25	0.75	0.75	0.85	0.75	0.75
10-30-97	1530	0.17	0.10	0.07	0.05	0.10	0.12	0.12	0.07
11-01-97	1430	0.02	trace	trace	trace	trace	trace	0.01	0.02
11-02-97	1500	0.00	0.00	0.00	0.00	0.00	trace	0.00	trace
11-03-97	1400	0.16	0.05	0.04	0.01	0.02	0.03	0.05	0.05
11-04-97	1430	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-05-97	1530	0.01	trace	0.00	0.00	trace	0.00	0.01	0.01
11-06-97	1530	0.15	0.05	0.06	0.00	0.06	0.06	0.14	0.07
11-07-97	1530	0.10	0.05	0.08	0.06	0.06	0.05	0.11	0.01
11-08-97	1530	trace	0.00	0.00	0.00	trace	0.00	0.00	trace
11-09-97	1600	trace	0.00	0.00	0.00	0.00	0.00	trace	trace
11-10-97	1530	trace	trace	0.00	0.00	0.00	trace	trace	trace
11-11-97	1630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-12-97	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-13-97	1530	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-14-97	1530	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-15-97	1530	trace	trace	0.00	0.00	0.00	0.00	trace	trace
11-16-97	1530	trace	0.00	0.00	0.00	0.00	0.00	trace	trace
11-17-97	1400	0.15	0.07	0.06	0.03	0.02	0.03	0.10	0.08
11-18-97	1530	0.08	0.03	0.04	0.04	0.06	0.04	0.11	0.05
11-20-97	1530	0.36	0.05	0.08	0.04	0.04	0.04	0.15	0.06
11-21-97	1530	0.01	trace	0.00	0.00	trace	0.00	trace	trace
11-24-97	1330	0.48	0.25	0.17	0.20	0.27	0.25	0.48	0.22
11-25-97	1415	0.10	0.07	0.01	0.05	0.07	0.05	0.10	0.06
11-27-97	1530	0.09	0.07	0.06	0.06	0.05	0.05	0.08	0.05
11-28-97	0930	0.32	0.14	0.18	0.21	0.15	0.24	0.30	0.17
11-29-97	1330	0.17	0.03	0.05	0.05	0.04	0.04	0.09	0.03
11-30-97	1400	trace	0.00	0.00	0.00	0.00	0.00	trace	trace

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
12-01-97	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-02-97	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-03-97	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-04-97	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-05-97	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-06-97	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-07-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-08-97	1030	0.07	trace	0.02	trace	0.05	0.01	0.03	0.01
12-09-97	1630	trace	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-10-97	1000	0.045	0.01	0.01	trace	0.01	trace	0.01	trace
12-11-97	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-12-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-13-97	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-14-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-15-97	1000	0.13	0.05	0.01	0.04	0.05	0.09	0.11	0.06
12-16-97	1000	0.77	0.44	0.54	0.36	0.52	0.45	0.36	0.38
12-17-97	1000	0.50	0.36	0.33	0.32	0.40	0.38	0.48	0.33
12-18-97	1000	0.03	0.01	0.01	trace	0.02	0.02	0.03	0.01
12-19-97	1400	0.07	0.02	0.02	0.01	0.01	0.01	0.02	0.02
12-20-97	1530	0.12	0.03	0.06	trace	0.04	0.02	0.05	0.02
12-21-97	1400	0.17	0.15	0.10	0.13	0.15	0.15	0.16	0.12
12-22-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-23-97	1400	0.09	0.01	0.025	0.01	0.025	0.015	0.02	0.02
12-24-97	1100	trace	trace	trace	trace	trace	trace	trace	trace
12-25-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-26-97	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-27-97	1000	0.24	0.16	0.17	0.14	0.18	0.15	0.15	0.16
12-28-97	0900	0.27	0.19	0.23	0.16	0.23	0.20	0.24	0.19
12-29-97	1100	0.05	0.01	0.025	0.05	0.015	0.01	0.03	0.005
12-30-97	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-31-97	1100	0.01	trace	trace	trace	trace	trace	trace	trace
01-01-98	1500	0.53	0.50	0.33	0.50	0.50	0.42	0.51	0.48
01-02-98	1000	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05
01-03-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-04-98	1500	0.23	0.13	0.09	0.24	0.18	0.21	0.32	0.17
01-05-98	1000	0.29	0.10	0.18	0.07	0.14	0.11	0.14	0.09
01-06-98	1000	0.51	0.35	0.29	0.40	0.44	0.37	0.51	0.40
01-07-98	1000	0.15	0.08	0.09	0.08	0.11	0.10	0.16	0.08
01-08-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-09-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-10-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-11-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-12-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
01-14-98	1000	0.68	0.50	0.40	0.49	0.55	0.50	0.55	0.51
01-15-98	1000	0.57	0.19	0.28	0.13	0.28	0.26	0.35	0.19
01-16-98	1000	0.18	0.06	0.07	0.04	0.09	0.08	0.11	0.06
01-17-98	1000	0.29	0.09	0.05	0.05	0.08	0.15	0.14	0.07
01-18-98	1030	0.03	0.02	0.015	0.01	0.01	0.01	0.01	0.01
01-19-98	1430	0.09	0.01	0.01	0.02	0.02	0.01	0.05	0.02
01-20-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-21-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01-22-98	1500	0.01	trace	trace	trace	trace	trace	trace	trace
01-24-98	1400	0.20	0.05	0.05	0.03	0.09	0.04	0.11	0.06
01-25-98	1530	0.25	0.11	0.17	0.09	0.13	0.14	0.18	0.13
01-26-98	1000	0.09	0.03	0.03	trace	0.015	trace	0.02	0.02
01-27-98	1000	0.04	0.01	trace	0.02	0.02	0.02	0.03	0.02
01-30-98	1000	0.23	0.12	0.09	0.11	0.13	0.08	0.21	0.12
01-31-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-01-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-02-98	0930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-03-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-04-98	1000	0.14	0.07	0.02	0.04	0.05	0.06	0.11	0.03
02-05-98	1400	0.01	trace	trace	trace	trace	trace	trace	trace
02-06-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-07-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-08-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-09-98	1000	0.10	0.02	0.05	0.01	0.03	0.04	0.07	0.02
02-10-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-11-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-12-98	1200	0.03	trace	trace	trace	trace	trace	trace	trace
02-13-98	1400	0.19	0.035	0.06	0.035	0.04	0.05	0.10	0.03
02-14-98	1330	0.04	trace	trace	0.01	trace	trace	0.02	0.01
02-15-98	0900	0.06	0.03	0.01	0.02	0.02	0.03	0.05	0.02
02-16-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-18-98	1000	0.05	trace	0.01	0.00	0.01	trace	0.02	trace
02-19-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-20-98	1000	0.045	0.01	trace	0.01	0.02	0.02	0.03	0.01
02-21-98	1030	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-22-98	0900	0.04	0.00	0.00	0.00	0.10	trace	trace	0.01
02-23-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-24-98	1000	0.05	0.01	0.02	0.00	0.02	0.01	0.03	0.01
02-25-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-26-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02-27-98	1000	0.01	0.00	0.00	0.00	0.00	0.00	0.005	0.00
02-28-98	0900	0.09	0.04	0.03	0.04	0.04	0.08	0.06	0.04

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
03-01-98	0900	0.38	0.17	0.18	0.14	0.18	0.15	0.24	0.18
03-03-98	1000	0.23	0.09	0.08	0.08	0.10	0.10	0.19	0.08
03-04-98	1130	0.16	0.11	0.09	0.10	0.10	0.085	0.17	0.15
03-05-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-06-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-07-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-08-98	0900	0.085	0.02	0.03	trace	0.02	0.01	0.02	0.015
03-09-98	1100	0.05	0.01	0.015	trace	0.015	0.015	0.01	0.005
03-10-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-11-98	1000	0.17	0.03	0.04	0.04	0.05	0.04	0.10	0.15
03-12-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-13-98	1000	0.08	0.02	0.02	0.02	0.03	0.03	0.07	0.04
03-14-98	1000	0.03	0.02	0.02	0.03	0.02	0.03	0.02	0.02
03-15-98	0900	0.04	0.02	trace	0.01	0.02	0.02	0.04	0.02
03-16-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-17-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-18-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-19-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-20-98	1000	0.03	0.01	0.01	trace	trace	0.01	.015	trace
03-21-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-22-98	0900	0.26	0.12	0.10	0.11	0.13	0.14	0.24	0.11
03-23-98	1000	0.23	0.10	0.03	0.09	0.13	0.09	0.23	0.11
03-24-98	1000	0.08	0.04	0.02	0.03	0.03	0.03	0.05	0.04
03-25-98	1000	0.02	0.01	trace	0.01	0.02	0.01	0.03	0.01
03-26-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-27-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-28-98	1000	0.24	0.13	0.10	0.11	0.14	0.18	0.22	0.15
03-29-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-30-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03-31-98	0730	0.28	0.12	0.09	0.13	0.14	0.16	0.225	0.15
04-01-98	1000	0.05	0.03	0.04	0.03	0.04	0.03	0.05	0.03
04-02-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-03-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-04-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-05-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-06-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-07-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-08-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-09-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-10-98	1000	0.07	0.02	trace	0.01	0.02	0.02	0.07	0.01
04-11-98	1000	0.08	0.01	0.01	0.01	0.02	0.01	0.05	0.02
04-12-98	0900	0.05	0.02	0.01	trace	0.05	0.01	0.03	0.01

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
04-13-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-14-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-15-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-16-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-17-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-18-98	1000	0.07	0.04	0.01	0.03	0.04	0.04	0.07	0.03
04-19-98	1000	0.04	0.02	trace	0.01	0.01	0.02	0.03	0.02
04-20-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-21-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-22-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-23-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-24-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-25-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-26-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-27-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-28-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-29-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04-30-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-01-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-02-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-03-98	9000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-04-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-05-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-06-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-07-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-08-98	1000	0.16	0.09	0.03	0.05	0.06	0.08	0.15	0.06
05-09-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-10-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-11-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-12-98	1000	0.02	trace	trace	trace	trace	trace	0.01	trace
05-14-98	1000	0.16	0.02	0.02	0.02	0.03	0.03	0.10	0.03
05-15-98	1000	0.14	0.08	0.07	0.06	0.06	0.10	0.12	0.07
05-16-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-17-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-18-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-19-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-20-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-21-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-22-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-23-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-25-98	1000	0.67	0.44	0.80	0.50	0.31	0.45	0.66	0.44
05-26-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-27-98	1000	1.28	0.75	0.83	0.64	0.62	0.94	1.26	0.64

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
05-28-98	1000	0.05	0.02	0.02	0.02	0.03	0.03	0.05	0.01
05-29-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-30-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05-31-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-01-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-02-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-03-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-04-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-05-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-06-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-07-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-08-98	1000	0.02	trace	0.01	trace	trace	0.01	0.02	0.01
06-09-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-10-98	1000	0.41	0.28	0.25	0.28	0.14	0.27	0.41	0.21
06-11-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-12-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-13-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-14-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-15-98	1000	0.04	0.01	trace	trace	trace	0.01	0.03	0.01
06-16-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-17-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-18-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-19-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-20-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-21-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-22-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-23-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-25-98	1000	0.44	0.22	0.22	0.29	0.17	0.31	0.34	0.29
06-26-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-27-98	1000	0.04	0.02	trace	trace	0.02	0.03	0.03	0.02
06-28-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-29-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06-30-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-01-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-02-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-04-98	1000	0.46	0.20	0.32	0.25	0.17	0.32	0.37	0.17
07-05-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-06-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-07-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-08-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-09-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-10-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
07-11-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-12-98	0900	0.15	0.11	0.07	0.09	0.08	0.12	0.13	0.06
07-13-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-14-98	1000	0.13	0.08	0.04	0.06	0.04	0.08	0.10	0.05
07-15-98	1000	0.11	0.05	0.03	0.03	0.02	0.07	0.07	0.02
07-16-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-17-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-18-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-19-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-20-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-21-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-22-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-23-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-24-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-25-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-26-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-27-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-28-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-29-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07-30-98	1000	0.015	trace	0.00	0.00	0.00	0.00	0.00	0.00
07-31-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-01-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-02-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-03-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-04-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-05-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-06-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-07-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-08-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-09-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-10-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-11-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-12-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-13-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-14-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-15-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-16-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-17-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-18-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-19-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-20-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
08-21-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-22-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-23-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-24-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-25-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-26-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-27-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-28-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-29-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-30-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
08-31-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-01-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-02-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-03-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-04-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-05-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-06-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-07-98	1000	0.04	trace	0.00	trace	0.00	0.00	0.02	trace
09-08-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-09-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-10-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-11-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-12-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-13-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-14-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-15-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-16-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-17-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-18-98	1000	0.19	0.10	0.05	0.08	0.10	0.10	0.16	0.09
09-19-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-20-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-21-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-22-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-23-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-24-98	1000	0.05	0.01	0.01	0.02	0.03	0.01	0.04	0.02
09-25-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-26-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-27-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-28-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-29-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09-30-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 16. Precipitation and throughfall in a predominantly evergreen forest located on Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

Date	Time	Precip-itation (inches) (#1)	Throughfall under forest canopy at indicated gage number (inches)						
			(#2)	(#3)	(#4)	(#5)	(#6)	(#7)	(#8)
10-01-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-02-98	1000	0.14	0.04	0.03	0.05	0.06	0.07	0.10	0.04
10-03-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-04-98	0900	0.08	0.04	trace	0.02	0.03	0.02	0.05	0.02
10-05-98	1000	0.08	0.04	trace	0.02	0.03	0.02	0.05	0.02
10-06-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-07-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-08-98	1000	0.04	0.03	0.00	trace	0.03	trace	0.03	0.01
10-09-98	1000	0.08	0.04	0.01	0.03	0.04	0.025	0.05	0.02
10-10-98	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-11-98	0900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-12-98	1000	0.21	0.04	0.03	0.025	0.06	0.03	0.14	0.03
10-13-98	1000	0.09	0.01	0.01	trace	0.02	0.01	0.03	0.01
10-14-98	0900	0.30	0.15	0.19	0.16	0.18	0.20	0.26	0.15

[1]Value subject to large error due to heavy snow storm during this period.

Table 17. Monthly water-budget components for the L1 study basin, Lopez Island, San Juan County, Washington, water years 1997-98

[**PRECP**, measured precipitation; **POTET**, potential evapotranspiration (may be less than sum of evaporation and transpiration components, as discussed in report); **CHGINT**, change in moisture stored on foliage (zero for cells with land cover for which throughfall data are used); **RUNOFF**; measured or estimated direct runoff; **RECHRG**; soil water that percolates below the root zone (recharge); **SOLPEV**, potential soil evaporation over bare soil areas (none in this investigation); **ACTSEV**, actual bare-soil evaporation; **SNWEVP**, direct evaporation of snow; **PPLTR**, foliage-type-dependent potential transpiration; **APLTR**, actual plant transpiration; **CHGSM**, change in soil moisture; **EVINT**, interception loss computed from input precipitation throughfall, and DPM-simulated throughfall where land use is not evergreen forest; **CHGSNW**, change in snowpack; **AVTMP**, average temperature; **DEFCIT**, if the following is negative: rain + snowmelt + starting soil moisture in excess of available water-holding capacity - evaporation and transpiration components - observed direct runoff; if the following is positive: rain + snowmelt - (available water-holding capacity + specific yield - starting soil moisture) - observed direct runoff - recharge. All values in inches of water except AVTMP, which is in degrees Farenheit. All values rounded to two significant figures. Because of rounding totals may not exactly equal the sum of the shown monthly values]

DATE		PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Year**	**Water Year 1997**														
October	1996	3.48	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.68	2.11	0.69	0.00	50.2	0.00
November	1996	4.59	0.44	0.02	0.00	0.04	0.00	0.00	0.00	0.10	0.10	3.84	0.59	0.00	43.2	0.00
December	1996	3.45	0.32	0.00	0.36	0.44	0.00	0.00	0.08	0.02	0.02	1.75	0.79	0.00	37.9	0.00
January	1997	3.94	0.40	-0.01	3.28	0.76	0.00	0.00	0.00	0.07	0.07	-0.77	0.61	0.00	41.5	0.00
February	1997	2.91	0.73	-0.01	1.33	0.76	0.00	0.00	0.00	0.31	0.31	0.02	0.50	0.00	42.6	0.00
March	1997	2.60	1.36	0.00	0.54	0.83	0.00	0.00	0.00	0.63	0.63	-0.17	0.77	0.00	44.5	0.00
April	1997	1.75	2.89	0.00	0.02	0.29	0.01	0.01	0.00	1.87	1.86	-1.10	0.68	0.00	49.1	0.00
May	1997	2.06	4.45	0.01	0.00	0.11	0.00	0.00	0.00	3.17	2.91	-1.57	0.60	0.00	55.5	0.00
June	1997	1.72	4.96	-0.01	0.00	0.02	0.00	0.00	0.00	3.66	2.89	-1.71	0.53	0.00	57.1	0.00
July	1997	0.98	5.53	0.00	0.00	0.02	0.00	0.00	0.00	4.43	2.69	-2.06	0.32	0.00	59.5	0.00
August	1997	0.60	5.05	0.00	0.00	0.01	0.00	0.00	0.00	4.20	1.44	-1.03	0.18	0.00	62.2	0.00
September	1997	1.96	3.15	0.02	0.00	0.01	0.01	0.00	0.00	2.18	0.78	0.35	0.79	0.00	59.3	0.00
Totals		30.04	30.54	0.02	5.53	3.29	0.03	0.02	0.08	21.36	14.38	-0.33	7.05	0.00	50.3	0.00
Month	**Year**	**Water Year 1998**														
October	1997	4.16	1.28	-0.01	0.00	0.01	0.00	0.00	0.00	0.48	0.48	2.68	1.00	0.00	51.6	0.00
November	1997	2.02	0.65	0.01	0.00	0.01	0.00	0.00	0.00	0.26	0.26	1.08	0.65	0.00	48.5	0.00
December	1997	2.79	0.35	-0.01	0.01	0.11	0.00	0.00	0.00	0.12	0.12	2.01	0.55	0.00	43.5	0.00
January	1998	3.09	0.40	-0.01	0.38	0.52	0.00	0.00	0.00	0.06	0.06	1.51	0.63	0.00	42.2	0.00
February	1998	0.72	0.70	0.03	0.00	0.40	0.00	0.00	0.00	0.32	0.32	-0.44	0.41	0.00	46.7	0.00
March	1998	2.60	1.60	0.00	0.10	0.61	0.00	0.00	0.00	0.81	0.81	0.14	0.93	0.00	47.0	0.00
April	1998	0.37	3.23	-0.02	0.02	0.21	0.01	0.00	0.00	2.41	2.37	-2.49	0.27	0.00	49.7	0.00
May	1998	2.17	3.65	0.00	0.00	0.12	0.00	0.00	0.00	2.63	2.39	-0.98	0.63	0.00	53.5	0.01
June	1998	1.11	4.77	0.00	0.00	0.03	0.00	0.00	0.00	3.69	2.72	-2.00	0.36	0.00	56.8	0.00
July	1998	1.28	5.21	0.00	0.00	0.02	0.00	0.00	0.00	4.16	2.18	-1.31	0.38	0.00	60.0	0.00
August	1998	0.06	5.46	0.00	0.00	0.01	0.01	0.00	0.00	4.61	1.10	-1.10	0.05	0.00	60.6	0.00
September	1998	0.18	3.65	0.00	0.00	0.01	0.01	0.00	0.00	3.02	0.36	-0.32	0.13	0.00	58.3	0.00
Totals		20.54	30.95	-0.02	0.52	2.06	0.03	0.02	0.00	22.57	13.17	-1.20	5.99	0.00	51.6	0.02

Table 17. Monthly water-budget components for the L1 study basin, Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

DATE	PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Average monthly values**														
October	3.82	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.58	2.39	0.85	0.00	50.9	0.00
November	3.31	0.54	0.02	0.00	0.02	0.00	0.00	0.00	0.18	0.18	2.46	0.62	0.00	45.8	0.00
December	3.12	0.33	-0.01	0.19	0.28	0.00	0.00	0.04	0.07	0.07	1.88	0.67	0.00	40.7	0.00
January	3.51	0.40	-0.01	1.83	0.64	0.00	0.00	0.00	0.07	0.07	0.37	0.62	0.00	41.8	0.00
February	1.81	0.72	0.01	0.67	0.58	0.00	0.00	0.00	0.32	0.32	-0.21	0.45	0.00	44.6	0.00
March	2.60	1.48	0.00	0.32	0.72	0.00	0.00	0.00	0.72	0.72	-0.01	0.85	0.00	45.7	0.00
April	1.06	3.06	-0.01	0.02	0.25	0.01	0.01	0.00	2.14	2.11	-1.79	0.48	0.00	49.4	0.00
May	2.12	4.05	0.00	0.00	0.11	0.00	0.00	0.00	2.90	2.65	-1.27	0.61	0.00	54.5	0.01
June	1.41	4.87	0.00	0.00	0.02	0.00	0.00	0.00	3.68	2.80	-1.85	0.44	0.00	57.0	0.00
July	1.13	5.37	0.00	0.00	0.02	0.00	0.00	0.00	4.29	2.44	-1.68	0.35	0.00	59.7	0.00
August	0.33	5.25	0.00	0.00	0.01	0.00	0.00	0.00	4.40	1.27	-1.06	0.12	0.00	61.4	0.00
September	1.07	3.40	0.01	0.00	0.01	0.01	0.00	0.00	2.60	0.57	0.02	0.46	0.00	58.8	0.00
Totals	25.29	30.74	0.00	3.02	2.67	0.03	0.02	0.04	21.97	13.77	-0.77	6.52	0.00	50.9	0.01

Table 18. Monthly water-budget components for the L2 study basin, Lopez Island, San Juan County, Washington, water years 1997-98

[**PRECP**, measured precipitation; **POTET**, potential evapotranspiration (may be less than sum of evaporation and transpiration components, as discussed in report); **CHGINT**, change in moisture stored on foliage (zero for cells with land cover for which throughfall data are used); **RUNOFF**; measured or estimated direct runoff; **RECHRG**; soil water that percolates below the root zone (recharge); **SOLPEV**, potential soil evaporation over bare soil areas (none in this investigation); **ACTSEV**, actual bare-soil evaporation; **SNWEVP**, direct evaporation of snow; **PPLTR**, foliage-type-dependent potential transpiration; **APLTR**, actual plant transpiration; **CHGSM**, change in soil moisture; **EVINT**, interception loss computed from input precipitation throughfall, and DPM-simulated throughfall where land use is not evergreen forest; **CHGSNW**, change in snowpack; **AVTMP**, average temperature; **DEFCIT**, if the following is negative: rain + snowmelt + starting soil moisture in excess of available water-holding capacity - evaporation and transpiration components - observed direct runoff; if the following is positive: rain + snowmelt - (available water-holding capacity + specific yield - starting soil moisture) - observed direct runoff - recharge. All values in inches of water except AVTMP, which is in degrees Farenheit. All values rounded to two significant figures. Because of rounding totals may not exactly equal the sum of the shown monthly values]

DATE		PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Year**	**Water Year 1997**														
October	1996	3.51	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.89	0.73	2.10	0.67	0.00	50.2	0.00
November	1996	4.54	0.52	0.04	0.00	0.24	0.00	0.00	0.00	0.10	0.10	3.67	0.49	0.00	43.2	0.00
December	1996	2.98	0.34	-0.01	0.42	0.59	0.00	0.00	0.01	0.01	0.01	1.49	0.47	0.00	37.9	0.00
January	1997	4.71	0.43	-0.02	3.92	0.73	0.00	0.00	0.00	0.03	0.03	-0.43	0.51	0.00	41.5	-0.04
February	1997	2.87	0.84	-0.02	2.06	0.58	0.00	0.00	0.00	0.33	0.33	-0.52	0.48	0.00	42.5	-0.03
March	1997	2.52	1.57	0.00	0.97	0.40	0.00	0.00	0.00	0.74	0.74	-0.03	0.72	0.00	44.5	-0.28
April	1997	1.78	3.41	0.00	0.22	0.02	0.01	0.00	0.00	2.31	2.21	-1.21	0.66	0.00	49.1	-0.13
May	1997	2.26	5.45	0.00	0.02	0.02	0.00	0.00	0.00	3.99	2.78	-1.24	0.70	0.00	55.5	-0.01
June	1997	1.75	6.10	0.00	0.00	0.04	0.00	0.00	0.00	4.66	2.61	-1.50	0.60	0.00	57.0	0.00
July	1997	0.90	6.87	0.00	0.00	0.04	0.00	0.00	0.00	5.80	2.20	-1.65	0.31	0.00	59.4	0.00
August	1997	0.53	6.38	0.00	0.00	0.04	0.00	0.00	0.00	5.67	1.06	-0.75	0.19	0.00	62.2	0.00
September	1997	2.02	3.96	0.03	0.00	0.02	0.01	0.00	0.00	2.99	0.67	0.48	0.82	0.00	59.3	0.00
Totals		30.37	37.42	0.03	7.61	2.71	0.03	0.02	0.02	27.52	13.46	0.40	6.61	0.00	50.2	-0.50
Month	**Year**	**Water Year 1998**														
October	1997	4.27	1.59	-0.02	0.00	0.02	0.00	0.00	0.00	0.57	0.54	2.65	1.07	0.00	51.6	0.00
November	1997	.00	0.82	0.02	0.00	0.11	0.00	0.00	0.00	0.31	0.31	1.00	0.56	0.00	48.5	0.00
December	1997	2.98	0.41	-0.03	0.00	0.36	0.00	0.00	0.00	0.12	0.12	2.13	0.40	0.00	43.5	0.00
January	1998	3.03	0.47	-0.01	0.15	0.56	0.00	0.00	0.00	0.05	0.05	1.78	0.49	0.00	42.2	0.00
February	1998	0.68	0.86	0.04	0.15	0.41	0.00	0.00	0.00	0.41	0.41	-0.71	0.39	0.00	46.7	0.00
March	1998	.67	1.88	-0.01	0.25	0.55	0.00	0.00	0.00	1.00	0.99	0.08	0.80	0.00	46.9	0.00
April	1998	0.34	3.84	-0.03	0.03	0.30	0.01	0.00	0.00	2.96	2.67	-2.92	0.29	0.00	49.6	0.00
May	1998	2.05	4.44	0.00	0.00	0.23	0.00	0.00	0.00	3.31	2.29	-1.02	0.55	0.00	53.5	0.00
June	1998	1.11	5.86	0.00	0.00	0.21	0.00	0.00	0.00	4.73	2.33	-1.74	0.31	0.00	56.8	0.00
July	1998	1.47	6.50	0.00	0.00	0.04	0.00	0.00	0.00	5.45	1.97	-0.94	0.39	0.00	60.0	0.00
August	1998	0.07	6.82	0.00	0.00	0.04	0.01	0.00	0.00	6.17	1.06	-1.10	0.07	0.00	60.5	0.00
September	1998	0.21	4.56	0.00	0.00	0.04	0.01	0.00	0.00	4.09	0.40	-0.40	0.17	0.00	58.3	0.00
Totals		20.88	38.06	-0.03	0.58	2.86	0.03	0.01	0.00	29.14	13.14	-1.18	5.48	0.00	51.5	0.01

Table 18. Monthly water-budget components for the L2 study basin, Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

DATE	PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Average monthly values**														
October	3.89	1.58	-0.01	0.00	0.01	0.00	0.00	0.00	0.73	0.64	2.38	0.87	0.00	50.9	0.00
November	3.27	0.67	0.03	0.00	0.17	0.00	0.00	0.00	0.20	0.20	2.34	0.52	0.00	45.8	0.00
December	2.98	0.38	-0.02	0.21	0.47	0.00	0.00	0.01	0.07	0.07	1.81	0.43	0.00	40.7	0.00
January	3.87	0.45	-0.01	2.04	0.64	0.00	0.00	0.00	0.04	0.04	0.68	0.50	0.00	41.8	-0.02
February	1.78	0.85	0.01	1.10	0.49	0.00	0.00	0.00	0.37	0.37	-0.62	0.43	0.00	44.6	-0.02
March	2.60	1.73	0.00	0.61	0.48	0.00	0.00	0.00	0.87	0.87	0.02	0.76	0.00	45.7	-0.14
April	1.06	3.63	-0.02	0.13	0.16	0.01	0.00	0.00	2.64	2.44	-2.06	0.47	0.00	49.4	-0.06
May	2.16	4.94	0.00	0.01	0.12	0.00	0.00	0.00	3.65	2.53	-1.13	0.62	0.00	54.5	0.00
June	1.43	5.98	0.00	0.00	0.12	0.00	0.00	0.00	4.69	2.47	-1.62	0.46	0.00	56.9	0.00
July	1.19	6.68	0.00	0.00	0.04	0.00	0.00	0.00	5.63	2.09	-1.30	0.35	0.00	59.7	0.00
August	0.30	6.60	0.00	0.00	0.04	0.00	0.00	0.00	5.92	1.06	-0.93	0.13	0.00	61.3	0.00
September	1.12	4.26	0.01	0.00	0.03	0.01	0.00	0.00	3.54	0.53	0.04	0.50	0.00	58.8	0.00
Totals	25.63	37.74	0.00	4.10	2.78	0.03	0.01	0.01	28.33	13.30	-0.39	6.05	0.00	50.9	-0.24

Table 19. Monthly water-budget components for the L3 study basin, Lopez Island, San Juan County, Washington, water year 1997-98

[**PRECP**, measured precipitation; **POTET**, potential evapotranspiration (may be less than sum of evaporation and transpiration components, as discussed in report); **CHGINT**, change in moisture stored on foliage (zero for cells with land cover for which throughfall data are used); **RUNOFF**; measured or estimated direct runoff; **RECHRG**; soil water that percolates below the root zone (recharge); **SOLPEV**, potential soil evaporation over bare soil areas (none in this investigation); **ACTSEV**, actual bare-soil evaporation; **SNWEVP**, direct evaporation of snow; **PPLTR**, foliage-type-dependent potential transpiration; **APLTR**, actual plant transpiration; **CHGSM**, change in soil moisture; **EVINT**, interception loss computed from input precipitation throughfall, and DPM-simulated throughfall where land use is not evergreen forest; **CHGSNW**, change in snowpack; **AVTMP**, average temperature; **DEFCIT**, if the following is negative: rain + snowmelt + starting soil moisture in excess of available water-holding capacity - evaporation and transpiration components - observed direct runoff; if the following is positive: rain + snowmelt - (available water-holding capacity + specific yield - starting soil moisture) - observed direct runoff - recharge. All values in inches of water except AVTMP, which is in degrees Farenheit. All values rounded to two significant figures. Because of rounding totals may not exactly equal the sum of the shown monthly values]

DATE		PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Year**	**Water Year 1997**														
October	1996	3.33	3.00	0.00	0.00	0.00	0.00	0.00	0.00	2.51	1.03	1.76	0.54	0.00	50.2	0.00
November	1996	4.56	0.97	0.01	0.36	0.04	0.00	0.00	0.00	0.53	0.33	3.16	0.65	0.00	43.2	0.00
December	1996	3.49	0.54	0.00	1.46	0.08	0.00	0.00	0.06	0.16	0.14	0.80	0.95	0.00	38.0	0.00
January	1997	3.34	0.77	-0.01	5.43	0.07	0.00	0.00	0.00	0.43	0.39	-2.85	0.50	0.00	41.5	-0.19
February	1997	2.85	1.64	0.00	1.51	0.04	0.00	0.00	0.00	1.22	0.94	0.33	0.43	0.00	42.5	-0.40
March	1997	2.54	3.07	0.00	0.78	0.07	0.00	0.00	0.00	2.28	1.25	-0.37	0.81	0.00	44.5	0.00
April	1997	1.69	6.49	0.00	0.17	0.01	0.00	0.00	0.00	5.40	1.84	-0.90	0.65	0.00	49.0	-0.09
May	1997	1.95	10.26	0.00	0.03	0.00	0.00	0.00	0.00	8.87	2.11	-0.72	0.55	0.00	55.4	-0.03
June	1997	1.71	11.42	0.00	0.01	0.00	0.00	0.00	0.00	10.03	2.06	-0.80	0.44	0.00	56.9	-0.01
July	1997	0.99	12.85	0.00	0.00	0.00	0.00	0.00	0.00	11.58	1.60	-0.91	0.30	0.00	59.3	0.00
August	1997	0.61	11.95	0.00	0.00	0.00	0.00	0.00	0.00	10.92	0.55	-0.09	0.15	0.00	62.1	0.00
September	1997	1.93	7.42	0.00	0.00	0.00	0.00	0.00	0.00	6.41	0.61	0.53	0.78	0.00	59.2	0.00
Totals		28.98	70.37	0.00	9.76	0.31	0.02	0.01	0.06	60.33	12.88	-0.08	6.76	0.00	50.2	-0.73
Month	**Year**	**Water Year 1998**														
October	1997	4.12	3.06	0.00	0.00	0.01	0.00	0.00	0.00	2.34	0.86	2.40	0.86	0.00	51.5	0.00
November	1997	1.98	1.60	0.00	0.01	0.06	0.00	0.00	0.00	1.18	0.54	0.67	0.69	0.00	48.5	0.00
December	1997	2.65	0.77	0.00	0.18	0.06	0.00	0.00	0.00	0.52	0.33	1.47	0.60	0.00	43.4	0.00
January	1998	3.01	0.85	0.00	1.16	0.07	0.00	0.00	0.00	0.42	0.33	0.77	0.68	0.00	42.2	0.00
February	1998	0.69	1.69	0.00	0.57	0.06	0.00	0.00	0.00	1.31	0.76	-1.12	0.41	0.00	46.6	0.00
March	1998	2.53	3.63	0.00	0.49	0.07	0.00	0.00	0.00	2.75	1.07	-0.16	1.06	0.00	46.9	0.00
April	1998	0.38	7.29	0.00	0.12	0.06	0.01	0.00	0.00	6.37	1.94	-2.01	0.26	0.00	49.6	0.00
May	1998	2.20	8.36	0.00	0.02	0.00	0.00	0.00	0.00	7.18	1.89	-0.47	0.76	0.00	53.4	0.00
June	1998	1.07	10.95	0.00	0.00	0.00	0.00	0.00	0.00	9.71	2.10	-1.38	0.34	0.00	56.7	0.00
July	1998	1.23	12.15	0.00	0.00	0.00	0.00	0.00	0.00	10.96	1.47	-0.55	0.30	0.00	59.9	0.00
August	1998	0.06	12.73	0.00	0.00	0.00	0.00	0.00	0.00	11.66	0.47	-0.46	0.05	0.00	60.4	0.00
September	1998	0.17	8.57	0.00	0.00	0.00	0.01	0.00	0.00	7.82	0.14	-0.08	0.11	0.00	58.2	0.00
Totals		20.07	71.64	0.00	2.54	0.40	0.02	0.01	0.00	62.21	11.92	-0.93	6.12	0.00	51.5	0.00

Table 19. Monthly water-budget components for the L3 study basin, Lopez Island, San Juan County, Washington, 1997-98—*Continued*

DATE	PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	Average monthly values														
October	3.73	3.03	0.00	0.00	0.00	0.00	0.00	0.00	2.42	0.94	2.08	0.70	0.00	50.9	0.00
November	3.27	1.28	0.00	0.18	0.05	0.00	0.00	0.00	0.85	0.44	1.92	0.67	0.00	45.8	0.00
December	3.07	0.66	0.00	0.82	0.07	0.00	0.00	0.03	0.34	0.24	1.14	0.77	0.00	40.7	0.00
January	3.17	0.81	0.00	3.30	0.07	0.00	0.00	0.00	0.43	0.36	-1.04	0.59	0.00	41.9	-0.10
February	1.77	1.66	0.00	1.04	0.05	0.00	0.00	0.00	1.26	0.85	-0.40	0.42	0.00	44.6	-0.20
March	2.53	3.35	0.00	0.63	0.07	0.00	0.00	0.00	2.51	1.16	-0.27	0.94	0.00	45.7	0.00
April	1.03	6.89	0.00	0.15	0.04	0.00	0.00	0.00	5.88	1.89	-1.46	0.46	0.00	49.3	-0.05
May	2.07	9.31	0.00	0.03	0.00	0.00	0.00	0.00	8.03	2.00	-0.60	0.66	0.00	54.4	-0.02
June	1.39	11.18	0.00	0.01	0.00	0.00	0.00	0.00	9.87	2.08	-1.09	0.39	0.00	56.8	-0.01
July	1.11	12.50	0.00	0.00	0.00	0.00	0.00	0.00	11.27	1.54	-0.73	0.30	0.00	59.6	0.00
August	0.34	12.34	0.00	0.00	0.00	0.00	0.00	0.00	11.29	0.51	-0.27	0.10	0.00	61.3	0.00
September	1.05	7.99	0.00	0.00	0.00	0.00	0.00	0.00	7.11	0.38	0.22	0.45	0.00	58.7	0.00
Totals	24.53	71.00	0.00	6.15	0.35	0.02	0.01	0.03	61.27	12.40	-0.50	6.44	0.00	50.8	-0.37

Table 20. Monthly water-budget components for the SJ1 study basin, San Juan Island, San Juan County, Washington, water years 1997-98

[**PRECP**, measured precipitation; **POTET**, potential evapotranspiration (may be less than sum of evaporation and transpiration components, as discussed in report); **CHGINT**, change in moisture stored on foliage (zero for cells with land cover for which throughfall data are used); **RUNOFF**; measured or estimated direct runoff; **RECHRG**; soil water that percolates below the root zone (recharge); **SOLPEV**, potential soil evaporation over bare soil areas (none in this investigation); **ACTSEV**, actual bare-soil evaporation; **SNWEVP**, direct evaporation of snow; **PPLTR**, foliage-type-dependent potential transpiration; **APLTR**, actual plant transpiration; **CHGSM**, change in soil moisture; **EVINT**, interception loss computed from input precipitation throughfall, and DPM-simulated throughfall where land use is not evergreen forest; **CHGSNW**, change in snowpack; **AVTMP**, average temperature; **DEFCIT**, if the following is negative: rain + snowmelt + starting soil moisture in excess of available water-holding capacity - evaporation and transpiration components - observed direct runoff; if the following is positive: rain + snowmelt - (available water-holding capacity + specific yield - starting soil moisture) - observed direct runoff - recharge. All values in inches of water except AVTMP, which is in degrees Farenheit. All values rounded to two significant figures. Because of rounding totals may not exactly equal the sum of the shown monthly values]

DATE		PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Year**	**Water Year 1997**														
October	1996	4.76	1.16	0.00	0.01	0.03	0.02	0.02	0.00	0.64	0.64	2.83	1.22	0.00	50.2	0.00
November	1996	5.28	0.41	0.00	1.06	0.08	0.01	0.01	0.00	0.12	0.12	1.80	0.92	0.00	43.1	1.27
December	1996	5.40	0.31	0.00	2.20	0.08	0.00	0.00	0.08	0.05	0.05	0.47	2.01	0.00	37.8	0.46
January	1997	5.44	0.41	0.00	7.22	0.08	0.01	0.01	0.00	0.11	0.11	-2.98	1.26	0.00	41.5	-0.25
February	1997	3.67	0.78	0.00	2.40	0.07	0.01	0.01	0.00	0.38	0.38	0.26	0.77	0.00	42.6	-0.23
March	1997	3.63	1.43	0.00	2.22	0.08	0.02	0.02	0.00	0.63	0.63	-0.66	1.32	0.00	44.6	0.00
April	1997	2.22	2.89	0.00	0.56	0.01	0.05	0.02	0.00	1.71	1.71	-0.46	0.84	0.00	49.2	-0.46
May	1997	2.13	4.09	0.00	0.13	0.00	0.02	0.00	0.00	2.71	2.00	-0.41	0.52	0.00	55.6	-0.13
June	1997	1.71	4.52	0.00	0.07	0.00	0.00	0.00	0.00	3.12	2.03	-0.72	0.40	0.00	57.2	-0.07
July	1997	1.24	4.89	0.00	0.03	0.00	0.00	0.00	0.00	3.56	1.47	-0.62	0.38	0.00	59.5	-0.03
August	1997	0.90	4.31	0.00	0.00	0.00	0.03	0.01	0.00	3.14	0.38	0.26	0.24	0.00	62.2	0.00
September	1997	1.93	2.73	0.00	0.00	0.00	0.04	0.01	0.00	1.73	0.69	0.47	0.74	0.00	59.3	0.00
Totals		38.31	27.94	0.00	15.90	0.43	0.22	0.10	0.08	17.91	10.20	0.25	10.62	0.00	50.3	0.54
Month	**Year**	**Water Year 1998**														
October	1997	4.02	1.16	0.00	0.09	0.01	0.02	0.02	0.00	0.55	0.55	2.27	1.10	0.00	51.6	-0.03
November	1997	2.52	0.57	0.00	0.33	0.08	0.01	0.01	0.00	0.28	0.28	0.71	1.09	0.00	48.6	0.00
December	1997	3.18	0.33	0.00	1.37	0.08	0.01	0.01	0.00	0.13	0.13	0.66	0.92	0.00	43.5	0.00
January	1998	4.13	0.39	0.00	3.25	0.08	0.01	0.01	0.00	0.07	0.07	-0.57	1.26	0.00	42.1	0.00
February	1998	1.25	0.68	0.00	0.71	0.08	0.01	0.01	0.00	0.30	0.30	-0.64	0.77	0.00	46.7	0.00
March	1998	2.90	1.63	0.00	0.55	0.08	0.03	0.02	0.00	0.78	0.78	0.18	1.25	0.00	47.0	0.00
April	1998	0.39	3.17	0.00	0.18	0.05	0.05	0.01	0.00	2.20	2.19	-2.26	0.23	0.00	49.7	0.00
May	1998	2.56	3.41	0.00	0.04	0.00	0.02	0.00	0.00	2.25	1.63	0.10	0.80	0.00	53.6	-0.03
June	1998	1.50	4.34	0.00	0.02	0.00	0.00	0.00	0.00	3.02	1.78	-0.82	0.52	0.00	57.0	-0.02
July	1998	0.92	4.57	0.00	0.05	0.00	0.00	0.00	0.00	3.31	0.99	-0.39	0.32	0.00	60.1	-0.05
August	1998	0.01	4.78	0.00	0.01	0.00	0.04	0.00	0.00	3.54	0.14	-0.13	0.01	0.00	60.7	-0.01
September	1998	0.17	3.20	0.00	0.00	0.00	0.05	0.00	0.00	2.29	0.06	0.01	0.09	0.00	58.4	0.00
Totals		23.54	28.22	0.00	6.60	0.47	0.23	0.08	0.00	18.72	8.90	-0.88	8.36	0.00	51.6	-0.13

Table 20. Monthly water-budget components for the SJ1 study basin, San Juan Island, San Juan County, Washington, water years 1997-98—*Continued*

DATE	PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Average monthly values**														
October	4.39	1.16	0.00	0.05	0.02	0.02	0.02	0.00	0.59	0.59	2.55	1.16	0.00	50.9	-0.01
November	3.90	0.49	0.00	0.69	0.08	0.01	0.01	0.00	0.20	0.20	1.26	1.01	0.00	45.8	0.63
December	4.29	0.32	0.00	1.79	0.08	0.00	0.00	0.04	0.09	0.09	0.56	1.47	0.00	40.7	0.23
January	4.78	0.40	0.00	5.24	0.08	0.01	0.01	0.00	0.09	0.09	-1.78	1.26	0.00	41.8	-0.13
February	2.46	0.73	0.00	1.55	0.07	0.01	0.01	0.00	0.34	0.34	-0.19	0.77	0.00	44.7	-0.11
March	3.27	1.53	0.00	1.39	0.08	0.02	0.02	0.00	0.71	0.71	-0.24	1.29	0.00	45.8	0.00
April	1.31	3.03	0.00	0.37	0.03	0.05	0.01	0.00	1.96	1.95	-1.36	0.53	0.00	49.5	-0.23
May	2.34	3.75	0.00	0.09	0.00	0.02	0.00	0.00	2.48	1.82	-0.15	0.66	0.00	54.6	-0.08
June	1.60	4.43	0.00	0.04	0.00	0.00	0.00	0.00	3.07	1.91	-0.77	0.46	0.00	57.1	-0.04
July	1.08	4.73	0.00	0.04	0.00	0.00	0.00	0.00	3.44	1.23	-0.50	0.35	0.00	59.8	-0.04
August	0.45	4.54	0.00	0.01	0.00	0.03	0.00	0.00	3.34	0.26	0.07	0.13	0.00	61.5	-0.01
September	1.05	2.96	0.00	0.00	0.00	0.05	0.01	0.00	2.01	0.37	0.24	0.42	0.00	58.9	0.00
Totals	30.92	28.08	0.00	11.25	0.45	0.23	0.09	0.04	18.31	9.55	-0.31	9.49	0.00	50.9	0.21

Table 21. Monthly water-budget components for the OR1 study basin, Orcas Island, San Juan County, Washington, water years 1997-98

[**PRECP**, measured precipitation; **POTET**, potential evapotranspiration (may be less than sum of evaporation and transpiration components, as discussed in report); **CHGINT**, change in moisture stored on foliage (zero for cells with land cover for which throughfall data are used); **RUNOFF**; measured or estimated direct runoff; **RECHRG**; soil water that percolates below the root zone (recharge); **SOLPEV**, potential soil evaporation over bare soil areas (none in this investigation); **ACTSEV**, actual bare-soil evaporation; **SNWEVP**, direct evaporation of snow; **PPLTR**, foliage-type-dependent potential transpiration; **APLTR**, actual plant transpiration; **CHGSM**, change in soil moisture; **EVINT**, interception loss computed from input precipitation throughfall, and DPM-simulated throughfall where land use is not evergreen forest; **CHGSNW**, change in snowpack; **AVTMP**, average temperature; **DEFCIT**, if the following is negative: rain + snowmelt + starting soil moisture in excess of available water-holding capacity - evaporation and transpiration components - observed direct runoff; if the following is positive: rain + snowmelt - (available water-holding capacity + specific yield - starting soil moisture) - observed direct runoff - recharge. All values in inches of water except AVTMP, which is in degrees Farenheit. All values rounded to two significant figures. Because of rounding totals may not exactly equal the sum of the shown monthly values]

DATE		PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Year**	**Water Year 1997**														
October	1996	4.33	1.15	0.00	0.01	0.00	0.03	0.02	0.00	0.64	0.64	2.47	1.17	0.00	50.3	0.00
November	1996	4.81	0.40	0.00	1.08	0.05	0.01	0.01	0.00	0.12	0.12	2.62	0.86	0.00	43.1	0.06
December	1996	4.92	0.31	0.00	2.10	0.08	0.01	0.01	0.08	0.05	0.05	0.41	1.91	0.00	37.7	0.24
January	1997	4.95	0.41	0.00	6.44	0.04	0.01	0.01	0.00	0.11	0.11	-1.49	1.19	0.00	41.5	-1.37
February	1997	3.35	0.79	0.00	2.56	0.05	0.02	0.02	0.00	0.40	0.40	-0.28	0.71	0.00	42.6	-0.13
March	1997	3.31	1.45	0.00	1.78	0.05	0.03	0.03	0.00	0.67	0.67	-0.37	1.16	0.00	44.6	-0.04
April	1997	2.02	2.93	0.00	0.40	0.00	0.06	0.03	0.00	1.75	1.75	-0.54	0.73	0.00	49.3	-0.38
May	1997	1.94	4.08	0.00	0.16	0.00	0.03	0.00	0.00	2.73	2.60	-1.07	0.39	0.00	55.7	-0.16
June	1997	1.56	4.52	0.00	0.05	0.00	0.00	0.00	0.00	3.13	2.71	-1.48	0.32	0.00	57.3	-0.05
July	1997	1.13	4.87	0.00	0.01	0.00	0.00	0.00	0.00	3.50	1.92	-1.12	0.32	0.00	59.7	-0.01
August	1997	0.82	4.24	0.00	0.00	0.00	0.04	0.01	0.00	3.04	0.63	-0.05	0.23	0.00	62.3	0.00
September	1997	1.76	2.71	0.00	0.00	0.00	0.06	0.02	0.00	1.71	0.64	0.44	0.65	0.00	59.4	0.00
Totals		34.90	27.87	0.00	14.60	0.28	0.29	0.15	0.08	17.85	12.26	-0.47	9.65	0.00	50.3	-1.84
Month	**Year**	**Water Year 1998**														
October	1997	3.67	1.14	0.00	0.00	0.00	0.03	0.03	0.00	0.55	0.55	2.05	1.02	0.00	51.7	0.00
November	1997	2.29	0.56	0.00	0.03	0.01	0.01	0.01	0.00	0.28	0.28	0.92	1.02	0.00	48.6	0.00
December	1997	2.90	0.33	0.00	0.68	0.03	0.01	0.01	0.00	0.13	0.13	1.28	0.81	0.00	43.6	-0.06
January	1998	3.76	0.38	0.00	2.17	0.08	0.01	0.01	0.00	0.08	0.08	0.27	1.13	0.00	42.1	0.00
February	1998	1.14	0.68	0.00	0.53	0.04	0.01	0.01	0.00	0.32	0.32	-0.47	0.69	0.00	46.8	0.00
March	1998	2.64	1.65	0.00	0.25	0.08	0.04	0.03	0.00	0.82	0.82	0.30	1.14	0.00	47.1	0.00
April	1998	0.36	3.20	0.00	0.15	0.02	0.07	0.01	0.00	2.20	2.19	-2.15	0.19	0.00	49.8	-0.05
May	1998	2.33	3.42	0.00	0.04	0.00	0.03	0.00	0.00	2.23	2.11	-0.47	0.67	0.00	53.8	-0.04
June	1998	1.36	4.35	0.00	0.02	0.00	0.00	0.00	0.00	3.02	2.37	-1.45	0.43	0.00	57.1	-0.02
July	1998	0.84	4.54	0.00	0.01	0.00	0.00	0.00	0.00	3.25	1.35	-0.81	0.29	0.00	60.2	-0.01
August	1998	0.01	4.75	0.00	0.00	0.00	0.05	0.00	0.00	3.44	0.38	-0.38	0.01	0.00	60.9	0.00
September	1998	0.15	3.17	0.00	0.00	0.00	0.07	0.00	0.00	2.23	0.11	-0.04	0.07	0.00	58.5	0.00
Totals		21.44	28.19	0.00	3.88	0.26	0.32	0.11	0.00	18.55	10.70	-0.94	7.48	0.00	51.7	-0.17

Table 21. Monthly water-budget components for the OR1 study basin, Orcas Island, San Juan County, Washington, water years 1997-98—*Continued*

DATE	PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Average monthly values**														
October	4.00	1.15	0.00	0.00	0.00	0.03	0.02	0.00	0.60	0.60	2.26	1.10	0.00	51.0	0.00
November	3.55	0.48	0.00	0.56	0.03	0.01	0.01	0.00	0.20	0.20	1.77	0.94	0.00	45.8	0.03
December	3.91	0.32	0.00	1.39	0.06	0.01	0.01	0.04	0.09	0.09	0.84	1.36	0.00	40.6	0.09
January	4.36	0.40	0.00	4.30	0.06	0.01	0.01	0.00	0.09	0.09	-0.61	1.16	0.00	41.8	-0.69
February	2.24	0.73	0.00	1.55	0.05	0.02	0.02	0.00	0.36	0.36	-0.37	0.70	0.00	44.7	-0.06
March	2.98	1.55	0.00	1.02	0.07	0.03	0.03	0.00	0.75	0.75	-0.04	1.15	0.00	45.8	-0.02
April	1.19	3.07	0.00	0.27	0.01	0.07	0.02	0.00	1.98	1.97	-1.34	0.46	0.00	49.6	-0.21
May	2.13	3.75	0.00	0.10	0.00	0.03	0.00	0.00	2.48	2.36	-0.77	0.53	0.00	54.8	-0.10
June	1.46	4.44	0.00	0.03	0.00	0.00	0.00	0.00	3.07	2.54	-1.47	0.38	0.00	57.2	-0.03
July	0.98	4.70	0.00	0.01	0.00	0.00	0.00	0.00	3.37	1.63	-0.96	0.31	0.00	60.0	-0.01
August	0.41	4.50	0.00	0.00	0.00	0.05	0.00	0.00	3.24	0.51	-0.21	0.12	0.00	61.6	0.00
September	0.95	2.94	0.00	0.00	0.00	0.06	0.01	0.00	1.97	0.38	0.20	0.36	0.00	59.0	0.00
Totals	28.17	28.03	0.00	9.24	0.27	0.31	0.13	0.04	18.20	11.48	-0.70	8.56	0.00	51.0	-1.01

Table 22. Monthly water-budget components for the SH1 study basin, Shaw Island, San Juan County, Washington, water years 1997-98

[**PRECP**, measured precipitation; **POTET**, potential evapotranspiration (may be less than sum of evaporation and transpiration components, as discussed in report); **CHGINT**, change in moisture stored on foliage (zero for cells with land cover for which throughfall data are used); **RUNOFF**; measured or estimated direct runoff; **RECHRG**; soil water that percolates below the root zone (recharge); **SOLPEV**, potential soil evaporation over bare soil areas (none in this investigation); **ACTSEV**, actual bare-soil evaporation; **SNWEVP**, direct evaporation of snow; **PPLTR**, foliage-type-dependent potential transpiration; **APLTR**, actual plant transpiration; **CHGSM**, change in soil moisture; **EVINT**, interception loss computed from input precipitation throughfall, and DPM-simulated throughfall where land use is not evergreen forest; **CHGSNW**, change in snowpack; **AVTMP**, average temperature; **DEFCIT**, if the following is negative: rain + snowmelt + starting soil moisture in excess of available water-holding capacity - evaporation and transpiration components - observed direct runoff; if the following is positive: rain + snowmelt - (available water-holding capacity + specific yield - starting soil moisture) - observed direct runoff - recharge. All values in inches of water except AVTMP, which is in degrees Farenheit. All values rounded to two significant figures. Because of rounding totals may not exactly equal the sum of the shown monthly values]

DATE		PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Year**	**Water Year 1997**														
October	1996	3.83	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.60	1.92	1.30	0.00	50.3	0.00
November	1996	4.60	0.39	0.01	0.30	0.14	0.00	0.00	0.00	0.09	0.09	2.93	1.14	0.00	43.1	0.00
December	1996	3.79	0.31	0.00	1.08	0.25	0.00	0.00	0.08	0.03	0.03	0.73	1.63	0.00	37.7	0.01
January	1997	4.75	0.39	0.00	2.84	0.25	0.00	0.00	0.00	0.08	0.08	-0.04	1.62	0.00	41.5	0.00
February	1997	3.04	0.70	0.00	1.19	0.22	0.00	0.00	0.00	0.33	0.33	0.29	0.95	0.00	42.6	0.06
March	1997	2.83	1.28	0.00	0.76	0.25	0.00	0.00	0.00	0.57	0.57	0.05	1.11	0.00	44.6	0.10
April	1997	1.86	2.64	0.00	0.30	0.24	0.00	0.00	0.00	1.57	1.57	-1.08	0.83	0.00	49.3	0.00
May	1997	2.09	3.84	0.00	0.09	0.11	0.00	0.00	0.00	2.59	2.58	-1.24	0.55	0.00	55.7	0.00
June	1997	1.64	4.28	-0.01	0.07	0.03	0.00	0.00	0.00	2.93	2.69	-1.64	0.51	0.00	57.3	0.00
July	1997	0.99	4.68	0.00	0.01	0.00	0.00	0.00	0.00	3.46	2.40	-1.80	0.39	0.00	59.6	-0.01
August	1997	0.65	4.16	0.00	0.00	0.00	0.00	0.00	0.00	3.13	1.11	-0.72	0.27	0.00	62.2	0.00
September	1997	1.88	2.63	0.01	0.00	0.00	0.00	0.00	0.00	1.64	0.64	0.37	0.85	0.00	59.4	0.00
Totals		31.96	26.38	0.01	6.64	1.49	0.00	0.00	0.08	17.03	12.69	-0.25	11.15	0.00	50.3	0.15
Month	**Year**	**Water Year 1998**														
October	1997	3.95	1.07	0.00	0.01	0.01	0.00	0.00	0.00	0.41	0.41	2.09	1.42	0.00	51.7	0.00
November	1997	2.10	0.53	0.00	0.06	0.11	0.00	0.00	0.00	0.23	0.23	0.68	1.02	0.00	48.6	0.00
December	1997	2.90	0.33	0.00	0.35	0.16	0.00	0.00	0.00	0.11	0.11	1.28	1.00	0.00	43.5	0.00
January	1998	3.31	0.37	0.00	1.02	0.20	0.00	0.00	0.00	0.07	0.07	0.86	1.16	0.00	42.1	0.00
February	1998	0.87	0.62	0.01	0.38	0.19	0.00	0.00	0.00	0.28	0.28	-0.50	0.52	0.00	46.8	0.00
March	1998	2.62	1.47	0.00	0.36	0.23	0.00	0.00	0.00	0.73	0.73	0.07	1.22	0.00	47.0	0.00
April	1998	0.34	2.91	-0.01	0.12	0.10	0.00	0.00	0.00	2.05	2.02	-2.11	0.23	0.00	49.8	0.00
May	1998	2.15	3.19	0.00	0.06	0.03	0.00	0.00	0.00	2.15	1.73	-0.40	0.73	0.00	53.7	-0.01
June	1998	1.21	4.12	0.00	0.01	0.01	0.00	0.00	0.00	2.94	2.06	-1.34	0.48	0.00	57.1	0.00
July	1998	1.17	4.39	0.00	0.00	0.00	0.00	0.00	0.00	3.22	1.57	-0.92	0.52	0.00	60.2	0.00
August	1998	0.04	4.60	0.00	0.00	0.00	0.00	0.00	0.00	3.52	0.67	-0.66	0.03	0.00	60.8	0.00
September	1998	0.18	3.06	0.00	0.00	0.00	0.00	0.00	0.00	2.27	0.20	-0.13	0.11	0.00	58.5	0.00
Totals		20.84	26.66	-0.01	2.36	1.04	0.00	0.00	0.00	17.99	10.09	-1.08	8.45	0.00	51.7	-0.01

Table 22. Monthly water-budget components for the SH1 study basin, Shaw Island, San Juan County, Washington, water years 1997-98—*Continued*

DATE	PRECP	POTET	CHGINT	RUNOFF	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP	DEFCIT
Month	**Average monthly values**														
October	3.89	1.08	0.00	0.01	0.01	0.00	0.00	0.00	0.50	0.50	2.00	1.36	0.00	51.0	0.00
November	3.35	0.46	0.00	0.18	0.13	0.00	0.00	0.00	0.16	0.16	1.80	1.08	0.00	45.8	0.00
December	3.35	0.32	0.00	0.71	0.20	0.00	0.00	0.04	0.07	0.07	1.01	1.31	0.00	40.6	0.00
January	4.03	0.38	0.00	1.93	0.22	0.00	0.00	0.00	0.08	0.08	0.41	1.39	0.00	41.8	0.00
February	1.96	0.66	0.00	0.78	0.21	0.00	0.00	0.00	0.30	0.30	-0.11	0.74	0.00	44.7	0.03
March	2.73	1.37	0.00	0.56	0.24	0.00	0.00	0.00	0.65	0.65	0.06	1.16	0.00	45.8	0.05
April	1.10	2.77	-0.01	0.21	0.17	0.00	0.00	0.00	1.81	1.80	-1.59	0.53	0.00	49.5	0.00
May	2.12	3.52	0.00	0.08	0.07	0.00	0.00	0.00	2.37	2.15	-0.82	0.64	0.00	54.7	0.00
June	1.42	4.20	0.00	0.04	0.02	0.00	0.00	0.00	2.93	2.37	-1.49	0.49	0.00	57.2	0.00
July	1.08	4.53	0.00	0.01	0.00	0.00	0.00	0.00	3.34	1.99	-1.36	0.45	0.00	59.9	-0.01
August	0.35	4.38	0.00	0.00	0.00	0.00	0.00	0.00	3.32	0.89	-0.69	0.15	0.00	61.5	0.00
September	1.03	2.84	0.01	0.00	0.00	0.00	0.00	0.00	1.96	0.42	0.12	0.48	0.00	58.9	0.00
Totals	26.40	26.52	0.00	4.50	1.27	0.00	0.00	0.04	17.51	11.39	-0.66	9.80	0.00	51.0	0.07

Table 23. Monthly water-budget components for Lopez Island, San Juan County, Washington, water years 1997-98

[**PRECP**, measured precipitation; **POTET**, potential evapotranspiration (may be less than sum of evaporation and transpiration components, as discussed in report); **CHGINT**, change in moisture stored on foliage (zero for cells with land cover for which throughfall data are used); **SYM-RO**, DPM-simulated direct runoff; small negative values should be interpreted as zero-negative values caused by roundoff error during summation for large number of cells; **RECHRG**; soil water that percolates below the root zone (recharge); **SOLPEV**, potential soil evaporation over bare soil areas (none in this investigation); **ACTSEV**, actual bare-soil evaporation; **SNWEVP**, direct evaporation of snow; **PPLTR**, foliage-type-dependent potential transpiration; **APLTR**, actual plant transpiration; **CHGSM**, change in soil moisture; **EVINT**, interception loss computed from input throughfall, or DPM-simulated throughfall if not input; **CHGSNW**, change in snowpack; **AVTMP**, average temperature; **DEFCIT**, if the following is negative: rain + snowmelt + starting soil moisture in excess of available water-holding capacity – evaporation and transpiration components – observed direct runoff; if the following is positive: rain + snowmelt – (available water-holding capacity + specific yield – starting soil moisture) – observed direct runoff – recharge. All values in inches of water except AVTMP, which is in degrees Farenheit. All values rounded to two significant figures. Because of rounding totals may not exactly equal the sum of the shown monthly values]

DATE		PRECP	POTET	CHGINT	SYM-RO	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP
Month	**Year**	**Water Year 1997**													
October	1996	3.54	2.35	0.00	0.02	0.00	0.02	0.02	0.00	1.85	0.73	2.17	0.60	0.00	50.2
November	1996	4.78	0.79	0.02	0.21	0.06	0.01	0.01	0.00	0.44	0.16	3.73	0.59	0.00	43.2
December	1996	3.73	0.48	0.00	0.67	0.33	0.00	0.00	0.06	0.17	0.06	1.72	0.88	0.00	37.9
January	1997	3.60	0.66	-0.01	1.40	0.53	0.01	0.01	0.00	0.34	0.16	0.96	0.55	0.00	41.5
February	1997	3.00	1.31	0.00	1.46	0.52	0.01	0.01	0.00	0.92	0.45	0.11	0.45	0.00	42.5
March	1997	2.70	2.43	0.00	1.08	0.56	0.02	0.02	0.00	1.71	0.75	-0.50	0.77	0.00	44.5
April	1997	1.79	5.12	0.00	0.48	0.49	0.05	0.04	0.00	4.11	1.78	-1.65	0.64	0.00	49.1
May	1997	2.04	8.05	0.00	0.16	0.23	0.05	0.05	0.00	6.80	2.54	-1.45	0.51	0.00	55.5
June	1997	1.77	8.96	0.00	0.07	0.14	0.05	0.05	0.00	7.67	2.66	-1.61	0.47	0.00	57.0
July	1997	1.04	10.07	-0.01	0.02	0.07	0.06	0.06	0.00	8.89	2.62	-2.02	0.30	0.00	59.4
August	1997	0.65	9.33	0.00	-0.01	0.04	0.06	0.05	0.00	8.33	1.49	-1.08	0.17	0.00	62.1
September	1997	2.00	5.80	0.01	0.02	0.05	0.04	0.03	0.00	4.82	0.84	0.32	0.73	0.00	59.3
Totals		30.65	55.34	0.02	5.59	3.03	0.38	0.35	0.07	46.07	14.22	0.68	6.66	0.00	50.2
Month	**Year**	**Water Year 1998**													
October	1997	4.28	2.39	0.00	0.13	0.05	0.02	0.02	0.00	1.70	0.57	2.64	0.86	0.00	51.6
November	1997	2.08	1.26	0.01	0.16	0.08	0.01	0.01	0.00	0.88	0.31	0.86	0.65	0.00	48.5
December	1997	2.78	0.64	-0.01	0.29	0.18	0.01	0.01	0.00	0.40	0.16	1.59	0.57	0.00	43.5
January	1998	3.19	0.71	0.00	0.71	0.44	0.01	0.01	0.00	0.35	0.12	1.28	0.63	0.00	42.2
February	1998	0.75	1.33	0.02	0.35	0.32	0.01	0.01	0.00	0.97	0.39	-0.76	0.41	0.00	46.7
March	1998	2.65	2.87	0.00	0.38	0.42	0.03	0.02	0.00	2.09	0.84	0.03	0.95	0.00	46.9
April	1998	0.39	5.75	-0.02	0.13	0.19	0.05	0.04	0.00	4.88	2.06	-2.28	0.28	0.00	49.6
May	1998	2.30	6.57	0.00	0.05	0.11	0.04	0.04	0.00	5.52	1.97	-0.54	0.68	0.00	53.4
June	1998	1.13	8.60	0.00	0.02	0.06	0.05	0.05	0.00	7.48	2.40	-1.74	0.35	0.00	56.7
July	1998	1.26	9.51	0.00	0.01	0.05	0.05	0.05	0.00	8.40	2.00	-1.17	0.33	0.00	60.0
August	1998	0.06	9.97	0.00	-0.04	0.03	0.06	0.05	0.00	8.94	1.01	-1.04	0.05	0.00	60.5
September	1998	0.17	6.70	0.00	-0.03	0.01	0.05	0.04	0.00	5.95	0.37	-0.33	0.12	0.00	58.3
Totals		21.05	56.29	-0.02	2.15	1.94	0.39	0.34	0.00	47.57	12.20	-1.46	5.86	0.00	51.5

Table 23. Monthly water-budget components for Lopez Island, San Juan County, Washington, water years 1997-98—*Continued*

DATE	PRECP	POTET	CHGINT	SYM-RO	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP
Month	**Average monthly values**													
October	3.91	2.37	0.00	0.08	0.03	0.02	0.02	0.00	1.78	0.65	2.40	0.73	0.00	50.9
November	3.43	1.02	0.01	0.19	0.07	0.01	0.01	0.00	0.66	0.23	2.30	0.62	0.00	45.8
December	3.26	0.56	-0.01	0.48	0.25	0.00	0.00	0.03	0.28	0.11	1.65	0.72	0.00	40.7
January	3.39	0.68	0.00	1.05	0.49	0.01	0.01	0.00	0.35	0.14	1.12	0.59	0.00	41.8
February	1.87	1.32	0.01	0.90	0.42	0.01	0.01	0.00	0.95	0.42	-0.33	0.43	0.00	44.6
March	2.67	2.65	0.00	0.73	0.49	0.02	0.02	0.00	1.90	0.80	-0.24	0.86	0.00	45.7
April	1.09	5.44	-0.01	0.30	0.34	0.05	0.04	0.00	4.50	1.92	-1.96	0.46	0.00	49.3
May	2.17	7.31	0.00	0.10	0.17	0.05	0.04	0.00	6.16	2.25	-1.00	0.60	0.00	54.5
June	1.45	8.78	0.00	0.04	0.10	0.05	0.05	0.00	7.58	2.53	-1.68	0.41	0.00	56.9
July	1.15	9.79	-0.01	0.02	0.06	0.05	0.05	0.00	8.65	2.31	-1.59	0.31	0.00	59.7
August	0.36	9.65	0.00	-0.02	0.04	0.06	0.05	0.00	8.64	1.25	-1.06	0.11	0.00	61.3
September	1.09	6.25	0.01	0.00	0.03	0.05	0.03	0.00	5.38	0.60	-0.01	0.42	0.00	58.8
Totals	25.82	55.82	0.00	3.87	2.49	0.38	0.34	0.03	46.82	13.21	-0.39	6.26	0.00	50.9

Table 24. Monthly water-budget components for San Juan Island, San Juan County, Washington, water years 1997-98

[**PRECP**, measured precipitation; **POTET**, potential evapotranspiration (may be less than sum of evaporation and transpiration components, as discussed in report); **CHGINT**, change in moisture stored on foliage (zero for cells with land cover for which throughfall data are used); **SYM-RO**, DPM-simulated direct runoff; small negative values should be interpreted as zero-negative values caused by roundoff error during summation for large number of cells; **RECHRG**; soil water that percolates below the root zone (recharge); **SOLPEV**, potential soil evaporation over bare soil areas (none in this investigation); **ACTSEV**, actual bare-soil evaporation; **SNWEVP**, direct evaporation of snow; **PPLTR**, foliage-type-dependent potential transpiration; **APLTR**, actual plant transpiration; **CHGSM**, change in soil moisture; **EVINT**, interception loss computed from input throughfall, or DPM-simulated throughfall if not input; **CHGSNW**, change in snowpack; **AVTMP**, average temperature; **DEFCIT**, if the following is negative: rain + snowmelt + starting soil moisture in excess of available water-holding capacity – evaporation and transpiration components – observed direct runoff; if the following is positive: rain + snowmelt – (available water-holding capacity + specific yield – starting soil moisture) – observed direct runoff – recharge. All values in inches of water except AVTMP, which is in degrees Farenheit. All values rounded to two significant figures. Because of rounding totals may not exactly equal the sum of the shown monthly values]

DATE		PRECP	POTET	CHGINT	SYM-RO	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP
Month	**Year**	**Water Year 1997**													
October	1996	4.10	1.14	0.00	0.06	0.00	0.04	0.04	0.00	0.59	0.57	2.57	0.84	0.00	50.2
November	1996	5.31	0.40	0.02	0.70	0.15	0.01	0.01	0.00	0.08	0.08	3.60	0.72	0.00	43.1
December	1996	4.23	0.31	0.00	1.54	0.31	0.01	0.01	0.08	0.02	0.02	1.20	1.05	0.00	37.8
January	1997	4.49	0.39	0.00	2.61	0.37	0.01	0.01	0.00	0.06	0.06	0.63	0.79	0.00	41.5
February	1997	3.39	0.67	0.00	2.48	0.37	0.03	0.03	0.00	0.27	0.27	-0.34	0.59	0.00	42.6
March	1997	3.09	1.23	0.00	1.63	0.40	0.05	0.05	0.00	0.49	0.49	-0.36	0.86	0.00	44.6
April	1997	2.04	2.63	0.00	0.66	0.32	0.10	0.08	0.00	1.57	1.56	-1.36	0.76	0.00	49.2
May	1997	2.31	4.05	0.00	0.20	0.17	0.11	0.09	0.00	2.81	2.69	-1.45	0.60	0.00	55.6
June	1997	1.94	4.54	-0.01	0.03	0.10	0.10	0.10	0.00	3.24	2.90	-1.77	0.58	0.00	57.2
July	1997	1.15	5.05	0.00	-0.06	0.03	0.10	0.10	0.00	3.96	2.73	-2.00	0.35	0.00	59.5
August	1997	0.73	4.60	0.00	-0.07	0.00	0.11	0.09	0.00	3.68	1.26	-0.78	0.22	0.00	62.2
September	1997	2.20	2.87	0.02	-0.01	0.00	0.09	0.07	0.00	1.86	0.77	0.54	0.81	0.00	59.3
Totals		34.99	27.88	0.02	9.77	2.24	0.77	0.68	0.08	18.62	13.40	0.48	8.16	0.00	50.3
Month	**Year**	**Water Year 1998**													
October	1997	4.68	1.15	-0.01	0.11	0.03	0.04	0.04	0.00	0.37	0.37	3.01	1.10	0.00	51.6
November	1997	2.35	0.58	0.01	0.32	0.13	0.02	0.02	0.00	0.22	0.22	0.88	0.76	0.00	48.5
December	1997	3.17	0.33	-0.01	0.71	0.24	0.01	0.01	0.00	0.09	0.09	1.47	0.65	0.00	43.5
January	1998	3.64	0.38	-0.01	1.49	0.39	0.01	0.01	0.00	0.05	0.05	0.92	0.76	0.00	42.1
February	1998	0.89	0.63	0.02	0.65	0.29	0.02	0.02	0.00	0.25	0.25	-0.81	0.46	0.00	46.7
March	1998	2.97	1.45	0.00	0.78	0.37	0.06	0.05	0.00	0.67	0.67	0.06	1.01	0.00	47.0
April	1998	0.42	2.94	-0.03	0.25	0.18	0.11	0.08	0.00	2.10	2.07	-2.43	0.29	0.00	49.7
May	1998	2.53	3.33	0.00	0.03	0.08	0.09	0.07	0.00	2.33	2.14	-0.47	0.67	0.00	53.6
June	1998	1.30	4.37	0.00	-0.05	0.03	0.09	0.09	0.00	3.30	2.64	-1.85	0.42	0.00	56.9
July	1998	J1.38	4.76	0.00	-0.06	0.01	0.10	0.10	0.00	3.71	2.03	-1.13	0.42	0.00	60.1
August	1998	0.06	5.00	0.00	-0.09	0.00	0.13	0.10	0.00	4.07	0.84	-0.84	0.05	0.00	60.7
September	1998	0.20	3.32	0.00	-0.06	0.00	0.11	0.07	0.00	2.61	0.27	-0.21	0.13	0.00	58.4
Totals		23.59	28.23	-0.02	4.10	1.75	0.79	0.67	0.00	19.76	11.65	-1.39	6.73	0.00	51.6

Table 24. Monthly water-budget components for San Juan Island, San Juan County, Washington, water years 1997-98—*Continued*

DATE	PRECP	POTET	CHGINT	SYM-RO	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP
Month	**Average monthly values**													
October	0.39	1.14	0.00	0.09	0.02	0.04	0.04	0.00	0.48	0.47	2.79	0.97	0.00	50.9
November	3.83	0.49	0.02	0.51	0.14	0.02	0.02	0.00	0.15	0.15	2.24	0.74	0.00	45.8
December	3.70	0.32	-0.01	1.13	0.27	0.01	0.01	0.04	0.06	0.06	1.34	0.85	0.00	40.7
January	4.06	0.38	0.00	2.05	0.38	0.01	0.01	0.00	0.06	0.06	0.78	0.77	0.00	41.8
February	2.14	0.65	0.01	1.56	0.33	0.03	0.03	0.00	0.26	0.26	-0.58	0.52	0.00	44.6
March	3.03	1.34	0.00	1.21	0.39	0.05	0.05	0.00	0.58	0.58	-0.15	0.94	0.00	45.8
April	1.23	2.79	-0.01	0.46	0.25	0.10	0.08	0.00	1.83	1.82	-1.90	0.53	0.00	49.5
May	2.42	3.69	0.00	0.12	0.12	0.10	0.08	0.00	2.57	2.42	-0.96	0.63	0.00	54.6
June	1.62	4.45	-0.01	-0.01	0.06	0.09	0.09	0.00	3.27	2.77	-1.81	0.50	0.00	57.1
July	1.27	4.90	0.00	-0.06	0.02	0.10	0.10	0.00	3.83	2.38	-1.57	0.39	0.00	59.8
August	0.40	4.80	0.00	-0.08	0.00	0.12	0.10	0.00	3.87	1.05	-0.81	0.14	0.00	61.5
September	1.20	3.10	0.01	-0.04	0.00	0.10	0.07	0.00	2.23	0.52	0.16	0.47	0.00	58.9
Totals	29.29	28.05	0.00	6.93	1.99	0.78	0.68	0.04	19.19	12.52	-0.46	7.45	0.00	50.9

Table 25. Monthly water-budget components for Orcas Island, San Juan County, Washington, water years 1997-98

[**PRECP**, measured precipitation; **POTET**, potential evapotranspiration (may be less than sum of evaporation and transpiration components, as discussed in report); **CHGINT**, change in moisture stored on foliage (zero for cells with land cover for which throughfall data are used); **SYM-RO**, DPM-simulated direct runoff; small negative values should be interpreted as zero-negative values caused by roundoff error during summation for large number of cells; **RECHRG**; soil water that percolates below the root zone (recharge); **SOLPEV**, potential soil evaporation over bare soil areas (none in this investigation); **ACTSEV**, actual bare-soil evaporation; **SNWEVP**, direct evaporation of snow; **PPLTR**, foliage-type-dependent potential transpiration; **APLTR**, actual plant transpiration; **CHGSM**, change in soil moisture; **EVINT**, interception loss computed from input throughfall, or DPM-simulated throughfall if not input; **CHGSNW**, change in snowpack; **AVTMP**, average temperature; **DEFCIT**, if the following is negative: rain + snowmelt + starting soil moisture in excess of available water-holding capacity – evaporation and transpiration components – observed direct runoff; if the following is positive: rain + snowmelt – (available water-holding capacity + specific yield – starting soil moisture) – observed direct runoff – recharge. All values in inches of water except AVTMP, which is in degrees Farenheit. All values rounded to two significant figures. Because of rounding totals may not exactly equal the sum of the shown monthly values]

DATE		PRECP	POTET	CHGINT	SYM-RO	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP
Month	**Year**	**Water Year 1997**													
October	1996	4.93	1.05	0.00	0.10	0.01	0.02	0.02	0.00	0.56	0.56	3.09	1.13	0.00	50.3
November	1996	5.75	0.39	0.00	1.71	0.13	0.01	0.01	0.00	0.10	0.10	2.94	0.85	0.00	43.1
December	1996	5.50	0.31	0.00	2.71	0.21	0.01	0.01	0.08	0.04	0.04	0.64	1.79	0.00	37.6
January	1997	5.47	0.39	0.00	3.98	0.24	0.01	0.01	0.00	0.09	0.09	0.04	1.10	0.00	41.5
February	1997	3.89	0.71	0.00	3.25	0.23	0.02	0.02	0.00	0.34	0.34	-0.63	0.68	0.00	42.6
March	1997	3.76	1.29	0.00	1.98	0.25	0.03	0.03	0.00	0.57	0.56	-0.15	1.08	0.00	44.6
April	1997	2.34	2.61	0.00	0.49	0.18	0.06	0.06	0.00	1.52	1.52	-0.67	0.75	0.00	49.4
May	1997	2.35	3.72	0.00	0.21	0.15	0.07	0.07	0.00	2.46	2.44	-0.94	0.41	0.00	55.8
June	1997	1.94	4.15	-0.01	0.10	0.10	0.07	0.07	0.00	2.77	2.72	-1.48	0.42	0.00	57.4
July	1997	1.32	4.51	0.00	0.01	0.06	0.08	0.08	0.00	3.21	2.74	-1.91	0.34	0.00	59.7
August	1997	0.93	3.98	0.00	-0.04	0.03	0.08	0.07	0.00	2.87	1.46	-0.83	0.24	0.00	62.3
September	1997	2.18	2.53	0.01	0.00	0.02	0.06	0.05	0.00	1.56	0.91	0.48	0.72	0.00	59.4
Totals		40.37	25.65	0.01	14.50	1.60	0.51	0.49	0.09	16.08	13.48	0.59	9.50	0.00	50.4
Month	**Year**	**Water Year 1998**													
October	1997	0.59	1.04	0.00	0.15	0.04	0.02	0.02	0.00	0.45	0.45	2.83	1.09	0.00	51.7
November	1997	2.68	0.52	0.00	0.43	0.11	0.01	0.01	0.00	0.23	0.23	0.85	1.03	0.00	48.6
December	1997	3.42	0.32	0.00	1.28	0.17	0.01	0.01	0.00	0.11	0.11	1.06	0.78	0.00	43.6
January	1998	4.31	0.37	0.00	2.58	0.25	0.01	0.01	0.00	0.06	0.06	0.34	1.06	0.00	42.1
February	1998	1.23	0.62	0.00	0.53	0.19	0.01	0.01	0.00	0.27	0.27	-0.43	0.65	0.00	46.8
March	1998	3.16	1.48	0.00	0.93	0.23	0.03	0.03	0.00	0.71	0.71	0.08	1.17	0.00	47.1
April	1998	0.44	2.86	-0.01	0.20	0.12	0.07	0.06	0.00	1.94	1.93	-2.10	0.24	0.00	49.9
May	1998	2.78	3.11	0.00	0.09	0.08	0.06	0.06	0.00	2.00	1.96	-0.08	0.67	0.00	53.9
June	1998	1.56	4.01	0.00	0.03	0.07	0.07	0.07	0.00	2.75	2.54	-1.58	0.43	0.00	57.2
July	1998	1.14	4.23	0.00	-0.02	0.04	0.07	0.07	0.00	2.99	2.01	-1.34	0.37	0.00	60.3
August	1998	0.03	4.44	0.00	-0.07	0.02	0.09	0.08	0.00	3.26	0.99	-1.01	0.02	0.00	61.0
September	1998	0.19	2.94	0.00	-0.05	0.00	0.07	0.05	0.00	2.10	0.35	-0.27	0.10	0.00	58.6
Totals		25.53	25.94	-0.01	6.08	1.33	0.52	0.48	0.00	16.87	11.61	-1.65	7.62	0.00	51.8

Table 25. Monthly water-budget components for Orcas Island, San Juan County, Washington, water years 1997-98—*Continued*

DATE	PRECP	POTET	CHGINT	SYM-RO	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP
Month	**Average monthly values**													
October	4.76	1.04	0.00	0.12	0.02	0.02	0.02	0.00	0.50	0.50	2.96	1.11	0.00	51.0
November	4.21	0.45	0.00	1.07	0.12	0.01	0.01	0.00	0.17	0.17	1.90	0.94	0.00	45.8
December	4.46	0.32	0.00	2.00	0.19	0.01	0.01	0.04	0.08	0.08	0.85	1.29	0.00	40.6
January	4.89	0.38	0.00	3.28	0.25	0.01	0.01	0.00	0.08	0.08	0.19	1.08	0.00	41.8
February	2.56	0.67	0.00	1.89	0.21	0.02	0.02	0.00	0.30	0.30	-0.53	0.66	0.00	44.7
March	3.46	1.38	0.00	1.46	0.24	0.03	0.03	0.00	0.64	0.63	-0.04	1.12	0.00	45.8
April	1.39	2.74	0.00	0.35	0.15	0.06	0.06	0.00	1.73	1.72	-1.38	0.50	0.00	49.6
May	2.57	3.42	0.00	0.15	0.11	0.07	0.06	0.00	2.23	2.20	-0.51	0.54	0.00	54.8
June	1.75	4.08	0.00	0.06	0.08	0.07	0.07	0.00	2.76	2.63	-1.53	0.43	0.00	57.3
July	1.23	4.37	0.00	-0.01	0.05	0.08	0.08	0.00	3.10	2.37	-1.62	0.35	0.00	60.0
August	0.48	4.21	0.00	-0.05	0.02	0.08	0.07	0.00	3.07	1.23	-0.92	0.13	0.00	61.7
September	1.19	2.73	0.00	-0.02	0.01	0.06	0.05	0.00	1.83	0.63	0.10	0.41	0.00	59.0
Totals	32.95	25.79	0.00	10.29	1.46	0.52	0.49	0.04	16.47	12.54	-0.53	8.56	0.00	51.1

Table 26. Monthly water-budget components for Shaw Island, San Juan County, Washington, water years 1997-98

[**PRECP**, measured precipitation; **POTET**, potential evapotranspiration (may be less than sum of evaporation and transpiration components, as discussed in report); **CHGINT**, change in moisture stored on foliage (zero for cells with land cover for which throughfall data are used); **SYM-RO**, DPM-simulated direct runoff; small negative values should be interpreted as zero-negative values caused by roundoff error during summation for large number of cells; **RECHRG**; soil water that percolates below the root zone (recharge); **SOLPEV**, potential soil evaporation over bare soil areas (none in this investigation); **ACTSEV**, actual bare-soil evaporation; **SNWEVP**, direct evaporation of snow; **PPLTR**, foliage-type-dependent potential transpiration; **APLTR**, actual plant transpiration; **CHGSM**, change in soil moisture; **EVINT**, interception loss computed from input throughfall, or DPM-simulated throughfall if not input; **CHGSNW**, change in snowpack; **AVTMP**, average temperature; **DEFCIT**, if the following is negative: rain + snowmelt + starting soil moisture in excess of available water-holding capacity – evaporation and transpiration components – observed direct runoff; if the following is positive: rain + snowmelt – (available water-holding capacity + specific yield – starting soil moisture) – observed direct runoff – recharge. All values in inches of water except AVTMP, which is in degrees Farenheit. All values rounded to two significant figures. Because of rounding totals may not exactly equal the sum of the shown monthly values]

DATE		PRECP	POTET	CHGINT	SYM-RO	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP
Month	**Year**	**Water Year 1997**													
October	1996	4.06	1.11	0.00	0.03	0.02	0.01	0.01	0.00	0.61	0.61	2.16	1.23	0.00	50.3
November	1996	5.06	0.40	0.01	0.40	0.16	0.00	0.00	0.00	0.09	0.09	3.30	1.09	0.00	43.1
December	1996	4.32	0.31	0.00	1.36	0.21	0.00	0.00	0.08	0.03	0.03	0.93	1.71	0.00	37.7
January	1997	4.47	0.40	0.00	2.07	0.26	0.00	0.00	0.00	0.09	0.09	0.71	1.33	0.00	41.5
February	1997	3.30	0.74	0.00	2.35	0.26	0.01	0.01	0.00	0.35	0.35	-0.56	0.89	0.00	42.6
March	1997	3.08	1.35	0.00	1.56	0.29	0.01	0.01	0.00	0.60	0.60	-0.51	1.12	0.00	44.6
April	1997	1.98	2.76	0.00	0.72	0.28	0.02	0.02	0.00	1.64	1.64	-1.50	0.82	0.00	49.3
May	1997	2.15	3.94	0.00	0.11	0.11	0.03	0.03	0.00	2.61	2.58	-1.20	0.52	0.00	55.7
June	1997	1.80	4.37	-0.01	0.00	0.03	0.03	0.03	0.00	2.94	2.70	-1.44	0.49	0.00	57.3
July	1997	1.12	4.75	0.00	-0.03	0.01	0.04	0.04	0.00	3.41	2.47	-1.76	0.39	0.00	59.6
August	1997	0.74	4.19	0.00	-0.03	0.00	0.03	0.03	0.00	3.06	1.16	-0.69	0.27	0.00	62.2
September	1997	2.04	2.66	0.01	-0.01	0.00	0.02	0.02	0.00	1.63	0.72	0.44	0.85	0.00	59.4
Totals		34.12	26.99	0.01	8.52	1.62	0.21	0.21	0.08	17.08	13.06	-0.10	10.71	0.00	50.3
Month	**Year**	**Water Year 1998**													
October	1997	4.31	1.10	0.00	0.03	0.02	0.01	0.01	0.00	0.43	0.43	2.44	1.37	0.00	51.7
November	1997	2.28	0.55	0.00	0.19	0.14	0.00	0.00	0.00	0.24	0.24	0.66	1.04	0.00	48.6
December	1997	3.02	0.33	0.00	0.41	0.18	0.00	0.00	0.00	0.12	0.12	1.37	0.95	0.00	43.5
January	1998	3.58	0.38	0.00	1.10	0.26	0.00	0.00	0.00	0.07	0.07	1.02	1.12	0.00	42.1
February	1998	0.93	0.65	0.01	0.69	0.23	0.01	0.01	0.00	0.29	0.29	-0.84	0.55	0.00	46.8
March	1998	2.81	1.55	0.00	0.61	0.27	0.01	0.01	0.00	0.76	0.76	-0.10	1.26	0.00	47.0
April	1998	0.40	3.03	-0.01	0.16	0.12	0.03	0.02	0.00	2.09	2.09	-2.23	0.25	0.00	49.8
May	1998	2.42	3.29	0.00	0.01	0.02	0.03	0.02	0.00	2.15	1.84	-0.25	0.78	0.00	53.7
June	1998	1.29	4.21	0.00	-0.02	0.01	0.03	0.03	0.00	2.92	2.21	-1.43	0.47	0.00	57.1
July	1998	1.20	4.44	0.00	-0.03	0.00	0.03	0.03	0.00	3.18	1.70	-0.99	0.48	0.00	60.2
August	1998	0.05	4.65	0.00	-0.03	0.00	0.04	0.03	0.00	3.45	0.67	-0.66	0.04	0.00	60.9
September	1998	0.18	3.10	0.00	-0.02	0.00	0.03	0.02	0.00	2.25	0.20	-0.13	0.10	0.00	58.5
Totals		22.47	27.28	-0.01	3.11	1.25	0.22	0.21	0.00	17.97	10.64	-1.14	8.40	0.00	51.7

Table 26. Monthly water-budget components for Shaw Island, San Juan County, Washington, wter years 1997-98—*Continued*

DATE	PRECP	POTET	CHGINT	SYM-RO	RECHRG	SOLPEV	ACTSEV	SNWEVP	PPLTR	APLTR	CHGSM	EVINT	CHGSNW	AVTMP
Month	**Average monthly values**													
October	4.18	1.11	0.00	0.03	0.02	0.01	0.01	0.00	0.52	0.52	2.30	1.30	0.00	51.0
November	3.67	0.47	0.00	0.30	0.15	0.00	0.00	0.00	0.17	0.17	1.98	1.06	0.00	45.8
December	3.67	0.32	0.00	0.89	0.19	0.00	0.00	0.04	0.08	0.08	1.15	1.33	0.00	40.6
January	4.03	0.39	0.00	1.58	0.26	0.00	0.00	0.00	0.08	0.08	0.87	1.23	0.00	41.8
February	2.12	0.69	0.00	1.52	0.25	0.01	0.01	0.00	0.32	0.32	-0.70	0.72	0.00	44.7
March	2.94	1.45	0.00	1.08	0.28	0.01	0.01	0.00	0.68	0.68	-0.30	1.19	0.00	45.8
April	1.19	2.90	0.00	0.44	0.20	0.02	0.02	0.00	1.87	1.86	-1.86	0.53	0.00	49.6
May	2.29	3.61	0.00	0.06	0.07	0.03	0.03	0.00	2.38	2.21	-0.73	0.65	0.00	54.7
June	1.54	4.29	0.00	-0.01	0.02	0.03	0.03	0.00	2.93	2.46	-1.43	0.48	0.00	57.2
July	1.16	4.60	0.00	-0.03	0.01	0.03	0.03	0.00	3.30	2.09	-1.37	0.43	0.00	59.9
August	0.39	4.42	0.00	-0.03	0.00	0.03	0.03	0.00	3.26	0.92	-0.68	0.15	0.00	61.5
September	1.11	2.88	0.00	-0.01	0.00	0.02	0.02	0.00	1.94	0.46	0.16	0.48	0.00	58.9
Totals	28.29	27.13	0.00	5.81	1.44	0.22	0.21	0.04	17.52	11.85	-0.62	9.55	0.00	51.0