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THE WATER RESOURCES OF NORTHERN LUMMI ISLAND

An Inventory and Management Plan
for
Mr. James Arthur, Planner
and
Whatcom County Planning Department

June 1978

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1978

By Ronald G. Schmidt, CPG, RPG

The preparation of this report was financially aided through a grant from the Washington State Department of Ecology with funds obtained from the National Oceanic and Atmospheric Administration, and appropriated for Section 306 of the Coastal Zone Management Act of 1972.

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PROLOGUE

Island Water resources are among the most fragile and sensitive systems existing in nature. They depend on a critical balance between precipitation falling on the land surface and on runoff of water both on the surface and through the ground. Interference by water production and waste disposal by man affects that system in various ways, sometimes both quickly and dramatically. Understanding the character and limits of the natural processes involved, and how they are effected by human activities, is essential to gaining maximum utilization of the resource through intelligent management. Without such management much of the resource is commonly wasted or inefficiently used, resulting in unnecessary pursuit of alternative measures for water supply involving major engineering works and committment of economic resources. For these reasons, islands warrant special attention and special effort in planning for water resource utilization. Because of the attraction of island environments for human recreation and residency they tend to be more keenly stressed than mainland areas. In response to both the resulting needs and the inherent fragility, water resource management knowledge and technology has been strongly developed in recent years.

The concept of developing Water Resource Management Plans as a precursor and prerequisite to Land Use Planning is as yet not widely applied, but it is growing at a very rapid pace as the effects of our failure to do so compound our other environmental problems.

THE WATER RESOURCES

OF

NORTHERN LUMMI ISLAND

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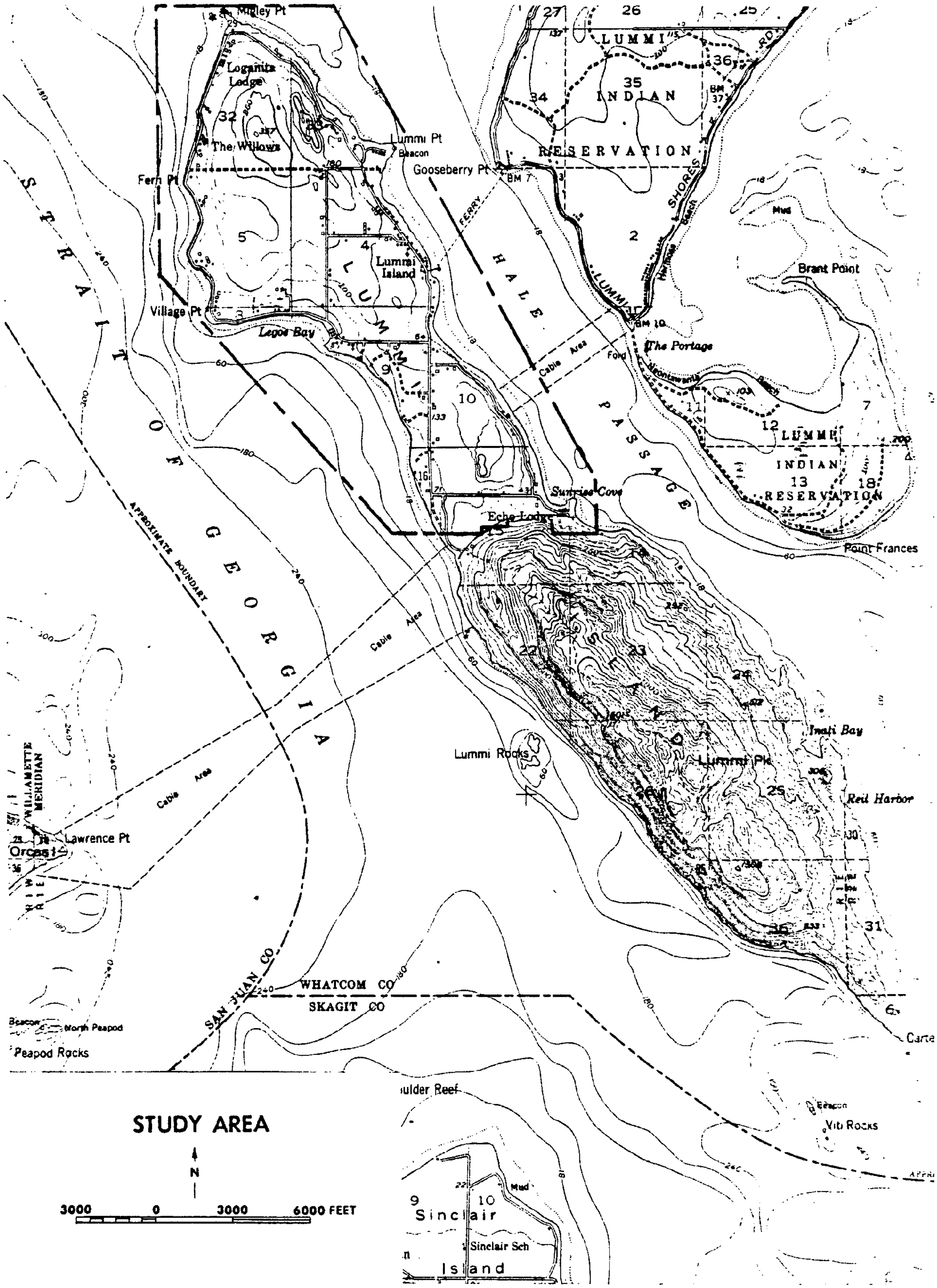
INTRODUCTION

Lummi Island is a northwest-southeast trending elongate island in Puget Sound just off the Lummi Peninsula. It lies a few miles west of Bellingham across Bellingham Bay. The majority of the island area lies within T.37N, R. 1E with small portions in T.38N, R.1E, T.37N, R.2E and T.36N, R.2E. The northern portion of the island is relatively low lying, gently rolling, with elevations ranging from sea level to 362 feet above sea level. The southern portion of the island is mountainous with elevations from sea level to Lummi Peak, with an elevation of 1,665 feet.

This study, a survey of the geology and water resources and preparation of a preliminary water resource management plan for the island, was undertaken by Dr. Ronald G. Schmidt of Robinson & Noble, Inc. at the request of Mr. James Arthur, acting on behalf of the Whatcom County Planning Commission. It is to be used as part of the physical resources inventory in the preparation of an updated, comprehensive plan for the island.

FIGURE 1



Migley Pt
Loganita Lodge
The Willows
Fern Pt
Lummi Pt
Beacon
Gooseberry Pt
Lummi Island
Village Pt
Legoe Bay
LUMMI
STRAIT OF GEORGIA
APPROXIMATE BOUNDARY
HALE PASSAGE
FERRY
Cable Area
LUMMI INDIAN RESERVATION
SHORES RD
Brant Point
The Portage
Sunrise Cove
Echo Lodge
Point Frances
Lummi Rocks
Lummi Pk
Inati Bay
Reil Harbor
WILLAMETTE MERIDIAN
Lawrence Pt
Orcas
North Peapod
Peapod Rocks
SAN JUAN CO
WHATCOM CO
SKAGIT CO
Viti Rocks
Sinclair Island
Sinclair Sch
STUDY AREA
N
3000 0 3000 6000 FEET

The work summarized by this report was characterized by an unusual spirit of cooperative endeavor. Much of the preliminary collection of data and a considerable amount of the field effort during the assimilation of that data was carried out by Mr. James Arthur and by Mr. Mark Ingham. Through their efforts, more data were made available than would have otherwise been possible within the scope of this study.

Purpose

The objectives of this report are:

1. To define and to delimit the ground water resource base in sufficient depth and reliability to permit preparation of a water resources management plan.
2. To determine the technical and management options which the community can elect for such a plan.
3. To describe the limitations of the information upon which this study is based and to recommend means for removing remaining uncertainties.

Scope

The economic framework established for this study has limited the work principally to collection and review of that existing information which could be obtained from the usual sources. Additional steps included compilation of additional data where feasible, assimilation, calculation and formulation of a plan. The geographic scope was limited to the northern portion of the island because the shallow impermeable bedrock of the southern part was known to have limited ground water resources.

Approach

In addition to compilation of available summary reports, a data base was compiled of information from 116 water wells previously drilled in the study area. Of these wells, most have been located. However, somewhat limited log information is available on only 67 and the locations of a number are somewhat questionable. Wherever possible locations were checked in the field in the course of gathering additional information. Well locations shown on the accompanying figures are for those wells for which the writer feels that adequate information is available to permit reliable interpretation for purposes of this report.

In order to understand the resources and develop a viable management plan it is essential to understand the full scope and limitations of the hydrologic system involved. This necessitates knowing quite accurately the volume and distribution of the resources available. An important key factor involved is the water entering the system from climatic sources. Because there is not an official weather station on the island, climatic data have of necessity been approximated from the closest observation points.

The general spectrum of data are generally considered to be adequate for planning purposes and to establish a general framework of the hydrologic system and its water management parameters. Implementation of a water management program, however, will require verification and completion of the data net as a requisite to reliable resource management.

PREVIOUS WORK

The principal sources of background material for this report are the published works of federal and state government workers who have gathered data in previous years. The most comprehensive examination of the geology of Lummi Island itself was done by Parker Calkin in 1959. The island is mentioned or described as a part of larger scope studies by Easterbrook (19XX), Water Supply Bulletin No. 12 (1960), Easterbrook (1973), Newcomb and Sceva (1949) and by Walters (1971). Several reports not dealing directly with Lummi but containing information concerning surrounding areas and/or principals which were pertinent include U. S. Geological Survey (1971), Water Supply Bulletin No. 46 (1975), U. S. Geological Survey (1974).

In addition, two unpublished engineering reports were reviewed but proved of limited value for purposes of this study. They were: Carey and Kramer (1968) and Hammond, Collier and Wade - Livingstone Associates (1974).

Regional studies of the glacial and/or bedrock geology are contained in numerous reports which will not be referenced here. The reader is referred to the bibliographies of those cited above and to the bibliography at the end of this report for a comprehensive listing.

GEOLOGY

The northern half of Lummi Island is essentially an irregular bedrock surface mantled by glacial drift. In several places, bedrock is exposed directly or is covered by a thin veneer of soil and vegetation (see Geologic Map - Figure 2). The bedrock consists of four different units whose ages, stratigraphy and structure are not clearly understood. The Chuckanut Formation is largely sandstone and conglomerate on the island and makes up the majority of the area where bedrock is exposed at the surface or encountered in drilled wells. Volcanic rocks crop out at several locations at the coast (e.g. Migley Point, Legoe Bay, Echo Point). Pre-Tertiary metamorphic rocks tentatively identified as Turtleback Formation crop out in a small area on a hilltop inland near the southern end of the north part of the island. Metamorphosed sedimentary rocks which form the bedrock for the bulk of the southern part of the island crop out locally at the base of the mountain on the extreme southern edge of the study area.

Pleistocene (ice-age) deposits mantle the flanks and valleys in the older bedrock topography. They are composed principally or entirely of glacial deposits of varying origins. The bulk of the section appears to be till and clay with lesser amounts of sands and gravels. Units of both range in thickness from a few inches to as much as 50 feet or more. The maximum overall thickness of the Pleistocene deposits is more than 207 feet (Well 15E3). Where the bedrock crops out at the surface, the Pleistocene deposits are absent. (See Geologic Map - Figure 2, Cross Sections, Figure 3 and Depth to Bedrock Map - Figure 4.)

The configuration of the base of the Pleistocene mantle suggests moderately rugged topographic relief on the bedrock surface in pre-Pleistocene time. Glacial debris was deposited directly from the ice and in a lake environment resulting from ice ponding. Surface soils are generally gravelly and moderately well drained.

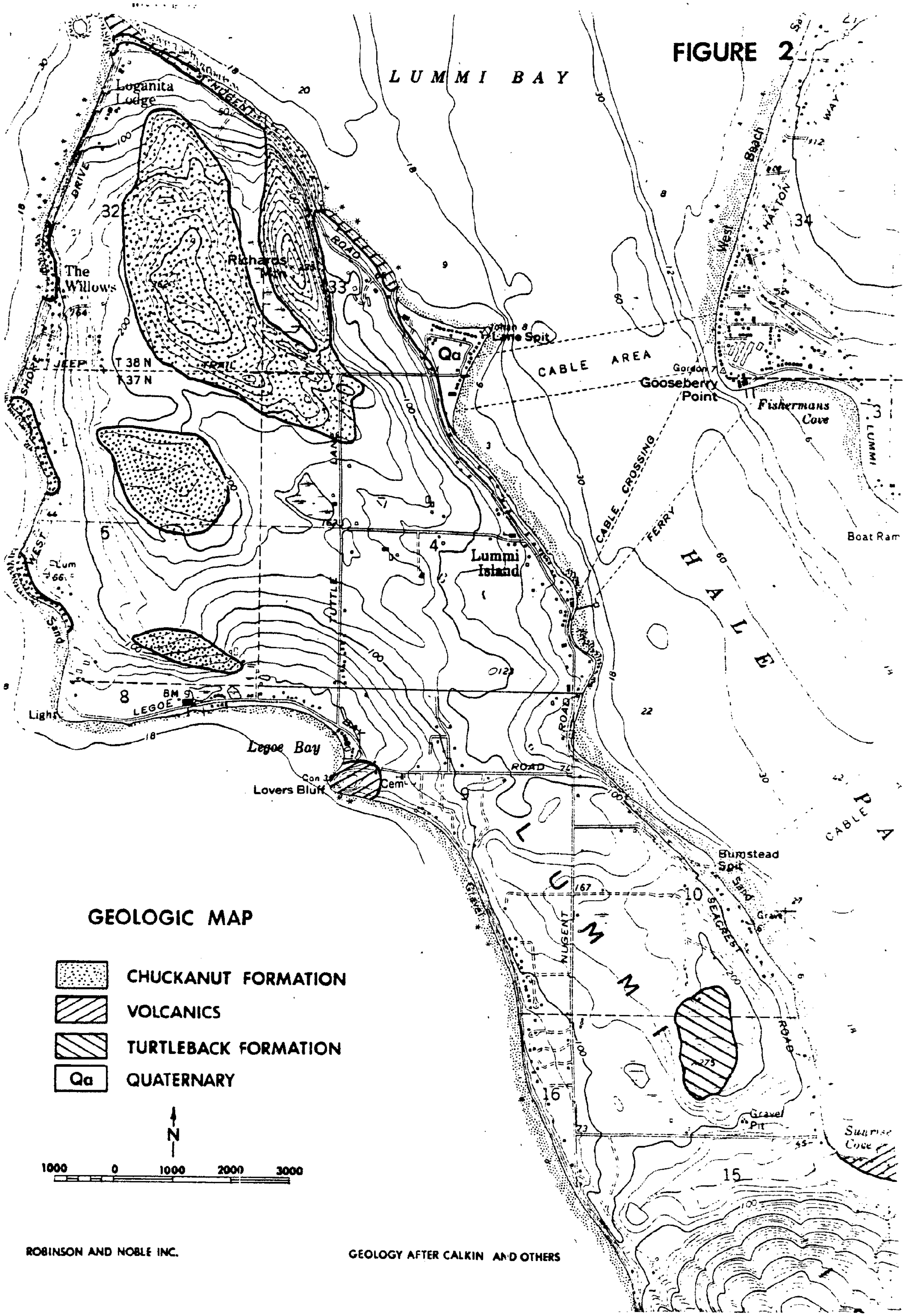


FIGURE 2
LUMMI BAY
Loganita Lodge
Richards Mtn
The Willows
Lane Spit
CABLE AREA
Gooseberry Point
Fishermans Cove
CABLE CROSSING
FERRY
Lummi Island
HALE PA
Boat Ram
Legoe Bay
Lovers Bluff
LEGOE BAY
Bumstead Spit
LUMMI
Gravel Pit
Sunrise Cove
T 38 N
T 37 N
JEEP TRAIL
WEST SHORE DRIVE
NUGENT ROAD
TUTTLE LANE
SEACREST ROAD
West Beach
HAXTON WAY
GEOLOGIC MAP
CHUCKANUT FORMATION
VOLCANICS
TURTLEBACK FORMATION
Qa QUATERNARY
N
1000 0 1000 2000 3000
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GEOLOGY AFTER CALKIN AND OTHERS

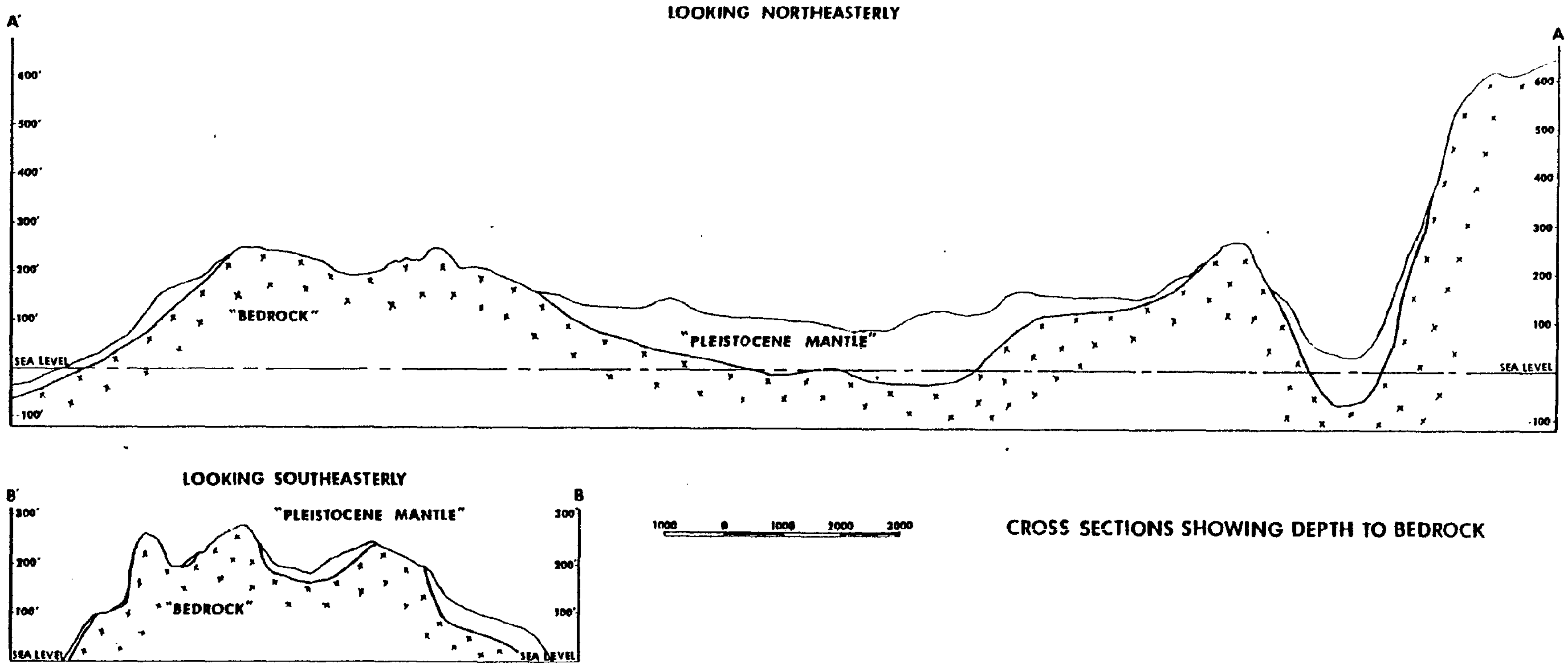
Extensive discussion of both the bedrock and the Pleistocene geology has been presented in the publications cited under Previous Work. Since these details are not pertinent to the task at hand, they will not be repeated or abstracted here.

HYDROLOGY

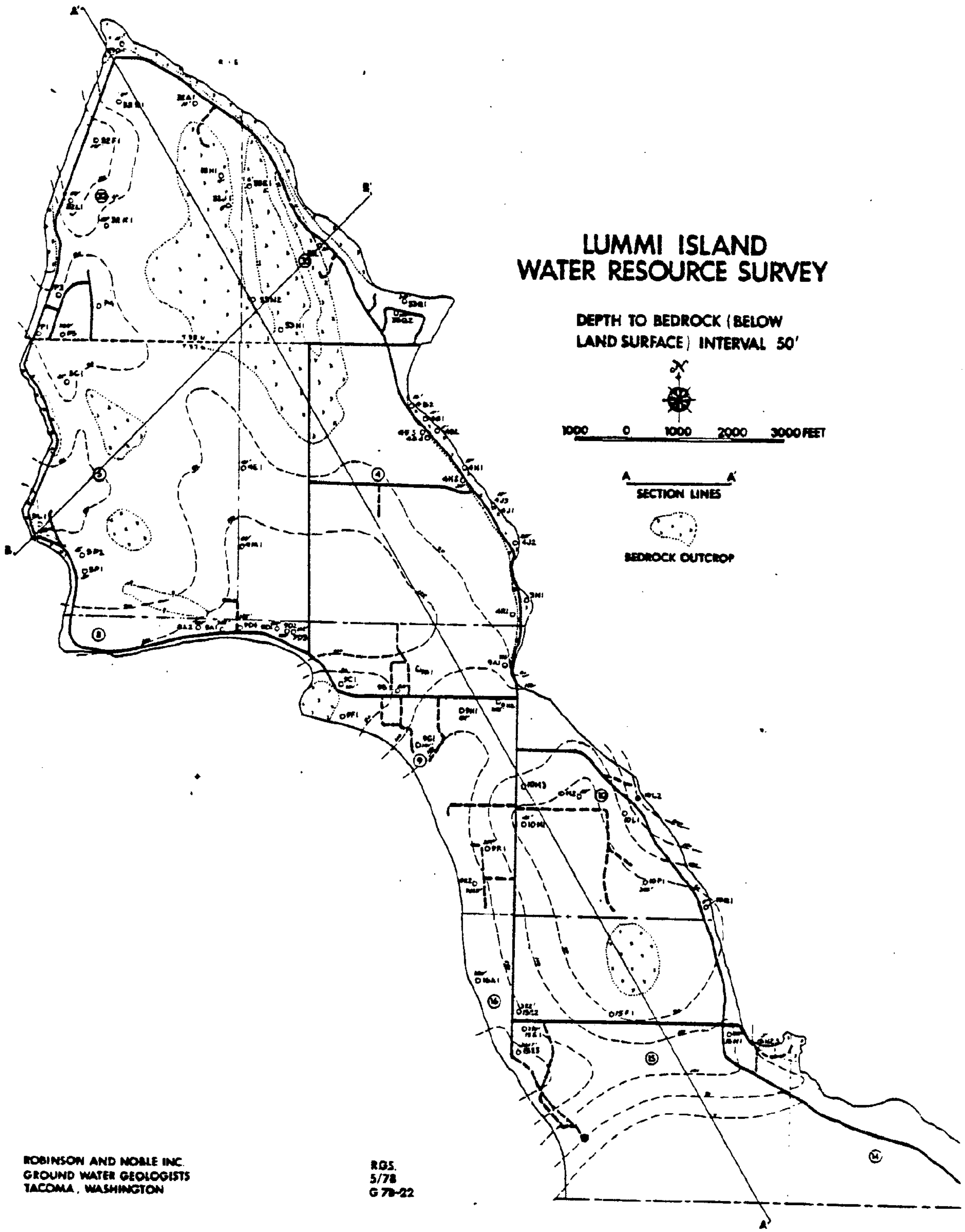
Climate

Formal weather data for Lummi Island is not available because of the absence of a weather station on the island. In order to deal with the hydrology of the area, the data were gathered from the two nearest weather station locations, Olga on Orcas Island, and Bellingham on the mainland. These data summaries are presented in Appendix A. The average rainfall at Olga is 27.9 inches per year and that for Bellingham is 49.1 inches per year. Because Lummi lies within the edge of the Olympic Rain Shadow, the average precipitation is judged to be somewhat less than the average between Olga and Bellingham, or about 36 inches per year. However the southern part of the island is very mountainous and probably receives over 40 inches per year leaving a net rainfall average of perhaps 32 inches for the northern part of the island which is generally the lowland area.

In other respects the climatic conditions are similar to conditions either in the San Juans or the mainland. Mean annual temperature is just under 50°. The winter mean is probably about 39°F and the summer mean is estimated to be about 58°F. As judged by observation of vegetation, topography, and cultural features, the climate is a marine type with cool dry summers, mild wet winters, and rather narrow daily fluctuation in temperature.



CROSS SECTIONS SHOWING DEPTH TO BEDROCK


LUMMI ISLAND
WATER RESOURCE SURVEY
DEPTH TO BEDROCK (BELOW LAND SURFACE) INTERVAL 50'
1000 0 1000 2000 3000 FEET
A A'
SECTION LINES
BEDROCK OUTCROP
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RGS.
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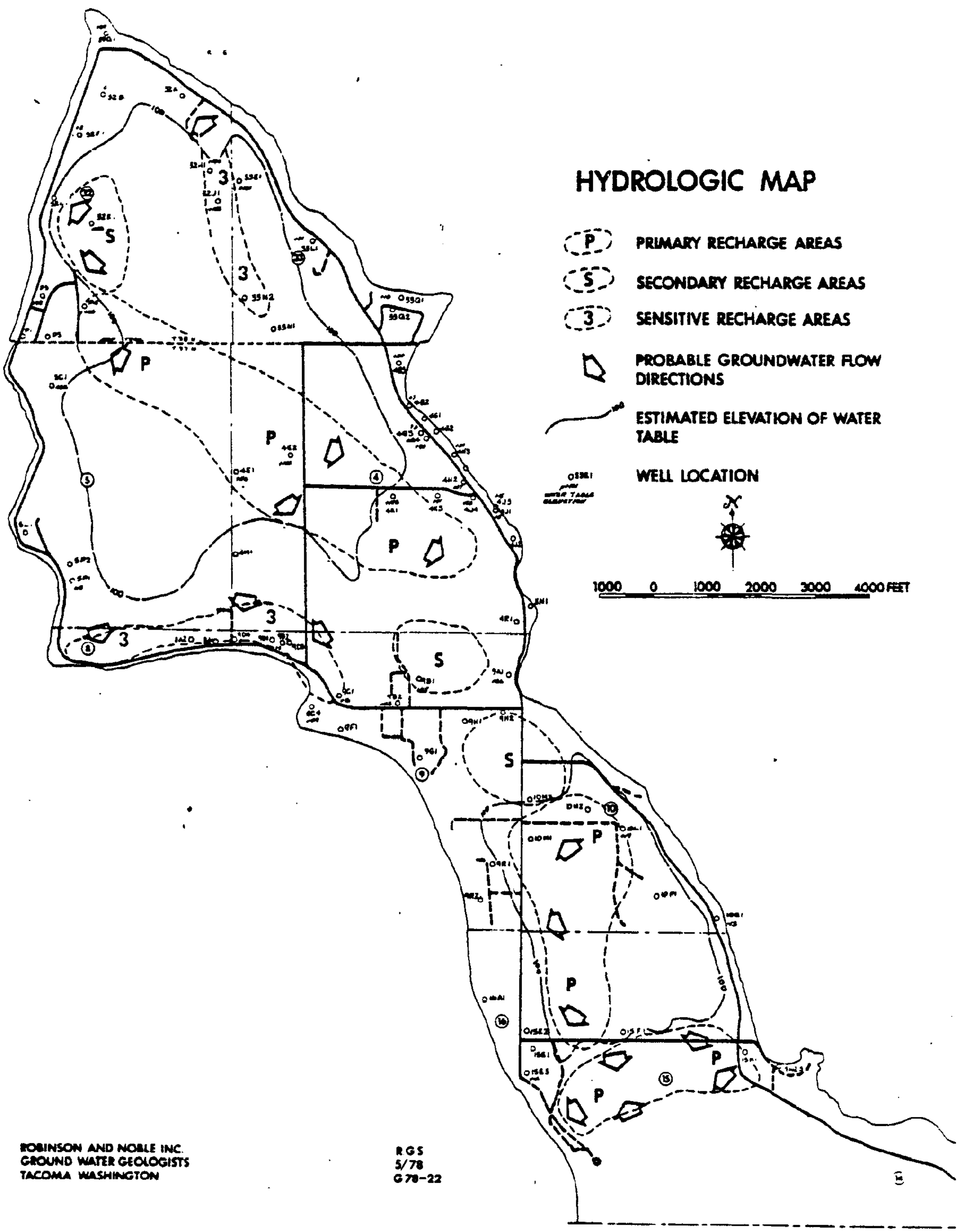
Hydrogeology

The geologic framework described above reduces itself to two basic hydrologic regimes. The bedrock, in which water is stored in fractures and fissures in the relatively impermeable ground mass of the rock, and the Pleistocene sedimentary mantle. In the latter case, water is stored in both the permeable sands and gravels and in the much less permeable but still quite porous silts and tills. The storage capacity of the silts and tills is judged to be at least ten times as good as the bedrock and the transmissivity (ability of the water to move through the material) is judged to be generally higher. Wells which penetrate the bedrock have moderate to low yield. In some cases the yield is so low that the well cannot be used for domestic purposes. In the absence of sufficient water at shallow depths several wells have been drilled from 200 to 300 feet in bedrock. Those wells have significantly lower water quality.

General geologic conditions indicate that there is both a regime water table and one or more perched water tables. In areas at or near the coast the water table is near sea level. Inland, and especially in the areas where bedrock is at or near the surface, wells have an independent and much higher water table. There is no evidence for confined aquifers either at shallow or greater depths. All of the ground water present is believed to be derived from infiltration from precipitation or, at greater depth, from sea water intrusion.

Because the surface soils tend to be granular and in some cases coarsely granular, infiltration takes place readily. Where the slopes are very gentle and where sufficient fine soil materials or bedrock lie near the surface, there are marshy spots and infiltration



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may not be as rapid. Nevertheless it is in many of these relatively flat areas where the water table is shallow that the majority of the infiltration probably takes place for the Pleistocene materials.

Observations concerning the water table gradient await additional data concerning water table elevation in drilled wells. At the present time, only a handful of such data exists and anything more than a general description cannot be made as yet. Most of the recharge rainwater is wasted to the sea in coastal areas and beneath the lens of fresh water on the island.

Water Quality

In 1971 the U. S. Geological Survey and State Department of Ecology cooperated in a study of sea water intrusion along coastal areas for the state. They concluded:

> "On Lummi Island, sea-water intrusion is presently (1968) a problem only along the northeast shoreline between the northernmost point of the island and the community of Lummi Island, and for about half a mile east of Village Point (pl. 8). The highest chloride concentration (355 mg/l) sampled was from well 37/1-4J1, which is 55 feet deep and taps a sandstone aquifer. No wells are now in use in the intruded area east of Village Point. Chloride concentrations of 15 to 30 mg/l are common on the island and do not indicate intrusion, as some of the concentrations in that range are from wells that do not extend to sea level. However, substantial increases in ground-water withdrawal on the island without danger of intrusion probably could be accomplished by means of widely spaced wells, each of fairly low yield"

At the present time the U. S. Geological Survey is gathering samples to update that ten-year-old study. Sampling done within the scope of the report does not reveal any areas of serious salt water intrusion although there are some wells which show more than twice the background content of 20 ppm chloride. Most notably Well 38/32P4 has an usually high chloride content indicating either intrusion or penetration of brackish water at the base of the fresh water lens.

Production Potential

From a water production point of view the greatest potential for sustained yield at moderate production rates appears to be sand and gravel layers and lenses within the Pleistocene mantle. Although this regime has potentially the greatest storage capacity, the sand and gravel layers are relatively thin. A potential of 20 to 30 gpm per well should be the maximum design criteria for water resource planning purposes.

Water Budget

In order to provide an estimate of the resource base available for water resource planning in the next section of this report, an estimate must be made of the hydrologic budget. Preparation of such a budget requires accounting for all of the water entering and leaving the system. Although such a budget usually requires accounting for approximately nine terms an island system such as Lummi permits a more simplified approximation accounting for only four terms. Figure 6 is a presentation of the overall budget considerations and a tabular presentation of the data.

As already outlined, precipitation (P) for the north part of Lummi Island is estimated to be 32 inches per year. By using a standard technique for such estimation outlined in Appendix B, values for R & I and Et may be derived. Specific measurement of drainage

FIGURE 6

LUMMI ISLAND WATER RESOURCE STUDY

WATER BUDGET CALCULATIONS

A. GENERAL WATER BUDGET EQUATION

$$P + I = R + Et + O + W + G + S + Sm$$

where:
- P = Precipitation
- I = Inflow from surrounding regions
- R = Stream runoff
- Et = Evapotranspiration
- O = Groundwater
- W = Wastage at base of fresh water lens
- G = Changes in ground water storage
- S = Changes in surface water storage
- Sm = Changes in soil moisture

B. SIMPLIFIED WATER BUDGET EQUATION - Applicable to Lummi Island Study Area

$$P = R + I + Et$$

where:
- P = Precipitation
- R = Surface runoff
- I = Infiltration
- Et = Evapotranspiration

I. Precipitation (P)

Bellingham = 49.1 in/yr average
Olga = 27.9 in/yr average

Average of the two stations = 38.5

N. Lummi estimated P = 32 in/yr
S. Lummi estimated P = 46 in/yr

II. Runoff (R), Infiltration (I) and Evapo-transpiration (Et)

Et = Estimated by standard practice
(Thornthwaite, method - see Appendix B)

Et = 21 inches

P = R + I + Et

32 = R + I + 21

R + I = 11 inches

III. Calculation of four cases for Reasonable Value Ranges for R + I

	A	B	C	D
R =	6 inches	4 inches	3 inches	2 inches
I =	5 inches	7 inches	8 inches	9 inches

IV. Recoverable Underflow - Estimated as 50% (maximum) of I

	A	B	C	D
UR = inches/yr	2.5	3.5	4	4.5

V. Annual Recoverable Water (QR) - Sustained Yield (QR = Area x UR)

	A	B	C	D
QR gallons	173,760,000	243,264,000	278,016,000	312,768,000

VI. Population and Housing supportable under Water Management Program disregarding short-term supply/demand variables and assuming permanent population.

	A	B	C	D
Population	4760	6665	7617	8567
Dwelling Units	1763	2468	2821	3173
Population Density	1.9/acre	2.6/acre	3.0/acre	3.3/acre

VII. Population and Housing supportable under no Management Program

Population	2380	3333	3800	4284
Dwelling Units	880	1234	1410	1586
Population Density	1/acre	1.25/acre	1.5/acre	1.7/acre
Housing Density	2.9ac/Du	2.0ac/Du	1.8ac/Du	1.6ac/Du

basin runoff would be necessary to determine a specific value for R. Since that data is not available, calculations have been based on assumed values for R & I for four cases which together are believed to represent a reasonable range of real values. Thus the estimated maximum groundwater which could be produced annually within a carefully managed program is shown in calculation V. Translated to population demand and dwellings which could be supported, these figures yield calculation group VI. Without management, the best performance (yield) which could be expected is shown in calculation VII. Within the range of values given under the assumptions of A, B, C & D, the values represented by A or B are preferred as appropriately conservative until additional data from a management program might permit more relaxed conditions.

WATER RESOURCES

General

The hydrologic budget developed above represents the broad concept of the hydrologic cycle. Driven by the sun's energy both directly and indirectly through wind, the water resources of the world are part of a dynamic process of movement. In certain ways living things intercede in that process and affect the dynamic balance which is a product of the physical processes. The amount and nature of the vegetation which covers the land directly affects the evapotranspiration rate as one example. In addition, human intervention through growing technology and increasing demands for water resources has become an increasing factor in what otherwise is a totally natural cycle. By intercepting either surface water

WATER RESOURCE DEVELOPMENT OPTIONS

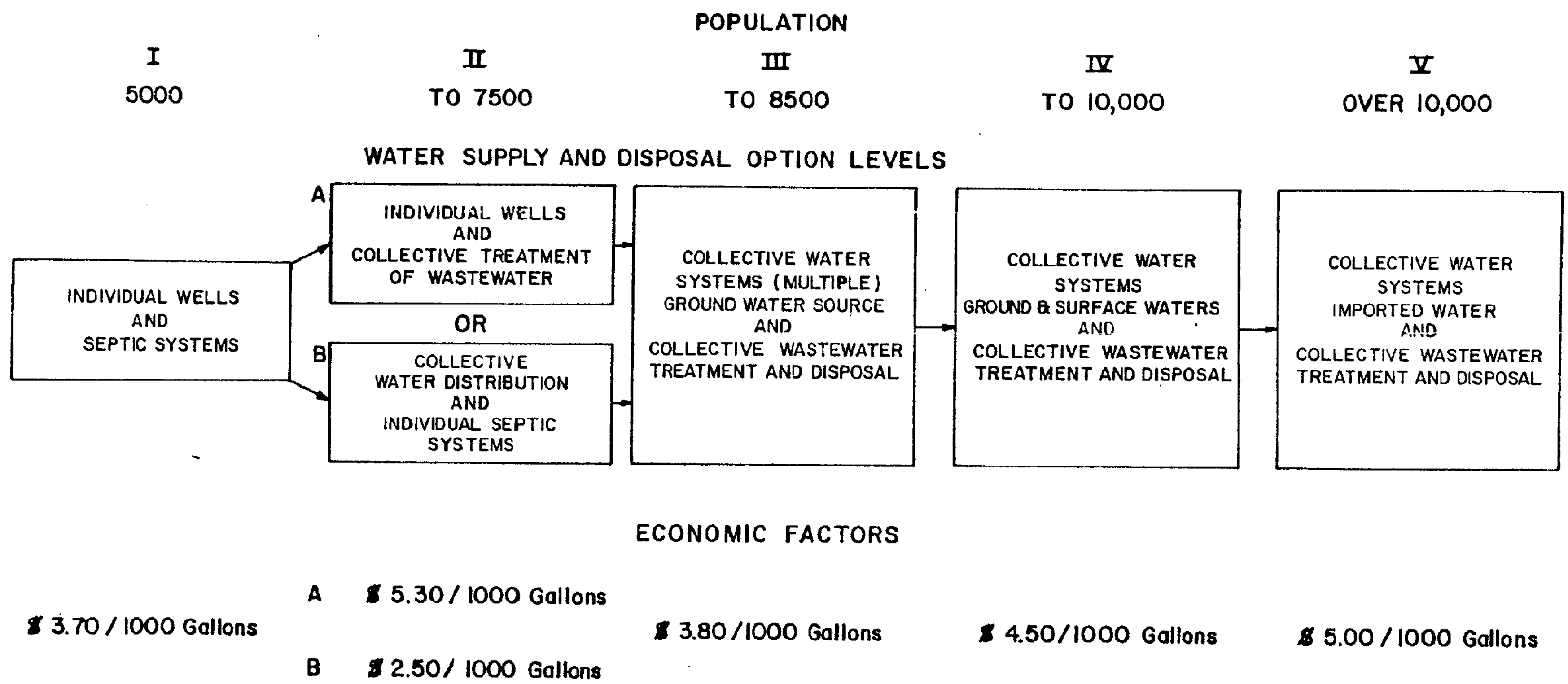

FIGURE 7

or ground water in that portion of the cycle where water moves through or over the land surface we are able to utilize the water for various purposes. Almost all of the water is returned to some other portion of the hydrologic cycle. If we view man's interception as a sub-cycle in itself, we must deal with balancing concepts of supply and demand bringing these into some sort of reconciliation by a management "routine" or set of management principals.

Supply

The overall framework or resource base was established for the Lummi Island study area under the Hydrology section above. In the absence of concrete data for the assumed values or ranges of values shown, we must necessarily adopt a conservative position with respect to estimates of supply. Analyses of the range of variables will be expedited by developing the concepts of three alternate routes:

Alternative A - Dispersed Private Wells. This production alternative is the one which has been historically used because it is the least costly and lends itself to a population base which is also dispersed, has low density and relatively low requirements for water.

Alternative B - Community Water Systems - Wells. This is a somewhat more sophisticated version of the first alternate. Multiple wells are combined into a water system serving more than one user. Such systems may be very simple or much more complex depending upon the hydrologic setting, the distribution and the number of users.

Alternate C - Public Utility System. Such a system is usually utilized in instances where user requirements and/or environmental factors require an engineered capital-intensive water distribution system.

Because these alternatives are closely related to and indirectly impacted by environmental factors related to waste water and solid waste disposal, consideration of system alternatives must also take into account waste water systems. Figure 7 shows five alternative stages of water resource development and utilization associated with appropriate levels of population. It should be clear that there are not distinct boundaries between these alternatives. Many urban areas or suburban regions are served by all of these alternatives. They are here divided for purposes of contrast, comparison and analysis. So, too, the economic framework constructed for better understanding of the alternatives is generalized, assumptive and not intended to represent engineering estimates of the costs of such systems. Such an analysis would require much more detailed information than is currently available and a much more rigorous engineering treatment of that data than is possible within the scope of this study. Nevertheless, the alternatives and their economic correlatives serve to illustrate variations in cost. Because the data have been adjusted for island conditions, they cannot be compared to typical costs encountered in urban or suburban situations.

There are a variety of engineering measures which could lend themselves to enhancement of the supply. Included among these would be dams or levees to create surface water impoundments, grout curtains to reduce groundwater underflow and various types of storage structures. The specific selection of one or more of these would depend not only upon the geologic, topographic and climatic conditions, but also upon economic factors. All are highly capital intensive and relatively high in operating, repair and maintenance costs.

Demand

Neglecting commercial or industrial utilization, water demand for residential purposes is directly related to population, socia-economic or technology level and supply. In the absence of limits to supply, demand is determined entirely by the first two factors. Calculated as an average daily requirement, demand has slowly been increasing over the years from approximately 50 gallons per day per person at the turn of the century to a current utilization for the United States of almost 100 gallons per day per person. For planning purposes this historic growth per capita is usually projected to a figure of approximately 150 gallons per day per person on a national average, including commercial, industrial and agricultural usage. It should be noted that these demands fluctuate considerably not only within a daily time frame but with annual and sometimes other periodicity. Because utilization is highly time dependent, the Department of Social and Health Services in the State of Washington requires a planning figure of 800 gallons per day per dwelling unit for water system design. This is more than twice the average daily requirement for a dwelling unit containing 3.5 people at a current national average use level of 100 gallons per day per person. The average figure of 2.7 persons per dwelling unit is indicated as appropriate for Lummi Island. Although average utilization is probably less than 100 gallons per day per person, that figure has been utilized for purposes of this plan. It should be recognized that utilization of national standards would require 150 gallons per day per person, a figure that is probably reasonable for the level of usage which might be expected from a fair proportion of new dwelling units to be built in the future.

Management Principals

Balancing supply and demand so as not to create dislocations and to accomodate the expectations of users within a reasonable economic framework is the basic requirement of a water resource management system. In order to do so, management personnel must have a very accurate picture of both the available supply and the time and space related factors which bear upon it. They must also understand as completely as possible the entire fabric of demand and its time and space variables as well. The system requires adequate background knowledge of the scope of the resource, how that resource increases or diminishes under natural conditions and under the impact of demand patterns. Adjustments can then be made either in capacity, delivery, or in reduced utilization in order to keep the system in balance.

The essential elements for effective management then are:

- Accurate Resource Base
- Accurate Supply Data
- Accurate Demand Data
- A "reporting" system of feedback loops which relay data from each area to the others to permit management decisions to be made.

CONCLUSIONS AND RECOMMENDATIONS

The absence of an economic framework for implementation of a viable, active water resource management plan mitigates against presenting one at this time. Instead, the current and immediate future needs of the community and its ability to execute water management functions dictate that a passive or land-use regulatory management approach be adopted at this time.

The following suggestions are presented for consideration:

A. Regulate by zoning, conditional-use ordinance, or other appropriate statutory authority the population density and land use in order to balance development needs against available water resources.

B. Under interim standards, such as those suggested in Figure 8 ~~B~~, continue to gather additional and more accurate data to add to the data base. This could be achieved either through volunteer technical help from one or more island residents, through county-funded professional staff time, through state or federal agency cooperative programs, or through federal or state grant programs.

C. As demand increases, and the perception of the need for a management program becomes more acute and widespread, appropriate mechanisms for active program management can be introduced.

D. The first incremental change which would have both management and economic advantages would be the consolidation of individual user facilities into user groups under some kind of "cooperative" system of management. Such groups should be formally constituted under county and state regulations to guarantee adequate engineering and management standards. If organized under the expectation of later consolidation, the transition to a comprehensive management system could be expedited.

E. Because of the obvious dangers of salt water intrusion, septic tank pollution and well interference, it may be possible to constitute a "critical water supply service area" under new state law (HB 165). This designation establishes the mechanism for a viable cooperative management program and should be thoroughly investigated as a means of expeditious implementation of a management program.

F. Solid waste disposal by landfill should be prohibited on the study-area portion of the island. Appropriate regulatory machinery should be investigated to evaluate its effectiveness as a deterrent against even casual abuse.

Suitability Matrix

In order to implement an interim control strategy, a matrix of tentative standards has been prepared (Figure 8).

One scenario for use of the matrix might be to require application for building permits to contain:

A. Predrilling of a domestic well to prove adequate water supply. The well report should show:

- Depth to bedrock.
- Depth to water table.

FIGURE 8

ON-SITE WASTEWATER DISPOSAL SUITABILITY MATRIX

	1 Geologic Setting	2 Bedrock Depth	3 Depth to Water Table	4 Primary Recharge Area	5 Secondary Recharge Area	6 Sensitive Recharge Area	7 Slope	8 Elevation	9 Soil Thickness
Septic Tanks Permitted Density A	P P	>50' <50>25	>25' <25>15	No No	Yes No	No No	>5% >5%	NS NS	>5' >5'
Septic Tanks Permitted Density B	P	>50'	>25	Yes	Yes	No	>5%	NS	>5'
Septic Tanks Conditional*	P P & C	<50>15 <50>15	<25>10 <25>10	No No	Yes No	No No	>5% <5%	NS NS	>5' <5'
No Septic Tanks	V C	<15' <15'	<10' <10'	NA NA	NA NA	NA NA	<5% <5%	<10' <10'	<5' <5'

NOTES:

1 V = Volcanics
C = Chuckanut SS
P = Pleistocene

NS = Not Significant
NA = Not Applicable
* Requires Test & Geology Report. All other conditions not listed.

Interim Density Standards: A = 3 acres/Du B = 6 acres/Du
Matrix to be included in Conditional Use Ordinance.

- Elevation and location.
- Driller's log with pump or bailer test data, casing data, descriptive log

B. Results of percolation test for septic tank.

Based on the data supplied and using the matrix - determine suitability and approve, require additional data, or disapprove.

Additional Data

Utilizing personnel and/or finding sources as mentioned above, the following data should be gathered.

Inventory

- Accurately locate all wells on the island.
- Determine total depth, diameter, depth to water, materials penetrated, and all other data shown on well schedule form wherever feasible.
- Plot such data from all new wells drilled on the island.
- Maintain and improve detail on the basic maps in report using this data.

Longitudinal Studies

- Establish a weather station on the island (The Olga station on Orcas has been operated by one family since 1889!). Gather temperature and precipitation data.
- Measure runoff on one or more of the island drainage basins to establish a better R factor for the water budget.
- Measure water table elevations in several wells in both bed-rock and Pleistocene materials and establish long-term fluctuation patterns.

- Sample and conduct periodic measurements of chlorides in selected deep wells and coastal wells to determine changes in the sea water intrusion flux.

Interference/Intrusion Studies

Higher capacity wells sometimes reduce the capacity of surrounding wells. They can also induce sea water intrusion and contamination of the aquifer thus reducing water quality in their vicinity. For these reasons a careful testing program should be required for any well designed to serve more than a single dwelling unit. That program should provide for regression analysis, removal of tidal effects in neighboring observation wells and for multiple testing for chlorides at the start, during and at the end of the pump test. Decisions concerning establishment of capacity limits for such wells should be based on this data.

Respectfully submitted,

ROBINSON & NOBLE, INCORPORATED
Ground Water Geologists

By Ronald G. Schmidt
Ronald G. Schmidt

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A P P E N D I X   A

CLIMATOLOGICAL DATA

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
IN COOPERATION WITH WASHINGTON STATE FERRIES
CLIMATOGRAPHY OF THE UNITED STATES NO. 20 – 45

LATITUDE 48° 37'
LONGITUDE 122° 48'
ELEV. (GROUND) 80 feet

CLIMATOLOGICAL SUMMARY

STATION OLGA, WASHINGTON
(Orcas Island)

MEANS AND EXTREMES FOR PERIOD 1929 – 1958

Month	Temperature (°F)							** ‡	Precipitation Totals (Inches)									Mean number of days					Month
	Means			Extremes								Snow, Sleet							Temperatures				
																			Max.		Min.		
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean degree days	Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year	Precip. .10 inch or more	90° and above	32° and below	32° and below	0° and below	Month
(a)	30	30	30	30		30		30	30	30		30	30		30		30	30	30	30	30	
Jan	43.2	33.1	38.2	65	1931	-8	1950	820	3.79	3.40	1935	2.8	19.7	1950	7.5	1954	10	0	3	12	0	Jan
Feb	46.6	34.6	40.6	65	1931	5	1936	680	2.93	2.80	1949	1.2	6.5	1937	4.5	1936	8	0	*	9	0	Feb
Mar	50.8	36.8	43.8	68	1941	14	1955	660	2.53	1.74	1948	.8	18.4	1951	5.0	1951	8	0	0	6	0	Mar
Apr	57.0	40.2	48.6	76	1941	28	1936	490	1.58	.89	1942	T	.7	1955	.5	1955	5	0	0	1	0	Apr
May	62.8	43.9	53.4	83	1958	31	1954	370	1.27	1.98	1948						4	0	0	0	0	May
Jun	66.7	47.3	57.0	86	1955	37	1933	240	1.49	1.85	1946						4	0	0	0	0	Jun
Jul	70.2	48.9	59.6	92	1941	40	1949+	180	.86	1.10	1954						3	*	0	0	0	Jul
Aug	70.4	49.4	60.0	89	1939	42	1949+	160	.82	1.22	1956						3	0	0	0	0	Aug
Sep	66.0	47.7	56.9	87	1951	37	1951+	250	1.51	.92	1945	T	T	1950	T	1950	5	0	0	0	0	Sep
Oct	58.1	43.6	50.9	76	1932	26	1935	430	3.09	2.61	1945	T	T	1957+	T	1957+	9	0	0	*	0	Oct
Nov	49.8	38.7	44.3	64	1950	10	1955	620	3.72	1.83	1955	.2	5.0	1937	3.5	1937	9	0	*	4	0	Nov
Dec	46.2	36.3	41.3	60	1939	14	1951	740	4.34	1.82	1956	.8	5.5	1955	4.0	1949	12	0	*	8	0	Dec
Year	57.3	41.7	49.6	92	Jul 1941	-8	Jan 1950	5640	27.93	3.40	Jan 1935	5.8	19.7	Jan 1950	7.5	Jan 1954	80	*	3	40	0	Year

(a) Average length of record, years.
T Trace, an amount too small to measure.
** Base 65°F
\+ Also on earlier dates, months, or years.
* Less than one half.
‡ Estimated.

NARRATIVE CLIMATOLOGICAL SUMMARY

Olga is located on Orcas Island, the largest island of the San Juan group. The San Juan Islands are located between the northwestern Washington coast and Vancouver Island, British Columbia, and includes 172 islands ranging in area from less than one acre to approximately 57 square miles. The terrain is rather rough and a large portion of most of the islands is covered with timber. The highest point in the San Juan Islands is Mt. Constitution, elevation 2454 feet, located on Orcas Island. The summit of Mt. Constitution is an excellent view point from which many of the San Juan Islands and some of the Washington and Canadian coastal areas can be seen. The summit is easily reached by a good highway during most of the year. Some of the more level land on each of the larger islands is devoted to agriculture. All transportation to and from the islands is by ferry, plane or privately-owned boats. Ferries which carry both passengers and vehicles are operated on a regular schedule during the entire year by Washington State Ferries, from Anacortes, Washington, through the San Juan Islands to Vancouver Island, British Columbia. The following islands in the San Juan group are served by the Washington State Ferries: Lopez, Orcas, San Juan and Shaw. The remainder of the islands are reached by plane, boat or privately-operated ferry. The winding waterways between the islands, sheltered bays, inlets and beautiful beaches have made the San Juan Islands a very popular cruising place for private boats and vacation areas. The largest public recreation area is Moran State Park. However, there are numerous smaller public and privately-operated recreational areas on each of the larger islands. The operation of resorts and other facilities for tourists are important sources of income on the islands.

The climate in the San Juan Islands is predominately a marine-type with cool summers, rather mild winters, moist air and a small daily range of temperature. Some of the factors which influence the climate in this area are: terrain, distance and direction from the Ocean and the position of the semi-permanent high and low pressure centers located over the north Pacific Ocean. Mountains, ranging in elevation from 4000 to 7000 feet, on the Olympic Peninsula and Vancouver Island protect the islands from storms moving eastward over the Ocean. In an easterly direction, and at a distance of approximately 50 miles, the Cascade Mountains rise to elevations of 5000 to 7000 feet, with peaks in excess of 10,000 feet and form a major north-south topographic and climatic barrier across the State. The Cascade Mountains protect this area from the low temperatures in the winter and the high temperatures in the summer, which are experienced east of the mountains. The lowest temperatures during the winter usually occur when a high pressure area develops over the Pacific Northwest and cold air moves out through the Fraser River Canyon into northwestern Washington and the San Juan Islands. Cold weather associated with an influx of air from the interior of the continent seldom lasts more than a few days.

Snow occurs rather frequently at the beginning and end of these periods of low temperatures. Snow depth seldom exceeds a few inches in the lower elevation or remains on the ground for more than a few days. The prevailing direction of the wind is south or southwest during most of the year. The highest temperatures in the summer and lowest in the winter usually occur with north or northeast winds. The average temperature of the water surrounding the San Juan Islands ranges from about 45 degrees in February to 52 degrees in August. The average afternoon temperature in mid-summer is about 70 degrees. Maximum temperatures in excess of 85 degrees occur very infrequently. The average daily range of temperature increases from about 10 degrees in the winter to 20 degrees during the summer.

The high pressure area over the Ocean becomes smaller and moves southward during the fall and winter, and the low pressure area, with its center near the Aleutian Islands, intensifies and also moves southward. A clockwise circulation of air around the high pressure center and a counter-clockwise circulation around the low pressure brings a flow of warm and moist air into western Washington and the San Juan Islands. Cooling and condensation occur as the air rises along the southwestern slopes of the mountains on Vancouver Island and the Olympic Peninsula, resulting in heavy precipitation in those areas and light precipitation along the northeastern slopes of the mountains and in the San Juan Islands. The fall rains usually begin about October and continue until March. The driest weather occurs in July and August. A difference of several days in the length of the growing season can be expected with changes in elevation and distance from the waterfront.

WASHINGTON STATE FERRIES
Colman Ferry Terminal
Seattle 4, Washington

Earl L. Phillips
State Climatologist
Weather Bureau
Seattle, Washington

Average Temperature (°F)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1929	33.9	36.8	45.4	47.4	53.4	57.9	61.6	61.5	58.0	52.6	43.0	41.3	49.4
1930	29.5	42.4	44.6	50.8	52.3	57.4	59.1	61.4	57.1	48.9	43.8	42.4	49.1
1931	46.0	43.3	46.4	50.9	55.1	56.9	60.7	59.2	56.8	50.2	41.6	41.2	50.5
1932	36.6	39.6	44.5	48.8	52.2	57.0	57.0	58.6	56.0	50.8	46.8	36.8	48.6
1933	37.6	35.6	43.0	46.2	50.4	54.4	57.1	60.6	53.8	50.8	45.2	42.0	48.1
1934	43.4	46.0	48.0	52.4	54.7	57.8	59.5	60.9	56.4	52.4	48.4	41.6	51.7
1935	38.6	43.5	41.8	47.8	52.6	57.8	56.6	59.6	57.0	48.4	42.3	44.2	49.4
1936	41.6	31.4	41.3	49.2	54.0	58.3	59.5	60.2	55.2	52.3	43.8	41.7	49.0
1937	29.7	38.8	46.6	47.5	53.4	58.3	59.8	59.6	57.2	53.4	46.0	42.3	49.4
1938	40.6	41.8	44.8	50.2	54.1	58.2	61.4	58.6	58.6	51.9	43.2	41.8	50.4
1939	42.4	38.4	44.2	49.6	54.3	55.4	60.0	61.8	57.6	50.8	[illegible]	46.6	50.8
1940	43.0	44.6	47.8	51.8	56.1	59.3	60.7	61.4	59.2	53.8	42.0	43.8	52.0
1941	43.6	45.3	50.0	52.6	54.8	58.9	63.7	61.0	56.5	52.2	46.6	41.2	52.2
1942	40.4	42.4	44.2	48.8	53.4	56.7	61.9	62.4	56.5	51.8	42.8	41.6	50.3
1943	33.5	43.2	42.4	48.8	51.5	56.2	58.0	59.0	58.5	51.4	45.8	41.0	49.2
1944	41.6	41.2	42.7	48.8	52.6	56.6	59.9	59.4	57.4	53.8	46.0	40.0	50.0
1945	42.1	42.4	43.1	46.4	54.2	56.0	59.2	60.1	54.7	51.0	42.6	40.6	49.4
1946	40.9	41.9	43.6	47.3	54.8	56.8	60.4	59.8	56.4	48.0	40.9	39.0	49.2
1947	35.8	43.4	40.9	49.0	55.0	56.3	60.6	59.9	56.4	50.8	42.4	41.9	50.0
1948	39.2	37.8	42.6	46.4	52.0	58.4	58.8	58.6	56.0	49.6	42.6	36.1	48.2
1949	31.6	37.0	44.6	48.5	54.1	56.5	57.4	58.8	57.6	47.7	48.8	38.5	48.4
1950	24.4	40.2	42.1	46.7	48.9	57.8	58.7	59.5	56.0	48.9	43.1	44.8	47.6
1951	37.6	40.2	39.5	49.0	52.8	58.4	59.9	59.1	56.5	50.0	44.4	36.6	48.7
1952	37.3	41.2	42.3	47.7	52.4	53.9	58.6	59.0	57.8	52.7	43.4	43.0	49.1
1953	43.7	41.5	44.1	47.4	53.3	55.3	59.1	60.7	56.7	51.7	47.1	42.6	50.3
1954	35.9	42.2	41.5	46.1	52.9	54.4	57.0	57.3	56.5	50.1	46.3	41.8	48.6
1955	39.8	37.9	38.0	44.4	48.9	55.5	56.2	57.9	55.3	49.3	38.4	37.6	46.6
1956	39.1	36.0	41.1	48.6	54.6	55.1	59.9	59.0	55.3	48.6	42.5	39.9	48.3
1957	31.9	37.7	43.4	48.5	54.7	56.8	58.1	59.4	60.1	50.8	44.3	42.8	49.0
1958	44.3	46.3	46.3	49.2	56.5	61.0	64.2	61.8	58.1	51.5	42.4	43.3	52.0

STATION HISTORY

The cooperative weather observing station located on Orcas Island has remained in the same location since it was first established at the residence of Richard C. Willis in January 1891. The station is located approximately two miles southeast of Olga, and is on the east slope of a small hill, slightly less than ½ mile from the beach. This station has the distinction of being one of the very few climatological stations which has remained in the same location and where records have been kept by members of the same family since before the turn of the century. The weather observational duties have been passed along from father to son since the station was established. The following members of the Willis family have been the official observers:

Richard C. Willis	January 1891 - December 1907
Cecil B. Willis	January 1908 - May 1927
Culver Willis	June 1927 to date

Mrs. Louise Willis assisted her husband Cecil B. Willis with the observations during the period he was the official observer and has continued to assist her son, Culver Willis, in keeping the climatological records.

Total Precipitation (Inches)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1929	1.11	.85	2.57	.95	.68	.51	.13	.51	.31	1.38	2.01	4.08	15.09
1930	1.32	3.95	2.70	1.75	.88	1.08	T	T	1.47	5.31	1.26	1.22	20.94
1931	4.13	2.58	3.31	.76	.92	2.92	.81	.17	3.43	.85	4.24	2.63	26.75
1932	3.73	4.93	4.68	2.06	.34	.82	3.30	.75	.94	3.27	7.71	3.51	36.04
1933	5.51	1.85	2.75	.36	2.06	1.15	1.30	.60	2.80	4.02	3.48	8.75	34.63
1934	5.92	1.35	2.96	1.07	.78	.07	.58	.95	1.40	1.77	4.30	5.63	26.78
1935	13.04	1.01	3.75	.47	.29	.45	1.14	.61	1.35	2.52	2.21	1.61	28.45
1936	5.65	3.46	2.29	1.19	2.67	1.74	.80	.31	2.04	.98	1.37	6.12	[illegible]
1937	1.52	3.65	1.90	2.20	1.16	3.96	T	1.56	.90	2.47	4.05	6.08	29.45
1938	2.95	1.47	2.11	2.20	.94	.01	.42	.19	1.32	2.83	2.92	6.13	23.49
1939	5.28	3.53	1.07	1.07	1.17	2.26	1.34	.58	.26	3.19	4.36	4.51	26.62
1940	2.20	4.19	3.77	1.06	1.81	.10	.82	.47	1.45	2.80	3.40	3.95	26.04
1941	2.75	1.88	1.12	1.97	2.20	1.20	.37	1.32	2.94	2.37	4.54	4.27	26.53
1942	1.23	1.63	1.47	2.08	1.53	3.40	1.46	.22	.32	1.61	4.51	4.56	[illegible]
1943	1.45	2.80	1.92	2.56	.86	.96	.57	1.77	.49	3.03	1.21	1.83	[illegible]
1944	2.39	2.04	1.70	2.16	.93	1.56	.42	1.03	1.56	1.94	2.78	1.57	20.08
1945	4.47	2.67	2.08	2.55	1.13	.52	.26	.67	3.56	6.42	5.11	3.48	32.92
1946	4.16	2.93	3.71	1.88	.76	3.27	.74	.24	.60	3.50	1.88	3.04	26.71
1947	5.12	2.84	2.58	2.38	1.12	1.50	.51	.87	1.22	5.15	3.77	5.09	32.15
1948	2.96	5.28	2.50	1.69	4.20	2.61	1.09	2.71	1.53	2.50	5.18	5.22	37.47
1949	.62	4.66	2.15	1.22	.59	1.25	1.32	.61	1.76	2.85	5.20	7.33	29.56
1950	2.88	3.34	3.82	1.56	1.05	.41	1.15	1.77	.63	5.00	4.23	4.24	30.08
1951	5.86	4.79	3.18	.47	1.79	.24	.27	.53	1.75	4.93	2.41	3.29	29.41
1952	2.63	2.06	3.40	1.63	1.86	1.45	.65	.37	.68	1.76	.68	2.73	19.90
1953	8.41	2.96	1.49	2.46	1.06	1.73	.99	.71	1.83	2.47	4.92	6.49	35.52
1954	5.74	3.37	.83	1.93	1.33	1.49	1.49	2.17	2.31	1.22	6.49	2.30	30.73
1955	2.29	4.35	2.48	1.87	1.82	2.40	2.34	.34	1.09	4.29	5.99	5.32	34.58
1956	3.14	1.83	2.89	.20	.31	2.91	.30	1.62	2.99	5.81	2.19	6.57	30.76
1957	1.96	2.73	3.76	1.83	.63	1.49	1.35	.61	.47	2.02	1.95	4.22	23.02
1958	3.27	2.88	1.05	1.87	1.15	1.26	.00	.48	1.76	4.24	6.74	3.77	[illegible]

27.93

PROBABILITY OF 32° AND 28° OCCURRING AS LATE IN THE SPRING OR AS EARLY IN THE FALL AS THE DATES LISTED IN THE FOLLOWING TABLES

	PROBABILITY - SPRING MONTHS				PROBABILITY - FALL MONTHS			
	75%	50%	30%	10%	10%	30%	50%	75%
32°	Mar. 6	Mar. 21	Apr. 1	Apr. 18	Oct. 19	Nov. 3	Nov. 12	Nov. 25
28°	Jan. 10	Feb. 9	Feb. 23	Mar. 13	Nov. 10	Nov. 24	Dec. 6	Dec. 30

In the above table, the 50 percent point is the same as the average for each freeze category.

From a statistical viewpoint based on past data, the probabilities could be considered as follows when converted into the number of occurrences to expect in a 40-year period:

75% -	30 years in 40	30% -	12 years in 40
50% -	20 years in 40	10% -	4 years in 40

38.5

DOCUMENTS
OCT 3 1972
WESTERN WASHINGTON STATE COLLEGE

U. S. DEPARTMENT OF COMMERCE WEATHER BUREAU
IN COOPERATION WITH BELLINGHAM CHAMBER OF COMMERCE
CLIMATOGRAPHY OF THE UNITED STATES NO. 20 – 45

CLIMATOLOGICAL SUMMARY

STATION: BELLINGHAM, WASH.

LATITUDE 48° 47'
LONGITUDE 122° 29'
ELEV. (GROUND) 120'

MEANS AND EXTREMES FOR PERIOD 1928 – 1957

Month	Temperature (°F) Means: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Mean degree days ** ∮	Precipitation Totals (Inches): Mean	Greatest daily	Year	Snow, Sleet: Mean	Maximum monthly	Year	Greatest daily	Year	Mean number of days: Precip. .10 inch or more	Temperatures Max.: 90° and above	32° and below	Min.: 32° and below	0° and below	Month
(a)	30	30	30	30		30		30	30	30		30	30		30		30	30	30	30	30	
JAN	43.1	28.9	36.0	64	1935	- 4	1937+	900	3.98	2.95	1935	2.5	11.0	1937	7.5	1929	11	0	4	18	*	JAN
FEB	47.5	30.7	39.1	66	1943+	- 3	1950	730	3.15	2.02	1951	2.3	15.2	1936	6.0	1949	9	0	1	16	*	FEB
MAR	52.2	33.9	43.1	72	1928	10	1955	680	3.21	1.59	1930	1.3	27.0	1951	9.0	1951	10	0	*	13	0	MAR
APR	58.6	37.0	47.8	82	1934	19	1951	520	2.16	1.28	1944	T	T	1948	T	1948	7	0	0	8	0	APR
MAY	64.9	41.1	53.0	85	1956	22	1954	370	1.72	2.26	1952						5	0	0	2	0	MAY
JUN	68.8	46.1	57.5	92	1955	29	1933	230	1.96	2.52	1946						5	*	0	*	0	JUN
JUL	73.3	47.7	60.5	94	1951+	34	1949+	140	1.00	1.50	1932						3	*	0	0	0	JUL
AUG	73.7	47.0	60.4	91	1935+	34	1945+	140	1.00	1.77	1950						3	*	0	0	0	AUG
SEP	69.5	43.5	56.5	90	1951	27	1934	260	1.88	1.50	1930						5	0	0	1	0	SEP
OCT	60.8	39.0	50.0	83	1936	22	1940	470	3.63	1.96	1945	T	T	1949	T	1949	9	0	0	6	0	OCT
NOV	51.6	34.5	43.1	71	1949	3	1955	660	4.18	1.81	1932	.7	7.0	1937	4.0	1955+	11	0	*	11	0	NOV
DEC	46.6	32.4	39.5	67	1941	5	1932	800	4.76	1.85	1949	1.8	7.5	1948	5.0	1949+	13	0	1	14	0	DEC
Year	59.2	38.5	48.9	94	JUL 1951+	- 4	JAN 1937+	5900	32.63	2.95	JAN 1935	8.6	27.0	MAR 1951	9.0	MAR 1951	91	*	6	89	*	Year

(a) Average length of record, years.
T Trace, an amount too small to measure.
** Base 65°F
\+ Also on earlier dates, months, or years.
* Less than one half.
∮ Estimated.

NARRATIVE CLIMATOLOGICAL SUMMARY

Bellingham, the County Seat of Whatcom County, is located along the shore of Bellingham Bay. To the west, across the Strait of Georgia, is Vancouver Island, with the San Juan group between and extending southward to the confluence of the Straits of Georgia and Juan de Fuca. The Strait of Georgia offers a sea level outlet to the Pacific Ocean in a northwesterly direction, and the Strait of Juan de Fuca in a westerly direction.

Some of the factors which play an important role in the climate of Bellingham are its distance from the Pacific Ocean and other large bodies of water, coastal ranges of mountains on the Olympic Peninsula and Vancouver Island, the Cascade range of mountains which rise to elevations of 5000 to 8000 feet within 75 miles east of the city, the southerly migration of storms moving out of the Gulf of Alaska during the winter and their return to a more northerly path in the summer.

The coastal mountains on Vancouver Island and the Olympic Peninsula protect the city from the main force of storms moving eastward from over the Pacific Ocean. Breaks in the coastal mountains and the Straits of Georgia and Juan de Fuca permit a large amount of moist air from over the ocean to reach the area. This marine air is usually warmer in the winter and cooler in the summer than air over the interior of the continent at this latitude. The climate of Bellingham can be classified as a marine-type in most respects. The air is rather moist throughout most of the year and the daily range in temperature is small. Maximum temperatures of 90 degrees or above are unusual and are of short duration in the summer.

The Cascade Mountains shield the area from cold air in the interior during the winter, and the warm air in the summer. However, occasionally cold air from the interior of Canada will move through the Fraser River Canyon and spread southward bringing low temperatures to the Bellingham area.

The lowest temperatures in the winter and highest in the summer are usually associated with easterly or northeasterly winds. The lowest humidity is observed when easterly winds are blowing down the western slope of the Cascades.

The prevailing southwesterly circulation of warm, moist air from over the Pacific Ocean keeps the average winter daytime temperature in the 40's and the nighttime temperature in the upper 20's or lower 30's. There is a gradual shift of the winds to a westerly and northerly direction during the summer. Cool air from over the Pacific Ocean in the summer keeps the average afternoon temperature in the mid-70's and the nighttime temperature in the mid 40's.

The highest wind velocities are usually from a southwesterly direction during the winter, although occasionally strong northerly winds occur with the passage of a storm. Wind velocities are usually much lower in the summer than in the winter months.

There is a pronounced, though not sharply defined, rainy season and considerable cloudiness during the winter. About three-fourths of the annual rainfall is received from October through April. December is the wettest month and July and August are the driest months. The precipitation pattern in the agricultural area north and south of Bellingham is similar. Snowfall is rather light and on the average does not remain on the ground for long periods of time. Precipitation and snowfall increase rapidly in an easterly direction. Some of the heaviest snowfall and greatest snow depths in the United States have been recorded in the Mt. Baker area, approximately 40 miles east of the city.

Earl L. Phillips
State Climatologist
U.S. Weather Bureau
Seattle, Washington

Reprinted by the Washington State Department of Commerce & Economic Development

Total Precipitation (Inches)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1928	4.75	1.05	2.87	3.17	.26	2.21	.40	.60	1.18	5.50	2.56	2.47	27.22
1929	1.56	1.44	2.77	1.32	1.90	.60	.11	.54	1.21	2.17	2.38	3.94	19.94
1930	2.48	5.18	3.07	2.07	2.53	1.59	.06	.01	2.81	5.35	2.46	1.48	29.09
1931	5.44	2.71	5.44	1.95	1.44	4.71	.77	.05	5.07	1.33	5.20	4.95	38.46
1932	4.12	5.72	7.20	2.88	.60	2.05	3.18	1.34	.96	5.90	9.51	5.15	48.61
1933	5.10	2.43	3.31	1.17	2.41	1.50	1.46	1.00	5.18	6.07	3.50	10.89	44.02
1934	5.47	1.81	4.97	.87	1.90	.29	1.14	.79	2.01	1.91	5.06	5.57	32.67
1935	11.71	1.41	3.93	1.26	.31	1.61	1.15	.97	2.82	3.26	2.08	2.03	32.54
1936	5.84	4.36	3.09	3.23	3.12	3.45	1.67	.85	2.81	.77	1.35	6.67	37.21
1937	1.58	4.96	2.50	3.41	1.46	4.67	.02	1.91	1.03	2.72	7.41	5.29	36.95
1938	2.61	1.66	2.52	3.76	1.24	.04	1.04	.29	1.15	3.52	3.77	7.59	29.19
1939	6.20	3.64	1.94	1.99	1.54	2.31	1.52	.40	.28	4.31	5.16	5.98	35.26
1940	2.13	5.07	5.13	1.11	2.11	.26	.69	.91	1.06	2.72	2.50	5.28	28.97
1941	3.47	2.10	1.20	1.82	3.67	.98	.50	2.69	3.75	3.08	4.36	4.55	32.17
1942	1.30	1.15	2.15	2.41	2.12	4.45	2.53	.20	.35	1.73	5.56	5.55	29.50
1943	1.45	2.94	2.51	2.41	1.56	1.22	1.69	2.16	1.03	4.26	1.01	3.58	26.22
1944*	2.29	1.43	1.20	2.44	1.26	1.64	.01	.79	1.56	2.28	4.47	2.10	21.47
1945	3.20	2.59	3.92	2.48	2.06	.52	.16	.38	3.00	6.97	5.56	3.60	36.44
1946	4.09	2.95	3.82	2.71	.28	3.83	.83	.45	1.45	3.04	2.23	3.80	29.48
1947	5.48	2.86	3.63	2.26	1.05	2.55	.09	.46	1.52	5.94	4.35	4.96	35.15
1948	3.19	4.82	1.61	1.44	4.13	2.21	1.44	3.55	2.27	2.66	4.78	3.18	34.98
1949	.58	3.92	2.53	1.56	.46	1.46	1.43	.70	2.06	3.51	4.97	7.37	30.54
1950	3.14	5.40	5.12	3.95	1.77	.33	1.05	2.68	.74	4.80	4.86	5.26	39.10
1951	5.00	5.77	3.99	1.09	2.62	.22	.08	.39	1.47	4.48	2.78	3.44	30.93
1952	1.97	2.24	2.48	2.44	2.75	1.99	.57	.32	.88	1.85	1.05	2.99	21.13
1953	7.99	2.73	2.99	2.12	1.45	2.02	.81	.89	2.08	4.56	6.54	6.62	40.40
1954	5.84	2.77	1.46	2.37	1.17	1.98	1.48	2.32	1.20	1.51	8.05	3.41	33.57
1955	2.67	3.82	2.13	2.40	2.71	1.94	1.77	.27	1.15	4.52	6.69	5.57	35.64
1956	4.78	2.36	3.22	.48	.84	4.55	.14	1.36	3.32	5.69	2.62	5.96	35.32
1957	2.17	3.07	4.78	2.59	.72	1.65	1.97	.69	.92	2.55	1.91	3.53	26.55
1958	4.00	4.20	1.35	2.52	1.39	.77	.00	.29	1.91	6.52	7.27	4.86	35.08
1959	5.87	3.28	2.07	4.42	2.32	1.37	.51	1.33	4.26	3.80	5.07	4.53	38.83

*CAA

PROBABILITY OF 32°, 28° AND 24° OCCURRING AS LATE IN THE SPRING OR AS EARLY IN THE FALL AS THE DATES LISTED IN THE FOLLOWING TABLES

	PROBABILITY - SPRING				PROBABILITY - FALL			
	75%	50%	30%	10%	10%	30%	50%	75%
32°	May 6	May 16	May 24	Jun 4	Sep 10	Sep 23	Oct 1	Oct 12
28°	Apr 5	Apr 15	Apr 23	May 4	Oct 2	Oct 14	Oct 22	Nov 3
24°	Mar 7	Mar 18	Mar 26	Apr 6	Oct 23	Nov 5	Nov 13	Nov 24

In the above table, the 50% point is the same as the average for each freeze category.

From a statistical viewpoint based on past data, the probabilities could be considered as follows when converted into the number of occurrences to expect in a 40-year period:

75% - 30 years in 40   30% - 12 years in 40

50% - 20 years in 40   10% - 4 years in 40

Average Temperature (°F)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1928	39.0	40.0	45.0	47.8	55.6	57.8	62.8	59.2	54.0	48.7	43.9	38.6	49.4
1929	30.2	33.7	44.2	44.8	51.8	57.2	60.0	60.8	55.8	51.2	40.6	38.2	47.4
1930	25.6	41.8	43.2	50.0	51.0	56.3	59.0	60.6	56.4	46.6	41.6	39.8	48.5
1931	44.1	40.8	45.0	49.6	54.6	58.2	60.6	59.6	55.8	49.9	39.4	40.3	49.8
1932	35.2	38.1	44.3	47.6	51.6	58.0	57.2	59.3	56.3	50.3	42.4	35.8	48.5
1933	37.8	34.6	43.8	45.8	50.2	55.4	58.0	62.2	54.0	49.6	44.6	41.6	48.2
1934	42.2	43.2	46.0	52.1	53.2	57.3	59.4	60.9	55.3	51.2	47.7	40.4	50.7
1935	36.4	42.6	40.7	46.2	51.2	57.4	60.1	60.4	57.3	47.8	40.4	42.6	48.5
1936	40.0	29.7	41.2	49.0	55.2	59.7	60.6	60.6	54.6	51.3	41.3	40.6	48.7
1937	24.9	37.1	46.5	46.8	52.1	58.2	60.6	59.6	56.6	52.5	44.4	40.2	48.3
1938	38.4	39.7	42.6	48.6	51.4	58.4	60.8	58.4	58.9	50.7	40.2	38.8	48.9
1939	41.6	36.2	42.8	48.6	52.6	55.7	60.5	61.3	55.2	49.4	48.6	45.2	46.3
1940	40.2	43.0	46.2	50.5	54.8	59.4	60.4	61.0	55.8	52.2	39.8	41.6	50.7
1941	41.2	42.8	47.7	50.2	53.1	57.0	63.5	60.2	55.1	50.6	45.4	40.0	50.6
1942	37.0	40.2	44.2	48.6	53.0	57.0	62.5	63.2	55.8	52.0	42.0	40.8	49.7
1943	30.1	42.3	40.7	49.8	49.8	55.6	59.7	59.6	57.7	49.8	44.3	37.2	48.0
1944	40.0	40.4	42.0	48.2	52.0	57.7	62.3	60.5	58.2	51.6	44.6	36.6	49.5
1945	40.4	41.9	42.8	44.8	54.9	56.3	61.2	62.0	54.2	49.9	40.9	38.4	48.8
1946	40.6	42.0	43.9	47.3	54.7	57.7	60.8	60.8	56.8	47.2	39.3	37.9	49.1
1947	33.9	42.1	44.8	50.2	55.2	58.4	61.2	59.8	57.0	50.5	41.4	40.4	48.6
1948	38.0	37.5	41.7	45.3	52.2	60.6	60.1	60.2	55.6	47.8	42.0	33.5	48.0
1949	28.7	34.7	43.4	47.6	53.6	56.4	59.3	59.8	57.4	46.2	48.7	36.5	47.7
1950	20.9	39.5	42.4	46.3	50.5	58.9	61.4	60.7	56.1	49.5	42.2	44.4	47.7
1951	36.5	38.2	37.7	47.0	53.2	58.6	61.4	59.4	56.7	49.3	42.6	34.3	47.9
1952	34.8	40.1	42.7	47.2	53.2	55.5	60.3	61.2	58.3	51.7	40.7	41.4	48.9
1953	43.9	40.9	43.5	48.4	54.9	56.3	61.9	62.6	57.5	51.7	40.1	42.4	51.0
1954	33.2	42.1	40.4	45.1	52.8	55.3	58.3	59.9	57.3	49.4	48.7	41.4	48.6
1955	38.8	37.5	38.1	44.2	49.6	56.7	58.6	58.8	55.4	49.7	36.9	36.2	46.7
1956	37.9	35.2	40.7	48.3	55.0	56.8	62.4	60.4	57.0	45.9	41.3	39.4	48.6
1957	28.6	36.8	43.8	48.9	56.8	59.7	59.9	60.2	60.3	49.8	42.1	43.0	49.2
1958	43.1	47.0	43.8	48.7	58.5	64.4	67.5	63.9	58.1	50.7	41.7	41.8	52.4
1959	38.7	39.4	43.7	48.4	53.6	60.1	63.8	60.2	56.8	49.6	41.2	39.4	49.6

49.1

STATION HISTORY

Weather records have been kept at several locations in the Bellingham area. The first records were kept at the Fort Bellingham Post Hospital from June 1857 to July 1859. Very little information is available regarding the exact location of some of the early stations. Weather records have been kept by the following observers: Lewis Mayhew, June 1895-May 1903; Sanford Mayhew, June 1903-December 1913; Bellingham Herald, January 1929-1938; Weather Bureau 1938-1941; Civil Aeronautics Administration 1941-date.

Climatological data used in this summary was recorded at the present Weather Bureau climatological station which was established at the U.S. Bureau of Plant Industries station located two miles north of the Bellingham Post Office on September 9, 1910. A continuous climatological record has been maintained at this location since the station was established. The equipment was relocated 700 feet northwest of the original installation on March 1, 1943. The station was operated by the U.S. Bureau of Plant Industries from 1910-1917; U.S. Soil Conservation Service from 1917-1954 and by the Washington State Department of Agriculture from 1954 to date. The weather observations were either made by or were under the supervision of Mr. R.E. Jeswann from September 1910 to February 1924; Mr. B.L. Peters, March 1924 to October 1952; Mr. E.R. Lausch, November 1952 to February 1954; Mr. M.M. Ossewarde, March 1954 to August 1954, and Mr. R.C. Melland, September 1954 to date.

Minimum temperatures recorded at this location are slightly lower than those recorded in the downtown business district.

A P P E N D I X   B

PAGES 48-49 OF SAN JUAN REPORT
PAGES 59-69 OF SAN JUAN REPORT

9. Along the west coast of Blakely Island from Bald Bluff north. Interglacial sediments (silts and clays) are overlain by Vashon Till.

10. Prominent cliffs on the southeast side of Decatur Island (Figs. 10 and 11). This is one of the most spectacular outcrops of surficial sediments in all of the San Juans. The Vashon Till is exposed at the top of the cliff (approximately 15 feet thick) beneath which is about 150 feet of bedded sediments, including advance outwash sediments (sands and gravels) and interglacial sediments (silty clays). An older till may underlie the interglacial sediments. An unusual feature of this exposure is the folding that has occurred in the bedded sediments; some beds are even overturned. It is likely that this deformation was caused by the glacier which deposited the Vashon Till, pushing on the weakly consolidated sediments below it.

Water-bearing Characteristics of Surficial Sediments

The surficial sediments on Lopez and Decatur Islands are probably the largest easily-tapped groundwater reservoir in San Juan County. There is relatively little water in glacial till or fine grained interglacial sediments, but the advance outwash sediments are normally coarse enough to have good porosity and permeability. Generally speaking, the coarser the sediment the better, as far as its potential as a source of groundwater.

Obtaining groundwater from surficial sediments involves drilling into porous sands and gravels that occur below the water table. It would be nice to have some sort of x-ray vision in order to look downward and see how deep you would have to drill in order to reach this sand and gravel. Although this talent (water-dowsing) is claimed by some, the majority find it more satisfactory to rely on geologic evidence.

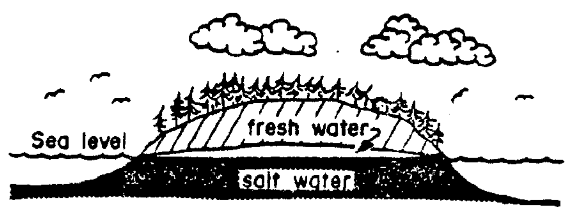
Geologic data come largely from well logs furnished by drillers. It is not easy to identify the ground up mess brought up at the end of a drill bit, and it takes some judgment to interpret the drillers' nomenclature. Nonetheless, Plate 2 is an attempt to draw geologic crosssections through Lopez showing bedrock, impermeable sediments, and sand and gravel. Most of the sand and gravel is probably advance outwash; it is not possible to say in every case whether the impermeable sediments are interglacial sediments or till.

Below the water table the sands and gravels should be water-bearing. Little water is likely to be obtained from impermeable sediments even below the water table.

The location of the cross sections is shown on the geologic map (Plate 1). A-A′ and B-B′ both trend southwest-northeast, while C-C′ trends northwest-southeast.

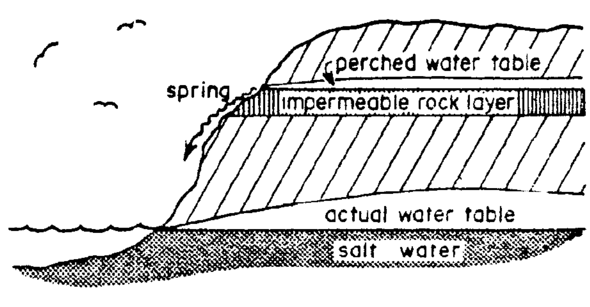
How deep should one be prepared to drill in surficial sediments? Perhaps the most instructive point of Plate 2 is that many wells drilled in sand and gravel terminate within a few tens of feet above or below sea level. Wells in impermeable sediments often end a hundred feet or more *below* sea level. This suggests that the regional water table is very near sea level, and when drilling in sands and gravels, that is where you encounter water. When drilling in impermeable sediments (clays and till), however, it is often necessary to drill a considerable distance below the water table to get an adequate supply. Below-sea-level wells seem to be the general rule in the roughly triangular area bounded by the north side of Lopez Hill, Hummel Lake, and Spencer Spit (see the right side of cross-section B-B′ Plate 2). In summary, then, you should be prepared to drill to sea level unless you hit impermeable sediments, in which case you will probably have to drill deeper.

What about salt water intrusion? Fresh water occurs as a lens-shaped layer which floats on top of salt water because it is less dense. If you drill deep enough on the islands you will eventually hit salt water. The goal of the driller is to intersect the layer of fresh water without drilling through it. The fresh water lens is thinnest at the coastline, therefore the greatest danger of salt water intrusion is in coastal wells that go below sea level.



Once fresh water is found, not much can happen to the supply unless water is withdrawn at a rapid rate for an extended period of time, which could lower the water table. If the water table is lowered too far too fast it is possible for salt water to intrude, either from below or from the side, and occupy the empty pore space. The easiest way of making sure that you never pump salt water is to see that your pump intake is never below sea level. If the water table is lowered sufficiently your pump may break suction, but at least it will never pump salt water. Once salt water intrudes into an aquifer it may take a long time (years), to remove it.

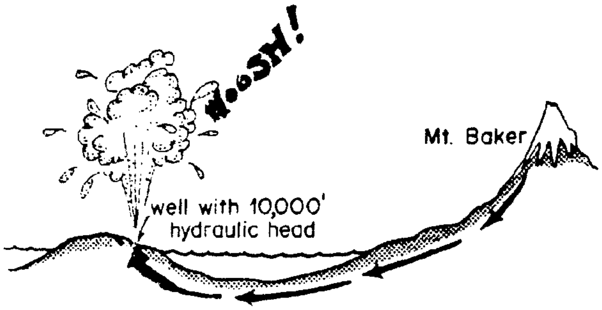
There are a number of small perched water tables within the surficial sediments. These generally occur on top of impermeable layers such as till or silty clay. Where till is exposed at or near the surface the ground is commonly swampy or marshy due to accumulated rainwater that moves downward very slowly through the till. Similar perched water tables exist beneath the land surface, and well drillers must be careful not to confuse a perched water table for the regional water body, or the supply of water could be very limited. Sometimes coastal cliffs of surficial sediments appear to be wet in certain zones (Fig. 7). This



"bleeding" usually occurs when a perched water table is intersected by the cliff.

Recharge to the groundwater body comes from rain water falling on the land surface which seeps downward through soil, sediment, and rock material until it reaches the zone of saturation. The top of this zone is the water table. It may take hundreds of years for water to reach the water table.

There are no underground streams, rivers, springs, lakes, or ponds. And, contrary to popular view, groundwater in the San Juans does *not* come from Mt. Baker. Assuming that there was some way of transporting Mt. Baker water, it is interesting to speculate on the consequence of discharging at sea level a pipe or tube filled with water with a ten thousand-foot hydraulic head!



There is, of course, a certain amount of risk in drilling water wells. A distraught person recently phoned to say that the driller was down 250 feet in "blue clay" in an area of surficial sediments that was supposed to have good water potential. What is the blue clay—Till? Clay beneath advance outwash? Water should have been encountered at about 100' below land surface, but wasn't. What to do? Relocate and try again? Keep going in the same hole? Pull back the casing and try for water above the clay? These questions are difficult ones, and require the advice of an experienced groundwater geologist.

One bit of advice is offered: when developing a piece of property which will ultimately need water, you should make the well or water supply the *first* major investment, not the last. Too often the house is built first and the water system comes later. Should there then be a problem getting adequate water, the problem will be much worse if structures are already built.

BEDROCK GEOLOGY

It is surprising that more geologists haven't been attracted to working on the bedrock geology of the San Juans considering the great variety of rock types and structures that are present, not to mention the almost unbelievably pleasant and beautiful surroundings. Compared to many other regions our geologic knowledge of the bedrock is not very extensive—but geologic interest in the area is growing rapidly.

As explained earlier, the bedrock of the southeastern San Juans is a complicated jumble of blocks of rocks juxtaposed against one another by faulting and shearing. Some blocks are very large, perhaps up to a mile or more across, whereas others are almost microscopic. Some blocks show only minor internal folding and faulting, while others are intensely sheared throughout. Thus this melange, like almost all others, shows a baffling array of faults and shear zones, very few folds, and rock types that crop out in practically random order. In other types of more moderately deformed terrain, even though rocks may be broken by faults, it is possible to explain why different rock types occur where they do, and sometimes it is possible to predict which rock will occur over the hill or on the next island. Because these islands are so intensely deformed, this cannot be done.

Geologists feel obliged to classify and define. This seems to help explain things, even though we often oversimplify by doing so. The diverse types of bedrock occurring in the southeastern San Juan Islands have been grouped into five general categories: greenstones, flysch-type sedimentary rocks, volcanic rocks, plant-bearing sandstones and conglomerates, and serpentinite. Within categories there are some exceptions, most particularly among sedimentary rocks. Nevertheless, these rock types are the basis for mapping the bedrock in the southeastern San Juans (Plate 1): continuity and stratigraphic order have been severely modified. An added virtue of mapping rock types is the extra information it gives the planner and land user. In theory, at least, all rock types should be reasonably consistent in their properties. This is not necessarily true of formations.

Joe Vance has mapped the remainder of the archipelago in a more conventional manner. He takes the approach that rock types are stratigraphic, although he recognizes that they have been severely modified by faulting. Thus, he has mapped formations instead of lithologies. The difference in the two approaches is in part one of philosophy, but it may also be due to different conditions within the respective map areas. There simply has not been sufficient time to explore the two areas thoroughly and straighten out differences. One aspect is certain: the stage is now set for further examination and analysis of all the islands. There are still many questions to be resolved.

It would be an enormous help if we had more knowledge of the age of the rocks in the southeastern San Juans. Some dates were obtained from tiny zircon crystals by the fission track method, but fossils, the most common means of dating, are very scarce. Up to now the rocks have been most stubborn in their refusal to yield anything but squashed and smeared branches, stems, and twigs. Sooner or later some good identifiable marine mollusk fossils or microfossils will turn up to provide a basis for dating the rocks.

Some readers will be interested in knowing how the present mapping compares with that of Roy McClellan, who completed the first county-wide geologic map and report in 1927. McClellan's Leech River Group includes both the flysch-type sedimentary rocks and the plant-bearing sandstones and conglomerates. His Eagle Cliff Porphyrites are pillow lavas, and in some areas of Lopez Island, greenstones. He mapped Blakely and Frost Islands as

APPENDIX C

CHEMICAL DATA

BENNETT CHEMICAL LABORATORIES, INC.

ANALYTICAL CHEMISTS & ASSAYERS

901 SOUTH 9th STREET TACOMA, WASHINGTON 98405
(206) 272-4507 or 272-7969

REPORT OF ANALYSIS May 5, 1978

Our analysis of the sample of Water

From Robinson & Noble
Sample received 4/17/78

Marked: Well #77B

Requested Test	Contents Analyzed	Group I	Group II	Group III	Group IV	Group V	Other	Sample Test Results
x	Arsenic				x	x		0.01 mg/liter *
x	Barium				x	x		0.10 mg/liter *
x	Cadmium				x	x		0.005 mg/liter *
x	Chromium				x	x		0.01 mg/liter *
x	Iron	x	x	x		x		0.16 mg/liter
x	Manganese	x		x		x		0.007 mg/liter
x	Mercury		x		x	x		0.001 mg/liter *
x	Silver				x	x		0.01 mg/liter *
x	Selenium				x	x		0.01 mg/liter *
x	Lead				x	x		0.01 mg/liter *
x	Color		x	x		x		5 Units
x	Fluoride	x	x	x		x		0.175 mg/liter
x	Nitrate	x	x	x		x		0.96 mg/liter
x	Total Hardness as Calcium Carbonate		x	x		x		42.5 mg/liter
x	Specific Conductance					x		105 micromhos/cm
x	Turbidity		x	x		x		1 F.T.U. *
x	pH		x	x				Trace
x	Bicarbonate Alkalinity as Calcium Carbonate		x	x				48 mg/liter
x	Carbonate Alkalinity as Calcium Carbonate		x	x				0
x	Free Carbon Dioxide			x				9.2 mg/liter
x	Calcium			x				25.5 mg/liter
x	Magnesium			x				6.04 mg/liter
x	Sodium			x				8.08 mg/liter
x	Chloride	x	x	x				6.7 ppm
x	Sulfate	x	x	x				8.5 mg/liter
x	Phosphate			x				0.009 mg/liter
x	Silica			x				15.0 mg/liter
	Total Dissolved Solids	x						
x	Total Residue			x				86.8 mg/liter

* Less than.

To Robinson & Noble
10318 Gravelly Lake Dr. SW
Tacoma, WA 98499

BENNETTS CHEMICAL LABORATORY, Inc.

By [signature]

BENNETT CHEMICAL LABORATORIES, INC.

ANALYTICAL CHEMISTS & ASSAYERS

901 SOUTH 9th STREET TACOMA, WASHINGTON 98405

(206) 272-4507 or 272-7969

REPORT OF ANALYSIS May 5, 1978

Our analysis of the sample of Water

From Robinson & Noble
Sample received 4/17/78

Marked: Well #2

Requested Test	Contents Analyzed	Group I	Group II	Group III	Group IV	Group V	Other	Sample Test Results
x	Arsenic				x	x		0.01 mg/liter *
x	Barium				x	x		0.10 mg/liter *
x	Cadmium				x	x		0.005 mg/liter *
x	Chromium				x	x		0.01 mg/liter *
x	Iron	x	x	x		x		0.36 mg/liter
x	Manganese	x		x		x		0.006 mg/liter
x	Mercury		x		x	x		0.001 mg/liter *
x	Silver				x	x		0.01 mg/liter *
x	Selenium				x	x		0.005 mg/liter *
x	Lead				x	x		0.01 mg/liter *
x	Color		x	x		x		1.5 Units
x	Fluoride	x	x	x		x		0.23 mg/liter
x	Nitrate	x	x	x		x		1.75 mg/liter
x	Total Hardness as Calcium Carbonate		x	x		x		101.05 mg/liter
x	Specific Conductance					x		270 micromhos/cm
x	Turbidity		x	x		x		1.2 F.T.U.
x	pH		x	x				Trace
x	Bicarbonate Alkalinity as Calcium Carbonate		x	x				115.0 mg/liter
x	Carbonate Alkalinity as Calcium Carbonate		x	x				0 mg/liter
x	Free Carbon Dioxide			x				5.2 mg/liter
x	Calcium			x				36.0 mg/liter
x	Magnesium			x				15.2 mg/liter
x	Sodium			x				25.2 mg/liter
x	Chloride	x	x	x				1.74 mg/liter
x	Sulfate	x	x	x				45.8 mg/liter
x	Phosphate			x				0.0306 mg/liter
x	Silica			x				20.6 mg/liter
	Total Dissolved Solids	x						
x	Total Residue			x				214.4 mg/liter

* Less than.

To Robinson & Noble
10318 Gravelly Lake Dr. SW
Tacoma, WA 98499

BENNETTS CHEMICAL LABORATORY, inc.

By [signature]

CHEMICAL DATA FOR WELLS SAMPLED MAY, 1978

Field Number	Location Number	Specific Conductance	Hardness	Chlorides
4	33N4	350	95	20
13	29Q2	540	20	27
17	32F	400	175	16
22	32P1	220	60	19
23	32P2	1670	30	400
26	5C1	390	90	24
35	4L1	600	5	45
39	4B3	240	95	15
40	4G3	390	110	18
43	4F2	325	80	20
41	4G4	410	160	20
45	4H3	470	36	25
46	4H2	350	140	18
47	4K1	410	70	35
49	4K3	350	110	18
51	4J4	360	130	20
57	9A1	350	160	13
59	4B1	450	65	20
63	9C1	350	150	30
65	9CA	350	150	26
67	9G2	240	115	10
77A	10M1	240	107	16
78	10N1	300	100	15
79		600	190	105
80	10Q1	360	10	14
83	33Q1	550	230	48
84	15H1	250	110	5
88	15F3	650	15	20
89	33P3	600.	250	25
90	33Q2	300	145	20
96		430	35	48
98		440	65	25
99		360	150	15
100		290	130	8
101	10M3	250	10	20
Stewart		410	40	225

APPENDIX D

WELL SCHEDULE
WELL LOGS

Field locations of wells are shown on Master Maps by Field Number and by Location Number (USGS System).

Field Numbers - (Arthur) Sequential in Blue

Field Numbers - (Calkin) Sequential in Orange

Location Number - pencil

Attached is a Conversion Table correlating Location Numbers with Field Numbers. All are plotted on the Master Map, but only those for which some data have been developed are listed on the Well Schedule. Please note that some locations may not be accurate. Those on the Well Schedule have generally been field checked and are believed to be the most accurate.

CONVERSION TABLE

FLD #	LOC #	FLD #	LOC #	FLD #	LOC #	FLD #	LOC #
1	38/1/33P1	48	37/1/4K2	96		T1	37/1/15E1
2	38/1/33L1	49	37/1/4K3	97		T2	37/1/15E2
3	38/1/33N3	50	37/1/4J3	98		T3	37/1/16A
4	38/1/33N4	51	37/1/4J4	99		T4	37/1/9R1
5	38/1/33N2	52	37/1/4J5	100		T5	37/1/10M1(77)
6	38/1/33N5	53		101	37/1/10M3	T6	37/1/9H(69)
7	38/1/33P2	54	37/1/4J6			T7	37/1/9F
8	38/1/33E1	55	37/1/4R2			T8	37/1/9C1(63)
9	38/1/32H1	56	37/1/4R3			T9	37/1/9O1
10A	38/1/32J1	57	37/1/9A1			T10	37/1/9D2
10B	38/1/32H2	58A	37/1/9B1			T11	37/1/9D3
11	38/1/32A(T20)	58B	37/1/9B2			T12	37/1/9D4(85)
12	38/1/29Q1(T19)	59	37/1/4B1			T13	37/1/8A1(81)
13	38/1/29Q2	60	37/1/8A3			T14	37/1/8A2(61)
14	38/1/32B3	61	37/1/8A2(T14)			T15	37/1/4N(30)
15	38/1/32B1	62	37/1/9B3			T16	37/1/5L(28)
16	38/1/32B2	63	37/1/9C1(T8)			T17	37/1/5C(26)
17	38/1/32F	64	37/1/9C3			T18	38/1/32L
18	38/1/32G1	65	37/1/9C4			T19	38/1/29Q(12)
19	38/1/32L2	66	37/1/9F2			T20	38/1/32A(11)
20	38/1/32L3	67	37/1/9G2			T21	37/1/4G1
21	38/1/32K1	68	37/1/9G1			T22	37/1/4G2
22	38/1/32P1	69	37/1/9H1(T6)			T23	37/1/4H1
23	38/1/32P2	70	37/1/9J1			T24	37/1/4H2(46)
24	38/1/32P4	71	37/1/10M4			T25	37/1/4J1
25	38/1/32P3	72	37/1/10M2			T26	37/1/4J2
26	37/1/5C1(T17)	73	37/1/10L2			T27	37/1/3N1
27	37/1/5H1	74	37/1/10L1			T28	37/1/15H2
28	37/1/5L1(T16)	75	37/1/10P2			T29	37/1/15H1(84)
29A	37/1/5P1	76	37/1/10P1			T30	
29B	37/1/5P2	77	37/1/10M1(T5)			T31	
30	37/1/4M1(T15)	78	37/1/10N1			T32	
31	37/1/4N1	79					
32	37/1/5R1	80	37/1/10Q1				
33	37/1/5O1	81	37/1/8A1(T13)				
34	37/1/4P1	82	37/1/15G1				
35	37/1/4L1	83	38/1/33Q1				
36	37/1/4E1	84	37/1/15H1(T29)				
37	37/1/4E2	85	37/1/9D4(T12)				
38	37/1/4D1	86	37/1/4J3				
39	37/1/4E3	87	37/1/9H2				
40	37/1/4G3	88	37/1/15F3				
41	37/1/4G4	89	38/1/33P3				
42	37/1/4F1	90	38/1/33Q2				
43	37/1/4F2	91	37/1/4B2				
44	37/1/4L2	92	37/1/4B1				
45	37/1/4H3	93	37/1/9R3				
46	37/1/4H2(T24)	94	37/1/9R2				
47	37/1/4K1	95	37/1/15H3				

WELL	OWNER OR TENANT	FIELD NUMBER	ALTITUDE	DRILLING METHOD	DEPTH	DIAMETER	WATER LEVEL YIELD				LOG AVAILABLE	CASING DEPTH	BEDROCK DEPTH OF	QUALITY DATA			NOTES
							DTW	DATE	GPM	DD				SP. CON.	H	CL	
	T38N, R1E																
29Q1	Austin	T19-12	36'		60		12'	5/78			T		14'	540	20	27	
32A1	A. Granger	T20-11			100						T		10'				
32B1	G. Gossette	15b	72'			6"?	72'	4/78									
32B2	Moen	16															
32F1	Carl Hansen	17	102±		137	6"	100'	6/74	7	Max?	S	132'	137'	400	175	16	
32G1	Irene Thomas	15a	100'	cbl	153	6"	4'	2/75			USGS		0?	574		15	
32H1	R. McFarland	9	184'	cbl	110	10"	4'	2/73	20	56'	S	110'	41'				
32J1	W. Hansen	10a	194'	cbl	100		8'	7/69	12	30'	S	11'	6'				
32L1	Griesing	T18			127						T		113'				
32K1	Si Eldred	21	190'	cbl	215	8"	6'	4/78	60	15'	S	49'	44'				
32P1	John Melcher	24	50'	cbl	180	6"					USGS			350		30	
32P2	Lehr Miller		70'	cbl	73	4"	63'	2/60			USGS			1670	30	400	
32P3	Isle Aire	22	105'	cbl	73	5"	53'	1960			S			220	60	19	
32P4	Isle Aire	23	200?	cbl	250		135?	4/78			S						
32P5	Virg Stark	25			58	6"	37'	6/76	20	2'	S	58'	58'				
33E1	Rhl/Hammond	8	175'	cbl	185	6"	14'	5/78	2	185'	S	20'	6'				
33L1	Mac Granger	2	80'		70	6"	9'	4/78		30'	S		22'	489		25	
33N1	W.Richardson	89-5	204'	cbl	120	6"	0	6/75	10	100'	S	120'	23'	600	260	25	
33N2	Mac Granger	4	222	cbl	97	6"	36'	5/66	$2\frac{1}{2}$	57'	S	36'	31'	350	95	20	
33Q1	John Slater	83	15'	dug	10	18"	5'	3/69			S		10'	550	230	48	
33Q2	Gene Long	90	16'	cbl	40	6"	0	11/74	12	32'	S	34'	40'	300	145	20	

WELL	OWNER OR TENANT	FIELD NUMBER	ALTITUDE	DRILLING METHOD	DEPTH	DIAMETER	WATER LEVEL YIELD				LOG AVAILABLE	CASING DEPTH	BEDROCK DEPTH OF	QUALITY DATA			NOTES
							DTW	DATE	GPM	DD				SP. CON.	H	CL	
	T37N, R1E																
3N1	O'Rouke	T27			155				3?		Thesis		14'				
4B3	GS Schular	39	20'				9'	5/78						240	95	15	
4E1	Terry Moore	36	166'	cbl	150	6"	50'	12/74	2	90	Sched.	47'	40'				
4E2	Angus McLane	43	128'				23'	4/78						325	80	20	
4G1	Landon	T21			170				17?		Thesis		18'				
4G2	Astell	T22			85						Thesis		5'				
4G3	Dick Hudson	40	81'				0	4/78						390	110	18	
4G4	Gary Gaines	41	90'				11'	4/78						410	160	20	
4H1	M. Heath	T23			90				3?		Thesis		19'				
4H2	J.Chrstnson	T24-46			103				1?		Thesis		24'	350	140	18	
4H3														470	36	25	
4J1	Anderson	T26	36'		65		31'	5/78	3?		T		15'	2000		355	
4J2	Brown	T25-86	46'		100		32'	5/78	9?		T		23'				
4J3	G.Chrstnson	T25-86	38'	cbl	105	6"	38'	10/73	7	20	S	26'	18'				
4J4	Hawley	51	65'				10'	4/78						360	130	20	
4K1	Schneider	47	112'				10'	4/78						410	70	35	
4K2																	
4K3	Jewell	49	96'				15'	4/78						350	110	18	
4M1	F.Granger	T15-30			116						T		116?				
5C1	J. Melcher	T17-26	103'		168		78'	4/78			T		72?	390	100	45	
5L1	F. Granger	T16-28			300						T		52'				
5P1	W.T.Lockwood	29a	45'	cbl	353	6"	15	1948	17	50	S	80'	85'				
5P2	W.T.Lockwood	29b	87'	cbl	301	6"	140'	12/77	7	20	S	21'	16'				

WELL	OWNER OR TENANT	FIELD NUMBER	ALTITUDE	DRILLING METHOD	DEPTH	DIAMETER	WATER LEVEL YIELD				LOG AVAILABLE	CASING DEPTH	BEDROCK DEPTH OF	QUALITY DATA			NOTES
							DTW	DATE	GPM	DD				SP. CON.	H	CL	
	T37N, R1E																
8A1	L. Chambers	T13-81	10'	cbl	85	6"			9	Max?	S&T	80'	-85'				
8A2	J. Miller	T14-61	9'		84						T		-84'				
9A1	Earl Granger	57	19'	cbl	76	6"	109'	5/78						350	160	13	
9B1	Hilltop W.A.	58a	90'	cbl	240	6"	85'	5/78						441		15	
9B2	Gramac Const	58b	73'	cbl	252	6"	68'	5/78	12	217	S	135'	52'				
9C1	M. Tuttle	T8-63	23'		51		7'	4/78			T		51'	350	150	30	
9C4	Agriculture	65	8'				16'	5/78						350	150	26	
9D1	G. Johnson	T11	15'	cbl	58	8"					T		-58'	303		16	
9D2	Walker	T10	91'		62		5'				T		-62'				
9D3	K. Gardner	T9			62						T		-62'				
9D4	John Brown	T12-85	10'	cbl	95	6"	10'				T&S	92'	-95'				
9F1	C.E.Castle	T7			115						T		14'				
9G1	Fred Graham	68	95'	cbl	101	6"					S		101'	368		62	
9H1	Haven	T6-69	118'		143				6		T		138'?				
9R1	Flockenhagen	T4			114						T		114'?				
9R2	R.A. Lehn	94			123	6"					S		123'				
9R3		93															
10L1	Mike Mayes	74	182'		116	6"	63'	9/74	2	41	S		116'				
10L3	Kepferle	101	74'	cbl	195'	6"	79'	5/78	7		S	195'	195'				
10M1	J. Granger	T5-77			170				½		T		40	240	107	16	
10M2	Bill Ralph	72		cbl	250	5"			1½	214	S	160'	38'				
10M3	Owens													250	10	20	

WELL	OWNER OR TENANT	FIELD NUMBER	ALTITUDE	DRILLING METHOD	DEPTH	DIAMETER	WATER LEVEL YIELD				LOG AVAILABLE	CASING DEPTH	BEDROCK DEPTH OF	QUALITY DATA			NOTES
							DTW	DATE	GPM	DD				SP. CON.	H	Cl	
	T37N, R1E																
10P1	L.Carothers	76	221'		46				10	1	S		46'				
10Q1	Doolie Brown	80	62'		225	6"	75	4/76	½		S	20'	11'	360	10	14	
11C1	S.R.Boynton		10'		150		8	1954									
15E1	Pearson	T1			48						T		48'				
15E2	J. Selke	T2			82						T		82'				
15E3	Ellis Massey	88	78'	cbl	207	6"	74		5	35	S	207'	207'				
15F1	Carl Otto		100'	dug	12	36"					USGS						
15H1	Ernest Nolte	T29-84	39'	cbl	118	8"					S	118'	118'	250	110	5	
15H2	L. Luke	T28	24'		150						T		35'				
15H3	L. Luke		20'	dug	32	36"					USGS			682		32	
16A1	L. Parberry	T3			86						T		86				

APPENDIX E

WATER SYSTEM COORDINATION ACT
PROPOSED REGULATIONS

FEBRUARY 1, 1978

WATER SYSTEM COORDINATION ACT:

PLAN CONTENTS GUIDELINES

DRAFT

Department of Social and
Health Services
Water Supply and Waste Section
Mail Stop LD-11
Olympia, Washington 98504

CONTENTS OF A COORDINATED WATER SYSTEM PLAN

The following purveyors are required by various state regulations to develop a Water System Plan and/or Coordinated Water System Plan:

1. All water systems with more than 1,000 service connections (WAC 248-54-580, State Board of Health Water Supply Regulations).

2. All water systems within the external boundaries of a Critical Water Supply Service Area. (WAC 248-54-580, State Board of Health Water Supply Regulations, and WAC 13, Water System Coordination Regulations - See Footnotes 1 and 2).

3. All water systems within the geographical area established for reserving a future domestic water supply (WAC 173-590-070(1) Reservation of Public Water Supply Regulations).

If a water system plan is required based on the above categories, the contents of that plan will vary in detail according to the size of the public water system, consistent with the following:

1. <u>Water System Plan</u> - for those public water systems with over 1,000 service connections (Page ____).

2. <u>Abbreviated Water System Plan</u> - for those public water systems serving between 100 and 1,000 service connections. (Page 5).

3. <u>Water System Planning Questionnaire</u> - for all remaining public water systems. (Page 6)

A <u>Regional Supplement</u> is required in addition to the above plans for those water systems within the external boundaries of a Critical Water Supply Service Area or within the geographical area established for reserving a future domestic water supply. (Page 14)

The following sections of these guidelines are intended to serve as an outline for preparation of water system plans and to serve as criteria for approval of those plans by the Department of Social and Health Service's district engineer.

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[1] Water Systems in existance prior to January 1, 1978, which are owner-operated and serve less than 10 service connections (or serve one industry) are exempt from all planning requirements.

[2] Non-municipally owned public water systems are exempt from the planning requirements (except for the establishment of service area boundaries) if they were in existance as of January 1, 1978, have no plans for expansions and meet State Board of Health regulations.

WATER SYSTEM PLAN

A. Basic Planning Data

1. A general description of the water system's existing and future service area including a history of the water system, available water resources, topography, justification of the future service area boundary, and inventory of related plans.

2. An assessment of present land use patterns and projected changes based on adopted land use plans.

3. Present population distribution pattern, population projections, and assessment of potential growth areas which are anticipating future service from the water system.

4. Present water uses, projected water demand, and justification for projected water demand.

B. Inventory of Existing Water System Facilities

1. An inventory and description of existing water sources, treatment, storage, transmission, and distribution facilities, including assessment of recent system improvements.

2. Hydraulic analysis of the water system.

3. Conformance with State Board of Health minimum water quality standards, including documentation of the physical, chemical, and bacteriological quality of the water supply before and after treatment.

4. Discussion of applicable fire flow performance standards and ability of the water system to meet those standards. (WAC __________)

C. Formulation of Needed Water System Improvements

1. Projection of anticipated water system needs at least ten years into the future.

2. A description and assessment of water source, storage, treatment, transmission, and distribution alternative "packages" to fulfill anticipated needs, including costs.

3. Selection of and justification for an alternative "package".

4. A time schedule, based on either growth within the service area, or fixed dates for improvements, required to meet documented water system needs. Include justification for timing of improvements.

5. A proposed financial program for obtaining needed improvements, including discussion concerning rates, various charges for new hook-ups, and expansion policies.

D. <u>Miscellaneous Topics</u>

1. For those systems utilizing surface supplies with disinfection only, a report should be included identifying all facilities, conditions and activities within its watershed together with a proposed program for necessary surveillance and control. (WAC 248-54-660)

2. Written service area agreements or documentation of any attempts to reach such agreements with neighboring water purveyors.

3. Description of agreements or documentation of any attempts to reach agreements with neighboring water purveyors regarding shared or joint-use facilities, including interties.

4. A discussion on the relationship and compatability between the water system plan and city or county proposed or adopted plans, policies, and land use controls; adjacent water system plans and related water resource plans.

5. An Operations Program for routine maintenance and operation, water quality monitoring, cross-connection control, response in case of emergency, and identification of person(s) responsible for system management. (WAC 248-54-610)

6. When either a variance or exemption is required, the following information shall be included in the Water System Plan:

   a. Assessment of why the water system is not able to comply with these regulations.

   b. Documentation that the variance or exemption would not result in an unreasonable risk to public health.

   c. Schedule for bringing the water system into compliance with the State Water Supply Regulations, or full documentation of special circumstances leading to non-conformance with state water supply regulations together with a water quality monitoring program.

   d. (For exemptions only) documentation that the water system was officially in operation on the effective date of the State Water Supply Regulations.

7. An official negative declaration or final environmental impact statement fulfilling requirements of the state environmental Policy act (WAC 248-06 and WAC 197-10).

E. Mapping

1. At least the following maps are to be included in the water system plan:

   a. Existing and future service area boundaries

   b. Existing and projected land use patterns, including current local zoning

   c. Present and future population distribution patterns

   d. Fire flow development classifications

   e. Existing and future high demand areas (those portions of the water system subject to excessive water use)

   f. Critical elevation and pressure zones

   g. Existing and future facilities, including source, storage, treatment, transmission (interties), and major distribution

DRAFT

ABBREVIATED WATER SYSTEM PLAN

Plans developed in accordance with this section are expected to be less detailed in nature than those required under the previous section entitled water system plan. The plan is expected to contain, but not be limited to the following:

A. General Background

1. History of water system and population served

2. Inventory of existing facilities including map of facilities and pressure zones

3. Necessary water quality information

B. Future Water Needs

1. Identify future service areas (include map and any agreements)

2. Identify water needs and future water use

3. Discussion of Fire flow requirements, including map of "development classificaitons" (See WAC ________)

C. Needed Improvements

1. Identify future facilities (include a map, along with identified joint-use projects, interties, etc.)

2. Improvement schedule

3. Financial program

4. Discussion of relationship with plans of other nearby purveyors and other related plans

D. Miscellaneous Topics

1. Operations program in accordance with WAC 248-54-610 (See Topic D5 in water system plan)

2. If a variance or exemption from the state board of health regulations is requested, certain additional information is required in accordance with WAC 248-54-800 (See Topic D6 in water system plan)

3. Necessary compliance with state environmental policy act regulation (WAC 248-06 and WAC 197-10)

WATER SYSTEM PLANNING - QUESTIONNAIRE

The water system planning questionnaire is designed to be less detailed than the abbreviated water system plan outlined in the previous section. The questionnaire will provide information about key considerations in operating and developing an adequate public water system.

The questionnaire consists of two parts:

<u>Part 1</u> consists of the Water Facilities Inventory required in WAC 248-54-810, which deals with the status of the existing public water system.

<u>Part 2</u> deals with an assessment of future water system needs and how those needs might relate to other water systems in the area.

DRAFT

DEPARTMENT OF SOCIAL AND HEALTH SERVICES
WATER SUPPLY AND WASTE SECTION
Mail Stop 4-1
Olympia, Washington 98504

Water Facilities Inventory And Annual Report Form Explanation Sheet

(1) I.D. Number - This number is assigned by the Water Supply and Waste Section, Department of Social and Health Services. Each system has been assigned a permanent number which should be used on all correspondence with this Department and must be shown on all annual reports and bacteriological analysis forms. All records and reports are now filed according to I.D. number. If you do not have your I.D. number, complete the form and we will fill in your number. If you have a four-digit I.D. number, place a zero in front when entering it in this report.

(2) County - The county where the system is located is given by a two-digit code.

01 - Adams	09 - Douglas	17 - King	25 - Pacific	33 - Stevens
02 - Asotin	10 - Ferry	18 - Kitsap	26 - Pend Oreille	34 - Thurston
03 - Benton	11 - Franklin	19 - Kittitas	27 - Pierce	35 - Wahkiakum
04 - Chelan	12 - Garfield	20 - Klickitat	28 - San Juan	36 - Walla Walla
05 - Clallam	13 - Grant	21 - Lewis	29 - Skagit	37 - Whatcom
06 - Clark	14 - Grays Harbor	22 - Lincoln	30 - Skamania	38 - Whitman
07 - Columbia	15 - Island	23 - Mason	31 - Snohomish	39 - Yakima
08 - Cowlitz	16 - Jefferson	24 - Okanogan	32 - Spokane	

(3) Basin No. - The State of Washington has been divided into 62 regional basins by the State Department of Ecology. These numbers have been included here to facilitate use of our data in conjunction with their projects. The number pertains to the location of the water system rather than its source. If you do not know this number, it is the two-digit number on your address label.

(4) Date Completed - The date this form was completed.

(5) Annual Report Year - All Class 1 systems are required to submit an annual report (this form) each year. The "Annual Report Year" should denote the calendar year of the report data which is, in most cases, the year preceding the current year.

(6) System Class - Check the appropriate box. Each customer or lot is considered a service. If the system serves a subdivision or development, include all lots as a "service" even if they are not presently served by the system, but will be when the lot is developed.

(7) Ownership - Check one box.

(8) Predominent Characteristic - Check one box.

(9) System Name and Address - This information should be complete so that all official mailings of the Department are sent to the proper place. If there is no mailing address for the system office, insert the name of the system and leave the address blank. The "Address of Owner" must be filled out if the system address is not given. Please do not forget to fill in the zip code.

(10) Address of Owner - Give the complete mailing address of the owner if it is not the same as the "System Name and Address".

(11) Distribution Reservoir and Capacity - The location of each reservoir or complex of reservoirs, such as "5th Street", with the combined capacity of the reservoir(s) at the site. In all cases, please provide total capacity at the bottom. The volume of pressure tanks should not be included here.

(12) Permanent Population Served - Population being served at the present time.

(13) If Population Served Varies - Give the maximum number of people that can potentially be served by the system. If it is a new subdivision or a recreational plat, assume 3.0 people per lot and record total here. The total must include all lots in the subdivision served by the system even if a service water line has not yet been installed. If the system serves a camp, resort, etc., give the maximum population served at any one time.

(14) Is The System Primarily A Hydropneumatic Pressure System? - (Pressure Tanks) If your system operates primarily with a pressure tank (no gravity storage) so indicate.

(15) Number of Water Services - Include the total number of customers.

(16) Number of Services Metered - Include only those services that have an active metered service. If none, leave blank.

(17) Range of System Pressures - Static = Range of system static pressure in the low and high pressure area. Residual = Range of system pressure during peak use period. Estimate if information is not available.

(18) Annual Water Use - This information should be based upon present use data. If the information is not readily available, estimate the usage data based upon the following:Average day = 125 gallons per capita/day; Peak day = 250 gallons per capita/day, computed on a basis of 3.0 people per active connection.

(19) Approx. % Of Total Ave. Use For Non-Residential Use - Estimate the percent of total water use being used by industry; commercial; and for non-residential irrigation. Use whole numbers, not decimals.

Percentage of Total Production Lost or Unaccounted For - Estimate the amount of water lost through leaks, evaporation, etc. Use whole numbers, not decimals.

(20) Name of Source(s) - List each source, well or name of surface supply (Cowlitz River, Summit Lake, etc.). If the number of sources used exceed into one grouping if the well depth and treatment are about the same. If you list well fields as a single source, the well capacity should reflect the total capacity of the wells grouped together. Breakdowns of the groupings may be provided on a separate sheet or under "comments" on the reverse side of the report page.

(21) Source Type - Check appropriate box for each source listed.

(22) Well Depth - Record the well depth or average of well depths if a well field is grouped together.

(23) Well or Plant Capacity - For each source listed, record the pumping capacity of the well or the production capacity of the treatment facilities. To convert gpm to Thou/Gal/Day, multiply gpm by 1.44. Provide total capacity at bottom.

(24) Location of Source - The location code is based on the U.S.G.S. township and section system for survey of public lands. Sequencing of sections and subdivisions is as follows:

Thirty-six 1-mile square sections in a township.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Sixteen 1/4-mile square (40-acre) subdivisions in a section.

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

NOTE: I and O are omitted because of similarity to one and zero.

Twp. - All townships in Washington State are north of the Base Line at 45°31' north latitude, so the customary N after the township number is omitted but understood.

Range - A "W" following the two digit range number indicates west of the Willamette Meridian and an "E" indicates east.

Sec. Code - The first two digits are the section number, the third is the subdivision letter.

EXAMPLE: Twp: 35, Range: 02E; Sec. Code: 20K

(25) Treatment Provided - Check appropriate box for each source listed with an "x" to indicate the type of treatment provided. More than one may be checked.

(26) Evaluation of Water System - The State Board of Health Rules and Regulations regarding Public Water Supplies should be referred to when answering questions 1, 5, 6 and 7. The other questions are self-explanatory.

(27) Water Quality Control Improvements Needed - This section is to be completed by the DSHS engineer or county sanitarian.

COMPLETED BY: ______

WATER FACILITIES INVENTORY AND ANNUAL REPORT

STATE OF WASHINGTON
DEPARTMENT OF SOCIAL AND HEALTH SERVICES
HEALTH SERVICES DIVISION
WATER SUPPLY AND WASTE SECTION

I D NUMBER (1-5) [1]	COUNTY NAME [2]	CO NO (7-8)	BASIN NO (9-10) [3]	DATE COMP MO DAY YR (11-16) [4]	ANNUAL REPORT [5]

SYSTEM CLASS (17) [6]
1 ☐ COMMUNITY 100 SERVICES OR MORE
2 ☐ COMMUNITY 10 THRU 99 SERVICES
3 ☐ NON-COMMUNITY, 25 PEOPLE OR MORE
4 ☐ COMMUNITY & NON-COMMUNITY, 2-THRU 9 SERVICES LESS THAN 25 PEOPLE

OWNERSHIP (18) [7]
P ☐ PRIVATE, INDUSTRY
M ☐ MUNICIPAL, WATER DISTR., PUD, CO.
C ☐ NON-PROFIT, CORP., COOP., ASSOC
G ☐ STATE, FEDERAL

PREDOMINENT CHARACTERISTIC (19) [8]
1 ☐ RESIDENTIAL DEVELOPMENT
2 ☐ MOBILE HOME PARK
3 ☐ RECREATIONAL AREA, NON-RESID
4 ☐ SCHOOL, INSTITUTION
5 ☐ LODGING
6 ☐ FOOD SERVICE
7 ☐ SERVICE STATION
8 ☐ OTHER

SYSTEM NAME (20-59) [9]

STREET ADDRESS (60-80) 1ST LINE / (7-26) 2ND LINE

CITY (27-46) ZIP CODE (47-51)

ADDRESS OF OWNER IF DIFFERENT FROM SYSTEM ADDRESS (7-46) [10]

CITY ZIP CODE

DISTRIBUTION RESERVOIR SITE(S) [11] — CAPACITY (GALLONS) (47-55) TOTAL

PERMANENT POPULATION SERVED [12] (56-62)

IF POPULATION SERVED VARIES, WHAT IS THE MAXIMUM NUMBER SERVED? [13] (63-69)

IS THE SYSTEM PRIMARILY A HYDROPNEUMATIC PRESSURE SYSTEM? [14] (70-1) ☐ YES (70-2) ☐ NO

NUMBER OF WATER SERVICES (7-13) [15]

NUMBER OF SERVICES METERED (14-20) [16]

RANGE OF SYSTEM PRESSURES (PSI) [17] (21-23) (24-26) STATIC ______ TO ______ (27-29) (30-32) RESIDUAL DURING PEAK USE PERIOD ______ TO ______

ANNUAL WATER USE (GAL/DAY) (33-41) [18] AVERAGE DAY ______ (42-50) PEAK DAY ______

APPROXIMATE % OF TOTAL AVERAGE USE FOR NON-RESIDENTIAL USE? [19] (51-53) ______ %

PERCENTAGE OF TOTAL PRODUCTION LOST OR UNACCOUNTED FOR? (54-56) ______

[20] NAME OR DESIGNATION OF SOURCE(S)	[21] SOURCE TYPE (7) SURFACE	WELL	SPRING	PURCHASE	[22] WELL DEPTH (8-11)	[23] WELL OR PLANT CAPACITY GPM (12-18)	THOU/GAL/DAY (19-25)	[24] LOCATION OF SOURCE TWP (26-27)	RANGE (28-30)	SEC CODE (31-33)	[25] TREATMENT PROVIDED NONE (36)	CL_2 (37)	FILT (38)	FLUOR (39)	IRON ATO (40)	OTHER (41)
(A)																
(B)																
(C)																
(D)																
(E)																
(F)																
(G)																
(H)																
(I)																
TOTALS																

[26] EVALUATION OF WATER SYSTEM

PLEASE REFER TO THE RULES AND REGULATIONS OF THE STATE BOARD OF HEALTH REGARDING PUBLIC WATER SUPPLIES (ADOPTED DECEMBER 10, 1971) WHEN ANSWERING THESE QUESTIONS N A — NOT APPLICABLE

1. Is there an approved Comprehensive System Plan? (See WAC 248-54 280 page 2) DATE APPROVED BY DSHS ______ Mo Day Year (7-12) ☐ YES (13-1) ☐ NO
2. Storage
   (A) Are all Distribution Reservoirs covered? ☐ N A ☐ YES (14-1) ☐ NO
   (B) Do all open Distribution Reservoirs have Post Chlorination? ☐ N A ☐ YES (15-1) ☐ NO
3. Can peak domestic demands be met for 24 hours with a loss of either (1) the main power supply (2) the largest well or (3) transmission line? ☐ YES (16-1) ☐ NO

DSHS 4-80 (REV. 9-76)

[illegible]

A. Does the basic system include a majority of looped 6-inch or larger pipe? .... ☐ YES (17-1) ☐ NO (17-2)

B. Do the standards for new construction require 6-inch or larger pipe? .... ☐ YES (18-1) ☐ NO (18-2)

C. Is the system capable of meeting peak demands without routine seasonal use restrictions? .... ☐ YES (19-1) ☐ NO (19-2)

[illegible] Cross Connection Control. (See WAC 248-54-470, page 13-16)

A. Is there a comprehensive program of elimination and containment? .... ☐ YES (20-1) ☐ NO (20-2)

B. Are all hazardous premises protected by backflow prevention devices? (See WAC 248-54-500 (g), page 18) .... ☐ N.A. ☐ YES (21-1) ☐ NO (21-2)

[illegible] Quality Control (See WAC 248-54-430, pages 8-11)

A. How many bacteriological samples are required per month?

Distribution Samples: ______

Raw Samples: ______

B. Have the above required samples been submitted routinely? .... ☐ YES (22-1) ☐ NO (22-2)

C. Has a complete chemical analysis been made on each source of supply during the last calendar year? .... ☐ YES (23-1) ☐ NO (23-2)

[illegible] Operations (See WAC 248-54-440, page 12)

A. Are the individuals in responsible charge of operation certified? .... ☐ YES (24-1) ☐ NO (24-2)

B. Are the operation reports (treatment, etc.) submitted as required? .... ☐ YES (25-1) ☐ NO (25-2)

[illegible] Capital Improvements (Class I Systems only)

A. What was the approximate total cost of systems improvements during the last calendar year? .... $ ______ (26-34)

B. What is the anticipated expenditure for the present calendar year? .... $ ______ (35-43)

C. What is the anticipated expenditure for the next five years? .... $ ______ (44-52)

9. Survey Completion

Date of on-site survey ______

Mo. Day Yr.

[illegible] Responsible Personnel

A. Name of person in charge of water system operation:

Address ______

______

Telephone ______

B. Person in responsible charge of operation (if different from above)

Name ______

11. MAJOR NEWSPAPERS AND RADIO STATIONS IN AREA IF PUBLIC NOTICE IS REQUIRED:

	NAME	LOCATION (CITY)
NEWSPAPERS:		
RADIO STATIONS:		

[27] THE FOLLOWING INFORMATION WILL BE COMPLETED BY THE DSHS ENGINEER OR COUNTY SANITARIAN

WATER QUALITY CONTROL IMPROVEMENTS NEEDED

(CHECK ITEMS WHERE IMPROVEMENTS ARE NEEDED)

Source of Supply	Source Prot.	Watershed Control	Chlorination	Filtration	Turbidity Monitoring	Iron/Mn Control	Bacteriological Monitor	Chemical Monitor	Cross Conn. Control	OTHER IMPROVEMENT NEEDS
Total System							(53)	(54)	(55)	
Wells	(56)		(57)			(58)				
Springs	(59)		(60)	(61)		(62)				
Surface H2O	(63)	(64)	(65)	(66)	(67)					

COMMENTS

Return to DSHS, Water Supply and Waste Section, Mail Stop 4-1, Olympia, Washington 98504

1. On a map, indicate the existing and future service area of your system. Include a short explanation of why the future service area boundary is located where it is, and identify neighboring water systems.

2. Does your future service area overlap with adjacent water systems?

   Yes _____ No _____. If yes, explain why.

DRAFT

3. How many service connections does your system anticipate 10 years from now? ______
   Include a short explanation of how you arrived at this number.

4. Is your system required to meet fire flow performance standards?

   (WAC __________) Yes _____ No _____. If yes, include map of "development classifications".

5. List facilities your system intends to develop during the next 10 years, including the year each will be developed.

6. List reasons why those new facilities are necessary.

7. The new facilities will be financed by: User Charges _____ Loans _____

Bonds _____ Government Assistance _____ Other _____

8. Does your system have any interties or other joint-use facilities with a neighboring water system? Yes _____ No _____
If yes, explain.

DRAFT

9. Do your improvements include any potential interties or joint-use facilities? Yes _____ No _____ If yes, explain. If no, are you interested in the possibility of sharing facilities with another water system if the cost would be less? Yes _____ No _____.

10. Is your utility responsible for its own operation and maintenance? Yes _____ No _____ If no, explain. If yes, are you interested in having another entity operate and maintain your system if the cost would be less? Yes _____ No _____

11. If reliable, good quality water is available from a neighboring system, would you be willing to have that system serve your customers if you receive just compensation for your system? Yes _____ No _____

12. Would you be willing to expand your system if a neighboring water system requested you to provide service to its customers?
Yes _____ No _____

Other items which need to be included in Part 2 are identified in Section D of the Water System Plan, and include:

1. Operations Program (WAC 248-54-610)

2. Information for variance or exemption (if appropriate) (WAC 248-54-800)

3. Information needed to comply with the State Environmental Policy Act (WAC 248-06 and WAC 197-10)

DRAFT

REGIONAL SUPPLEMENT

The regional supplement is intended to address areawide water system concerns for the critical water supply service area, or the geographical area established for reserving a future domestic water supply. This supplement is expected to contain, but not be limited to, the following:

A. Assessment of all appropriate plans and policies which have been adopted by local, regional and state governmental entities. These include water resource plans, water quality plans, comprehensive land use plans, shoreline master programs, etc.

B. Compilation of future water service areas as identified in each purveyor's water system plan, including:

   1. A map depicting existing and future service areas.

   2. Copy of service area agreements between water systems.

DRAFT

C. Establishment of minimum design standards applicable to water system improvements within the critical water supply service area. Include map of "development classifications" pertaining to fire flow as identified in each purveyor's water system plan.

D. Establishment of a process for assessing new public water systems which locate within the critical water supply service area, consistent with those requirements outlined in WAC 10. The process should address:

   1. How the minimum water system design standards are to be applied.

   2. A method for counties to assess water supply to new developments.

E. Identification of potential joint-use or shared water system facilities as outlined in each purveyor's water system plan, including:

   1. A map of all potential joint-use or shared facilities, including interties.

   2. List joint-use or shared facilities to be developed, together with documentation from the utilities involved outlining arrangements for development and use of such facilities.

   Note: This topic should be closely related to the discussion on alternatives and projection of improvements included in each purveyor's water system plan.

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