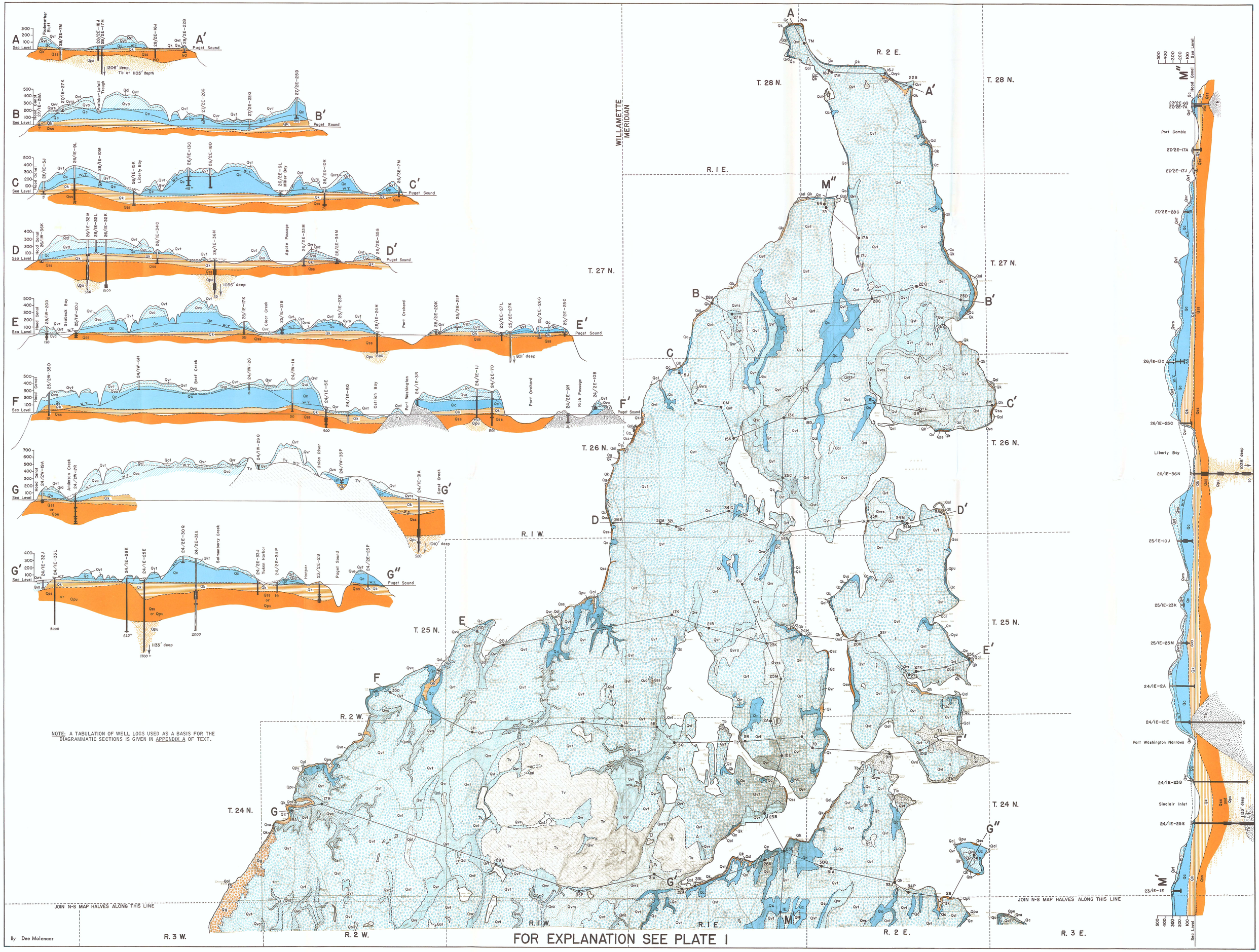
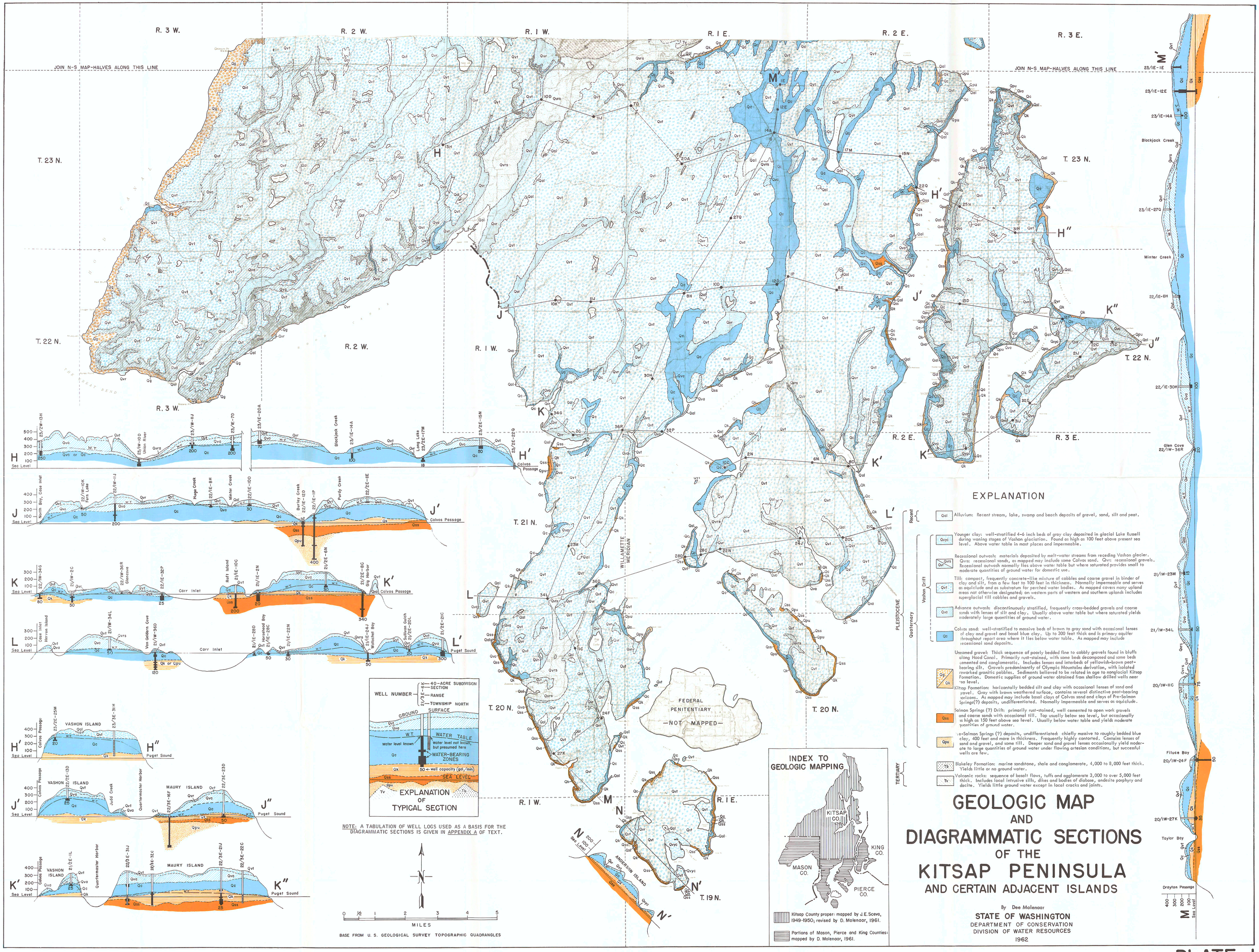


NOTE: A TABULATION OF WELL LOGS USED AS A BASIS FOR THE DIAGRAMMATIC SECTIONS IS GIVEN IN APPENDIX A OF TEXT.

By Dee Molenaar

FOR EXPLANATION SEE PLATE I

PLATE I NORTH HALF



EXPLANATION

Recent

Qal — Alluvium: Recent stream, lake, swamp and beach deposits of gravel, sand, silt and peat.

Quaternary — Vashon Drift

Qvyc — Younger clay: well-stratified 4-6 inch beds of gray clay deposited in glacial Lake Russell during waning stages of Vashon glaciation. Found as high as 100 feet above present sea level. Above water table in most places and impermeable.

Qvrs / Qvr — Recessional outwash: materials deposited by melt-water streams from receding Vashon glacier. Qvrs: recessional sands, as mapped may include some Colvos sand. Qvr: recessional gravels. Recessional outwash normally lies above water table but where saturated provides small to moderate quantities of ground water for domestic use.

Qvt — Till: compact, frequently concrete-like mixture of cobbles and coarse gravel in binder of clay and silt, from a few feet to 100 feet in thickness. Normally impermeable and serves as aquiclude and as substratum for perched water bodies. As mapped covers many upland areas not otherwise designated; on western parts of western and southern uplands includes superglacial till cobbles and gravels.

Qva — Advance outwash: discontinuously stratified, frequently cross-bedded gravels and coarse sands with lenses of silt and clay. Usually above water table but where saturated yields moderately large quantities of ground water.

Qc — Colvos sand: well-stratified to massive beds of brown to gray sand with occasional lenses of clay and gravel and basal blue clay. Up to 300 feet thick and is primary aquifer throughout report area where it lies below water table. As mapped may include recessional sand deposits.

Quaternary — Vashon Drift

Qg / Qk — Unnamed gravel: Thick sequence of poorly bedded fine to cobbly gravels found in bluffs along Hood Canal. Primarily rust-stained, with some beds decomposed and some beds cemented and conglomeratic. Includes lenses and interbeds of yellowish-brown peat-bearing silt. Gravels predominantly of Olympic Mountains derivation, with isolated reworked granitic pebbles. Sediments believed to be related in age to nonglacial Kitsap Formation. Domestic supplies of ground water obtained from shallow drilled wells near sea level.

Kitsap Formation: horizontally bedded silt and clay with occasional lenses of sand and gravel. Gray with brown weathered surface, contains several distinctive peat-bearing horizons. As mapped may include basal clays of Colvos sand and clays of Pre-Salmon Springs(?) deposits, undifferentiated. Normally impermeable and serves as aquiclude.

Qss — Salmon Springs (?) Drift: primarily rust-stained, well cemented to open work gravels and coarse sands with occasional till. Top usually below sea level, but occasionally as high as 150 feet above sea level. Usually below water table and yields moderate quantities of ground water.

Qpu — Pre-Salmon Springs (?) deposits, undifferentiated: chiefly massive to roughly bedded blue clay, 400 feet and more in thickness. Frequently highly contorted. Contains lenses of sand and gravel, and some till. Deeper sand and gravel lenses occasionally yield moderate to large quantities of ground water under flowing artesian conditions, but successful wells are few.

TERTIARY

Tb — Blakeley Formation: marine sandstone, shale and conglomerate, 4,000 to 8,000 feet thick. Yields little or no ground water.

Tv — Volcanic rocks: sequence of basalt flows, tuffs and agglomerate 3,000 to over 5,000 feet thick. Includes local intrusive sills, dikes and bodies of diabase, andesite porphyry and dacite. Yields little ground water except in local cracks and joints.

GEOLOGIC MAP AND DIAGRAMMATIC SECTIONS OF THE KITSAP PENINSULA AND CERTAIN ADJACENT ISLANDS

By Dee Molenaar
STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

1962

PLATE 1

GENERAL INFORMATION*

FEATURES OF GROUND-WATER OCCURRENCE

The interstices or spaces in rock materials below a certain depth are usually saturated with water under hydrostatic pressure. Water within this zone of saturation is termed ground water. The water above this zone, but below the ground surface, and not saturating the rock materials, is termed vadose water.

In many places an impermeable stratum of clay or till ("hardpan") will impede the downward percolation of vadose water and cause it to accumulate and form a local zone of saturation, or zone of perched ground water.

An aquifer is a water-bearing formation that is capable of yielding water to a well or spring.

In permeable materials the top of the zone of saturation is the water table. This is the static water level, or the level at which water will stand in a well that penetrates the zone of saturation. The water surface of a locally perched zone of saturation is termed the perched water table, while the surface of the zone below which all permeable materials are saturated on a regional extent is termed the regional water table.

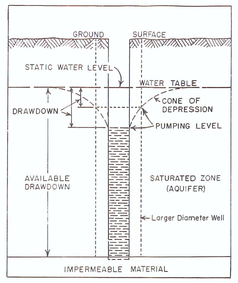
In an area where only permeable materials exist there will be but one water table. All wells drilled in the area will encounter water when the water table is reached and water levels in wells will define that surface. Water occurring under such water-table conditions is termed unconfined ground water.

Where ground water moves beneath some impermeable stratum which confines its upward movement under pressure it is termed confined or artesian ground water. Water encountered by a well penetrating the overlying confining layer will rise in the well casing to the piezometric surface or the height corresponding to the pressure head of the confined aquifer. Although popular usage of the term "artesian well" usually implies one that flows at the surface, the term accepted by hydrologists refers to wells in which ground water will rise to a level higher than that at which it was first encountered, whether or not it reaches ground surface. Since numerous impermeable zones may be penetrated during a single deep drilling operation, and each may have its own piezometric surface, several water levels may be experienced as the different zones are penetrated.

The water table is generally a sloping surface, having a gradient in the direction of ground-water movement. Movement is from the points or areas of recharge, where water is added to the ground-water body, to points or areas of discharge, where water is lost to the surface. The water table fluctuates

from time to time, owing generally to seasonal changes in the amounts of recharge and discharge. The chief source of ground-water recharge is precipitation. Part of the precipitation falling on an area will generally flow off as surface runoff, part will evaporate, and part will percolate downward into the soil, some of which will eventually reach the water table to become ground water. Ground water is recharged naturally also by both downward percolation and lateral seepage from surface ponds, lakes, and rivers that are located above the water table. Irrigation can be considered as a form of artificial recharge, as part of the water spread over the ground surface will generally percolate to the underlying aquifer. Ground-water discharge is the outflow of water from the ground-water body and is accomplished naturally by flow onto the land surface as springs or directly into lakes, streams, or into the sea. Artificial discharge takes place when the ground-water body is tapped by wells.

HYDRAULICS OF A WELL



Wells Pumping Unconfined Ground Water:

When a well is pumped the static water level within the well drops to a pumping level. The pumping level is dependent upon the following factors: (1) rate of pumping, measured in gallons per minute (gpm), (2) length of time well is pumped, (3) permeability of aquifer, (4) diameter of well or casing, and (5) size and number of openings in well to allow entrance of outside water into well (size and length of screen, perforated areas, or open-end casing).

As the water level drops within the well, there is a reflected drop in the water table immediately around the well. This usually takes the shape of an inverted cone or "cone of depression" in the water table. The inverted apex of the cone is at the same depth as the water level or pumping level within the well. As pumping is continued at a given rate, equilibrium is established in the cone of depression when the water enters the well at the same rate that it is pumped. The drawdown is the depth the water level has lowered to reach equilibrium. For a given well, different pumping rates have individual levels of drawdown.

The size and shape of the cone of depression depends upon the permeability of the water-bearing materials and the rate of withdrawal. At a constant rate of pumping, the cone of depression will have a flatter gradient and greater areal extent in highly permeable materials such as coarse gravels, while on the other hand it will have a steeper gradient and lesser areal extent in materials of lower permeability such as fine sands. The outer limit of the cone of depression is termed the area of influence. Accordingly, it may be seen that in order to avoid the possibilities of interference between wells they should be located at distances that will preclude an overlapping of their individual areas of influence.

The permeability of an aquifer is defined as the capacity of the aquifer to transmit water. This is determined primarily by the size, shape and arrangement of particles in unconsolidated deposits, and by the size, number and interconnections of joints and fractures in consolidated rocks.

The specific capacity of a well is defined as the gallons per minute for each foot of drawdown experienced in pumping the well. The specific capacity is dependent upon the permeability and extent of the aquifer, the diameter of the well, and the amount of open area through which water enters the well. As most wells within a given area vary somewhat in the manner of construction and development (diameter, screen, perforation) each well will have its own characteristic specific capacity.

About 90 percent of the full capacity of a well can be obtained when two-thirds of its available drawdown, or depth of water in the well, has been utilized. Further pumping of the water level toward the bottom of the well may frequently result in increased turbulance which in turn may cause undesirable entrance of finer sands and silt into the pump.

For determination of the capacity of wells (as shown in blue numerals on the adjoining map) the specific capacity of the individual wells is multiplied by roughly two-thirds of the available drawdown in feet. For example, a 90-foot well that tested at 20 gpm with a 10-foot drawdown from a 30-foot static water level would have a specific capacity of 2 gpm for each foot of drawdown, and an available supply of 60 feet to the bottom of the well. Two-thirds of this, or 40 feet, multiplied by the specific capacity would give a well capacity of 80 gpm. As pointed out earlier, the diameter of the well would influence this figure, so that for a given aquifer and area, there may be a slight variance in the calculated well capacities.

Wells Pumping Artesian Ground Water:

When a well penetrating a confined or artesian aquifer is pumped the pressure on the piezometric surface immediately around the well will be lessened and that surface will form a theoretical cone of depression similar to the true cone of depression formed in an unconfined aquifer. In the case of a flowing artesian well, pumping the confined aquifer at a rate greater than that at which water enters the well will cause the flow to decrease, and eventually the flow will cease if the piezometric surface, originally above ground level, drops to below ground surface. Upon cessation of pumping this theoretical piezometric surface will again rise as water enters the well and the water will again flow at ground surface If a flowing artesian well is capped there will be a pressure exerted at the cap. This pressure is usually measured in pounds per square inch (lbs./sq. in.) and will be equal to the pressure head in feet multiplied by 0.431. Conversely, the pressure head in feet can be calculated by multiplying the pressure (lbs./sq. in.) by 2.31.

Among the conditions causing artesian flows is that produced as a result of tidal fluctuations along the Puget Sound shoreline. Here the fresh water table near beach level will rise and fall with the tide, causing wells located near sea level to flow or increase flow during high tide and, conversely, to cease or decrease flow during low tide. These wells usually have very little pressure head and the flows are small in most cases.

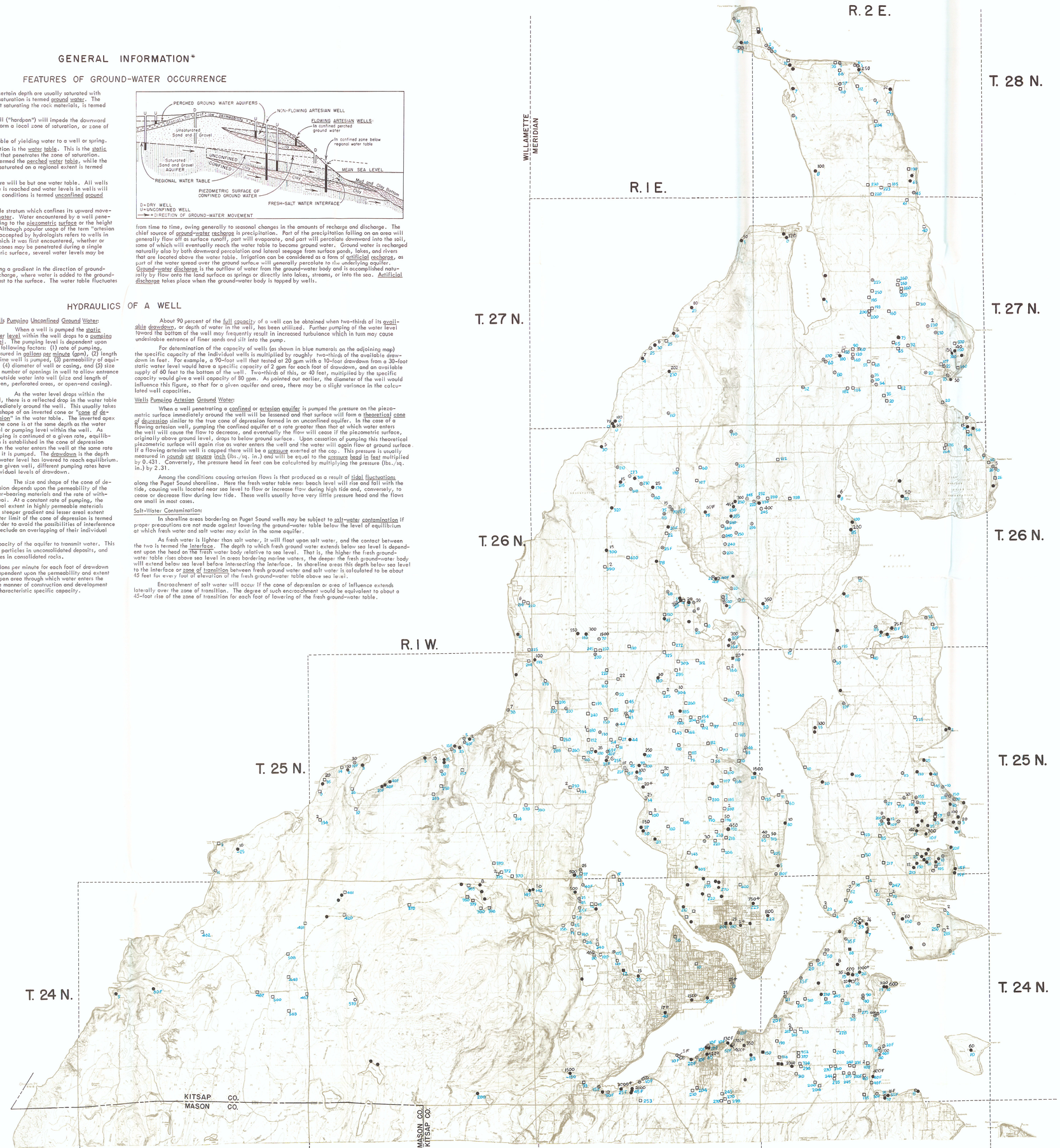
Salt-Water Contamination:

In shoreline areas bordering on Puget Sound wells may be subject to salt-water contamination if proper precautions are not made against lowering the ground-water table below the level of equilibrium at which fresh water and salt water may exist in the same aquifer.

As fresh water is lighter than salt water, it will float upon salt water, and the contact between the two is termed the interface. The depth to which fresh ground water extends below sea level is dependent upon the head on the fresh water body relative to sea level. That is, the higher the fresh ground-water table rises above sea level in areas bordering marine waters, the deeper the fresh ground-water body will extend below sea level before intersecting the interface. In shoreline areas this depth below sea level to the interface or zone of transition between fresh ground water and salt water is calculated to be about 45 feet for every foot of elevation of the fresh ground-water table above sea level.

Encroachment of salt water will occur if the cone of depression or area of influence extends laterally over the zone of transition. The degree of such encroachment would be equivalent to about a 45-foot rise of the zone of transition for each foot of lowering of the fresh ground-water table.

* Adapted from Sceva, 1957.

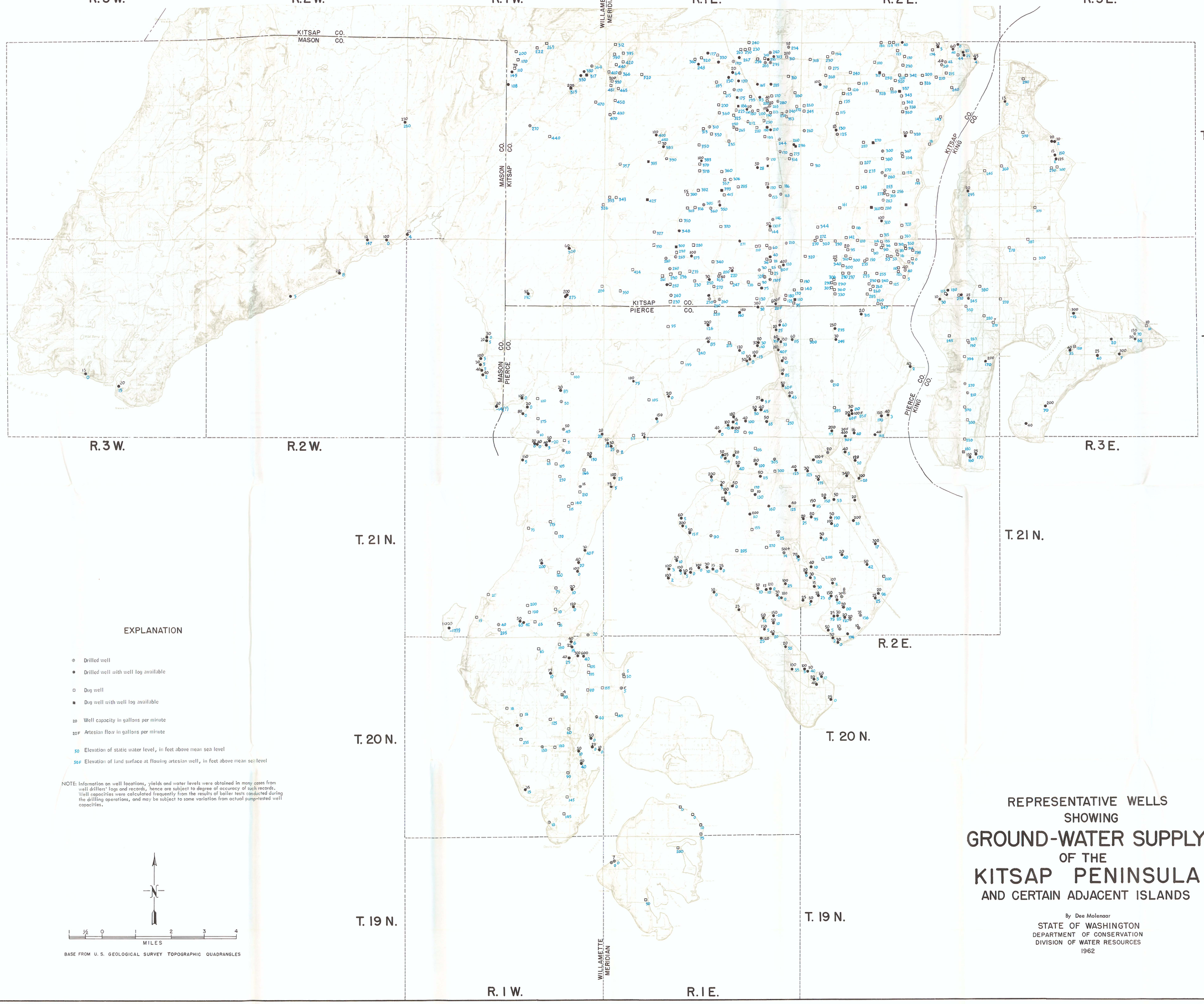


FOR EXPLANATION SEE PLATE 2

By Dee Molenaar

R. 3 W. R. 2 W. R. I W. R. I E. R. 2 E. R. 3 E.

PLATE 2 NORTH HALF



EXPLANATION

- Drilled well
- Drilled well with well log available
- Dug well
- Dug well with well log available
- 20 Well capacity in gallons per minute
- 20F Artesian flow in gallons per minute
- 50 Elevation of static water level, in feet above mean sea level
- 50F Elevation of land surface at flowing artesian well, in feet above mean sea level

NOTE: Information on well locations, yields and water levels were obtained in many cases from well drillers' logs and records, hence are subject to degree of accuracy of such records. Well capacities were calculated frequently from the results of bailer tests conducted during the drilling operations, and may be subject to some variation from actual pump-tested well capacities.

N

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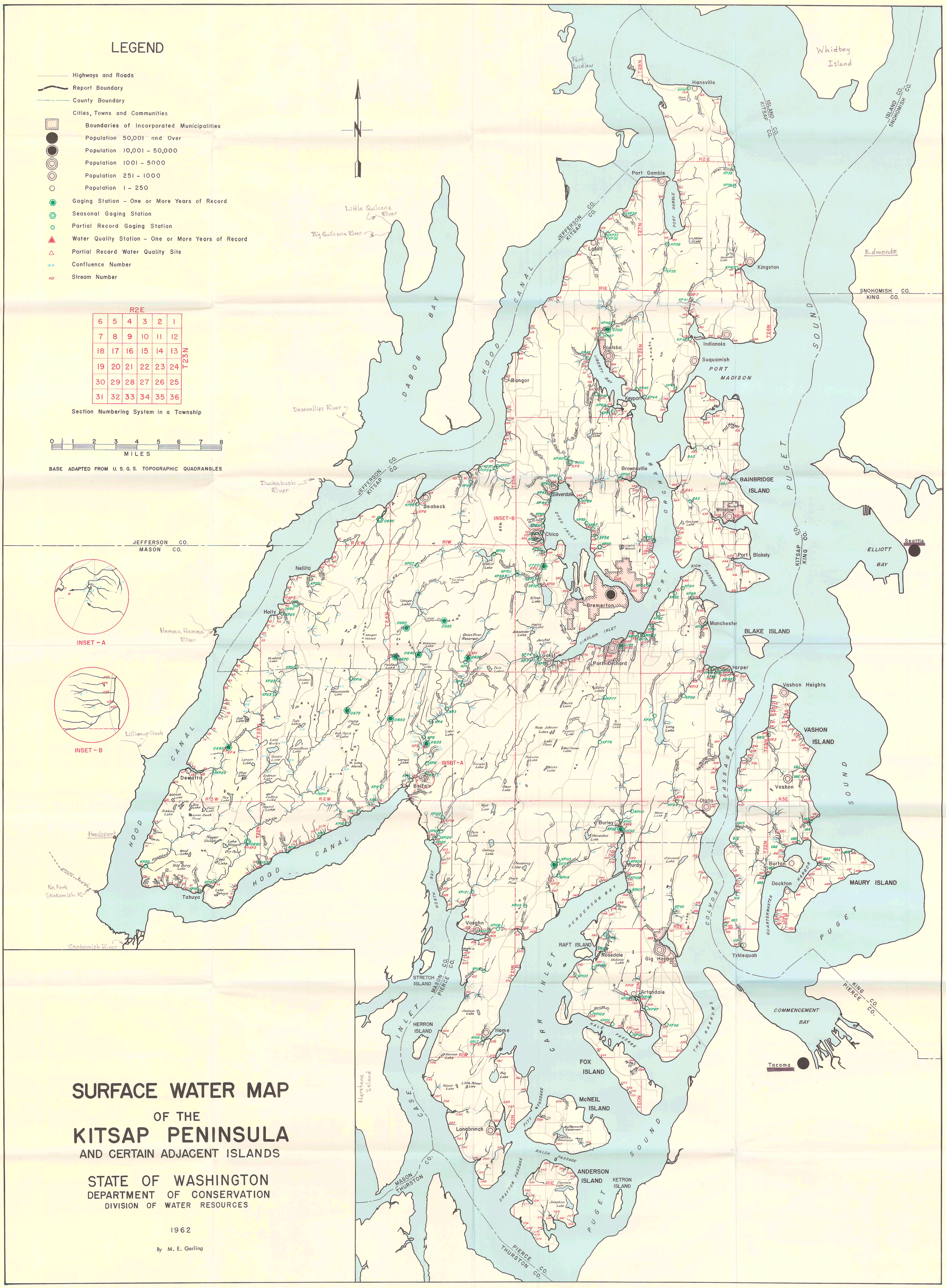
MILES

BASE FROM U. S. GEOLOGICAL SURVEY TOPOGRAPHIC QUADRANGLES

REPRESENTATIVE WELLS SHOWING GROUND-WATER SUPPLY OF THE KITSAP PENINSULA AND CERTAIN ADJACENT ISLANDS

By Dee Molenaar
STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES
1962



SURFACE WATER MAP

OF THE

KITSAP PENINSULA

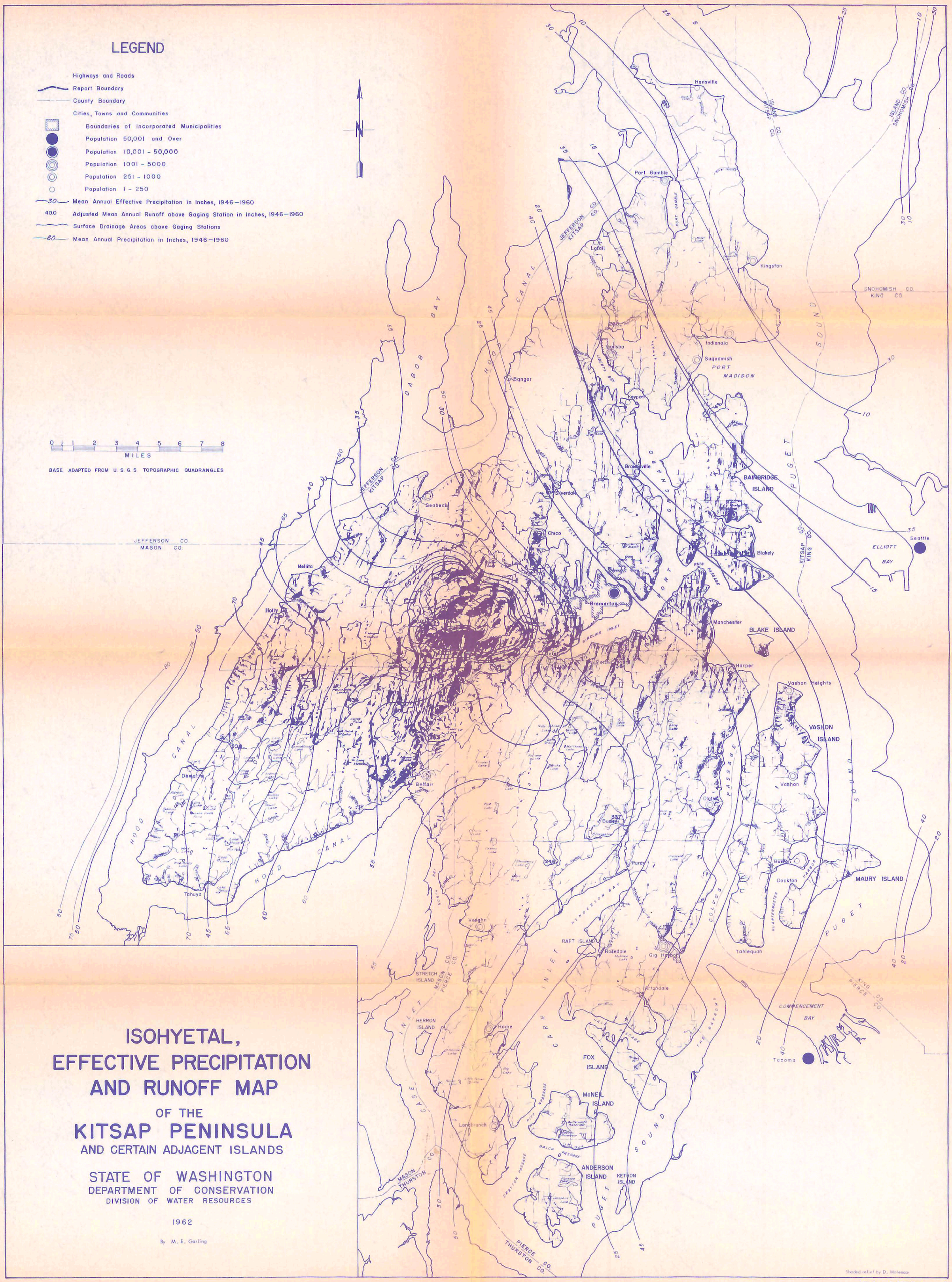
AND CERTAIN ADJACENT ISLANDS

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

1962

By M. E. Garling

PLATE 3



ISOHYETAL, EFFECTIVE PRECIPITATION AND RUNOFF MAP

OF THE

KITSAP PENINSULA

AND CERTAIN ADJACENT ISLANDS

STATE OF WASHINGTON
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1962

By M. E. Garling

Shaded relief by D. Molenaar

PLATE 4

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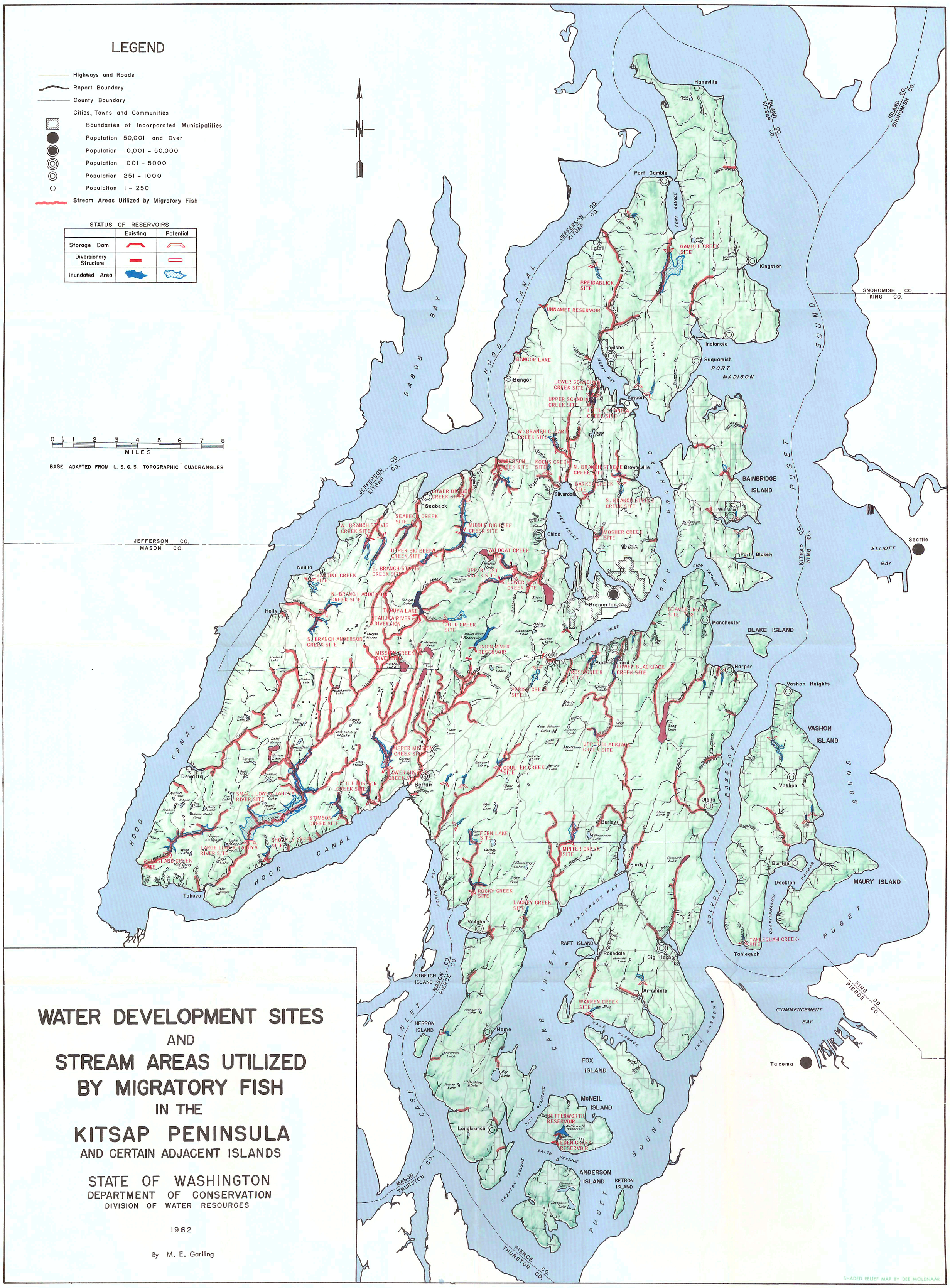

WATER DEVELOPMENT SITES AND STREAM AREAS UTILIZED BY MIGRATORY FISH IN THE KITSAP PENINSULA

AND CERTAIN ADJACENT ISLANDS

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PLATE 5