wells; the rate of ground-water recharge; and the hydraulic characteristics of the aquifer. Because these conditions vary locally, the depth to the transition zone below sea level differs from one place to another on the Island.

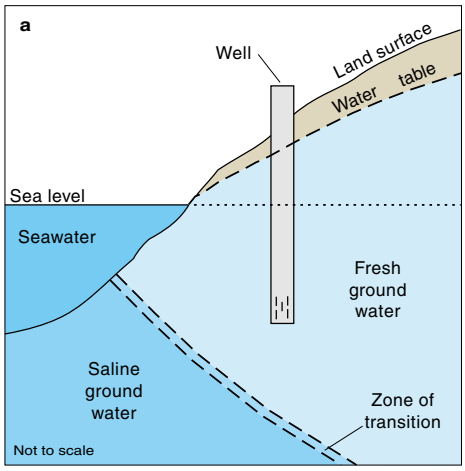
WHAT INDICATES SEAWATER INTRUSION?

One indicator of seawater intrusion is an increased chloride concentration in a freshwater aquifer, because chloride, a major constituent of seawater, is chemically stable and moves at about the same rate as intruding seawater. For the purposes of this study, chloride concentrations of 100 milligrams per liter (mg/L) or more were assumed to indicate seawater intrusion.

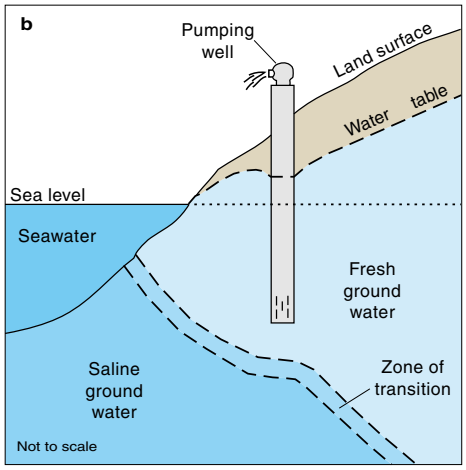
This study's indication of seawater was also used in a previous USGS study conducted in San Juan County in 1981. That 1981 study used graphical analysis and the cumulative frequency distribution of chloride concentrations to establish a threshold value of 100 mg/L for seawater intrusion (Whiteman and others, 1983).

Seawater contains approximately 35,000 mg/L of dissolved solids, which include about 19,000 mg/L of chloride. Fresh ground water in most coastal areas of Washington generally contains less than 10 mg/L of chloride. Even so, concentrations in excess of 10 mg/L are not conclusive evidence of seawater intrusion because they could be due to airborne sea spray in precipitation, to substantial well pumping rates, to local sources of chlorides, including septic systems or animal manure, or to *relict seawater* in the aquifer.

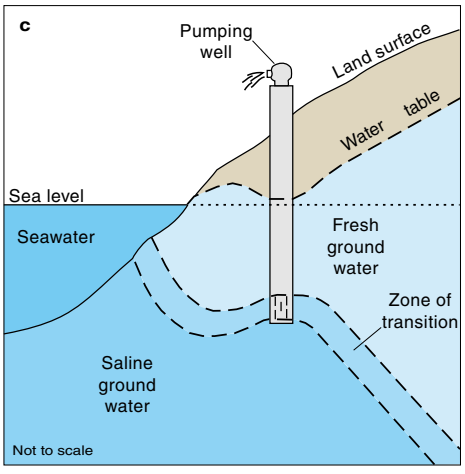
At times during the last million and a half years, the sea level along the Washington coastline was higher than now, and the transition zone between fresh and salty ground water was correspondingly farther inland and at higher elevations. Today, occurrences of salt water in Washington coastal aquifers may be due to *relict seawater*— seawater incompletely flushed from rock materials after the latest decline of sea level. The term *relict seawater* can also refer to *connate water*, or water trapped in an aquifer since its formation (Dion and Sumioka, 1984).



Nonpumping well in an unconfined (water-table) aquifer under conditions of equilibrium--no intrusion has occurred.



Well pumping from an unconfined (water-table) aquifer--seawater intrusion not affecting salinity of pumped water.



Well pumping from an unconfined aquifer--seawater intrusion affecting salinity of pumped water.

Figure 2. *Hypothetical hydrologic conditions before and after seawater intrusion.*

WHAT CAN HELP REDUCE SEAWATER INTRUSION?

Seawater intrusion on Lopez Island can be minimized by water conservation, efficient well construction, and by judicious well-operation practices like these:

- Using such water-conserving devices as low-volume plumbing fixtures and toilets.

- Keeping outdoor watering to a minimum.

- Reusing or recycling water when possible.

- Augmenting fresh ground-water recharge by, for example, using surface ponds to slow surface runoff and raise infiltration rates.

- Constructing wells that do not penetrate deeper below sea level than necessary.

- Sizing pumps for lower pumping rates and minimizing lengths of pumping cycles.

- In multiple-well systems, pumping wells alternately.