TEXT TO ACCOMPANY THE
SHALLOW GROUND-WATER HAZARD MAP
FOR UTAH COUNTY, UTAH

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ABSTRACT

Shallow ground water occurs in unconsolidated sediments in much of Utah Valley. Most problems associated with shallow ground water occur when the water table is within about 10 feet of the ground surface. The most significant hazard associated with shallow ground water is the flooding of subsurface facilities (such as basements), utility lines, and septic-tank soil-absorption fields. Shallow ground water can also destabilize foundations or excavations and contribute to liquefaction of sandy soils during earthquakes.

Shallow ground-water maps have been constructed for Utah County by compiling information from existing water-table maps; water levels recorded in wells, borings for soil-foundation reports, and test pits for septic tanks; and the distribution of plants requiring water at shallow depths. The principle users for these maps are planners, building officials, health department officials, and others who must know where further studies are required prior to development.
INTRODUCTION

Water in saturated zones beneath the land surface, referred to as ground water, occurs in various materials at various depths throughout Utah (Hecker and others, 1988). Ground water fills fractures and pore spaces in rocks and fills voids between grains in unconsolidated deposits (clay, silt, sand, and gravel). Ground water is considered to be shallow where the water table is within 30 feet of the ground surface.

Hazards associated with shallow ground water include flooding of subsurface facilities such as basements, surface flooding, destabilization of foundations or excavations, and liquefaction of soils during earthquakes. Problems from shallow ground water generally arise only when the saturated zone is within about 10 feet or less of the ground surface because this is the depth to which most foundations of buildings are excavated. Shallow ground water is a significant factor which must be considered when siting waste-disposal facilities and septic-tank soil-absorption systems. Liquefaction can occur in saturated sandy soils up to a depth of 30 feet during earthquakes and result in ground failure.

It is the purpose of this report to discuss: 1) the nature of shallow ground-water hazards in Utah County, 2) the potential consequences, 3) Utah County shallow ground-water hazards maps, and 4) recommendations regarding use of the maps in land-use planning. Liquefaction hazards are discussed in a separate report entitled "Liquefaction Hazards, Utah County, Utah". Surface flooding from shallow ground water in areas experiencing subsidence as a result
of earthquakes is discussed in a separate report entitled "Tectonic Subsidence, Utah County, Utah". Shallow ground water in rock is not as common as shallow ground water in unconsolidated sediments and is not considered here because it poses a relatively insignificant geotechnical hazard. Foundations and conventional wastewater disposal systems in rock are uncommon, and foundation stability is not appreciably reduced by saturated conditions (Hecker and others, 1988). Also, rock is not susceptible to liquefaction.

NATURE AND CAUSES OF SHALLOW GROUND WATER

Shallow ground water occurs in unconsolidated sediments in much of Utah Valley. Ground water in unconsolidated deposits, chiefly stream alluvium and alluvial-fan and lacustrine (lake) basin fill, occurs under unconfined and confined conditions and frequently occurs in geologic units, known as aquifers, which are permeable enough to yield water in usable quantities to wells and springs (Heath, 1983). An unconfined aquifer is generally not saturated for its entire thickness, and the water table marks the top of the zone in which the pore spaces in the unconsolidated sediments are saturated (fig. 1). Localized occurrences of unconfined ground water above the principle water table are called perched zones (fig. 1). Perched ground water commonly occurs above localized deposits of low-permeability sediment. Where ground water saturates the entire thickness of an aquifer below an areally-extensive low-permeability zone, termed a confining bed, the
aquifer is said to be under confined conditions. Ground water beneath a confining bed is usually under artesian pressure as a result hydrostatic pressure exerted by higher water levels in recharge areas, and water in wells penetrating a confined aquifer usually rises above the top of the aquifer to the level of the potentiometric surface (fig. 1). The level of the potentiometric surface is determined by the amount of hydrostatic pressure at that point in the confined aquifer. Confining beds in unconsolidated sediments are generally semi-permeable and thus allow underlying, artesian water to leak upward and help maintain a water table above the confined aquifer (fig. 1). Shallow ground water in Utah County occurs in perched and unconfined aquifers.

Water in shallow saturated zones is replenished by infiltration from streams, lakes, and precipitation, lateral subsurface flow from adjacent higher ground-water areas, and upward leakage from underlying confined aquifers (Hecker and others, 1988). The shallowest water tables are generally found in stream valleys and in the center of basins where upward leakage from underlying artesian aquifers is greatest and their potentiometric surfaces are highest (fig. 1). Ground water discharges naturally from springs and by evapotranspiration (direct evaporation and plant transpiration). Man influences local water levels through irrigation, pumping from wells, and surface-drainage diversions and reservoirs.

The shallow water table is dynamic and fluctuates daily, seasonally, annually, and over longer periods in response to a
variety of conditions (Hecker and others, 1988). Ground-water levels may rise and fall with seasonal variations in precipitation, longer-term changes in climate, or changes in rates of irrigation or pumping. A series of years with greater-than-average precipitation beginning in the late-1960s, but particularly since 1982, has increased ground-water recharge to basins and generally elevated ground-water tables statewide in the mid-1980s (Hecker and others, 1988), including Utah County. Drought conditions in the late-1980s have caused a general decline.

HAZARDS ASSOCIATED WITH SHALLOW GROUND WATER

The most significant hazard associated with shallow ground water is the flooding of subsurface facilities (such as basements), utility lines, and septic-tank soil-absorption fields. Structures extending below the water table may experience water damage to foundations as well as contents. Landfills and waste dumps may become inundated and contaminate aquifers. Underground utilities may also experience water damage. Septic-tank soil-absorption fields can become flooded which may cause ground-water contamination as well as system failure. Roads and airport runways may buckle or settle as bearing strength in susceptible soils are reduced by saturation. Wetting of collapsible or expansive soils by ground water may cause settlement or expansion and damage to foundations and structures.

Dissolution of subsurface materials and soil piping causing sinkholes and collapse-induced depressions may also be caused by
shallow ground water. Water flowing through bedrock fissures in limestone or gypsiferous rocks can dissolve the rock and create holes which may collapse. Sinkholes and piping can occur in unconsolidated sediments as water flowing through conduits beneath the ground surface erodes sediments to create cavities ("pipes") which may collapse.

Because shallow ground water is readily accessible from the surface, contaminants are easily introduced. Pollutants will flow with the ground water and may enter lower aquifers or seep into wells. About 85 percent of the Utah's wells are located within basin-fill aquifers; some are becoming increasingly contaminated (Waddell and Maxell, 1987).

**SHALLOW GROUND-WATER HAZARD REDUCTION**

Avoidance is the easiest method of reducing shallow ground-water problems. However, because many of Utah County's population centers are on the relatively flat land on the floor of Utah Valley, coincident with areas of shallow ground water, avoidance may not be possible. Construction techniques may be employed which reduce or eliminate the adverse effects of ground-water flooding. Water-proofing of subsurface structures may be the most common technique used, and may include installation of drainage systems around basements. Requirements for water-proofing are given in the Uniform Building Code. Slab-on-grade buildings, which have no basement, are common in areas with a shallow water table. Pile foundations may also be used to increase foundation stability.
Occasionally it is necessary to add fill to the construction site to raise the elevation of the building.

Pumping water to lower the water table is also possible in areas subject to a shallow water table. This procedure is typically used only during the construction phase, and is an expensive and unreliable technique for permanently lowering a water table. However, basement sump pumps may be effective for individual homes.

Septic-tank soil-absorption fields do not function properly if inundated by shallow ground water. Utah State Health Department regulations therefore require that the base of the drain lines be at least two feet above the highest seasonal ground-water table. Wisconsin mound septic-tank soil-abortion systems are currently experimental in Utah, but may be an alternative system that could be used in shallow ground-water areas. The drain lines in this type of system are buried in a mound above the natural ground surface to increase evaporation and increase the soil thickness above the water table.

SUMMARY OF METHODS USED IN MAP PREPARATION

Difficulties in mapping shallow ground-water tables occur because of diurnal, seasonal, annual, or longer period fluctuations. These variations may be in response to storms, seasonal changes in precipitation, long-term climatic changes, draw down from wells, or flooding from irrigation. To determine the potential for shallow ground-water problems, it is best to identify
the highest level the water table can be expected to reach. This is very difficult to do because of these fluctuations, and the map shows long-term averages rather than highest levels. Shallow ground-water maps were constructed from maps by Anderson and others (1986); water levels recorded in water wells, borings for soil-foundation reports, and test pits for septic tanks; and from the distribution of plants whose roots intersect the water table (phreatophytes). Phreatophytes are not as accurate an indicator of depth to water as measured water levels in wells because these plants do not respond to fluctuations. However, they are a good indicator of long-term, persistent shallow ground-water areas.

**RECOMMENDED USE OF SHALLOW GROUND-WATER HAZARD MAPS**

Most problems associated with shallow ground water occur when the water table is within about 10 feet of the ground surface. Areas where the water table is within 10 feet of the ground surface are recommended as a special study zone for shallow ground water. Areas where the water table is between 10 and 50 feet of the ground surface are shown on the maps because of the possibility of liquefaction at greater depths. Areas where the water table is greater than 50 feet of the ground surface are shown on the maps for informational purposes only, and includes areas not evaluated.

The principal users targeted for these maps are planners, building officials, health department officials, and others who must know where further studies are required prior to development. Buildings scheduled for construction within the special study zone,
depending on the type of structure, may need additional information about the potential for shallow ground-water problems before a building permit is issued. Also, shallow ground-water studies are required before approval is given by the Utah County Health Department for septic-tank soil-absorption systems.

Because of fluctuations of the water table, the accompanying maps are not intended to replace site-specific data. Ground-water information is quite extensive in some of the more urbanized areas, but is sparse in rural areas where subsurface investigations have not been performed or are not available.

**SCOPE OF SITE INVESTIGATIONS**

If a project is located within the special study zone, site-specific studies should be conducted to identify the highest shallow ground-water level recorded or visible in sediments as well as the present and highest expected level of the water table. To do this, it may be necessary to use additional information about long-term water-level fluctuations from measurements in wells over time and define a range of seasonal and annual fluctuation. Water-table measurements during known wet periods, such as 1983-1985, can also be used to approximate highest levels. Shallow ground-water hazards can be addressed in the soil-foundation report for a site, which should contain recommendations for stabilizing or lowering the water table, if necessary, and design of floodproofing or other mitigation strategies. Such studies must also address soil conditions and the potential for collapse, piping, dissolution, or
swelling if saturated. The site-specific studies will be reviewed by the County Geologist, County Surveyor, and Building Official. The shallow ground-water maps will be amended as new information becomes available.

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REFERENCES CITED


Figure 1. Generalized diagram showing the relationship of the ground water to the local geologic features. Probable ground water movement directions are shown by arrows.