UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	Docket No. 40-8943-MLA-2
CROW BUTTE RESOURCES, INC.	ASLBP No. 13-926-01-MLA-BD01
(Marsland Expansion Area)	

Hearing Exhibit

Exhibit Number: NRC015

Exhibit Title: Excerpts from Todd, "Groundwater Hydrology", 2d ed. (1980)

Groundwater Hydrology

SECOND EDITION

David Keith Todd
UNIVERSITY OF CALIFORNIA, BERKELEY
and
DAVID KEITH TODD,
CONSULTING ENGINEERS, INC.

John Wiley & Sons
New York Chichester Brisbane Toronto

Endpaper: Productive aquifers and withdrawals from wells in the United States after Dept. of Economic and Social Affairs, *Ground water in the Western Hemisphere,* United Nations, New York, 1976.

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Todd, David Keith, 1923-
Groundwater hydrology.

Includes bibliographical references and index.
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a semipervious aquitard, or semiconfining layer (see Fig. 2.13). Pumping from a well in a leaky aquifer removes water in two ways: by horizontal flow within the aquifer and by vertical flow through the aquitard into the aquifer.

Idealized Aquifer. For mathematical calculations of the storage and flow of groundwater, aquifers are frequently assumed to be homogeneous and isotropic. A *homogeneous aquifer* possesses hydrologic properties that are everywhere identical. An *isotropic aquifer* is one with its properties independent of direction. Such idealized aquifers do not exist; however, good quantitative approximations can be obtained by these assumptions, particularly where average aquifer conditions are employed on a large scale. Anisotropic aquifers, which possess directional characteristics, are discussed in Chapter 3.

Storage Coefficient

Water recharged to, or discharged from, an aquifer represents a change in the storage volume within the aquifer. For unconfined aquifers this is simply expressed by the product of the volume of aquifer lying between the water table at the beginning and at the end of a period of time and the average specific yield of the formation. In confined aquifers, however, assuming the aquifer remains saturated, changes in pressure produce only small changes in storage volume. Thus, the hydrostatic pressure within an aquifer partially supports the weight of the overburden while the solid structure of the aquifer provides the remaining support. When the hydrostatic pressure is reduced, such as by pumping water from a well penetrating the aquifer, the aquifer load increases. A compression of the aquifer results that forces some water from it. In addition, lowering of the pressure causes a small expansion and subsequent release of water. The water-yielding capacity of an aquifer can be expressed in terms of its storage coefficient.

A *storage coefficient* (or *storativity*) is defined as the volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of head normal to that surface. For a vertical column of unit area extending through a confined aquifer, as in Fig. 2.14*a*, the storage coefficient S equals the volume of water released from the aquifer when the piezometric surface declines a unit distance. The coefficient is a dimensionless quantity involving a volume of water per volume of aquifer. In most confined aquifers, values fall in the range $0.00005 <$

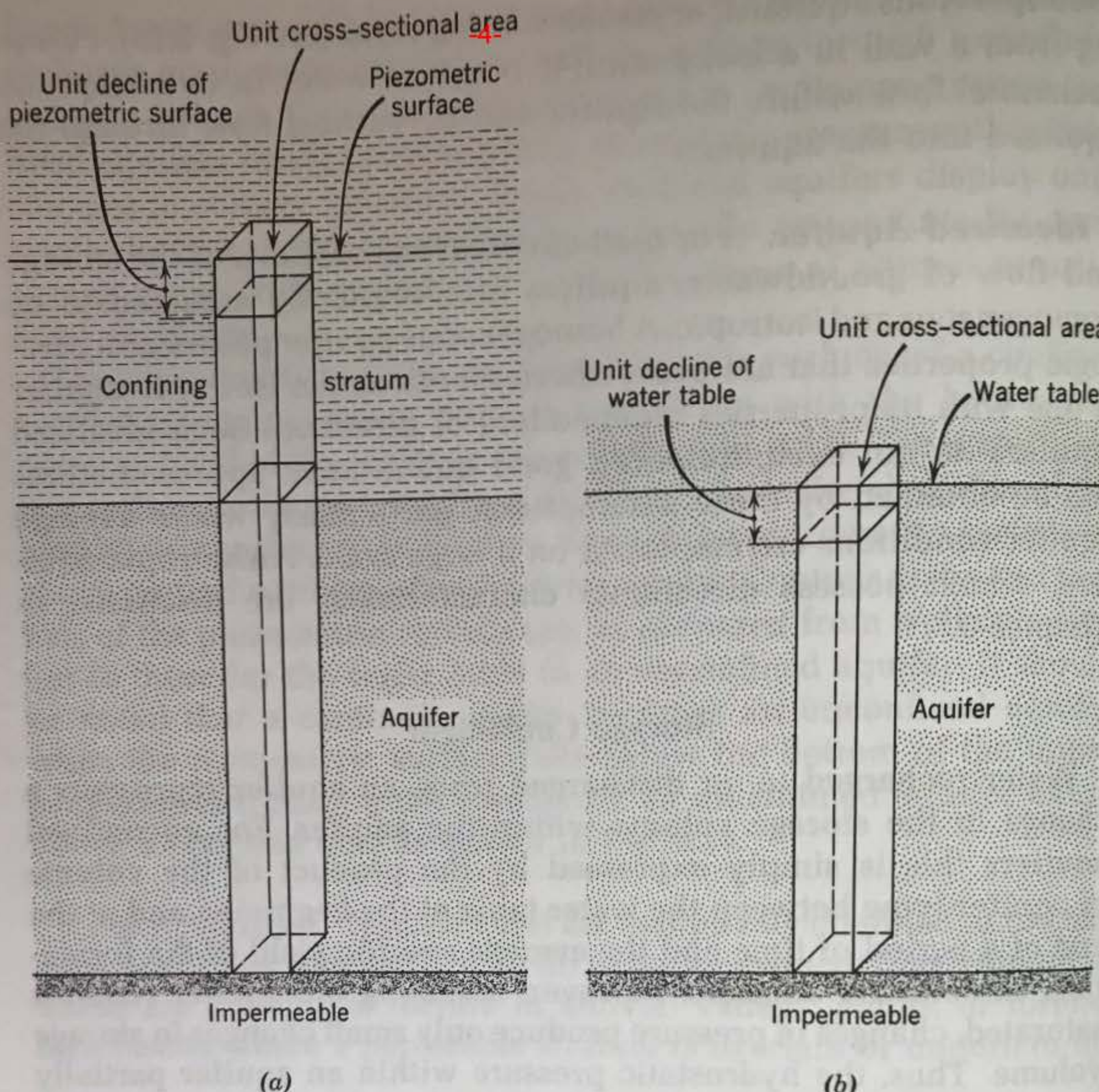

Fig. 2.14 Illustrative sketches for defining storage coefficient of (*a*) confined and (*b*) unconfined aquifers.

$S < 0.005$, indicating that large pressure changes over extensive areas are required to produce substantial water yields. Storage coefficients can best be determined from pumping tests of wells (Chapter 4) or from groundwater fluctuations in response to atmospheric pressure or ocean tide variations (see Chapter 6).

The fact that S normally varies directly with aquifer thickness enables the rule-of-thumb relationship[24]

$$S = 3 \times 10^{-6} b \tag{2.10}$$

where b is the saturated aquifer thickness in meters to be applied for estimating purposes.

The storage coefficient for an unconfined aquifer corresponds to its specific yield, as shown in Fig. 2.14*b*.