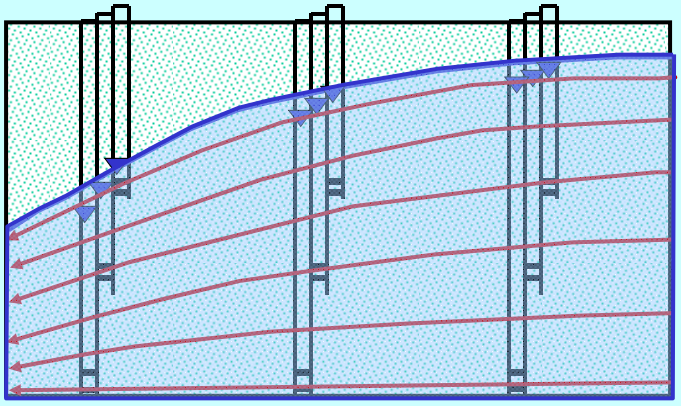
MEASURING HEAD IN THE FIELD

Piezometer

Pressure Meter

Standpipe Piezometers in an Unconfined Aquifer

short screened intervals reflect vertical head distribution

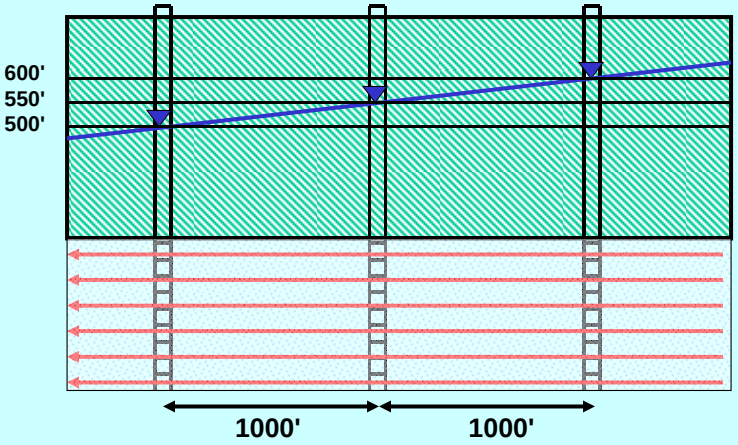


To get the flow velocity in the field the section must be oriented in the direction of flow

MEASURING HEAD IN THE FIELD

Standpipe Piezometers in a Confined aquifer

Slotted over entire length



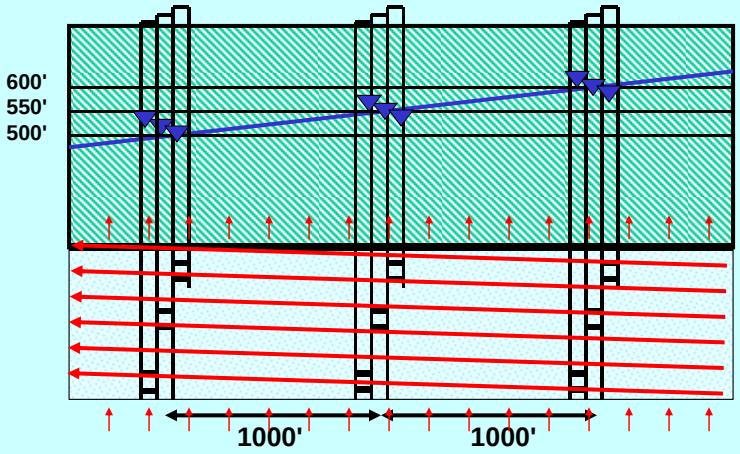
This is a confined aquifer.

Heads are above the top of the aquifer.

To get the flow velocity in the field the section must be oriented in the direction of flow

MEASURING HEAD IN THE FIELD

Standpipe Piezometers in a Confined aquifer short screened intervals

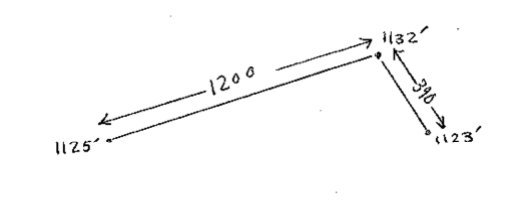


To get the field flow velocity the section must be oriented in the direction of flow

if you have many piezometers installed over an area, you can map the groundwater potential

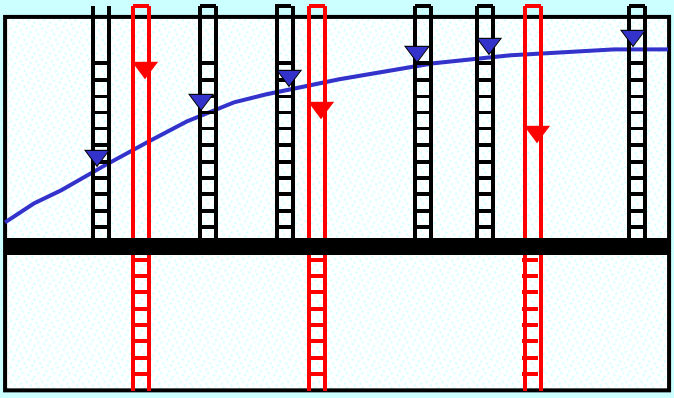
in a material of isotropic K, flow lines are perpendicular to equipotential lines and a flow net can be draw (more about this later)

you need at least three points to determine the gradient
Calculate a gradient for the following



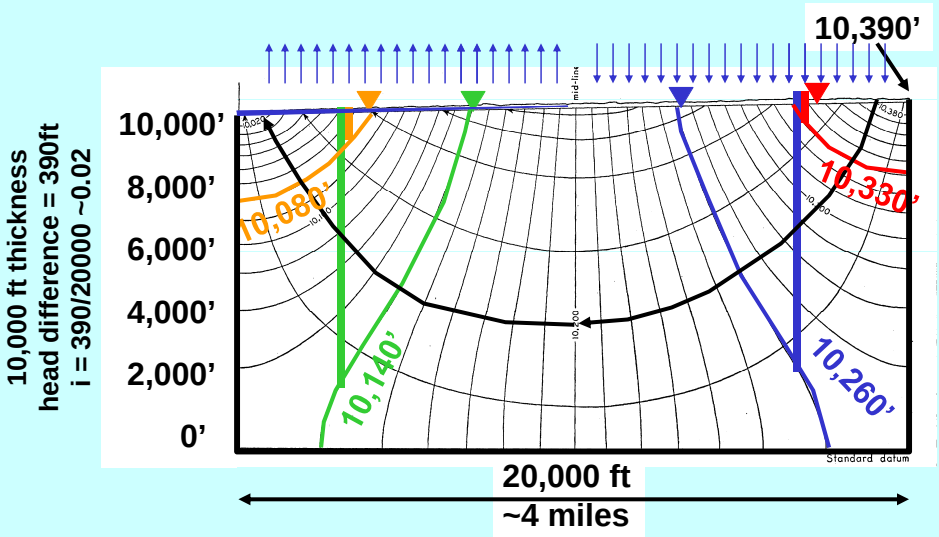
MEASURING HEAD IN THE FIELD

Standpipe Piezometers in Multiple Aquifers



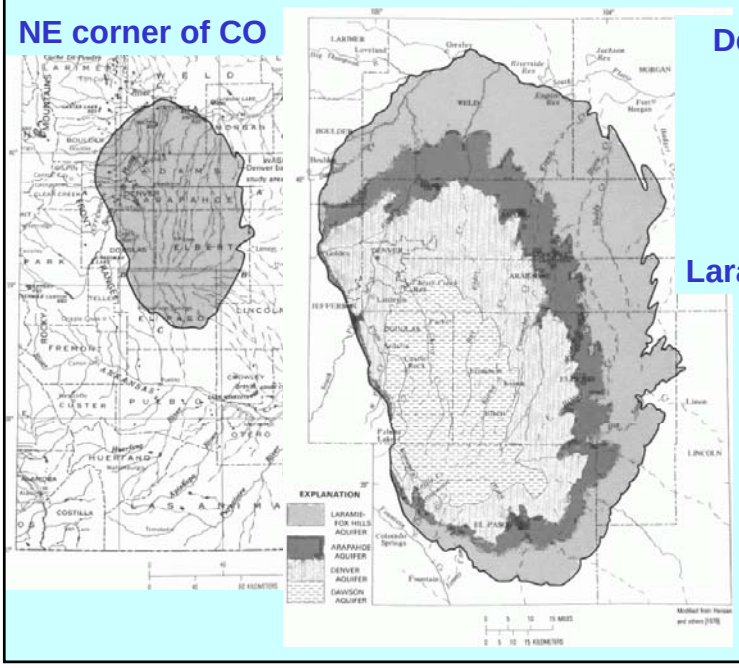
Beware evaluation of heads in multiple aquifer systems

RECALL THE CLASSIC SYSTEM



Consider a Ground Water System in a familiar location

NE corner of CO

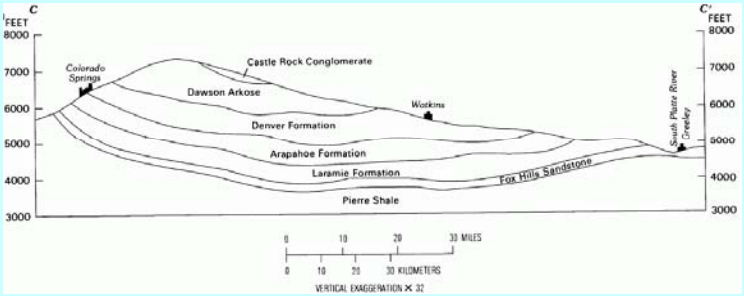


Denver Basin Aquifers:

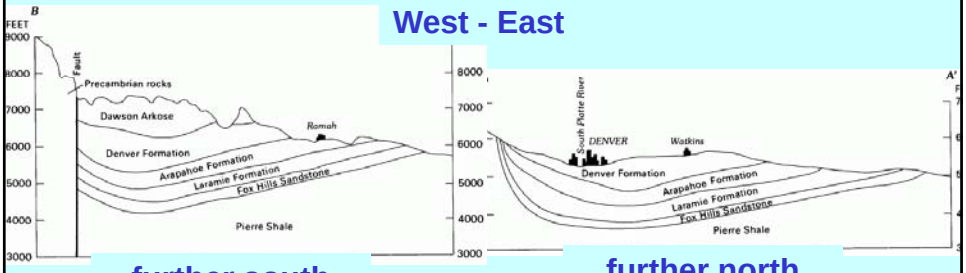
Dawson
Denver
Arapahoe
Laramie-FoxHills

Denver Basin

South - North



West - East

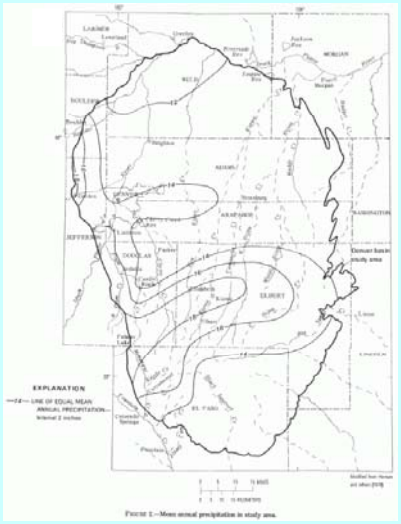


further south

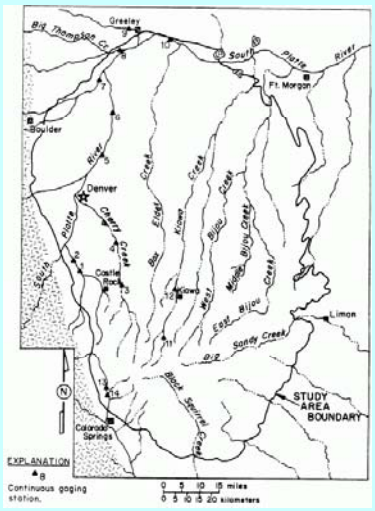
further north

Denver Basin

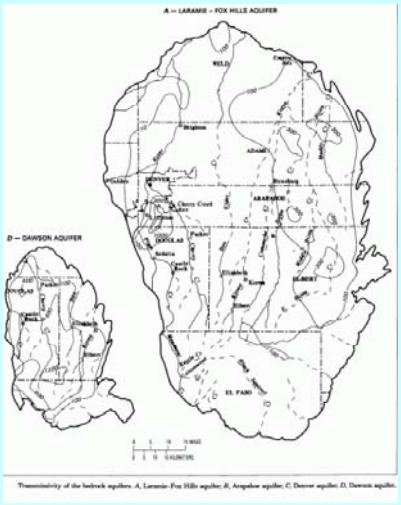
Precipitation (in/yr)



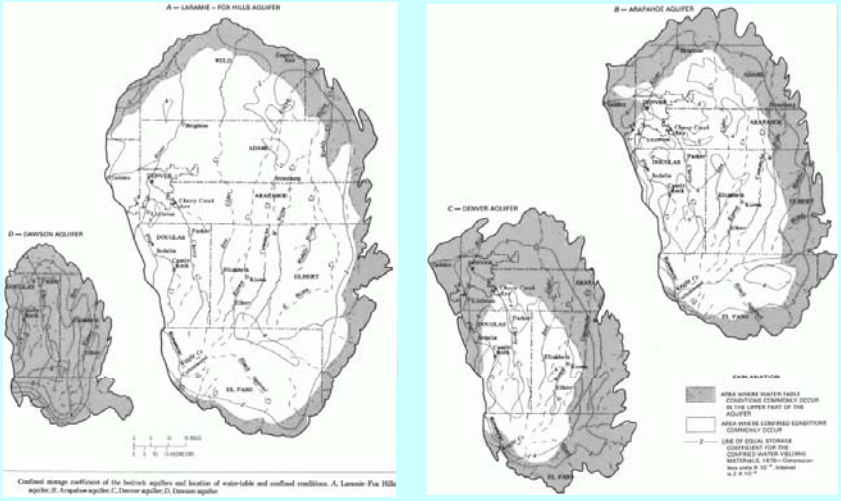
Stream gages



Distribution of Transmissivity (ft²/day)

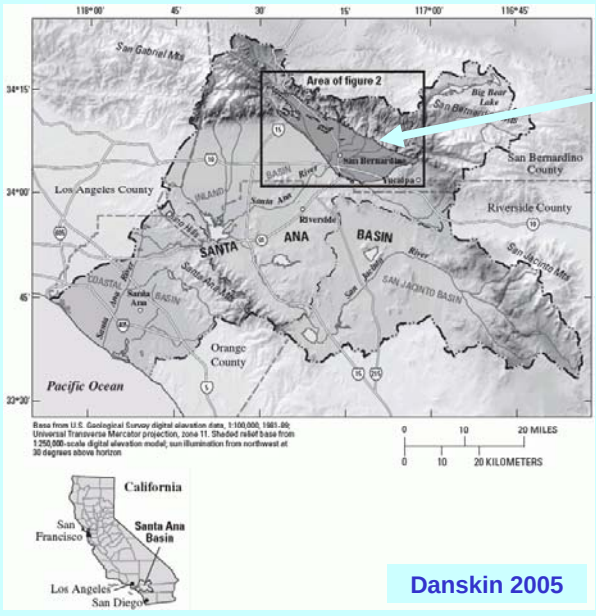


Distribution of Unconfined / Confined



Given what you now know about the Denver Basin, what do you expect the flow patterns and head distribution would be?
Sketch on the maps above or draw maps/sections on scratch paper

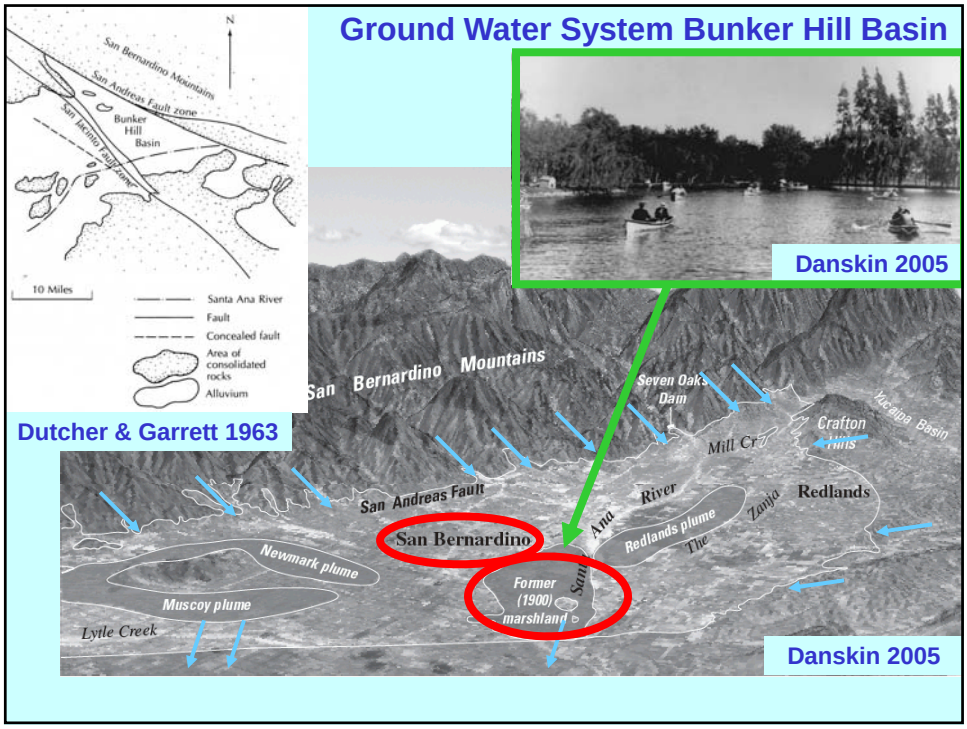
Consider a Ground Water System in Southern California



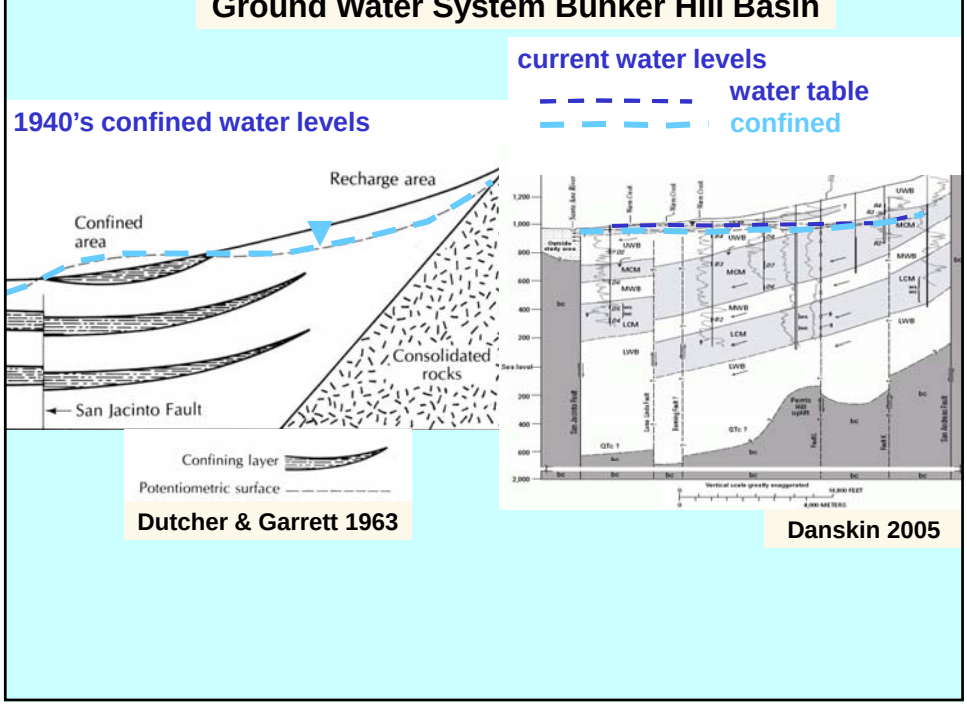
Bunker Hill Basin

Danskin 2005

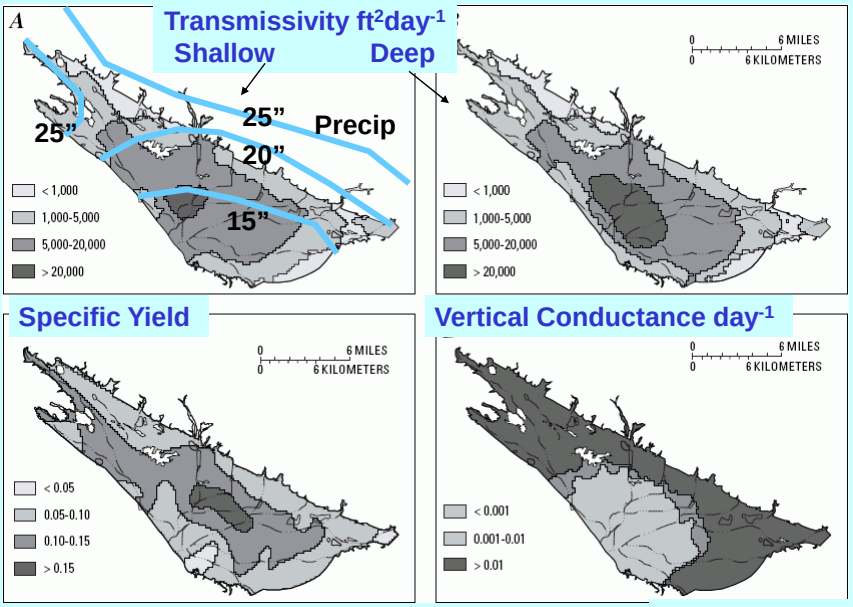
Ground Water System Bunker Hill Basin



Ground Water System Bunker Hill Basin

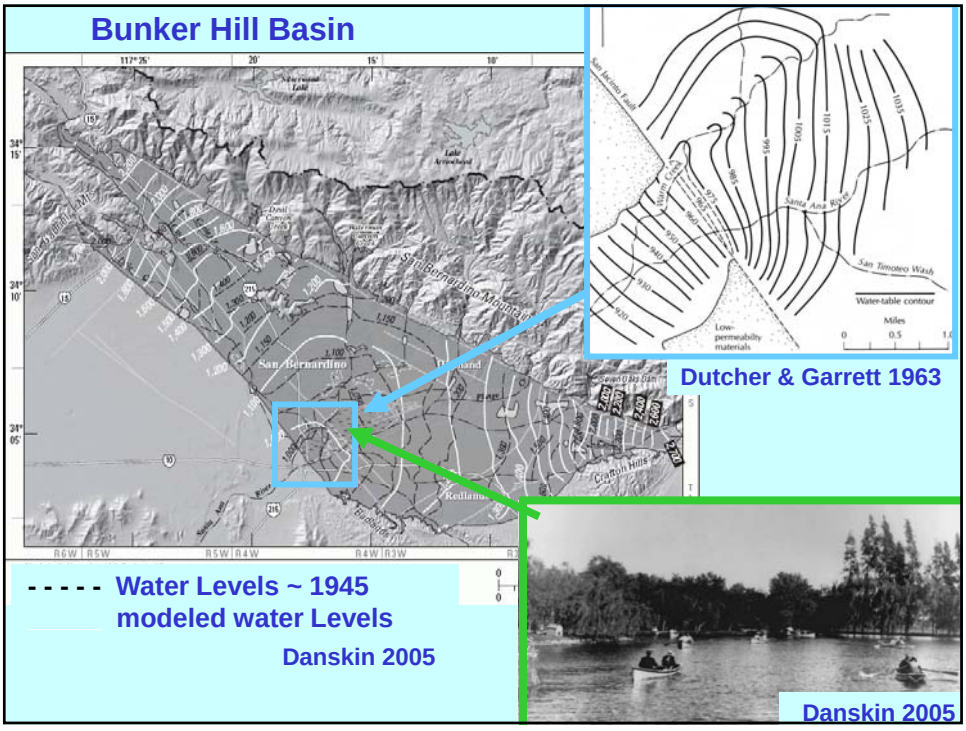


Ground Water System Bunker Hill Basin



Danskin 2005

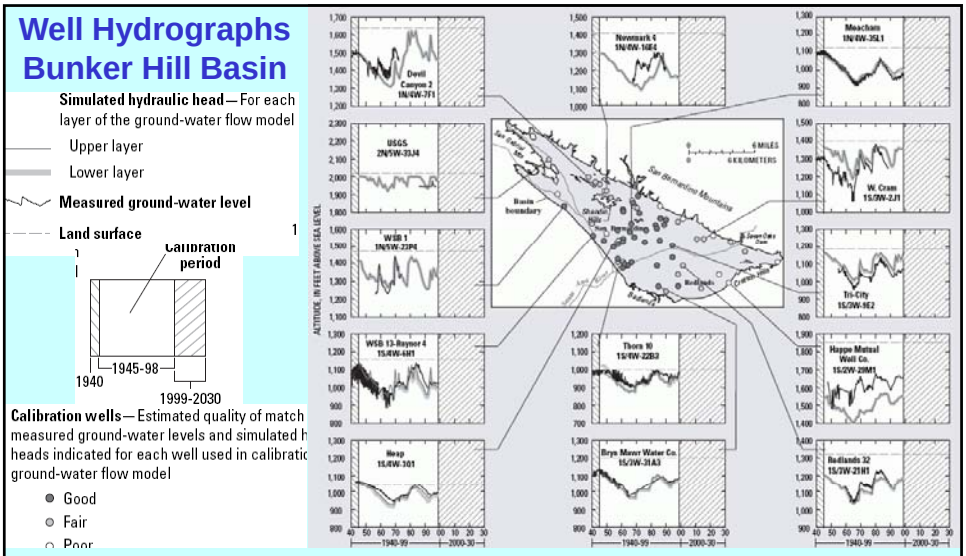
Bunker Hill Basin



Dutcher & Garrett 1963

Danskin 2005

Well Hydrographs Bunker Hill Basin



Water levels were high in early years and good for recreation
Increased pumping led to problems with land subsidence
Urbanization resulted in less pumping & flooded foundations
Thus pumping was increased to lower water levels
An additional 15,000AFY is needed to keep levels in check
Projection is growth will require an additional 50,000AFY

~ location of maximum subsidence in USA identified by Dr. Joseph Poland. Signs on pole show ~ altitude of land surface in 1925, 1955, and 1977. San Joaquin Valley southwest of Mendota, California.

Development of a new irrigation well in west-central Florida triggered hundreds of sinkholes over a 20-acre area (933ftx933ft). The sinkholes ranged in size from less than 1 foot to more than 150 feet

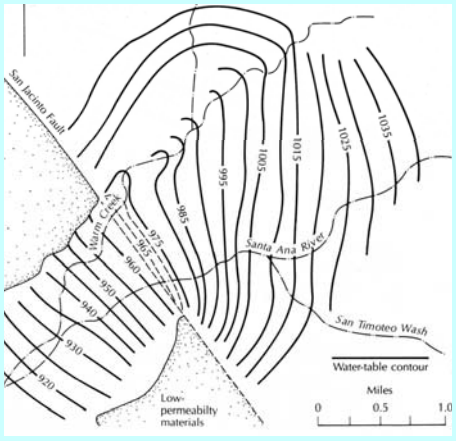
Sign warning motorists of subsidence hazard in Pima County, Arizona, USA, 1981.
Credit: S.R. Anderson, USGS

Let's work on some conceptualizations of systems to which we can apply Darcy's Law to estimate flow

Estimate the flux through Colton Narrows in the 1940s

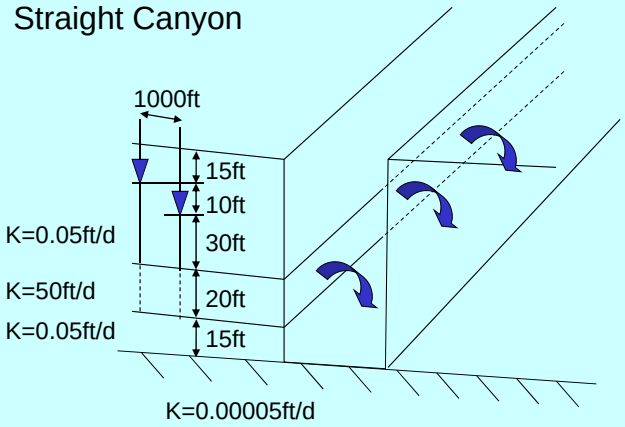
Average K ~5x10^{-6} ft/sec

Sediment thickness ~1400 ft



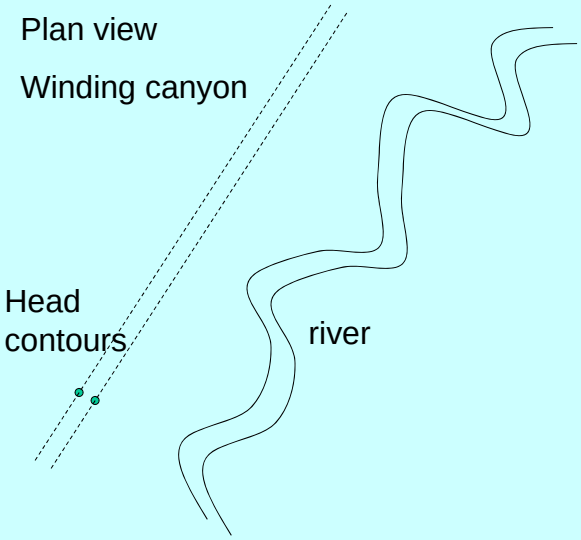
Oblique view

Straight Canyon

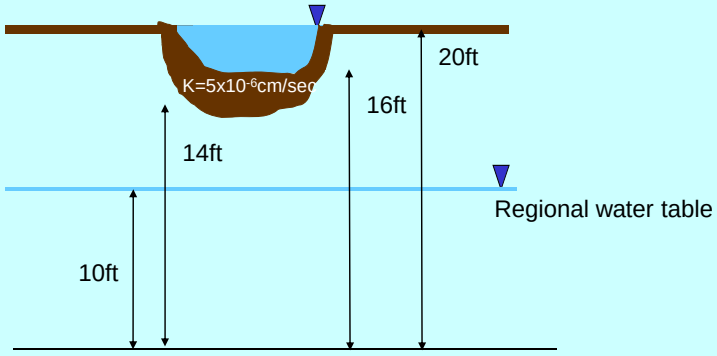


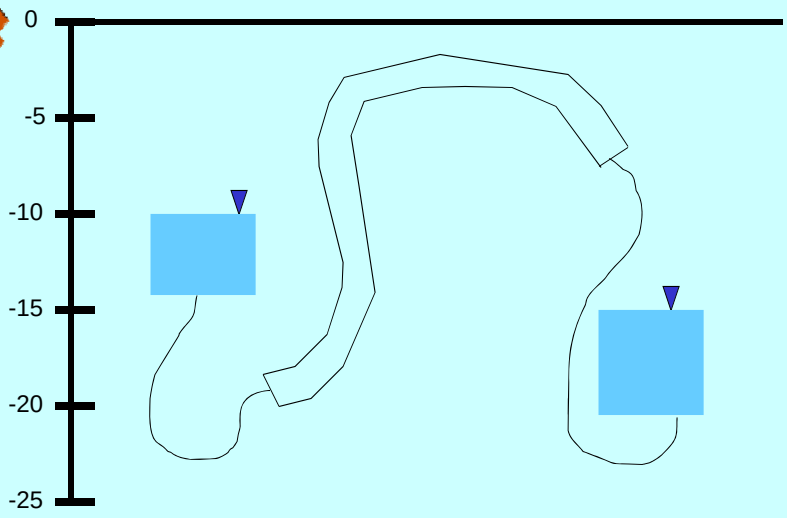
Plan view

Winding canyon

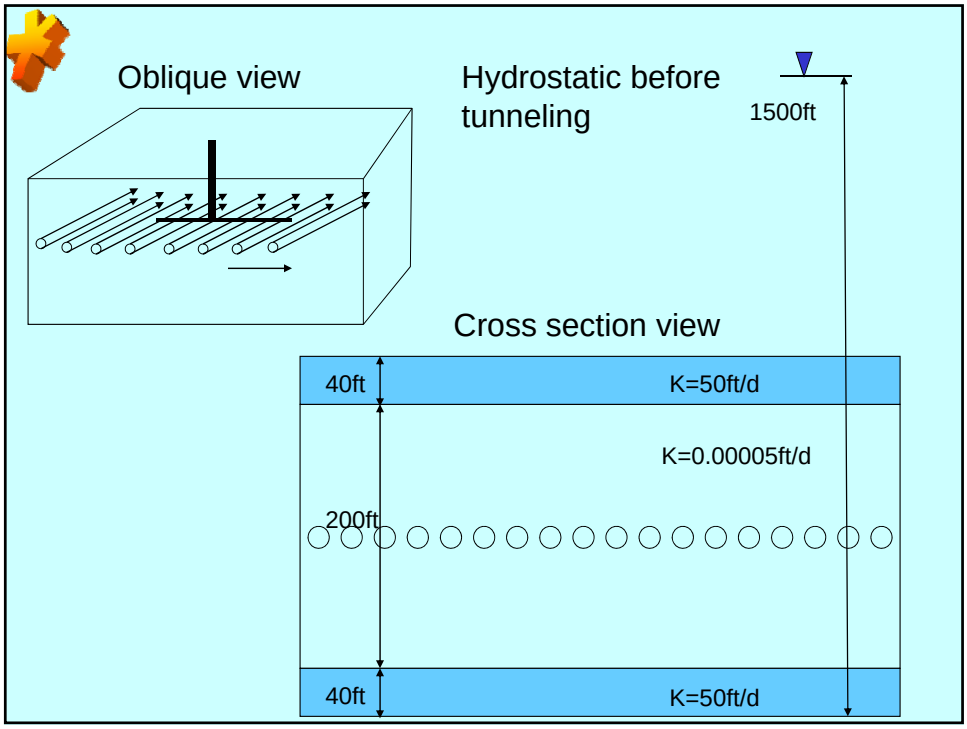


What is the rate of leakage from the pond?





What are the total, elevation, and pressure heads in that tube?

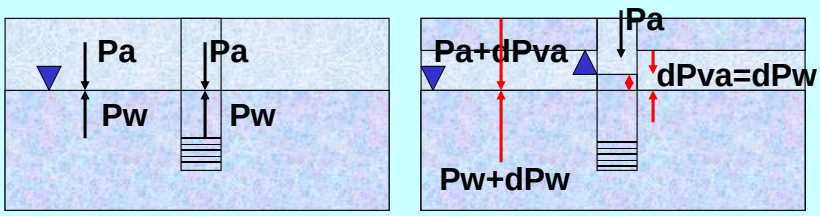


WATER LEVELS ARE NOT ALWAYS WHAT THEY SEEM

WATER LEVELS ARE NOT ALWAYS WHAT THEY SEEM

Air entrapment during recharge
Unconfined Aquifer Phenomena

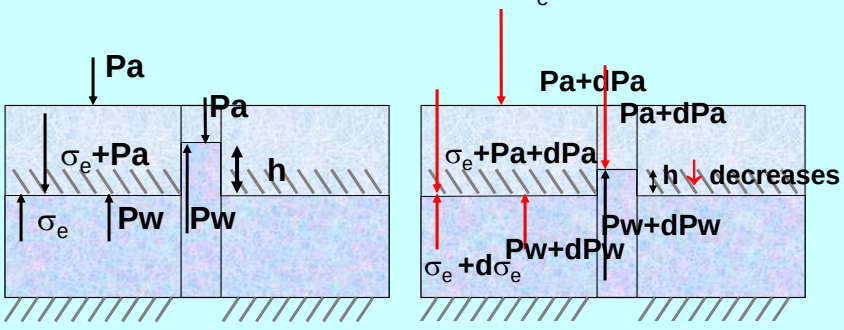
Pw=waterP Pa=atmosP Pva=void-airP



WATER LEVELS ARE NOT ALWAYS WHAT THEY SEEM

Barometric Pressure Changes
Confined Aquifer Phenomena

Pw=waterP Pa=atmosP σ_e=skeletalP



Equilibrium
Confined Pw ≠ Pa

some dPa
→ dσ_e & some → dPw

dPw < dPa
& h decreases

WATER LEVELS ARE NOT ALWAYS WHAT THEY SEEM

Barometric Pressure Changes

Correct for this effect in well data

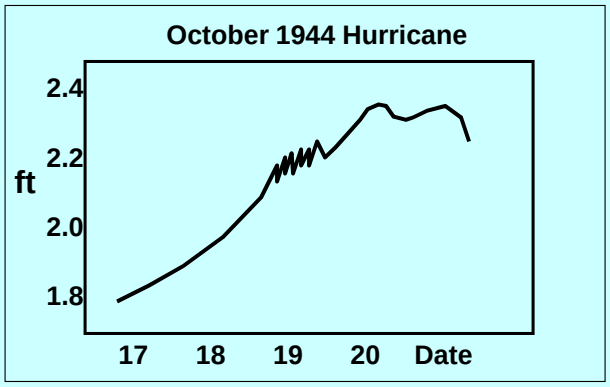
Barometric Efficiency - head change/pressure change

$$B = \frac{\gamma dh}{dP_a}$$

Typically on the order of 0.2-0.75

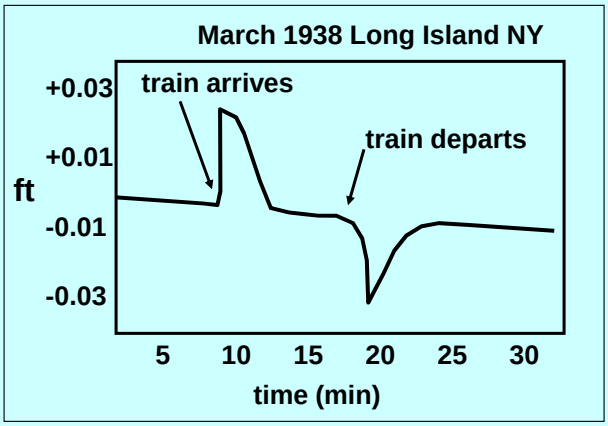
WATER LEVELS ARE NOT ALWAYS WHAT THEY SEEM

Wind



WATER LEVELS ARE NOT ALWAYS WHAT THEY SEEM

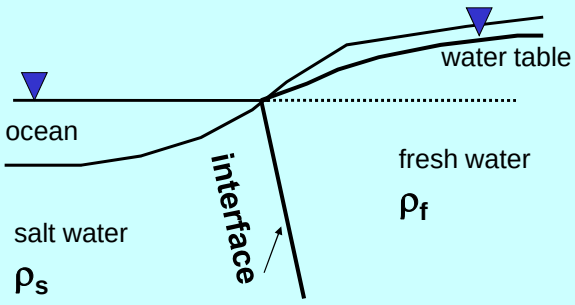
External Loading (Trains Blasts Earthquakes Tides)



WATER LEVELS ARE NOT ALWAYS WHAT THEY SEEM

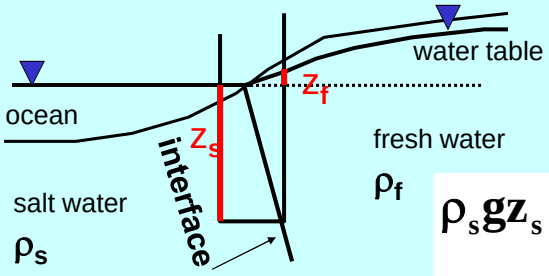
Fresh - Salt Water Interface

Ghyben-Herzberg - Unconfined-hydrostatic



Fresh - Salt Water Interface

Ghyben-Herzberg - Unconfined-hydrostatic



$$\rho_s g z_s = \rho_f g(z_s + z_f)$$

$$z_s = \frac{\rho_f}{\rho_s - \rho_f} z_f$$

$$\rho_f = 1.0 \text{ and } \rho_s = 1.025$$

$$z_s = 40 z_f$$

drawdown the water table 1 ft and the interface rises 40 ft

Fresh - Salt Water Interface

Hubbert - allowed for outflow; located interface by constructing a flownet