Napa Valley Groundwater Advisory Committee
February 23, 2012

A Tradition of Stewardship
A Commitment to Service

Groundwater and Groundwater – Surface Water Interaction: How Does It Work?

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UCANR MAKING A DIFFERENCE
UNIVERSITY OF CALIFORNIA AGRICULTURE AND NATURAL RESOURCES • Cooperative Extension • Agricultural Experiment Station

Groundwater Resources Association of California

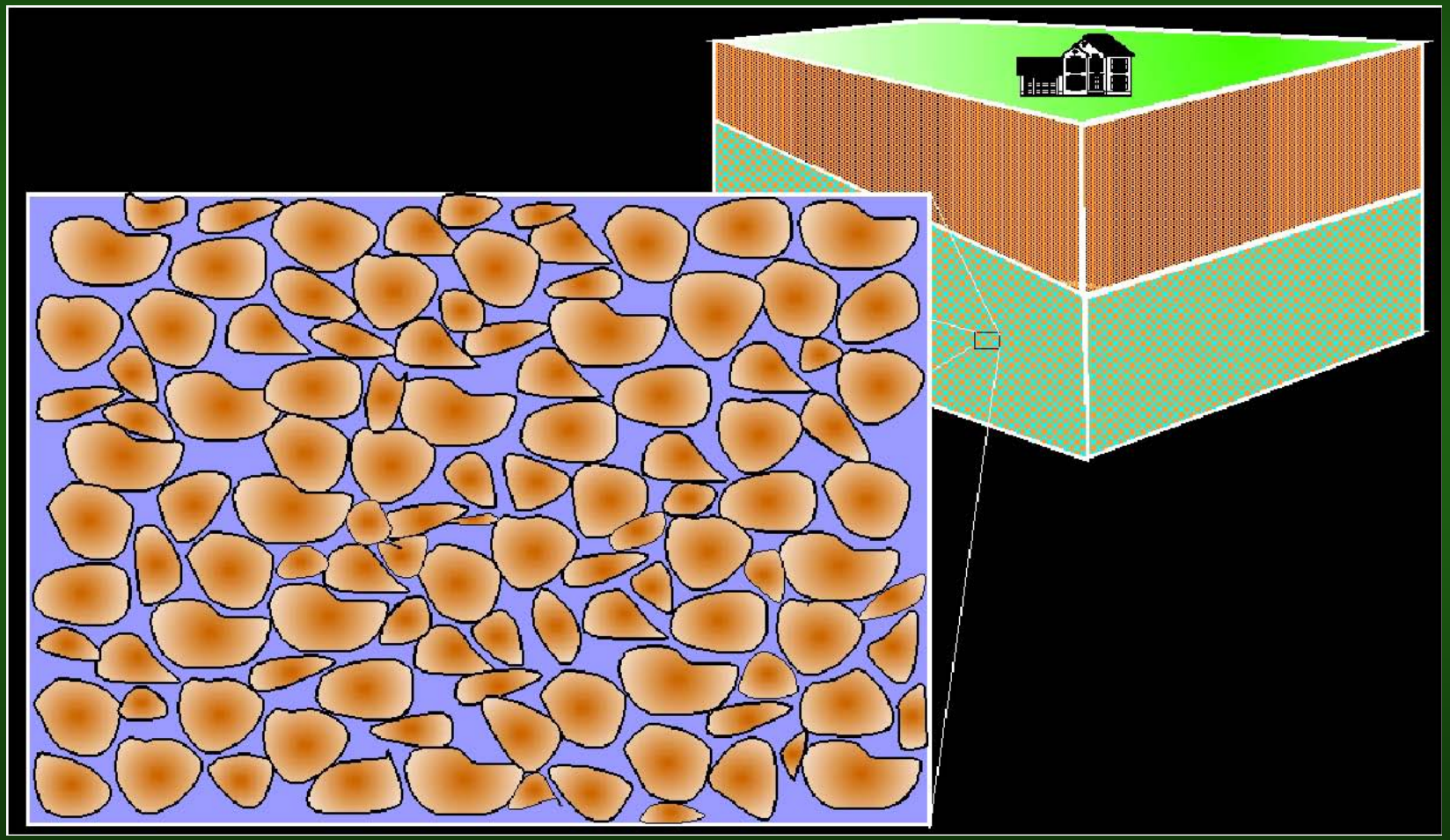
Overview

- What is groundwater?
  - How much groundwater is there?
  - How fast does groundwater move?
  - How do we measure groundwater?
- Where does groundwater come from and where does it go?
- How do Californians use it?
- Groundwater management and groundwater quality

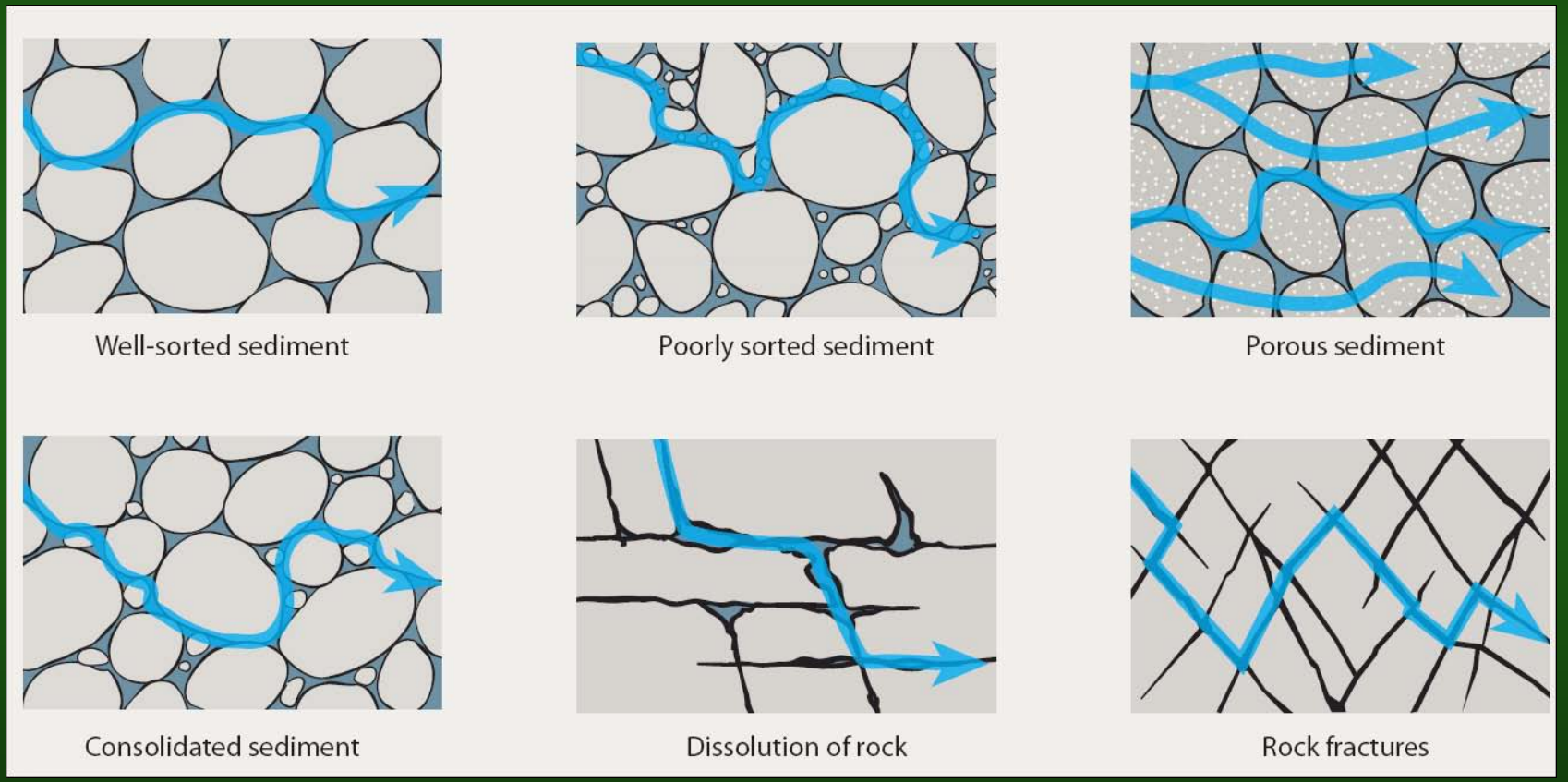
What is Groundwater?

- An underground lake?
- A network of underground rivers?
- A rectangular network of pipelike water arteries?
- A giant sponge?

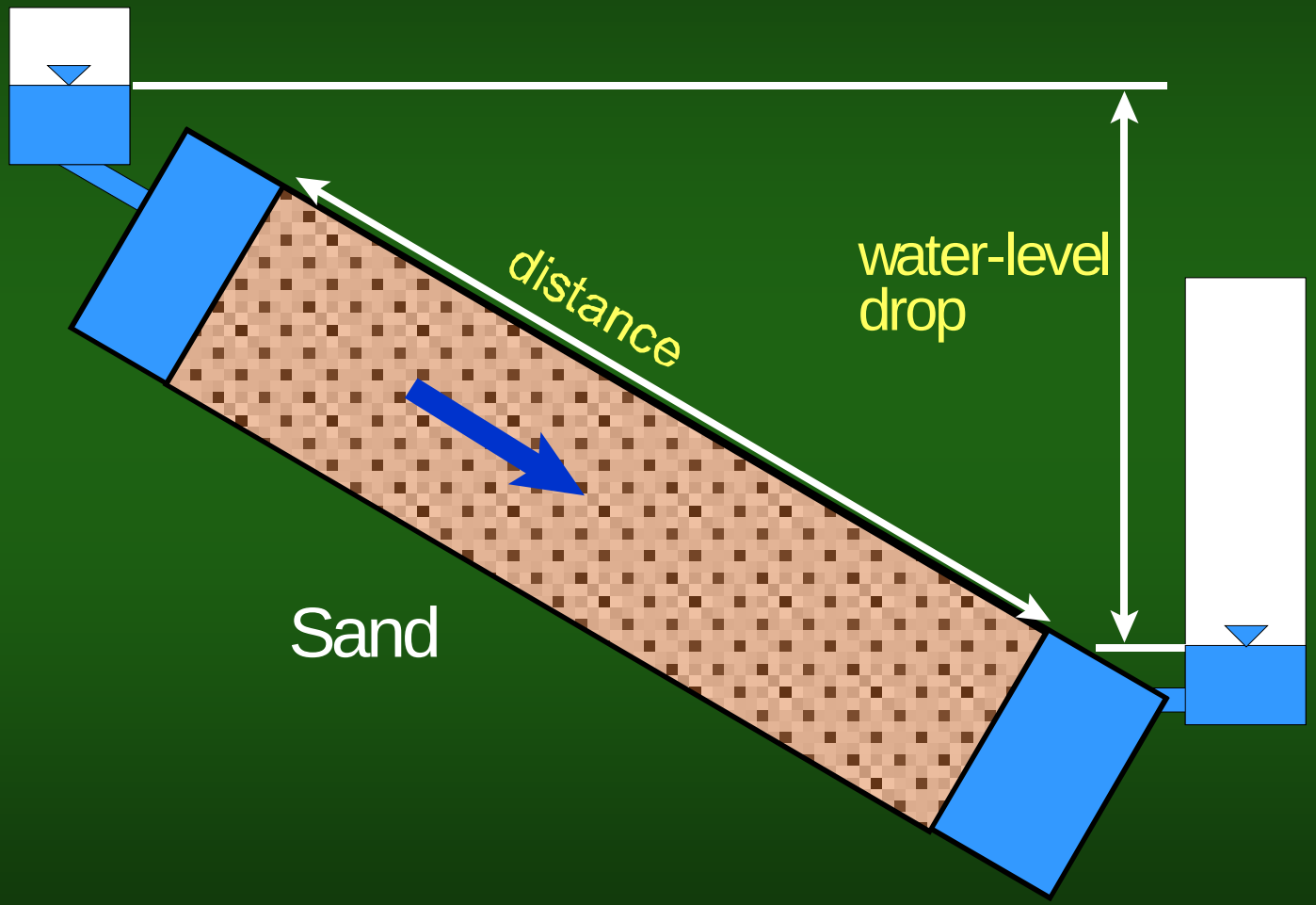
Groundwater = Water completely filling Pores/Fractures



Groundwater in Different Sediments and Rocks



How fast does water flow?



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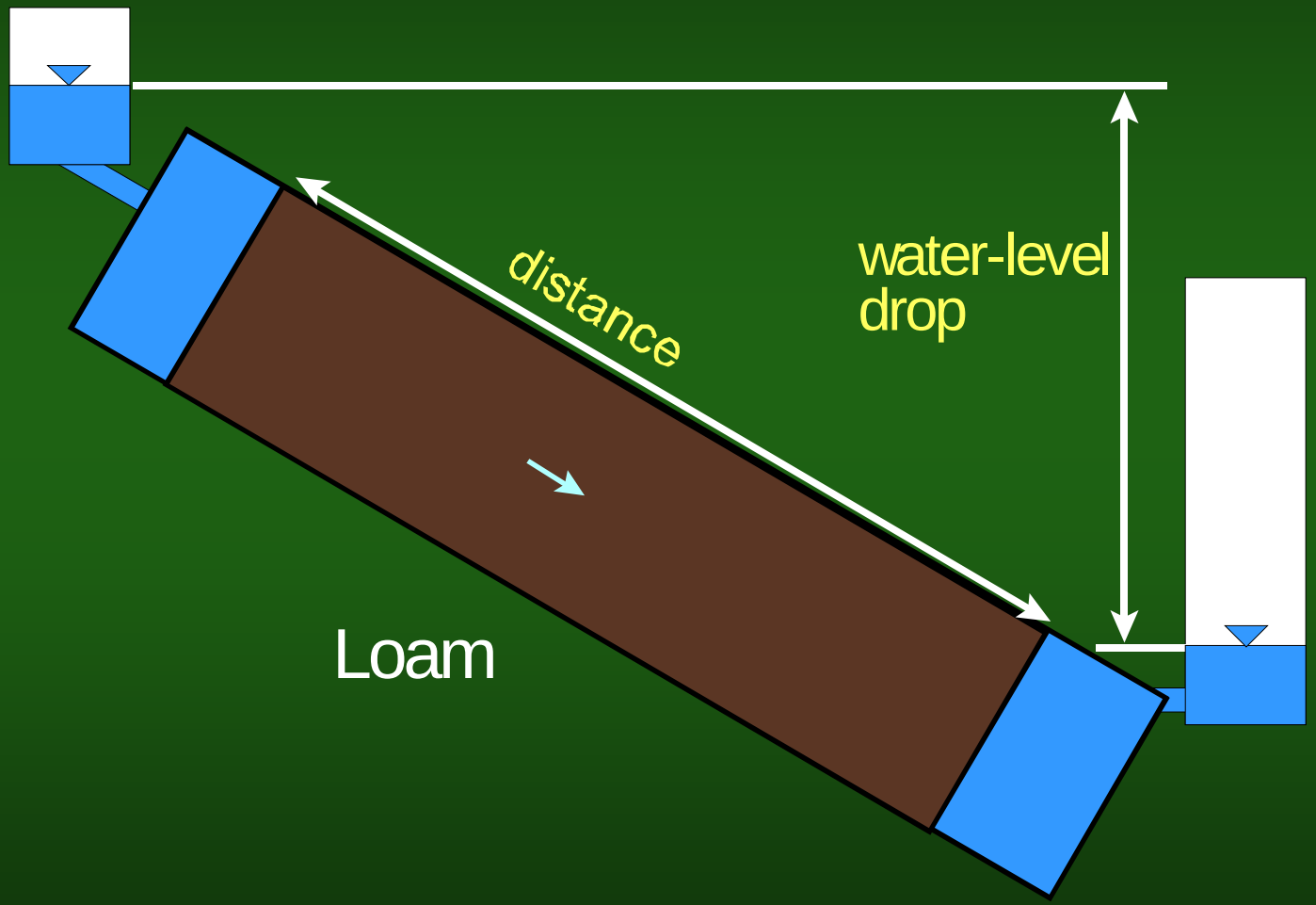

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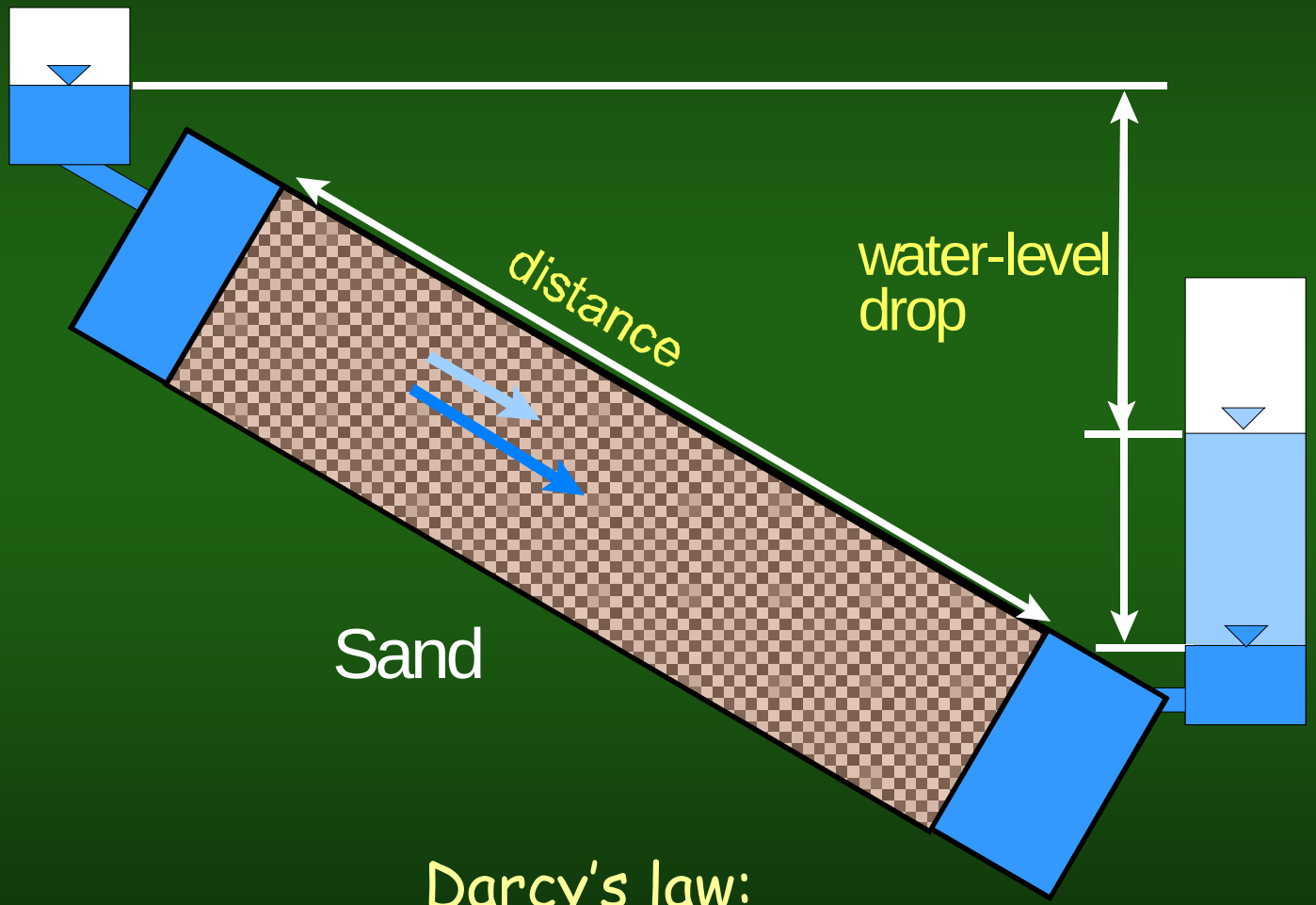
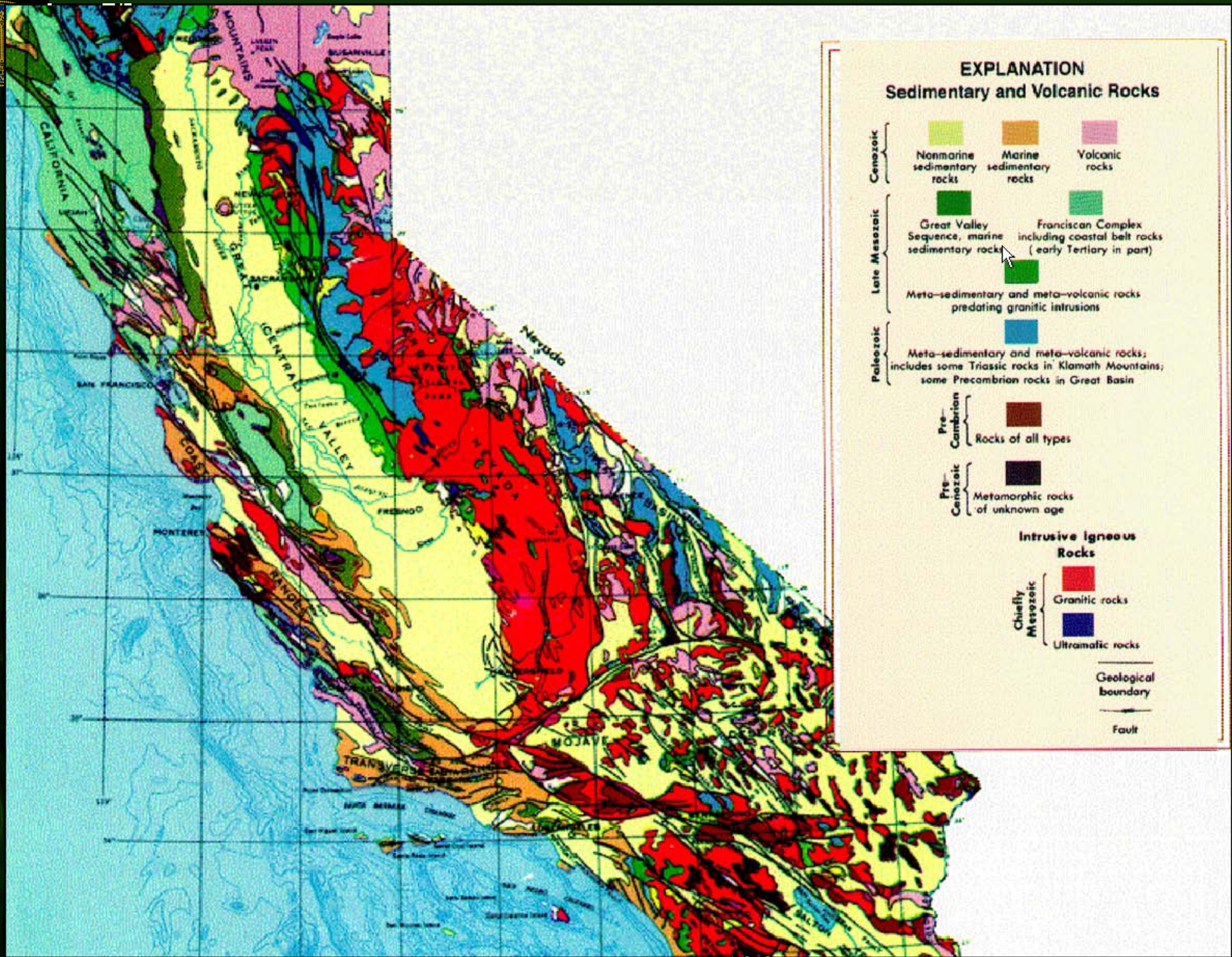
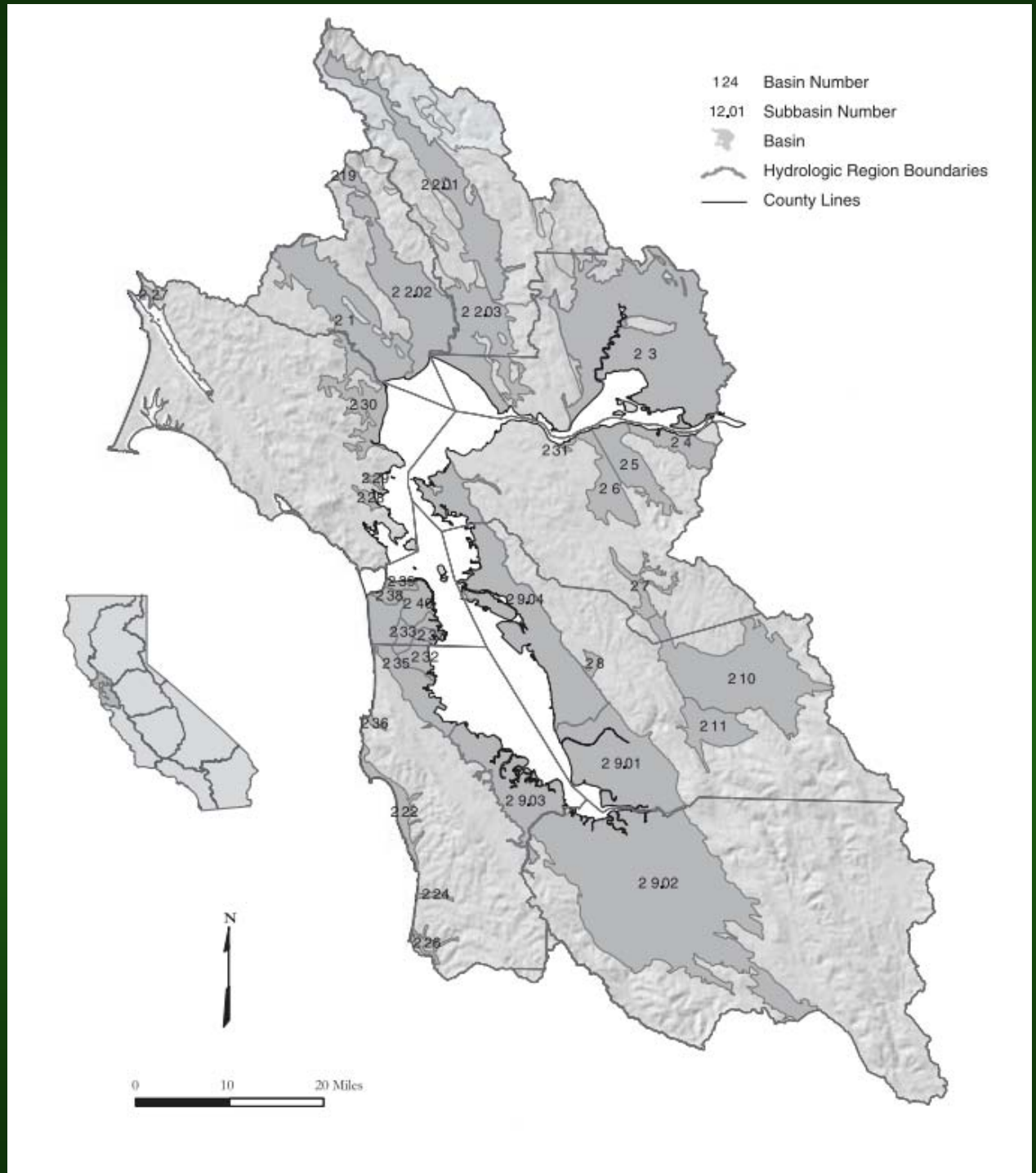


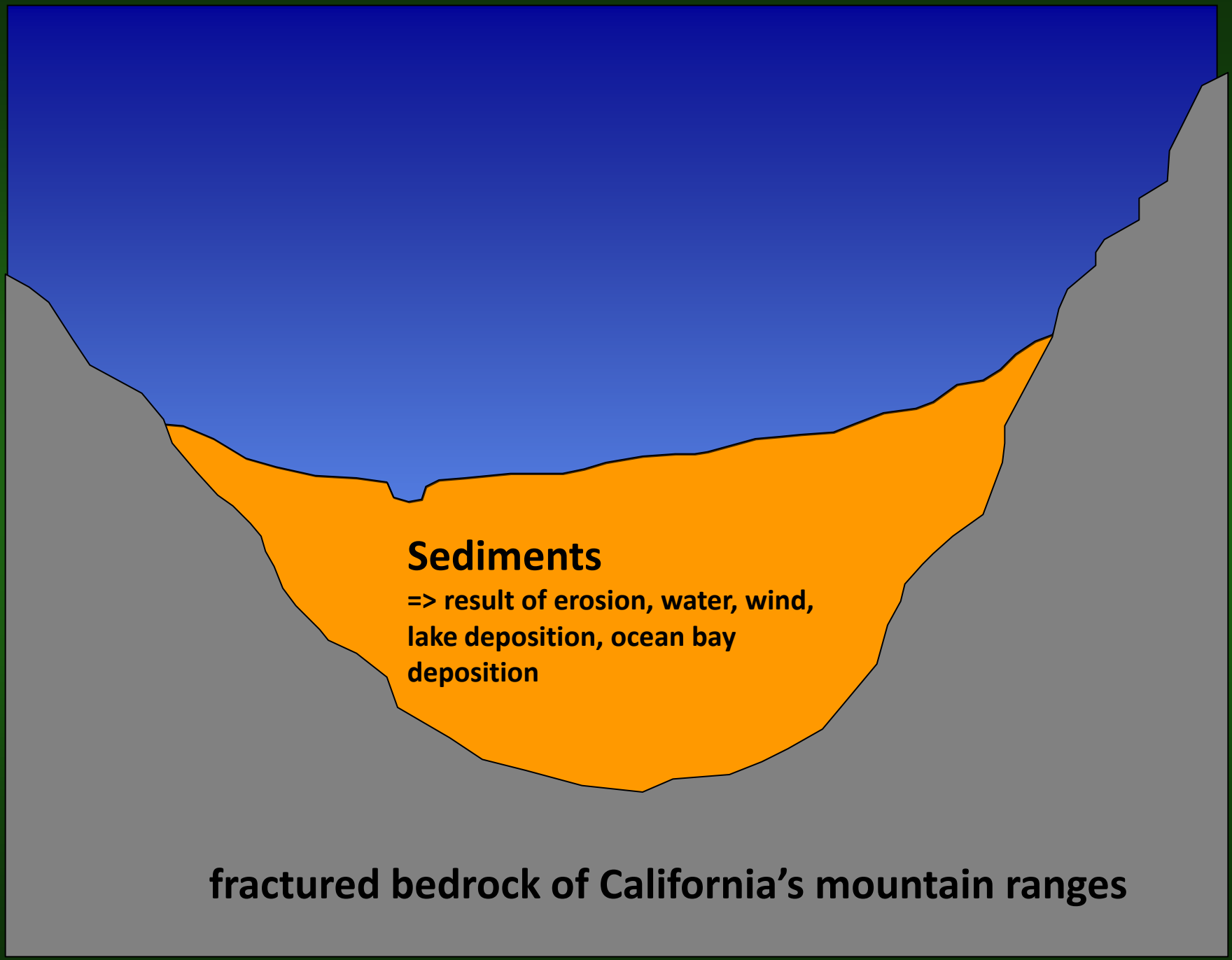
Darcy's law:
groundwater flow = hydraulic conductivity x pressure gradient

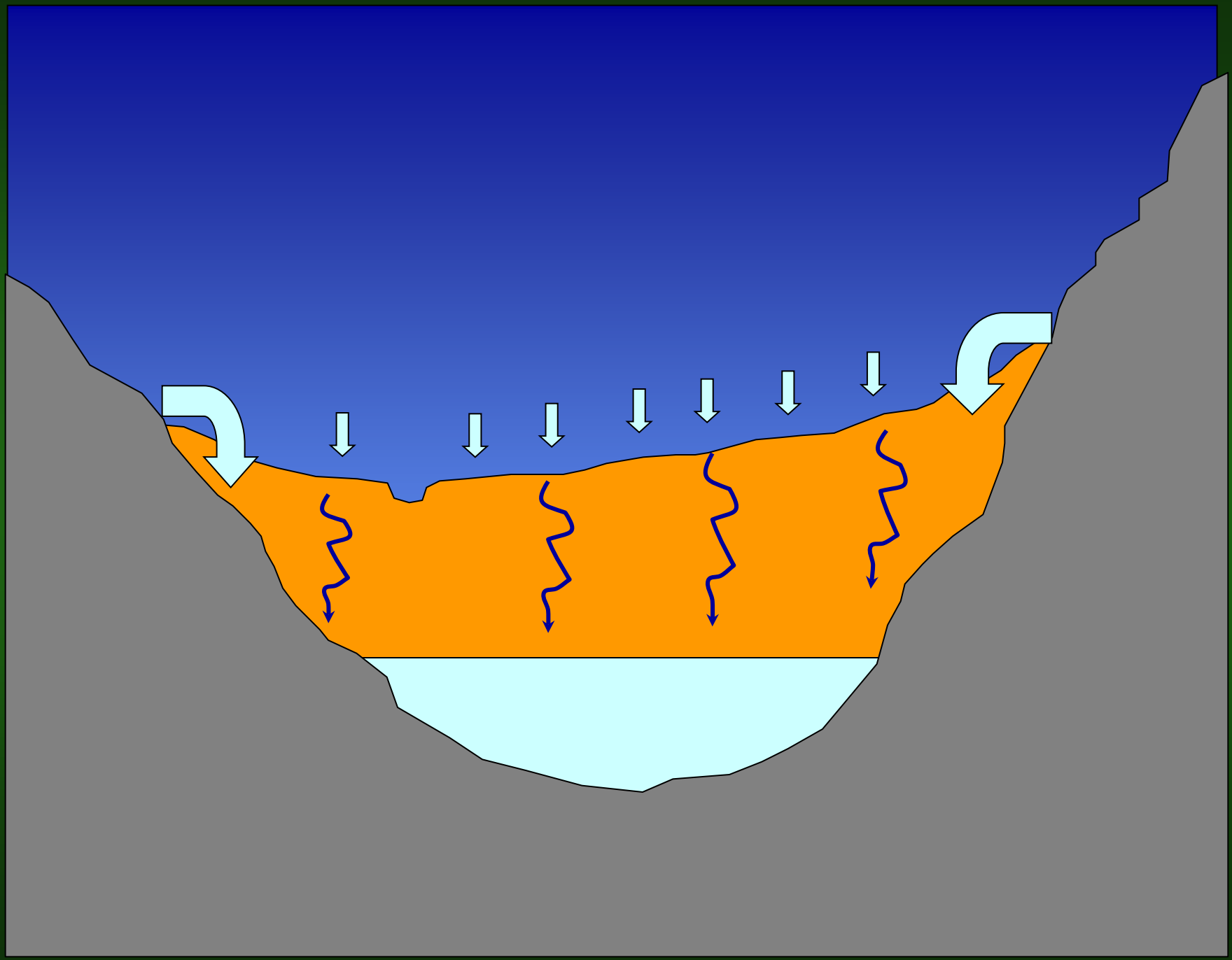
How do we measure hydraulic conductivity?

- Estimate based on sediment type (gravel, sand, silt, clay, fractured rock):
  - => well logs (geologic logs, geophysical logs)
- Measure on sediment/rock cores in laboratory
- Estimate from specific capacity of wells:
  - ratio of pumping rate to well water level drawdown
- Measure using an aquifer test:
  - 1-day to 7-day well pumping tests
- Estimate from groundwater models:
  - => matching model results to measured water levels, groundwater flows

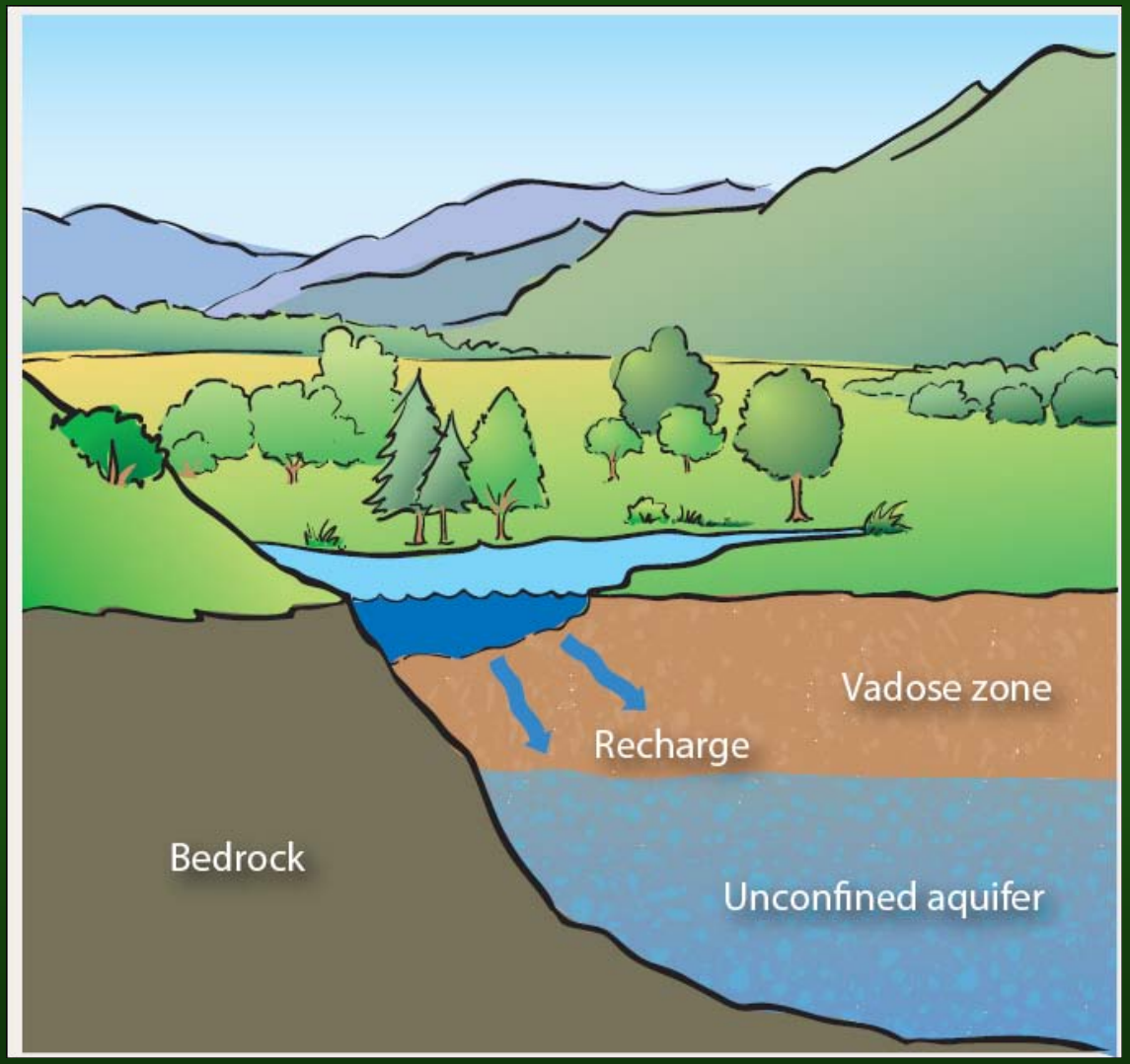

EXPLANATION
Sedimentary and Volcanic Rocks
Cenozoic
Nonmarine sedimentary rocks
Marine sedimentary rocks
Volcanic rocks
Late Mesozoic
Great Valley Sequence, marine sedimentary rocks
Franciscan Complex including coastal belt rocks (early Tertiary in part)
Meta-sedimentary and meta-volcanic rocks predating granitic intrusions
Paleozoic
Meta-sedimentary and meta-volcanic rocks; includes some Triassic rocks in Klamath Mountains; some Precambrian rocks in Great Basin
Pre-Cambrian
Rocks of all types
Pre-Cenozoic
Metamorphic rocks of unknown age
Intrusive Igneous Rocks
Chiefly Mesozoic
Granitic rocks
Ultramafic rocks
Geological boundary
Fault
CALIFORNIA
SACRAMENTO
SAN FRANCISCO
CENTRAL VALLEY
COAST RANGES
FRESNO
MONTEREY
MOJAVE
TRANSVERSE RANGES
LOS ANGELES
SALTON TROUGH
Nevada


124 Basin Number
12.01 Subbasin Number
Basin
Hydrologic Region Boundaries
County Lines
219
2201
2202
2203
21
23
230
231
24
25
26
27
2904
28
210
211
236
2901
2903
222
2902
224
226
N
0
10
20 Miles


Sediments
=> result of erosion, water, wind, lake deposition, ocean bay deposition
fractured bedrock of California's mountain ranges

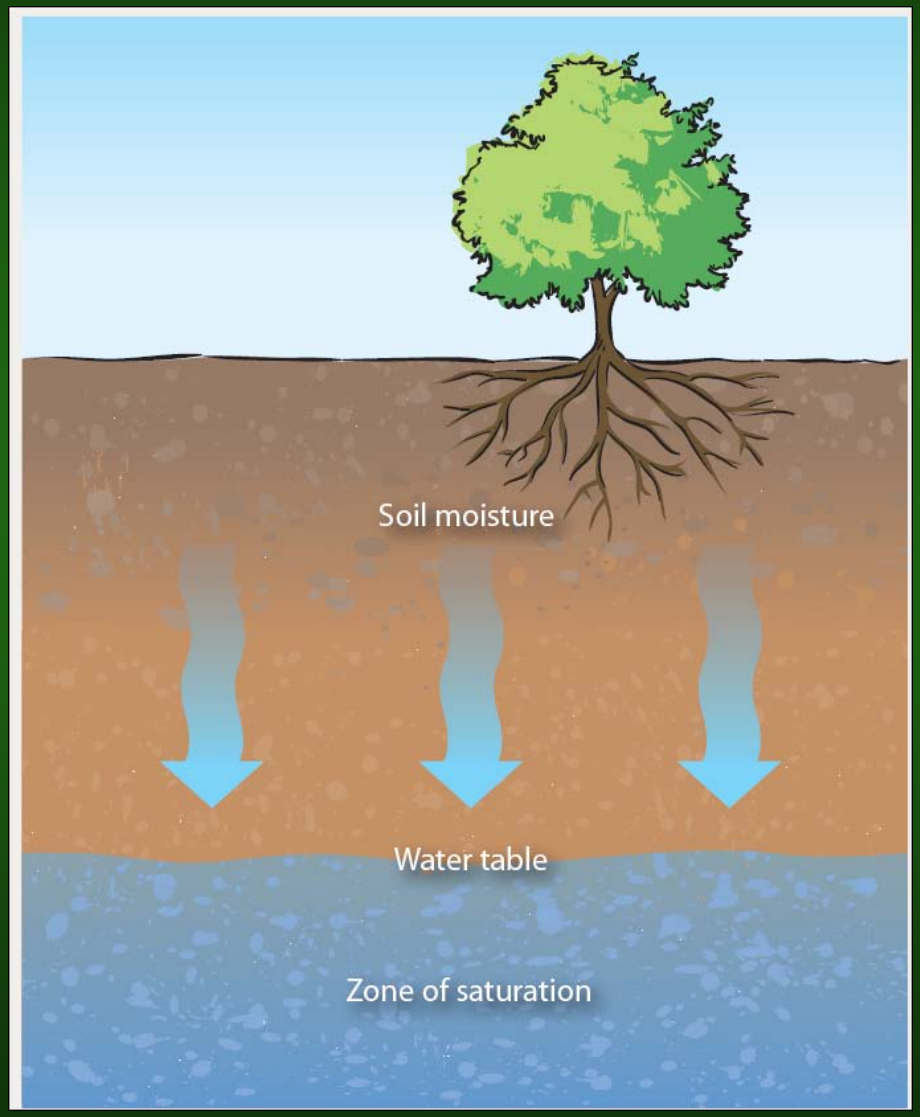


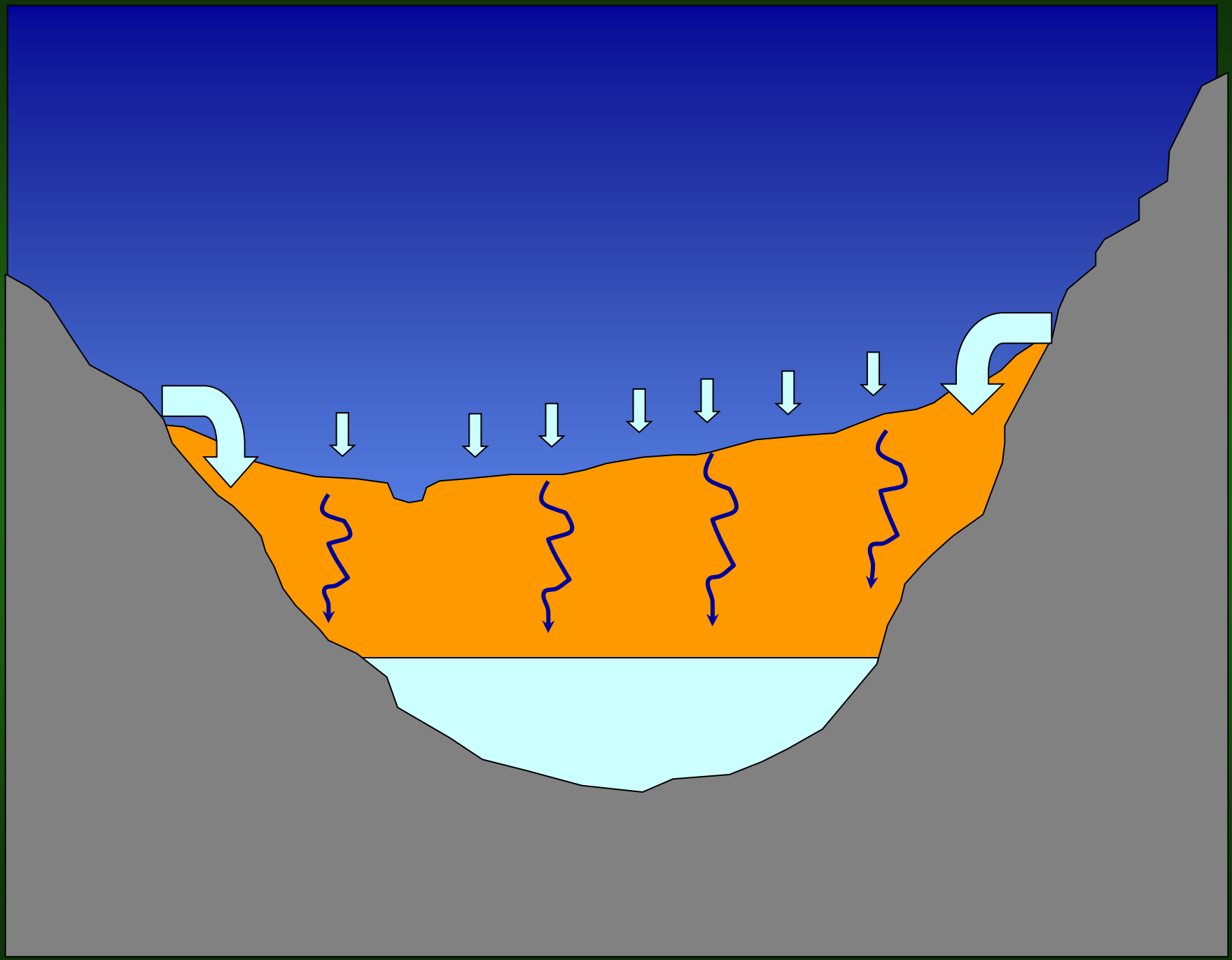
Unconfined Aquifer

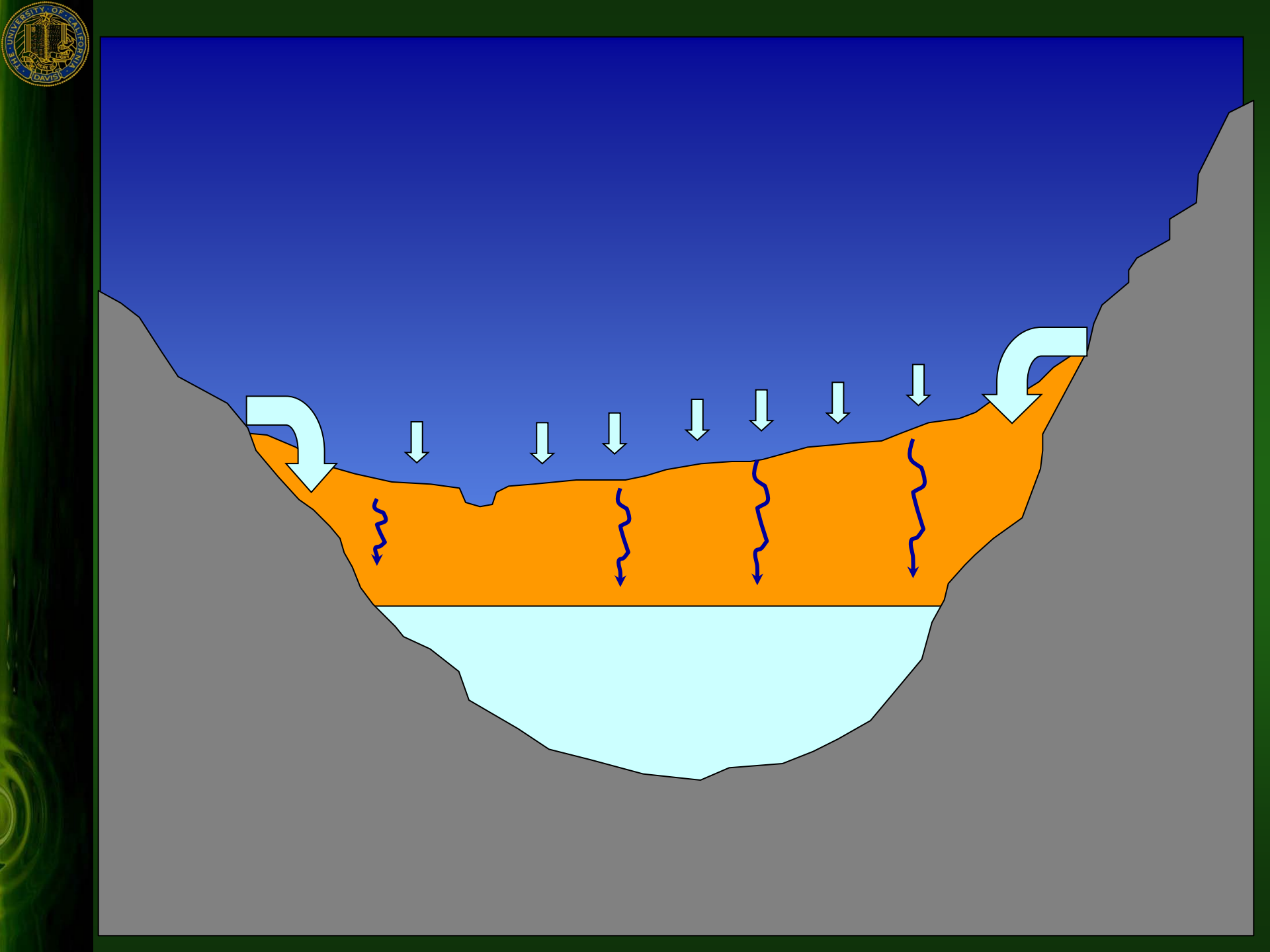


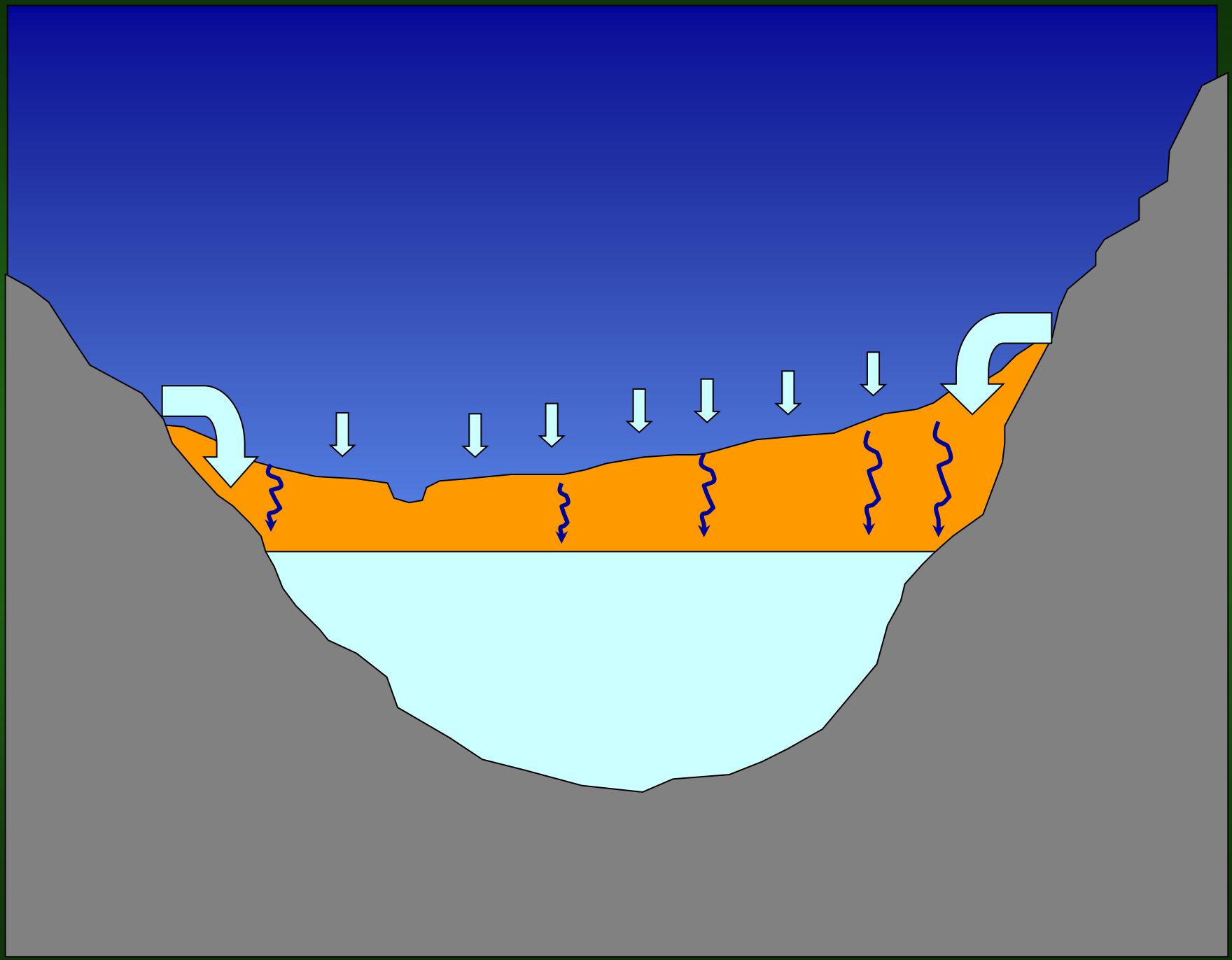
Losing stream

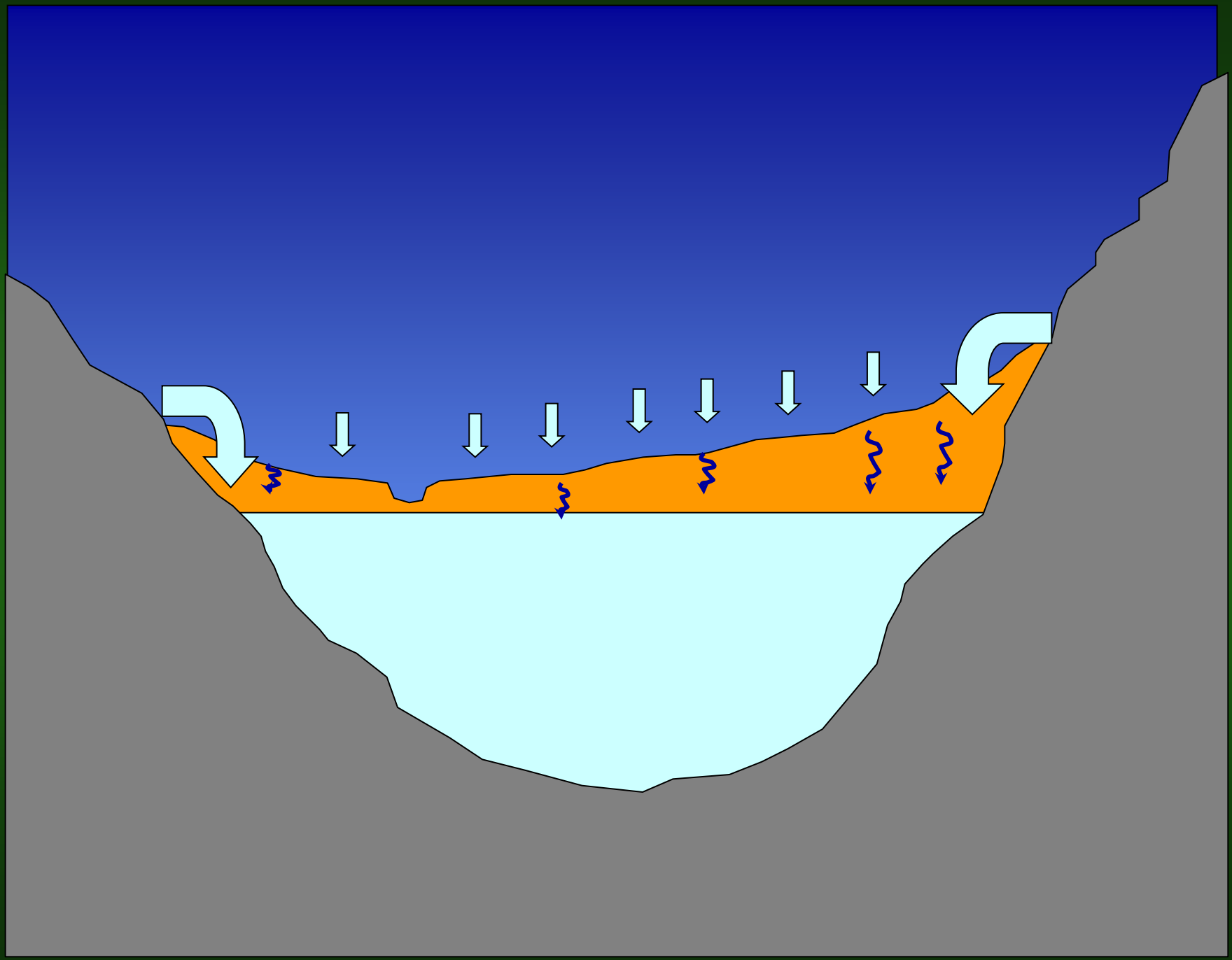
What is Groundwater?

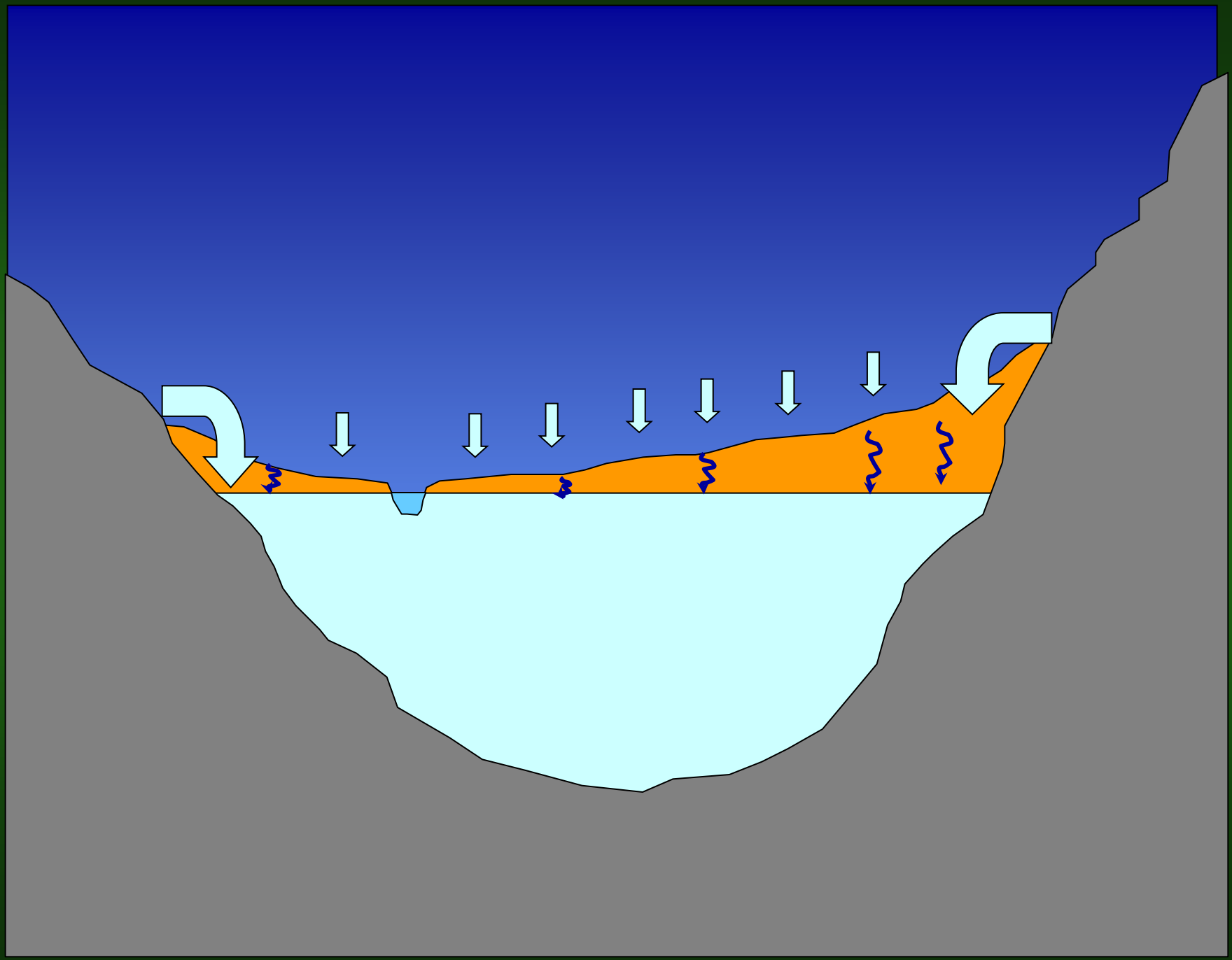


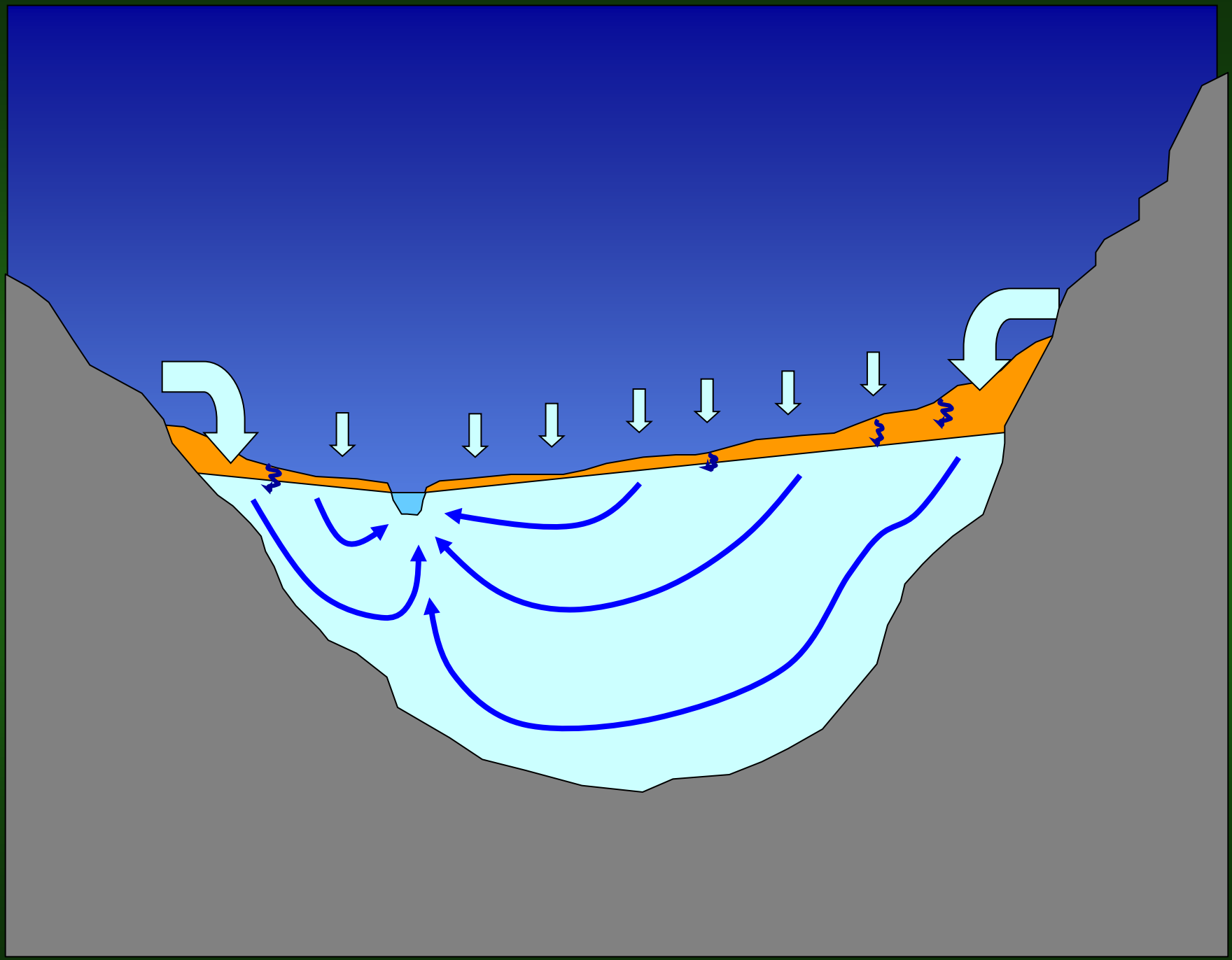




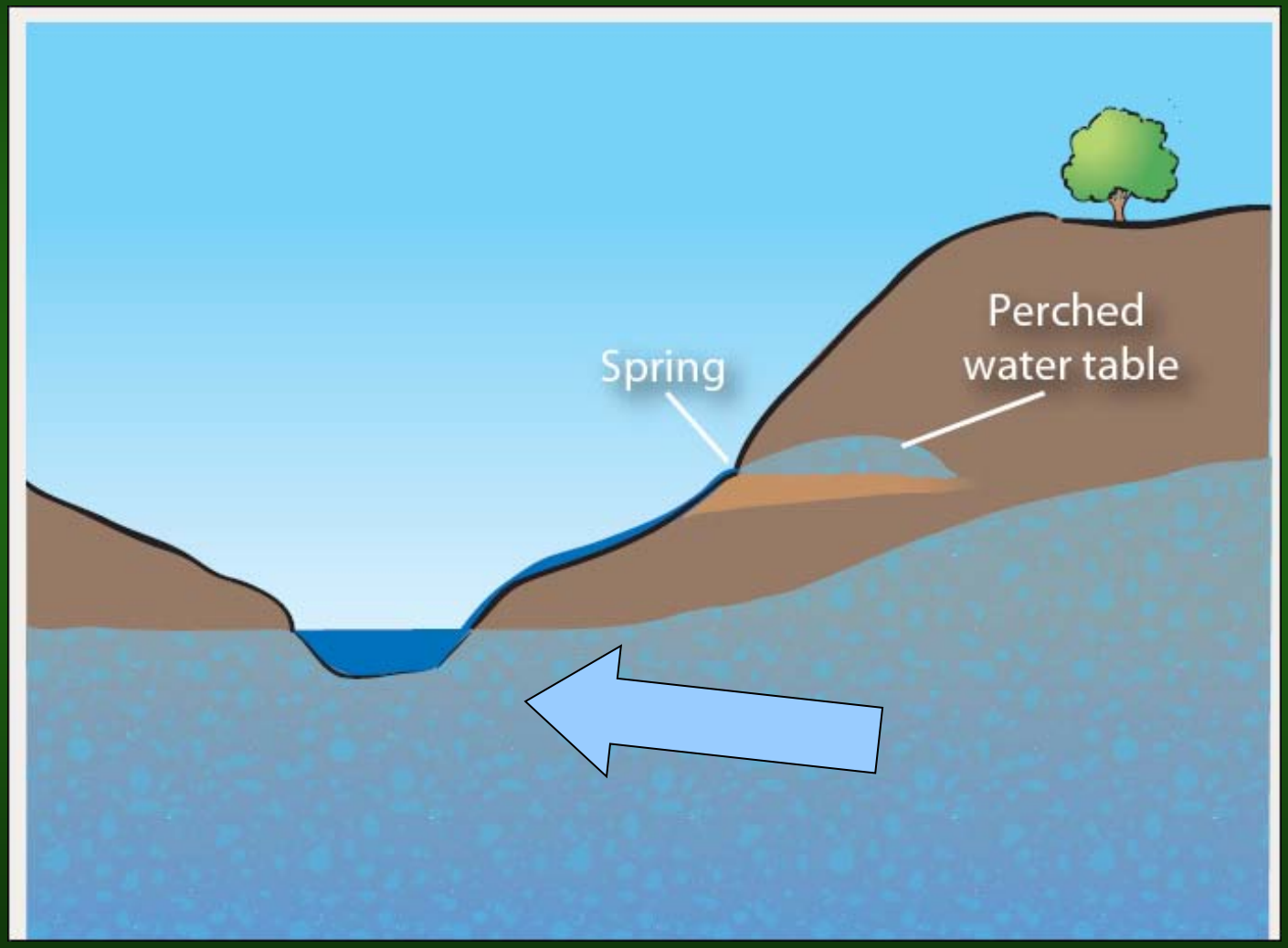






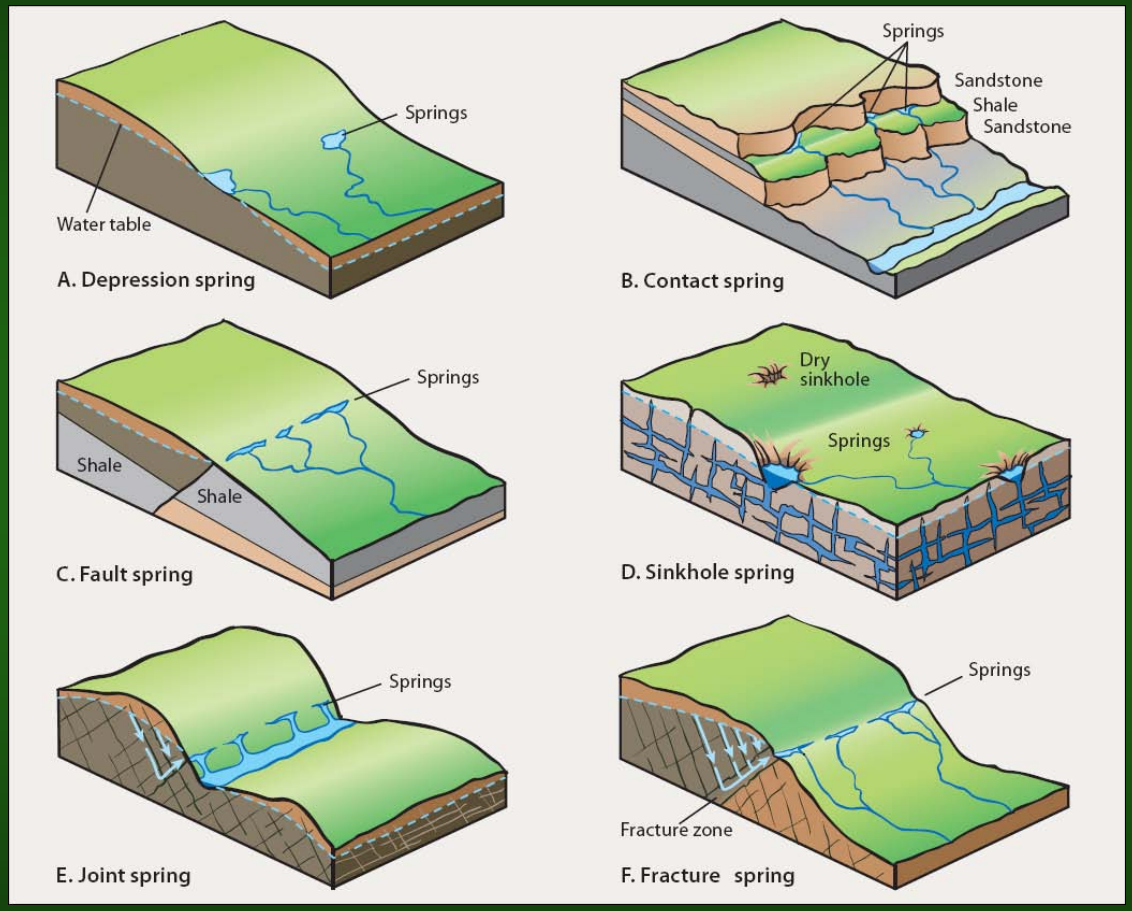


Unconfined Aquifer



Gaining stream

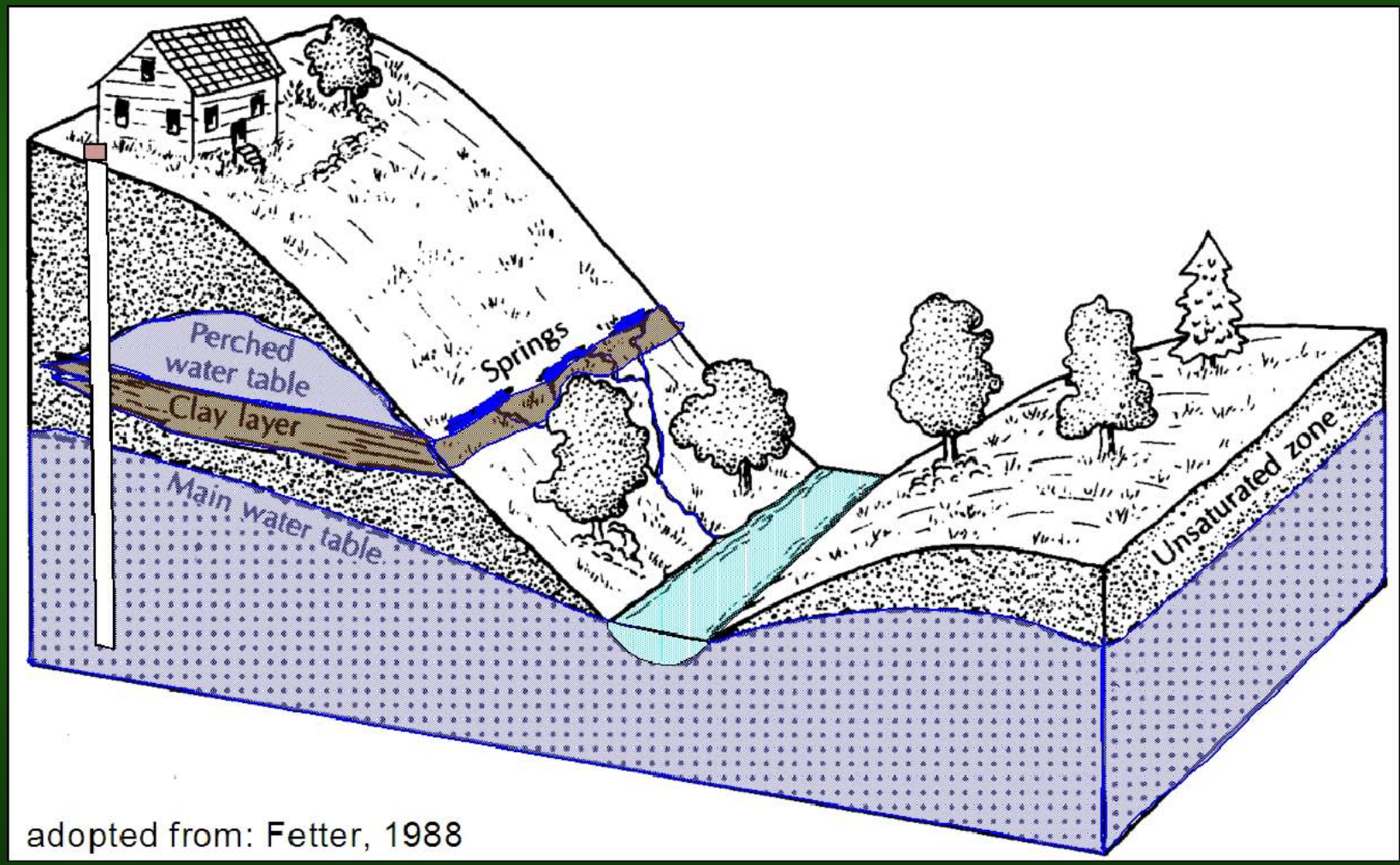
Springs



From: Harter and Rollins, Watersheds, Groundwater, and Drinking Water - A Practical Guide. University of California Agriculture and Natural Resources Publication 3497, 2008; http://anrcatalog.ucdavis.edu/Items/3497.aspx

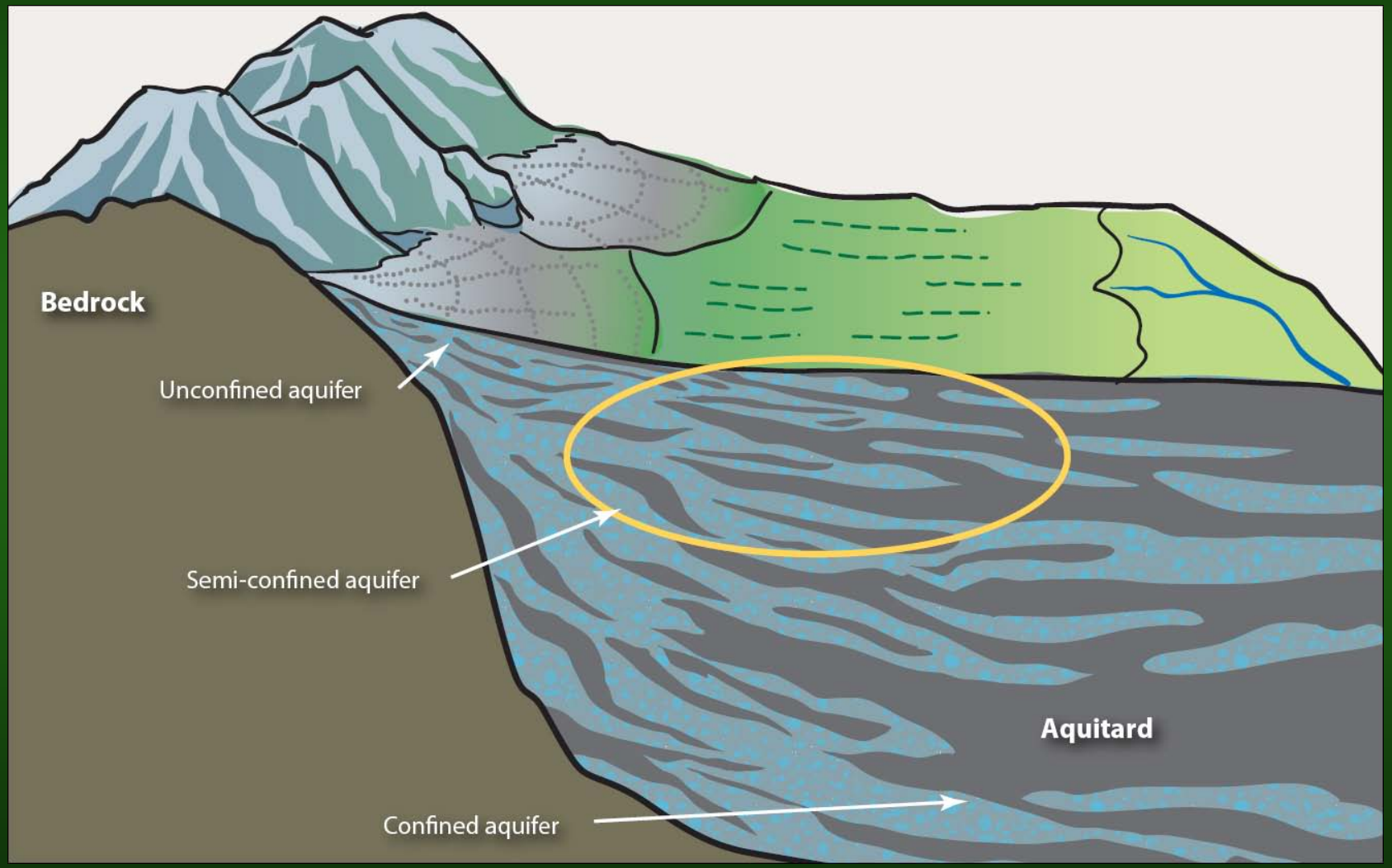
Fall River, NE California

Perched Water Table



adopted from: Fetter, 1988

(Semi-) Confined Aquifer

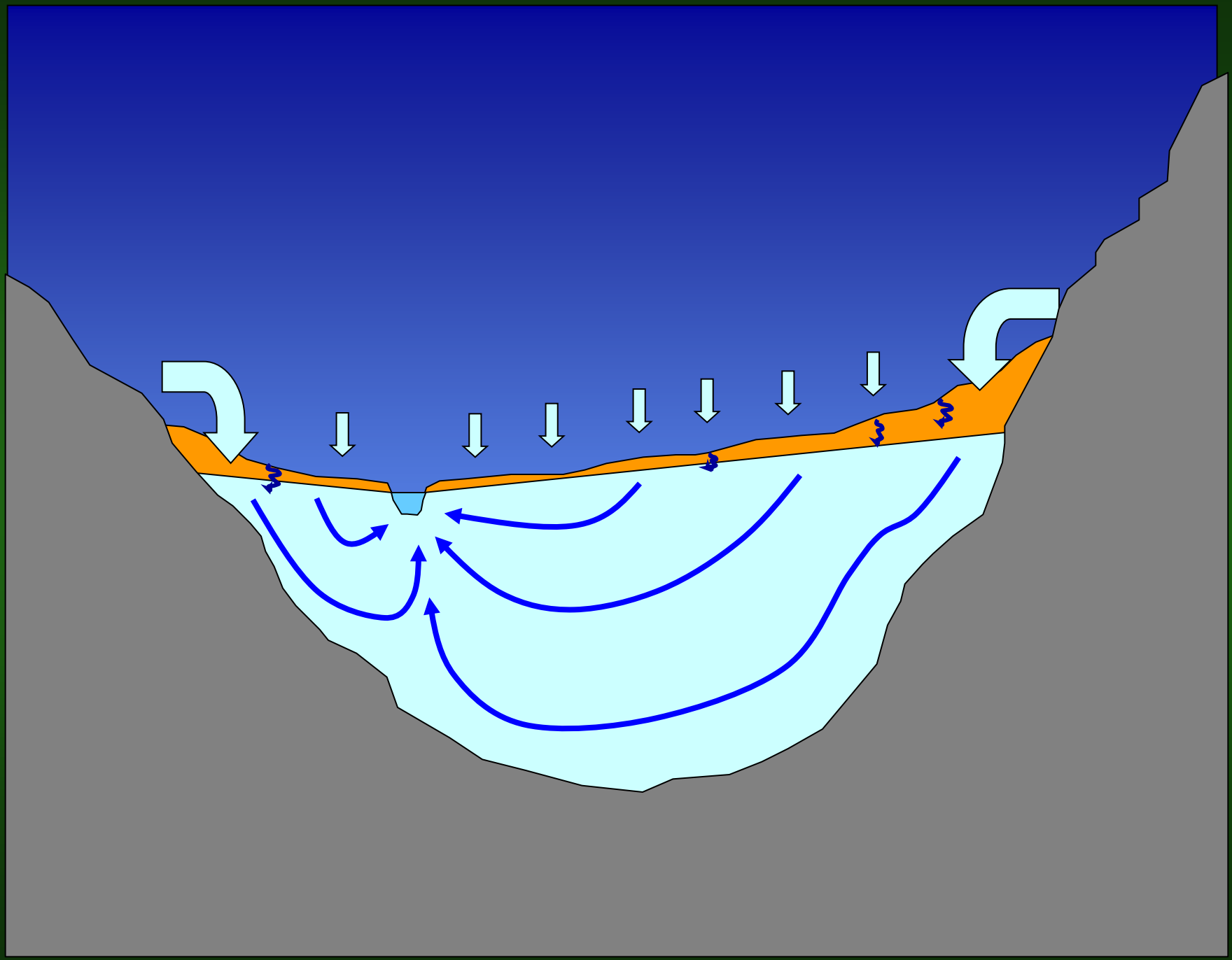


Artesian Well (Confined Aquifer)

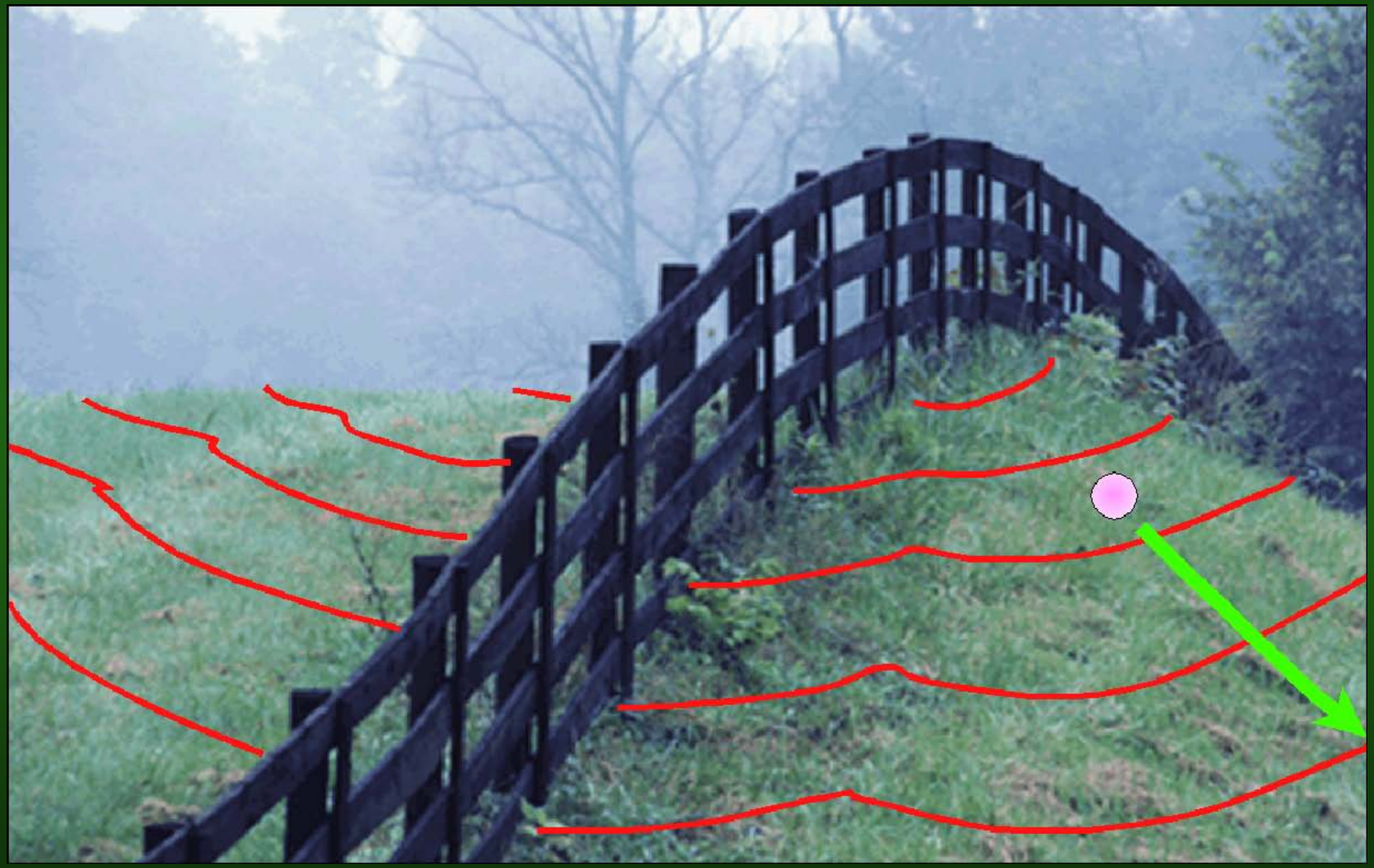
Vernal Pools

aka

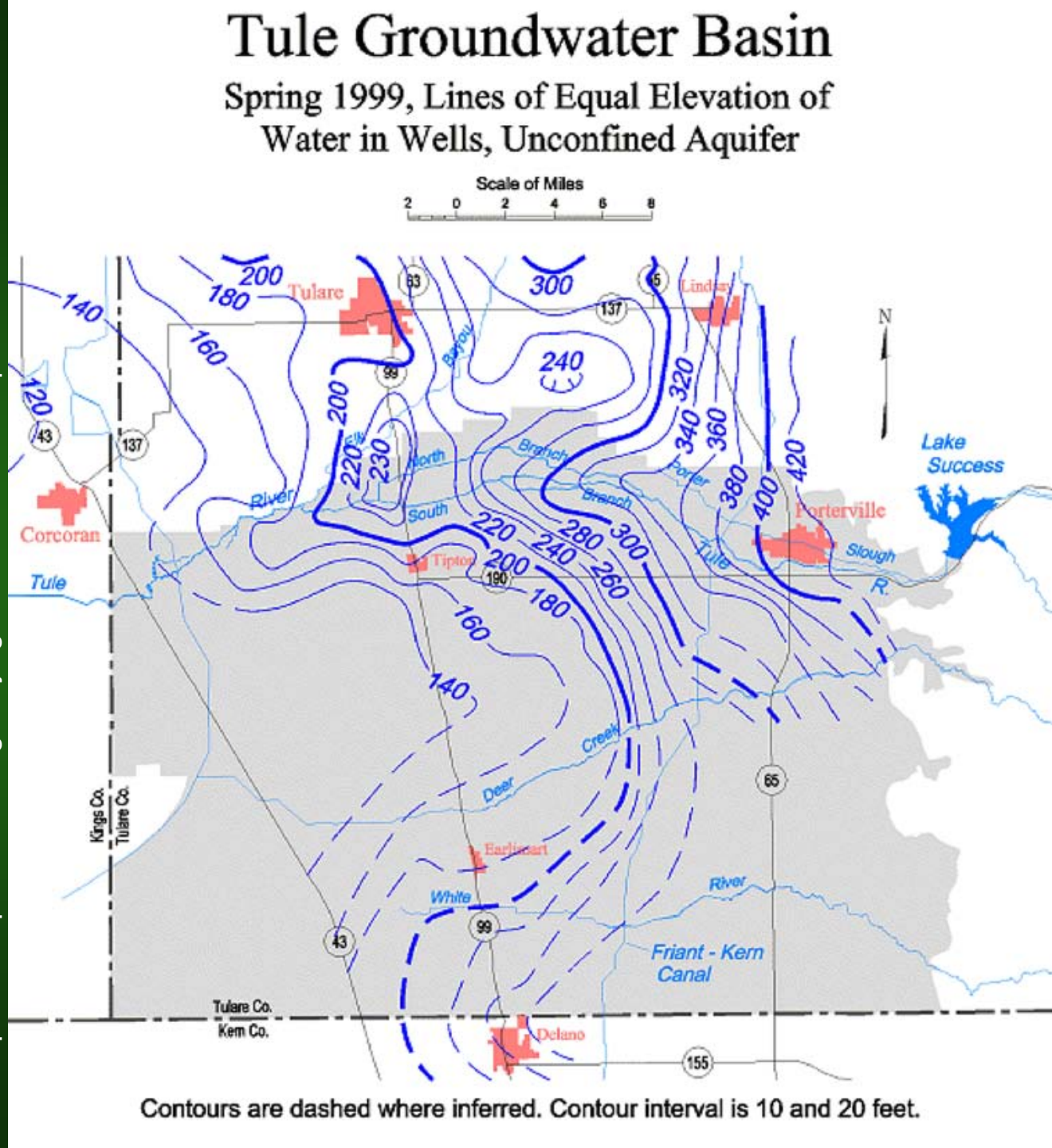
Seasonal Wetlands



Direction of Groundwater Flow?

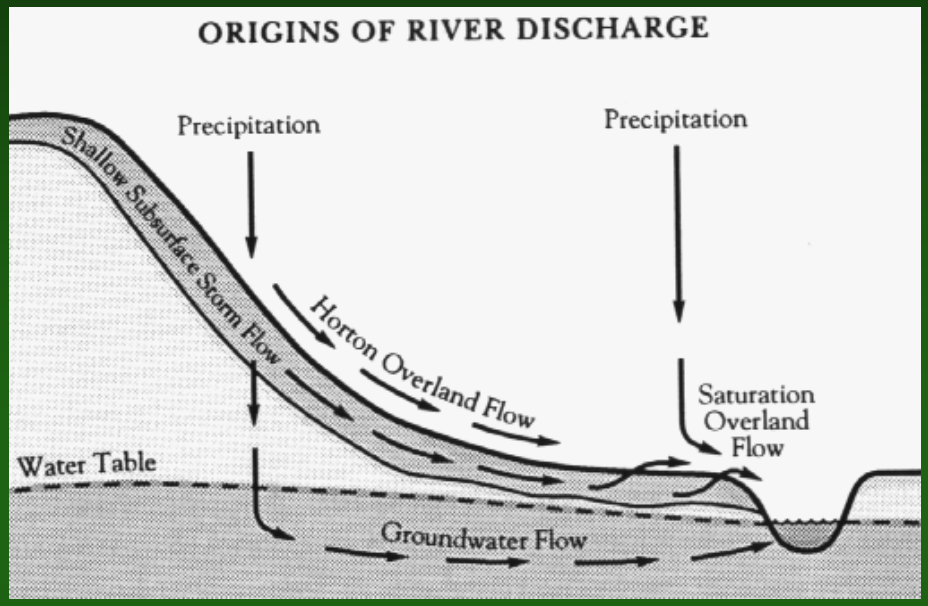


Direction of Regional GW Flow

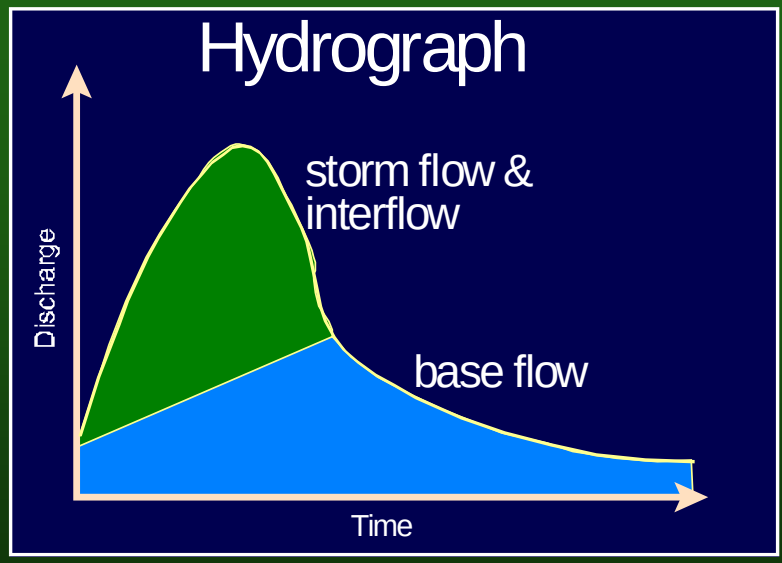


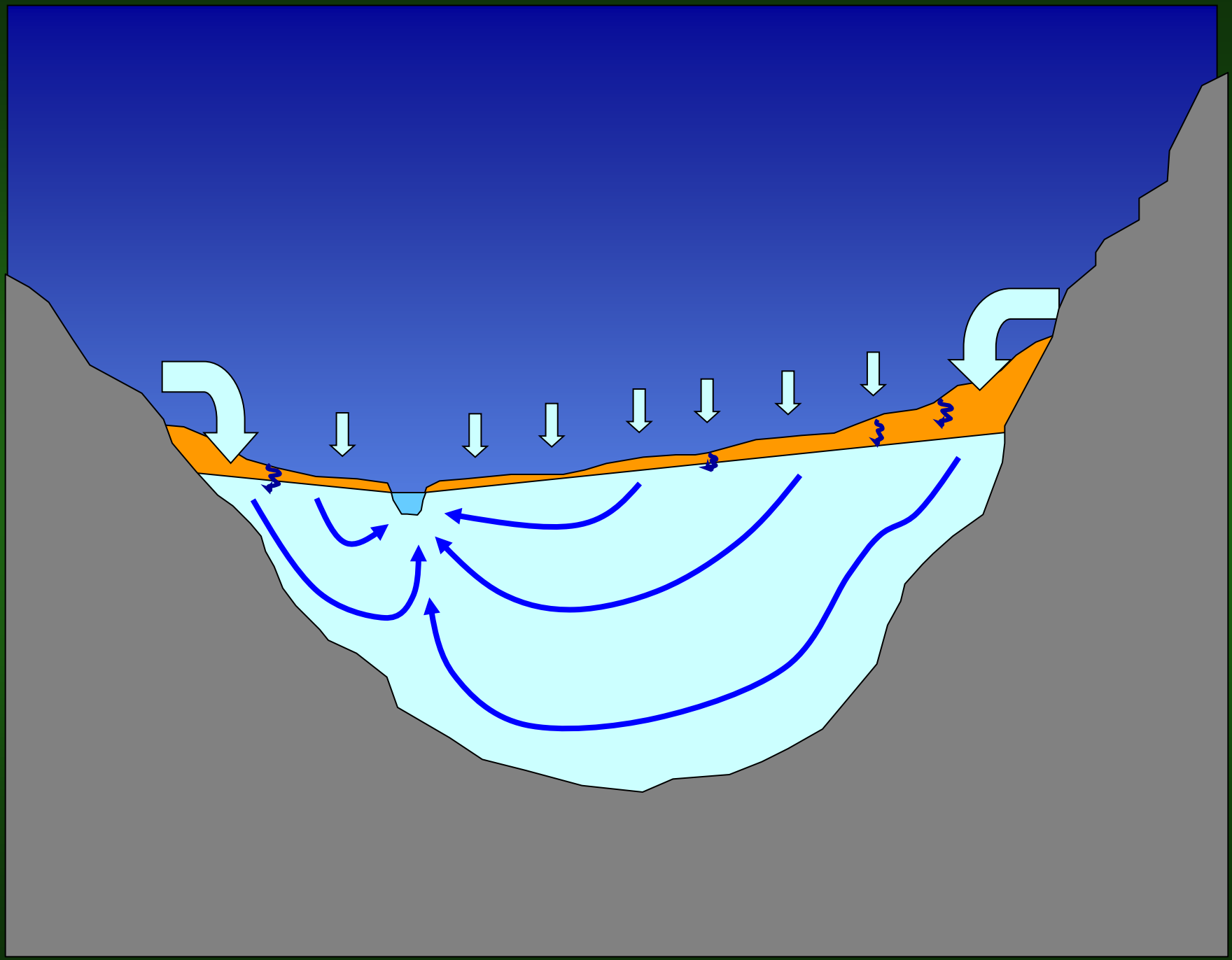
Map from: http://wwwdpla.water.ca.gov/sjd/groundwater/tle-emap99.html

The Classic Hydrology View

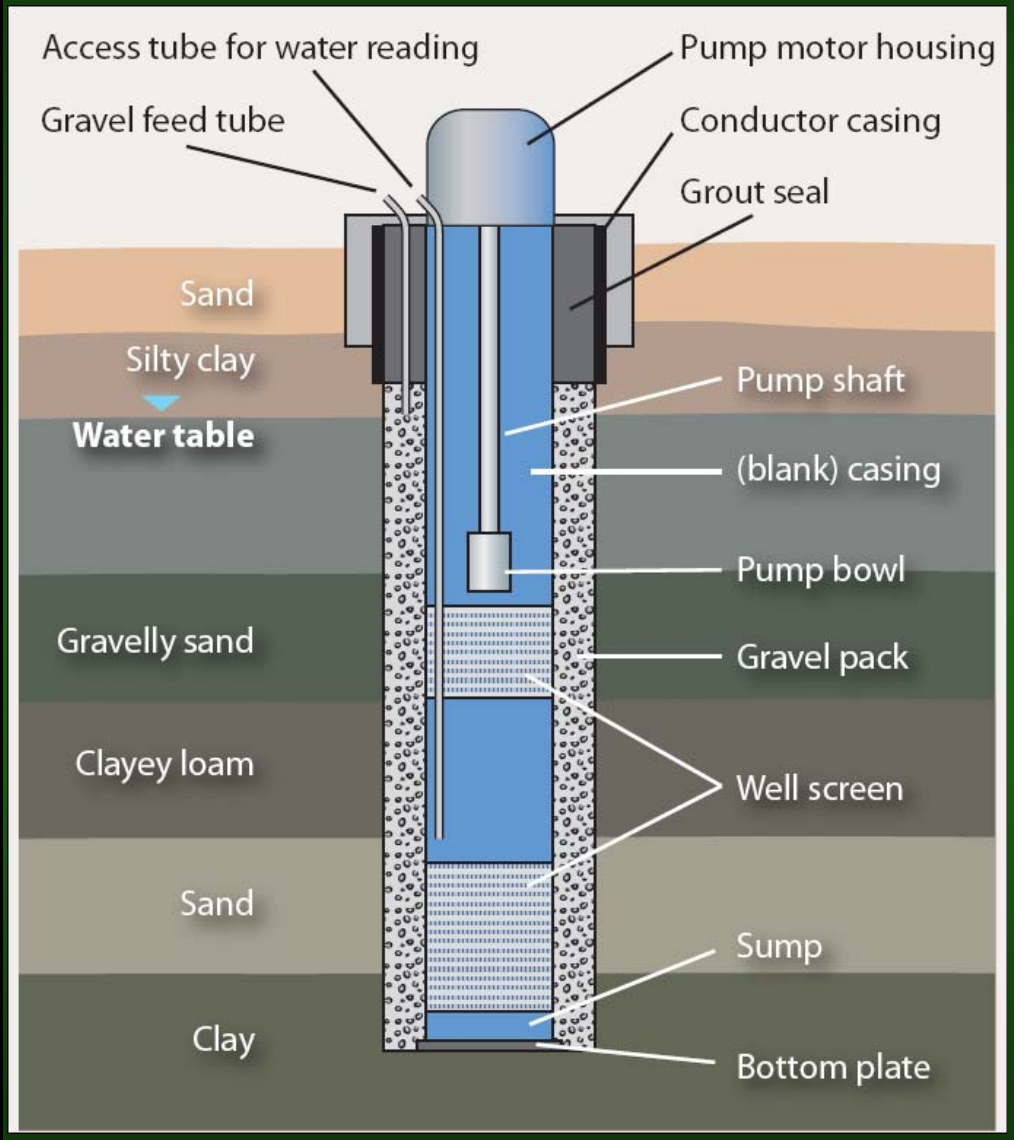


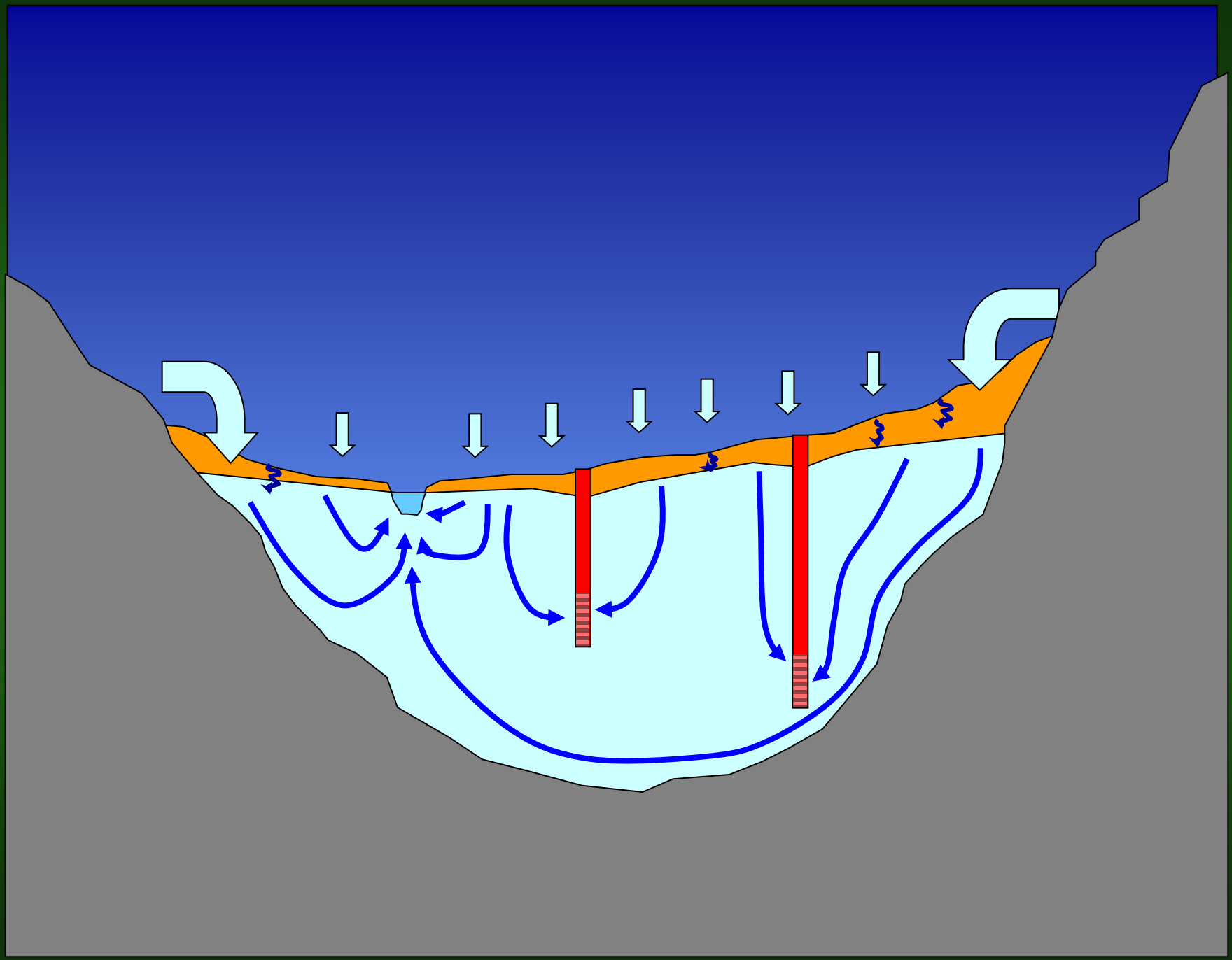
From: Jeff Mount "California Rivers and Streams"



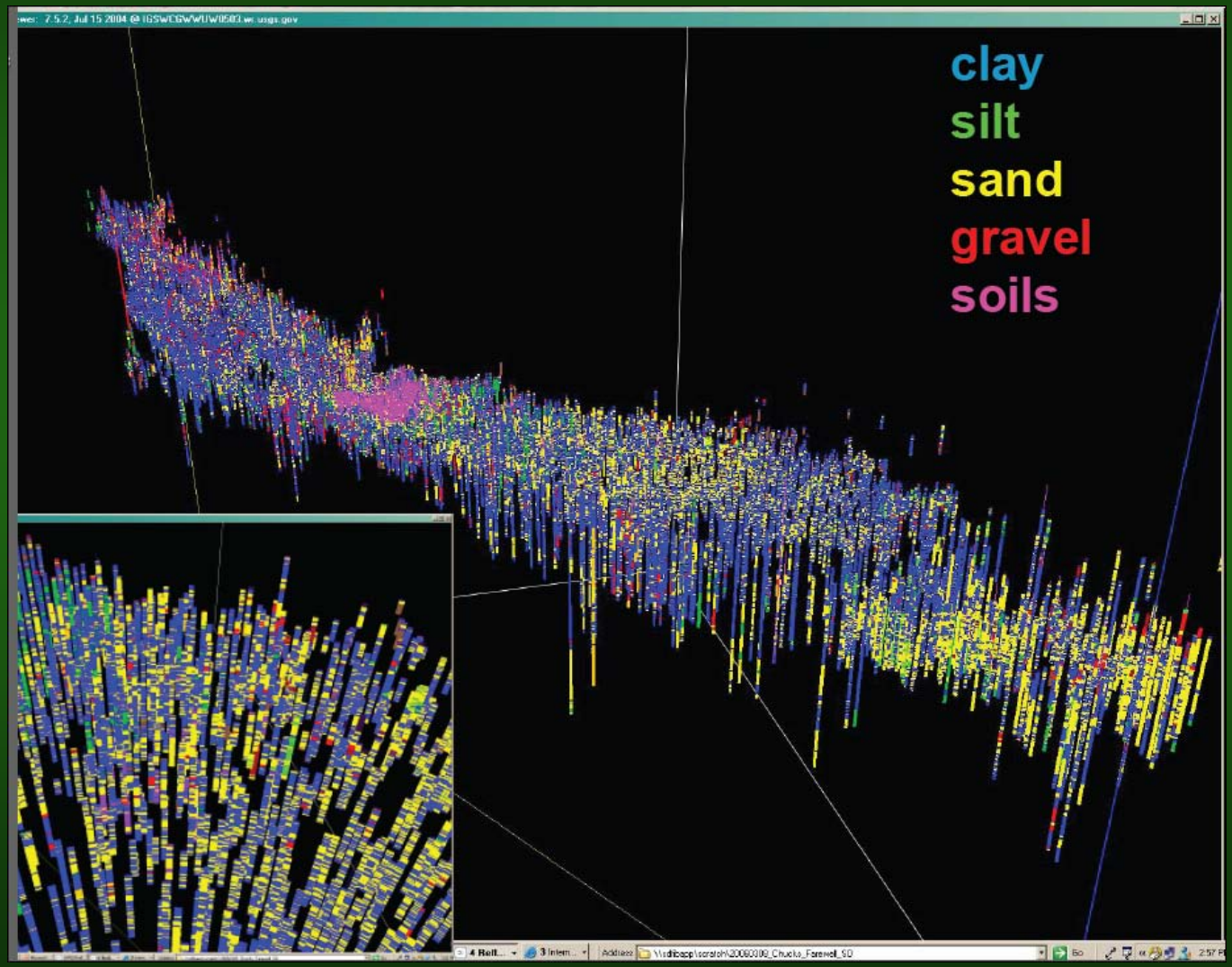


A Groundwater Well



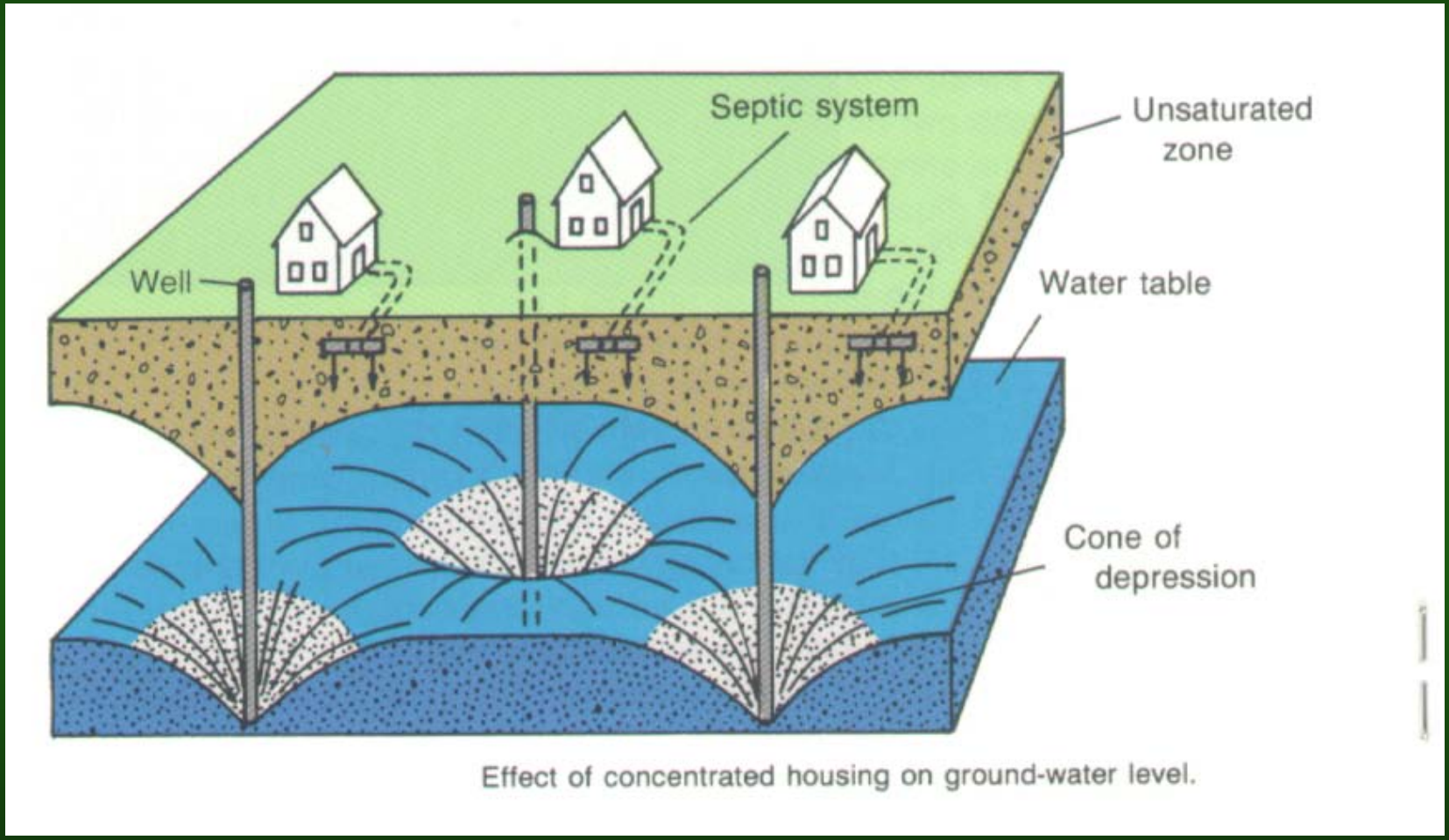


Hydraulic Conductivity from Borehole Logs (Estimated)



Courtesy, Claudia Fawn, USGS, 2008

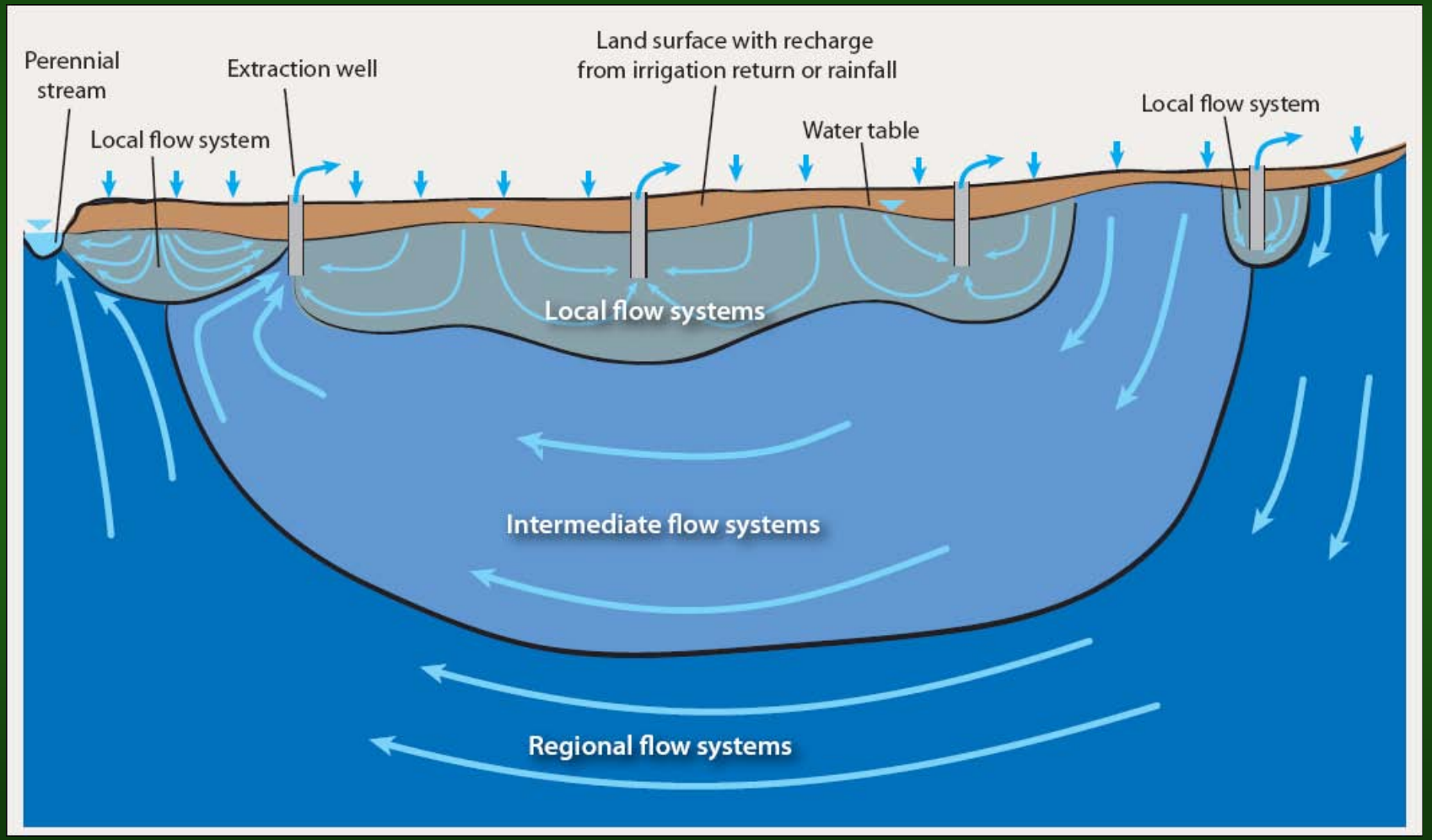
Cone of Depression near a Well

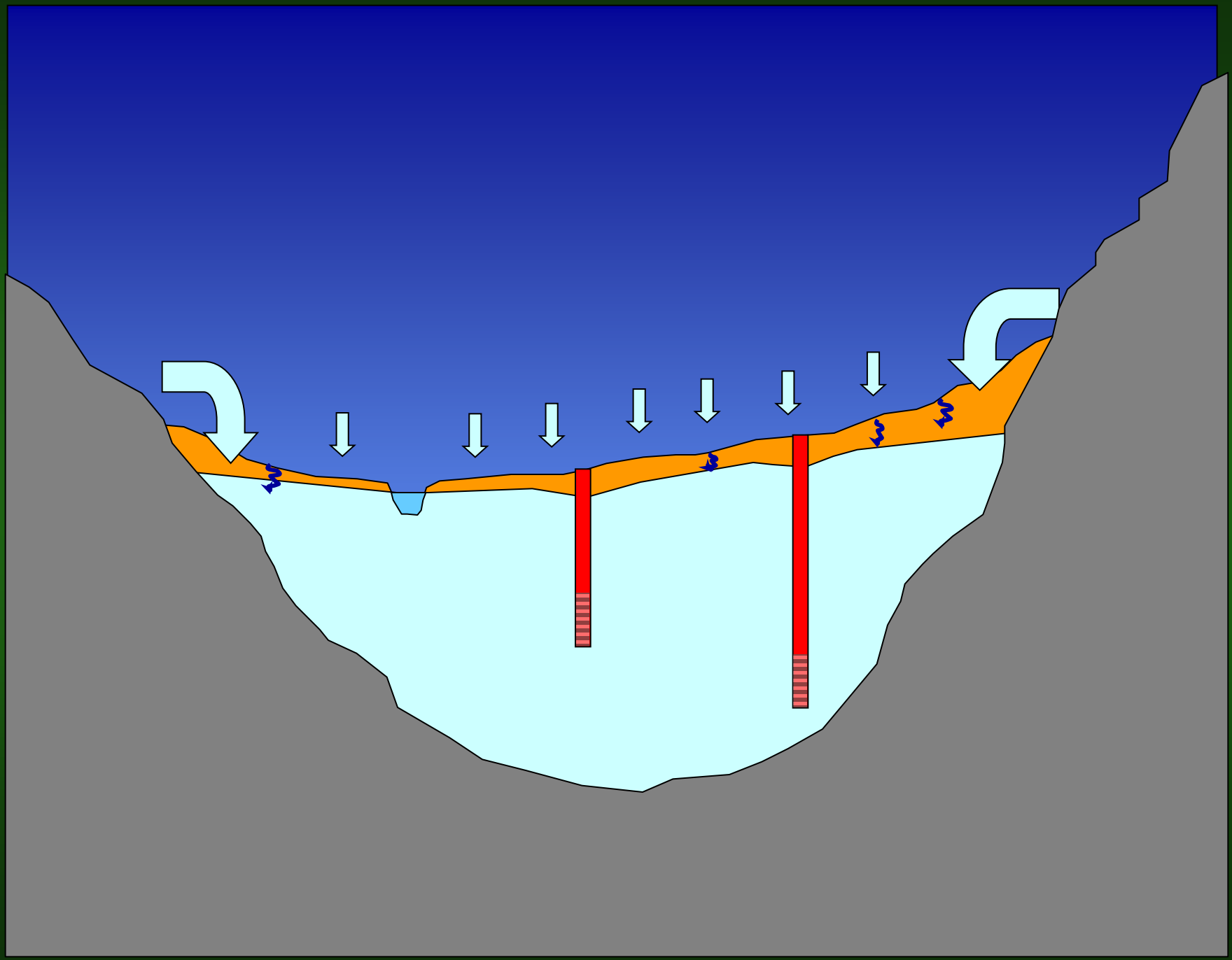


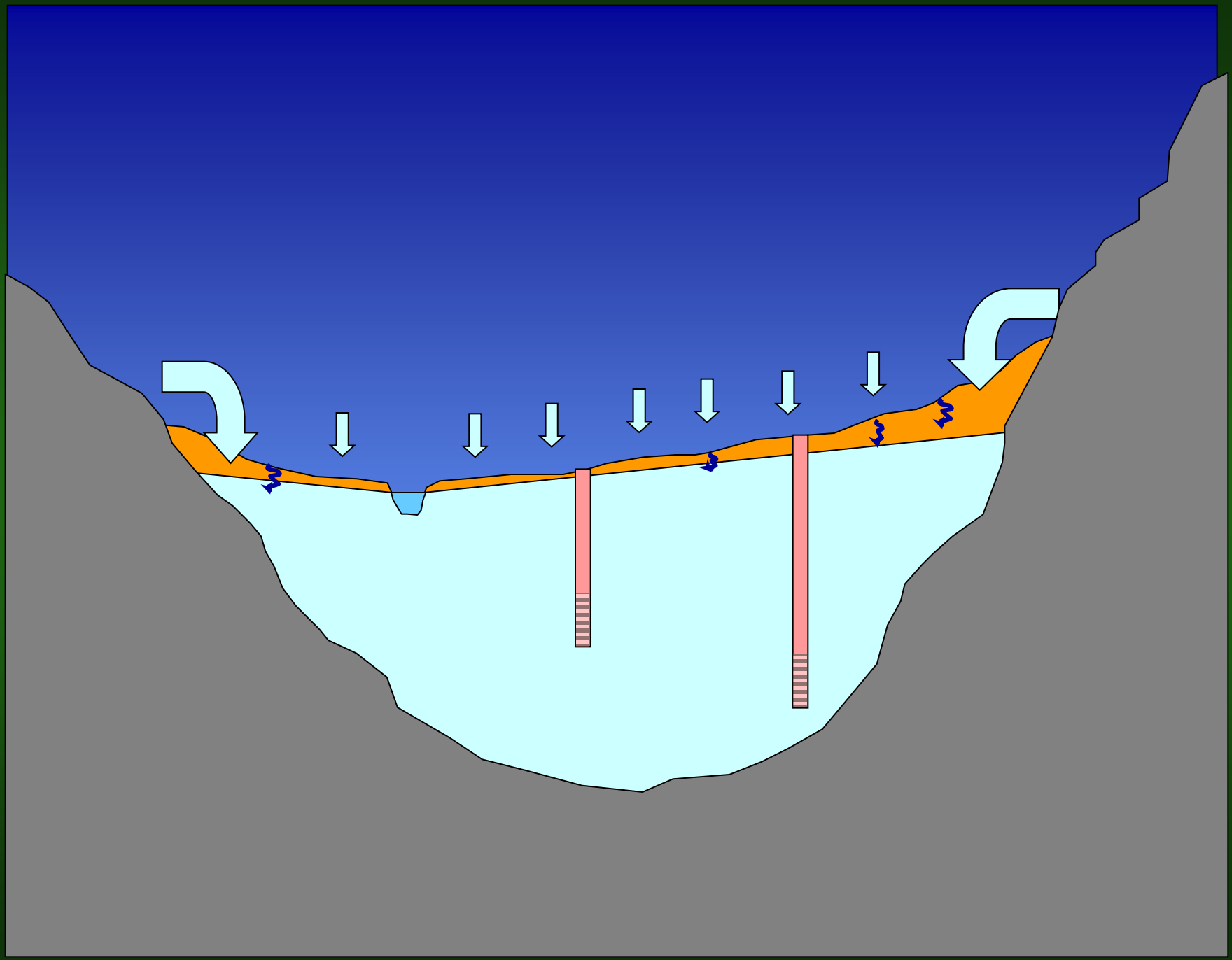
Effect of concentrated housing on ground-water level.

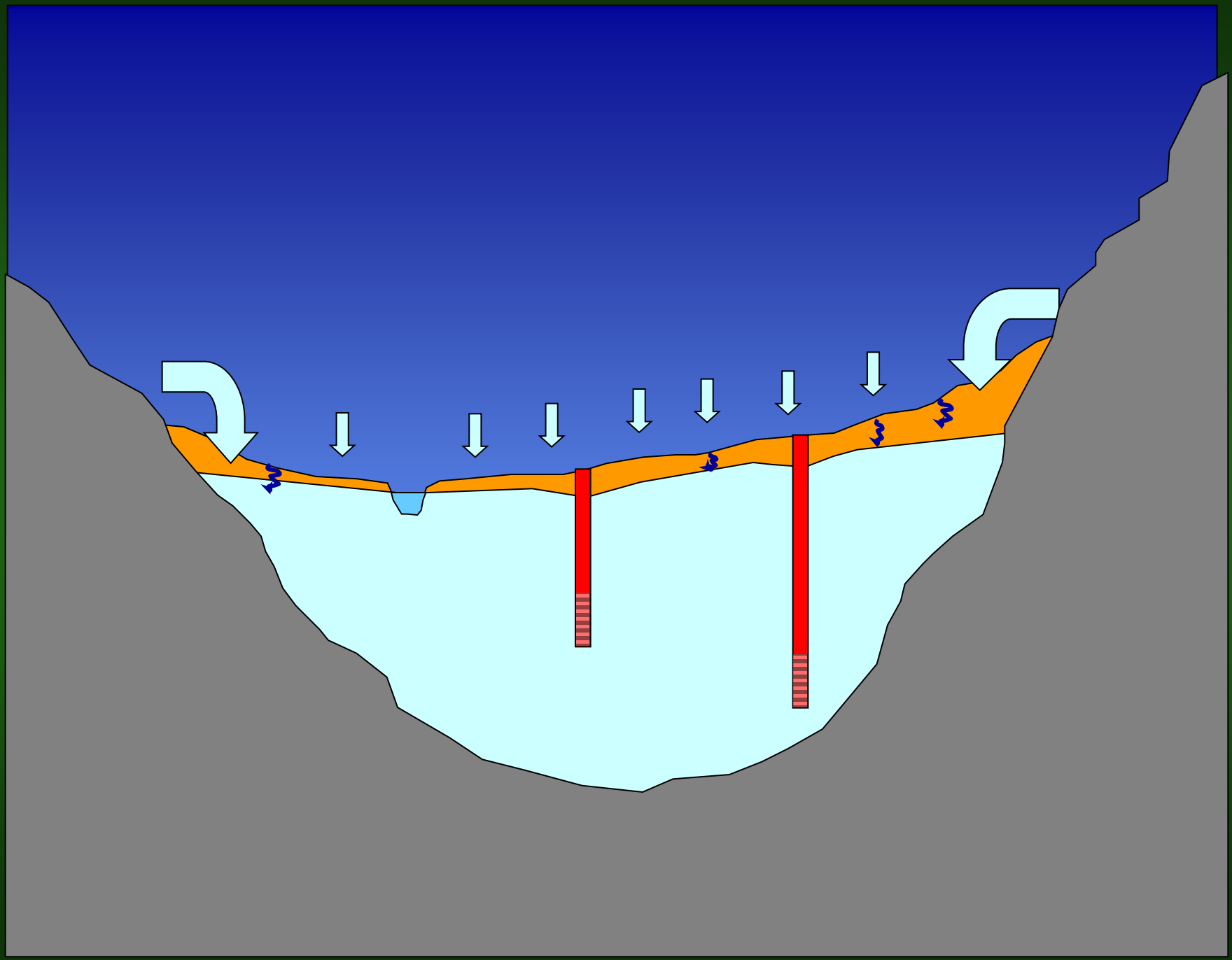
from: U.S. Geological Survey, 'Ground Water and the Rural Homeowner'

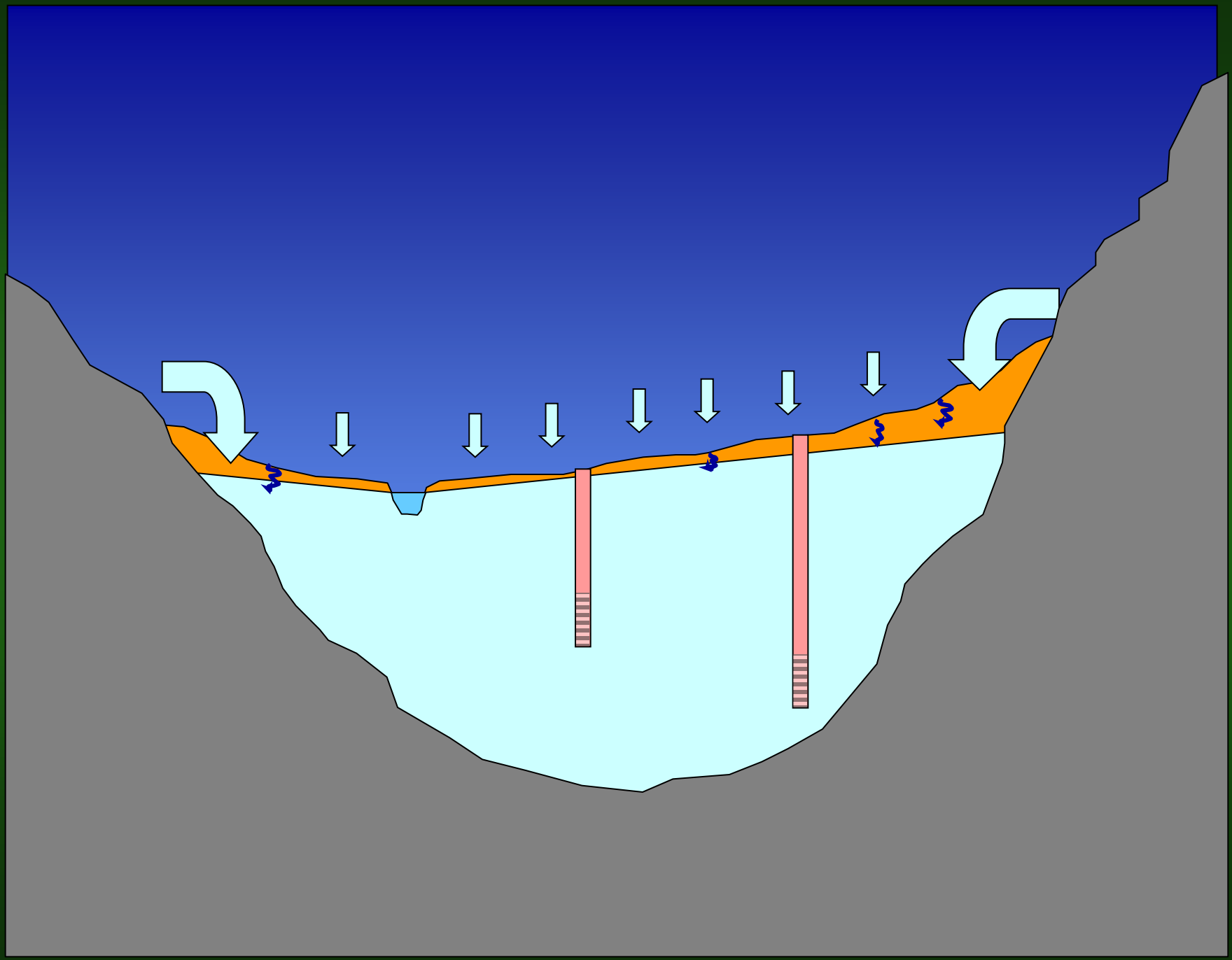
Local & Regional Groundwater Flow

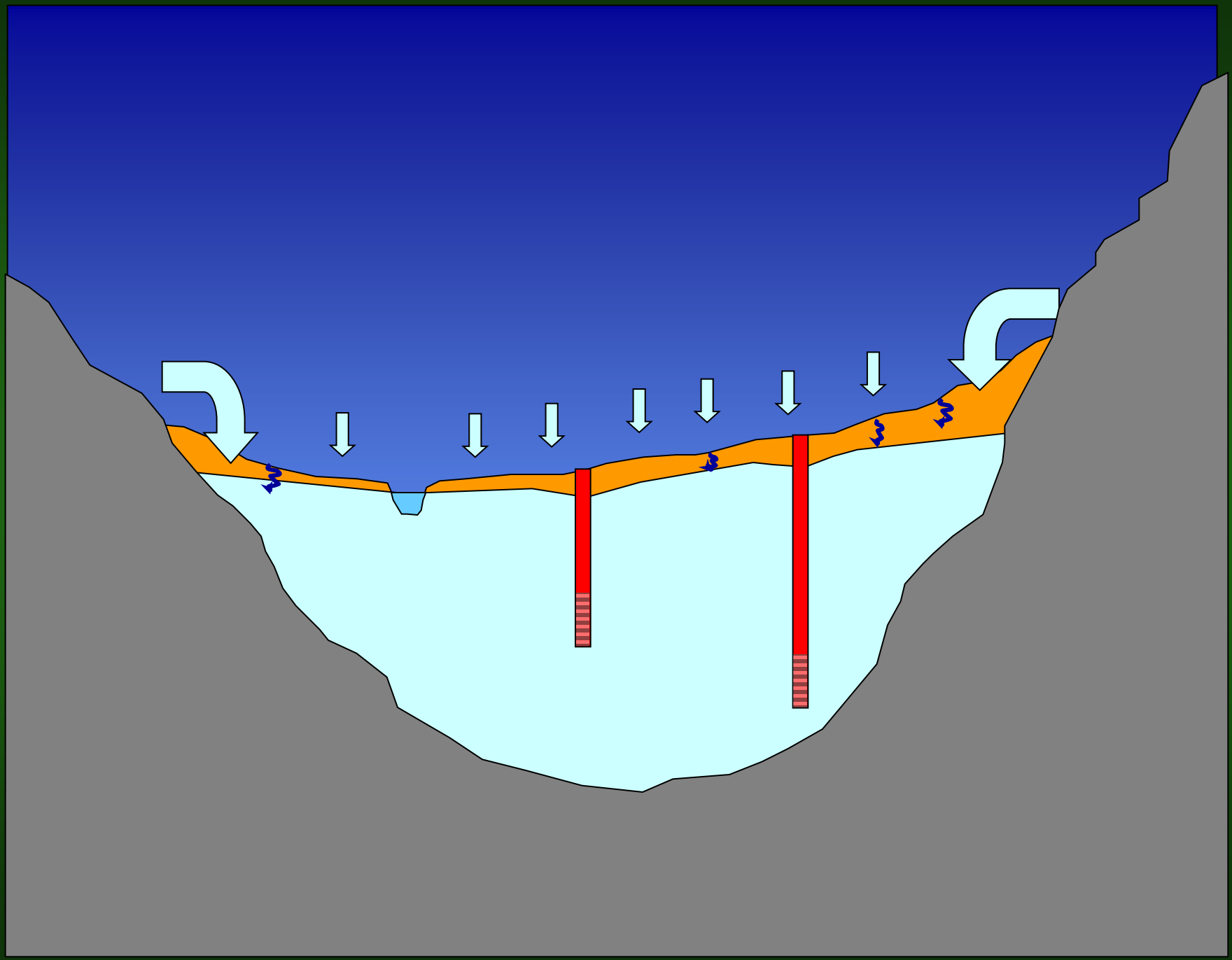


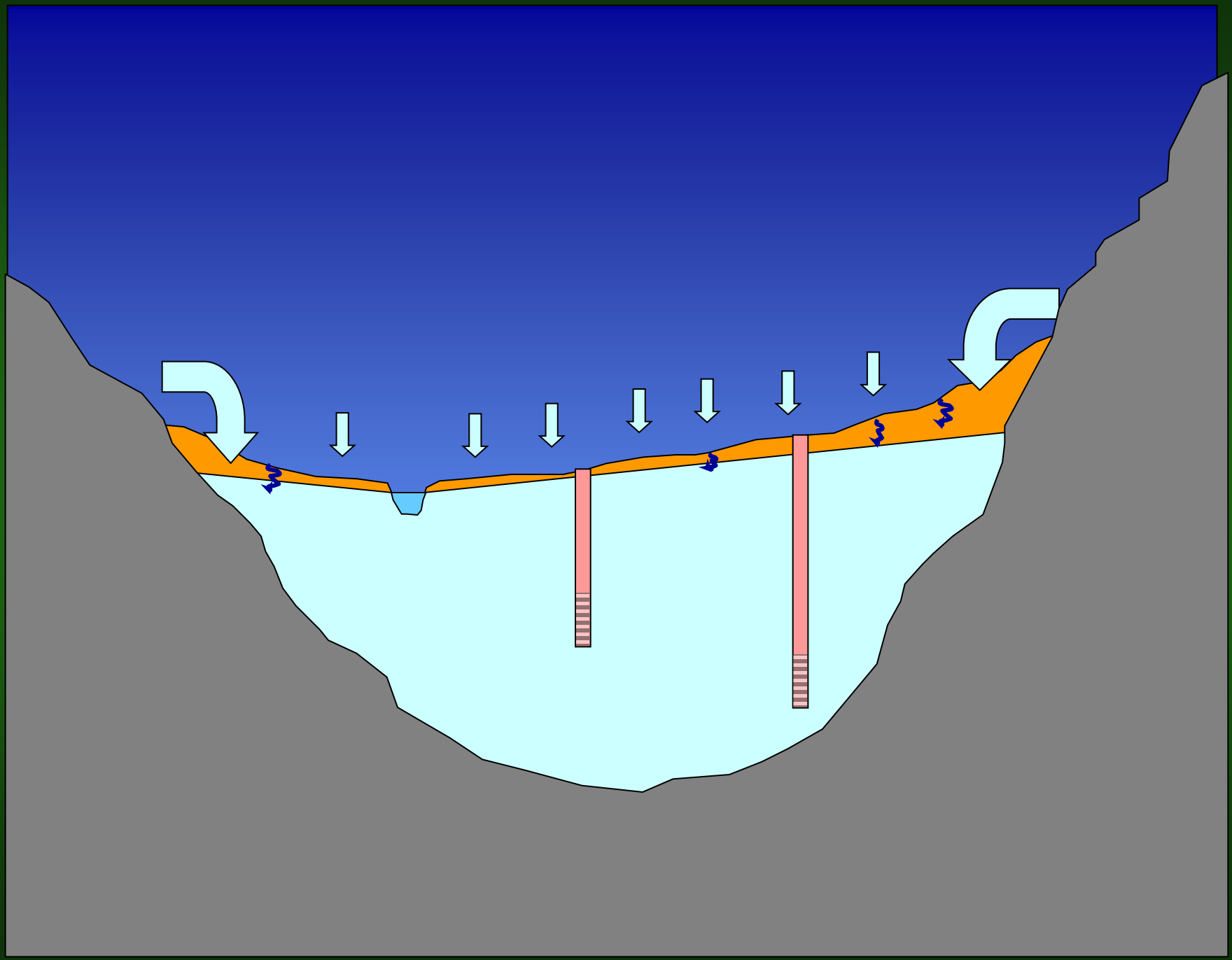


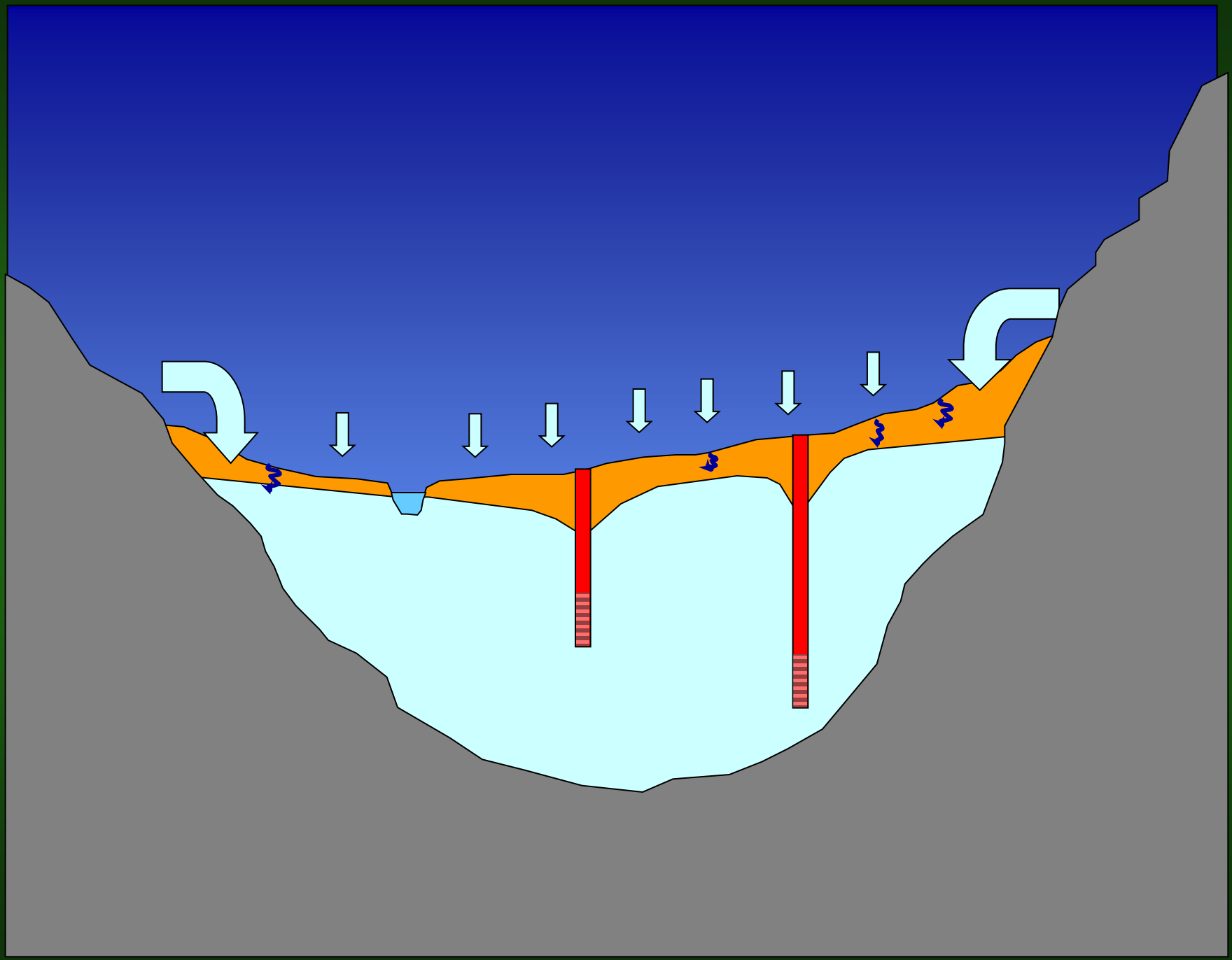


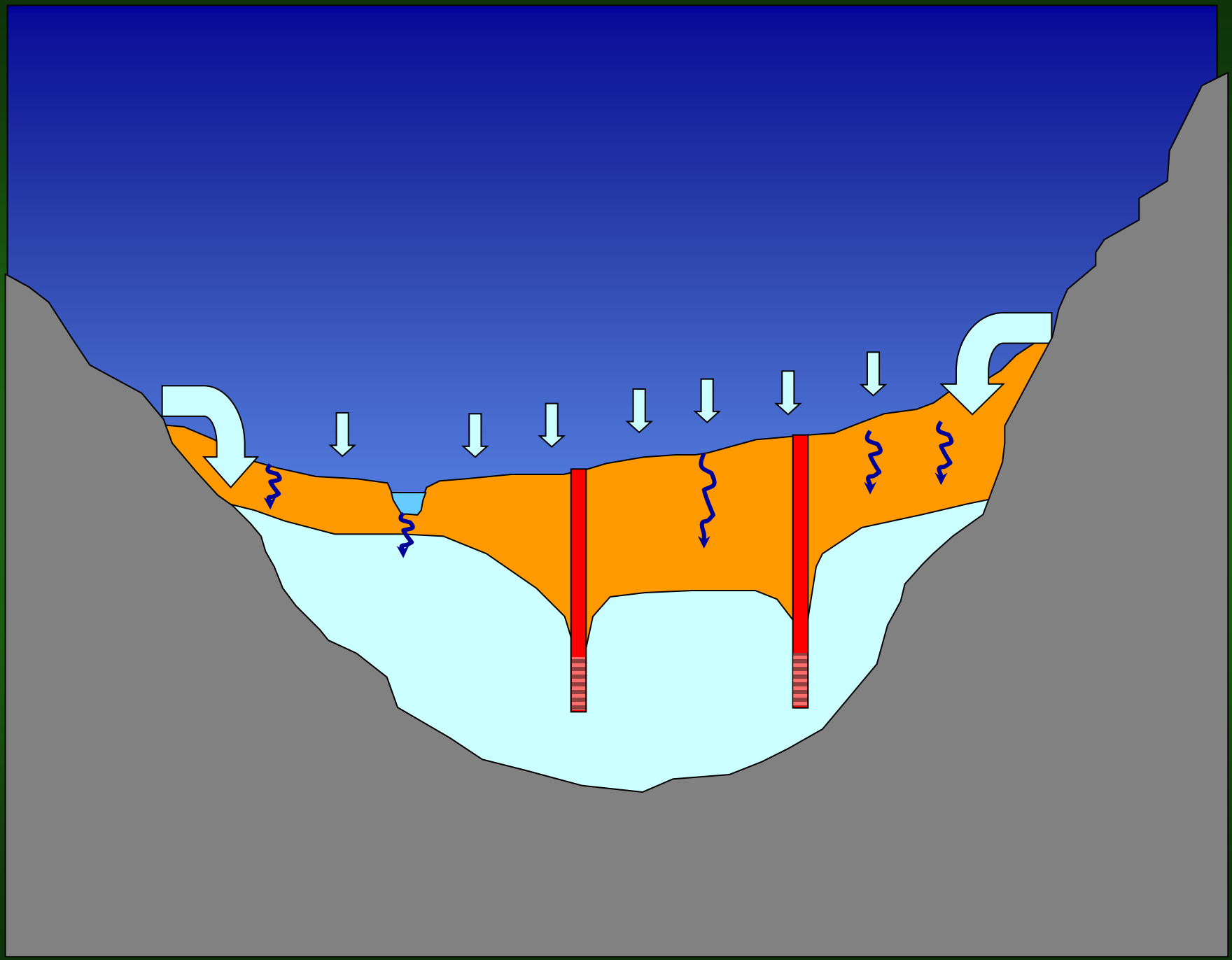


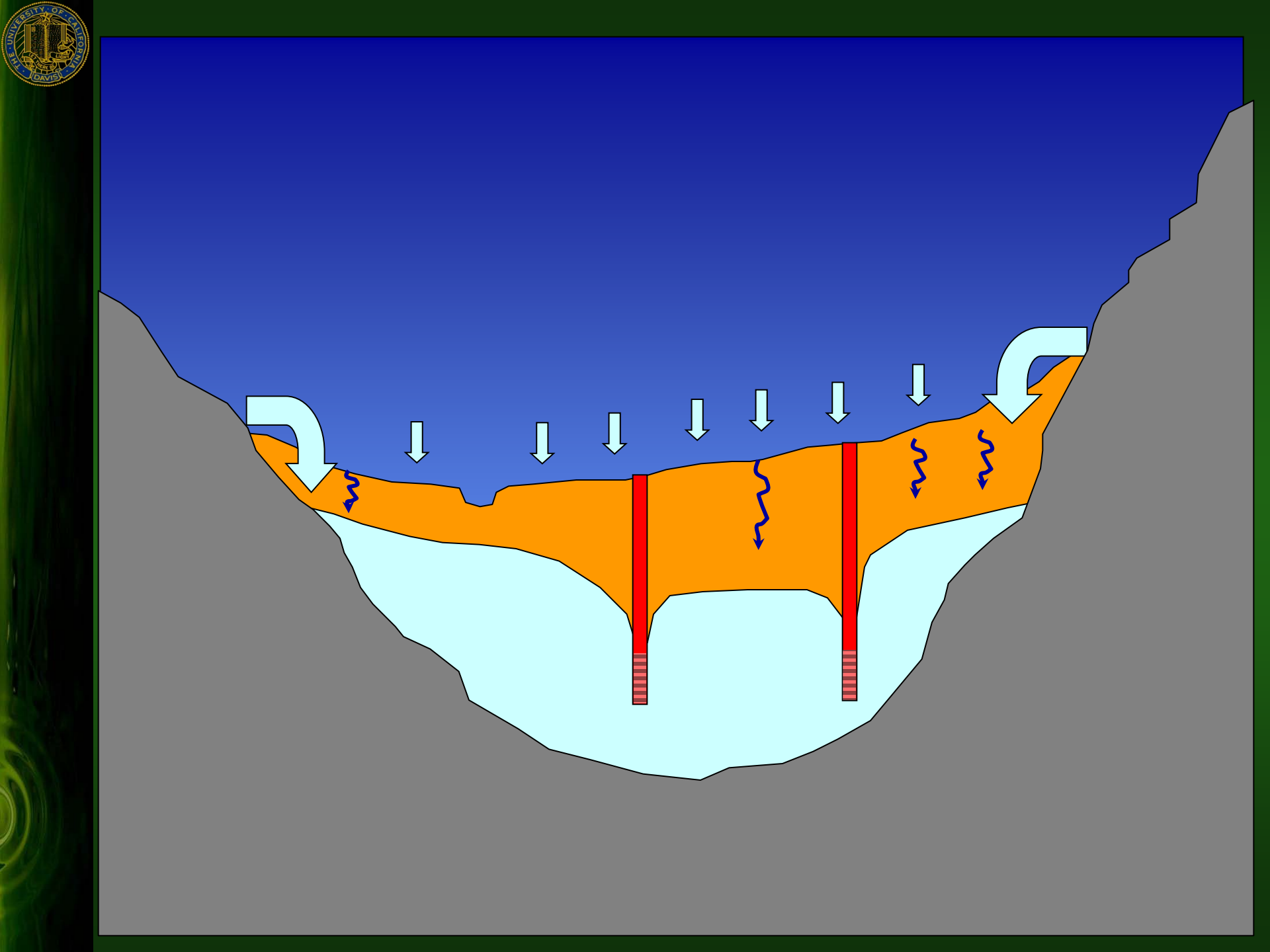








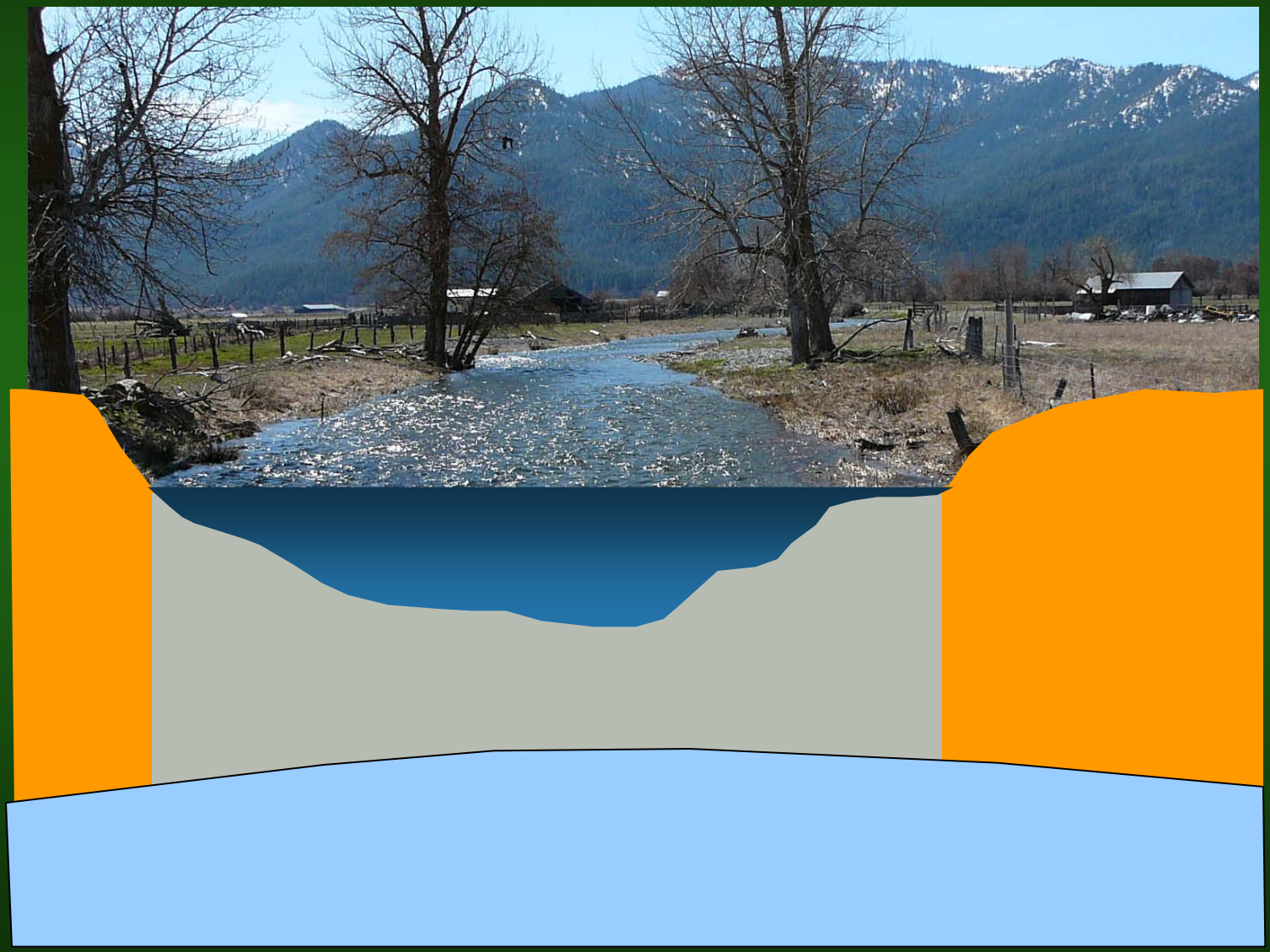




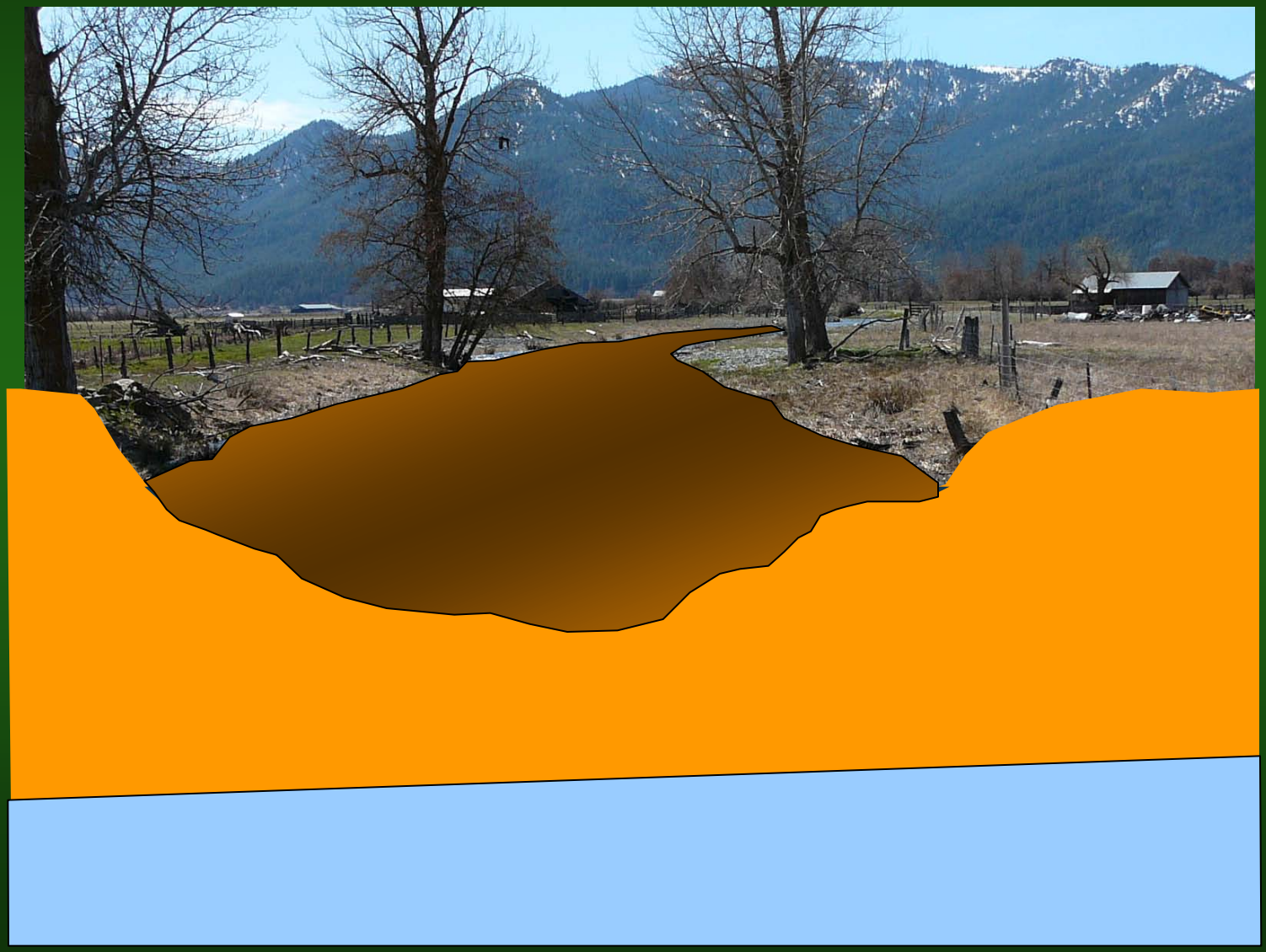
Gaining Stream

Losing Stream

Disconnected Stream

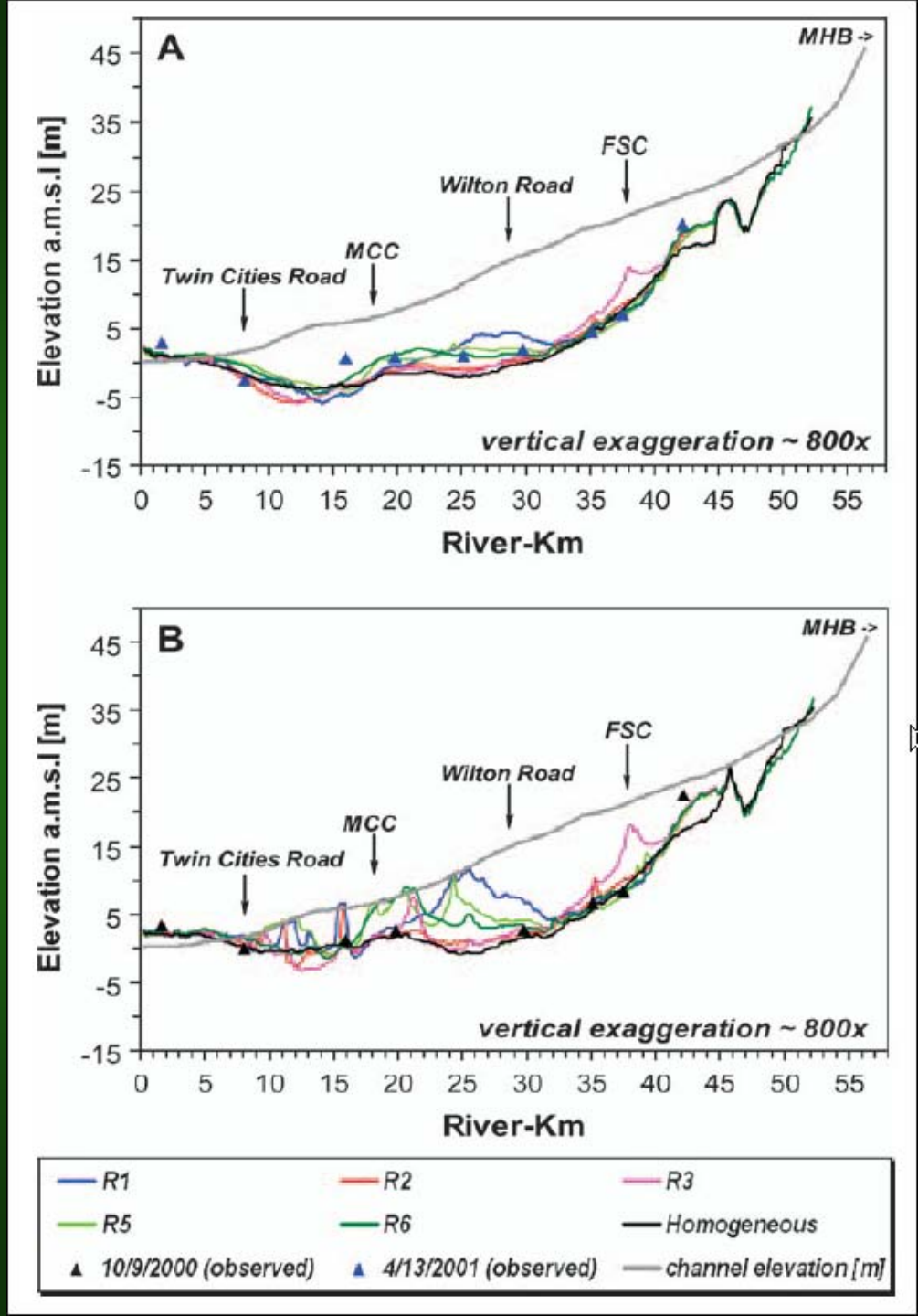


Dry Stream



Reconnecting Groundwater to Surface Water:

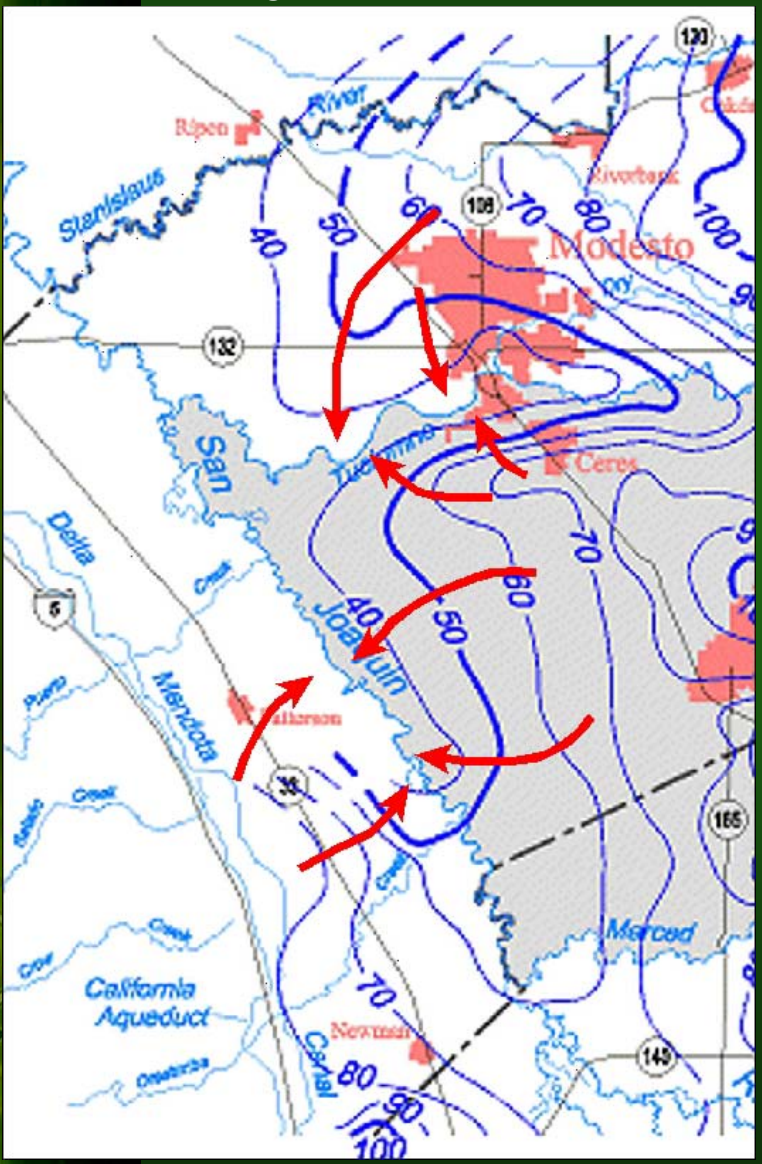
Role of Aquifer Heterogeneity

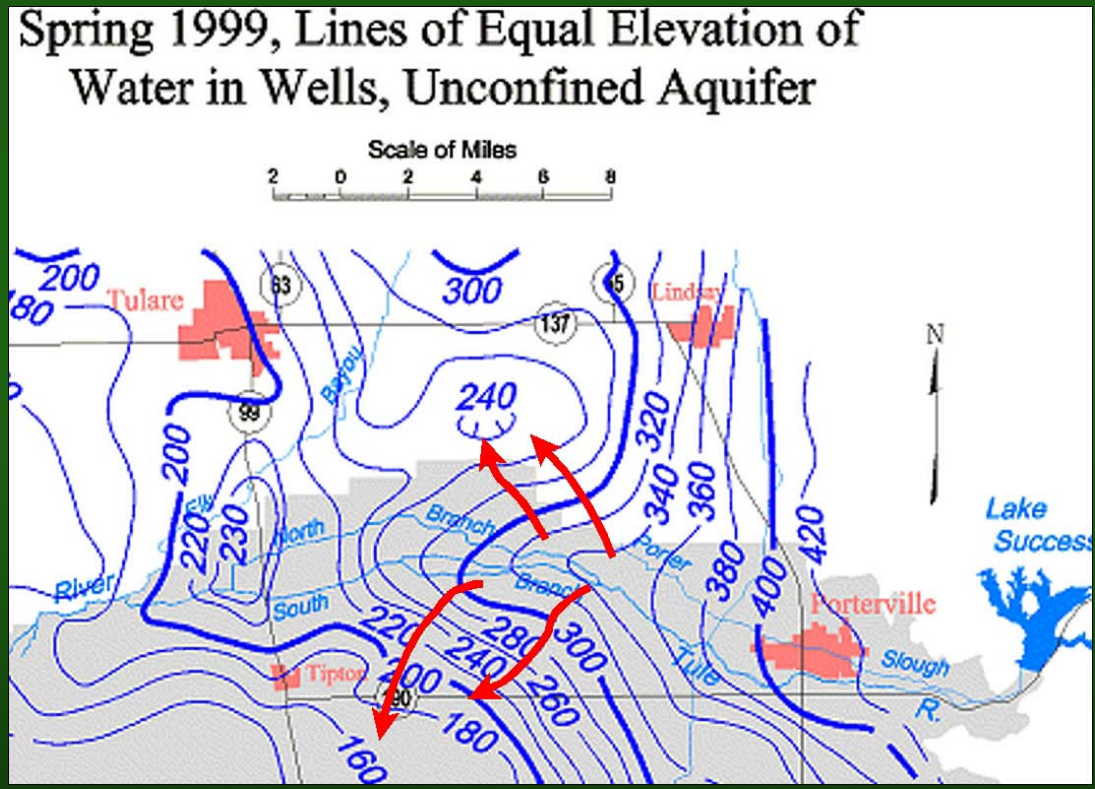


Fleckenstein et al., Ground Water 2006

Stream-Aquifer Connection at the Regional Scale

Gaining Stream

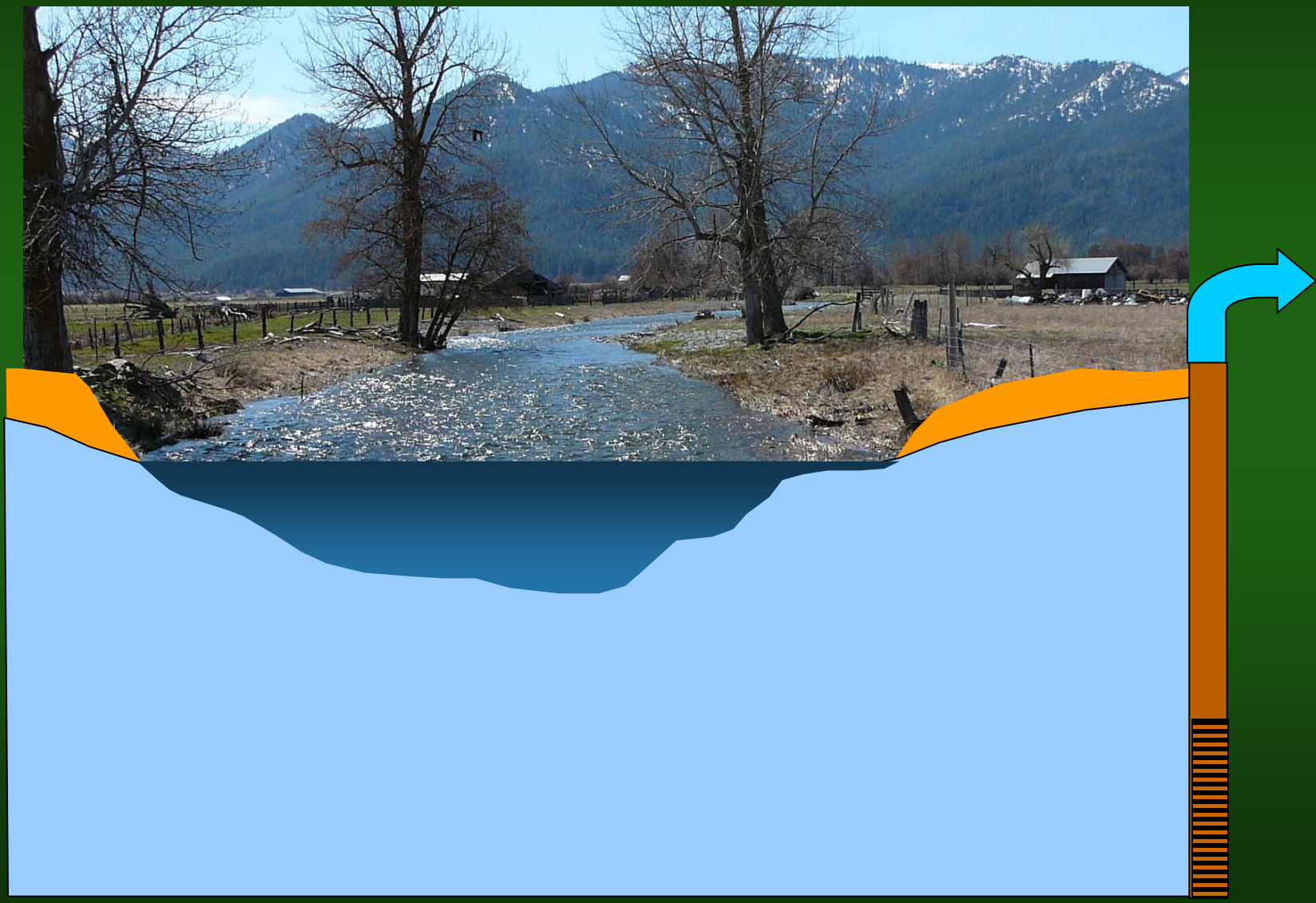




Losing or Disconnected Stream

Well Near a Stream

Well Near a Stream



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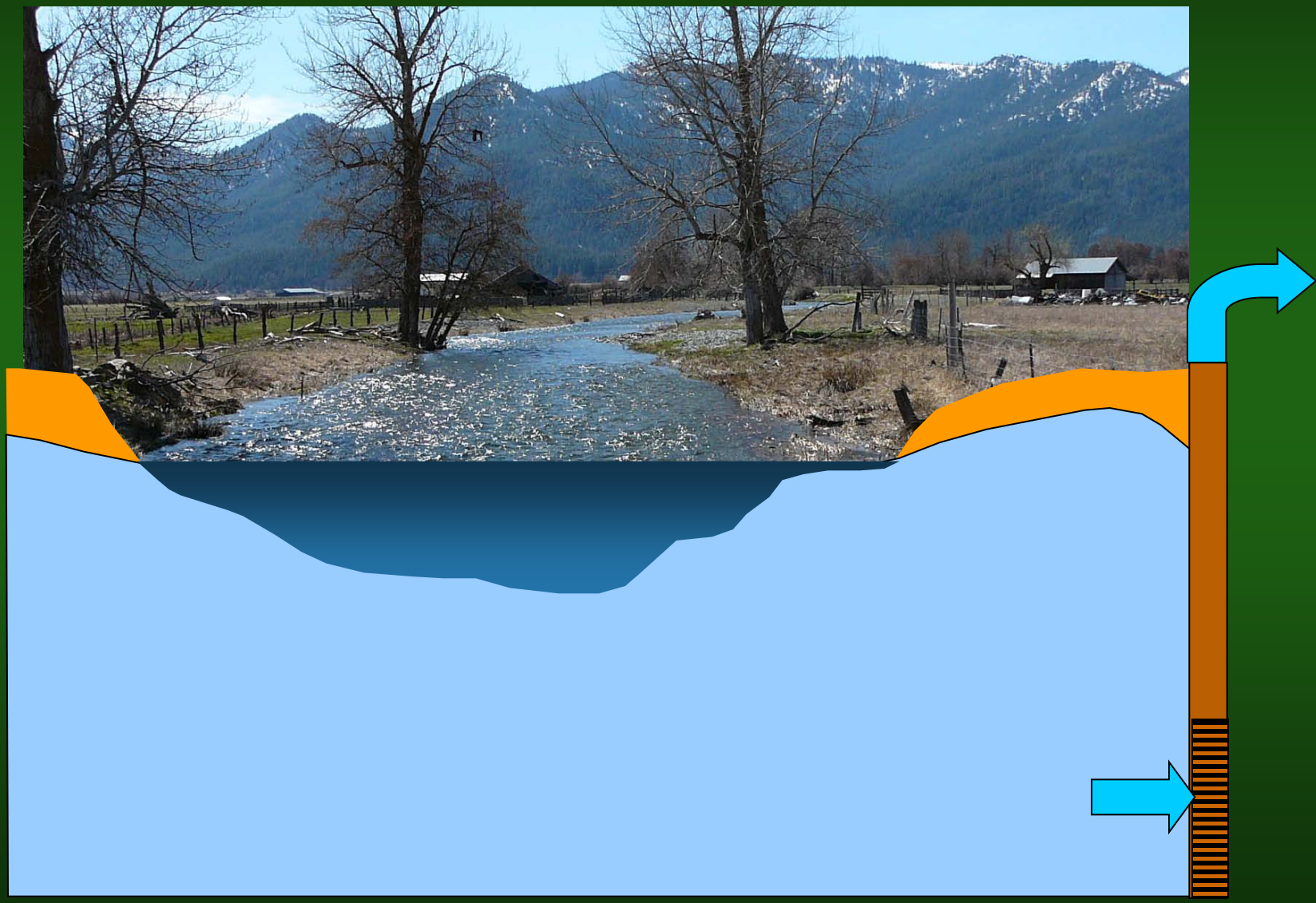

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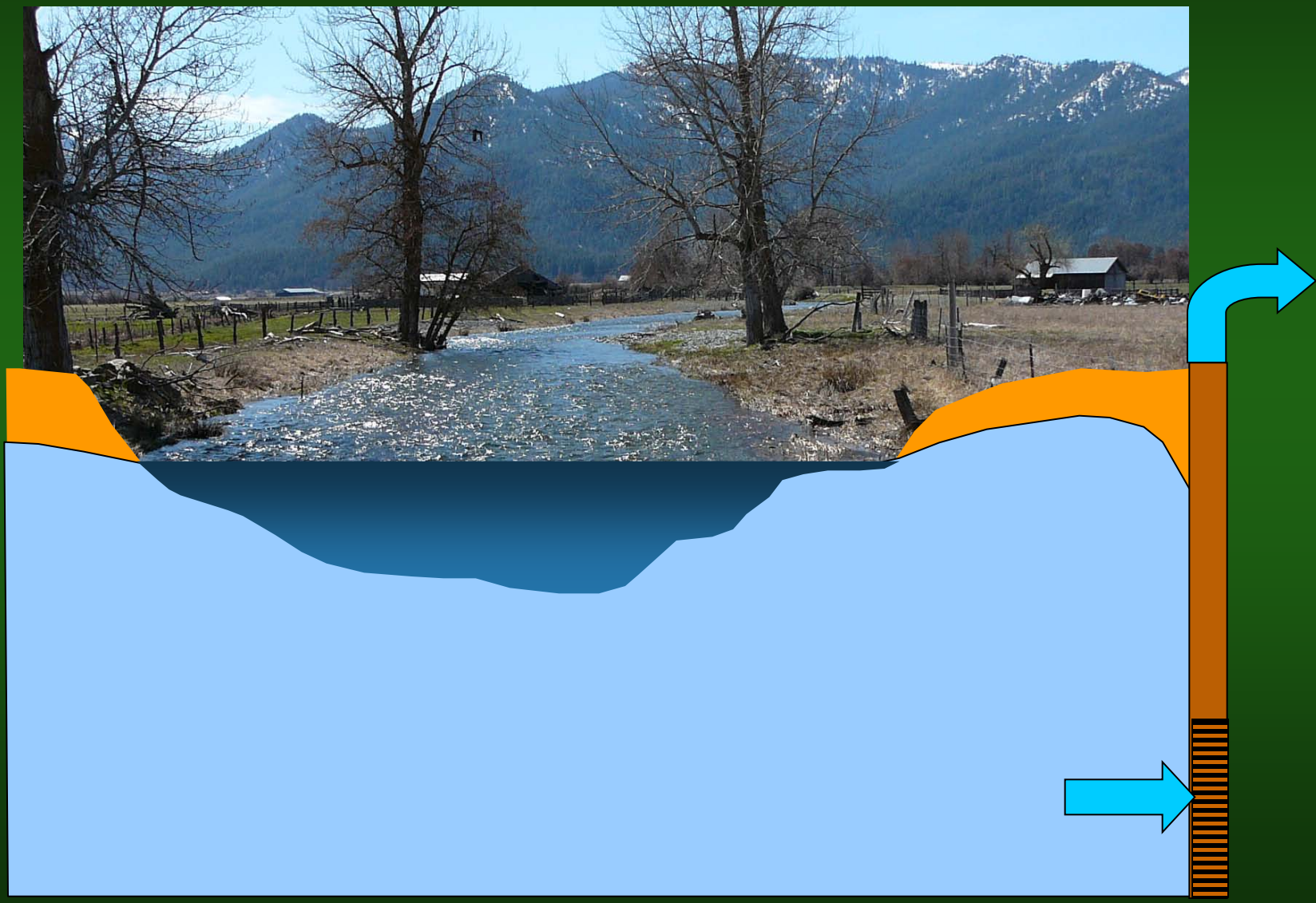
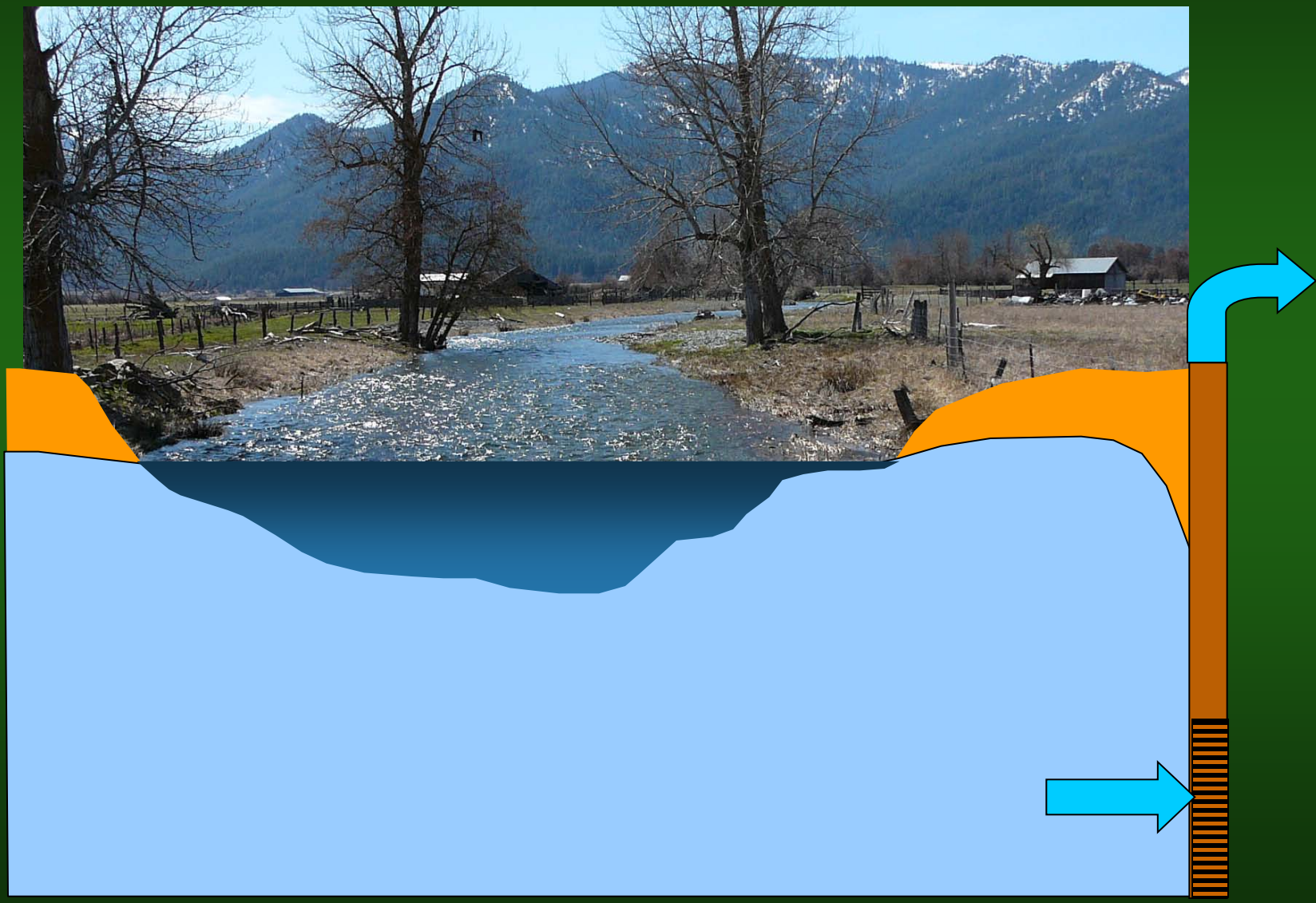
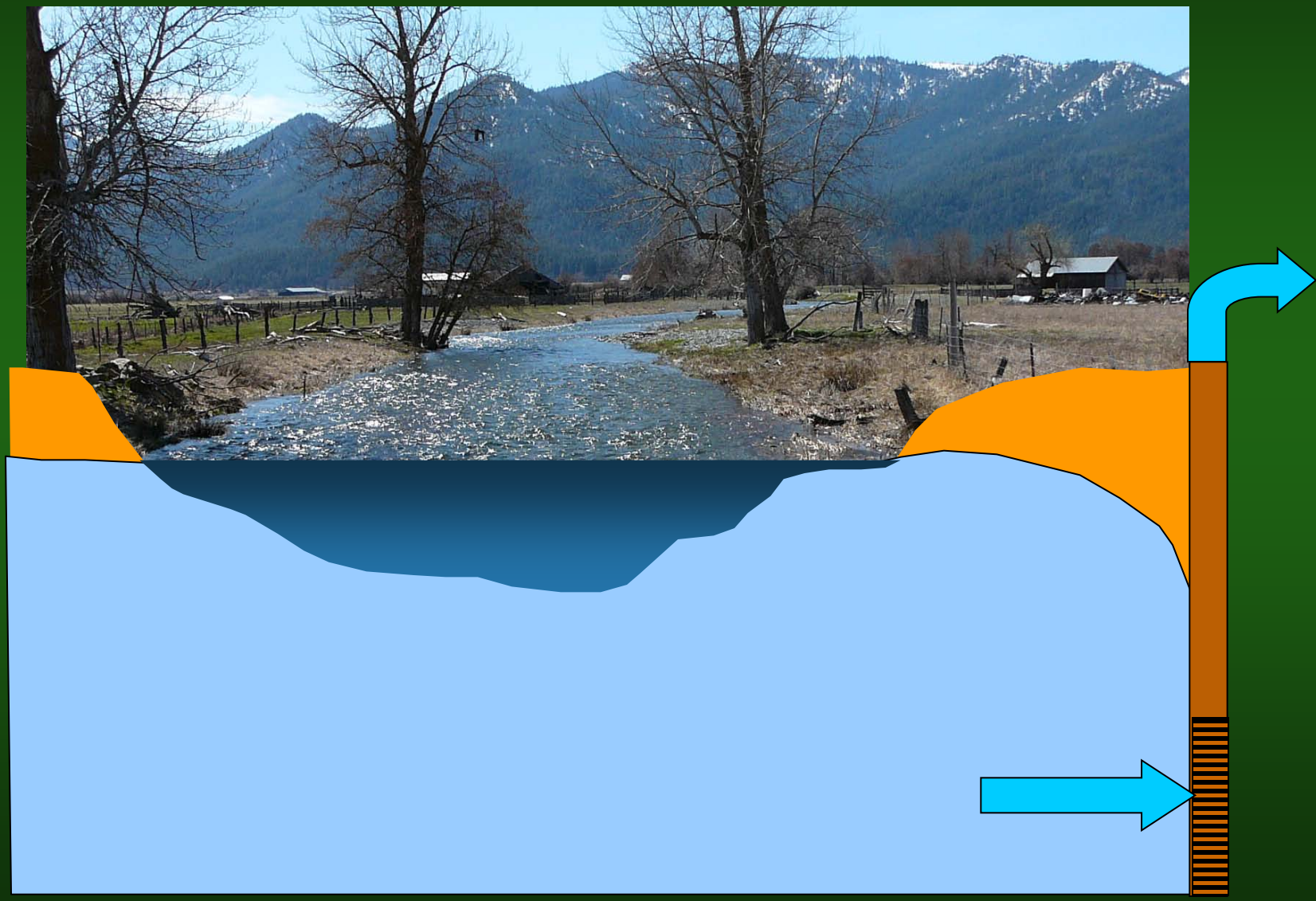


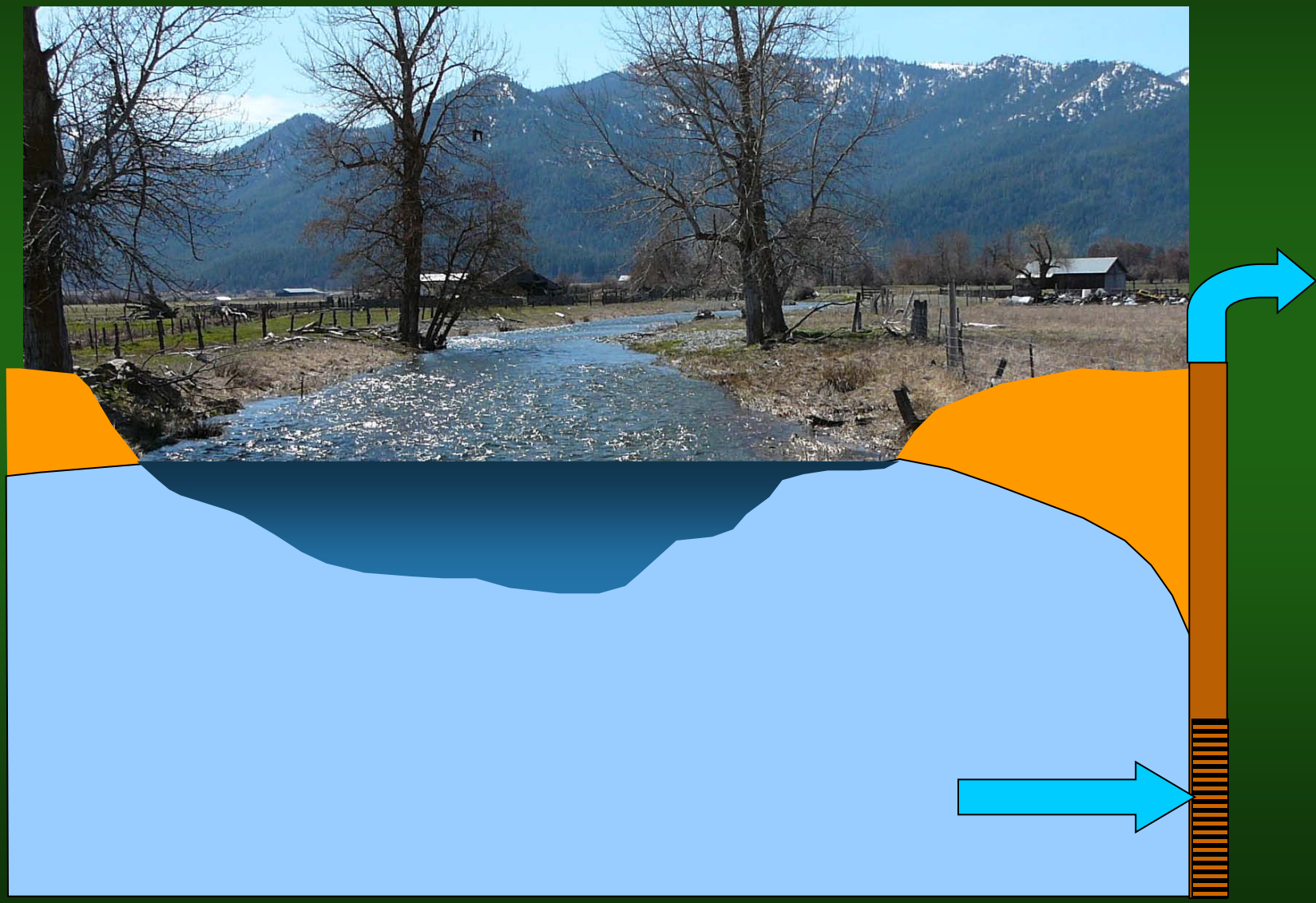
Well Near a Stream



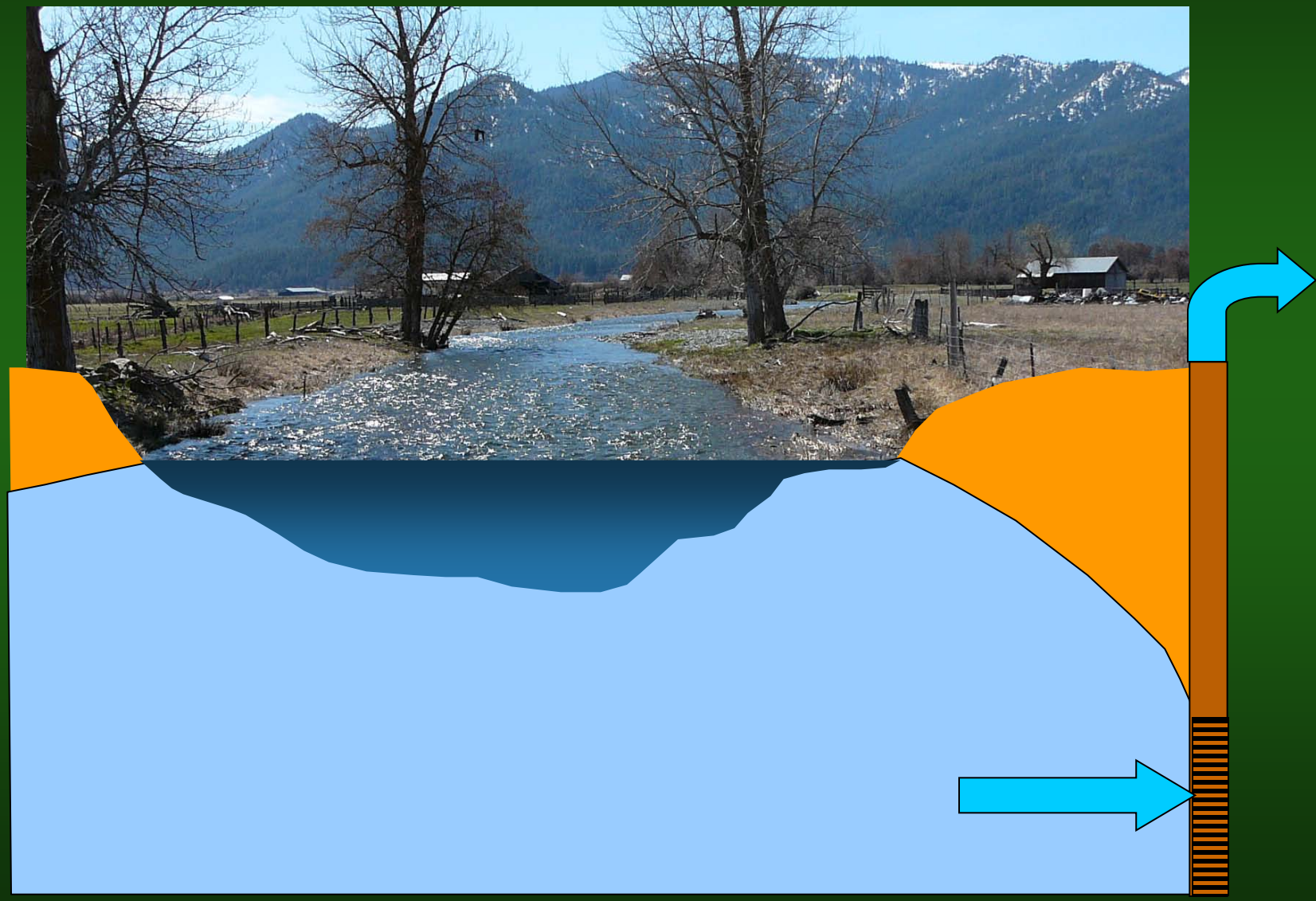
Well Near a Stream



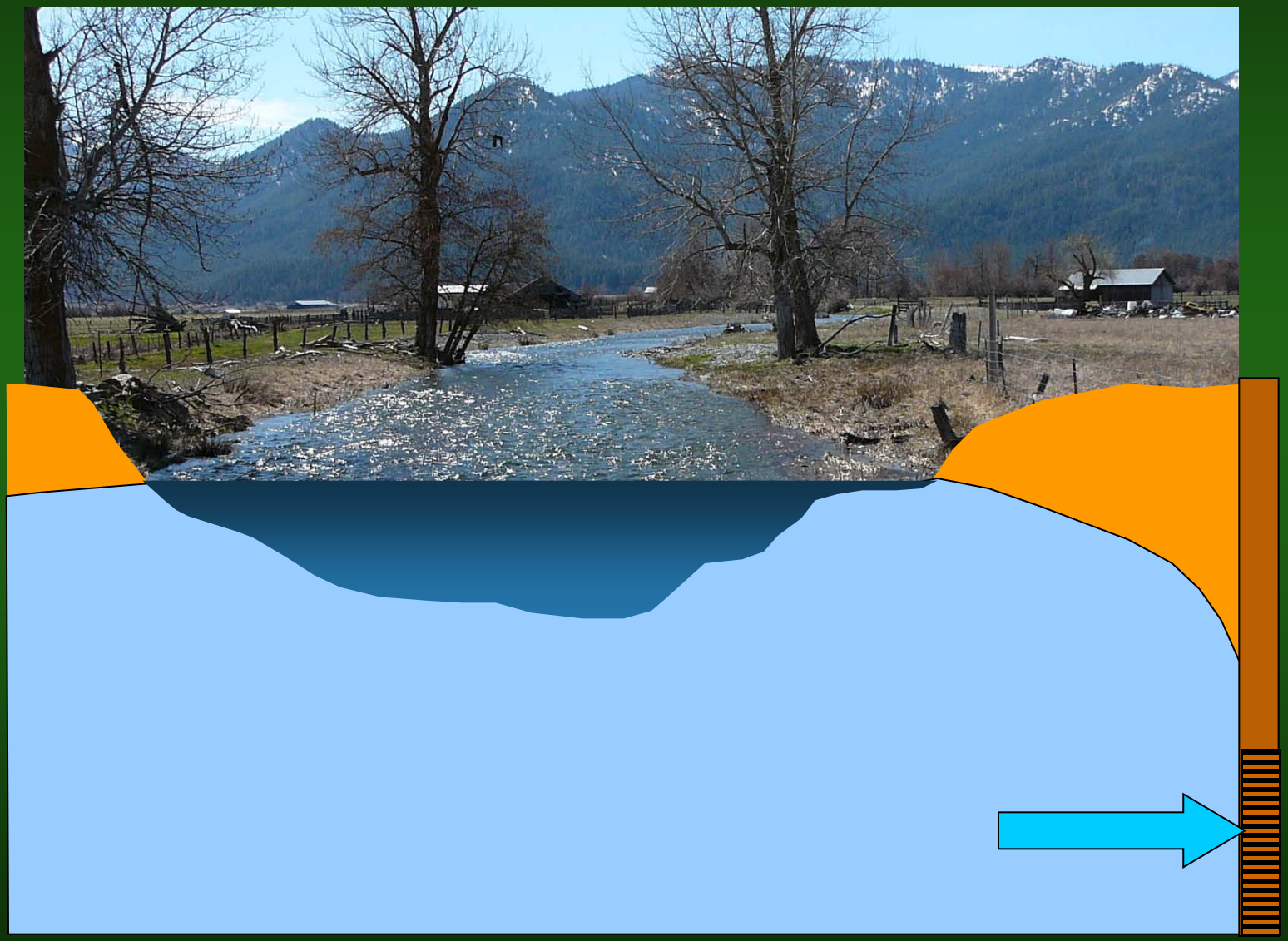
Well Near a Stream



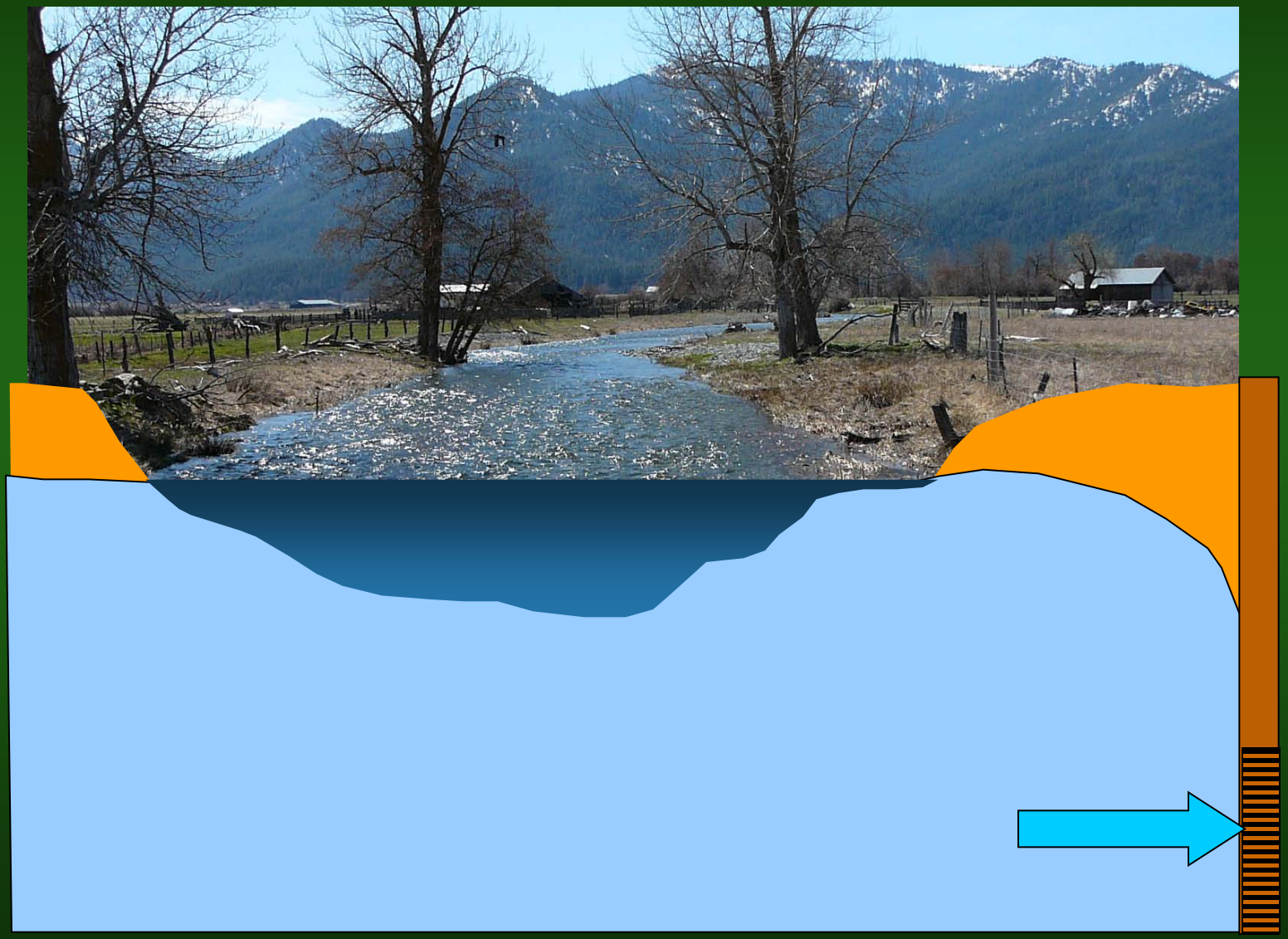
Well Near a Stream



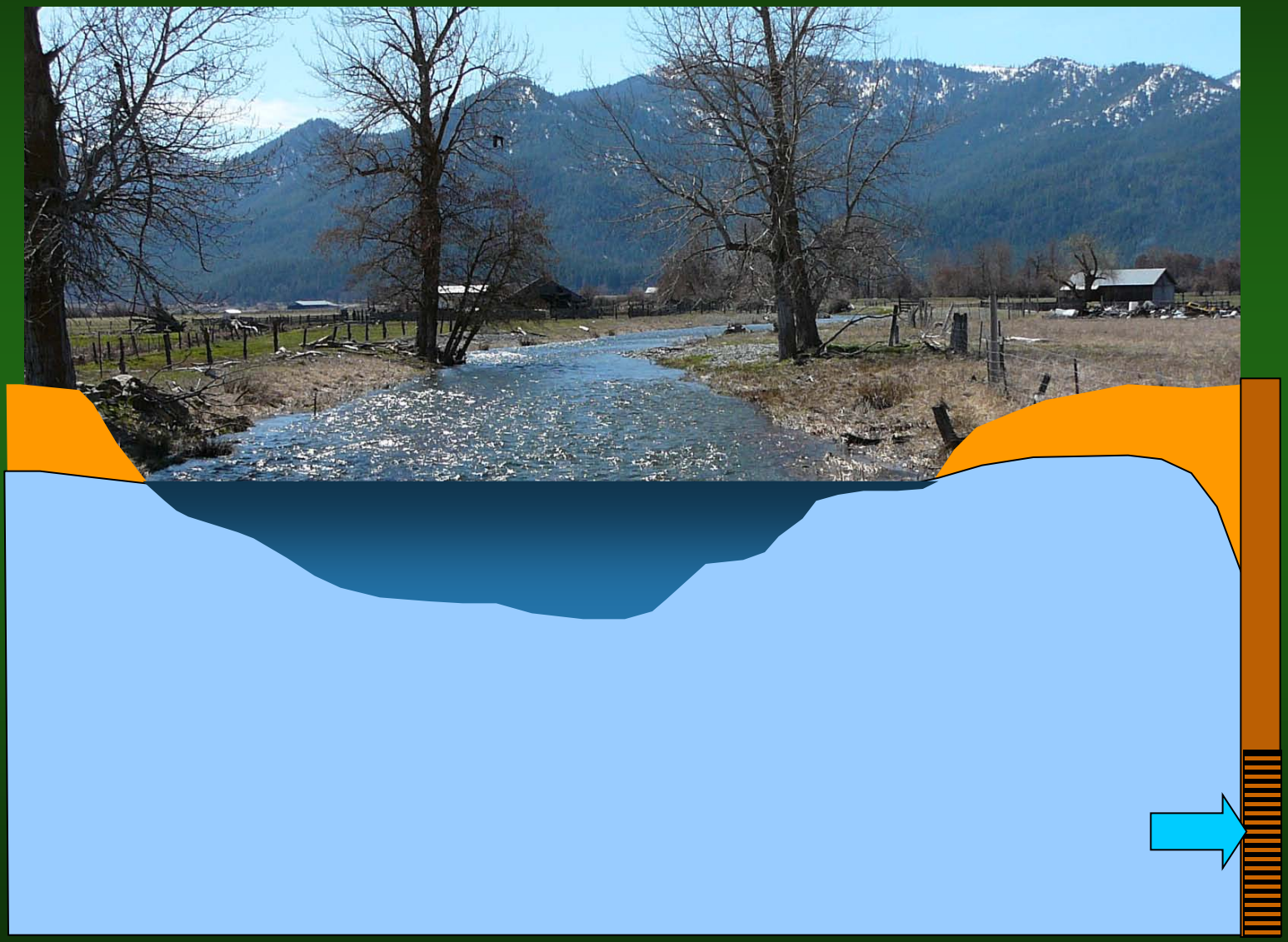
Well Near a Stream



Well Near a Stream



Well Near a Stream

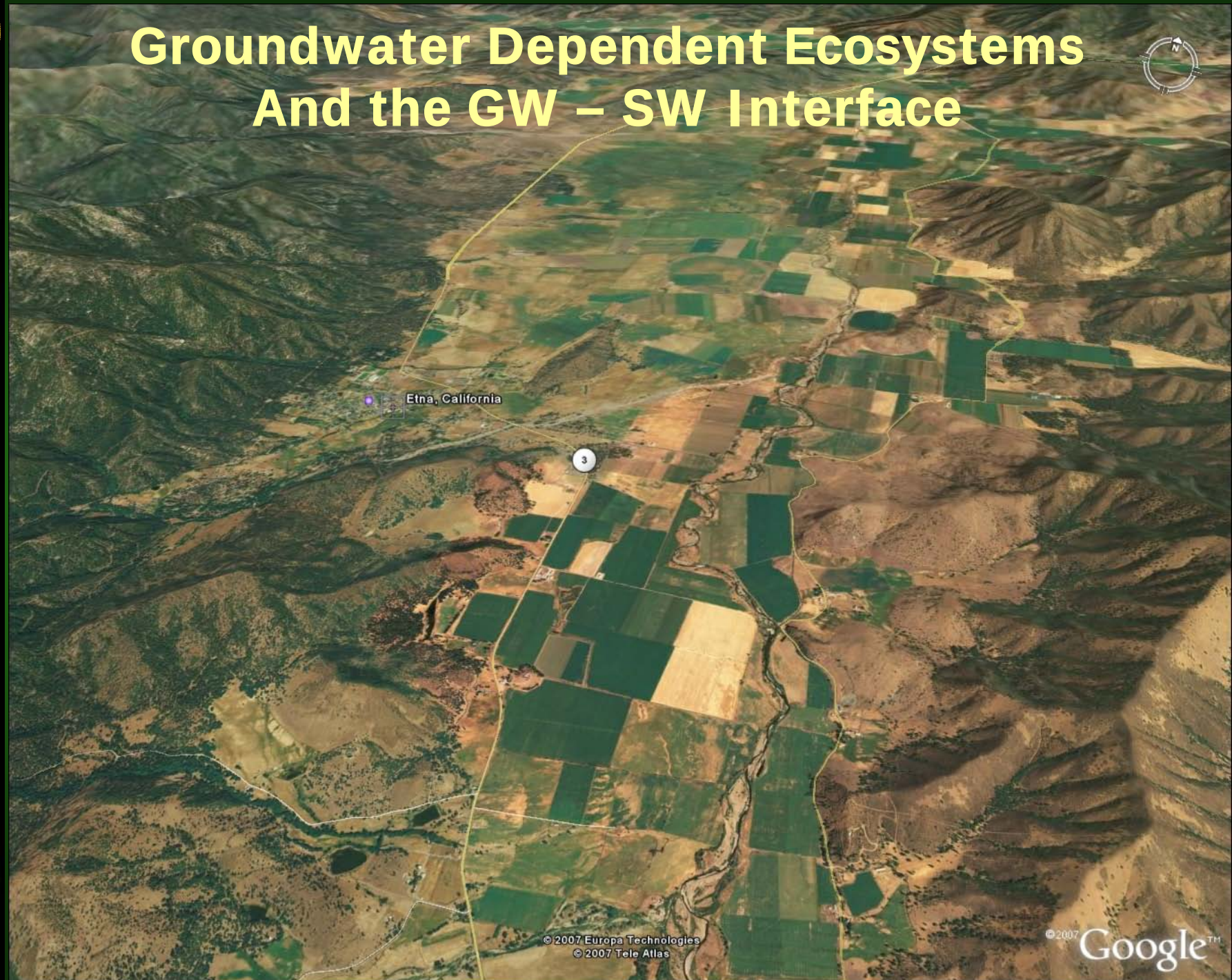


Well Near a Stream

Well Near a Stream

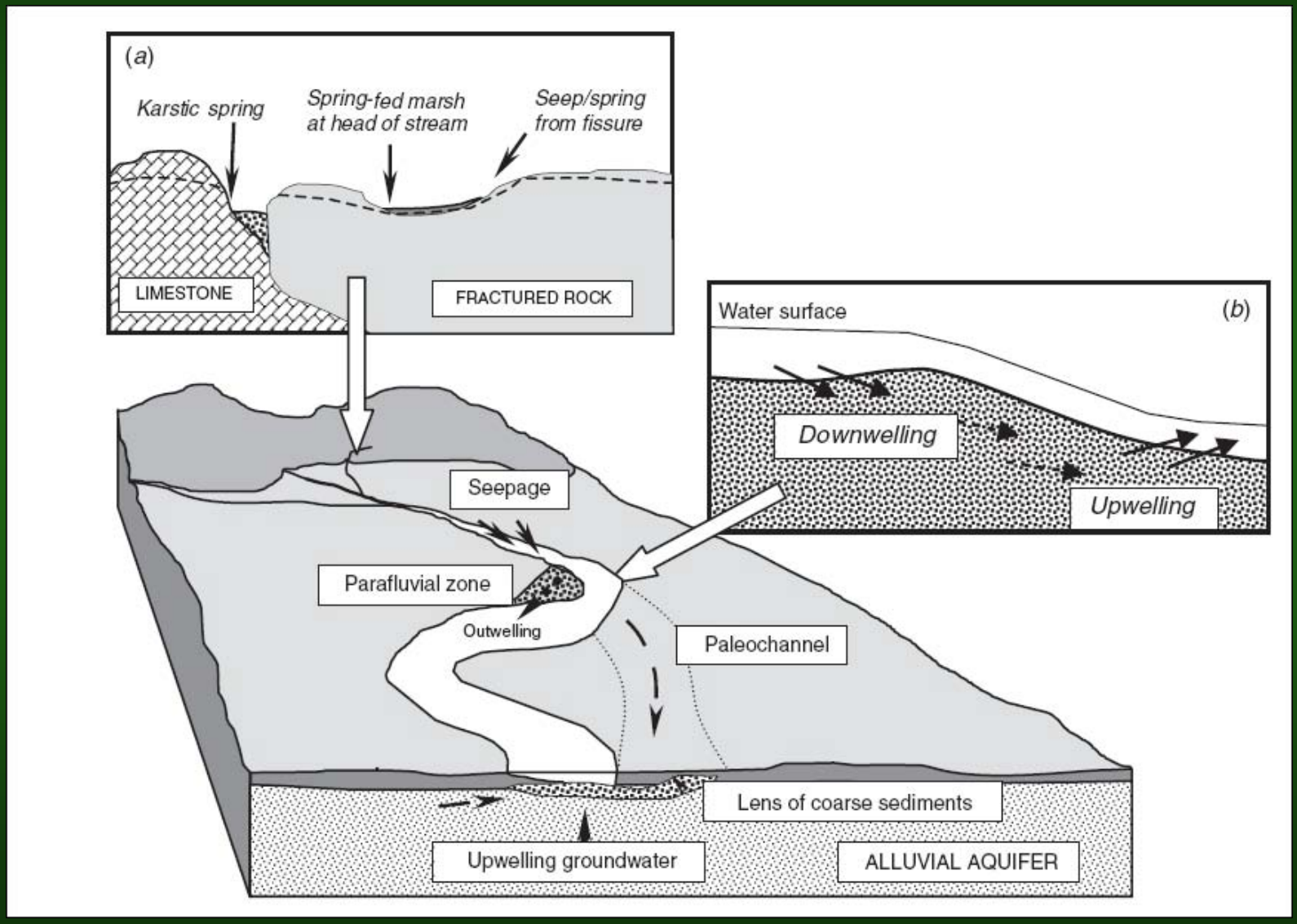
Well Near a Stream

Groundwater Dependent Ecosystems And the GW – SW Interface



Conjunctive Use

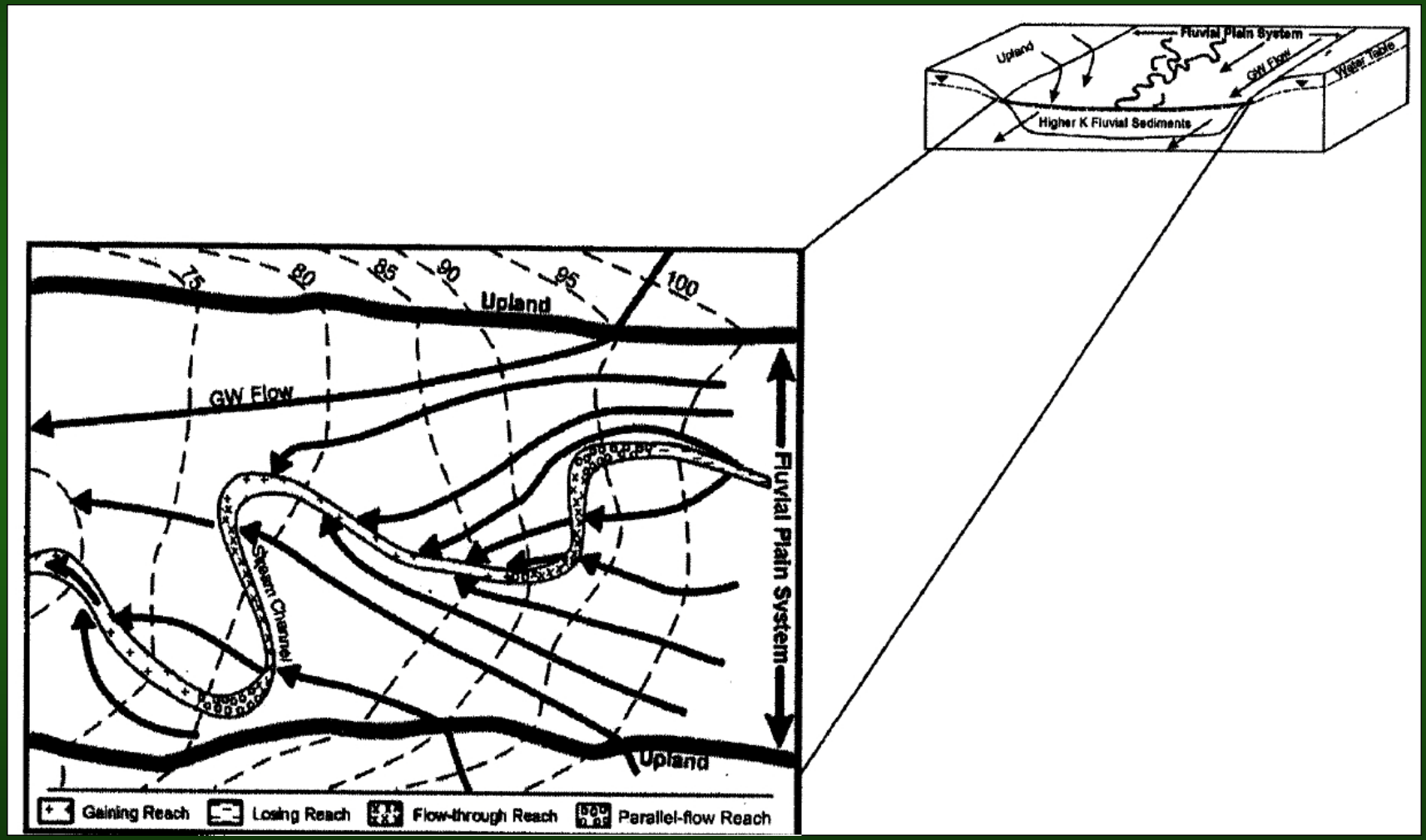
Meandering Streams & Paleochannels



Boulton and Hancock, Austral J Botany, 2006

The Hyporheic Zone

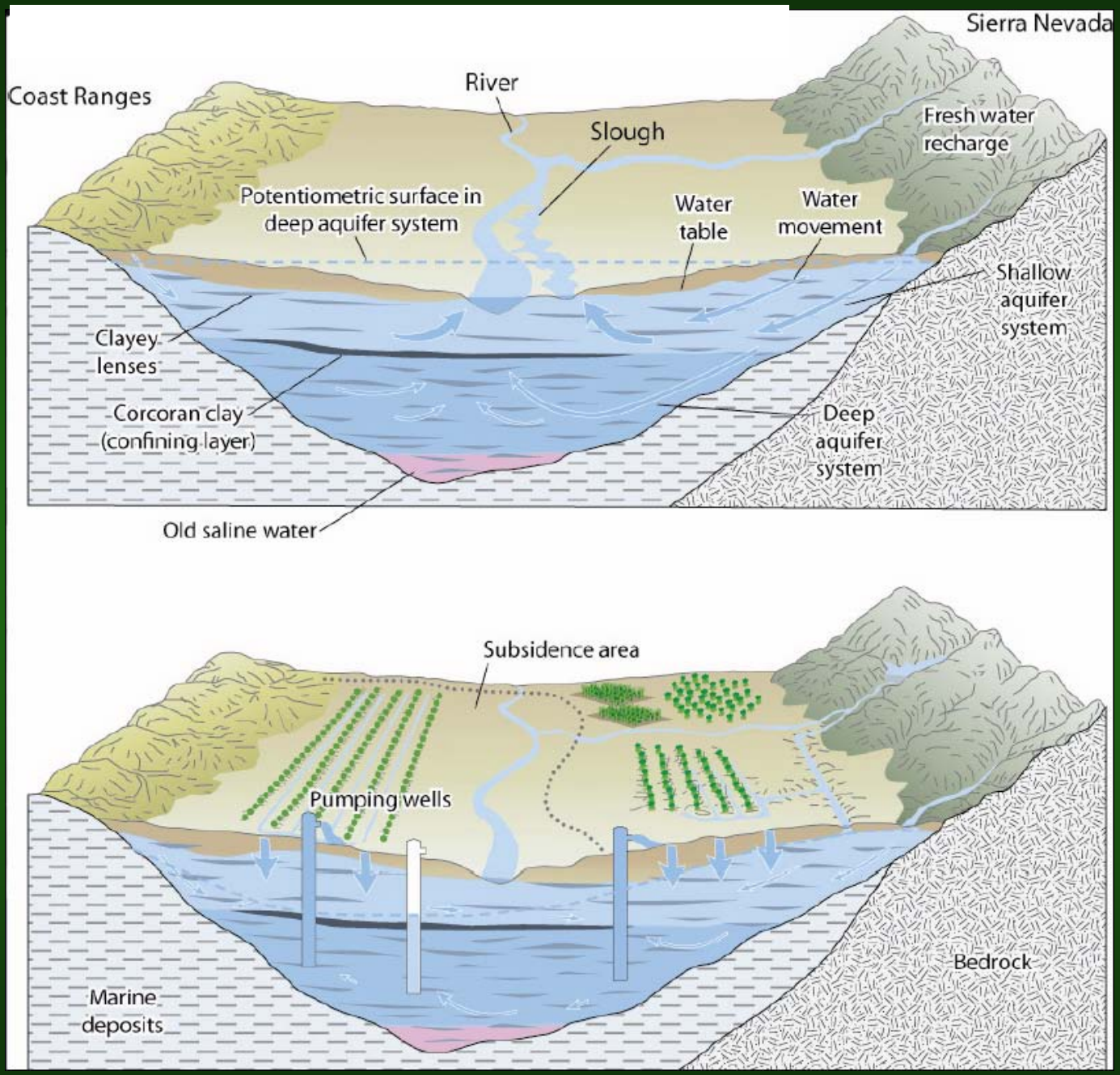
Losing – Gaining – Flow Through



Woessner, Ground Water 2000

Where does groundwater come from and where does it eventually go?

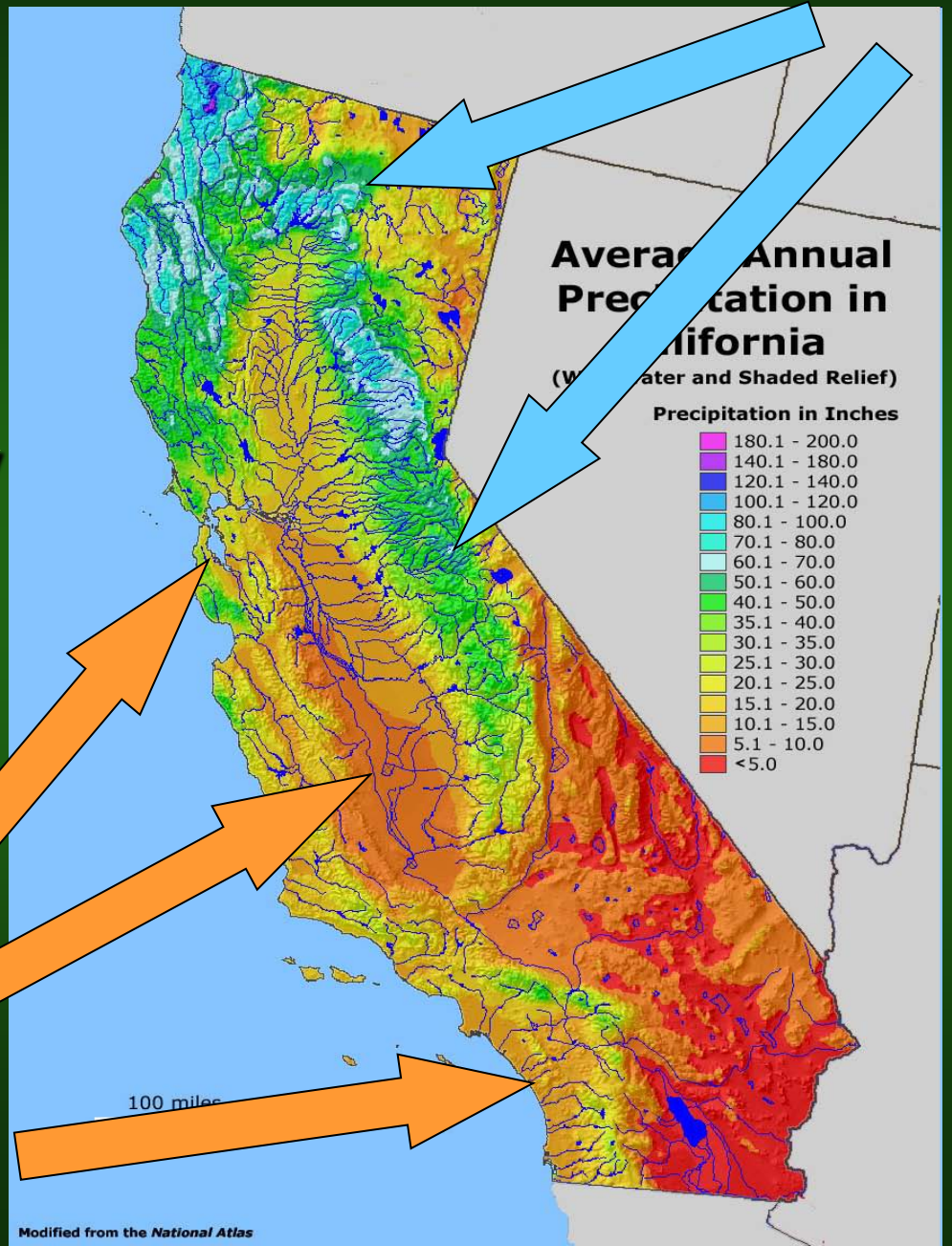
- The Hydrologic Cycle -



Courtesy, Claudia Fawn, USGS, 2008

RAIN

Space and Time Disconnect between Water Supply and Water Use



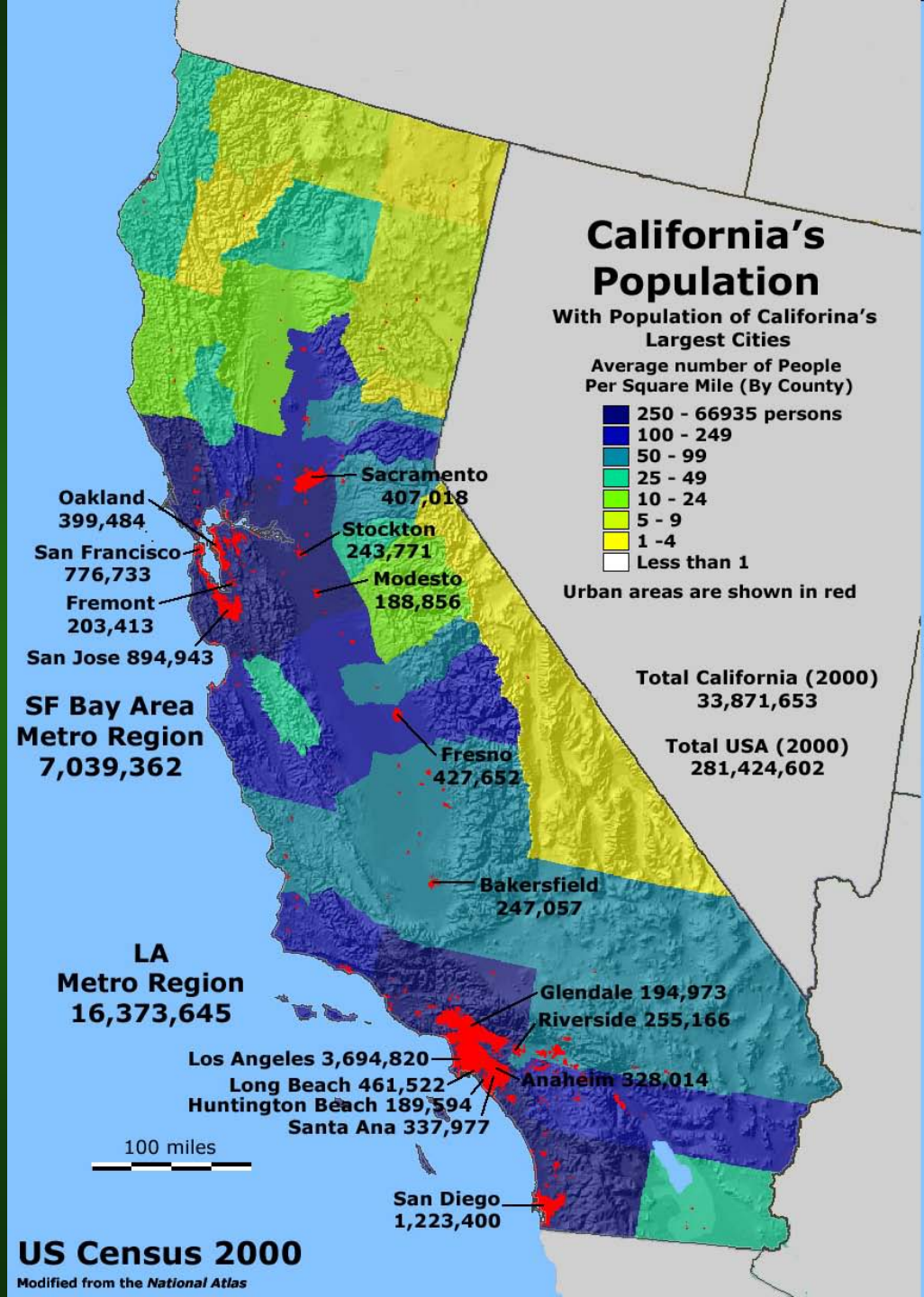
WATER USERS

California's Urban Water Users

Population (Year 2000): 34 million

Water Use: 8 - 9 MAF

MAF = million acre-feet



California's Agricultural Water Users

Irrigated Acreage (Year 2000): 9.5 million acres

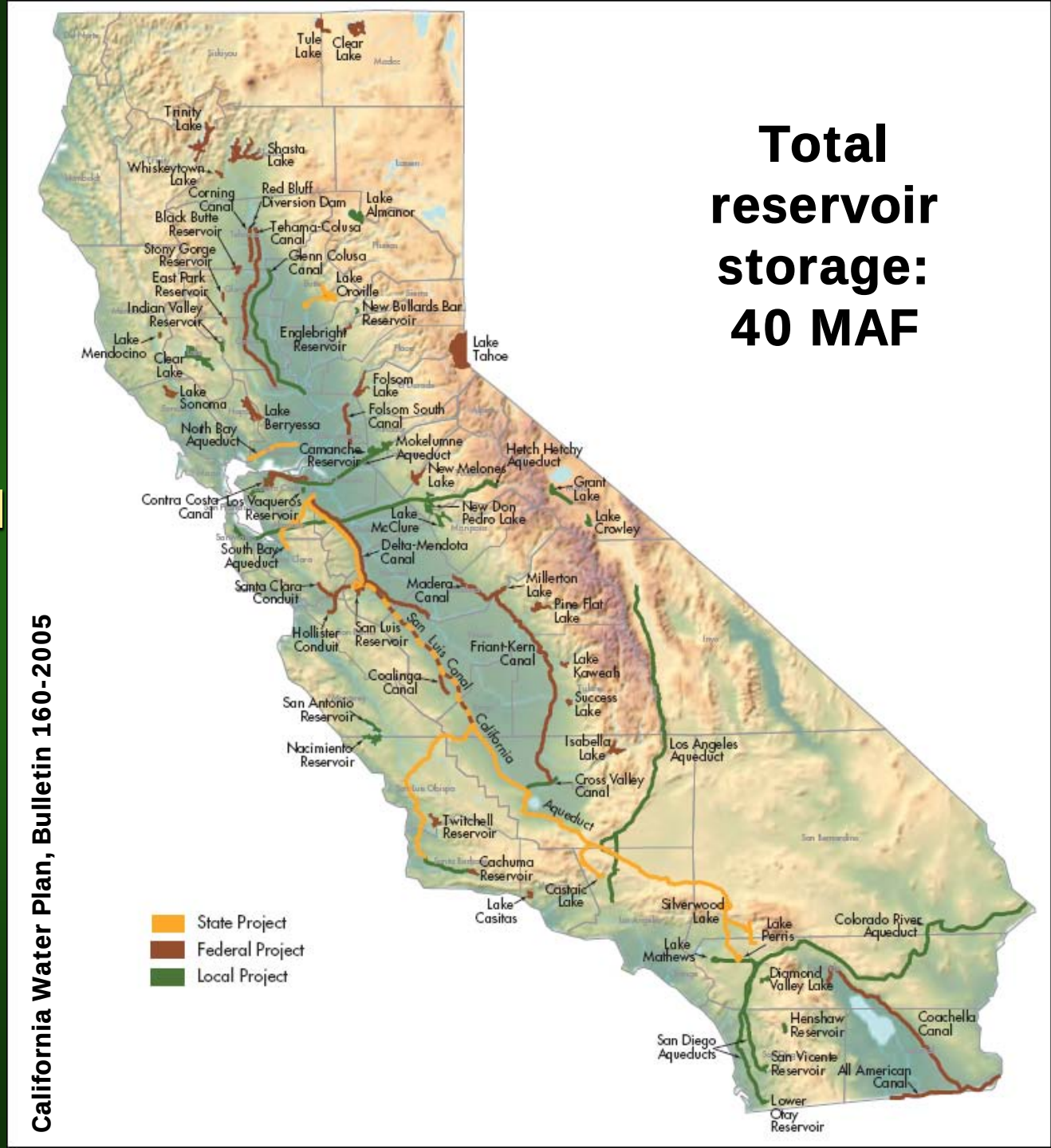
Water Use: 27 – 35 MAF

MAF = million acre-feet

California Water Infra-structure

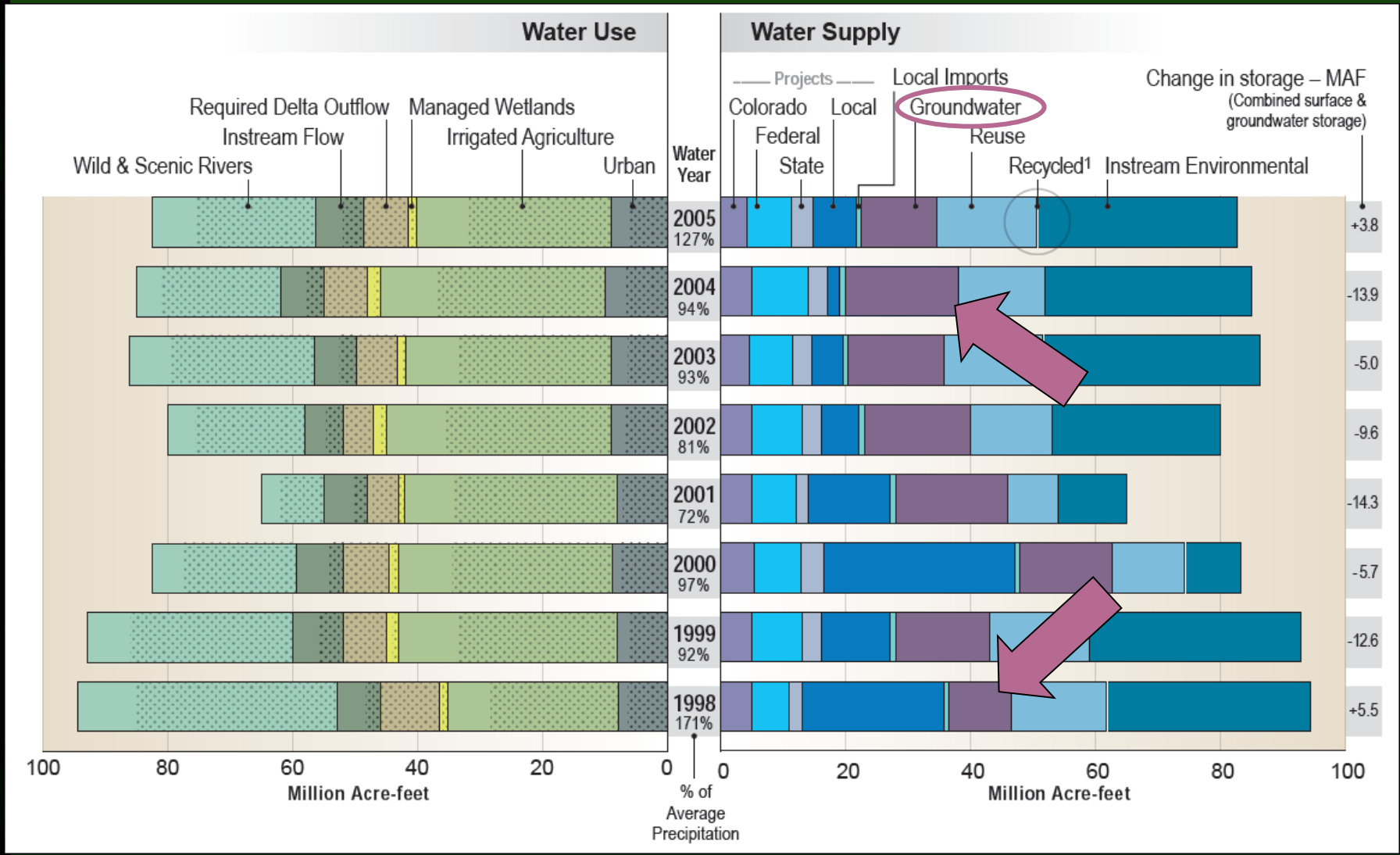
Bridging the Spatial and Temporal Disconnect between SUPPLY and USE

Total reservoir storage: 40 MAF



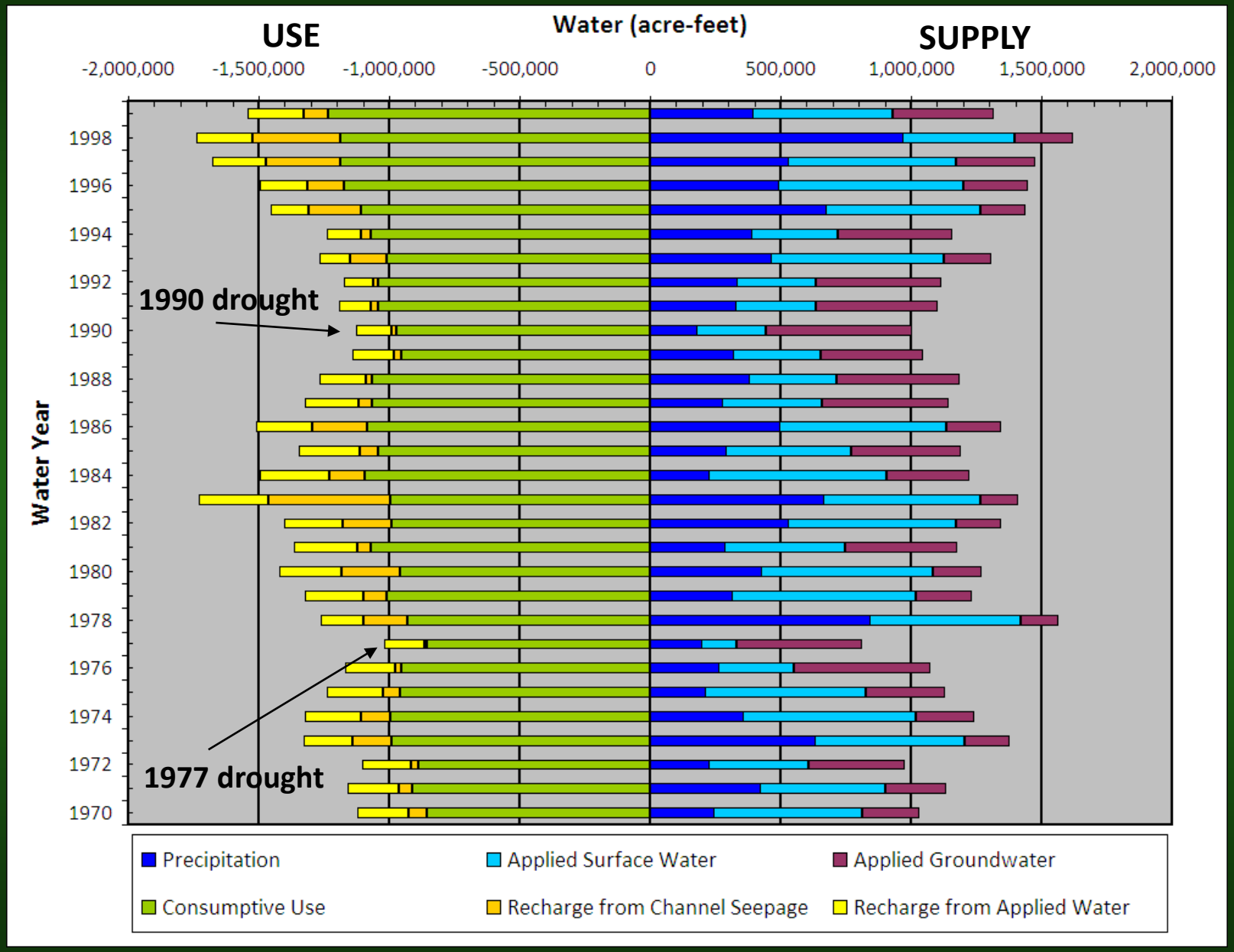
California Water Plan, Bulletin 160-2005

Groundwater Use in California: The Invisible Storage Reservoir



From: DWR California Water Plan 2009 (Bulletin 160-2009)

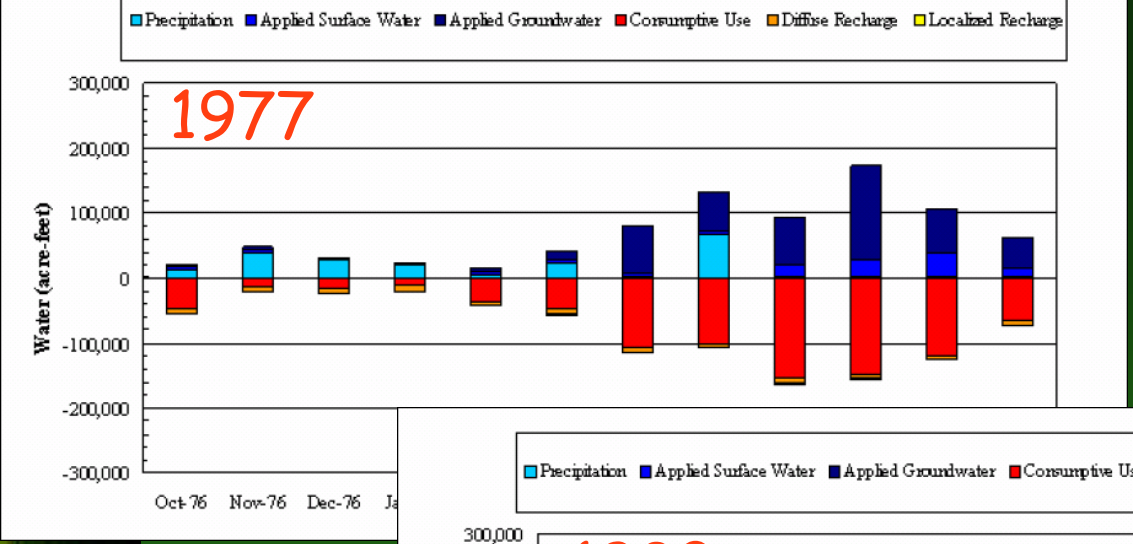
Southern Tulare County Water Budget

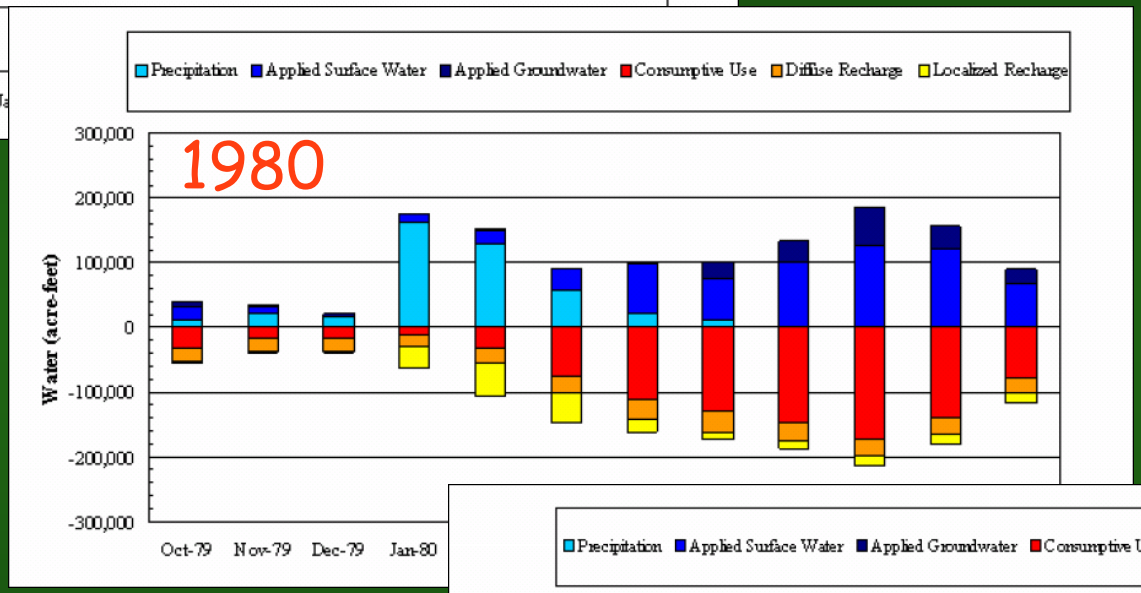


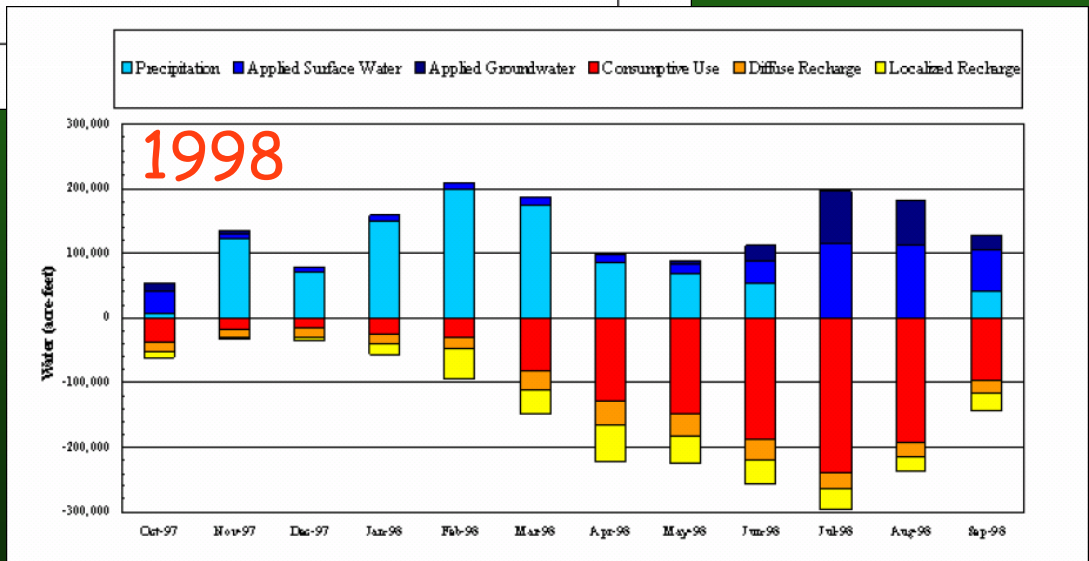
Ruud, Harter et al., 2003, 2004

Tule River Basin: Monthly Water Budgets, Oct-Sep

Ruud, Harter et al., 2003, 2004



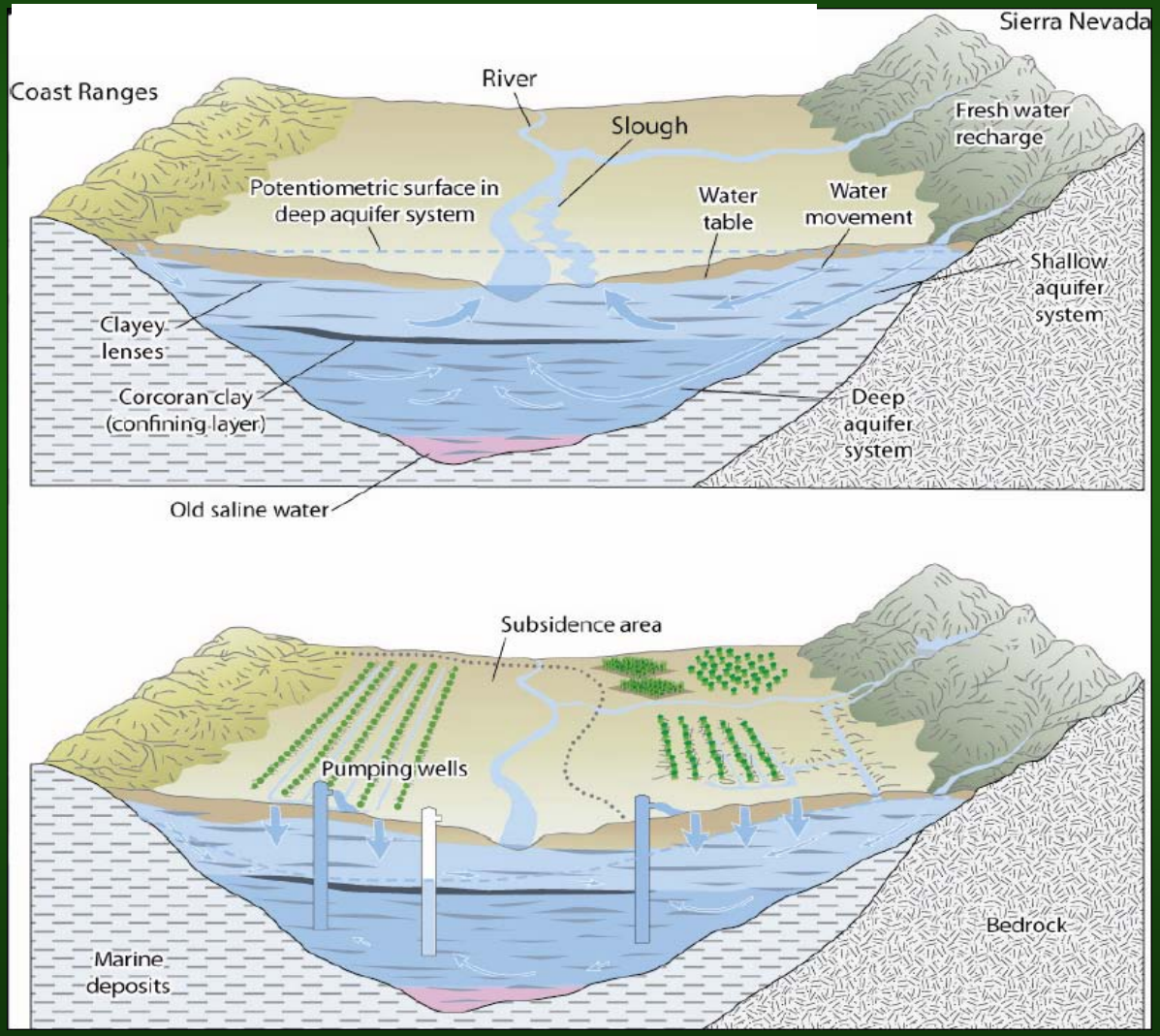




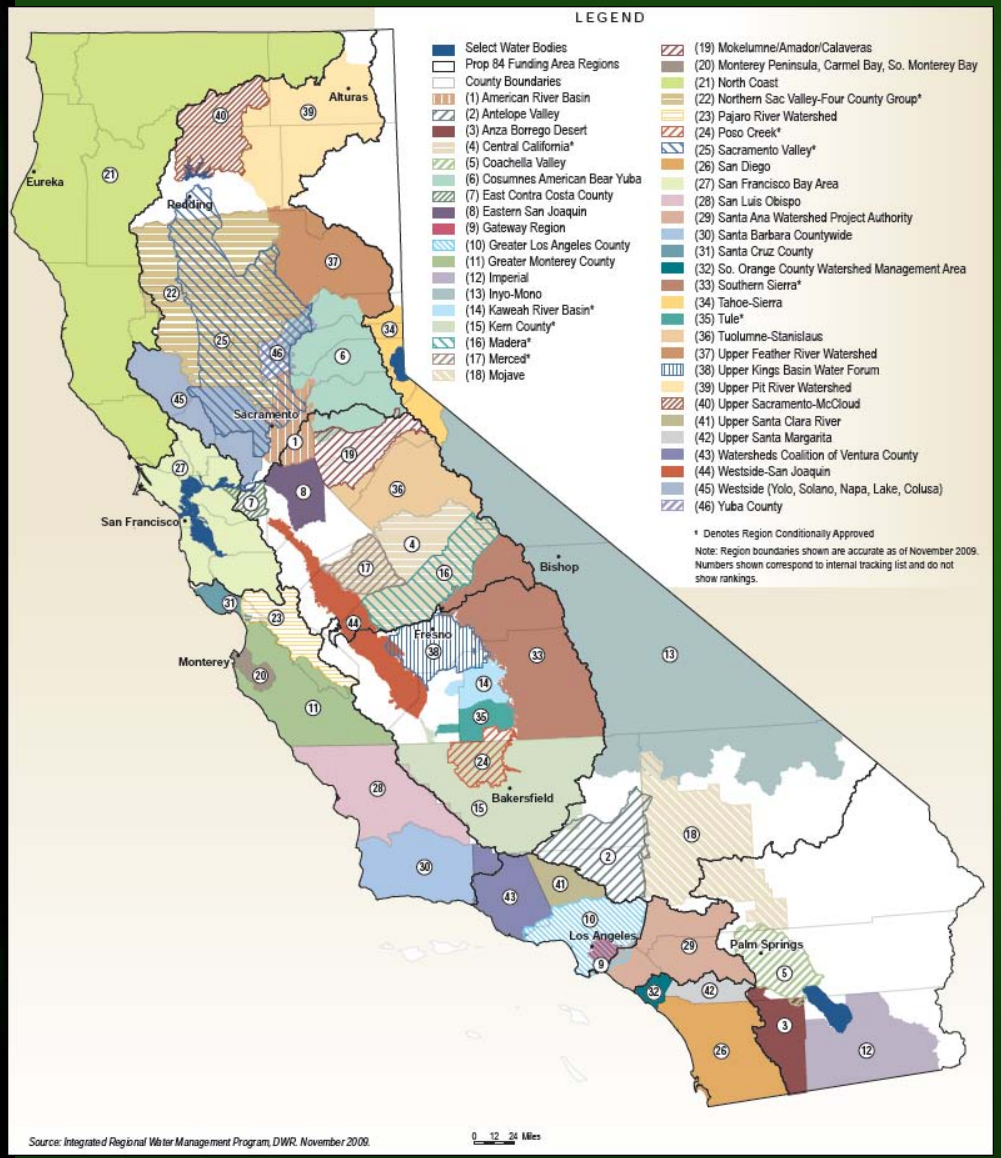
Irrigation Efficiency

Irrigation Efficiency

Groundwater Management and Groundwater Quality



Integrated Regional Water Management Planning



⇒ toward Integrated Resource Management Planning

- Groundwater
- Surface Water
- Air
- Soil quality
- Energy / Carbon
- Landuse planning

(*Courtesy:* Sarge Green, CSU Fresno)

Questions?


THE
END