

Lecture 14b – Groundwater quality

Learning Outcomes

- Be able to explain/describe how humans are causing problems with groundwater:
 - Drawdown of the water table
 - Be able to draw/describe and carry out simple calculations related to cones of depression
 - Be able to explain the consequences of drawdown
 - Compaction and subsidence
 - Contamination of groundwater
 - Be able to describe sources of contamination and challenges of prevention/clean up
 - Be able to describe/explain how groundwater overuse can cause saltwater intrusion near the coast and pollutant plume capture
- Be aware of the laws/regulation around groundwater

Groundwater Problems

- Groundwater is an important natural resource
 - It accounts for 95% of all the liquid freshwater on Earth
 - It supplies a substantial portion of drinking-water needs
 - Groundwater is threatened by...
 - Mismanagement
 - Overuse
 - Pollution



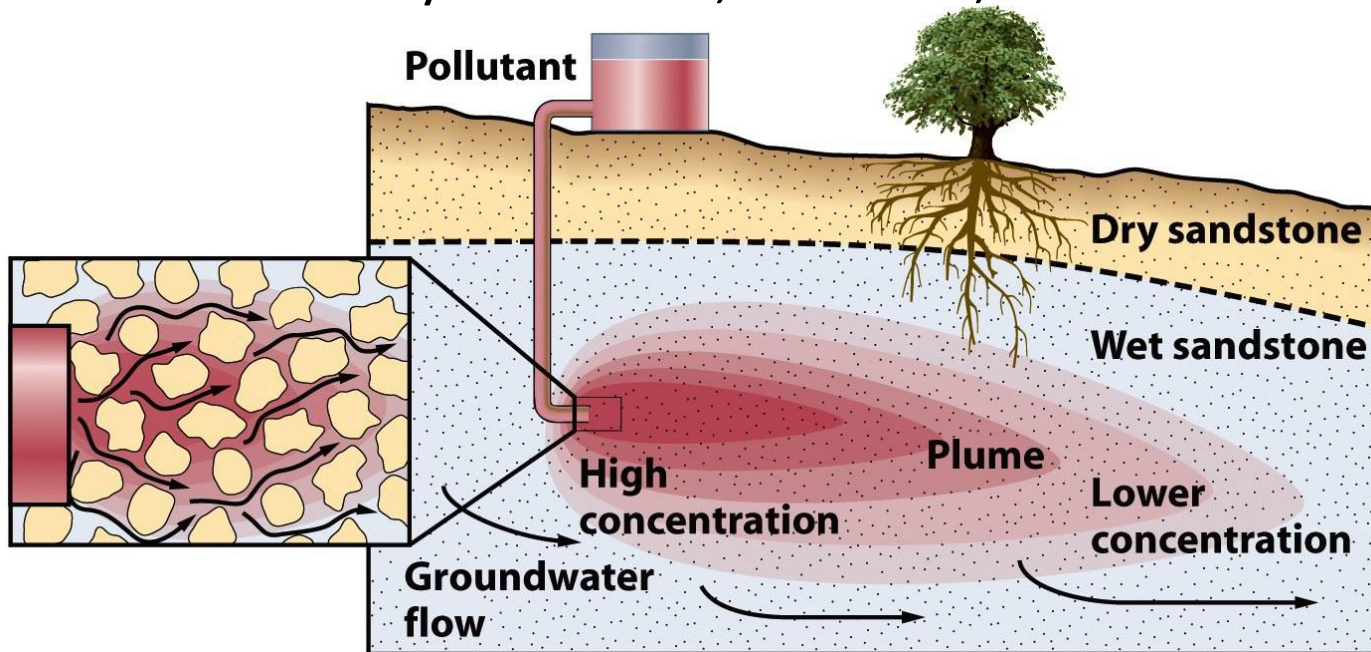
Groundwater Quality

- Groundwater is often of high-quality
 - Filtering effect removes particulates
 - Clay minerals can adsorb certain dissolved ions
- Natural groundwater may contain unwanted substances
 - Hardness
 - Dissolved iron, manganese, and hydrogen sulfide gas
 - Dissolved arsenic



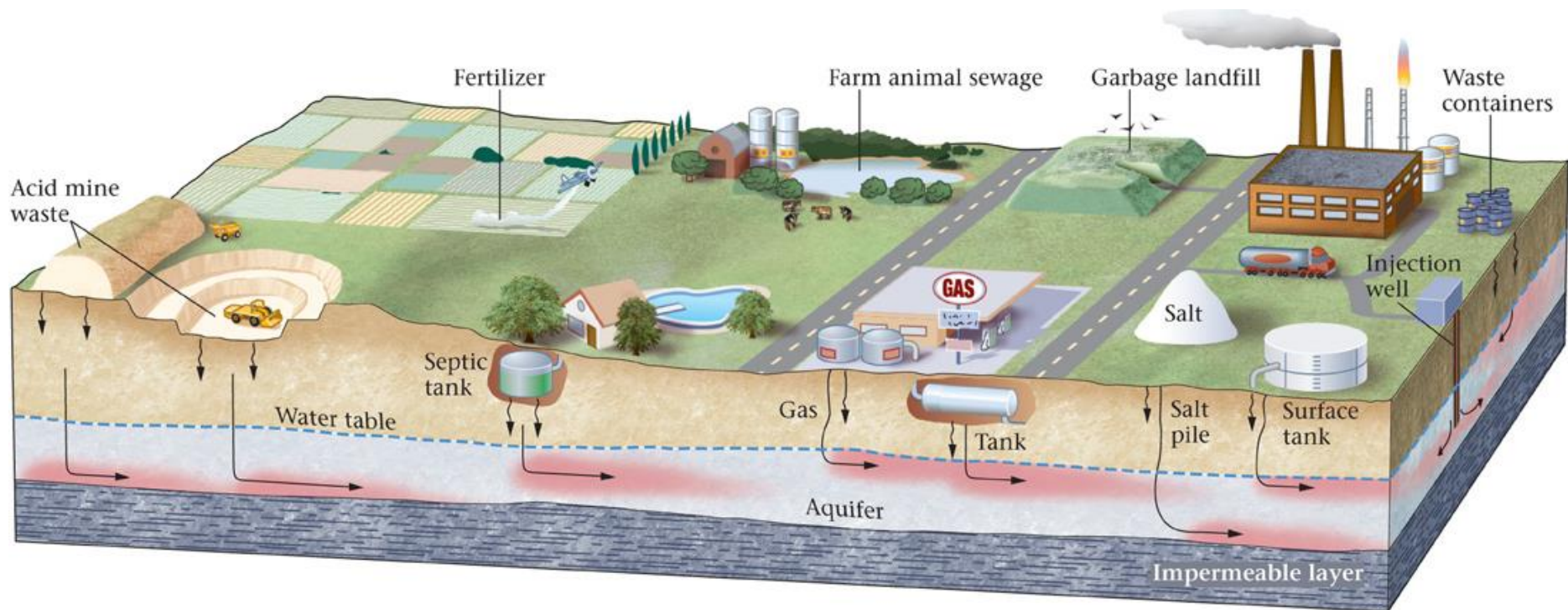
Groundwater Contamination

- Human activities add pollutants to groundwater flow
 - Dissolved and pure organic and inorganic compounds
 - Dissolved metals
 - Pathogenic microbes
- Groundwater transports pollutants away from a source – controlled by advection, diffusion, and reactions



Groundwater Contamination

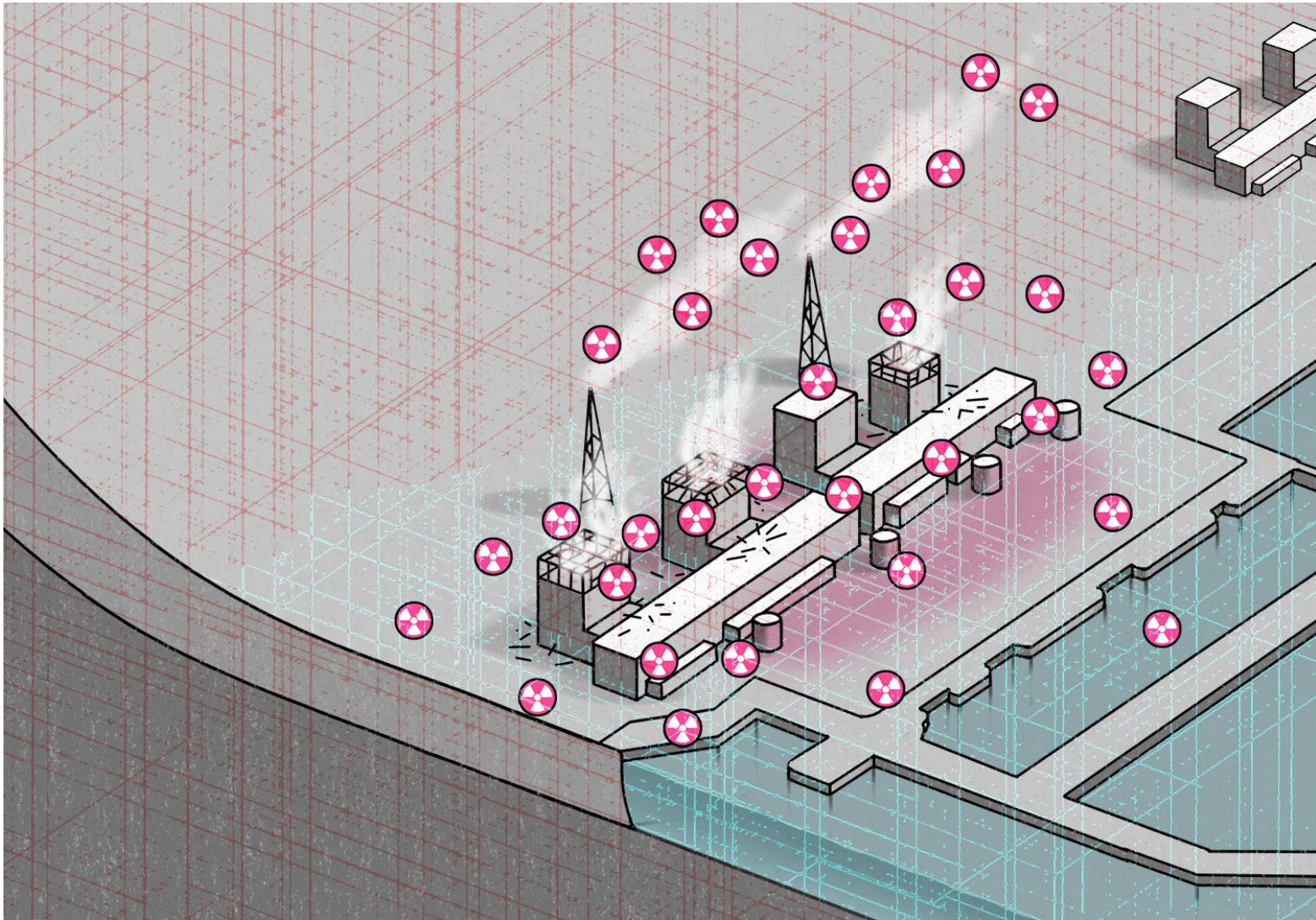
- Point vs non-point sources of groundwater contamination
- Pollution is often not recognized until damage occurs
- Groundwater cleanup is slow, expensive, and limited



Groundwater Contamination

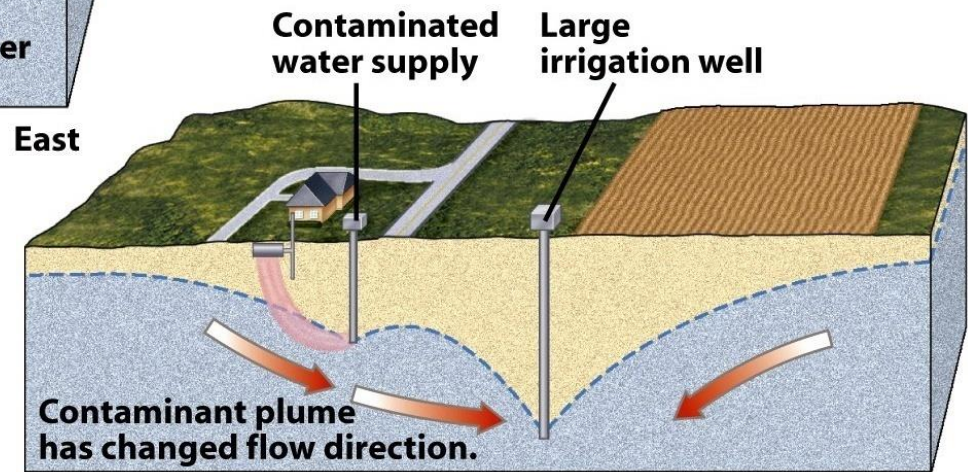
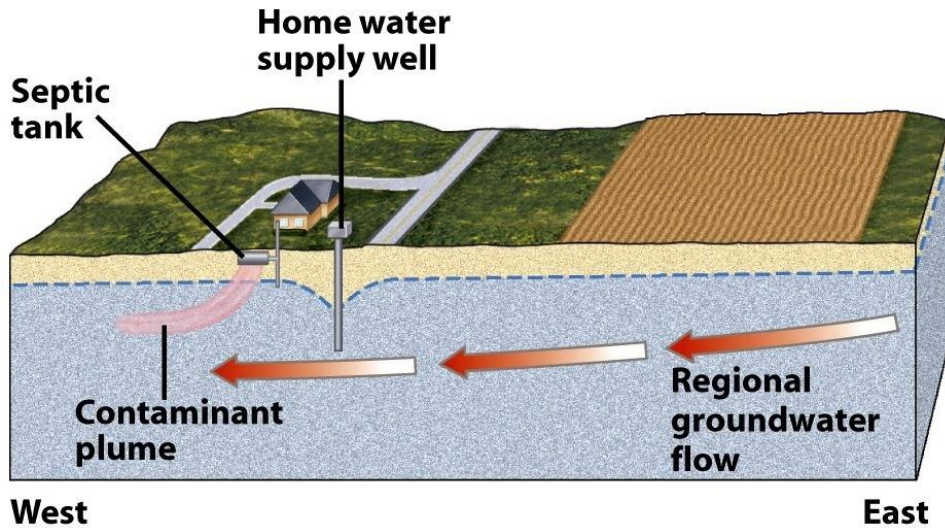
- Prevention:
 - Careful regulation and periodic checks of possible contamination sources, including decisions about locating these sources
 - Clean up of soils in contaminated areas e.g. by removal of soil itself, or thermal treatment to remove organic compounds etc
 - Treatment of wastewater before it enters groundwater
- Clean up/remediation
 - Containment by a physical barrier to spread
 - Removal of groundwater for cleaning or to prevent contamination
 - Treatment through either chemical means or bioremediation

Case study: Fukushima, Japan



<http://apps.washingtonpost.com/g/page/world/preventing-radioactive-leaks-at-fukushima-daiichi/511/>

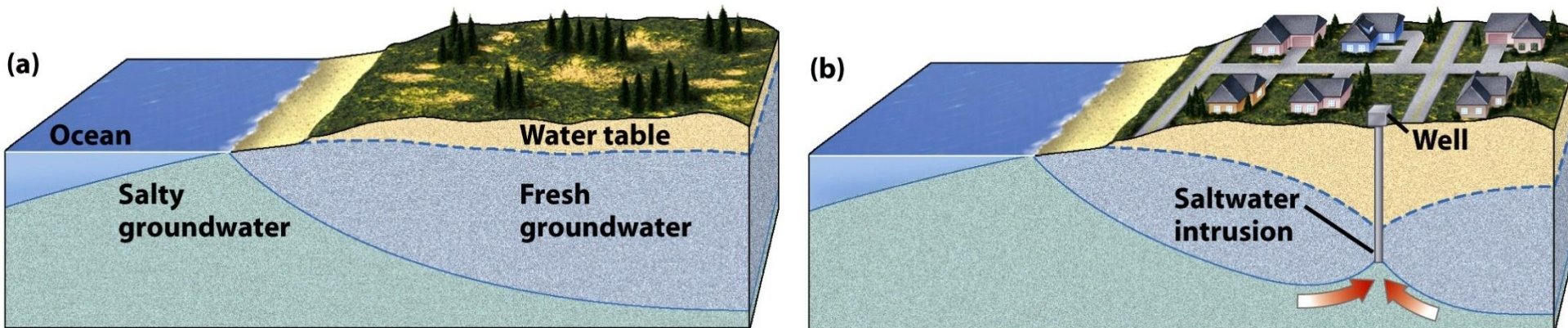
Groundwater Depletion: Pollutant capture



Groundwater Depletion: Seawater intrusion

$$z_{s(x)} = 40 h_{f(x)}$$

Where $z_{s(x)}$ = depth of interface below sea level at distance x inland
 $h_{f(x)}$ = elevation of water table above sea level at distance x inland

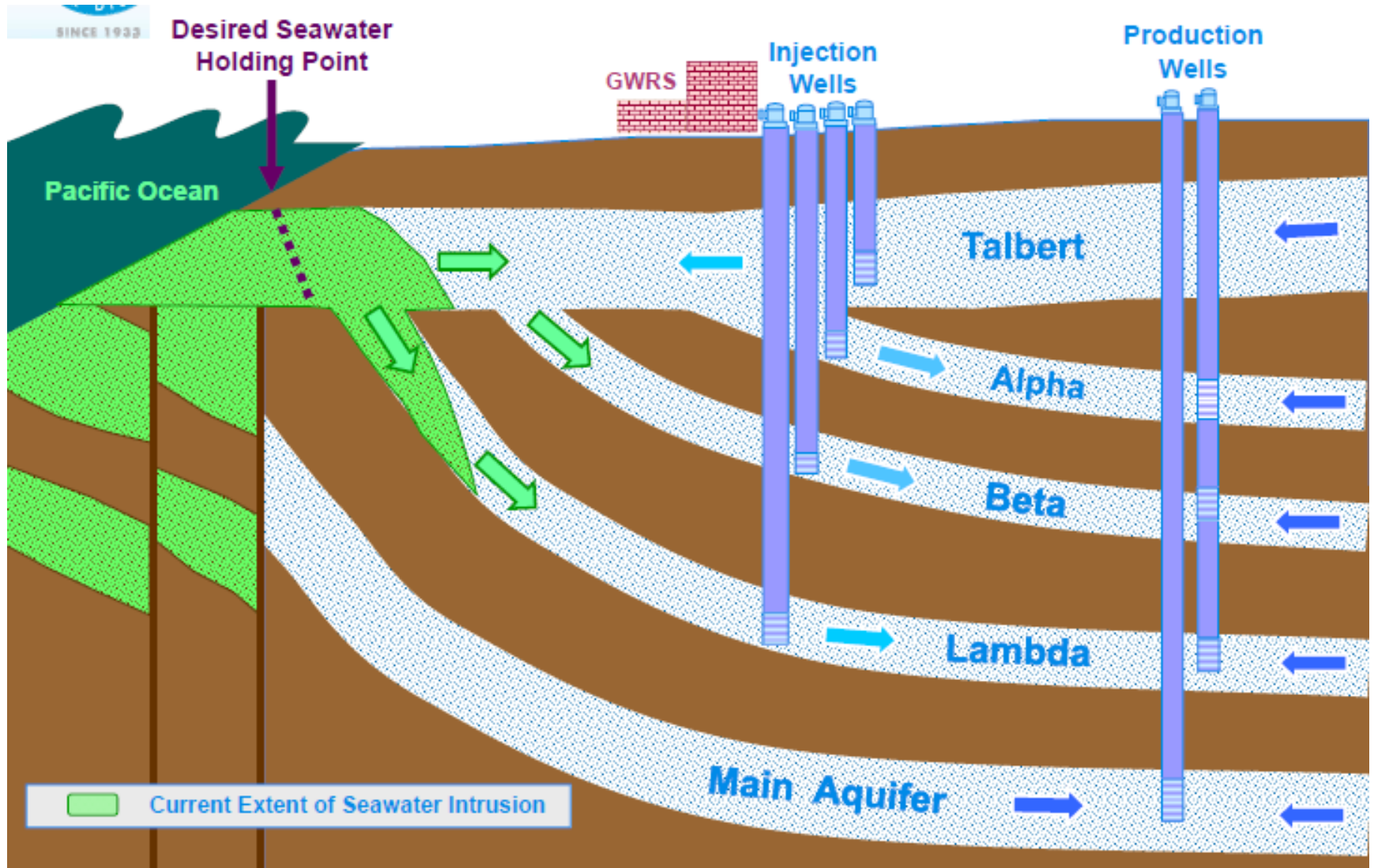


Case Study: Orange County (and California)

- Orange County Groundwater Replenishment System



Case Study: Orange County (and California)



Orange County seawater intrusion barrier

