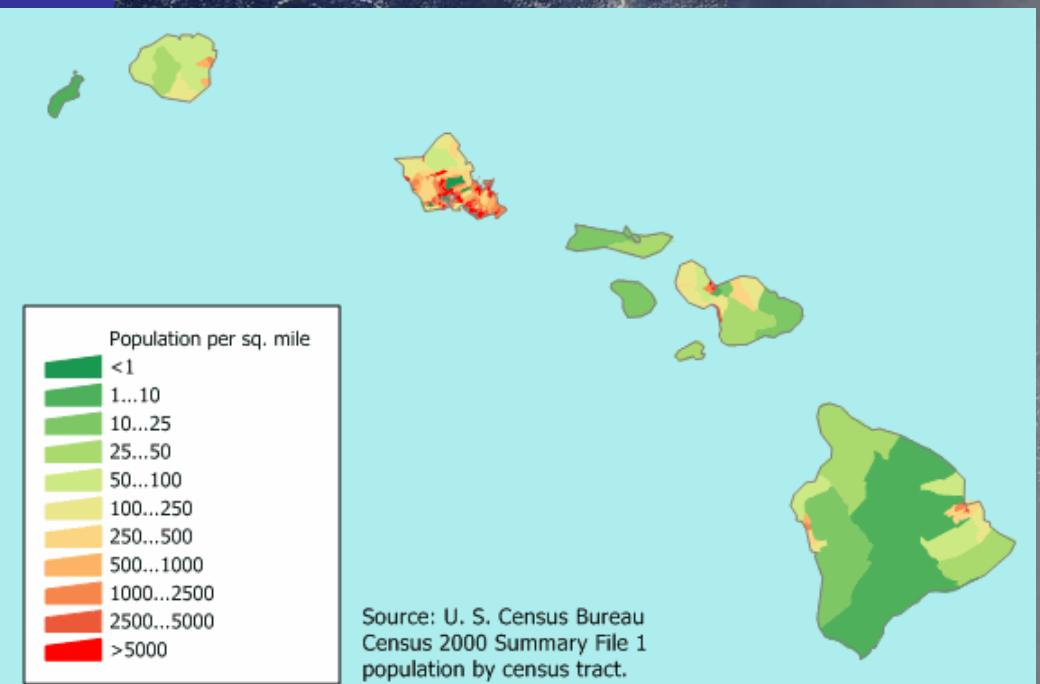
Why is Oahu Hawaii's most densely populated island?

A) Best harbor
B) Best surf
C) Best groundwater
D) Volcanically inactive
E) Most whales





What are the sources of Oahu's water?









How much water actually stays in the ground?

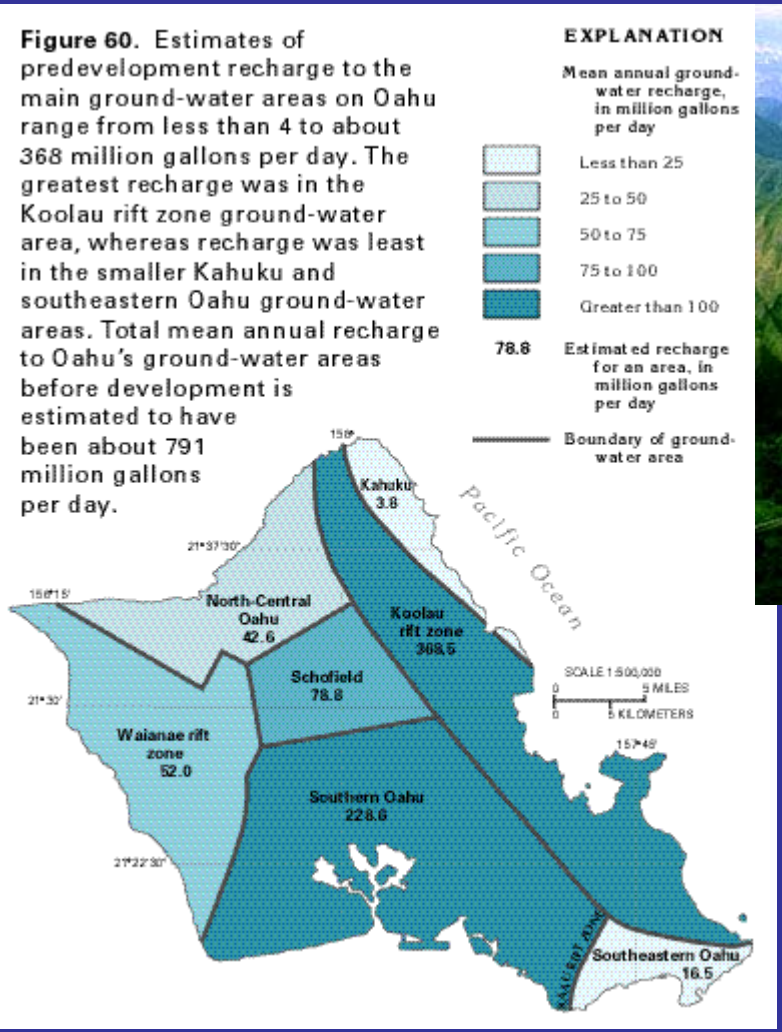




Oahu RECHARGE = 10-50% of rainfall, fog drip, irrigation

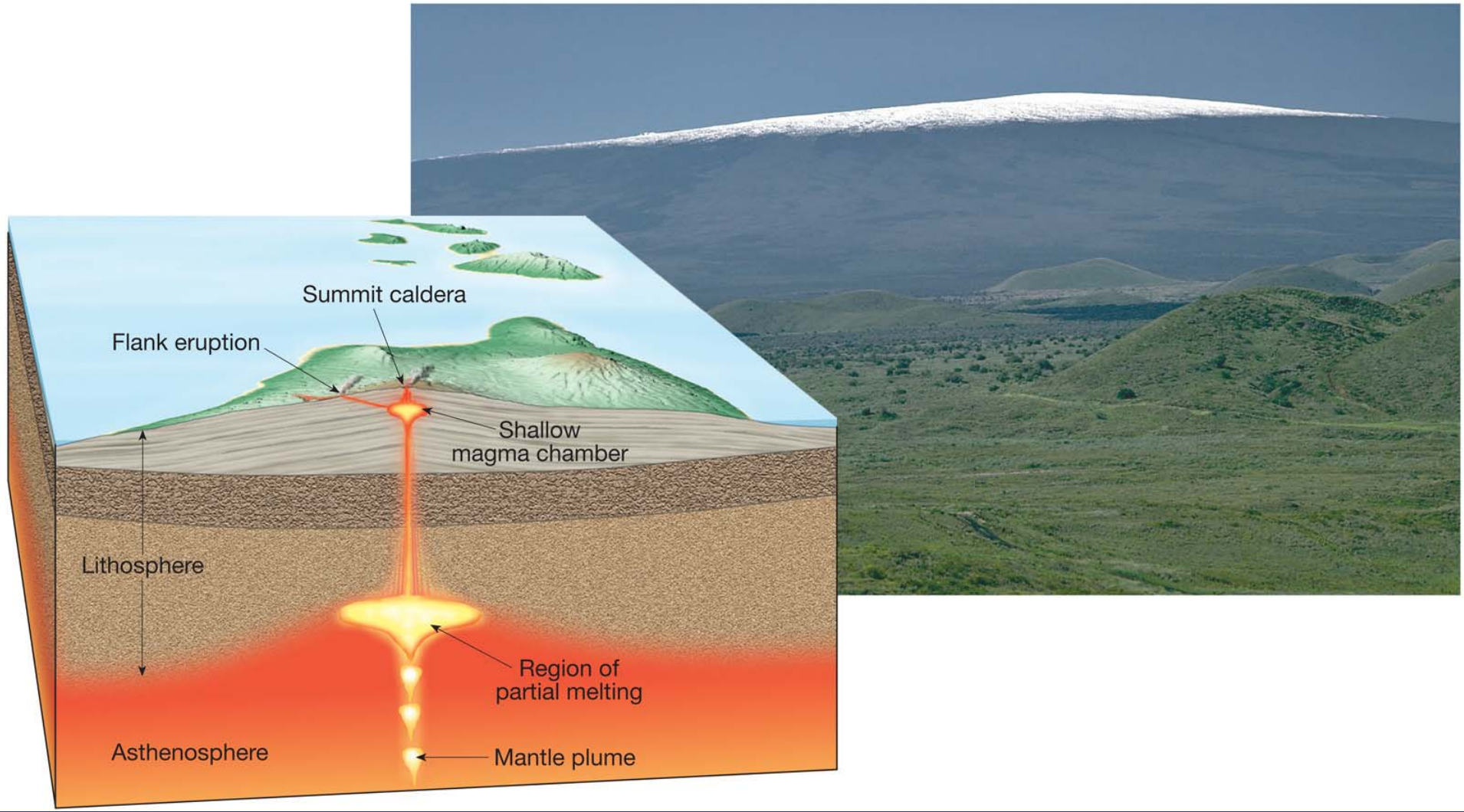
Oahu recharge by area

Figure 60. Estimates of predevelopment recharge to the main ground-water areas on Oahu range from less than 4 to about 368 million gallons per day. The greatest recharge was in the Koolau rift zone ground-water area, whereas recharge was least in the smaller Kahuku and southeastern Oahu ground-water areas. Total mean annual recharge to Oahu's ground-water areas before development is estimated to have been about 791 million gallons per day.







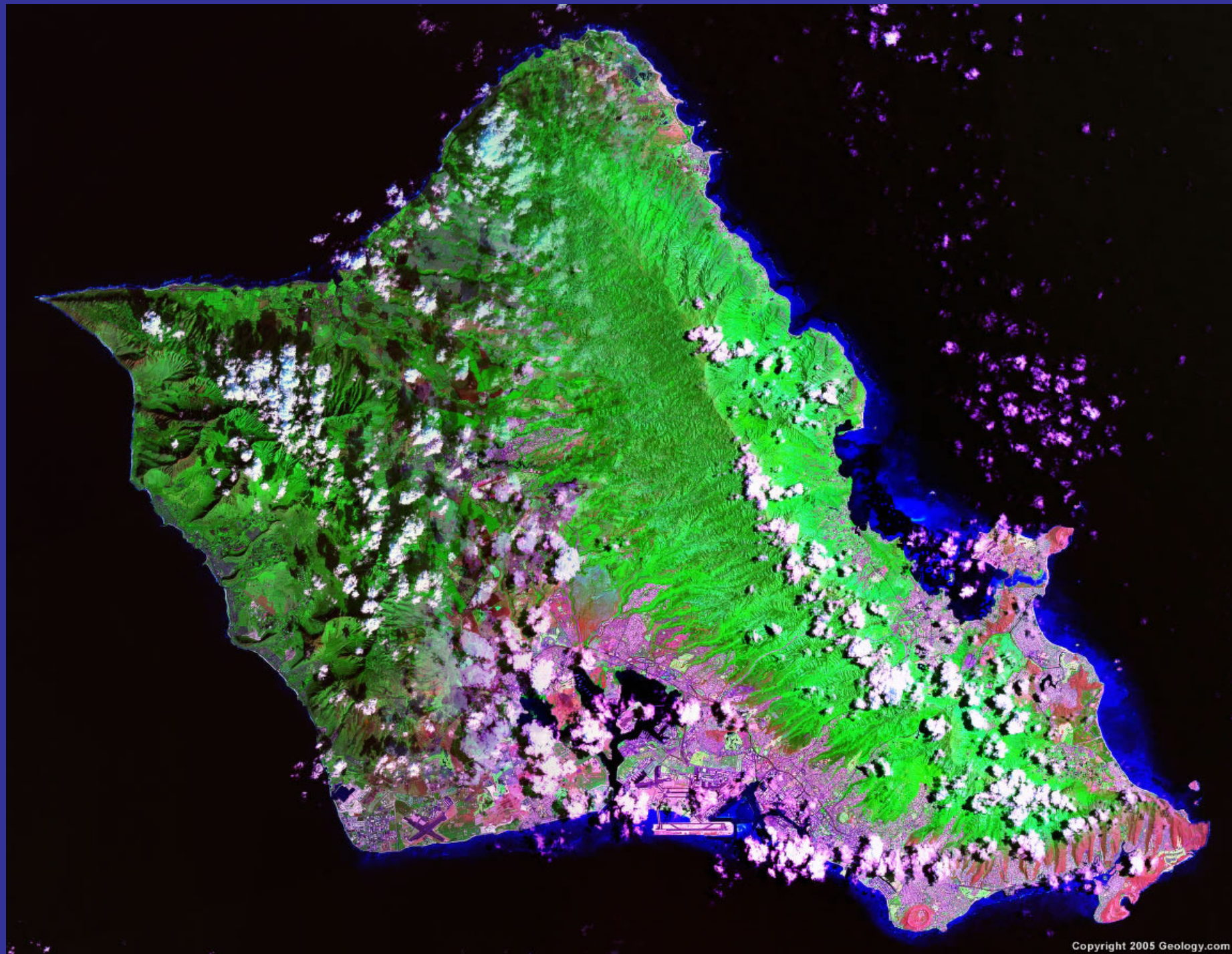


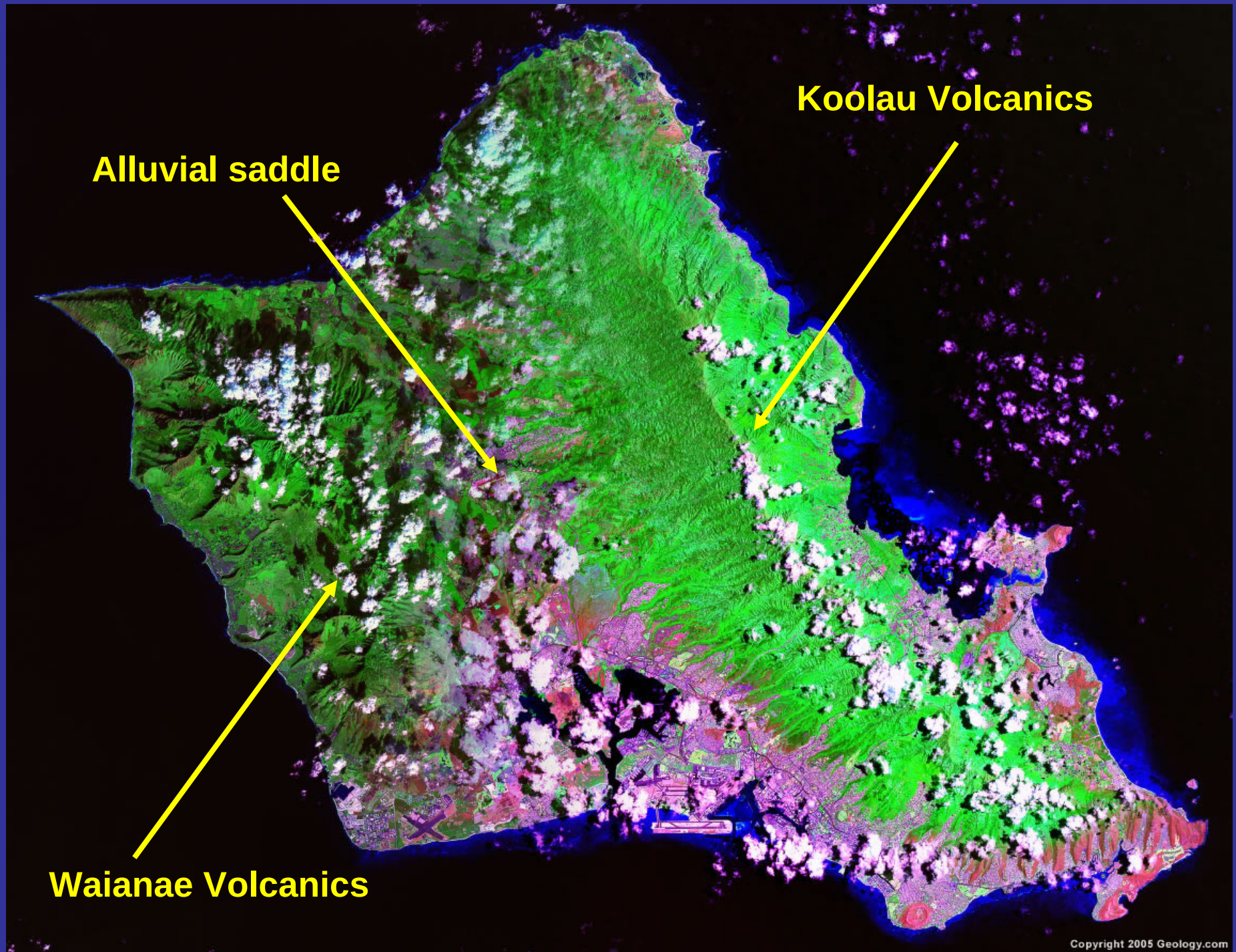
Where does the groundwater go?

Which will hold more water? A) Aa, B) Pahoehoe




Hawaiian Red Dirt - “Saprolite”


Copyright 2005 Geology.com


Koolau Volcanics
Alluvial saddle
Waianae Volcanics
Copyright 2005 Geology.com

Porosity

% of the total volume of the rock that contains pore spaces

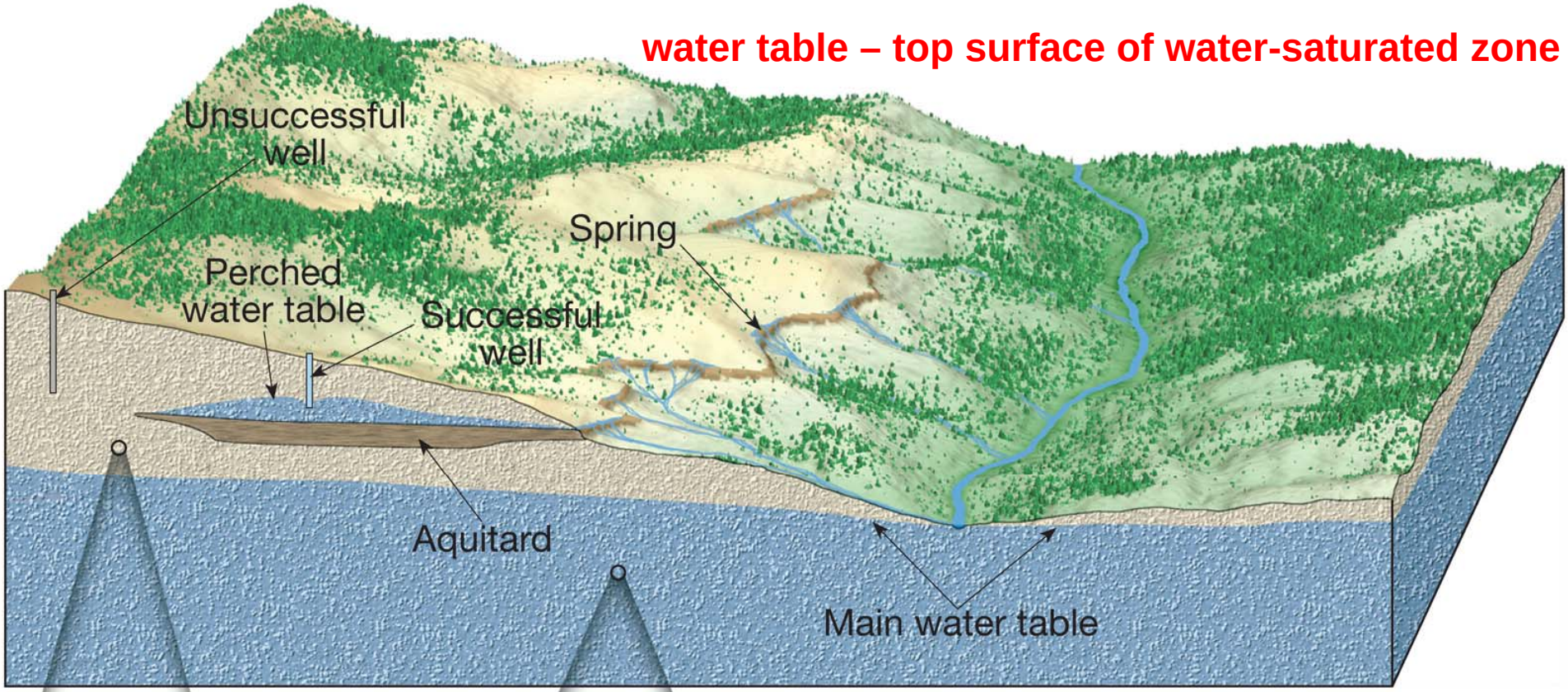
Permeability

the ability of a material to transmit fluid

Aquifer

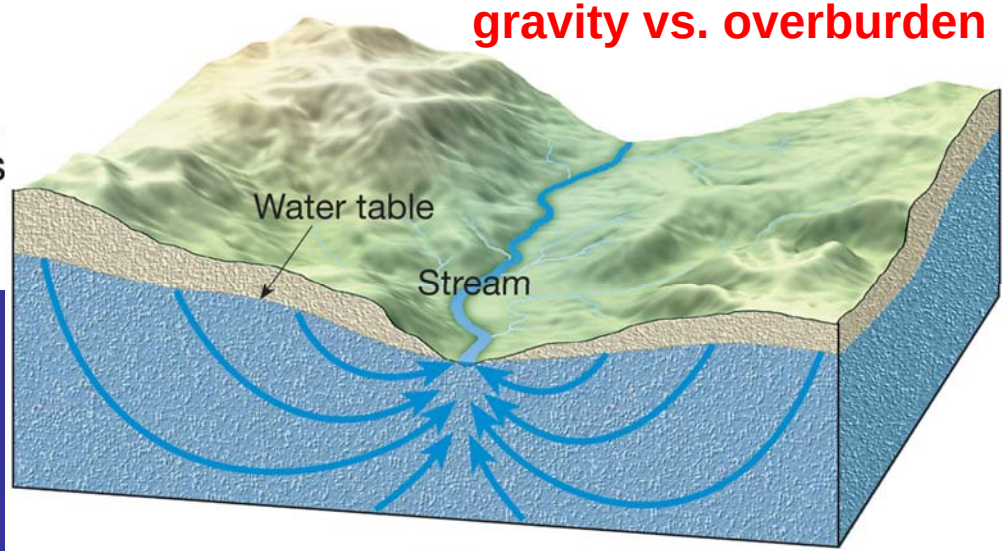
Permeable rock strata or sediments that transport groundwater

water table – top surface of water-saturated zone



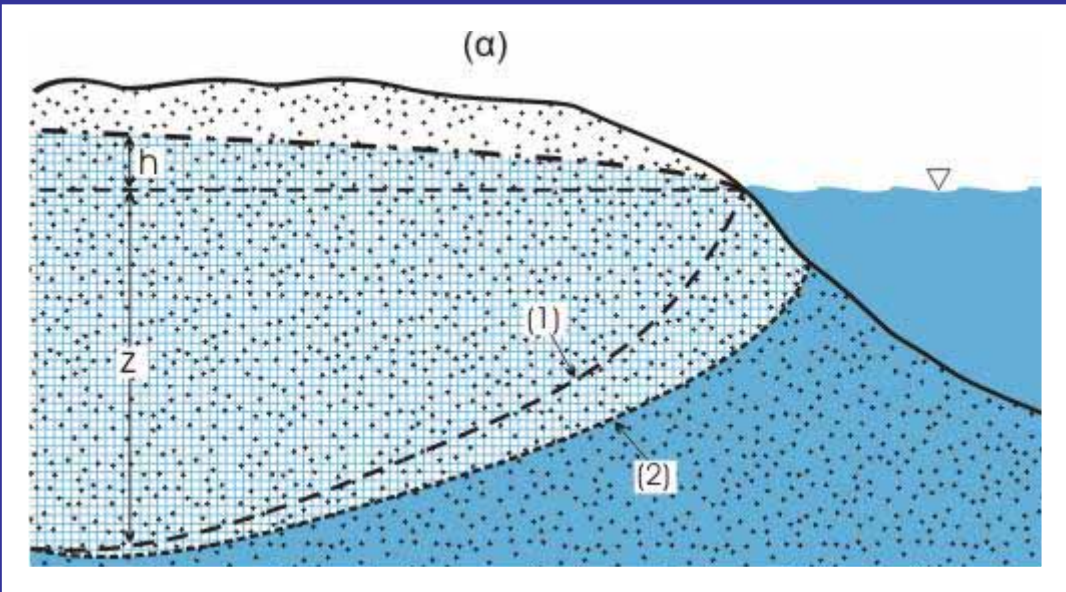


gravity vs. overburden



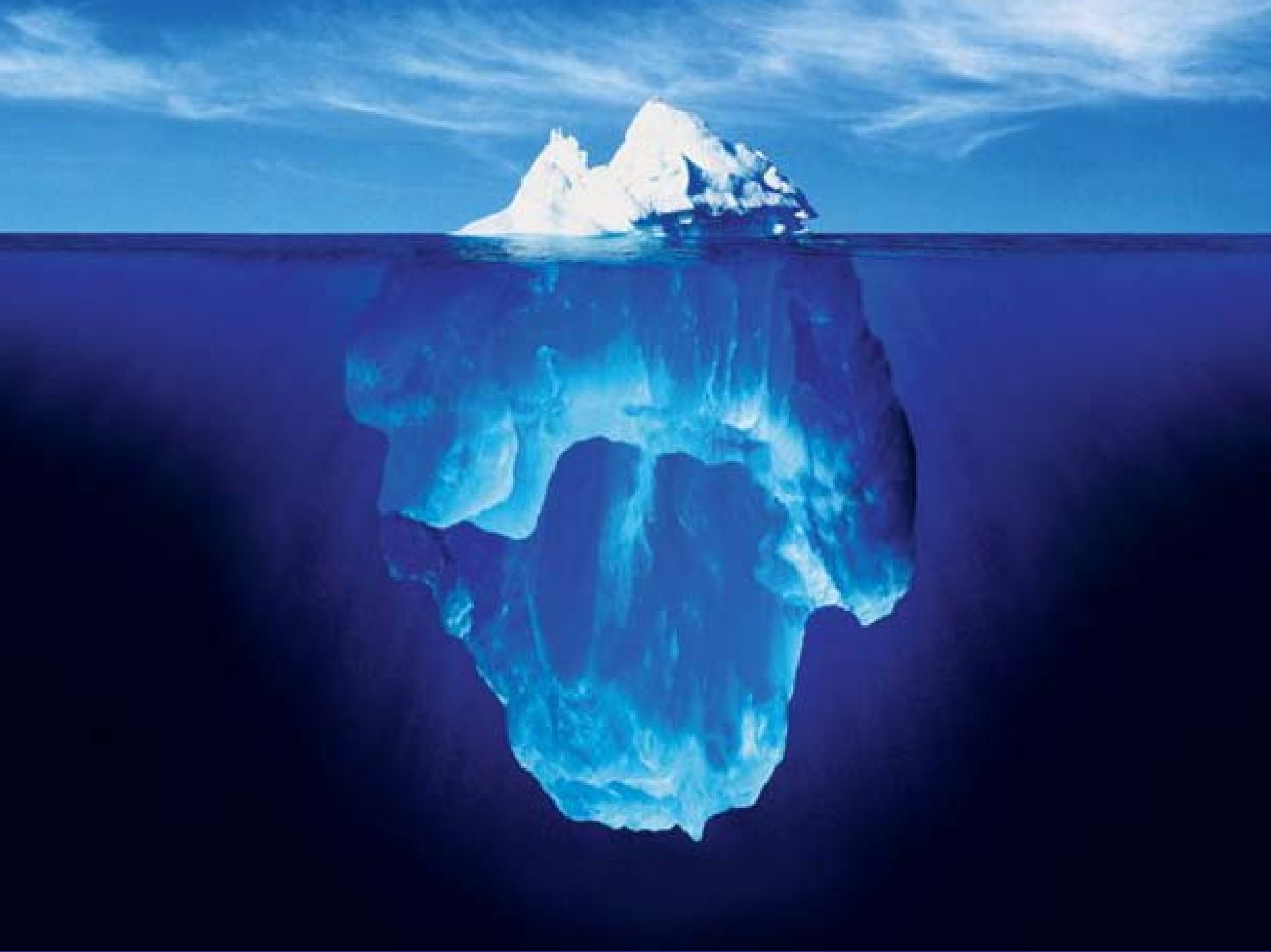
Typical groundwater configuration

Which is less dense?
A) fresh water, B) salt water

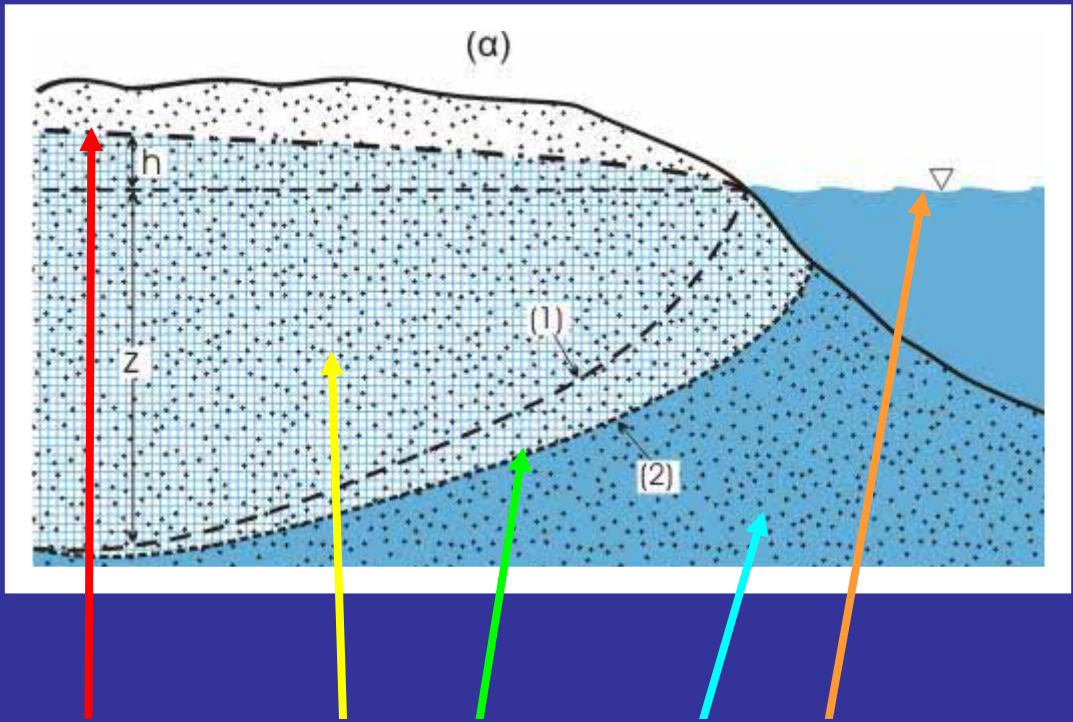








Island aquifers are unique: Fresh water floats on salt water



Height of groundwater above sea level

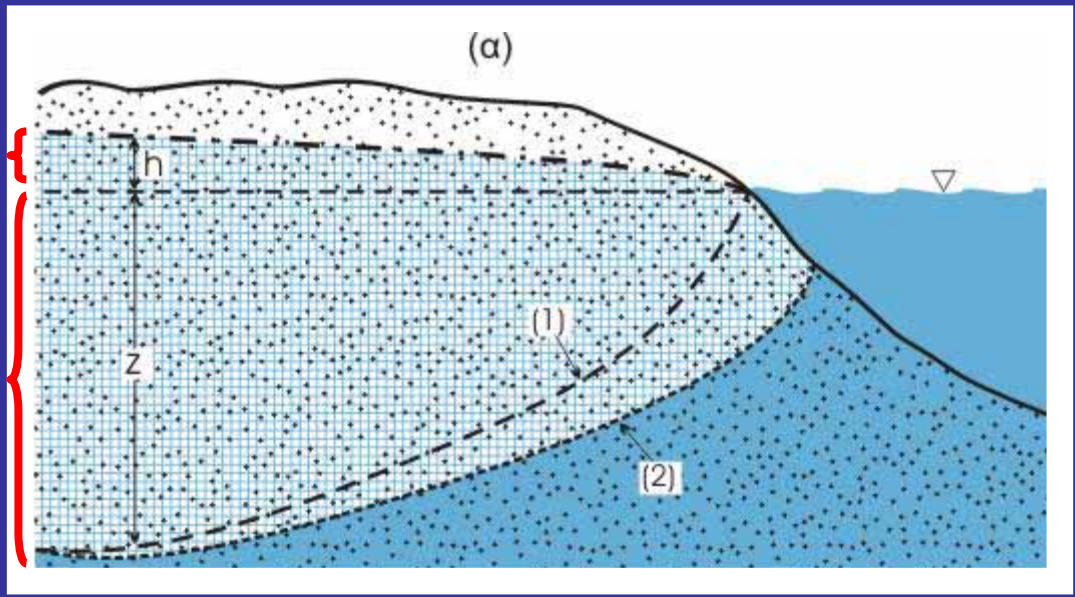
Sea level

Freshwater lens

Brackish water transition zone

Salt water

Ghyben-Herzberg Principle

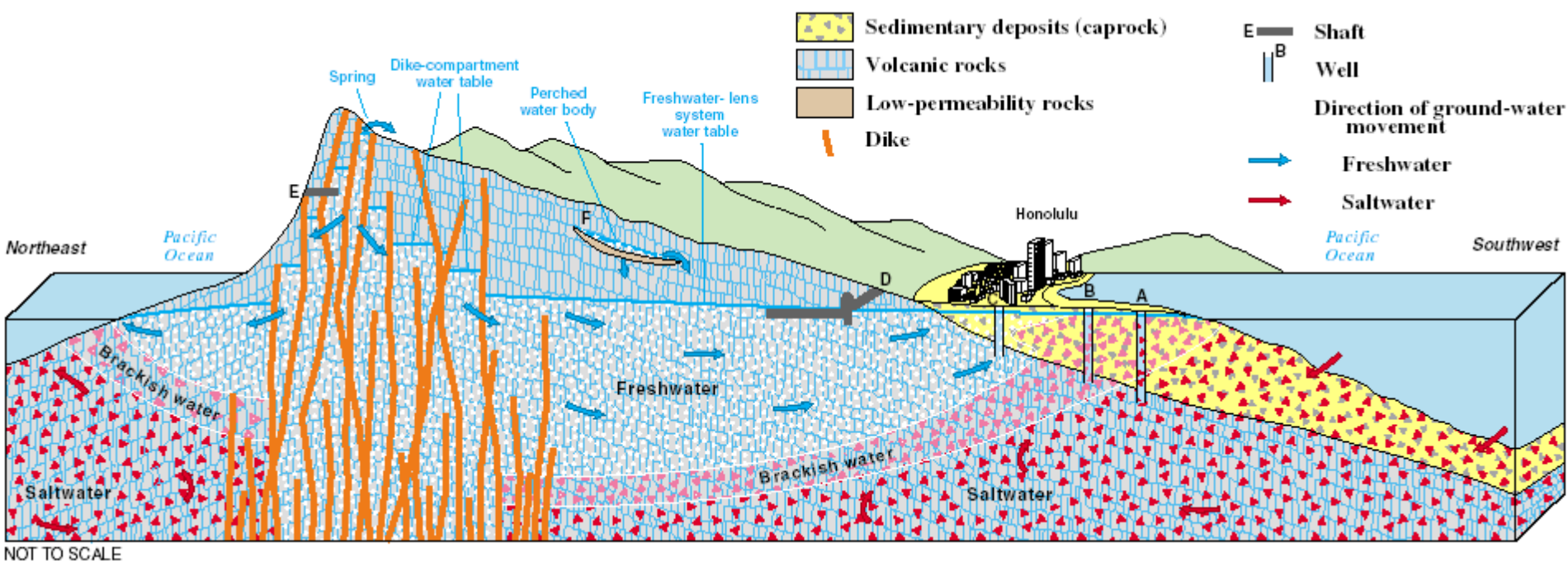


Height of groundwater above sea level (water table) =

1/40th

Freshwater lens thickness

(Sea water 1/40th more dense than fresh water)



Porosity and permeability of volcanic material good

What impedes groundwater flow on Oahu?



Shiprock, New Mexico



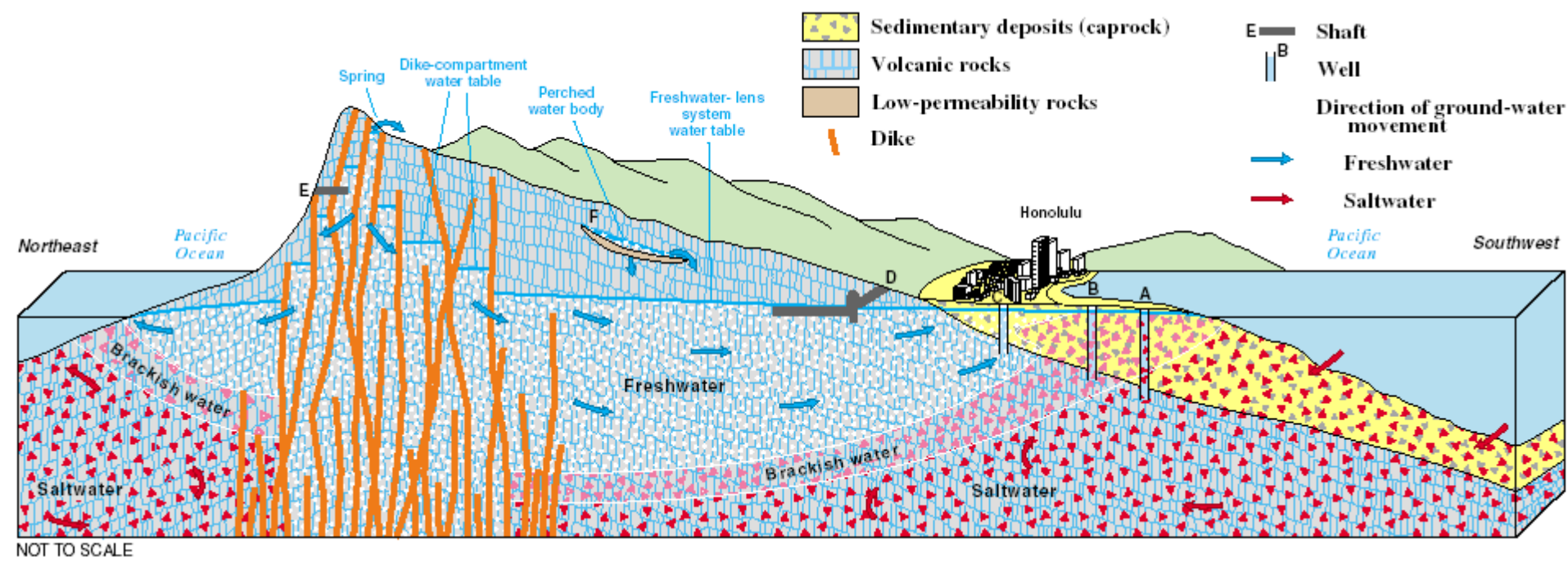
Volcanic dikes create impermeable barriers



Limestone Caprock





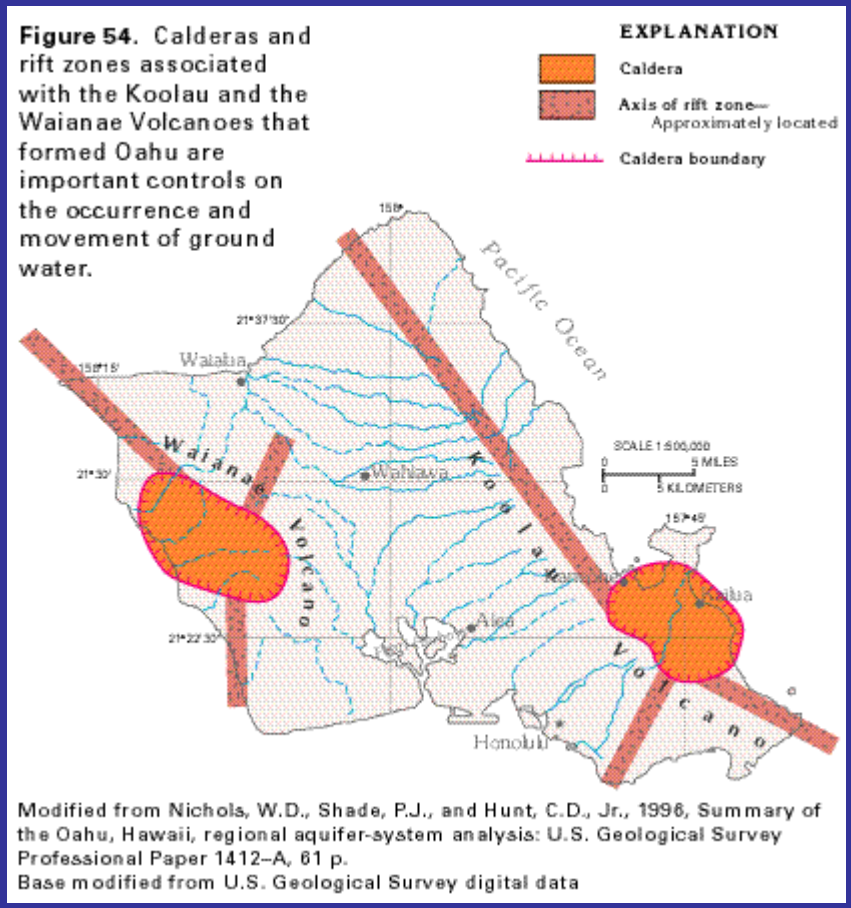


Volcanic dikes and the limestone caprock cause fresh water to <u>pond</u> in the island's interior

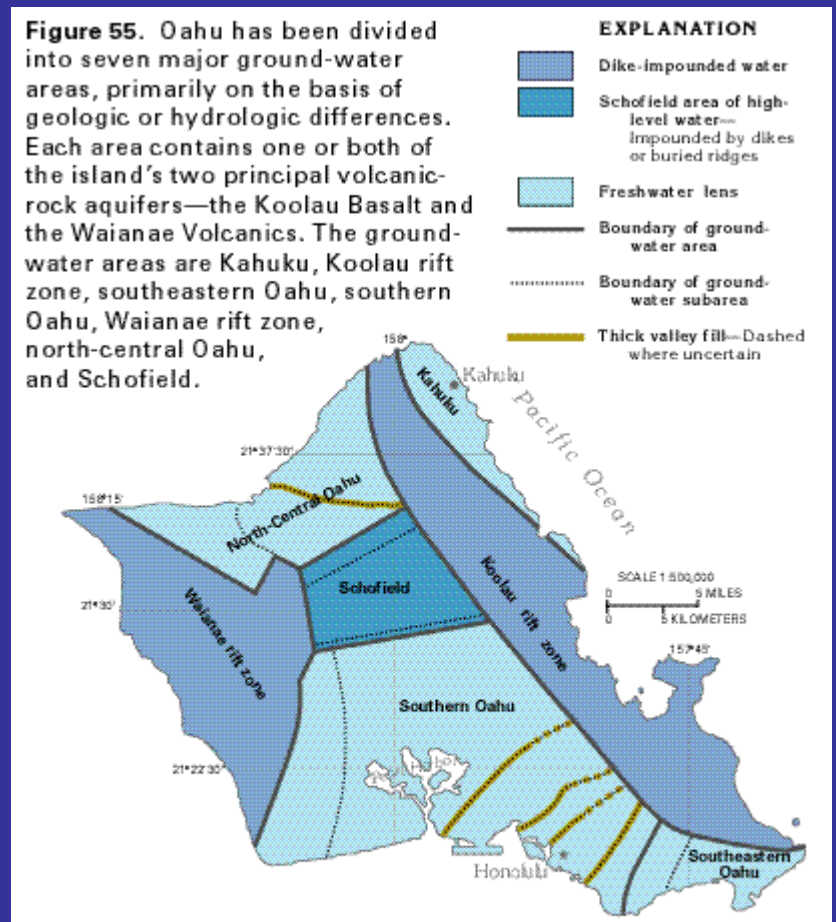




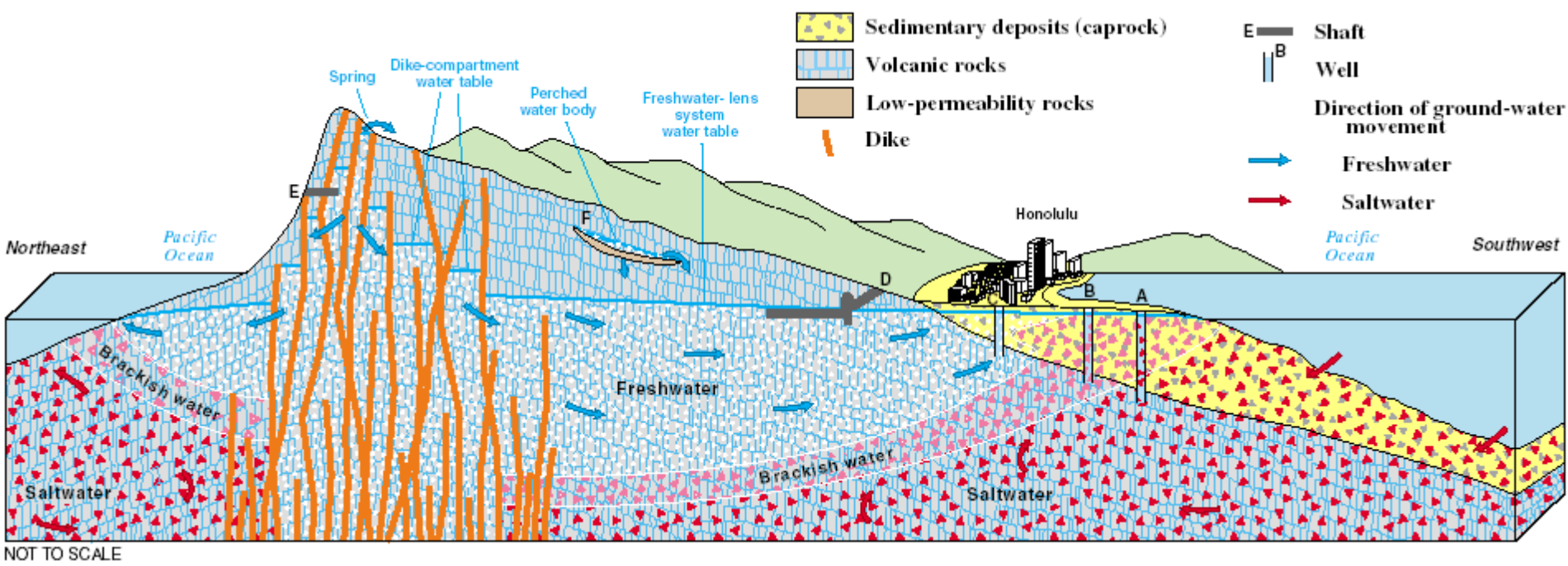
Geology controls aquifer locations



Modified from Nichols, W.D., Shade, P.J., and Hunt, C.D., Jr., 1996, Summary of the Oahu, Hawaii, regional aquifer-system analysis: U.S. Geological Survey Professional Paper 1412–A, 61 p.
Base modified from U.S. Geological Survey digital data

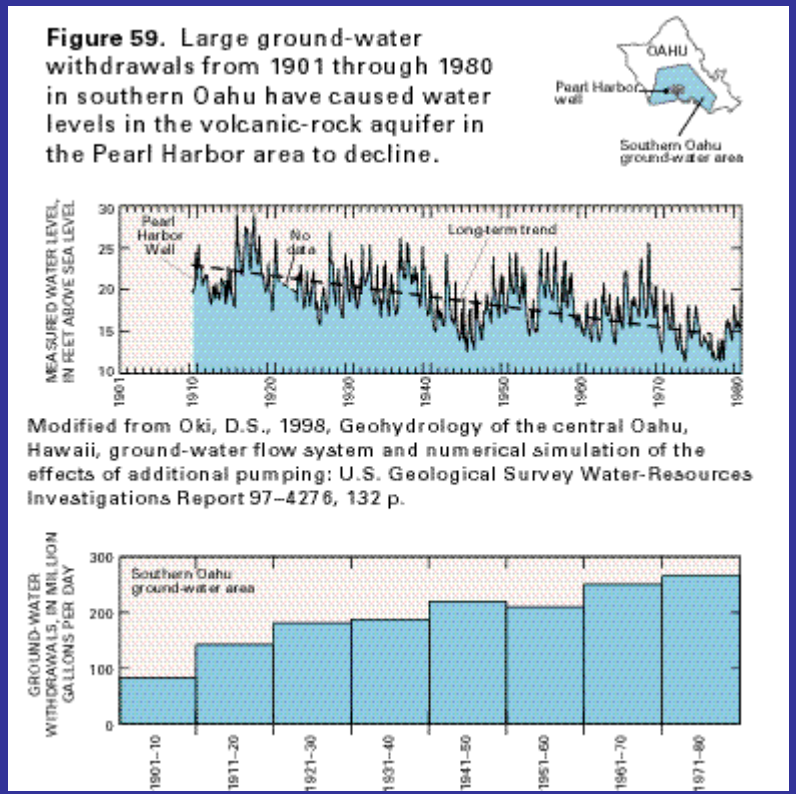


Modified from Nichols, W.D., Shade, P.J., and Hunt, C.D., Jr., 1996, Summary of the Oahu, Hawaii, regional aquifer-system analysis: U.S. Geological Survey Professional Paper 1412–A, 61 p.
Base modified from U.S. Geological Survey digital data

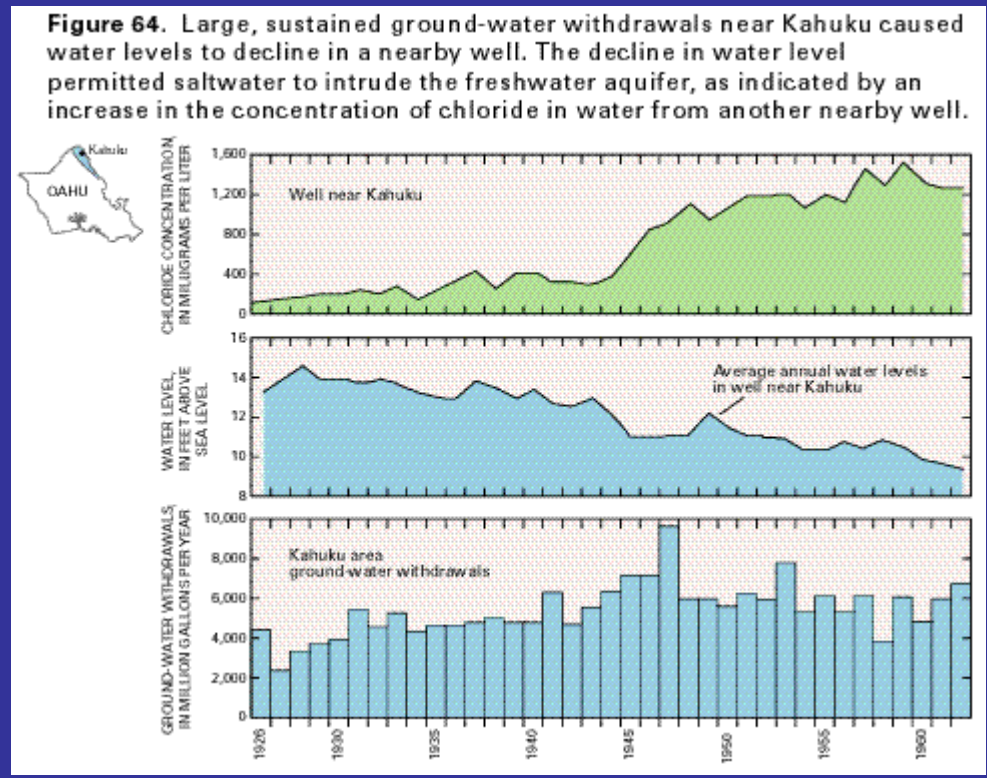


How do we access these aquifers?

How do pumping rates affect aquifers?



1901-1980

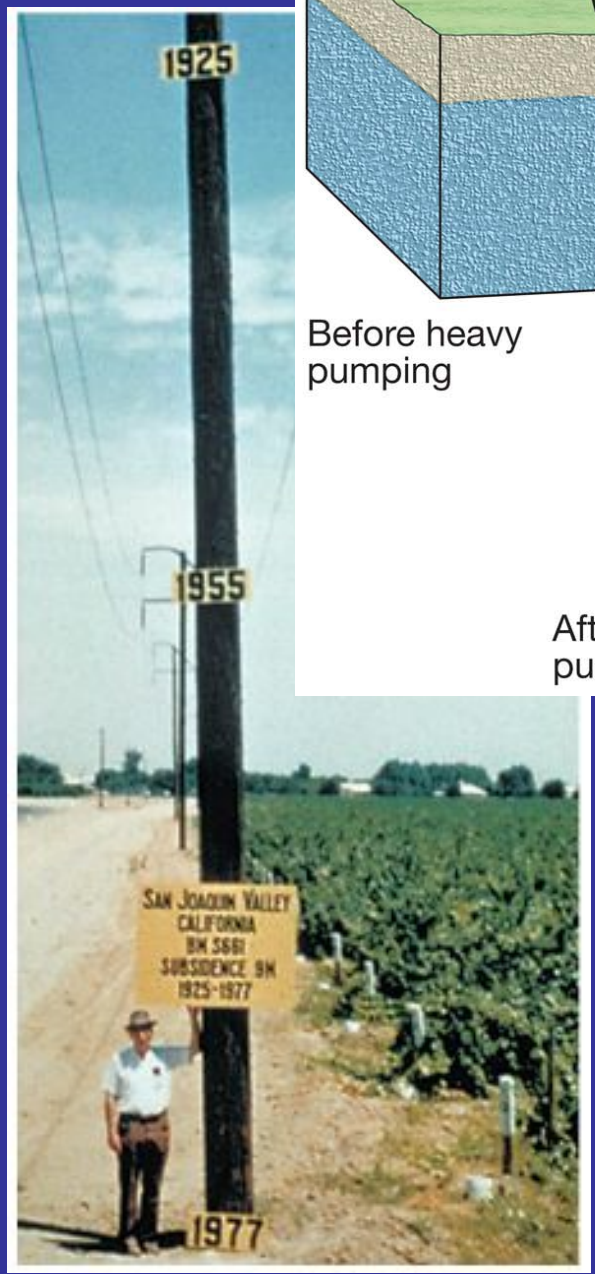


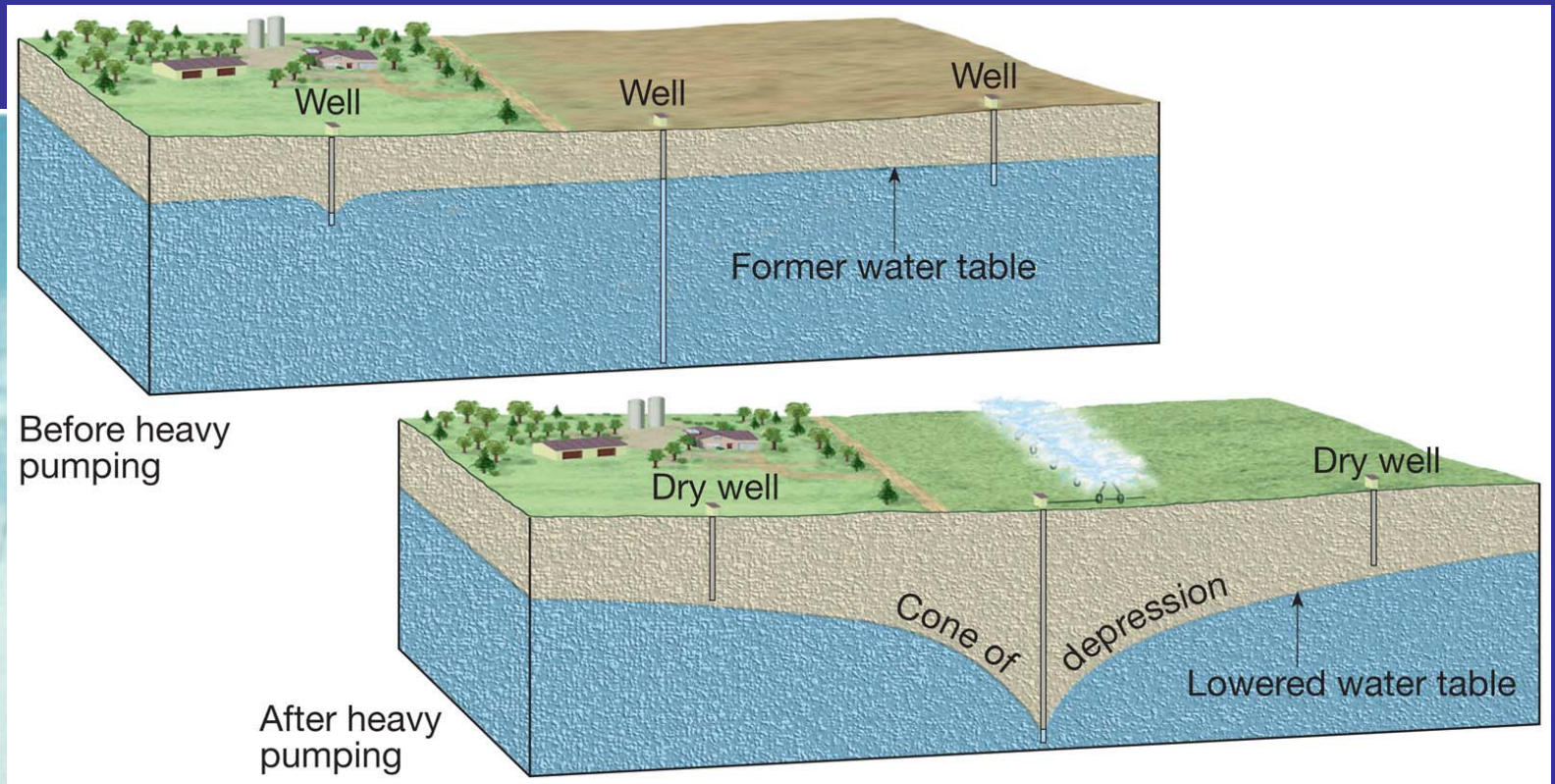
1925-1965

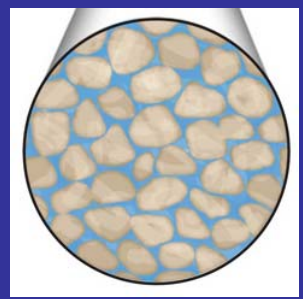
<u>What is relationship between:</u>

1. **Pumping rate**
2. **Well water level**
3. **Chloride content (salt intrusion)**

???



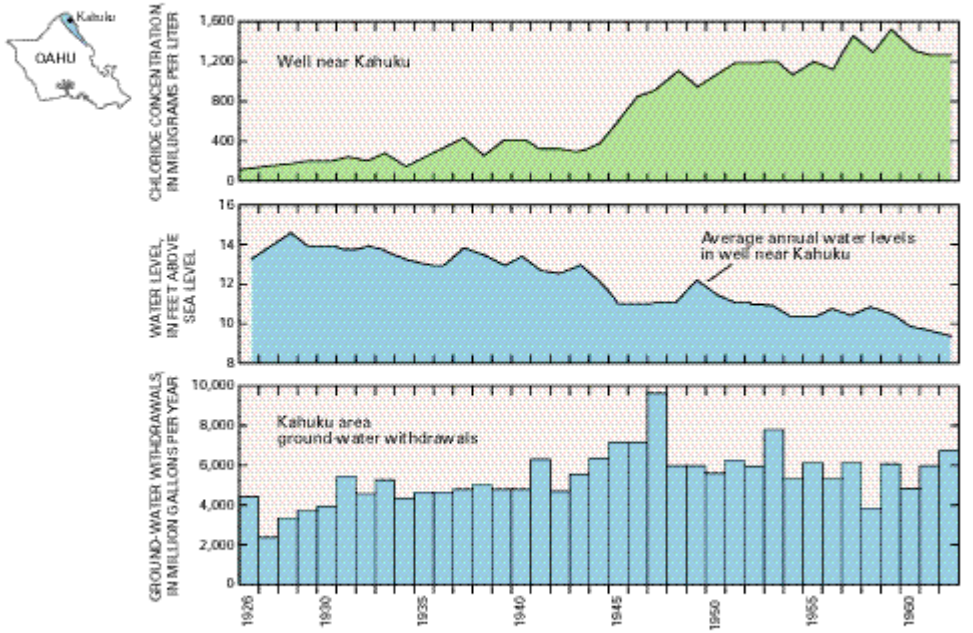




Over-pumping can:

1) **Lower water table**
2) **Cause ground subsidence**

Figure 64. Large, sustained ground-water withdrawals near Kahuku caused water levels to decline in a nearby well. The decline in water level permitted saltwater to intrude the freshwater aquifer, as indicated by an increase in the concentration of chloride in water from another nearby well.

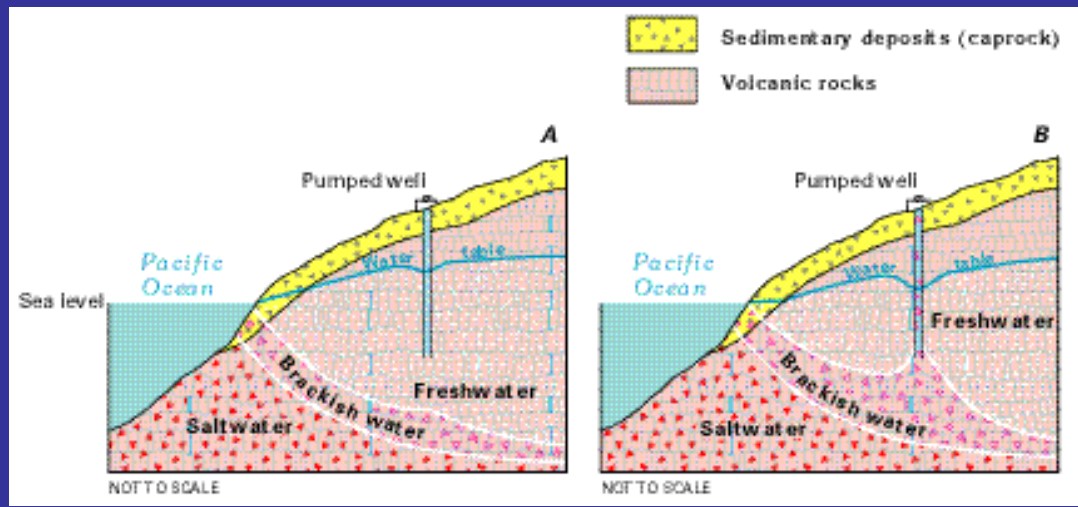


Modified from Takasaki, K.J., and Valenciano, Santos, 1969, Water in the Kahuku area, Oahu, Hawaii: U.S. Geological Survey Water-Supply Paper 1874, 59 p.

- Pumping rate
- Well water level
- Chloride content

1) Water table is Lowering

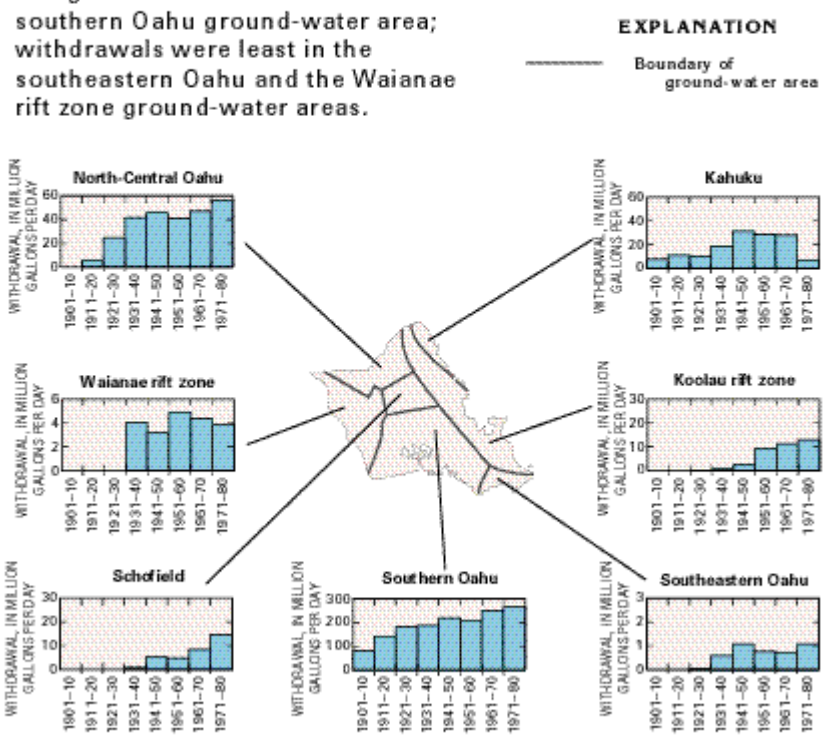
2) Saltwater is intruding



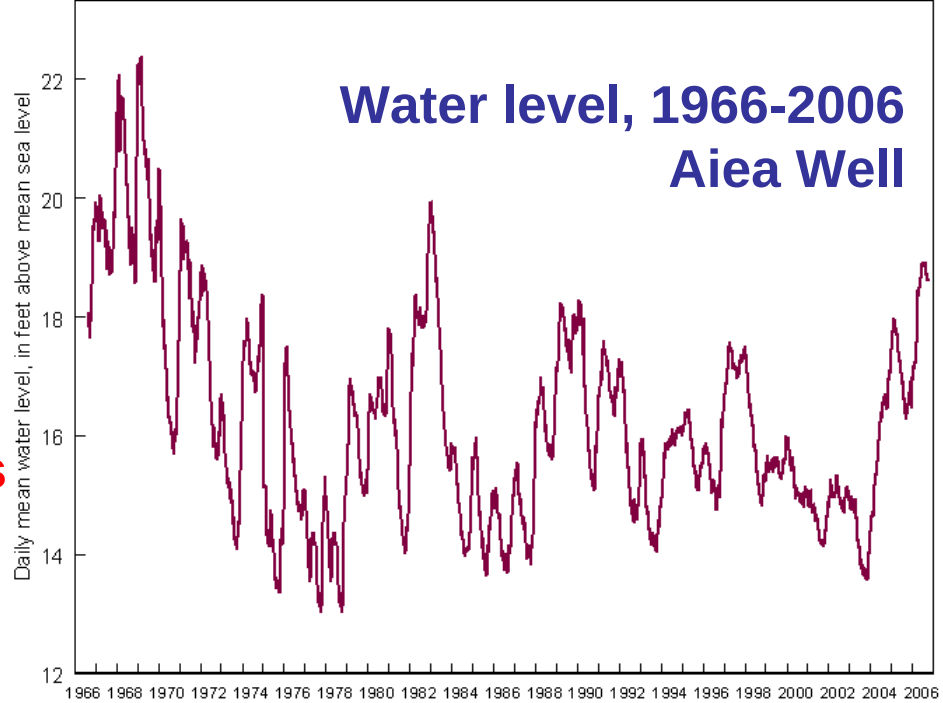
Excessive pumping thins fresh water lens

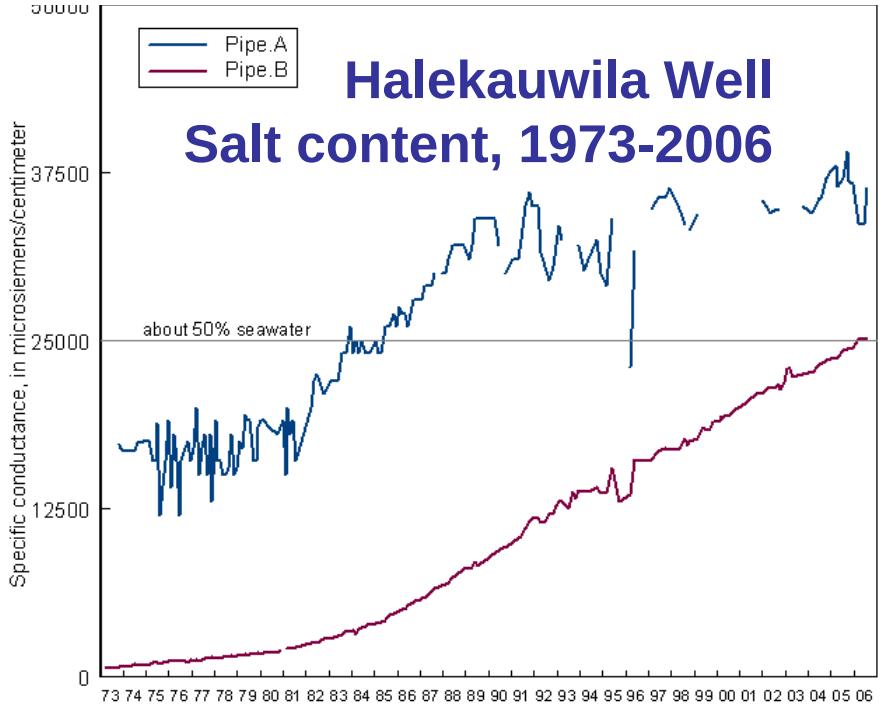
Figure 61. Estimates of ground-water withdrawals for each ground-water area range from less than 5 million to more than 200 million gallons per day during the decades from 1901 to 1980. The greatest withdrawals were in the southern Oahu ground-water area; withdrawals were least in the southeastern Oahu and the Waianae rift zone ground-water areas.

Pumping rates 1901-1980

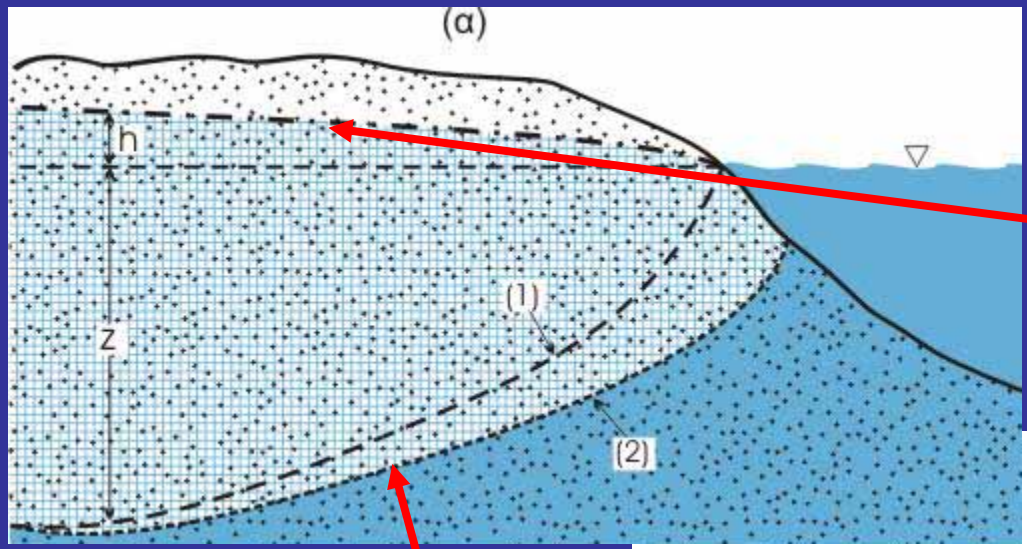


Modified from Hunt, C.D., Jr., 1996, Geohydrology of the island of Oahu, Hawaii: U.S. Geological Survey Professional Paper 1412–B, 54 p.



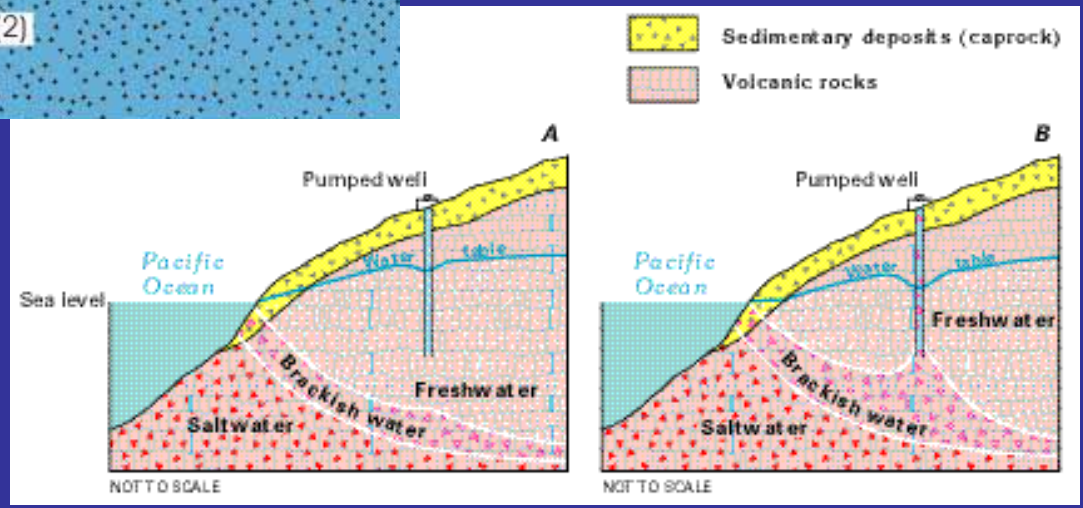


Oahu's fresh water lens, the source of our drinking water, is <u>thinning</u>



Depth to water table increasing

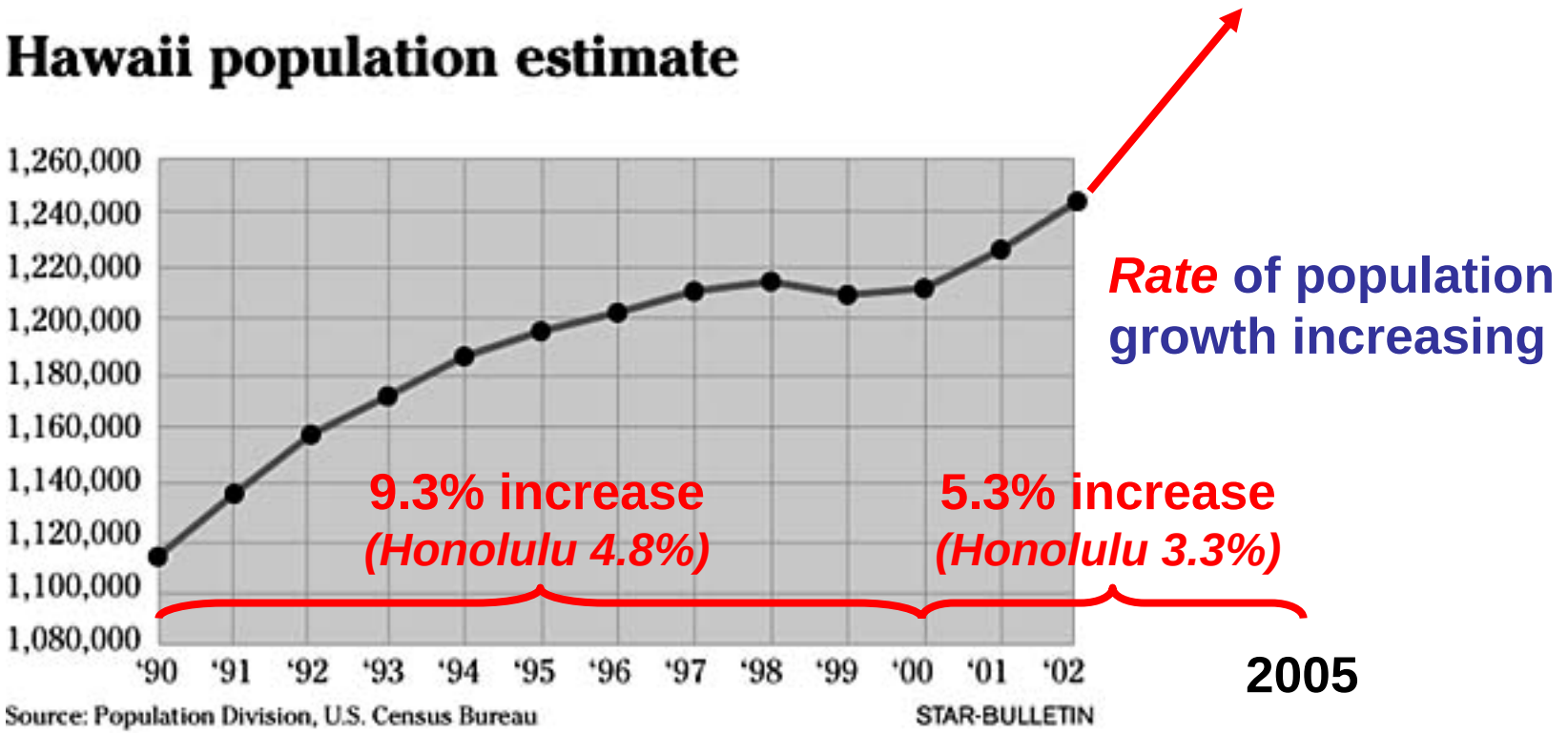
Depth to salt water decreasing



What's happening to Hawaii's population?



What's happening to Hawaii's population?



Where is growth happening?



A) Honolulu
B) Hawaii Kai
C) Central Oahu
D) Leeward
E) North Shore

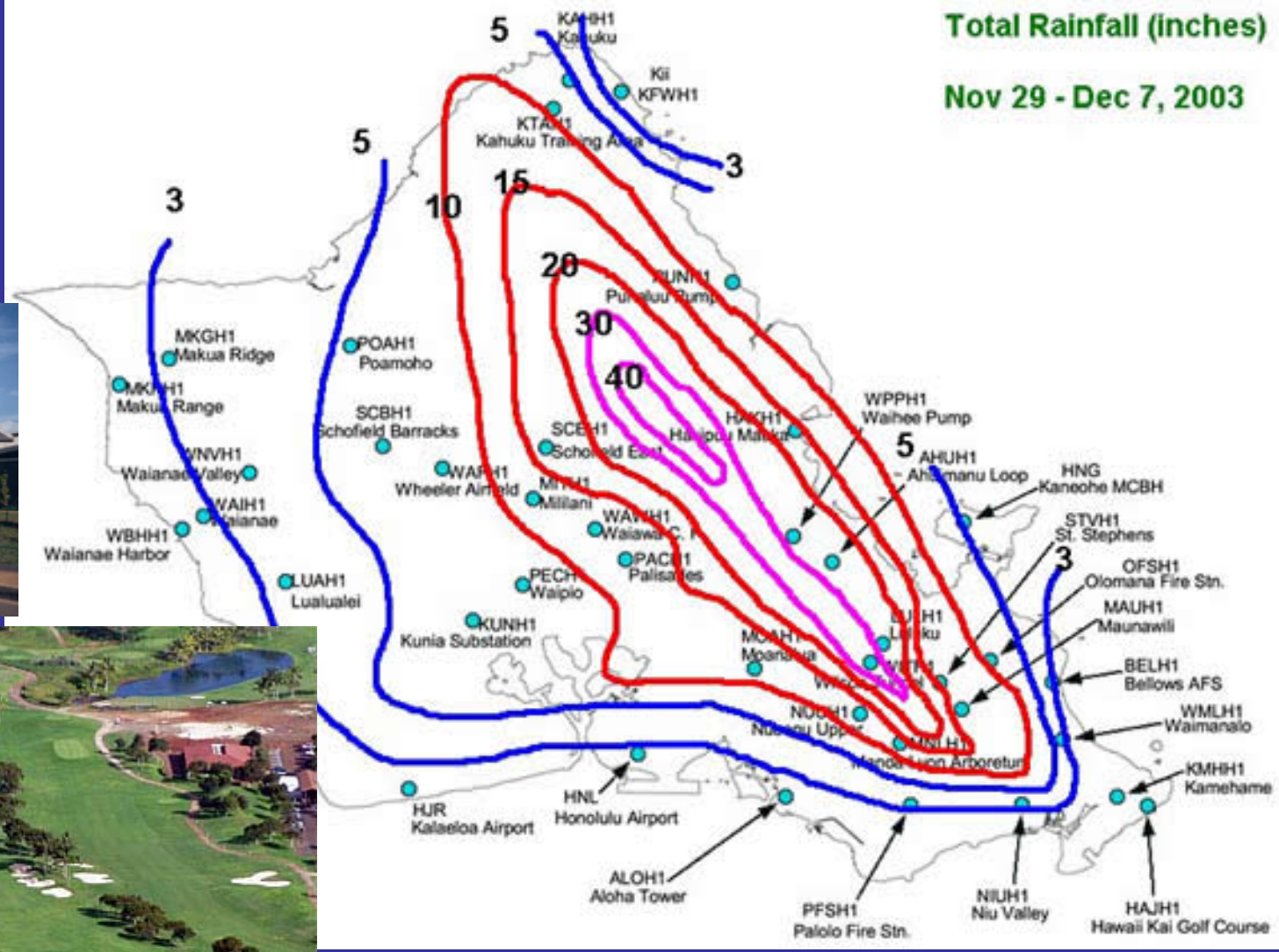


Population and Employment Growth by Development Plan Area

Oahu Population Growth







How will the expected population growth affect groundwater resources ???

1. Growing population

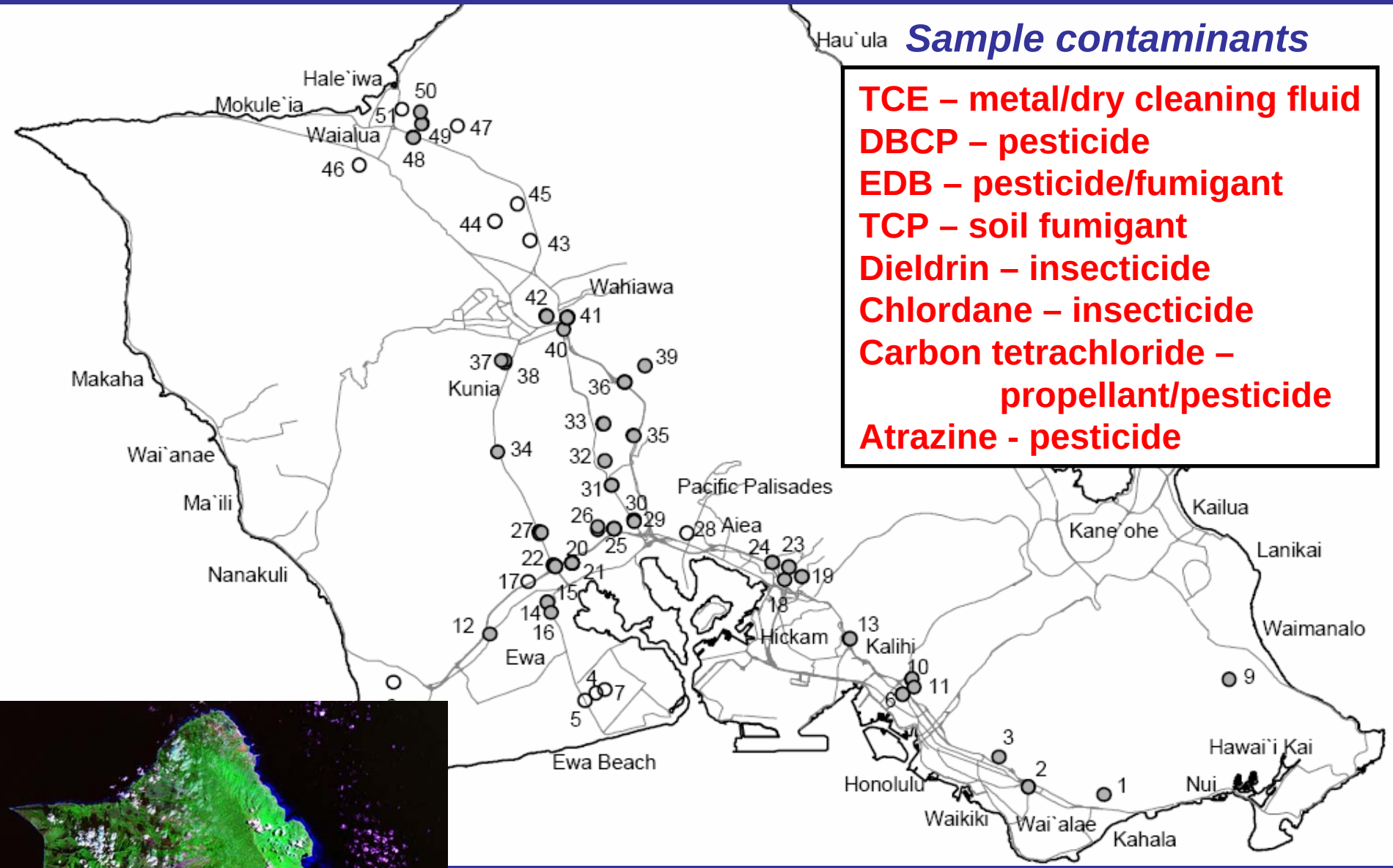
2. Increasing groundwater withdrawal

3. Thinning fresh water lens

What else do we have to protect our groundwater from?

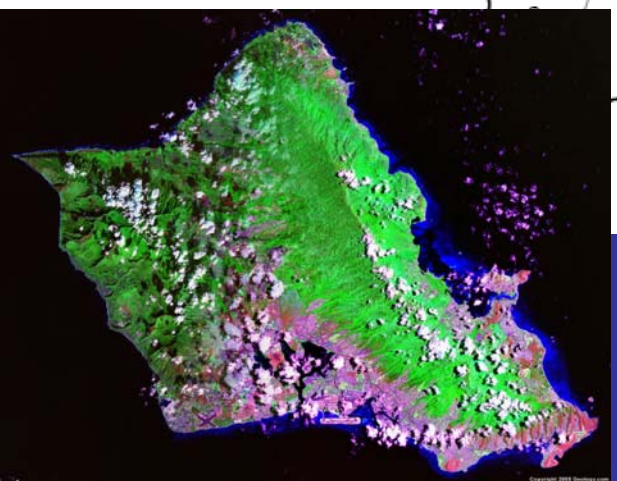
What's in your drinking water?

A) Chromium (wood preserver)
B) Fecal coliform (human/animal feces)
C) Dieldrin (insecticide)
D) All of the above
E) None of the above



Sample contaminants

TCE – metal/dry cleaning fluid
DBCP – pesticide
EDB – pesticide/fumigant
TCP – soil fumigant
Dieldrin – insecticide
Chlordane – insecticide
Carbon tetrachloride – propellant/pesticide
Atrazine - pesticide



Contaminated drinking water wells on Oahu results from 1995-2005


Dole
PLANTATION
DOLE

Del Monte
Quality
Del Monte Fresh Produce (Hawaii) Inc.
PRIVATE PROPERTY
NO TRESPASSING

Pesticides









DBCP (1,2-dibromo-3-chloropropane)

Carcinogen
Reproductive toxicant
Developmental toxicant
Endocrine toxicant
Gastrointestinal/liver toxicant
Neurotoxicant
Respiratory toxicant
Skin toxicant
Top 10% most hazardous compounds





Dieldrin

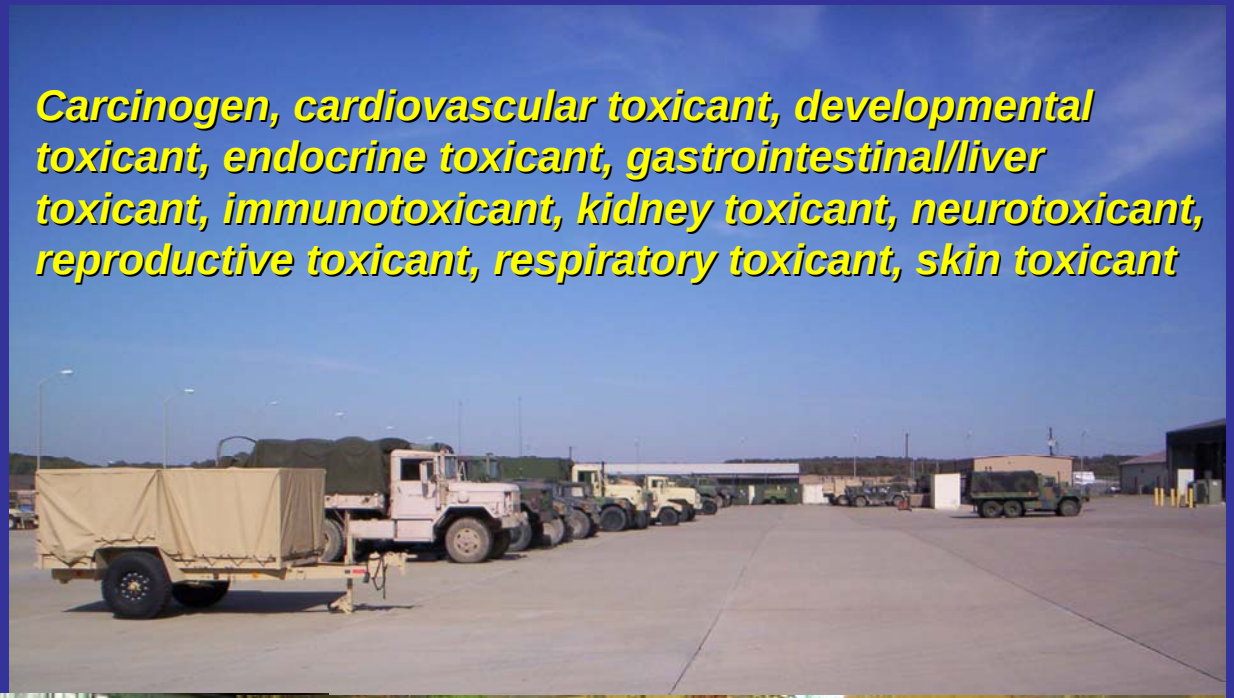
Carcinogen
Cardiovascular toxicant
Endocrine toxicant
Gastrointestinal/liver toxicant
Immunotoxicant
Kidney toxicant
Neurotoxicant
Reproductive toxicant
Respiratory toxicant
Top 10% most hazardous compounds

Industrial Solvents:

Trichlorethene (TCE)

- **Removes grease from vehicle parts, paint remover**

Found in Schofield wells in 1985





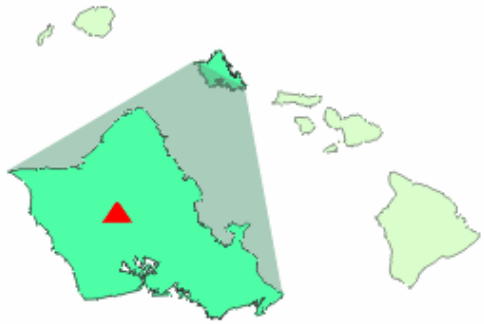


Region 9 Home
Region 9 Cleanup Home
R9 Superfund Home
Site Overviews
Administrative Records
Fact Sheets
Records of Decision
Images
Maps
Legal Documents

SCHOFIELD BARRACKS

HAWAII

EPA ID# HI7210090026



Click here for interactive site area map

EPA Region 9
City: Wahiawa, Oahu
County: Oahu
Other Names:

Table of Contents

Click on a category below or scroll down the page.

- Site Description and History
  - Maps
  - Images
- Threats and Contaminants
  - Description
  - Environmental Data
- Cleanup Approach
  - Response Action Status
- Environmental Progress
- Potentially Responsible Parties
- Site Documents and Reports
- Community Involvement: Public Meetings, Newsletters, and Fact Sheets
- Site Repositories/Library Sources
- Contacts
- Miscellaneous Information

Drinking water wells serving 25,000 military and 55,000 civilians contaminated with TCE.

Oahu Superfund Sites

NPL Sites in Hawaii by County
To access the fact sheet for each site, select the site name.
For the NPL Site Narrative, select the CERCLIS ID.
Federal Register notices can be accessed by selecting the date of each action listed.

HONOLULU COUNTY

Site Name CERCLIS ID	Proposed Listing	Final Listing	Construction Completion	Partial Deletion	Deletion
Del Monte Corp. (Oahu Plantation)					
HID980637631	5/10/93	12/16/94	N/A	1/13/04	N/A
Naval Computer & Telecommunications Area					
HI0170090054	1/18/94	5/31/94	N/A	N/A	N/A
Pearl Harbor Naval Complex					
HI4170090076	7/29/91	10/14/92	N/A	N/A	N/A
Schofield Barracks (USARMY)					
HI7210090026	7/14/89	8/30/90	9/23/98	N/A	8/10/00

Contaminants

Fumigants: EDB, DBCP, DCP

PCBs, volatile organics, semi-volatile organics, metals

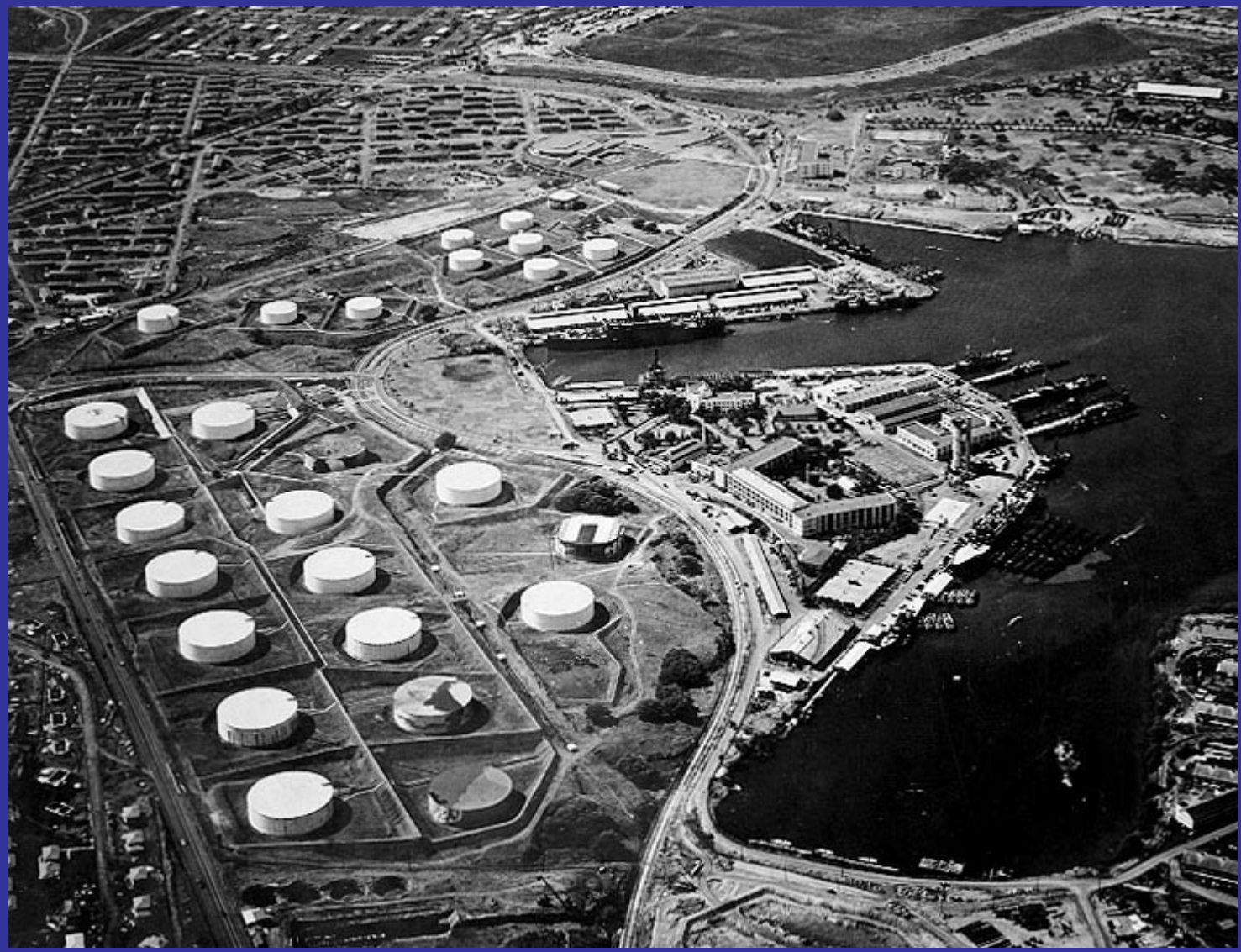
Metals, organic compounds, petroleum hydrocarbons

Industrial solvent: TCE

PCB – polychlorinated biphenyl, banned 1970s, bioaccumulates

Pearl Harbor Superfund Site

Soil, *groundwater*, sediment contaminated with metals, organic compounds, petroleum hydrocarbons



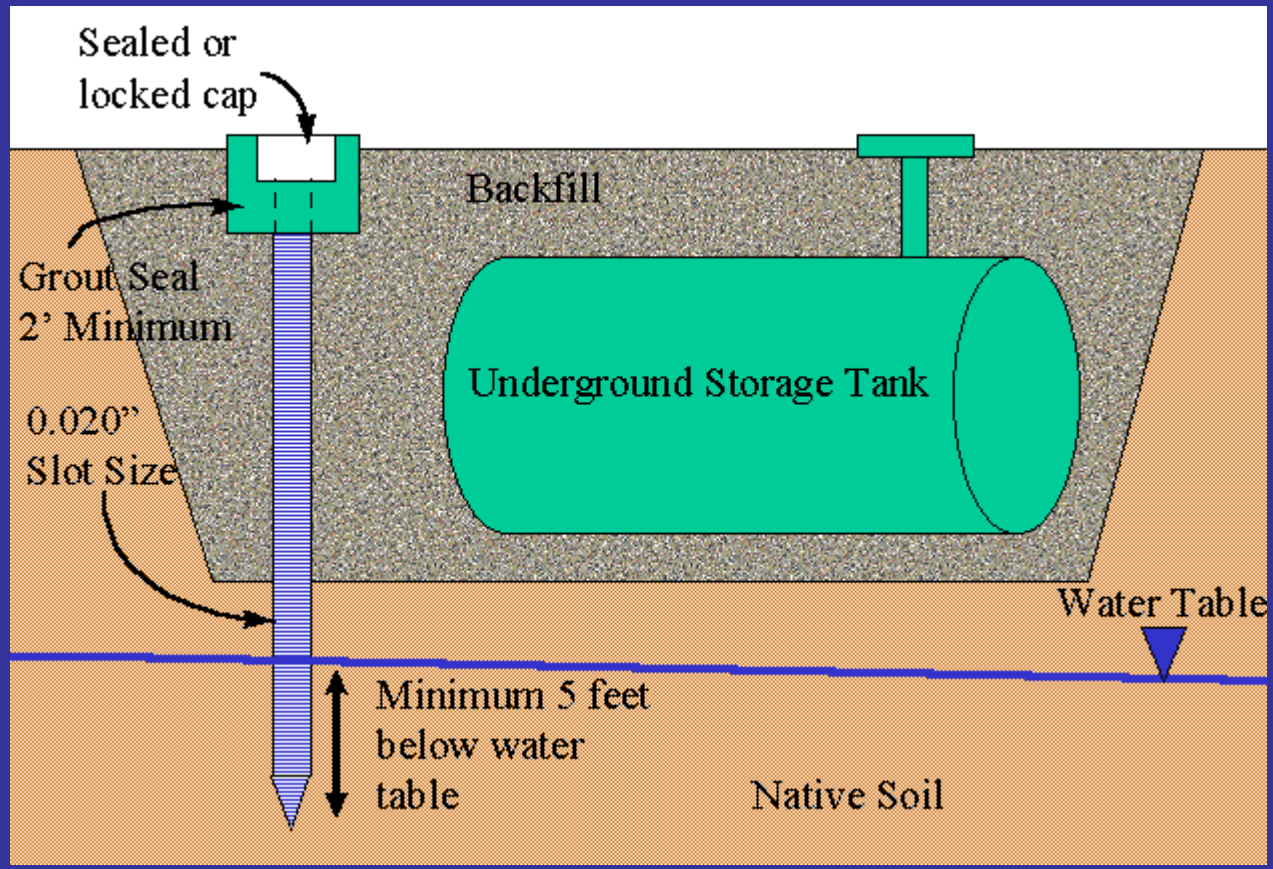
Fuel Additives





MTBE – fuel efficiency enhancer, possible carcinogen, nervous system effects, liver & kidney damage, etc.

Where is water table on Oahu?











Leaking Underground Storage Tanks



Irritability, excess salivation, labored breathing, tremors, convulsions, deep depression, anemia, leukemia, damage to liver, kidney, lungs, heart, spleen, adrenal glands; cancer, death



<u>Chlordane: pesticide</u>
Illegal since 1988
Prior to that 3.6 million lbs/year used in U.S.



Waimanalo (?) Gulch Landfill

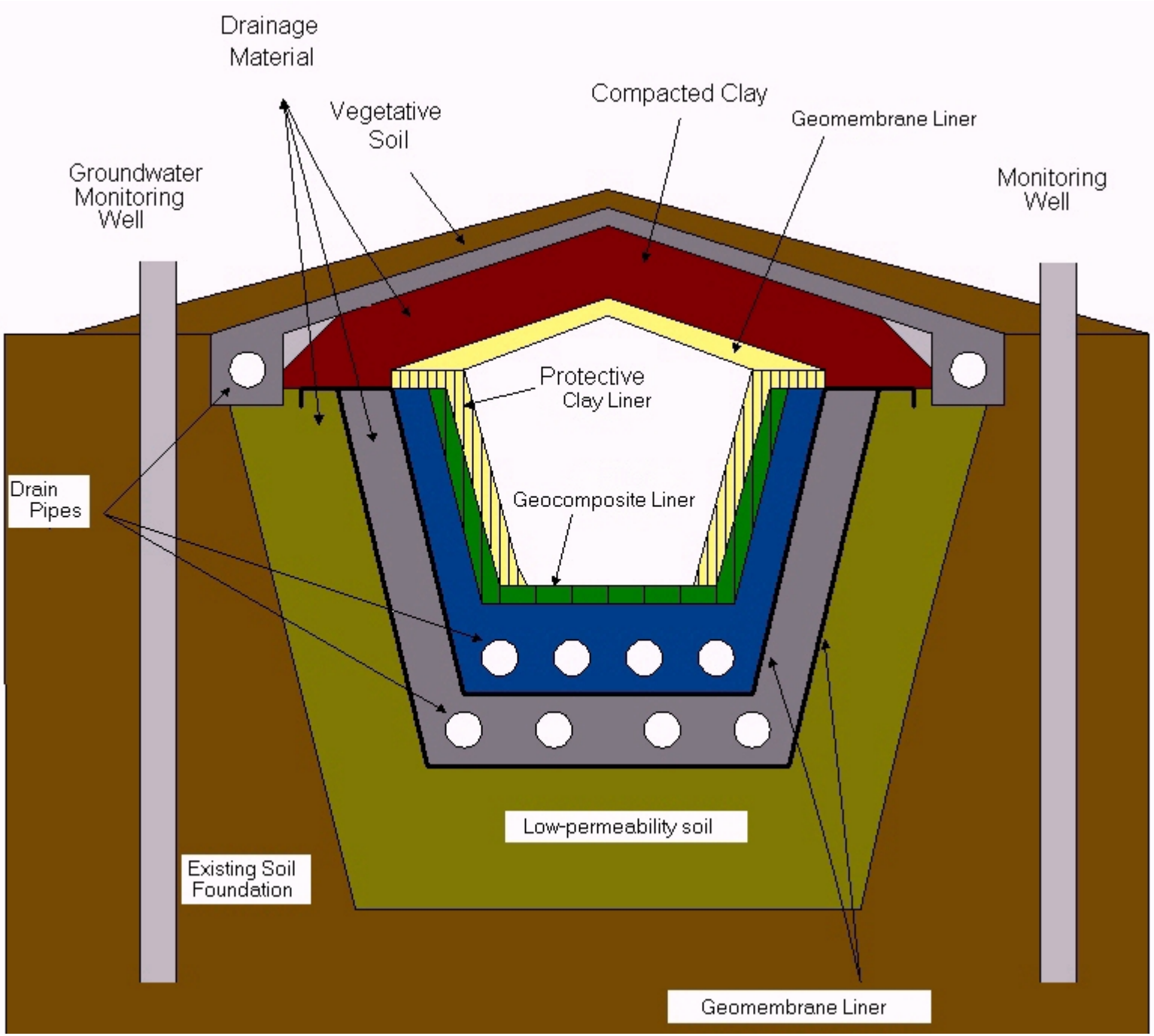
Ma'ili 200 acres 15 years
Nanakuli B 432 acres 15.6 years
Makaiwa Gulch 338 acres 25 years
Ameron Quarry 391 acres 15 years

80 abandoned landfills on Oahu





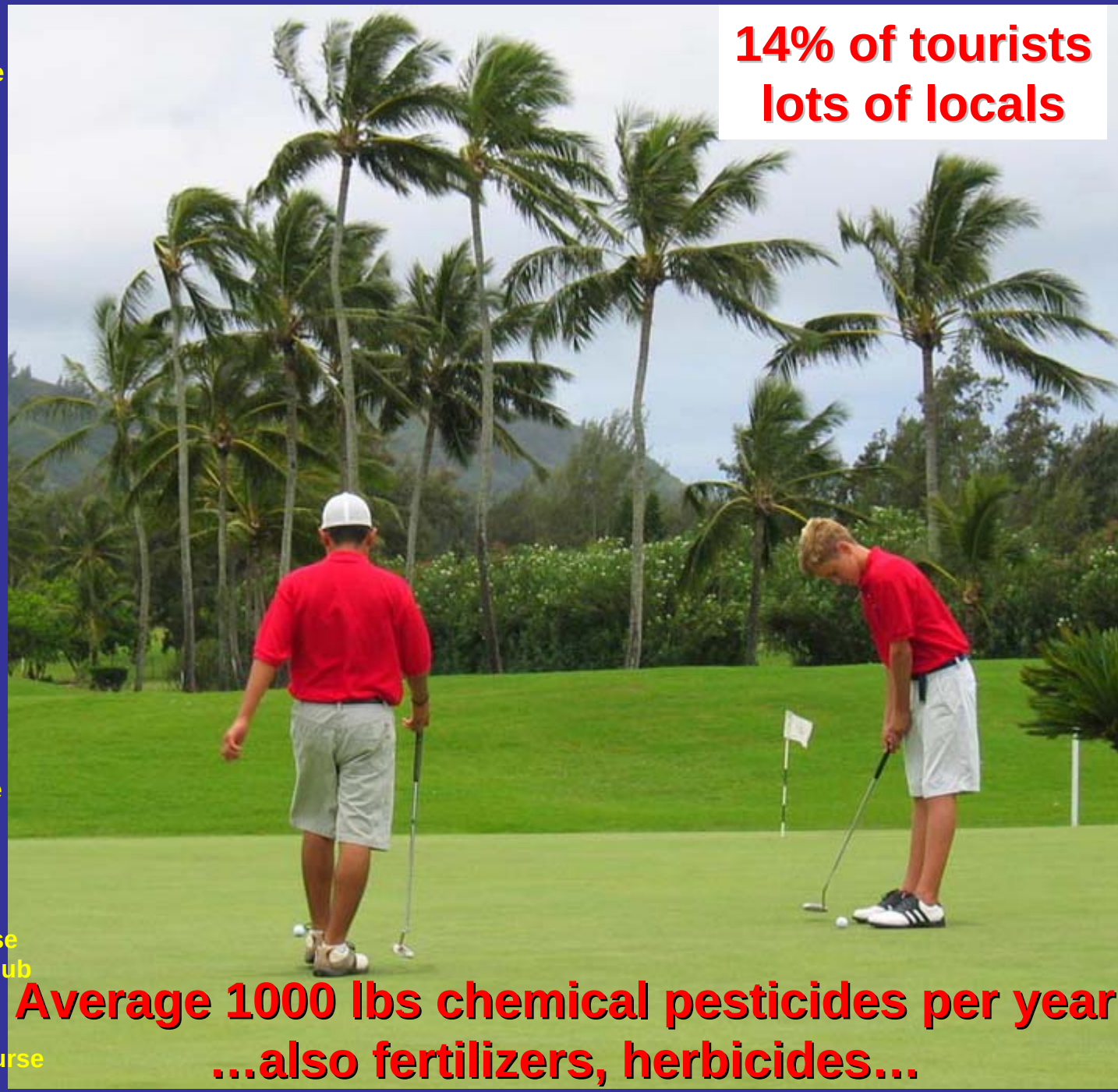
decorating products (paints, stains, varnish, paint thinners), garden products (pesticides, fungicides, herbicides), vehicle products (engine oil, brake fluid, antifreeze, car batteries), household cleaners (bleach, disinfectant, air fresheners), toiletries (cosmetics, old medicines), batteries from watches, radios, mobile phones, etc. may contain heavy metals like mercury, nickel, cadmium

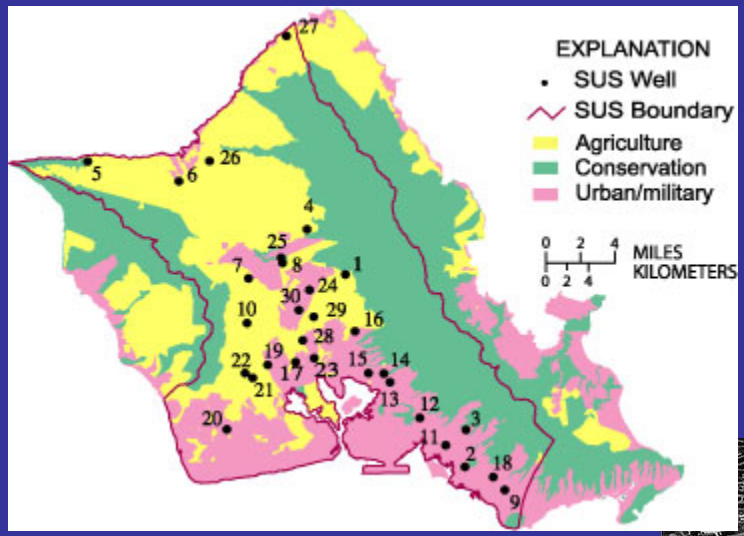

Drainage Material
Vegetative Soil
Compacted Clay
Geomembrane Liner
Groundwater Monitoring Well
Monitoring Well
Protective Clay Liner
Geocomposite Liner
Drain Pipes
Low-permeability soil
Existing Soil Foundation
Geomembrane Liner


What do golf courses contribute to groundwater?
A) Pesticides, B) Herbicides, C) Fertilizer, D) Water, E) All of the above

Oahu Golf Courses

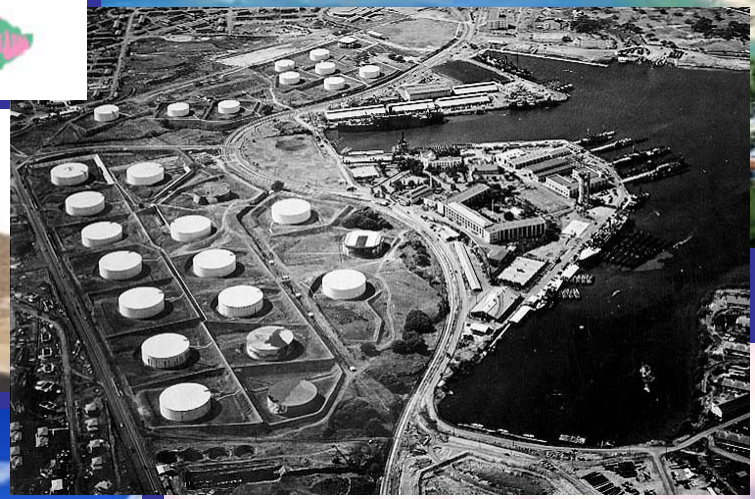
1) Ala Wai Golf Course
2) Barbers Point Golf Course
3) Bayview Golf Links
4) Coral Creek GC
5) New Ewa Beach GC
6) Ewa Villages Golf Course
7) Ford Island Golf Course
8) Hawaii Country Club
9) Hawaii Kai Golf Courses
10) Hawaii Prince Golf Club
11) Hickam Mamala Bay
12) Honolulu Country Club
13) Kahuku Golf Course
14) Kalakaua Golf Course
15) Kaneohe Klipper GC
16) Kapolei Golf Course
17) Ko Olina Golf Club
18) Koolau Golf Course
19) Leileihua Golf Course
20) Luanna Hills
21) Makaha Valley CC
22) Makaha Resort GC
23) Mid Pacific CC
24) Mililani Golf Club
25) Moanalua Golf Club
26) Navy-Marine Golf Course
27) Oahu Country Club
28) Olomana Golf Links
29) Pali Golf Course
30) Pearl Country Club
31) Ted Makalena Golf Course
32) Turtle Bay Resort Golf Club
33) Waialae Country Club
34) Waikele Golf Club
35) Walter Nagorski Golf Course
36) West Loch Golf Course




EXPLANATION
SUS Well
SUS Boundary
Agriculture
Conservation
Urban/military
0 2 4
MILES
0 2 4
KILOMETERS
27
26
5
6
4
25
7
8
1
24
30
10
29
16
28
22
19
17
23
15
14
21
13
12
20
3
11
2
18
9

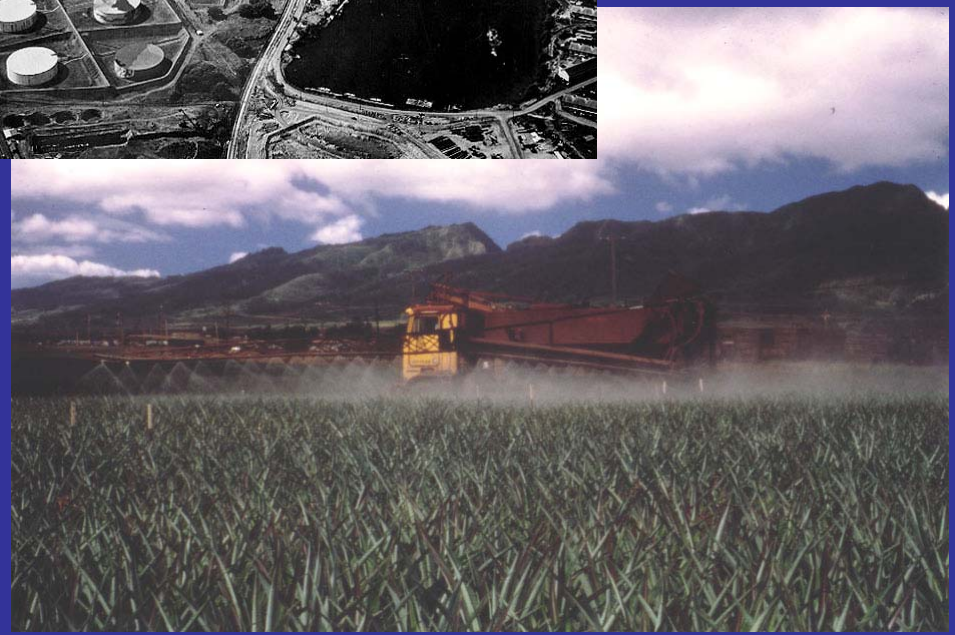






Industrial





Non-point source pollution





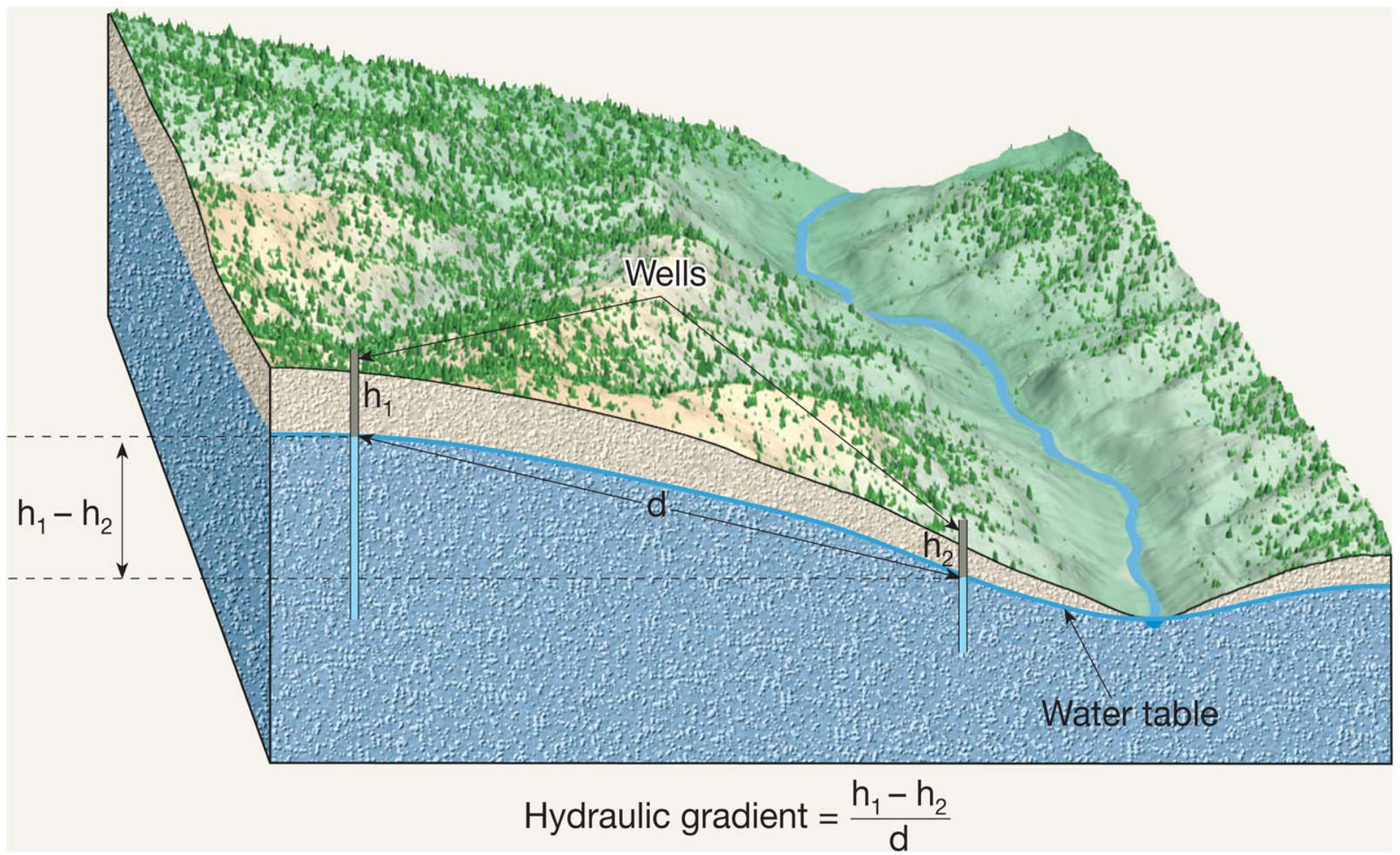


Now that the pollution is there, what can we do?



Now that the pollution is there, what can we do?

1. Stop polluting



DISCHARGE - the volume of water that flows through an aquifer in a specified time – Oahu average 25 yrs

Now that the pollution is there, what can we do?

1. Stop polluting ($)

   Military $5.6 billion in Hawaii in 2005; 125,000 jobs
   Hawaii pineapple industry worth $135 million annually
   pest control, petroleum industry, golfing…$$$

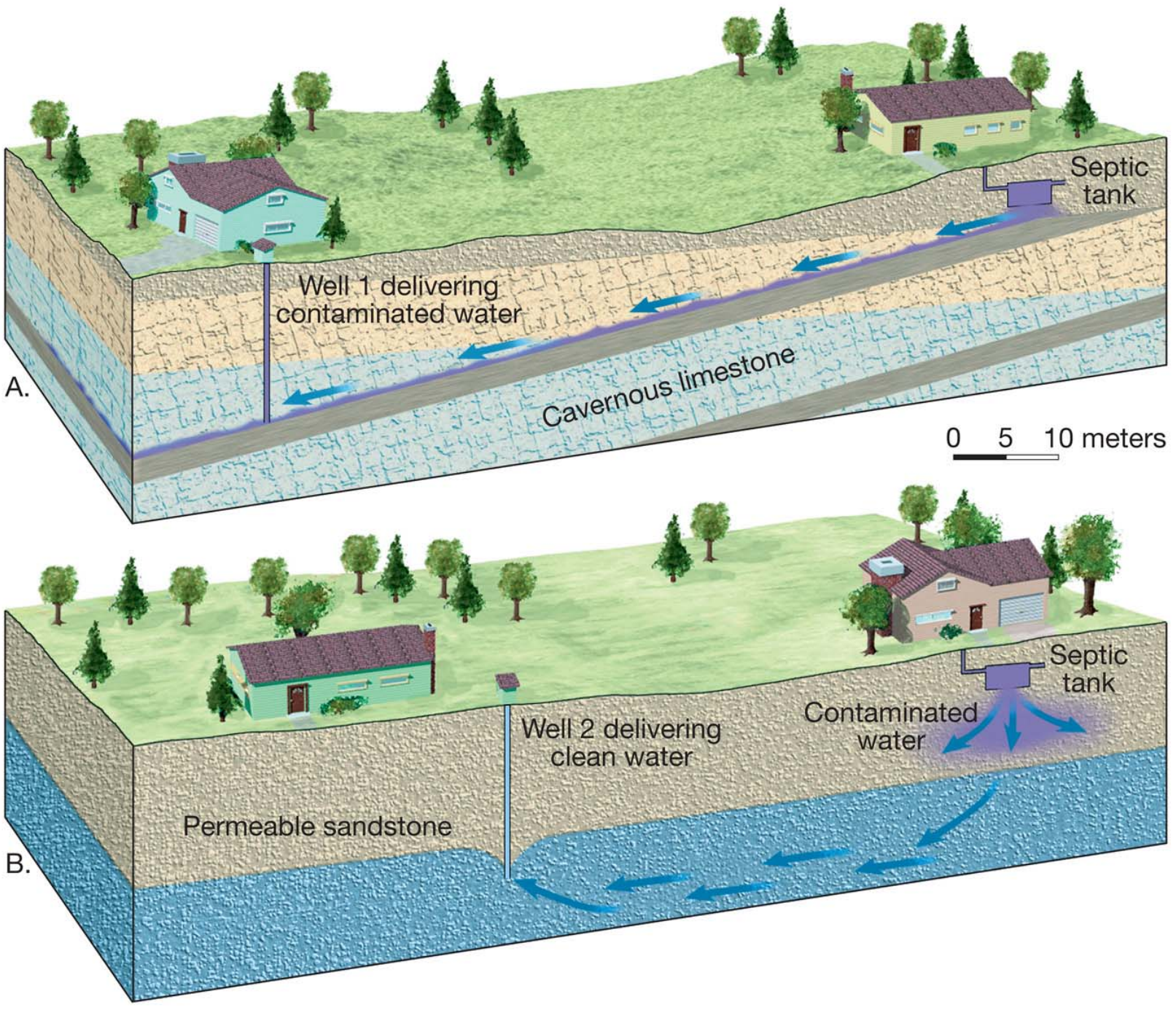
2. ?

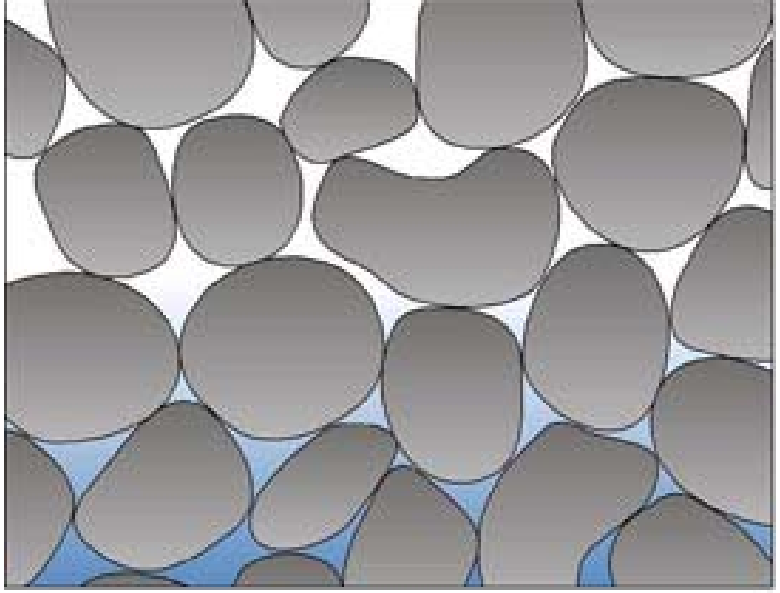
Now that the pollution is there, what can we do?

1. **Stop polluting ($)**

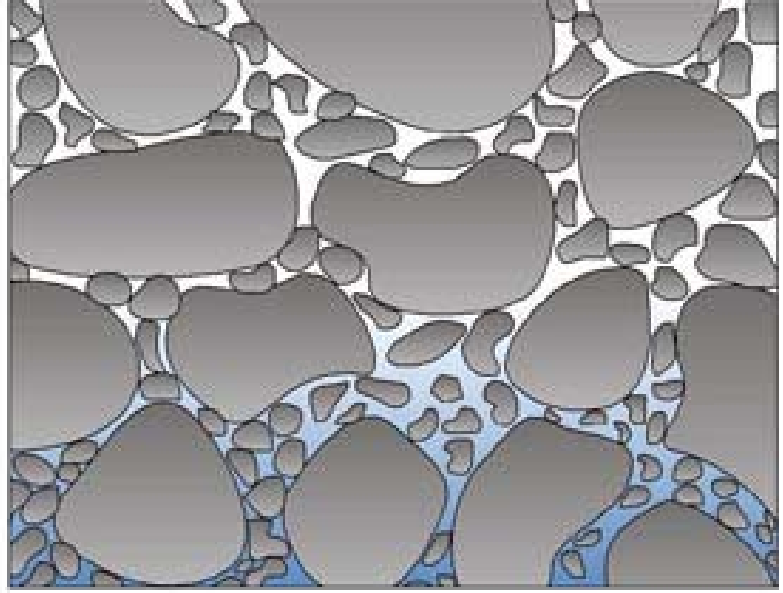
   Military $5.6 billion in Hawaii in 2005; 125,000 jobs
   Hawaii pineapple industry worth $135 million annually
   Pest control, petroleum industry, golfing…$$$

2. **Filtration**

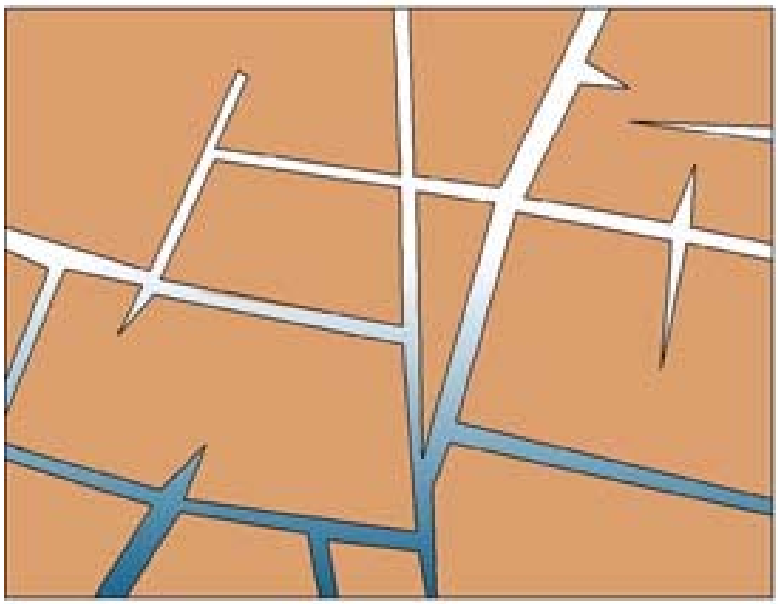

Septic tank
Well 1 delivering contaminated water
Cavernous limestone
A.
0 5 10 meters
Septic tank
Contaminated water
Well 2 delivering clean water
Permeable sandstone
B.



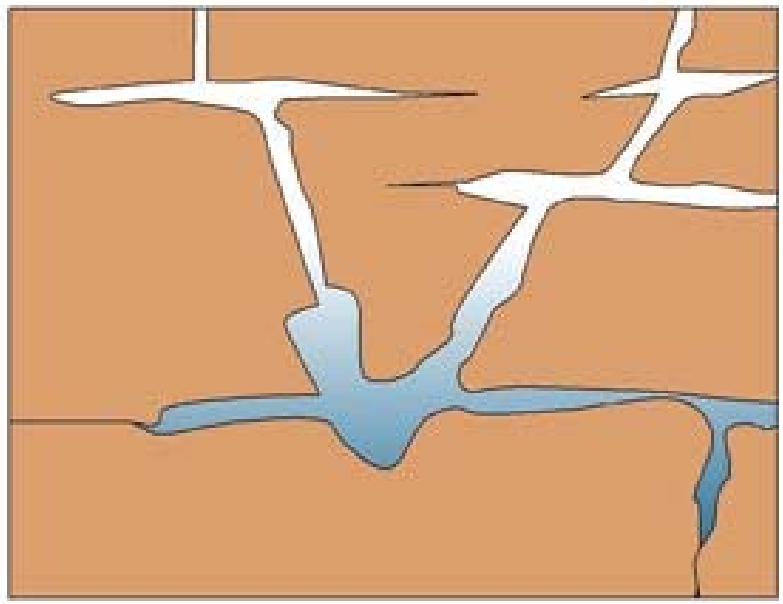
Well-sorted sedimentary material
(Alluvium of the South Platte River)



Poorly sorted sedimentary material
(Dawson, Denver, Arapahoe aquifers)



Fractured crystalline rocks
(Pikes Peak Granite)



Soluble rock-forming material
(Leadville Limestone)

Now that the pollution is there, what can we do?

1. Stop polluting ($)

Military $5.6 billion in Hawaii in 2005; 125,000 jobs
Hawaii pineapple industry worth $135 million annually
Pest control, petroleum industry, golfing…$$$

2. Install filtration systems ($)

$895-$8,000+ / household, municipal???

3. ?

Now that the pollution is there, what can we do?

1. Stop polluting ($)

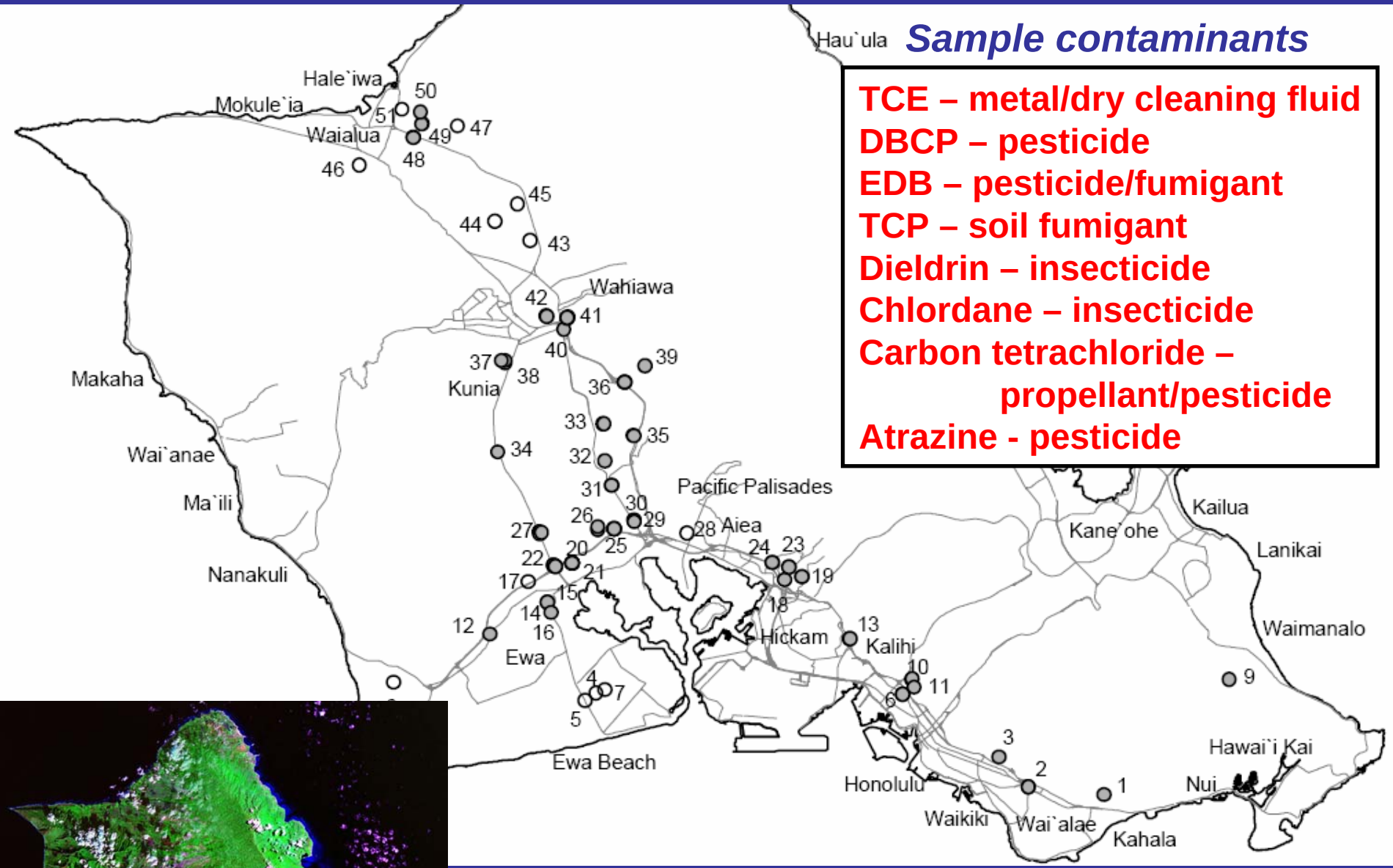
Military $5.6 billion in Hawaii in 2005; 125,000 jobs
Hawaii pineapple industry worth $135 million annually
Pest control, petroleum industry, golfing…$$$

2. Install filtration systems ($)

$895-$8,000+ / household, municipal???

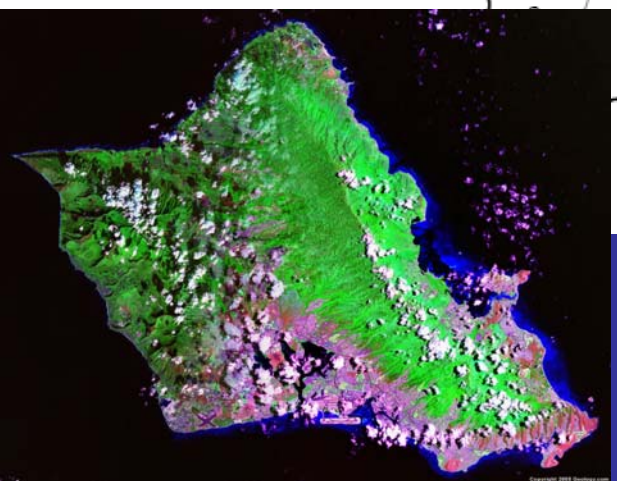
3. Monitor water quality ($)

Hawaii Department of Health Environmental Monitoring
Budget FY2007 - $243,953,098 ($201/person/year)



Sample contaminants

TCE – metal/dry cleaning fluid
DBCP – pesticide
EDB – pesticide/fumigant
TCP – soil fumigant
Dieldrin – insecticide
Chlordane – insecticide
Carbon tetrachloride – propellant/pesticide
Atrazine - pesticide



Contaminated drinking water wells on Oahu results from 1995-2005

- Safe Drinking Water
- Water Quality Report
- Our Drinking Water
- What You Can Do

PRINT THIS PAGE

CONSERVATION TIP

Remember, whatever you place on the ground may someday end up in our island water supply. It's up to all of us to do our part to make sure that our groundwater resources are protected for present and future generations.

SITE MAP | FAQ | CONTACT US

Enter Keywords GO!

Water Quality Report



The BWS Water Quality Report - also known as the "Consumer Confidence Report" (CCR) - is sent to all customers each summer. The CCR contains a wealth of information about your water quality.

Click to download the 2006 Water Quality Report (PDF)
Click to download the Water Quality Report for your specific area

This report does several things:

- Identifies the source which supplies water for your address
- Reports detected contaminants or elements in the water and ensures that your drinking water meets all safe drinking water standards
- Describes any treatment process used, if necessary, to make your water safe to drink
- Explains terms used in the regulation of drinking water
- Tells you where to go for additional information



What we all do and the habits that we practice every day will determine both the quality of our water and the quantity available for our use. Monitoring the quality of our water won't matter if we don't take care of our environment as individuals and as a community.

Oahu is blessed with water that is among the best quality in the world. At the Board of Water Supply (BWS), our job is to make sure it's also the safest.

That is why water from each of our sources is regularly tested. We must ensure that Oahu's water supply not only meets the Safe Drinking Water Act requirements, but also exceeds the most demanding regulations governing the quality of our drinking water.

As mandated under Federal and State law, the State Department of Health and the Board of Water Supply regularly test Oahu's drinking water for more than 100 different kinds of chemical "contaminants". At BWS, over 18,500 tests are conducted by our Chemical Laboratory.

Groundwater contaminants

REGULATED	
Alpha emitters Beta/photon emitters Radium 228	radioactive particles (naturally-occurring)
Nitrate	fertilizer
Barium	metal – drilling mud
Chromium	metal – making steel, dyes & pigments, chrome plating, leather tanning, wood preserving
1,2,3-Trichloropropane	industrial solvent, paint and varnish remover, cleaning and degreasing agent
Fluoride	dental health additive
UNREGULATED	
Sulfate	mineral (naturally-occurring)
Dieldrin	pesticide