Water Management and Water Reuse

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2007 Idaho Wastewater Reuse Conference
June 26 - 27, 2007
DoubleTree Riverside
Boise, Idaho

A Couple of Water Thoughts:

"Water is our most important natural resource."

A Couple of Water Thoughts:

"All the water on earth is all the water it has had or will have."

Presentation Overview

- Environment Ethics
- Urban Development
- (Integrated) Water Management
- Water sources
- Water Reuse

Environmental Ethics

Environmental Ethics

"Environmental ethics involves a moral responsibility for managing our natural environment."

Environmental Ethics

"Anthropocentric (human-centered) perspective emphasizes environmental protection for the survival and well-being of humans alone."

Environmental Ethics

"Ecocentric (nature-centered) perspective regards humans as only one element of the broader natural community, and bases moral responsibility on nature's essential value and rights."

Environmental Thought

Environmental ***ISSUES*** *are* ***EMOTIONAL***

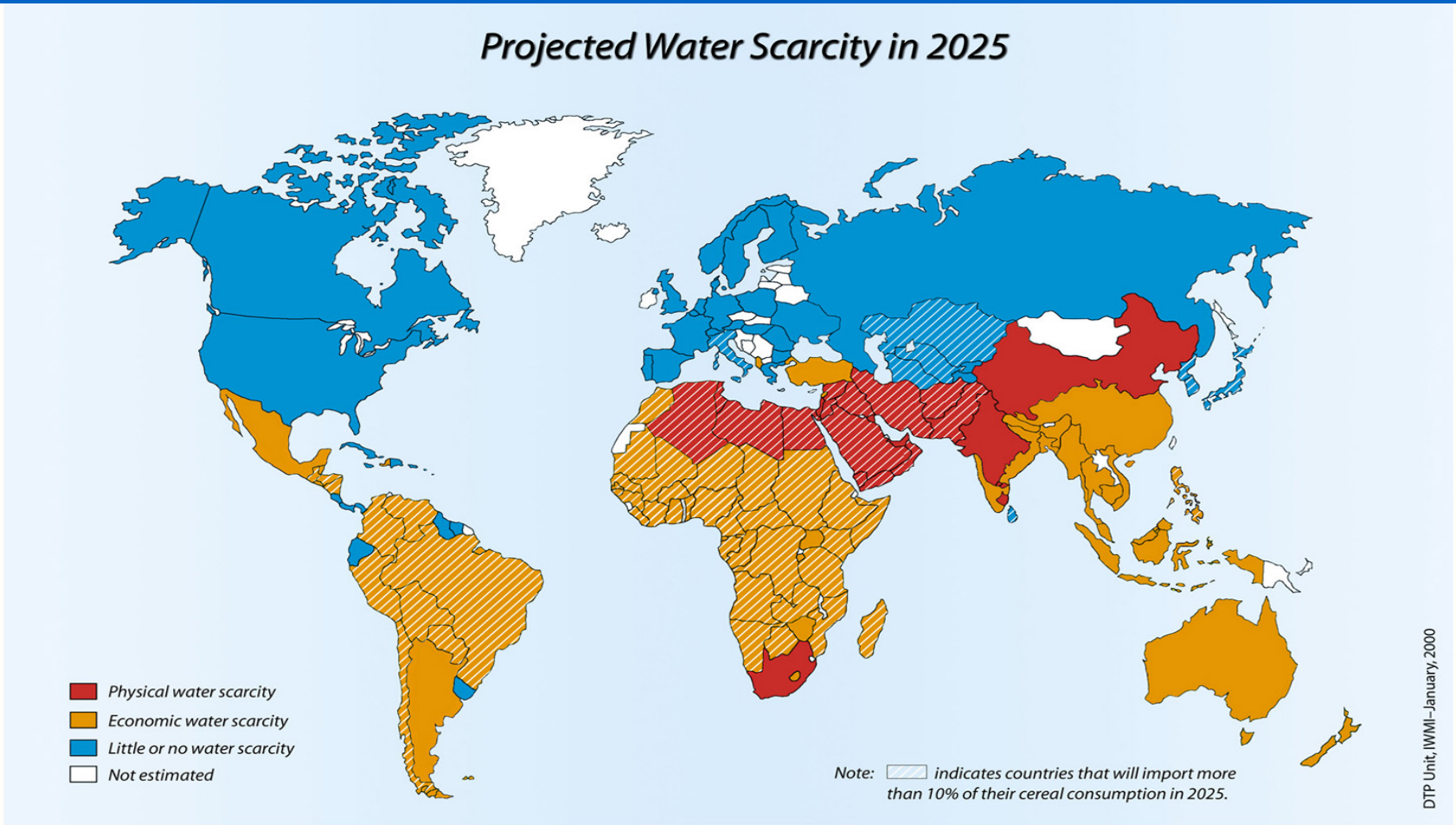
Environmental ***DECISIONS*** *are* ***POLITICAL***

Environmental ***SOLUTIONS*** *are* ***TECHNICAL***

Urban Development

World-wide Urban Development

World-wide Urban Development

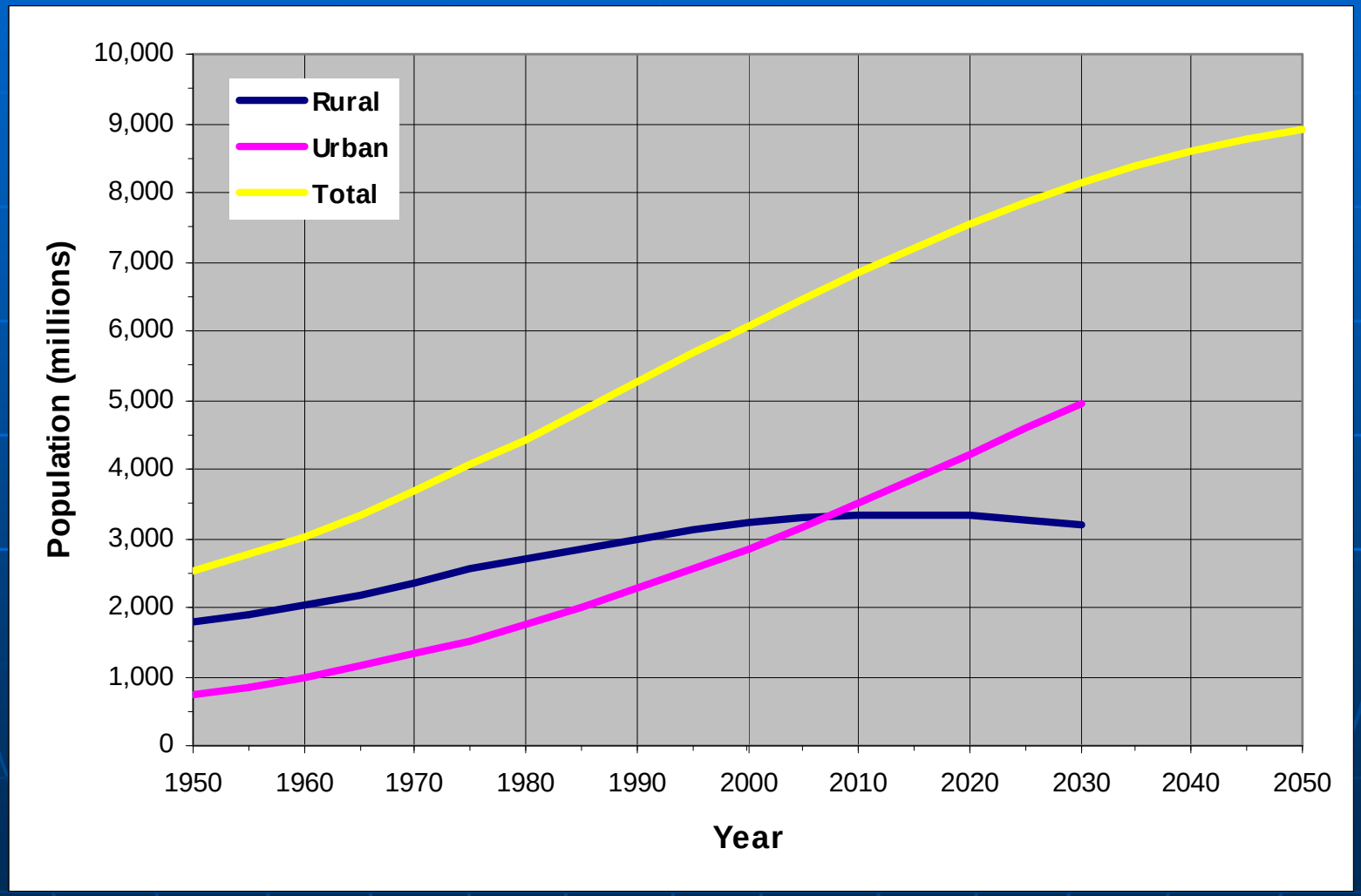


INTERNATIONAL WATER MANAGEMENT INSTITUTE

Prepared by IWMI as input for the World Water Vision, The Hague, March, 2000.

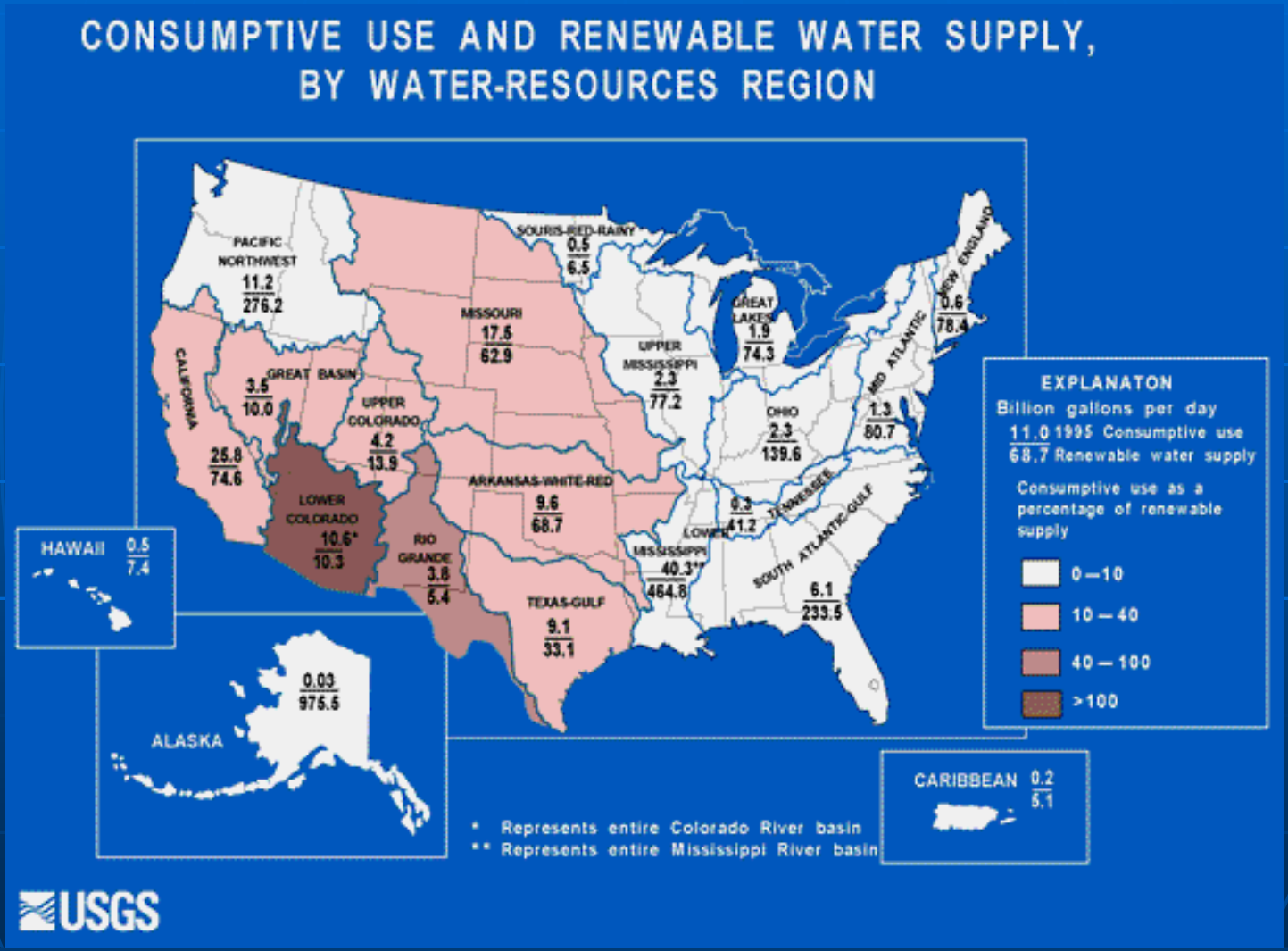
http://iwmi.org

Urban/Rural Population Projection World-wide

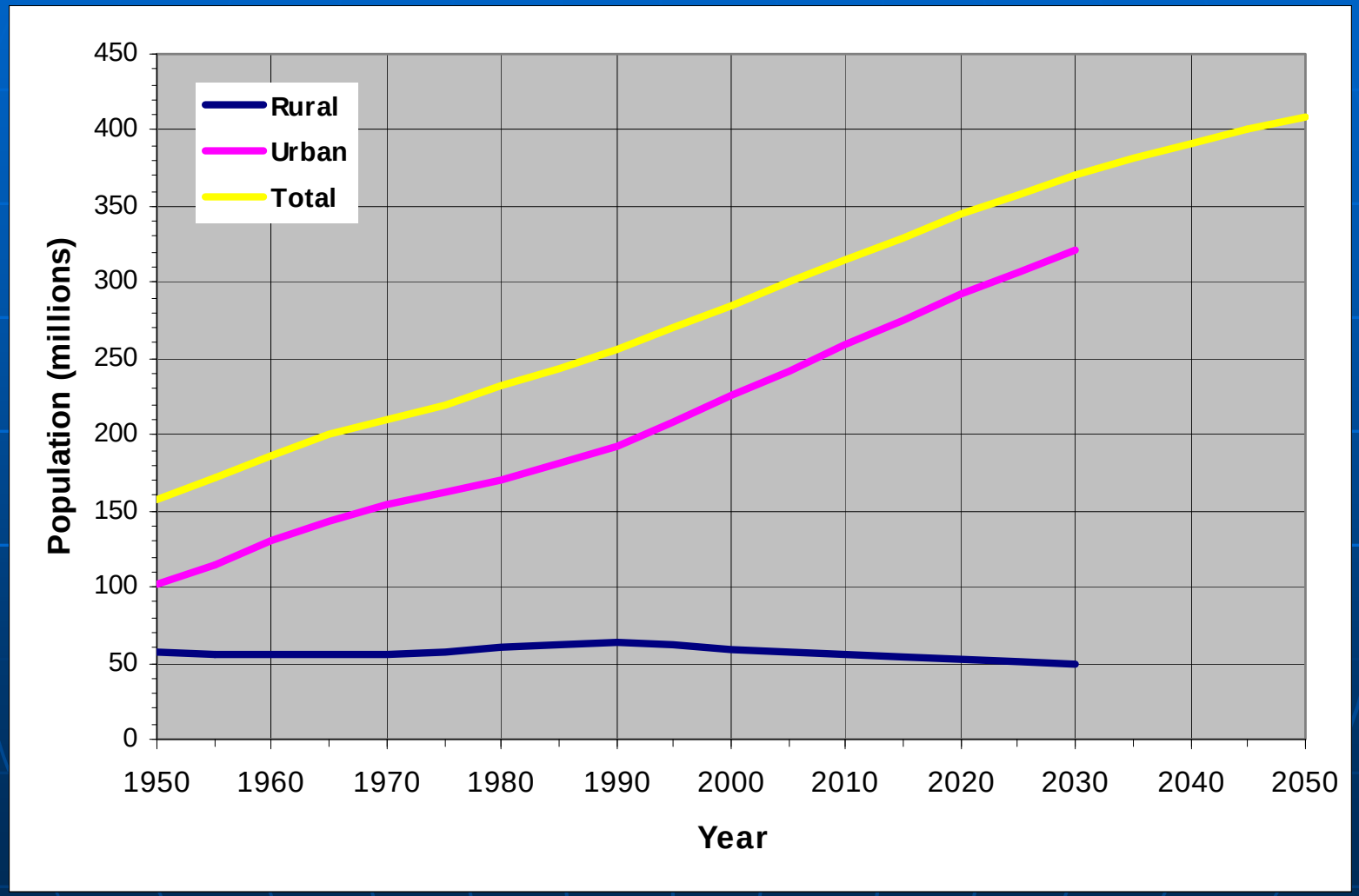


North American Urban Development

North American Urban Development



Urban/Rural Population Projection USA



Integrated Water Managment

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Integrated Water Management

A tool box that must have an all-inclusive approach that addresses an inventory of accomplishable requirements to be successful, while providing economic development, environmental quality, and meeting society needs.

Integrated Water Management

This means that we must develop, implement, monitor, enforce, and maintain short- and long-term policies (including laws and regulations) to protect and conserve our water sources, both traditional (surface and groundwater) and non-traditional (conservation, groundwater recovery, rainfall catchment, saltwater desalination, water recycling, and water transfers).

Integrated Water Management

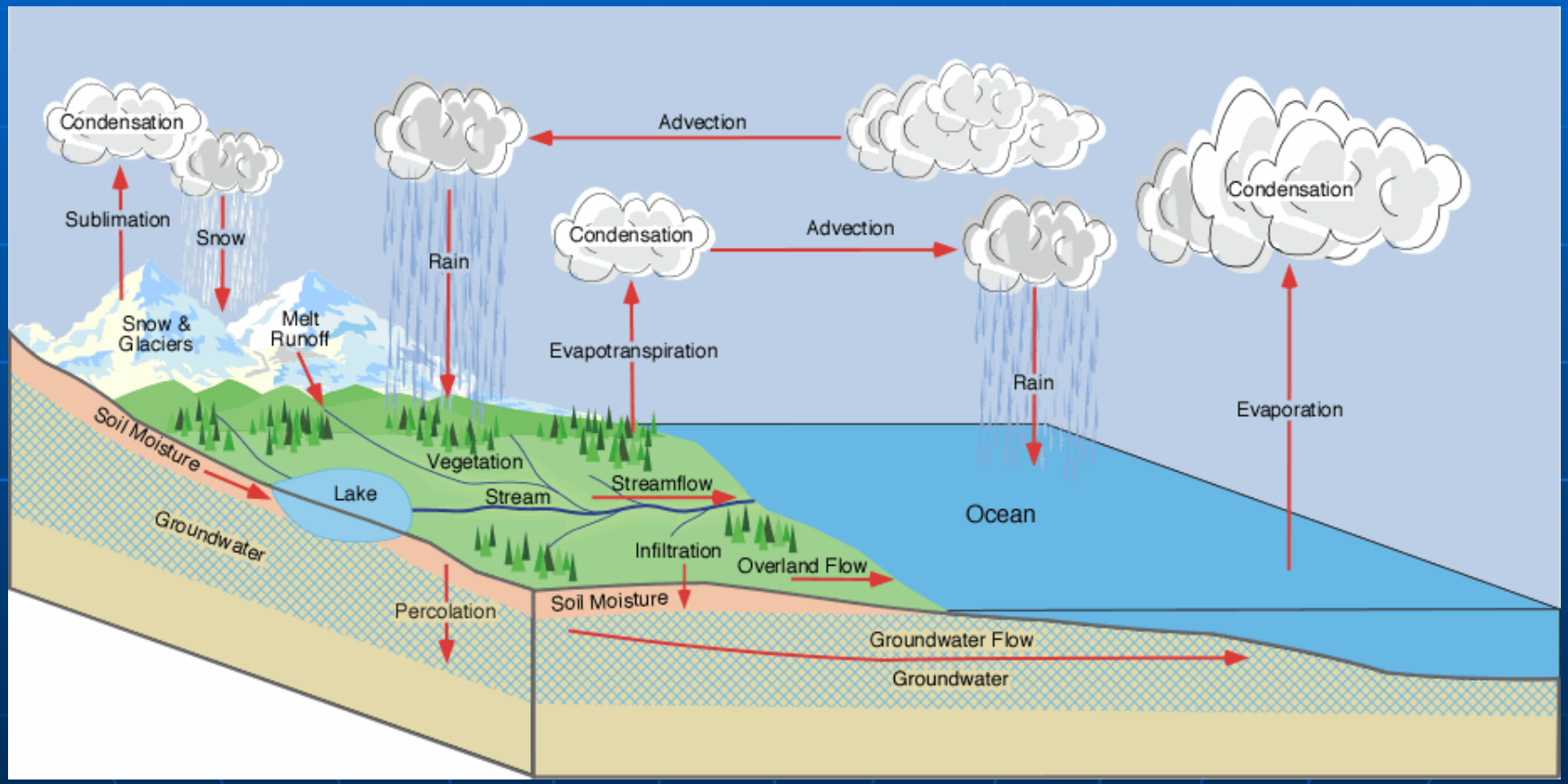
- Provides options for a long term, reliable water supply
- Determines a proper blend between demand management and supply augmentation
- Provides beneficial uses at a reasonable cost
- Provides highest possible benefits to water users
- While providing economic development, environmental quality, and meeting society needs.

IWM Considerations

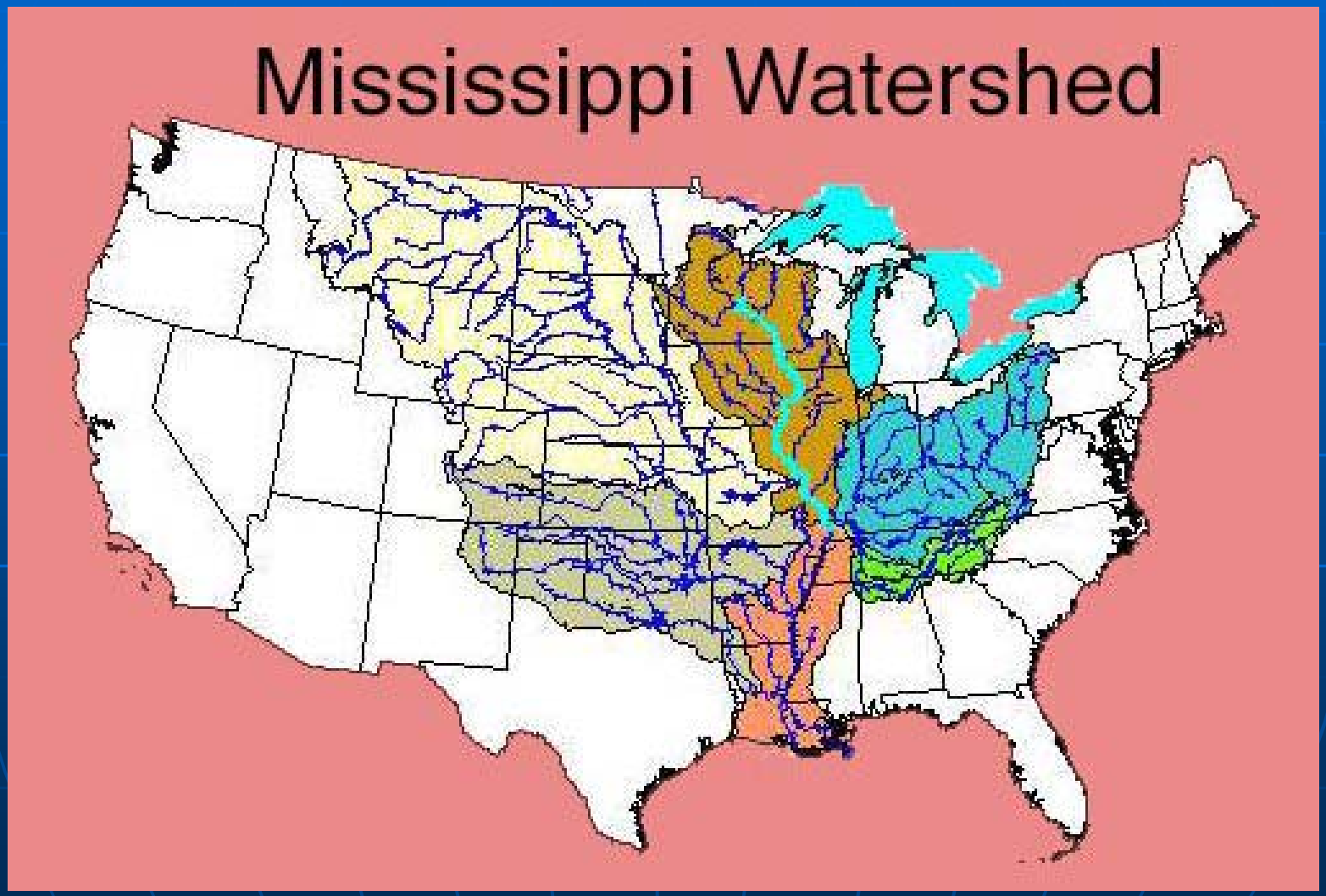
- Supply availability (traditional and non-traditional water sources)
- Water uses (agriculture, domestic, environmental, industrial, mining, and power)
- Supply enhancement (traditional and non-traditional water sources)
- Development of multiple management options
- Water quality and water quantity
- Water with other planning processes and resources (land use, flood control, transportation, energy)
- Cultural values (past, present, and future)
- Toolbox approach (develop a multitude of tools)

Water Sources

Hydrologic cycle



Think about the Politics



World Water Supply

Major stocks of water on earth
(thousand cubic kilometres)

Saltwater stocks	Volume (1000 km³)	Percentage of total water	Percentage of total fresh water
Oceans	1 338 000	96.54	
Saline/brackish groundwater	12 870	0.93	
Saltwater lakes	85	0.006	
Total salt water stocks	1 350 955	97.476	
Freshwater stocks			
Glaciers, permanent snowcover	24 064	1.74	68.7
Fresh groundwater	10 530	0.76	30.06
Ground ice, permafrost	300	0.022	0.86
Total frozen and underground freshwater stocks	*34 894*	*2.522*	*99.62*
Freshwater lakes	91	0.007	0.26
Soil moisture	16.5	0.001	0.05
Atmospheric water vapour	12.9	0.001	0.04
Marches, wetlands*	11.5	0.001	0.03
Rivers	2.12	0.0002	0.006
Incorporated in biota*	1.12	0.0001	0.003
Total not frozen or underground freshwater stocks	*135*	*0.0103*	*0.389*
Total freshwater stocks	35 029	2.5323	100
TOTAL WATER ON EARTH (1000 km³)	1 385 984	100	

Source: Adapted from Peter H. Gleick. *The World's Water 2000-2001.* Washington, D.C. Island Press, 2000.

Note: Totals may not add due to rounding

*Marshes, wetlands and water incorporated in biota are often mixed salt and fresh water.

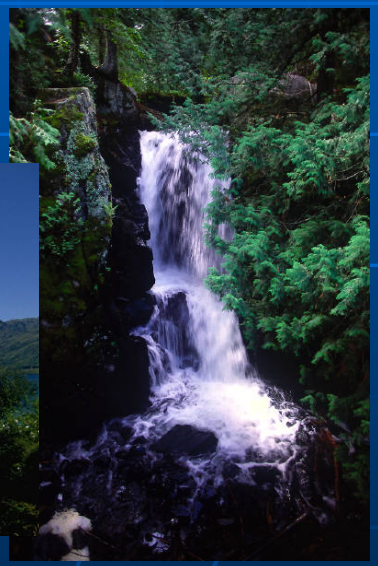
Saltwater = 97.5 %

Freshwater = 2.5 %

- Frozen = 69.6 %
- Groundwater = 30 %
- Surface water = 0.4 %

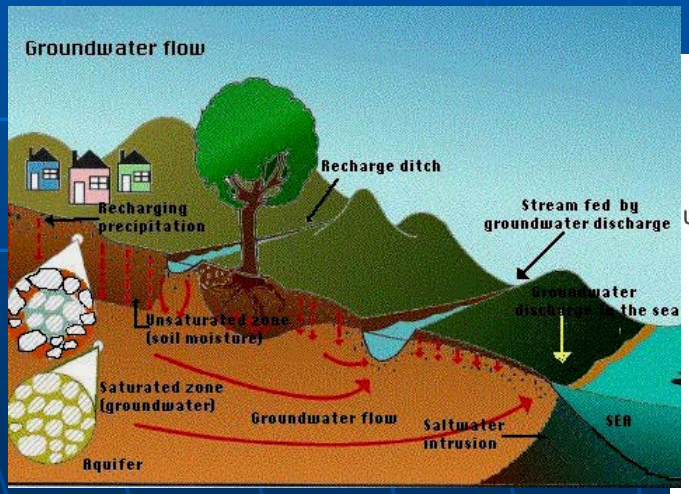
Water Sources (Traditional)

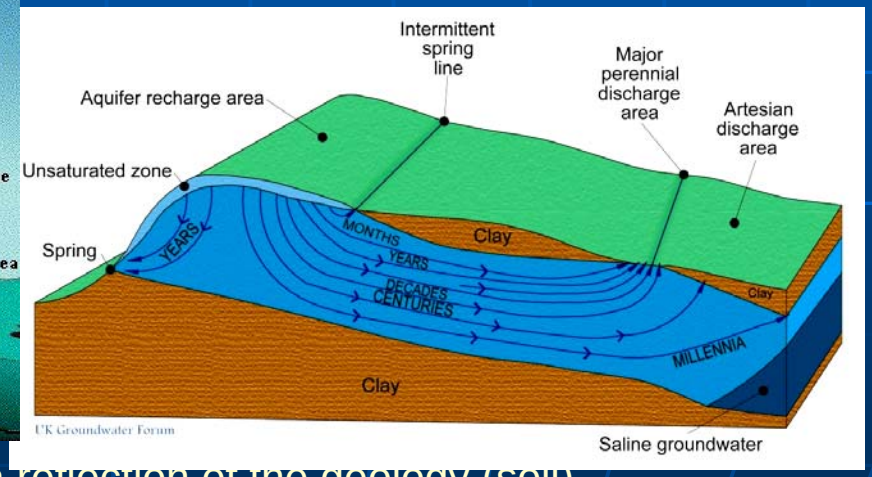
- Surface water
  - all water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.)
  - water quality associated with particulates, color, taste, odor, natural organic matter (NOM) and microbial organisms



Water Sources (Traditional)

- Groundwater
  - the supply of fresh water found beneath the earth's surface (usually in aquifers) often associated with wells and springs
  - water quality associated with high hardness (Ca^{+2}, Mg^{+2}), iron (Fe^{+2}) and manganese (Mn^{+2})



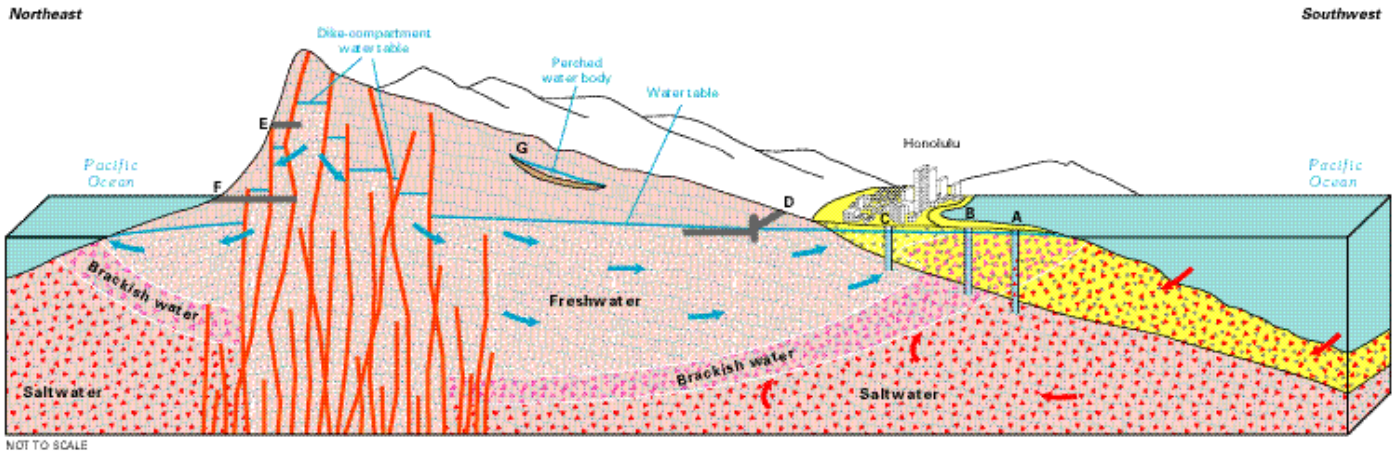


remember: a reflection of the geology (soil)

Water Sources (Traditional)

- Groundwater

Figure 39. On Oahu, freshwater is in a lens and dike-impounded water bodies and can be confined or unconfined. Wells A, B, and C are completed in a confined volcanic-rock aquifer. Well A produces only saltwater, well B produces brackish water, and well C produces freshwater. Shaft D produces large quantities of freshwater by skimming ground water just below the water table. Shafts E and F are constructed at different altitudes in dike-impounded water bodies; shaft F intercepts more dikes and likely will supply larger quantities of freshwater than shaft E. A bed of low-permeability ash creates a localized perched water body at site G.



Modified from Macdonald, G.A., Abbott, A.T., and Peterson, F.L., 1983, Volcanoes in the sea: The geology of Hawaii (2nd ed.): Honolulu, Hawaii, University of Hawaii Press, 517 p.

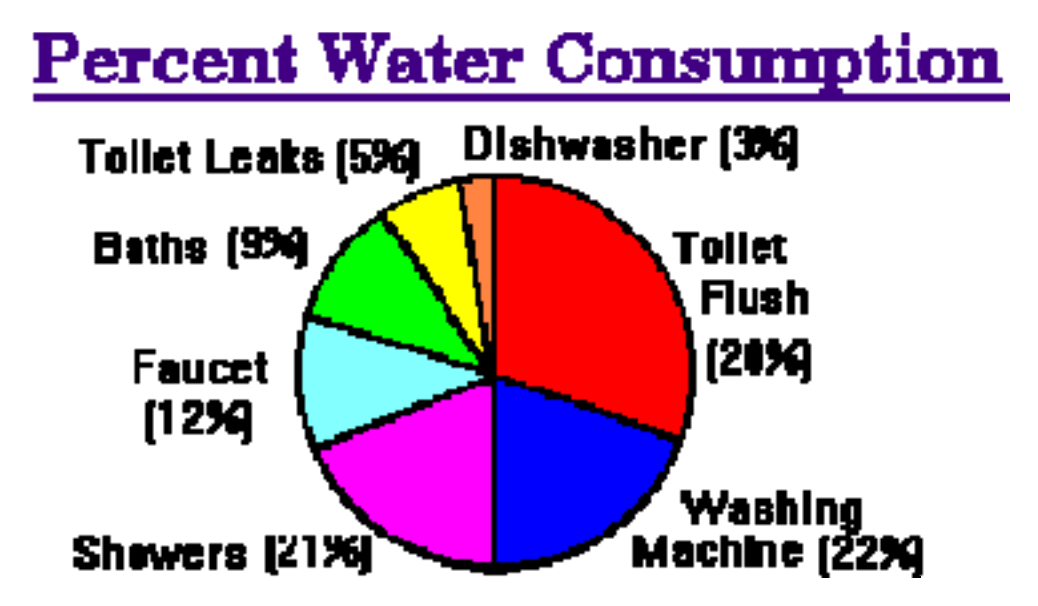
remember: a reflection of the geology (soil)

Water Sources (Non-Traditional)

- Conservation
- Groundwater recovery (aquifer storage and retrieval)
- Rainfall catchment
- Saltwater desalination (from the *really big* surface water)
- Water recycling
  - Domestic
  - Industrial
  - Agriculture
  - Commercial
- Water transfers

Water Uses

- Residential
  - Single family units
  - Multi-family units
    - Apartments
    - Condominiums
    - Townhouses
- Non-residential
  - Businesses
  - Commercial
  - Government
  - Industrial
  - Institutional



Water Reuse

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Water Reuse

- Urban growth in the Western U.S. and increasing concerns for environmental and recreational uses conflict with water requirements for western farms and ranches
- This has prompted the U.S. Bureau of the Interior to develop *Water 2005*, with these goals as a minimum:
  - promote forward-looking focus on water starved areas
  - assist water purveyors while protecting environmental needs and strengthen regional, tribal, and local economies
  - provide added environmental benefits to watersheds and waterways
  - provide a balanced, practical approach to water management

Water Reuse (cont'd)

- United Nations Economic and Social Council stated a policy in 1958 that, "No higher quality water, unless there is surplus of it, should be used for a purpose that can tolerate a lower grade."
- Reclaimed water use for non-potable uses offers a "new" resource that can be substituted for existing potable sources
- Arid and semi-arid areas are incorporating reuse
- Some Municipalities requiring nutrient (N and P) reductions are implementing reuse programs to avoid discharging into environmentally sensitive surface waters

Water Reuse (cont'd)

Recycled water recommendations

Description	WHO	U.S. National	Hawai'i
Process requirements	wastewater stabilization ponds (series)	oxidation, filtration, disinfection	oxidation, filtration, disinfection
Microbe of concern	helminths (worms)	virus	virus
Indicator organism	faecal coliform	fecal coliform	fecal coliform

Water Reuse (cont'd)

Recycled water barriers and uses

Treatment	Barriers, number	Recycle water use
secondary, disinfection	3	restricted access area irrigation, agricultural use - food crops not contacting edible portion and non-food crops, landscape impoundment - non-contact access, construction use - compaction, dust control, aggregate washing and concrete, urban use - irrigation, vehicle washing, toilet, fire protection, etc
secondary, filtration, disinfection	4	agricultural use - food crops contacting edible portion, recreational impoundments - incidental and full contact, industrial use - recirculation cooling, environmental use - wetlands, marshes, wildlife habitat, and stream augmentation

Water Reuse (cont'd)

Recycled water barriers and uses

Treatment	Barriers, number	Recycle water use
secondary, filtration, disinfection, advanced treatment	≥ 5	indirect potable reuse - groundwater recharge, spreading basin, groundwater injection well, surface water augmentation, industrial use - boiler makeup water and high purity water, saltwater intrusion barrier

Recycled Water Uses in Hawai‘i

Recycled Water Uses in Hawai‘i

Challenges in Water Reuse

- Resource sustainability
- Water resource opportunities
- Economic considerations
- Public policy
- Regulations

Resource Sustainability

- Create and implement integrated and adaptable systems while optimizing water use efficiency
- Solutions
  - require water conservation
  - develop water supplies including marginal water (both quality and quantity)
  - import water
  - use treated municipal wastewater for non-potable uses
- Natural ecosystems must be preserved and restored
- Must include aspects that vary over time and space (energy, resource use, and environment pollution)

Water Resource Opportunities

- Agricultural irrigation and industrial use evolved based on proximity
- Golf irrigation evolved based on proximity and water conservation (mandated to conserve potable water)
- Treatment decentralization is opportunity based on need
- Keep in mind that reused water is a sustainable source with great reliability

Economic Opportunities

- Highly dependent on local conditions (reclaimed water location, users location, water quality needs, additional treatment?, competing water sources cost)
- Water supply considerations:
  - water acquisition cost (including water rights)
  - facility capital cost
  - operating cost
  - maintenance cost
  - financing cost
- Water reuse considerations:
  - incremental treatment cost (capital, operation, and maintenance)
  - infrastructural cost to deliver water

Economic Opportunities (cont'd)

- Offsetting cost factors:
  - loan and grant programs (where available)
  - revenue generated from water sales
  - potable water treatment costs saved
  - avoided water source development costs

Public Policy

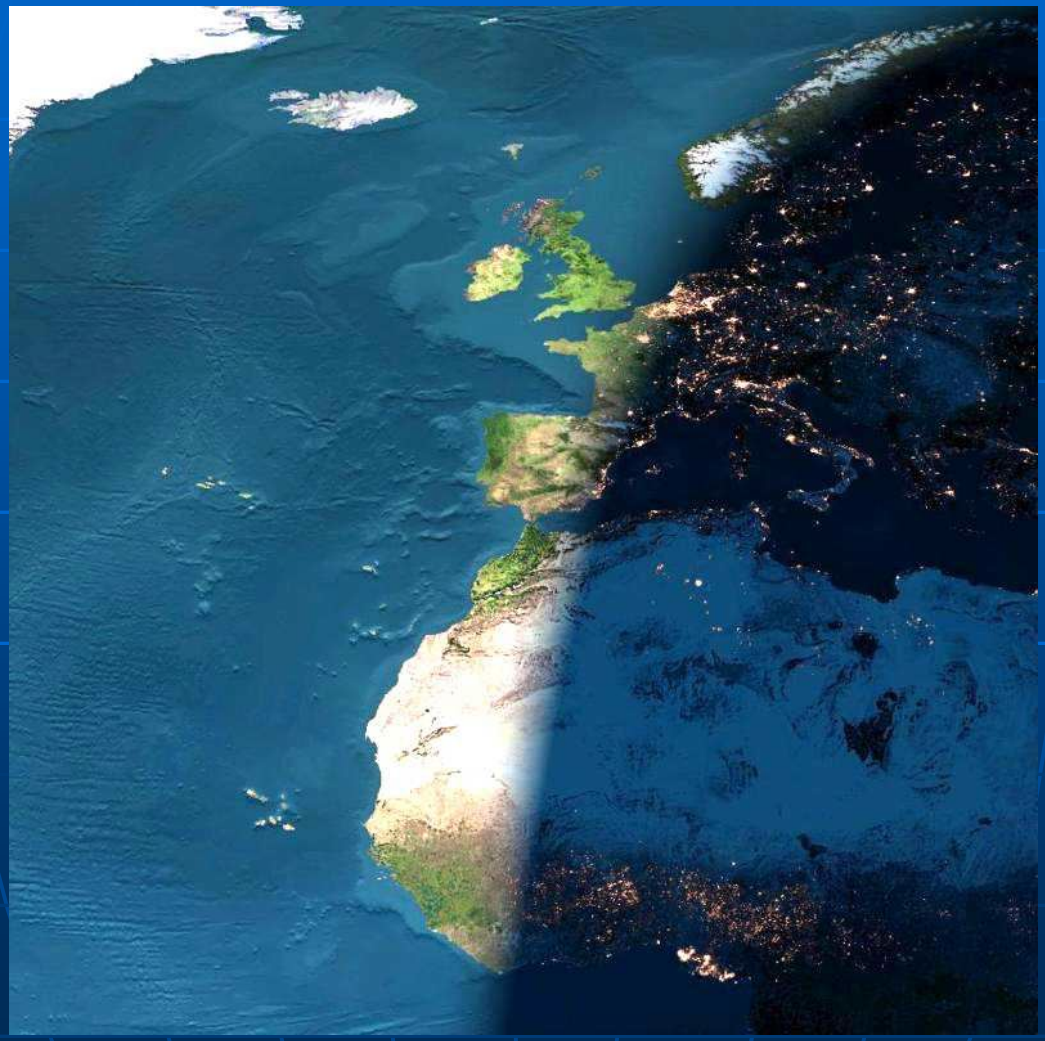
- Must have advocates (champions) from all groups:
  - general public
  - potential users
  - water purveyors
  - environmental organizations
  - special interest groups
  - home owners associations
  - regulators (agencies)
  - educational institutions, political leaders
  - agricultural organizations
  - business/academic/community leaders

Regulations/Guidelines

State	Arizona	California	Florida	Hawai‘i	Idaho	Washington
Treatment	secondary, filtration, disinfection	oxidized, coagulated, filtered, disinfected	secondary, filtration, high-level disinfection	oxidized, filtered, disinfected	oxidized, coagulated, clarified, filtered, disinfected	oxidized, coagulated, filtered, disinfected
BOD_5	NS	NS	20 mg/L $CBOD_5$	NS	5 mg/L	30 mg/L
TSS	NS	NS	5 mg/L	NS	NS	30 mg/L
Turbidity	2 NTU avg 5 NTU max	2 NTU avg 5 NTU max	NS	2 NTU max	2 NTU avg 5 NTU max	2 NTU avg 5 NTU max
Coliform	Fecal non-detect 4 of 7 23/100 mL max	Total 2.2/100 mL median 23/100 mL max	Fecal 75% non-detect 25/100 mL	Fecal 2.2/100 mL median 23/100 mL max	Total 2.2/100 mL median 23/100 mL max	Total 2.2/100 mL median 23/100 mL max

Conclusions

Conclusions

- Recycled water is a valuable resource and should be integrated with other water sources to provide a complete water resources package for us to use.
- Water purveyors should complete an integrated water management plan and update every 5 years.
- We need to work more closely and cooperatively with the public to insure success.

Our Environment