Purified Recycled Water
Global Drivers and Trends

Brian Good, Denver Water

June 17, 2015

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Topics

- Brief History of Water Recycling
- Drivers of Water Recycling
- Water Recycling Around the Globe
- Final Thoughts

Brief History of Water Recycling

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Historical Water Recycling

- Use of wastewater for agricultural irrigation goes back at least 5,000 years
  - Minoans in ancient Greece
- Wastewater used for agriculture in Europe
  - Germany and United Kingdom since 16th and 18th centuries
- Problem: waterborne disease outbreaks

Evolution of Water Recycling in the U.S.

- It's been around a LONG time!
  - 1926 Grand Canyon Village, Arizona
  - 1961 Colorado Springs, Colorado
  - 1970s St. Petersburg, Florida
- Initially for irrigation & power generation

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Evolution of Modern Water Recycling

- Then purified and blended with other sources for drinking
  - Scottsdale, AZ
  - Wulpen, Belgium
- Then purified for direct drinking
  - Windhoek, Namibia 1969

Drivers of Water Recycling

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Drivers of Water Recycling

- Water Scarcity
- Sustainability and the Environment

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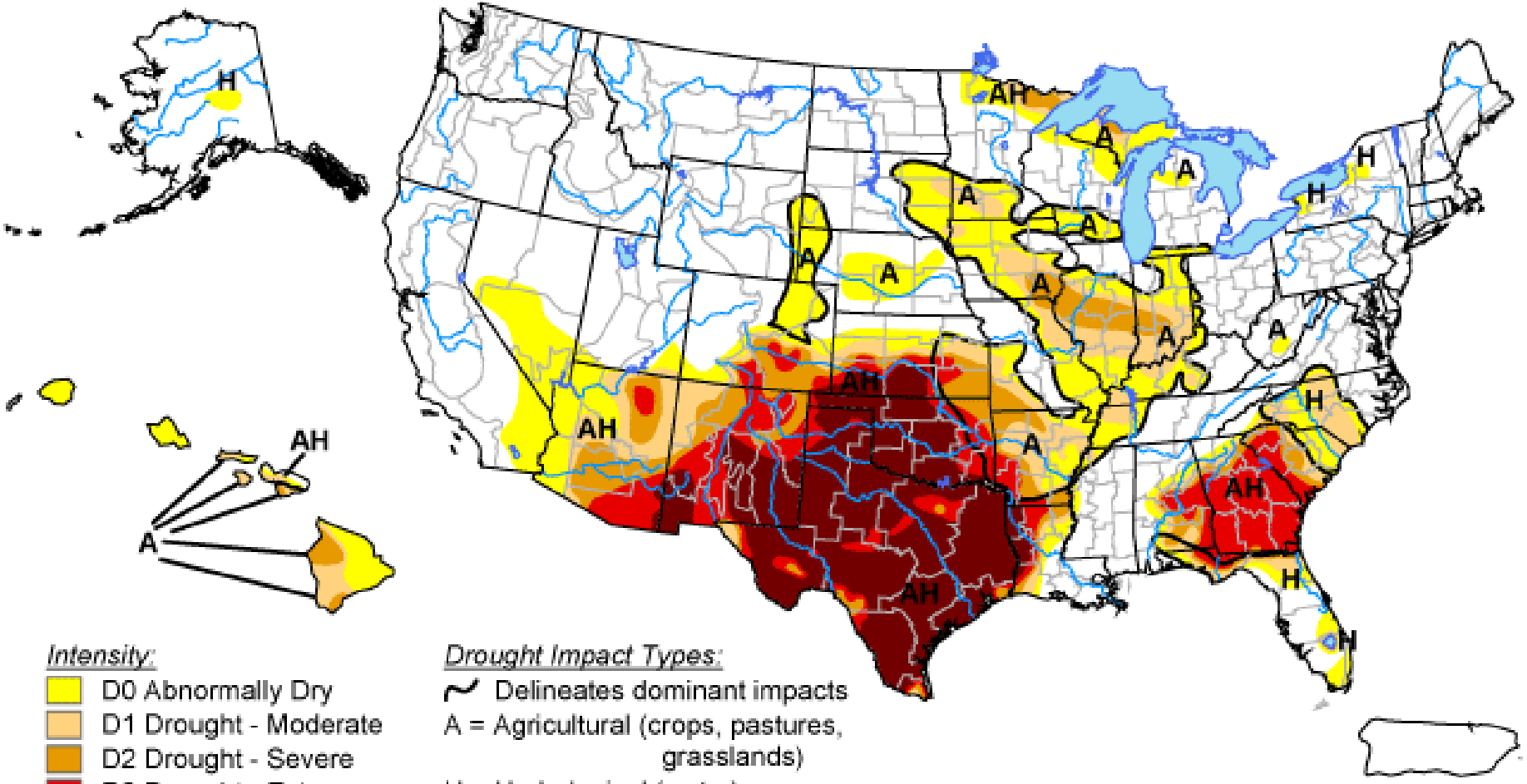
U.S. Drought Monitor

September 13, 2011
Valid 8 a.m. EDT



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:
- ~ Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, September 15, 2011

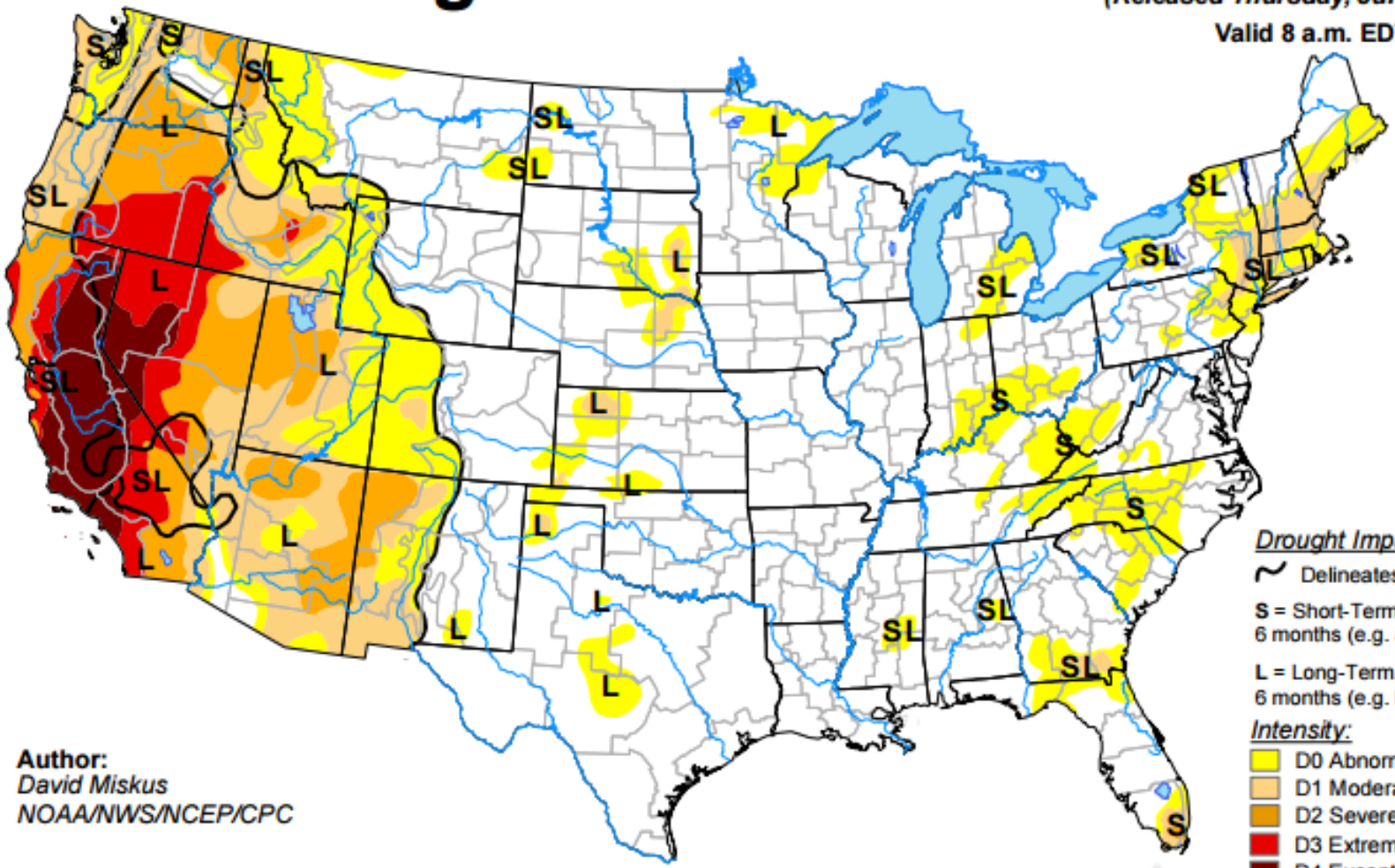
Author: Mark Svoboda, National Drought Mitigation Center

U.S. Drought Monitor

June 9, 2015

(Released Thursday, Jun. 11, 2015)

Valid 8 a.m. EDT



Author:
David Miskus
NOAA/NWS/NCEP/CPC

Drought Impact Types:

~ Delineates dominant impacts

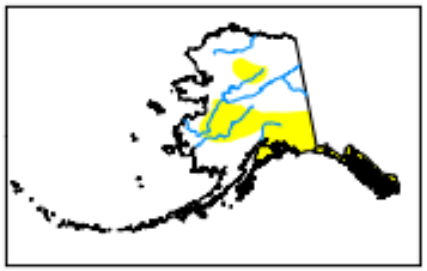
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)

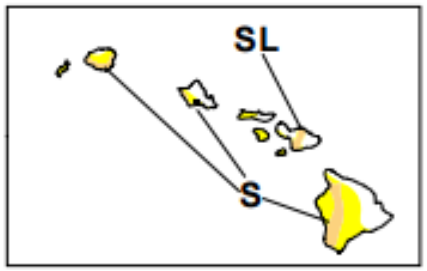
L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

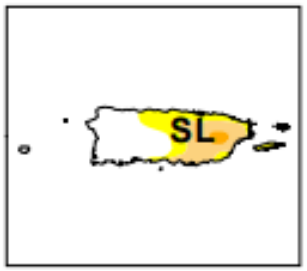
Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.



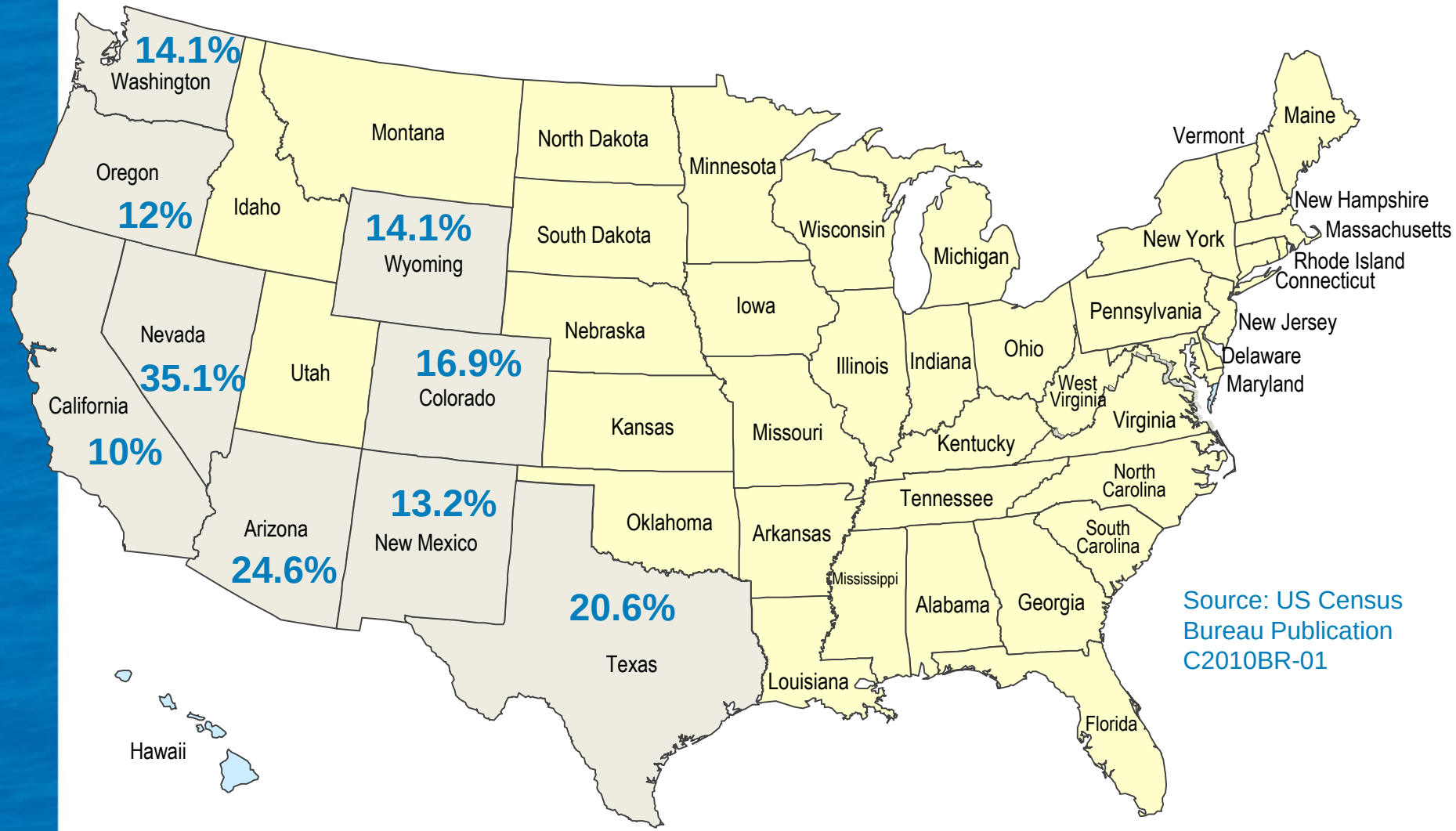




USDA National Drought Mitigation Center

http://droughtmonitor.unl.edu/

Population Increase 2000-2010



Source: US Census Bureau Publication C2010BR-01

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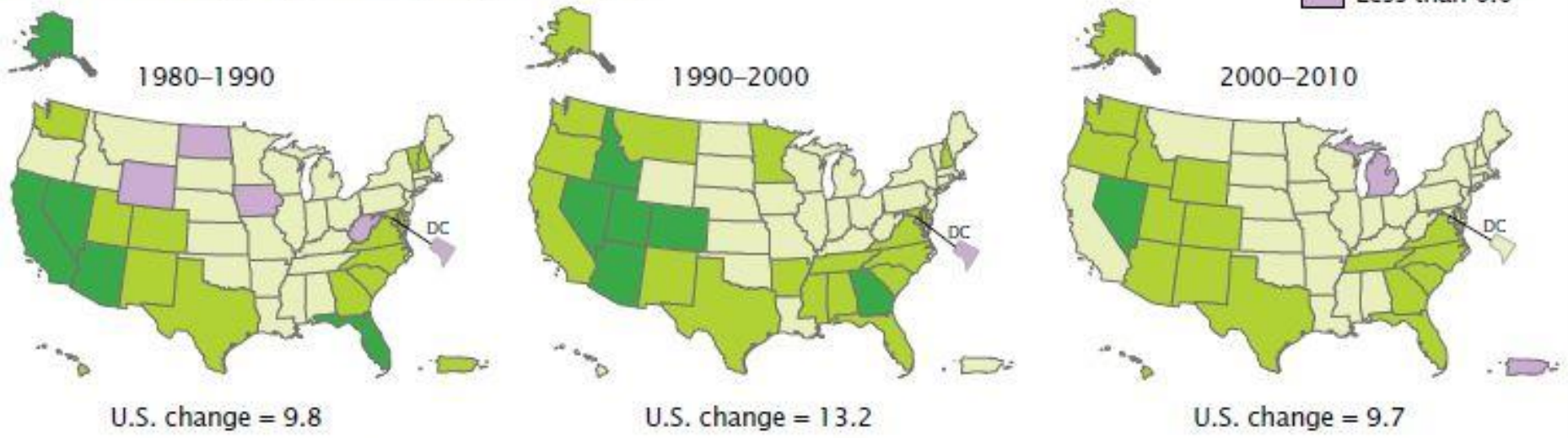
Figure 3.

Percentage Change in Population by State and Decade: 1980–1990 to 2000–2010

(For information on confidentiality protection, nonsampling error, and definitions, see *www.census.gov/prod/cen2010/doc/pl94-171.pdf*)



Source: U.S. Census Bureau, 2010 Census, Census 2000, 1990 Census, and 1980 Census.

Graphic Source: US Census Bureau Publication C2010BR-01

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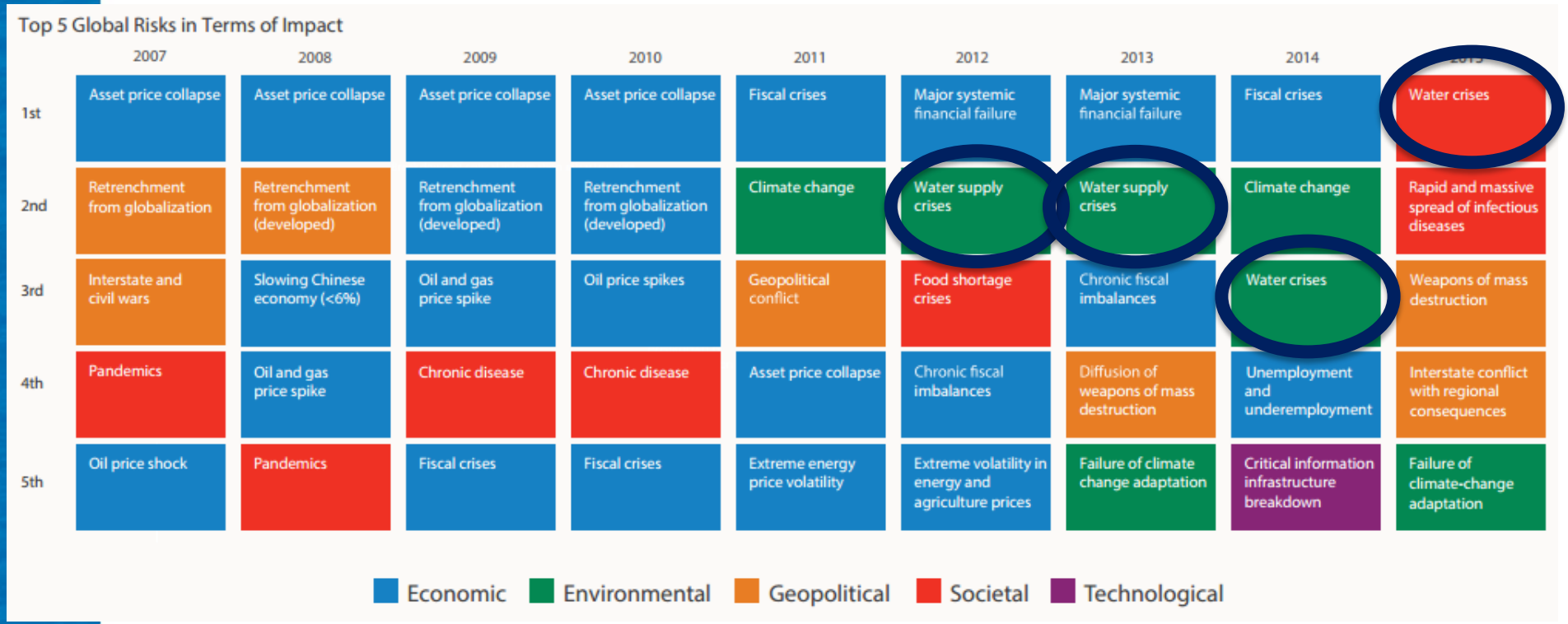
Water Scarcity - Who Cares?



Source: World Economic Forum

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Sustainability / Environmental Reasons for Water Recycling

Photo credit: History.com

Photo credit: United States Geological Survey

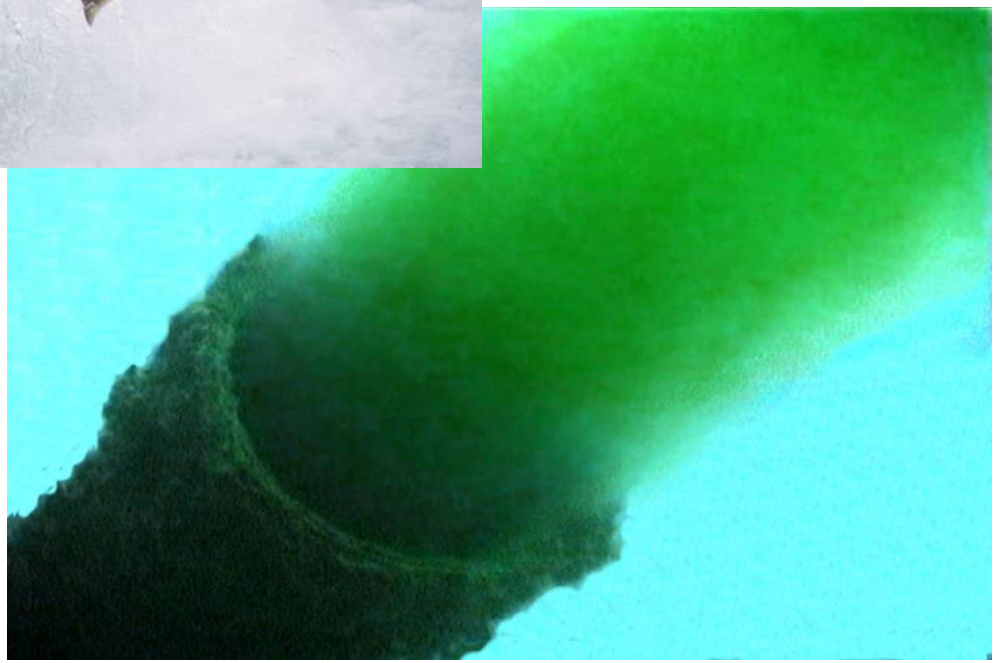

Photo credit: ReefRescue.worldpress.com

Sustainability / Environment:
Increased Demand For Industrial Water Recycling

Hospitality

Ritz Carlton Hotel, India

Shopping Centers

Shopping Mall, Brazil

Venues

Target Field, Minnesota, USA

Food & Beverage

Food Manufacturing, Philippines

Breweries

Brewery, Venezuela

Dairy

Dairy company, Texas, USA

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Sustainability / Industrial Water Recycling

- An emphasis on corporate social responsibility
- “Sustainability” and “sustainable development” are currently in-vogue
- Many Fortune 500 companies have definitive aspirational goals for reducing their energy, water, and environmental footprints
- Increasing demand for water to support oil and gas exploration / development

PEPSICO

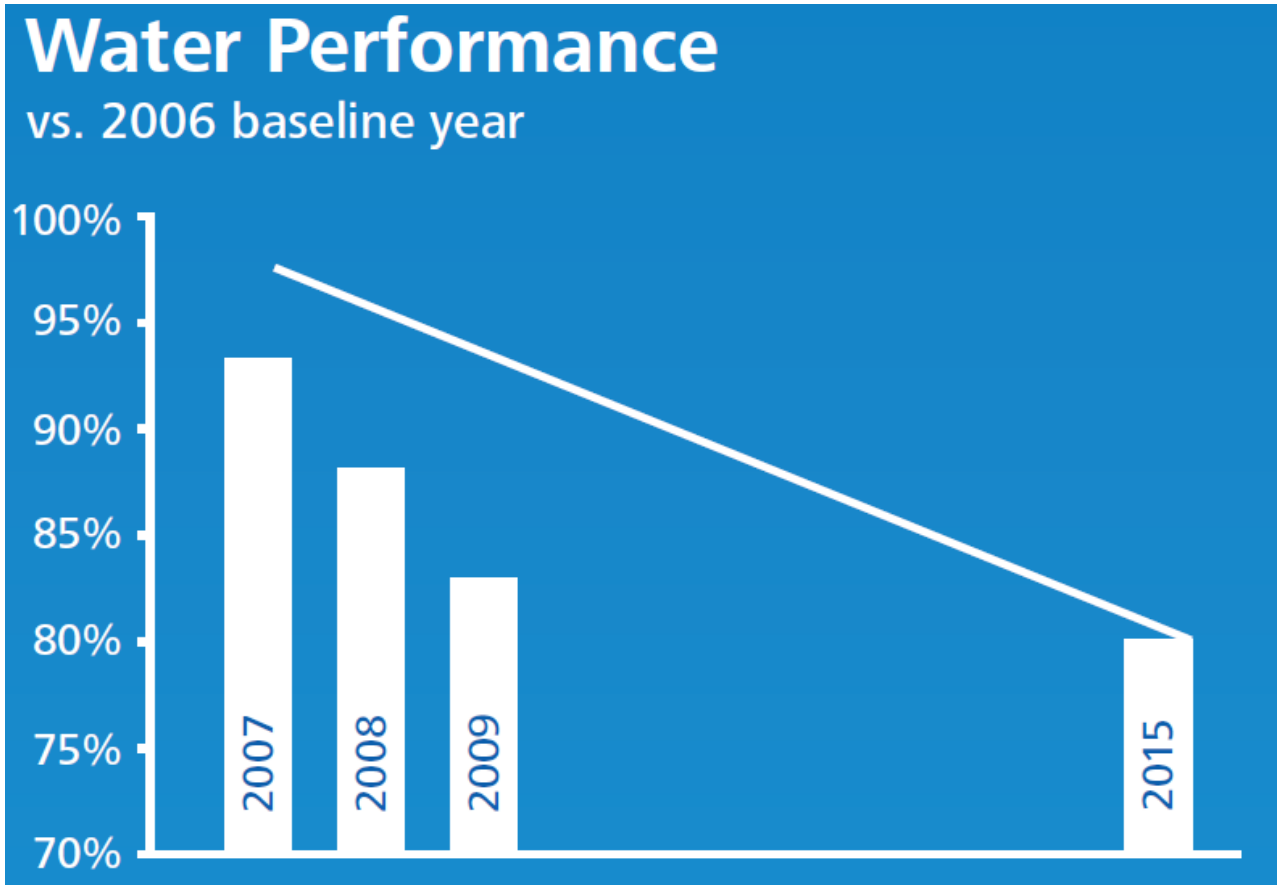
Company-wide targets for 2015 using 2006 baseline:

- Electricity – 20%
- Fuel – 25%
- Water – 20%

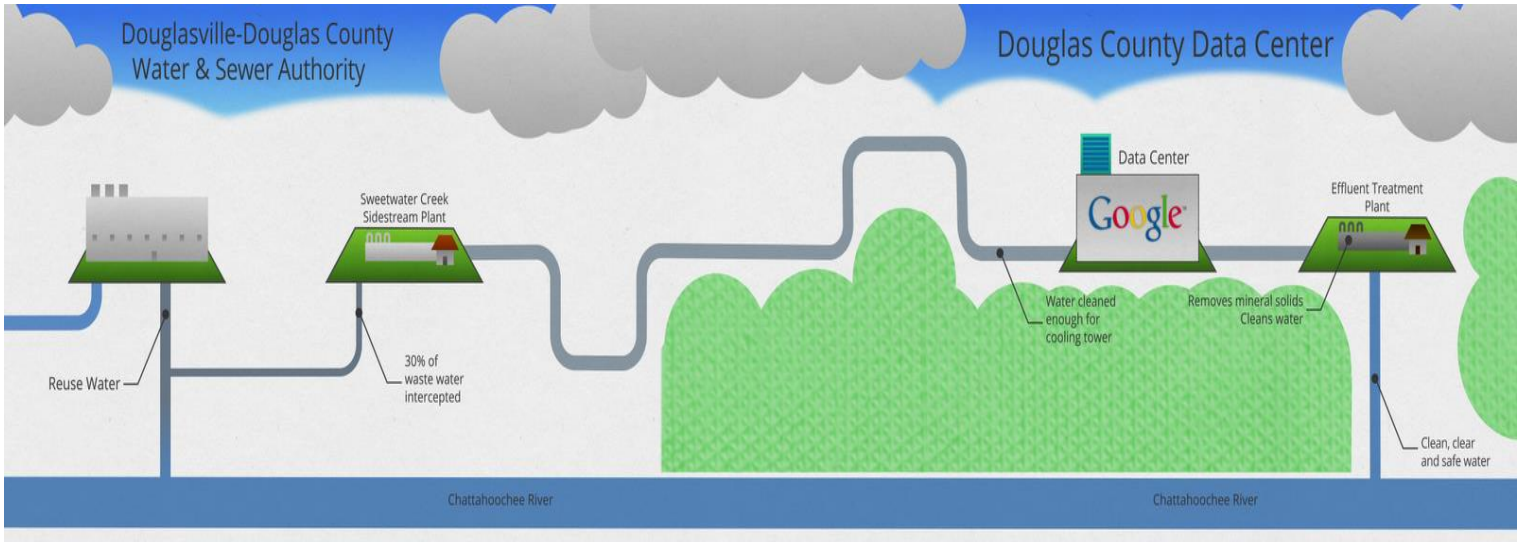
Source: Pepsico Water Report

"...by addressing water, energy and food security together, the impact is much more synergistic."

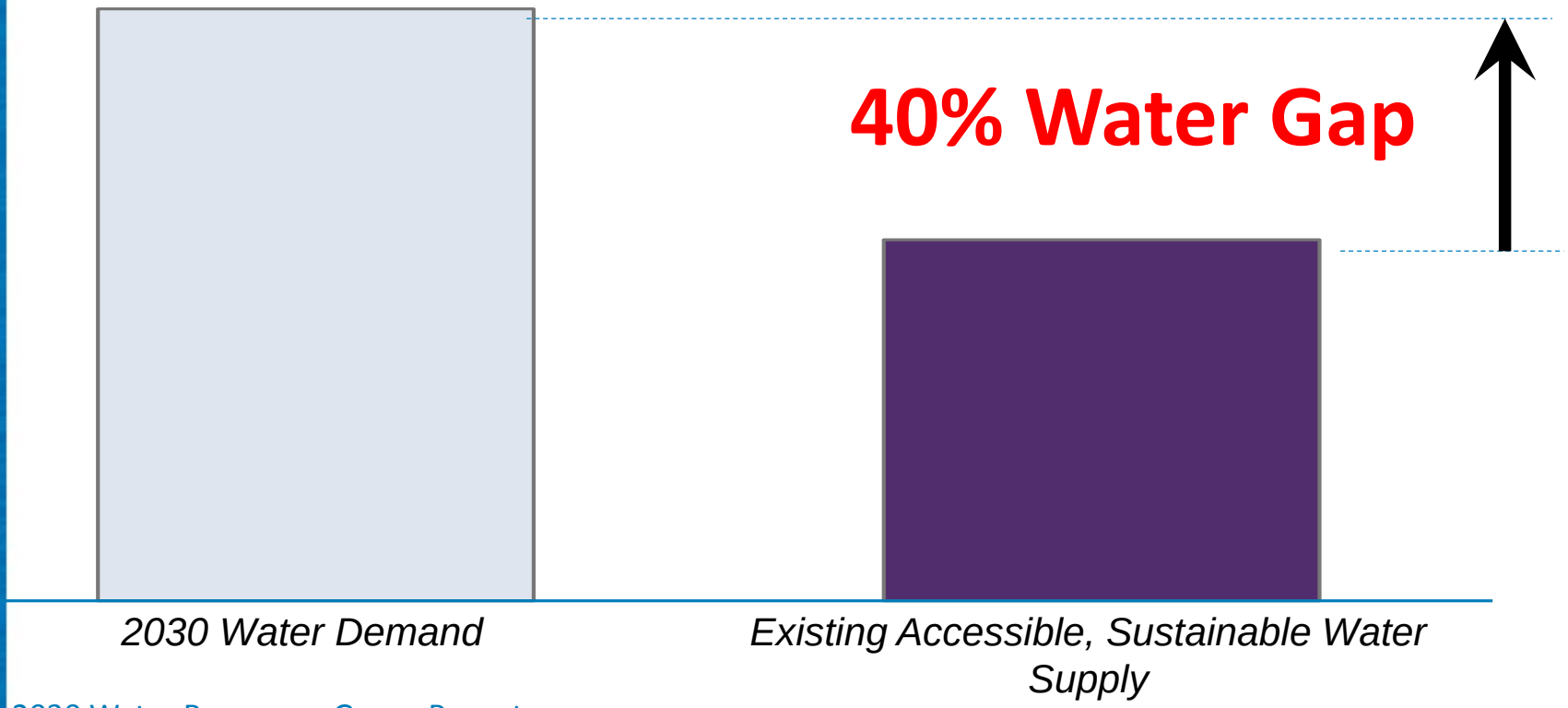
Dan Bena, Director of Sustainable Development



Google uses a specifically engineered type of water to cool its servers, and even partners with the local water utility in water supply planning. Its facilities around the world are models of water reuse and sustainable resource management.



Water Supply & Demand



Source: 2030 Water Resources Group Report

"If Current Fresh-Water Consumption Trends Continue, We Could see a 40% Shortfall between Demand for Water and Supply in just 20 years" – **Peter Voser, CEO, Royal Dutch Shell**

Water Recycling Around the Globe

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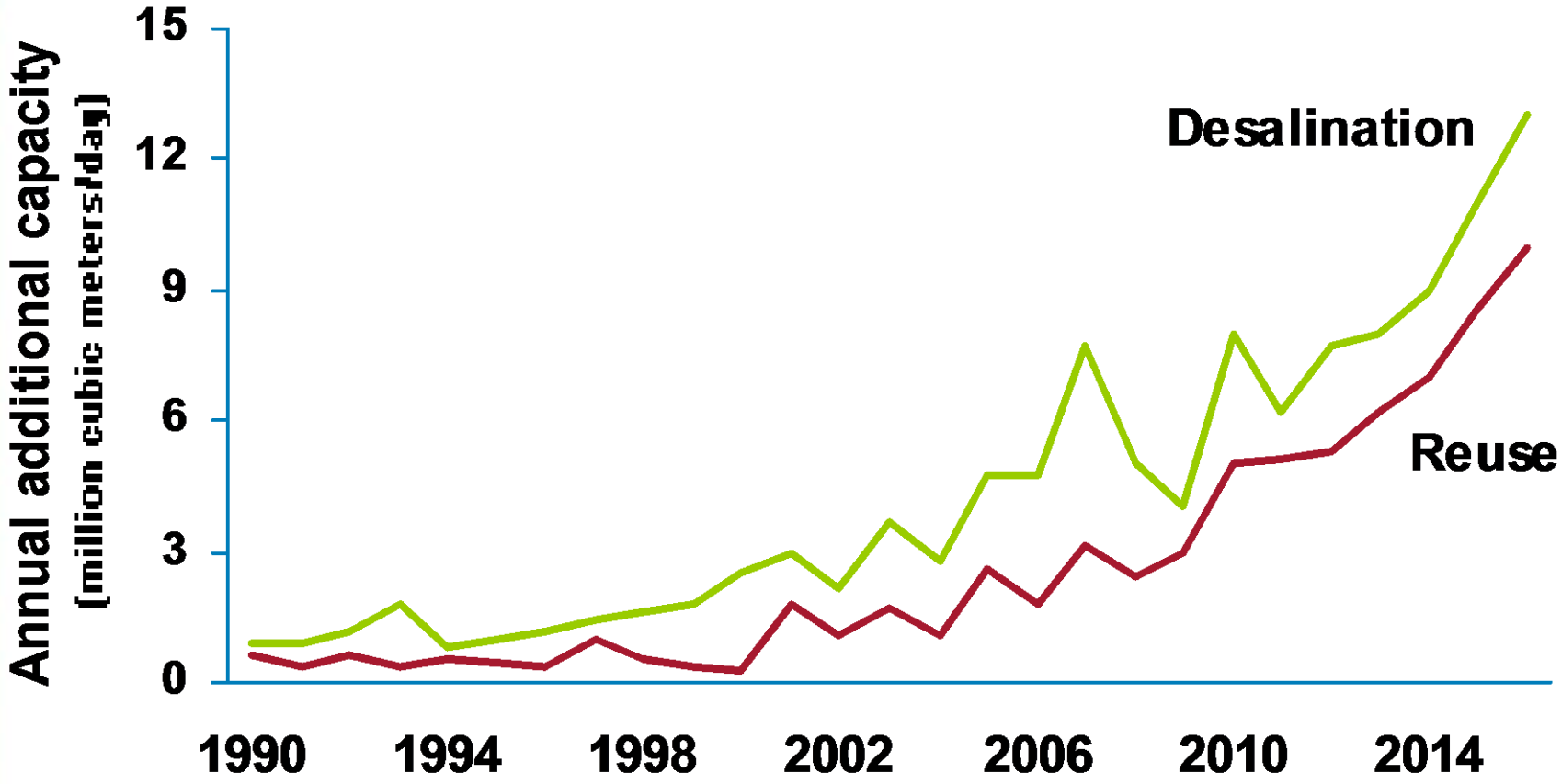
Growth of Renewable Water Supplies

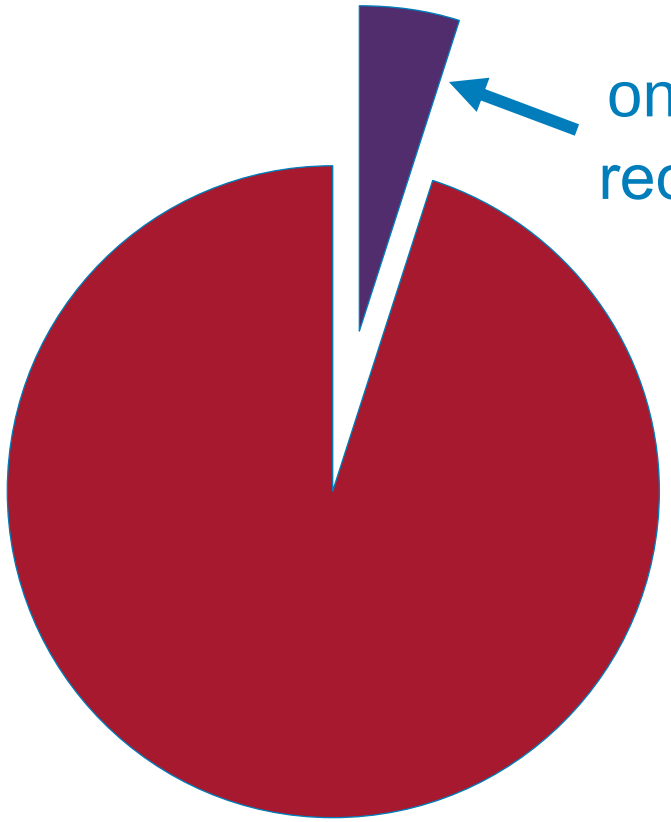


Source: GWI. Global Water Market 2011

Water Recycling in Five Countries

- Israel reuses more than 70%
- Singapore reuses 30%, up from 15% in recent years
- Australia, now at 8% - national goal of 30% by 2015
- Saudi Arabia, now at 16%, has goal of 65% by 2016

About 32 BGD municipal effluent in the United States.



Australia

- 10+ years of serious drought (2000-2010):
  - Invested ~$10 billion in recycling and desalination
- Toowoomba – failed reservoir augmentation project in 2006
  - Public voted “no,” even with water storage at 20% capacity
- National Goal: 30% Reuse by 2015
- Perth…”Water forever, whatever the weather.”

Singapore

- Historically, relied on imported water from Malaysia
- Large investment in desalination, water recycling, and storm water catchment for diversity
- Have achieved >30% recycling (including indirect potable)

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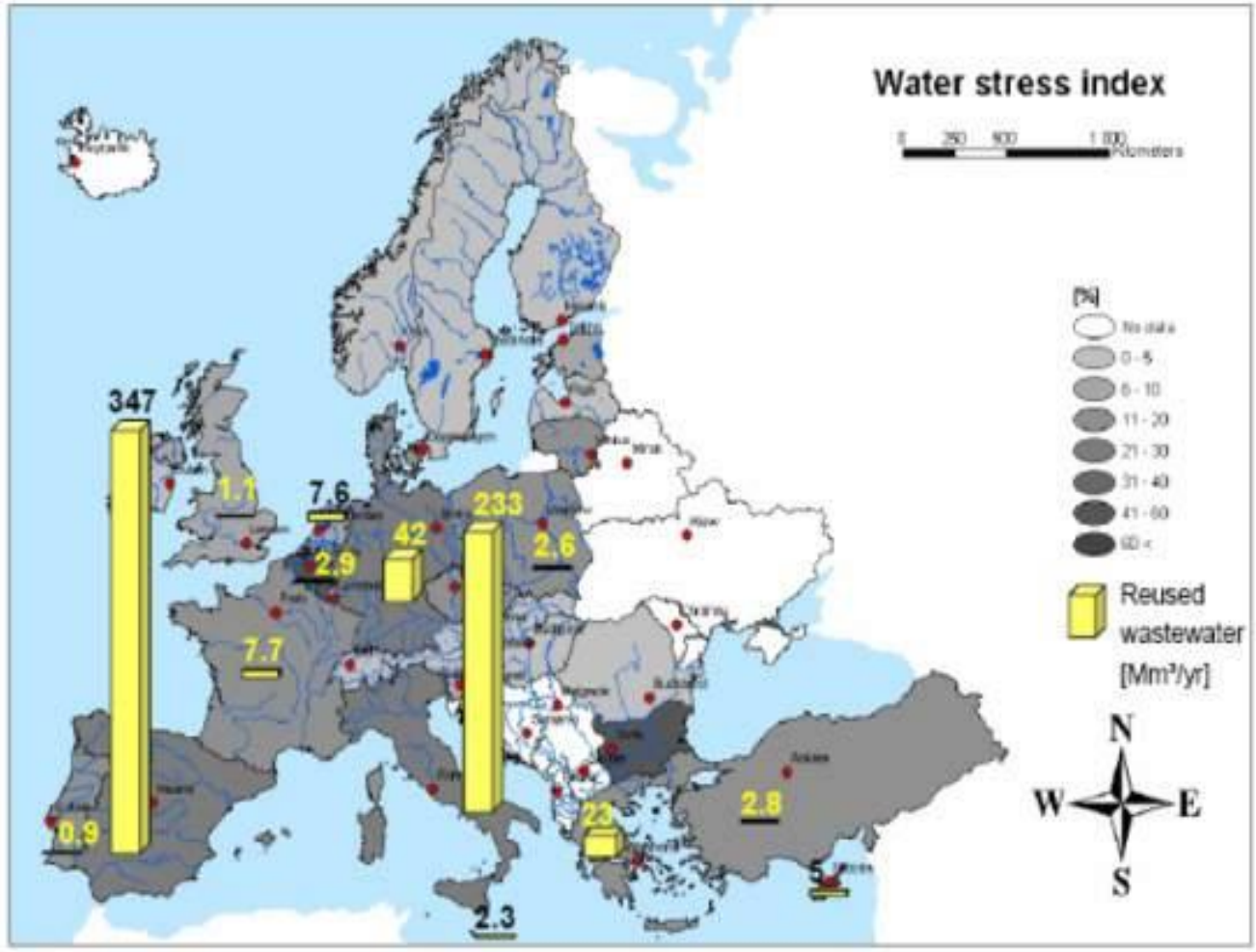
Water Recycling – European Trends



>3,300 projects

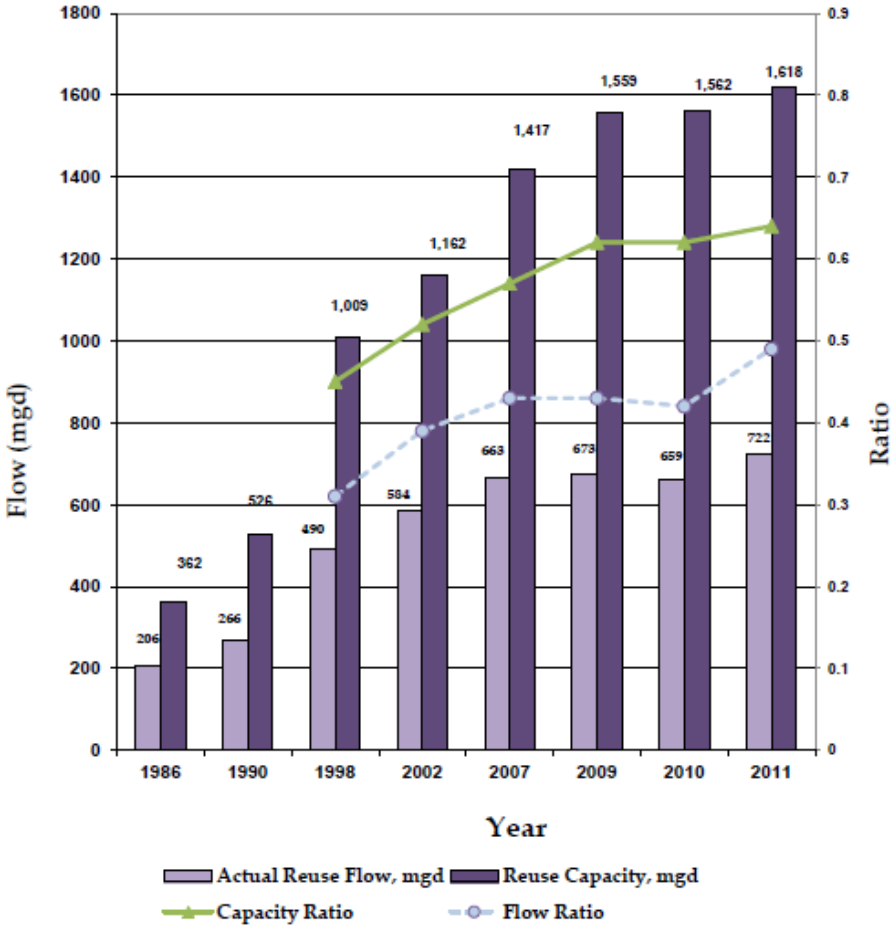
- 75% for agricultural irrigation
- Belgium has a large indirect potable recycling project
- Two aquifer recharge projects in England

Adapted fromAquarec EU Project, 2006

U.S. Report: Florida

- A leader in reuse for years (mostly irrigation)
- More reuse than any other state (by volume)
- 434 permitted systems
- 11% of average daily flow goes to aquifer recharge and indirect potable reuse

Figure 3. Florida's Reuse Growth



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U.S. Report: Arizona

- Different types of reuse – potable and nonpotable
  - 181 permitted facilities
- Scottsdale recycles water for aquifer recharge / indirect potable reuse
- Governor's Blue Ribbon Panel Report 11/2010:
  - Recommendation: Develop definitions and guidance for indirect potable reuse

Potable Water Recycling in the U.S.

- Montebello Forebay 1962
- Water Factory 21 1976
- Upper Occoquan Service Authority 1978
- Clayton County, Georgia 1985
- West Basin Recycling Project 1993
- Gwinnett County, Georgia 1999
- Scottsdale, Arizona 1999

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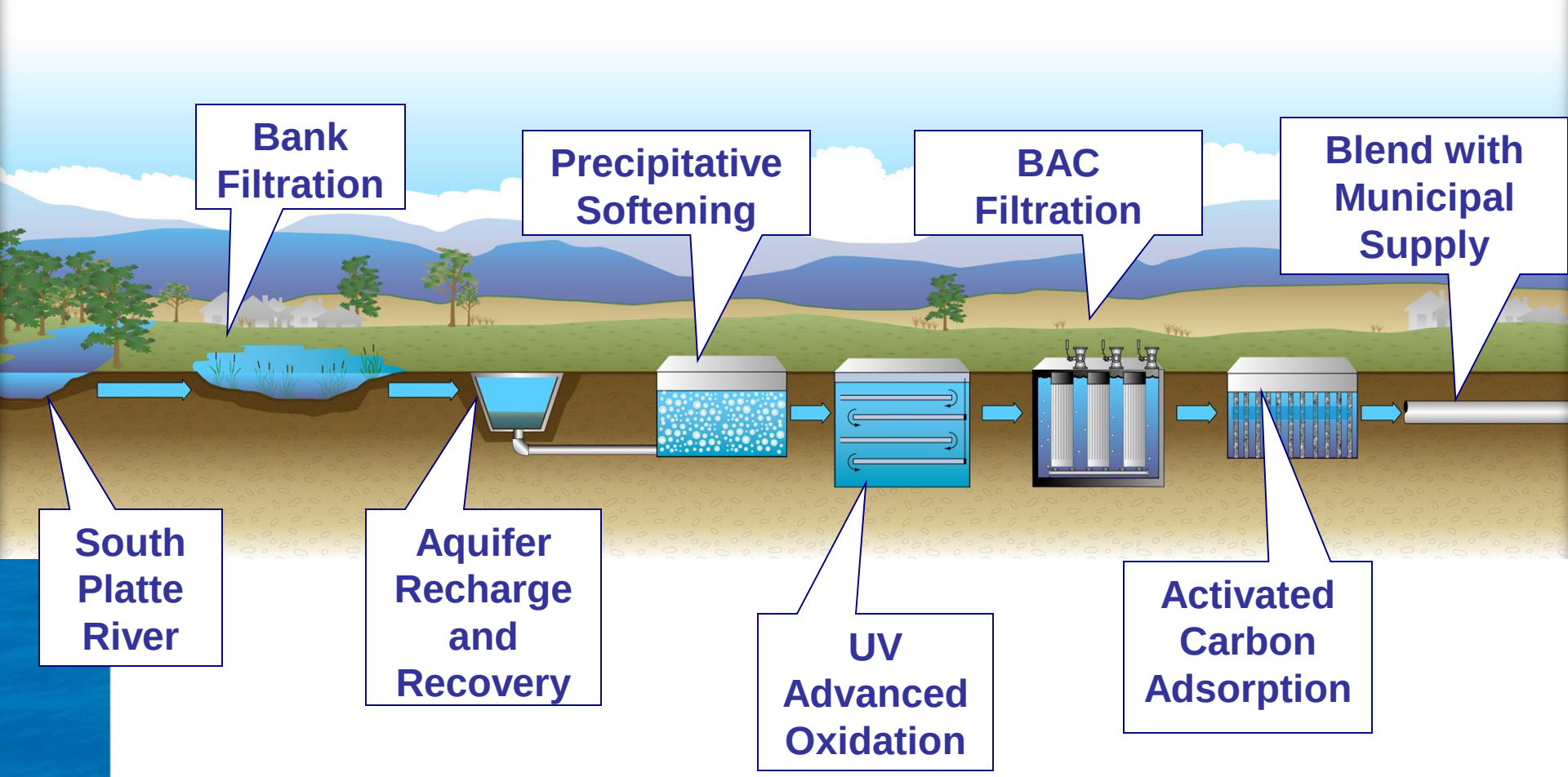
Then Purified for Direct Drinking

- Cloudcroft, New Mexico 2007
- Aurora, Colorado 2010
- Big Spring, Texas 2013
- Wichita Falls 2014
- Brownwood, Texas (approved by regulators 2013)
- San Diego…?

National Academies of Science Report on Water Reuse

- 32 BGD of wastewater discharged; 12 BGD to oceans
  - Reuse could directly augment nation's total water supply
- Emphasized importance of multiple treatment barriers
- No demonstrable difference between technology and "environmental buffers"
- Risk of exposure to chemicals and pathogens:
  - No greater than some drinking water supplies
- Use of "indirect" and "direct" is not productive
- Suggested EPA evaluate pros and cons of national regs.
- Identified research needs

Aurora Water – Potable Reuse

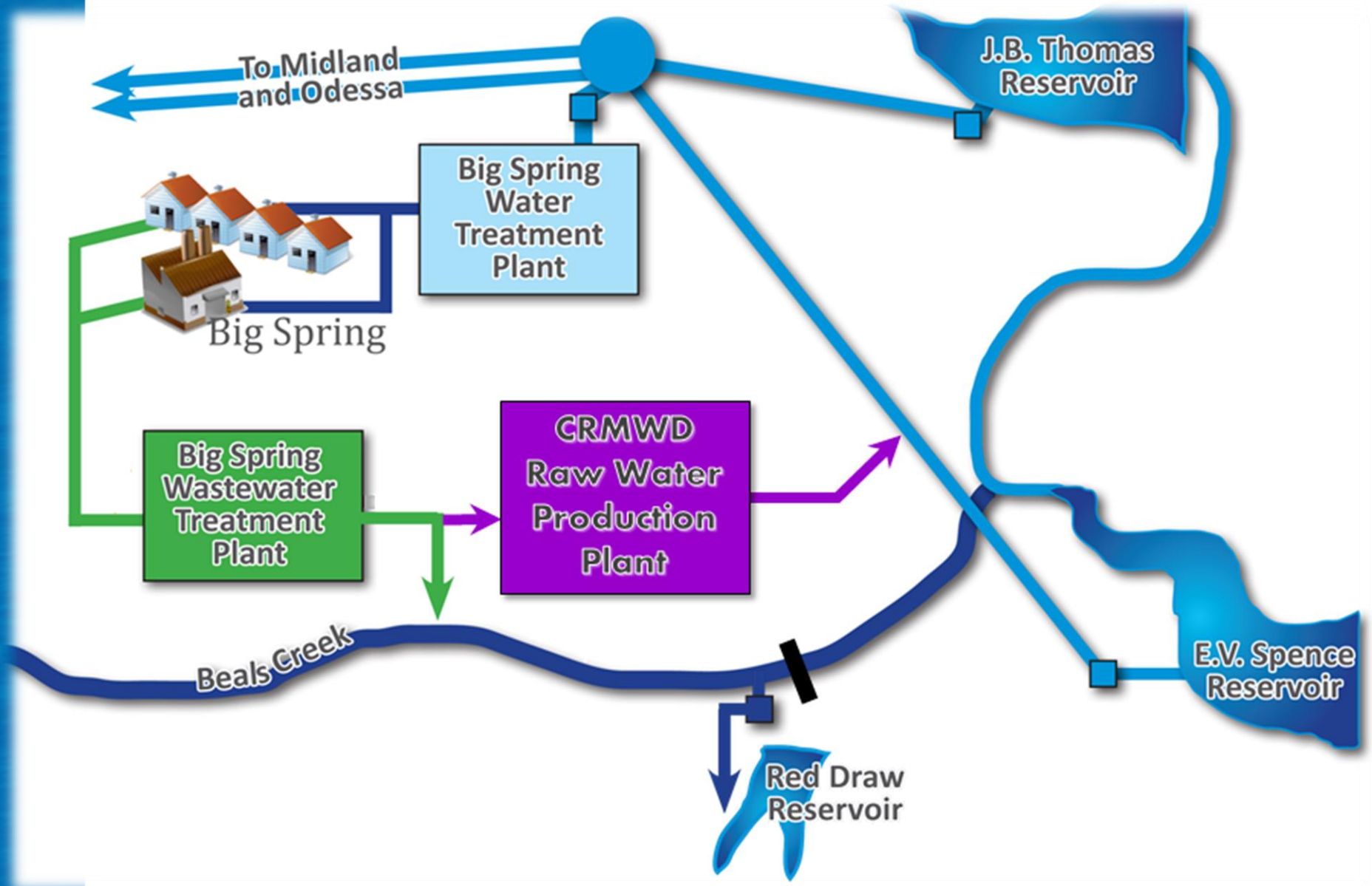


Prairie Waters Project
Aurora, Colorado

Paul Swaim, CH2MHill


Wichita Falls
Brownwood
Midland
Stanton
Austin
San Antonio
Houston
El Paso
Dallas
Interstate Highways
US Highways
0 100 KM 100 Miles
© geology.com

Big Spring Reclamation Project



Final Thoughts

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A Few Observations

- Mixed messages, terminology, and implementation strategies cause confusion
- Need coordination both within the US and internationally
- The industry is changing quickly – policy must be backed up with sound science that protects public health
- We need the water. For agriculture, for cities, for the environment.

A Few More Observations

- Need to stop pretending potable reuse is not already happening
- Blending highly purified water with other sources is already commonplace
- Need education about the complete water cycle
- ALL WATER IS REUSED!
- We all live Downstream!

The Future of Water Reuse

- Industrial water reuse is gaining popularity: it's green, it's eco-friendly, and it's good for the bottom line
- Water scarcity will become one of the "macrotrends" of the 21st century. By 2020, there will be intense competition for water by agriculture, energy producers, cities, and industries
- Water reuse and desalination are the only "new sources" of water and are, therefore, essential to human survival
- Direct Potable Reuse will be widely accepted by 2020

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Thank You

Brian Good

Deputy Manager, Denver Water

brian.good@denverwater.org

(303) 628-6503

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Additional Information

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Quotes

- *"The Three Greatest Challenges that will face Humankind in the 21st Century are Food, Energy, and Water."* **Neville Isdell, former CEO of Coca-Cola**

- *"If the wars of this century were fought over oil, the wars of the next century will be fought over water."*
  Ismail Serageldin, director of the Bibliotheca Alexandrina

- *"If we had a reasonable price on water, we could have a sustainable water supply everywhere, forever."*
  David Zetland, author of *The End of Abundance*

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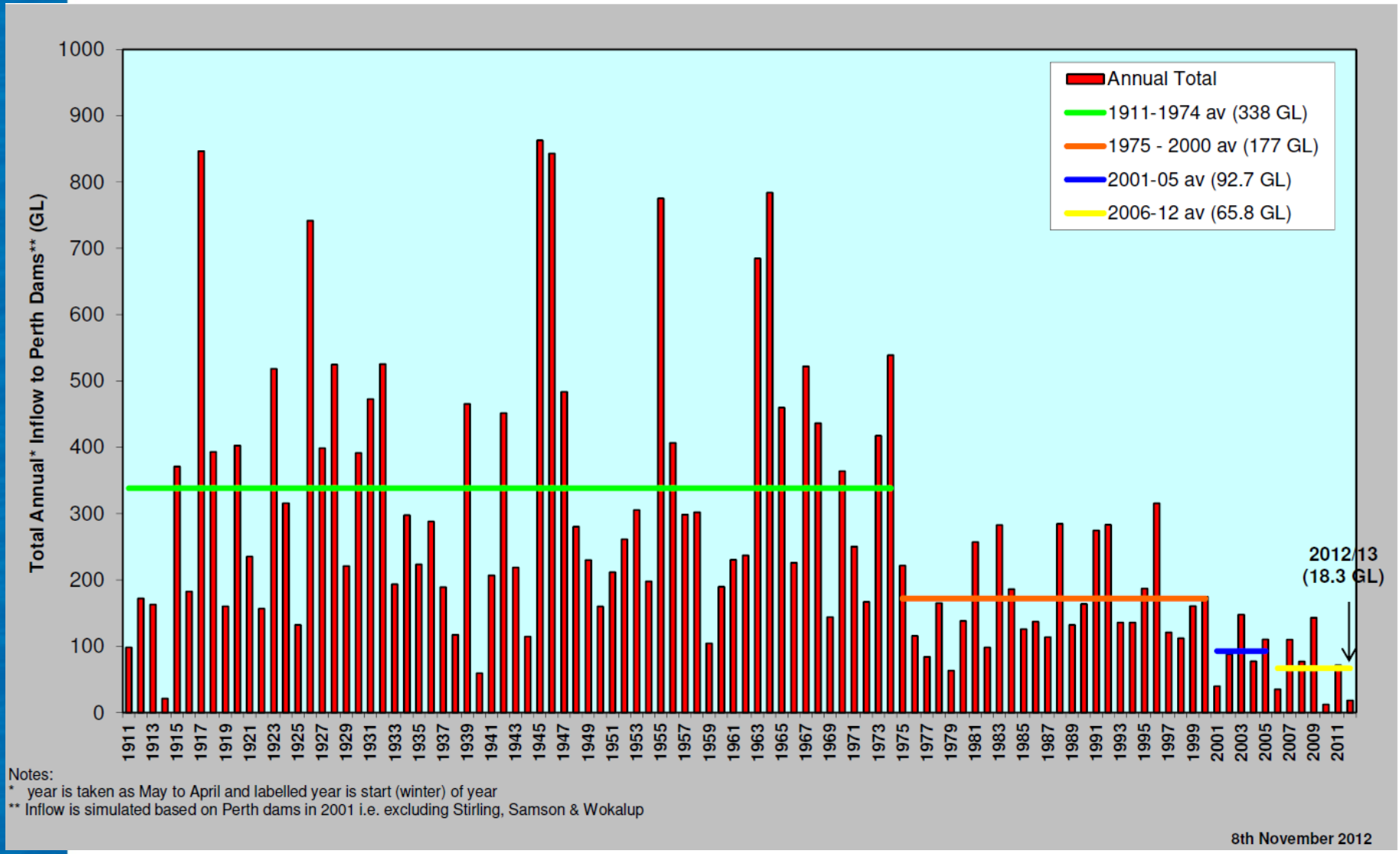
Perth, Australia

Mapsoftheworld.com

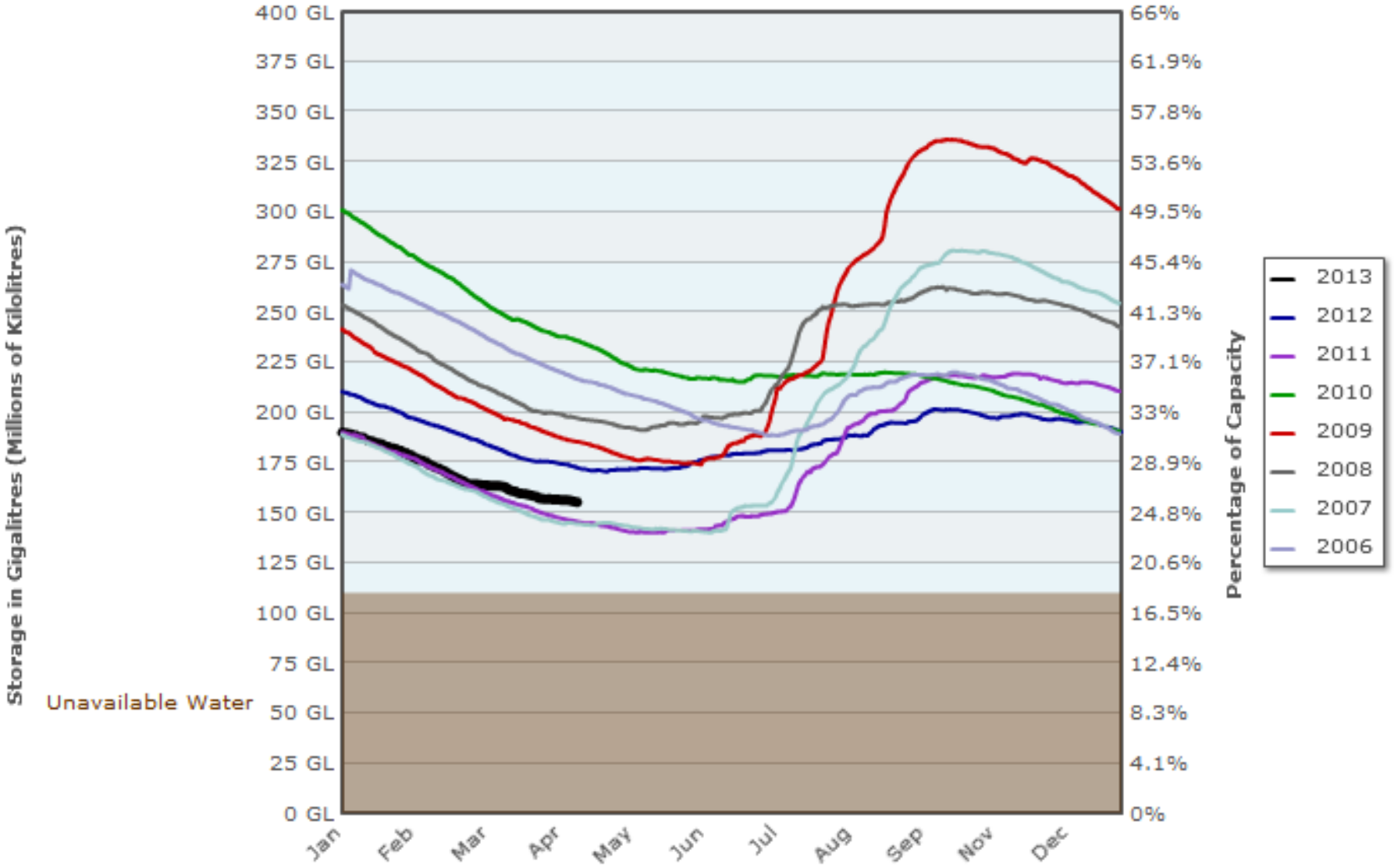
Inflow to Perth's Dams



Notes:
* year is taken as May to April and labelled year is start (winter) of year
** Inflow is simulated based on Perth dams in 2001 i.e. excluding Stirling, Samson & Wokalup

8th November 2012

Perth's Reservoir Levels



Perth's Future Plan

- Utilize deeper aquifers
- Replenish aquifers with recycled water
- Expand seawater desalination capacity
- Increase water use efficiency
- Use water reuse for industry, public open spaces and agriculture.

"Water forever, whatever the weather."

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U.S. Report: Texas

- A Big State with Big Challenges…
  - Population *doubling* in 50 years
  - More frequent / severe drought
  - Project permitting harder than it used to be
- …and Big Solutions:
  - Reuse to be 14% of all new water supplies
  - Desalination to be 3% of all new water supplies

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U.S. Report: Texas

- Great history of water reuse and desalination:

El Paso	San Antonio
Dallas	Trinity River Authority
Austin	North Texas Municipal W.D.
Fort Worth	(and others)

- New and very diverse projects:
  - Tarrant Regional Water District: Wetlands
  - Corpus Christi: Aquifer Storage & Recovery
  - Odessa: Desalination
  - Big Spring: Direct Potable Reuse
  - Brownwood: Direct Potable Reuse
  - Wichita Falls Direct Potable Reuse

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Big Spring Treatment Sequence