# Water Use and Conservation

- Household Water Use
- Local Issues with Water Supply
- Conservation Opportunities
- Water Use Regulations

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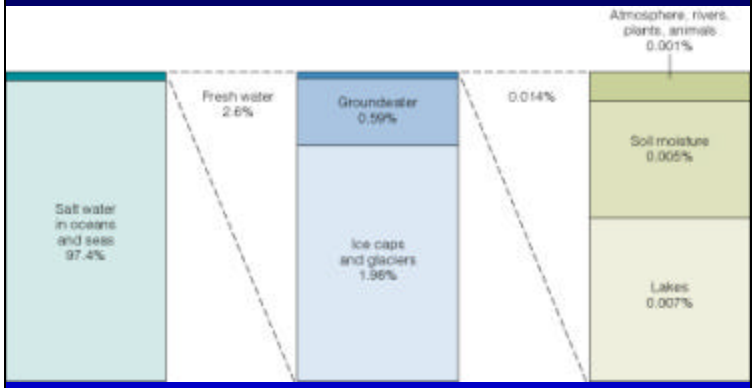
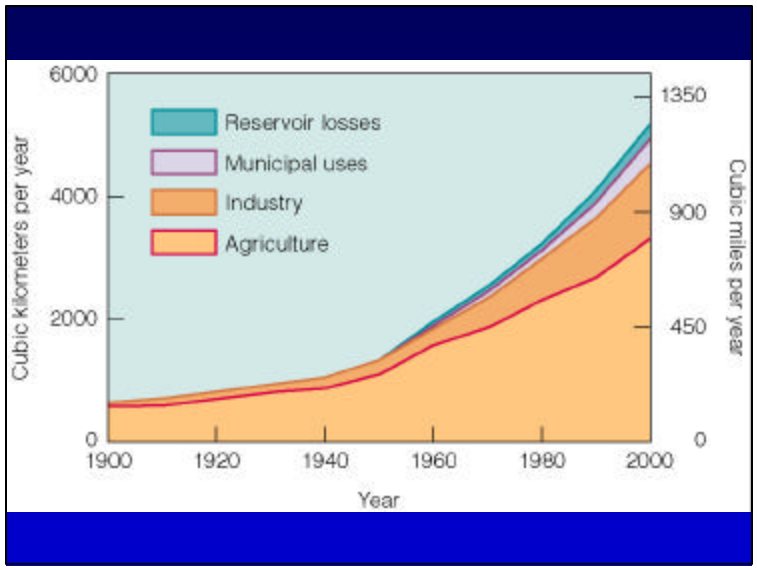
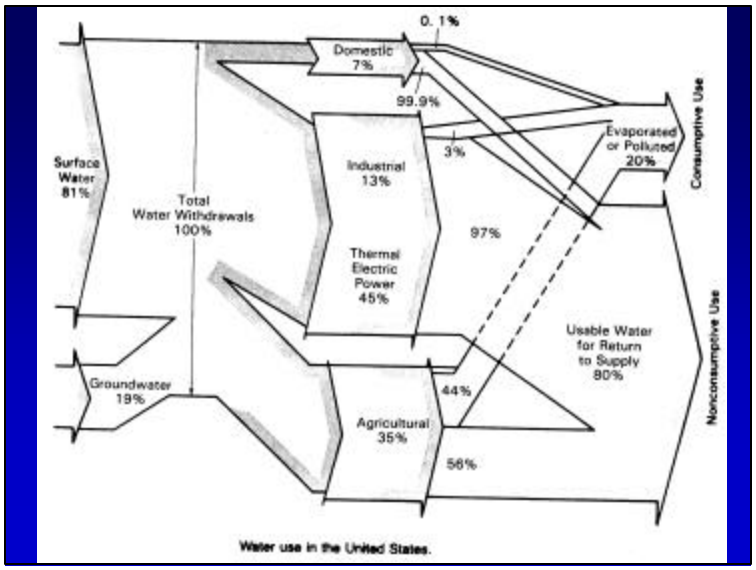
## Available Freshwater Resources Small Fraction of all Water



## WATER USE IN NORTH AMERICAN CITIES

| Use | Average daily consumption per person* Lpcd | gpcd | Percentage of total use % |
|---|---|---|---|
| Domestic | 300 | 79 | 45 |
| Commercial | 100 | 26 | 15 |
| Industrial | 160 | 44 | 25 |
| Other | 100 | 26 | 15 |
| TOTAL | 660 | 175 | 100 |

*Public Water Supply in Gallons per head per day*

| | 50 B.C. | A.D. 100 | 1823 | 1830 | 1835 | 1936 |
|---|---|---|---|---|---|---|
| Rome | 198 | 300 | | 250 | | 150 |
| Paris | | | 3 | | | |
| London | | | 3 | | 10.0 | 35.5 |
| Manchester | | | | | 5.5 | 33 |
| Liverpool | | | | | 3.5 | 36.5 |
| Edinburgh | | | | | 7.5 | 52 |
| Glasgow | | | | | 12.0 | 57 |
| Leipzig | | | | | | 20 |
| Frankfort | | | | | | 40 |
| Münich | | | | | | 55 |
| New York | | | | | | 120 |

## Typical US Water Use (gallons/person/day)

| Device | |
|---|---|
| Bathtub faucet | 8 |
| Clothes washing machine | 9 |
| Kitchen-sink faucet | 7 |
| Lavatory faucet | 3 |
| Shower head | 12 |
| Toilet | 24 |
| Total | 64 |

Typical Household Water Use in the United States

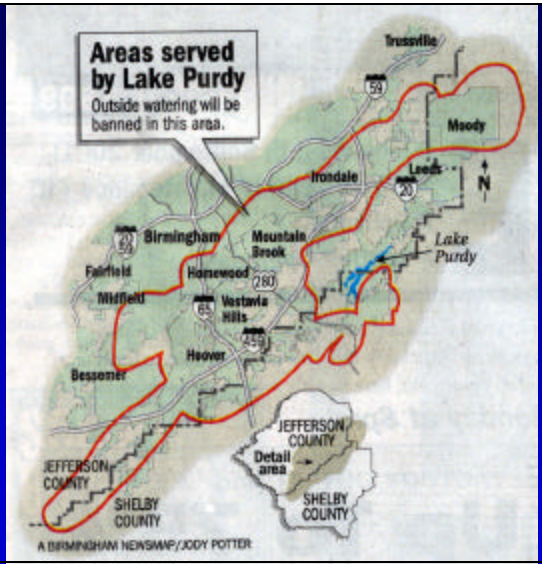
| Use | Unit | Range |
|---|---|---|
| Washing machine | Liters per load | 130–270 |
| Standard toilet | Liters per flush | 10–30 |
| Ultra volume toilet | Liters per flush | 6 or less |
| Silent leak | Liters per day | 150 or more |
| Nonstop running toilet | Liters per minute | 20 or less |
| Dishwasher | Liters per load | 50–120 |
| Water-saver dishwasher | Liters per load | 40–100 |
| Washing dishes with tap running | Liters per minute | 20 or less |
| Washing dishes in a filled sink | Liters | 20–40 |
| Running the garbage disposal | Liters per minute | 10–20 |
| Bathroom faucet | Liters per minute | 20 or less |
| Brushing teeth | Liters | 8 |
| Shower head | Liters per minute | 20–30 |
| Low-flow shower head | Liters per minute | 6–11 |
| Filling a bathtub | Liters | 100–300 |
| Watering a 750-square meter lawn | Liters per month | 7,600–16,000 |
| Standard sprinkler | Liters per hour | 110–910 |
| One drip-irrigation emitter | Liters per hour | 1–10 |
| 1/2 inch diameter hose | Liters per hour | 1,100 |
| 5/8 inch diameter hose | Liters per hour | 1,900 |
| 3/4 inch diameter hose | Liters per hour | 2,300 |
| Slowly dripping faucet | Liters per month | 1,300–2,300 |
| Fast-leaking faucet | Liters per month | 7,600 or more |
| Washing a car with running water | Liters in 20 minutes | 400–800 |
| Washing a car with pistol-grip faucet | Liters in 20 minutes | 60 or more |
| Uncovered pool (60 square meters) | Liters lost per month[c] | 3,000–11,000+ |
| Covered pool | Liters lost per month[c] | 300–1,200 |

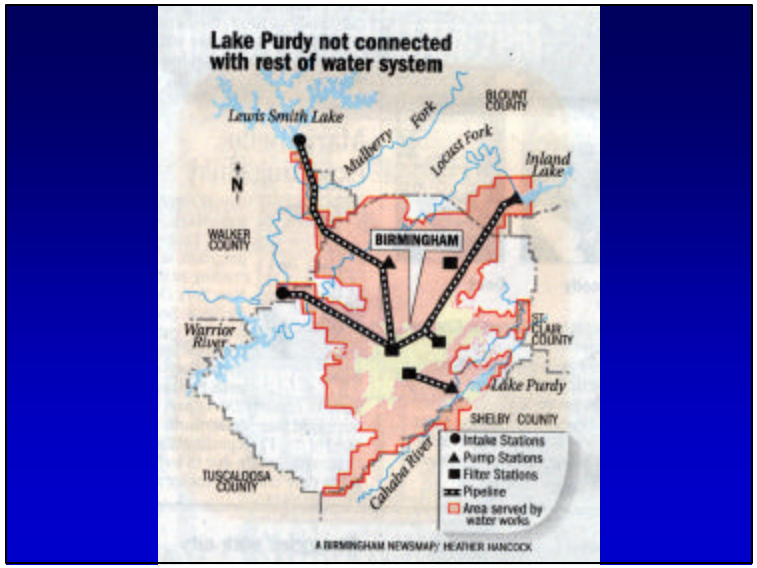
**Water savings possible with various flow reduction devices**

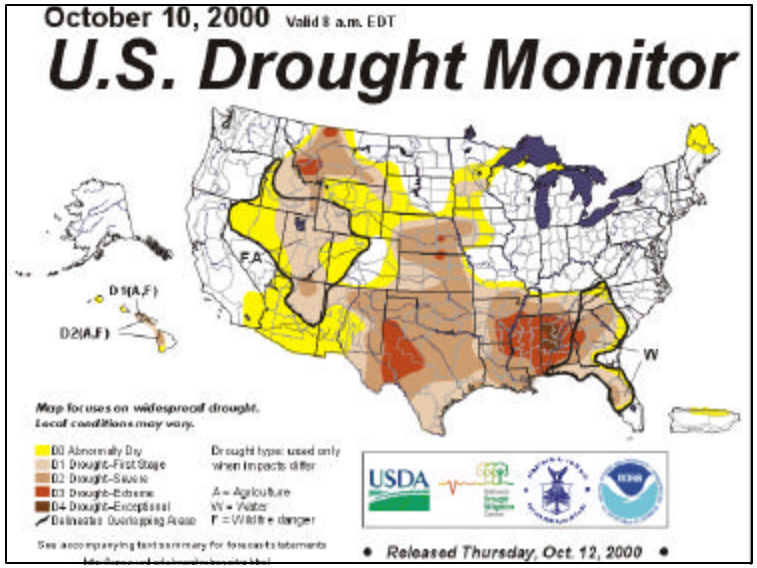
| Device | Wastewater-flow reduction: Gallons per capita per day | Wastewater-flow reduction: Percentage of conventional device |
|---|---|---|
| Level control for clothes washer | 1.2 | 13 |
| Recirculating mineral-oil toilet system | 25 | 100 |
| Shower | | |
| Flow-limiting valve | 6 | 50 |
| Flow-limiting shower head | 7.5 | 62 |
| Sink faucet | | |
| Faucet aerator | 0.5 | 7 |
| Flow-limiting valve | 0.5 | 7 |
| Toilet | | |
| Brick in toilet | 1.0 | 4 |
| Dual-batch flush valve | 15.5 | 62 |
| Dual-cycle tank insert | 10.0 | 40 |
| Dual-cycle toilet | 17.5 | 70 |
| Reduced-flush device | 10.0 | 40 |
| Single-batch flush valve | 7.5 | 30 |
| Water-saver toilet | 7.5 | 30 |
| Vacuum-flush toilet system | 22.5 | 90 |
| Wastewater-recycle system for toilet flushing | 25 | 100 |

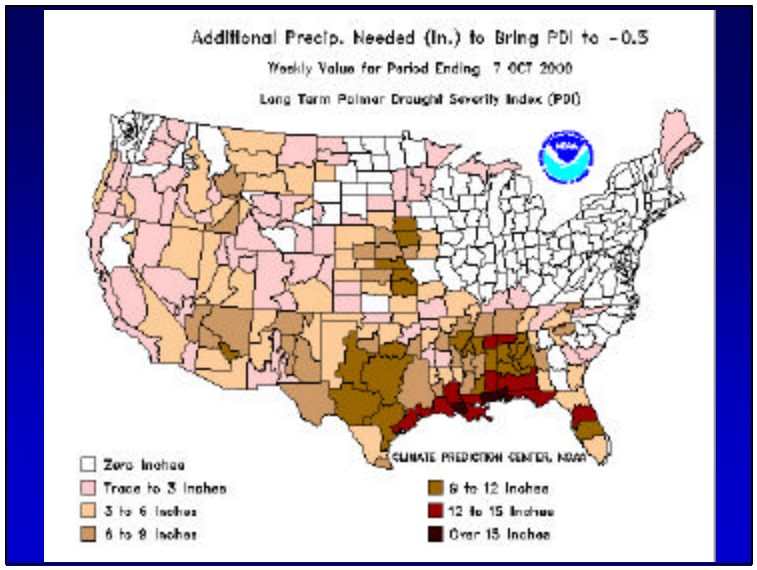
Average Daily Water-Use Chart

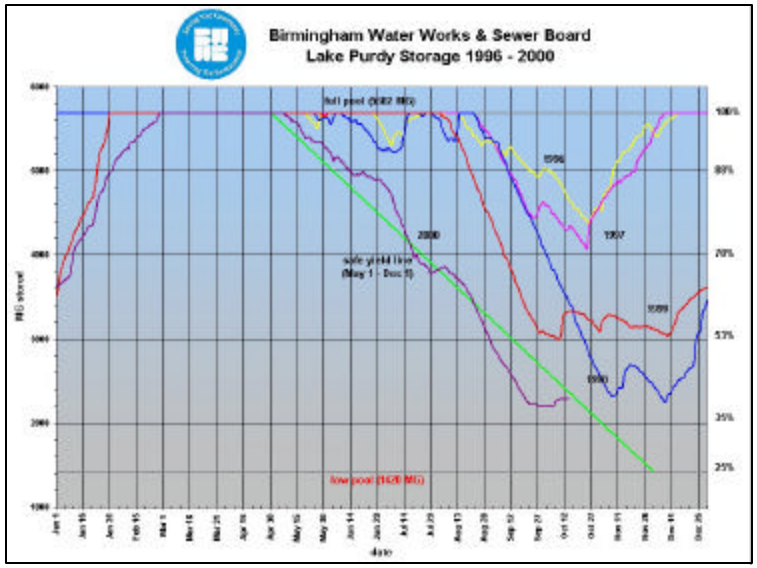
| Activity | Normal Use per Person (gallons) | Conservation Use (gallons) |
|---|---|---|
| Showering | Water running: 25 | Wet down, turn off shower; soap up, turn on shower and rinse off: 4 |
| Brushing teeth | Tap running: 10 | Wet brush, turn off water; brush, rinse briefly: ½ |
| Tub bathing | Full tub: 36 | Fill to minimal water level: 8 to 10 |
| Shaving | Tap running: 20 | Fill basin: 1 |
| Dishwashing–by hand | Tap running: 30 | Wet dishes, suds up, rinse in filled dishpan or sink: 5 |
| Dishwashing–by machine | Full cycle: 30 | Short cycle: 7 |
| Washing hands | Tap running: 2 | Fill basin: 1 |
| Flushing toilet | Depending on tank size: 5 to 7 | With displacement containers: 4 to 6 |
| Washing clothes | Full cycle, top water level: 60 | Short cycle, minimal level: 27 |

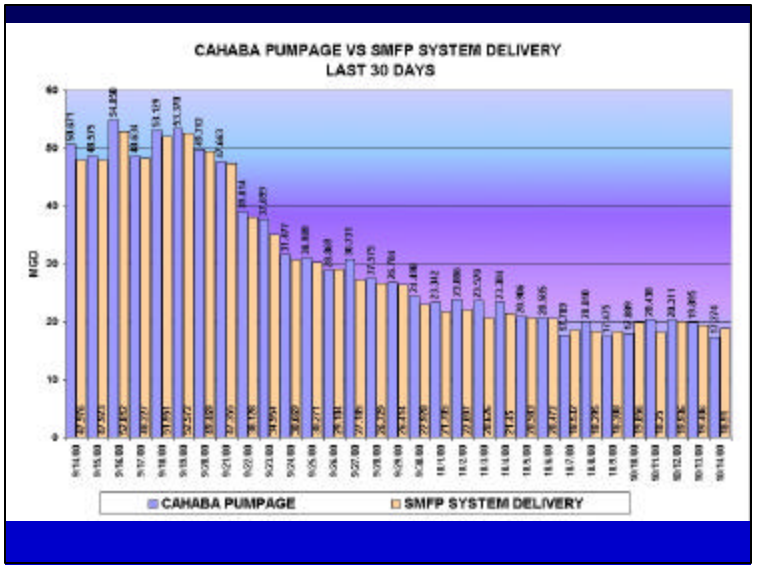




Lake Purdy not connected with rest of water system
Lewis Smith Lake
Mulberry Fork
Locust Fork
Inland Lake
BLOUNT COUNTY
N
WALKER COUNTY
BIRMINGHAM
ST. CLAIR COUNTY
Warrior River
Lake Purdy
SHELBY COUNTY
TUSCALOOSA COUNTY
Cahaba River
Intake Stations
Pump Stations
Filter Stations
Pipeline
Area served by water works
A BIRMINGHAM NEWS/MAP: HEATHER HANCOCK


October 10, 2000 Valid 8 a.m. EDT
U.S. Drought Monitor
D1(A,F)
D2(A,F)
W
Map focuses on widespread drought.
Local conditions may vary.
D0 Abnormally Dry
D1 Drought-First Stage
D2 Drought-Severe
D3 Drought-Extreme
D4 Drought-Exceptional
Delineates Overlapping Areas
Drought type: used only when impacts differ
A = Agriculture
W = Water
F = Wildfire danger
See accompanying text summary for forecast statements
USDA
Released Thursday, Oct. 12, 2000


Additional Precip. Needed (In.) to Bring PDI to -0.5
Weekly Value for Period Ending 7 OCT 2000
Long Term Palmer Drought Severity Index (PDI)
CLIMATE PREDICTION CENTER, NOAA
Zero Inches
Trace to 3 Inches
3 to 6 Inches
6 to 9 Inches
9 to 12 Inches
12 to 15 Inches
Over 15 Inches


Birmingham Water Works & Sewer Board
Lake Purdy Storage 1996 - 2000
full pool (1692 MG)
1996
1997
2000
safe yield line
(May 1 - Dec 1)
1999
1998
low pool (1628 MG)
MG stored
100%
80%
60%
40%
20%
date


CAHABA PUMPAGE VS SMFP SYSTEM DELIVERY
LAST 30 DAYS
MGD
CAHABA PUMPAGE
SMFP SYSTEM DELIVERY


Birmingham Water Works and Sewer Board
Supply and Purification Morning Report


Mayors divided on water surcharge
Two suburban leaders frown on council role
"We're basically out of business. . . . If we can't use water, we can't work."
Mike Pate
ABC Pressure Wash
Purdy hits critical; outside watering banned in areas

## Tipsters help enforce water ban

NEWS STAFF/CHARLES NESBITT

Birmingham Mayor Bernard Kincaid works his cell phone Friday to find someone who could turn off city sprinklers on 20th Street North. "That was an unfortunate set of circumstances," Kincaid said.

## Ban boosts car wash business

NEWS STAFF/JOE SONGER

THE WATER CRISIS: Guiltless car wash in Homewood


NEWS STAFF/JOE SONGER

Jack Rabbit Auto Detailing uses water hauled in from a Shelby County stream to pressure-wash cars driven to the Homewood business. An easy-to-read sign tells motorists the business uses "Guilt Free Wash! Non-Lake Purdy Water." A large yellow tank in front of the business filled with that water lets Will Jowers clean a car.

THE WATER CRISIS

## Cities to start clamping down on violators of water-use rules

## Emergency rules sink in


*"We are heading into a crisis situation. If we don't get rain, the pipes will be dry."*

## Fines toughen water ban

# Siegelman decrees water emergency

## Suburbanites heed water use warnings

By GIGI DOUBAN
*News staff writer*

More than a week after watering bans took effect in suburban cities south of Birmingham, not one person has been fined, arrested or cited for outdoor water use.

Officials in the four over-the-mountain cities said residents have been taking the water shortage seriously and citations have been unnecessary. Police there have been given discretion to issue warnings to first-time offenders before socking them with penalties.

Birmingham police, on the other hand, have issued 70 tickets to water-ban violators in just the first six days of enforcement of the mandatory restrictions.

City officials said Thursday that's far more than they anticipated at the onset.

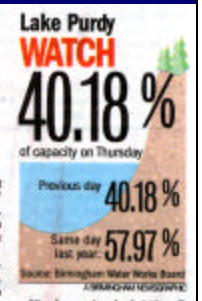
"It was our hope that citizens would understand that this was a serious emergency and that they would heed our warnings," said police spokesman Lt. Moody Duff. "It's important to make sure there's enough water to go around."

Birmingham police began issuing warnings to residents Oct. 4. Those warnings turned into serious cash citations three days later, on Oct. 7.

Most of the tips have come in through a hot line established by Birmingham police.

"So far, we've had 149 calls from people turning in other people," Duff said. "We'll be

▶ See Water, Page 2C




*"It's a class of customer that stretched our minds about what people can consume."*
**Randy Chafin**
*Assistant general manager of the Water Works*

THE WATER CRISIS

## Groups urge no new water, sewer hookups

THE WATER CRISIS

## Water Works looks at tapping other systems

## Complex system amplifies drought

## Sharing water is uphill battle

THE WATER CRISIS

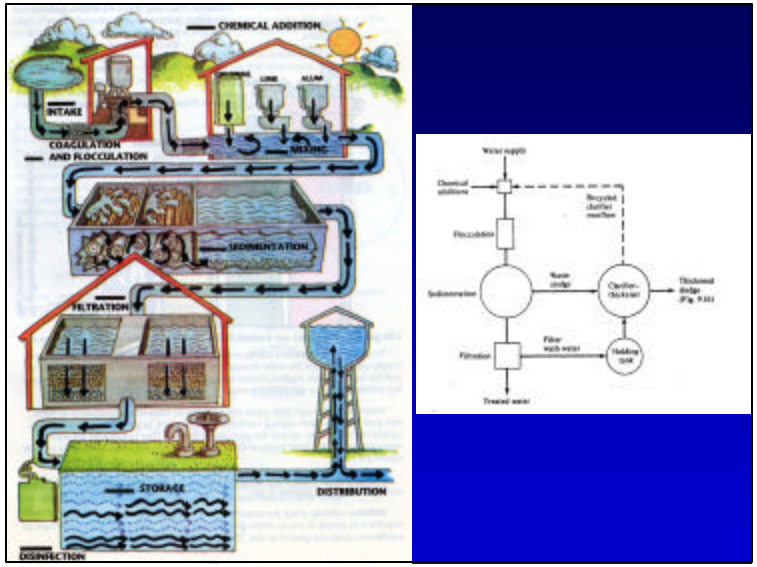
## Engineers racing to lay line, test tunnel

Water Works plans quick action on projects to ease Purdy demand

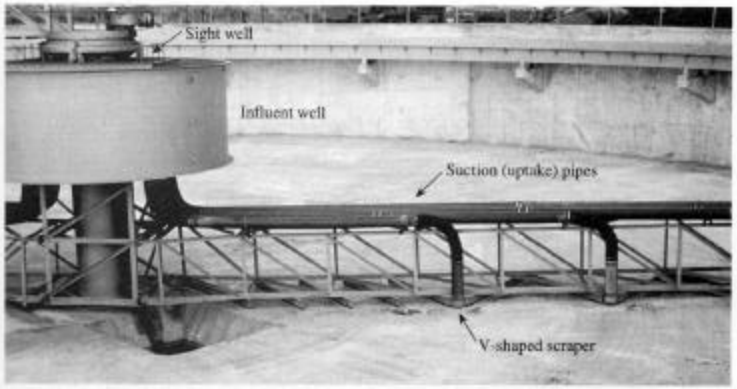
## Council to get bid for water assets vote

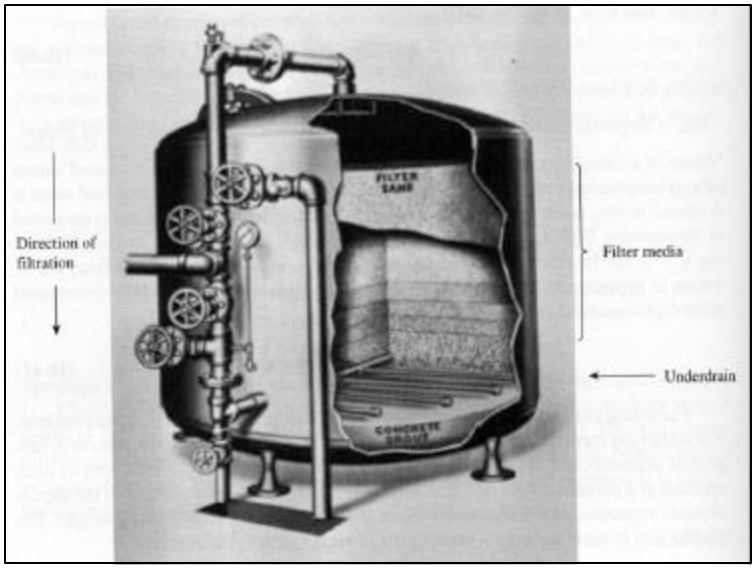
Judge rules signatures sufficient for referendum


| | | |
|---|---|---|
| Turbidity (NTU) | N/A | Treatment Technique = 5 NTU |
| Alpha emitters (pCi/l) | | 15 |
| Arsenic (ppb) | N/A | 50.0 |
| Barium (ppm) | 2.00 | 2.00 |
| Fluoride (ppm) | 4.00 | 4.00 |
| Nitrate (as Nitrogen) (ppm) | 10.0 | 10.0 |
| Nitrite (as Nitrogen) (ppm) | 1.00 | 1.00 |
| TTHMs (ppb) (Total Trihalomethanes) | 0.00 | 100 |
| Chloroform (ppb) | N/A | N/A |
| Bromodichloromethane (ppb) | N/A | N/A |
| Chlorodibromomethane (ppb) | N/A | N/A |
| Bromoform (ppb) | N/A | N/A |
| Total Coliform Bacteria | 0 | Presence of coliform bacteria in 5% of monthly samples. |






## Water Regulations and Conflicts

**"Water flows uphill towards money."**

Old western US saying

**"Whiskey's for drinking – water's for fighting about."**

Mark Twain

## Riparian water law is a common-law idea

- Owner of land has the right to withdraw water that is adjacent to the land.
- Water must be returned in a relatively unpolluted condition to ensure that downstream users do not have their water rights violated.
- The water must be used on land adjacent to the water source, not exported (reasonable use doctrine now allows irrigation).
- Evolved through practical use.
- Practiced mostly east of the Mississippi River where sufficient water resulted in few conflicts.

## Appropriation water law adopted from Roman civil law

- Owners of land may be denied the right to withdraw water if a more beneficial use is found.
- Government agencies “appropriate” the water.
- Water right can be taken away if better use found, or lost if abandoned.
- Water can be used away from the source.
- Common in western states where water is much more scarce.

## Increasing Recognition of Water Rights to Protect the Natural Environment

- Loss of fisheries, wetlands, lakes, and other ecological assets are shifting the balance of power governing water use, away from agriculture and towards protecting the natural environment.
- Australia’s Murray-Darling river basin states have agreed to allocate 25% of the river’s natural flow to maintaining ecological health in the system.
- 10% of the water from the Central Valley Project in California is to go for maintaining fish and wildlife habitat.


**Northern China is running a chronic water deficit, with ground-water overpumping of some 30 billion cubic meters a year.**

## Water Deficits in Key Countries and Regions, Mid-1990s

| Country/Region | Estimated Annual Water Deficit (billion cubic meters per year) |
|---|---|
| India | 104.0 |
| China | 30.0 |
| United States | 13.6 |
| North Africa | 10.0 |
| Saudi Arabia | 6.0 |
| Other | unknown |
| Minimum Global Total | 163.6 |

## 34 Countries in Africa, Asia and the Middle East are Classified as Water-Stressed

- Occurs when a country's renewable water supplies drop below about 1,700 $m^3$ per person.
- At this level, it becomes difficult for a country to collect enough water to satisfy all the food, household, and industrial needs of the population.
- These countries then begin to import grain (requires about 1,000 tons of water to produce a ton of grain).
- Poor countries have the vast majority of the water-stressed populations and they can ill afford imported grains.

| Region/Country | Renewable Water Supplies (cubic meters per person) | Population (million) | Population Doubling Time (years) |
|---|---|---|---|
| Africa | | | |
| Algeria | 730 | 26.0 | 27 |
| Botswana | 710 | 1.4 | 23 |
| Burundi | 620 | 5.8 | 21 |
| Cape Verde | 500 | 0.4 | 21 |
| Djibouti | 750 | 0.4 | 24 |
| Egypt | 30 | 55.7 | 28 |
| Kenya | 560 | 26.2 | 19 |
| Libya | 160 | 4.5 | 23 |
| Mauritania | 190 | 2.1 | 25 |
| Rwanda | 820 | 7.7 | 20 |
| Tunisia | 450 | 8.4 | 33 |
| Middle East | | | |
| Bahrain | 0 | 0.5 | 29 |
| Israel | 330 | 5.2 | 45 |
| Jordan | 190 | 3.6 | 20 |
| Kuwait | 0 | 1.4 | 23 |
| Qatar | 40 | 0.5 | 28 |
| Saudi Arabia | 140 | 16.1 | 20 |
| Syria | 550 | 13.7 | 18 |
| United Arab Emirates | 120 | 2.5 | 25 |
| Yemen | 240 | 10.4 | 20 |
| Other | | | |
| Barbados | 170 | 0.3 | 102 |
| Belgium | 840 | 10.0 | 347 |
| Hungary | 580 | 10.3 | — |
| Malta | 80 | 0.4 | 92 |
| Netherlands | 660 | 15.2 | 147 |
| Singapore | 210 | 2.8 | 51 |
| Total Population | | 231.5 | |

## Populations in Selected Hot Spots of Water Dispute, 1999, with Projections to 2025

| River Basin/Countries | Total 1999 Population (million) | Projected 2025 Population | Change (percent) |
|---|---|---|---|
| Aral Sea[1] Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan | 56 | 74 | + 32 |
| Ganges Bangladesh, India, Nepal | 1,137 | 1,631 | + 43 |
| Jordan Gaza, Israel, Jordan, Lebanon, Syria, West Bank | 34 | 58 | + 71 |
| Nile Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, Uganda | 307 | 512 | + 67 |
| Tigris-Euphrates Iraq, Syria, Turkey | 104 | 156 | + 50 |

## About 40% of the World's Population live in Water Basins Shared by more than two Countries

**Biggest potential problems in Middle East:**

- Jordan River (Israel, Jordan, Syria, and Lebanon)
- Nile River (Egypt, Sudan, Ethiopia, Zaire, Uganda, Tanzania, Burundi, Eritrea, Kenya)
- Tigris-Euphrates Rivers (Iraq, Syria, and Turkey)

## King Hussein declared in 1990 that water was the only issue that could take him to war with Israel

## "The national security of Egypt is in the hands of the eight other African countries in the Nile basin."

Boutros Boutros-Gali, when he was Egypt's Minister of State for Foreign Affairs

## Saudi Arabia uses Fossil Groundwater for 40% of their needs

- Groundwater depletion more than 5 billion cubic meters per year and rapidly growing.

## Water Issues Increasingly Responsible for Armed Conflict

- Dispute over the headwaters of the Jordan River helped spark the 1967 Arab-Israeli war.
- Bypass canal project in southern Sudan one factor in continuing civil war.

## Current Serious Water Conflicts

- Israel's unrestricted use of groundwater from the Jordan River basin in occupied territories.
- Egypt-Sudan agreement totally allocates Nile River downstream flow without reference to upstream needs.
- Construction of dams in Turkey reduce Euphrates water to Iraq to as little as 10% of normal flow, and to 60% for Syria.

## More than 2,000 International Treaties Relating to Common Water Basins

**Common basins make up 60% of the land in Africa and South America**

- US and Canada Great Lakes Compact
- The Nile Water Agreement (Egypt and Sudan)
- India and Pakistan share development of the Indus River.
- India and Bangladesh agree to maintain minimal flows in the Ganges.
- US and Mexico agree on flow conditions in Colorado and Rio Grande Rivers.
- Argentina and Brazil agree on management of the Paraná River.


Gonick and Outwater. *The Cartoon Guide to the Environment.*

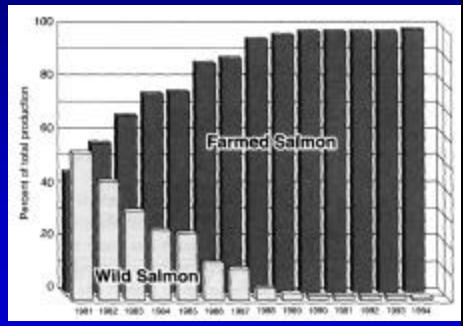
# Formula for "Survival"

$$\frac{\text{(Population) X (Demand)}}{\text{(Sustainable Supply)}} \text{ must be } < 1$$

Malthus 1766 - 1834

**"A decade ago, a fish Malthusian might have predicted the end of salmon as a food. Human ingenuity seems to have beaten nature once again."**

*Forbes* 1990



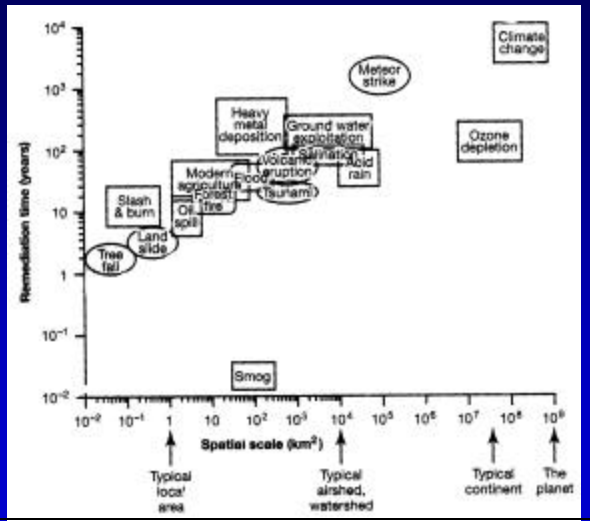

Bailey, *Earth Report 2000*.

# Environmental Trends Shaping the New Century

*State of the World* 2000

- Population growth
- Rising temperature
- Falling water tables
- Shrinking cropland per person
- Collapsing fisheries
- Shrinking forests
- Loss of plant and animal species

# Time and Scale of Environmental Concerns (Graedel)



## Problems in Our Future (recovery periods for individual actions)

- **Short Term (< 100 years):**
  - Tree falls
  - Land slides
  - Oil spills
  - Slash and burn
  - Forest fires
  - Floods
  - Tsunamis
  - Volcano eruption
  - Acid rain
- **Long-Term (>100 years):**
  - Heavy metal deposition
  - Groundwater exploitation
  - Ozone depletion
  - Meteor strike
  - Climate change

## Water Supply and Water Quality

- Conservation easiest to develop and cheapest new water source
- Water quality problems becoming better understood
- Habitat destruction becoming recognized as serious issue

## Development or Reservation?


**Development**:
Atmospheric nitrogen, electric steel, cement, marble, brick, lime, iron, coal, fruit, lumber, and cotton.

300,000 horsepower

Coosa-AL navigation = 10 railroads

**Reservation**:
Falling, wasting as I flow.
A mighty brimming river.
My commerce tied,
my strength untried.
Fix me now or never.

W.P. Lay. *River Problems of Alabama*. 1915

"Nearly the entire spectrum of conservation and efficiency options cost less than the development of new water sources."

Sandra Postel 1996

## Estimated Costs of Water Management Options

| | Estimated cost range (cents/$m^3$) |
|---|---|
| Reducing demand through conservation/efficiency | 5 – 50 |
| Treatment and reuse of wastewater for irrigation | 30 – 60 |
| Desalination of brackish water | 45 – 70 |
| Development of marginal water | 55 – 85 |
| Desalination of seawater | 100 – 150 |

World Bank 1995

In El Paso, pricing and educational efforts are credited with a substantial reduction in water use. Conservation meets about 15 to 17% of the city's future water needs. Besides slowing the rate of depletion of the groundwater supply, the conservation measures cost about 8% less than the cost of existing water supplies (about \$135 per 1,000 $m^3$).

## John Boland, Johns Hopkins University, Abel Wolman Lecturer

My worry is that many think that private sector involvement ends the responsibility of government.

A. My greatest surprise was that there are very few, if any, water issues that are unique to the developing world, just as there are very few issues unique to industrial countries.

*Do you see any hopeful trends that indicate that the world is making progress in managing our water resources?*

A. One indication of progress would be an understanding that most water uses respond to changes in human behavior.

I went along to find out how far vested interests control the debate. My first stop was Mr Luis J. Guiliano CEO of ITT Industries.

'Water is a resource like oil and timber, but as access to it is simpler, you don't know the real cost of it,' he said.

I pointed out that some politicians and experts claim that water is a human right.

'Yes, but only if you can get it. No one says that electricity or petrol should be a human right,' Mr Giuliano replied.

*WorldWater*, January 2003

## A model from Jamaica

At the National Water Commission (NWC) in Jamaica, I contacted Mr Charles Buchanan, who told me that the average Jamaican household uses 2.8% of its expenditure on water supply, approximately half it spends on electricity (5.2%) and on telephone charges (5.7%).

The Water Sector Policy of the Government of Jamaica recognises water as an essential provision to which all Jamaicans should have access. The Policy states:

'Potable water should be available to all citizens in such quantity and at such quality as to sustain life, irrespective of the citizen's ability to pay.'

A heavily subsidised 'Life-Line Supply' is provided for households using up to 3,000 gallons per month who pay far less than the cost of providing the service. Over and above that, the subsidy decreases per 1,000 gallons consumed. By way of this cross-subsidizitaion, conservation is also encouraged.

*WorldWater*, January 2003

*The South African government wants everyone in the country to have 6 cubic meters of free water, inciting Suez to innovate, despite complaints. In Johannesburg, the company serves a population of 3 million.*

## Legislation in South Africa

Speaking to Professor Robyn Stein at her office of Bowman Gilfillan Inc in Johannesburg, she had only one comment on ITT's vision of 'full and fair water pricing'.

'Well, I'm approaching it from a country where water is recognised as a basic human right. Our constitution protects water, and there is a government commitment to provide free water - at least around 3 - 5 litres per person per day.'

At least half of the population in South Africa has access to potable water, and the hope is that the other half will, by 2005.

Afin d'éviter les coupures pour impayés, Johannesburg Water et Suez ont décidé d'installer des compteurs prépayés.
*To avoid cuts off for unpaid bills, Johannesburg Water and Suez want to introduce prepayments meters.*

*WorldWater*, January 2003
*Hydroplus*, July 2003

The plan is not welcomed in all quarters. Researchers at the Municipal Services Project (MSP), a university research centre, are protesting against prepayment meters, arguing that they were made illegal in Britain in 1998 for public health reasons, with a jump in reported cases of dysentery. They also claim that 6m³ hardly represents any more than a bath a day, and is not enough, especially in the underprivileged communities. The problem is worse in the hostels, which frequently house eight to ten people and need more than the guaranteed minimum.

*Hydroplus*, July 2003

"After the first block of free water, households pay a steep fee for the next blocks. This can mean that most families end up paying as much or more for water than they did before free water came into effect." For example, 20m³ now costs more than 7 euros, compared with 6.6 euros under the old system.

MSP and the South African Human Rights Commission ran a study in July 2001 when the free minimum was first introduced, on the reasons for non-payment of public services, and found that 17% of the population can only pay if they cut back on other expenses such as food and clothing. These services were beyond the means of 18% of those surveyed. In these circumstances, prepayment meters might deprive families that cannot pay for their water in advance.

Installation du système d'assainissement condominial à Orange Farm.
*Set up of a condominium sewerage in Orange Farm.*

In order to keep poor homes within the quota, Suez has come up with an intermediate type of service for new-build low-cost housing designed for low consumption, below the 6m³ mark. It is an improvement on the makeshift districts with their latrines, chemical toilets and standpipes: water and sewerage are brought to each dwelling. The WC bowl must be flushed manually (known as pour-flush) and the water service pipe has a 'trickler,' a flow reducer. There is no bathroom.

*Hydroplus*, July 2003

“Nature has no reset button”

*State of the World* 2000