Rainwater Harvesting for Military Installations – The Time is Now

Environment, Energy & Sustainability Symposium
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Richard J. Scholze
U.S. Army Corps of Engineers

Construction Engineering Research Laboratory (CERL)
Champaign, IL

Jeannette Fiess
U.S. Army Corps of Engineers
Seattle District

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U.S. Army Corps of Engineers
Headquarters

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Water Thoughts

- **"Water is the oil of the 21st Century." Andrew Liveris, CEO, Dow, 2008**
- **Half the world does not have access to an adequate, safe water supply**
- **The ultimate source of all of our fresh water is precipitation**
- **8% of all energy use in the USA is directly related to pumping, treating or heating water – Clark Reed, USEPA**
- **The cheapest water you will ever have is the water you already have.**
- **Equivalent of green energy**
  - **Utility costs - $2.00 to $5.00 per gallon day of capacity to build water or wastewater treatment plant**
  - **New supplies costly and rising**
  - **Consumer costs – water and sewer combined between 0.5 and 1.0 cent per gallon**

What Are PWTBs?

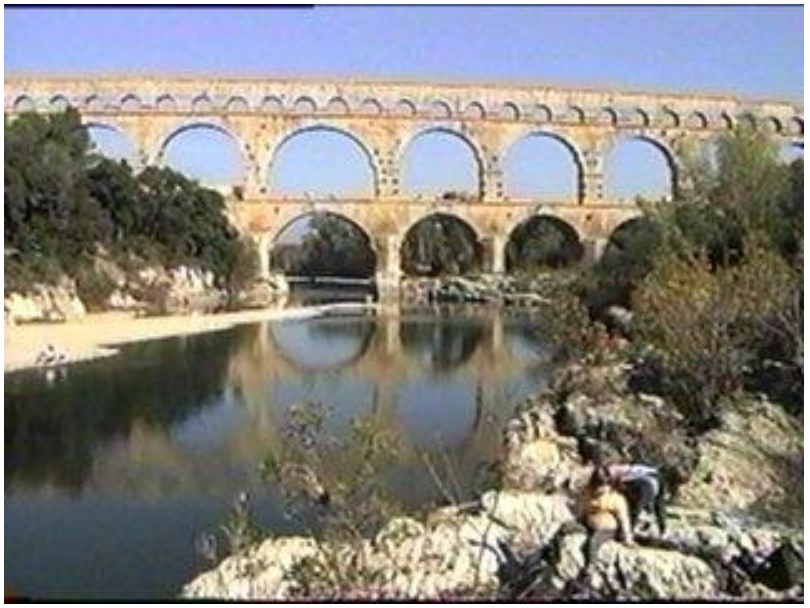
- Introducing: Rainwater Harvesting for Army Installations PWTB 200-1-75
- Public Works Technical Bulletins
- Sponsored by USACE HQ
- Variety of subjects
- Available through Whole Building Design Guide
- Accessible at:
- http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215
- May have to use alternate path – CCB, Army/COE, then PWTB

PWTB Contents

- History of Rainwater Harvesting
- Overview
- Drivers, Opportunities and Regulations
- Developing a Rainwater Harvesting System
- Types of Systems
- Operation and Maintenance
- Potential Military Installation Applications
- Lessons Learned
- Summary

History

- Not a new idea
- Long history in the U.S. and the world
- Catchment structure evidence dates back to third millennium B.C.
- Negev Desert, Greece, Italy, Egypt, Turkey, Mexico
- In U.S. – Historic evidence in Texas and Arizona
  - First - Water source for residents, then stopping points for travelers, commerce centers
- Recently, Germany a technology leader
- Common in rural areas



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Military Installation Water Drivers

Water Resources

- Increasing Water Quantity and Quality Concerns
- Drought
- Climate Change

Legislative and Executive Drivers

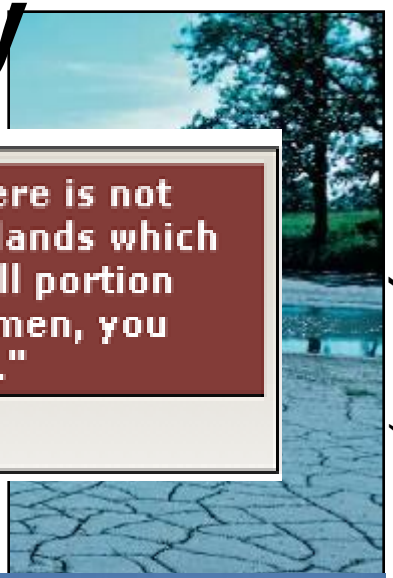
- Clean Water Act
- Energy Policy Acts
- Executive Order 13514
- EISA Section 438

Defense/Army Strategies and Policies

- Strategic Plan for Army Sustainability
- Army Strategy for the Environment
- 2005 Army Energy and Campaign Plan for Installations
- 2010 IMCOM Campaign Plan
- Installation Sustainability Plans - Water Conservation Goals
- LEED (Leadership in Energy and Environmental Design) USGBC
- Green Building Initiative
- Federal Best Management Practices

Decreasing Supply

- Over Withdrawal
- Climate Change
- Cost and Financing
- Quality Degradation



Lynn Betts, NRCS

"I wish to make it clear to you, there is not sufficient water to irrigate all the lands which could be irrigated, and only a small portion can be irrigated. I tell you, gentlemen, you are piling up a heritage of conflict."

-- Maj. John Wesley Powell, 1893

FEMP Best Management Practices

1. Water Management Planning
2. Information and Education Programs
3. Distribution System Audits, Leak Detection and Repair
4. Water Efficient Landscaping
5. Water Efficient Irrigation
6. Toilets and Urinals
7. Faucets and Showerheads
8. Boiler/Steam Systems
9. Single-Pass Cooling Equipment
10. Cooling Tower Management
11. Commercial Kitchen Management
12. Laboratory/Medical equipment
13. Other Water Use
14. Alternate Water Sources

Other Water Use/Alternate Water Sources Options

What can be done to increase available supply?
How can we efficiently use what's available?

- Water Reuse
- Desalination
- Produced Water
- **RAINWATER HARVESTING**
- Ground Water Recharge
- Graywater Reuse
- Sewer Mining

Rainwater Harvesting

Ideal for nearly any large building

Also applicable to expansive parking lots

Water stored in tanks or ponds – reducing runoff

Stored water can be used indoors – filtered and treated – fixture flushing, laundry, cooling tower, boiler makeup

Outdoors – irrigation, water features

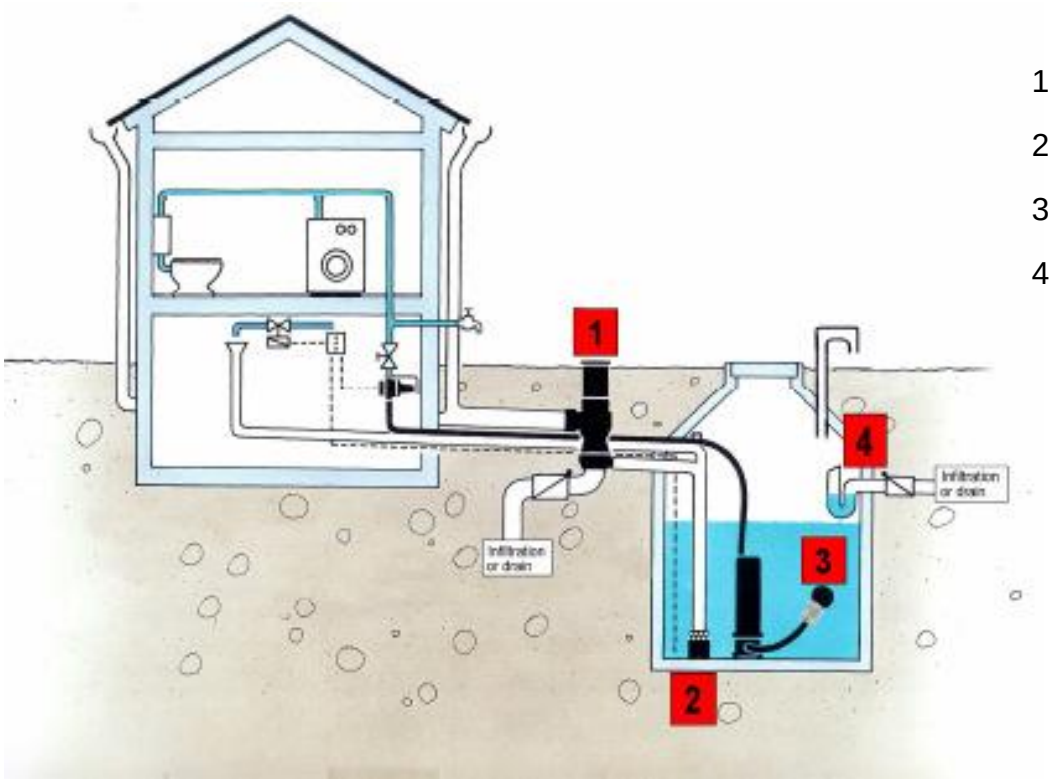
Some areas – potable water source

Result – reduces overall demand for municipal water

Why Rainwater Harvesting?

- Climate change
- Water shortages – Augment supply
- Save resources
- Maintain local control
- Insure reliability of supply
- Mitigate flooding
- Reduce erosion
- Reduce hydraulic loading
- Requires little energy input
- Excellent water quality
- LEED points – percent water savings, storm water reduction, reduction of sewage from potable water
- Most water used on installations does not have to be of drinking water quality.
- Beneficially use water which would normally be discarded as stormwater

Rainwater Harvesting System



1 First flush fine filter

2 Calming inlet

3 Floating filter

4 Overflow

From: VA Rainwater Harvesting Manual

Standards

- No national standards
- Plumbing Codes Changing - Currently UPC and IPC do not directly address rainwater harvesting in potable or stormwater sections causing confusion
- Definitions – UPC
- Harvested rainwater – Conveyed from a building roof, stored in a cistern and disinfected and filtered before being used for toilet flushing, can also be used for landscape irrigation
- States and local jurisdictions have developed standards or guidelines
- Ex. Texas – State promotes for any use Including potable provided appropriate treatment
- Portland, OR – Use for nonpotable applications
- Draft guidelines suggested by American Rainwater Catchment Systems Association
- Many states and municipalities established or establishing rules – OH, KY, HI,AZ, NM, WA, WV, TX and others
- Rules, ordinances, building codes etc. run gamut from requiring RWH systems in new construction to prohibiting tanks as an eyesore

Development of An Active Rainwater Harvesting System

- **Questions to Be Answered**
  - Retrofit to an existing building or a new integral system?
  - System size - L,M,S?
  - How complex – “Active” or “Passive”?
  - Permissible costs?
  - System requirements - Intensity of use, level of commitment, water security?
  - Intended use of the system? Irrigation, potable, other?
  - What water quality is required?

Water Balance Analysis

Allows designer to determine how much rainwater can be collected.

Provides a supply and demand analysis on a monthly or quarterly basis

Examine variables of rainfall and water demand

Determine cistern capacity – Is backup potable available or not?

Theory – 1 inch of rain on 1000 square feet of nonpermeable surface provides 620 gallons

Estimate demand

Candidate Buildings and Locations

Best candidates

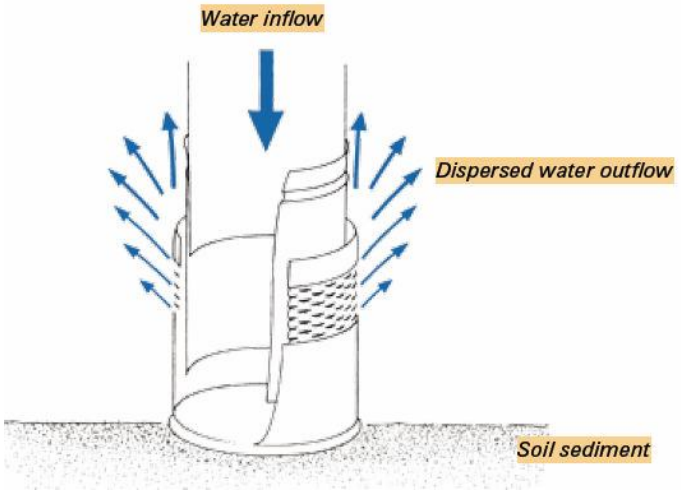
Simplest Collection Point – Roof

Ex. Low to Mid-rise Buildings Best Ratio: Roof Area to Toilets

However, Nearly Any Building Can be Used

Components of a Rainwater Harvesting System

Catchment Surface/Collection Area
Conveyance
Roof Washer (Prefiltration)
Primary Settling Tank
Storage
Distribution
Purification
Screens, Debris Excluders, Etc.



Calming Inlet

Figures from VA Rainwater Harvesting Manual

Components

Roofing Materials

- **Metal**
- **Clay/Concrete Tile**
- **Shingles**
- **Slate**
- **Wood, Tar or Gravel**

Siphonic filter

Downspout filter

Old and Modern Filter Designs

Images from VA Rainwater Harvesting Manual

Components (Cont.)

Gutters and Downspouts

- **Careful of metals, if potable use**
- **Most common – PVC, vinyl, pipe, aluminum, steel**
- **Ensure adequate pitch**
- **Modern filters extremely low maintenance and cleaning**
- **Filters should be self-cleaning and self-drying between events**
- **Use stable materials which will not change shape and can withstand temperature changes, e.g. stainless steel is best**

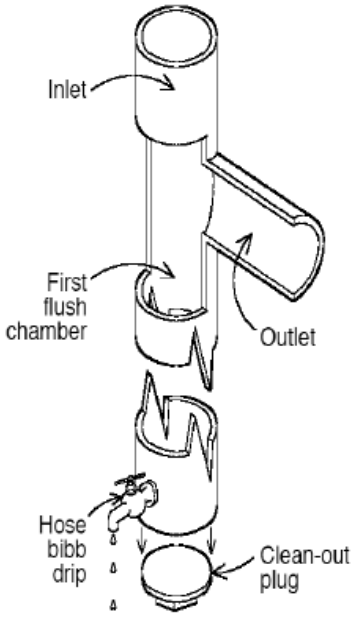
Leaf screens – variety available, must be maintained

First-flush diverters – routes first flush flow away from storage tanks

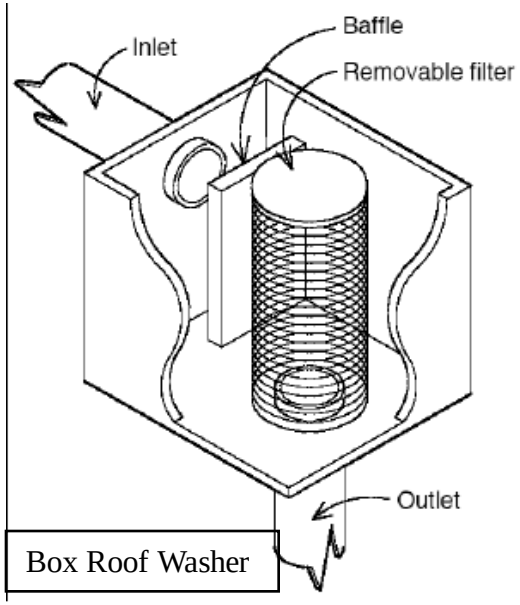
Roof washers – just before storage tank, filter small debris

- **Modern versions require little maintenance**

Disinfection array with pump, filters and UV lamp



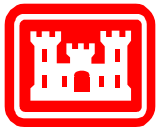
First Flush Diverter



Box Roof Washer

Components (Cont.)

- Storage Tank or Cisterns
  - Heart of system and most expensive component
  - Above or below ground
  - Epoxy steel, fiberglass, concrete, polyethylene, or other materials
  - Must be opaque, covered, vents screened
  - Potable tanks must have accessibility
  - Locate near to supply and demand points
  - Provide proper seating



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Components (Cont.)

Pumps, Filters, Treatment, Valves, Piping and Controls

Distribute harvested rainwater from storage tank to designated end use

Filtering and disinfection prior to delivery

Control valves monitor level of rainwater versus pump operation

Many municipalities require piping to toilets, urinals, irrigation systems and hose bibs be continuously labeled with "Harvested rainwater, do not drink"

Usually a pump and pressure tank between water storage and treatment and the end use

On-demand pumps eliminate need for a pressure tank, an all-in-one unit

Disinfection, usually UV or chlorination, for potable use, any military application for potable should consult Public Health Command

Economics

- Varies considerably with the application
- - Often $1 per gallon of storage capacity
- Paybacks variable – often 10 to 15 years
- One school in TX had 5-year payback for irrigation use.

Military Experience

- Army Experience
- Limited in CONUS, HI and Guam have potable collection facilities
- Buildings have been designed with focus on nonpotable applications

Kilauea Military Camp, Hawaii

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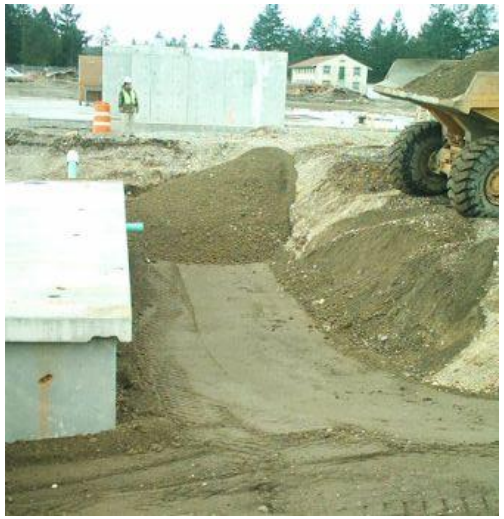
Army Example
Joint Base Lewis –McChord
Company Building

Rainwater Vault Sizing

- **Review occupancy**
  - High use after morning PT
  - Standard office use during day
  - 80% male, 20% female
    - Indicated 107.2 gallons/day usage
    - 10,107 gallons/month storage required
- **Review water availability**
  - Lowest monthly rainfall is 0.78 inches (August)
  - With roof area this amounts to 50.57 m^3
- **Size the vault**
  - Vault sized to hold 2 months' water to account for dry months
  - Standard vault sized at 84 m^3

Rainwater Retention Vaults

- 22,000 gallon precast concrete vault
- Roof runoff directed to vault
- Non-potable pumped into buildings and used to flush toilets



Retention Vault Lessons Learned

- Non-potable water isn't metered
- Consider filter design
  - Toilets were getting stained
- Review industry standards and design recommendations
- Education
- Flush out system prior to turn over

Military Experience

- Air Force Guidance approves for irrigation and fixture flushing
- Portions of Guidance
  - Cross-connection testing
  - Identify piping as nonpotable
  - Monthly inspections of systems
  - Fixture flushing water must be filtered and disinfected
  - Makeup provisions in case of drought
  - Appropriate consultation with DPW/Bioenvironmental
  - Labeling of toilets and buildings

Military Experience

- Lessons learned
- During design phases increase coordination between all engineering disciplines and improve technical drawings.
- Essential for design team to have familiarity with rainwater detention technologies.
- O&M staff need thorough training
- Buy-in is essential between designers and construction and O&M staff to be aware of water reduction goals of the project and be committed.
- Thoroughly review early construction documents to avoid change orders
- Require rainwater harvesting at the Request for Proposal level and emphasize life cycle costs over first costs

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Rainwater from Roof

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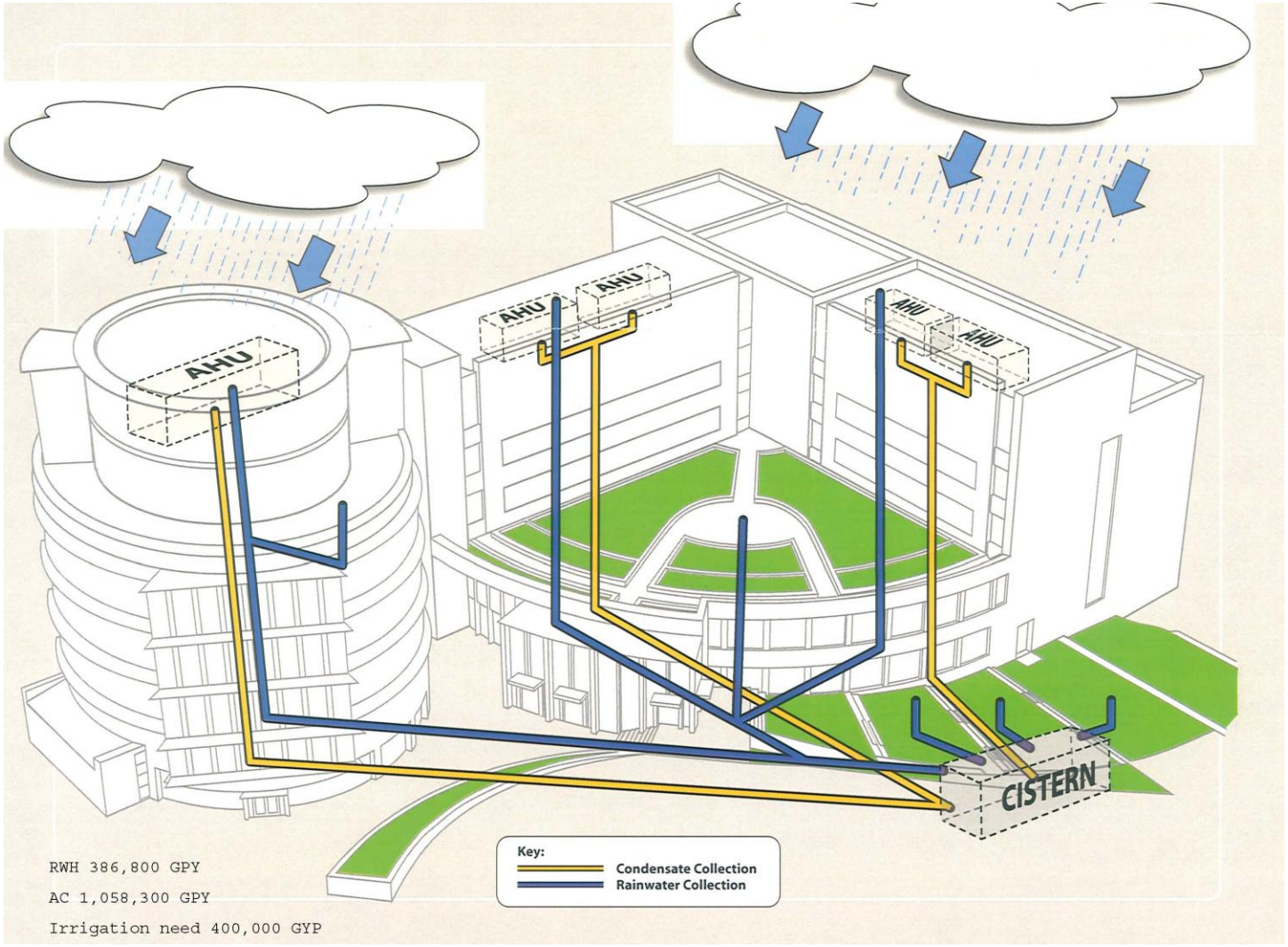
In order to conserve water...
RAINWATER
HARVEST
IN USE
DO NOT
DRINK THE
WATER
NO TOME
EL AGUA

Mitchell Physics



Rain Tank


B
A

Pump Enclosure

30 GPM Pump

RWH Systems for Livestock and Wildlife

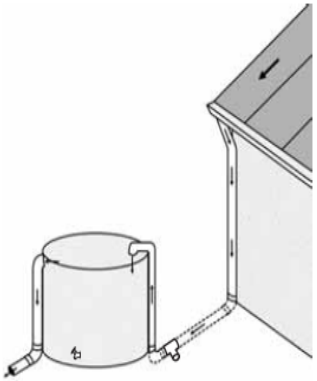


Figure 1. A typical rainwater harvesting system uses a roof, gutters, downspout and pipes underground, and backup into the top of the collection tank. This prevents livestock from damaging the pipes and allows the tank to be much further away from the shed. Unless there is a drain along the lower pipe, the standing pipes will contain water that is susceptible to freezing.

From: Texas Cooperative Extension TAMU

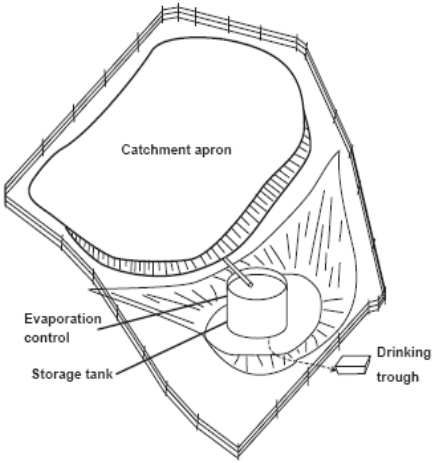


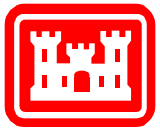
Figure 2. This rainwater harvesting system uses a prepared surface of concrete, rock or a sealing material to shed the rainfall. The rainwater is then diverted into the top of the collection tank.

Rainwater "guzzlers" at Big Bend State Park in far West Texas are used to provide water for wildlife.

Using Landscape as a Rain Harvesting System

Landscape Design Concepts

- Soil preparation and depth
- Shape land to hold water
- Chose appropriate plant material
- Proper irrigation system design
- Capture on-site sources of water
- Symbiosis between landscape and stormwater control
- *KEEP IT WHERE IT FALLS*



Shape land to hold water


2007 11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2007

Future and Larger Scale Systems

- More complex operations
- Collect large quantities
- Blocks and large buildings have dual plumbing and communal systems with treatment
- Combine with other sources such as graywater, condensate and infiltrating groundwater

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Summary

- Numerous drivers promote water efficiency
- Rainwater harvesting – one option to using less potable water
- Quantities can be significant
- Regulations changing
- Widely used in many states
- Match water quality with end use
- Treatment processes variable
- U.S. Playing Catch-up
- New/emerging technologies should be demonstrated/adopted
- Demonstrated on Federal facilities
- Spell out requirements in contracting documents for new construction
- PWTB available now

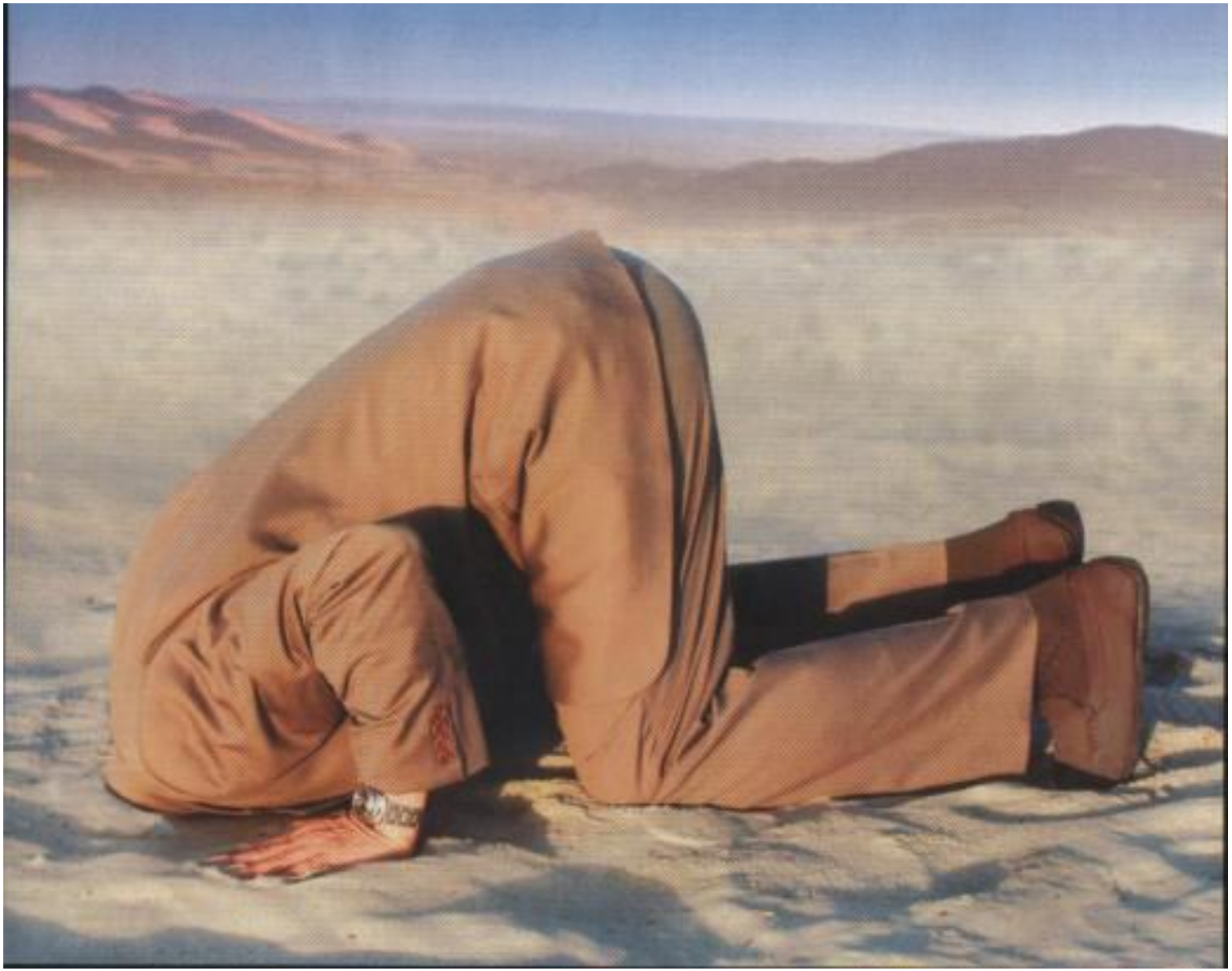
Questions, Comments?

Contact information or for additional information or resources

Richard.J.Scholze@usace.army.mil

217-398-5590

Thanks also to Bill Hoffman and Dan Pope for selected images



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