Grade School Education : Various Schools, New Mexico

Water literacy is the key to future generations' ability to live within natural limits of a place. Earthwrights Designs donates time and materials for these types of projects. Concepts such as level, flow, filtration versus flushing, passive water harvesting and water budgets, can all be taught in a language that children understand and remember. The key is active involvement through movement, and use of the senses as well as the intellect. #1 shows a combination of exercise and measuring—"How far did you run" using a standard measuring wheel. (Lead Instructor: Chrissie Orr). #2 shows 5th and 6th graders creating a swale on contour for passive water harvesting. They used sight levels and marked shovel handles to learn about grade and contours. Their completed swales were checked to see if they would hold water, and most did. (Lead Instructor: Zoe Nelsen). # 3 is a field trip to the Santa Fe River. Pollution was examined with a "garbage scavenger hunt" We also asked the question—"If this is a river—where's the water? (Lead Instructor: Lynn Osborne)


1

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Grade School Education

Various Schools, New Mexico

#4 shows Zoe Nelsen and class acting out hydrologic concepts. #5 is a piece created in Chrissie Orr's class. A boy drew this passive water harvesting plan view complete with a legend after we dug swales. #6 is a group of Gonzales Elementary students demonstrating their knowledge of why we don't store grey water. Their reaction comes after smelling a sample that had been stored for several days.

Thanks to the children, parents, and associate instructors of Los Padillas, Gonzales, and Cesar Chávez elementary schools.


4

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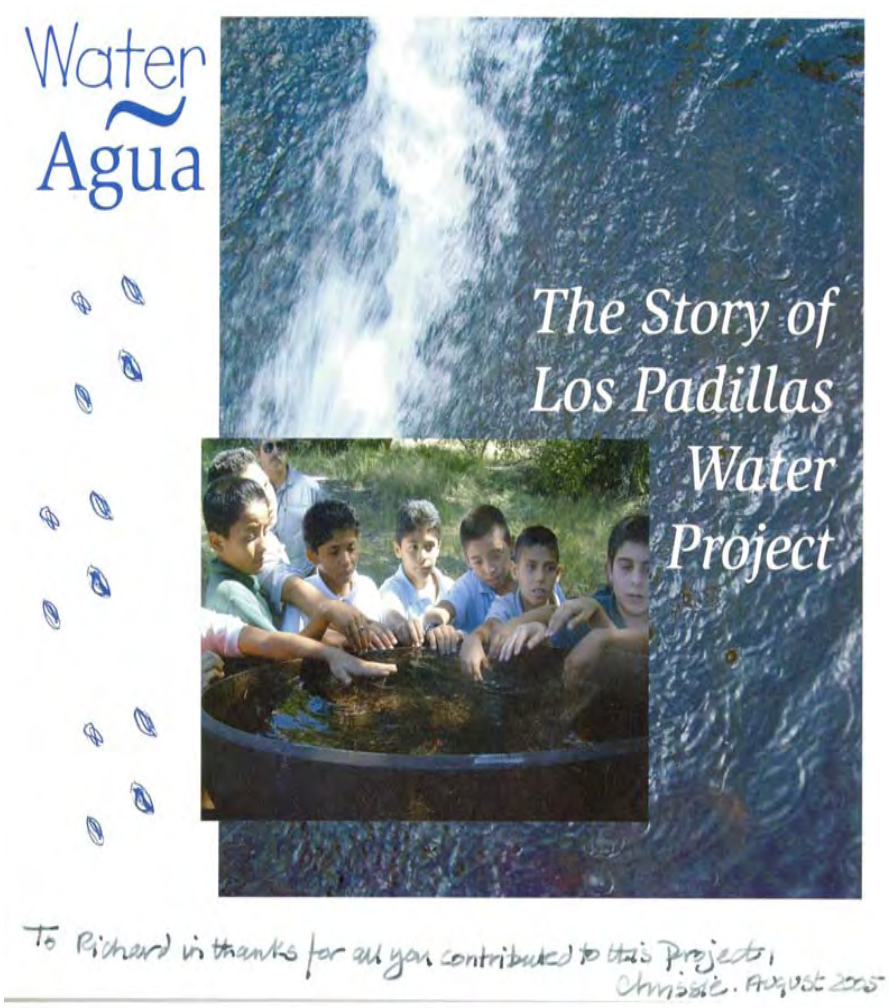

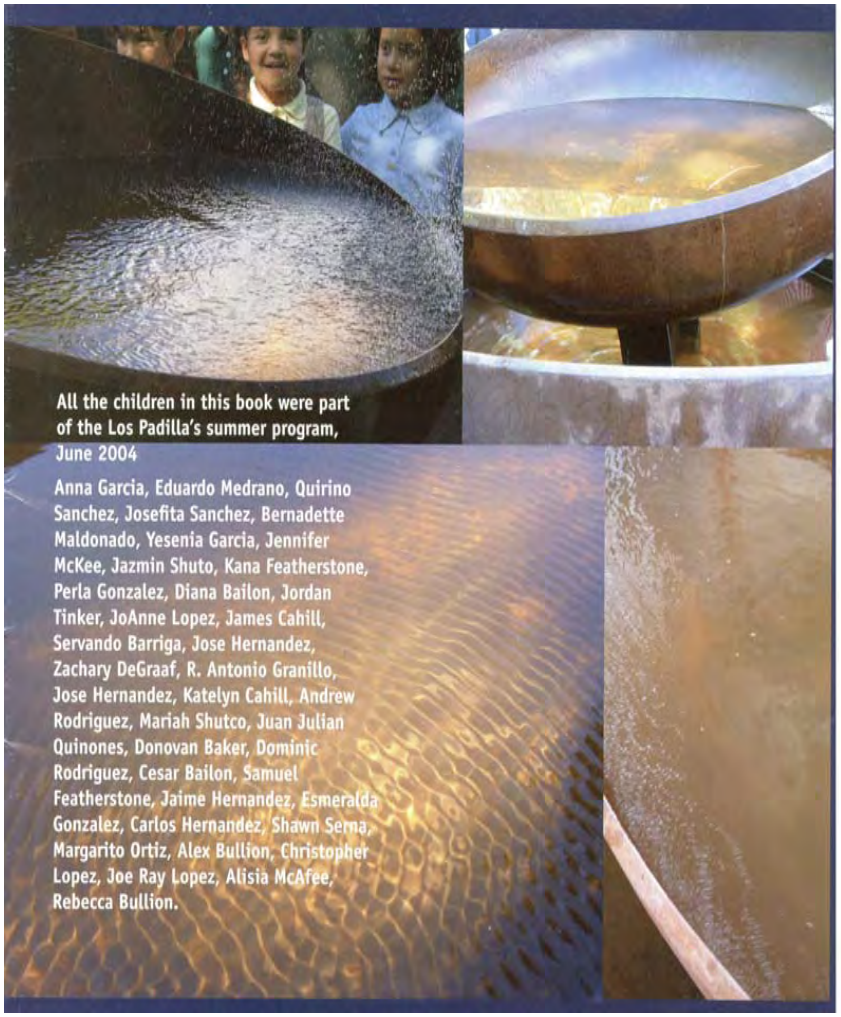

Water Literacy

Los Padillas School,
Albuquerque South Valley, New Mexico

Water Literacy is as important as any other academic subject. It involves knowing where your water comes from, how it moves through your community, an what happens to it when it leaves. Water literacy is based on watershed awareness. This booklet was created by artist Chrissie Orr to document a summer project with children from the South Valley of Albuquerque. Chrissie has done similar projects in various locations around the world. Water is a universal element and water literacy can be a universal language. Chrissie Orr can be reached at chrissie@metamorfosis.com

Once upon a time there was a river. This river started in the mountains and it ran down through a little valley. Every winter it would snow on the mountains and they would turn a beautiful white color. In the springtime the snow would melt and the water would soak into the mountain. The mountain and the valley were like a big sponge. They would soak up all the water from the melting snow. Then it rained and more water soaked into the sponge until it was full. In the summer, this water made the plants and the trees grow. Little animals came to eat the grass and bigger animals came to eat the little animals. They all pooped on the ground and the poop was food for the plants and the trees. Everything worked pretty well and there was always snow and rain and plants and animals and poop. Some years it snowed less so there was less water in the springtime. Then there were fewer plants and less animals, but there was always some of everything and everybody. There was so much water that it leaked out of the mountain and the valley and into the river. This is why there was always water in the river.

Down in the valley some people came and made a city. They put houses and shopping centers and schools and roads. Pretty soon the ground was all covered up. Now when it rained and snowed, there was nowhere that the water could get into the sponge. Instead the water all ran to the river. Now there was so much water in the river that it went very fast. The fast water carried away the earth around the river and soon it was a big, wide, and very dry ditch. Now the water would come all at once and leave very fast. The sponge got all dried out. Once it got so dry, the trees and plants died. The little animals had no plants to eat

so they died. The big animals had no little animals to eat so guess what. That's Right.

Well this was a pretty sad place. The people were also sad. Some people said, "Its too bad, but we have to do things the way we always did them". Other people said "When something doesn't work, then we better try something else". Those people started catching the rain in tanks. When there was no rain they would give the plants water from the tanks. Other people started catching the rain in the ground. They did not let the water run away. Pretty soon there were places that the sponge started filling up again. When the sponge got full, the plants and animals came back. Pretty soon even the river came back. The people learned that they could share the mountain and the valley and the river with the plants and animals, but they had to take care of the water and the sponge that they lived on.

Richard Jennings

Hi my name is Cesar Bailon.
I learned a lot of things but my favorite was the siphon.
With one of those you can get water up hill. I had lots of fun with every thing we did. I think the water sculpture came out really well.
It would be cool if we had you guys come and teach us after school. I had a lot of fun and I also learned a lot.

César Chávez Public School is located on the South Side of Santa Fe in the area that is experiencing rapid growth. This growth has required that portable classrooms be added. As the photos on this page indicate, there was virtually nothing green on the school property. Lynn Osborne, a science teacher for grades 4 and 5, decided to do something. She applied for a grant from Partners in Education. Her intent was to create a water harvesting system and garden that would be a teaching model and inspiration for the school and community. The $1200 that she received was enough to cover some expenses but was far short of what would be needed to create any project. Earthwrights Designs volunteered to donate design, materials, classroom time, and project administration. The donors listed below supplied materials and labor. Lynn Osborne supplied the consistent effort to keep the project on track and she also acted as the representative for the project when dealing with the school administration.

The system was designed and constructed over a period of 2 years. Whenever a task was safe and age appropriate, the students contributed their labor. This culminated in the landscape planting and irrigation where the labor was mostly supplied by the students.

Rainwater Harvest Demonstration System at César Chávez Public School

Santa Fe, New Mexico

Project Creator and Administrator: Lynn Osborne

Donors:

AAA Allied Septic, Earthwrights Designs, Ecoscapes Landscapes, The Firebird, Partners In Education, Plants of the Southwest, Santa Fe Greenhouses Starite Pumps, Weathermatic

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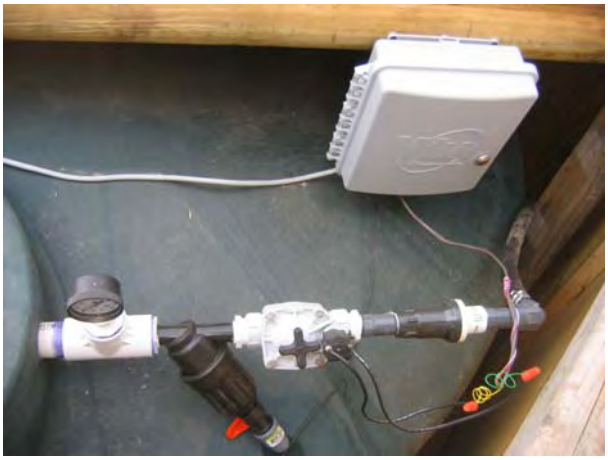
Students smoothing and leveling the base for the tank

Students passing cobble stones for retaining walls

Lynn Osborne and the rainwater tank

The tank is installed in a plywood enclosure and two roofs are piped with first flush diverters

Inlet Filtration



Controls and valves were installed inside of the enclosure.

Students planting and installing drip irrigation

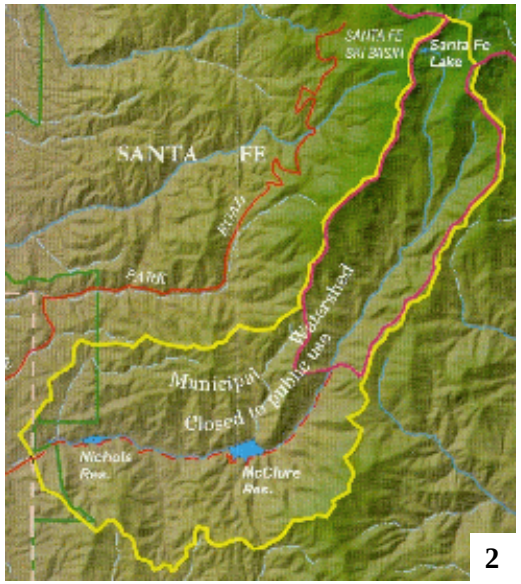
Classroom instruction about weather and irrigation

The project used drought tolerant perennials for maximum water efficiency, fruit trees for future shade and food, and broad leaf evergreens for all year greenery.

1

Santa Fe, New Mexico was built along a river with sections of both perennial and ephemeral flows (#1). In the early part of the 20th Century, dams were created in the upper watershed (#2). This provides about 40% of the municipal supply. The consequence of this change is that the river's flow has been moved. The former channel is now largely dried up and the riparian zone destroyed (#3). The majority of flows in the river now are stormwater pulses that are short duration and highly erosive (#4). The channel has been cut up to 20 feet in parts (#5). The result is a dead and dry river over most of its length

3



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A Proposal For Restoration of Flows in The Santa Fe River

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The Santa Fe River has disappeared from the river channel because it has been moved. The river now flows through a network of pipes into the homes, businesses, and institutions of the City. It then continues its flows in 36 inch sewer mains (#6) to a treatment plant downstream of the City. The treated effluent is returned to the river at this location (#7). The result is that the only perennial above ground flow of the river is well to the south of the community. The water quality from the plant is relatively high. This is graphically demonstrated when the outflow meets a storm pulse (#8).

The community of Santa Fe has demonstrated that it wants the return of a living river. The mayor elected in 2006 made this part of his platform. One idea that has circulated is to pump treated effluent 12 miles back up the river to the headwaters and then to allow it to flow back down. This requires that a 2 foot diameter pipe move 2500 acre feet per year up the river bed. The estimated construction cost is $12-25 million.

There are several flaws in this plan. The first is a legal problem in that the effluent now flows downstream to irrigator communities that hold senior water rights. The second is that there has been no demonstrated energy budget to pump all of the weight up hill. Any sustainable plan must recognize the connection of water money and energy. For example the generation of our electric energy uses .75 gallons per kilowatt hour. So a large pumping system will use up water as well as energy. It would also add more CO_2 to the atmosphere.

7

8

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Another solution to the problem can be found that integrates water, money, energy, and existing infrastructure. The Santa Fe sewer system has old sections and costly backups. Repairs are needed. What if small package plants were installed upstream. The treated effluent could then be released to the river as seeps and springs. Gravity would create the flow downhill. Infiltration and re-charge of the surrounding aquifers would also take place.

Flows are generated mostly during the day when the sun shines, so solar energy could be used to operate the systems and create a carbon neutral system on the energy side. As a bonus there will be empty sewer pipes in some areas if this plan is used. Other infrastructure could be considered for these tubes beneath the community. One possibility is for heat distribution pipes. A visionary group has proposed district heating systems using excess sustainable biomass from the surrounding forests as fuel. This would allow the distribution of the heat in the more densely built areas of the city, many of which are close to the river.

As part of Helen and Newton Harrison's exhibition at the Santa Fe Art Institute in 2005-2006, a display called "Seeps and Springs" was created to see what such a system would look like. A flyover of a section of the city was used (#9). Sewer mainlines (red lines) and laterals (orange lines) were mapped and marked on the display (#10). Treatment plant areas were located along the river and discharge points selected (blue line at the bottom). This created an alternate vision for restoration of flows that would use or improve existing infrastructure and create the possibility of some additional employment in the form of public/private entities called Public Improvement Districts. At the same the emerging realities of water, money, and energy can be fully considered. A system can then be created that accomplishes the goal of a living river in the most sustainable manner possible.

10

9

A Proposal For Restoration of Flows in The Santa Fe River

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WATER LITERACY = Adult Education: this is an outline for a class that will be taught at the local community college in 2006

INTRODUCTION TO WATER SYSTEMS : **I Hydrology and Politics**

The ways in which water is used and allocated is a reflection of the cultural values of the people and the political and legal systems that control water resources. The limited supply of water resources has created conflict between agricultural, urban and rural users, and the needs of the environment and wildlife. This study begins with the hydrologic cycle, and explores water use as a cultural and environmental issue and the policies and laws that control its' use.

CLASS 1

I Water in the Environment (1.5 hours)

A. What is Water Electro-chemical qualities

READING: Molecular Water Peter Warshall
PRESENTATION OF MATERIAL: Discuss article and implications
EXCERCISES: None
LEARNING OUTCOME: the molecular structure of water, what is unique about water, that water cannot be manufactured

B. Geo-Hydro-Chemo cycles

READING: Life's Matrix: A Biography of Water Phillip Ball, 1999 "Blood of the Earth" pp 22-58
PRESENTATION OF MATERIAL: Carbon Cycle, Nitrogen Cycle, Humic Cycle,
EXCERCISES: Draw cycles and energy exchanges
LEARNING OUTCOME:
Learning Outcome: how the hydrological system works, how much water exists in various parts of the cycle, how the cycle relates to drought cycles, how other chemical and energy cycles interact with water

C. The Water-Energy-Money (WME) triangle

READING: "The Unholy Triumvirate: Water, Energy, and Cash Flows" Peter Warshall Whole Earth Magazine Winter 2001 pp32-36
PRESENTATION OF MATERIAL: Discuss article
EXCERCISES: Compare the water energy relations of a swamp cooler versus an air conditioner Analyze the virtual water/energy connections
LEARNING OUTCOME: student should know that water energy and money are always related in human systems and how some of these connects work

II Water in the World (1.5 hours)

A. Where's the water?

READING: The World's water 200-2001 Gleik 2000 pp 20-37
Water Wars Shiva 2002
PRESENTATION OF MATERIAL: Discuss article, Present graph of where the water is (lakes, rivers, glaciers, clouds, ground water, bound water) Discuss Shiva and philosophy and reality of water allocation
EXCERCISES: Discuss- What is sustainable with a finite amount of water?
LEARNING OUTCOME: Understanding of how much water there is on the planet, where it is and how it cycles.

B. Whose water is it – All species perspective

READING: The World's water 200-2001 Gleik 2000 pp 2-15
Collection of press on Silvery Minnow
PRESENTATION OF MATERIAL: Discuss articles

EXCERCISES: Discuss ethics and ecology as they relate to water
LEARNING OUTCOME: Understanding of water's place in civilization and in ecology

III Water in the West (1 hour)

READING: High and Dry, The Texas-New Mexico Struggle for the Pecos River, Hall, UNM Press, 2002 pp224-249
PRESENTATION OF MATERIAL: Discuss how riparian and priority rights differ, Was the Pecos compact fair?
LEARNING OUTCOME: Understanding of Riparian versus prior appropriation rules, individual perspective on water rights issues

IV Water in New Mexico and Santa Fe (3 hours)

A. History of Water and Growth

READING: Taking Charge of our Water Destiny, Bellin, Bokum, Titus 2002
DVD or Videos by Joe Day "Rio Grande" and "Drought"
PRESENTATION OF MATERIAL: Watch recorded material, discuss readings
EXCERCISES: Homework—Choose an issue eg acquias and write an essay on the past present and future of water in New Mexico.
LEARNING OUTCOME: Understand history and issues of water in New Mexico

CLASS 2

IV Water in New Mexico and Santa Fe continued

B. Watershed Realities (2 hours)

READING: Water and Growth in Santa Fe Area, Thaw Charitable Trust
40 Year Water Plan 2001 City of Santa Fe
PRESENTATION OF MATERIAL: Discuss documents. Focus on learning outcomes
EXCERCISES:
LEARNING OUTCOME:

1. What are our water resources in place?
    a. Groundwater
    b. Surface water
    c. Other
2. How much water is there?
3. Where is it
4. Where does it come from and where does it go
    a. Diversion
    b. Return Flows
    c. Consumption
5. How is it divided
6. Sourcing attempts for imported water
    a. Estancia and San Juan Chama

C. Big pipe/small pipe Centralized vs. Decentralized systems (1.5 hours)

READING:
PRESENTATION OF MATERIAL:

1. What are the elements of a system (diversion, consumption, return flows)
2. What are the differences between centralized and decentralized
    a. Costs – Economic and Ecological
    b. WME perspective
    c. Operation and maintenance

What does conservation really mean? Toilet retrofits, alternative water budgets, ordinances

EXCERCISES: Take a subdivision plan and consider centralized vs decentralized
LEARNING OUTCOME: understand the assumptions of centralized versus decentralized, Understand

the implications in the choice of one system over the other

V Cultural Basis of Water Use (2 hours)

READING: Native Peoples of the Southwest: Negotiating Land, Water, and Ethninicity Laurie Weinstein Editor Chapter entitled "Soaking it In, Northern Rio Grande Pueblo lessons of water management and Landscape Ecology" Anshuetz, Kurt 2001
Historic Pueblo and Acequia Water Use: Development of Community Ditch Associations
José Rivera, In Law of The Rio Grande pp A3-1 to A3-10
PRESENTATION OF MATERIAL: Discussion of articles
EXCERCISES: Review essays from previous class
LEARNING OUTCOME: Understanding of Native American and Acequia water rights

VI Water Law & Resource Allocation and Politics (3 hours)

READING: New Mexico Water Rights NM WRRI 2002
Aamodt Newspaper articles
History of the Riob Grande Compact, Littlefield 8pp WRRI 1999
Rainwater Harvesting Policy of OSE
NMED greywater laws
Summaries of Endangered Species Act and Clean Water Act
PRESENTATION OF MATERIAL: Discuss readings
EXCERCISES: Debate who has water rights, what is right and wrong with the system
LEARNING OUTCOME: Understanding of the following as they relate to water use :

Acequias Prior Appropriation
Interstate Compacts; Rio Grande, Pecos, Colorado
Clean Water Act
Endangered Species Act
New Laws
NMED greywater laws
NMED wastewater disposal - new policies

\Additional Readings

The amount of material on water and water issues is immense. The readings below go well beyond the scope of what is practical for a 64 hour certificate course. Key readings are suggested for each section. Additional reading are listed for motivated students to pursue outside of the class

Water in Crisis: A Guide to the World's Fresh Water Resources, and The World's Water, Gleick and the Pacific Institute for Studies in Development, Environment and Security, Island Press This author and group publishes a series of books on the world water situation.

Water Follies Robert Glennon 2002 Island Press

High and Dry: The Texas-New Mexico Struggle for the Pecos River G. Emlen Hall, 2002 UNM Press

Water in The West, Miller, Oregon State University Press, 2000 pp

Pillar of Sand: Can the Irrigation Miracle Last? Sandra Postel WW Norton & Co. 1999

Rivers for Life: Managing Water for People and Nature Postel and Richter Island Press 2003

Water: The Fate of Our Most Precious Resource Marq de Villiers Mariner Books 2000

Blue Gold: The Fight to Stop Corporate Water Theft Barlow and ClarkeThe New Press 2002

Cochabamba! Water War in Bolivia Olivera and Lewis South End Press 2004

INTRODUCTION TO WATER SYSTEMS: III Constructed Water Systems

This exploration of constructed water systems will concentrate on the site and building and small business scale of activity. The fundamentals of water system planning and design will be explored. Water technologies and projects will be presented including: development practices, indoor and outdoor conservation, rainwater harvesting, grey-water and effluent recycling. The students will plan and design a water harvesting and/or effluent recycling system for a residential or commercial building and site, and model water use scenarios to explore conservation and sustainability.

CLASS 1

I What is Sustainable? (1 hour)

READING: RJ Essay "Its All Water, Its All Good and Moisture Management
PRESENTATION OF MATERIAL: Slide show of "Its all water—Its all good" Tree ring records of cycles, Drought is normal, Discuss groundwater mining

EXCERCISES: Discuss Systems, Cycles, Define Sustainability– list elements on black board; What if everybody lived like us (China and India) EWM again; Global warming and simple math of sustainability
LEARNING OUTCOME: Sustainability of systems Use Eldorado or other locale as example for water management

II Water Budgets (1 hour)

A. No model is correct – Some models are useful

READING: None
PRESENTATION OF MATERIAL: Use laptop, spreadsheet for water harvesting or household demand and project on wall. Manipulate assumptions to show great variability
EXCERCISES: 1. If no model is correct why do we use them
2. Discuss Assumptions and math and the limits of models
3. Deconstruct a model
LEARNING OUTCOME: What is a model and why are they used. How can you assess the validity of a model?

B. What is a water budget?

READING: None
PRESENTATION OF MATERIAL: Use laptop, spreadsheet for water budget

1. Supply elements
   a. Permaculture and sustainable principles
      a1). Stacking functions: how many services can you buy for the money?
      a2). Redundancy: What happens when something breaks
      a3). Matching quality to purpose
   a. Diversions
      a1). Ground water
      a2). Surface water
   b. Conservation – negadrops
   c. Water Harvesting
      c1) Passive Water Harvesting
      c2) Active Water Harvesting
   d. Effluent Recycling
      d1) Greywater
      d2) Blackwater
2. Demand Elements
   a. Overall demand World, USA, New Mexico, Areas of New Mexico
   b. Gallons per capita per day
   c. Agriculture
   d. Residential

e. Industrial, Commercial, Institutional
f. Industrial
c1). Power Generation
c1a) Reservoirs
c1b) Coal
c1c) Nuclear
c1d) Fossil Fuel
c1e) Sustainable sources
g. Commercial
h. Institutional
3. Reserves
a. Soil Moisture
b. Reservoirs
c. Tanks
d. Virtual Water

EXCERCISES: GROUP ACTIVITY
1. What elements are in a water budget?
2. Create and manipulate a water budget
LEARNING OUTCOME: What is a water budget. What are the elements of water budgets. What are the tradeoffs in a water budget model?

III Design (1 hour)

A. Elements of Design
READING: None
PRESENTATION OF MATERIAL: Describe micro utilities, List and Discuss elements (simplicity, Permaculture principles, repairable and cleanable, cost vs value, hassle to live with) show examples of good and bad systems Explain moisture management concept re biomass and biodiversity
EXCERCISES: Analyze systems and look for good and bad design
LEARNING OUTCOME: The elements of good and bad design

B. Plans and Scales
READING: None
PRESENTATION OF MATERIAL: Describe concept of scale, Why scales are used (placement of elements in the real world, elevations and drainage, costing, visualizing construction)
EXCERCISES: sample plan sets for measurement and analysis
LEARNING OUTCOME: Understanding scale and plan reading, elevation and how it relates to drainage

IV Built Projects (4.5 hours)

READING: (Chose one per student interest) Create an Oasis with Greywater Ludwig 2004
Rainwater Harvesting for Drylands Lancaster 2005
PRESENTATION OF MATERIAL: Slideshow of Built projects
A. Conservation – and demand management
B. Water Harvesting
1. Passive Water Harvesting
2. Active Water Harvesting
C. Effluent Recycling
1. Greywater
2. Blackwater

EXCERCISES: Assign homework: design a system
LEARNING OUTCOME: Understanding of Active vs Passive Rainwater harvesting, Greywater vs Blackwater. Know how to evaluate a good and bad design

CLASS 2

IV Built Projects Continued

A. Review of student Designs **(** Depends on number of students—allow 15 minutes per design)

B. Field trip (to include 1 active, 1 passive, 1 greywater, 1 blackwater system**)**

Additional Reading

Rainwater: the secret of coexistence with the Semi-arid region of Brazil Caritas of Brazil, 2001 A mix of politics and technology with beautiful photos and even a music CD

Storm water: Asset not Liability Dallman and Piechota, Los Angeles and San Gabriel Rivers Watershed Council 2000, www.LASGRiversWatershed.org

The Rainwater Technology Handbook König, Wilo-Brain, Dortmund, 2001

Rainwater Harvesting Pacy and Cullis, Intermediate Technology Publications, London, 1986

Rainwater Catchment Systems Gould and Nissen-Petersen, Intermediate Technology Publications, London, 1999

Stormwater Background Recycling Study WBM Oceanics, Brisbane, Australia 1999

Second Nature, Adapting LA's Landscape for Sustainable Living Lipkis, Metropolitan Water District of Southern California, Beverley Hills, CA 1999

Dying Wisdom: Rise, fall, and potential of India's traditional water harvesting systems, Agarwal and Narain, Center for Science and Environment, New Delhi, 1997

Making Water Everybody's Business: Practice and Policy of Water Harvesting Agarwal, Khurana, and Narain, Center for Science and Environment, New Delhi, 1997

The Home Water Supply, Campbell, Storey Communications, Vermont, 1983

Sustainable Landscape Construction: A Guide to Green Building Outdoors, Thompson and Sorvig, Island Press, Washington, D.C. 2000 A "hands on" book for designing and building with special attention given to water

Handbook of Water Use and Conservation, Vickers, Waterplow Press 2001