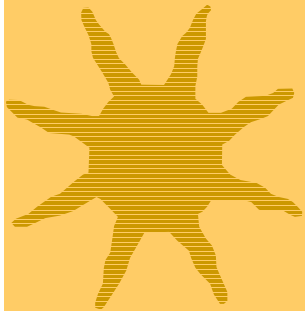
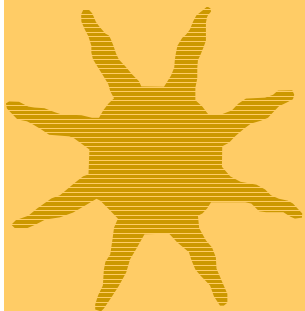


Solar Water Purification for the Border: Solar Distillation



Robert Foster

SWTDI - New Mexico State University

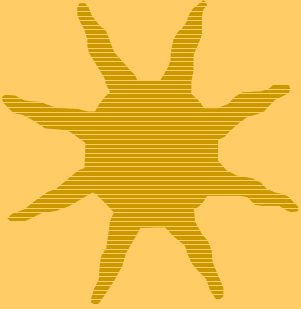


Sharon Eby-Martin

El Paso Solar Energy Association



Solar Water Purification through Distillation



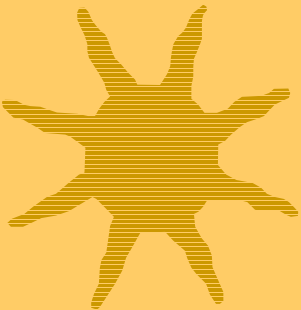
★ **Distillation Process**

★ **Water Production**

★ **Water Quality**

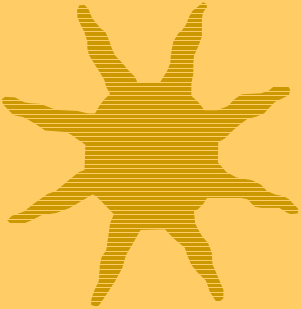
★ **Economics**

★ **BorderPACT Project**

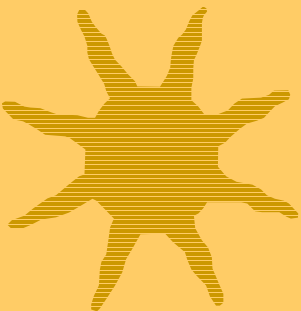
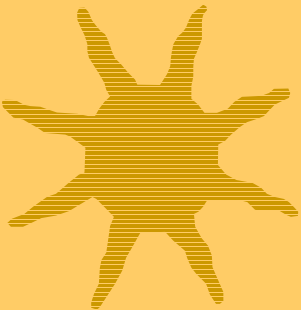




Solar Distillation

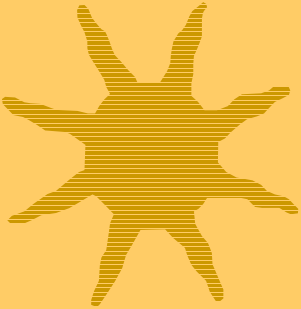


- ★ **Solar Stills are effective in removing**
 - Salts/Minerals (e.g., Na, Ca, As, Fl, Fe, Mn)
 - Bacteria (e.g., E. Coli, Cholera, Botulinus)
 - Parasites (e.g., Giardia, Cryptosporidium)
 - Heavy Metals (e.g., Pb, Cd, Hg)
- ★ **Stills can effectively purify seawater and even raw sewage**

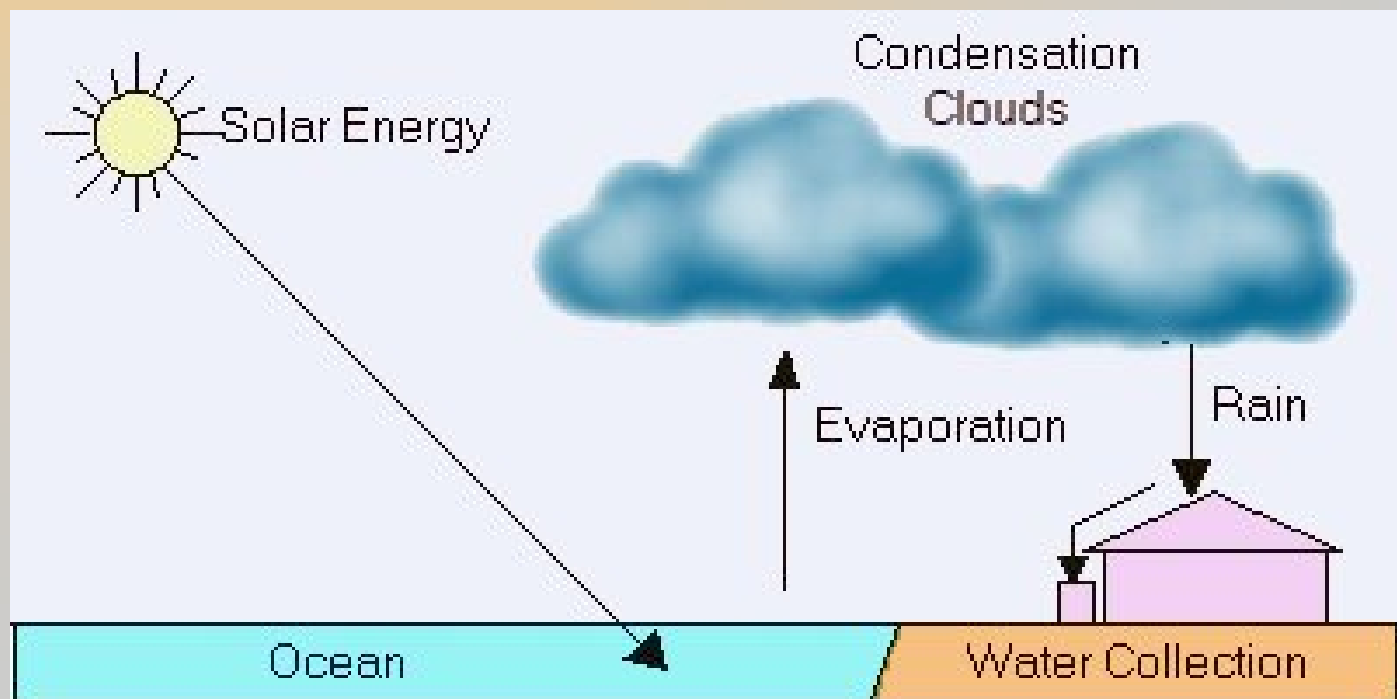
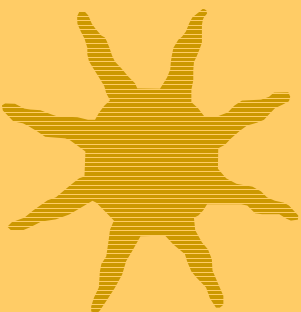




Distillation is same as Rainwater Process

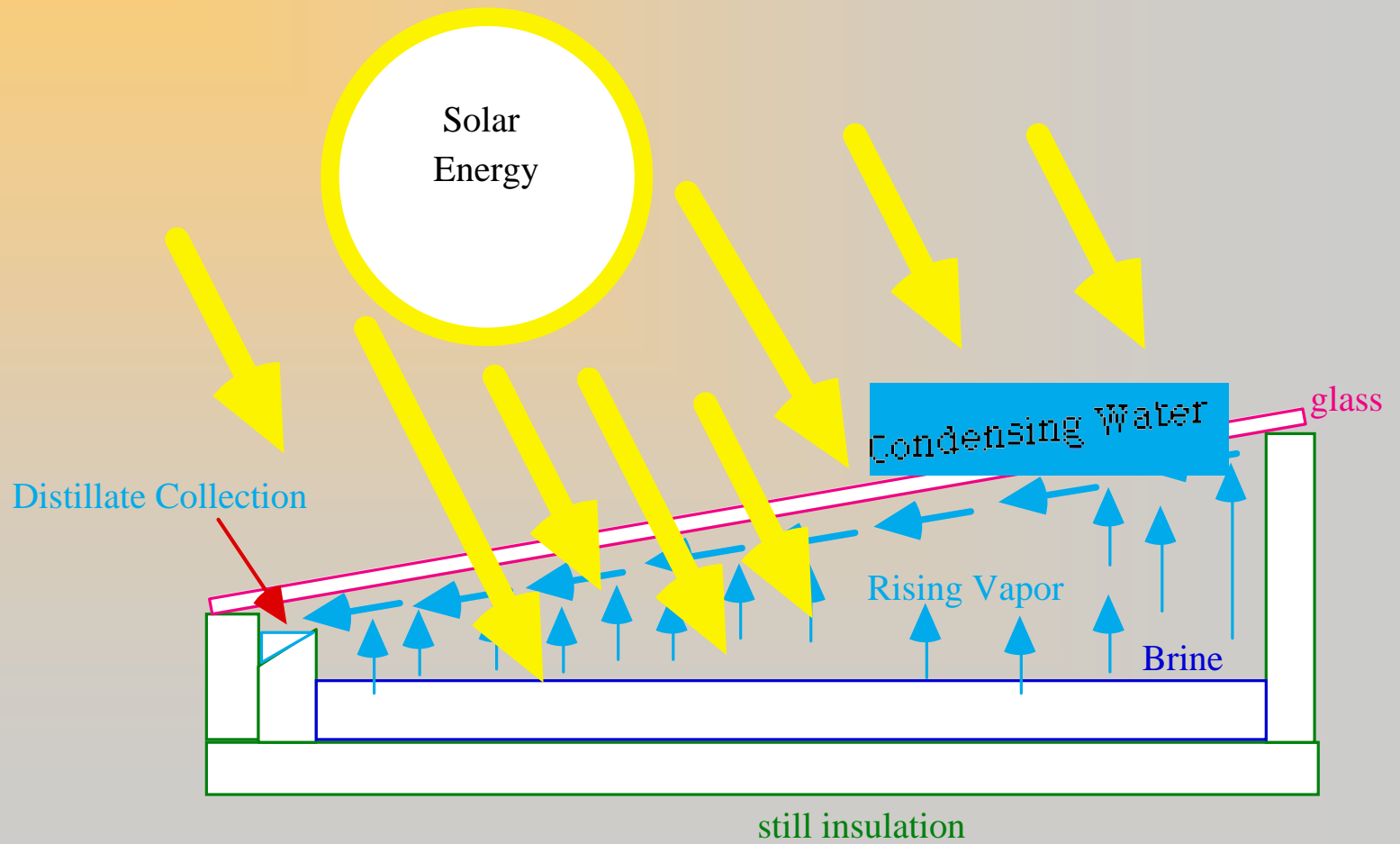
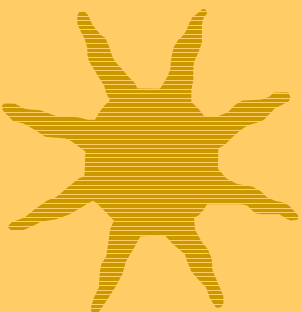


- ★ Solar energy heats water, evaporates it (salts and microbes left behind), and condenses as clouds to return to earth as rainwater.



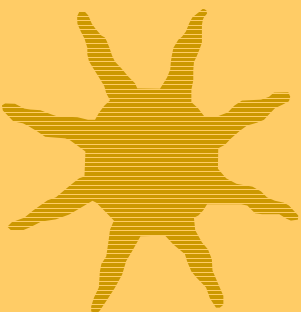
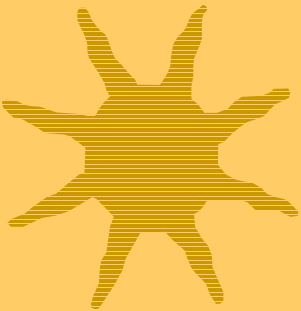
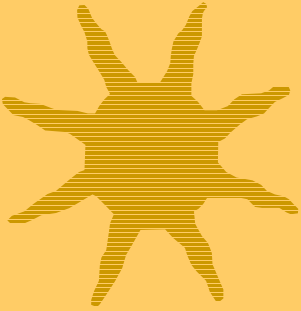


Solar Still Operation





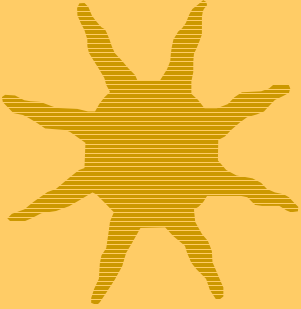
Typical Still Installation



- ★ **3'x6' family-sized still in Columbus which produces 3-4 gpd in the summer, and half that amount in winter. Water is typically collected in a 5 gal glass container.**

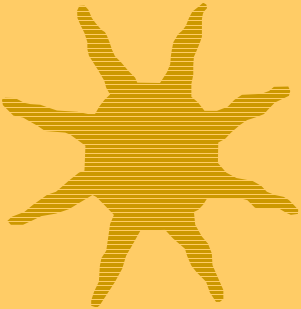


Simple Operation

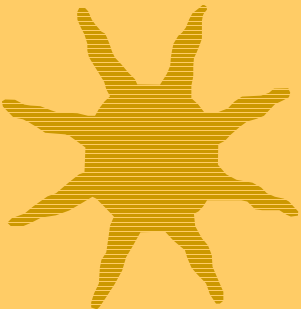


★ **Face still due south**

★ **Level Still**

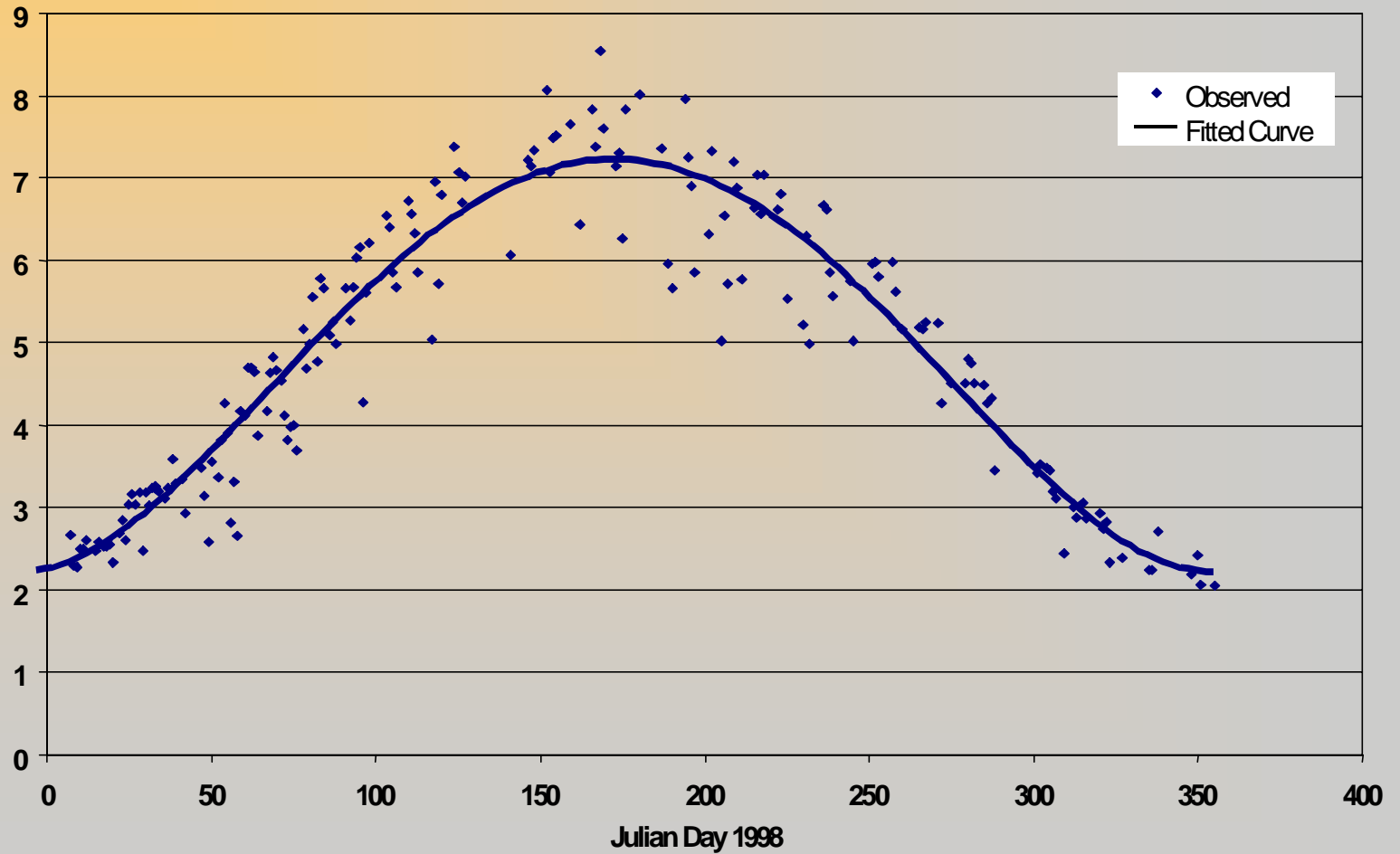
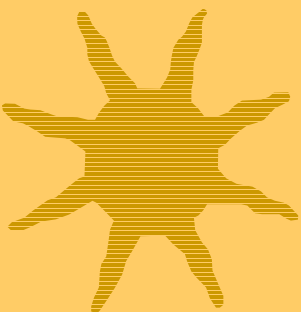
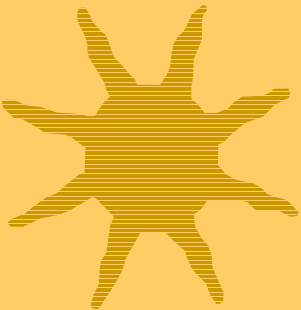
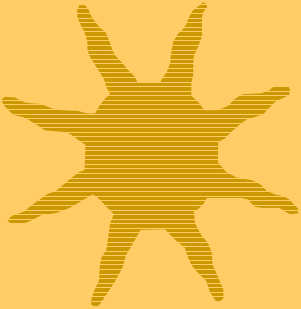


★ **Add make-up water once a day at 2-3 times daily production rate (depending on make-up water salinity)**



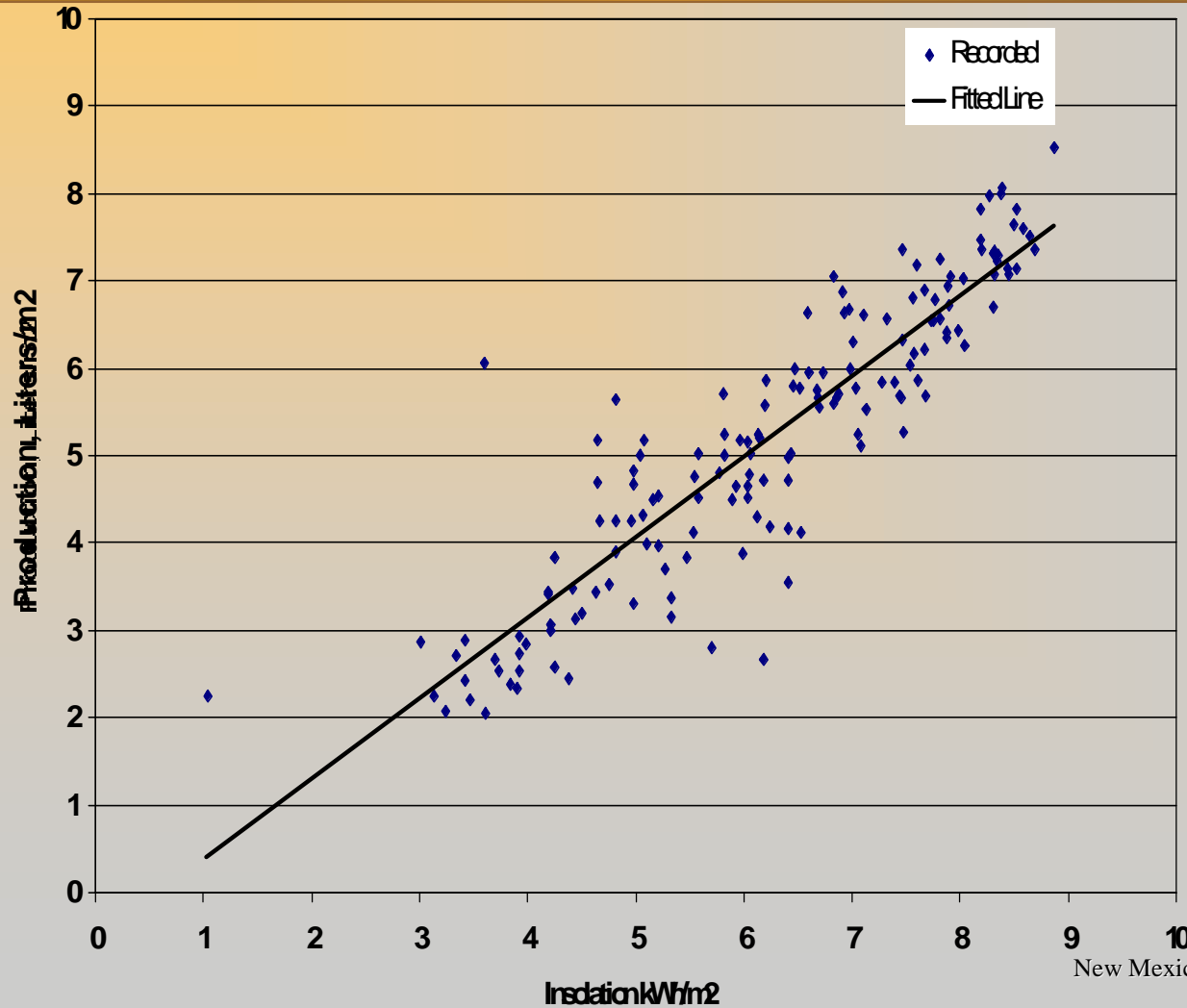
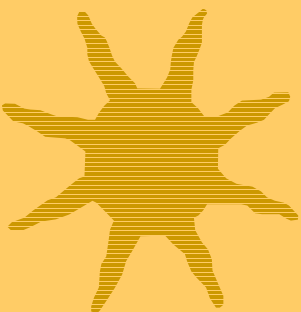
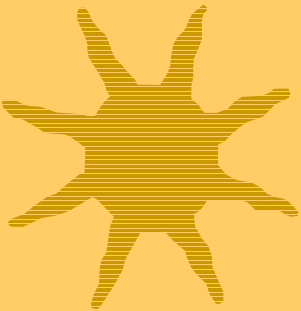
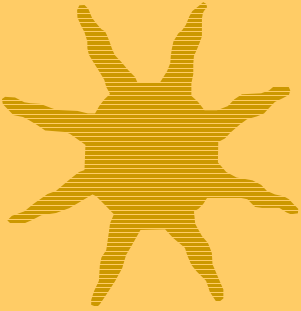


Annual Solar Still Production Las Cruces, NM





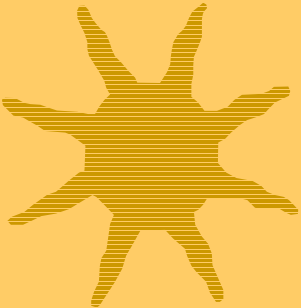
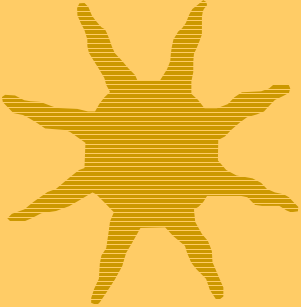
Still Water Production Compared to Solar Insolation





Still Water Quality Results

Sandia National Laboratories

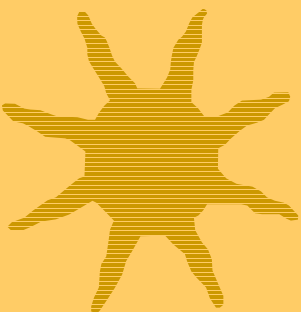
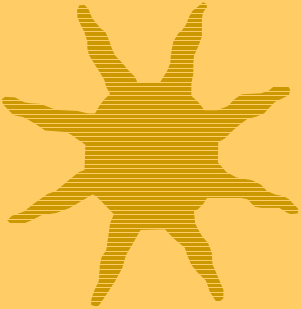


Sample Type	13% salinity feedwater	Solar Distilled water (13% case)	16% salinity feedwater	Solar Distilled water (16% case)
Calcium (total)	340	1.5	371	<0.10
Iron (total)	0.27	<0.05	0.48	<0.06
Magnesium (total)	2.1	2.1	<0.005	<0.005
Manganese (total)	0.04	<0.02	0.07	<0.02
Ammonia as N	<0.1	0.1	<0.1	<0.1
Chloride	19000	<1.0	25000	2.6
Fixed Solids	32000	<1.0	41000	31
Nitrate as NO₃	34	0.1	26	<0.1
Nitrate as NO₂	0.013	<0.01	0.02	<0.01
TDS	36000	<1.0	48000	<1.0
Volatiles & Organics	4200	<1.0	6000	13



Water Quality Test Results

New Mexico State University

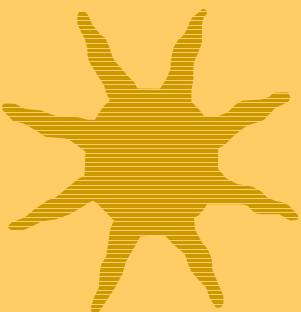
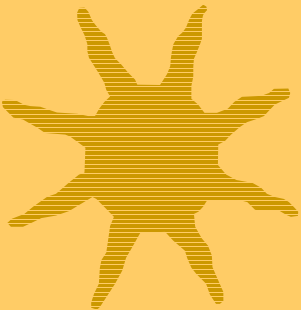
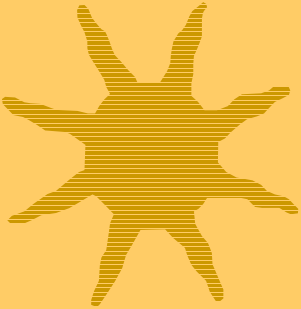


Sample	Volume Tested ml	Total Organisms per liter
Supply	50	16,000
Distillate	1,000	4
<i>E. coli</i> Seed	--	2,900,000,000
Distillate	750	11 (No <i>E. coli</i>)
<i>E. coli</i> Seed	--	7,500,000,000
Distillate	1,000	18 (No <i>E. coli</i>)
Supply	10	24,000
Distillate	1,000	13
Supply	1	12,000
Distillate	1,000	6

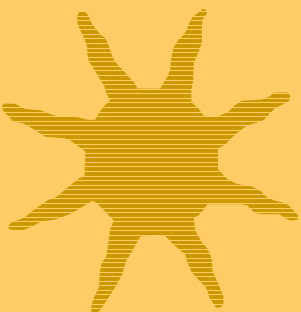
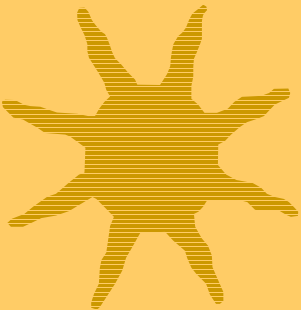


Water Quality Results - NMSU

Columbus, New Mexico



Field Still Ref. No.	Conductivity, $\mu\text{S/cm}$	Hardness, mg/L CaCO_3	Fluoride, mg/L	pH
#20 input	1190	260	6.2	7.9
#20 output	4.8	4	0.1	9.2
#22 input	1180	250	8.2	7.4
#22 output	1.8	0	0.10	9.1
#29 input	1200	250	6.0	8.1
#29 output	5.8	8	0	8.8
#30 input	2390	480	n/a	6.8
#30 output	4	4	n/a	9.4

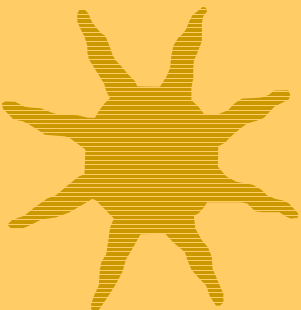
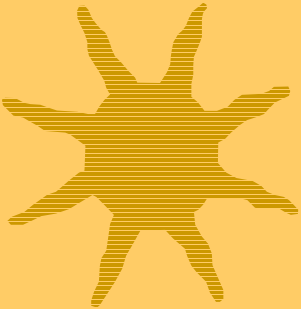


Solar Distilled Water Taste

- ★ **Equivalent or superior taste to commercially available bottled water (NMS U Taste Tests)**
- ★ **Water only comes in contact with food grade materials and glass**
- ★ **Natural bicarbonate buffering produces excellent taste compared to steam distillation**



Cost Comparison: Amortization 7% for 10 years



Method(s)	Initial Cost per month (\$)	Initial Cost per gallon (\$)	Replacement Parts per gallon (\$)	Power Cost per gallon (\$)	Total Cost Per gallon (\$)
R.O.-4 stgs.	9.23	0.123	0.110		0.23
R.O.-4 stgs.	8.71	0.116	0.086		0.20
R.O.-3 stgs.	6.73	0.090	0.094		0.18
Dist.-Elec.	5.68	0.076	0	0.37	0.45
Dist.-Elect.	16.22	0.216	0	0.35	0.57
Dist.-Elect.	20.89	0.279	0	0.35	0.63
Solar still (2-man)	8.24	0.110	0		0.11
Solar still (many)	5.54	0.074	0		0.07
Plastic (PVC, Polyp.)	6.24	0.083	0		0.08
Bottled Water	0.00	0.000	0	0	0.25



Solar Still Economics

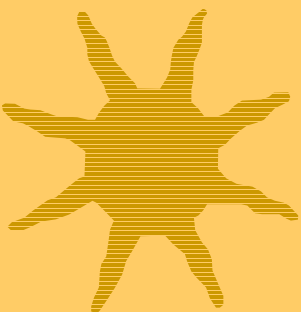
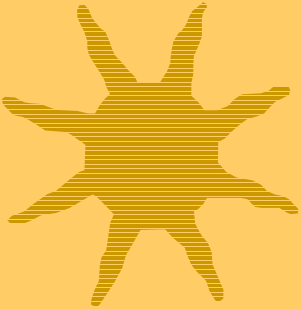
★ **Approximate Solar Still Costs**

– 3' x 8' ~ US\$850

– 3' x 6' ~ US\$650

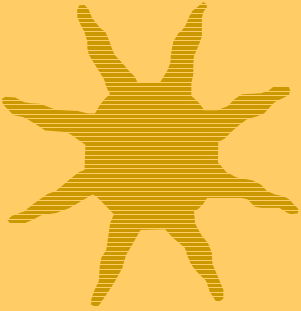
– 3' x 3' ~ US\$450

★ **Compared to purchasing bottled water, solar still simple payback is typically less than 2 years.**

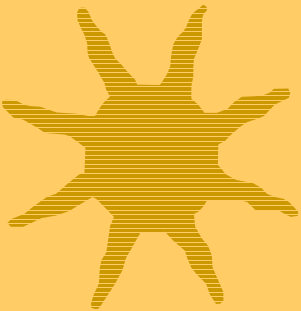




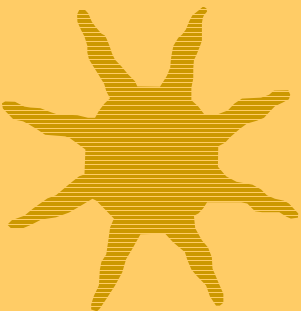
El Paso Solar Energy Association Stills Project



★ EPSEA received a BorderPACT/Conahec mini-grant to install 12 solar water distillers in Ciudad Juárez, Mexico.

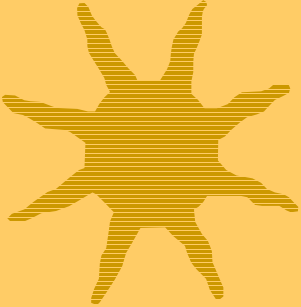


★ EPSEA has just begun a community solar stills development project with EPA for Texas and New Mexico.

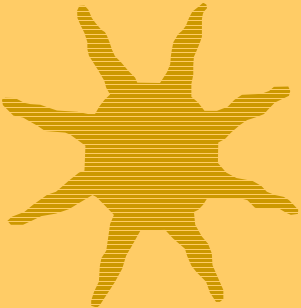




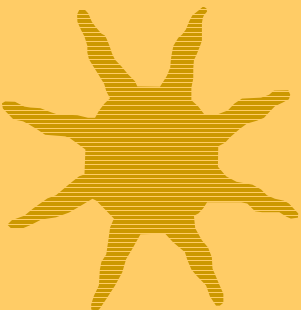
El Paso Solar Energy Association Solar Still Development History



★ **1995-97 - Texas State Energy Conservation Office sponsors still design and demonstration in College Park Colonia**



★ **1998-99 - U.S. Economic Development Administration sponsors extensive testing at NMSU with EPSEA demonstration in Columbus, NM**

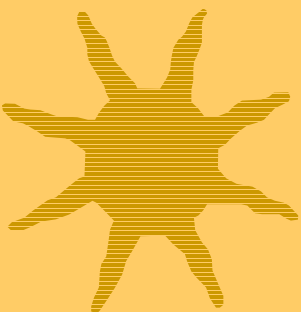
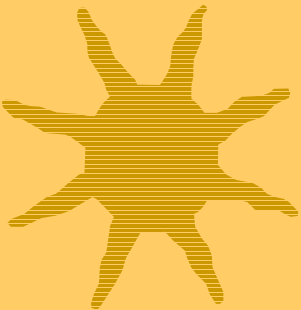


★ **2000 - BoderPACT EPSEA demonstration project in Ciudad Juárez colonias**

★ **2001 - EPA Project for 80 families for Texas and New Mexico colonias**



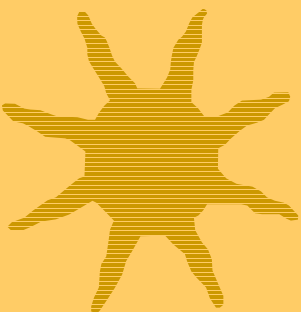
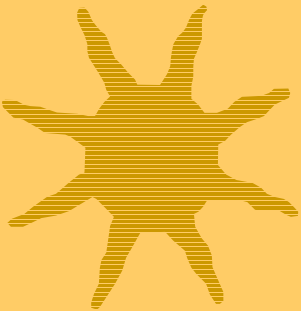
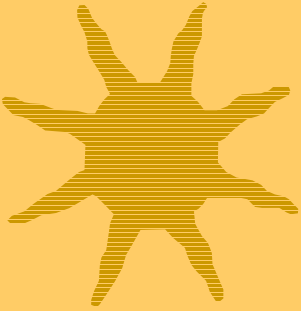
Solar Distilled Water...



Natural Process	Renewable Energy	Economical	Ultra-Pure Product
Eliminates Chemicals	Eliminates Salts	Eliminates Sediments	Eliminates Heavy Metals
Eliminates Coliform Bacteria	Eliminates Micro-organisms	On-Site Treatment and Energy	<i>Supports Healthy Living!</i>



EPSEA Still Installations in Mexico

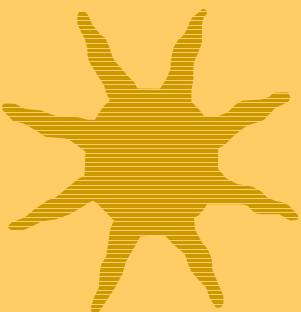
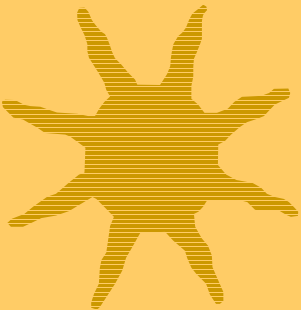
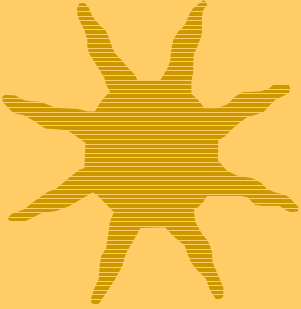


Solar still of Lupita Cruz Duran

- ★ **Family Still installed at a home in the Anapra Colonia in the outskirts of Ciudad Juárez, Mexico. Family with one daughter and a baby on the way.**

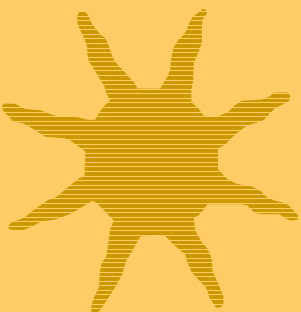
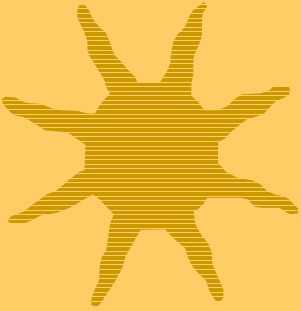


BorderPACT/Conahec Grant Funds Stills for Families in Need



**BorderPACT Coordinator
Marcos Rodríguez with the
Valdez family in Anapra**

★ **The Valdez family used to buy water at 13 pesos every 3 days (US\$175/year) until they received their still. They say that the still water tastes better than store-bought water!**

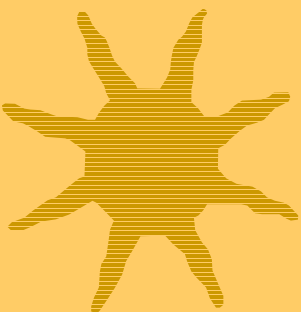
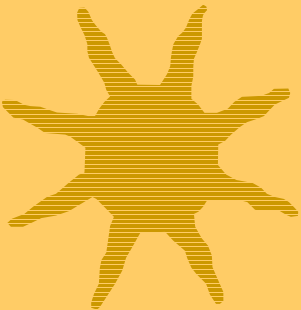


Stills at Anapra Orphanage



**Anapra orphanage
solar distillation units**

- ★ **Reducing the high costs to provide potable water to the >30 children and workers at the Anapra Orphanage**



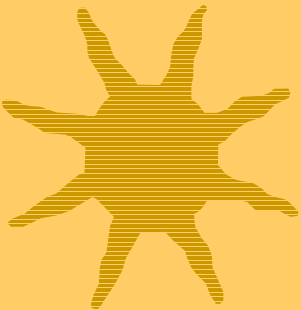
Clean Water for Everyone



- ★ **Anapra Orphanage kitchen that provides meals for the many children that reside there. Clean water is essential for cooking and drinking each day.**



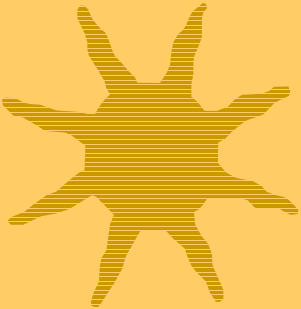
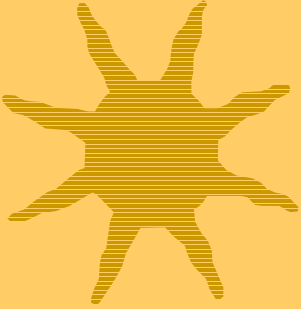
Thanks to BorderPACT/CONAHEC!



★ *Special thanks goes out to BorderPact/Conahec from EPSEA and especially the families and children of the orphanage in Mexico for the chance to have clean water in the border colonia areas!*



This is Only One Step!

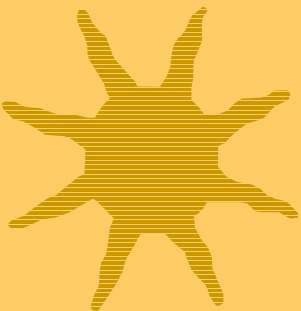
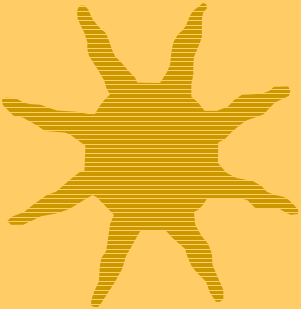
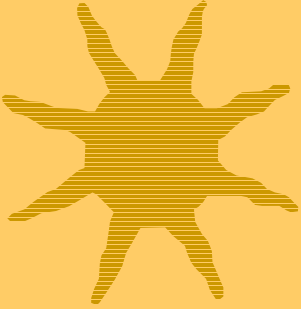


- ★ EPSEA will continue with Solar Still Development along the Border.
- ★ Education, projects, workshops, conferences, and Fairs are all part of continuing outreach and development by EPSEA.





El Paso Solar Energy Association



¡¡MUCHAS GRACIAS POR SU ATENCIÓN!!

THANK YOU!!!

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