

Three ideas...

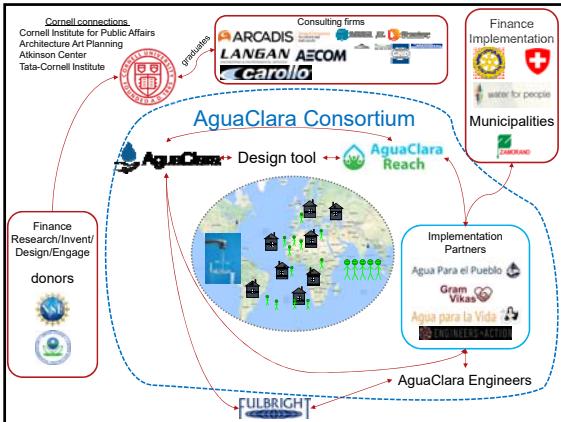
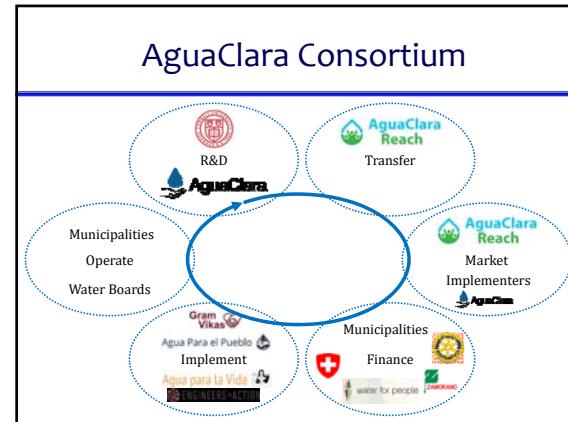
- Evolution – Iteration – **Mistakes** - Learning
- Creativity for Environmental Engineers can be expressed in how we solve the challenges of the interaction between fluids, particles, and geometry
- It's about details! (It is about all of the things that traditional textbooks tend to ignore.)
 - Density currents caused by temperature change
 - Flow distribution to reduce mean currents

Inventing Perfection

- “Furthermore, as the full scale plant is already in operation, the need for further design changes is not clear.”
-(Anonymous Reviewer)
- Ideas spring fully formed from their creator’s mind?

- Athena leaped from Zeus’s head, fully grown and armed

<http://designserver.cee.cornell.edu/Designs>



What is the conventional high tech solution?

- Technologies from the early 1900's: Flocculation – sedimentation – filtration – disinfection
- “Advances” over the last 50 years have focused on automation and increased use of electricity
- Increased cost, reduced reliability, more difficult to maintain, reduced useful life (cell phone life)
- 50% of the high tech plants that were installed in Honduras since 2003 have been abandoned



What happens when high tech water meets small town?

- Software expires and no one is able or willing to pay for the upgrade
- Everything that moves fails!
 - Valves, pumps, compressors, switches, relays
- Electricity bill is too high
- Entire treatment plant is abandoned
- 3 year average life for package plants installed in Africa – World Bank Engineer

Simple, Elegant, or Complicated?

- ***“Any intelligent fool can make things bigger, more complex, and more violent. It takes a touch of genius — and a lot of courage — to move in the opposite direction.”***

--- E.F. Schumacher

- ***“Simplicity is the ultimate sophistication.”***

--- Leonardo da Vinci

Elegant Solution

- Solves the problem very well
- No unnecessary complexity
- Easy to understand
- Simple and beautiful
 - Bicycle
 - Windmills
- Context matters in defining elegant!

Pride of Ownership

- What happens when the check engine light goes on in your car?
- What do you do if your bicycle brakes need to be adjusted?
- What does the plant operator do if the chemical feed stops working?

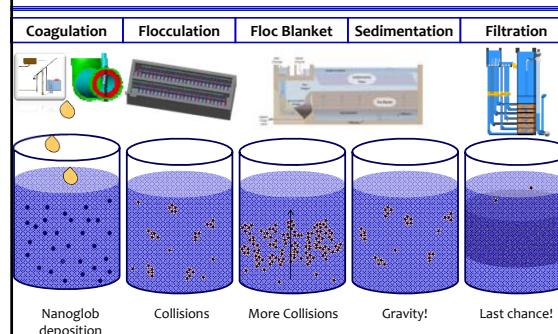


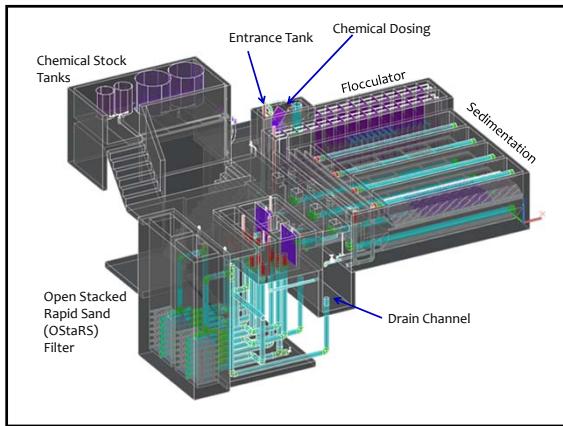
We want the plant operator to diagnose and fix the problem without needing to call anyone.

AquaClara Technologies

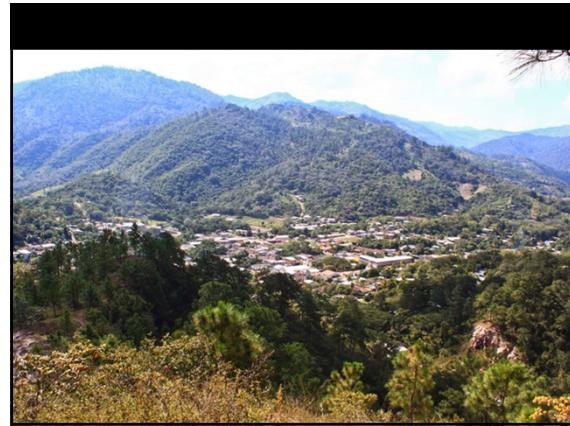
- Chemical dosing
- Rapid Mix
- Flocculator
- Sedimentation
- Filtration
- Conclusions

Stages of particle removal





Tour of an Aguac Clara plant

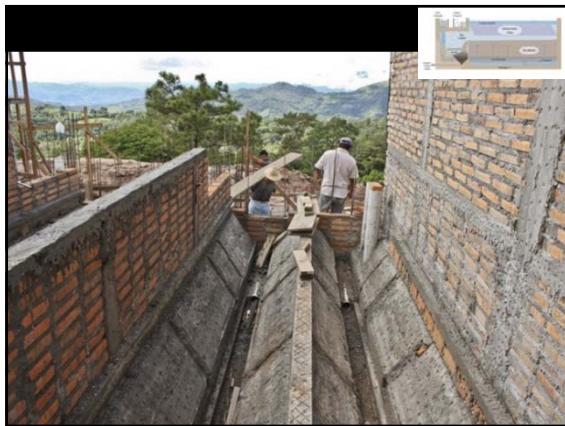


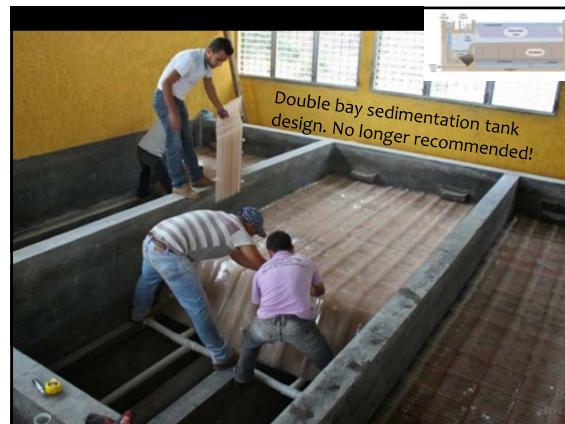


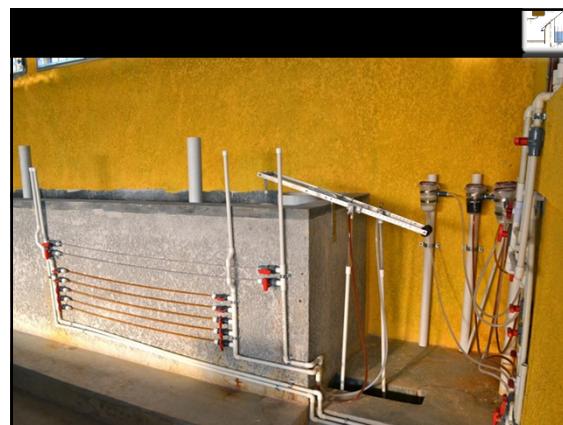
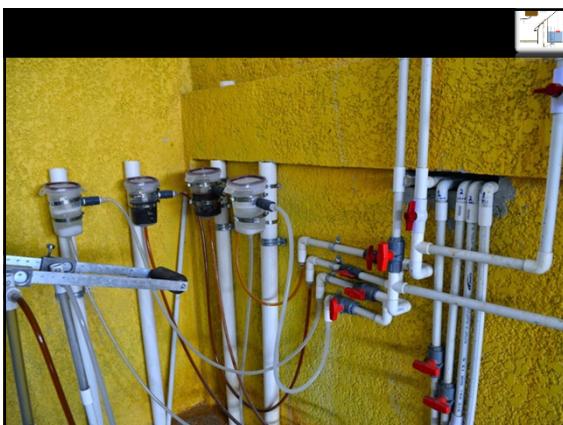
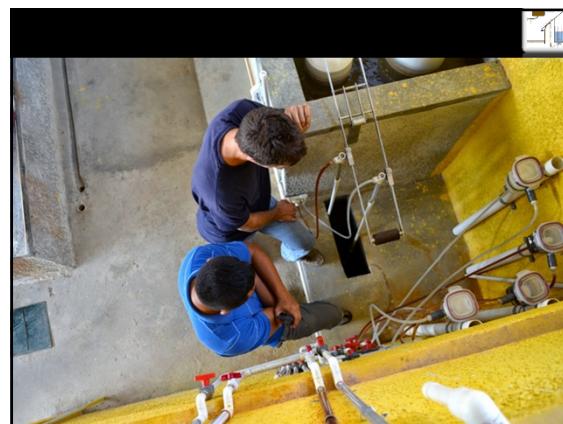
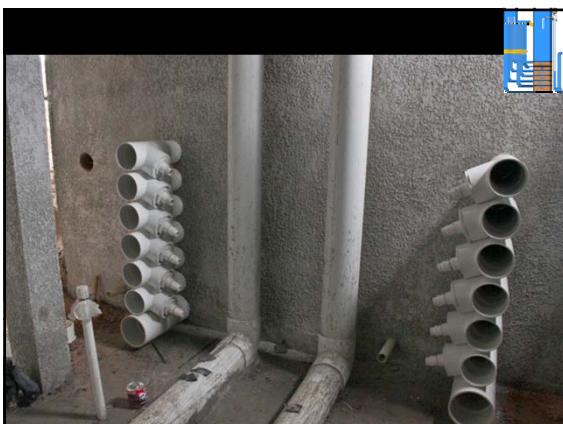
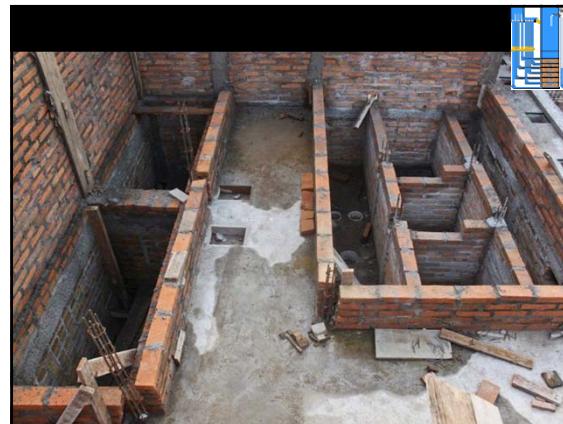
What is the difference between laser level and water level?

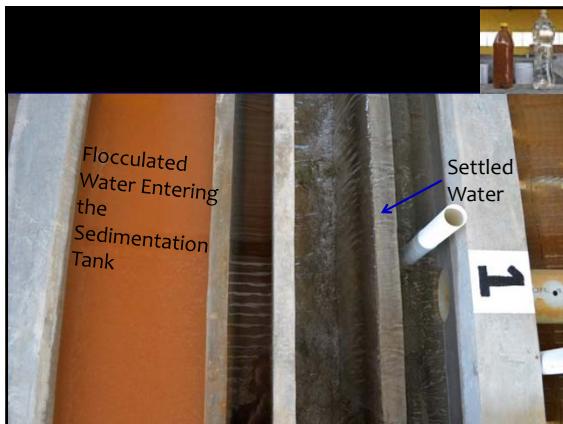
- Suppose I am building a really big structure...











Three Key Innovations

- AguaClara is open source engineering:
 - Many inventions, **ZERO patents**
 - Our technologies are described on our website and published in the literature.
 - Our [example designs are available on the web!](#)
 - Our technologies **use ZERO electricity** (except for batteries in the turbidimeters)
 - Some plant [performance data is online](#)

How Much Does it Cost?

CAPITAL COST
\$50,000 + \$800 per L/s of capacity*



OPERATING COST
\$5 per person per year or \$50 per million liters



ELECTRICITY COST
ZERO

Reflections



- Technology and Engineering Philosophy matter!
- Infrastructure failures often have multiple causes and many of them are linked to design choices
- We design for Simplicity on the other side of Complexity

