# AguaClara





## Municipal Drinking Water Treatment Simplified

AguaClara is an electricity-free technology for removing turbidity from contaminated surface water sources, scalable to fit the needs of many communities. AguaClara plants currently provide clean drinking water to over 45,000 people in Honduras.

## AguaClara's sustainable technology

**No electricity** or mechanization for low cost, long lifetime, and sustainable operation by local service providers

**Innovative use** of geometry and hydraulics to practically eliminate moving parts

**Simple parts** and materials for local empowerment

**Operator-friendly** design

**Exceptional** performance for particle removal

aguaclara.cornell.edu

# AguaClara

# The AguaClara Process

Hydraulic
semi-automatic
**chemical dosing**

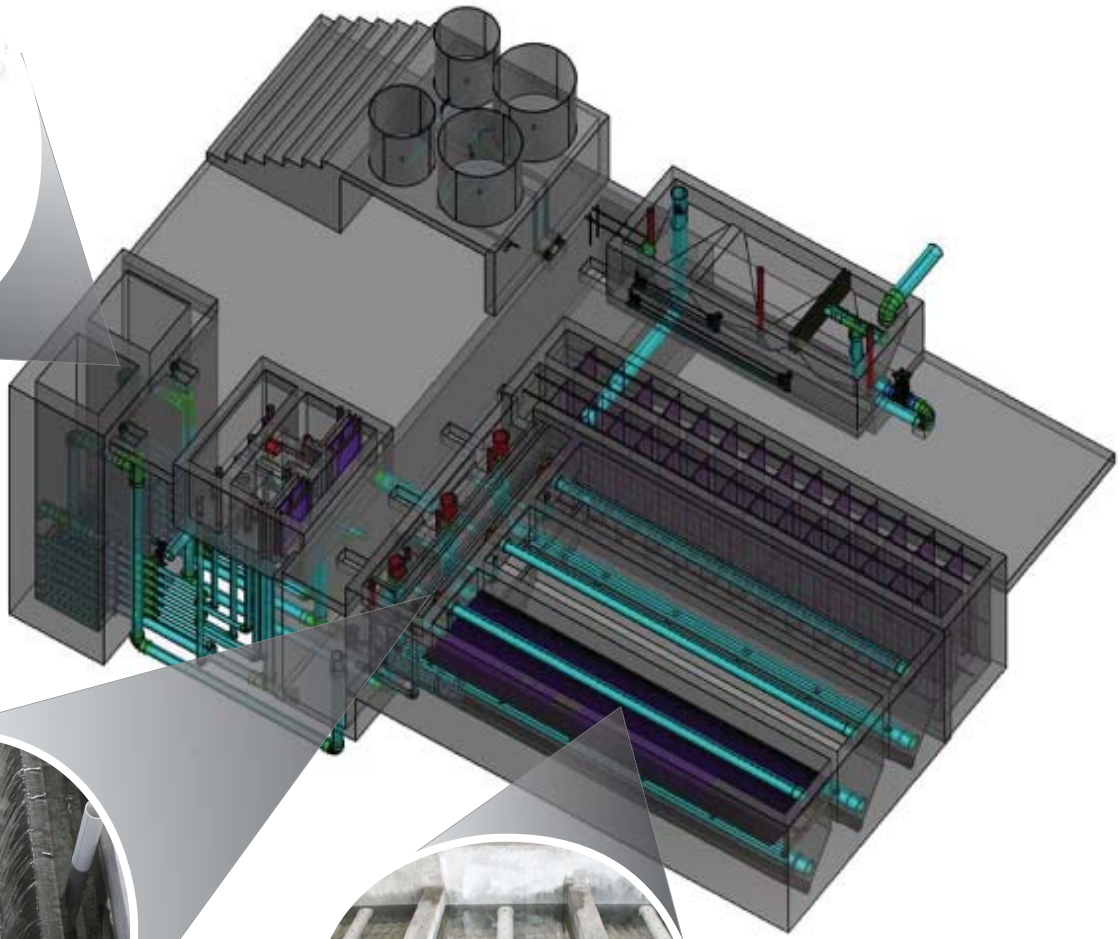
Entrance tank
with **flow**
**metering**





Vertical flow
**hydraulic**
**flocculation**

aguaclara.cornell.edu



**Rapid Sand Filtration** with stacked geometry

**Upflow Sedimentation** with floc blanket

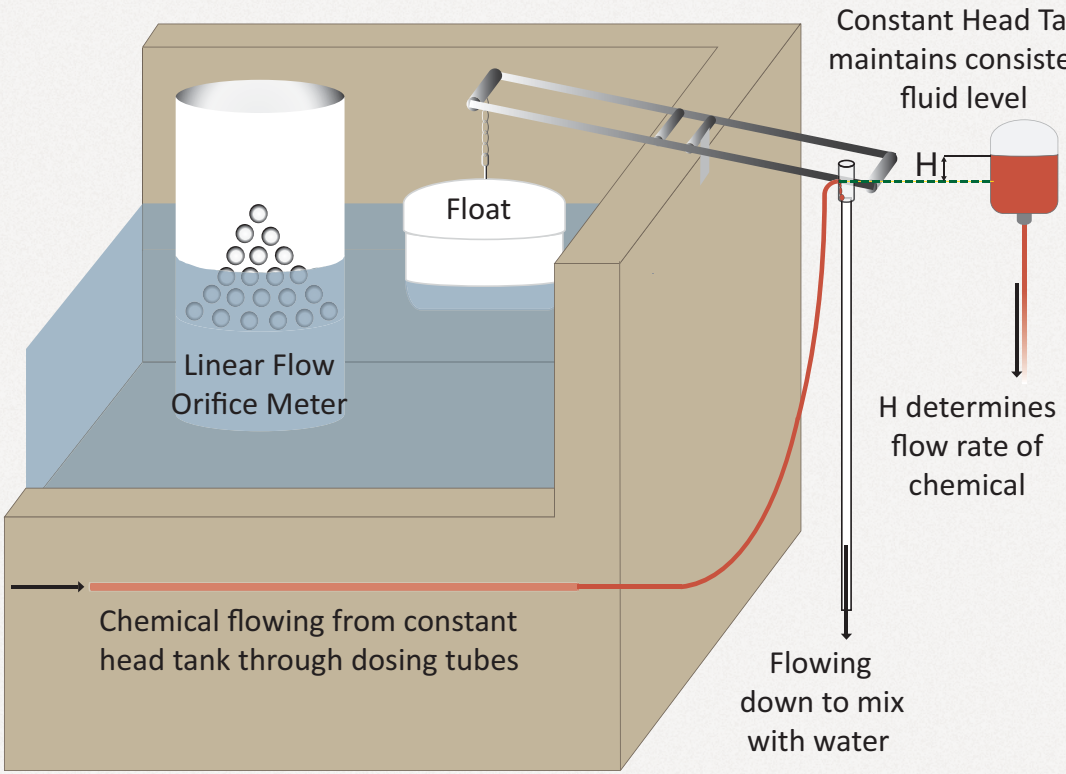
# The AguaClara Process

# Chemical Dose Controller

## AguaClara Chemical Dose Controller Features

**Semi-automatic** operation maintains the dose the operator sets even with varying plant flow
**Gravity** powered design employs novel approach to chemical dosing
**Universally** available coagulant for flocculation
**Safer** granular calcium hypochlorite for disinfection, avoiding chlorine gas accidents
**Logical**, in-view parts and plumbing

aguaclara.cornell.edu




**AguaClara's Chemical Dose Controller** maintains the dose the operator sets even with varying plant flow. Having the flow of chemical controlled only by the elevation difference between the end points allows precision dosing with a simple gravity-fed system.

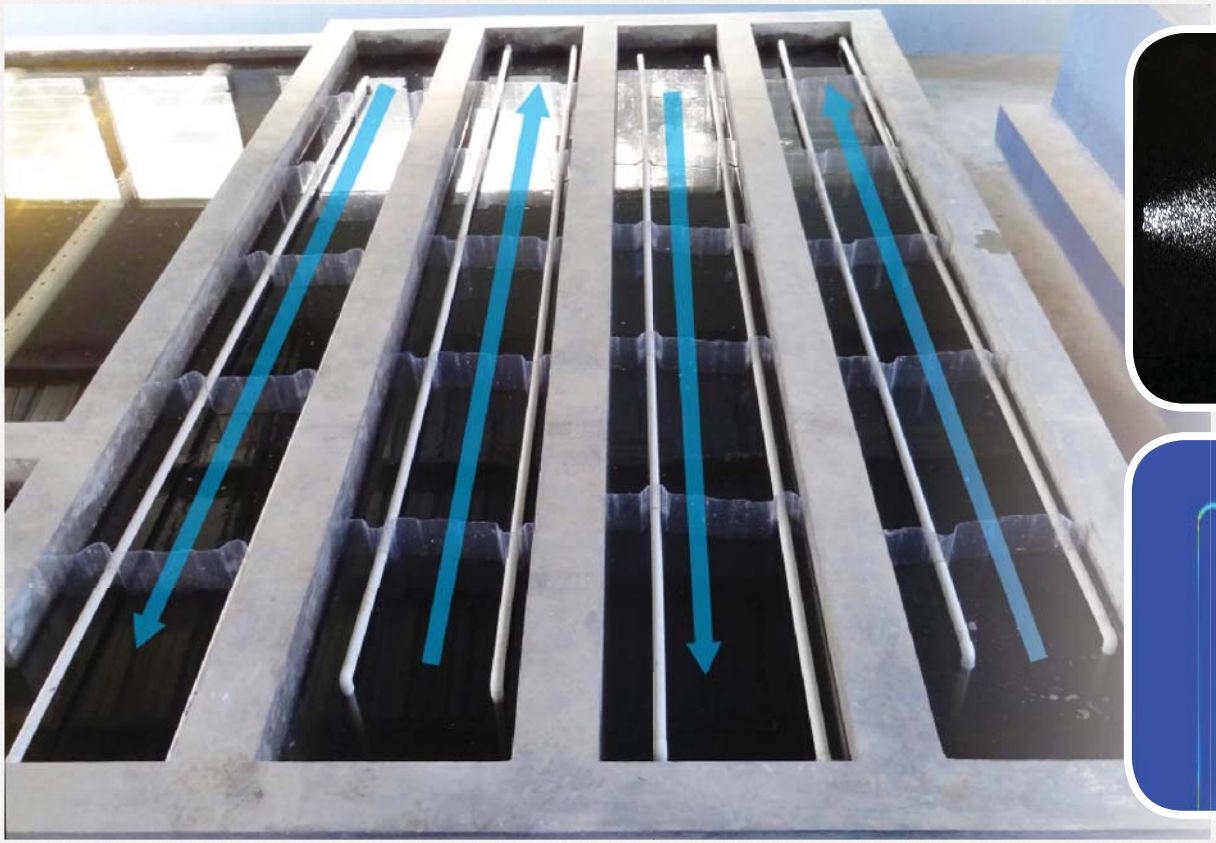
The elevation difference can change in two ways:

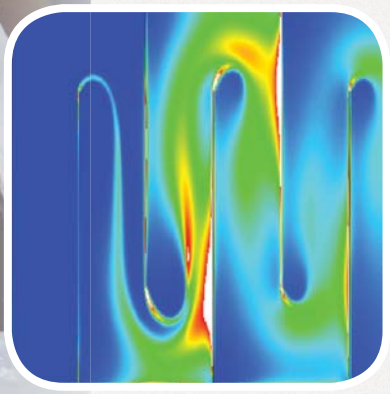
1) The operator slides the end of the dosing tube along the lever arm to set the dose.

2) The plant flow rate changes, causing a corresponding change in the entrance tank water level that in turn changes the inclination of the lever arm.

# Chemical Dose Controller

# Flocculation





**Flocculation** is the process of aggregating the tiny coloidal particles in raw water by first adding a chemical coagulant and then promoting collisions between particles by means of gentle mixing. The aggregates, called flocs, are heavy enough to be removed in the sedimentation process.

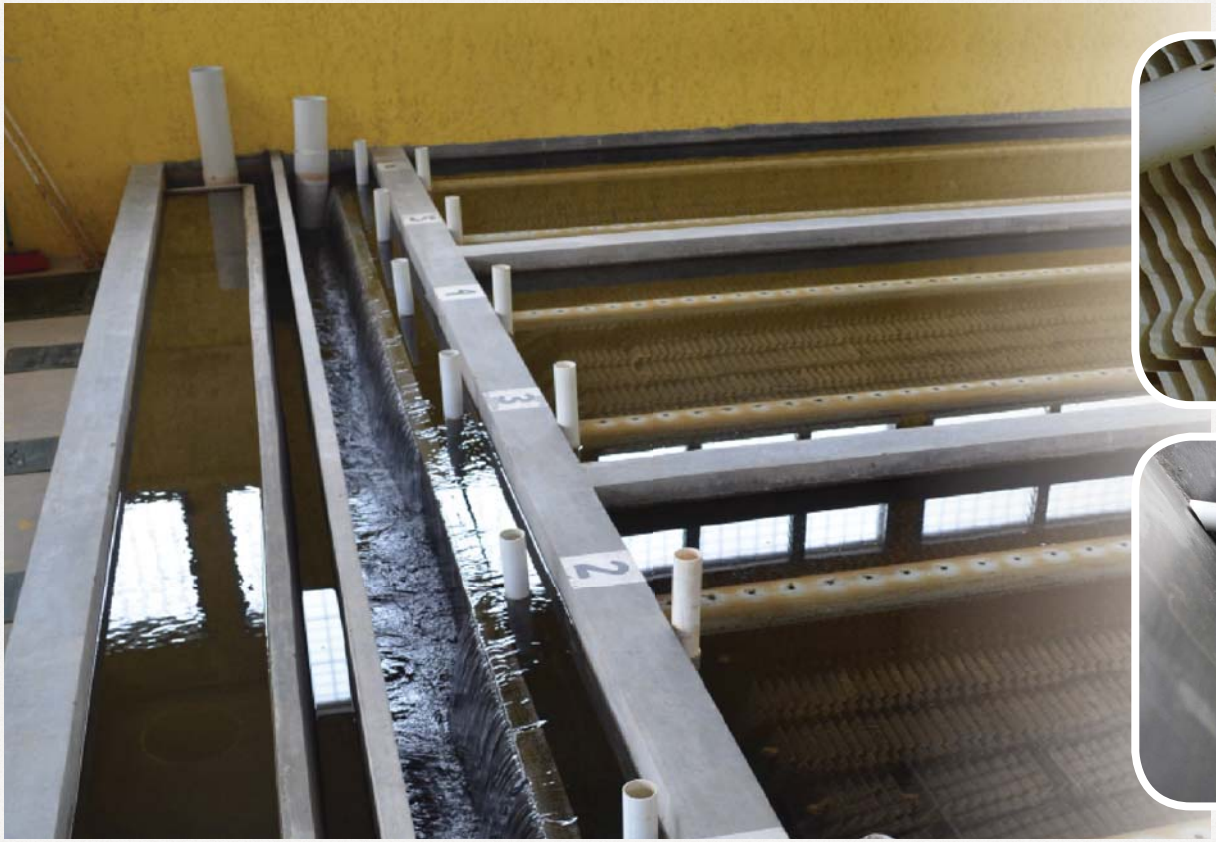
## AguaClara Flocculation Features

**Novel** design approach based on new flocculation models and research allows higher efficiency and reduced flocculator size

**Simple** to build and operate with local materials

# Flocculation

# Sedimentation

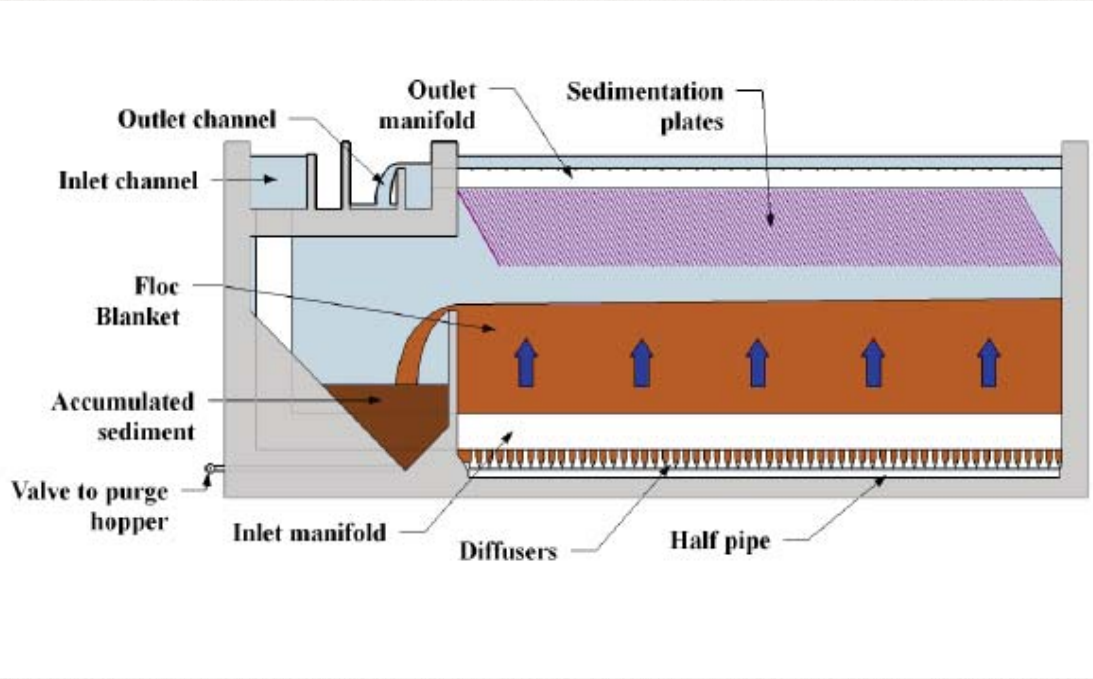


**Sedimentation** is the process of allowing particles to settle out of the water by gravity.

## AguaClara Sedimentation Tank Features

**"Sludge-less"** tank design with floc blanket achieves high performance and incredibly easy operation and maintenance

**Minimizes** expensive valves with operation controlled by placing or removing pipe stubs in couplings in the simple and innovative inlet/outlet channel system



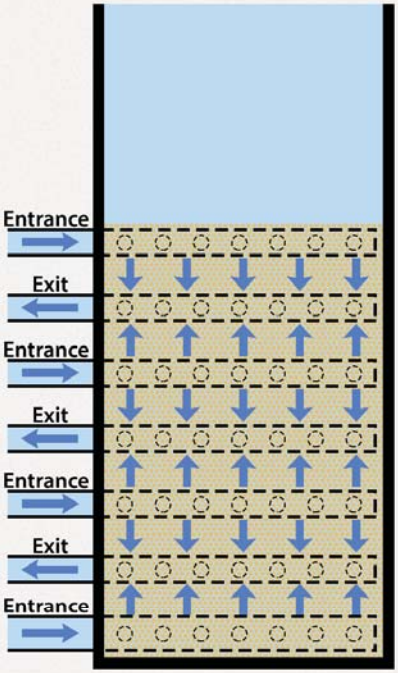

**The floc blanket** is a dense bed of fluidized particles in the bottom of the sedimentation tank. It acts as an extension of the flocculator, which means cleaner water from a more compact facility.

**Daily operation** of the sedimentation tanks consists primarily of manipulating a small valve to purge excess sediment.

# Sedimentation

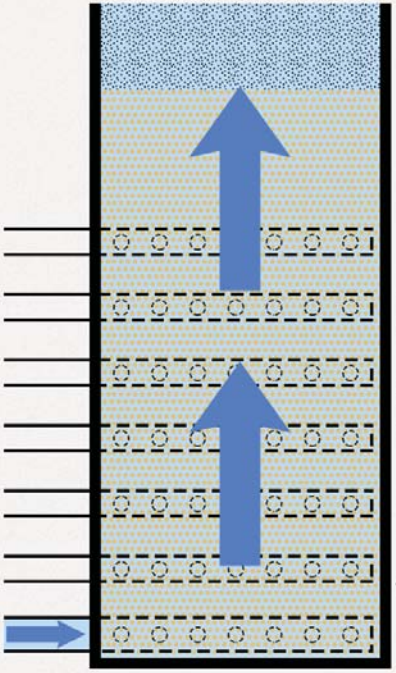
# Stacked Rapid Sand Filter

## Filtration Mode




The flow divides between six layers of sand

## Backwash Mode



All of the water enters from below and passes through the sand in one direction, achieving velocity needed to fluidize sand

**Rapid Sand Filtration** passes settled water through a bed of sand to capture fine particles and pathogens. It is the final step in solids removal before disinfection.

## AguaClara Open Stacked Rapid Sand Filter (OStaRS) Features

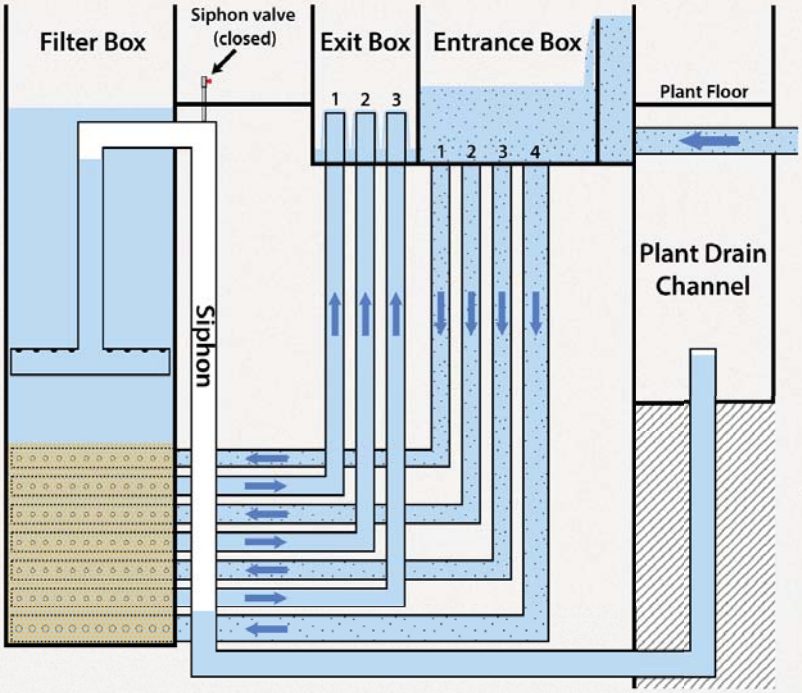
**Stacked** geometry allows simple backwash without pumps or filtered water storage

**Use of siphon** for backwash outlet makes for effortless operation and eliminates large valves

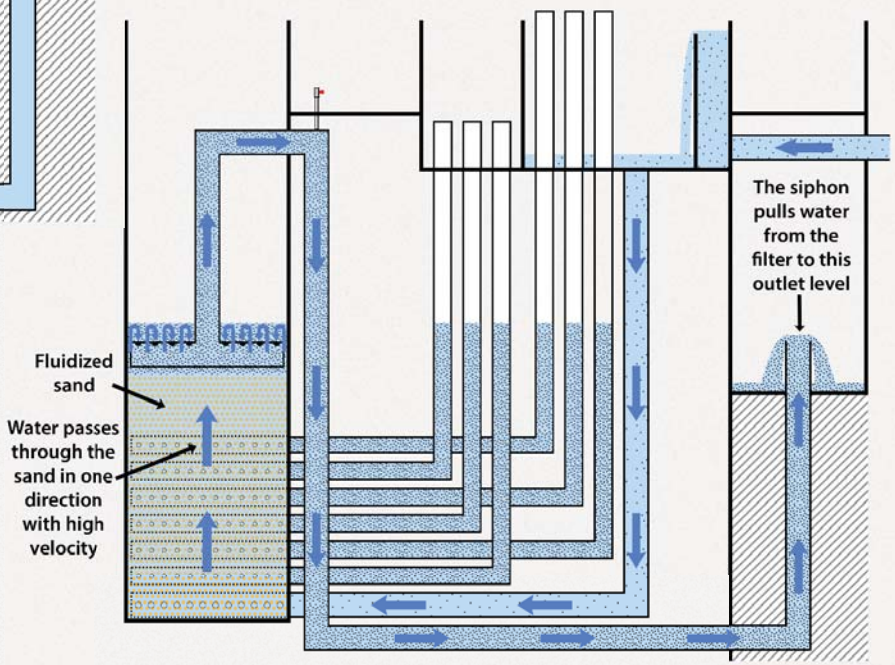
**Fraction** of plan view area needed compared to conventional rapid sand filters

aguaclara.cornell.edu

## Filtration Mode




## Backwash Mode




**Water** enters and exits the sand via a network of finely slotted pipes

**Siphon pipe** controls the state of operation of the filter by changing the outlet level using only an air release valve

# Stacked Rapid Sand Filter

# Compared to Conventional Plants

## Qualitative

**Very low** operating and maintenance costs.

**Long lifetime** in any context by not relying on moving parts, proprietary components or automated systems.

**Ease** of achieving optimal operation, therefore ensuring excellent water quality. All too often with conventional mechanized treatment plants that lack strong support networks, the plants produce poor quality water because operation is complex.

**Exclusive** use of 2 universally available chemicals, no need for flocculation aids or other special inputs.

**Reliable** in places where electrical service is not.

**Environmentally friendly** because of use of local materials and gravity power.

## Quantitative

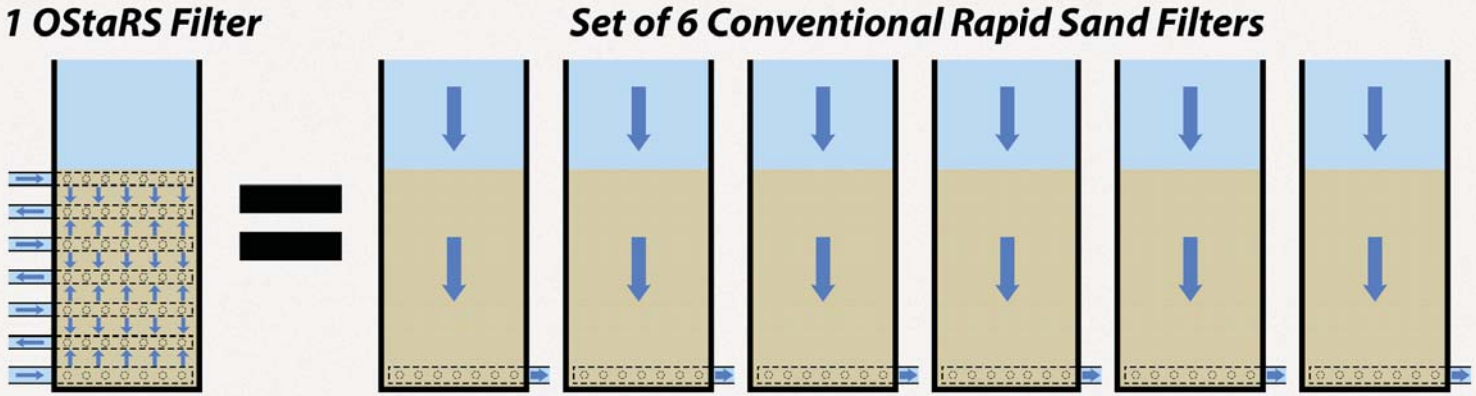
**100%** reduction in electric bill.

**6x** reduction in rapid sand filter plan view area.

**6x** reduction in wasted water for filter backwash.

**Reduced** sedimentation sludge production due to concentration of floc blanket excess.

**Reduced** flocculator volume compared with typical conventional design.




# Compared to Conventional Plants

# What problem does AguaClara solve?

## Turbidity

**An AguaClara plant** is a good option if turbidity peaks above 10 NTU are common and/or the source has unacceptably high colloidal color. These conditions are very common for surface water sources. AguaClara plants in Honduras have successfully treated turbidity over 1000 NTU to below 1 NTU with no interruption in service.

## Flow rates successfully built and operated

**Smallest:** Cuatro Comunidades, Francisco Morazán. 250 households :: 6 L/s

**Largest:** Marcala, La Paz. 3000 households :: 54 L/s

## Flow rates thought to be practical

**Lowest:** Perhaps 1 L/s (60 households), limited by whether community can sustain full-time operation

**Highest:** City-scale designs of several hundred L/s capacity are feasible

## Ability to treat water quality problems beyond particle removal

AguaClara plants excel at removing turbidity and colloidal color from surface waters to ensure effective disinfection. The flocculation/sedimentation/filtration process can therefore reduce certain chemical contaminants that are largely adsorbed to suspended solids in water. However, the extent of contaminant removal has not been quantified.


## Innovative solutions for new problems

Where the full AguaClara treatment process is not appropriate, the AguaClara program looks to develop practical alternatives for community-scale treatment.


**Enclosed Stacked Rapid Sand (EStaRS) Filters** are being used for direct filtration of contaminated shallow wells in India.

**Two-Stage Reticulated Foam Filters** are quick-to-deploy filtration systems that can treat high turbidity for very small communities or in emergency situations, and are currently under development.

# What problem does AguaClara solve?

# Institutional Organization

## Cornell University

- Research and development
- Hydraulic design
- Education of current and/or future implementers

## Implementers

**Agua Para El Pueblo (APP)** in Honduras
**AguaClara LLC** with Pradan in India
**Many** models possible

- Feasibility assesment and project formulation
- Building design & Construction
- Fundraising
- Community organization & Operator training
- Long-term support for service providers and operators
- Feedback to Cornell University team based on field experience

## Local Service Providers

**Water Boards**
**Municipalities**

- Operation and maintenance
- Data reporting


# Institutional Organization

# Frequently Asked Questions

## Have AguaClara projects in Honduras been successful?

All 10 AguaClara plants that have been built in Honduras are successfully treating water, after up to seven years of community-owned operation. In just a few cases, minor accessories have needed replacement. Additionally, water boards have transformed their water service in several communities. They have been able to raise water tariffs with community support because of the high quality of service and generate savings, which they are now reinvesting in their infrastructure.

## Do you expect the AguaClara technology to continue to evolve?

The Cornell AguaClara team is committed to ongoing research and innovation in order to lower costs, simplify operation, boost performance, meet new water quality challenges, and push the limits of understanding of treatment processes. Each plant built has incorporated new insights and innovations in an adaptive learning cycle that incorporates field experience and ideas from the laboratory.

The team plans to implement a version release system in order to keep improving designs while allowing partners to work with a consistent design for a period of time without interruption.

## Does AguaClara have a solution to my community's water quality problem?

AguaClara is a centralized treatment option best suited for turbid surface waters:

- If the turbidity from the source is consistently low - less than 10 NTU - the full treatment process may not be necessary in order to achieve effective disinfection.
- AguaClara plants will not remove hardness in water. However, they can solve problems with calcium scaling in pipes and fixtures by lowering the pH of the water.
- In a gravity-fed water system, the sources of water to be treated must be able to be combined and piped to one location where the plant can be built.
- The community must be able to sustain operation of the plant, either by means of a water tariff or another form of financial support.
- There must be a qualified implementer of AguaClara technologies able to work in your location.

## What are the largest costs in an AguaClara plant project?

Budgets for plant projects may vary widely in new locations. For some sample plants built in Honduras, the largest costs have been:

- Local and non-local materials: 40-50%
- Skilled and unskilled labor: 20-30%
- Engineering: 10%
- Overhead: 10%
- Operator training, socialization, and follow-up: 10%.

## How are AguaClara plants constructed?

The plants are built with local construction techniques, employing local skilled and unskilled labor, using local or readily-available materials such as brick, stone, concrete, rebar, and PVC pipes and fittings.

## How long do AguaClara plants take to build?

In Honduras the period for carrying out a project once designed is typically about eight months for medium-size plants:

- Construction, fabrication, and preliminary operator training - 6 months
- Follow-up and operational training - 2 months

## Who can build AguaClara Plants?

AguaClara's vision is widespread implementation with many qualified partners. However, the plants are more intricate than can be communicated currently with only the design materials. Organizations wishing to use AguaClara technology should seek training and accompaniment for at least the first project.

Agua Para el Pueblo in Honduras is the only organization currently experienced in the construction and operation of full-scale AguaClara plants. Implementation by inexperienced partners is strongly discouraged.

## Does the plant need a full-time operator?

Yes, each AguaClara facility will require trained personnel on hand 24 hours a day to adjust chemical doses, monitor performance, backwash the filters, fill the chemical stocks, purge excess sediment, and perform daily maintenance. Plant operators are usually trained community members.

## Is the technology proprietary?

The AguaClara hydraulic designs are open source and cannot be patented by anyone.

# Frequently Asked Questions