

About the AguaClara Technology

A brief overview of our water treatment systems

The AguaClara technology is an innovative form of flocculation-sedimentation that has been adapted at Cornell University to operate without electrical input. Unlike conventional flocculators, which rely on large motor-driven stirring devices, ours create mixing solely with gravitational forcing through turning channels. The chemical dosing for the plants is all accomplished by using simple float valve-regulated constant head devices, and the plant flow rates are controlled using riser pipes with calculated patterns of holes drilled through.

A Detailed Plant Tour

The entrance tank to the rapid mix

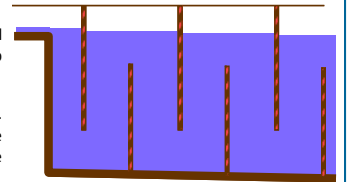


Source water flows via the pre-existing transmission line to the entrance tank for an AguaClara plant. This entrance tank contains riser pipes with orifices of calculated size and spacing to obtain a linear relationship between the depth of water in the entrance tank and flow rate of water through the plant. This design mimics the shape and function of a Sutro Weir. The water leaving the entrance tank is mixed with alum, a coagulant, en route to the flocculator. When alum is added to water it decreases the net charge on suspended dirt particles in the flow. When particles collide in an un-coagulated stream (one not treated with alum), they tend to repel one another. Conversely, particles in a coagulated stream are more likely to actually stick together and form larger conglomerates. These larger clumps of particles are referred to as flocs.

Alum and chlorine are dosed using a flow controller (FC) developed by AguaClara. The FC is a small jar fitted with a plastic float valve on the inlet, and a calculated length of tubing on the outlet. The float valve ensures a nearly constant head, while the elevation of the discharge of the exit tubing determines the total head loss, and hence flow rate. Plant operators adjust the alum dosing by adjusting the height at which the exit tubing discharges into the raw water stream. The operators have a chart that relates influent turbidity to required alum dose, and required alum dose to the required tubing exit height. Chlorine is dosed similarly, except that the chlorine FC exit tube discharges into the plant exit stream. The dose delivered by the FC is therefore a function of the (constant) head in the bottle, the (constant) length and diameter of the outflow tubing, and the elevation at which the tubing discharges.

The rapid mix through the flocculator

Alum and raw water flow through a short series of pipe elbows acting as a rapid mix. This mixed water then enters the vertical flow hydraulic flocculator. The vertical flocculator for treatment of small flow rates was also developed by the team at Cornell University. The flocculator is comprised of a series of channels with alternating up and down baffles. The baffles force water to change direction through an amount of space that is calculated to provide target mixing.



This mixing is vital to the water treatment process because it is the engine that drives floc formation. At the beginning of flocculation the suspended particles are small. The vertical flocculator has many more tight turns in the early sections of the tank as compared with the later sections. As the stream mixes and larger flocs form, the number of baffles per unit length of the tank decreases to reduce the strain on the flocs. The exact values for mixing parameters at various stages of floc formation are currently a central focus for the AguaClara laboratory research team.

Earlier AguaClara plant designs employed the use of a horizontal flocculator instead of the vertical model now in use. The horizontal model is similar to the vertical one, except that the stream is forced to side-wind from left to right through the channels, instead of up to down. The vertical flocculator has a smaller footprint than its horizontal counterpart, which decreases the overall cost of construction. The vertical model also is less prone to premature sedimentation throughout the tank, which is another main reason why the team has shifted focus to vertical flocculation.

The sedimentation tanks to the customers



The stream leaves the flocculator and travels to the sedimentation tanks via a channel. The tanks have bottom-level entrance manifolds to distribute water evenly across the floor of each tank, and an effluent launder pipe collects water from the top of each tank. Tanks are fitted with arrays of lamella that are angled 60° from the tank floor. The heavy flocs settle out of the slowly rising water and onto the lamella. The size of the tanks and the positioning of the lamella are engineered to allow the water to rise up through the tank at a slower speed than the flocs take to fall out onto the lamella.

Sludge, made up of settled-out flocs, collects at the bottom of the sedimentation tanks and can create a diffuse filter for incoming water. Having some degree of sludge build-up is therefore desirable, but excess sludge will begin to rise through the tank if it builds up too much. The AguaClara team has recently begun to design weirs into the sedimentation tanks to control sludge levels to create a beneficial sludge blanket. In earlier designs plant operators isolated each sedimentation tank and opened a bottom drain to wash the sludge out. Current designs incorporate a system of sludge hoppers that remove the sludge only to a specific level in the tank, leaving some to act as a filter. Most of the initial turbidity is removed from the water by the time it exits the sedimentation tanks either way, but the sludge blanket filtering effect may help us achieve even better standards for effluent water.

From the launder at the top of the sedimentation tanks, clear water flows to a distribution tank. Chlorine is dripped into the stream of water entering the distribution tank to kill any bacteria that weren't eliminated by removing sediment. The chlorine is dosed using the same type of flow controller used for alum. Clean, disinfected water then flows from the distribution tank into people's homes along a series of municipal pipes.

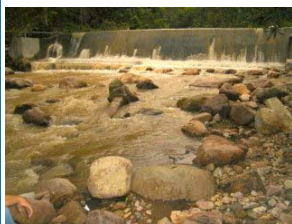


The social and cultural side



Social sustainability is of key importance to the AguaClara team. The first concern for plant design features is that they be practical for the communities using them. All AguaClara plants are built by locals through construction projects supervised by the Honduran NGO Agua Para el Pueblo (APP). Two Cornell graduates apply to spend a year as employees of APP while assisting with plant operator training and data collection. Groups from the Cornell team visit the sites of AguaClara plants several times each year, interviewing customers and plant operators to gain an understanding of how to better suit our research and design to the local needs.

The case for treatment before chlorination



Influent water straight from the source contains dirt, organics, and potential pathogens. Although chlorine is used as a broad-spectrum disinfectant worldwide, it is not necessarily an easy solution. Chlorine reacts with organics present in the water, forming carcinogenic compounds. This has the dual effect of not achieving disinfection because the chlorine is "used up" on the dead matter, while also creating a new health hazard. Flocculation is essentially the process of sticking solids in raw water together, while sedimentation is the process of letting those heavy solids sink out. The resulting water is clear of most solids, which allows us to add chlorine to kill remaining pathogens without producing excessive byproducts.



Demand Estimation for the AguaClara Technology

People often ask what we will do with our project after the demand for safe water is met. Below you will find a series of back-of-the-envelope calculations to give an idea of just how much work there is left to do.

The context



Over 25% of Hondurans live in towns with populations between 1000 and 50,000. Most of these communities use untreated surface water sources that are often extremely turbid during the rainy season. This is the demographic that AguaClara serves.



The estimations

We can create a very rough estimate for the global demand for AguaClara technology by employing a few assumptions. The demand for robust and energy efficient water treatment technology is based on a combination of the already large demand for safe drinking water, the increased demand due to population growth and urbanization, and the need to replace aging infrastructure.



A conservative estimate of the unmet demand for safe drinking water is that globally, 1 billion people are currently without access to an improved water supply and an additional number of those with *improved* water supply do not have access to *safe* water (WHO & UNICEF, 2004). Improved water supplies are defined by the World Health Organization as household connections, public standpipes, boreholes, protected dug wells, protected springs, and rainwater collections. Unimproved water sources are unprotected springs, unprotected wells, vendor-provided water, tanker truck-provided water, and bottled water. Inclusion of household connections in the list of improved water sources without regard for the source or treatment of that water has led to a gross overestimation of the number of people who have access to safe water. Given these definitions, **untreated** surface waters that are piped to homes count as improved water supplies and thus are classified as safe for the purposes of the Millennium Development Goals.

Quantifying demand

To create a very rough estimate of the global demand for the AguaClara technology, we make the following assumptions:

- 2 billion people worldwide lack access to safe water (based on the 1B without improved water and another 1B with unsafe improved water)
- 25% of those people live in communities with populations between 1000 and 50,000 (as is the case in Honduras)
- 25% of their communities use surface water sources



The resulting math shows that approximately 125 million people live in communities that need small-scale water treatment plants. If we further assume that our goal is to meet this demand in 10 years and that there are an average of 12,000 people per community, we obtain an estimate of *1000 plants needed per year!* This estimate does not include any population growth or the certain need to replace aging infrastructure.

Why Donate to the AguaClara Project?

Are you curious as to why our project is seeking support? Below you will find a brief outline of some of our major costs, as well as how your support can directly improve educational opportunities for our students.

Where does your donation go?



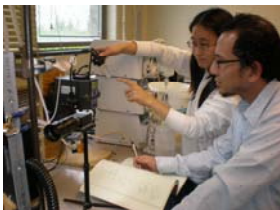
The AguaClara project is supported by a network of dedicated donors and sponsors. These individuals, companies, and institutions furnish everything we need from laboratory supplies to student scholarships. The AguaClara team receives some support from Cornell, but we are always seeking to raise more funds to support students at home and interns abroad. You can even donate towards the next construction project, or support our efforts to attend conferences and raise scientific awareness of our work.

What opportunities are you supporting for Cornell students?

Students from any college, in any major and any year, are always welcomed to our team. AguaClara provides hands-on experience in applied engineering, fluid mechanics, international development, graphic design, project management, research methodology, computer drafting, programming, and more! The project allows students to take on variable degrees of responsibility so they can develop a truly diverse array of skills. Our graduating team members often remark on how impressed employers are by their experience on the AguaClara team.



AguaClara also offers students several opportunities to travel abroad and experience firsthand the conditions affecting water quality in developing nations. Every January a team of about 20 students travels to Honduras to visit the AguaClara plants that have been built. This group stays with families in every town we serve, which provides students with the opportunity to see just how different conditions are for our partner communities. There are also opportunities for students to spend time over the summer in Honduras, and we support year-long internships for recent graduates of the project. These AguaClara Engineers work for our partner NGO Agua Para el Pueblo, for which they provide on-the-ground assistance to AguaClara plants around the country. The international experiences tend to be so rewarding for our students that we consistently have more interest than space available for trips.



The AguaClara wish list



If the team had unlimited resources, the first act would be to fund more fellowships for Master of Engineering students. Many M.Eng students chose to work on the AguaClara team for their design project, so we would like to be able to support and recruit them better.

The team also would upgrade its research facilities to include a pilot-scale test facility in the laboratory. Currently we only have the capacity to run bench-scale experiments on site, and we can only operate pilot-scale experiments at the Cornell University Water Filtration Plant. Upgrading our lab to handle the larger set-up would allow students to control for more error during their work.

Support for the team in Honduras would also be greatly appreciated. The AguaClara Engineers receive language training and a stipend to cover housing, food, and other necessities while gaining exposure to NGO work and municipal-scale field engineering. While abroad, our engineers have done everything from helping with plant construction and design, to collecting data on plant performance, to hosting a health fair to bring in medical professionals to a partner community. Support is always appreciated to continue funding this incredible opportunity for our students and partners abroad.



Donation Card

The AguaClara team greatly appreciates your donation.
Thank you for joining our team of supporters!

There are several ways to help our team

You can donate online <https://www.giving.cornell.edu/give/>

All you have to do is designate the gift for *Other* and then type "AguaClara" into the field for *Special Instructions*. You can also further designate the funds for building water treatment plants or to support the research, development, and design work done by the AguaClara team at Cornell.

Funds designated for building water treatment plants will be forwarded to an implementation partner.

Alternately, you can send checks to:

AguaClara
220 Hollister Hall
Cornell University
Ithaca, NY 14853

If you would like to designate your donation for a specific cause, please include a note so we can make sure that it is used correctly.

We also have a wonderful network of businesses that provide us with donations and reduced costs for supplies. If your business is interested in helping, please contact our project director, Monroe Weber-Shirk.

Do you have questions or comments?

Feel free to contact Monroe by phone or email

Phone: 607-255-8445

E-mail: mw24@cornell.edu

Our website also contains information on every facet of our work. As part of our commitment to open source engineering you can find research and design details, as well as updates from the team in Honduras.

<http://aguaclara.cee.cornell.edu>