



Sustainability  Decathlon
ORANGE COUNTY

Efficient Water Usage and Recycling

Team ThREe

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Problem Definition



- Efficient water usage and recycling
- Find ways which water saving technologies can be incorporated into a modular accessory dwelling unit (ADU)
- How to integrate water recycling and bioremediation systems into the ADU
- Used in low-income neighborhoods
- Good HERS ratings
- Come up with bill of materials by the end of the quarter



Figure: Hydroloop gray water recycling system





Project Overview:

- Group members research about water efficiency, recycling, and bioremediation
- Existing regulations on water quality and consumption
- Design water recycling and bioremediation systems:
 - Where does water go after use
- Cost analysis
- Bill of materials

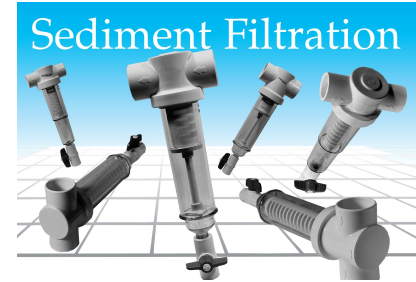


Figure: WaterSense® label



Figure: EnergyStar® label



California per capita use: 146 gallons of water per day

An average person uses 80-100 gallons of water per day indoors

Indoor water use can be more efficient with low consumption fixtures

Appliance Name	Amount of Water Saved
Toilet	1.664 gal/day/person
Shower head	2.73 gal/day/person
Faucet	3.468 gal/day/person
Dishwasher (standard)	0.47 gal/day/person
Dishwasher (compact)	0.583 gal/day/person
Countertop Dishwasher	0.783 gal/day/person
Washing Machine	1.429 gal/day/person

Outdoor water use

- 30-60% household water use, near 60% in dry regions
- ~50% of irrigation water is wasted due to evaporation, wind, and runoff
- An average US family uses 96 gallons of water per day outdoors



Touchless faucet



1.5 Gallon/min aerator



Irrigated garden

Haoming

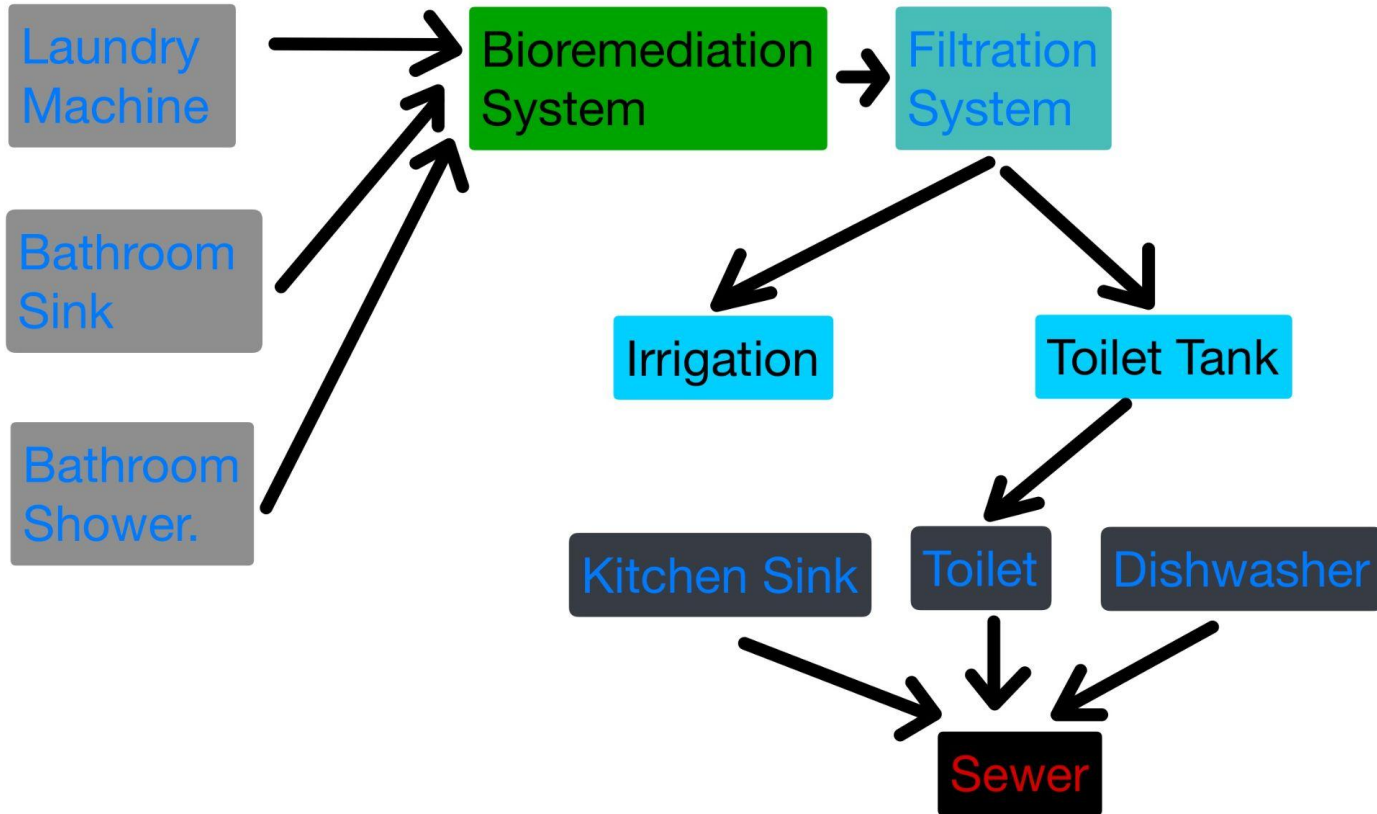


- 75% of water used each day is deemed “Gray Water”
 - Gray Water is water that is considered recyclable in the state of California and can be filtered for further use
 - The remaining water is “Black Water” which must go to wastewater treatment plant
- Washing Machines, bathroom sinks, showers are all grey water producers
- Our team has focused on how to reuse this water to reduce waste water for toilet flushing and irrigation
- We have a team goal of reducing individual water waste by 20 gallons per day, means 140 gallons per person per week
 - Low flow filter saves individual roughly 10 gallons per day
 - Our system in theory saves an individual 24 gallons of water per day after low flow appliances have been applied





Water Flow Chart





- By the California code of regulations title 22, Division 4, Chapter 3, Article 3: Uses of recycled water.
- **Recycled water** used for the **surface irrigation** or other purposes of the following shall be a **disinfected tertiary recycled water**. The definition of **disinfected tertiary recycled water** is a filtered and subsequently disinfected wastewater.

The recycled water can be used for:

- Flushing toilets and urinals
- Food crops, including all edible root crops, where the recycled water comes into contact with the edible portion of the crop
- Residential landscaping
- Any other irrigation use not specified in this section and not prohibited by other sections of the California Code of Regulations



Water Recycling Requirements

- By the California code of regulations title 22, Division 4, Chapter 3, Article 3: Uses of recycled water.
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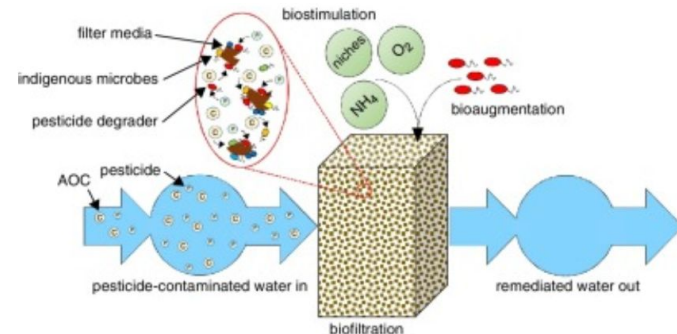
<p>The definition of MPN is: The most probable number (MPN) analysis is a statistical method based on the random dispersion of microorganisms per volume in a given sample</p>	<p>The median concentration of total coliform bacteria maximum in 7 days sample:</p>	<p>The median concentration of total coliform bacteria maximum in 30 days sample:</p>	<p>The median concentration of total coliform bacteria maximum at all time:</p>
<p>Disinfected Tertiary Recycled Water</p>	<p>MPN of 2.2 per 100 milliliters</p>	<p>MPN of 23 per 100 milliliters</p>	<p>MPN of 240 total coliform bacteria per 100 milliliters</p>

<p>The definition of NTU is: NTU stands for Nephelometric Turbidity unit, i.e. unit used to measure the turbidity of a fluid or the presence of suspended particles in water</p>	<p>The maximum NTU requirement within 24- hour period</p>	<p>The maximum NTU requirement at all time</p>
<p>Disinfected Wastewater</p>	<p>0.2 NTU more than 5 percent of the time</p>	<p>0.5 NTU</p>



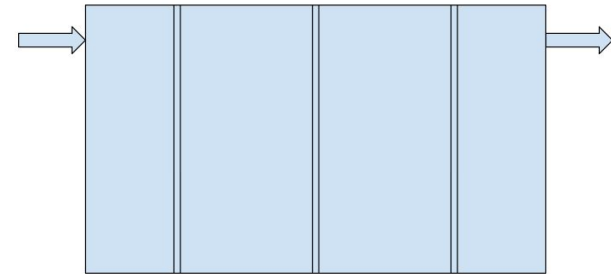
Background:

- Bioremediation is process in which indigenous microbes decompose organic + inorganic contaminants (soil or water)
- Ex situ vs in situ processes
- Water from bathroom sinks, showers, and washing machines





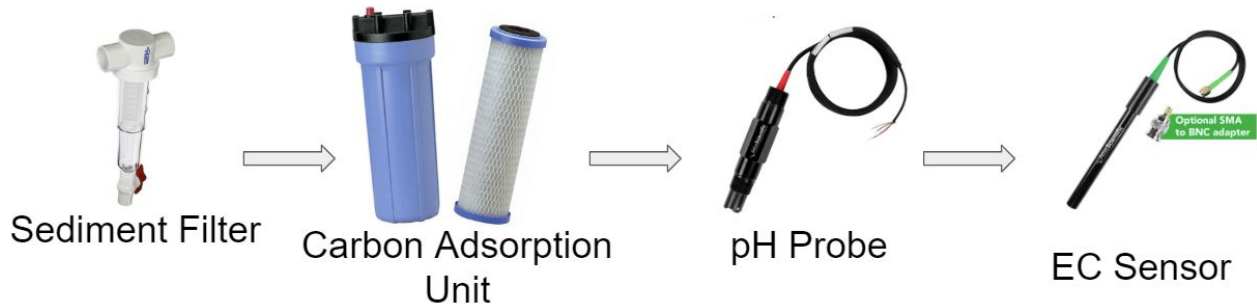
- Purpose: primary treatment → coarse filtration, flotation decomposition
- Preliminary System design + Reasoning
- BioGF: multi-strain blend of microbes that degrades FOGs





System Overview

- Purpose is to ensure particles in the water do not damage pipes for toilet or clog drip irrigation system
- Sensors are safety check to make sure system is working
- Sensors when readings are within desired range will transmit green light, when outside of range light will be red

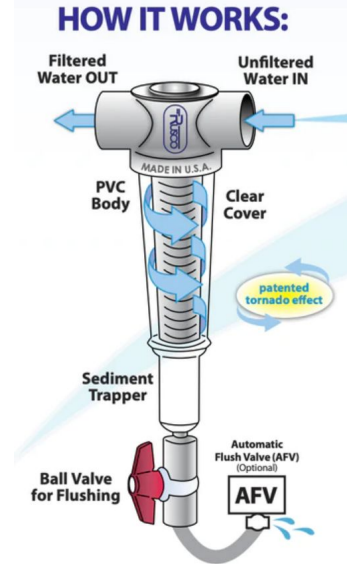




Sediment Filter

- Will remove larger particles (silt, sand, loose scale, organic material)
- Better sediment filtration will lengthen the lifespan of the carbon adsorption unit
- Spin down method
- Sediment trapper helps handel dirtier water

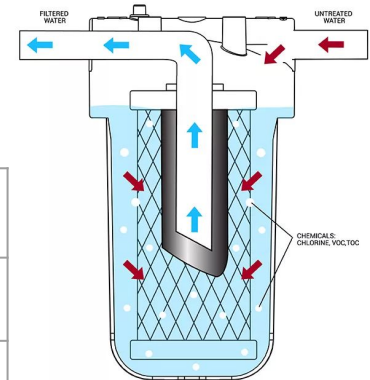
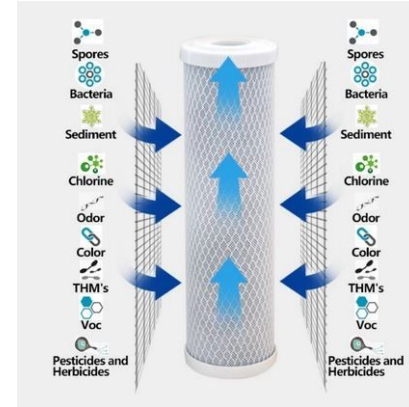
	Filtration Method	What sizes can filter	Initial Cost	Replacement Costs
Traditional Micron Filters	Physical barrier	5-50 microns	\$40	\$20
Spin Down Filter	“Centrifugal” force	10-711 microns	\$84	\$0





Carbon Adsorption Unit

- Carbon block acts as a second sediment filter
 - Removing smaller particles not previously removed
- Largest size PAC unit (20" x 4.5")
 - Lifetime ~150,000 gal
 - More surface area, higher flow rate
- Adsorbs chlorine, organic chemicals, THMs, VOCs, solvents, industrial cleaners
- Very limited microbial filtering



	Particle Size	Flow rate	Surface area	Replacement Cost
GAC	10-50 microns	Not limited	smaller	~\$30
PAC	0.5-20 microns	1-3 gal/min	larger	~\$30



pH Sensor

- Measures pH level of the water
- Most outdoor plants thrive in water ranging from 6-8 pH
- Water should be filtered near 7 pH so probe will confirm health of system
- I found the Atlas Scientific Industrial pH probe
 - It is indefinitely submersible
 - Accuracy is +/- 0.002

Response Time	Life Span	Recalibration Life Span	Cost
95% in 1s	4 Years+	1 Year	234.99

 **Industrial pH Probe**
#ENV-50-pH





Electric Conductivity Sensor

- Measures the Conductivity of the water
 - Conductivity is affected by inorganic dissolved solids
 - In our system the soaps are the main contributor to the water conductivity
- Tap water does not exceed 800 $\mu\text{S}/\text{cm}$
- The EC Sensor will essentially let us know that the filter is keeping the Conductivity rating down
- The probe I found is from Atlas Scientific
 - If is indefinitely submersible
 - Accuracy is +/- 2%

Response Time	Life Span	Recalibration Life Span	Cost
90% in 1s	10 Years	10 Years	157.99

Conductivity Probe K 1.0

#ENV-40-EC-K1.0





- Filtration Team
 - Create 3D Cad design for components
 - Connect components for System Diagram
- Find and Apply fixtures for low flow/lower water appliances
 - This includes shower heads, sinks, toilet, dishwasher & washing machine
 - Recycling water is good but the best way to conserve it is by limiting the water use in the first place
- Educate Residents
 - During the last two weeks the team will be working on means to educate resident of ADU
 - This includes attachments to appliances to remind user to be water cautious and avoid negligent usage



- Look into requirements for pipe regulations for recycled water
- Proper signage identifying water is recycled water (similar to what UCI has)
- Gray water can't be stored for more than 24 hours, our water is filtered so it is potentially not gray water anymore
 - Potentially add bleach or chlorine to toilet water since it is no coming into contact with humans