

# Water Treatment Competition

**Dates of Competition:** Thursday, March 31, 2022 - Presentation  
Saturday, April 1, 2022 - Construction

**Competition Location:** UC Davis Campus

## Abstract:

The ASCE Mid-Pacific Student Water Treatment Competition is an undergraduate project that will give civil and environmental engineering students hands-on experience and apply their knowledge learned in class. In this project, students will work in teams to build a filtration system that will be judged based on water quality, design report, construction, efficiency, cost, and an oral presentation. Simulated wastewater will be loaded into the filter and teams will be ranked and are expected to collaborate in solving this real-world problem. The competitors will use materials attainable at a hardware store to design their filter which will treat wastewater based on real-world scenarios in the rules of the competition.

## Important Deadlines:

- Questions and Materials requests: Emailed by **Saturday, January 15<sup>th</sup>, 2022**, by 11:59pm (PST).
- Technical Paper: Submitted electronically in PDF format by **Sunday, March 10<sup>th</sup>, 2022** by 11:59 pm (PST).
- Presentation: Submitted electronically in PowerPoint format by **Thursday, March 24<sup>th</sup>, 2022** by 11:59 pm (PST).

*\*Failure to comply with deadlines listed above will result in your team's immediate disqualification from the competition.*

## Contact and Submission Information:

Email: [watertreatment.midpac2022@gmail.com](mailto:watertreatment.midpac2022@gmail.com)

*\*Please send any questions or inquiries about the water treatment competition to the above email. Messages/emails sent to any other account will NOT be addressed. Expect replies to take up to 3 business days.*

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## Scenario

California, notorious for facing droughts in the past, has one rainy season remaining in the year. A farmer prepares a water recycling system to collect rainfall, runoff water from watering agricultural crops, and gray water from his kitchen into a large water basin. The farmer wants to be able to recycle and reuse the collected water around the farm such as providing potable water to his livestock, watering plants in his greenhouse, and doing household chores such as washing laundry. The water is polluted with debris such as fertilizer and kitchen products that must be filtered so that it is safe for these various uses. He tasks a group of students with the task of creating a recycling system that will purify the water enough for these uses. For the students to complete this project, they will be able to only use materials that he has around the farm.

## Inlet Water Constituents

Two (2) 5-gallon buckets total will be prepared for each team. All constituents will be added and stirred with a wooden stir stick 24-hours prior and then stirred again 5-minutes before the filter loading phase.

### Per 5-gallon bucket

Great Value Apple Cider Vinegar	1 cup
Great Value Tomato Sauce	8 oz
Great Value Vegetable Oil	1 cup
Miracle-Gro Potting Mix	500g
Quaker Oats, Old Fashioned Oats	1 cup
Gatorade Thirst Quencher Fruit Punch Powder	¼ cup

*\*Images and estimated costs of wastewater constituents can be found in Appendix B.*

# Competition Scoring

## Water Quality Testing

Immediately after construction and loading, the final treated water will be tested using university laboratory equipment. The following five (5) water quality parameters of your final treated product will be graded based on the scoring methods described below. Water quality is worth 35 total points.

### pH Value (Max: 10 points)

pH range	Points
$7 \leq \text{pH} \leq 7.5$	10
$6.5 \leq \text{pH} < 7$ or $7.5 < \text{pH} \leq 8$	8
$6 \leq \text{pH} < 6.5$ or $8 < \text{pH} \leq 8.5$	6
$5.5 \leq \text{pH} < 6$ or $8.5 < \text{pH} \leq 9$	4
$5 \leq \text{pH} < 5.5$ or $9 < \text{pH} \leq 9.5$	2
All other pH ranges	0

### Turbidity (Max: 10 points)

Turbidity Ranges	Points Allocated
NTU < 15	10
$15 \leq \text{NTU} < 50$	8
$50 \leq \text{NTU} < 85$	6
$85 \leq \text{NTU} < 120$	4
$120 \leq \text{NTU} < 155$	2
NTU $\geq 155$	0

### Electric Conductivity (Max: 5 points)

**Target:** Minimal  $\mu\text{S}/\text{cm}$

**Grading:** (Best team's rank/ your rank) \* 5 points

Note: Teams will be ranked from best to worst with #1 being the team with the electrical conductivity closest to the target value.

### Volume (Max: 5 points)

**Target:** 9 gallons

**Grading:** (Your effluent volume in gal / 9 gallons) \* 5 points

Note: There is a maximum of 5 points allotted for volume. It is conceivable, however unlikely, that a team could have a volume greater than 9-gallons; in that case, the team would still only receive 5 points.

## Dissolved Oxygen (Max: 5 points)

Percentage of D.O.	Points
100%	5
$90\% \leq DO < 100\%$ or $100\% < DO \leq 110\%$	4
$80\% \leq DO < 90\%$ or $110\% < DO \leq 120\%$	3
$70\% \leq DO < 80\%$ or $120\% < DO \leq 130\%$	2
$60\% \leq DO < 70\%$ or $130\% < DO \leq 140\%$	1
All other D.O. values outside of these ranges	0

## Technical Report

Each team is required to submit a technical design report detailing the overall project. The report must include a description of the design process, treatment principles utilized, environmental impacts, a cost analysis, and tables of material and operational costs. The design report is worth 25 total points. Please submit an electronic version of your report in PDF format via email to [watertreatment.midpac2022@gmail.com](mailto:watertreatment.midpac2022@gmail.com) by no later than 11:59 PM Pacific Time on Sunday March 10, 2022. Hard copy submittals will not be accepted.

### Formatting

The following format is required:

- **Report Cover Page:** Must contain school name, team name, and competition name: “2022 ASCE Mid-Pacific Student Water Treatment Competition”
- **Table of Contents:** Limited to a total of one (1) page.
- **Body of Work:**
  - Must be a minimum of 1000 words
  - May not exceed ten (10) pages. Cover page, table of contents, and appendices are not included in the page count.
  - Use 12-point Times New Roman font, single-spaced, using normal width character spacing, and 1-inch margins on all sides
  - Headings may be of any font, size, or color
  - Body pages shall be numbered, beginning with ‘1’
  - Captions used for any photographs, tables, line drawings, graphs, or other figures shall have normal width character spacing and be no less than 10-point font.
  - Photographs, tables, line drawings, graphs, headers, and footers are permitted and shall be counted as part of the page limits defined above.
- **References:**
  - A list of references or works cited page should be included. This list will not be counted as part of the report page limit.
  - All work, figures, or tables not generated by the authors must be cited.

- Acknowledgements: any assistance received from others not on the team shall be recognized. Acknowledgements will not be counted as part of the report page limit.
- **Appendices:** Pages shall be numbered in such a way that the appendix and page number are clearly listed (i.e., A1, A2, B1, B2, etc.). There is no limit to appendix length, but it must only contain relevant materials.
- **Paper:** The report and appendices shall be presented on 8.5"x 11" pages using portrait or landscape orientation as appropriate.

One (1) point will be deducted from the team's design report score for each format violation.

## Body of Work Content

The grading point distribution for each section is shown below for the design report.

- **Filter Discussion (15):** The design report must include an overview of the filter's composition and how it functions. This section should elaborate on the engineering design processes, filters, and test results that were used to achieve the required water quality. Each filter will be judged based on approach along with principles implemented in the design process.
- **Materials and Cost Analysis (3):** The design report must include a material list along with a short explanation of why each item was selected. Reference Appendix A to see a list of materials that are allowed. Additionally, this section must include a cost analysis which should include both material cost estimate and labor costs. The lower the cost estimate, the more points awarded.
- **Sustainability (5):** The design report must include the sustainability aspect of the filter such as environmental impacts or minimizing cost.
- **Professional Quality (2):** The design report's professional quality will be based on appearance, language used, and organization.

Plagiarism will not be tolerated. Teams caught plagiarizing will be disqualified from the competition.

# Construction and Loading

This section is worth 20 points and it will be judged based on the orderliness of construction site, cost of treatment system, teamwork, and construction time. Scoring and deduction methods will be available below. Please construct filter designs as shown on your team's technical report.

## Site Constraint

Teams will be allowed 10' x 10' area of space to construct their filters. These sites include hard surfaces like that of concrete. No operators nor material should exceed the boundaries of this area. Teams will be scored on how well they utilize the given space and the organization of their construction site along with operator's safety when working in teams.

## Time Constraint

Teams will be given 30 minutes to construct the treatment system. After this time segment, teams will be given 10 minutes to load their systems with a 20-minute treatment period following. The collection container must be removed from the treatment system immediately after the treatment phase.

## Construction Details

- Teams will use the 10' x 10' space to construct their systems. This area will be marked using marking tape and all material must be contained inside those markings.
- Prior to the beginning of the construction phase, the judges will compare the materials in the team's technical report to the materials that are present in the competition. These raw materials must be in their original packaging and disassembled.
- Teams are not allowed to preassemble, precut, or pre-mark materials before it is time to start the construction of the filter. Decoration is encouraged, however, in order to mark any material, teams must have their own markers, measuring cups, scales, and tape. Teams should not list marking materials in the materials list nor in the cost analysis.
- Any prewashed material should be dry and placed back into their original packaging. Loose sand, GAC, lava rock and pebbles are an exception to this list. Any packaging time does not have to be added to the materials list or the cost analysis portion of the design report. Materials that are not prewashed must be in their sealed state, the same way it comes when it is purchased in a store.
- Power saws and power blades are not permitted in this competition. This means any corded power tool. Please bring battery-powered tools if needed.
- Reference Appendix B to see the approved list of the tools permitted in the competition.
- 4 operators can be used to construct the team's system. Once the chief operator says "ready," the clock will start. When the chief operator says "stop", the judge will stop the clock.

- Teams will not be allowed to re-enter the construction region until the filter loading phase is completed once they run out of time.
- Treatment systems must include containers that can hold 9 gallons of water.

## **Treatment Phase**

Two (2) operators of each will may add treatment chemicals to their effluent when the 10-minute loading period begins. A stirring stick will be provided. All operators must be outside of the construction site before the end of the 10-minute loading period. Then, 20 minutes will be provided for the treatment system to work. The collecting container must be removed from the treatment system after the 30-minute treatment phase.

## **Scoring and Deductions**

This category is 20 points out of the 100 in the competition. 13 points for construction are going to be handed out based on the time remaining, the total cost of the system is going to be 5 points, the organization of the construction site will be 1 point, and the overall teamwork is 1 point. All points will be determined by the judges.

Construction time points will be awarded using this equation below:

$(\text{Best team's rank} / \text{your rank}) * 13 \text{ points}$

\*Note: Teams will be ranked from best to worst with #1 being the team with the best construction.

The construction subcategory score will be affected by any deductions.

- Violating the construction area boundaries will result in a 1-point deduction for each time that a construction material goes outside of the 10ft. X 10ft.
- 1-point deduction will result for any pre-marked, pre-assembled, tampered, or pre-cut material.
- 1-point deduction if an operator begins construction before the start of the stopwatch.
- 1-point deduction for material used that is not present in the team's material list.
- 2-point deduction for material used that is not present in the Competition Rules (this information can be found in Appendix B).
- 5-point deduction for non-battery powered tools (i.e., Powered saw or powered blades).
- Disqualification if the team has more than 4 operators.
- 1-point deduction for if a worker and/or material enters the site boundary when in the treatment phase.

No more than 15 points can be lost. The judges will decide disqualification along with the number of points deducted.



## Cost of Treatment System

The cost of the treatment system is worth 10 points and will be given to the team with the lowest cost of treatment system. Points will be awarded according to the following equation:

$$(\text{Best team's cost} / \text{Your team's cost}) * 10$$

The total cost of treatment system will include the cost of materials, tools, and labor (set at \$30 regardless of time and number of operators used) used for construction. Cost for materials will be based on how much is purchased NOT how much is used.

## Safety

Operators must wear safety goggles/glasses, hard hats, safety gloves, long pants, closed-toes shoes, and always tie up any long hair to ensure safety. The team will be advised on any safety practices if a judge deems the violation of safety.

## Poster presentation

Poster boards cannot have dimensions larger than 36" x 24". Below are the point distributions for each category that the poster presentation entails.

1. **Professional Quality (1):** The professional quality of the team's poster will be based on neatness, appearance, and diction.
2. **Technical Content (2):** Poster must contain the purpose of the competition, material list, filter cost, and an overview of the filter's design.
3. **Presentation/Q&A (2):** At least one member should be present after the presentation to answer any question regarding the poster and/or construction to judge.

Teams will be provided with their own stands, or any other equipment needed to display their poster.

## Oral Presentation

Lastly, this competition consists of an oral presentation where judges will award points based on clarity, design, and professional system when presenting the design analysis and performance. The order of these presentations will be chosen at random, so each team must be prepared when it is time to present. Presentation times will be handed in in advance. People will not be allowed to leave or enter the room once the presentation begins for the respect of the presenters.

Teams will use PowerPoint to present. Please submit your team's PowerPoint presentation via email to [watertreatment.midpac2022@gmail.com](mailto:watertreatment.midpac2022@gmail.com) by midnight on Tuesday, April 5, 2022 (11:59

PM). You will be allowed to request changes to slides after the submission date but will result in a 4-point reduction to the overall Oral Presentation score.

## Scoring

Sub-Category	Points
Technical Content	8
Q&A Session	5
Voice Projection	4
Visuals	3

## Deductions

- 1 point deducted for every 10 seconds after the 6 minutes and 5 second mark

Time Frame	Points Deducted
6:26 – 6:35	3
6:16 – 6:25	2
6:06 – 6:15	1

## Competition Scoring

Category <sup>[AA1]</sup>	Sub - Categories	Points
Water Quality	pH	10
	Turbidity	10
	Electrical conductivity	5
	Dissolved Oxygen	5
	Volume	5
	<b>Subtotal</b>	<b>/35</b>
Design Report	Filter design and analysis	15
	Materials list/cost analysis	3
	Sustainability	5
	Professional Quality	2
	<b>Subtotal</b>	<b>/25</b>
Construction	Construction Time	13
	Cost of Treatment System	5
	Organization of Construction Site	1
	Overall Teamwork	1
	<b>Subtotal</b>	<b>/20</b>
Oral Presentation	Technical Content	8
	Visuals	3

	Q&A Session	5
	Voice Projection	4
	<b>Subtotal</b>	<b>/20</b>
<b>Total</b>		<b>/100</b>

## Appendices

### Appendix A: Materials List

Every team is permitted to submit a request to add two (2) materials or tools to this list. Please submit the request to [watertreatment.midpac2022@gmail.com](mailto:watertreatment.midpac2022@gmail.com) by **Sunday, December 5, 2022**. These requests will be evaluated for appropriateness in the competition. If your suggestions are accepted, these materials will become accessible to all teams. Teams requesting additional material must also provide the unit of measure and the unit cost which will be verified by the competition host.

All items must be in their original packaging. This means unopened packaging. Any item will be charged and included in the cost analysis section of the design report, despite how much is used.

Item	Unit	Cost (\$/unit)
1/2" Hardware Cloth	/sq. ft.	0.67
1/4" Hardware Cloth	/sq. ft.	0.67
4 Gallon Trash Can	/unit	2.50
13 Gallon Trash Can	/unit	5.00
20 Gallon Trash Can	/unit	7.00
32 Gallon Trash Can	/unit	13.00
2' Ladder	/unit	30.00
4' Ladder	/unit	40.00
6' Ladder	/unit	50.00
2" Adjustable Spring Clamp	/unit	6.00
2" PVC Pipe Elbow	/unit	3.00
2" x 4" 3M Steel Wool	/unit	0.83
2" x 4" Dimensional Lumber	/4 lin. ft.	2.00
2" x 6" Dimensional Lumber	/4 lin. ft.	2.50
4" x 4" Dimensional Lumber	/4 lin. ft.	3.00
3/4" Black Electrical Tape	/lin. ft.	0.06
3/4" Thick Plywood	/4 sq. ft.	1.00
3/8" Thick Plywood	/4 sq. ft.	2.00
3/8" Nylon Rope	/lin. ft.	0.20
30 Gallon Tote	/unit	12.00

36 Gallon Garbage Bag	/unit	0.60
5 Gallon Bucket	/unit	3.00
5 Gallon Bucket Lid	/unit	1.50
5/8" Carpet Pad	/sq. ft	0.50
8" x 6" x 2" Grout Sponge	/unit	2.00
Alum (McCormick)	/oz.	1.50
Aqueon Water Clarifier	/fl. oz.	2.50
All Purpose Gravel (Quickrete) /50 lb.		10.00
Astroturf	/sq. ft.	4.00
Baking Soda	/oz.	0.10
Borax (20 Mule Team)	/oz.	1.00
18 cup Brita Filter	/unit	12.00
1" 3 Ring Binder	/unit	3.00
2" 3 Ring Binder	/unit	5.00
Vinegar	/1 cup	1.00
Bounce Dryer Sheet	/20 units	5.00
Bentonite Clay	/oz.	1.50
Paper Towels	/roll	1.50
Burlap	/sq. ft.	0.30
Canvas Drop Cloth	/sq. ft.	0.50
Charcoal	/lb.	0.50
Clorox Bleach, Concentrated	/5 cups	2.50
Clorox Disinfecting Wipes	/15 units	1.25
Clorox Water Clarifier	/fl. oz.	2.50
Clorox pH Up	/fl. oz.	3.00
Coarse Compost	/gallon	3.00
CoCo Liner, 18"	/unit	4.00
Coconut Fiber Husk	/gallon	1.50
Coffee Filter	/unit	0.05
Cotton Fabric	/sq. yard	3.00
Commercial Grade Fine Sand	/lb.	0.20
Commercial Grade Sand	/lb.	0.15
Cotton Balls	/50 units	0.50
Diatomaceous Earth	/lb.	2.50
Duct Tape	/yard	0.50
Epsom Salt	/oz.	0.50
Fiber Twine	/ft.	0.15
Gelatin (Knox Unflavored)	/5 oz.	1.50
Granular Activated Carbon	/oz.	0.50
Gypsum	/lb.	0.25
Hydrogen Peroxide	/3 cups	1.50

Lava Rock	/cu. ft.	5.00
Lemon Juice	/5 fl. oz.	2.50
8 oz. Mason Jar	/unit	1.50
Masking Tape	/yard	0.20
Mylar Emergency Sleeping Blanket	/unit	3.00
Milk of Magnesia	/oz.	3.00
6.5 Gallon Milk Crate	/unit	5.00
Paint Tray	/tray	2.00
Packing Tape	/yard	0.25
Peat Moss	/cu. ft.	5.00
Powdered Activated Carbon	/oz.	0.50
Powdered Chalk	/oz.	0.50
Pebbles, Large	/5 lb.	2.50
Pebbles, Pond/Landscape	/0.5 cu. ft.	2.50
Pickling Lime	/oz.	0.20
Plaster of Paris	/lb.	0.50
Plastic Tarp	/sq. ft.	0.10
Play Sand	/lb.	0.10
Plumbing Epoxy Putty	/putty	2.50
OxiClean Stain Remover	/lb.	1.00
Potassium Permanganate	/5 oz.	5.00
ABS Pipe, 1-1/2" Diameter	/5 lin. ft.	1.50
ABS Pipe, 2" Diameter	/5 lin. ft.	2.50
Copper Pipe, 1/2" Diameter	/5 lin. ft.	5.00
Copper Pipe, 1" Diameter	/5 lin. ft.	10.00
Corrugated Pipe, 3" Diameter	/5 lin. ft.	2.50
Corrugated Pipe, 4" Diameter	/5 lin. ft.	4.50
PVC Pipe, 1" Diameter	/5 lin. ft.	1.00
PVC Pipe, 1-1/2" Diameter	/5 lin. ft.	1.50
PVC Pipe, 2" Diameter	/5 lin. ft.	2.00
Pool Sand Filter	/lb.	0.20
Pumice Stone (1 CF)	/cu. ft.	3.00
Rubbing Alcohol	/3 cups	1.50
Salt (Morton Iodized Table Salt)	/20 oz.	1.00
Sham-Wow	/sq. ft.	3.00
Stainless Steel Safety Wire	/lb.	3.00
Standard Air Conditioning Filter	/unit	5.00
Sterilite 3 Drawer Medium Countertop (13 5/8" x 11" x 10")	/unit	10.00
Scotch Tape	/yard	0.10
Terrycloth Rag	/lb.	2.50
Tote, 5 Gallon	/unit	6.00

Tote Lid, 5 Gallon	/unit	1.00
Tote, 10 Gallon	/unit	8.00
Tote Lid, 10 Gallon	/unit	1.00
Tote, 13 Gallon	/unit	10.00
Tote Lid, 13 Gallon	/unit	1.00
Tote, 18.5 Gallon	/unit	12.00
Tote Lid, 18.5 Gallon	/unit	10.00
Toilet Paper	/roll	1.50
TSP/90	/lb.	3.00
Turtle Wax Hard Shell Paste Wax	/fl. oz.	0.50
Upholstery Fabric	/sq. yard	4.00
Weed Control Fabric	/sq. ft.	0.10
Window Screen Mesh	/3 sq. ft.	0.50
Wood Mulch	/cu. ft.	5.00
Vanity Fair Napkins	/10 napkins	0.10
21-31 in x 18 in Adjustable Window Screen	/screen	7.00
Ferric Chloride	/oz. or /fl. oz.	0.20
Bon Tool 5 Gal. Paint Strainer	/strainer	3.10
Scott Shop Towels 11in x 40in (55 sheets per roll)	/roll	3.50

**Table 3: Labor and Tool Costs**

<b>Item</b>	<b>Cost (\$/unit)</b>
Operator	30.00 (flat fee)
Adjustable Wrench	3.00
Basic Socket Set	5.00
Caulking Gun	2.00
Channel Locks	1.50
Hand Saw	10.00
Pliers	1.50
Scissors	2.00
Screwdriver	1.00
Standard Builder's Hammer	5.00
Utility Knife	2.00
Wire cutters	2.00
Pipe Cutters	10.00
Pipe Wrench	5.00

## Appendix B: Operational Costs

These wastewater constituents can be bought from Amazon, Target, Walmart and more. Pictures are shown below.

- Great Value Apple Cider Vinegar



Great Value

**Great Value Apple Cider Vinegar, 128 fl oz**

★★★★☆ (4.6) [192 reviews](#)

**\$4.34** 3.4 ¢/fl oz

- Great Value Tomato Sauce



Great Value

**Great Value Tomato Sauce, 8 oz**

**\$0.32** 4.0 ¢/oz

Add to cart

- Great Value Vegetable Oil



Great Value

**Great Value Vegetable Oil, 1 gal**

★★★★☆ (4.7) [1567 reviews](#)

**\$7.44** 5.8 ¢/fl oz

- Miracle-Gro Potting Mix



**Miracle-Gro 16 qt. Potting Mix**

Model# 75686300

★★★★☆ (651)

**\$8.79**

- Quaker Oats, Old Fashion



**Quaker Oats Heart  
Healthy Old Fashioned  
Oats - 42oz**

Quaker

★★★★☆ 1154

**\$3.19**

- Gatorade Thirst Quencher Fruit Punch



Gatorade

**Gatorade Thirst Quencher Fruit  
Punch Powder, 51 Oz.**

★★★★☆ (4.6) 305 reviews

**\$8.38** 56.6 ¢/oz