

2025 Mid-Pacific Conference

Water Treatment Competition

Competition Date: Sunday, April 6, 2025

Competition Location: University of California, Berkeley

SUMMARY

Protecting water quality and providing clean water is the fundamental focus of the ASCE Mid Pacific Water Treatment Competition. Students from civil and environmental engineering, related majors, and those passionate about providing clean water come together to participate in the competition each year. The competition gives students a chance to gain hands-on experience with research, design, and laboratory testing involved with water treatment principles as well as an opportunity to develop professional skills such as technical writing and public speaking. It provides students the opportunity to develop leadership and project management skills in the water/wastewater field by engaging students with faculty and water/wastewater professionals.

The ASCE Mid-Pacific Student Water Treatment Competition includes the research, design, presentation, and hands-on construction of a filter made from supplies commonly found in homes/businesses. The filter is loaded with standardized simulated wastewater to test and rank the participants from ASCE student chapters across California, China, and Canada. Students must collaborate in order to apply wastewater treatment principles and provide a solution for a real world situation. During the competition, the project is judged on sustainability, treatment efficiency, cost, and a technical oral presentation.

IMPORTANT DEADLINES

- Registration: See Deadline Information
- Questions & Materials Requests: Emailed by 11:59 pm (Pacific Time) Sunday January 12th, 2025
- Design Report: Submitted electronically in PDF format by Monday March 31st, 2025 by 11:59 pm (Pacific Time)
- Presentation: Submitted electronically in PowerPoint format by Monday March 31st, 2025 by 11:59 pm (Pacific Time)

The Competition Director will send teams confirmation emails when team presentations and design reports are received.

**Failure to comply with the deadlines listed above will result in a 5-point deduction from the team's final score*

CONTACT

Water Treatment Competition Director:
Kathy48919@berkeley.edu

**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.*

IMPORTANT NOTES

- If teams have questions or are unclear about rules, please email the Water Treatment Competition Director (Kathy Luo). It is better to ask for clarification than to have points deducted at competition!!!
- The Water Treatment Competition Director has the right to make final decisions about point deductions, rule discrepancies, team order, etc.
- Any violations of the rules will result in a 5-point deduction from the team's final score unless otherwise stated.
- Please email the Competition Director if you spot any errors/typos with the water treatment rules.

*****Please remember that the Competition Director is a student. The Competition Director is voluntarily dedicating time to organize this competition, so please be patient and understanding as the Competition Director will make mistakes.*****

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SCENARIO

The “Big Quake” has hit California and has severely damaged the main aqueducts that supply Bay Area communities with water. The government estimates it will take months to repair the aqueducts and restore regular drinking water supply, so heavy water conservation efforts are needed. As part of the conservation effort, your community decides to look towards local surface water sources for non-potable water use, but find that it has been contaminated with debris and pollutants from the earthquake and subsequent fires. You and a group of civil engineers are tasked with building a filtration system to filter the water and establish a safe source of water for non-potable use.

INFLUENT CONSTITUENTS

Two (2) 5-gallon buckets total will be prepared for each team. All constituents will be added and stirred 24 hours prior to competition and stirred again 5 minutes before construction/treatment.

Per 5-gallon bucket:

Water	4.5 Gallons
Miracle-Gro Potting Mix	16 oz
Gatorade Thirst Quencher Fruit Punch Powder	¼ Cup
Mott’s Apple Juice	8 oz
Fleischmann’s Rapid Rise Yeast	¼ oz
Krusteaz Buttermilk Pancake Mix	8 oz

COMPETITION SCORING

The point distribution is listed in Table 1 and is described in the following sections:

Table 1: Point Breakdown Summary

Category	Sub-Category	Points
Water Quality (Point Subtotal: /35)	pH	10
	Turbidity	10
	Electrical Conductivity	5
	Dissolved Oxygen	5
	Volume	5
Design Report (Point Subtotal: /25)	Filter Design & Analysis	15
	Materials & Cost Analysis	3
	Sustainability	5
	Professional Quality	2
Construction (Point Subtotal: /25)	Construction Time	8
	Cost of Treatment System	10
	Orderliness of Construction Site	2
	Safety	3
	Overall Teamwork	2
Oral Presentation (Point Subtotal: /10)	Technical Content	4
	Visuals	1
	Oral Presentation	3
	Q&A Session	2
Poster Presentation (Point Subtotal: /5)	Technical Content	3
	Professional Quality	2
Total		/100

WATER QUALITY TESTING (35 POINTS)

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 (Max: 10 points)

pH Ranges	Points
$6.5 \leq \text{pH} \leq 7$	10
$6 \leq \text{pH} < 6.5$ or $7 < \text{pH} \leq 7.5$	8
$5.5 \leq \text{pH} < 6$ or $7.5 < \text{pH} \leq 8$	6
$5 \leq \text{pH} < 5.5$ or $8 < \text{pH} \leq 8.5$	4
$4.5 \leq \text{pH} < 5$ or $8.5 < \text{pH} \leq 9$	2
All other values	0

Turbidity (Max: 10 points)

Turbidity Ranges	Points
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 ≥ 155	0

Electrical Conductivity (Max: 5 points)

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

Grading: (Your rank / number of teams) * 5 points

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

Dissolved Oxygen (Max: 5 points)

DO is measured as % saturation.

DO Range	Points
$90\% < \text{DO} \leq 100\%$	5
$80\% < \text{DO} < 90\%$	4
$70\% < \text{DO} < 80\%$	3
$60\% < \text{DO} < 70\%$	2
All other DO values outside of these ranges (e.g. The DO meter is out of range because an excessive quantity of oxidant was added)	0

Volume (Max: 5 points)

Target: 9 gallons

Grading: (Your effluent volume in gallons / 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.

DESIGN REPORT (25 POINTS)

Each team is required to submit a 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 ascemidpac2025@gmail.com by no later than 11:59 PM Pacific Time on Monday March 31st, 2025. 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: “2025 ASCE Mid-Pacific Student Water Treatment Competition”
- **Table of Contents:** Limited to one (1) page for the report.
- **Body of Contents (Format):**
 - Minimum 1,000 words
 - The page limit is ten (10) pages. The cover page, table of contents, appendices, and list of references are not included in the page count
 - Use 12-point font (Times New Roman), single-spaced format with 1” margins on all sides
 - Headings may be in any font, size, or color
 - Body pages shall be numbered, beginning on the page of your team’s table of contents.
- **Appendices:** Pages shall be numbered so that the appendix and page number are clearly listed (i.e. A1, A2, B1, B2, etc.). There is no limit to appendix length, but all material in the appendix must be relevant to the design process.
- **Paper:** The design report shall be presented on 8.5”x 11” pages. The body of contents must be presented on portrait-orientated pages, but the appendices may be presented in either portrait or landscape-oriented pages.
- **Miscellaneous:**
 - 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, footers, or other figures included in a team’s body of contents shall be included in the page count. At any point in the design report, a team may reference figures in the appendix.
 - All work, figures, or tables not generated by the authors must be cited.
 - A list of references (or works cited page) shall be included (if necessary). As previously mentioned, a reference page does not count toward the ten (10) page limit.
 - Acknowledgements: Please show appreciation for any assistance received from other people not on the team by listing those sources at the bottom of the team’s

references page. Acknowledgements will not count toward the ten (10) page limit. One (1) point will be deducted from the team's design report score for each format violation.

Report Content

The design report must include the following content. The point distribution for grading of each section is presented in [Table 1](#).

- **Filter Design & Analysis:** The body of the design report shall contain a description of the treatment system and how it works. The system design will be judged based on the approach each team used to solve the problem as well as the industry treatment principles implemented in the design process. This section must include clear descriptions of engineering design processes, lab techniques used, and test results obtained.
- **Materials & Cost Analysis:** The design report must include a material list with a brief explanation and justification of each material selected. See [Appendix A](#) for a list of permitted materials. The design report must include a cost analysis which must include both a material cost estimate and an operational cost estimate. The total cost will be taken as a sum of the material and labor costs. Teams will be ranked by the lowest cost estimate. Material cost will be determined by the number of units bought regardless of how much was used. For example, if you buy a 12 oz. bottle of hydrogen peroxide but only use 5 oz, the total cost will be for the 12 oz. bottle.
- **Sustainability:** The design report must include an explanation of the sustainability aspects of the treatment system. This section must include a life cycle assessment (LCA) where the sustainability of materials, tools, and waste products are assessed. Include the environmental impacts of materials used and decisions made regarding choices to minimize cost or reduce environmental impact.
- **Professional Quality:** Professional quality of the design report will be based on organization, presentation, quality of writing, and effectiveness of figures, tables, and other resources presented in the report.

Plagiarism of any kind will not be tolerated. Teams caught plagiarizing any portion of their design report will be disqualified.

CONSTRUCTION (25 POINTS)

Teams will construct their treatment system as described in their design report. This phase will include the construction, chemical treatment, loading, and filtration of the effluent into their filter. This section is worth 25 total points and will be judged based on the orderliness of the construction site, construction and treatment time, cost of the treatment system, safety, and overall teamwork - see scoring and deduction methods presented below and in [Table 1](#) for point distribution.

***All teams will be required to use a plastic tarp during the construction process. Tarps will be provided for each team. Because the wastewater has the possibility of staining the ground, the school is requiring teams to build on tarps.

Construction & Treatment Time

Teams will be timed on the construction of their filters.

- Each team will be limited to a total of thirty (30) minutes to construct their treatment systems.
- The loading phase will follow, which includes ten (10) minutes for teams to chemically treat the influent and load their systems.
- A twenty (20) minute treatment period will follow.
- Any disinfectants in the system must be built into the final filtration system. Operators will not be allowed to add materials to their filtration system after the construction period.
- Immediately after the treatment period is completed, the collection basin will be removed from the treatment site and taken to the lab for testing.

Construction Phase Details

Teams will construct their systems in a 8'x8' (2.4x2.4 m) space. Site limits will be based on the inside of the borders made, using either tape or chalk. Sites are not guaranteed to be completely flat or level. Sites will be located on either concrete, pavement, or bricks.

- Teams will place all their unassembled raw materials and tools in the competition area along with two provided 5-gallon buckets of contaminated water and two provided stirring sticks. Prior to the construction phase, judges will compare the provided materials list in the team's design report to the materials present at the competition.
- Teams shall not pre-assemble, pre-cut, pre-mark, or tamper with materials prior to beginning of the construction, although decoration is encouraged. Teams must provide their own markers, tape measure, measuring cups, and scales, on an as-needed basis. Items used for measuring or marking should not be included in the cost estimate.
- All prewashed materials must be dry and must be placed in their original packaging. Loose sand, GAC, lava rocks, and pebbles may be placed in clear containers based on the predetermined quantity size options in [Appendix A](#). A burlap sack may be used instead of

a clear container but should be open for judges to inspect. Packaging for storage does not need to be included in the materials list or the cost analysis portion of the design report. All materials not prewashed should be in original sealed packaging, as if purchased from the store. For example, if hydrogen peroxide is purchased, the hydrogen peroxide bottle should be sealed in the manner bought from the store.

- All construction materials should be sorted to match the quantity lengths provided in the Competition Rules, for example, the lumber should be four linear feet before bringing the material to the competition regardless of the initial length of purchase. In an effort to be more environmentally mindful, items that are packaged in large quantities may be opened before the competition with materials used. For example, if the design requires two feet of nylon rope and the team purchases a package of pre-cut 16 feet long rope, the team is not required to purchase a new package of material for competing.
- Battery-powered tools are permitted, with the exception of power saws or power blades. Corded power tools are not permitted.
- Teams must provide their own tools based on the approved list given in Appendix B.
- Treatment systems must include a collection basin or multiple collection basins capable of holding 9 gallons of water.
- All construction materials, equipment, operators and chemicals must stay within the 8'x8' construction/treatment zone.
- Teams may use up to 4 operators to construct their systems. Each operator will be charged for labor.
- Construction time will start once the head judge says "go", and the clock will be started. After 30 minutes, construction time will end with the head judge saying "stop".
- Operators must leave the 8'x8' space when time is up or once they are finished with construction, whichever is earlier.

Treatment and Loading and Phases

At the designated start time of the loading phase, teams will have ten (10) minutes to chemically treat and load the influent into their filtration systems. **Prescreening of influent prior to the loading phase is not permitted.** A stirring stick will be provided. Teams will be given twenty (20) minutes after the loading phase to allow the water to filter through their systems. Immediately after the treatment phase, the collection basin will be removed.

Scoring

The Construction category is worth 25 points out of the 100 total points in the competition. Point allocations are shown in [Table 1](#). Construction scoring will be based on construction time, cost of materials, and construction site organization, teamwork, and safety. All points are to be determined by the judges.

Points for construction time will be awarded based on the following guidelines:

Construction/Treatment Time (minutes)	Points
Time \leq 18	8
18 < Time \leq 19.5	7
19.5 < Time \leq 21	6
21 < Time \leq 22.5	5
22.5 < Time \leq 24	4
24 < Time \leq 25.5	3
25.5 < Time \leq 27	2
27 < Time \leq 28.5	1
28.5 < Time \leq 30	0

The construction score will be adjusted if any of the violations below occur during the construction, loading, or treatment phases of the competition.

Violation	Points Deducted
Operator outside construction area	1
Any pre-marked, pre-assembled, or pre-cut materials	10
Operator begins constructing prior to start of construction	5
Any materials not in the team's material list reported in the design report	1 per item
Any tools used in construction not permitted in the Construction Rules or Appendix B	2 per tool
Usage of powered saws or powered blades	5

COST OF TREATMENT SYSTEM

The cost of the treatment system is worth 10 points, with the lowest cost system receiving the most points. The cost of the treatment system includes materials, tools, and operation costs as listed in the Appendices. Cost will be based on how much material is purchased; it does NOT consider how much is used. For example, if you buy a 12 oz. bottle of hydrogen peroxide but only use 5 oz, the total cost will be for the 12 oz. bottle

Points will be awarded based on the following equation:

$$\frac{\text{Your rank}}{\text{Total number of teams}} \times (10 \text{ points})$$

Teams will be ranked from worst to best, with #1 being the team with the highest cost.

Safety

Safety is critical to any engineering project. Operators must wear personal protective equipment including hard hats, safety gloves, safety glasses, closed-toed shoes, and long pants at all times during the construction and treatment phases. Any person handling chemicals must wear a long sleeved shirt or other article of clothing to cover arms and hands must be protected using chemical hazard protection gloves (i.e. latex or nitrile). If at any point a judge deems safety as a risk, the judge may stop the team from proceeding and will review safety practices. The stopwatch will continue running during this time.

ORAL PRESENTATION (10 POINTS)

Each team shall prepare an oral presentation on their treatment system. Presentations will be evaluated on technical content and delivery. Oral presentations shall be presented in English. Presentation order shall be randomly selected before the competition begins and shall be provided at the time of on-site registration.

Teams are required to submit their presentations in PowerPoint or Google Slides.. Please submit your team's presentation via email to ascemidpac2025@gmail.com by 11:59 PM (Pacific Standard Time) on Monday, March 31st, 2025. Two points will be deducted from the overall Oral Presentation score for changes submitted after the deadline.

Scoring

The presentations will be scored by the parameters listed below. Point distribution is denoted in [Table 1](#).

Oral Presentation

- A maximum of two (2) team members may present and answer questions. No other members may stand up with the presenters.
- The presentations should be five (5) to six (6) minutes in duration. There will be a 5-second grace period to account for timer (stopwatch) reaction times.
- Point deductions will occur if the duration is not within the specified time range:

Timing (seconds)	Presentation Durations		Points Deducted
± 1 – 5	4:55 – 4:59	6:01 – 6:05	0 (grace period)
± 6 – 15	4:45 – 4:54	6:06 – 6:15	1
± 16 – 25	4:35 – 4:44	6:16 – 6:25	2
± 26 – 35	4:25 – 4:34	6:26 – 6:35	3
± 35 and more	4:24 and under	6:36 and over	3
± 45 and more	4:14 and under	6:46 and over	4

- No notes or visual aids other than the PowerPoint (i.e. posters) are allowed during the presentation. The presenters will only be allowed to use their PowerPoint during the presentation. The Director will give time cues when the time is at 5-minutes and 5:30-minutes.

Technical Content

- Presentations must include (at a minimum): the system design, treatment process used, materials used, a cost analysis, and a discussion of sustainability.

- The content may be presented in any order and is not limited to these components.

Visuals

- Teams may use PowerPoint or Google Slides for their presentations.
- Teams may use visual aids including graphs or photographs to enhance the presentation. Video clips may not be included.

Question-and-Answer Session

- There will be a 5-minute question-and-answer session immediately following the presentation. Only the panel judges will be permitted to ask questions

POSTER PRESENTATION

Each team must display a poster board of dimensions no larger than 36"x24" next to their construction site. The point distribution for the poster is described in [Table 1](#). Poster should be in English, but teams are welcome to display an additional poster in another language.

- **Technical Content (3):** Poster must contain the purpose of the competition, material list, filter cost, and an overview of the filter's design.
- **Professional Quality (2):** The professional quality of the poster will be scored based on organization, appearance, and quality of scientific writing..

Note: Teams must provide their own poster stands and/or any other equipment required to display the poster.

WATER TREATMENT COMPETITION APPENDICES

Appendix A: Materials List

Each team is permitted to submit a request to add two (2) materials or tools to this list. Please submit for approval to ascemidpac2025@gmail.com by January 12, 2020. 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 Director.

Note: All items must be in their original packaging (see exceptions in the Construction and Treatment section). For example, if a store sells hardware cloth in 10 square foot sizes, bring the unopened packaging to the competition. The hardware cloth will therefore be charged as \$6.70 in the cost analysis section of the design report, regardless of the amount used during the construction phase.

Table 2: List of Materials and Associated Costs

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

Appendix B: Tools and Operational Costs

Note: As stated in the Construction and Treatment Section, teams must provide their own markers, tape measure, measuring cups, and scales, as needed. Items used for measuring or marking should not be included in the cost estimate.

Table 3: Breakdown of Tools and Operational Costs

Item	Cost (\$/unit)
Operator	30.00/person
Adjustable Wrench	3.00
Basic Socket Set	5.00
Caulking Gun	2.00
Channel Locks	1.50
Cordless Drill	10.00
Drill Bits (each)	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 C: Wastewater Constituents

All wastewater constituents can be bought from multiple stores including Walmart, Target, or Amazon. Pictures are shown below as references when purchasing constituents.

Table 4: Wastewater Influent Constituents

<p>Miracle-Gro Potting Mix</p>	
<p>Gatorade Thirst Quencher Fruit Punch Powder</p>	
<p>Mott's Apple Juice</p>	

Krusteaz Buttermilk Pancake Mix



Fleischmann's Rapid Rise Yeast

