

WATER TREATMENT

Competition Rules

ASCE Mid-Pacific Student Symposium

April 9—11, 2027

Hosted by CSU Fresno & UC Merced

ASCE FRESNO STATE STUDENT CHAPTER

ASCE STUDENT CHAPTER University of California, Merced

Water Treatment Competition Rules

Competition: Sunday, April 11, 2027 (check-in 9:30 – 10:00 AM; competition 10:00 AM – 2:30 PM). All deadlines are 11:59 PM Pacific Time. Questions: ascemidpac2027@gmail.com.

Overview

The ASCE Mid-Pacific Water Treatment Competition includes the research, design, presentation, and hands-on construction of a filtration system from household supplies. The filter will be loaded with standardized simulated wastewater for testing, and teams will be judged on water quality, design report, construction (time, cost, and safety), and a technical oral presentation and poster.

Competition Prompt

Years of constant wildfires have severely damaged mountain vegetation, causing surface runoff to stress valley watersheds. This runoff, combined with recent atmospheric rivers, has created widespread flooding across the Central Valley, damaging agricultural and public water supply infrastructure. Floodwaters carrying heavy sediment, agricultural debris, animal waste, and harmful pesticides have entered local waterways and threaten community water supplies. It is now up to your engineering team to design and build a functional filtration system under tight constraints to safely generate usable, clean drinking water for the affected community.

Key Dates (2027)

Item	Date
Team registration (regular, $150 per team)	Tuesday, December 1, 2026
Team registration (late, $180 per team)	Monday, January 18, 2027 (checks must be postmarked by this date)
Attendee registration and team roster due	Monday, February 15
Request for Information (RFI) and materials-request deadline	Friday, February 19
RFI answers posted	Friday, February 26
Design report due (PDF)	Friday, March 26
Late individual registration deadline	Tuesday, March 30
Poster (PDF) and presentation (.pptx) due	Friday, April 2
Captains' meeting, online (informational only)	Thursday, April 8, 7:00 – 8:00 PM
Captains' meeting, in person (mandatory; captain or designee)	Friday, April 9, 8:30 – 9:15 AM
Presentations	Friday, April 9, 1:00 – 4:00 PM

Item	Date
Competition check-in	Sunday, April 11, 9:30 – 10:00 AM
Water Treatment competition (construction, loading, treatment)	Sunday, April 11, 10:00 AM – 2:30 PM

Registration, roster, and chapter-standing deadlines follow Mailer 1. All submission deadlines are 11:59 PM Pacific Time. Final times and locations will be confirmed in Mailer 2 and on the symposium website.

Eligibility and Participant Rules

1. Every team member must be an ASCE student member and a registered attendee of the ASCE Mid-Pacific Student Symposium, and the university's chapter must be in good standing (annual report and dues submitted by February 1).
2. Students may compete in more than one competition but may captain only one team. Because each competition demands significant time before and during the symposium, students are encouraged to focus on one competition.
3. Up to four operators may build the system on competition day. Each operator is charged for labor.
4. All participants are expected to follow the professionalism and sanctions policies in Mailer 1. Events are drug and alcohol free.

Submissions and File Naming

Email all deliverables to the general symposium address below, using the subject line and file name shown. The competition chair will email a confirmation when each file is received.

Deliverable	Format	Due Date	Subject Line / File Name
Design Report	PDF	Fri, Mar 26	Subject: UniversityName_Water Treatment Report File: UniversityName_Report_WaterTreatment.pdf
Poster	PDF	Fri, Apr 2	Subject: UniversityName_Water Treatment Poster File: UniversityName_Poster_WaterTreatment.pdf
Presentation	PowerPoint (.pptx)	Fri, Apr 2	Subject: UniversityName_Water Treatment Presentation File: UniversityName_Presentation_WaterTreatment.pptx

Late Policy

A late submission loses 4 points for each of the first three days (up to 72 hours late) and an additional 8 points on the fourth day (72 to 96 hours late), for a maximum loss of 20 points. Submissions more than 96 hours late will not be accepted. The penalty applies separately to each deadline: the design report (March 26) and the poster and presentation (April 2). Submitting more than one file late on the same deadline counts as one late submission, so the maximum total late penalty is 40 points. This policy replaces all earlier late penalties.

Requests for Information (RFIs) and Materials Requests

Send questions and materials requests by **Friday, February 19**. Answers will be posted to all teams on **Friday, February 26**. Each team may request one (1) new material or tool (see Appendix A).

Contact

Send all questions about this competition to ascemidpac2027@gmail.com. Replies may take up to 3 business days. Messages sent to any other account will not be addressed.

Background

Years of constant wildfires have severely damaged vegetation in the surrounding mountains, causing surface runoff to stress the valley watersheds. This increase in runoff, combined with a series of atmospheric rivers, has created the conditions for widespread flooding in the Central Valley. Severe flooding has damaged agricultural and public water supply infrastructure throughout the valley. Floodwaters carrying sediment, agricultural debris, animal waste, and pesticides have entered local waterways and threaten community water supplies. It is now up to you and your fellow civil engineers to build a filtration system that treats this water so it is cleaner and more usable for the community.

Safety notice: Effluent produced in this competition is for testing only. It is NOT safe to drink. Do not taste or drink any influent or effluent.

Influent Constituents

Two (2) 5-gallon buckets will be prepared for each team. All constituents will be added and stirred 24 hours prior to the competition and stirred again 5 minutes before construction and treatment. Images of the constituents are in Appendix C.

Per 5-Gallon Bucket	Amount
Water	4.5 gallons
Miracle-Gro Potting Mix	22 oz
Great Value Plain Bread Crumbs	16 oz
ULTHMOK Hibiscus Tea	10 tea bags
Carnation Evaporated Milk	24 fl oz
Activia Vanilla Yogurt	4 oz

Water Quality Testing: 35 Points

Immediately after construction and loading, the final effluent will be tested using university laboratory equipment. The following six (6) water quality parameters will be graded using the methods below.

pH Value (Max: 8 Points)

pH Range	Points
$6.5 \leq pH \leq 7$	8
$6 \leq pH < 6.5$ or $7 < pH \leq 7.5$	7
$5.5 \leq pH < 6$ or $7.5 < pH \leq 8$	5
$5 \leq pH < 5.5$ or $8 < pH \leq 8.5$	3

pH Range	Points
4.5 ≤ pH < 5 or 8.5 < pH ≤ 9	1
All other pH ranges	0

Turbidity (Max: 8 Points)

Target: minimum NTU.

Turbidity Range	Points
NTU < 15	8
15 ≤ NTU < 50	7
50 ≤ NTU < 85	5
85 ≤ NTU < 120	3
120 ≤ NTU < 155	1
NTU ≥ 155	0

Electrical Conductivity (Max: 5 Points)

Target: minimal µS/cm. Points = (Your Rank ÷ Number of Teams) × 5. Teams are ranked from worst to best, with rank 1 being the team with the highest conductivity.

Dissolved Oxygen (Max: 5 Points)

Target: dissolved oxygen (D.O.) measured as percent saturation.

Percentage of D.O. Saturation	Points
100%	5
90% ≤ D.O. < 100%	4
80% ≤ D.O. < 90%	3
70% ≤ D.O. < 80%	2
60% ≤ D.O. < 70%	1
All other D.O. values	0

Chlorine (Max: 5 Points)

Target: a free chlorine residual between 0.2 and 2.0 mg/L, based on federal drinking-water limits (a minimum residual of 0.2 mg/L and a maximum of 4.0 mg/L). Free chlorine will be measured with a DPD colorimeter.

Free Chlorine (mg/L)	Points
0.2 – 2.0	5

Free Chlorine (mg/L)	Points
Above 2.0 – 4.0	3
Detectable but below 0.2	2
None detected, or above 4.0	0

Volume (Max: 4 Points)

Target: 9 gallons. Points = (Your effluent volume in gallons ÷ 9) × 4. A team cannot earn more than 4 points, even if its volume exceeds 9 gallons.

Design Report: 25 Points

Each team must submit a design report detailing the overall project, including: a description of the design process, treatment principles used, environmental impacts and considerations, a cost analysis, and tables displaying material and operational costs. Submit the report as a PDF to ascemidpac2027@gmail.com by **Friday, March 26 at 11:59 PM Pacific Time**. Hard copies are not required.

Formatting

- **Cover page:** school name, team name, and the competition name: "2027 ASCE Mid-Pacific Student Water Treatment Competition."
- **Table of contents:** limited to one (1) page.
- **Length:** minimum 1,000 words; page limit of ten (10) pages. The cover page, table of contents, appendices, and list of references are not counted.
- **Font and margins:** 12-point Times New Roman, single-spaced, 1" margins on all sides. Headings may be in any font, size, or color.
- **Page numbers:** body pages are numbered beginning on the table of contents page. Appendix pages are numbered with the appendix letter and page number (A1, A2, B1, B2, …). There is no limit on appendix length, but all appendix material must be relevant to the design process.
- **Paper:** 8.5" × 11". The body is portrait; appendices may be portrait or landscape.
- **Captions:** figures, tables, photographs, line drawings, and graphs need captions in normal character spacing and at least 10-point font.
- **Page count:** figures, tables, headers, and footers in the body count toward the page limit. Teams may reference figures in the appendix at any point.
- **Citations:** all work, figures, or tables not generated by the authors must be cited. A list of references does not count toward the page limit.
- **Acknowledgements:** thank anyone outside the team who helped by listing them at the bottom of the references page (not counted toward the page limit).
- One (1) point is deducted from the design report score for each format violation.

Report Content

- **Filter Design & Analysis (10):** a description of the treatment system and how it works. The design is judged on the team's approach and the industry treatment principles used. Include clear descriptions of engineering design processes, lab techniques used, and test results, including how the system disinfects the water.

- **Materials & Cost Analysis (5):** a material list with a brief justification of each material (see Appendix A for permitted materials), plus a cost analysis with both a material cost estimate and an operational cost estimate. Total cost is the sum of material, tool, and labor costs. Material cost is based on the number of units bought, regardless of how much is used (for example, a 12 oz bottle of hydrogen peroxide is charged as 12 oz even if only 5 oz is used). Points will be adjusted at the competition if the filter changes after the report is submitted.
- **Sustainability (6):** an explanation of the sustainability aspects of the treatment system, including a simplified life cycle assessment (LCA). The LCA follows the system's materials, tools, and chemicals through four stages: (1) sourcing and production (where materials come from, and whether they are new, recycled, reused, or natural); (2) transportation (how materials reach the site); (3) use (energy, water, and chemicals consumed during construction and treatment); and (4) end of life (what happens to used filter media, chemicals, and wastewater, and what can be reused, recycled, or safely disposed of). A qualitative assessment is acceptable; quantitative estimates, such as waste mass or published embodied-carbon values, are encouraged. The section should also explain the environmental impacts of the materials chosen and the decisions made to reduce cost or environmental impact.
- **Professional Quality (4):** organization, presentation, quality of writing, and effectiveness of figures, tables, and other resources.

Construction: 20 Points

Teams construct the treatment system described in their design report. This phase includes construction, chemical treatment, loading, and filtration of the influent. It is judged on construction and treatment time, cost of the treatment system, orderliness of the site, teamwork, and safety (Table 1). All points are determined by the judges.

All teams must build on a plastic tarp, which will be provided, because the wastewater may stain the ground.

Construction and Treatment Time

- Each team has thirty (30) minutes to construct its treatment system.
- The loading phase follows: ten (10) minutes to chemically treat the influent and load the system.
- A twenty (20) minute treatment period follows.
- Any disinfectants must be built into the final filtration system. Operators may not add materials after the construction period.
- Immediately after the treatment period, the collection basin is removed from the site and taken to the lab for testing.

Construction Phase Details

- Teams build in an 8' × 8' (2.4 m × 2.4 m) space marked with tape or chalk; site limits are measured to the inside of the border. Sites may not be level and are on concrete, pavement, or brick.
- Teams place all unassembled raw materials and tools in the competition area with two provided 5-gallon buckets of contaminated water and two stirring sticks. Judges compare the materials list in the design report to the materials present before construction begins.
- Teams may not pre-assemble, pre-cut, pre-mark, or tamper with materials before construction begins (decoration is encouraged). Teams provide their own markers, tape measure, measuring cups, and scales as needed; these items are not included in the cost estimate.

- Prewashed materials must be dry and in their original packaging. Loose sand, GAC, lava rocks, and pebbles may be placed in clear containers in the quantity sizes in Appendix A, or in an open burlap sack for judges to inspect. Packaging for storage is not included in the materials list or cost analysis. Materials that were not prewashed must be in original sealed packaging, as purchased.
- Construction materials must be sorted to the quantities listed in Appendix A (for example, lumber should be 4 linear feet regardless of the length purchased). Items sold in large quantities may be opened before the competition; for example, a team that needs two feet of nylon rope is not required to buy a new package for the competition.
- Battery-powered tools are permitted, except power saws and power blades. Corded power tools are not permitted. Teams provide their own tools from the approved list in Appendix B.
- Treatment systems must include a collection basin (or multiple basins) capable of holding 9 gallons of water.
- All materials, equipment, operators, and chemicals must stay within the 8’ × 8’ zone.
- Teams may use up to four (4) operators; each operator is charged for labor.
- Construction begins when the head judge says “go” and ends after 30 minutes when the head judge says “stop.” Operators must leave the 8’ × 8’ space when time is up or when they finish, whichever is earlier.

Treatment, Loading, and Phases

At the start of the loading phase, teams have ten (10) minutes to chemically treat and load the influent into their filtration systems. Prescreening of influent before the loading phase is not permitted. A stirring stick is provided. Teams then have twenty (20) minutes for the water to filter through their systems. Immediately afterward, the collection basin is removed and taken to the lab for testing.

Construction Scoring

Construction is worth 20 points (Table 1). Construction time points = (Your Rank ÷ Total Number of Teams) × 5, with rank 1 being the slowest team.

The construction score will be adjusted for any violation during construction, loading, or treatment:

Violation	Deduction
Any violation of construction limits	0.5 point per incident
Any pre-marked, pre-assembled, or pre-cut materials	1 point
Operator begins construction before the start of construction	1 point
Any material not on the materials list in the design report	1 point
Any tool used that is not permitted in Appendix B	2 points
Use of powered saws or powered blades	5 points
More than 4 operators at the start of the competition (extra students will be asked to step out)	1 point per additional student
Material or teammate crosses the site boundary during construction or treatment	1 point

Cost of Treatment System (7 points)

The lowest-cost system receives the most points. Cost includes materials, tools, and operation costs as listed in the appendices, and is based on how much material is purchased, not how much is used. Points = (Your Rank ÷ Total Number of Teams) × 7, with rank 1 being the highest-cost team.

Safety (2 points)

Safety is critical to any engineering project. Operators must wear hard hats, safety gloves, safety glasses, closed-toed shoes, and long pants at all times during construction and treatment. Anyone handling chemicals must also wear a long-sleeved shirt (or other covering for the arms) and chemical-resistant gloves (latex or nitrile). If a judge deems a practice unsafe, the judge may stop the team and review safety practices; the clock keeps running.

Never mix chemicals. Do not combine bleach with vinegar or lemon juice. Do not combine potassium permanganate with hydrogen peroxide or rubbing alcohol. Keep chemicals in separate, labeled containers.

Spill and Waste Plan

- Stop work and notify a judge immediately for any spill. The clock keeps running during cleanup.
- Teams bring paper towels or another absorbent for small spills. Do not wash chemicals or influent into storm drains.
- Used filter media, chemicals, and treated effluent must be placed in the waste containers provided by the organizers at the end of the competition.
- Teams must leave the site clean. Site orderliness is scored under Construction (2 points).

Presentation: 15 Points

Each team prepares an oral presentation on its treatment system, evaluated on technical content and delivery. Presentations are in English and take place on **Friday, April 9, from 1:00 to 4:00 PM**. Presentation order is randomly selected and posted at the Friday captains' meeting. If registration exceeds one room's capacity, additional rooms will be added.

Teams must submit the presentation as a **PowerPoint (.pptx) file** by **Friday, April 2 at 11:59 PM Pacific Time**. Google Slides presentations must be exported to .pptx. Teams present from the submitted file, and changes after the deadline are subject to the late policy.

- **Presenters:** a maximum of two (2) team members may present and answer questions. No other members may stand with the presenters.
- **Length:** five (5) to six (6) minutes. Organizers will keep time and give time cues at 5:00 and 5:30. Presentations between 5:00 and 6:00 are not penalized. Overtime deductions increase with each 15 seconds past 6:00 (up to 3 points); the presentation is stopped at 6:30, and any time past 6:00 comes out of the Q&A session. Undertime deductions increase with each 15 seconds under 5:00 (up to 6 points). Deductions are listed below.
- **Visuals:** only the PowerPoint may be used (no posters or notes). Graphs and photographs are encouraged. Video clips may not be included.
- **Technical Content (6):** at a minimum, the system design, treatment process, materials used, a cost analysis, and a discussion of sustainability, in any order.
- **Visuals (4):** clarity and effectiveness of the slides.

- **Question-and-Answer Session (5):** a 5-minute session immediately after the presentation. Only the panel judges may ask questions.

Overtime deductions

Presentation length	Deduction for interval	Total deduction	Q&A time remaining
5:00 – 6:00	0	0	5:00
6:01 – 6:15	1	1	4:45
6:16 – 6:30	2	3 (maximum)	4:30

Undertime deductions

Presentation length	Deduction for interval	Total deduction	Time under 5:00
5:00 – 6:00	0	0	None (no penalty)
4:45 – 4:59	1	1	0:01 – 0:15
4:30 – 4:44	2	3	0:16 – 0:30
Under 4:30	3	6 (maximum)	More than 0:30

Poster: 5 Points

Each team displays a poster no larger than 36" × 24" next to its construction site. Posters are in English; teams may also display a poster in another language. A PDF is due **April 2** (see Submissions and File Naming).

- **Technical Content (3):** the purpose of the competition, material list, filter cost, and an overview of the filter design.
- **Professional Quality (2):** organization, appearance, and quality of scientific writing.
- Teams must provide their own poster stands and any other display equipment.

Scoring

The competition is scored out of 100 points (Table 1). Late penalties (see Late Policy, up to 20 points per deadline) are subtracted from the final score. Deductions for presentation timing and construction violations are described in the sections above.

Table 1: Point Breakdown Summary

Category	Sub-Category	Points
Water Quality (35)	pH	8
	Turbidity	8
	Electrical Conductivity	5

Category	Sub-Category	Points
	Dissolved Oxygen	5
	Chlorine	5
	Volume	4
Design Report (25)	Filter Design & Analysis	10
	Material Cost & Analysis	5
	Sustainability	6
	Professional Quality	4
Construction (20)	Construction Time	5
	Cost of Treatment System	7
	Orderliness	2
	Overall Teamwork	4
	Safety	2
Presentation (15)	Technical Content	6
	Visuals	4
	Question & Answer Session	5
Poster (5)	Technical Content	3
	Professional Quality	2
Total		**100**

Competition Schedule and Logistics

The symposium schedule in Mailer 1 is tentative. Final times and rooms will be confirmed in Mailer 2 and on the symposium website.

Date and Time	Event
Thursday, April 8, 7:00 – 8:00 PM	All-competition captains' meeting (online, synchronous). Informational only; attendance is encouraged but not required.
Friday, April 9, 8:30 – 9:15 AM	Water Treatment captains' meeting (mandatory; captain or designee). Presentation order, site assignments, and heat assignments are posted.
Friday, April 9, 1:00 – 4:00 PM	Presentations.
Sunday, April 11, 9:30 – 10:00 AM	Check-in at the competition site: confirm the roster, set up on the assigned 8' × 8' tarp, and have judges inspect materials against the design report. Posters are displayed next to the site.

Date and Time	Event
Sunday, April 11, 10:00 AM – 2:30 PM	Construction (30 min), loading (10 min), and treatment (20 min), followed by effluent testing. Teams run at the same time, one assigned site per team. If registration exceeds the number of sites, teams are split into two heats, assigned at the Friday captains' meeting.
Sunday, April 11, 5:00 – 9:00 PM	Awards Ceremony & Banquet (results announced).

Policies

AI Use and Plagiarism

The use of generative artificial intelligence (AI) and natural language processing models (NLP), such as OpenAI's ChatGPT©, is neither encouraged nor discouraged. However, if such models are used, all instances shall be cited as work completed by the respective generative AI/NLP. Failure to cite all instances of generative AI/NLP use will be considered plagiarism.

Plagiarism of any kind will not be tolerated. Teams caught plagiarizing any portion of their submitted work will be disqualified.

Professionalism and Judging

All participants are expected to follow the professionalism and sanctions policies in Mailer 1. The judges follow the rules as published, using reasonable judgment and interpretation. The head judge is the arbiter of any dispute, which may be brought only by the team captain, and decisions of the head judge are final.

Drug and Alcohol-Free Events

The use of drugs and alcohol is prohibited at all ASCE Student Symposium events, including this competition.

Appendix A: Materials List

Each team may request one (1) additional material or tool by emailing ascemidpac2027@gmail.com by **Friday, February 19, 2027**. Accepted items become available to all teams. Requests must include the unit of measure and unit cost, which the Competition Director will verify.

All items must be in their original packaging (see the exceptions under Construction Phase Details). For example, if hardware cloth is sold in 10 square foot packages, bring the unopened package. It is charged at $6.70 in the cost analysis, regardless of the amount used.

Table 2: List of Material and Associated Cost

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	5.00
13 Gallon Trash Can	unit	13.00
20 Gallon Trash Can	unit	16.00
32 Gallon Trash Can	unit	20.00
2’ Ladder	unit	30.00
4’ Ladder	unit	44.00
6’ Ladder	unit	60.00
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	lin. ft.	1.00
2” x 6” Dimensional Lumber	lin. ft.	0.75
4” x 4” Dimensional Lumber	lin. ft.	1.50
3/4” Black Electrical Tape	lin. ft.	0.06
3/4” Thick Plywood	sq. ft.	4.00
3/8” Thick Plywood	sq. ft.	1.50
3/8” Nylon Rope	lin. ft.	0.71
30 Gallon Tote	unit	12.00
36 Gallon Garbage Bag	unit	0.60
5 Gallon Bucket	unit	4.00
5 Gallon Bucket Lid	unit	1.50
5/8” Carpet Pad	sq. ft.	0.50

Item	Unit	Cost ($/unit)
8” x 6” x 2” Grout Sponge	unit	2.00
Alum (McCormick)	oz.	2.00
Alum (Innovative Science, Eisen-Golden Laboratories, or Alpha Chemicals)	oz.	2.00
Alum (CCS Consolidated Chemical & Solvents)	oz.	2.00
Aqueon Water Clarifier	fl. oz.	2.50
All Purpose Gravel (Quikrete)	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 Landscape Fabric	sq. ft.	0.75
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
Coarse Compost	gallon	3.00
CoCo Liner, 18”	unit	8.00
Coconut Coir Brick	oz.	0.45
Coffee Filter (Basket) 8/12 Cups (100%)	unit	0.01
Cotton Fabric (Broadcloth)	sq. yard	3.00
Commercial Grade Fine Sand	lb.	0.15
Commercial Grade Sand	lb.	0.10
Cotton Balls	50 units	0.50
Diatomaceous Earth	lb.	2.50

Item	Unit	Cost ($/unit)
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.	12.50
Lemon Juice	5 fl. oz.	0.75
8 oz. Mason Jar	unit	1.50
Masking Tape	yard	0.20
Mylar Emergency Sleeping Blanket	unit	3.00
Milk of Magnesia	oz.	0.65
6.5 Gallon Milk Crate	unit	6.50
Paint Tray	tray	2.00
Packing Tape	yard	0.25
Powdered Activated Carbon	oz.	0.50
Powdered Chalk	oz.	0.50
Pebbles, Large	5 lb.	2.50
Pebbles, Pond/Landscape	0.5 cu. ft.	5.00
Pickling Lime	oz.	0.40
Plaster of Paris	lb.	1.50
Plastic Tarp	sq. ft.	0.20
Play Sand	lb.	0.15
Plumbing Epoxy Putty	putty	2.50
OxiClean Stain Remover Powder	lb.	3.50
Potassium Permanganate	5 oz.	5.00
ABS Pipe, 1-1/2” Diameter	5 lin. ft.	5.50
ABS Pipe, 2” Diameter	5 lin. ft.	10.00
Copper Pipe, 1/2” Diameter	5 lin. ft.	12.00
Copper Pipe, 1” Diameter	5 lin. ft.	15.00

Item	Unit	Cost ($/unit)
Corrugated Pipe, 3” Diameter	5 lin. ft.	4.50
Corrugated Pipe, 4” Diameter	5 lin. ft.	8.00
PVC Pipe, 1” Diameter	5 lin. ft.	2.00
PVC Pipe, 1-1/2” Diameter	5 lin. ft.	4.75
PVC Pipe, 2” Diameter	5 lin. ft.	7.00
Pool Sand Filter	lb.	0.40
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	11.00
Scotch Tape	yard	0.25
Terrycloth Rag	lb.	3.50
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.	4.50
Turtle Wax Hard Shell Paste Wax	fl. oz.	0.50
Weed Control Barrier/Landscape Fabric	sq. ft.	0.40
Window Screen Mesh	1 sq. ft.	0.50
Wood Mulch	cu. ft.	5.00
Vanity Fair Everyday Napkins	10 napkins	0.30
21–31 in x 18 in Adjustable Window Screen	screen	9.00

Item	Unit	Cost ($/unit)
Ferric Chloride	oz. or fl. oz.	0.20
Bon Tool 5 Gal. Paint Strainer	strainer	3.50
Scott Shop Towels 11” x 40” Original (55 sheets)	roll	4.50

Appendix B: Tools and Operational Costs

Teams must provide their own markers, tape measure, measuring cups, and scales as needed. Items used for measuring or marking are not included in the cost estimate.

Table 3: Breakdown of Tools and Operational Costs

Item	Cost ($/unit)
Operator	30.00
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.

Miracle-Gro Potting Mix



Great Value Plain Bread Crumbs



ULTHMOK Hibiscus Tea



Carnation Evaporated Milk



Activia Vanilla Yogurt

