Environmental Competition

Environmental Competition

Pacific Southwest Conference 2019

1. **Objective**

   The PSWC Environmental Competition is an undergraduate project that gives students with civil and environmental engineering and related majors a chance to gain hands-on experience. With research, design, and lab testing surrounding water treatment principles, students gain invaluable opportunities to develop and refine professional skills such as technical writing and presenting. Teams from 18 schools in the Pacific Southwest Region participate in this competition to design a filter to treat typical winery pond wastewater effluent to allow for reuse as irrigation water.

   This project is judged based on (1) system construction and performance, (2) a design report, and (3) an oral presentation. Students are encouraged to work closely with university faculty and local engineering professionals to create a practical and innovative method of addressing the problem stated.

2. **Participant Rules**

- Each university may enter only one team.
- Each team must be comprised of 4 members who construct and operate the treatment system. Each team may have one additional member who acts as a Project Manager and may oversee and direct construction and operation but may not physically participate.
- The team must have at least one underclassman.
- The team must have at least one male and at least one female.
- Everyone on the team must be a registered participant of PSWC 2019.

3. **Event Description**

   You and your team of environmental engineers work for a prestigious engineering consulting firm in San Luis Obispo, CA. Your client for this project is a nearby winery and artisan olive oil producer. They currently treat their wastewater via an anaerobic pond system. However, due to ongoing drought conditions and declining water table levels in their area, they would like to reuse this water instead of simply discharging it after treatment. They have asked you to design a polishing treatment system to improve the quality of their treatment pond effluent to the quality necessary for reuse in their vineyard drip irrigation system.

   Your team must devise and construct a polishing treatment system that will remove contaminants and bring the water up to reuse standards. To meet demand during heavy irrigation periods, your system must be able to filter a minimum of 5 gallons in a 30 minute period.

Each team will be judged on four considerations: treatment system construction and scale-up cost (20 points); system performance at achieving the desired water quality goals (40 points); technical design report (25 points); interview (15 points). Details for judging and point assignments are described below.

4. Inlet Water Constituents

Two 5-gallon buckets, 10 gallons total, will be prepared for each team. All constituents will be added and stirred with a wooden stir stick 24 hours prior to the start of the competition, then stirred again 5 minutes before the filter loading phase.

Per 5-gallon bucket:

- Top Soil - 300 g
- Olive Oil - ½ cup
- Distilled White Vinegar - 1 cup
- Iodized Salt - 50 g
- Ferrous Sulfate Granules - 100 mg

5. System Performance Testing

System performance measures include quality of treated product and rate of treatment. Immediately after completion of treatment, a bulk sample (1 L) of the final effluent water will be taken for analysis of the following constituents. The following eight (8) system performance measures will be scored based on the methods described below. The system performance section is worth 40/100 points.

Dissolved Oxygen
Target: 100% saturation DO
Scoring:
100% DO saturation will result in 5 points
90% ≤ DO < 100% or 100% < DO ≤ 110% will result in 4 points
80% ≤ DO < 90% or 110% < DO ≤ 120% will result in 3 points
70% ≤ DO < 80% or 120% < DO ≤ 130% will result in 2 points
60% ≤ DO < 70% or 130% < DO ≤ 140% will result in 1 point
All other DO saturation values outside of these ranges will result in 0 points.
Analytical Methods/Materials: Dissolved Oxygen meter, Hach Method 10360

pH Value
Target: Between 6.50 and 7.50
Grading:

6.50 ≤ pH ≤ 7.50 will result in 5 points
6.00 ≤ pH < 6.50 or 7.50 < pH ≤ 8.00 will result in 4 points
5.50 ≤ pH < 6.00 or 8.00 < pH ≤ 8.50 will result in 3 points
5.00 ≤ pH < 5.50 or 8.50 < pH ≤ 9.00 will result in 2 points
4.50 ≤ pH < 5.00 or 9.00 < pH ≤ 9.50 will result in 1 point
All other pH values outside of these ranges will result in 0 points.
Analytical Methods/Materials: pH Electrode, Hach Method 8156 (EPA Method)

Turbidity/Total Suspended Solids
Target: Minimum NTU (Nephelometric Turbidity Unit)
Grading: (Your rank / best team's rank) * 5 points
Analytical Methods/Materials: Portable Turbidimeter, Hach handbook PDF

Total Dissolved Solids
Target: Minimal μS/cm
Grading: (Your rank / best team's rank) * 5 points
Analytical Methods/Materials: Conductivity/TDS meter, Hach Method 8160 (EPA Compliant)

Total Organic Carbon
Target: Minimal mg/L C
Grading: (Your rank / best team's rank) * 5 points
Analytical Methods/Materials: DR3800 Laboratory VIS Spectrophotometer, TNTplus 810, Hach Method 10267

Iron
Target: Minimal mg/L Fe
Grading: (Your rank / best team's rank) * 5 points
Analytical Methods/Materials: DR3800 Laboratory VIS Spectrophotometer, TNTplus 858, Hach Method 10229 (EPA Compliant)

Water Color
Target: Clear
Grading: (Your rank / best team's rank) * 5 points
Analytical Methods/Materials: *TBD*

Rate of Treatment
Target: 5 gallons in 30 minutes of treatment time
Grading: (Your effluent volume (gal) / Your treatment time) * (Fastest team's time / 5 gallons) * 5 points

Please note that there is a maximum of 5 points allotted for treatment rate.
Analytical Methods/Materials: We will provide the 5-gallon catch basin and overflow containment, as well as a judge in charge of timing.

6. **Design Report**

Each team is required to submit a technical design report detailing the overall project goals and the team's design. The report must include a description of the design process, treatment principles utilized, environmental impacts, and a cost analysis. The design report is worth 25 points.

Please submit an electronic version of your report (in PDF format) via email to *pswc2019@gmail.com* with the subject line "Environmental Competition Design Report – [YOUR SCHOOL NAME]" by no later than 11:59 PM on March 15, 2019. A hard copy submission is not required.

Formatting

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

- **Report Cover Page:** Must contain school name, team name, and competition name: "2019 ASCE PSWC 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 eight (8) pages, not including cover page and table of contents.
  - Specific content requirements for the Body of Work are presented below.
- **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.
- **List of References:**
  - In-text citations should be used as appropriate throughout the Body of Work. A list of references or works cited should be included (if necessary) and will not count towards the report page limit.
  - Any advisors on the project shall be recognized either in the List of References or in an Acknowledgements section.
- **Formatting & Miscellaneous:**
  - Photographs, tables, line drawings, graphs, headers, and footers counted as part of the page limits defined above.
  - Use 12-point font, single spaced, and 1-inch margins on all sides.
  - Apart from headings, Times New Roman or Arial font must be used, and the text shall have normal width character spacing.

- 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.
- The main report shall be presented on 8½" x 11" pages with portrait orientation. Appendices shall also be presented on 8½" x 11" pages; however, appendices may include landscape-orientated pages for figures, tables, etc. if desired.

Body of Work Content

The design report must include the following content. The point distribution for grading of each section is denoted in parenthesis.

- **Project Introduction and Goals (5):** The design report must include a brief discussion of the background of the project and the client's goals. A simple process flow diagram describing the proposed treatment and reuse system is recommended.
- **Filter Discussion (10):** The body of the design report shall contain an overview of the filter and how it works. The filter design will be judged based on the approach each team used to solve the problem as well as the treatment principles implemented in the design process. This section must include clear descriptions of preliminary test results, engineering design processes, and the filter's success in achieving the water quality requirements. This section should also include a detailed schematic or diagram of your design, explaining design and intended operation. Finally, this section should include discussion of potential for scale-up for full operation at the winery.
- **Cost Analysis (4):** The design report must include a discussion of capital cost of the system. Your cost analysis should include two values: (1) the total cost to construct the demonstration treatment unit, with any reused, free, or donated items noted. (2) An estimated scale up cost to treat the pond effluent (filter influent) at a rate of 750 gallons per hour, assuming all materials must be purchased at typical commercial values. Unit costs and sources for those costs should be noted. This section should include discussion of design decisions made to minimize both capital and operation & maintenance (O&M) costs. Note that a detailed O&M cost estimate is not required, but potential for O&M savings may be of value to your client.
- **Environmental Impact (4):** The design report must include an explanation of the potential environmental impacts of your treatment system. This section should include the environmental impacts of materials used to design your filter and decisions made regarding choices to minimize environmental impacts.
- **Professional Quality (2):** Professional quality of the design report will be based on organization, appearance, use of language, and correct use of citations.

7. Construction and Loading

Team will construct their filter design as shown on their technical report. This phase will include construction, filter loading, and transportation of effluent to the testing lab. This section is worth 20 total points, and will be judged based on construction time, cost of treatments system, orderliness of construction site, and overall teamwork – see scoring and deduction methods described below as well as the breakdown of competition scoring on page 7 for the point distribution.

Site Constraints

The teams will be given a 10' x 10' area to construct their filters defined by lines on the floor. The site limits will be measured from the inside of the boundary marker. Neither materials nor participants may exceed the boundaries of the area. All sites will be located on level concrete or another hard surface. Teams will be scored on their utilization of the space, the orderliness of the site during construction, and the operators' safety and overall teamwork.

Time Constraints

Teams will be timed on the construction of their filters. Each team will be limited to a total of thirty (30) minutes in which to construct the treatment systems. The treatment phase will follow and includes ten (10) minutes for teams to load their systems and a twenty (20) minute treatment period. The collection basin will be removed by the judges from the treatment system immediately after 5 gallons have been treated; there will be a secondary collection basin provided for excess effluent.

Construction Site Details

- Teams will be given a maximum of 30 minutes for the construction of the system.
- Teams will construct their systems in a 10' x 10' space marked with tape.
- Teams will place all their unassembled raw materials and tools in the competition area.
- Teams shall not pre-mark, pre-assemble, or pre-drill materials prior to beginning of the construction. Teams are allowed to pre-cut materials (such as wood planks or pipes) and prep their filter materials (such as rinsing). In order to mark any materials, teams must provide their own markers, tape, measure, measuring cups, and scales, on an as-needed basis.
- Powered saws or power blades are not permitted. Corded power tools of any kind are not permitted. Only battery-powered tools are allowed.
- Teams must provide their own tools.
- The Project Manager may help with communication or instruction during the construction phase, but they are not allowed within the space. They are also allowed to keep time for their team and update them with progress.

- Teams may use up to 4 operators to construct their system. Construction time will start once the judge says "ready," which will start the clock. Construction time will end once the judge says "stop," which will stop the clock. If the team finishes construction before the 30 minutes of allotted time, the team must step out of the construction space and the judge will stop the clock and record the early time.
- If a member of the construction team steps outside of the 10' x 10' space, they may not re-enter. If a material or tool leaves the space, it is unusable and irretrievable.
- Once the judge says "stop," teams may not re-enter the construction region until the filter loading phase.
- Treatment systems must be designed to allow for a Home Depot-sized, 5-gallon bucket to fit below the filter. Judges will be extracting the bucket once 5 gallons are achieved, so the design must allow for easy and seamless extraction of the collection bucket.

Treatment Phase

At a designated start time, the 10-minute loading period will begin, in which only 2 operators from each team may add any treatment chemicals to their effluent. A wooden stirring stick will be provided. Operators must be outside of their construction site before the end of the 10-minute loading period. Teams will then have 20 minutes for the treatment system to work. The collection basin must be removed from the treatment system immediately following the 30-minute treatment phase or if 5 gallons is obtained before the 30-minute mark.

Scoring and Deductions:

The Construction category is worth 20 points out of the 100 total points in the competition. Construction points will be based on the construction time remaining (12 points), the scale-up cost of the treatment system (4 points), the orderliness of their site during construction (2 points), and the team's overall teamwork (2 points). The orderliness of their site during the construction phase, and the operators' overall teamwork will be determined based on the judge's discretion.

Points for construction time will be awarded as such: (Your rank / best team's rank) * 12 points

Deductions that affect the overall "Construction" subcategory score.

- Any violation of construction limits will result in a 1 point deduction (i.e. each time an operator or a construction material goes outside the 10' x 10' boundary during the construction phase, 1 point will be deducted).
- Any pre-marked, pre-assembled, or pre-drilled materials will result in a 1 point deduction. Teams that have pre-cut materials or prepped their filter materials will not be deducted points.
- 1 point deduction for any time an operator begins construction prior to the judge starting the stopwatch.

- Usage of powered saws or powered blades will result in a 5 point deduction.
- Teams using more than 4 operators will be asked to dismiss the extra operators; ignorance of this request will result in the team's disqualification. Project Managers are separate from operators and can verbally participate as long as they are outside the construction space.
- 1 point will be deducted from the team's construction score for every time a worker or material touches or enters the site boundary during the treatment phase. Additionally, that worker or material will be disqualified from participating in the further construction of the filter.

Note: It is not possible to lose more than 15 points**. Clear violation of ethical practices, based on the judge's discretion, will result in disqualification of the team.**

Cost of Treatment System

The scale-up cost of the treatment system is worth 4 points. The lowest cost treatment system will receive the most points. Note that the points awarded for the cost section in the report are based on quality of the cost discussion. The points described in this section are based on the estimated scale-up cost itself.

Points will be awarded based on the following equation: (your rank / best team's rank) * 4 points

Safety

Safety is a vital part of this competition. Operators **must** wear hard hats, appropriate safety gloves, safety glasses, close-toed shoes, and long pants at all times during the construction and treatment phases. Long hair must be safely secured during construction and operation. If at any point the judge deems safety is being violated by a team, the team's construction will come to a halt and the judge will advise the team on best safety practices, while the stopwatch continues running. Any person handling chemicals must be wearing a long-sleeved shirt or other article of clothing to cover arms.

8. On-Site Interview

Once the 20-minute treatment period begins, the judge(s) will interview each team's Project Manager regarding design, operation, and potential scale-up of their treatment system, as if they were the client or winery manager. Project Managers may involve members of the construction team during the interview with no point deduction. Team members should be prepared to discuss any of the items required in the design report. Interviews will be judged based on:

- **Technical Knowledge (10)**
- **Confidence & Professionalism (5)**

9. Scoring

Category	Sub- Category	Points
System Performance	Dissolved Oxygen	5
	pH	5
	Turbidity	5
	Total Dissolved Solids	5
	Total Organic Carbon	5
	Iron	5
	Color	5
	Rate of Treatment	5
	Subtotal	**/40**
Design Report	Introduction & Goals	5
	Filter Design and Analysis	10
	Cost Analysis	4
	Environmental Impacts	4
	Professional Quality	2
	Subtotal	**/25**
Interview	Technical Knowledge	10
	Confidence & Professionalism	5
	Subtotal	**/15**

Construction	Construction Time	12
	Cost of Treatment System	4
	Orderliness of Construction Site	2
	Overall Teamwork	2
	Subtotal	**/20**
Total		**/100**