

# UPDATES - WATER TREATMENT COMPETITION

**Presentation Date:** Thursday, April 19, 2018

**Construction/ Treatment Date:** Saturday, April 21, 2018

**Contact:**

Any submissions and questions may be sent to:

Kourtnie Sicam

[2018midpacwatertreatment@gmail.com](mailto:2018midpacwatertreatment@gmail.com)

## UPDATES:

Any updates or RFIs after the release of Mailer 2 will be posted on the website; it is the responsibility of the teams to check the website regularly for any updates.

## Presentation and Construction/Treatment

The presentation order and construction/treatment phase heats will be decided using a random number generator and listed in Mailer III.

## Additional Information for Influent Constituents

Images of the constituents are below:



## Updated Cost Analysis

The cost of the construction and treatment materials must be calculated using the exact amount of material used. For example, if 10 square feet of hardware cloth is used for the construction/ treatment phase then \$6.70 must be added in the cost analysis.

Note: During the construction/ treatment phase the materials must be in original packaging.

## Appendix A: Updated 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 2018midpacwatertreatment@gmail.com by **January 28, 2018**. 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. The list of newly accepted materials will be emailed to each school by **January 30, 2018**; accepted materials will also be posted on the website.

\*Updated materials are highlighted in the list below

**Table 2: List of Eligible Materials and their Associated Costs**

Number	Item	Unit	Cost (\$/unit)
1	1/2" Hardware Cloth	/sq. ft.	0.67
2	1/2" I.D. Soaker Hose	/lin. ft.	0.36
3	1/4" Hardware Cloth	/sq. ft.	0.53
4	1" High Pressure Washer Hose	/lin. ft.	2.50
5	4 Gallon Trash Can	/unit	2.50
6	13 Gallon Trash Can	/unit	5.00
7	20 Gallon Trash Can	/unit	8.00
8	16 Qt. Igloo Can Cooler	/unit	23.00
9	2' Ladder	/unit	30.00
10	2" Adjustable Spring Clamp	/unit	6.00
11	2" PVC Pipe Elbow	/unit	3.00
12	2"x4" 3M Steel Wool	/unit	0.83
13	2"x4" Dimensional Lumber	/4 lin. ft.	1.70

14	2"x6" Dimensional Lumber	/4 lin. ft.	2.44
15	3/4" Black Electrical Tape	/lin. ft.	0.06
16	3/4" Thick Plywood	/4 sq. ft.	1.06
17	3/8" Nylon Roper	/lin. ft.	0.20
18	3/8" Thick Plywood	/4 sq. ft.	2.00
19	30 Gallon Tote	/unit	12.00
20	32 Gallon Trash Can	/unit	13.00
21	36 Gallon Garbage Bag	/unit	0.63
22	3M Compressed Air Dust Remover	/unit	4.67
23	4' Ladder	/unit	40.00
24	4" x 4" Dimensional Lumber	/4 lin. ft.	3.00
25	5 Gallon Bucket	/unit	2.50
26	5 Gallon Bucket Lid	/unit	2.50
27	5/8" Carpet Pad	/sq. ft	0.44
28	5/8" I.D. Garden Hose	/lin. ft.	0.66
29	6' Ladder	/unit	60.00
30	8" x 6" x 2" Grout Sponge	/unit	2.00
31	Alum (McCormick)	/oz.	1.60
32	All-Purpose Gravel (Quikrete)	/50 lb.	8.00
33	Aqueon Water Clarifier	/oz.	1.00
34	Vinegar	/1 cups	0.99
35	Astroturf	/sq. ft.	4.00
36	Baking Soda	/oz.	0.10
37	Bolts	/units	0.05
38	Bounce Dryer Sheets	/20 units	5.00
39	Brawny Paper Towels	/roll	3.00
40	Burlap	/sq. ft.	0.14

41	Canvas Drop Cloth	/sq. ft.	0.25
42	Charcoal	/lb.	0.50
43	Clorox Bleach, concentrated	/5 cups	1.17
44	Clorox Disinfecting Wipes	/15 units	1.50
45	Coarse Compost	/gallon	3.00
46	CoCo Liner, 18"	/unit	4.00
47	Coffee Filter	/unit	0.03
48	Commercial Grade Fine Sand	/lb.	0.16
49	Commercial Grade Sand	/lb.	0.12
50	Cotton Ball	/20 units	0.40
51	Diatomaceous Earth	/1 lb. bag	5.00
52	Duct Tape 20 yd. Roll	/unit	10.00
53	Fiber Twine	/ft.	0.01
54	Gelatin (Knox Unflavored)	/4 oz.	2.00
55	Granular Activated Carbon	/oz.	0.40
56	Gutter Insert Foam, 3'	/unit	8.00
57	Gypsum	/lb.	0.23
58	Hydrogen Peroxide	/3 cups	1.49
59	50 Qt. Igloo Cooler	/unit	70.00
60	94 Qt. Igloo Cooler	/unit	90.00
61	Lava Rock	/cu. ft.	6.00
62	Lemon Juice	5 fl. oz.	1.00
63	Mylar Emergency Sleeping Blanket	/unit	3.00
64	Nail	/unit	0.05
65	Nut	/unit	0.05
66	OxiClean Stain Remover	/lb.	1.20
67	Paint Tray	/tray	2.00

68	Peat Moss	/cu. ft.	6.50
69	Pebbles, Large	/5 lb.	2.50
70	Pebbles, Pond/Landscape	/.5 cu. ft.	4.99
71	Pickling Lime	/oz.	0.20
72	Plant Protector Bags	/bag	5.00
73	Plaster of Paris	/lb.	0.70
74	Plastic Tarp	/sq. ft.	0.20
75	Play Sand	/lb.	0.10
76	Plumbing Epoxy Putty	/putty	3.49
77	Loudwolf Potassium Permanganate	/6 oz.	12.00
78	ABS Pipe, 1-1/2" Diameter	/5 lin. ft.	3.50
79	ABS Pipe, 2" Diameter	/5 lin. ft.	9.00
80	Copper Pipe, 1/2" Diameter	/5 lin. ft.	6.00
81	Copper Pipe, 1" Diameter	/5 lin. ft.	16.00
82	Corrugated Pipe, 3" Diameter	/5 lin. ft.	2.50
83	Corrugated Pipe, 4" Diameter	/5 lin. ft.	3.00
84	PVC Pipe, 1" Diameter	/5 lin. ft.	1.00
85	PVC Pipe, 1-1/2" Diameter	/5 lin. ft.	1.50
86	PVC Pipe, 2" Diameter	/5 lin. ft.	2.00
87	Pool Filter Sand	/lb.	0.30
88	Pumice Stone (1 CF)	/cu. ft.	11.99
89	Rubbing Alcohol	/3 cups	1.49
90	Salt (Morton Iodized Table Salt)	/26 oz.	1.00
91	Screw	/unit	0.05
92	Sham-Wow	/sq. ft.	5.00
93	Stainless Steel Safety Wire	/lin. ft.	0.25
94	Standard Air Conditioner Filter	/unit	10.00

95	Terrycloth Rags	lb.	5.00
96	Tote, 5 Gallon	/unit	8.00
97	Tote Lid, 5 Gallon	/unit	1.00
98	Tote, 10 Gallon	/unit	10.00
99	Tote Lid, 10 Gallon	/unit	1.00
100	Tote, 13 Gallon	/unit	18.00
101	Tote Lid, 13 Gallon	/unit	1.00
102	Tote, 18.5 Gallon	/unit	20.00
103	Tote Lid, 18.5 Gallon	/unit	1.00
104	TSP/90	/lb.	3.00
105	Turtle Wax Hard Shell Paste Wax	/fl. oz.	0.55
106	Weed Control Fabric	/sq. ft.	0.11
107	Window Screen Mesh	/3 sq. ft.	1.00
108	Window Squeegee	/unit	6.00
109	Wood Mulch	/cu. ft.	6.00

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# ASCE 2018 MID-PACIFIC 18 STUDENT CONFERENCE



**MAILER I**

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## **WATER TREATMENT COMPETITION**

**Competition Date:** Thursday, April 19, 2018

Saturday, April 21, 2018

**Competition Location:** Sacramento State Campus

### **Summary:**

The ASCE Mid-Pac Student Water Treatment Competition includes the research, design, presentation, and hands-on construction of a treatment filter made of supplies found in a hardware store. The filter is loaded with a standardized simulated wastewater to test and rank the participants.

The competition allows civil and environmental engineering students to apply principles of water and wastewater treatment to develop design alternatives in a collaborative and empirical manner. It provides students an opportunity to develop leadership and project management skills and to increase awareness of technologies and opportunities in the water/wastewater fields by way of engaging with other students, faculty, and industry professionals on a practical design project.

### **Contact:**

Any questions regarding the Water Treatment Competition may be sent to:

Kournie Sicam

[2018midpacwatertreatment@gmail.com](mailto:2018midpacwatertreatment@gmail.com)



## IMPORTANT DEADLINES

- Registration – See Deadline Information
- Questions and Materials Requests – E-mailed by Sunday, January 28, 2018
- Design Report – Submitted electronically (in PDF format) by 11:59 p.m. (Pacific Time) Saturday, March 17, 2018
- Presentation – Submitted electronically by 11:59 p.m. (Pacific Time) April 15, 2018

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

## SCENARIO

You and a group of fellow civil engineers take a vacation to the Pacific Islands. Unfortunately, you are unaware that it is the wet season and a tropical storm crashes through the islands ruining your tropical getaway. Now you're left with no power or a clean source of water.

Being very proactive, you lead your group to the highest point on the island to avoid flooded streets and contaminated water. You find an old, damaged water tank with debris in it from the storm and treat it with Bleach to kill any disease causing pathogens. Fortunately, you have taken a few water resources and environmental engineering classes and can lead the survivors in designing and building a water treatment filtration system to supply potable water for drinking and bathing. May the odds be ever in your favor.

## 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 the construction/treatment.

### Per 5-gallon bucket:

- 4.5 Gallons of Water
- 1 - 6.0 oz. can of Dole 100% Pineapple Juice
- ¼ cup (50.0 g) Kool-Aid Tropical Punch Drink Mix (Powder)
- 1-4.0 oz. container of Activia Yogurt, vanilla flavor
- ¼ cup (55.9 g) Aztec Secret Indian Healing Clay
- 1 lb. African Violet Potting Mix

## 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	pH	10
	Turbidity	10
	Electrical Conductivity	2
	Dissolved Oxygen	5
	Volume	8
	<b>Subtotal</b>	<b>/35</b>
Design Report	Filter Design & Analysis	15
	Materials /Cost Analysis	3
	Sustainability	3
	Professional Quality	4
	<b>Subtotal</b>	<b>/25</b>
Construction	Construction Time	8
	Cost of Materials	12
	Orderliness of Construction Site	2
	Originality of Design	1
	Overall Teamwork	2
	<b>Subtotal</b>	<b>/25</b>
Oral Presentation	Technical Content	5
	Visuals	2
	Oral Presentation	4
	Q&A Session	4
	<b>Subtotal</b>	<b>/15</b>
<b>Total</b>		<b>/100</b>

## 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

pH Range	Points Allocated
$7 \leq \text{pH} \leq 7.5$	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<sup>2</sup>

**Target:** Minimal NTU

**Grading:** (Your rank / number of teams) \* 10 points

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

### Electrical Conductivity

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

**Grading:** (Your rank / number of teams) \* 2 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

DO Range	Points Allocated
100% DO	5
$90\% \leq \text{DO} < 100\%$	4
$80\% \leq \text{DO} < 90\%$	3
$70\% \leq \text{DO} < 80\%$	2

60% ≤ DO < 70%	1
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

**Target:** 9 gallons

**Grading:** (Your effluent volume (gal) / 9 gallons) \* 8 points

*Note: There is a maximum of 8 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 8 points.*

## DESIGN REPORT

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 2018midpacwatertreatment@gmail.com by no later than 11:59 PM Pacific Time on March 17, 2018. 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: “2018 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 1,000 words
  - May not exceed eight (8) pages. Cover page, table of contents, and appendices are not included in the page count.
  - Use 12-point Times New Roman or Arial 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
  - All work, figures, or tables not generated by the authors must be cited.
  - A list of references or works cited should be included (if used). This list will not be counted as part of the report page limit.
  - 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 8-1/2" x 11" pages using portrait or landscape orientation, as appropriate.
- **Miscellaneous:**
  - Photographs, tables, line drawings, graphs, headers, and footers are permitted and shall be counted as part of the page limits defined above.

One (1) point will be deducted from the team's 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.

- **Treatment System Discussion:** 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 and Cost Analysis:** The design report must include a material list with a brief explanation and justification of each material selected. See Appendix A for 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 lowest cost estimate.
- **Sustainability:** The design report must include an explanation of the sustainability aspects of the treatment system. This section may 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 AND TREATMENT

Teams will construct their treatment system as described in the project report. This will include construction, chemical treatment, loading, and filtration. Construction and treatment is worth 25 total points and will be judged based on orderliness of construction site, construction and treatment time, cost of the treatment system, originality of design, and overall teamwork – see scoring and deduction methods presented below and in Table 1 for point distribution.

## Construction and Treatment Time

Construction and Treatment time will include:

- Construction
- Chemical measuring and mixing (if used)
- Loading
- Filtration

Teams may choose to allocate their time to these components as they see fit.

## Construction Details

Teams will each be given a 10' x 13' area, which will be marked on the floor as shown in Figure 1. The site limits will be measured from the inside of the boundary marker. All sites will be located on level concrete or pavement or other hard surface.

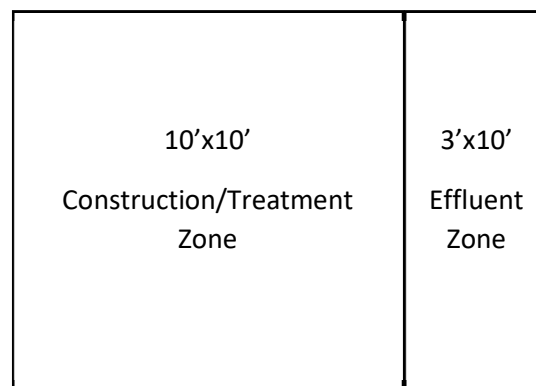


Figure 1. Construction area breakdown

- Operators must stay within the 10'x13' area. All construction materials, equipment, chemicals must stay within the 10'x10' construction/treatment zone. Only the effluent basin and treated water may enter the effluent zone.
- Construction/treatment time will start once the head judge says "go" at which each judge will start the clock. Construction/treatment time will end after operators move the effluent basin to the effluent zone, and once all operators leave the 10' x 13' space and say "time." No further water or chemicals can be added to the basin once the basin is moved to the effluent zone.
- Once an operator leaves the 10'x13' area, they may not re-enter the area.
- Teams will place all their unassembled raw materials and tools in their designated 10'x10' construction/treatment zone along with two provided 5-gallon buckets of contaminated water and two provided stirring sticks. Prior to beginning the construction phase, judges will compare the provided materials list in the team's technical report to the materials present at the competition.
- Teams shall not pre-assemble, pre-cut, pre-label, or tamper with materials prior to beginning of

the construction, although decorations are encouraged. 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.

- All prewashed materials must be dried and must be placed in their original packaging with the exception of loose sand, GAC, pebbles, and lava rocks which can be placed in clear containers based on the predetermined quantity sizes in Appendix A. (The original containers and/or bags should accompany these items.) A burlap sack may be used instead of a clear container but should be opened for judges' inspection. Packaging shall not be added to 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.
- With the exception of materials delivered in their original packaging, all materials shall be delivered to the construction area in unit quantities that match the unit quantities provided in the Competition Rules. For example, 2" x 4" lumber is specified in 4 ft lengths in the Materials List (see Appendices). Therefore, 2" x 4" lumber placed in the competition area shall be in 4 ft sections, regardless of the initial length of purchase. Play sand is specified in a per pound basis. Therefore, if used, play sand must either be in the original packaging, or if washed, then must be delivered in 1-lb. quantities.
- Power saws or power blades are not permitted.
- Battery-powered tools are permitted, with the exception of the items listed in the above detail. Corded power tools are not permitted.
- Teams must provide their own tools based on the approved list given in the Competition Rules, Appendix B.
- There are no limits to the number of operators.
- Construction/treatment time may not exceed 40 mins.
- To avoid damage to floor materials, each team must provide a back-up basin to collect any effluent discharged after the end of the treatment system. The back-up basin will not be included in the cost of the system. Any effluent collected after the effluent basin is moved to the effluent zone will not be included in volume or water quality testing.

## Scoring

The Construction category is worth 25 points out of the 100 total points in the competition and the point allocations are shown in Table 1. The orderliness of the site during the construction phase, the operators' overall teamwork, and the originality of the design will be determined based on the judge's discretion.

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

Construction/Treatment Time (minutes)	Points Allocated
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Construction/Treatment Time $\leq 20$	8
$20 < \text{Construction/Treatment Time} \leq 22.5$	7
$22.5 < \text{Construction/Treatment Time} \leq 25$	6
$25 < \text{Construction/Treatment Time} \leq 27.5$	5
$27.5 < \text{Construction/Treatment Time} \leq 30$	4
$30 < \text{Construction/Treatment Time} \leq 32.5$	3
$32.5 < \text{Construction/Treatment Time} \leq 35$	2
$35 < \text{Construction/Treatment Time} \leq 37.5$	1
$37.5 < \text{Construction/Treatment Time} \leq 40$	0

The team with the fastest construction/treatment time will be awarded one additional point.

Any necessary point deductions shall be determined by judges, and be made as follows:

Violation	Points Deducted
Operator outside 10'x13' construction area	1
Material, tools, chemicals (besides effluent basin) outside construction/treatment zone	1
Any pre-assembled, pre-cut, or tampered materials	10
Operator begins constructing prior to the judge starting the stopwatch	5
Operator or material touches or enters the site boundary after time has started	3

- Any materials present in the team's construction site but not located in the team's design report will result in the removal of the material(s).
- Any materials or tools used that are not present in Competition Rules, Appendix A or B, will result in the removal of the material(s).
- Any tampering of another team's materials or operators will result in an automatic disqualification of the team.

Note: Clear violation of ethical practices, based on judge's discretion, will result in disqualification of the team.

### Cost of Treatment System

The cost of the treatment system is worth 12 points. The lowest cost treatment system will receive 12 points. The cost of the treatment system includes the cost of materials, tools and labor (\$30/operator, regardless of construction time) used for construction as listed in the Appendices. Trash or recycling receptacles do not need to be included in the cost of the treatment system. Points will be awarded based on the following equation:



(Your rank / number of teams)\*12 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 is being violated by a team, the judge may stop the team from proceeding and will review safety practices. The stopwatch measuring the team's construction time will continue running during this time.

### **ORAL PRESENTATION**

Each team shall make an oral presentation on their treatment system. Presentations will be evaluated on the 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. A maximum of two team members may make the presentation. Only members of the presenters' school shall be allowed to attend the presentation of that school.

Teams are required to use PowerPoint to present their projects. Please submit your team's PowerPoint presentation via email to 2018midpacwatertreatment@gmail.com by 11:59 PM (Pacific Standard Time) on April 15, 2018. If a team chooses to make changes to the PowerPoint presentation after the deadline, they are allowed to do so, if changes are submitted no later than 24 hours before the presentation date. 2 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.

- **Technical Content:** Presentations must include, at least, the system design and 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.
- **Oral Presentation:** The presentations shall be five (5) to six (6) minutes in duration. There will be a 5-second grace period to account for timer (stopwatch) reaction. A maximum of two team members may present the PowerPoint and answer questions. ☐
- **Visuals:** Teams may only use PowerPoint for their presentations. Teams may use visual aids including graphs or photographs to enhance the product of the presentation. Video clips may not be included.
- **Question & Answer:** There will be a 4-minute question-and-answer session immediately following the presentation. Only the panel judges will be permitted to ask questions.

Points shall be deducted if the duration of the presentation is less than 5 minutes or more than 6 minutes,

as follows.

Presentation Time	Points Deduction
4:45 – 4:54 or 6:06 – 6:15	1
4:35 – 4:44 or 6:16 – 6:25	2
4:25 – 4:34 or 6:26 – 6:36	3
And so on...	

## **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 2018midpacwatertreatment@gmail.com by January 28, 2018. 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.

Note: All items must be in its original packaging (see exceptions in construction details). 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 how much is used during the construction phase.

**Table 2: List of Eligible Materials and their Associated Costs**

Number	Item	Unit	Cost (\$/unit)
1	1/2" Hardware Cloth	/sq. ft.	0.67
2	1/2" I.D. Soaker Hose	/lin. ft.	0.36
3	1/4" Hardware Cloth	/sq. ft.	0.53
4	1" High Pressure Washer Hose	/lin. ft.	2.50
5	4 Gallon Trash Can	/unit	2.50
6	13 Gallon Trash Can	/unit	5.00
7	20 Gallon Trash Can	/unit	8.00
8	16 Qt. Igloo Can Cooler	/unit	23.00
9	2' Ladder	/unit	30.00
10	2" Adjustable Spring Clamp	/unit	6.00
11	2" PVC Pipe Elbow	/unit	3.00
12	2"x4" 3M Steel Wool	/unit	0.83
13	2"x4" Dimensional Lumber	/4 lin. ft.	1.70
14	2"x6" Dimensional Lumber	/4 lin. ft.	2.44
15	3/4" Black Electrical Tape	/lin. ft.	0.06
16	3/4" Thick Plywood	/4 sq. ft.	1.06
17	3/8" Nylon Roper	/lin. ft.	0.20

18	3/8" Thick Plywood	/4 sq. ft.	2.00
19	30 Gallon Tote	/unit	12.00
20	32 Gallon Trash Can	/unit	13.00
21	36 Gallon Garbage Bag	/unit	0.63
22	3M Compressed Air Dust Remover	/unit	4.67
23	4' Ladder	/unit	40.00
24	4" x 4" Dimensional Lumber	/4 lin. ft.	3.00
25	5 Gallon Bucket	/unit	2.50
26	5 Gallon Bucket Lid	/unit	2.50
27	5/8" Carpet Pad	/sq. ft	0.44
28	5/8" I.D. Garden Hose	/lin. ft.	0.66
29	6' Ladder	/unit	60.00
30	8" x 6" x 2" Grout Sponge	/unit	2.00
31	Alum (McCormick)	/oz.	1.60
32	All-Purpose Gravel (Quikrete)	/50 lb.	8.00
33	Aqueon Water Clarifier	/oz.	1.00
34	Vinegar	/1 cups	0.99
35	Astroturf	/sq. ft.	4.00
36	Baking Soda	/oz.	0.10
37	Bolts	/units	0.05
38	Bounce Dryer Sheets	/20 units	5.00
39	Brawny Paper Towels	/roll	3.00
40	Burlap	/sq. ft.	0.14
41	Canvas Drop Cloth	/sq. ft.	0.25
42	Charcoal	/lb.	0.50
43	Clorox Bleach, concentrated	/5 cups	1.17
44	Clorox Disinfecting Wipes	/15 units	1.50

45	Coarse Compost	/gallon	3.00
46	CoCo Liner, 18"	/unit	4.00
47	Coffee Filter	/unit	0.03
48	Commercial Grade Fine Sand	/lb.	0.16
49	Commercial Grade Sand	/lb.	0.12
50	Cotton Ball	/20 units	0.40
51	Diatomaceous Earth	/1 lb. bag	5.00
52	Duct Tape 20 yd. Roll	/unit	10.00
53	Fiber Twine	/ft.	0.01
54	Gelatin (Knox Unflavored)	/4 oz.	2.00
55	Granular Activated Carbon	/oz.	0.40
56	Gutter Insert Foam, 3'	/unit	8.00
57	Gypsum	/lb.	0.23
58	Hydrogen Peroxide	/3 cups	1.49
59	50 Qt. Igloo Cooler	/unit	70.00
60	94 Qt. Igloo Cooler	/unit	90.00
61	Lava Rock	/cu. ft.	6.00
62	Lemon Juice	5 fl. oz.	1.00
63	Mylar Emergency Sleeping Blanket	/unit	3.00
64	Nail	/unit	0.05
65	Nut	/unit	0.05
66	OxiClean Stain Remover	/lb.	1.20
67	Paint Tray	/tray	2.00
68	Peat Moss	/cu. ft.	6.50
69	Pebbles, Large	/5 lb.	2.50
70	Pebbles, Pond/Landscape	/.5 cu. ft.	4.99
71	Pickling Lime	/oz.	0.20

72	Plant Protector Bags	/bag	5.00
73	Plaster of Paris	/lb.	0.70
74	Plastic Tarp	/sq. ft.	0.20
75	Play Sand	/lb.	0.10
76	Plumbing Epoxy Putty	/putty	3.49
77	Loudwolf Potassium Permanganate	/6 oz.	12.00
78	ABS Pipe, 1-1/2" Diameter	/5 lin. ft.	1.50
79	ABS Pipe, 2" Diameter	/5 lin. ft.	20.00
80	Copper Pipe, 1/2" Diameter	/5 lin. ft.	6.00
81	Copper Pipe, 1" Diameter	/5 lin. ft.	16.00
82	Corrugated Pipe, 3" Diameter	/5 lin. ft.	2.50
83	Corrugated Pipe, 4" Diameter	/5 lin. ft.	3.00
84	PVC Pipe, 1" Diameter	/5 lin. ft.	1.00
85	PVC Pipe, 1-1/2" Diameter	/5 lin. ft.	1.50
86	PVC Pipe, 2" Diameter	/5 lin. ft.	2.00
87	Pool Filter Sand	/lb.	0.30
88	Pumice Stone (1 CF)	/cu. ft.	11.99
89	Rubbing Alcohol	/3 cups	1.49
90	Salt (Morton Iodized Table Salt)	/26 oz.	1.00
91	Screw	/unit	0.05
92	Sham-Wow	/sq. ft.	5.00
93	Stainless Steel Safety Wire	/lin. ft.	0.25
94	Standard Air Conditioner Filter	/unit	10.00
95	Terrycloth Rags	lb.	5.00
96	Tote, 5 Gallon	/unit	8.00
97	Tote Lid, 5 Gallon	/unit	1.00
98	Tote, 10 Gallon	/unit	10.00

99	Tote Lid, 10 Gallon	/unit	1.00
100	Tote, 13 Gallon	/unit	18.00
101	Tote Lid, 13 Gallon	/unit	1.00
102	Tote, 18.5 Gallon	/unit	20.00
103	Tote Lid, 18.5 Gallon	/unit	1.00
104	TSP/90	/lb.	3.00
105	Turtle Wax Hard Shell Paste Wax	/fl. oz.	0.55
106	Weed Control Fabric	/sq. ft.	0.11
107	Window Screen Mesh	/3 sq. ft.	1.00
108	Window Squeegee	/unit	6.00
109	Wood Mulch	/cu. ft.	6.00



## Appendix B: Construction Costs: Labor and Tools

**Table 3: Labor and Tool Costs**

Number	Item	Cost (\$/unit)
1	Operator	30.00/operator
2	Adjustable Wrench	3.00
3	Basic Socket Set	5.00
4	Caulking Gun	2.00
5	Channel Locks	1.50
6	Cordless Drill	10.00
7	Drill Bits (Each)	1.50
8	Hand Saw	10.00
9	Pliers	1.50
10	Scissors	2.00
11	Screwdrivers (Each)	1.00
12	Standard Builder's Hammer	5.00
13	Utility Knife	2.00
14	Wire Cutters	2.00
15	Pipe Cutters	10.00
16	Pipe Wrench	5.00