

NAVIGATOR Product demonstration prop building instructions

Regional competitions may build product demonstration props out of materials other than PVC pipe. Your regional coordinator will inform you of any changes to materials for your regional competition. Look for a regional information document posted on your [regional website](#). This document will list any changes to the product demonstration props.

Companies should be aware that tolerances in lengths of cut pipe and length of pipe inserted into joints can change the overall dimensions of product demonstration tasks. Except where noted, companies should expect tolerances in all product demonstration props and should build their ROVs and tools accordingly. In no case should the dimensions given in this document for a product demonstration prop be used to calibrate a measuring device.

Online links and Home Depot part numbers are given for certain construction items. However, some Home Depot stores may not carry the listed items or Home Depot may not be available in your area. MATE recommends checking other local hardware stores or online sources, such as those listed below, for the required component.

<https://www.pvcfittingsonline.com/>
<https://pvcpipesupplies.com/pvc-fittings/schedule-40-pvc-fittings/>

SolidWorks files will be available soon for all product demonstration props. [SolidWorks Student Edition](#) is free for MATE competitors. The [eDrawings Viewer](#) is a free download that allows the Solidworks files to be viewed dynamically.

See last page for update notes.

Task 1: Dam Inspection and Repair

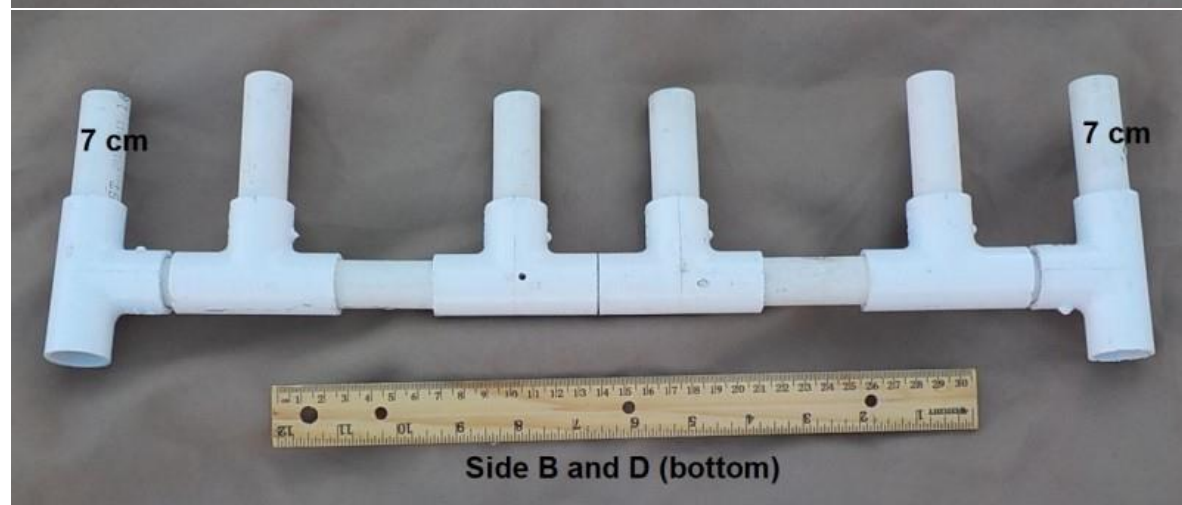
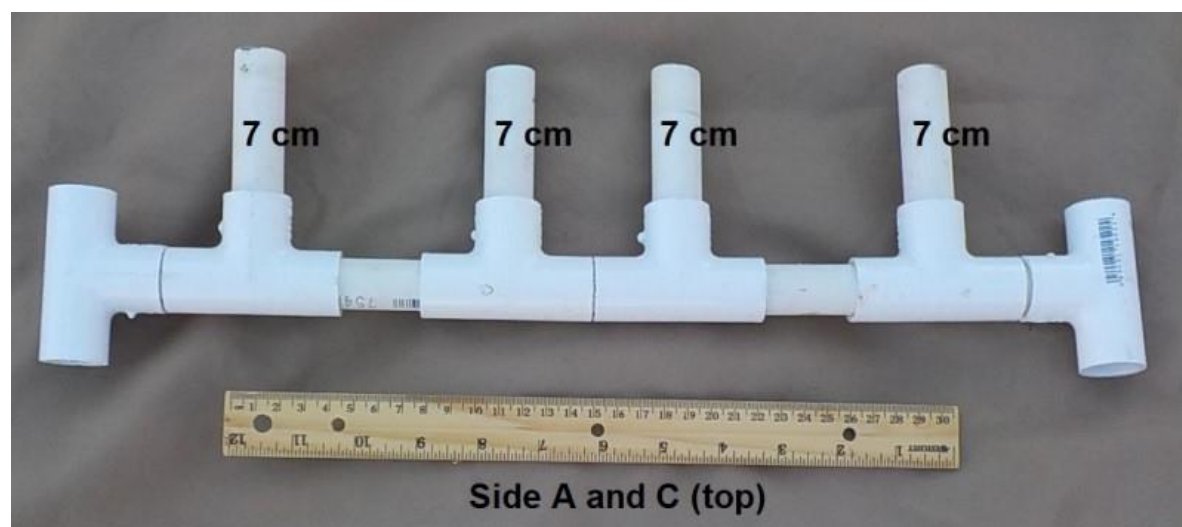
Foundation of the dam:

The foundation of the dam consists of four drain pipes. The drain pipes are constructed from 50 cm lengths of 3-inch ABS or PVC pipe. The pipes are capped on one end with either a 3-inch end cap or 3-inch knockout cap. The pipes are positioned 20 cm to 50 cm above the bottom of the pool on a ½-inch PVC pipe framework.

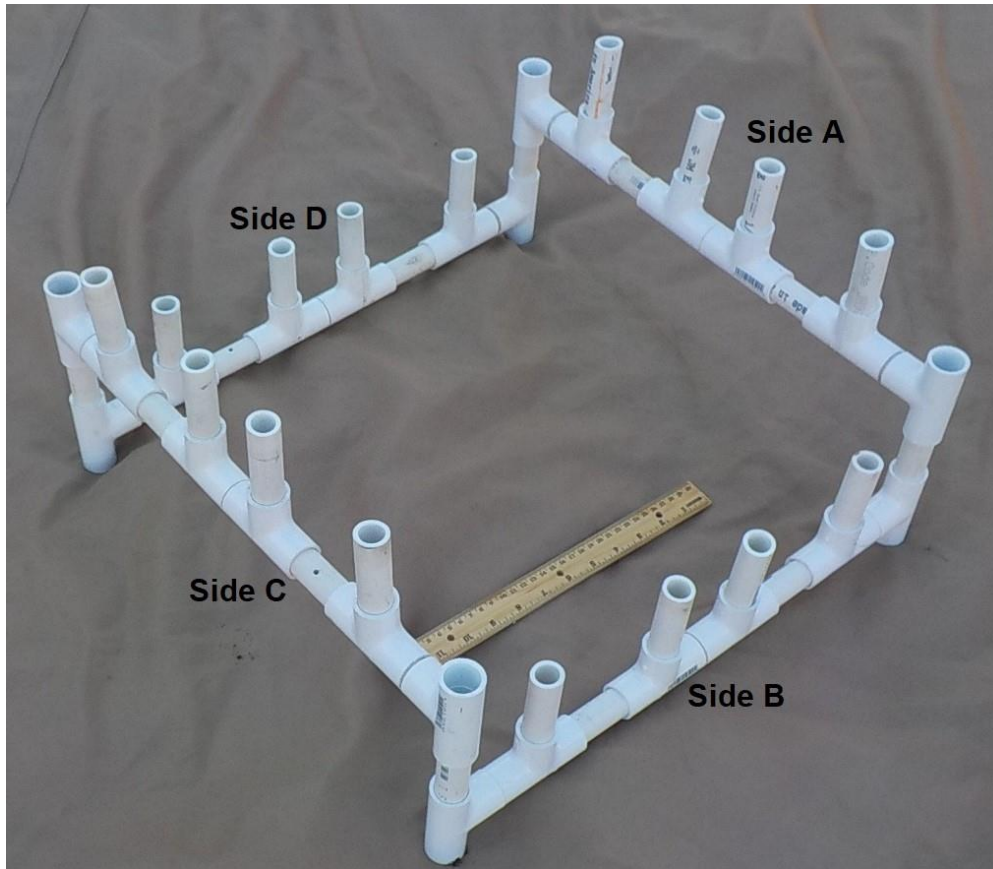
The PVC framework base is the same for all four sides of the foundation of the dam.



Seven cm lengths of pipe are attached to the ½-inch tees. These lengths of pipe are the cradles for the drain pipes. Side A and C make up the top of the foundation. Side B and D make up the bottom of the foundation.



The sides are attached together to form a square. A and C are on the top, B and D are on the bottom.



The four drain pipes are simulated by 50 cm long lengths of 3-inch ABS pipe. An end cap or knockout cap is attached to one end of the pipe. Two are placed within the holders (cradles?!) at the bottom of the foundation; two are placed within the holders (cradles?!) at the top of the foundation. If needed, the drain pipes may be attached to the framework with cable ties.





After the drain pipes are placed within the foundation, legs are attached to the bottom of the foundation to bring the drain pipes 20 cm to 50 cm above the bottom of the pool. The legs can be 10 cm to 15 cm in length. All four legs must be the same dimension so that the foundation is stable.



The muddy water flow is simulated by 5 cm long strands of [brown foam sheeting](#) attached to a ½-inch end cap and placed at the capped end of some of the 50 cm long lengths of 3-inch PVC or ABS. A cable tie is used to secure the ½-inch end cap/foam sheeting in place.

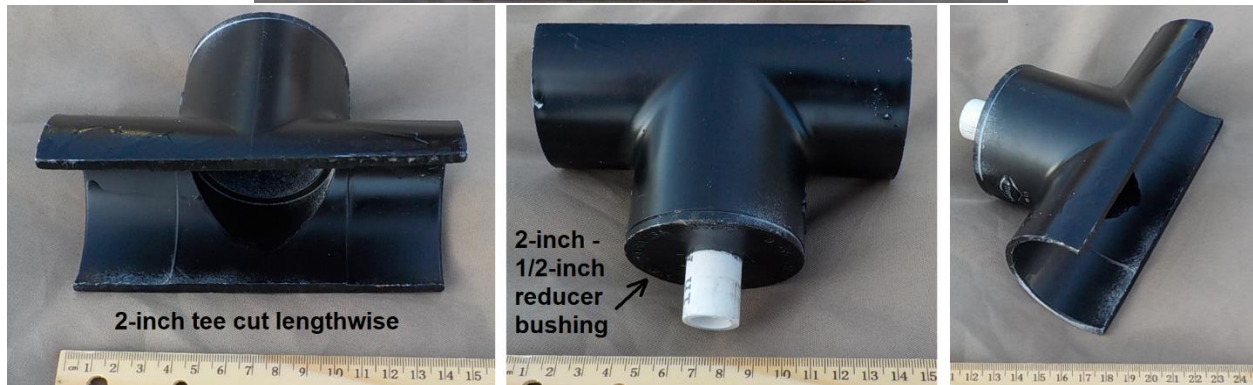
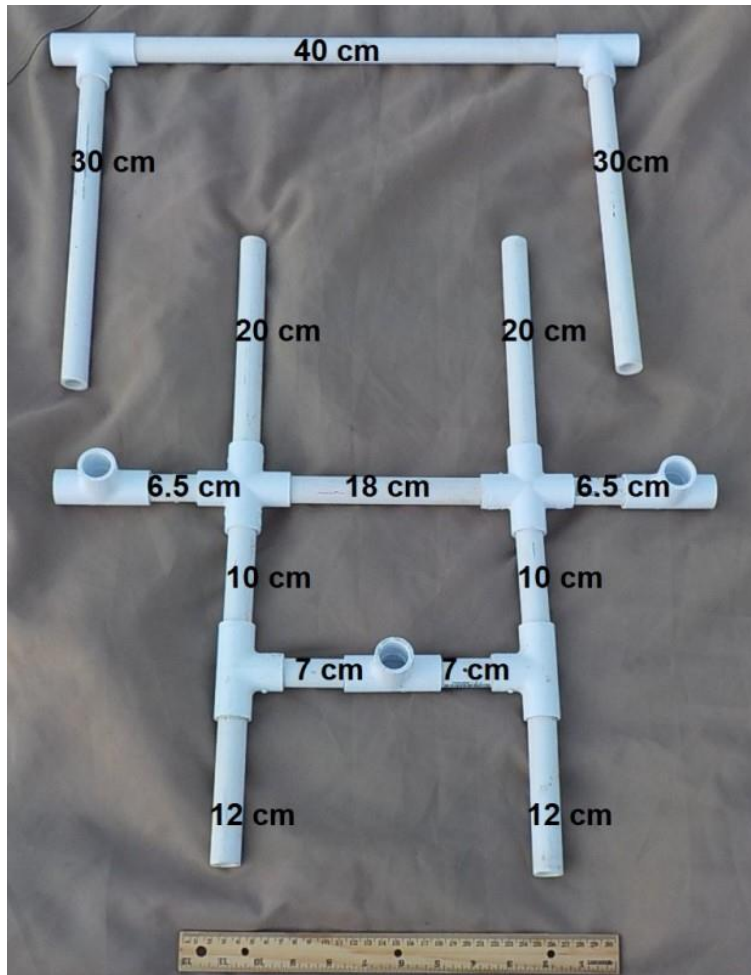




Some pipes (as shown above) will have a muddy flow at the capped end. Other pipes will not have a muddy flow at the capped end.

Trash rack:

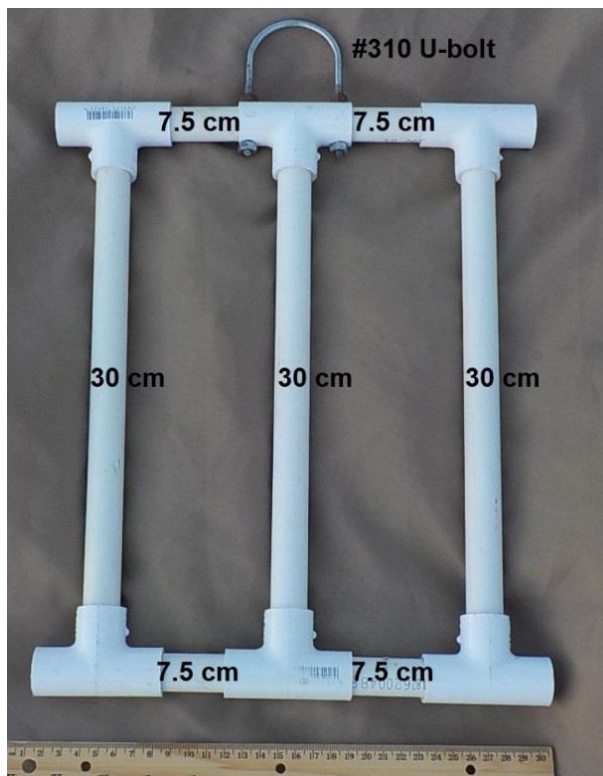
The trash rack is constructed from ½-inch PVC pipe. One 2-inch tee cut lengthwise acts as a cradle for the bottom edge of the trash rack screen. A 2-inch to ½-inch reducer bushing connects the 2-inch tee to the ½-inch framework.



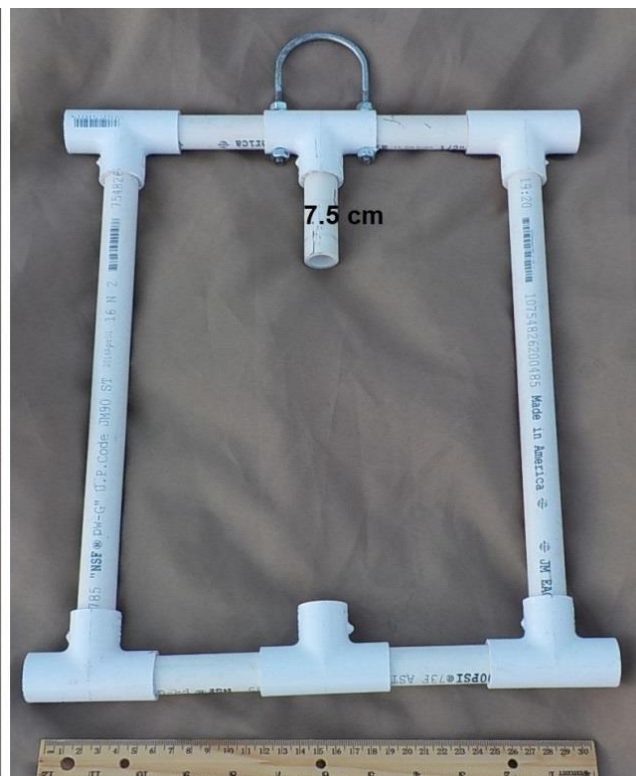
Design note: A cradle section of the 2018 I-AMP is used for the 2019 cradle on the trash rack.

Trash rack screens:

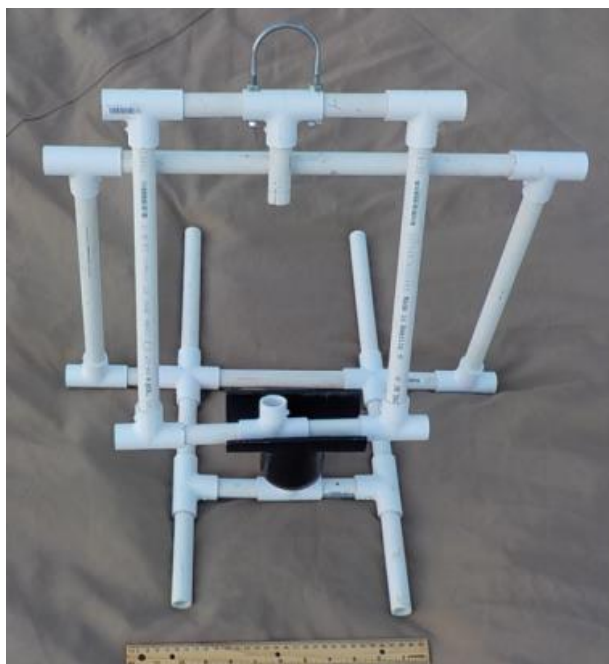
Both the damaged trash rack screen and the new trash rack screen are the same with the exception of the center length of PVC pipe. The screens are constructed from ½-inch PVC pipe with a [#310 U-bolt](#) on top. The center vertical section of PVC pipe is shorter on the damaged trash rack screen. Flotation may be added inside the top pipes to achieve the desired weight in water.



Left: New trash rack screen.



Right: Damaged trash rack screen.



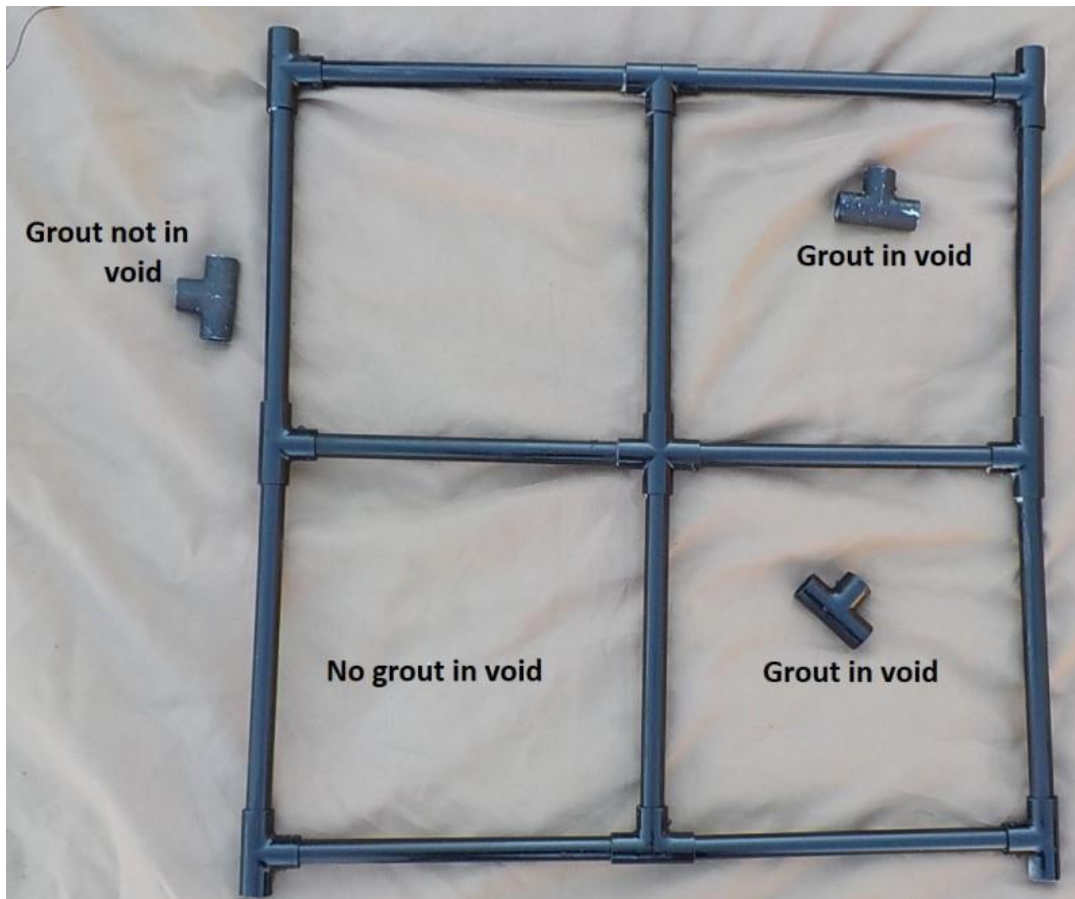
Left: Damaged trash rack screen on trash rack.



Right: New trash rack screen on trash rack.

Grout and voids:

Grout is simulated by ½-inch PVC tees painted black. The grid of four voids is constructed of ½-inch PVC pipe and tees painted black. Each length of pipe in the grid is 30 cm. Ten black painted tees will be available on the surface to insert into the four voids.



Task 2: Maintaining Healthy Waterways

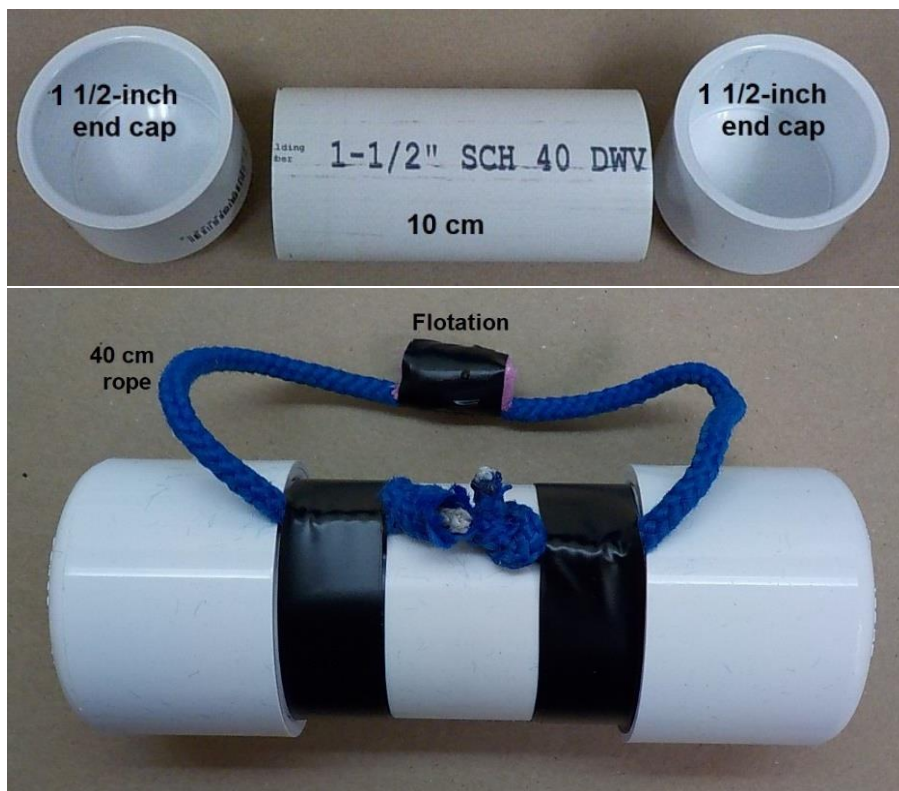
Temperature sensor:

Companies are required to provide their own sensor to measure temperature. The MATE ROV Competition will not provide one. The competition manual reference section has additional notes about temperature sensors.

Water sample:

The water sample is constructed from a 10 cm length of 1 ½-inch PVC pipe with end caps on both ends. Do not use glue or screws to secure the end caps. A 40 cm length of [rope](#) (colors may vary) is used as a grab point to collect the water sample. An overhand knot on each end of the 40 cm length of rope and plastic tape will secure the grab point to the PVC pipe.

Note: The competition manual states the water sample is constructed from 1-inch PVC pipe with a screw on end cap. The design has been updated to 1 ½-inch pipe.



Two [10 ml plastic test tubes](#) are located inside the 1 ½-inch PVC. One tube will be labeled pH, the other will be labeled phosphate. Companies will remove an end cap to obtain the plastic tubes inside the PVC pipe. The water inside each test tube will be mixed with other substances to achieve a certain pH or certain phosphate levels.



pH Test:

[Jellas Universal pH Test Kit With Paper Strips Roll](#)

Companies will need to open the sample tube labeled pH and use the Jellas pH test kit to measure the sample inside. If your regional competition is using a different brand of testing kit, your regional coordinator will let you know and provide information on the kit.

The process for using the Jellas Universal pH Test Kit is as follows. Unroll approximately 4 cm from the pH paper strip and cut/tear it off. Alternatively, your regional coordinator may have 4 cm strips pre-cut for you. Take the strip and dip one half of it into the sample liquid. The strip will change colors in just a few seconds. Compare the color on the strip to the color code on the side of the test kit and inform the station judge of the pH.

Consider practicing pH measurements with some of the following substances mixed into the water sample:

- Baking soda or baking powder
- Lemon juice
- Vinegar
- Cream of Tartar

Phosphate Test:

[Lamotte Insta-Test Phosphate Test Kit](#)

Companies will need to open the sample tube labeled phosphate and use the Lamotte Insta-Test phosphate test kit to measure the sample inside. If your regional competition is using a different brand of testing kit, your regional coordinator will let you know and provide information on the kit.

The process for using the LaMotte phosphate test kit is as follows. Take one phosphate test strip from the bottle and gently bend the strip in half with the pads facing inwards. Place the strip inside the test tube cap. Cap the test tube with the strip inside, and slowly invert (turn upside-down) five times (allow the bubble to form from the top to bottom and bottom to top). Remove the cap and test strip. Place the bottom of the test tube on the white boxed area of the color chart. Look down through the OPEN test tube and compare the sample to the color chart.

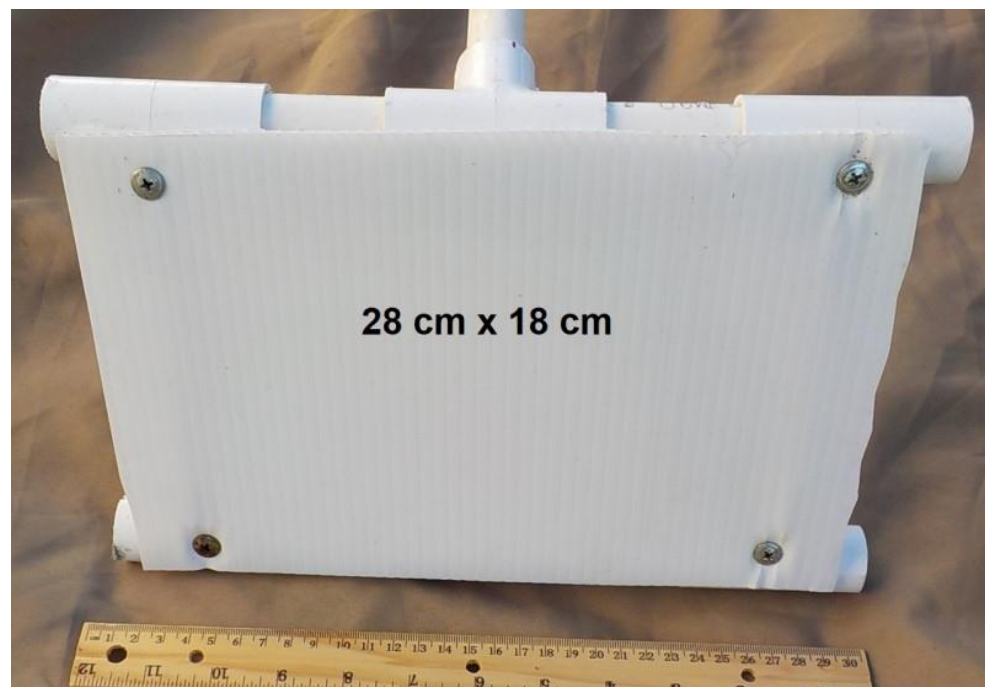
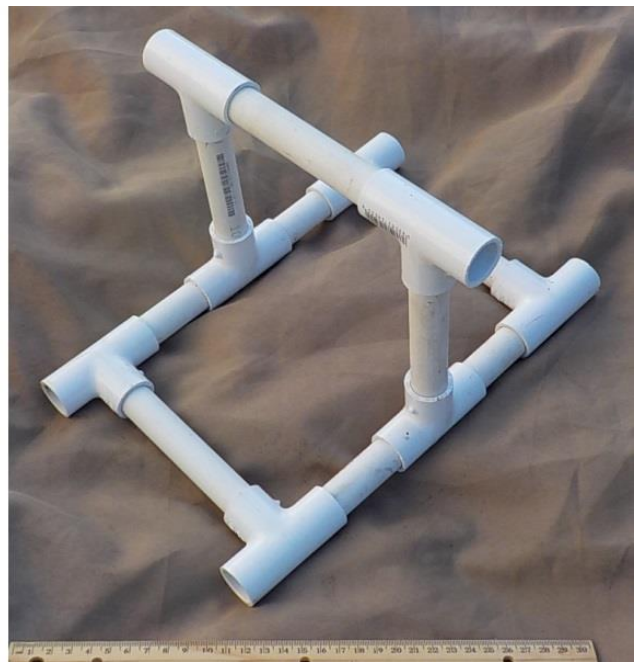
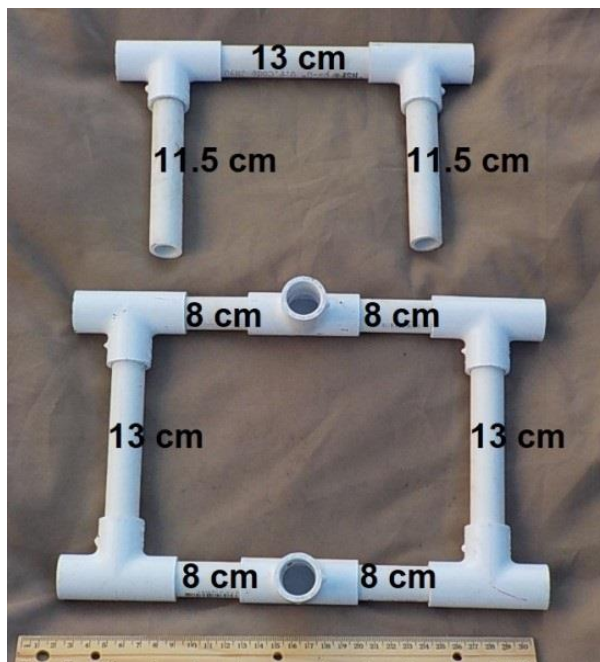


Left: The test strip inside the test tube cap with pads facing inwards.

Right: Looking down through the OPEN test tube to compare color to the sample color chart.

Simulated rock:

The simulated rock is constructed from ½-inch PVC pipe and a 32 cm x 20 cm square of corrugated plastic sheeting. The corrugated plastic sheet is attached to the PVC framework with screws.

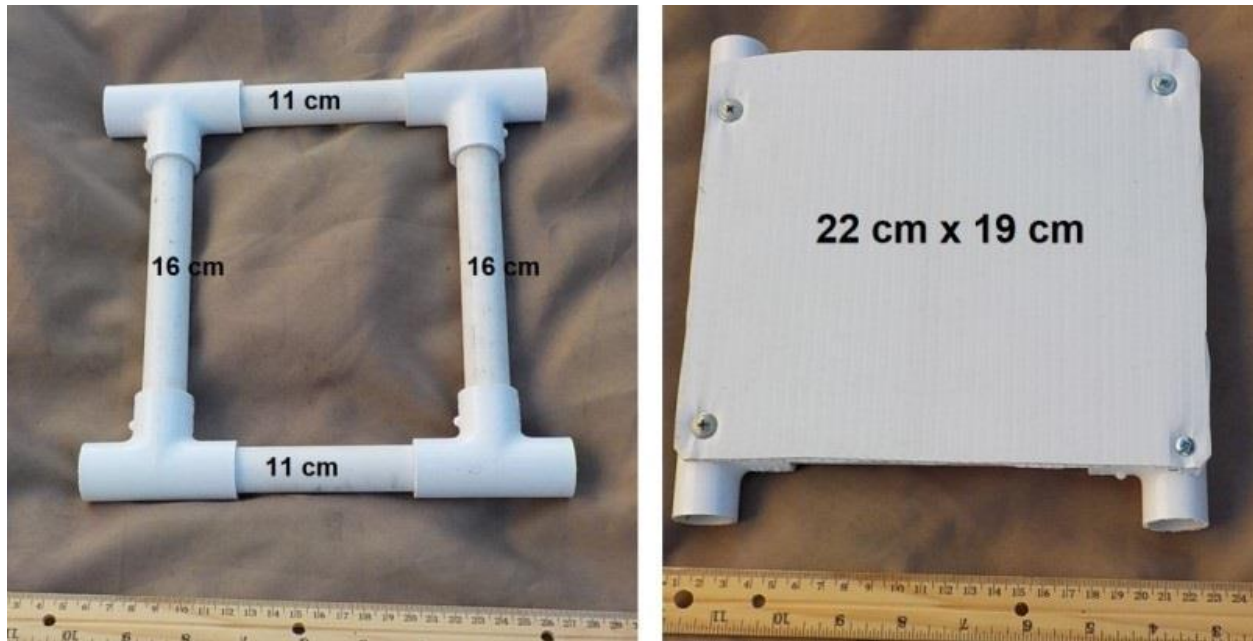


Flotation is added into the top and vertical pipes to make the simulated rock weigh less than 5 Newtons in water.

Benthic species:

The benthic species are located on a 22 cm x 19 cm square of corrugated plastic sheeting attached to a PVC framework. The corrugated plastic sheeting is attached to the PVC framework with screws. Rebar inside the ½-inch pipe adds weight and helps to hold the benthic species to the pool bottom. The

corrugated plastic sheet is covered in [bug stickers](#) representing benthic species. More information on what stickers represent what benthic organisms can be found in the [NAVIGATOR Benthic Species Handbook](#).

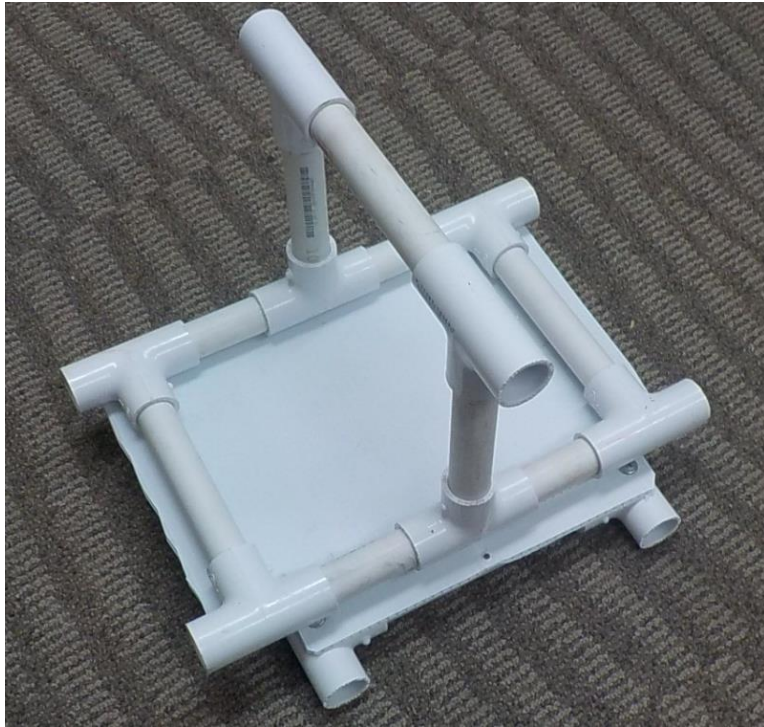


If the bug stickers are not staying on the corrugated plastic sheet after long-term submersion in water, consider wrapping the entire corrugated sheet in clear packing tape.



An example of the species diversity underneath the rock.

The simulated rock will be positioned on top of the benthic species.



Trout fry:

The trout fry are simulated with [rubber fishing lures](#) whose hooks have been removed. Use needle nose pliers to open the split ring holding the treble hook. Remove and discard the hook. Use heavy duty wire cutters to cut the hook on the top of the fish as close to the rubber body as possible. Be safe and wear safety glasses and gloves when removing the hooks.



Degraded tires:

The degraded tires are simulated with 16.5 cm diameter [plastic pool rings](#) painted black. Use black spray paint to color both sides of the ring. The ring includes flotation and should stand upright on the bottom.

**Reef/fish balls:**

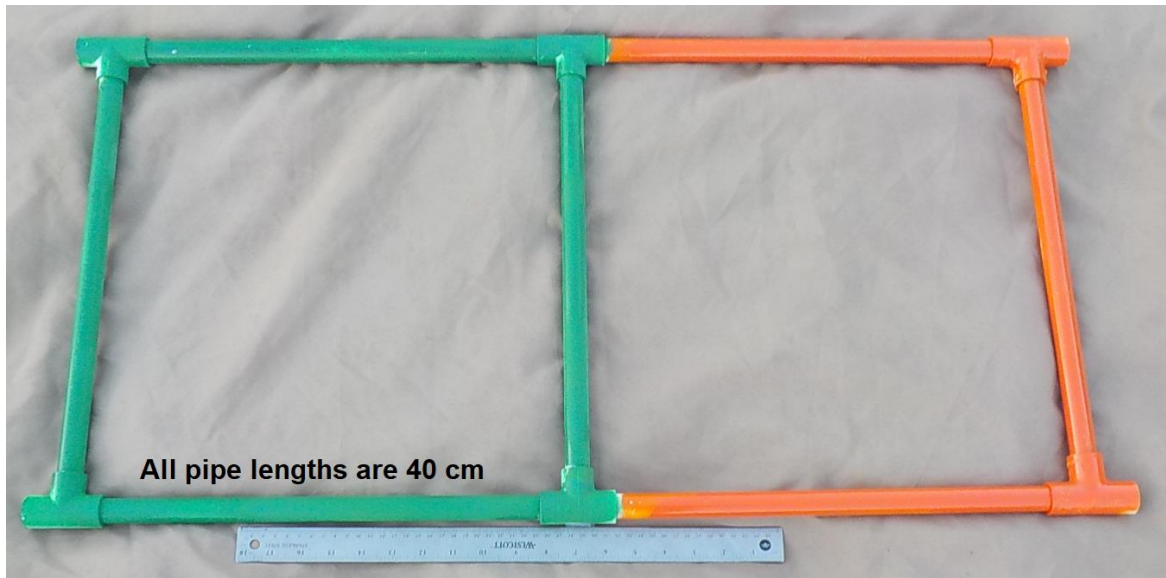
The reef/fish balls are simulated with plastic 4-inch [O-balls](#). Also check toy stores and the baby department of box stores such as Walmart, Target, etc.



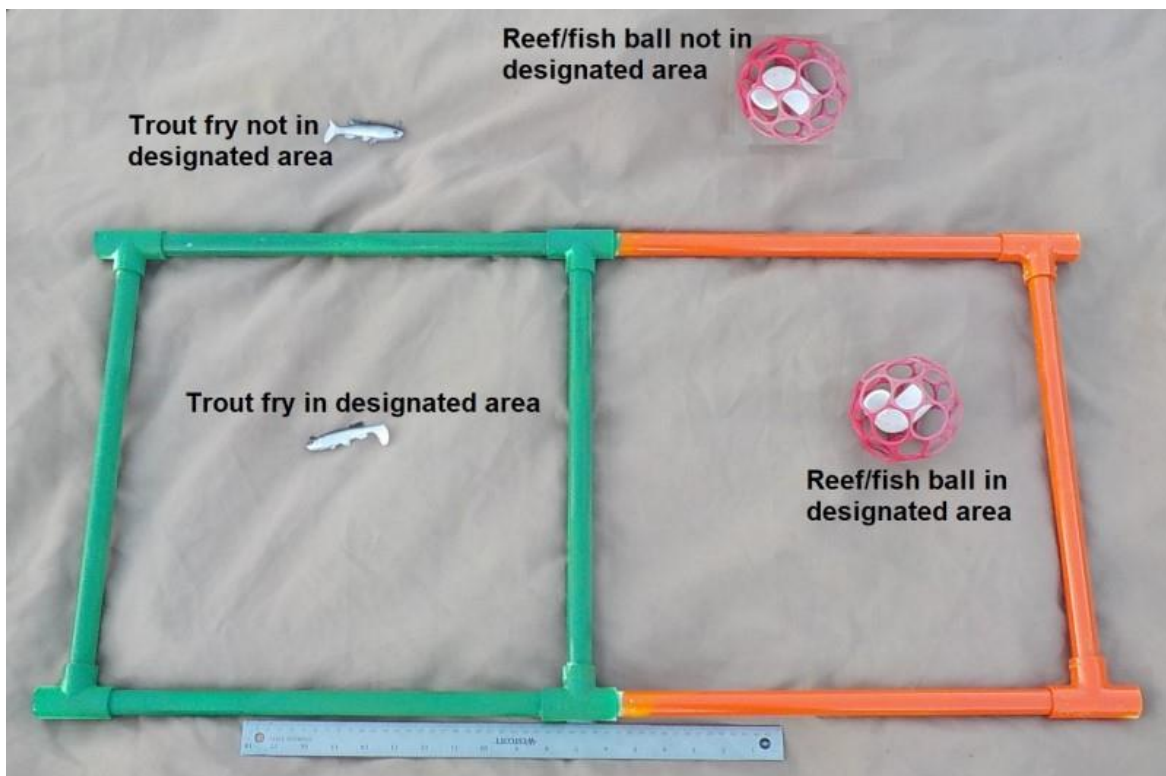
A ½-inch PVC 90° elbow inside the O-ball stabilizes the O-ball against rolling.

Trout fry and reef/fish ball designated area:

Both the trout fry designated area and the reef/fish ball designated area are constructed from ½-inch PVC pipe. Each square designated area is 40 cm x 40 cm. The designated area for trout fry is painted green. The designated area for the reef/fish ball is painted orange.



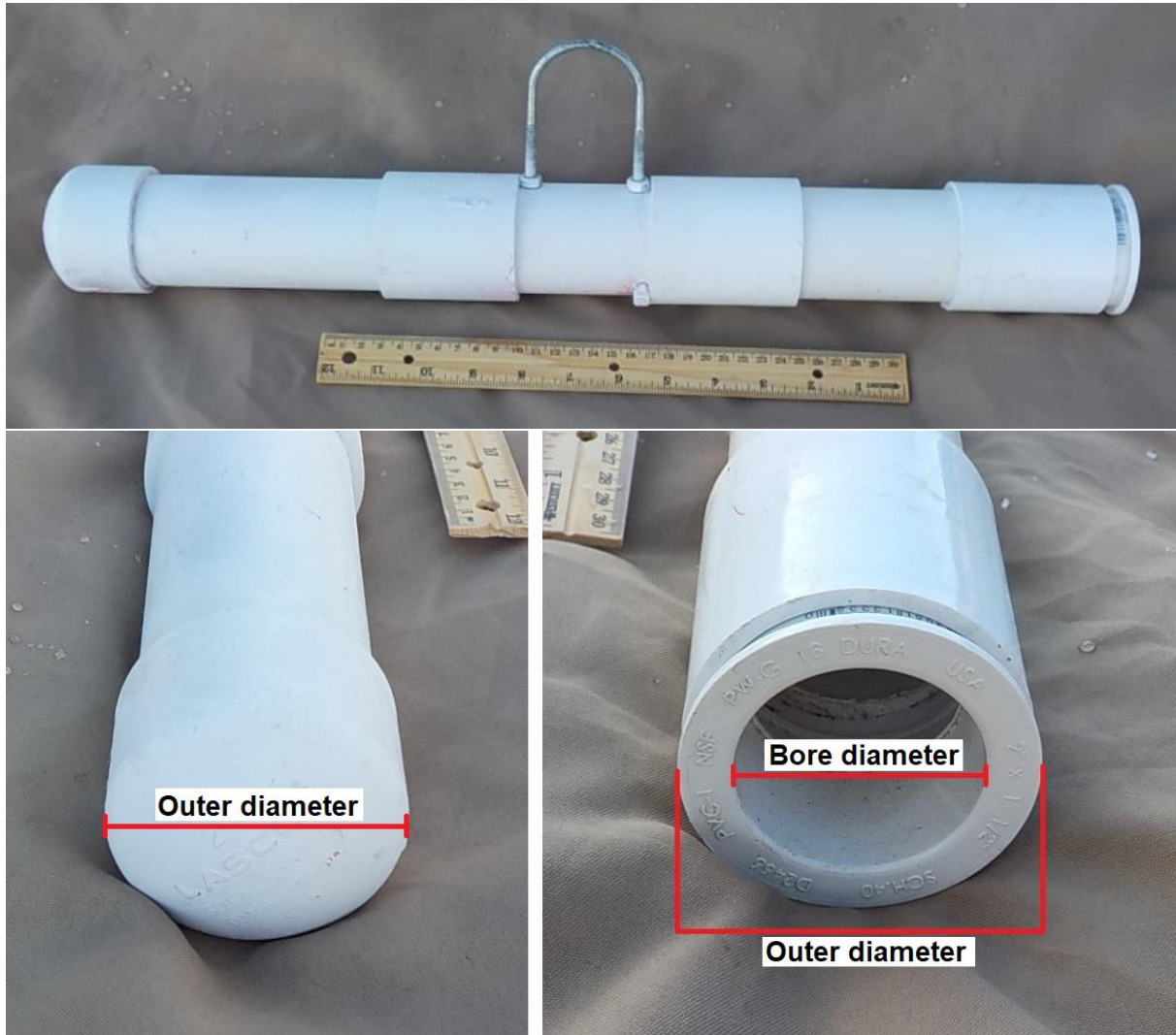
Design note: The designated areas for trout fry and the reef/fish ball is a combination of two 2018 designated areas (eel grass and mooring).



Task 3: Preserving History

Cannon:

The cannon is constructed from variable lengths of PVC or ABS pipe and couplings. The outer diameter of both ends of the cannon will be the same. A [#310 U-bolt](#) is located approximately halfway down the length of the pipe.



In the above photos, the cannon is constructed from 2-inch pipe. The cannon has an end cap at one end and a coupling with a reducer bushing on the other end. Cannon will differ in the sizes of pipes and connectors used.

Cable ties are used to attach weight inside the cannon.

MATE supplied lift bag:

NAVIGATOR companies may be required to provide their own lift bag and air pump. Alternatively, the MATE ROV Competition may supply both the lift bag and air pump for companies. Check your regional information document posted on your [regional website](#) to determine if your regional is providing these product demonstration props. If your regional is providing these items, the lift bag will be constructed from 30 cm of 3-inch ABS pipe with a 3-inch end cap on one end. A 30 cm length of [rope](#) (colors may vary) will be connected to the other end of the 3-inch ABS pipe through two holes drilled in the pipe. The rope will run through a 2 cm length of ½-inch PVC pipe. A [#6 screw hook](#) will be drilled through the 2 cm length of pipe. The #6 screw hook will attach to the U-bolt on the cannon.



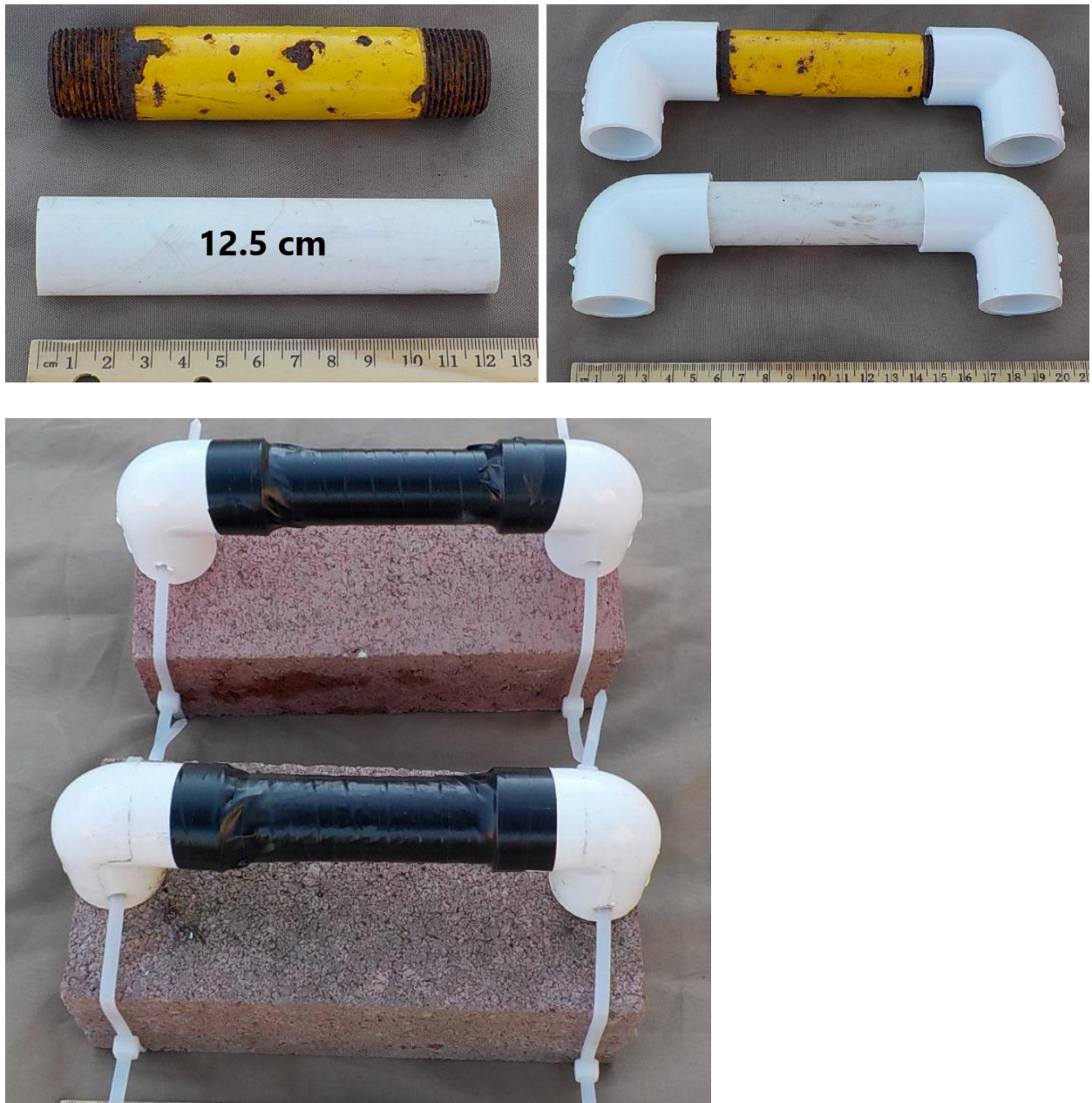
Two holes are drilled on opposite sides of the bottom of the lift bag and a 30 cm length of rope is inserted into the holes and secured with an overhand knot. The rope runs through a 2 cm length of ½-inch pipe with the screw hook attached.

If ABS pipe is not available in your area, PVC pipe can be substituted. However, additional flotation may need to be added to make the lift bag positively buoyant in water. To add foam flotation, remove the 3-inch end cap side and insert the foam into the top of the lift bag. Insert enough foam to make the lift bag slightly positively buoyant. The length of the PVC pipe should also be increased from 30 cm to 35 cm. When filled with air, the additional volume will compensate for the additional weight of the PVC pipe in water.

If your regional is providing a pump, your coordinator will provide information and specifications on that pump. It may be a manual pump such as a [bicycle pump](#) with [3/16-inch airline tubing](#). Alternatively, your regional coordinator may provide an air compressor or other pump at each station. If your regional competition is providing an air compressor, all teams must pass the fluid power quiz.

Cannon shells:

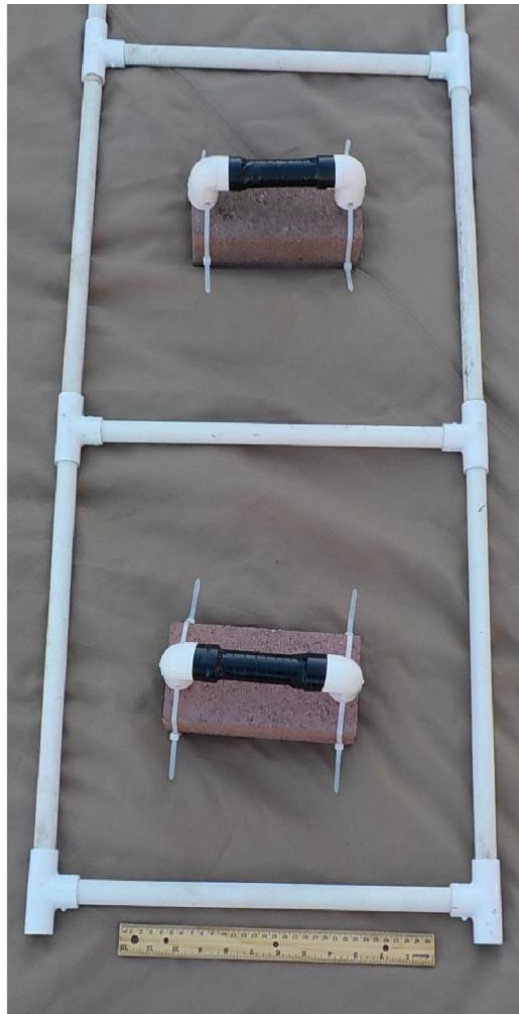
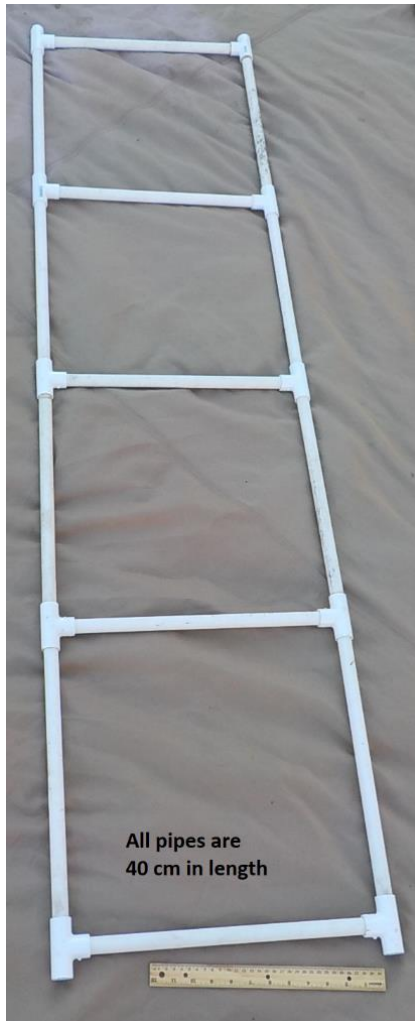
The base of the cannon shell is a 19 cm x 9 cm x 5.5 cm [red brick](#). A cannon shell is simulated by a ¾-inch diameter, 12.5 cm (5-inch) length of [galvanized steel pipe](#). The non-metal debris is simulated by a ¾-inch diameter, 12.5 cm (5-inch) length of PVC pipe. ¾-inch PVC elbows are attached to each end of both the metal and PVC pipes. The pipes are completely covered in black plastic tape. Cable ties are used to secure the pipe to the brick.



Design note: The cannon shells are from the 2012 competition.

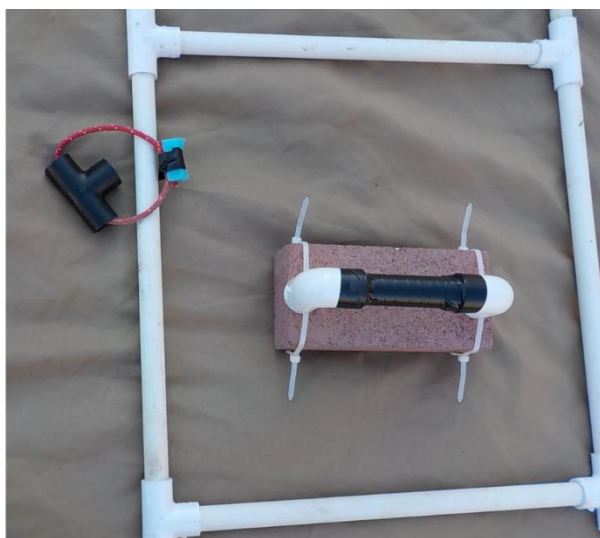
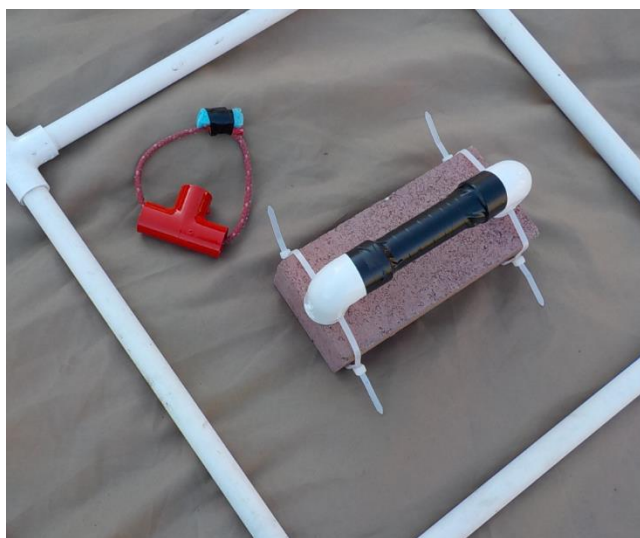
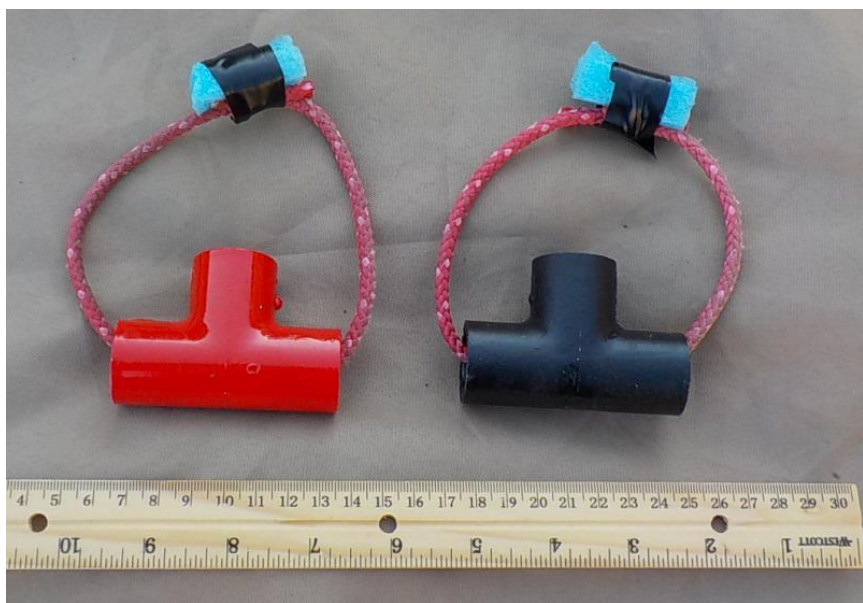
Cannon shell grid:

The grid is constructed from ½-inch PVC pipe. All pipe lengths are 40 cm.



Cannon shell markers:

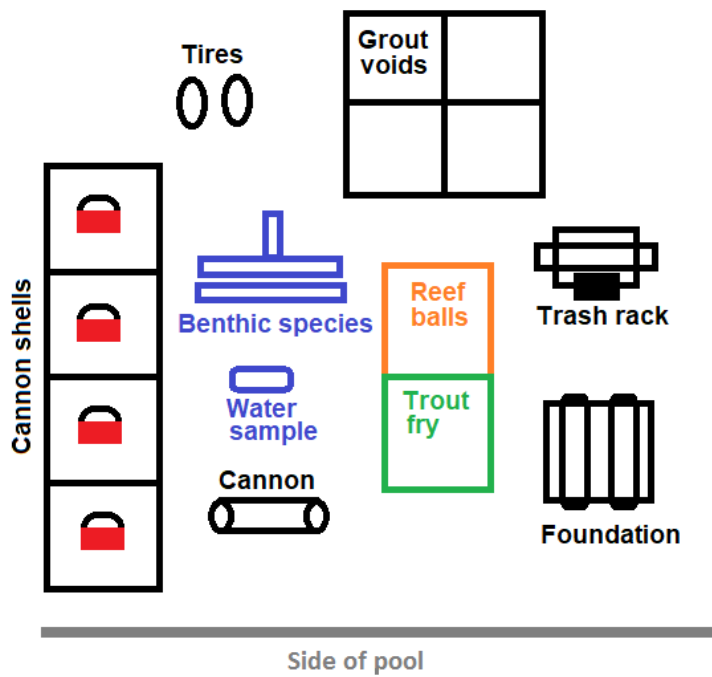
Markers are constructed from ½-inch PVC tees painted red and black. A 40 cm length of [rope](#) (colors may vary) is attached to each tee as a grab loop. Attach a small amount of flotation to the rope to ensure that the rope floats in the water.



The red marker is successfully marking a metal object. The black marker is outside the PVC square, so has NOT successfully identified a non-metal object.

NAVIGATOR class product demonstration set up:

The following is a potential underwater set up for the NAVIGATOR class product demonstration.



The NAVIGATOR benthic species handbook and data sheet are on the surface.

The new trash rack screen, grout, trout fry, reef balls and cannon shell markers are on the surface.

If provided by the competition, the cannon lift bag and manual pump are on the surface.

Update Notes:

Updates are highlighted in yellow.

December 20, 2019:

Updated photo of water sample on pg. 10. 1 ½-inch end caps were labeled as ½-inch end cap.