



2017 FIRST Global Challenge:

(In English)

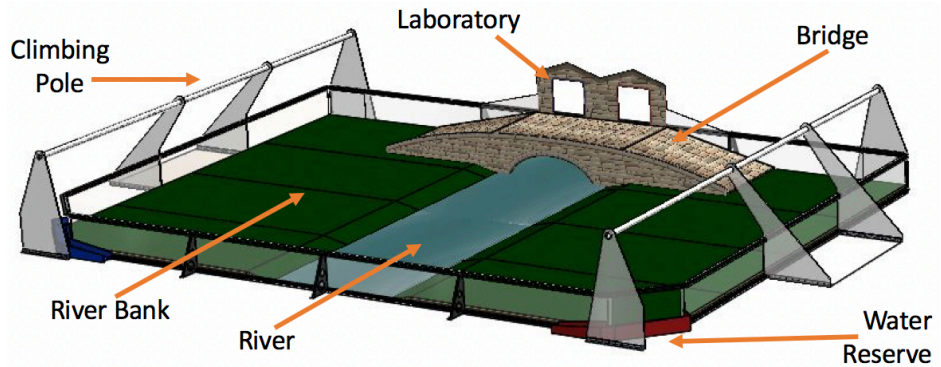
H2O Flow



H2O Flow Game Summary

Narrative

In *H2O Flow*, teams learn about real-world water scarcity and contamination issues. In the game, two villages exist on either side of a contaminated river. The villagers compete to create and store purified water in their respective reserves. In a laboratory upstream, the villagers come together to research the contaminants and ultimately create a purification system so contaminants are removed before they reach the villages, thus providing clean water for all. In the end, each village prepares for the coming flood by searching for higher ground.



Gameplay

At the beginning of the match, 40 water (represented by blue balls) and 10 contaminant (represented by orange balls) particles flow into the river. After this initial flood, balls continue to flow at a steady rate.

Two alliances of three robot teams each represent the two villages. Each alliance receives points for putting contaminants in their respective laboratory and water in their respective water reserve. Penalties are incurred if contaminants enter an alliance's respective water reserve.

Once 10 orange balls are deposited in the laboratories (regardless of the distribution among the two alliances laboratories), orange balls will stop flowing into the river. Once the river is free from all contaminants, both alliances receive a "coopertition" bonus.

At the end of the match, teams must prepare for a coming flood by searching for higher ground. Points are received for robots fully on the bridge, or off the ground using the climbing bar.

Scoring

Type	Action	Points
PARTICLE	Scored Clean Water Particle into alliance Water Reserve	1
	Scored Contaminant Particle into alliance Laboratory	4
Coopertition	Clean River	15 (both alliance)
End Game	Robot parked on Bridge	5
	Robot hanging on Climbing Bar	20
Penalty	Penalty	5 points (to opposing alliance)

Challenge Overview

Access to clean, drinkable water has proven to be a potent source of political, economic, and social strife in nations throughout the world – the effects of which have been felt everywhere from Sub-Saharan Africa to the United States. At the present, more than one billion people do not have access to clean water and over half of them are children. This lack of access to drinkable water results in more deaths each year than those resulting from war. If current water consumption trends continue across the globe, two out of three people on earth will suffer from water-stressed conditions by the year 2025.

Water is not only an essential ingredient that helped lead to the development of life on Earth, but it comprises between 50 percent and 70 percent of the human body. Along with mild temperatures and breathable atmosphere, the continued ability of intelligent life on Earth to thrive depends on maintaining persistent and plentiful access to clean water.

Due to the importance of resolving this immense issue, the US National Academy of Engineering, UK Royal Academy of Engineering, and Chinese Academy of Engineering have deemed “providing access to clean water” to be one of their 14 “Grand Challenges for Engineering.” The Grand Challenges are engineering issues that must be addressed to ensure a healthy, sustainable, and increasing quality of life for billions of people across the world.

In recognition of the challenge’s importance and applicability to all nations, *FIRST* Global is taking this most universal of challenges – access to clean water – as the focus for the inaugural *FIRST* Global robotics game. *FIRST* Global teams from around the world will come together in a yearly robotics challenge and be inspired to pursue STEM education and careers.

Game Overview

This year’s robotics challenge will reflect how we need to cooperate as a global society to solve the water crisis. Teams representing over 140 different countries will be organized into two (2) competing alliances, hydrogen and oxygen, each alliance composed of three (3) national teams that rearrange into different alliances each match. These alliances are tasked with transforming a polluted river into a clean water source while storing as much water as possible. As the teams prepare for the end of the game, they get out of the path of the flooding river by seeking higher ground.

Solving this global water issue will need much more than the best engineering minds of our era. It will require a whole new generation of tech savvy future STEM leaders who will demand a global response to the issue of water security. These students are doing much more than competing in a robotics game – they are learning that these challenges will only be defeated when people realize we are all on the same team, and that with technology, we can accomplish things we can only imagine by communicating, cooperating, and working together to apply technology as a tool for positive change in the world.

The Arena

A1: The game is played on a 4 meter by 5.5-meter FIELD, bounded by and including the upward- and inward-facing surfaces of the GUARDRAIL around the field.

A2: In the center of the FIELD is the RIVER, a 4-meter-long by 1 meter wide section comprised of a flat polycarbonate panel covered in a decorative vinyl graphic.

A3: Extending out from the RIVER are the RIVER BANKS which are 4-meter-long by two-meter-wide platforms covered in green carpet, raised from the RIVER by approximately 2.25 inches (5.71 cm). There are 25cm long ramps at a 13-degree angle leading from the RIVER to the top surface of the RIVER BANKS.

A4: At each end of the FIELD is the CLIMBING BAR, which is a 4.2cm diameter, 75cm high (measured to the top of the bar) aluminum pipe that spans the width of the field, supported by polycarbonate uprights.

A5: Underneath each CLIMBING BAR in the front corners of the FIELD, there is a 20cm x 50cm opening along the top surface of the RIVER BANK called the WATER RESERVE.

A6: Spanning the RIVER BANKS and RIVER, at the back of the FIELD, is the BRIDGE. The BRIDGE is comprised of a 30cm high, 125cm long, by 80cm wide panel that is approximately parallel to the floor, with two ramps 100cm long at a 14-degree angle leading from the top surfaces of the RIVER BANKS.

A7: At the top of the BRIDGE, against the GUARDRAIL, there are two 30cm by 30cm square openings called LABORATORIES.

A8: There are two types of PARTICLES, both of which are 8cm diameter light plastic balls. CLEAN WATER PARTICLES are blue while CONTAMINANT PARTICLES are orange. PARTICLES flow out of the opening underneath the BRIDGE.

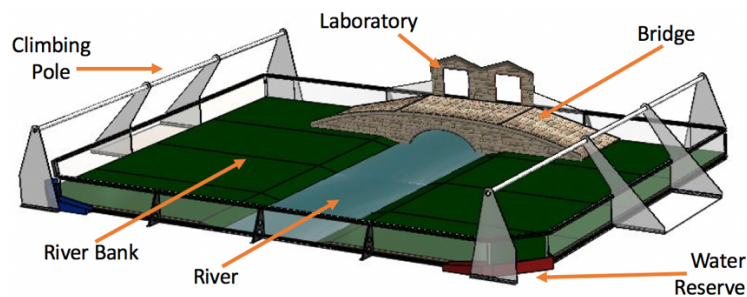


Figure A1: Field

The Match

M1: The game is designed with a minimum number of rules in order to encourage teams to be creative. While teams are encouraged to be creative on the playing field, the minimal use of rigid rules should not be taken as an invitation to intentionally bend or search for ways around the rules that do exist. This is to ensure safe and fair play for all FIRST Global teams. If you do not act within the spirit of the rules during gameplay, you will be penalized accordingly.

M2: As teams begin to strategize and wonder if certain tactics are legal, they can email GameQuestions@first.global to ask their questions. FIRST Global will review these questions, provide answers, and release game updates as needed. In certain cases, a game “update” will be sent if a question’s answer requires any change in the rules. In such cases, the game “update” will be sent to all teams.

M3: All members of a team in the play field area must be wearing ANSI (or equivalent) approved safety glasses and close-toed shoes (safety glasses will be provided at the game). This is to ensure the safety of all participants. Noncompliance will result in a penalty. (More information on PENALTIES can be found in the Scoring Summary and Glossary.)

Pre-Match

M4: Each game is played with six teams that are assigned to one of two competing, three team alliances. The two alliances are the Hydro Alliance and the Aqua Alliance. The three team alliances are determined at random for each round so that the participating *FIRST* Global teams will have the opportunity to work with different teams from around the world in each successive game. The three teams that compose an alliance must work together to accomplish their common goal of obtaining points for their alliance. Each team will attach a *FIRST* Global provided alliance flag and national flag to their robot, so that robots on the field can be easily identified. The alliance flag will be either red or blue to represent the Hydro Alliance or the Aqua Alliance. For more information on the flags, please refer to **R5**.

M5: Three (3) students are allowed within the ALLIANCE ZONE just outside the field area; two (2) robot drivers and one (1) robot tactician. Only robot drivers will be allowed to remotely operate their robot while the tactician may instruct the drivers.

M6: Prior to the start of the match, robot drivers and tacticians may place the robot anywhere fully inside the river bank on their side of the field. Hydro Alliance teams will place their robots on the field first, followed by the Aqua Alliance teams second.

M7: When the referees are ready, field personnel will instruct teams to select their Driver Controlled Op Mode (operational mode) and initialize their robots by triggering the teams' initialization event software with their Driver Station tablet.

M8: The match begins when field personnel reach "go" in the count down – "3-2-1-GO". Teams will then start their robots by pressing the start button on their tablet device. Teams that do not adhere to this start are subject to a PENALTY.

During the Match

M9: Each match faces the Hydro Alliance against the Aqua Alliance. Both alliances are comprised of three teams each. The individual matches are two and a half (2.5) minutes long.

M10: As soon as the match starts, an initial flood of 40 CLEAN WATER PARTICLES and 10 CONTAMINANT PARTICLES are released. Once this occurs, PARTICLES will be released into the RIVER at a rate of approximately 1 ball every 5 seconds. The PARTICLES will be a mixture of CLEAN WATER and CONTAMINANTS with a rate of about 4 CLEAN WATER PARTICLES to 1 CONTAMINANT PARTICLE.

M11: As soon as the match begins, robots are free to move about the full field, including the RIVER, BRIDGE, and both RIVER BANKS to begin sorting WATER and CONTAMINANT PARTICLES into their alliance's respective WATER RESERVE and LABORATORY.

M12: CLEAN WATER PARTICLES are considered "scored" if they are completely inside an alliance's WATER RESERVE. Once a CLEAN WATER PARTICLE has completely stopped inside of an alliance's WATER RESERVE, it may not be purposely removed into any other area of the field or scored again. Each scored CLEAN WATER PARTICLE is worth 1 point.

M12.A: If a CONTAMINANT PARTICLE finds its way into a WATER RESERVE, a PENALTY is applied to the alliance that causes the PARTICLE to enter.

M13: CONTAMINANT PARTICLES are considered "scored" if they have been completely placed inside an alliance's LABORATORY. A scored CONTAMINANT PARTICLE may not be removed from the LABORATORY to another area of the field, nor may it be scored again. Each scored

CONTAMINANT PARTICLE is worth 4 points.

M14: Once ten (10) CONTAMINANT PARTICLES are scored between the two alliances, the flow of CONTAMINANTS will stop. PARTICLES will continue to flow at a rate of one (1) PARTICLE every five (5) seconds, but only CLEAN WATER PARTICLES will flow.

M15: “Cooperation” Bonus: In the spirit of all robots working together within two alliances to solve the global water crisis, a bonus of 15 points will be awarded to both alliances if:

1) the flow of CONTAMINANT PARTICLES is stopped via the method described in rule **M14**, and

2) if all CONTAMINANT PARTICLES are outside the RIVER at the end of the match.

Please note that until the flow of contaminants is stopped, it will be very difficult to ensure there will be no contaminants in the river area. Also note that not all CONTAMINANT PARTICLES must be scored, they must simply be outside the RIVER to qualify for the bonus. Both Conditions 1 and 2 above must be met to qualify for the “Cooperation” bonus points.

M16: At the conclusion of the match (as described in rule **M18**), teams must prepare for the coming river flood by parking their robots fully on the BRIDGE or pulling themselves off the ground using the CLIMBING BAR. Robots must stay off the ground after the match has concluded to receive points. Parking your robot fully on the BRIDGE is worth 5 points. Pulling your robot off the ground using the CLIMBING BAR is worth 20 points.

M17: Robots acting out any of the actions listed below will incur a PENALTY for their alliance. PENALTIES include:

M17.A: Deliberately detaching parts of their own, a teammate’s, or an opponent’s robot during gameplay.

M17.B: Intentionally destroying, damaging, tipping, or other making other aggressive actions towards participating robots, particles, or the game field.

M17.C: Purposefully removing particles, robot parts, or any other objects located on or in the game field to a location outside of the game field.

M17.D: Purposefully manipulating anything on the game field in a way that is outside of the intent of fair and productive gameplay.

M17.E: Purposefully interfering with particle scoring in the opposite alliance’s alliance zone.

M17.F: Purposefully contacting anything outside of the game field with your robot.

M17.G: Robots may not pin an opponent’s robot against a wall, “t-bone”, or control another robot’s movement for more than 3 seconds as counted down by the referee.

M17.H: Forcing an alliance to break a rule.

M17.I: A robot may not intentionally impede access to scoring areas.

Post-Match

M18: At the end of the two and a half (2.5) minutes, the match will finish. Upon the conclusion of the game, the robots must immediately stop moving.

M19: Once the match is over, the referees will immediately inspect the field to finish the scoring process.

M20: Once the referees and field personnel have given the all-clear, teams may remove their robots from the field.

The Challenge

Overview

At the 2017 *FIRST* Global Challenge, a number of quantitative and qualitative awards will be presented at the conclusion of the event. Among the quantitative awards, there will be two main types.

Cumulative Points

C1: At the conclusion of each game, the individual teams on each alliance will be awarded the number of points that their alliance earned at the conclusion of their match. These points are known as Cumulative Points. At the conclusion of each round, the Cumulative Points are added to each team's previous total. At the end of the six rounds, the team with the highest number of Cumulative Points will be determined to be the winner. If two or more teams have an equal number of Cumulative Points, the team with the most Match Points (as described in rule **T1** and **T2**) will be determined to be the winner. If there is still a tie, the team with the highest number of Cumulative Points earned during a single game will be determined to be the winner.

Match Points

T1: Teams compete in matches to earn ranking status based on their win-lose-tie record. Teams will receive 2 ranking Match Points for wins, 1 for ties, and 0 for losses.

T2: Teams will first be ranked by their number of ranking Match Points. If two or more teams have an equal number of ranking Match Points, the team with the most Cumulative Points (as described in rule **C1**) will be determined to be the winner.

The Robot

R1: Robots must pass safety inspection before they enter the playing field.

R2: To participate in a match, teams must have passed safety, hardware, and field inspection.

R3: Robots must be comprised solely of items from one (1) *FIRST* Global Kit of Parts. Any additional parts found will prevent a team from participating until the unauthorized parts are removed.

R4: Teams must display a *FIRST* Global provided country flag at all times. Flags will be provided and attached to robots at the event. The flags are four (4) inches (10.16cm) by six (6) inches (15.24cm) and have an approximately ten and a half (10.5) inch (26.67cm) long pole with a diameter of 3/16th of an inch (0.48cm).

R5: During the match, robots must also display a *FIRST* Global provided Alliance flag reflecting the color of their alliance. Flags will be provided, and attached to robots prior to the match. The flags are four (4) inches (10.16cm) by six (6) inches (15.24cm) and have an approximately ten and a half (10.5) inch (26.67cm) long pole with a diameter of 3/16th of an inch (0.48cm).

R6: Both the alliance flag and the country flag should be attached to each robot by sliding them into the Extrusion t-slot as shown in **Figure R1** below. **The Alliance flag and country flag must be arranged exactly as shown below to ensure robots can be easily identified.**



Fig R1: Flag slotted into Extrusion t-slot

R7: The starting position of the robot must not exceed a starting volume of 50cm x 50 cm x 50cm. After the start of the match, robots may extend beyond this configuration. Any robots found in violation of this rule will not be allowed to play until they fit within the required volume.

R8: Robots must not pose a danger to other robots, the field, or people in the area. Any robot found in violation of this rule will prevent its team from participating until the robot is deemed safe by inspectors.

Example: Any parts tensioned using the surgical tubing must properly contain this energy to ensure it cannot be accidentally released, causing harm to a robot, field element, or human bystander.

Scoring Summary

Type	Action	Points
PARTICLE	Scored Clean Water Particle into alliance Water Reserve	1
	Scored Contaminant Particle into alliance Laboratory	4
Coopertition	Clean River	15 (both alliance)
End Game	Robot parked on Bridge	5
	Robot hanging on Climbing Bar	20
Penalty	Penalty	5 points (to opposing alliance)

Definitions

ALLIANCE: a cooperative of up to three teams.

BRIDGE: a system of PVC foam panels, polycarbonate panels, aluminum extrusions, and vinyl graphics that create the top platform, ramps and support structure for robots to drive upon.

CLEAN WATER PARTICLE: A blue PARTICLE that represents clean water.

CLIMBING BAR: a 4.2cm diameter, 75cm high (measured to the top of the bar), aluminum pipe that spans the width of the field.

CONTAMINANT PARTICLE: An orange PARTICLE that represents contaminants in the water.

FIELD: a 4 meter by 5.5-meter carpeted area, bounded by and including the upward and inward facing surfaces of the GUARDRAIL.

GUARDRAIL: a system of transparent polycarbonate panels, supported on the top and bottom edges by aluminum extrusions. The GUARDRAIL prevents ROBOTS from inadvertently exiting the FIELD during a MATCH.

LABORATORY: A 30cm by 30cm square opening at the top of the BRIDGE through which teams can score CONTAMINANT PARTICLES.

MATCH: a two (2) minute and thirty (30) second period of time in which ALLIANCES play H2O Flow.

PARTICLE: an 8cm diameter light plastic ball used to score points in H2O Flow.

PENALTY: An allocation of five (5) points to the opposing alliance.

RIVER: a four (4) meter long by one (1) meter wide section comprised of a flat polycarbonate panel covered in a decorative vinyl graphic.

RIVER BANKS: are four (4) meter long by one meter wide sections covered in green carpet, raised from the RIVER by approximately 2.25 inches (5.71 cm). There are 25cm long ramps at a 13-degree angle leading from the RIVER to the top surface of the RIVER BANKS, on each end of the field.

WATER RESERVE: A 20cm by 50cm opening on the GUARDRAIL sections in the front two corners of the field.