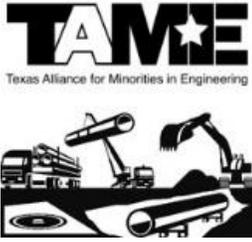


# Channel Crossing Challenge



At ConocoPhillips (COP), STEM professionals design, build and maintain channels to transport fluids (water, oil and gas) across varied, rugged landscapes. The COP team designs the channels so that the maximum amount of fluids are moved from one location to the other while keeping construction and maintenance costs low. The COP team also works together to make sure that the project is completed on time and makes careful use of the areas that are approved for this work. The team tries to reduce environmental impact by not having any spills during channel construction or transportation of fluids.

## DESIGN BRIEF

Design a channel to transport fluids (represented by bbs) across the landscape placed at your work station. The fluids (bbs) must move because of gravity (flow from higher to lower levels) and will need to move from the entry zone to the collection zone within 30 seconds. You have 60 minutes to design and build a covered channel to transport the fluid.

Your team will present your design concept and explain why you chose your materials and route. You will explain the strategy you used in moving the fluid (bbs) across the landscape. Teams will earn points for the amount of fluid that is delivered in 30 seconds. Points will be awarded based on the amount of fluid delivered to the collection circle and points will be taken away for fluid spilled out of the channel.

Do not underestimate the weight of the “fluid.” You have been given 10 bbs to test with. During the design process, judges will come to each team and show you the maximum amount of bbs that must be moved through your channel during judging. The weight of the fluid is significant and should be considered during your design process.

## TEAM ROLES

If you have less than six members on your team, the project engineer should be assigned an additional role.

- The **PROJECT ENGINEER** will work with all the team members to make sure that all parts of the design work together and deliver the presentation to the judges. The project engineer is also responsible for verifying that team members complete all required documentation.
- The **CIVIL ENGINEER** leads the design and is responsible for design drawings in the documentation.
- The **CONSTRUCTION ENGINEER** will lead construction of the channel.
- The **ENVIRONMENTAL ENGINEER** is responsible for route testing, ensuring fluid stays within the channel and collecting the fluid during the testing.
- The **ECONOMIST** will lead the team in developing a strategy to maximize points earned. The economist will calculate costs of various options to determine the most profitable design.
- The **OPERATIONS ENGINEER** will be responsible for pouring bbs into the channel during judging, constructing the mountain and examining design trade-offs.

## SUPPLY LIST – CIVIL ENGINEER, CHECK IMMEDIATELY

You have five minutes to replace any missing items.

RAW MATERIALS, MAY BE ALTERED				
1 sheet chip board	1 sheet card stock	6 craft sticks	4 paper clips	2 skewers
Masking tape	1 gallon baggie	4 pipe cleaners	1 paper cone	7 straws
OTHER RESOURCES, MAY NOT BE ALTERED OR USED IN CHANNEL DO NOT COUNT TOWARDS MATERIALS RETURNED				
1 pair of scissors	2 sharpened pencils	Design challenge instructions	Team number sign	
Landscape	10 bbs	Small baggie (used for collection)	1 plastic cup (to measure and pour bbs)	

## REQUIREMENTS

- Only the materials provided and listed in the supply list on the previous page may be used in building the channel. Materials that are intact and not altered may be returned at judging for cost savings (points).
- Your channel must have a name. Both the channel name and team number must be recorded on the scoring sheet and on the landscape.
- Your mountain must be constructed and accurately placed on your landscape. It may not be altered.
- Your entire channel must be covered.
- Your fluid must enter your channel in the loading area. The endpoint for your channel must be within the round collection area.
- You must choose a route over or around the mountain and justify it in terms of cost and successful engineering strategy.
- Your channel must stay within the boundaries of the provided landscape board. The landscape may not be moved, cut or reassembled.
- When loading bbs into your channel you may not touch any part of the channel.
- You must use the collection baggie to collect your fluid in the collection area. Fluid must enter the baggie within the collection area but your baggie may extend outside of this area. The environmental engineer will be responsible for holding the baggie for collection and making sure that there are no spills at this end.
- Each team is given 10 bbs for testing. Points will be given for each bb returned at judging.
- Team members may not consult with people who are not on their team or use any outside sources of information (cell phone, tablets, computers, etc.)

## TIME

- Teams will have 60 minutes to design and build the channel.
- After 60 minutes, time will be called and construction will be halted.
- Each team will have 2 minutes to deliver their presentation to the judges and 30 seconds to move the maximum amount of fluid through the channel.

## PROJECT PLAN

- Introduce yourself to your team. Decide who will take on each role. Each team member must have an assigned role and all roles must be assigned.
- Review the scoring sheet and determine how you can meet the requirements and maximize points.
- Test as you build to make sure the fluid flows through the channel and remains in the channel.
- Answer all questions in documents. Tied scores will be broken by the completeness of your paperwork.
- **Price Optimization:** There are costs associated with the materials and route your team chooses. It is worth spending time weighing the potential costs, benefits and risks to the route you design and build. **Costs are involved in crossing or building a support in protected lands as well as building a support in water.**
- You may separate the pages of this packet.
- Be creative and have fun with this project! Good luck!

## SCORING SHEET

Team Number: \_\_\_\_\_ Channel Name: \_\_\_\_\_

Position	First name	Last name	School
Project engineer			
Civil engineer			
Construction engineer			
Environmental engineer			
Economist			
Operations engineer			

### TO BE COMPLETED BY JUDGES – CIRCLE ONE ITEM PER LINE

# Raw materials returned: \_\_\_\_\_ (5 points per item) # BBs returned: \_\_\_\_\_ (5 points per bb)

DESIGN	Point Allocation	
Channel has a name marked on landscape	Yes (+10)	No (0)
Team number is marked on landscape	Yes (+10)	No (0)
Mountain is assembled, placed in accurate location and not altered	Yes (+10)	No (-50)
Entire channel is covered	Yes (0)	No (-30)
Fluid enters channel within entry zone	Yes (0)	No (-100)
Fluid leaves channel within collection circle	Yes (0)	No (-100)
Channel stays within board perimeter	Yes (0)	No (-100)
Channel has support structures in water	Yes (-100)	No (0)
Channel crosses protected lands	Yes (-30)	No (0)
Channel has support structures in the protected lands	Yes (-75)	No (0)

PRESENTATION	2	4	6	8	10
Strategy to maximize points earned					
Engineering challenges and design choices					
Team works well together					
Design drawing is complete and accurate					
Paperwork is complete					

PERFORMANCE	Yes	No
Operations engineer touches channel while pouring bbs during judging	Yes (-50)	No (0)
Environmental engineer uses small baggie to collect all bbs that are moving through the channel at testing.	Yes (+10)	No (-50)

40 – 60 ml of fluid collected (200 points)	20 – 40 ml of fluid collected (100 points)	0 – 20 ml of fluid collected (50 points)
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No fluid spilled (50 points)	Some fluid spilled during judging at entry zone, collection circle or along the channel (-50 points)
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## PROJECT ENGINEER

AVERAGE SALARY: \$76,000

A *project engineer's* responsibilities include schedule preparation, planning and resource forecasting for engineering and other technical activities related to the project. They may also be in charge of performance management of vendors.



Key Responsibilities: Organize team, fill out all paperwork or make sure other team members have done so. Verify all project requirements are completed.

- Lead the team in the 2 minute presentation to the judges. You may either make the entire presentation, or share it with other team members, making sure the entire presentation stays within two minutes.
- Lead the team in coming up with an interesting name for the channel. Make sure that the team name and team number are recorded on the landscape and scoring sheet. Record team number on all paperwork pages where indicated.
- Verify that all team members have a role and that all roles have been assigned to a team member. If there are less than 6 members on a team, the project engineer takes on the additional role.
- Ensure that team members have completed all required questions and documentation within these pages.
- Be responsible for handing the scoring sheet (with team member name and school information filled out) to the judges.
- Keep track of time.

### TIPS FOR A GREAT PRESENTATION:

- Fully define the challenge.
- Explain your solution.
- Look at the scoring sheet to see what the judges are evaluating you on. Be sure to address those issues. Stay aware of time, but also do not rush. Making a quick list of things you want to be sure to say and practicing with a teammate ahead of time is time well spent. Space here can be used for notes.

## CIVIL ENGINEER

AVERAGE SALARY: \$73,000

*Civil engineers* imagine, design, build, supervise, operate, construct, and maintain infrastructure projects and systems in the public and private sector, including roads, buildings, airports, tunnels, dams, bridges, and systems for water supply and sewage treatment.



Key responsibilities: Design channel, record design ideas.

- Check supplies and verify that all the items listed have been provided.
- During design, make drawings of the proposed different parts of the channel.
- During the building phase, work with all the team members to put the different parts of the channel together.
- Create final drawings of the finished channel here. Consider what changes were made and why.

Engineers' early ideas rarely work out perfectly. Why is it important to put your design on paper first?  
How does testing help to improve a design?

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**PRELIMINARY DRAWINGS  
NOT FOR CONSTRUCTION**

--- This space for civil engineer's design drawings. ---

## CONSTRUCTION ENGINEER      AVERAGE SALARY: \$80,000

*Construction engineering* deals with the designing, planning, construction, and management of infrastructures such as roads, tunnels, bridges, airports, railroads, facilities, buildings, dams, utilities and other projects.



Key responsibilities: Channel construction and optimization

- Work closely with the civil engineer to put design ideas into practice. Often ideas that look good on paper do not translate into success when the building starts. Redesign and refinement are common elements of the building process.

Channel Element	Did this element work the first time?	How did you change it to make it work better?
Fluid entry point (where bbs are entered into the channel)		
Support structures		
Bends in the channel		
Fluid collection area		
Other interesting or challenging elements in your channel		

**ENVIRONMENTAL ENGINEER**      **AVERAGE SALARY: \$78,000**

*Environmental engineering* deals with the protection of human populations from the effects of adverse environmental factors. It also includes the protection of environments, both local and global, from potentially dangerous effects of natural and human activities.



Key responsibilities: Ensure there are no leaks in the channel or fluid spills. Collect the fluid during judging.

- The environmental engineer has a specialized focus in considering how the bbs will flow. She/he is responsible for testing and controlling the precious 10 bbs worth of fluid given to the team for testing. Points will be given for each of the bbs returned during judging.
- Work with the civil and construction engineers to design and construct elements that will maximize fluid retention. Consider places in the channel where fluid might escape and help to design solutions to prevent this.
- You must use the small baggie to collect your fluid in the round collection area. Fluid must enter the baggie within the collection area but your baggie may stick outside of this area.

Requirements	Meets Requirement (Y/N)
Fluids can be reliably entered into the channel	
Fluid goes through channel without stopping	
Fluid can make turns without spilling	
Fluid can be gathered at collection point without spilling	
Channel is stable enough to support fluid	

What variables had the greatest impact in your design (for example, weight of fluid, path through landscape)? How did you address these variables in your design approach?

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## ECONOMIST

AVERAGE SALARY: \$76,000

*Economists* typically research and analyze economic issues, conduct surveys and collect and analyze data using mathematical models and statistical techniques.

Key Responsibility: Lead team in developing strategy to maximize points. Be able to explain your strategy.



- Work closely with all team members to determine the best balance of design and construction.
- Count and return all unused materials for points.
- Carefully review the scoring sheet and consider cost trade-offs to the route you choose.

A **back-of-the-envelope calculation** is a rough calculation, typically jotted down on any available scrap of paper such as an envelope. It is more than a guess but less than an accurate calculation or mathematical proof. Back of the envelope calculations are used in every part of a project, from beginning to end, and can help guide the project in meaningful ways. Use the space below to make some back of the envelope calculations and comparisons to help guide your build.

**Possible paths:**

**Materials used:**

## OPERATIONS ENGINEER

AVERAGE SALARY: \$73,000



*Operations engineers* make sure a company's operations, such as manufacturing and shipping, work properly and meet factory and management specifications. These engineers handle any repairs or upgrades to the machinery and coordinate with other department heads to fine-tune their operations systems.

*Key responsibilities:* Construct mountain and accurately place on landscape. Consider design trade-offs. Discuss these with team members who are designing, building, and pricing the channel. Insert fluid into the channel during the 30 second testing run. **When loading bbs into channel you MAY NOT touch your channel.**

A critical aspect of engineering design is in making design trade-offs. A design trade-off is a situation that involves losing one quality or aspect of something in order to gain another quality or aspect of something.

For example, the stronger you make something, the more materials you likely need to build it. More materials mean more money. As an engineer, you need to find the best balance for this trade of strength and budget. This can mean redesigning a part to use fewer materials or choosing a different route to add distance without adding as much cost.

Trade Study Topic	Trade Study Details
Loading accuracy	
Route stability	
Fluid collection considerations	

What was the most challenging requirement in this project? What was your team's approach to meeting this challenge?

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