

Applied Mathematics 30

**Student Project:
Minimizing Costs**



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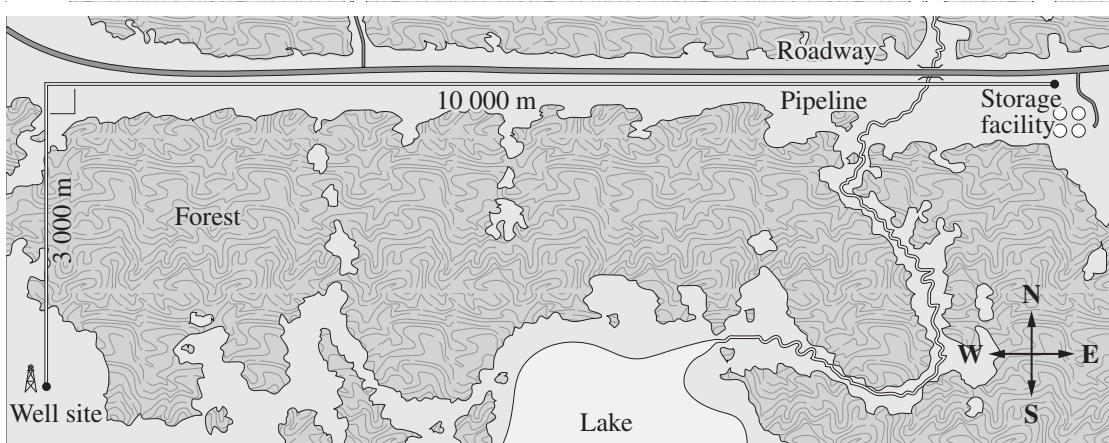
Project: Minimizing Costs

Introduction

A company that has been contracted to lay pipeline between a natural gas well and a storage facility wants to minimize its costs. The project manager has drawn up two proposals for the path of the pipeline.

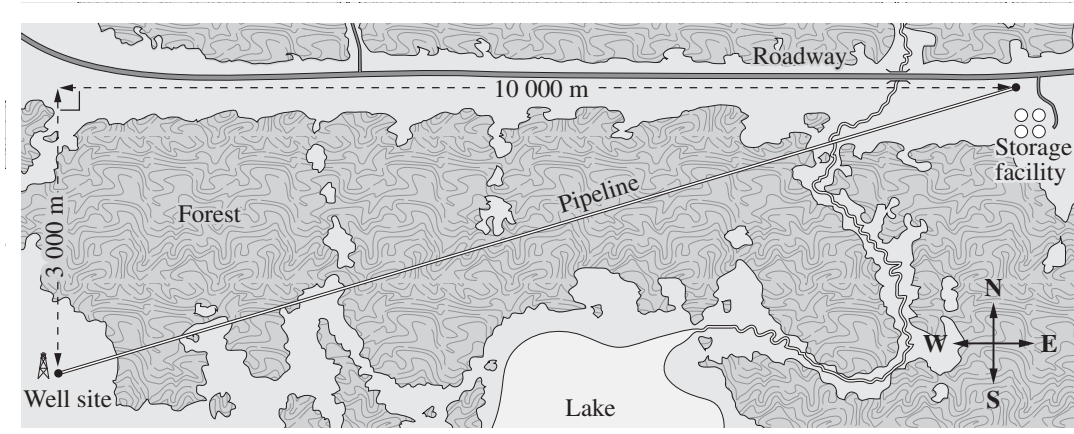
Proposal A

The company would lay 3 000 m of pipeline through a forested area and 10 000 m of pipeline parallel to an existing roadway, as shown below.



Proposal B

The company would lay pipeline directly from the well site to the storage facility through a forested area, as shown below.



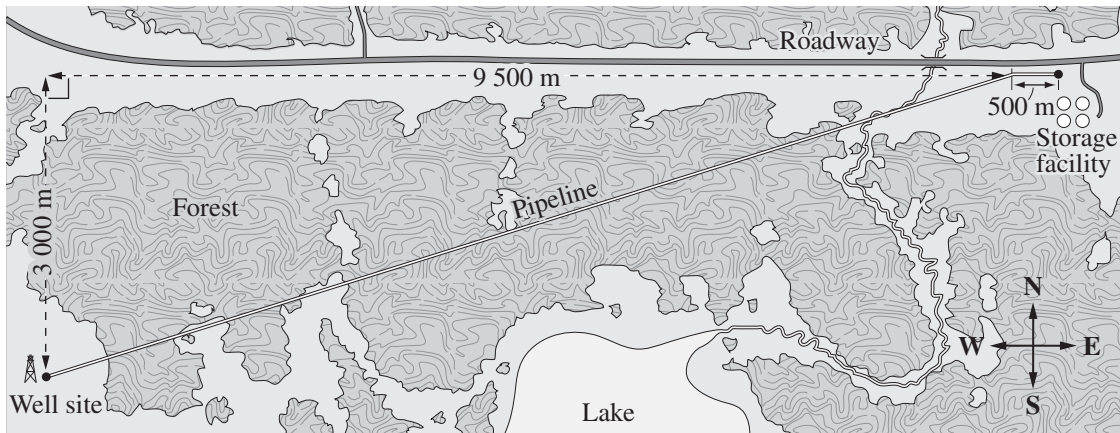
Part A

The project manager has been given the task of determining which proposal is the most cost-effective. The amount budgeted for the first phase of this project and some costs are given below.

- It will cost, on average, between \$330/m and \$340/m to lay pipeline parallel to the roadway.
 - It will cost, on average, between \$350/m and \$360/m to lay pipeline through the forested area.
 - The budget for the first phase of this project is \$3 700 000.
1. Determine the minimum total cost and the maximum total cost of the first phase of laying the pipeline as shown in proposal A.
 2. Determine the minimum total cost and the maximum total cost of the first phase of laying the pipeline as shown in proposal B.
 3. Should the project manager recommend proposal A or proposal B? Justify your answer.

4. In order to minimize costs, the project manager has developed a third proposal: the company would lay a portion of the pipeline parallel to the roadway and the rest of the pipeline through the forested area, as shown below.

Proposal C



- Determine the minimum total cost and the maximum total cost of the first phase of laying the pipeline as shown in proposal C.
5. Design a spreadsheet that will calculate the total cost of proposal C each time that the portion of the pipeline to be laid parallel to the roadway is extended by 100 m. Use the 500 m portion parallel to the roadway as trial 1 in the spreadsheet.
- Before you design the spreadsheet, choose a suitable cost per metre for each portion of the pipeline from the costs listed at the beginning of part A. Justify your choices.
 - Supply two printouts of your spreadsheet: one printout showing all lengths, costs, and totals and the other printout showing the formulas within the cells. Use your spreadsheet to determine the least expensive path for proposal C.
6. Compare the total cost for proposals A, B, and C.
7. Use appropriate vector terminology to describe the least expensive path for proposal C.

Part B

The project manager wants to have a visual model of his proposal as part of his presentation to the pipeline company owners.

1.
 - Perform a regression analysis on the data in your spreadsheet. In your analysis, relate the length of pipeline laid parallel to the roadway to the total cost of the project.
 - Determine an appropriate regression equation, and identify what each variable represents in the context of proposal C. Justify your choice of regression equation.
 - Graph your regression equation. Use your graph to determine the least expensive path for proposal C.
2. Is the regression equation a good model of the data shown in the spreadsheet? Justify your answer.

Part C

The project manager has also been asked to do a cost-recovery analysis for this phase of the pipeline project.

1. The volume of gas that will pass through the pipeline in one day is normally distributed with a mean of 1 530 000 m³/day and a standard deviation of 445 490 m³/day. Determine the probability that the volume of gas that will pass through this pipeline in one day is between 1 000 000 m³ and 2 000 000 m³.
2. The company has determined that the profit margin for the gas is 10% of the wholesale price. Based on an average historical wholesale gas price of \$6.978/1 000 ft³, how long will it take for the company to recover the cost of the first phase of laying the pipeline? (**Note:** 1 000 ft³ = 28.316 846 5... m³)

Part D

During the course of this project, you have investigated different proposals for minimizing the cost of laying a pipeline in a specific area. However, there are many other variables and issues—ranging from the size of pipe being installed to environmental concerns—surrounding pipeline development. Research and write a one- or two-page report on issues facing pipeline development. The following websites may help in your research.

www.arcticgaspipeline.com/
www.mackenziegasproject.com/
www.forests.org/archive/canada/cothweig.htm

Note: Website addresses sometimes change. If the websites listed above are not available, use a search engine and type in keywords such as those listed below:

“northern gas pipeline”
“Mackenzie Gas Project”
“environmental concerns pipeline development”

OR

Prepare a PowerPoint presentation that summarizes the main aspects of this project.