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MATH 1210 - Pipeline Project
Spring 2015 - SLCC

CEO

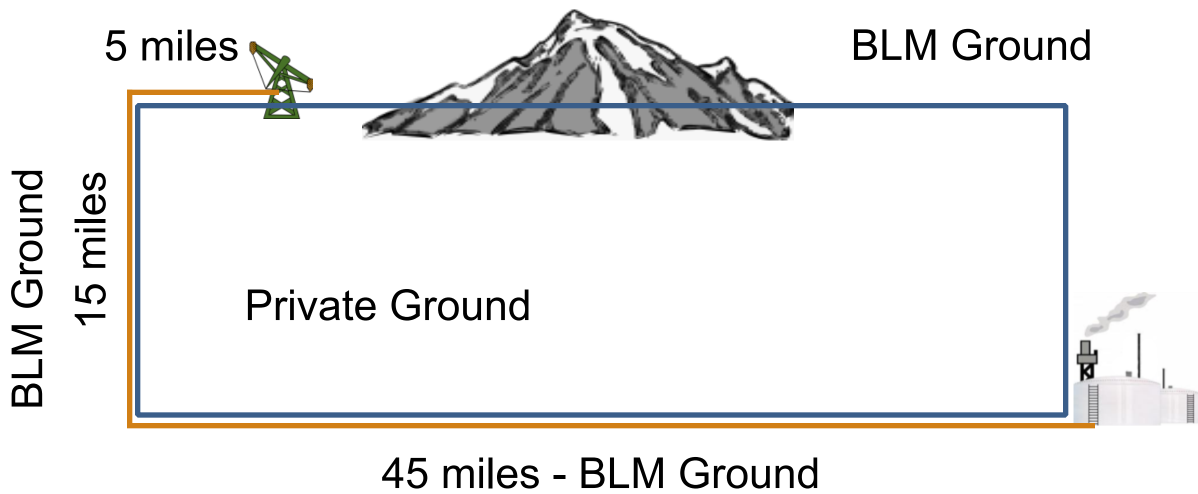
The report analyzes the most cost effective and the least cost effective routes for the pipeline project. Each scenario will include a figure with more descriptive information, calculations, and explanations between all of them that is cost effective. The last scenario will show the most cost effective route for the pipeline project. Each route has different expenses, fees, and environmental impact study that need to be considered for the near future.

Reflection

I have learned a tremendous amount of concepts upon taking this calculus course. I can definitely see why many people around the world like physicists and engineers using calculus in their area of work. It makes it useful when it comes to putting projects like the one I just did for the pipeline project. I'm planning to go into the medical field, and I can probably see how calculus gets you to think more logically and putting together medical equipment and building hospitals and clinics. Calculus is very important in this area in medicine especially in building medical equipment and hospitals and clinics. Without it, it would not be possible.

a) Determine the cost of running the pipeline strictly on BLM ground with two different cases:

i) One running west, south and then east to the refinery.



This figure represents the pipe skirting on BLM ground (around the private ground) marked in orange. Having this option around the private ground avoids the right-of-way fee, which is \$350,000 per mile. Drilling through the mountain will slow the production by 6 months costing the company another \$180,000 per month plus a one-time cost of \$3,500,000 for drilling through the existing mountain and \$420,000 for the environmental impact study. This option has no delays and has a route totaling 65 miles from the natural gas (oil rig) to the refinery, which requires more pipes.

<u>Key Information of Cost of Running Pipeline Strictly on BLM Ground with Option i)</u>

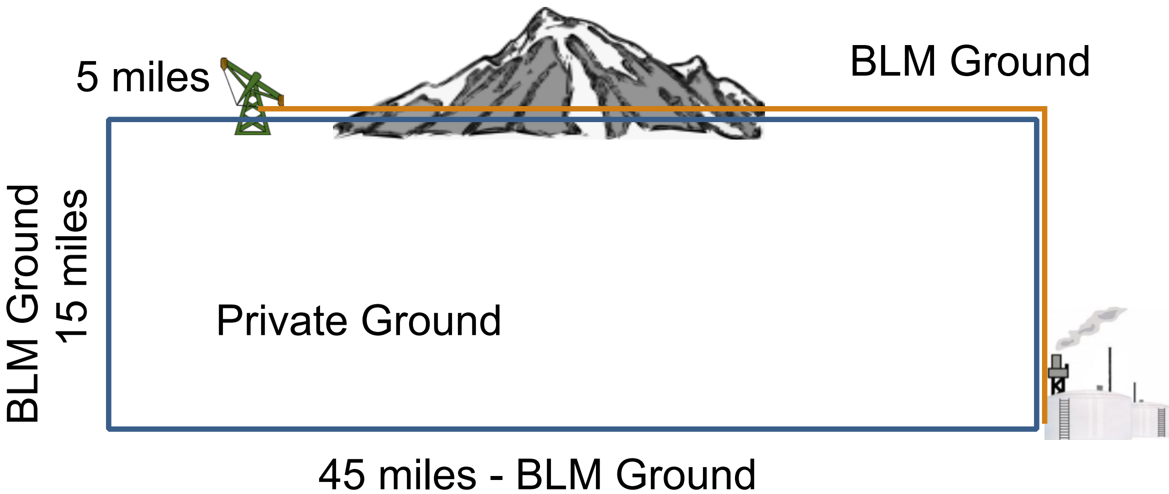
- \$500,000 per mile for normal cost of pipeline.
- 65 miles (5+15+45=65) is the distance between the natural gas (oil rig) and refinery.
- Total cost of project is \$32,500,000.

<u>Calculation</u>

C(x) = 500,000x

C(65) = 500,000(65) = \$32,500,000

ii) One heading east through the mountain and then south to the refinery.



This figure represents the drills through the mountain and pipe skirting on BLM ground (around the private ground) marked in orange. This option avoids the right-of-way fees when building on private ground. Drilling through the mountain makes the path shorter from the natural gas (oil rig) to the refinery, but there are additional costs for drilling through the mountain and environmental impact study. This will also delay the project for 6 months with added costs. On the other hand, this option uses less pipes because it has a shorter distance from the natural gas (oil rig) to the refinery. This option is also the same cost as option i).

Key Information of Cost of Running Pipeline Strictly on BLM Ground with Option ii)

- \$500,000 per mile for normal cost of the pipeline.
- 55 miles (45-5=40 —> 40+15=55) is the distance between the natural gas (oil rig) and refinery going through the mountain.
- \$3,500,000 is the one-time cost of drilling through the mountain.
- \$420,000 is the cost of the environmental impact study.
- \$1,080,000 is the total cost of the 6 month delay (180,000(6)=1,080,000).

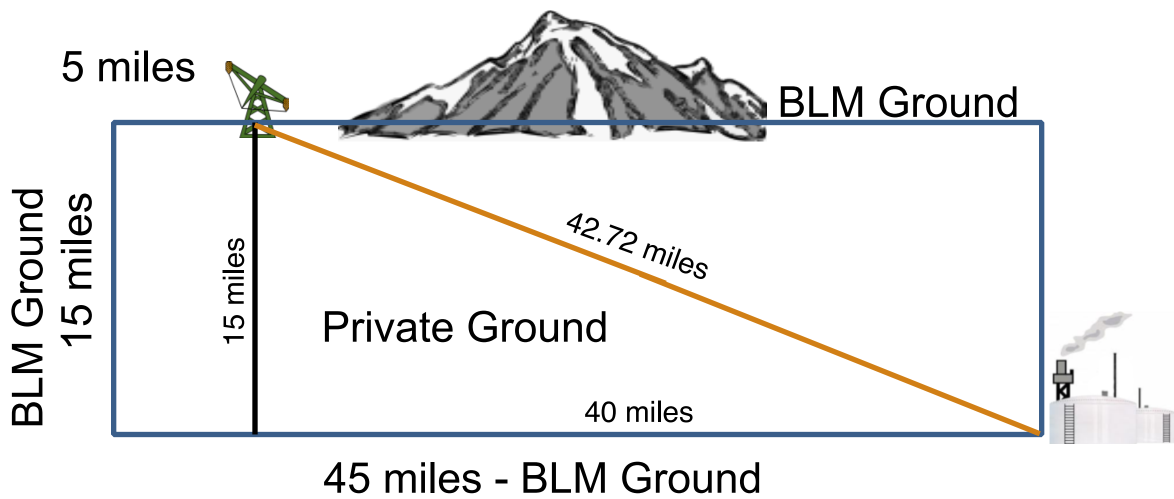
Calculation

C(x) = 500,000x + 3,500,000 + 420,000 + 1,080,000

C(55) = 500,000(55) + 3,500,000 + 420,000 + 1,080,000 = \$32,500,000

b) Determine the cost of running the pipeline:

i) The shortest distance across the private ground to the refinery.



This figure represents the shortest distance between the natural gas (oil rig) and the refinery marked in orange. The distance between the natural gas (oil rig) and the refinery is 42.72 miles with a right-of-way fee of $350,000 per mile plus the normal cost of pipeline of $500,000 per mile. The distance is found using the Pythagorean Theorem ($a^2+b^2=c^2 \longrightarrow 15^2+40^2=c^2 \longrightarrow c\approx42.72$). This option doesn't have to deal with the 6 month delay and the fees to drill through the mountain, but it's the most expensive method.

Key Information of Cost of Running Pipeline on Private Ground with Option i)

- $500,000 per mile for normal cost of the pipeline.
- $350,000 per mile for right-of-way fees.
- 42.72 miles is the x-value.

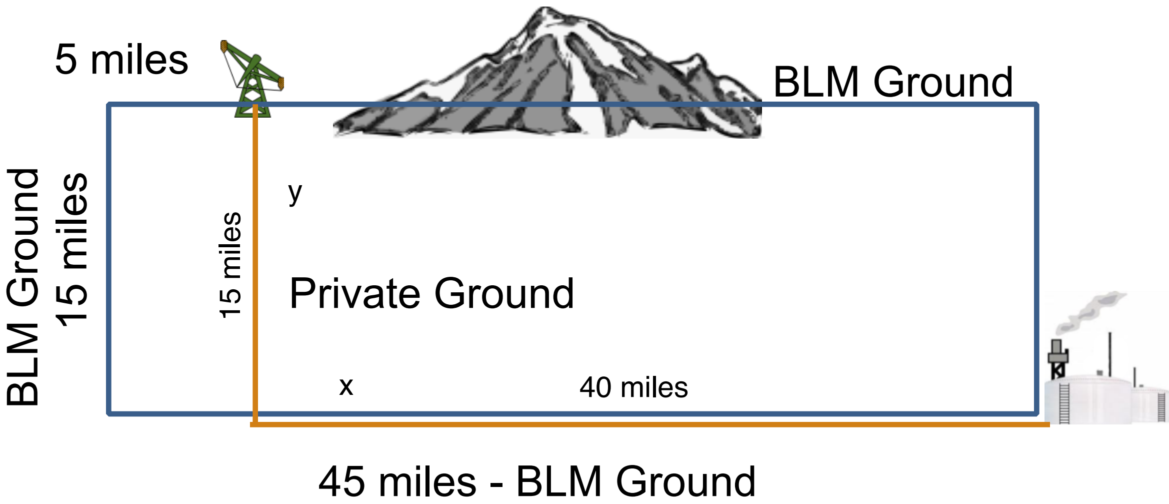
Calculation

$C(x) = 500{,}000x + 350{,}000x$

$C(x) = 850{,}000x$

$C(42.72) = 850{,}000(42.72) = \$36{,}312{,}000$

ii) Straight across the private ground, then straight to the refinery.



This figure represents the pipeline running straight south across the private ground from the natural gas (oil rig) then off of the private ground heading straight to the refinery marked in orange. This option is the second most expensive route to take.

<u>Key Information of Cost of Running Pipeline on Private Ground with Option ii)</u>

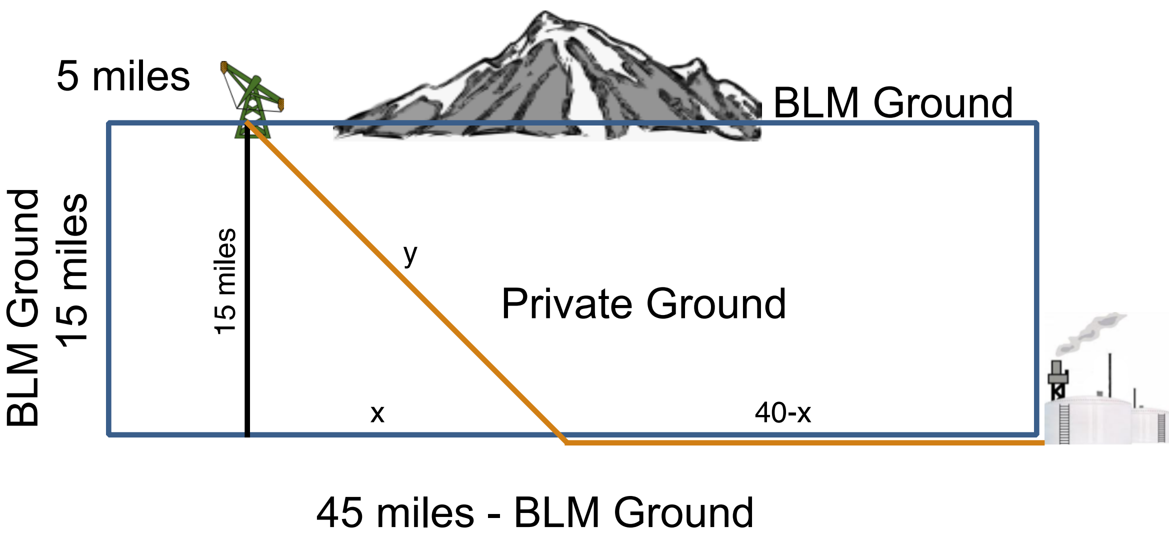
- $500,000 per mile for normal cost of the pipeline.
- $850,000 per mile for the right-of-way fee added on top of normal cost.
- 40 miles is the x-value for distance.
- 15 miles is the y-value for distance.

<u>Calculation</u>

C(x) = 500,000x + 850,000y

C(x) = 500,000(40) + 850,000(15) = $32,750,000

c) Determine the optimal way to run the pipeline to minimize cost.



This figure represents the optimizing production of the pipeline marked in orange. By minimizing the distance traveled and the total cost of the project and by creating an angle across the private ground and then moving off the pipeline onto the BLM ground, this will reduce the fee encored by building on private ground and minimize the distance between the natural gas (oil rig) and the refinery.

Calculation

$$y^2 = 15^2 + x^2$$

$$y = \sqrt{225 + x^2}$$

$$C(x) = 850{,}000y + 500{,}000(40 - x)$$

$$C(x) = 850{,}000(225 + x^2)^{1/2} + 500{,}000(40 - x)$$
$$C(x) = 850{,}000(225 + x^2)^{1/2} + 20{,}000{,}000 - 500{,}000x$$
$$C'(x) = 425{,}000(225 + x^2)^{-1/2}(2x) - 500{,}000$$
$$C'(x) = 850{,}000x(225 + x^2)^{-1/2} - 500{,}000$$
$$0 = 850{,}000x(225 + x^2)^{-1/2} - 500{,}000$$
$$500{,}000 = \frac{850{,}000x}{\sqrt{225 + x^2}}$$
$$\sqrt{225 + x^2} = \frac{850{,}000x}{500{,}000}$$
$$225 + x^2 = \left(\frac{850{,}000x}{500{,}000}\right)^2$$
$$225 + x^2 = \frac{(850{,}000)^2 x^2}{(500{,}000)^2}$$
$$225 + x^2 = 2.89x^2$$
$$225 = 1.89x^2$$
$$\frac{225}{1.89} = x^2$$
$$x = \sqrt{\frac{225}{1.89}} \approx 10.91$$

This is at minimum.

Plugging x to original function.

$$C(x) = 850{,}000(225 + 10.91^2)^{1/2} + 500{,}000(40 - 10.91)$$

$$\boxed{C(x) = \$30{,}310{,}795.33}$$

d) Graph of Cost Function

C(x) = 850,000(sqrt(225+x^2)) + 500,000(40-x)