

SPINOFF 5A

Functional Risk Assessment

Your supervisor was quite impressed with your fine work on the risk assessment of the Hansom Landfill Site. However, she has recently learned that the lab results for concentration of beryllium in the soil are faulty. Due to time and financial constraints, she determines that you are unable to wait for new lab results. She asks you to do a more in-depth analysis of the Cancer Risk for industrial workers due to the presence of beryllium in the soil at the site. In particular she wants you to use linear functions to analyze the information in Part 2 of LTA 5. Recall that beryllium is a metal, which is carcinogenic. Since it is in the soil you need to consider two cases: the Cancer Risk due to ingestion of soil and the Cancer Risk due to breathing airborne soil.

- 1) Refer to the material for Part 2 of LTA 5, and write the formula for Cancer Risk from ingestion of soil below.

Cancer Risk = _____

- 2) Since the lab results for the Chemical Concentration of beryllium may be faulty, you are to create a function, $C_1(x)$, which gives the Cancer Risk for an industrial worker at the site due to the ingestion of beryllium in the soil. Use the Chemical Concentration of beryllium as the independent variable, x .

$C_1(x) =$ _____

- 3) Now create a function, $C_2(x)$, which gives the Cancer Risk for an industrial worker at the site due to inhalation of beryllium in airborne soil. Use the Chemical Concentration of beryllium as the independent variable, x .

$C_2(x) =$ _____

- 4) Now use your answers from Exercises 2 and 3 to produce a function, $C_3(x)$, which gives the total Cancer Risk at the site due to the presence of beryllium in the soil.

$C_3(x) =$ _____

- 5) What are appropriate values for the domain and range of the functions $C_1(x)$, $C_2(x)$, and $C_3(x)$? Justify your answer.

- 6) Draw a graph of each of the functions you created in Exercises 2, 3, and 4. You will want to consider your answers for domain and range determined above. Be certain to label your axes and include appropriate units. Use a graphing utility to verify your results.
- 7) What percentage of the Cancer Risk is due to ingestion of beryllium in the soil, and what percentage of the Cancer Risk is due to breathing beryllium from airborne soil?
- 8) EPA guidelines state that a Cancer Risk of 10^{-6} is unacceptable. What concentration of beryllium in the soil gives an unacceptable Cancer Risk? Use a graphing utility to verify your results.
- 9) Further EPA guidelines suggest that if the Cancer Risk exceeds 10^{-4} , human contact with the site will have to be completely restricted. What is the concentration of beryllium in the soil that will result in a total Cancer Risk of 10^{-4} ? Use a graphing utility to verify your results.

Discussion Questions:

- 1) Write a memo to your supervisor discussing the results of your investigation of the Cancer Risk due to the presence of beryllium in the soil. Remember that your supervisor is busy and is not trained in engineering. This means you will need to explain yourself clearly without making your memo too long. However, you know your boss is fond of visual aids (graphs, tables, etc.) and you really want to impress her so including these is a must!
- 2) NASA is concerned with the cost of cleaning up a polluted site. The different possibilities for clean up with the total cost of this clean up are given in the table below:

Clean up Option	Total Cost (in millions of dollars)
Do not clean up - leave the beryllium in the soil	\$ 0
Leave the site alone for a few years and re-analyze it later	\$0.3
Construct a fence around the site and guard it to prevent any entry	\$0.5
Clean up the beryllium at the site to minimal EPA standards (Cancer Risk 10^{-6})	\$2.5
Clean up the site completely	\$10

Discuss which options for clean up you would use depending upon the different concentrations of beryllium in the soil. Remember money is not unlimited, and NASA would like to be as cost effective as possible. In addition to considering the concentration of beryllium in the soil you might also consider that the site is located near prime Florida coastline which might be developed in the near future. You should also consider that a number of species near the site are on the endangered list breed. It should also be noted that beryllium is a metal, so it does not decompose over time. Present your answer to this discussion as a memo to your supervisor.