1/8/2015

Independent Mathematical Contractors
00 Anystreet
Anytown, Anystate 00000

Dear IMC

The city I work for is currently undergoing a project to reduce the level of arsenic in its drinking water. Our city receives its drinking water from two different wells located around the city. Each well contains arsenic at varying levels. The Environmental Protection Agency gave our city an exemption for several years in complying with EPA rules. However, we are required to submit a plan to them in 6 months regarding how we will reduce the level of arsenic in the city's drinking water to an acceptable level.

Arsenic is an element in the periodic table that occurs naturally in the earth's crust. It also can enter the drinking water supply through agricultural and industrial practices. When ingested, arsenic can cause thickening and discoloration of the skin, stomach pain, nausea, vomiting, diarrhea, numbness in the extremities, paralysis and blindness. As if that was not enough, arsenic has been linked to several cancers including cancer of the bladder, lungs, skin, kidney, nasal passages, liver and the prostrate.

Under previous rules, my city was well within the acceptable arsenic standard which was 50 parts per billion (ppb). However, these rules changed and required compliance with a new standard by January 23, 2006. This standard was set at 10 ppb and only one of our wells was able to meet that standard. At the time, we were able to use this well to supply the drinking water for the entire city. Growth has necessitated that we use the other wells (that do not meet the standard).

The table below shows the two wells, their respective levels of arsenic and their capacities.

Well	Arsenic Level (ppb)	Cost per thousand gallons ($)
1	9	1.33
2	12	2

We are about to bring a third well online, however its arsenic levels are also too high. We are able to filter this well to reduce the arsenic in the well at the wellhead. We can filter the water to just about any level, but at a cost. If the water is filtered to an arsenic concentration of c, the cost per thousand gallons is $\frac{12}{c}$ dollars. The city has an average daily demand of $3.5 + 0.05 \cdot M$ million gallons that must be supplied from these three wells, where M is your team number. Because of the pipeline configuration, we cannot meet the demand using only one well. We must use at least two (preferably all three for redundancy).

To meet this demand, we plan to blend water from these three wells. This is done by piping the water to a central location and then combining different amounts from each well together to get a mixture that contains 8 ppb of arsenic. To help us write the plan for the EPA, we would like to know how much water we must pump daily from each of the wells and at what cost. We recognize that there may be many possible solutions due to the fact

CITY OF BADWATER
100 Main Street, Badwater, AZ

that we can filter at various levels on the third well. Focus on a process for obtaining a solution and not necessarily the solution itself.

Your instructor has constructed several technology assgnments to help you find a potential solution strategy.

- Technology Assignment Write Out the Equations – In this assignment you and your team will write out a system of equations for each level of contamination in Well 3.
- Technology Assignment Row Operations – Each team member will solve the system of equations using matrices and row operations.
- Technology Assignment Row Operations in Google Sheets – Each team member will verify their row operations from the previous assignment using a spreadsheet.

Please document your work in a technical memo. This document must contain enough detail so that we could modify your calculations should any of the numbers above change. This means that numbers alone will not be sufficient. We need to see your calculations and understand the steps you followed to solve the problem outlined above. You instructor will provide a sample technical memo that you may use as a starting point.

Sincerely,

Mortimer Bruster
Director of Utilities
City of Bad Water, Arizona