CONTOUR MAPS, PREPARATION, INTERPRETATION, FORENSIC PERSPECTIVE

Mehmet Pehlivan (mp@baysgrp.com) (Bays Environmental Remediation Management, Ladera Ranch, California, USA)

ABSTRACT/SUMMARY

Background/Objectives. This paper presents an outline of common pitfalls that many engineers and scientists encounter when preparing contour maps. A review of several public databases and reports indicated that a discussion about the contouring and interpretation is warranted. Many professionals prepare contour maps to illustrate subsurface conditions. Review of contour maps on Geotracker suggest that some basic points have frequently been overlooked. As a result, unintended interpretations have been presented without making any reference to their implications. Several cases and examples of contour maps were compiled from public databases and case files. These cases are presented anonymously. All names, site addresses and company logos were removed from the presentation. A special emphasis was given to the review of groundwater elevation contours and chemical concentration contours. Presentation also includes a brief discussion on: 1) how to recognize geological anomalies using contour maps; and 2) preparation of logarithmic contours. This presentation is not intended to provide information on editorial and presentation of the contour maps, such as scale, legend, and/or contour intervals.

Approach/Activities. Several files from Geotracker database were selected as worthwhile examples for purposes of this presentation.

Results/Lessons Learned. The results indicated that there is a significant tendency of making contours curve up around single well points and not following the three point rule. These may create unintended interpretations and results.

References:

http://geotracker.waterboards.ca.gov/

Freeze, Allan, R. , John A. Cherry, 1979, " Groundwater", Prentice-Hall, Inc., Englewood Cliffs, NJ 07632

Three-Point Problem

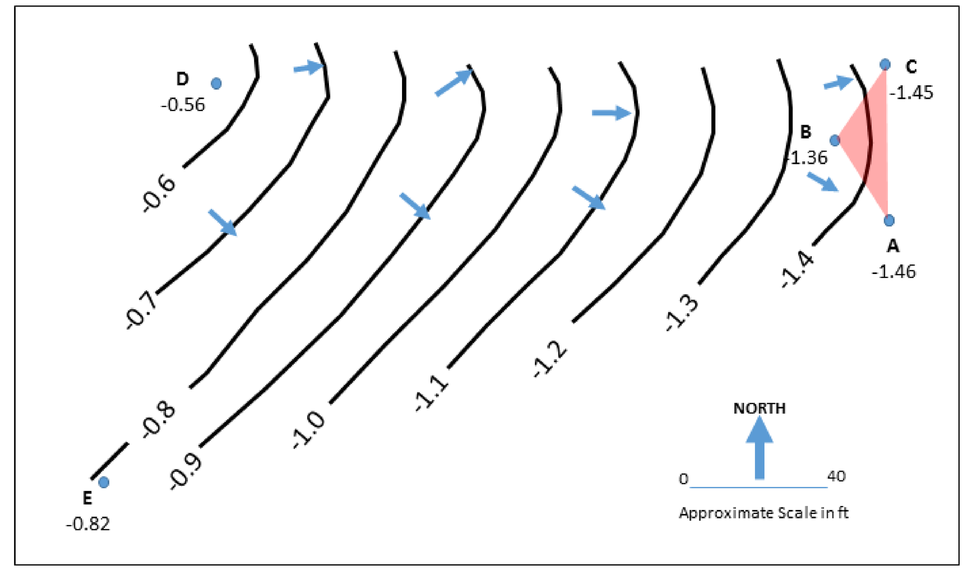

Figure 1 _ Three-Point Problem: Three points define a plane and equal elevation values on a plane form a straight line. Contour line between the ABC wells should have been a straight line. However, this contour was curved and was carried out on to other contours, which altered the groundwater flow pattern. Considering flow lines are perpendicular to contour lines, we should ask the following questions: 1) is there a losing underground stream from well B to well D? 2) is the line from B to D a water divide? There are no sufficient data to make such interpretations. All could have been avoided by simply following the three-point rule.

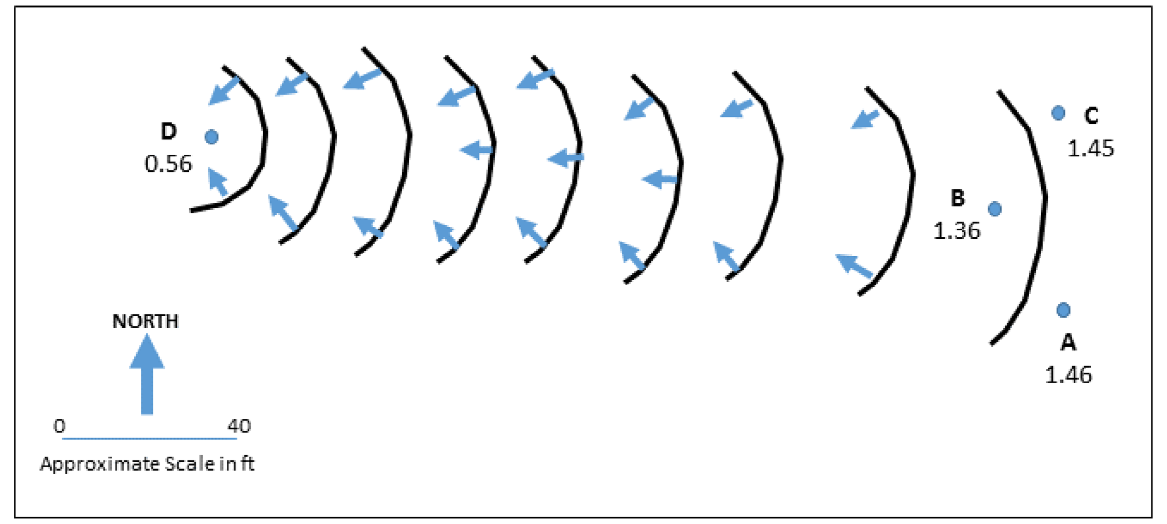

Figure 2_ Three Point Problem-Another Look: The case above is similar to the case in Figure 1 but the elevations are above mean sea level. In this scenario water is flowing toward well D. It appears like well D was actively pumping during groundwater gauging.

Variability in Contour Spacing

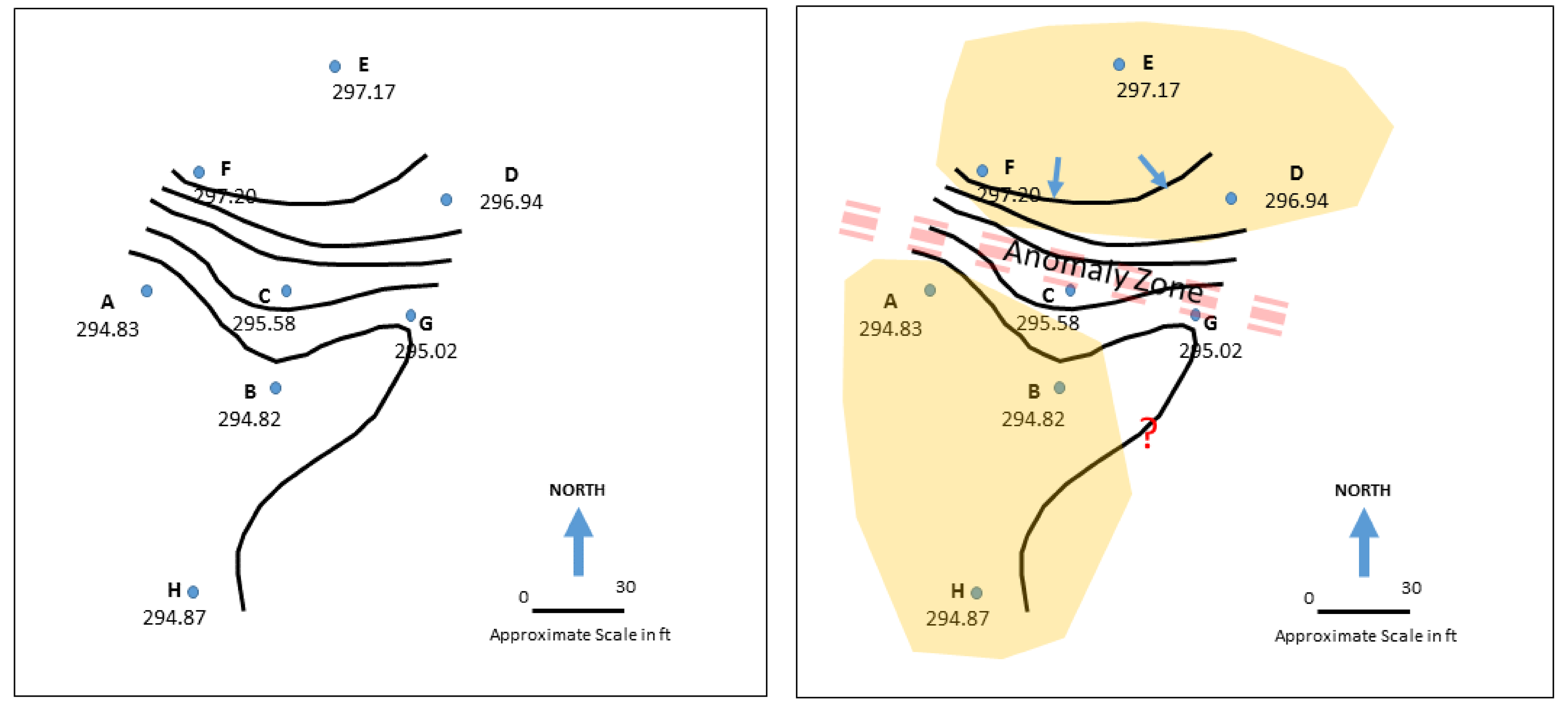

Figure 3 & 4_ Variations in contour spacing: The map on the left shows a contour map obtained from Geotracker. The map on the right shows another look at the map on the left. It looks like there are two blocks defined by the wells E, D and F (block 1) and the wells A, B, and H (block 2) separated by a lower? permeability zone. It is also possible that the wells were screened in two different zones. However, these scenarios requires a further look into the saturated zone soil profile, screen intervals as well as the well completion data. The contour line with question mark is not substantiated and should not have been drawn.

Sometimes we need to go back and remember what we learned at school

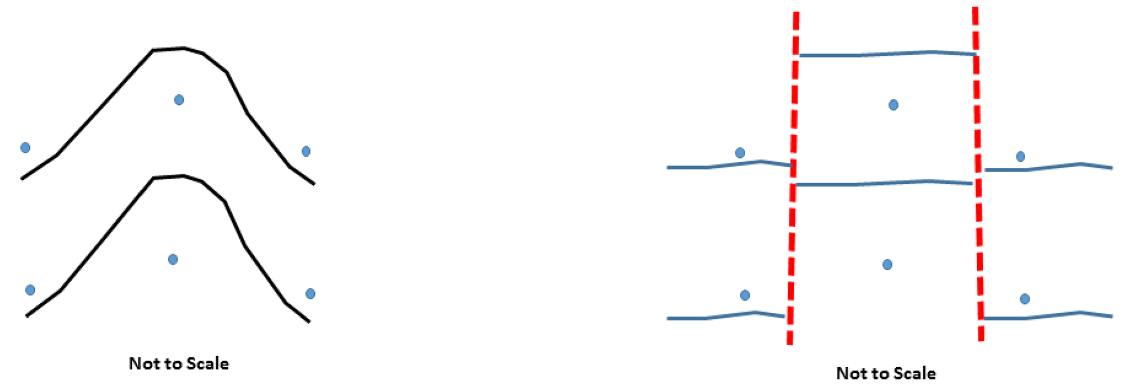

Figure 5 & 6_ When we were studying hydrogeology, we were told that if the water level contours looked like the one on the left; then we need to check the geology it may actually be like the one on the right.

GIS as a Contouring Tool

GIS and computer generated contouring are very valuable tools for mapping large, complex data sets. However, the computer generated maps require professional interpretation and editing. It is very important that a professional performing GIS mapping for groundwater and geological data must be educated in geological and hydrogeological sciences or working with a professional in these fields and needs to understand that a contour line is not just a line connecting points in a spatial world.

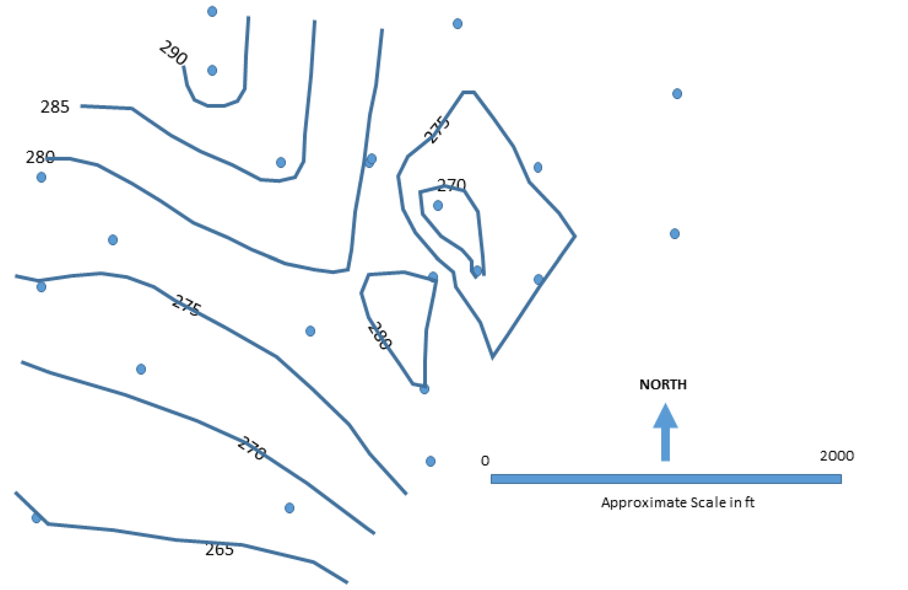

Figure 7_ Groundwater Contour of a perched zone with GIS Mapping: GIS mapping is a very valuable tool to map complex data, prepare cross sections and three dimensional diagrams. The map above is a groundwater elevation contour map of a perched layer. On the left side of the map there seems to be couple tubs (275, 270 and 280 closed contours)? They most likely are separated from the regional groundwater flow. When the water levels are high, these zones probably would not be visible. The questions is: Do we map these zones with the regional groundwater contours or present them separately? It is also possible that the two wells in the 270 closed contour area may be leaking. There are some sharp contour corners in the map that are products of GIS mapping. It may be necessary to add pseudo data to correct these sharp edges or manually edit them (human touch).

Logarithmic/Exponential Contouring Tool

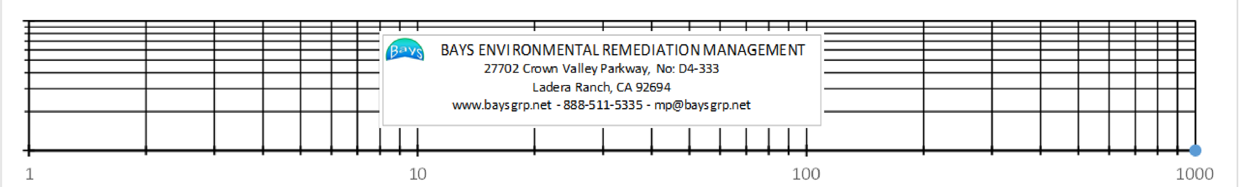

Figure 8_ Logarithmic Scale Ruler: When contouring using a logarithmic scale, we can use a tool like the one above. This can be made using a logarithmic paper. Note the distance between 1, 10, 100 and 1000 are equal. Only the magnitude of the numbers change exponentially. This needs to be remembered when contouring.

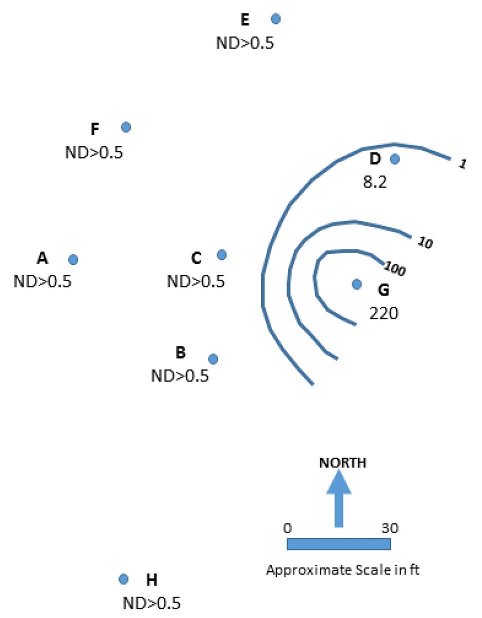

Figure 9_ Benzene Concentrations Contour on a Logarithmic Scale. On this map the distance between the 1, 10 and 100 contours should have been equal. If we use a logarithmic scale ruler (Figure 8) we can fix this contour easily. Set the logarithmic ruler at well D (8.2) at a 45 degree angle of the imaginary line between D and G. Draw a line from the logarithmic ruler "220 value" to the well G (220 line). Draw parallel lines to the 220 line from the 100 and 10 points on the logarithmic ruler. Where these lines cross the imaginary line between D and G will be the contour points for 100 and 10 values. However, the data on the map have no basis for eastern and southern contour lines. These will be drawn based on a professional experience with the site and/or based on the distribution of other compounds. Please note, ND is not a value and contour lines should not be going through the ND points.