

Using Automated Analytics to Optimize Groundwater Monitoring at MNA Sites

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Background/Objectives

After completion of remedial activities, many sites rely on Monitored Natural Attenuation (MNA) to demonstrate continued compliance and provide a line of evidence toward regulatory closure. Because this continued monitoring presents a long-term cost for responsible parties, reducing the number of samples collected each round can substantially reduce the total cost to closure.

Approach/Activities

To optimize groundwater monitoring programs, Woodard & Curran developed a list of criteria to review for each well currently monitored. These criteria include Mann-Kendall trends, spatial representation, current concentrations of site constituents of concern (COCs), and the extent of degradation. Because the cost-savings of an optimized groundwater monitoring program are greatest at sites with large monitoring well networks, modern technologies for processing and analyzing large data sets greatly enhance the efficiency and accuracy with which the well network can be evaluated.

CRITERIA REVIEWED:

1. Mann-Kendall Trends

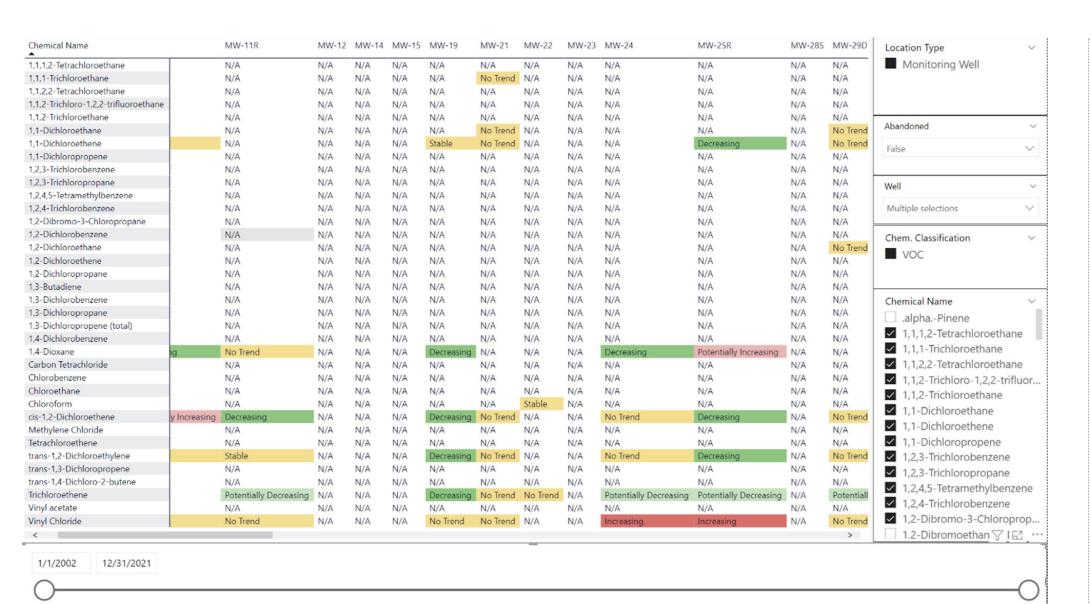


Figure 1. Example of Mann Kendall Trends Summary in Microsoft Power BI. Power BI's filtering abilities allow for dynamic recalculation of results if the project team wants to evaluate performance over a specific timeframe.

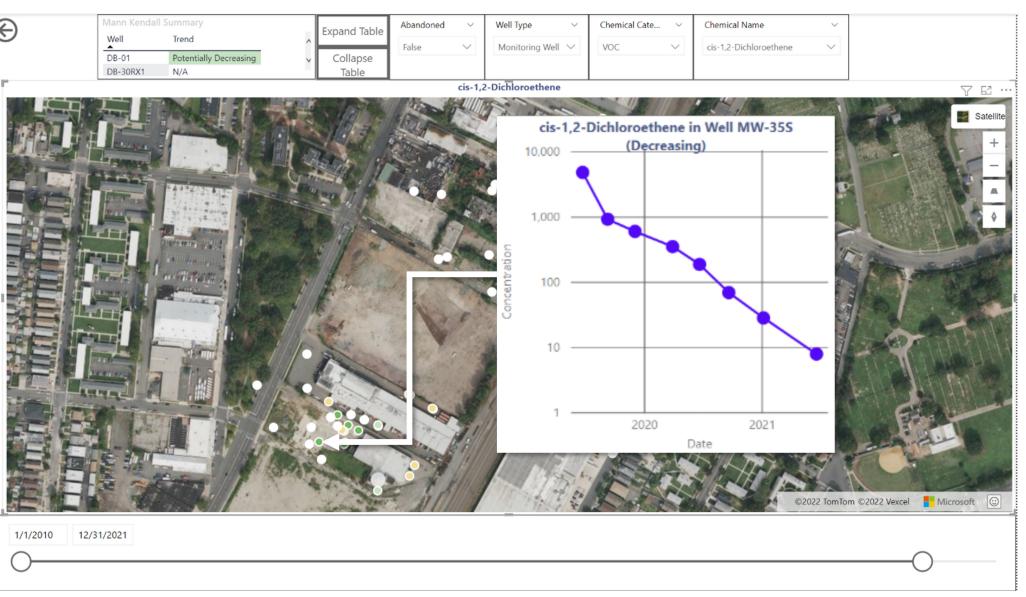


Figure 2. Example of Mann Kendall Trends displayed spatially in Microsoft Power Bl. A concentration timeseries chart for the selected analyte is displayed when hovering over a monitoring well.

The Mann-Kendall trend test provided information regarding whether trends observed in contaminant concentrations at each well were statistically significant.

2. Spatial Representation

A script was developed using the R programming language to summarize the following information regarding proximity of wells with a similar screen interval to a given well:

- » Name of and Distance to the nearest active well (nondecommissioned) with a similar screen interval
- » The number and names of active wells within 50 feet with a similar screen interval
- » The number and names of all wells within 50 feet with a similar screen interval over the Site's history.

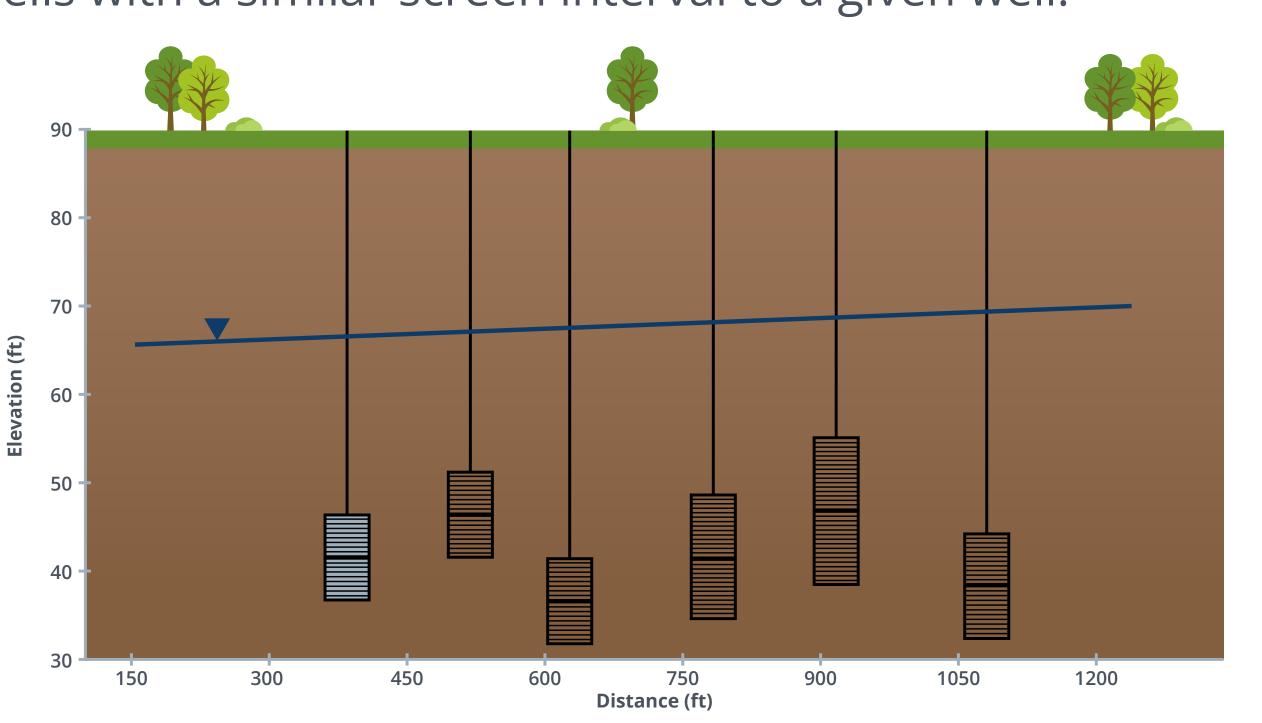


Figure 3. Examples of wells considered to have a similar screen interval to the well being evaluated (highlighted in blue).

3. Summary Statistics

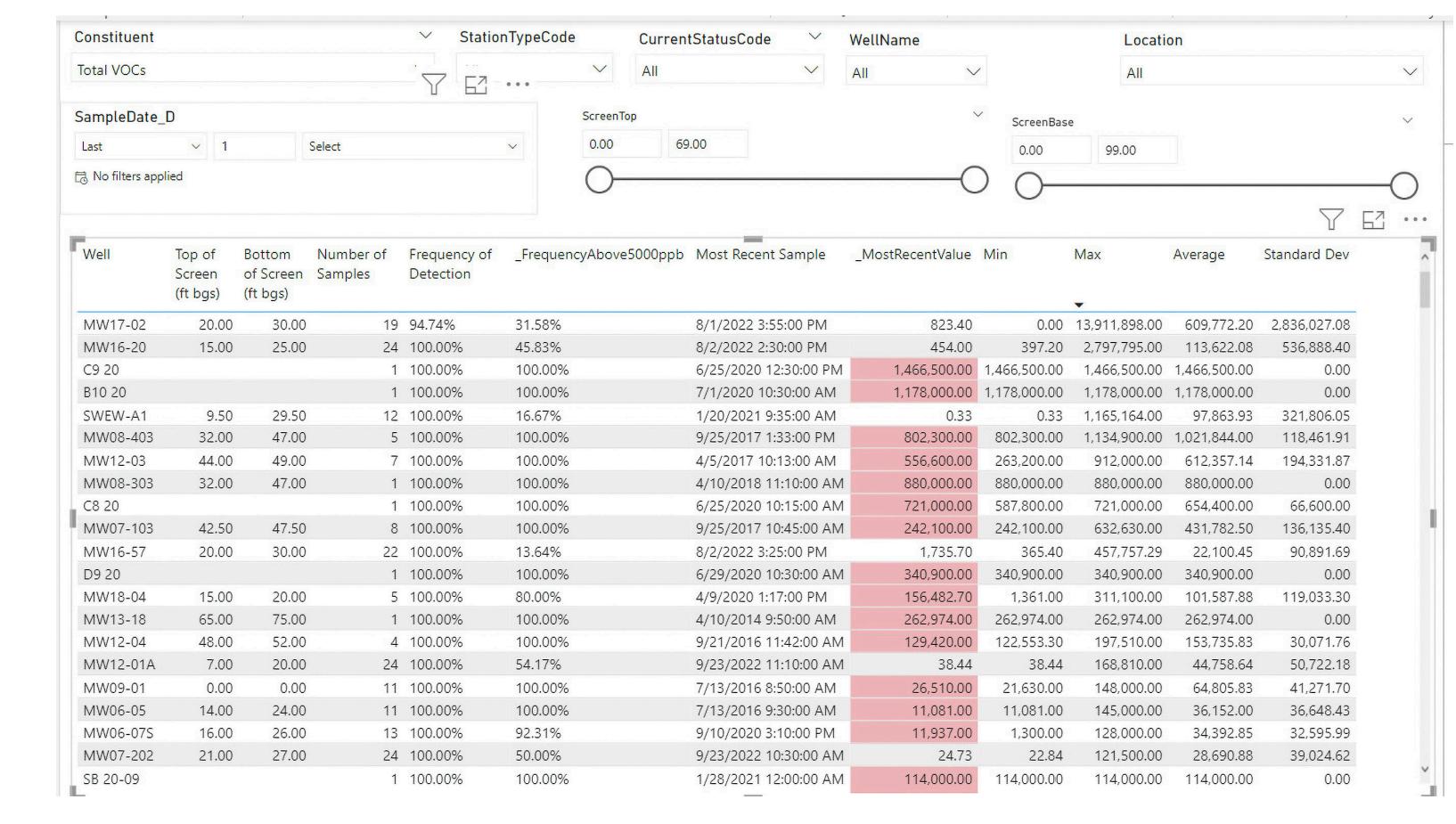


Figure 4. Microsoft Power BI display of summary statistics for selected analyte across all wells at the Site. If the most recent concentration at the listed well exceeds regulatory criteria, it is highlighted in red. The frequency at which the analyte was detected in the well, and the frequency at which the analyte was detected above the regulatory criteria were also considered.

4. Extent of Degradation

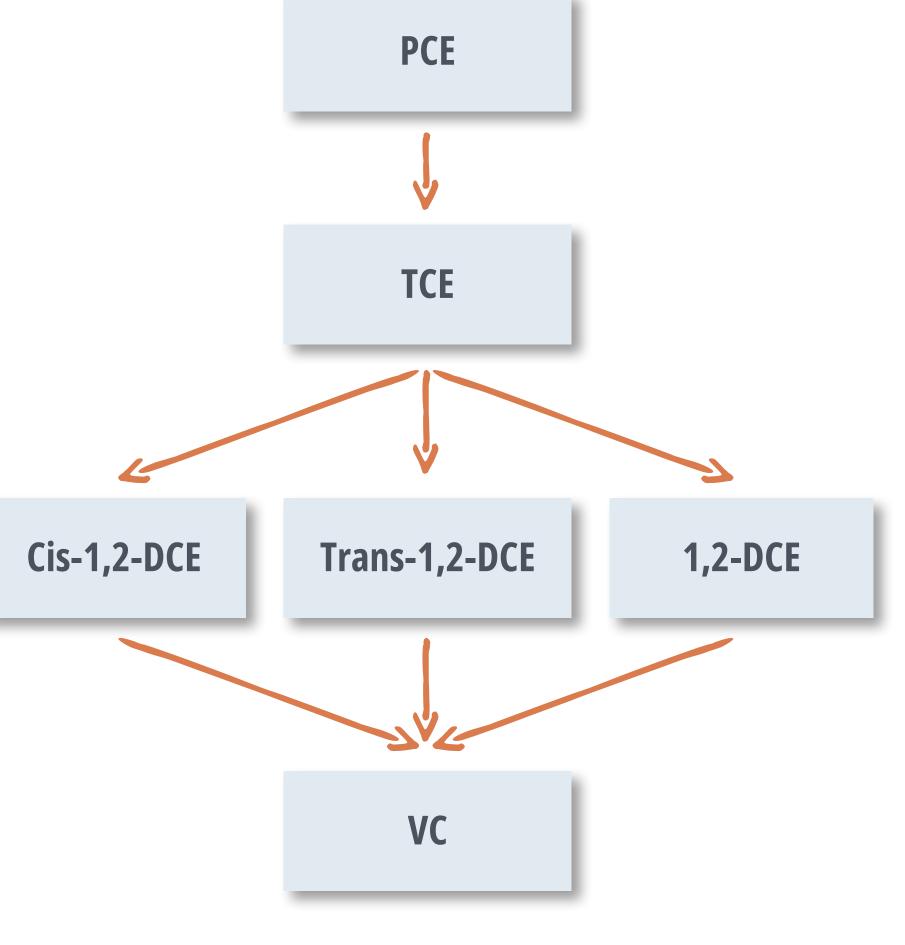


Figure 5. Tetrachloroethene (PCE) degradation pathways.

The extent of degradation was evaluated for target chlorinated volatile organic compounds (cVOCs) as another line of evidence to decide whether an argument could be made to discontinue monitoring certain wells.

The extent of degradation was calculated using the following equation:

\(\sum_{\text{molarity of degradation by - products}} \)
\text{degradation = } \(\frac{molarity of original compound} \)

If the degradation ratio is **greater than one**, the compound is considered to be degrading at that well.

Results/Lessons Learned

The results of each individual analysis were compiled into a summary matrix. For analyses such as the Mann-Kendall and concentration summary statistics, the project team selected a small number of high-priority analytes to include in the final evaluation matrix.

Well ID	Permit- Required Monitoring Location	Current Total VOC Concentration (µg/L)	Current 1,4-Dioxane Concentration (µg/L)	Trichlo- roethene Mann-Kendall Trend (last 5 years)	1,1,1-Trichlo- roethene Mann-Kendall Trend (last 5 years)	Total VOC (molarity) trend (last 5 years)	Degradation ((DCE and VC)/TCE)	Number of Criteria Met
MW-1	Yes	15	1	No Trend	Decreasing	No Trend	0.87	3
MW-2	No	1000	3	Decreasing	Potentially Increasing	Decreasing	21.8	5
MW-3	No	250	102	Stable	No Trend	Potentially Decreasing	0.6	3

Table 1. Example of summary matrix prepared for project team after several rounds of discussion reviewing the more detailed analyses.

The sites most likely to benefit from an optimized groundwater monitoring program are large, long-term sites with big data sets. Technological innovations make it possible to automate the holistic review of these data sets to defensibly identify reductions in the number and/ or frequency of samples collected. Not only can these technologies lead to reduced costs in the field, but these automated approaches eliminate the effort typically needed to update spreadsheet analyses as new data are generated. These tools have been successfully scaled to multiple projects, further increasing return on investment (ROI).

Tool	Hours Saved (range from small to large site)
Mann Kendall	10–100
Spatial Representation	2–200
Summary Statistics	5–20
Degradation Evaluation	10–100

Table 2. Summary of hours saved per monitoring round at a given site with each automated solution. Sites are considered small if they have fewer than 10 wells and large if they have over 50 wells.

Site	% reduction in routine wells monitored	% of remaining wells with reduced sampling frequency	Hours of fieldwork saved per sampling event
Example Site #1	30	40	19
Example Site #2	40	0*	50-60

Table 3. Summary of results for the two Sites on which we have completed groundwater monitoring optimization analyses using these automated tools.

*Because so many wells were removed entirely from the routine monitoring program, the frequency of retained wells was not reduced at Example Site #2; however, the list of analyses for several wells was reduced saving laboratory analytical costs and some field labor.