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Optimization of Groundwater Monitoring at a Research Facility in New Jersey (GWSDAT)

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Life Cycle Stage	Medium	Methods	Software Used
• Monitoring	• Groundwater	• Mann-Kendall • Nonparametric statistics • Penalized splines • Voronoi/ Delaunay mesh	• GWSDAT

Problem Statement

A large number of groundwater monitoring wells are located across this former research facility site. This study determined if the groundwater monitoring network was optimized at the site. Data were analyzed to identify opportunities to reduce monitoring without losing confidence or statistical robustness of the interpretation.

Site Background

The site consists of approximately 75 acres in northern New Jersey. The site was historically a facility for research in the areas of petrochemicals, fuels, oil blending, engine testing, polymer development, and associated analytical work. From the 1910s through the 1960s, bulk petroleum storage was also a major part of the operations at the site. The property was sold to another corporate owner in 1999.

The northern portion of the site was sold in 2004, and now contains a retail shopping center. The southern portion of the site currently consists of 11 buildings and several ancillary structures and is used for research and development activities related to petroleum oil additives.

Project Objectives

The following are project objectives:

- Optimize groundwater monitoring at the site using the GWSDAT software.
- Evaluate historical groundwater data collected for the site by previous consultants to identify opportunities for increasing efficiency of sampling and data collection, while still collecting the data necessary to adequately characterize groundwater conditions at the site.
- Identify potential reductions or modifications to the scope of work for groundwater sampling events (reduction in the number of wells sampled, change in frequency of wells sampled or change in parameters analyzed).

Data Set

Number of Wells	Number of Samples	Number of Sample Events	Total Data Points Analyzed
• 91 well network	• 63 wells sampled	• Semi annual sampling • 4 years	• 504

To date, a total of 110 monitoring wells have been installed at the site: 82 overburden monitoring wells and 28 bedrock monitoring wells. A total of 91 wells are currently sampled on a semiannual basis, including 63 overburden monitoring wells and 28 bedrock monitoring wells. Monitoring wells are sampled and analyzed for VOCs plus a 15-peak library search

(VO+15), methyl tertiary-butyl ether (MTBE), and tertiary-butyl alcohol (TBA). Select wells are also analyzed for total lead, nitrate, nitrite, sulfide, ferrous iron, dissolved carbon dioxide, and alkalinity. Groundwater sampling events have typically taken a team of 5 people 7 to 10 days to complete (280 to 400 labor hours per sampling event).

Groundwater data for 63 overburden monitoring wells for the past four years were provided for review. The data provided for each well consisted of groundwater elevation, LNAPL thickness, and benzene, toluene, ethylbenzene and total xylenes (BTEX) concentration. These values were input into Groundwater Spatio-temporal Data Analysis Tool (GWSDAT) version 2.0, produced under the GNU General Public License.

Methods

GWSDAT provided concentration trends for BTEX compounds in each well and identified hot spots—groups of monitoring wells containing LNAPL or elevated dissolved-phase hydrocarbon concentrations. GWSDAT also illustrated the various localized groundwater flow directions in various parts of the site.

GWSDAT uses the R statistical package to effectively evaluate simple linear or log-linear trends in concentrations of chemicals in groundwater, as well as providing nonparametric trend analysis using penalized splines (p-splines), contouring using local polynomial regression fitting, 95% confidence intervals regarding concentrations and the linear approximations of their temporal trends, and Mann-Kendall (S) statistics regarding the trend direction and degree of certainty. The data, trend estimates, and groundwater elevation measurements, and chemical concentrations in groundwater contours can be displayed for each well as shown in Figures 113 and 114.

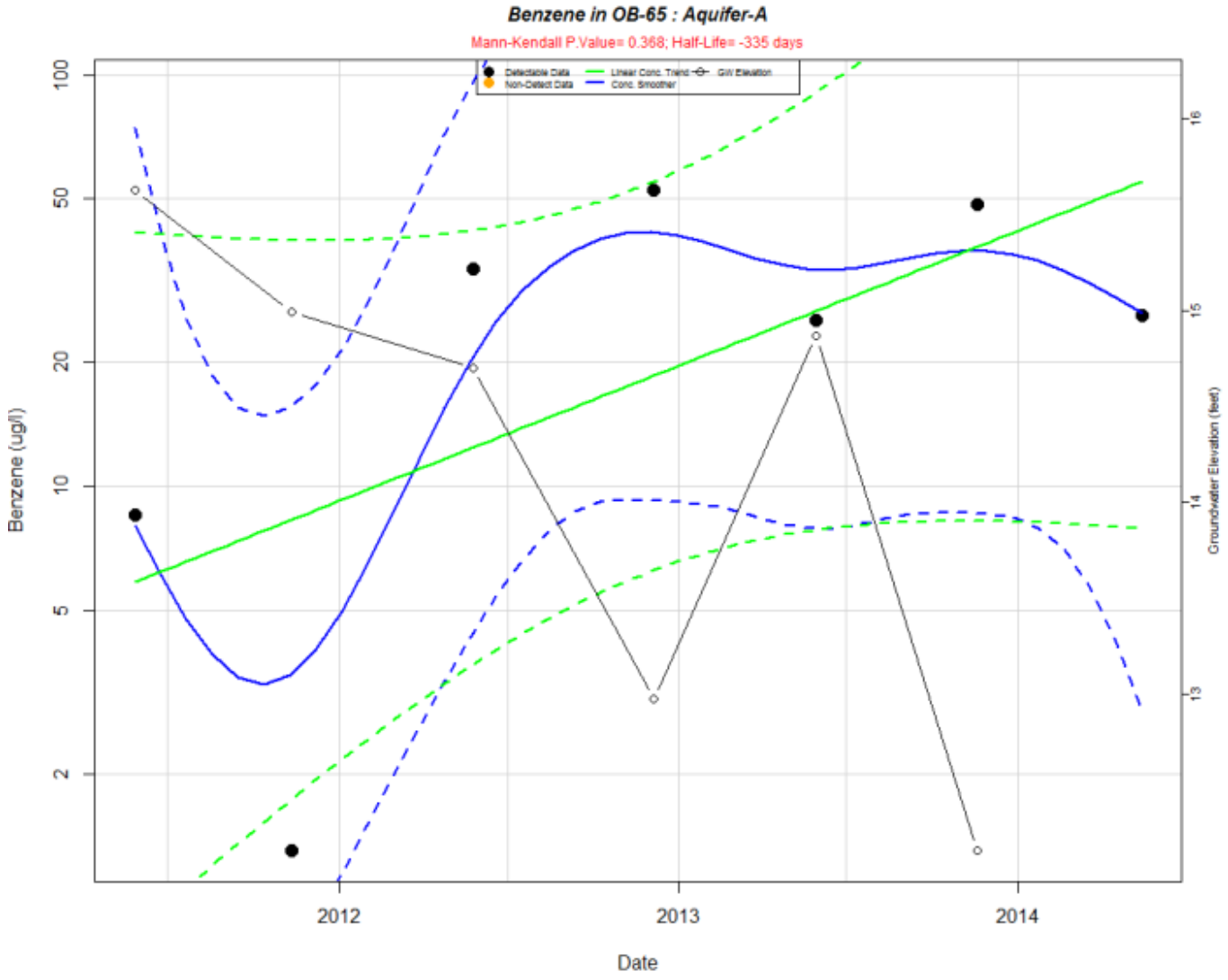


Figure 113. Date trends for benzene in well OB-65.

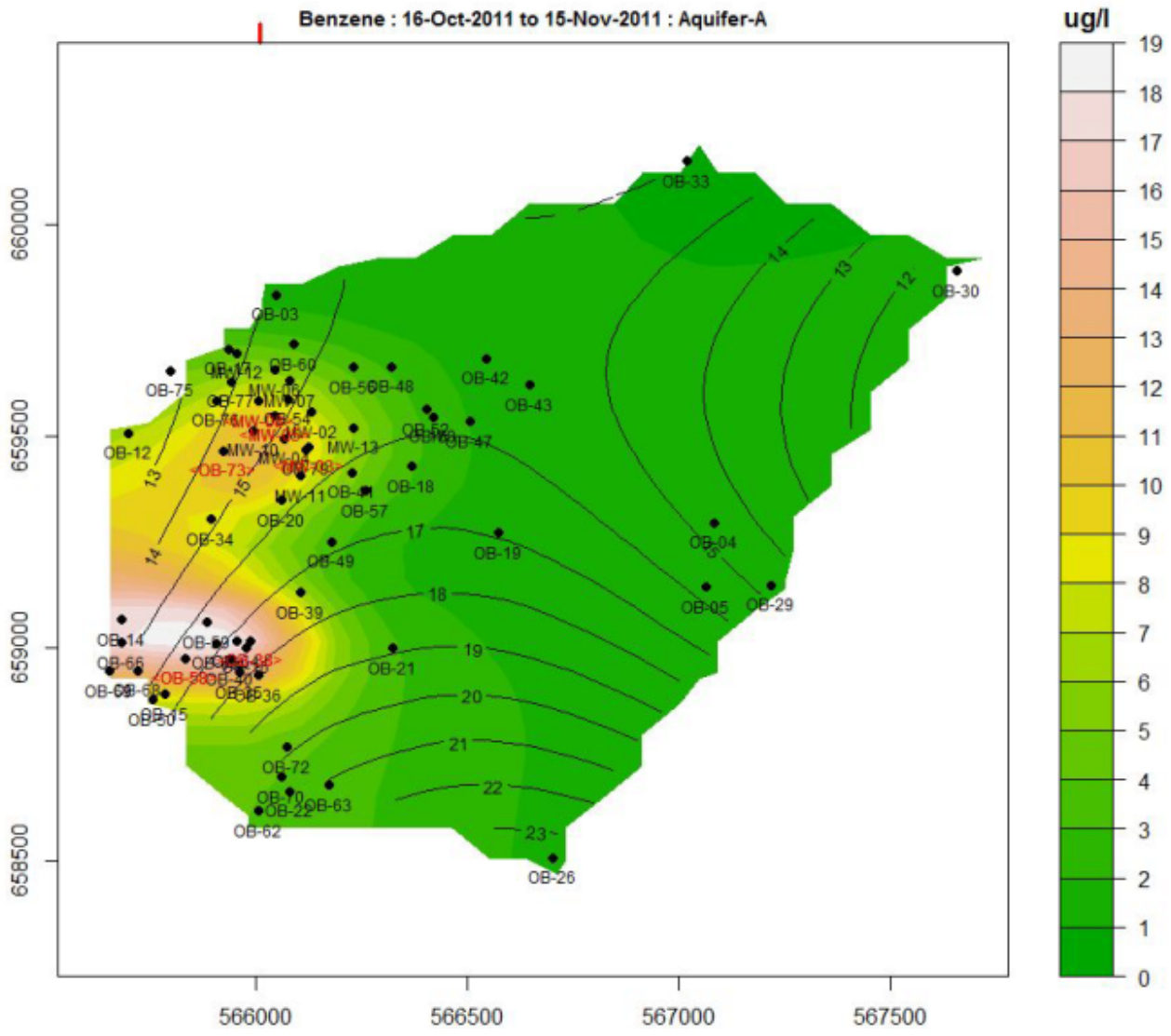


Figure 114. Benzene concentrations across the site Aquifer-A.

Additional groundwater analytical data including lead, chlorinated VOCs, and tentatively identified compounds (TICs) concentrations, were then retrieved from historical reports prepared by the previous consultant and included in the evaluation. The concentration trends for each well and hot-spot data from GWSDAT, as well as the additional information from historical reports were compiled into a spreadsheet. Wells with historical detections of LNAPL were kept on a semiannual sampling schedule. Low-flow sampling methods were planned to be continued for wells that are analyzed for total lead, nitrate, nitrite, sulfide, ferrous iron, dissolved carbon dioxide, and alkalinity. Wells where chlorinated compounds or TICs, or both were present at concentrations above regulatory criteria were planned to be analyzed for VO+15, MTBE and TBA. Recommendations for potential reductions in the number of wells sampled, frequency of sampling and analytical parameters (VO+15 to BTEX) were made for each individual well based on historical concentrations, LNAPL, and the wells' use for delineation of LNAPL or hot-spot areas.

Results

Based on the evaluation described above, the following proposed modifications to the groundwater sampling program for this site were made:

- discontinuation of sampling of 5 monitoring wells, expected to reduce the time needed for both of the semiannual sampling events by approximately 5 labor hours (10 labor hours per year),
- reduction of sampling frequency from semiannual to annual for 14 monitoring wells, expected to reduce the time needed for semiannual sampling events by approximately 14 labor hours,
- change in analysis from VO+15 to BTEX for 27 monitoring wells.
- The site sampling program had a cost savings of 16% annually.

The approximate cost savings for each of the proposed modifications were calculated outside of the GWSDAT software. The

proposed modifications were accepted by the Licensed Site Remediation Professional (LSRP). These modifications are in the process of being implemented.