Evaluation of Water Quality Monitoring Programs and Statistical Analysis Tools to be utilized in Shale Development

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Prepared for:
USEPA Hydraulic Fracturing Workshop
Case Studies

Overview

- Groundwater monitoring is complex
- Current baseline monitoring strategies
- Background monitoring programs
- Suggested Shale Monitoring program

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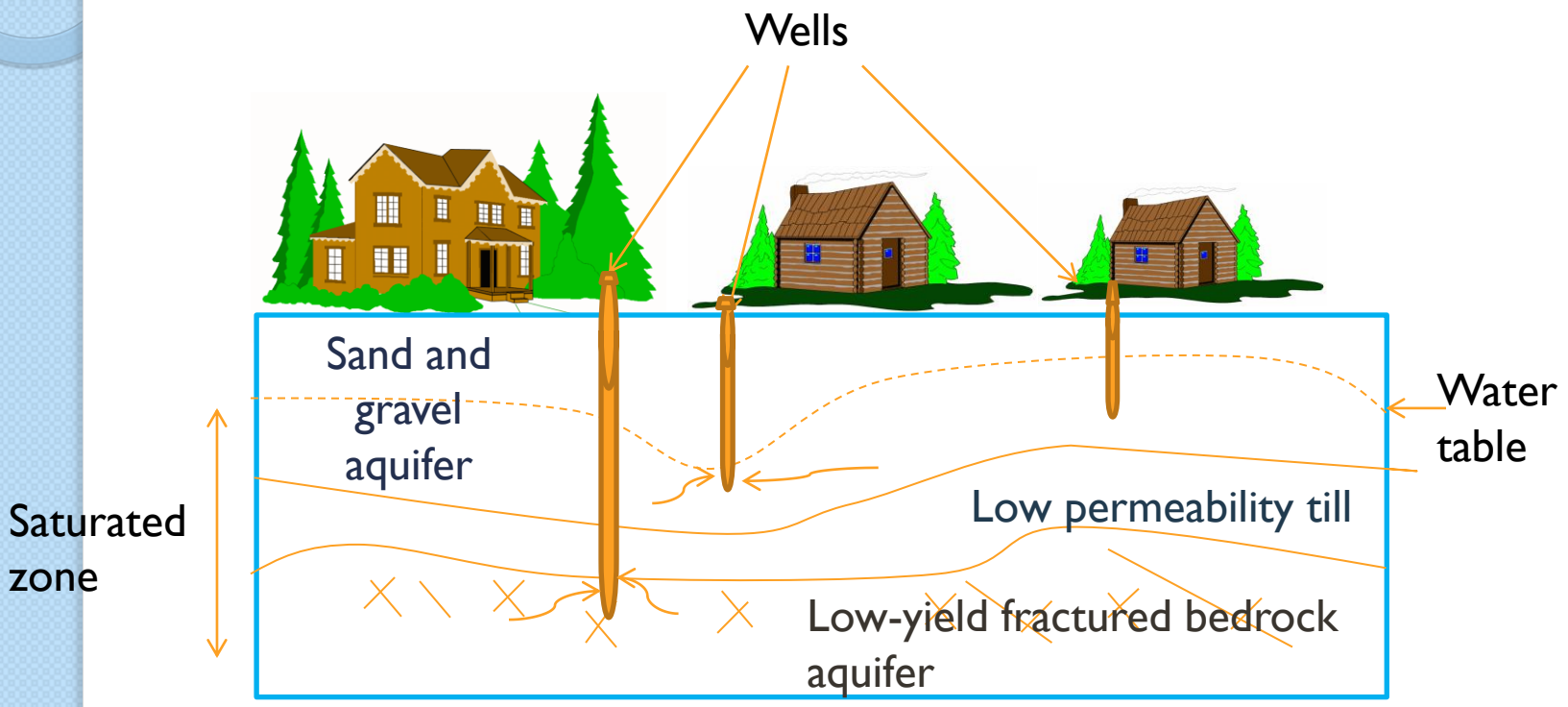
Complex/ Variability Baseline Water Quality



- Different water source in aquifer = variable water quality

Data Objective

- Sample sizes enough for comparison "before and after"
  - Abrupt changes (blowouts, casing failures)
  - Long term changes (seeps, surface spills)
  - Pre-existing issues
- Representative of groundwater/surface water quality

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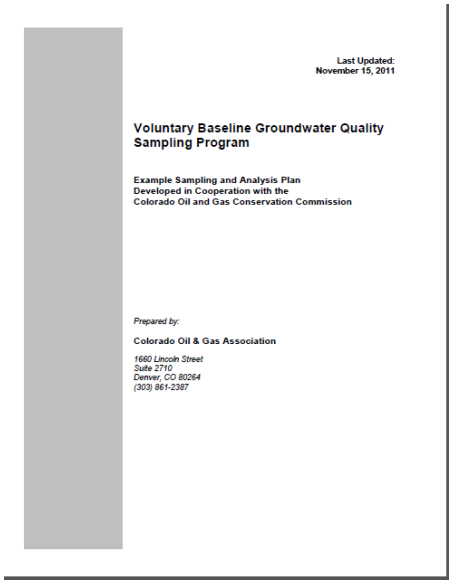
Data Objectives

Current Monitoring Strategies

2.3 Sampling Procedures

- Baseline groundwater samples must be collected **any time** prior to the setting of the oil and gas
- A **second** sample will be collected from each groundwater feature no later than one year after
- well completion……
- Post-completion samples must be collected **every two years** while wells are actively being drilled and completed on a pad, and within one year following completion of the final well on the pad.


Last Updated:
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Voluntary Baseline Groundwater Quality Sampling Program

Example Sampling and Analysis Plan
Developed in Cooperation with the
Colorado Oil and Gas Conservation Commission

Prepared by:

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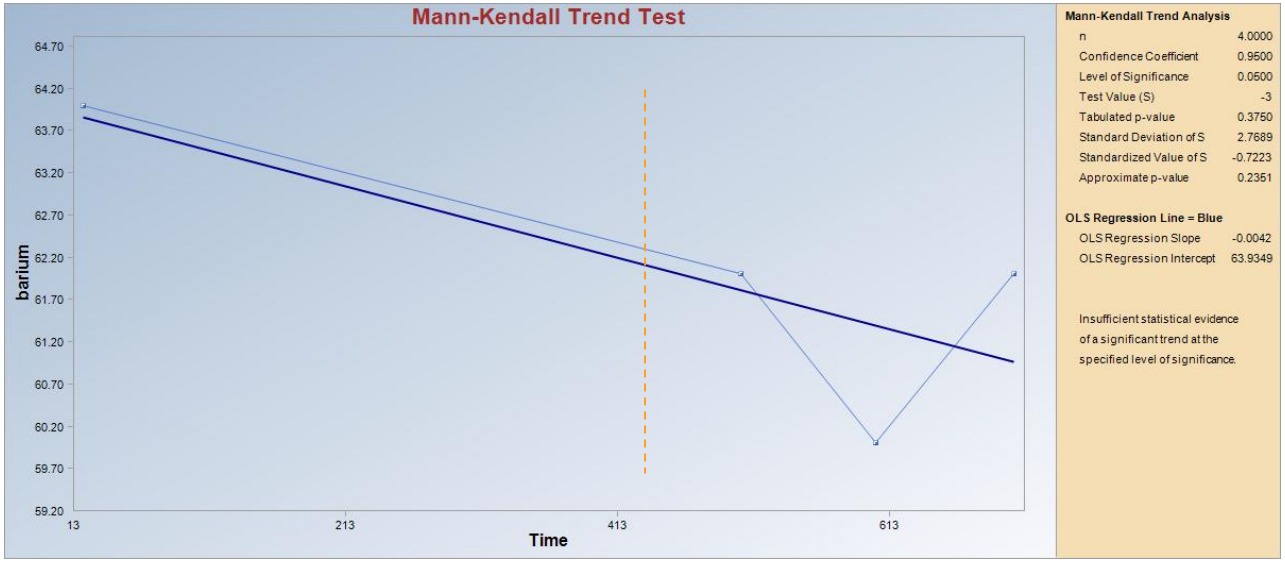
http://region8water.colostate.edu/PDFs/Factsheet%20COGA-sample-analysis-Plan.pdf

Data Objectives

Current Monitoring Strategies

- Not enough data points



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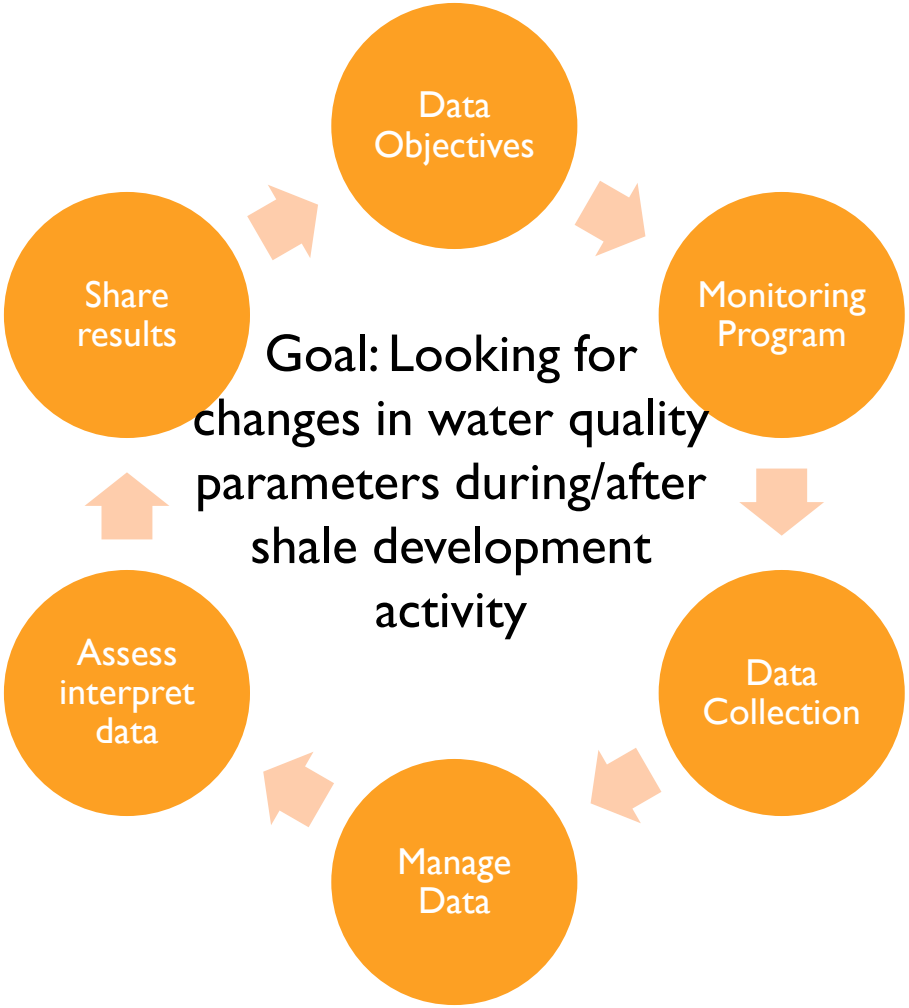
Shale Monitoring Program



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Data Analysis

- Ideal: No trends
- Linear, linear with breakpoint, step changes (abrupt)
- HVHF related activity
- Historical

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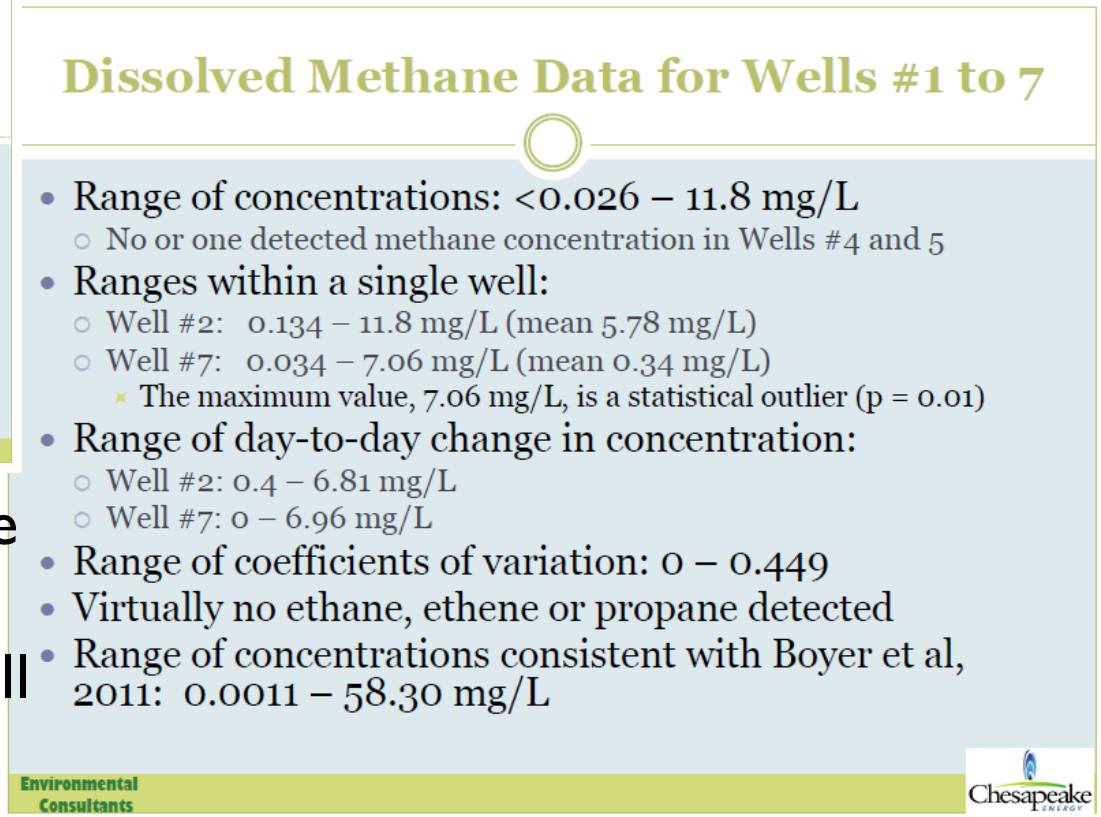
Data Objectives

- Natural variation in the concentration of methane and other well quality parameters.



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Data Management

- Organize and store data (databases, spreadsheets)
- Determine data quality
- Document assumptions and methods

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Analytical Tools/Methods

- Cost
- Reliability
- Technical Support
- Non-parametric Trends
  - Sen Slope / Kendall Theil
  - Seasonal Kendall Test
  - Wilcoxon-Mann Whitney Step Trend
- Regressions

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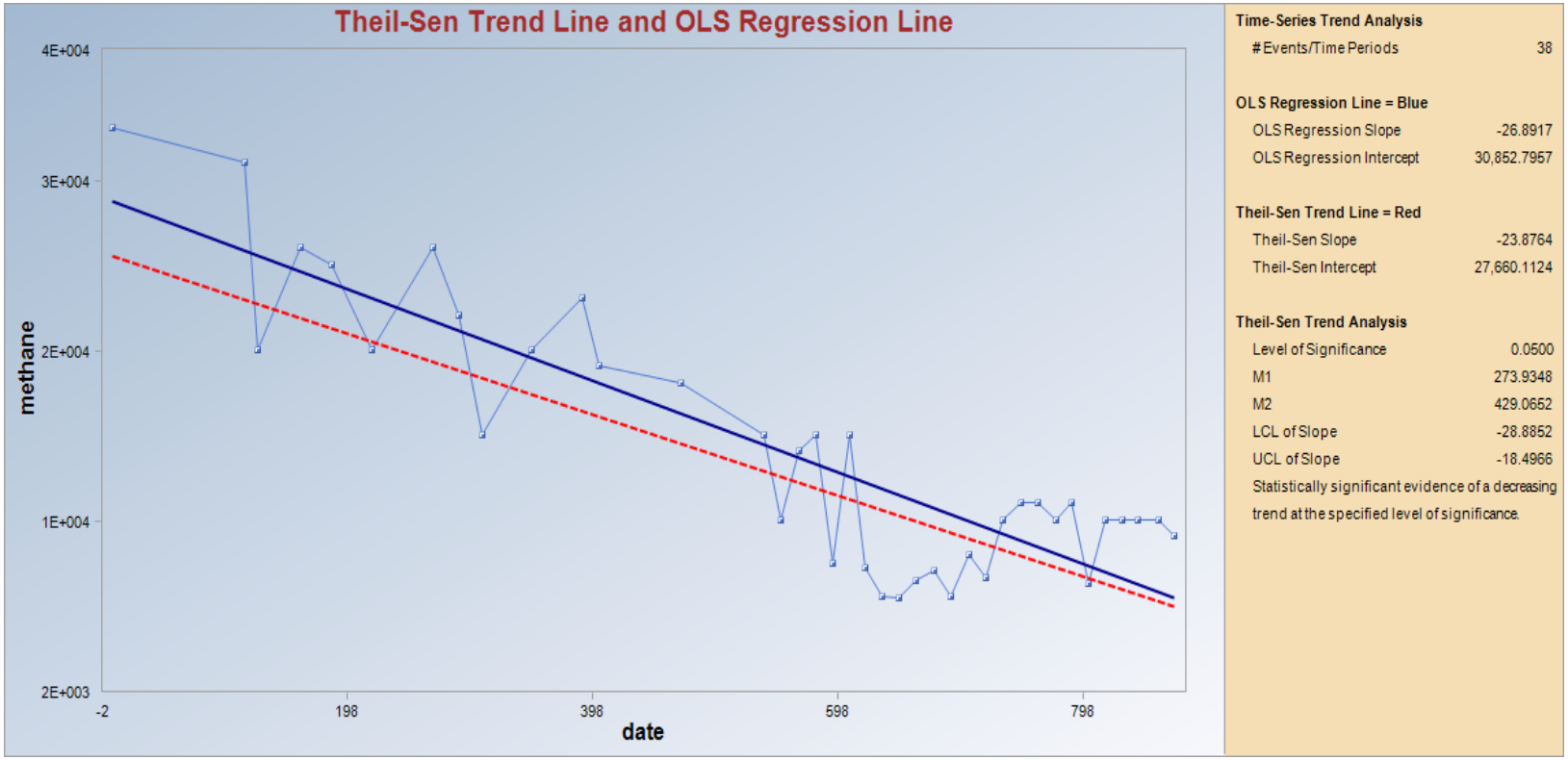
Methane Trend Analysis ProUCL 4.1 Time Series



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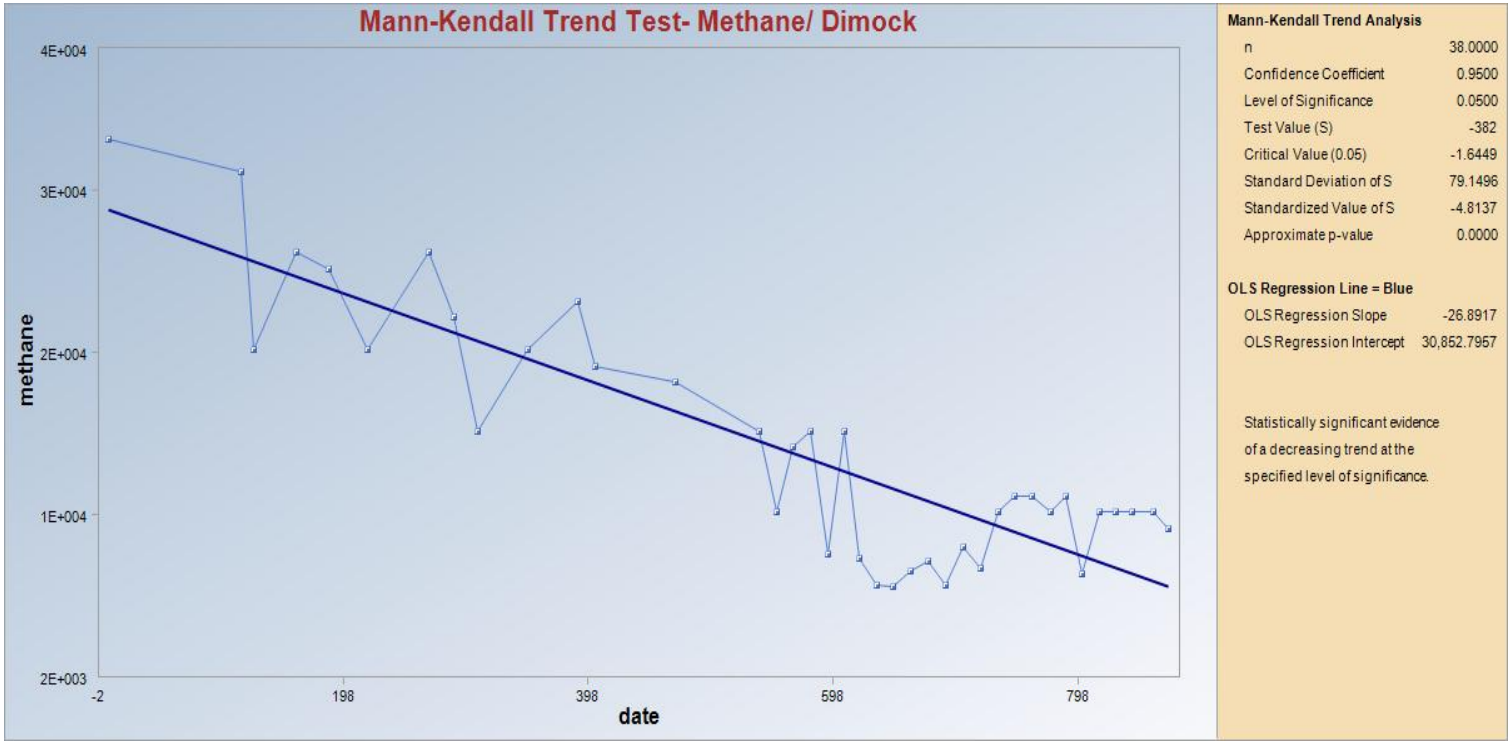
Methane Trend Analysis ProUCL 4.1 Mann-Kendall



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Considerations

- Good & Enough data (QA/QC)
- Support industry (affordability) and landowner (convenience)objectives
- Limit parameters assessed- (look for indicators like methane, barium, chloride, strontium etc.)
- Limit collection points
- Integrate all monitoring efforts
  - Manage water quality in a tier system of data quality
- Who maintains the data? Who pays?

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References

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- Coleman, Nancy P., and Debby McElreath. "Short-term Intra-Well Variability in Methane Concentrations from Domestic Well Waters in Northeastern Pennsylvania." (April 2011)
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- Hirsch R.M., R.B. Alexander, and R.A. Smith 1991. Selection of Methods for the Detection and Estimation of Trends in Water Quality. *Water Resources Research,* Vol. 27(5), pp. 803-813 May.

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