# Evaluation of Networked, Real-time Nitrate Sensors
# Groundwater Remediation Monitoring Demonstration Project

## Description of the Environmental Problem

As a result of human activity (transportation, industrial processes, agriculture) the annual transfer of nitrogen into biologically available forms has more than doubled (Vitousek, PM; Aber, J; Howarth, RW; Likens, GE; Matson, PA; Schindler, DW; Schlesinger, WH; Tilman, GD (1997). "Human Alteration of the Global Nitrogen Cycle: Causes and Consequences". *Issues in Ecology* **1**: 1–17).

Throughout the 2006-2011 EPA Strategic Plan are strategic commitments and measures that address emissions and concentrations of nitrogen and nitrogen compounds. This emphasis is continued in the recently released public review draft of the Strategic Plan Change Document. Underlying any approach to the reduction of nitrogen in the environment is the need to measure concentrations in a timely and useful manner.

Monitoring of environmental contaminants in groundwater is currently a costly and often lengthy process that is accomplished by collecting samples from wells, and then shipping the samples to a fixed-based laboratory where sample preparation, analysis and data reduction is performed. This process may not yield data for months after sample collection. This project will demonstrate a newer approach to monitoring.

## Networked Sensing Technology

Sensors are a category of measurement systems that can provide in-situ, real time data of environmental conditions. Cost of analysis would be reduced by the use of continuous networked sensors placed directly in wells, thereby eliminating sample collection and shipment costs, and reducing analytical costs for acquisition, measurement and reporting. Networked sensors can also provide many more data points over a given time interval, thereby offering the potential to identify trends in data and to observe less frequent but environmentally significant events that cannot currently be observed by current sampling and analysis paradigms.

Since sensor networks can provide data on a near real-time basis and with greater spatial resolution, there is little or no delay from the time a particular place is sampled until the user of the data has the information. Timeliness has been a neglected aspect of data quality. Sensors can therefore be extremely effective tools for meeting the emerging responsibilities of environmental stewardship.

Verification, guidance and education are needed to promote implementation of new technologies within State and Federal regulatory agencies. There is a growing

assortment of sensors. Knowledge of their reliability, capabilities and overall costs is limited. Studies need to address concerns about comparability of sensor data with results from conventional analytical methods. Without this kind of knowledge project managers and regulators will hesitate to incorporate on-site sensor technology into characterization and monitoring efforts.

The intent of this demonstration study is to gain a greater understanding of the use of sensor networks for real-time data generation through a demonstration study. The results of this study would be applicable to all regions, since nutrient groundwater monitoring is a national issue and concern. This approach to in-situ, real-time nutrient analyses could also be readily applied to other priority environmental programs such as monitoring of landfills or studies involving the operation and maintenance of Confined Animal Feeding Operations (CAFOs) and/or septic fields. These are all issues of national scope. For comparison purposes, this study will continue periodic reference analyses for nitrate in groundwater that are currently being performed by a conventional nitrate analytical methodology (USEPA Method 300.0 (Ion Chromatography).



**Research Team**

Besides EPA, the research team includes

- New Jersey Department of Environmental Protection - Office of Quality Assurance - Technical project oversight and quality assurance/data review
- Hall Consulting – Tulsa, OK - Assistance with project coordination, sensor installation and maintenance, and report preparation
- Instrumentation Northwest – Seattle, WA - Supply and installation of sensors and associated communications interfaces
- Groundswell Technologies, Inc. – Santa Barbara, CA - Data processing and visualization
- Battelle Advanced Monitoring Center – will carry out the technology verification

**Expected Outcomes**

The proposed study, to be carried out at a US Department of Agriculture research site in Iowa, will strengthen support for the use of real-time monitoring technologies in general, and specifically the understanding of technologies for sensing of nitrates in groundwater through an ETV verification test of such sensors at a real-world test site. An ETV verification test that directly compares sensor technologies to traditional means of data collection including issues such as data quality and cost of analyses is imperative to accelerate the use and acceptance of such technologies. This proposed project will support EPA's objective to more efficiently manage and reduce nutrient loadings by providing more cost effective tools for environmental monitoring.

- Prepare ETV verification reports/statements for all technologies;
- Presentation of the results at one or more environmental conference(s)
- Publication of the results in a peer-reviewed scientific journals (e.g., Journal of Environmental Monitoring, Royal Society of Chemistry, London, England)

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