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Using Risk-Based Analysis to Identify Inspection Priorities

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Abstract

Onsite inspection is the most expensive component of any regulatory oversight program, and agencies have been looking for ways to manage these programs cost-effectively while maintaining the same level of environmental protection. Developing the data analysis tools to monitor water quality and to assess available supplies has become critical to resource management. In response, the Ground Water Protection Council (GWPC) is expanding its Risk Based Data Management System (RBDMS) into source water quality protection, laboratory information management, produced water management, and water quantity assessment. RBDMS for Water tracks water and waste stream parameters and makes site-specific monitoring data available in a geographical information system (GIS) format. This paper discusses how RBDMS for Water is being customized by two regulatory agencies as a management and planning aid in re-focusing their field inspection programs. These agencies are tasked with continuing to meet environmental protection goals in the face of stagnating funding and escalating real costs for these programs. The agencies: the Nebraska Oil and Gas Conservation Commission (NOGCC) and the Ohio Department of Natural Resources (ODNR).

Pollution Prevention Management Concerns

Fiscal Realities of Environmental Protection Programs

Regulatory agencies are tasked with continuing to meet environmental protection goals in the face of stagnating funding and escalating real costs for the resources to operate these programs. For example, for oil and gas oversight programs, although underground injection control (UIC) permits set limits and conditions for operator performance, only inspections, mechanical integrity tests (MITs), and other well monitoring methods actually protect underground sources of drinking water (USDWs). The oil and gas field inspection program includes such activities as witnessing MITs, checking annulus pressures, and conducting unannounced routine inspections. Mining inspection programs include similar activities in addition to collecting and analyzing soil and water samples to assess the impacts of operations and the effectiveness of remedial measures and site restoration programs.

Though it is the best means of ensuring compliance, on-site inspection is also the most expensive component of the agencies' UIC and mines inspection programs (GWPC, July 2006). The Nebraska Oil and Gas Conservation Commission (NOGCC) is an example of an agency that received a federal grant to implement its environmental regulatory program for $100,000 in 1983. The problem is that, in 2006, the cost of those same goods and services is $203,313 (Belieu, 2006).

The fiscal mandate to cut the cost of pollution prevention without sacrificing services is especially stark in contrast to the reality that 99 percent of the drinking water in Nebraska comes from ground water. Despite the tightening budget, the NOGCC must fulfill a challenging work plan for fiscal year 2007:

- Inspect every UIC well once per year.
- Decrease the total number of inspections by 28 percent.
- Increase inspections of wells located in SWPA from annually to quarterly.
- Decrease the inspections of remote wells to every 2 to 3 years.

The Energy-Water Nexus

Meeting current and future water and energy consumption rates means juggling the inter-related and often conflicting demands of balancing ground water supply allocations and quality guarantees with encouraging the development of sustainable sources of affordable energy. The policy decisions and resulting management practices mandate innovative technological solutions. Having the data analysis tools to monitor water quality and to assess available supplies has become critical to resource management. In addition, where such inspection programs are run by people of widely varying computer skills, such analysis tools also must be intuitive to use, flexible in application, and powerful in its range of capability.

At the Ohio Department of Natural Resources (ODNR), Department of Mineral Resouces Management, the inspection priorities range across four distinct programs:

- The Abandoned Mine Lands group tracks samples for Acid Mine Drainage Abatement and Treatment plans and watershed restoration projects.
- The Coal Regulatory group tracks sampling for baseline and quarterly monitoring, hydrologic inventory, National Pollutant Discharge Elimination System (NPDES) discharges, and complaint investigations.
- The Industrial Minerals group tracks sampling results from site inspections for permit compliance, complaint investigations, and enforcement efforts.
- The Oil and Gas group tracks sampling results associated with complaint investigations, permit requirements, UIC facilities, and brine analysis inventories.

Personnel participating in these programs include managers who need summary information on demand; technical, field, and laboratory staff who require sophisticated analysis tools; and grassroot citizen volunteers who perform extensive routine watershed data collection.

RBDMS for Water: An Effective New Management Application

In response to the need to track water quality and quantity, the Ground Water Protection Council (GWPC) expanded the Risk Based Data Management System (RBDMS) family of software programs into source water quality protection, laboratory information management, produced water management, and water quantity assessment. The GWPC's RBDMS for Water application was developed to help regulatory agencies track baseline water quality and quantity data to evaluate permit applications and application revisions. Where agencies choose to Web-enable RBDMS for Water, oil and gas operators and mine owners will be able to query the database to track compliance with water information reporting requirements and, ultimately, to submit water quality reports from their third-party laboratories to the agencies in a standarddata format.

The RBDMS for Water application is a multi-tiered application developed with .NET, GIS and XML technologies. The user interface (UI) for the RBDMS for Water application is in no small part the reason for its effectiveness. The UI pairs a personalizable data view with a GIS window so that the user's focus is always on ***using*** information as opposed to ***searching*** for it. Innovative means of grouping locations, analysis parameters, and observation results also provides for creating and displaying varied formats of reports on the fly with as few as two or three mouse clicks. Role-based security is integrated into the application, so database administrators can set create, read, update, and delete privileges by user group for each form, sub-form, or report in the application.

The GWPC is committed to making the application available to interested agencies nationwide as a part of its RBDMS/Cost-effective Regulatory Approach (CERA) program.

Application Configuration and Features

NOGCC Implementation

In Nebraska, the GIS component of RBDMS for Water is being used to combine map coverages of wellhead protection areas with oil, gas, and UIC well locations from its oil and gas database. The resulting maps allow the NOGCC to manage its field inspection activities to target wells located in high-risk, environmentally sensitive areas for quarterly inspections.

The NOGCC has been working cooperatively with the Nebraska Department of Environmental Quality (NDEQ) to collect coverages of the source water protection areas delineated in the State and to identify the oil, gas, and UIC wells located within those areas from the RBDMS database. The resulting maps yield spatial representations of high-risk, environmentally sensitive areas with respect to those wells.

The NOGCC version of RBDMS for Water is an ASP.NET application that combines a GIS with full-text search-enabled SQL Server database in a personalizable Web part user interface. The Web application allows users to set their own display preferences within the browser.

RBDMS for Water offers a full-text search capability to minimize the need for general users to compose queries. When a keyword is entered, the search results are categorized in a tree control embedded in the *Search* Web part, with the list elements hyperlinked for either a *Details* display or zoom-to-location operation in the *Map* Web part. These features make browsing data fast and easy for both casual and power users. For example, entering the keyword *Sidney* organizes a tree structure that features all wells, leases, units, permits, and entities that include that character string in names or associated descriptions. Users can expand the tree control and click on the desired record to move the GIS map and to display detailed location, geological, permit or scout ticket information. The application also links to the NOGCC image library.

RBDMS for Water also includes advanced filtering options for detailed, specific database querying. The filters associated with the grid reports and lists in RBDMS for Water make it possible for power users to run sophisticated AND and OR sql statements against the database.

With the aid of the powerful spatial analysis and data organization and retrieval capabilities of RBDMS for Water, the NOGCC has re-prioritized its field inspection activities to target wells located in source water protection areas for quarterly inspections. Wells located outside these areas are inspected at less frequent intervals. The result is to focus the field inspection program more pro-actively on those areas where risk is greatest.

A screen capture of the NOGCC implementation of RBDMS for Water is presented in Figure 1.

ODNR Implementation

The ODNR views RBDMS for Water as a mission-critical tool that will significantly improve the ability of the agency and its watershed partners to access and analyze water quality data and the confidence and speed with which program decisions are developed. The ODNR will use RBDMS for Water to unify multiple databases that manage surface and ground water and waste stream quality data associated with mining operations and oil and gas development.

The water-related information that ODNR collects includes well and spring construction details, water well test data, surface sample source details, surface water flow measurements, waste stream source details, and abandoned and active mine source details such as seeps, impoundments, sediments, ponds, and underground mine intercepts. Aquifers, watersheds, and usage categories for ground and surface water also are tracked. (GWPC, July 2006; Kell, 2006).

RBDMS for Water is being customized for the ODNR in two phases. Phase 1 to unify existing databases and workflows is substantially complete, with acceptance testing now underway. In Phase 2 of development, the ODNR plans to Web-enable the application so that industry operators and their laboratory consultants will be able to refer to the database through the Web to track compliance with water information reporting requirements.

In Ohio, the RBDMS for Water application is a .NET desktop (WinForms) application that is paired with a SQL Server database. The application tracks organic, inorganic, and physical water quality parameters. Like the NOGCC version, the RBDMS for Water UI includes a map pane that is interactive with the grid views of the data. The application can be used as an integral part of field sampling program development, data entry for field test method results, and automated reporting of laboratory analyses (see Figures 2 and 3).

The reports module of the Ohio Mines RBDMS for Water application includes a variety of formats, including trend graphs with criteria limits, box-whisker charts, Microsoft .NET reports (.rdlc), and data grid reports (see Figure 4).

One of the most important program management features that RBDMS for Water offers is the ability for users to create and to subscribe to sets of automated alert notifications from the database. Users will be able to view messages from the database that pertain to any of the following occurrences within their assigned DMRM program (GWPC, December 2006):

- Parameter exceedances for reported values across the sites the user is assigned to monitor.
- Events and due dates for the user's assigned sites.
- Reminders associated with the requirements of and deadlines for the DMRM program to which the user is assigned.

Some of the specific water quality checks that have been programmed as automated alerts follow:

- Specific conductivity must be greater than the total dissolved solids (TDS).
- The TDS must be greater than the sum of the dissolved constituents.
- A total analysis concentration must be greater than the respective dissolved concentration.
- pH must be between 0 and 14.
- Total alkalinity and total acidity must be greater than or equal to 0.
- The sum of analysis concentrations must be less than the TDS.
- The analysis concentration must be greater than or equal to the method detection limit.
- The analysis list is complete.
- The cation/anion ratio is within tolerance.

Deviations from these conditions in the data collected at any given site being monitored will result in an automated alert being sent to subscribed users. As a further management aid, workflow steps are now being added to flag and to monitor response actions from the users.

Cost Analysis

The NOGCC estimates that the cost of modifying RBDMS for Water to add the GIS coverages of state source water protection areas has been $40,000. Annual hosting and software maintenance charges are expected to run about $9,000 per year.

However, with the revised structure and focus of the field inspection program, the cost savings that the NOGCC will realize also amount to approximately $40,000 per year. The NOGCC measured these savings in terms of reduced vehicle mileage and inspector labor. Essentially, the agency will recoup 100 percent of its investment in the RBDMS for Water application within one year of its inception. Using RBDMS for Water as a part of the management strategy for meeting work plan goals is thus demonstrated to be a cost-effective, sound investment for the agency.

Measures of Efficiency

NOGCC and ODNR program administrators find RBDMS for Water valuable in ensuring program compliance by the regulated industries, monitoring enforcement actions by staff, providing for on-demand statistical reporting, and adjudicating complaints.

For example, the flexibility to define sites by grouping or re-grouping point and polygon locations on the fly and to analyze water quality data across boundaries yields greater freedom to assess regional trends and impacts to ground water, and, by extension, to monitor enforcement actions.

Another example of the efficiency of the UI and reporting capabilities of the application is its value for complaint adjudication. RBDMS for Water speeds agency response by providing real-time and just-in-time analysis. While on the phone with a complainant, a program administrator can use RBDMS for Water to filter for the location of the complaint; zoom to it in the map pane, select it and evaluate the location with respect to other nearby facilities; review the sampling history and results; and generate a report to address that public inquiry about incidents or possible enforcement actions immediately and with confidence.

Conclusion: Greater Water Resource Protection Afforded at Current Funding Levels

Being able to overlay sampling locations with laboratory results within the boundaries of a well location, UIC facility, mine permit, watershed project area, or source water protection area will help all stakeholders protect water resources. By automating the flow and quality control of data through RBDMS for Water, regulators will be able to speed the analysis needed to target those violations that pose the greatest risk to underground sources of drinking water. Well and mine inspection programs that are focused in this way

afford greater environmental protection and make the best use of public funding.

Acknowledgement

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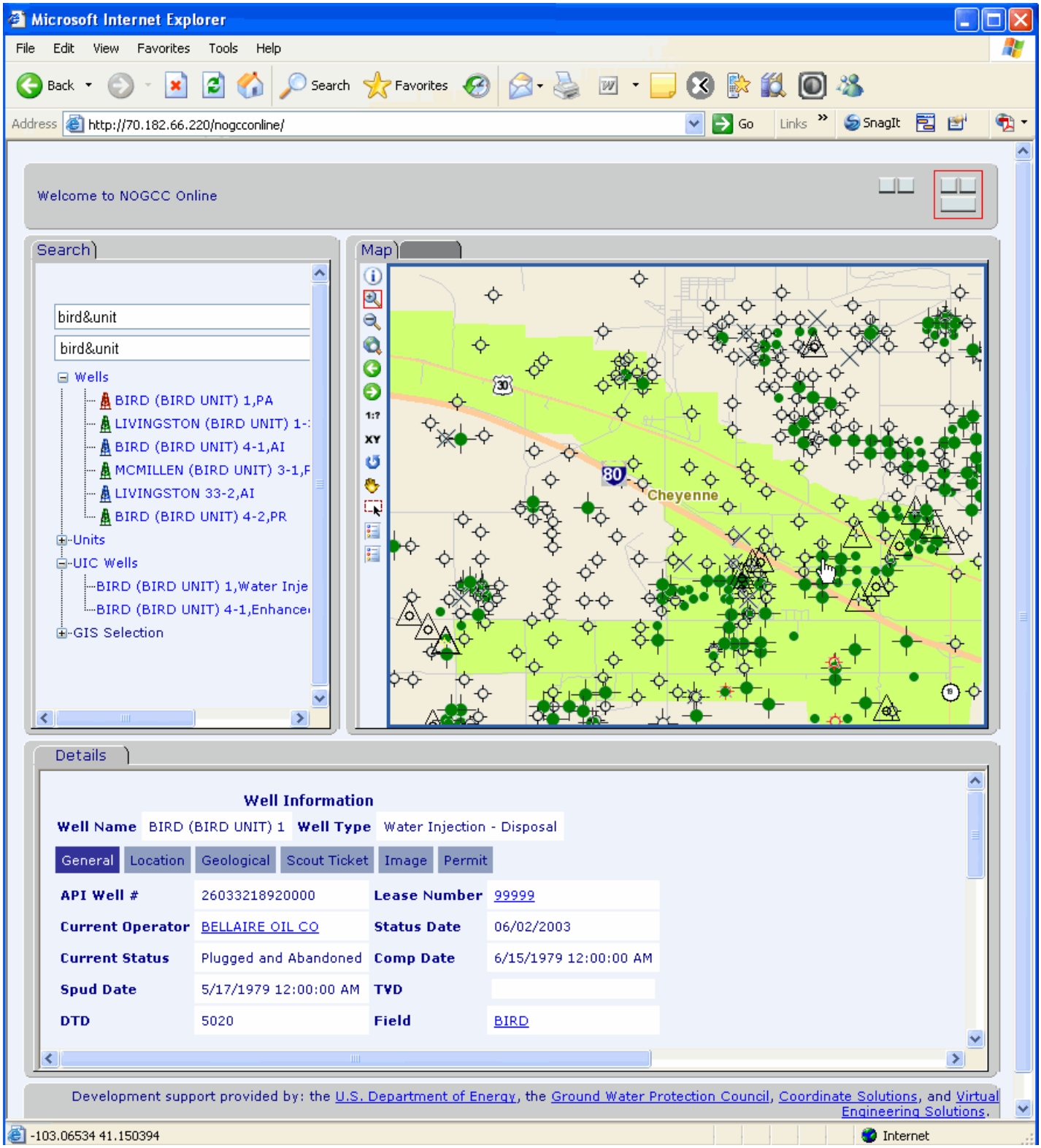
Figure 1. The NOGCC uses RBDMS for Water to prioritize oil, gas, and UIC well inspections in high-risk, environmentally sensitive areas by overlaying well locations on maps displaying source water protection areas.



Note: *Light-green area in Map pane denotes a source water protection area.*

Figure 2. ODNR uses RBDMS for Water to track mining impacts and the effectiveness of watershed restoration programs.

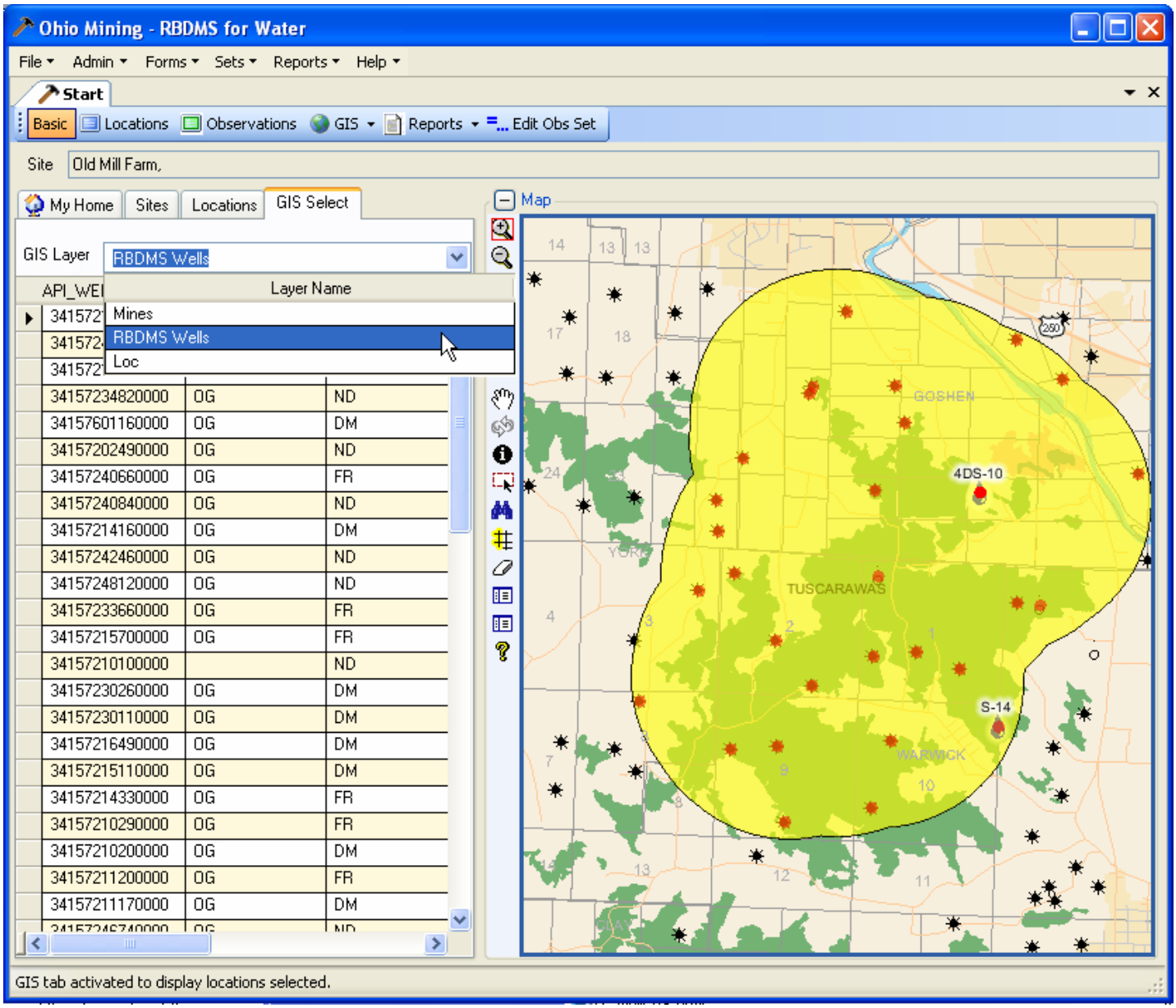


Figure 3. The Ohio Mines version of RBDMS for Water features field sampling program planning from chain-of-custody setup through automated reporting of laboratory analysis results.

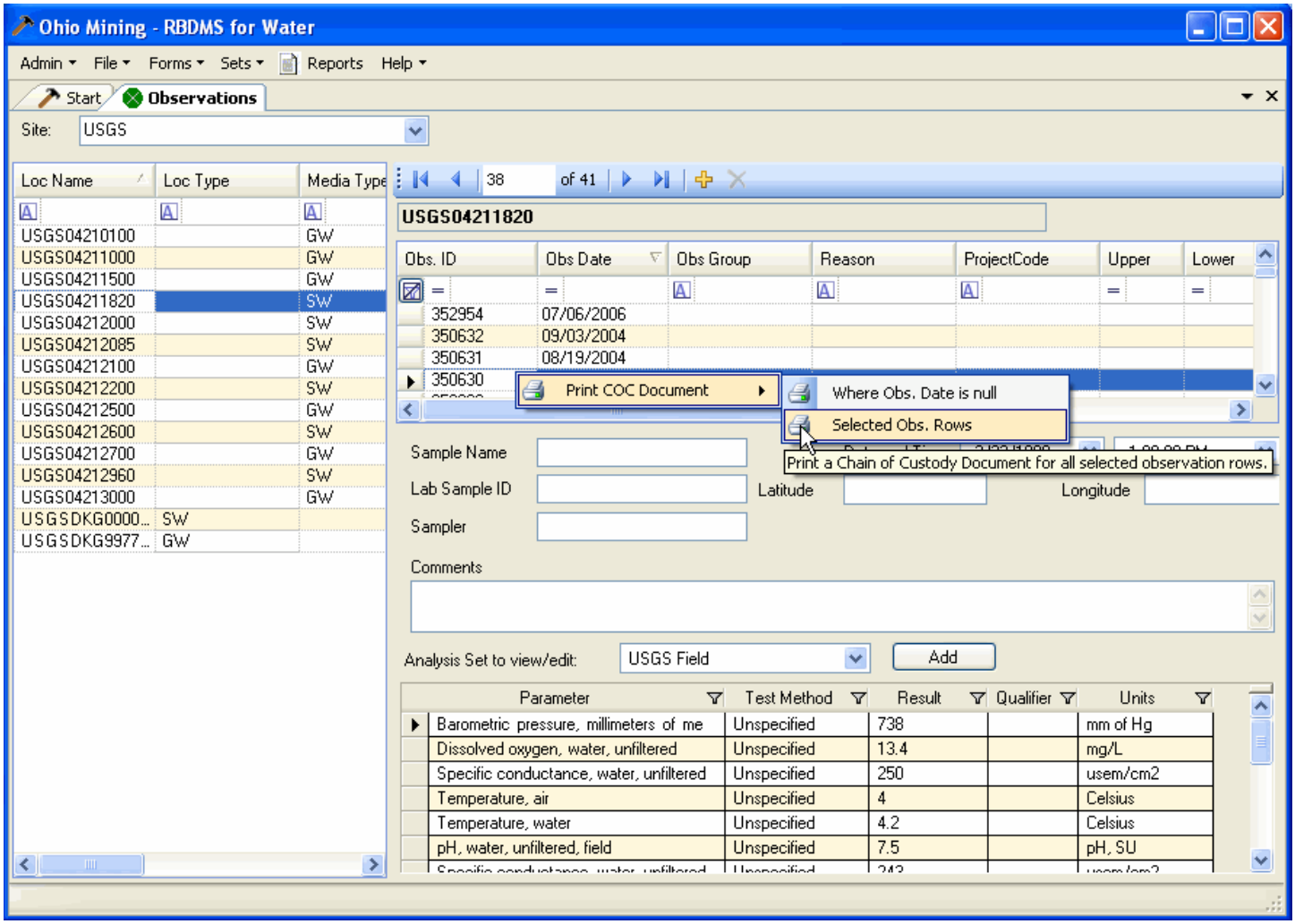


Figure 4. Reports from RBDMS for Water can be formatted as SQL Reporting Services tables, data grids with hyperlinked drilldowns, and trend graphs such as box-whisker, among other statistical outputs. Users decide how to group and analyze the data.