

Sustaining Groundwater Supplies through Wellfield Management

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Typical groundwater supply systems consist of a number of vertical wells that pump water to a treatment system, and then ultimately into a distribution system. Each well consists of several components, including the well casing and screen (or open-hole production zone), pump and motor, meters and gauges, piping, and electrical supply and controls.

As with any piece of equipment, production wells and pumps require periodic upkeep in order to maintain their design capacity and

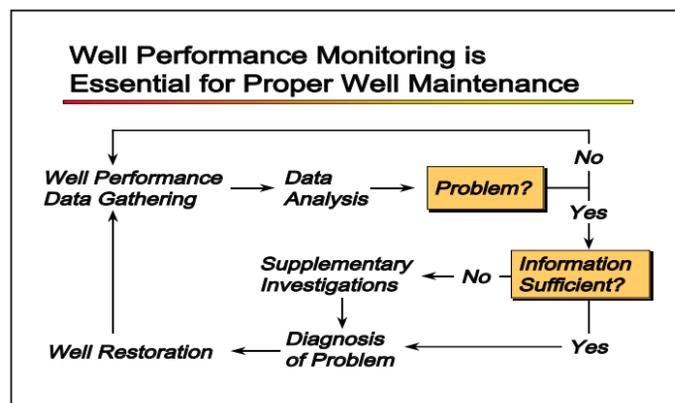
efficiency. Retaining the design capacity of the wells ensures that they will be able to meet water demands, and sustaining the efficiency of the wells directly affects the consumption of energy and the cost of operating the system.

Water supply wells naturally deteriorate with time. This deterioration often develops slowly, sometimes without being noticed. Once a critical point is reached, deterioration becomes rapid, resulting in a substantial decrease in yield. If it continues unnoticed, catastrophic failure may result.

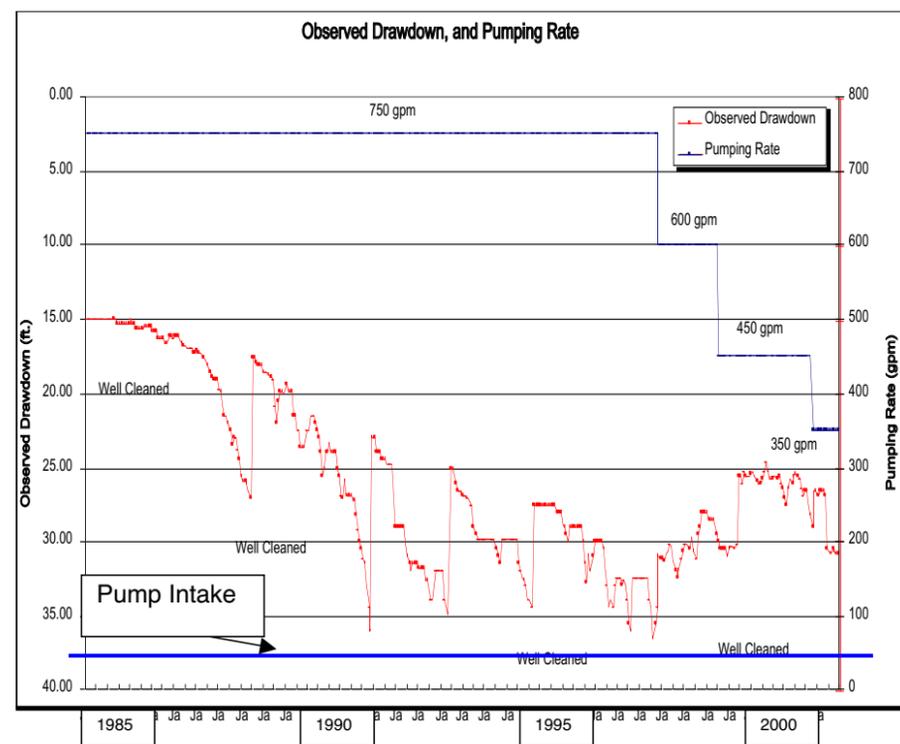
The proper operation of wells requires up-to-date, accurate well performance records. These records provide the basis for determining trends in the deterioration of performance and for diagnosing problems.

For well maintenance to be effective, it is imperative that wellfield managers are able to identify when and what part of the well is "breaking down." This information can be provided by systematically monitoring and analyzing some key operating parameters, but in many cases, this information is not collected, collected inconsistently, not managed, or not evaluated because an effective management system is not available.

(Right) Figure 1: A well performance monitoring process.



(Below) Figure 2: An example of drawdown data collected from a production well.



Typical Data Analysis & Review

The process begins with gathering well performance data. These data are subsequently analyzed in a manner that will alert operators to the onset of problems. If no problems are detected, monitoring continues. If the analysis does indicate a problem, the well performance data are used to develop a restoration program that addresses the specific problem(s). After the well is restored, monitoring is resumed in order to evaluate the effectiveness of the restoration techniques employed and to monitor for future problems.

Benefits of a Wellfield Management Program

Information from a comprehensive wellfield management system will provide the wellfield operators with the basis for making better, more cost-effective decisions about the operation and maintenance of their wellfield. Specifically, the benefits provided by such a management program include:

- 1) Increased value of dollars spent on well maintenance by identifying and focusing on the wells that are in greatest need of maintenance.
- 2) Reduced maintenance costs by providing an early warning of problems before they result in well/pump failures.
- 3) Optimized well rehabilitation by providing the means for evaluating the effectiveness of various well rehabilitation techniques.
- 4) Enhanced wellfield performance by providing objective data that can be used to identify operating inefficiencies, including declin-

Wellfield Maintenance System Database Components

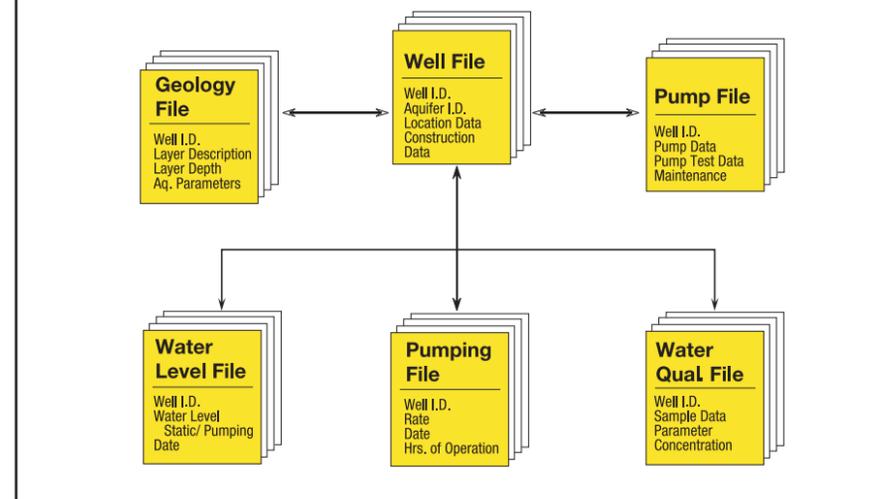


Figure 3: Data needed for a wellfield management database.

- ing static water levels and pumping well interference, and their possible solutions.
- 5) Quantitative assessment of the need for additional or replacement wells, and provision of new well design information.
- 6) Increase in the overall reliability and sustainability of the supply.

Well Performance Data Collection

Implementing a wellfield management program that uses the process illustrated in Figure 1 requires a system for collecting, analyzing, and evaluating well performance data. Collection methods range from simple manual techniques to more sophisticated automated systems such as SCADA systems. Basic information that should be collected as part of a wellfield management program includes:

- ◆ Hours each well is operated
- ◆ Pumping rate and volume from each well
- ◆ Static and pumping water levels
- ◆ Discharge pressure
- ◆ Production well completion information, such as length of screen or open area, well diameter, depth, screen slot size....
- ◆ Pump information
- ◆ Water quality information.

The graph in Figure 2 illustrates a case in which water levels were allowed to decline to near the pump intake before the well was cleaned and placed back into service. With time, cleaning became less effective and production rates decreased, but the data collected was placed in files instead of being used for well management. In this instance, delaying the cleaning until water levels reached the pump intake caused an irreversible degradation of the well, resulting in a shorter lifespan

data, along with other relevant information such as well construction, pump installation, water quality, and hydrogeologic data, should be combined to create a wellfield management database (Figure 3).

Data-gathering standards and protocols should be developed to ensure that the well performance data being collected are consistent. This is particularly important because most of the data evaluations involve a comparative analyses (i.e., data collected over time are compared in order to identify trends and/or anomalies).

Well Performance Data Analysis & Evaluation with Wellfield Management System

The timely analysis and evaluation of well performance monitoring data is essential for detecting excessive well deterioration. A computer-based system that utilizes a database for storing and manipulating dynamic data, along with a GIS-based system for storing static information, is ideal.

A wellfield management system will generally perform three primary functions:

- 1) **Data Management**—utilities to enter, edit, manipulate, store, and retrieve data
- 2) **Data Analysis**—routines to conduct stan-

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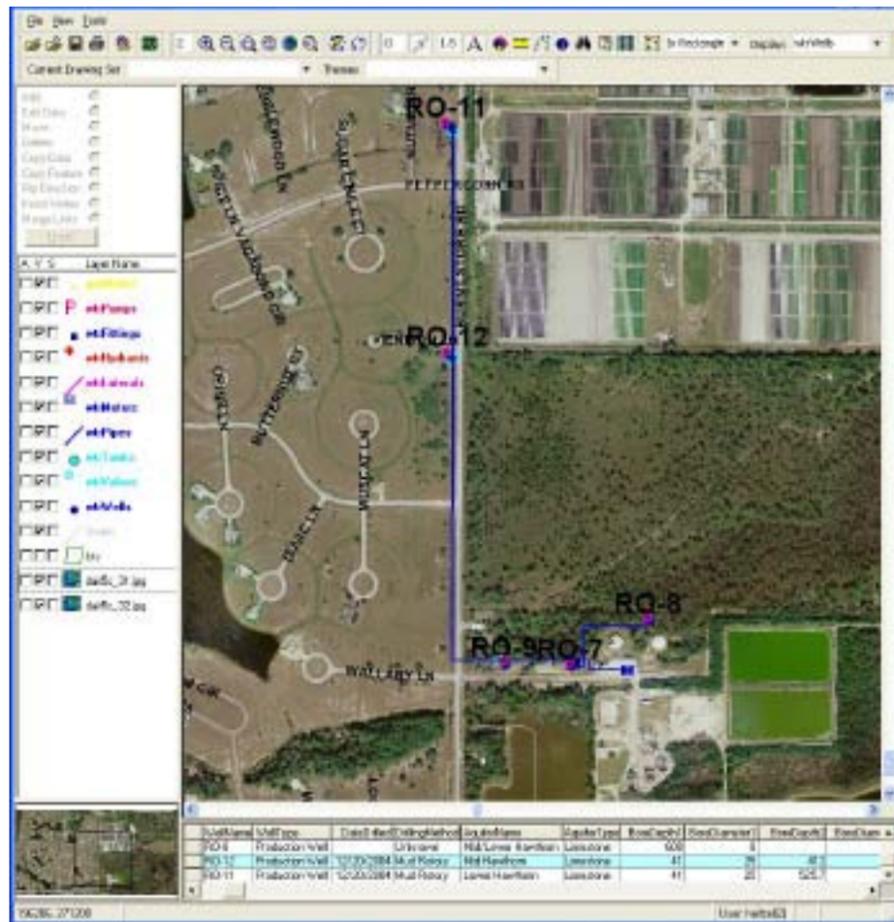
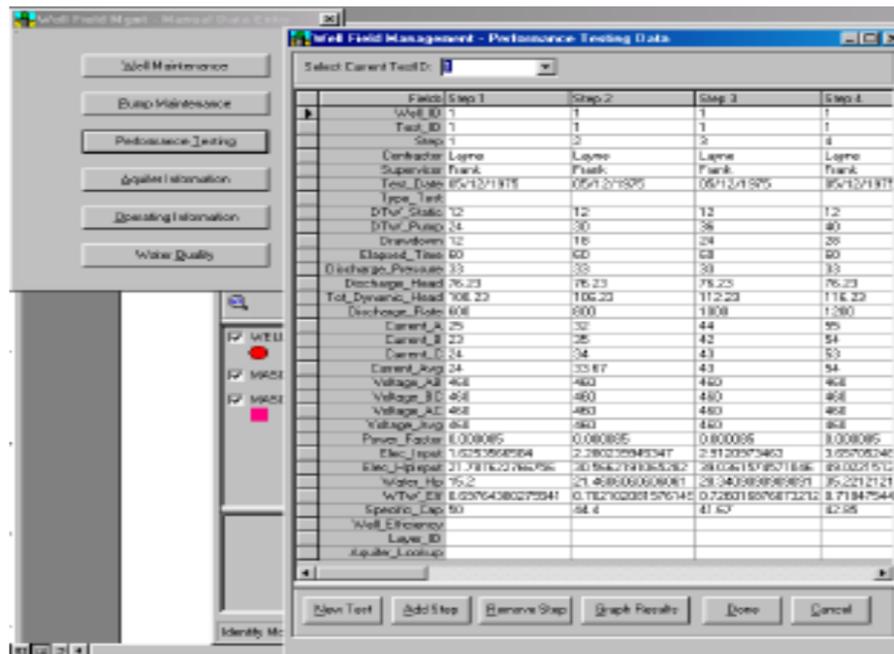


Figure 4: A GIS-based data management system is used to store static information such as well completion information, water line trends and diameters, valve locations, and pump/motor information. The data can be accessed easily when maintenance issues arise.



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standard and custom database queries and generate reports

3) **Data Evaluation**—programs to perform statistical operations and trend analyses and display results in a variety of formats

A well designed system will allow data to be viewed in graphical form to evaluate trends in overall wellfield water levels, pumping levels, specific capacity, and efficiencies. It will also aid in comparing water quality trends to production well and wellfield performance.

Collection, storage, and evaluation of wellfield/production-well data will enable managers to readily predict maintenance issues through the development of a proactive maintenance approach. This approach will help minimize production costs and maximize production efficiency. Screen shots from a GIS system and database from a wellfield management system are illustrated in Figures 4 and 5, respectively.

Summary

The collection of production well performance data such as water levels, pumping rates, and water quality information is critical for predicting well maintenance issues and maintaining wellfield performance. Once collected, this data should be managed using a system that allows operators to access and manipulate the data easily. The data can then be used as a management tool for individual well maintenance needs and overall wellfield production.

The benefits of a wellfield management system include:

- ◆ Increased value of dollars spent on well maintenance
- ◆ Reduced maintenance costs by providing an early warning of problems (proactive vs. reactive)
- ◆ Minimized production costs by maintaining higher well efficiencies
- ◆ Enhance wellfield performance
- ◆ Reliability of the water supply

Figure 5: A database can be used to store and manage information such as water quality data, water level and pumping level information, and production well testing information. The example shows step drawdown test data collected after a well cleaning. This information can be used to determine the effectiveness of the cleaning and can serve as a baseline for comparing well performance data to determine when the next cleaning is needed.