KENTUCKY DRILLER QUARTERLY

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Groundwater Branch Transfers Spring/Well Records To Digital Database

One of the functions of the Data Management and Support Section is to serve as custodian of the division's more than 54,000 spring inventories and water and monitoring well record files. The Data Management Section is in the process of overseeing the conversion of these records to a digital format. When a record is "imaged," a digital "photograph" of that record is created and stored. This digital record is also indexed so that it may be filed in and retrieved from a database. Index categories for each document in a well record include well/spring number, driller, county, quad, and document type (e.g. water or monitoring well record, bacteriological report, etc.). An electronic search of the digital well records can be conducted using any or all of the index categories, and the digital image database will retrieve one or many well records based on the information contained in the search.

Digital Well/Spring Record files allow division employees to more efficiently provide the information contained in these records to any interested person or entity. The desired information is readily accessible from desktop computers (as opposed to going to file cabinets for paper copies), and this information can be instantly sent to anyone with the capability to receive e-mail. This will greatly reduce the time from which Data Management receives an information request and the time the information is delivered to the requesting party. Eventually, all Department for Environmental Protection programs that have an interest in the information contained in these records (such as Wellhead Protection, Drinking Water, Underground Storage Tanks, Solid Waste, etc.) will also have access to well records via desktop computers; drillers and the public will be able to access well-record information via the Internet.

The digital conversion of well records will have the additional benefit of providing more security for the irreplaceable information contained in the files. Unlike the paper files, copies of the imaged records are stored in redundancy, and are not subject to flood, fire, theft, loss, etc.. Filing of the more that 3,800 well records received yearly by the division will be more efficient. As new records are received, they are imaged, and filing is done via computer.

These benefits result in greater efficiency and improved response to the need for information, and the process saves money. The imaging and indexing of well record files is being conducted by the Kentucky Department for Libraries and Archives through an agreement with the Division of Water. Once the paper records are imaged, the files are transferred to the Kentucky Geological Survey and are stored in their warehouse. However, the digital record remains as the official archive record.

Peter T. Goodmann, Manager, Groundwater Branch
John Shuttleworth, Supervisor, Data Management Support Section
Groundwater Branch

Bart Davidson, Richard Smath and Ray Daniel of the KGS help load the first shipment of imaged well records, consisting of approx. 36,000 files, to the KGS warehouse for storage.

What Causes Wells to Lose Capacity?

By Larry Thomas

Declining production is a fact of aging wells. Loss of well capacity usually results from mechanical clogging, biological plugging, or both. Techniques are available for recovering well capacity and for determining the most cost-effective time to do the work.

Wells completed in sand and gravel, limestone, or sandstone need to be rehabilitated periodically to maintain a source of water. Generally, water supply wells that are not rehabilitated on a periodic basis decline in their ability to produce water until they are no longer effective sources. Also, as a well ages, the water quality can decline because of increased bacteria counts, iron, taste, odors, and turbidity in the well.

What's Happening Down There?

Probably a number of things are happening in the well. Physical clogging and biological plugging prompt the need for well rehabilitation. And, yes, microorganisms are naturally present in the subsurface without a raccoon falling in the well and decomposing.

Groundwater Chemistry and Biology Issues.

Many water professionals believe that bacterial growth--not chemical depositions--is the key cause of well problems. However, groundwater biology and groundwater chemistry interact with each other and influence a well's condition. Many physical-chemical problems are associated with biological slimes. The following are examples of physical-chemical interactions:

- An aquifer has different environmental conditions in different locations. In some areas oxygen is present (such as near a well). In other areas it will be absent (reduced conditions). Bacteria grow very well at the transition point, or redox front, between oxidized and reduced conditions.
- In this same transition zone, if low-redox water mixes with high-redox water, chemical interactions and the creation of precipitates will occur.
- Colloidal particles that are sometimes found in water can also create interactions. They both adsorb chemicals and provide surface areas for the attachment and growth of bacteria.
- Iron is seldom present without bacteria also being present.
- Ammonia nitrogen tends not to move very far from its source. But once it is changed to nitrate, it moves quickly with the groundwater.
- Phosphate is a key element in the structure of cellular adenosine triphosphate (the energy storehouse for cells). This is the fundamental reason why phosphates encourage the growth of microorganisms.

Physical Issues. Clogging involves the physical blockage of flow paths by physical and chemical means. Causes can include the movement, caused by high water velocities, of the finer-grained particles (known as fines) of a mass of soil, sand, or gravel, which accumulate in and block flow paths, in the formation near a well; precipitation of chemicals at the redox boundary as water moves toward the well (basic groups of precipitates include carbonates, sulfates, oxides, and oxyhydroxides); and swelling of clays caused by changes in water chemistry.

Biological Issues. The subsurface is not sterile, as it was thought to be just a few years ago; bacteria are almost always found throughout the subsurface world. Wells may have different environments in different locations, but this only means that different populations of bacteria will dominate different areas of an aquifer.

Sand and gravel are not dead. Limestone is not dead. Sandstone is not dead. Bacteria can live and move about in the smallest of fissures (ones we cannot see). In recent studies of a limited number of wells, at least 4,500 species of bacteria were identified. Depth was not an issue.

Total coliforms, like other bacteria, can be found in the subsurface. They do not need to come from the surface, near surface soils, or drilling tools. They can live and reproduce within aquifers. The idea that they can only live for 30 days in the subsurface is now believed to be wrong. They have been found at great depths.

Fecal coliforms, however, do not live in the subsurface. These bacteria, if found, have migrated from the surface. Fecal coliforms, not total coliforms, are the better indicator of surface contamination entering a well.

Bacteria are generally not free-floating in the subsurface water. They are usually attached to surfaces and incorporated in biological slimes. Even when not attached, they are usually combined with other bacteria in a floating slime mass (biocolloids). Unfortunately, these slimes will always develop best in the most productive zones of the well.

As slimes grow they bioaccumulate metals and ions from the formation and the water. The reason for this is that slimes tend to be negatively charged. Thus, iron and manganese are accumulated because they carry a positive charge. As the slimes mature and slough, they tend to release those same ions, thereby causing fluctuations in water quality testing results and, accordingly, inaccurate representation of an aquifer's water quality.

Biological slimes that create problems do not consist of only one or two types of bacteria. Six to 30 species may be found in a slime mass. A water sample test indicating no bacteria present is a combination of pure chance and the fact that so many bugs are killed or damaged by the test procedures.

Bottom line No. 1. Physical and biological changes occur in the subsurface as a result of the increased movement of water toward the well. These changes will eventually result in plugging and clogging of the well.

When to Rehabilitate the Well

Collecting information is key to determining when to rehabilitate a well. This includes maintenance of accurate records over the long term to facilitate identifying the most cost-effective time to rehabilitate. The records would include aquifer and water well construction records; water level data--both static and pumping levels--and water production data in both gpd and gpm; electrical power usage in amperage draw, voltage, and number of hours of operation per day; well pump and well bore maintenance logs; observations of well operations; and water quality testing results.

Concerning testing records, at a minimum, tests should include calcium, magnesium, iron, manganese, sodium, potassium, carbonate, bicarbonate, chlorides, sodium, hardness, sulfates, metals, phosphate, pH, eH (redox potential), conductivity, turbidity, temperature, and sand and silt content. Biological activity reaction tests (BARTs) should also be included.

Consistent measurement of pumping levels and rates is critical to obtaining meaningful analyses of the information. The number of hours the well has been in operation prior to making measurements should be recorded. Ideally, the readings would be made after the same number of hours of operation each day. Similarly, a record of the number of hours a pump has been off before a static water reading is made is necessary. If there is a decline in a static water level, the problem must be identified as either regional or specific to a well. Also, meter and pressure gauge accuracy should be periodically confirmed.

Specific Capacity (SC). Calculating the specific capacity is an uncomplicated means to monitor the effectiveness of a well and an aquifer. It is calculated by dividing the production of the well in gpm by the feet of drawdown between the static water level and the pumping level. In collecting data for the calculation it is critical to measure the water levels only after they have stabilized.

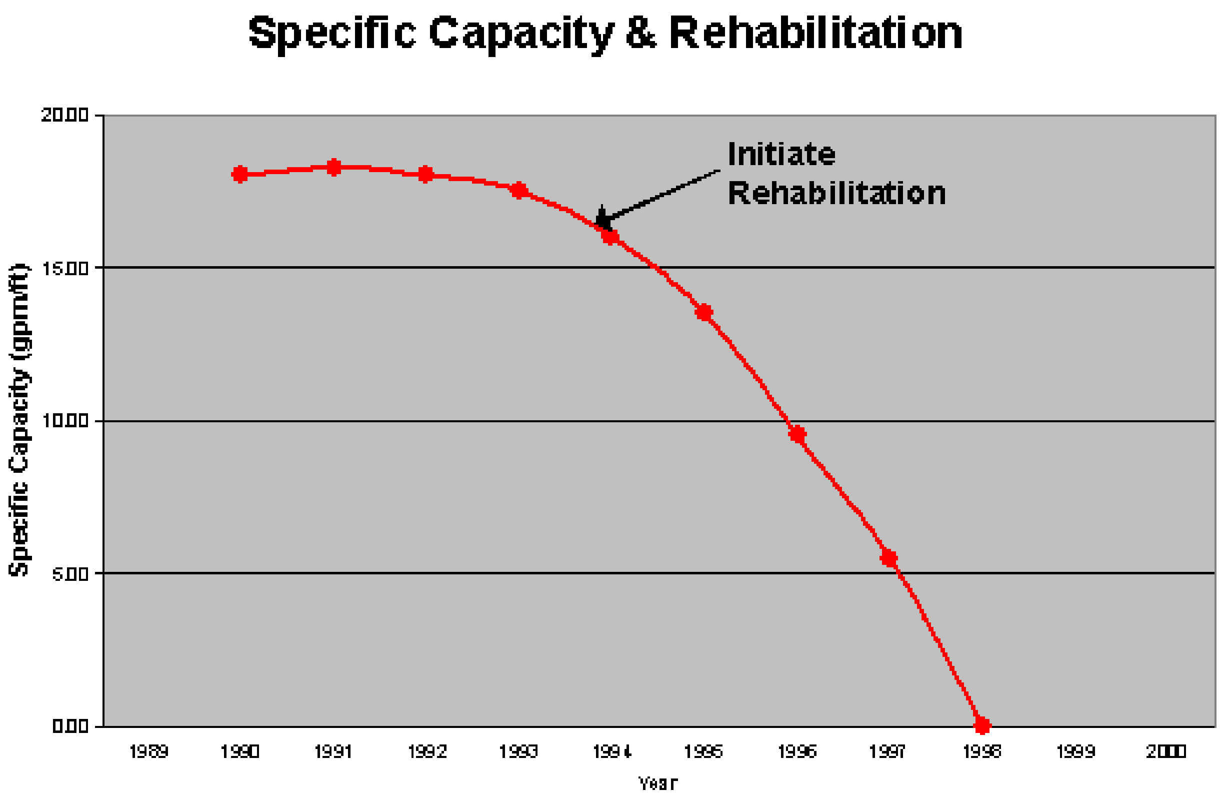
Once determined, the SC should be recorded and plotted against time. Normally, the SC holds steady during the early stages of a well's life, followed by a period of slow decline, and finally a sharp drop-off as the flow paths around the well close off; but there are many exceptions to this pattern. For example, it is not uncommon in limestone wells to see the SC increase as new flow paths develop.

The importance of knowing the SC is this: If the SC drops too far below the original SC, the full capacity will likely not be recovered with well rehabilitation. In determining the change in SC, the percentage change, not the absolute numbers, is important. The SC guidelines can be summarized as follows:

- Full recovery of capacity is probable with normal rehabilitation work if $SC_{current}$ is greater than 85 percent of $SC_{original}$
- Full recovery of capacity may still be possible, but more extensive work will be needed if $SC_{current}$ is less than 85 percent of $SC_{original}$ but greater than 60 percent of $SC_{original}$

- Full recovery of capacity is unlikely if $SC_{current}$ is less than 60 percent of $SC_{original}$
- The well may be unsalvageable if the specific capacity drops below 40 percent of the original

Bottom Line No. 2. Rehabilitation work should start before a well's specific capacity falls below 85 percent of the original value. Doing so increases the chance of success and reduces the amount of work necessary. This is a critical factor if the capacity of the well is to be recovered repeatedly in a cost-effective manner.



Biological Aggressivity

Aggressivity is a measure of the growth potential of bacteria--the quickness of regrowth. It is measured with BARTs and reported in terms of the number of hours or days (time lag) needed to see a measurable reaction in the test tube. For example, a one-day decrease in the time lag represents a 1-log increase in the number of bacteria.

Agar plates are not a favorable environment for bacteria, and so their use is not a good substitute for monitoring bacterial growth potential in a well. Populations can be underestimated by one to four orders of magnitude. On the other hand, BART test tubes provide a variety of environments and food sources in which the different types of bacteria can grow.

The key results given by BARTs are time-lag information and an indication of the dominant bacterial species at certain points of a well. Time-lag (TL) data tell how aggressive the biological growth is--its aggressivity. The data also indicate the general types of bacteria that are present.

TL is defined as the first observation of a reaction caused by growth. The chronological order in which the reactions are observed in the tubes gives an indication of the agressivity of the type or consortium of bacteria found in the water sample. The shorter the TL the more aggressive the bacteria in the water sample. The shortest TL can be 2 to 4 hours. The longest can be 42 days.

BARTs should be conducted as routine testing; not just when a well is in trouble. Over time, the TL and dominant bacteria should be plotted against time and trends monitored for early warning of trouble and the possible cause. For example, if the TL drops prior to a decline in a well's specific capacity, the well is likely plugging with biological growth.

Frequency of testing depends on prior experience with a well or an aquifer. Wells that are new or have a history of biological plugging should be tested once a month. If a well shows low aggressivity, the testing can be spaced out in longer intervals. The longest interval between testing of sand and gravel wells normally should be three months. The longest interval for testing limestone and sandstone wells normally should be one year.

Knowing the aggressivity and group type of the bacteria provides key information for determining when to initiate well rehabilitation work. Waiting too long and allowing the bacteria to become too aggressive can make it difficult to recover the well's full capacity with rehabilitation. The TL guidelines can be summarized as follows:

- Full recovery of capacity is probable with normal rehabilitation work if TL is greater than 5 to 8 days.
- Full recovery of capacity may still be possible, but more extensive work will be needed if TL is less than 7 days but greater than 3 days.
- Full recovery of capacity is unlikely if TL is less than 4 days but greater than 2 days.
- The well may be unsalvageable if the TL drops below 2 days.

Bottom Line No. 3. Well rehabilitation work should be done before bacteria populations become too aggressive and create dense slimes throughout the production zones of the well. However, the decision to do rehabilitation work should not be based solely on the TL data. Specific-capacity data must be considered in conjunction with the TL information.

Other Well Problem Indicators

Watch for changes in water quality when looking for indications of other impending well problems. Iron, sulfur, and manganese are commonly present in wells. A redox shift with any of these elements would indicate significant biological activity in the well.

Additionally, shifts in pH levels can result from biological activity and also point to an increased likelihood of corrosion and incrustation. Biological activity or inorganic clogging may be anticipated from an increase in conductivity and turbidity levels.

Source: Opflow, January 2002

2002 KGWA Meeting, Trade Show and Workshop

The Division of Water will be present at the **Kentucky Ground Water Association's Driller Workshop** **(Thursday and Friday, April 11 and 12)**. The division will be manning a sign-in table for **certified drillers only** in order for drillers to receive their training cards. Only certified drillers should sign in at this table. Others, including rig operators, should sign a separate list at an adjoining table. If a previously certified driller needs training in order to become recertified, he/she can sign this separate list and receive a different colored training card. After each of the one hour training sessions, your training card will be stamped to verify your attendance at the session.

The Division of Water will also be giving the Kentucky Water Well Exam and the National Ground Water Association's Exams starting at 10 a.m. Friday. If you are a certified driller and wish to take an exam to be certified for another specialty, you will need to schedule the exam around the training sessions on the agenda.

As with previous workshops, the Division of Water will have a request list available for well tags and forms, applications, Groundwater Protection Plans or other items needed.

Water Well Handbook

Please remember to give your water well customers a copy of the blue Handbook For The Kentucky Water Well User. This handbook can be very useful to the water well owner in answering questions they may have concerning their well.

It is also a requirement under KAR 6:310, Section 10, 2 (c), “The driller shall also give the owner information prepared by the cabinet explaining the importance of water well sampling, procedures for sampling, and how the water can be tested to assure a safe supply of water.” If you need to order additional handbooks, please call the Groundwater Branch at (502) 564-3410.

Joe Moffitt, Groundwater Branch

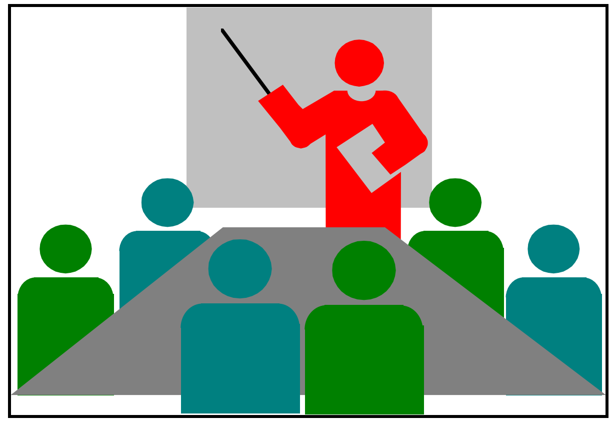
Groundwater Protection Plans (GPP) for domestic wells, septic systems and monitoring wells are also available to drillers. They can be located on the Groundwater Branch’s Web site at:
Http://water.nr.state.ky.us/dow/dwgr.htm
or by contacting Beverly Oliver at (502) 564-3410

Call BUD Before You Dig

Kentucky Underground Protection, Inc., is a non-profit organization established to provide a communication link between excavators and operators of underground utilities.

KRS 367.4901 to 367.4917 requires that you call two business days before you dig in the state of Kentucky.

The toll free number to call is:
1-800-752-6007
In Louisville, (502) 266-5123



Training Opportunities

National Ground Water Association Courses

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Principles of Ground Water – Flow, Transport, and Remediation

Columbus, OH
March 18 – 20

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Understanding Migration, Assessment, and Remediation of Non-Aqueous Phase Liquids (LNAPJs and DNAPLs)

Scottsdale, AZ
March 26 – 28

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Design and Construction of Wells

Chicago, IL
April 8 – 9
Columbus, OH
May 8 – 9

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Analysis and Design of Aquifer Tests Including Slug Tests and Fracture Flow

Columbus, OH
June 10 – 12

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Contact: National Ground Water Association
601 Dempsey Rd.
Westerville, OH 43081-8978
Phone: (800) 551-7379
Fax: (614) 898-7786
www.ngwa.org

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The Remediation Course

Denver, CO
March 18 – 22

Contact: Princeton Groundwater, Inc.
P. O. Box 273776
Tampa, FL 33688-3776
Phone: (813) 964-0800
Fax: (813) 964-0900
E-Mail: info@princeton-groundwater.com

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New England Water Well Association Convention & Show

Marlborough, MA
March 22 – 23

Phone: (860) 286-4238

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Kentucky Ground Water Association's 17th Annual Drillers Workshop & Trade Show

Louisville, KY
April 11 – 12

Contact: Kentucky Ground Water Association, Inc.
P. O. Box 991
Mayfield, KY 42066
Phone: (270) 247-6658

Applications are included in the Kentucky Ground Water Association's Newsletter.

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The Nielsen Environmental Field School, Inc. Courses

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Monitoring Well Design, Construction & Development

San Diego, CA
April 9 – 12

The Ground-Water Sampling Field Course

San Diego, CA
April 11 – 12
Columbus, OH
April 25 – 26
Boston, MA
May 13 – 14

Fundamentals of Ground Water & Contaminant Movement

San Diego, CA
April 8

Contact: The Nielsen Environmental Field School, Inc.
4686 South State Route 605
Galena, OH 43021-9852
Phone: (888) 965-5026
Fax: (740) 965-5027

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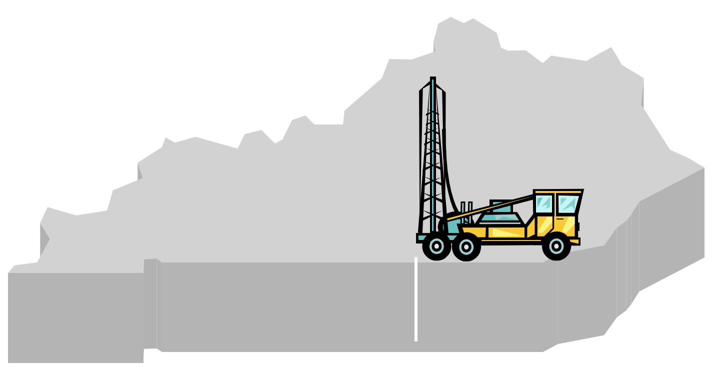
In order to use training other than the Kentucky Ground Water Association's Annual Drillers' Workshop, you MUST contact Joe Moffitt, Harold Lee or David Leo at the Groundwater Branch.

Remember to obtain proper attendance documentation when attending any training for your continuing training requirement. This includes a signed certificate, training card or letter along with an agenda.

Ground Water Atlas

The address for the Ground Water Atlas from the Kentucky Geological Survey is:
http://www.uky.edu/kgs/water/research/bwatlas.html
Or call (859) 257-5500.



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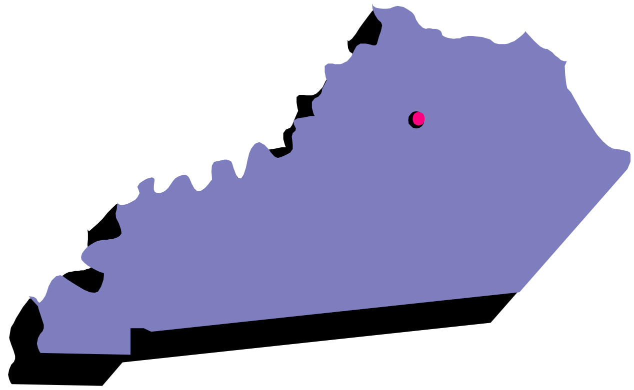
All contributors to this issue, except for the article "What Causes Wells to Lose Capacity?," are employees of the Division of Water.

Visit the Groundwater Branch page on the Internet at:

http://water.nr.state.ky.us/dow/dwgr.htm

E-mail: Harold.Lee@mail.state.ky.us



Natural Resources and Environmental Protection Cabinet
Department for Environmental Protection

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