Measuring Water Levels in Kansas

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Introduction

Groundwater is the primary water source for much of western Kansas. In order to effectively manage groundwater use, changes in water levels and the associated saturated thickness in aquifers are regularly and accurately monitored. As part of a statewide program, about 1,380 wells in 47 central and western Kansas counties are measured annually (fig. 1).

This program, sponsored by the Division of Water Resources (DWR) of the Kansas Department of Agriculture and the Kansas Geological Survey (KGS), is designed to monitor changes and identify regional trends in the High Plains, Dakota, and alluvial aquifers.

Water levels generally are measured during January by staff from the DWR and the KGS. The measured wells are used for livestock, irrigation, households, municipalities, industries, and monitoring (abandoned agricultural or domestic wells). Approximately 90% of these wells are in the High Plains aquifer, which consists of the Ogallala Formation and hydrologically connected units that lie above the Ogallala.

The principal product of the water-level measurement program is a regional view of water levels in central and western Kansas. Regulatory agencies use this information to judiciously determine water appropriations. Groundwater management districts use the information to better understand the status of area water levels and to make management decisions. Landowners use the data to make decisions about drilling and water use. The purpose of this circular is to describe how wells are selected and measured, how the public can gain access to this information, and how this information is used.

Selecting Wells to Measure

Not all water wells in Kansas are measured as part of this program. Instead, a representative sampling of wells is made, so that the resulting measurements provide an accurate but cost-effective snapshot of water levels in the aquifer. Wells included in the annual water-level census are selected based on the following characteristics: (1) what aquifer they penetrate, (2) the presence of substantial amounts of water in the aquifer, (3) where the wells are located, (4) how they were constructed, (5) the amount of historical data available, and (6) how the wells are used. In general, one well in every 16-square-mile area is measured. Each year, for various reasons, about 5% of the previously measured wells cannot be successfully measured and must be replaced by other wells in the same area.

Of the wells measured in 1998, over half had depths to water of less than 100 feet (30 m), with slightly more than 1% with depths greater than 300 feet (91 m) (table 1). Most of the wells measured (71%) currently are used for irrigation (table 2).

Measuring the Well

Techniques for measuring water levels are well established and have remained virtually unchanged for the last 40 years. Steel measuring tapes are the tool of choice; they provide uniformly accurate measurements at all depths. To prevent the tape from coiling, a lead weight is attached to

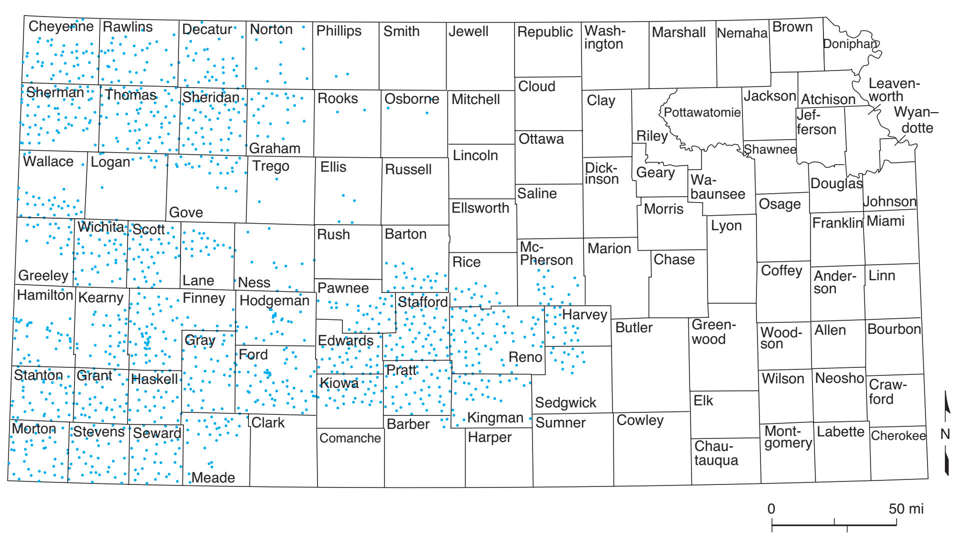

Figure 1. Locations of wells measured by DWR and KGS in 1998 water-level measurement program.

Table 1. Depth to water in wells measured in 1998

Depth to Water	Number of wells
Less than 100 ft	651
100 to 200 ft	509
200 to 300 ft	130
More than 300 ft	17

Table 2. Types of wells measured in 1998

Type of Well	Number of wells
Irrigation	979
Unused (monitor or abandoned)	274
Stock	64
Household	32

the end of the tape with copper wire. The weight pulls the end of the tape downward and reduces contact with the discharge pipe, casing, and pump equipment in the well. If the tape snags on a downhole obstacle, the lead weight can break free and fall harmlessly to the bottom of the well. The 3/8-inch (1-cm)-wide steel tape can then be easily retrieved from the well. Because steel tapes do not stretch and are unlikely to become entangled with downhole equipment, they are preferred over other measuring devices.

Because most of the measurements are taken in irrigation wells, access to the water surface is commonly limited by pumping equipment (fig. 2).

Most pump installations provide access to the water, either through metal tubes, threaded plug holes, or open slits in the wellhead base. These openings are generally less than 1 inch (2.5 cm) in diameter. Many times simply getting the measuring tape into the well casing through these small openings is challenging because the tape must make several sharp bends. Once inside the casing, the tape must snake alongside downhole equipment to reach the water surface (fig. 3).

The depth from the surface to the top of the water is determined by subtracting the length of tape immersed in water from the total length of tape lowered into the well. This is something like checking the oil in a car. The height of the oil on the dip stick is a direct measure of the level of oil in the crankcase. However, unlike oil, water on a steel tape can be difficult to see. To improve the contrast between wet (below the water level) and dry (above the water level) tape, a thin coating of blue carpenter's chalk is applied to several feet at the end of the tape. Once chalked, the weighted tip of the tape can be coaxed through an access hole and slowly lowered between the outer casing and discharge pipe to a predetermined depth derived from the previous year's measurements (fig. 3). The light-blue chalk on the end of the tape changes color when wet, making the water line easier to see.

After reaching the measurement depth, the tape is retrieved and carefully examined for the water line. Sometimes establishing exactly where the chalk changes from light blue (dry) to dark blue (wet) is difficult; wet or grimy spots on the tape above the water line can interfere with finding the water line. These smudges or wet areas result from tape contact with the casing above the water line. In most cases, the water line is obvious, with no trace of moisture above that line. Depth to water from the ground surface is calculated by subtracting the water-line measurement from the measurement depth (amount of tape lowered into the well).

If a water line cannot be determined or the calculated change in water level is not consistent with the local trend, the well must be remeasured. The local trend is the average change in water levels from

Figure 2. Water well showing pumping equipment.

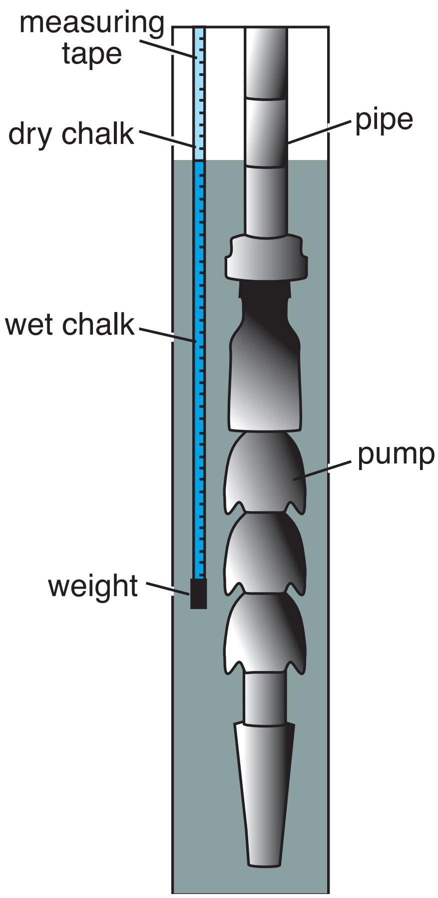

Figure 3. Diagram of the downhole portion of the water well.

the previous year in nearby wells sampled in the same aquifer. A water-level measurement is considered good when the water line can be determined with confidence.

Well Tags

Once a well has been successfully measured, a weather-resistant tag is attached to the well so landowners can tell, from a distance, that their well has been measured. Different colored tags are used each year. The tags provide information about well location, landowner's name, measuring agency, measurement access, obstructions, the quality of the water line, oil on water, remarks, depth to water in the current year, depth to water in the two previous years, date, and measurer identification (fig. 4). Tags are for the convenience and information of owners or operators, who can remove the tags if they so choose.

Accuracy of Well Measurements

For the water-level data to be useful, it is critical that the same well be sampled each year using identical methods. Map-reading errors, incorrect legal descriptions, and confusion with nearby wells can lead to misidentification. To eliminate (or at least minimize) such errors, KGS researchers have begun using a computer system called WaterWitch, which uses Global Positioning System (GPS) technology and an extensive digital map system to accurately locate wells in relation to such geographic landmarks as towns, highways, roads, houses, and rivers and streams. Besides acting as a navigational aid and data recorder, WaterWitch combines detailed site comments and photographs to enhance and improve location certainty, well familiarity, and visual identification.

Using WaterWitch has increased the number of wells routinely measured in a day and improved the overall precision of the data. Currently about 40% of the wells have GPS-measured latitudes and longitudes that insure future measurements will always come from the same wells. WaterWitch accepts on-site entry of depth-to-water measurements and comments, automatically checks data quality, records the GPS location of each measurement, and permits real-time review of the previous 10 years of historical data for the well.

Quality-control procedures are an important part of the water-level measurement program. Wells with measurements that deviated from the local trends during the initial visit are revisited and remeasured to confirm the recorded water depths. Wells that were not successfully measured during the primary trip also are revisited. In addition, about 6% of the wells measured by the KGS are randomly selected for remeasurement to make sure they were accurately measured during the initial trip that year.

Making Water-Level Data Available to the Public

Both the current year's measurements and historical water-level data are archived and maintained at the KGS in a large, statewide computer database known as Water Information Storage and Retrieval Database (WIZARD). This centralized database of Kansas water-level information can be accessed through the World Wide Web (https://geohydro.kgs.ku.edu/geohydro/wizard/) or on CD-ROM. Information on Kansas groundwater resources can be obtained for areas as small as a section or as large as the state. Data analysis, reports, and general queries also are available on the more than 50,000 wells that make up its primary inventory.

Once data from the annual water-level measurement program are recorded and checked, they are entered into WIZARD and are electronically available to the public. Various kinds of scientific analysis that follow the yearly data acquisition—including determinations of saturated thickness, depth to water, depletion trends, and water-resource predictions — are all possible using software that can directly access WIZARD.

This database currently includes all significant water-level information gathered by the U.S. Geological Survey and the KGS. Eventually, data from DWR, Kansas Department of Health and Environment, the City of Wichita, and groundwater management districts will be incorporated into the database. Once this database is complete, it will be the most inclusive listing of water-well information anywhere in Kansas.

Information on water levels also is available from the KGS in traditional, published form. The 1998 results, for example, were published in January 1998 Kansas Water Levels and Data Related to Water-level Changes, Technical Series 12 (Woods et al., 1998).

Using Water-Level Data

Data gathered from well measurements are used for a variety of purposes, both public and private. Organizations and governmental agencies use the data, especially in mapped form, to develop an understanding of trends in regional water levels. That understanding is then used in making decisions about water and in taking regulatory actions. Groundwater management districts use the results to better understand water levels in their area. For example, the Southwest Kansas Groundwater Management District No. 3 used the data to develop a series of maps that shows changes in saturated thickness in the High Plains aquifer in southwestern Kansas and to project those drawdowns into the future (Yoder et al., 1995).

The Division of Water Resources of the Kansas Department of Agriculture uses the data in making decisions about applications for new water rights and in declaring and regulating intensive groundwater use control areas (or IGUCAs), where new groundwater pumping is extremely limited. Private institutions use the measurements to appraise the value of land and in making lending decisions. Private landowners use the data to monitor water-levels in their own wells and in those nearby. All of these uses depend on high-quality data about water levels. The key to the quality of those data lies in the distribution, accuracy, and timeliness of water-level measurements, which, in turn, depend directly on the help and cooperation of local landowners.

Summary

The annual water-level measurement program is designed to sample the High Plains aquifer and other aquifers in western and central Kansas, allowing trends to be determined and evaluated for incorporation into management decisions. Many of the tools used to collect the annual measurements have been developed specifically for the Kansas network. The program's principal objective is to report accurate water-level measurements for each well. The combined data must be consistent so regional water-level trends are correctly represented. Continued development of techniques of measuring water levels in Kansas will eventually lead to a much more accurate and useful database and encourage responsible use in the future.

References

Woods, J. J., Schloss, J. A., and Macfarlane, P. A., 1998, January 1998 Kansas water levels and data related to water-level changes: Kansas Geological Survey, Technical Series 12, 89 p.

Yoder, S. Buddemeier, R. W., Jayatilake, H., Frost, S., and Coe, D., 1995, Saturated thickness at section centers in the High Plains aquifer: Kansas Geological Survey, Open-File Report 95-18 (prepared in cooperation with the Southwest Kansas Groundwater Management District), 8 sheets.

1999 Annual Water Level Measurement Program
of the
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The University of Kansas
1930 Constant Avenue
Lawrence, Kansas 66047
and the
Division of Water Resources
Kansas Department of Agriculture

SURVEY INFORMATION Tag # 990000

Land owner ______________________

Well location/ID # ______________________

Depth to water

1999 ________ 1998 ________ 1997 ________

Measured by ______________________ Date ________

GPS-measured ☐ yes ☐ no ☐ KGS ☐ DWR

WELL CHARACTERISTICS

Access ☐ easy ☐ difficult

Tape restriction at ____________ ft., ____________ ft.

Oil on water ☐ yes ☐ no

Weighted tape measure ☐ yes ☐ no

Chalk cut ☐ excellent ☐ good ☐ fair

NOTES

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Please contact Mary Brohammer at 785–864–3965
if any information on this tag is incorrect.

Figure 4. Information on well tag.

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The Kansas Geological Survey (KGS) is a research and service division of the University of Kansas that investigates and provides information about the state's natural resources. KGS scientists pursue research related to surface and subsurface geology, energy resources, groundwater, and environmental hazards. They develop innovative tools and techniques, monitor earthquakes and groundwater levels, investigate water-quality concerns, and map the state's surface geology.

The KGS has no regulatory authority and does not take positions on natural resource issues. The main headquarters of the KGS is in Lawrence in the West District of the University of Kansas, and the Kansas Geologic Sample Repository of the KGS is in Wichita.

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