Kansas Geological Survey

Kansas River Alluvial Aquifer Index Well Program: 2019 Annual Report

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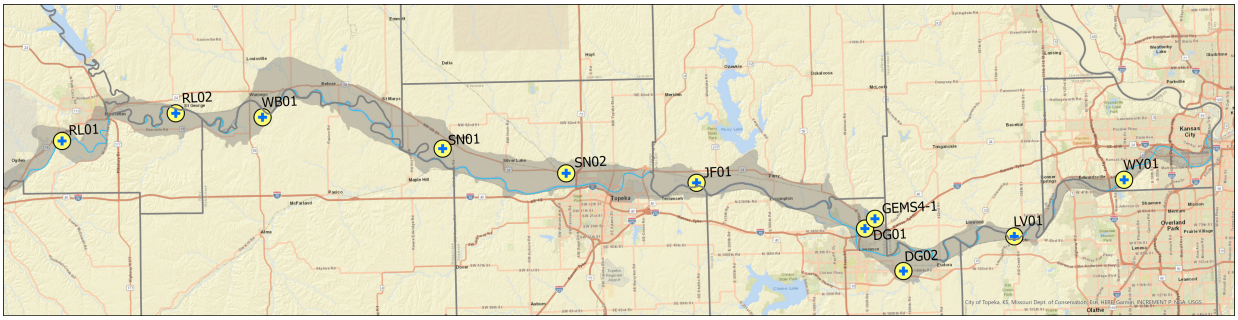

Kansas River Index Well Network – August 2020

Shawnee County Index Well 1 (SN01)

Kansas Geological Survey Open-File Report No. 2020-14
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GEOHYDROLOGY

KU KANSAS GEOLOGICAL SURVEY The University of Kansas

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Acknowledgments

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Executive Summary

The Kansas River alluvial aquifer index well program is directed at developing a better understanding of the aquifer and its relationship to flow in the Kansas River. Projections indicate that the Kansas River corridor from Junction City to Kansas City will continue to be a major area of population and economic expansion in the coming decades and that groundwater will help fuel that expansion. Thus, we need to be able to reliably assess how water levels in the aquifer and the Kansas River will respond to increased groundwater pumping. The Kansas Legislature charged the Kansas Geological Survey (KGS) with improving our knowledge of the aquifer and its interactions with the Kansas River. A major task of that effort is the establishment of a network of monitoring ("index") wells in the Kansas River alluvial aquifer (KRAA) that is patterned after the KGS index well network in the High Plains aquifer. The establishment of the KRAA network is the focus of this report. The Kansas River alluvial aquifer program is supported by the Kansas Water Office (KWO) and has benefited from assistance from personnel of the Kansas Department of Agriculture, Division of Water Resources, and past funding support by the U.S. Geological Survey's National Groundwater Monitoring Network program.

The project began with the installation of a monitoring well near the Lawrence Airport in late summer 2017. The network now consists of 11 wells from west of Manhattan to just north of Lake Quivira in the Kansas City metropolitan area. Each well is equipped with a transducer for continuous monitoring of water levels, and the transducers are connected to telemetry equipment to allow real-time viewing of well conditions on the KGS website (http://www.kgs.ku.edu/Hydro/KansasRiver/index.html). The vision of the program is that these wells, and others that will be added over time, will be monitored for the long term. The ultimate objective is to gather sufficient information through water-level monitoring and the additional activities of this program so that a groundwater model of the aquifer and its relationship to the Kansas River can be constructed and then improved over time.

This report provides a concise description of conditions as of June 2020. The report consists of a description of each of the 11 well sites, an initial interpretation of the well hydrographs, and a summary of the additional activities that have been performed at the sites. The COVID-19 pandemic has significantly slowed progress on a number of project activities, particularly on the installation of additional wells and the completion of the hydrostratigraphic framework portion of the project.

The major accomplishments of the index well program to date are as follows:

1. The network has been built from scratch and now consists of 11 wells spanning the length of the Kansas River corridor;
2. Telemetered data from all 11 wells are served on the KGS website;
3. We have initially analyzed hydrographs from all 11 wells and have begun to develop an understanding of the major mechanisms that produce water-level changes at each well.

The focus of activities for the remainder of 2020 and 2021 will be on the continuation of monitoring at all program wells; a more detailed analysis of hydrographs from all wells with a particular emphasis on teasing out the role of precipitation and river-stage changes; installation of an additional five wells to fill in gaps in the network and create transects from the river to the valley wall; the completion of a hydrostratigraphic analysis of the alluvial aquifer; and the chemical analysis of groundwater samples from all network wells.

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1 Introduction and Background

The Kansas River corridor is projected to continue to be a major area of population and economic expansion in the coming decades, and pumping of groundwater from the Kansas River alluvial aquifer (KRAA) will undoubtedly increase to help support that expansion. Currently, we have insufficient information to reliably assess how water levels in the aquifer and the Kansas River will respond to increases in the pumping of groundwater. That information is essential for, among other things, management of groundwater storage in the aquifer in conjunction with management of reservoir system storage.

The Kansas Legislature charged the Kansas Geological Survey (KGS) with improving the understanding of the aquifer and its relationship to Kansas River flow and provided funding for the project through the Kansas Water Office. A major task of the project is the establishment of an index well network in the KRAA that is similar to the KGS index well network in the High Plains aquifer (Butler et al., 2020). The first phase of this task consisted of the establishment of a 10-well network from upstream of Manhattan to the Kansas City metropolitan area either through the installation of new wells or the equipping of existing wells for real-time monitoring of water levels. Five of these wells were installed with funding through the KGS participation in the USGS National Groundwater Monitoring Network Program (Wilson, 2019). All 10 wells are now in operation and provide continuous water-level records that are accessible in real time through the KGS website (http://www.kgs.ku.edu/Hydro/KansasRiver/index.html). The second and third phases of the task involve the addition of six wells to the network to fill in gaps in the coverage and to complete transects of wells across the floodplain from the river to the edge of the aquifer; one of those wells is now in operation and provides continuous water-level records that are accessible through the KGS website. Concurrent with these phases are additional activities focused on obtaining information about the hydrostratigraphic framework of the aquifer and the hydraulic conductivity and water chemistry in the vicinity of each well; those activities are in varying degrees of progress. The ultimate objective is to gather sufficient information through water-level monitoring and additional activities so that a groundwater model of the aquifer and its relationship to the Kansas River can be constructed.

This report provides a concise description of conditions as of June 2020. The report consists of a description of each of the 11 well sites, an initial interpretation of the well hydrographs, and a summary of the additional activities that have been performed at the sites. The COVID-19 pandemic has significantly slowed progress on a number of project activities, particularly the installation of additional wells and the completion of the hydrostratigraphic framework portion of the project.

2 Overview of Aquifer Characteristics

Whittemore et al. (2019) provide a description of the general characteristics of the KRAA from which the following is drawn. The aquifer is composed of the unconsolidated sediments that fill the Kansas River valley. These alluvial sediments can be more than 80 ft in thickness in the deepest areas. The underlying bedrock consists primarily of limestone and shale, although some short sections of the valley are underlain by sandstone. The sediments in the deeper part of the alluvial aquifer are generally

coarse sand and gravel and overlain by finer-grained deposits (sand, silt, and silty clay) (Davis and Carlson, 1952; Dufford, 1958; O'Connor, 1960, 1971). Where the alluvial deposits are of substantial thickness, the aquifer has a high transmissivity and can commonly yield more than 1,000 gpm to large-capacity vertical wells (Fader, 1974). The quality of the water is fresh, although it is hard due to groundwater flow passing through the calcareous bedrock underlying the aquifer and in the valley walls. High iron and manganese occur in some portions of the alluvium as a result of chemically reducing conditions probably generated by organic matter in sediment in buried meander cutoffs and overbank deposits (Whittemore et al., 2014).

3 Program History

The Kansas River alluvial aquifer index well program began in late summer 2017 with the installation of a transducer- and telemetry-equipped well in Douglas County near the Lawrence Municipal Airport (Douglas County Index Well 1 [DG01]). This site was chosen so that we could build upon the 63-year record of monitoring from a previous well at the site. Over the next two years, an additional nine new wells were installed and an existing well was converted to an index well. The current network consists of 11 wells. All wells are equipped with a transducer to measure the position of the water level every hour and with telemetry equipment so that the measurements can be transferred to the KGS and viewed in real time on the KGS website. When possible, site locations were chosen, as with DG01, to build on previous monitoring efforts. In addition, when possible, an effort was made to site wells close to a USGS stream gage to develop a better understanding of the relationship between the river and the alluvial aquifer. The existing well that was incorporated into the network is at the edge of the floodplain in Douglas County and was chosen to be part of a transect that will run from the river to the edge of the floodplain.

Figure 1 shows the 11 wells that make up the current network. The next phase will be to add three new wells: one to fill the gap between WB01 and SN01, one to fill the gap between JF01 and DG01, and one to complete the transect that currently consists of DG01 and GEMS4-1. An additional two wells will be added to the network after completion of the hydrostratigraphic analysis and assessment of water-use patterns.

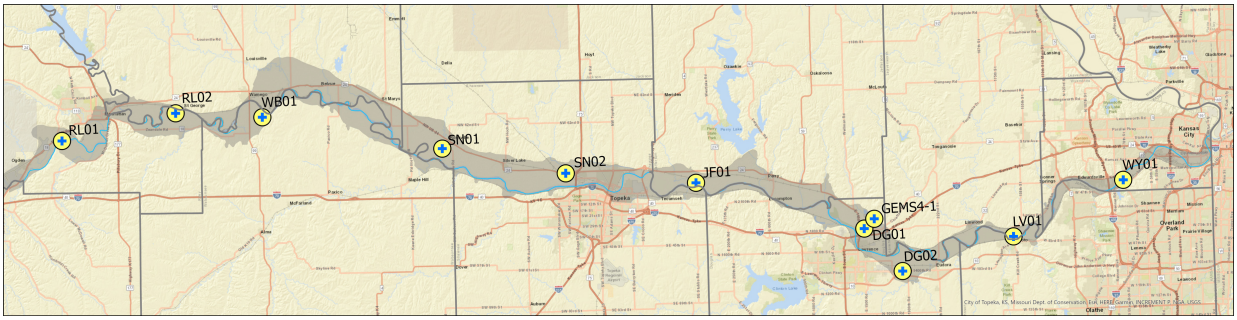

Figure 1—The Kansas River alluvial aquifer index well network as of early June 2020. The shaded area is the extent of the aquifer. GEMS4-1 is the previously existing well at the edge of the floodplain that was incorporated in the network as part of a transect that runs from the river to the edge of the floodplain.

4 Overview of Index Well Sites and Monitoring Data

This section describes the installation of the 11 index wells currently in operation and provides a brief discussion of the hydrographs from those wells. The duration of monitoring ranges from more than three years of hourly measurements at the first installed well (DG01) to a little more than half a year at the most recently added wells. The water-level data from the Kansas River network has very different characteristics from the data from the High Plains aquifer (HPA) index well network (Butler et al., 2020). In the HPA, the major drawdown in water level occurs during the summer when the aquifer is significantly stressed to provide water for irrigated agriculture. After cessation of irrigation pumping, water levels typically will increase until the start of the next pumping season; other than in the eastern portions of the HPA in south-central Kansas, stream-aquifer interactions are essentially negligible. In the KRAA, irrigation plays a more limited role than in the HPA, particularly in the eastern half of the network. In addition to irrigation pumping, which primarily occurs during the summer, the major mechanisms that produce changes in water level are precipitation recharge, stream-stage changes, and pumping for public water and industrial supplies, all of which can occur at any time during the year. As a result, the annual water-level change for an individual well is computed from the difference in the average water level from one year to the next, and not, as in the HPA network, from the difference in an annual water level measurement taken during the winter, three to four months after cessation of irrigation pumping.

In the following subsections, the installation, characteristics, and hydrograph of each well are discussed. The wells are organized by their location with respect to Topeka; wells in and to the west of Topeka are in the western reach of the network, while those east of Topeka are in the eastern reach. Details on the methods used for well installation and for subsequent slug tests can be found in the appendix. The Kansas River is also known as the “Kaw,” so that more succinct term will be used for the Kansas River in the aerial photos.

4.1 Western Reach — West of Manhattan to Topeka

Five index wells are located in this reach of the Kansas River alluvial aquifer (fig. 2). These wells were drilled between May and October of 2018. Tables 1 and 2 summarize the characteristics of the wells.

Table 1—Characteristics of the western wells in the Kansas River alluvial aquifer index well network.

Site	Average 2019 WL elev. (ft)[a]	Average 2019 saturated thickness (ft)[a]	Bedrock depth (estimated ft below land surface)	Screened interval (ft below land surface)	2018 water use (ac-ft)[b]		
					1 mi radius	2 mi radius	5 mi radius
RL01	1,018.13	31.38	50.25	45–50	195.30[d]	438.13[e]	1,758.87[f]
RL02	981.78	19.98	37.2	27–37	46.24	1,148.52[g]	5,233.25[h]
WB01	961.99	34.99	44[c]	22–37	326.42	1,605.23[i]	5,136.33[j]
SN01	908.51	27.01	46.5	36.5–46.5	484.78	1,796.01[k]	5,277.11[k]
SN02	870.72	32.22	71.5[c]	44–64	831.99[l]	1,420.28[m]	6,790.78[n]

[a] Averaging period is the full year unless stated otherwise:
RL01 3/22/19 – 12/31/19
WB01 3/2/19 – 12/31/19
SN02 1/11/19 – 12/31/19.

[b] Irrigation use unless noted

[c] Well did not reach bedrock, so value is the average of the two closest wells that reached bedrock.

[d] Includes 5.78 ac-ft of industrial water.

[e] Includes 65.33 ac-ft of industrial water.

[f] Includes 145.26 ac-ft of industrial, 148.20 ac-ft of municipal, and 699.25 ac-ft of other water.

[g] Includes 0.50 ac-ft of recreational water.

[h] Includes 19.73 ac-ft of industrial, 1,985.65 ac-ft of municipal, and 0.50 ac-ft of recreational water.

[i] Includes 38.42 ac-ft of industrial, 122.19 ac-ft of municipal, and 2.14 ac-ft of stock water.

[j] Includes 38.42 ac-ft of industrial, 778.37 ac-ft of municipal, and 2.14 ac-ft of stock water.

[k] Includes 98.67 ac-ft of municipal water.

[l] Includes 1.41 ac-ft of industrial and 526.25 ac-ft of municipal water.

[m] Includes 14.25 ac-ft of industrial and 784.30 ac-ft of municipal water.

[n] Includes 2,440.93 ac-ft of industrial, 1,946.22 ac-ft of municipal, and 10.99 ac-ft of other water.

Table 2—Additional characteristics of the western wells in the Kansas River alluvial aquifer index well network.

Site	Distance from Kansas River (miles)	Width of floodplain (miles)[a]	Nearby weather station[b]	Nearby stream gage[c]	Nearby previous monitoring		
					Nearby previous well?	Distance from index well (ft)	Monitoring period
RL01	0.20	1.86	Manhattan Airport	None	Yes	<450 ft	9/65–12/83
RL02	0.36	2.91	None	None	Yes	<30 ft	12/66–3/04
WB01	0.45	2.75	Wamego	06887500	Yes	<900 ft	6/66–3/04
SN01	1.00	4.82	Rossville	06888700[d]	Yes	<30 ft	6/78–3/04
SN02	1.20	2.55	None	06888990	Yes	<30 ft	7/50–3/04

[a]Distance perpendicular to valley axis using the Kansas Biological Survey's FLDPLN (floodplain) model.
[b]Name of the weather station within 5 miles of well.
[c]USGS ID# of the stream gage within 5 miles of well.
[d]Stream gage is on Cross Creek at Rossville; well is 0.40 miles from Cross Creek.

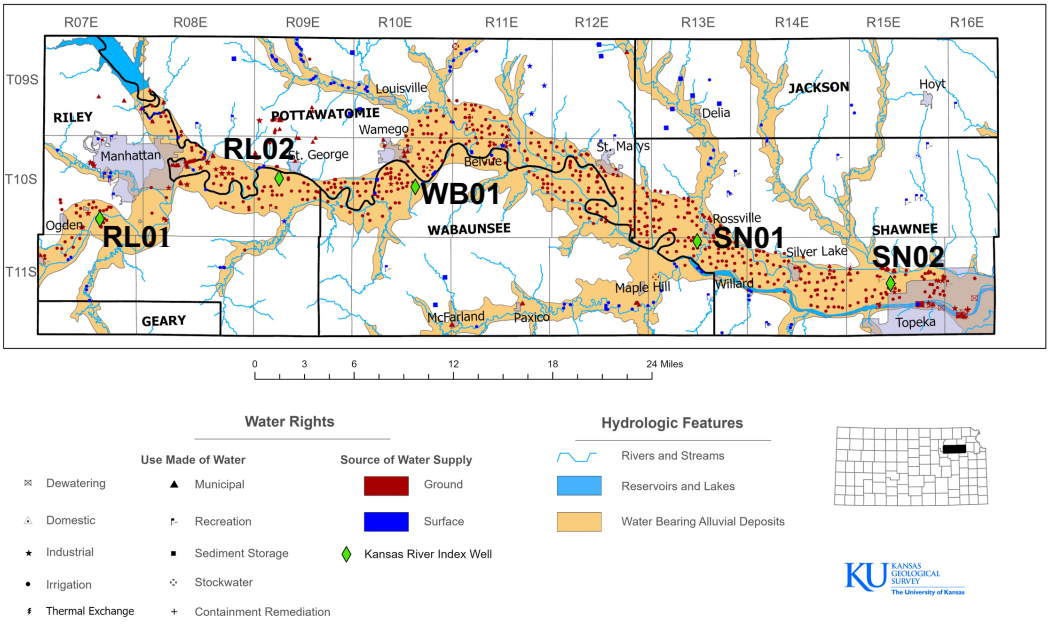

Figure 2—Map of index wells in the western reach of the Kansas River network; data from these wells can be viewed in real time on the KGS website (http://www.kgs.ku.edu/Hydro/KansasRiver/index.html).

4.1.1 Riley County Index Well 1

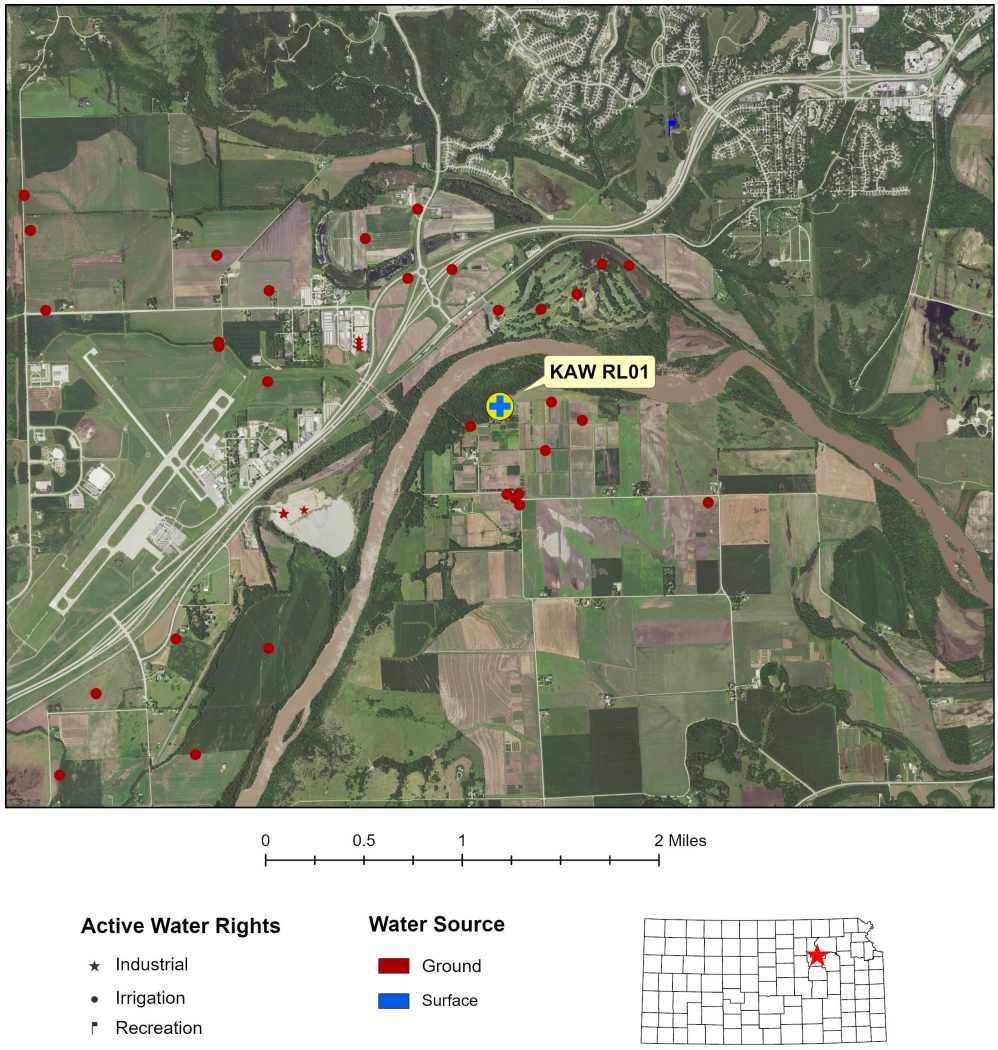

Figure 3—Aerial view of Riley County index well 1 (RL01) and nearby points of diversion. The Manhattan Regional Airport is to the west of the well, and the city of Manhattan is to the north and northeast.

Figure 3 is an aerial view of the Riley County index well 1 site (T. 10 S., R. 07 E., 34 BAA 01) at a scale that shows the site of the index well, the Kansas River, and nearby wells that have active water rights. The well was installed on 7/18/18 with a 5 ft screen at the bottom of the aquifer. The aquifer consists of sand with minor silt lenses (see Appendix for WWC-5 report and associated direct-push electrical conductivity log). The well was developed (hand bailed 3.5 well volumes) and monitoring began on 3/21/19; telemetry equipment was installed on 1/6/20. Slug tests were performed on 9/18/19; test results indicate a reasonable connection to the aquifer with a hydraulic conductivity value of 20–25 ft/d. Previously, water levels were monitored (6 to 16 times per year prior to 1971, quarterly thereafter) from September 1965 to December 1983 at a well (USGS ID # 390841096380802) about 450 ft south of the index well.

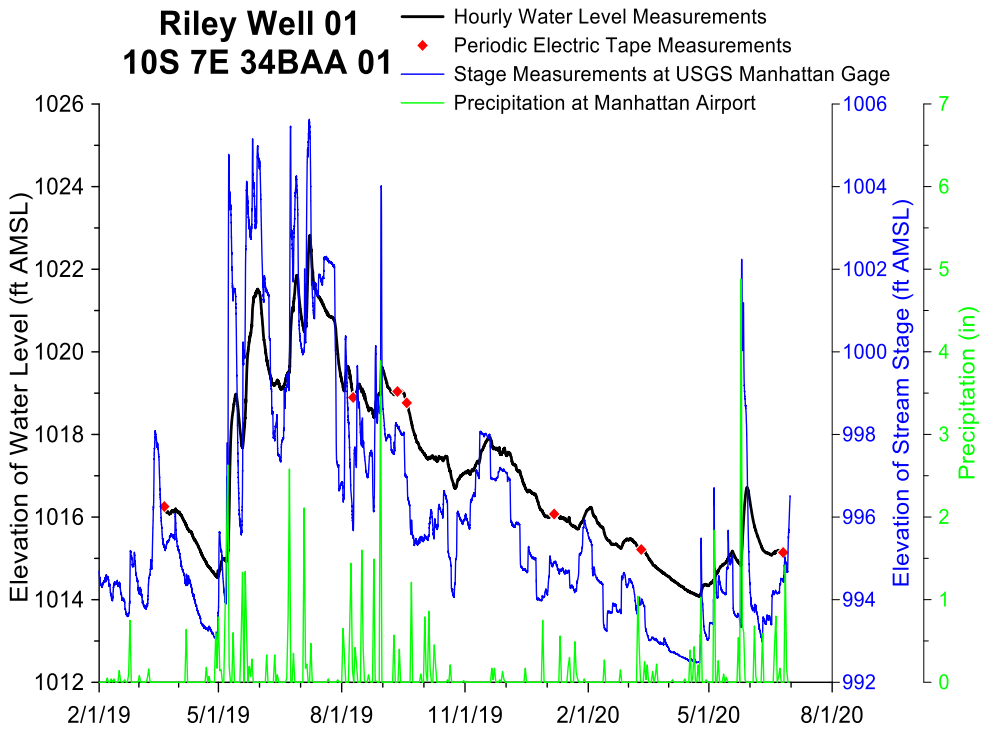

Figure 4—Riley County index well 1 hydrograph with stream stage and precipitation data—total data run to 6/25/20. A water-level elevation of 1,016 ft corresponds to a depth to water of 21 ft below land surface (lsf). The top of the screen is 45 ft below lsf (elevation of 992 ft), and the bottom of the aquifer is 50.2 ft below lsf (elevation of 986.8 ft). The screen terminates 0.2 ft above the bottom of the aquifer. Electric-tape measurements are in good agreement with transducer. Manhattan Airport weather station is across the river from the well (less than 2 miles); Manhattan gage is 8 miles downstream from the well.

Major Points

- Water-level changes appear to be primarily driven by changes in stream stage. The aquifer responds relatively rapidly to changes in stream stage, but responses are dampened with respect to those changes.
- Given the strong relationship with stream stage, it is difficult to discern the relationship between precipitation and water-level changes.
- The influence of nearby pumping wells is not discernible.
- Well does not appear to have a discernible response to changes in barometric pressure, which is consistent with the shallow depth to water and the sandy vadose zone (determined from electrical conductivity logging).

4.1.2 Riley County Index Well 2

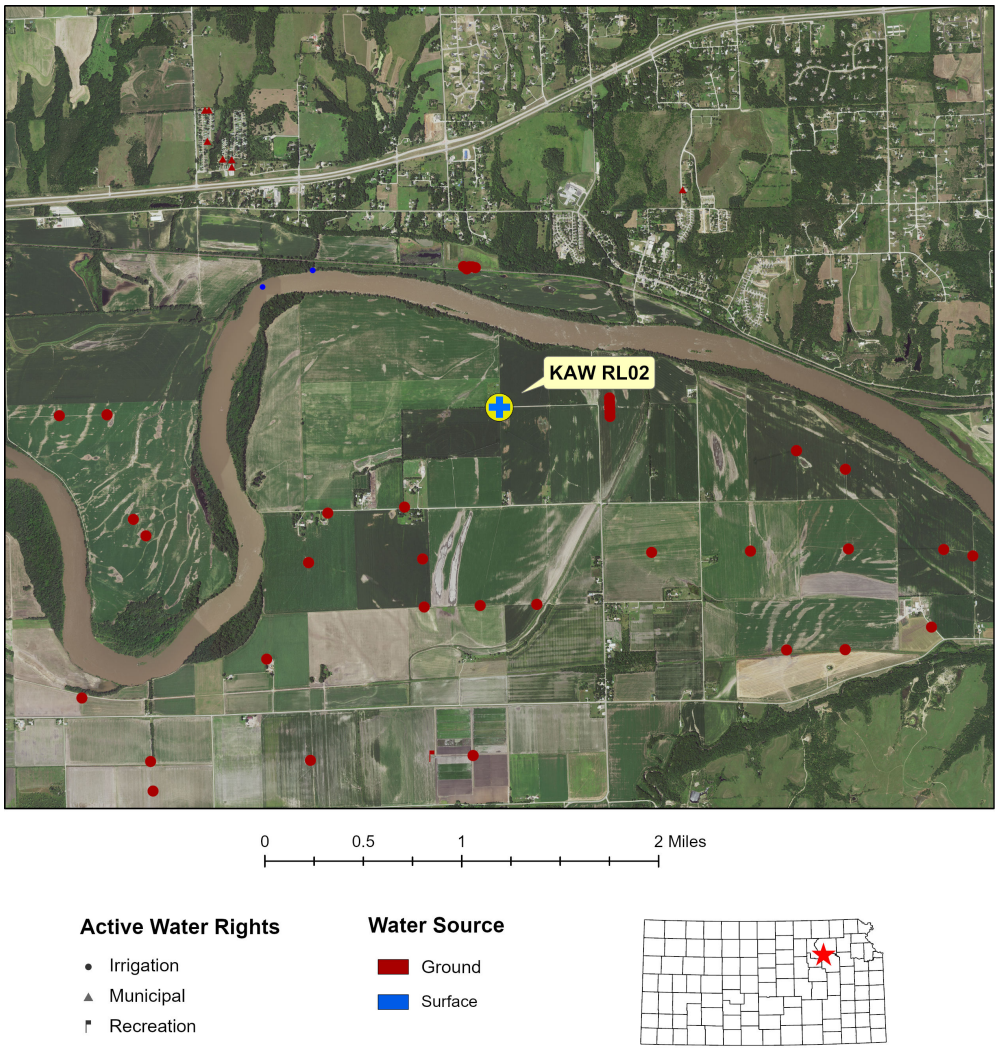

Figure 5—Aerial view of Riley County index well 2 (RL02) and nearby points of diversion. The city of St. George is across the river to the north, and the city of Manhattan is about 4 miles to the west.

Figure 5 is an aerial view of the Riley County index well 2 site (T. 10 S., R. 09 E., 17 BDD 01) at a scale that shows the site of the index well, the Kansas River, and nearby wells that have active water rights. The well was installed on 5/15/18 with a 10 ft screen at the bottom of the aquifer. The aquifer consists of sand with minor silt lenses (see Appendix for WWC-5 report and associated direct-push conductivity log). The well was developed (hand bailed 5.8 well volumes), a sensor and telemetry equipment were installed, and monitoring began on 8/15/18. Slug tests were performed on 9/18/19; test results indicate a good connection to the aquifer with a hydraulic conductivity value of 400–500 ft/d. Previously, water levels were monitored (2 to 12 times per year) from December 1966 to March 2004 at a well (USGS ID #391055096261701) within 30 ft of the index well.

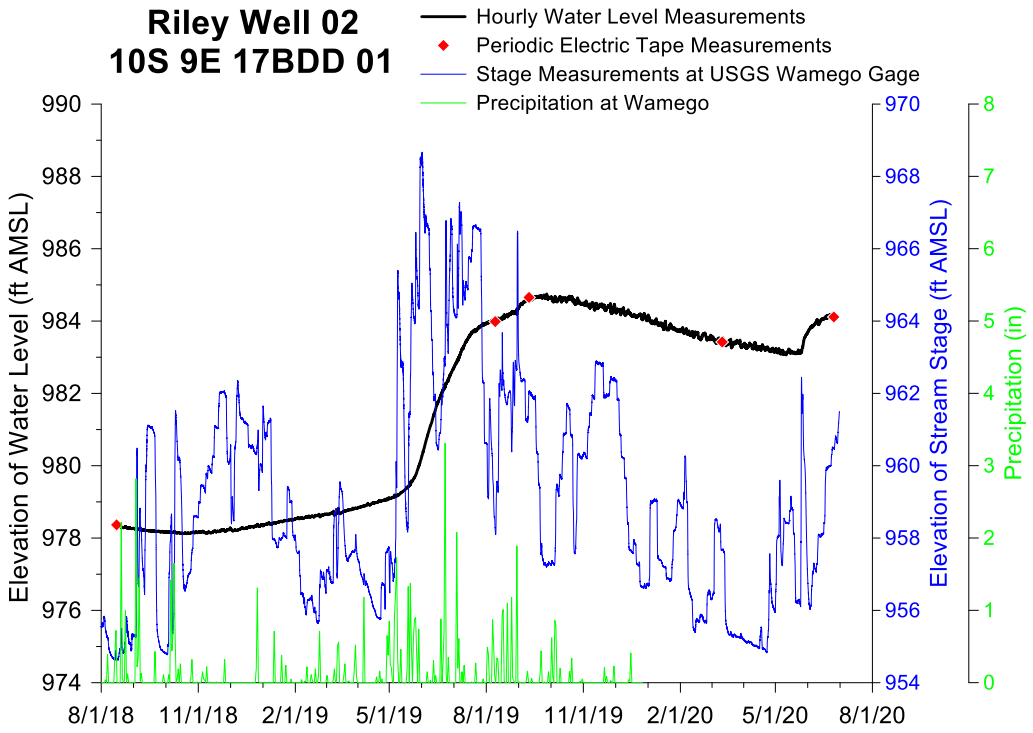

Figure 6—Riley County index well 2 hydrograph with stream stage and precipitation data—total data run to 6/25/20. A water-level elevation of 984 ft corresponds to a depth to water of 15 ft below land surface (lsf). The top of the screen is 27 ft below lsf (elevation of 972 ft), and the bottom of the aquifer is 37.2 ft below lsf (elevation of 961.8 ft). The screen terminates 0.2 ft above the bottom of the aquifer. Electric-tape measurements are in good agreement with transducer. Wamego gage is 10 miles downstream from the well. Precipitation measured at Wamego, approximately 6.5 miles to the east of the well; precipitation record ended on 12/27/19.

Major Points

- Water levels exhibit a very muted and lagged response to stream-stage changes, despite being within 0.4 mi of the river. This indicates that there is a low-permeability interval limiting the connection between the river and the portion of the aquifer in the vicinity of the well.
- Water levels have an extremely muted response to precipitation, despite being within 20 ft of the land surface. This indicates a low permeability layer above the water table, which is consistent with the results of electrical conductivity logging.
- The influence of nearby pumping wells is difficult to discern, likely as a result of the very small water use within a 1 mi radius of the well.
- Water levels fluctuate more after slug tests on 9/18/19 (shortly after third electric tape measurement on plot), likely as a result of further well development produced by the slug tests.

4.1.3 Wabaunsee County Index Well 1

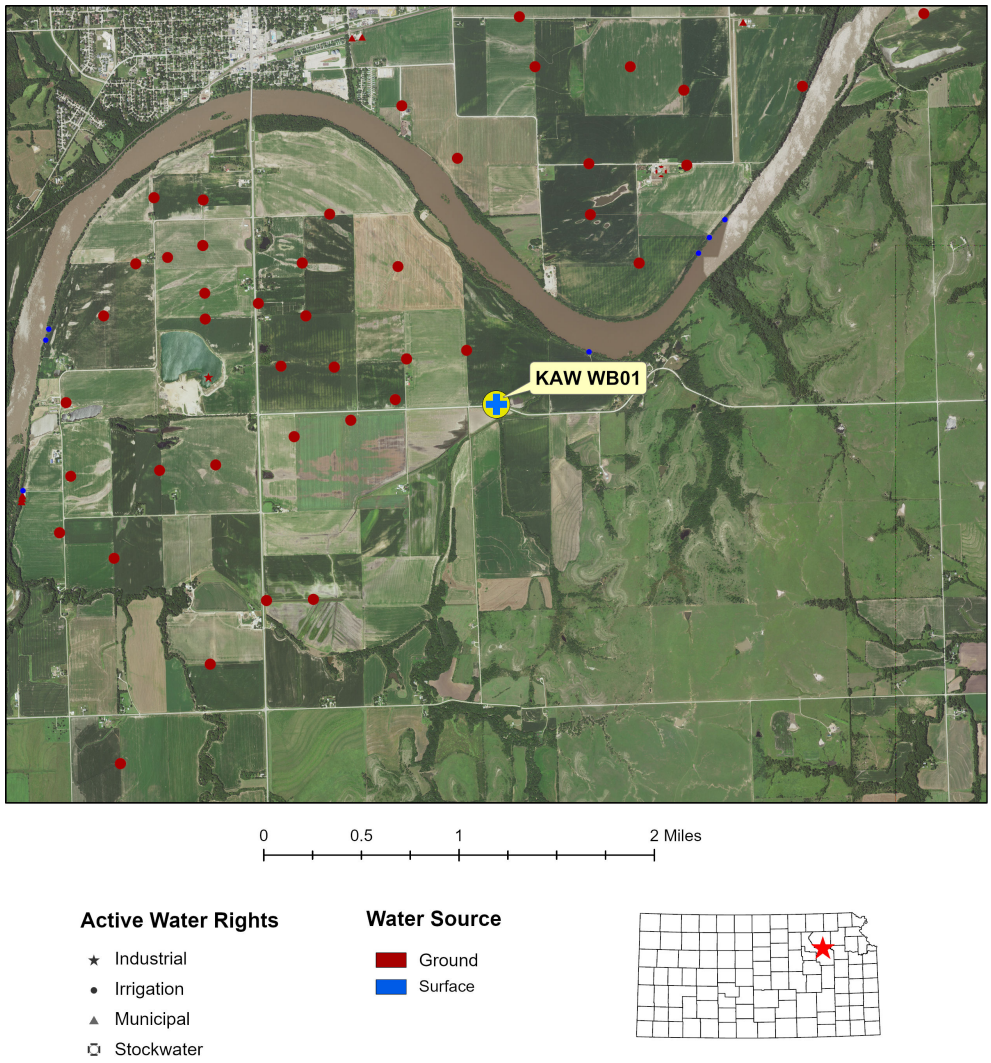

Figure 7—Aerial view of Wabaunsee County index well 1 (WB01) and nearby points of diversion. The city of Wamego is about 2 miles to the northwest.

Figure 7 is an aerial view of the Wabaunsee County index well 1 site (T. 10 S., R. 10 E., 15 DDC 01) at a scale that shows the site of the index well, the Kansas River, and nearby wells that have active water rights. The well was installed on 5/10/18 with a 15 ft screen terminating approximately 7 ft above the bottom of the aquifer. The aquifer consists of sand with a few thin silt lenses (see Appendix for WWC-5 report and associated direct-push conductivity log). A sensor was placed in the well and monitoring began on 3/1/19. The well was developed (hand bailed 4.4 well volumes) on 3/20/19, and telemetry equipment was installed the following day (3/21/19). Slug tests were performed on 10/17/19; test results indicate a good connection to the aquifer with a hydraulic conductivity value of 120–160 ft/d. Previously, water levels were monitored (2 to 12 times per year) from June 1966 to March 2004 at a well (USGS ID #391029096171301) within 900 ft of the index well.

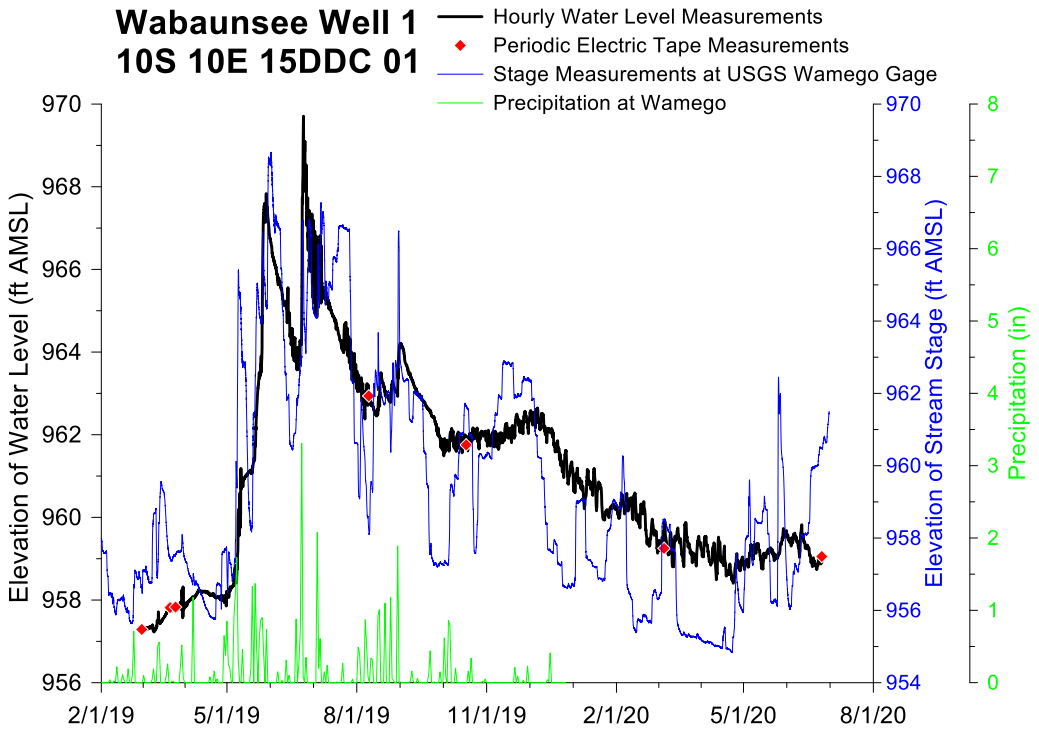

Figure 8—Wabaunsee County index well 1 hydrograph with stream stage and precipitation data—total data run to 6/25/20. A water-level elevation of 960 ft corresponds to a depth to water of 11 ft below land surface (lsf). The top of the screen is 22 ft below lsf (elevation of 949 ft), and the bottom of the aquifer is estimated to be 44 ft below lsf (elevation of 927 ft). The screen terminates 7 ft above the bottom of the aquifer. Electric-tape measurements are in good agreement with transducer. Wamego gage is 2 miles upstream from the well. Precipitation measured at Wamego, about 2.5 miles to the northwest of the well; precipitation record ended on 12/27/19.

Major Points

- Water levels clearly respond to precipitation and, to a lesser extent, changes in stream stage.
- Anomalous apparent water-level fluctuations occur intermittently in the first half of the record and nearly continuously in the second half. These fluctuations are artifacts produced by water blocking the vent tube of the gauge transducer; transducer and cable were replaced while this report was being prepared.
- There is no indication of nearby pumping of groundwater.

4.1.4 Shawnee County Index Well 1

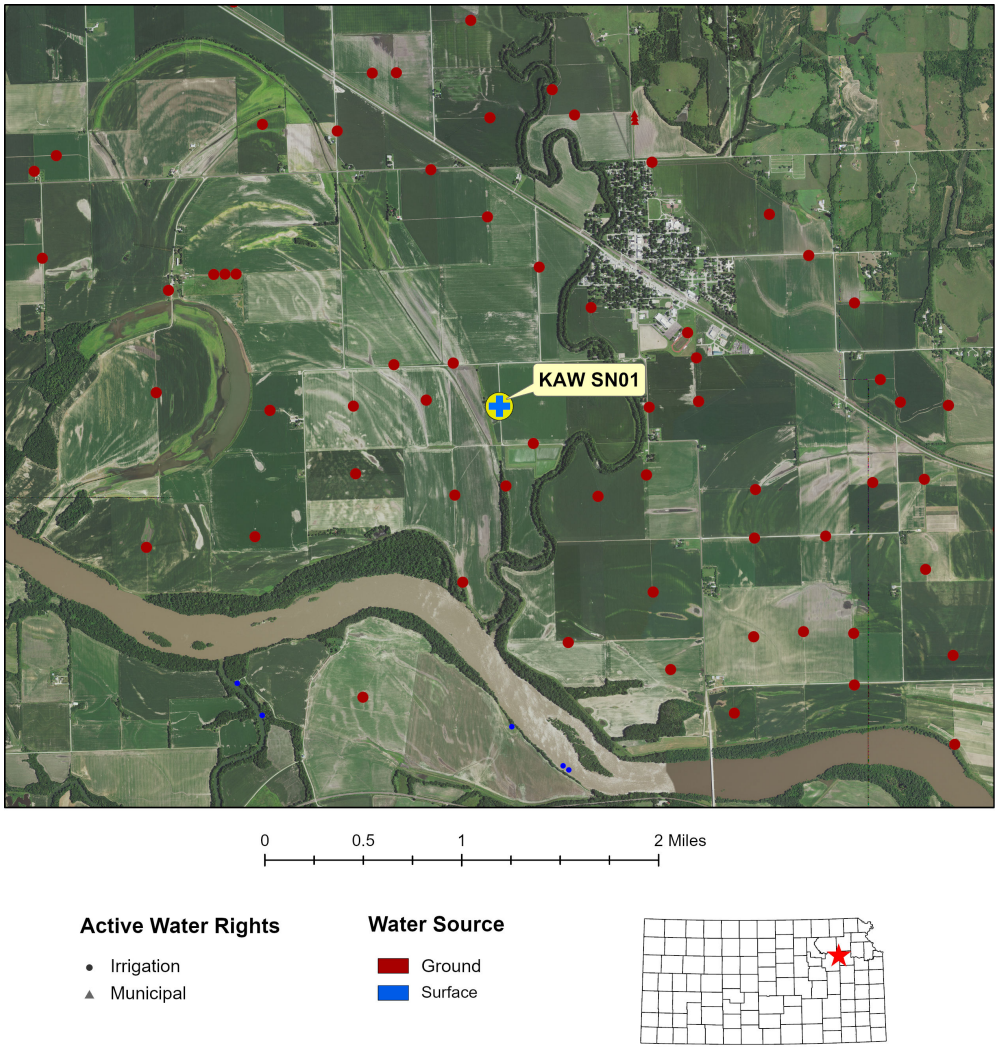

Figure 9—Aerial view of Shawnee County index well 1 (SN01) and nearby points of diversion. The city of Rossville is about a mile to the northeast. Cross Creek is within the dark green, sinuous line of vegetation to the east of the well.

Figure 9 is an aerial view of the Shawnee County index well 1 site (T. 11 S., R. 13 E., 04 AAD 01) at a scale that shows the site of the index well, the Kansas River, and nearby wells that have active water rights. The well was installed on 5/16/18 with a 10 ft screen terminating at the bottom of the aquifer. The aquifer consists of sand with some silt lenses and is overlain by clay and silty sands (see Appendix for WWC-5 report and associated direct-push conductivity log). The well was developed (hand bailed 5.7 well volumes) on 8/13/18, and sensor and telemetry equipment were installed on the same day. Slug tests were performed on 9/18/19; test results indicate a good connection to the aquifer with a hydraulic conductivity value of 180–240 ft/d. Previously, water levels were monitored (once to four times per year) from June 1978 to March 2004 at a well (USGS ID # 390731095575801) within 30 ft of the index well.

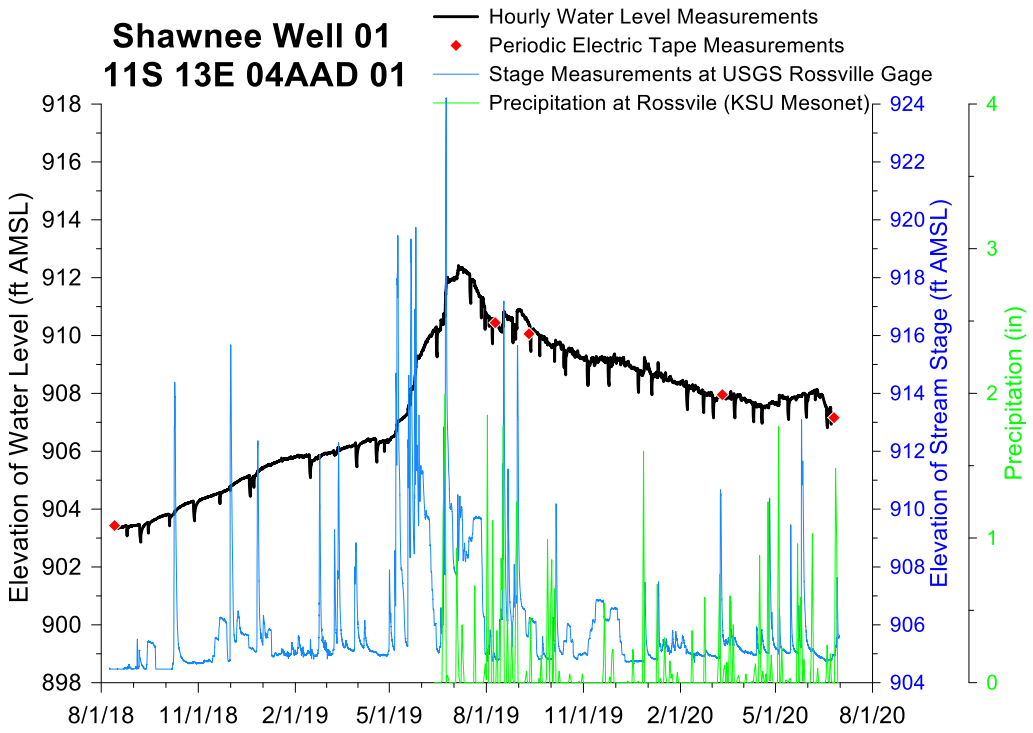

Figure 10—Shawnee County index well 1 hydrograph with stream stage and precipitation data—total data run to 6/25/20. A water-level elevation of 908 ft corresponds to a depth to water of 20 ft below land surface (lsf). The top of the screen is 36.5 ft below lsf (elevation of 891.5 ft), and the bottom of the aquifer is 46.5 ft below lsf (elevation of 881.5 ft). The screen terminates at the bottom of the aquifer. Electric-tape measurements are in good agreement with transducer. USGS gage is on Cross Creek at Rossville about 1 mile from well; there is no USGS gage on the Kansas River within 17 river miles of the well. The well is about 0.4 miles from Cross Creek and 1 mile from the Kansas River. Rossville precipitation records began on 6/13/19 (weather station slightly more than a mile from well).

Major Points

- Water levels appear to respond to both stream-stage changes and precipitation. Response to stream stage appears somewhat muted.
- Water levels fluctuate more after slug tests on 9/18/19 (shortly after third electric tape measurement on plot), likely as a result of further well development produced by the slug tests.
- A clear pumping signal is observable on the graph, but pumping is not restricted to the growing season; periodic pumping occurs throughout the year. Water use within a 2 mi radius of the well is the highest of any of the wells in the western reach.

4.1.5 Shawnee County Index Well 2

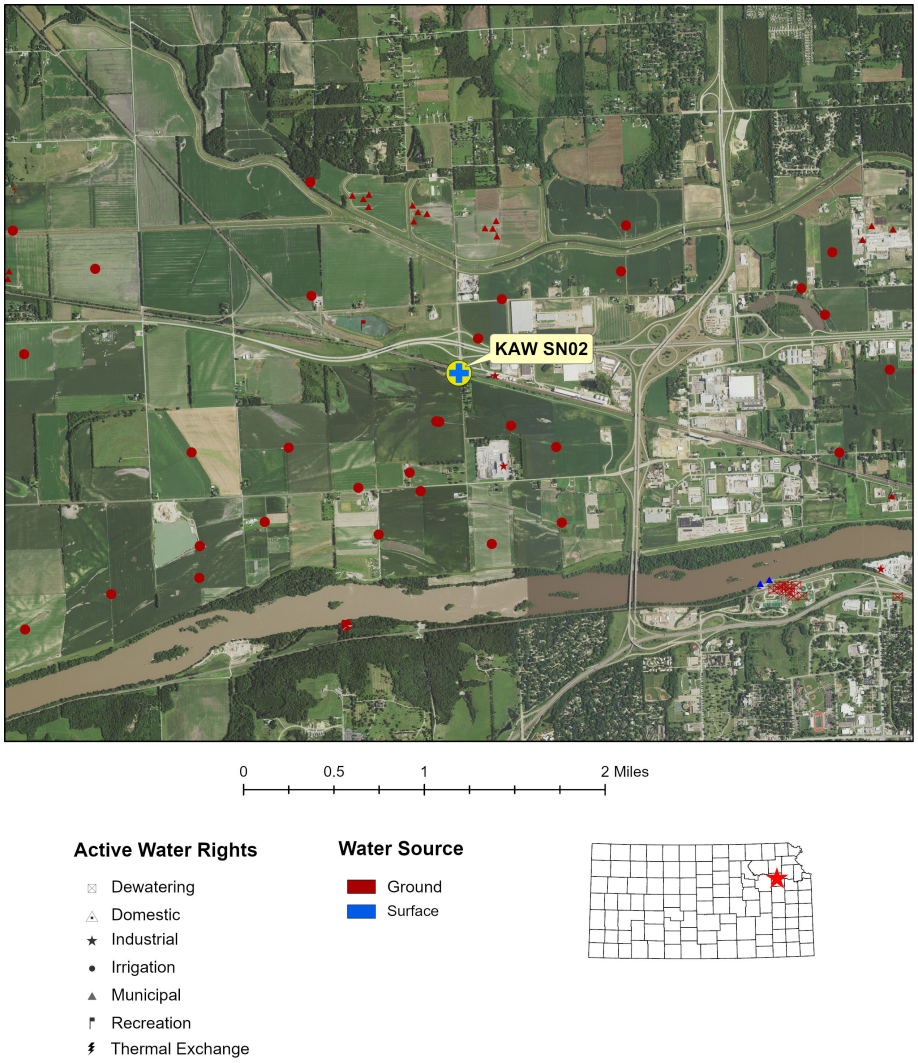

Figure 11—Aerial view of Shawnee County index well 2 (SN02) and nearby points of diversion. The city of Topeka is to the south and east. Just to the north of the well is a major rail line.

Figure 11 is an aerial view of the Shawnee County index well 2 site (T. 11 S., R. 15 E., 16 DCA 02) at a scale that shows the site of the index well, the Kansas River, and nearby wells that have active water rights. The well was installed on 10/18/18 with a 20 ft screen terminating approximately 7.5 ft above the bottom of the aquifer. The aquifer consists of sand with some silt lenses and is overlain by a thick (27.5 ft) interval of clay and silt (see Appendix for WWC-5 report and associated direct-push conductivity log). A sensor was placed in the well and monitoring began on 1/10/19. The well was developed (hand bailed 4.0 well volumes) on 3/20/19, and telemetry equipment was installed the following day (3/21/19). Slug tests were performed on 9/16/19; test results indicate a good connection to the aquifer with a hydraulic conductivity value of 220–360 ft/d. Previously, water levels were monitored every five days from July 1950 to October 1980 and then once to twelve times per year in most years to February 2004 at a well (USGS ID #390519095445301) within 30 ft of the index well.

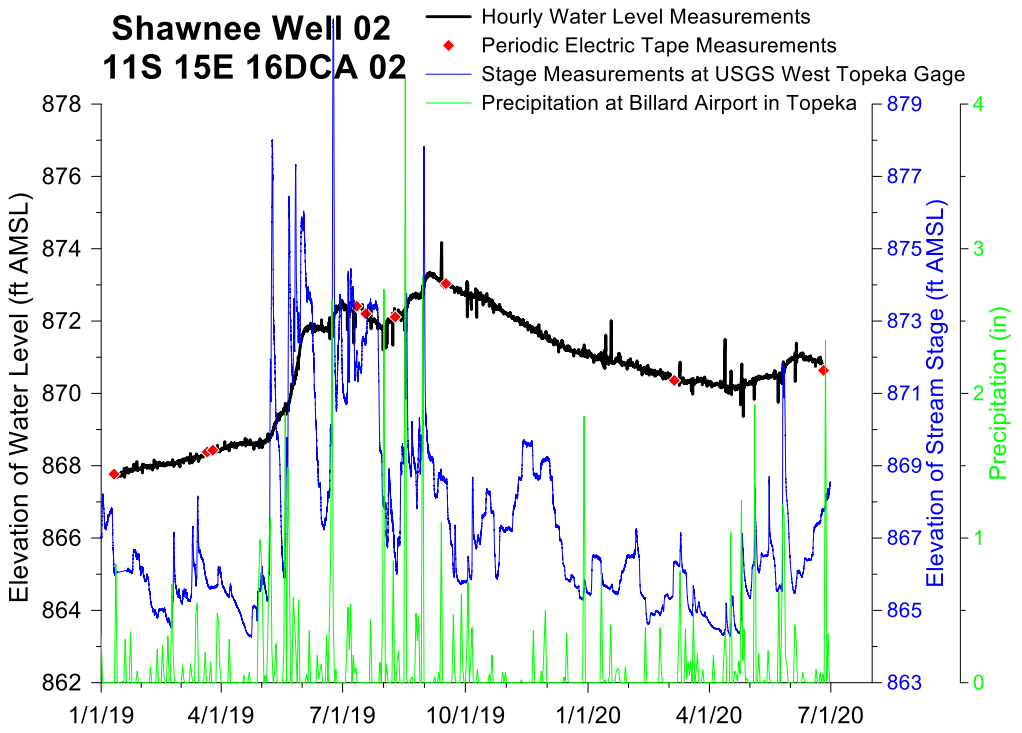

Figure 12—Shawnee County index well 2 hydrograph with stream stage and precipitation data—total data run to 6/25/20. A water-level elevation of 870 ft corresponds to a depth to water of 30 ft below land surface (lsf). The top of the screen is 44 ft below lsf (elevation of 856 ft), and the bottom of the aquifer is estimated to be 71.5 ft below lsf (elevation of 828.5 ft). The screen terminates 7.5 ft above the bottom of the aquifer. Electric-tape measurements are in good agreement with transducer. USGS gage is 3 miles downstream from well. Precipitation measured at Billard Airport, which is approximately 7 miles to the east of the well.

Major Points

- Water levels appear to respond to both stream-stage changes and precipitation. Response to stream stage are muted.
- The spikes in the water-level record, which appear to be related to nearby rail and heavy truck traffic, indicate a confined aquifer, consistent with the electrical conductivity log.
- A pumping signal is small but discernible on the graph; periodic pumping occurs throughout the year.

4.2 Eastern Reach — East of Topeka to Kansas City

Six index wells are located in this reach of the Kansas River alluvial aquifer (fig. 13). The GEMS4-1 well, which is on the long-term Geohydrologic Experimental and Monitoring Site (GEMS), was drilled in 1990, while the five other wells were drilled between August 2017 and July 2018. Tables 3 and 4 summarize the characteristics of these six wells.

Table 3—Characteristics of the eastern wells in the Kansas River alluvial aquifer index well network.

Site	Average 2019 WL elev. (ft)[a]	Average 2019 saturated thickness (ft)[a]	Bedrock depth (estimated ft below land surface)	Screened interval (ft below land surface)	2018 water use (ac-ft)[b]		
					1 mi radius	2 mi radius	5 mi radius
JF01	845.1	29.8	46.7	33–43	329	3,118[c]	4,370[d]
DG01	816.8	50.8	68	46.5–66.5	188	2,090[e]	3,313[f]
GEMS4-1	809.5	54.5	70	39.5–69.5	389[g]	1,041[g]	2,969[f]
DG02	795.1	52.1	74	55–70	39	131[h]	2,089[i]
LV01	765.4	45.6	66.2	45–65	7,392[j]	8,827[k]	12,571[l]
WY01	731.6	33.6	69	50–65	808[m]	875[n]	1,005[o]

[a] Averaging period is full year unless stated otherwise:
DG02 1/10/19 – 12/31/19.

[b] Irrigation use unless noted.

[c] Includes 2,064 ac-ft of industrial and 358 ac-ft of municipal water.

[d] Includes 2,064 ac-ft of industrial, 642 ac-ft of municipal, and 23 ac-ft of recreational water.

[e] Includes 451 ac-ft of industrial and 809 ac-ft of municipal water.

[f] Includes 456 ac-ft of industrial, 871 ac-ft of municipal,13 ac-ft of recreational, and 100 ac-ft of other water.

[g] Includes 26 ac-ft of industrial and 363 ac-ft of municipal water.

[h] Includes 5 ac-ft of industrial and 50 ac-ft of municipal water.

[i] Includes 430 ac-ft of industrial, 583 ac-ft of municipal, and 100 ac-ft of other water.

[j] Includes 7,389 ac-ft of municipal water.

[k] Includes 4 ac-ft of industrial and 8,820 ac-ft of municipal water.

[l] Includes 67 ac-ft of industrial and 12,451 ac-ft of municipal water.

[m] Includes 1 ac-ft of industrial and 807 ac-ft of municipal water.

[n] Includes 68 ac-ft of industrial and 807 ac-ft of municipal water.

[o] Includes 141 ac-ft of industrial, 807 ac-ft of municipal, and 57 ac-ft of other water.

Table 4—Additional characteristics of the eastern wells in the Kansas River alluvial aquifer index well network.

Site	Distance from Kansas River (miles)	Width of floodplain (miles)[a]	Nearby weather station[b]	Nearby stream gage[c]	Nearby previous monitoring		
					Nearby previous well?	Distance from index well (ft)	Monitoring Period
JF01	0.35	2.53	None	None	Yes	<30 ft	6/66–3/04
DG01	0.84	3.10	Lawrence Airport	06891080	Yes	<30 ft	2/52–5/15
GEMS4-1	2.10	3.00	Lawrence Airport	06891080	No	NA	NA
DG02	1.61	3.55	Eudora	06891080	Yes	<30 ft	5/66–7/89
LV01	0.20	2.12	None	06892350	No	NA	NA
WY01	0.09	1.10	Shawnee	06892518	Yes	<850 ft	3/67–12/99

[a]Distance perpendicular to the valley axis using the Kansas Biological Survey's FLDPLN (floodplain) model.
[b]Name of the weather station within 5 miles of well.
[c]USGS ID# of the stream gage within 5 miles of well.

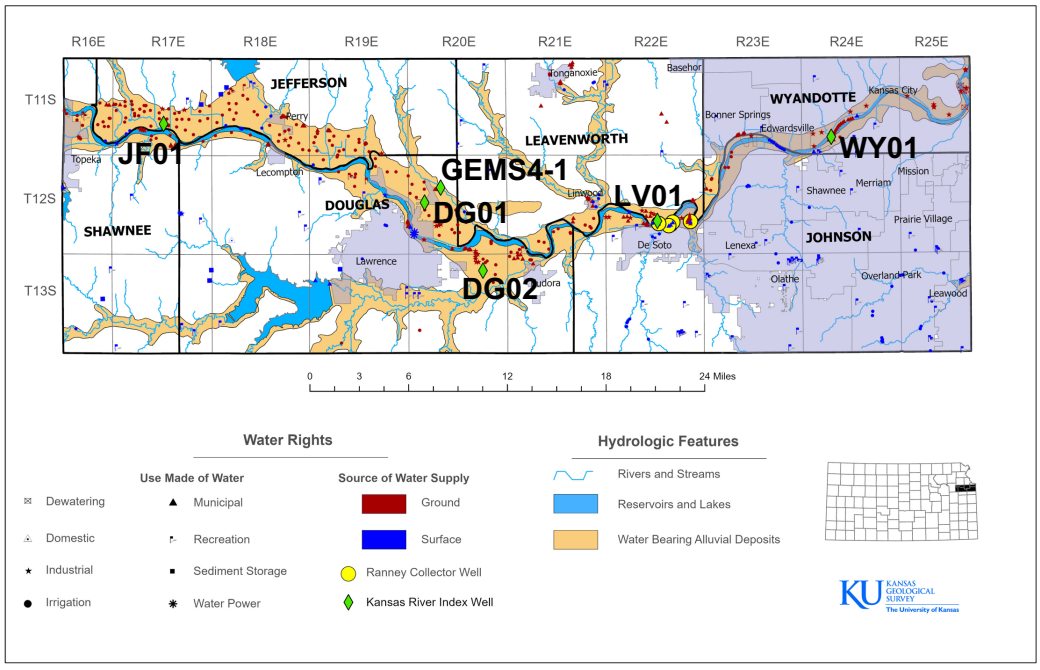

Figure 13—Map of index wells in the eastern reach of the Kansas River network; data from these wells can be viewed in real time on the KGS website (http://www.kgs.ku.edu/Hydro/KansasRiver/index.html).

4.2.1 Jefferson County Index Well 1

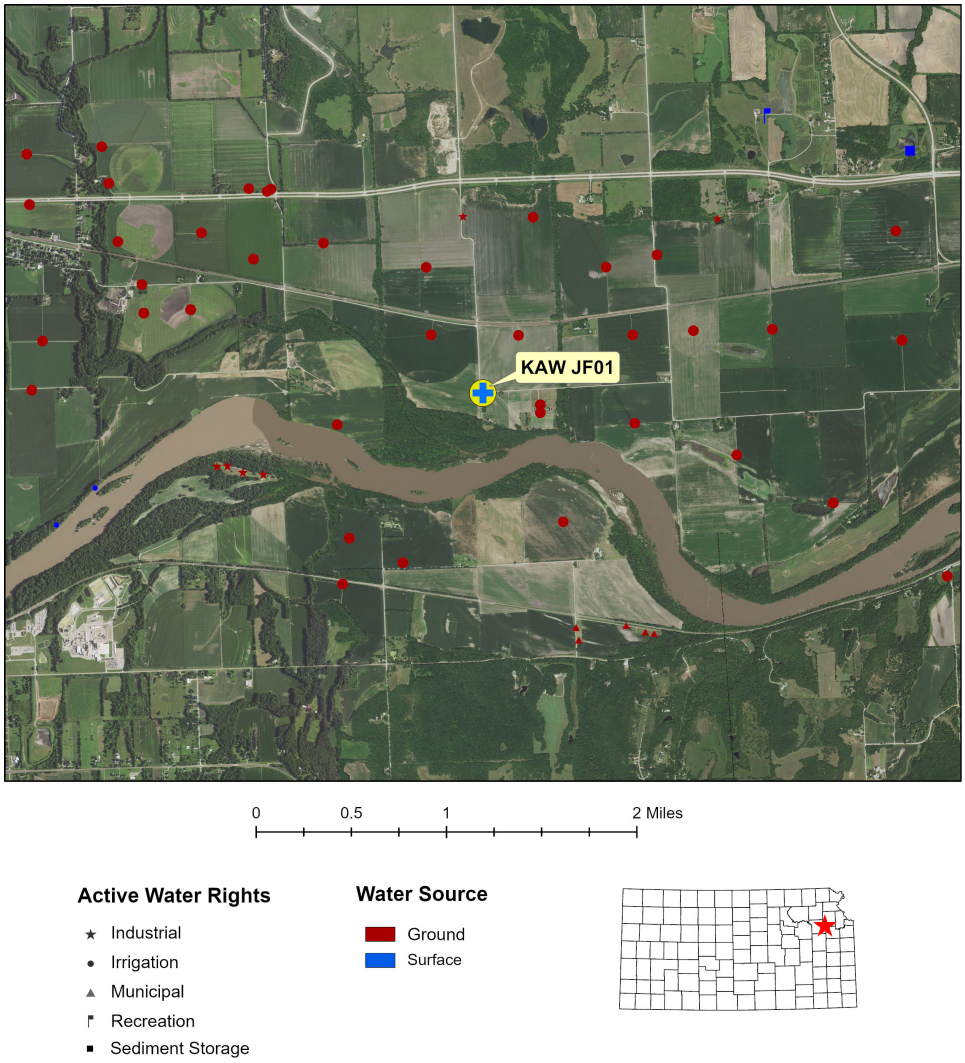

Figure 14—Aerial view of Jefferson County index well 1 (JF01) and nearby points of diversion. Perry Lake is approximately 5 miles northeast of the well.

Figure 14 is an aerial view of the Jefferson County index well 1 site (T. 11 S., R. 17 E., 27 BBB 01) at a scale that shows the site of the index well, the Kansas River, and nearby wells that have active water rights. The well was installed on 5/14/18 with a 10 ft screen that terminates 3.6 ft above the bottom of the aquifer. The aquifer consists of sand with minor silt lenses and is overlain by clay and silt (see Appendix for WWC-5 report and associated direct-push electrical conductivity log). The well was developed (hand bailed 6.1 well volumes) on 7/27/18, and sensor and telemetry equipment were installed on 8/10/18. Slug tests were performed on 9/16/19; test results indicate an excellent connection to a highly permeable aquifer with a hydraulic conductivity value of 140–190 ft/d. Previously, water levels were monitored (two to four readings per year) from June 1966 to March 2004 at a well (USGS ID #390407095310901) 30 ft south of the index well.

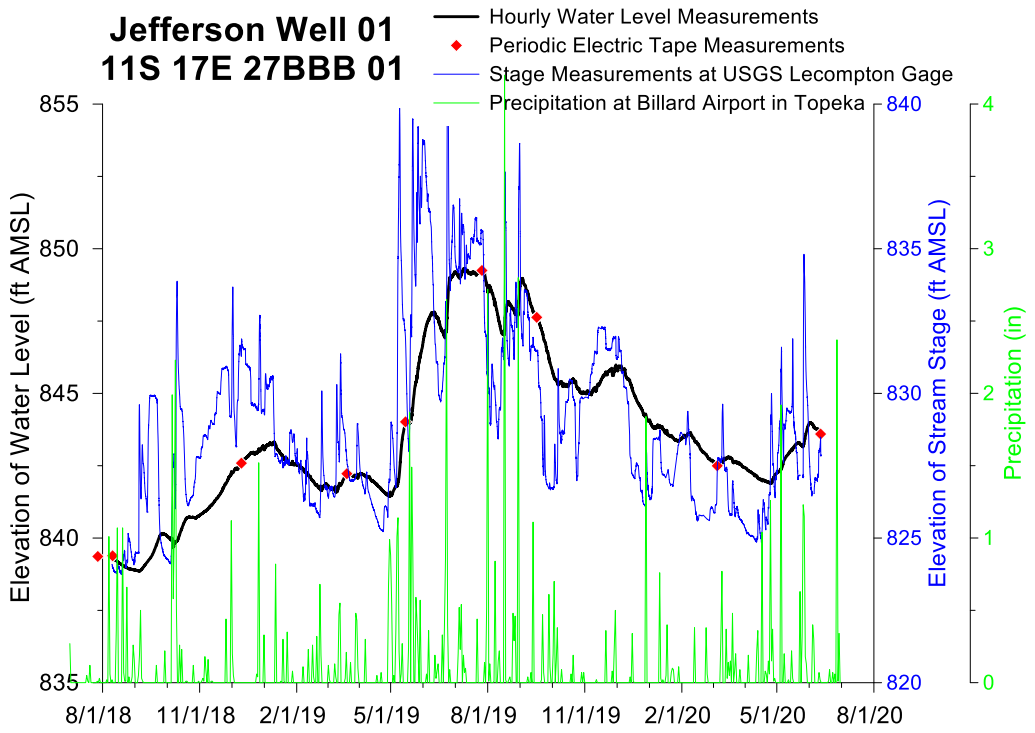

Figure 15—Jefferson County index well 1 hydrograph with stream stage and precipitation data—total data run to 6/11/20. A water-level elevation of 845 ft corresponds to a depth to water of 17 ft below land surface (lsf). The top of the screen is 33 ft below lsf (elevation of 829 ft), and the bottom of the aquifer is 46.6 ft below lsf (elevation of 815.4 ft). The screen terminates 3.6 ft above the bottom of the aquifer. Electric-tape measurements are in good agreement with transducer. USGS gage is 9 miles downstream from well. Precipitation measured at Billard Airport, which is approximately 6 miles to the west of the well.

Major Points

- Water-level changes appear to be primarily driven by changes in stream stage, although the aquifer response to stream-stage changes is muted and shifted in time.
- Given the relationship between water levels and stream stage, it is difficult to discern the effect of precipitation.
- The effect of nearby pumping wells on water levels appears very small despite the amount of pumping in the area.
- Well response to barometric pressure appears to depend on position of water level. Responses below an elevation of 842 ft are difficult to discern; responses at higher elevations appear to be consistent with a confined aquifer.

4.2.2 Douglas County Index Well 1

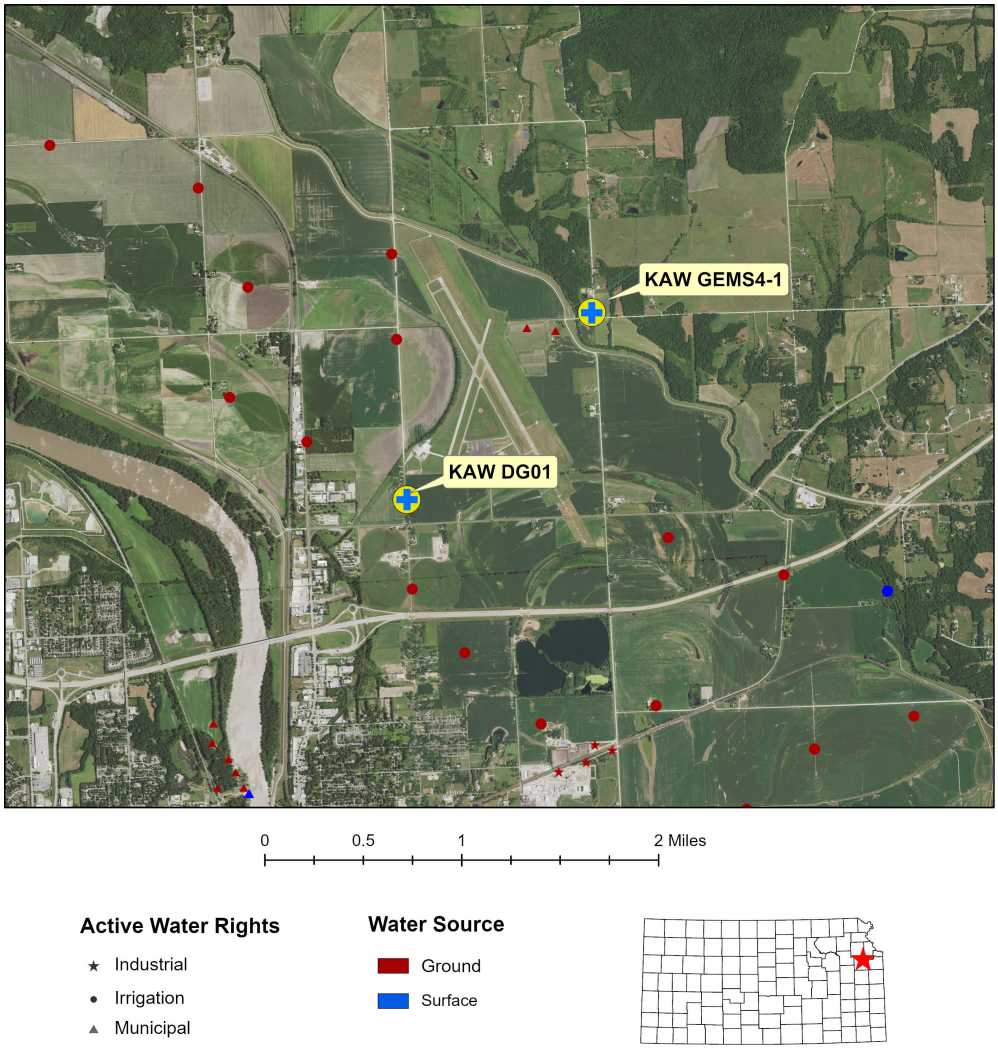

Figure 16—Aerial view of Douglas County index well 1 (DG01), GEMS4-1 index well, and nearby points of diversion. The Lawrence Municipal Airport is to the immediate east of the well, and the city of Lawrence is to the south and west.

Figure 16 is an aerial view of the Douglas County index well 1 site (T. 12 S., R. 20 E., 17 CCBC 01) at a scale that shows the site of the index well, the GEMS4-1 index well, the Kansas River, and nearby wells that have active water rights. The well was installed on 8/11/17 with a 20 ft screen that terminates 1.0 ft above the bottom of the aquifer. The aquifer consists of sand and gravel from 30 to 67.5 ft below land surface and is overlain by clay and silt (see Appendix for WWC-5 report and associated direct-push electrical conductivity log). The well was developed (surging followed by hand bailing of 3.2 well volumes), a sensor was installed, and monitoring began on 8/15/17; telemetry equipment was installed on 9/7/17. Slug tests were performed on 9/11/19; test results indicate an excellent connection to a highly permeable aquifer with a hydraulic conductivity value of 190–330 ft/d. Previously, water levels were monitored (readings reported every five days until 2000, less regularly after that) from February 1952 to May 2015 at a well (USGS ID #390006095132301) less than 30 ft south of the index well.

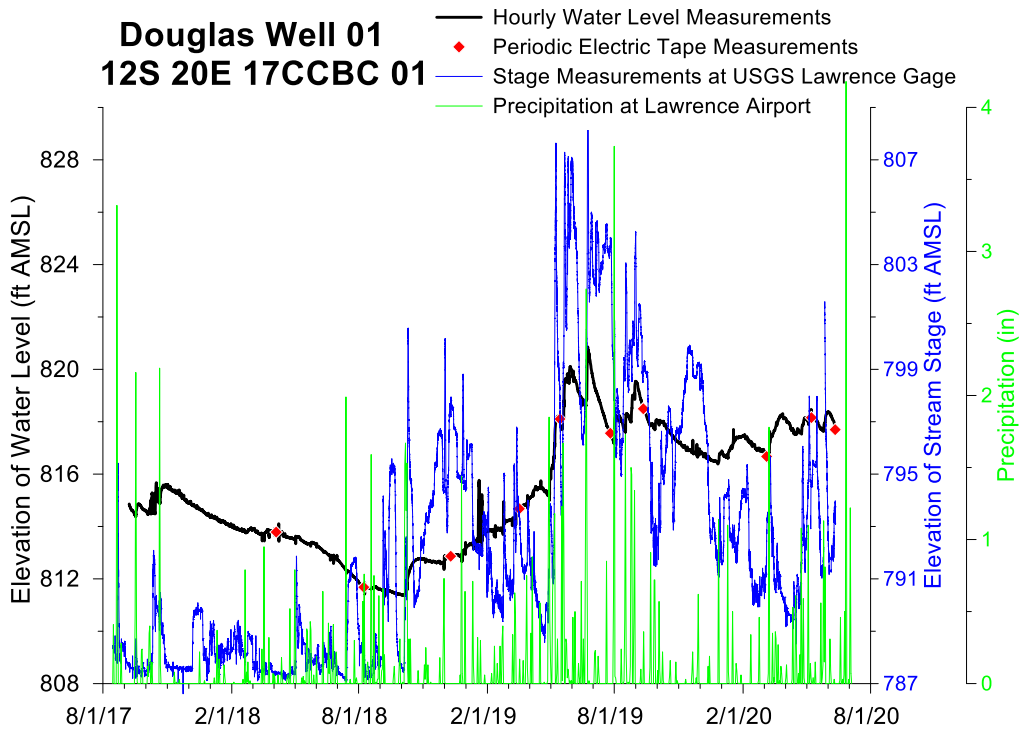

Figure 17—Douglas County index well 1 hydrograph with stream stage and precipitation data—total data run to 6/11/20. A water-level elevation of 816 ft corresponds to a depth to water of 18 ft below land surface (lsf). The top of the screen is 46.5 ft below lsf (elevation of 787.5 ft), and the bottom of the aquifer is 67.5 ft below lsf (elevation of 766.5 ft). The screen terminates 1.0 ft above the bottom of the aquifer. Electric-tape measurements are in good agreement with transducer. USGS gage is approximately 2 miles downstream from well, but the river is within 0.85 miles of the well upstream of the gage. Precipitation measured at Lawrence Municipal Airport, which is a short distance northeast of the well.

Major Points

- Water-level changes appear to be primarily driven by precipitation.
- Given the relationship between water levels and precipitation, it is difficult to discern the effect of stream-stage changes.
- The effect of nearby pumping wells on water levels appears very small, consistent with the relatively small amount of pumping within a mile of the well.
- Well response to barometric pressure appears to be consistent with a confined aquifer.

4.2.3 GEMS4-1 Index Well

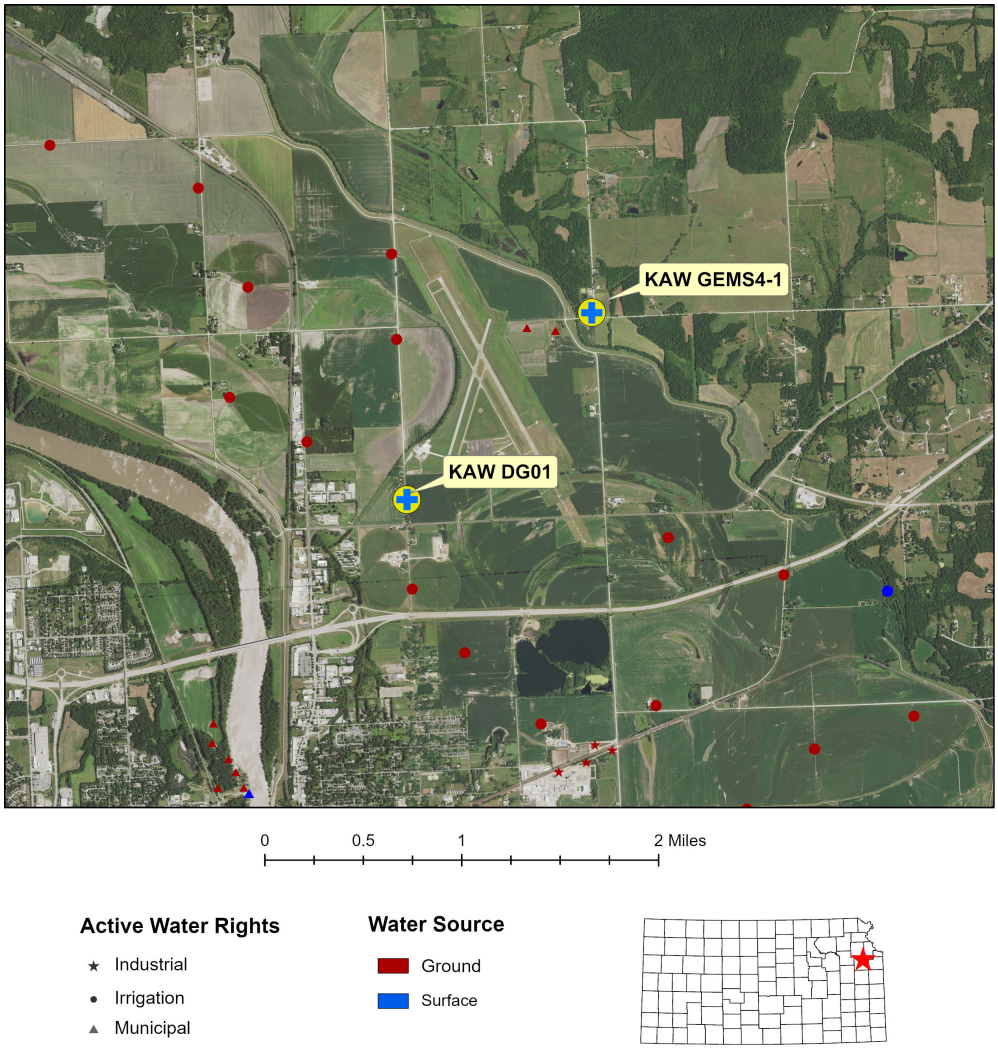

Figure 18—Aerial view of GEMS4-1 index well, Douglas County index well 1 (DG01), and nearby points of diversion. The Lawrence Municipal Airport is to the west of the well, and the city of Lawrence is to the south and southwest.

Figure 18 is an aerial view of the GEMS4-1 index well site (T. 12 S., R. 20 E., 08 DDD 01) at a scale that shows the site of the index well, Douglas County index well 1, the Kansas River, and nearby wells that have active water rights. The GEMS4-1 well was installed on 6/25/90 with a 30 ft screen that terminates less than 1.0 ft above the bottom of the aquifer. The aquifer consists of sand and gravel from 38.5 to 70.3 ft below land surface and is overlain by clay and silt (see Appendix for direct-push electrical conductivity log from a nearby [within 30 ft] location). Sensor and telemetry equipment were installed on 11/5/18. An initial round of slug tests was performed on 9/13/19; test results indicate the presence of a well skin of low hydraulic conductivity. The well was developed (surge block with suction pump moving in 2 ft increments along the screen) on 11/19/19. A second round of slug tests on 11/20/19 indicates a reasonable connection to a highly permeable aquifer with a hydraulic conductivity value of 70–140 ft/d. There was no previous monitoring at this site.

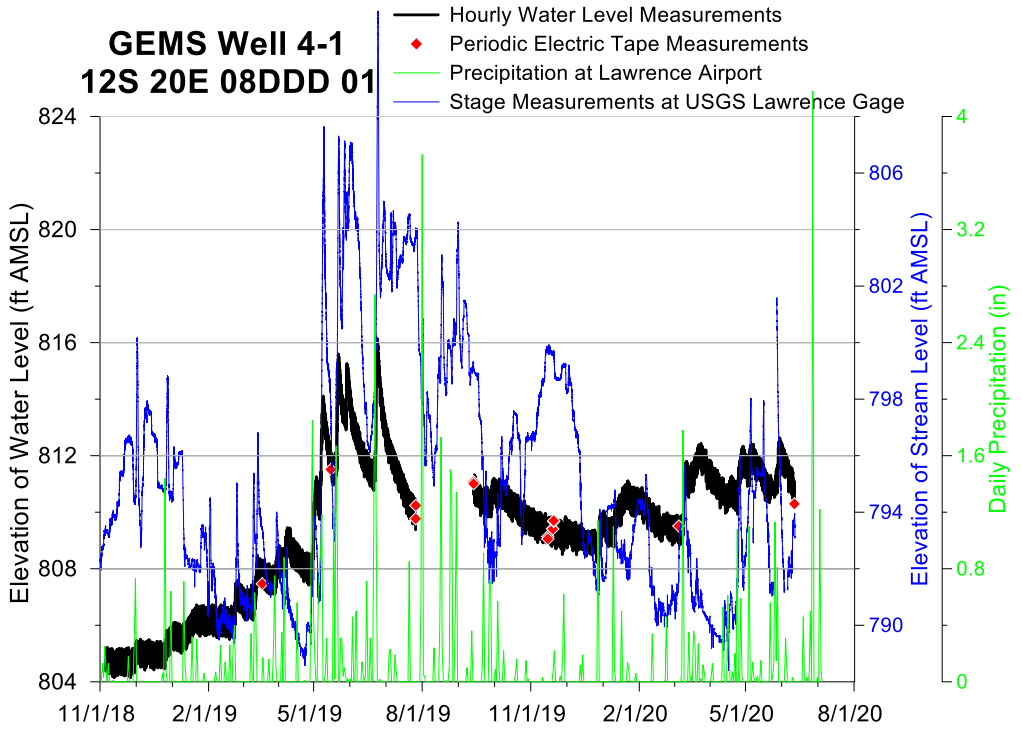

Figure 19—GEMS4-1 index well hydrograph with stream stage and precipitation data—total data run to 6/11/20. A water-level elevation of 810 ft corresponds to a depth to water of 15 ft below land surface (lsf). The top of the screen is 39.5 ft below lsf (elevation of 785.5 ft), and the bottom of the aquifer is 70.3 ft below lsf (elevation of 754.7 ft). The screen terminates less than 1 ft above the bottom of the aquifer. Electric-tape measurements are in good agreement with transducer. USGS gage is 3.2 miles from the well but the river is within 2.1 miles of the well upstream of the gage. Precipitation measured at Lawrence Municipal Airport, which is 0.9 miles southwest of the well.

Major Points

- Water-level changes appear to be primarily driven by precipitation.
- The band in the water-level record (approximately 1 ft in width) is created by nearby (a short distance to the west) supply wells for a rural water district turning on and off two to three times per day.
- The impact of stream-stage changes in the Kansas River appears very small. However, the role of a nearby stream, Mud Creek, has yet to be clarified.
- The form of the water-level responses to pumping indicates a confined aquifer, consistent with the direct-push electrical conductivity profile.

4.2.4 Douglas County Index Well 2

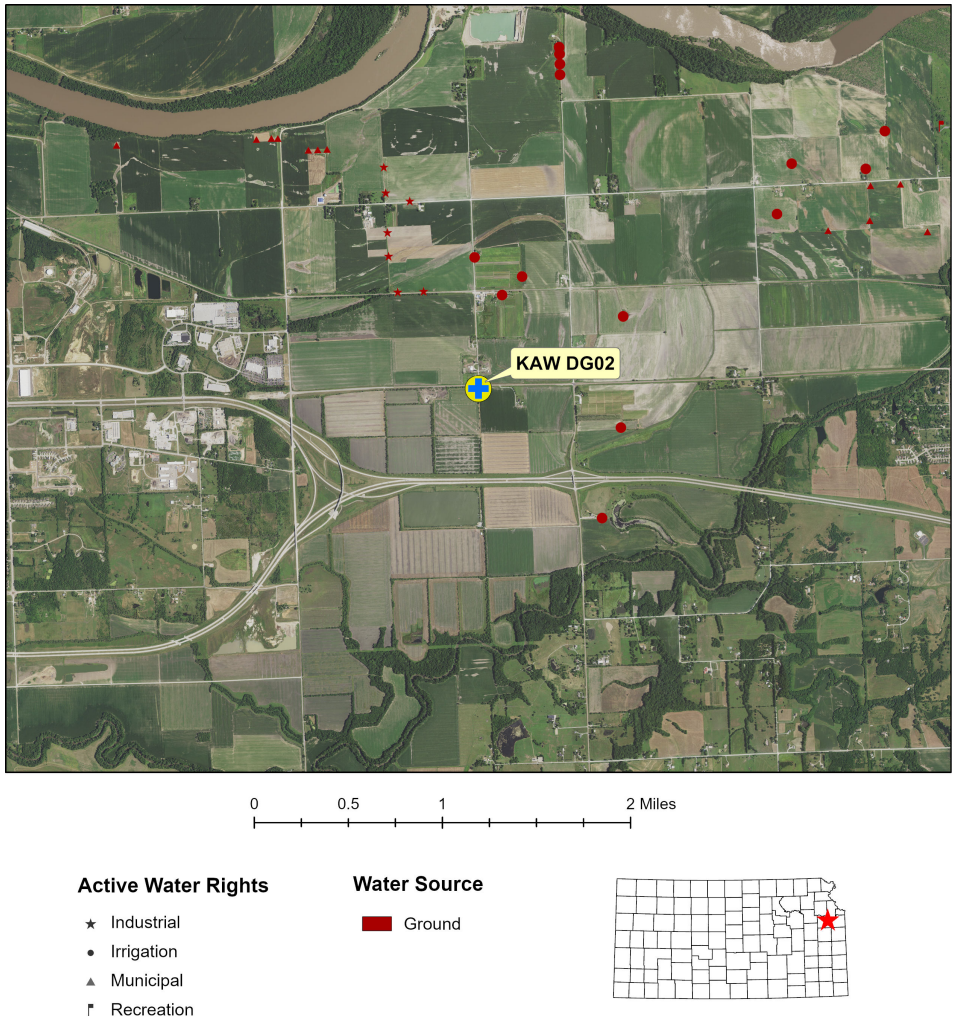

Figure 20—Aerial view of Douglas County index well 2 (DG02) and nearby points of diversion. The eastern edge of the city of Lawrence is to the west of the well, and the western edge of the city of Eudora is just visible to the east.

Figure 20 is an aerial view of the Douglas County index well 2 site (T. 13 S., R. 20 E., 11 BAA 02) at a scale that shows the site of the index well, the Kansas River to the north, the Wakarusa River to the south, and nearby wells that have active water rights. The well was installed on 7/17/18 with a 15 ft screen that terminates 4.0 ft above the bottom of the aquifer. The aquifer consists of sand and gravel from 37 to 62 ft below land surface and sand and gravel with silt from 62 to 74 ft below land surface. The aquifer is overlain by clay and silt (see Appendix for WWC-5 report and associated direct-push electrical conductivity log). The well was developed (surging followed by hand bailing of 5.0 well volumes) on 7/25/18. A sensor was installed and monitoring began on 8/15/17; telemetry equipment was installed on 9/7/17. Slug tests were performed on 9/13/19; test results indicated an excellent connection to a highly permeable aquifer with a hydraulic conductivity value of 100–180 ft/d. Previously, water levels were monitored (readings reported every five days until October 1974, then three to eight times a year after that) from May 1966 to July 1989 at a well (USGS ID #385624095093701) to the north (within 30 ft) of the index well.

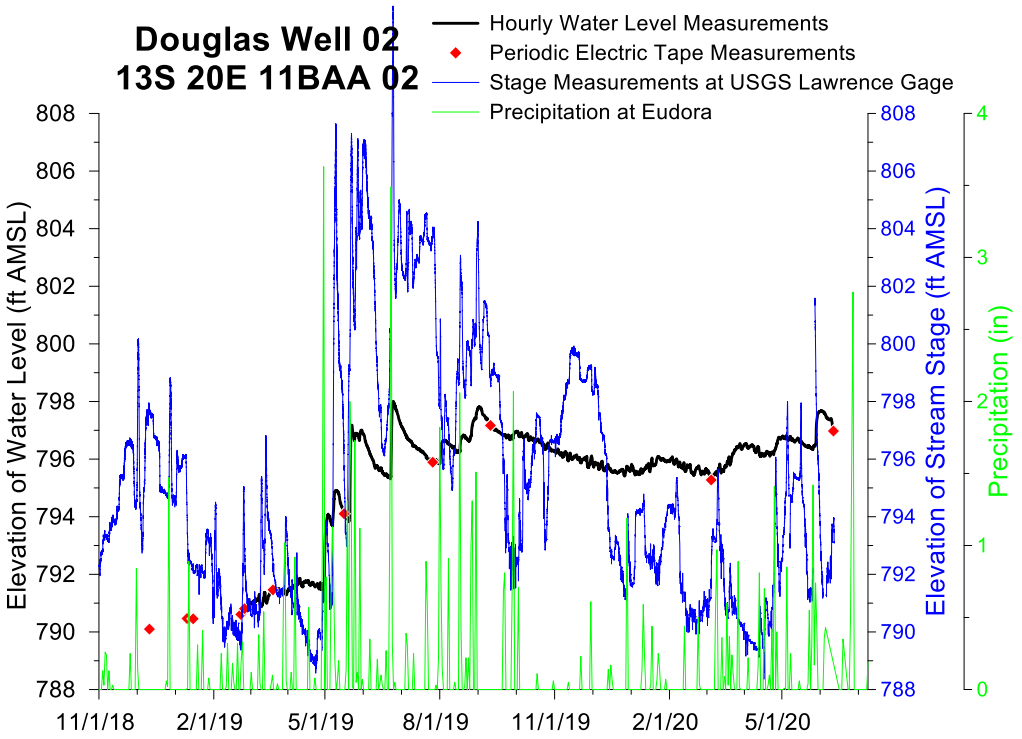

Figure 21—Douglas County index well 2 hydrograph with stream stage and precipitation data—total data run to 6/11/20. A water-level elevation of 796 ft corresponds to a depth to water of 21 ft below land surface (lsf). The top of the screen is 55 ft below lsf (elevation of 762 ft), and the bottom of the aquifer is 74 ft below lsf (elevation of 743 ft). The screen terminates 4 ft above the bottom of the aquifer. Electric-tape measurements are in good agreement with transducer. Well is 1.6 miles from the Kansas River channel, and the USGS gage is 3.5 miles upstream from that point. Well is 1.0 mile from the Wakarusa River channel. Precipitation measured at NOAA station in Eudora, which is 3.6 miles east of the well.

Major Points

- Water-level changes appear to be primarily driven by precipitation.
- Given the relationship between water levels and precipitation, it is difficult to discern the effect of stream-stage changes in either the Kansas or Wakarusa rivers.
- There is no detectable signal of nearby pumping, consistent with the lowest amount of pumping within a 2 mi radius for any of the network wells.
- Well response to barometric pressure appears to be consistent with a confined aquifer.

4.2.5 Leavenworth County Index Well 1

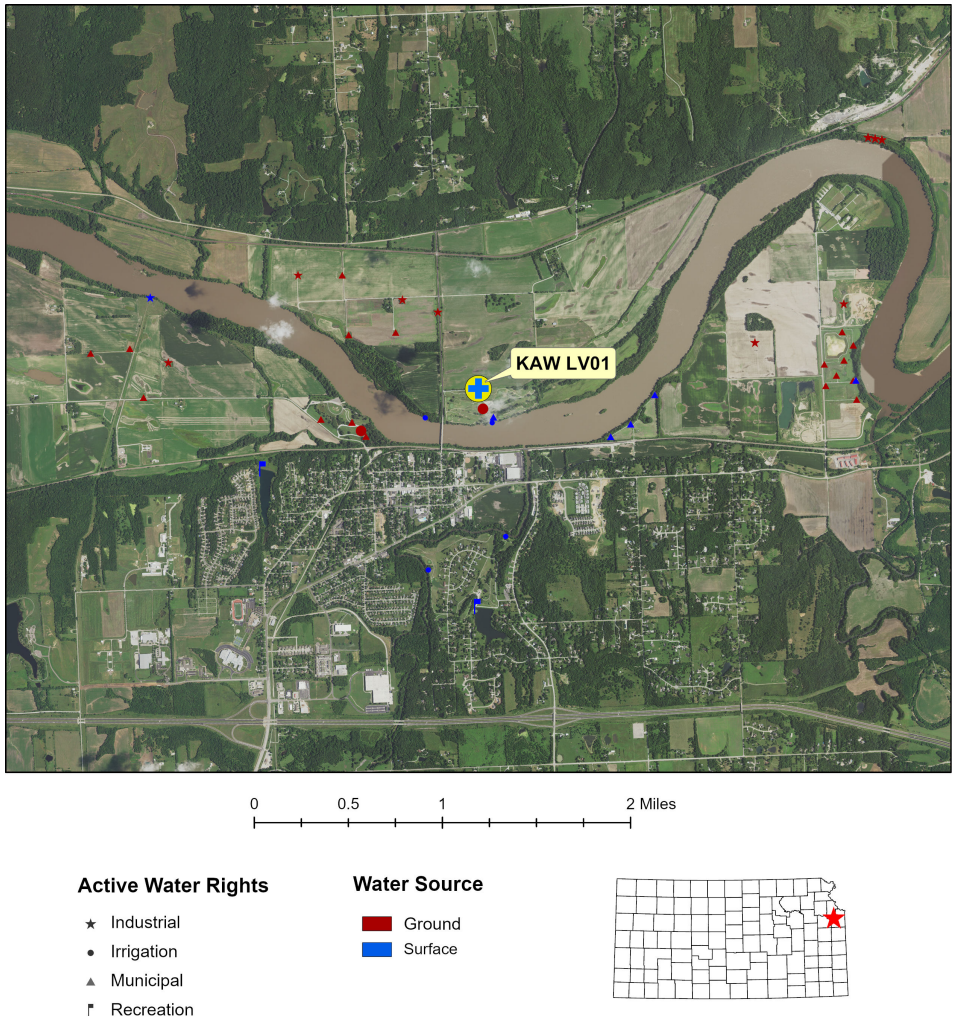

Figure 22—Aerial view of Leavenworth County index well 1 (LV01) and nearby points of diversion. The city of De Soto is south of the well.

Figure 22 is an aerial view of the Leavenworth County index well 1 site (T. 12 S., R. 22 E., 27 BBA 01) at a scale that shows the site of the index well, the Kansas River, and nearby wells that have active water rights. The well was installed on 5/8/18 with a 20 ft screen that terminates 1.1 ft above the bottom of the aquifer. The aquifer consists of sand from 27 to 66 ft below land surface. The aquifer is overlain by sand with intermittent sandy silt layers (see Appendix for WWC-5 report and associated direct-push electrical conductivity log). The well was developed (hand bailing of 4.0 well volumes) on 7/25/18, and a sensor and telemetry equipment were installed on 8/6/18. Slug tests were performed on 9/11/19; test results indicate an excellent connection to a highly permeable aquifer with a hydraulic conductivity value of 190–270 ft/d. There is no record of previous monitoring in the vicinity of this site; site was primarily chosen because of its proximity to the USGS stream gage at the De Soto bridge.

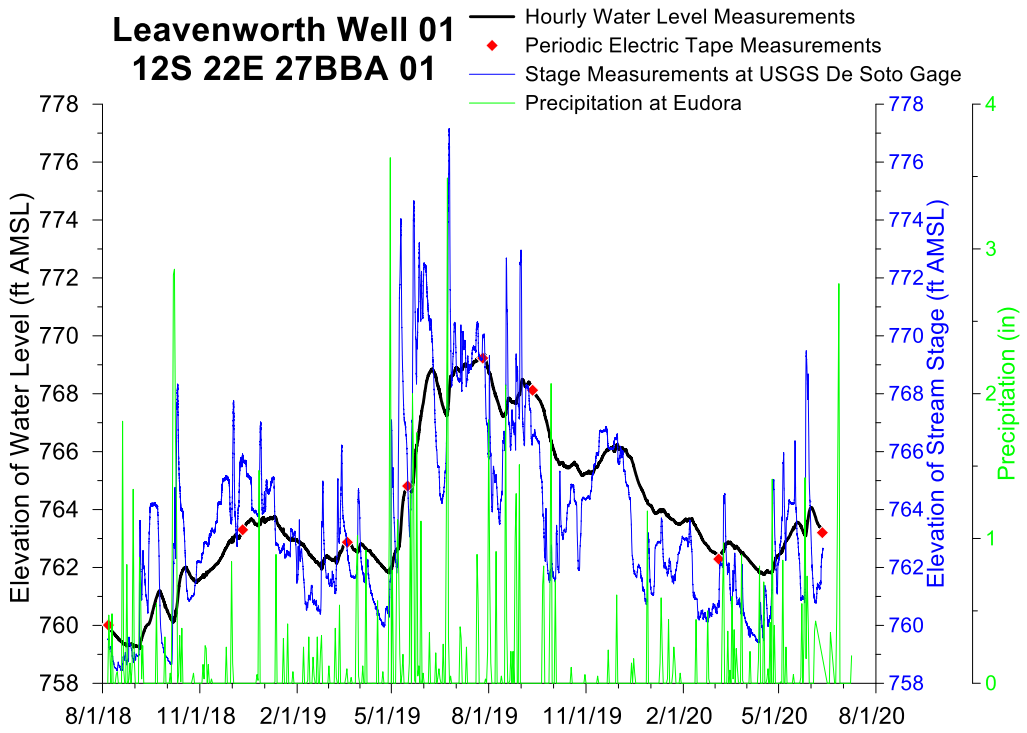

Figure 23—Leavenworth County index well 1 hydrograph with stream stage and precipitation data—total data run to 6/11/20. A water-level elevation of 764 ft corresponds to a depth to water of 22 ft below land surface (lsf). The top of the screen is 45 ft below lsf (elevation of 741 ft), and the bottom of the aquifer is 66.1 ft below lsf (elevation of 719.9 ft). The screen terminates 1.1 ft above the bottom of the aquifer. Electric-tape measurements are in reasonable agreement with transducer. Well is 0.2 miles from the Kansas River channel, and the USGS gage is 0.2 miles upstream from that point; at an approximate elevation change of 2 ft/mi along the river channel, the river stage perpendicular to the well would need to be shifted about a half foot lower to be comparable to the water-level elevation in the graph. Precipitation measured at NOAA station in Eudora, which is 7.9 miles southwest of the well.

Major Points

- Water-level changes appear to be primarily driven by changes in stream stage.
- The effect of precipitation appears small.
- The effect of nearby pumping wells on water levels appears very small despite the large amount of municipal pumping in the area. This may be an indication that most of the pumped water is being drawn from the river.
- Well response to barometric pressure is small.
- The relative changes in the elevation difference between the water level in the well and that in the river suggest that the general groundwater flow direction down the river valley shifted somewhat such that the component directed toward the river was greater after the high flows of mid-2019 than before.

4.2.6 Wyandotte County Index Well 1

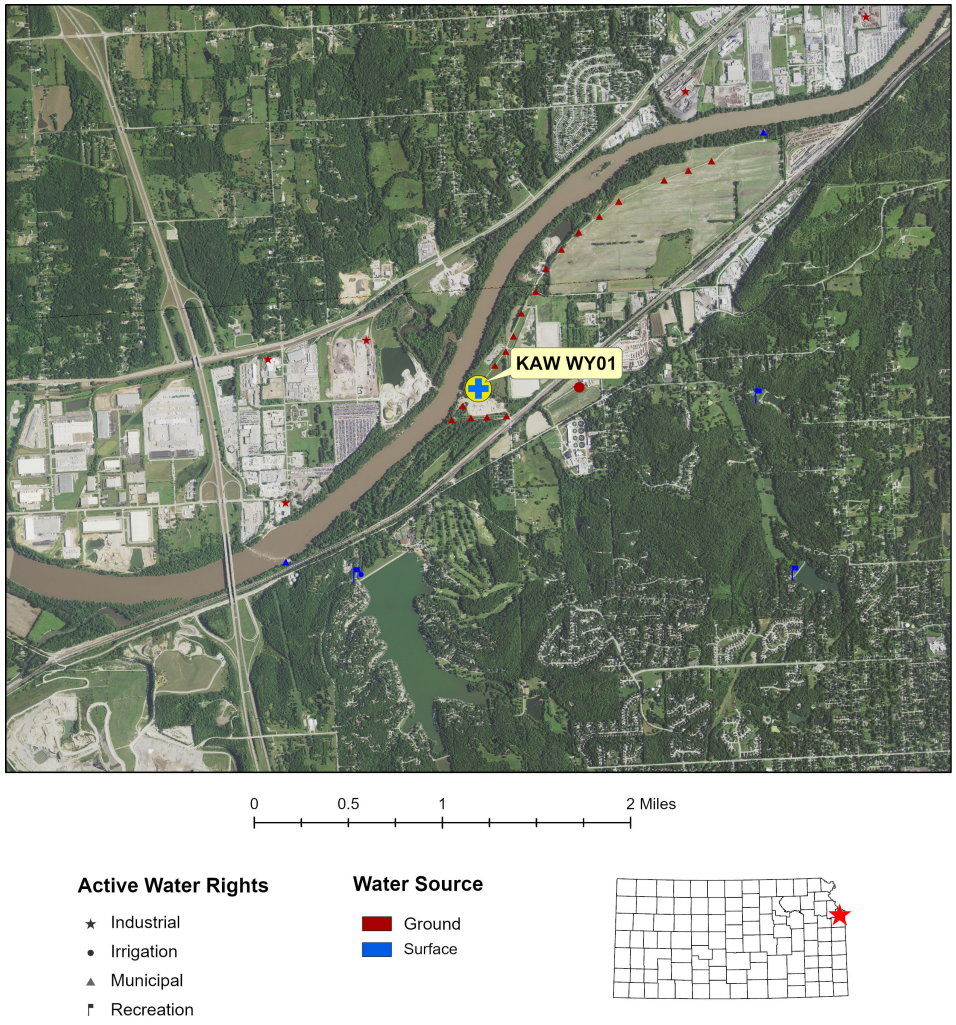

Figure 24—Aerial view of Wyandotte County index well 1 (WY01) and nearby points of diversion. The city of Lake Quivira is to the immediate south of the well.

Figure 24 is an aerial view of the Wyandotte County index well 1 site (T. 11 S., R. 24 E., 29 DDC 03) at a scale that shows the site of the index well, the Kansas River, and nearby wells that have active water rights. The well was installed on 5/9/18 with a 15 ft screen that terminates 4 ft above the bottom of the aquifer. The aquifer consists mainly of sand from 38.5 ft below land surface to bedrock at approximately 69 ft below land surface with some silt near the bottom. The aquifer is overlain by layers of clay, sand, and silt (see Appendix for WWC-5 report and associated direct-push electrical conductivity log). The well was developed (hand bailing of 5.2 well volumes) and sensor and telemetry equipment were installed on 8/9/18. Slug tests were performed on 9/13/19; test results indicate an excellent connection to a highly permeable aquifer with a hydraulic conductivity value of 260–430 ft/d. Previously, water levels were monitored (readings reported 4 to 12 times a year) from March 1967 to December 1999 at a well (USGS ID #390319094460802) to the southwest (within 850 ft) of the index well.

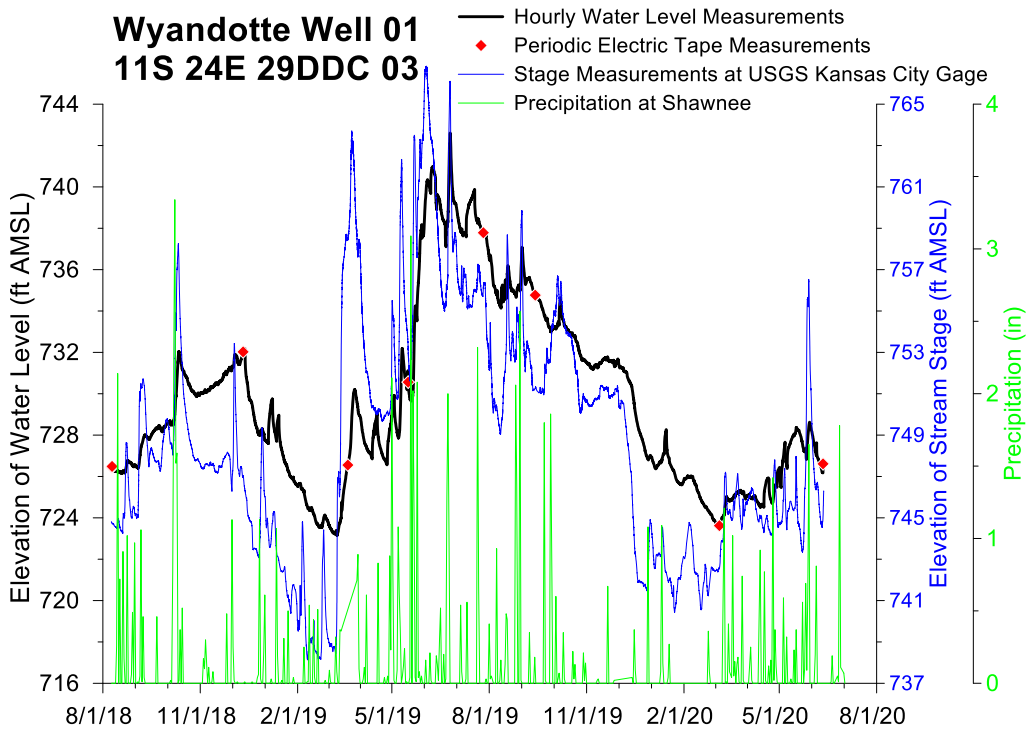

Figure 25—Wyandotte County index well 1 hydrograph with stream stage and precipitation data—total data run to 6/11/20. A water-level elevation of 732 ft corresponds to a depth to water of 35 ft below land surface (lsf). The top of the screen is 50 ft below lsf (elevation of 717 ft), and the bottom of the aquifer is 69 ft below lsf (elevation of 698 ft). The screen terminates 4 ft above the bottom of the aquifer. Electric-tape measurements are in reasonable agreement with transducer. Well is 0.09 miles from the Kansas River channel, and the USGS gage is approximately 1.6 miles upstream from that point; at an approximate elevation change of about 2 ft/mi along the river channel, the river stage perpendicular to the well would need to be shifted about 3 ft lower to be comparable to the water-level elevation in the graph. Precipitation measured at Shawnee, which is 3.75 miles south-southwest of the well.

Major Points

- Water-level changes appear to be primarily driven by changes in stream stage.
- The effect of municipal pumping wells very close to the index well is clear; numerous cusp-shaped features are indications of pumps turning on and off.
- The effect of precipitation appears small.
- Well response to barometric pressure is small.
- The river stage appears to be substantially higher than the water level in the aquifer at all times, suggesting that pumping in the vicinity of the well is inducing flow away from the river.

5 Summary of Phase One Accomplishments and Future Plans

5.1 Phase One Accomplishments

- Selected 10 sites for new monitoring wells in the Kansas River corridor from west of Manhattan to near the junction with the Missouri River in Kansas City.
- Obtained direct-push electrical conductivity logs at all 10 well sites; logs were used to understand site hydrostratigraphy and to select the screened intervals for each well.
- Drilled and constructed all 10 wells. Installed sensors and telemetry equipment and initiated monitoring at all of the wells.
- Converted an existing well into a monitoring well by the installation of a sensor and telemetry equipment.
- Served telemetered data from 11 wells on the KGS website in real time. Visited each well quarterly to take manual measurements of water levels and download data from sensors.
- Compared water-level responses to stream-stage changes and precipitation, and completed an initial interpretation of hydrographs from all 11 wells.
- Developed all 11 wells to ensure a good connection between the well and the aquifer; performed and analyzed slug tests at all 11 wells to confirm that connection.
- Selected sites for three additional monitoring wells.

5.2 Planned Activities, Remainder of 2020 and 2021

- Continue monitoring and processing water-level data from all wells in the network. Visit each well quarterly to take manual measurements of water levels and download data from sensors.
- Collect and analyze groundwater samples at all 11 wells.
- Obtain electrical conductivity profiles, select intervals for well screens, and install wells at the three new sites. Install sensors and telemetry equipment and initiate monitoring at these wells.
- Obtain direct-push electrical conductivity logs at another 16 locations (in four to five traverses from the river to the valley wall) at sites along the corridor.
- Using the results of the direct-push logging and the WWC-5 database, perform a hydrostratigraphic analysis of the Kansas River alluvial aquifer.
- Based on the previous work of the project, select two additional sites for monitoring wells.
- Obtain electrical conductivity profiles, select intervals for well screens, and install wells at these two additional sites. Install sensors and telemetry equipment and initiate monitoring at both wells.
- Develop the five new wells and then perform and analyze slug tests at each.
- Collect and analyze groundwater samples at the five new wells.
- Perform a detailed analysis of hydrographs from all wells involved in the program with a particular emphasis on the relationship between the Kansas River and the aquifer.

6 References

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7 Appendix — Field Methods, Well Completion Reports, and Direct-Push Logs

7.1 Field Methods

7.1.1 Well Installation

All 10 of the new wells discussed in this report were installed with the KGS Geoprobe direct-push unit. Direct-push technology uses hydraulic rams supplemented with the vehicle weight to rapidly advance small-diameter pipe into the subsurface; material is not removed as in traditional drilling methods but is displaced to the side by the advancing pipe (Liu et al., 2012). The technology can be used for advancing small-diameter sensors to obtain high-resolution information about the subsurface as well as for well installation. In this work, it was used for both purposes. Once a site had been selected and land owner approval had been obtained, the KGS team advanced small-diameter pipe with an electrical conductivity probe (Schulmeister et al., 2003) at its lower end from the surface to the bottom or near bottom of the aquifer to obtain high-resolution (≈0.05 ft) information about the hydrostratigraphy at the site and, in particular, the distribution of coarse materials (sands and gravels) versus fines (clays and silts). The electrical conductivity log was then used to create the geologic log for the site and to select the screened interval for the well.

The well was installed by advancing larger diameter pipe with a plug at the lower end and overdrilling the hole created by the direct-push electrical conductivity logging. Upon reaching the bottom, a 2” Sch. 40 well string (casing and screen) was installed down the center of the pipe. The well string was then used to push the plug out the bottom of the direct-push pipe and the pipe was withdrawn while leaving the well string in place. The formation quickly collapsed against the screen and casing except in the upper portions of the hole. The annulus in the upper section was then filled with bentonite pellets to the land surface. A steel well protector was placed around the casing extending above the surface. Each well was later developed as described in the main text.

The previously existing well (GEMS4-1) was installed with hollow-stem augers using standard drilling methods. A WWC-5 well completion report does not exist for that well, so we used a direct-push electrical conductivity log obtained within 20 ft of the well to create the geologic log included here. The well was developed for this project as described in the main text.

7.1.2 Slug Tests

Slug tests were performed at all 11 wells using the pneumatic method for test initiation and the field guidelines outlined in Butler (2019). Test data were analyzed using the Aqtesolv software (HydroSOLVE, Inc., 2007) to obtain a hydraulic conductivity (K) estimate for the screened interval. The three models used for the analyses were the KGS model, the high-K form of the Hvorslev model, and the Butler and Zhan model; details of the analysis procedures for all three are given in Butler (2019).

7.2 Well Completion Reports and Direct-Push Electrical Conductivity Logs

In this section, the well completion (WWC-5) reports and the corresponding electrical conductivity logs are given for each of the 11 wells discussed in the report. The well order is from west to east as in the report.

Riley County Index Well 1 – WWC-5 Form

WATER WELL RECORD Form WWC-5 Division of Water Resources App. No. _____ Well ID KAW-RL01

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Riley | Fraction: NE ¼ NE ¼ NW ¼ ¼ | Section Number: 34 | Township Number: T 10 S | Range Number: R 7 ■ E ☐ W

2 WELL OWNER: Last Name: First:
Business: Kansas Geological Survey
Address: University of Kansas
Address: 1930 Constant Ave
City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
3800 S. 20th St., Manhattan, KS

3 LOCATE WELL WITH "X" IN SECTION BOX:
N / W / E / S; NW, NE, SW, SE; |---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 50 ft.
Depth(s) Groundwater Encountered: 1) ..... ft. 2) ..... ft. 3) ..... ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: 24 ft.
■ below land surface, measured on (mo-day-yr) 07-18-18
☐ above land surface, measured on (mo-day-yr) .....
Pump test data: Well water was ..... ft. after ..... hours pumping ..... gpm
Well water was ..... ft. after ..... hours pumping ..... gpm
Estimated Yield: ..... gpm
Bore Hole Diameter: 3.25 in. to 50 ft. and ..... in. to ..... ft.

5 Latitude: 39.145327 (decimal degrees)
Longitude: -96.637193 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: .....) (WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 1037 ft. ■ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other State Lidar Data

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID .....
6. ☐ Dewatering: how many wells? .....
7. ☐ Aquifer Recharge: well ID .....
8. ■ Monitoring: well ID KAW-RL01
9. Environmental Remediation: well ID ..... ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease .....
11. Test Hole: well ID ..... ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ..... a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): .....

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: .....
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ..... CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 50 ft., Diameter ..... in. to ..... ft., Diameter ..... in. to ..... ft.
Casing height above land surface 36 in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40

TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) .....
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)

SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) .....
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)

SCREEN-PERFORATED INTERVALS: From 45 ft. to 50 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
GRAVEL PACK INTERVALS: From 20 ft. to 50 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other .....
Grout Intervals: From 0 ft. to 20 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

Nearest source of possible contamination:
☐ Septic Tank ☐ Lateral Lines ☐ Pit Privy ☐ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ■ Fuel Storage ☐ Abandoned Water Well
☐ Watertight Sewer Lines ☐ Seepage Pit ☐ Feedyard ■ Fertilizer Storage ☐ Oil Well/Gas Well
☐ Other (Specify) .....
Direction from well? Southwest Distance from well? 1500 ft.

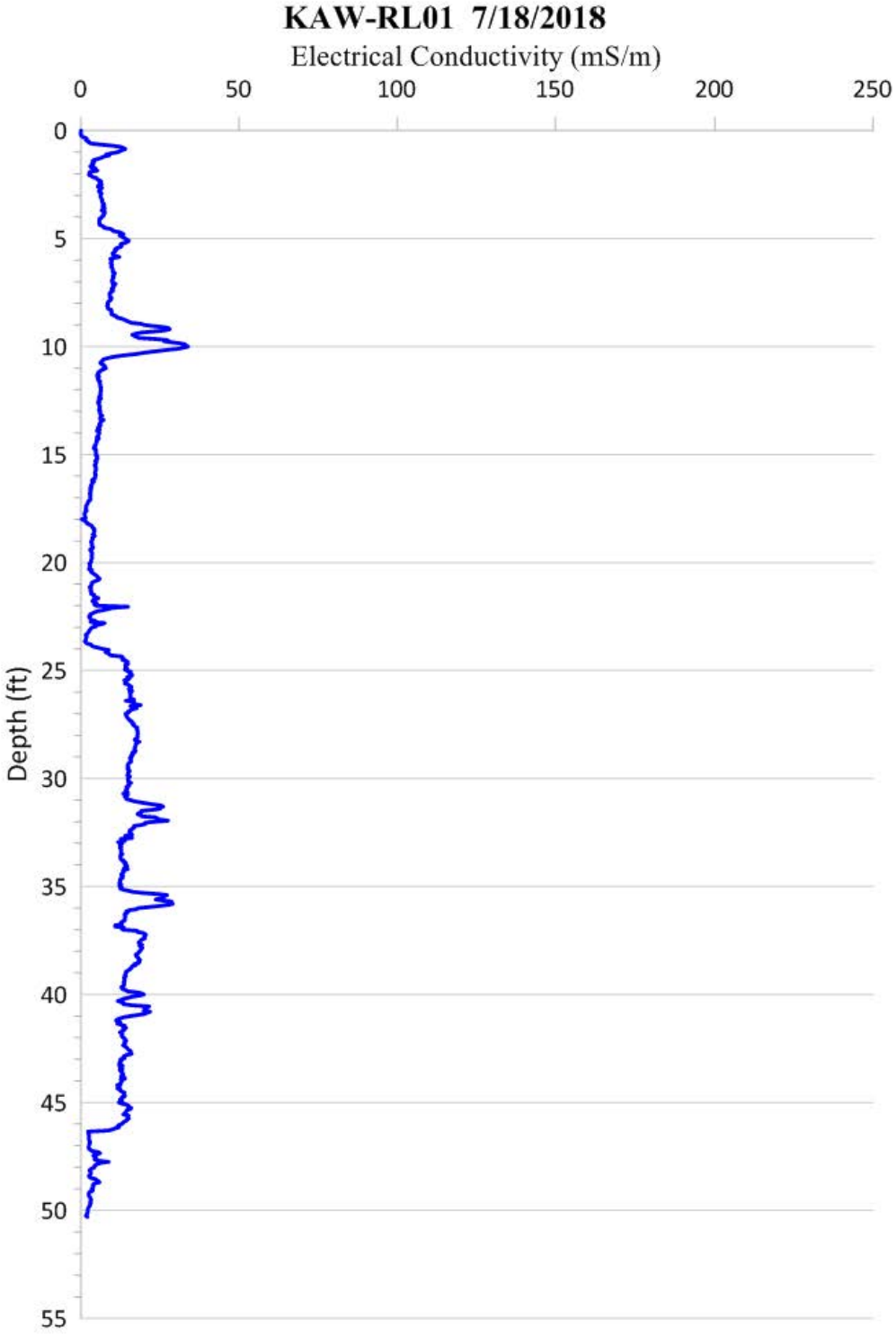
10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0	5	Soils			
5	8.5	Sand			
8.5	10.5	Silt			
10.5	20	Sand			
20	45	Sand with Ninor Silt lenses			
45	50.25	Sand			
50.25		Bedrock - Refusal (Limestone)			

Notes: See Attached Electrical Conductivity Log

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) 05-15-2018 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ..... This Water Well Record was completed on (mo-day-year) 05-22-2018 under the business name of Kansas Geological Survey Signature .....

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

Riley County Index Well 1 – Electrical Conductivity Log



Riley County Index Well 2 – WWC-5 Form

WATER WELL RECORD Form WWC-5 — Division of Water Resources App. No. ____ Well ID KAW-RL02

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Riley	Fraction: SE ¼ SE ¼ SE ¼ NW ¼	Section Number: 17	Township Number: T 10 S	Range Number: R 9 ■ E ☐ W

2 WELL OWNER: Last Name: First:
Business: Kansas Geological Survey
Address: University of Kansas
Address: 1930 Constant Ave
City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
4400 River Rd

3 LOCATE WELL WITH "X" IN SECTION BOX: N / W / E / S; NW, NE, SW, SE; |---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 37 ft.
Depth(s) Groundwater Encountered: 1) ..... ft. 2) ..... ft. 3) ..... ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: 20.23 ft.
■ below land surface, measured on (mo-day-yr) 05-15-18
☐ above land surface, measured on (mo-day-yr) .....
Pump test data: Well water was ..... ft. after ..... hours pumping ..... gpm
Well water was ..... ft. after ..... hours pumping ..... gpm
Estimated Yield: ..... gpm
Bore Hole Diameter: 3.25 in. to 37 ft. and ..... in. to ..... ft.

5 Latitude: 39.181389 (decimal degrees)
Longitude: -96.435834 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: .....) (WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 998 ft. ■ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other Google Earth Pro

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID .....
6. ☐ Dewatering: how many wells? .....
7. ☐ Aquifer Recharge: well ID .....
8. ■ Monitoring: well ID KAW-RL02
9. Environmental Remediation: well ID ..... ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease .....
11. Test Hole: well ID ..... ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ..... a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): .....

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: .....
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ..... CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 37 ft., Diameter ..... in. to ..... ft., Diameter ..... in. to ..... ft.
Casing height above land surface 36 in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40

TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) .....
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)

SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) .....
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)

SCREEN-PERFORATED INTERVALS: From 27 ft. to 37 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
GRAVEL PACK INTERVALS: From 20 ft. to 37 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other .....
Grout Intervals: From 0 ft. to 20 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

Nearest source of possible contamination:
☐ Septic Tank ☐ Lateral Lines ☐ Pit Privy ■ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ☐ Fuel Storage ☐ Abandoned Water Well
☐ Watertight Sewer Lines ☐ Seepage Pit ☐ Feedyard ☐ Fertilizer Storage ☐ Oil Well/Gas Well
☐ Other (Specify) .....
Direction from well? North Distance from well? 350 ft.

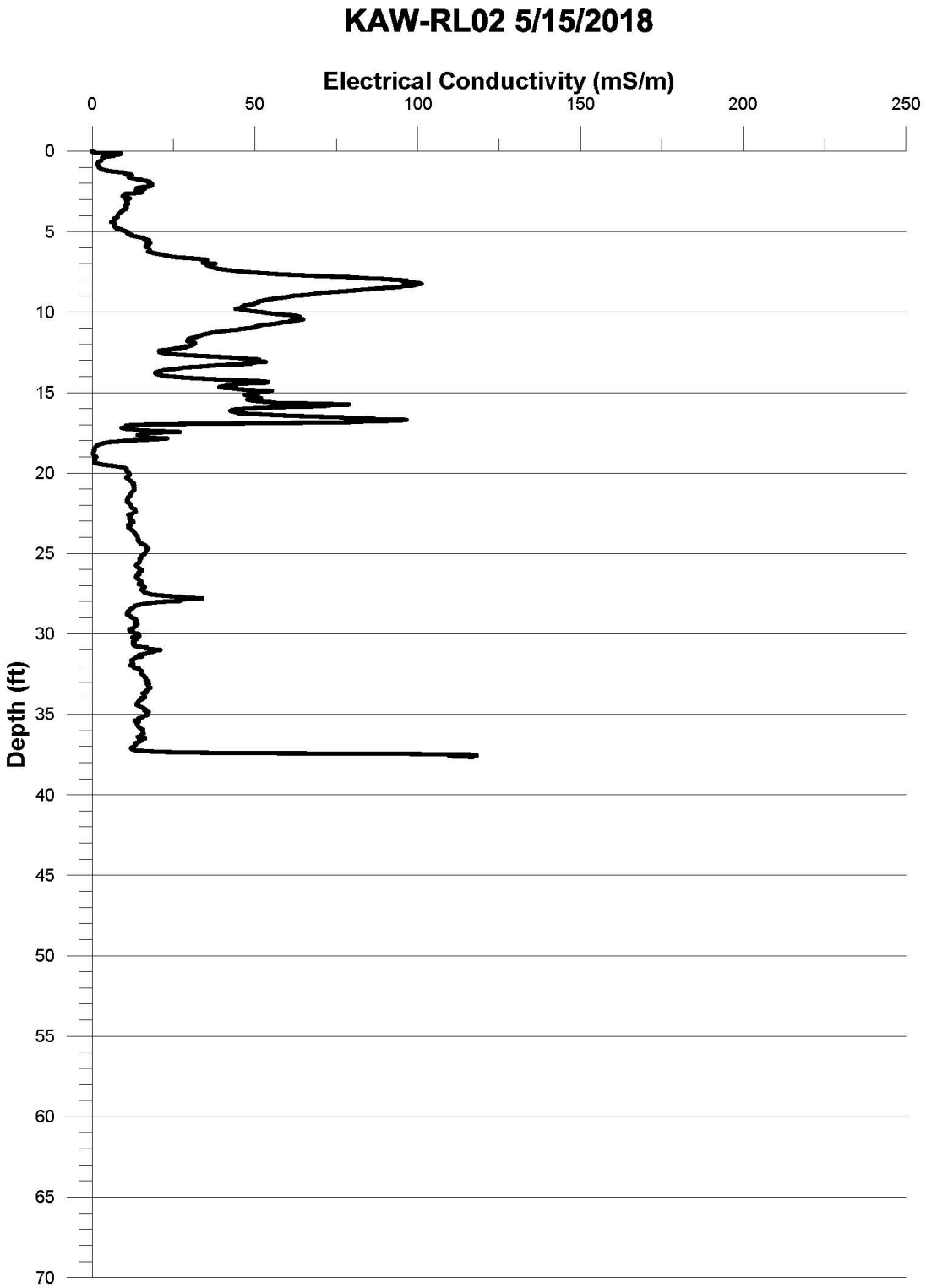
10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0	6	Sandy Soil			
6	17	Silty Clay			
17	18	Silt			
18.	27.5	Sands			
27.5	28	Silt			
28	37.2	Sand			
37.2		Shale - Refusal			

Notes: See Attached Electrical Conductivity Log

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) 05-15-2018 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ..... This Water Well Record was completed on (mo-day-year) 05-22-2018 under the business name of Kansas Geological Survey Signature .....

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

Riley County Index Well 2 – Electrical Conductivity Log



Wabaunsee County Index Well 1 – WWC-5 Form

WATER WELL RECORD Form WWC-5 — Division of Water Resources App. No. ____ — Well ID KAW-WB01

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL:	Fraction	Section Number	Township Number	Range Number
County: Wabaunsee	SW ¼ SE ¼ SE ¼ ¼	15	T 10 S	R 10 ■ E ☐ W

2 WELL OWNER: Last Name: First:
Business: Kansas Geological Survey
Address: University of Kansas
Address: 1930 Constant Ave
City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
800 feet East of the intersection of River Rd and W Boundary Rd on North side of road

3 LOCATE WELL WITH "X" IN SECTION BOX: N / W / E / S; - - NW - - - - NE - - - - SW - - - - SE - - ; |---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 37 ft.
Depth(s) Groundwater Encountered: 1) ..... ft. 2) ..... ft. 3) ..... ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: 23 ft.
■ below land surface, measured on (mo-day-yr) 05-10-18
☐ above land surface, measured on (mo-day-yr) .....
Pump test data: Well water was ..... ft. after ..... hours pumping ..... gpm
Well water was ..... ft. after ..... hours pumping ..... gpm
Estimated Yield: ..... gpm
Bore Hole Diameter: 3.25 in. to 37 ft. and ..... in. to ..... ft.

5 Latitude: 39.174223 (decimal degrees)
Longitude: -96.282614 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: .....)
(WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 972 ft. ■ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other Google Earth Pro

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID .....
6. ☐ Dewatering: how many wells? .....
7. ☐ Aquifer Recharge: well ID .....
8. ■ Monitoring: well ID KAW-WB01
9. Environmental Remediation: well ID ..... ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease .....
11. Test Hole: well ID ..... ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ..... a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): .....

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: .....
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ..... CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 37 ft., Diameter ..... in. to ..... ft., Diameter ..... in. to ..... ft.
Casing height above land surface 36 in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40

TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) .....
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)

SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) .....
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)

SCREEN-PERFORATED INTERVALS: From 22 ft. to 37 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
GRAVEL PACK INTERVALS: From 16.5 ft. to 37 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other .....
Grout Intervals: From 0 ft. to 16.5 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

Nearest source of possible contamination:
☐ Septic Tank ☐ Lateral Lines ☐ Pit Privy ☐ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ☐ Fuel Storage ☐ Abandoned Water Well
☐ Watertight Sewer Lines ☐ Seepage Pit ☐ Feedyard ☐ Fertilizer Storage ☐ Oil Well/Gas Well
■ Other (Specify) Creek
Direction from well? South Distance from well? 400 ft.

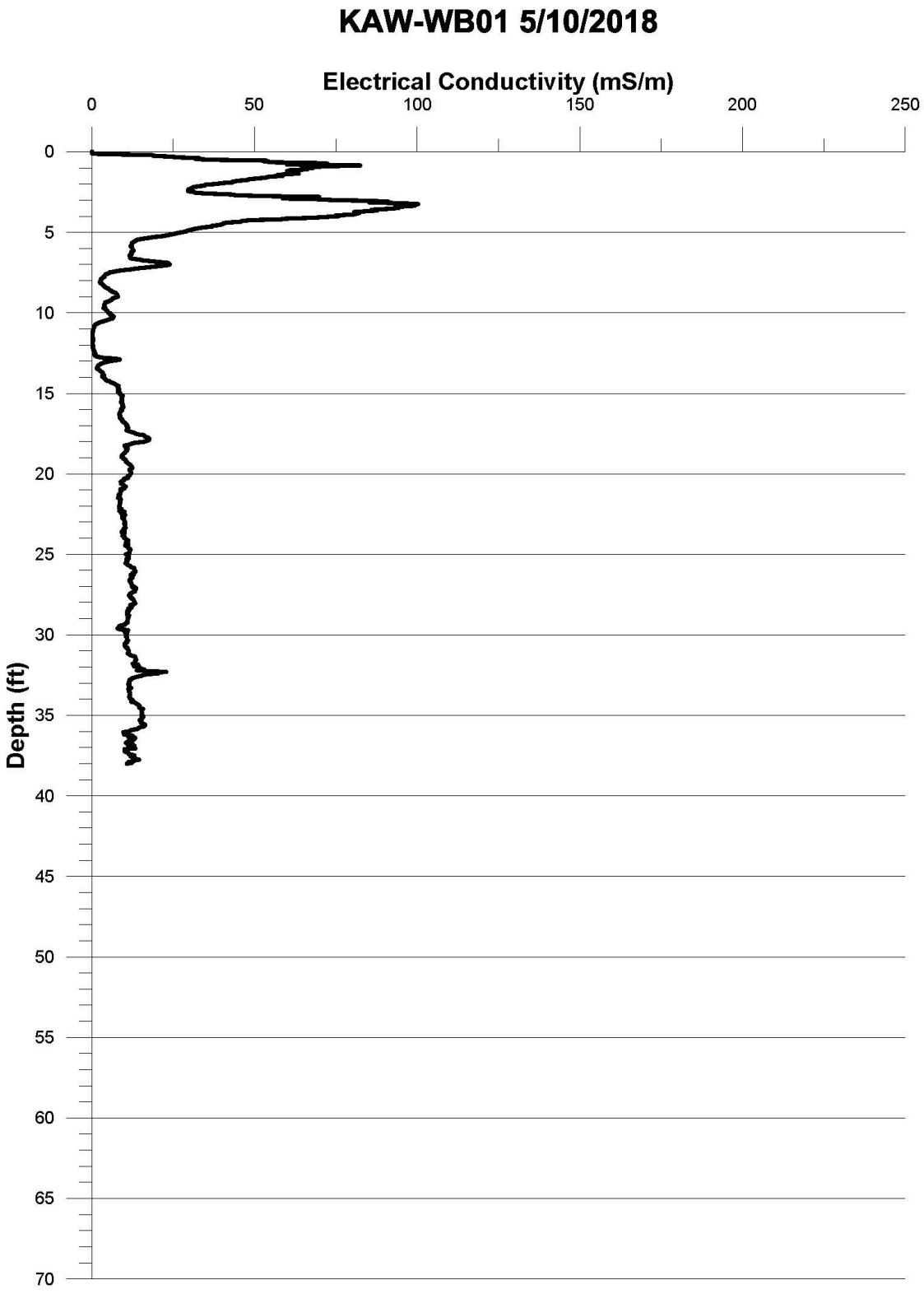
10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0	7	Soils			
7	38	Sands			

Notes: See Attached Electrical Conductivity Log

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) 05-10-2018 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ..... This Water Well Record was completed on (mo-day-year) 05-22-2018 under the business name of Kansas Geological Survey Signature .....

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

Wabaunsee County Index Well 1 – Electrical Conductivity Log



Shawnee County Index Well 1 – WWC-5 Form

WATER WELL RECORD Form WWC-5 — Division of Water Resources App. No. — Well ID: KAW-SN01

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Shawnee | Fraction: SE ¼ NE ¼ NE ¼ ¼ | Section Number: 4 | Township Number: T 11 S | Range Number: R 13 ■ E ☐ W

2 WELL OWNER: Last Name: First:
Business: Kansas Geological Survey
Address: University of Kansas
Address: 1930 Constant Ave
City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
4431 NW Capper Rd

3 LOCATE WELL WITH "X" IN SECTION BOX: N / W / E / S; - - NW - - - - NE - - - - SW - - - - SE - - ; |---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 46.5 ft.
Depth(s) Groundwater Encountered: 1) ..... ft. 2) ..... ft. 3) ..... ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: 18.4 ft.
■ below land surface, measured on (mo-day-yr) 05-16-18
☐ above land surface, measured on (mo-day-yr) .....
Pump test data: Well water was ..... ft. after ..... hours pumping ..... gpm
Well water was ..... ft. after ..... hours pumping ..... gpm
Estimated Yield: .....gpm
Bore Hole Diameter: 3.25 in. to 46.5 ft. and ..... in. to ..... ft.

5 Latitude: 39.126524 (decimal degrees)
Longitude: -95.965556 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: .....)
(WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 929 ft. ■ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other Google Earth Pro

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID .....
6. ☐ Dewatering: how many wells? .....
7. ☐ Aquifer Recharge: well ID .....
8. ■ Monitoring: well ID KAW-SN01
9. Environmental Remediation: well ID ..... ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease .....
11. Test Hole: well ID ..... ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ..... a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): .....

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: .....
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ..... CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 46.5 ft., Diameter ..... in. to ..... ft., Diameter ..... in. to ..... ft.
Casing height above land surface ..... in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40

TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) .....
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)

SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) .....
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)

SCREEN-PERFORATED INTERVALS: From 36.5 ft. to 46.5 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
GRAVEL PACK INTERVALS: From 20 ft. to 46.5 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other .....
Grout Intervals: From 0 ft. to 20 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

Nearest source of possible contamination:
☐ Septic Tank ☐ Lateral Lines ☐ Pit Privy ☐ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ☐ Fuel Storage ☐ Abandoned Water Well
☐ Watertight Sewer Lines ☐ Seepage Pit ☐ Feedyard ☐ Fertilizer Storage ☐ Oil Well/Gas Well
☐ Other (Specify) Pond
Direction from well? Southwest Distance from well? 350 ft.

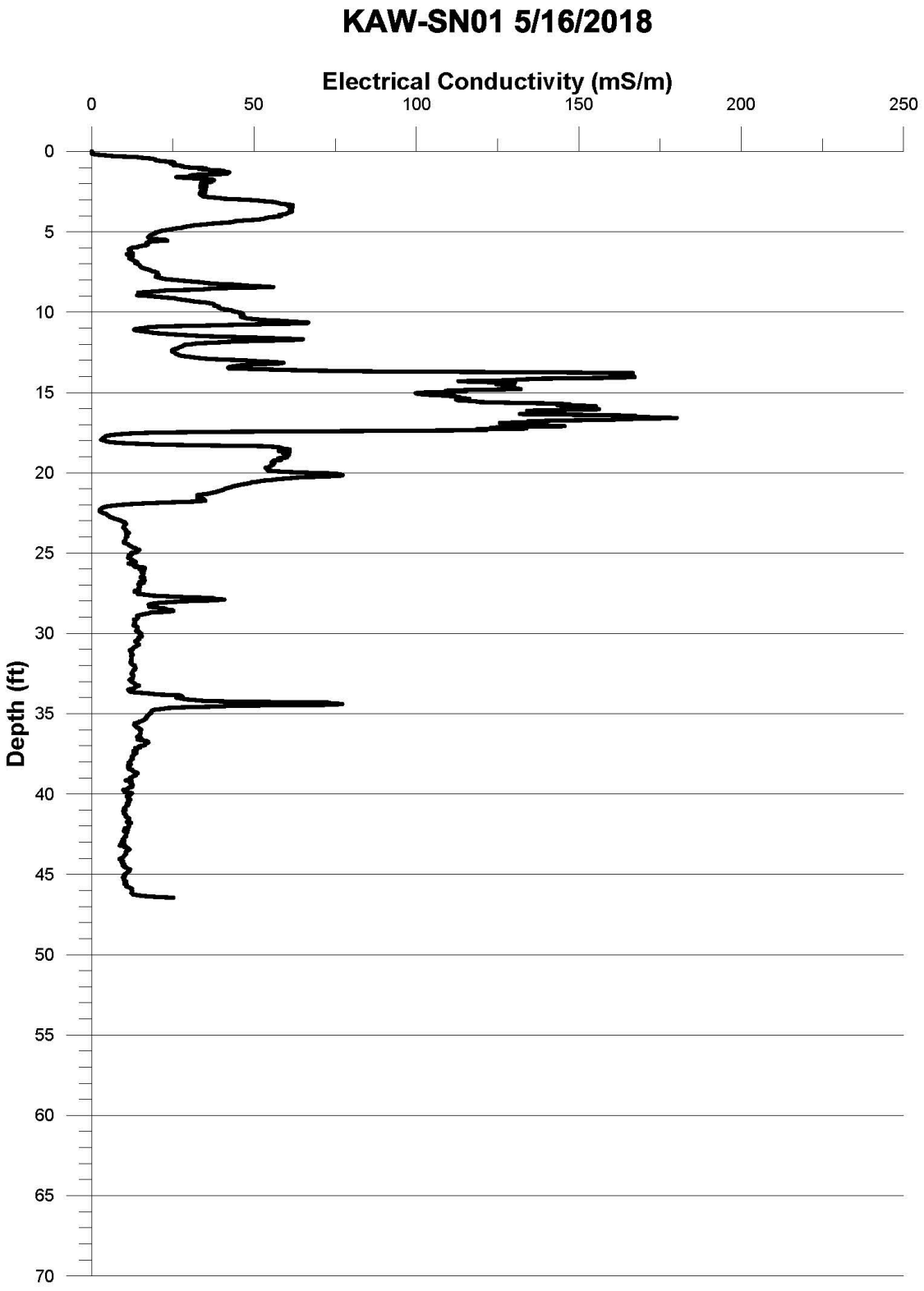
10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0	5	Soils			
5	8	Sands			
8	13.5	Silty Sands			
13.5	17.5	Clay			
17.5	18.3	Sands			
18.3	21.9	Silty Sands			
21.9	46.5	Sands with silty lenses			
46.5		Bedrock - Refusal			

Notes: See Attached Electrical Conductivity Log

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) 05-16-2018 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ..... This Water Well Record was completed on (mo-day-year) 05-22-2018 under the business name of Kansas Geological Survey Signature .....

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

Shawnee County Index Well 1 – Electrical Conductivity Log



Shawnee County Index Well 2 – WWC-5 Form

WATER WELL RECORD Form WWC-5 — Division of Water Resources App. No. ____ — Well ID KAW-SN02

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Shawnee | Fraction: NE ¼ SW ¼ SE ¼ ¼ | Section Number: 16 | Township Number: T 11 S | Range Number: R 15 ■ E ☐ W

2 WELL OWNER: Last Name: First:
Business: Kansas Geological Survey
Address: University of Kansas
Address: 1930 Constant Ave
City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
260 Feet South of NW 24th St on West side of NW Menoken Rd

3 LOCATE WELL WITH "X" IN SECTION BOX: N / W / E / S; NW, NE, SW, SE; |---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 64.2 ft.
Depth(s) Groundwater Encountered: 1) ..... ft. 2) ..... ft. 3) ..... ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: 33.15 ft.
■ below land surface, measured on (mo-day-yr) 10/18/18
☐ above land surface, measured on (mo-day-yr) .....
Pump test data: Well water was ..... ft. after ..... hours pumping ..... gpm
Well water was ..... ft. after ..... hours pumping ..... gpm
Estimated Yield: ..... gpm
Bore Hole Diameter: 3.25 in. to 64.5 ft. and ..... in. to ..... ft.

5 Latitude: 39.0889763 (decimal degrees)
Longitude: -95.748469 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: .....) (WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 898 ft. ■ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other Google Earth Pro

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID .....
6. ☐ Dewatering: how many wells? .....
7. ☐ Aquifer Recharge: well ID .....
8. ■ Monitoring: well ID KAW-SN02
9. Environmental Remediation: well ID ..... ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease .....
11. Test Hole: well ID ..... ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ..... a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): .....

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: .....
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ..... CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 64.2 ft., Diameter ..... in. to ..... ft., Diameter ..... in. to ..... ft.
Casing height above land surface 36 in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40

TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) .....
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)

SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) .....
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)

SCREEN-PERFORATED INTERVALS: From 44 ft. to 64 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
GRAVEL PACK INTERVALS: From 33 ft. to 64 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other .....
Grout Intervals: From 0 ft. to 33 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

Nearest source of possible contamination:
☐ Septic Tank ☐ Lateral Lines ☐ Pit Privy ☐ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ☐ Fuel Storage ☐ Abandoned Water Well
■ Watertight Sewer Lines ☐ Seepage Pit ☐ Feedyard ☐ Fertilizer Storage ☐ Oil Well/Gas Well
☐ Other (Specify) .....
Direction from well? North Distance from well? 20 ft.

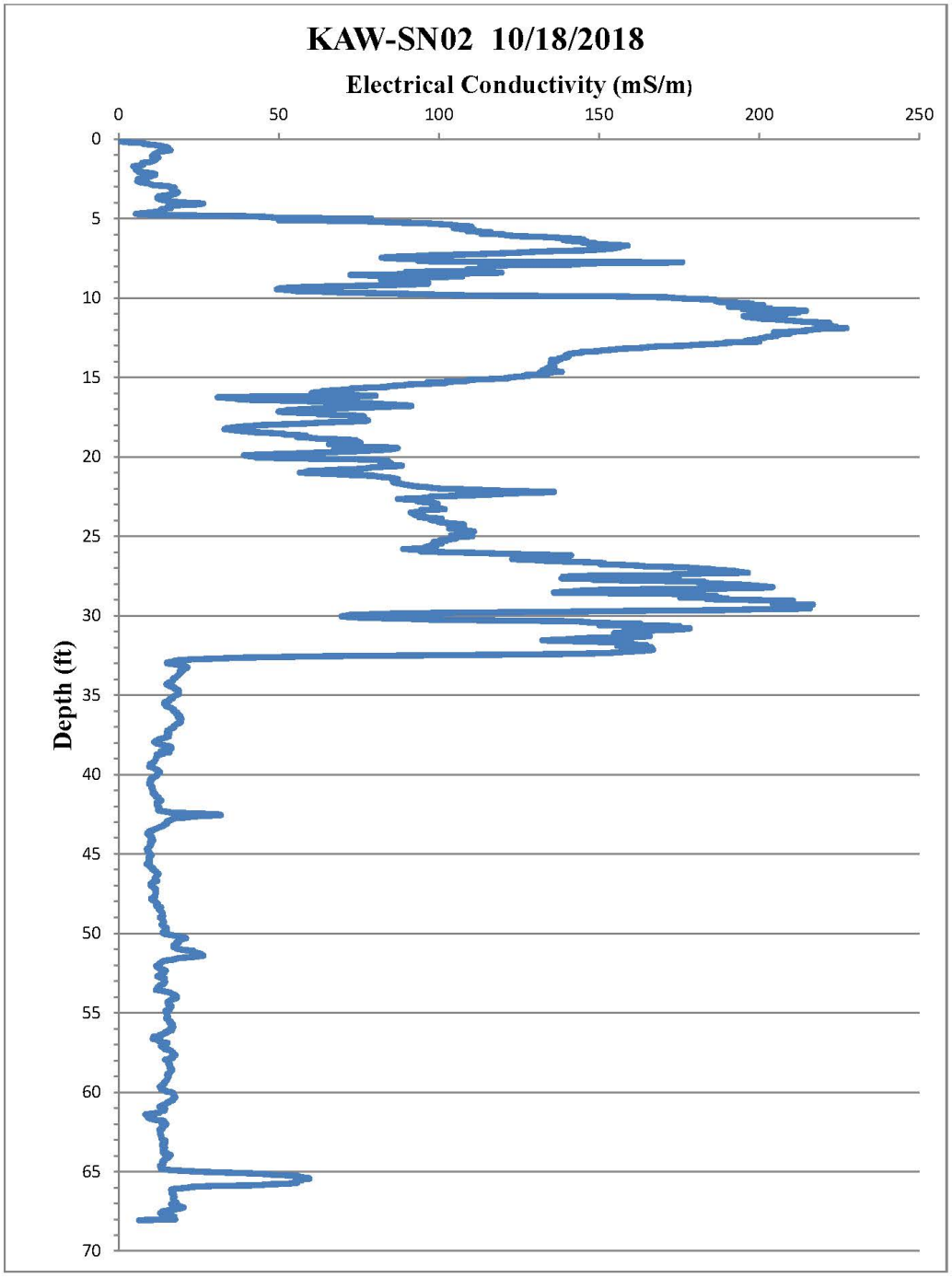
10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0.0	5.0	Soils			
5.0	15.5	Heavy Clay with Streaks of Slit			
15.5	26.0	Silty Clay			
26.0	32.5	Heavy Clay with Streaks of Slit			
32.5	65.0	Sand & Gravel			
65.0	66.0	Silty Sand Lens			
66.0	68.0	Sand			

Notes: See Attached Electrical Conductivity Log
Replaces Well 390519095445301

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) ..... and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ..... This Water Well Record was completed on (mo-day-year) 10/19/2018 under the business name of Kansas Geological Survey Signature .....

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

Shawnee County Index Well 2 – Electrical Conductivity Log



Jefferson County Index Well 1 – WWC-5 Form

WATER WELL RECORD Form WWC-5 — Division of Water Resources App. No. ____ — Well ID KAW-JF01

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Jefferson | Fraction: NW ¼ NW ¼ NW ¼ ¼ | Section Number: 27 | Township Number: T 11 S | Range Number: R 17 ■ E ☐ W

2 WELL OWNER: Last Name: First:
Business: Kansas Geological Survey
Address: University of Kansas
Address: 1930 Constant Ave
City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
50 feet East of the intersection of Decatur Rd and 17th St, South side of road

3 LOCATE WELL WITH "X" IN SECTION BOX: N / W / E / S; - - NW - - - - NE - - - - SW - - - - SE - - ; |---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 43 ft.
Depth(s) Groundwater Encountered: 1) ..... ft. 2) ..... ft. 3) ..... ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: 22 ft.
■ below land surface, measured on (mo-day-yr) 05-14-18
☐ above land surface, measured on (mo-day-yr) .....
Pump test data: Well water was ..... ft. after ..... hours pumping ..... gpm
Well water was ..... ft. after ..... hours pumping ..... gpm
Estimated Yield: ..... gpm
Bore Hole Diameter: 3.25 in. to 47 ft. and ..... in. to ..... ft.

5 Latitude: 39.071666 (decimal degrees)
Longitude: -95.518797 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: .....)
(WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 862 ft. ■ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other Google Earth Pro

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID .....
6. ☐ Dewatering: how many wells? .....
7. ☐ Aquifer Recharge: well ID .....
8. ■ Monitoring: well ID KAW-JF01
9. Environmental Remediation: well ID ..... ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease .....
11. Test Hole: well ID ..... ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ..... a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): .....

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: .....
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ..... CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 43 ft., Diameter ..... in. to ..... ft., Diameter ..... in. to ..... ft.
Casing height above land surface 36 in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40

TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) .....
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)

SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) .....
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)

SCREEN-PERFORATED INTERVALS: From 33 ft. to 43 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
GRAVEL PACK INTERVALS: From 23 ft. to 43 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other .....
Grout Intervals: From 0 ft. to 23 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

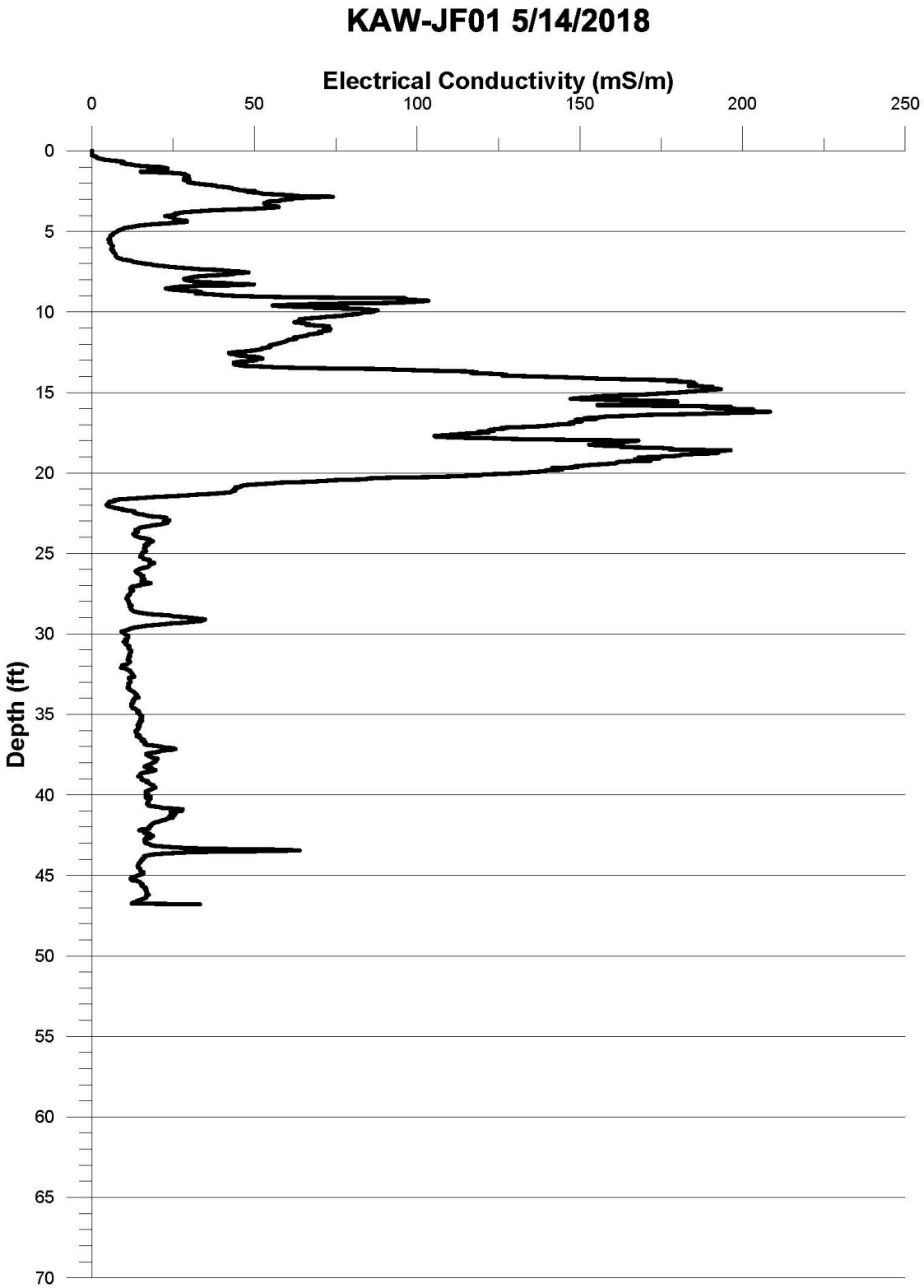
Nearest source of possible contamination:
☐ Septic Tank ☐ Lateral Lines ☐ Pit Privy ☐ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ☐ Fuel Storage ☐ Abandoned Water Well
☐ Watertight Sewer Lines ☐ Seepage Pit ☐ Feedyard ☐ Fertilizer Storage ☐ Oil Well/Gas Well
☐ Other (Specify) Creek
Direction from well? South Distance from well? 1600 ft.

10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0	4	Soils	46.65		Bedrock - Refusal
4	7	Sands			
7	13	Silts & Sands			
13	20.5	Clay			
20.5	28.5	Sands			
28.5	29.5	Silt Lens			
29.5	43	Sands			**Notes:** See Attached Electrical Conductivity Log
43	44	Silt Lens			
44	46.65	Sands			

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) 05-14-2018 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ..... This Water Well Record was completed on (mo-day-year) 05-22-2018 under the business name of Kansas Geological Survey Signature .....

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

Jefferson County Index Well 1 – Electrical Conductivity Log



Douglas County Index Well 1 – WWC-5 Form

WATER WELL RECORD Form WWC-5 — Division of Water Resources App. No. ____ — Well ID KAW-DG01

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Douglas | Fraction: SW ¼ NW ¼ SW ¼ SW ¼ | Section Number: 17 | Township Number: T 12 S | Range Number: R 20 ■ E ☐ W

2 WELL OWNER: Last Name: First:
Business: Kansas Geological Survey
Address: University of Kansas
Address: 1930 Constant Ave
City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
E 1500 Road, 675 feet North of intersection with US Highway 40
Lawrence, KS

3 LOCATE WELL WITH "X" IN SECTION BOX: N / W / E / S; - - NW - - - - NE - - - - SW - - - - SE - - ; |---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 66.5 ft.
Depth(s) Groundwater Encountered: 1) ..... ft. 2) ..... ft. 3) ..... ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: 19.3 ft.
■ below land surface, measured on (mo-day-yr) 08-15-17
☐ above land surface, measured on (mo-day-yr) .....
Pump test data: Well water was ..... ft. after ..... hours pumping ..... gpm
Well water was ..... ft. after ..... hours pumping ..... gpm
Estimated Yield: .....gpm
Bore Hole Diameter: 3.25 in. to 66.5 ft. and ..... in. to ..... ft.

5 Latitude: 39.002397 (decimal degrees)
Longitude: 95.223993 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: .....)
(WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 833 ft. ☐ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other Google Earth Pro

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID .....
6. ☐ Dewatering: how many wells? .....
7. ☐ Aquifer Recharge: well ID .....
8. ■ Monitoring: well ID KAW-DG01
9. Environmental Remediation: well ID ..... ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease .....
11. Test Hole: well ID ..... ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ..... a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): .....

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: .....
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ..... CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 66.5 ft., Diameter ..... in. to ..... ft., Diameter ..... in. to ..... ft.
Casing height above land surface 37.4 in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40
TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) .....
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)
SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) .....
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)
SCREEN-PERFORATED INTERVALS: From 46.5 ft. to 66.5 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
GRAVEL PACK INTERVALS: From 30 ft. to 66.5 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other .....
Grout Intervals: From 0 ft. to 30 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

Nearest source of possible contamination:
☐ Septic Tank ☐ Lateral Lines ☐ Pit Privy ☐ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ☐ Fuel Storage ☐ Abandoned Water Well
☐ Watertight Sewer Lines ☐ Seepage Pit ☐ Feedyard ☐ Fertilizer Storage ☐ Oil Well/Gas Well
☐ Other (Specify) .....
Direction from well? ..... Distance from well? ..... ft.

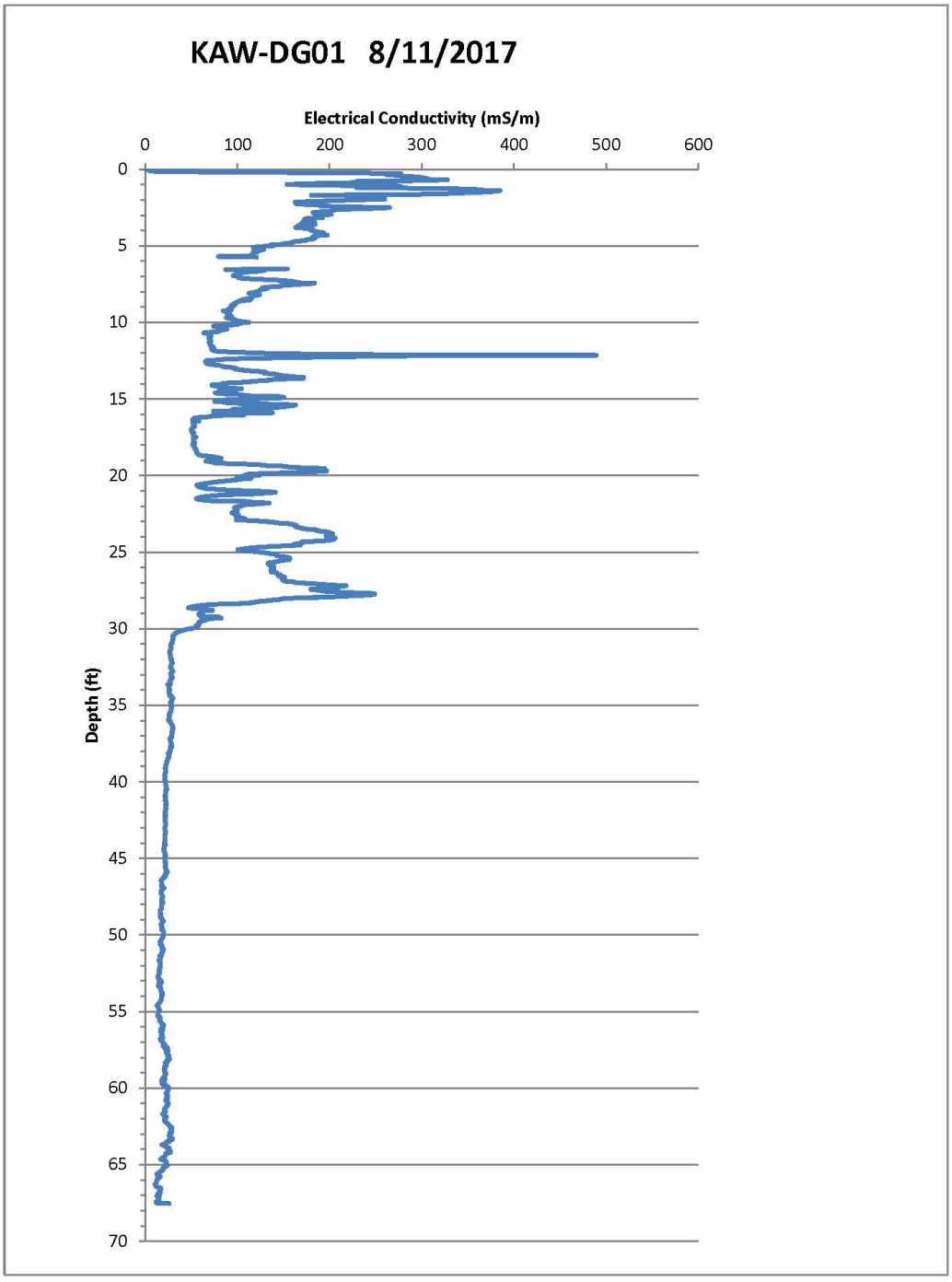
10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0	3	Soils			
3	16	Clays & Silts			
16	19	Silt			
19	30	Clays & Silts			
30	67.5	Sands			

Notes: See Attached Electrical Conductivity Log
Replaces USGS Well 390006095132301

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) 08/11/2017 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ..... This Water Well Record was completed on (mo-day-year) 08/22/2017 under the business name of Kansas Geological Survey Signature .....

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

Douglas County Index Well 1 – Electrical Conductivity Log



GEMS4-1 Index Well – WWC-5 Form

WATER WELL RECORD Form WWC-5 Division of Water Resources App. No. _____ Well ID GEMS_4-1

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Douglas | Fraction: SE ¼ SE ¼ SE ¼ SE ¼ | Section Number: 8 | Township Number: T 12 S | Range Number: R 20 ■ E ☐ W

2 WELL OWNER: Last Name: First: Business: Kansas Geological Survey Address: University of Kansas Address: 1930 Constant Ave City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
115 feet NW Center of Intersection of N1900 Rd and E1600 Rd. Lawrence, KS

3 LOCATE WELL WITH "X" IN SECTION BOX: N / W / E / S; NW, NE, SW, SE; |---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 70.80 ft.
Depth(s) Groundwater Encountered: 1) ..... ft. 2) ..... ft. 3) ..... ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: ..... ft.
■ below land surface, measured on (mo-day-yr)..... ☐ above land surface, measured on (mo-day-yr).....
Pump test data: Well water was ..... ft. after..... hours pumping ..... gpm
Well water was ..... ft. after..... hours pumping ..... gpm
Estimated Yield: .....gpm
Bore Hole Diameter: 7.25 in. to 70.8 ft. and ..... in. to ..... ft.

5 Latitude: 39.015533 (decimal degrees)
Longitude: 95.205856 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: .....) (WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 833 ft. ☐ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other Google Earth Pro

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID .....
6. ☐ Dewatering: how many wells? .....
7. ☐ Aquifer Recharge: well ID .....
8. ■ Monitoring: well ID GEMS 4-1
9. Environmental Remediation: well ID ..... ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease .....
11. Test Hole: well ID ..... ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ..... a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): .....

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: .....
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ..... CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 70.80 ft., Diameter ..... in. to ..... ft., Diameter ..... in. to ..... ft.
Casing height above land surface 19.8 in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40
TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) .....
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)
SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) .....
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)
SCREEN-PERFORATED INTERVALS: From 40.80 ft. to 70.80 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
GRAVEL PACK INTERVALS: From 30 ft. to 70.80 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other .....
Grout Intervals: From 0 ft. to 28 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
Nearest source of possible contamination:
☐ Septic Tank ☐ Lateral Lines ☐ Pit Privy ☐ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ☐ Fuel Storage ☐ Abandoned Water Well
☐ Watertight Sewer Lines ■ Seepage Pit ☐ Feedyard ☐ Fertilizer Storage ☐ Oil Well/Gas Well
☐ Other (Specify) .....
Direction from well? North Distance from well? 450 ft.

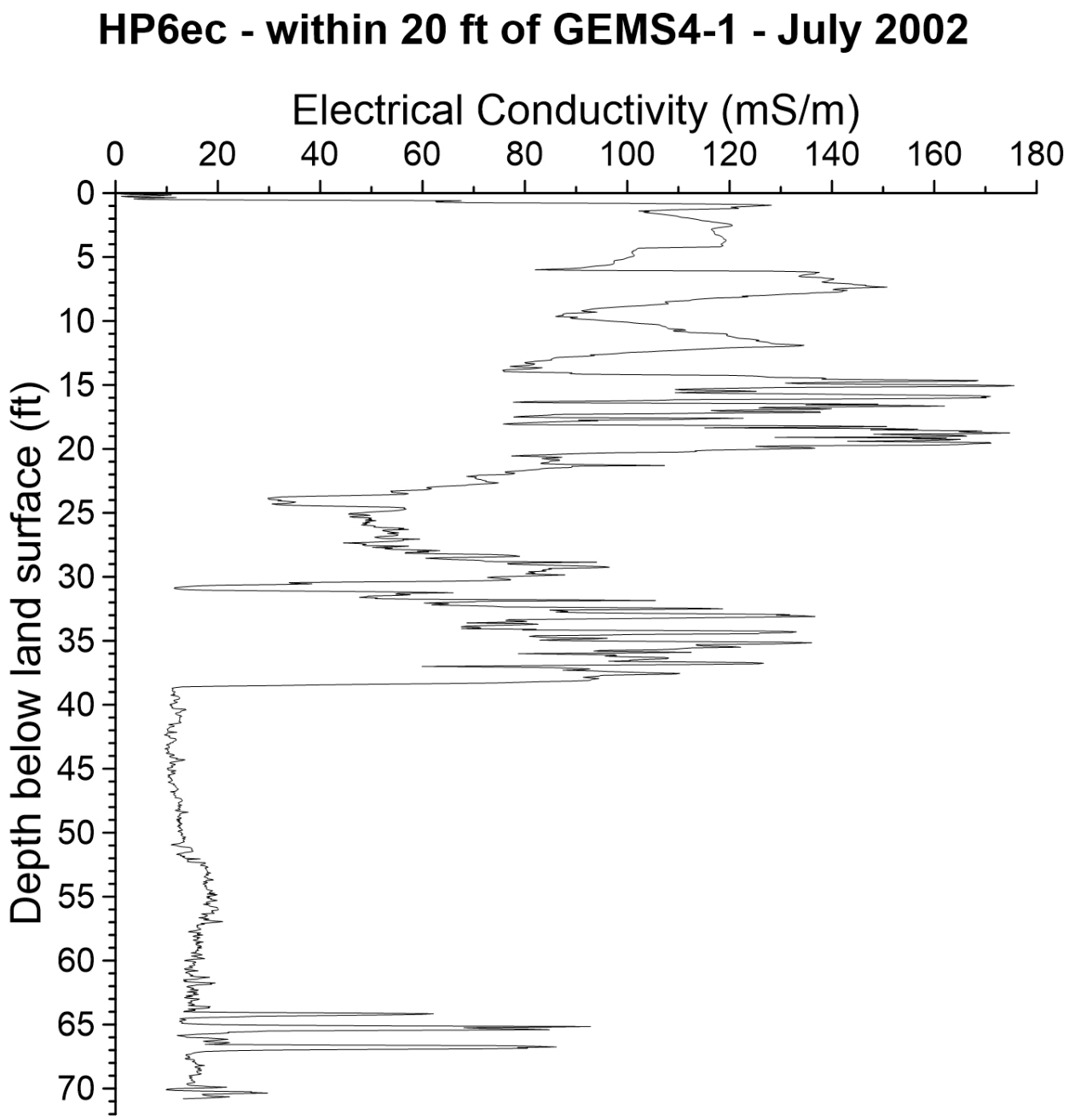
10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0	4	Soils			
4	21	Clays & Silts			
21	28	Silt			
28	38	Clays & Silts			
38	64	Sands			
64	67.5	Sand with Silty Clay Stringers			
67.5	70.8	Sands			
70.8		Limestone Bedrock			

Notes: See Attached Electrical Conductivity Log

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) 06/25/1990 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ..... This Water Well Record was completed on (mo-day-year) 09/14/2020 under the business name of Kansas Geological Survey Signature .....

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

GEMS4-1 Index Well – Electrical Conductivity Log



Douglas County Index Well 2 – WWC-5 Form

WATER WELL RECORD Form WWC-5 — Division of Water Resources App. No. ____ — Well ID KAW-DG02

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Douglas | Fraction: NE ¼ NE ¼ NW ¼ ¼ | Section Number: 11 | Township Number: T 13 S | Range Number: R 20 ■ E ☐ W

2 WELL OWNER: Last Name: First:
Business: Kansas Geological Survey
Address: University of Kansas
Address: 1930 Constant Ave
City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
100 feet south of intersection of N 1400 RD and E 1850 Rd

3 LOCATE WELL WITH "X" IN SECTION BOX: N / W / E / S; - - NW - - - - NE - - - - SW - - - - SE - - ; |---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 70 ft.
Depth(s) Groundwater Encountered: 1) ..... ft. 2) ..... ft. 3) ..... ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: ..... ft.
■ below land surface, measured on (mo-day-yr)..... ☐ above land surface, measured on (mo-day-yr).....
Pump test data: Well water was ..... ft. after..... hours pumping ..... gpm
Well water was ..... ft. after..... hours pumping ..... gpm
Estimated Yield: .....gpm
Bore Hole Diameter: 3.25 in. to 70 ft. and ..... in. to ..... ft.

5 Latitude: 38.942311 (decimal degrees)
Longitude: -95.158266 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: .....)
(WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 818 ft. ■ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other Google Earth Pro

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID .....
6. ☐ Dewatering: how many wells? .....
7. ☐ Aquifer Recharge: well ID .....
8. ■ Monitoring: well ID KAW-DG02
9. Environmental Remediation: well ID ..... ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease .....
11. Test Hole: well ID ..... ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ..... a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): .....

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: .....
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ..... CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 70 ft., Diameter ..... in. to ..... ft., Diameter ..... in. to ..... ft.
Casing height above land surface 36 in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40

TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) .....
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)

SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) .....
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)

SCREEN-PERFORATED INTERVALS: From 55 ft. to 70 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
GRAVEL PACK INTERVALS: From 34 ft. to 70 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other .....
Grout Intervals: From 0 ft. to 34 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

Nearest source of possible contamination:
■ Septic Tank ☐ Lateral Lines ☐ Pit Privy ☐ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ☐ Fuel Storage ☐ Abandoned Water Well
☐ Watertight Sewer Lines ☐ Seepage Pit ☐ Feedyard ☐ Fertilizer Storage ☐ Oil Well/Gas Well
☐ Other (Specify) .....
Direction from well? Northwest Distance from well? 300 ft.

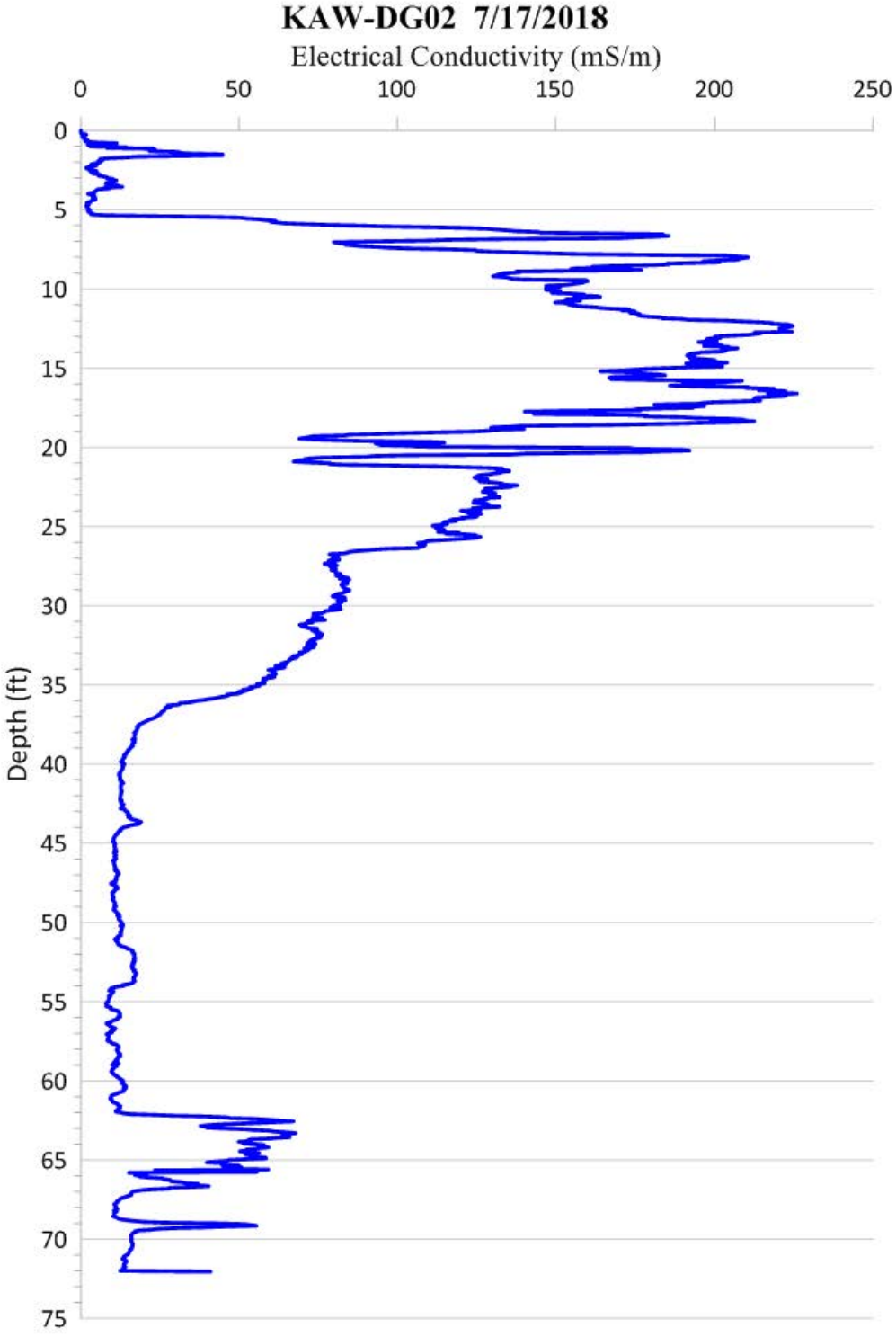
10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0.0	5.5	Soils			
5.5	21.0	Heavy Clay with Streaks of Slit			
21.0	27.0	Clay with Silt			
27.0	37.0	Silt with Sand, Fining Upwards			
37.0	62.0	Sand & Gravel			
62.0	72.0	Sand & Gravel with Silts			

Notes: See Attached Electrical Conductivity Log
Replaces Well 385624095093701

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) ..... and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ..... This Water Well Record was completed on (mo-day-year) ..... under the business name of Kansas Geological Survey ..... Signature .....

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

Douglas County Index Well 2 – Electrical Conductivity Log



Leavenworth County Index Well 1 – WWC-5 Form

WATER WELL RECORD Form WWC-5 — Division of Water Resources App. No. ____ — Well ID KAW-LV01

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Leavenworth | Fraction: NW ¼ NE ¼ NW ¼ NW ¼ | Section Number: 27 | Township Number: T 12 S | Range Number: R 22 ■ E ☐ W

2 WELL OWNER: Last Name: First:
Business: Kansas Geological Survey
Address: University of Kansas
Address: 1930 Constant Ave
City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
7909 Wyandotte St, De Soto, KS 66018

3 LOCATE WELL WITH "X" IN SECTION BOX: N / W / E / S; NW, NE, SW, SE; |---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 65 ft.
Depth(s) Groundwater Encountered: 1) ____ ft. 2) ____ ft. 3) ____ ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: 16.6 ft.
■ below land surface, measured on (mo-day-yr) 05-08-18
☐ above land surface, measured on (mo-day-yr) ____
Pump test data: Well water was ____ ft. after ____ hours pumping ____ gpm
Well water was ____ ft. after ____ hours pumping ____ gpm
Estimated Yield: ____ gpm
Bore Hole Diameter: 3.25 in. to 65 ft. and ____ in. to ____ ft.

5 Latitude: 38.985578 (decimal degrees)
Longitude: -94.961118 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: ____) (WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 788 ft. ☐ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other Google Earth Pro

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID ____
6. ☐ Dewatering: how many wells? ____
7. ☐ Aquifer Recharge: well ID ____
8. ■ Monitoring: well ID KAW-LV01
9. Environmental Remediation: well ID ____ ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease ____
11. Test Hole: well ID ____ ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ____ a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): ____

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: ____
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ____ CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 65 ft., Diameter ____ in. to ____ ft., Diameter ____ in. to ____ ft.
Casing height above land surface 36 in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40

TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) ____
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)

SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) ____
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)

SCREEN-PERFORATED INTERVALS: From 45 ft. to 65 ft., From ____ ft. to ____ ft., From ____ ft. to ____ ft.
GRAVEL PACK INTERVALS: From 25 ft. to 65 ft., From ____ ft. to ____ ft., From ____ ft. to ____ ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other ____
Grout Intervals: From 0 ft. to 25 ft., From ____ ft. to ____ ft., From ____ ft. to ____ ft.

Nearest source of possible contamination:
☐ Septic Tank ☐ Lateral Lines ☐ Pit Privy ☐ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ■ Fuel Storage ☐ Abandoned Water Well
☐ Watertight Sewer Lines ☐ Seepage Pit ☐ Feedyard ☐ Fertilizer Storage ☐ Oil Well/Gas Well
☐ Other (Specify) ____
Direction from well? SE Distance from well? 100 ft.

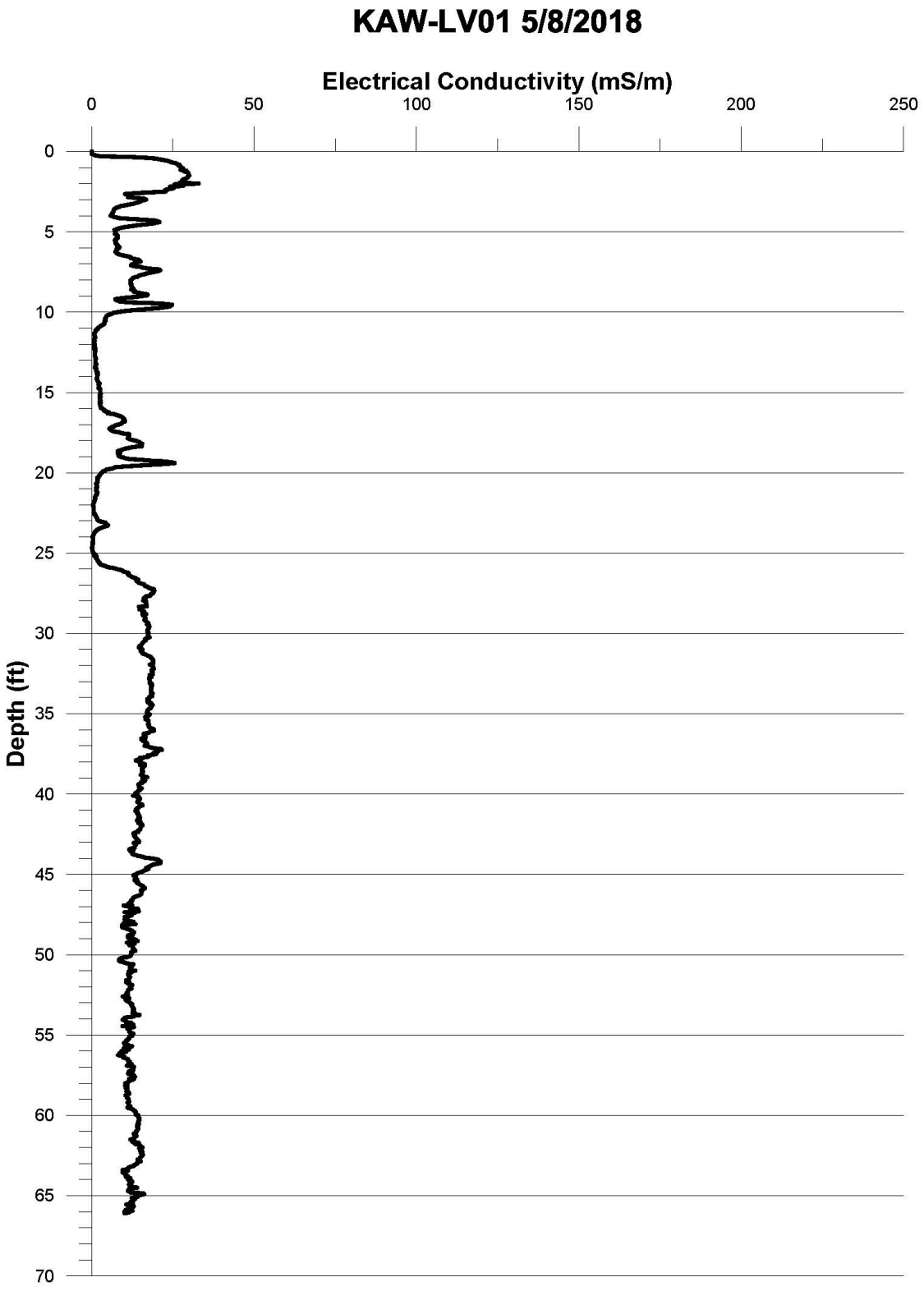
10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0	2.5	Soil			
2.5	10	Silty Sand			
10	16	Sand			
16	20	Silty Sand			
20	26	Sand			
26	66.1	Sands			

Notes: See Attached Electrical Conductivity Log

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) 05-08-2018 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ____ This Water Well Record was completed on (mo-day-year) 05-21-2018 under the business name of Kansas Geological Survey Signature ____

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

Leavenworth County Index Well 1 – Electrical Conductivity Log



Wyandotte County Index Well 1 – WWC-5 Form

WATER WELL RECORD Form WWC-5 — Division of Water Resources App. No. — Well ID: KAW-WY01

■ Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Wyandotte | Fraction: SW ¼ SE ¼ SE ¼ ¼ | Section Number: 29 | Township Number: T 11 S | Range Number: R 24 ■ E ☐ W

2 WELL OWNER: Last Name: First:
Business: Kansas Geological Survey
Address: University of Kansas
Address: 1930 Constant Ave
City: Lawrence State: KS ZIP: 66047

Street or Rural Address where well is located (if unknown, distance and direction from nearest town or intersection): If at owner's address, check here: ☐
1300 feet SE on gravel drive off S 78 St, 1900 feet SE of Douglas Ave and S 78 St

3 LOCATE WELL WITH "X" IN SECTION BOX:
N / W / E / S; - - NW - - - - NE - - - - SW - - - - SE - -
|---------1 mile---------|

4 DEPTH OF COMPLETED WELL: 65 ft.
Depth(s) Groundwater Encountered: 1) ..... ft. 2) ..... ft. 3) ..... ft., or 4) ☐ Dry Well
WELL'S STATIC WATER LEVEL: 45.2 ft.
■ below land surface, measured on (mo-day-yr) 05-09-18
☐ above land surface, measured on (mo-day-yr).....
Pump test data: Well water was ..... ft. after ..... hours pumping ..... gpm
Well water was ..... ft. after ..... hours pumping ..... gpm
Estimated Yield: .....gpm
Bore Hole Diameter: 3.25 in. to 65 ft. and ..... in. to ..... ft.

5 Latitude: 39.058812 (decimal degrees)
Longitude: -94.764252 (decimal degrees)
Horizontal Datum: ■ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude:
☐ GPS (unit make/model: .....)
(WAAS enabled? ☐ Yes ☐ No)
☐ Land Survey ☐ Topographic Map
■ Online Mapper: Google Earth Pro

6 Elevation: 769 ft. ■ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ■ Other Google Earth Pro

7 WELL WATER TO BE USED AS:
1. Domestic: ☐ Household ☐ Lawn & Garden ☐ Livestock
2. ☐ Irrigation
3. ☐ Feedlot
4. ☐ Industrial
5. ☐ Public Water Supply: well ID .....
6. ☐ Dewatering: how many wells? .....
7. ☐ Aquifer Recharge: well ID .....
8. ■ Monitoring: well ID KAW-WY01
9. Environmental Remediation: well ID ..... ☐ Air Sparge ☐ Soil Vapor Extraction ☐ Recovery ☐ Injection
10. ☐ Oil Field Water Supply: lease .....
11. Test Hole: well ID ..... ☐ Cased ☐ Uncased ☐ Geotechnical
12. Geothermal: how many bores? ..... a) Closed Loop ☐ Horizontal ☐ Vertical b) Open Loop ☐ Surface Discharge ☐ Inj. of Water
13. ☐ Other (specify): .....

Was a chemical/bacteriological sample submitted to KDHE? ☐ Yes ■ No If yes, date sample was submitted: .....
Water well disinfected? ☐ Yes ■ No

8 TYPE OF CASING USED: ☐ Steel ■ PVC ☐ Other ..... CASING JOINTS: ☐ Glued ☐ Clamped ☐ Welded ■ Threaded
Casing diameter 2 in. to 65 ft., Diameter ..... in. to ..... ft., Diameter ..... in. to ..... ft.
Casing height above land surface 36 in. Weight 0.698 lbs./ft. Wall thickness or gauge No. Sch 40

TYPE OF SCREEN OR PERFORATION MATERIAL:
☐ Steel ☐ Stainless Steel ☐ Fiberglass ■ PVC ☐ Other (Specify) .....
☐ Brass ☐ Galvanized Steel ☐ Concrete tile ☐ None used (open hole)

SCREEN OR PERFORATION OPENINGS ARE:
☐ Continuous Slot ■ Mill Slot ☐ Gauze Wrapped ☐ Torch Cut ☐ Drilled Holes ☐ Other (Specify) .....
☐ Louvered Shutter ☐ Key Punched ☐ Wire Wrapped ☐ Saw Cut ☐ None (Open Hole)

SCREEN-PERFORATED INTERVALS: From 50 ft. to 65 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.
GRAVEL PACK INTERVALS: From 41 ft. to 65 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

9 GROUT MATERIAL: ☐ Neat cement ☐ Cement grout ■ Bentonite ☐ Other .....
Grout Intervals: From 0 ft. to 41 ft., From ..... ft. to ..... ft., From ..... ft. to ..... ft.

Nearest source of possible contamination:
☐ Septic Tank ☐ Lateral Lines ☐ Pit Privy ☐ Livestock Pens ☐ Insecticide Storage
☐ Sewer Lines ☐ Cess Pool ☐ Sewage Lagoon ☐ Fuel Storage ☐ Abandoned Water Well
☐ Watertight Sewer Lines ☐ Seepage Pit ☐ Feedyard ☐ Fertilizer Storage ☐ Oil Well/Gas Well
■ Other (Specify) Kansas River
Direction from well? NE Distance from well? 500 ft.

10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0	4.5	Soils			
4.5	12	Sands			
12	16	Silt & Clay			
16	29.5	Sand			
29.5	33	Clay with Sand Streaks			
33	37.5	Sand			
37.5	38.5	Silty Lens			
38.5	67.9	Sand			

Notes: See Attached Electrical Conductivity Log

11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ■ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) 05-09-2018 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. ..... This Water Well Record was completed on (mo-day-year) 05-21-2018 under the business name of Kansas Geological Survey Signature .....

Mail 1 white copy along with a fee of $5.00 for each constructed well to: Kansas Department of Health and Environment, Bureau of Water, GWTS Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Mail one to Water Well Owner and retain one for your records. Telephone 785-296-5524.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212 **Revised 7/10/2015**

Wyandotte County Index Well 1 – Electrical Conductivity Log