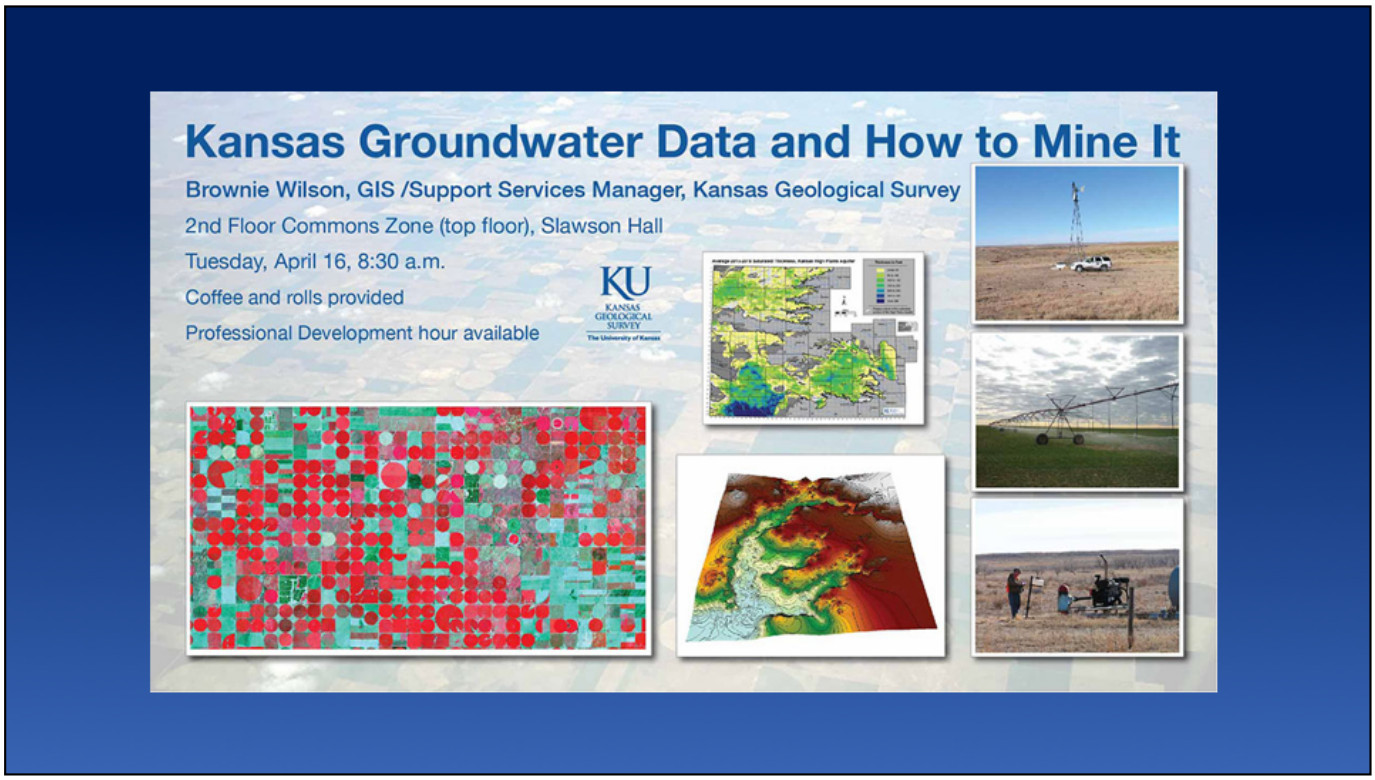


Kansas Groundwater Data and How to Mine It

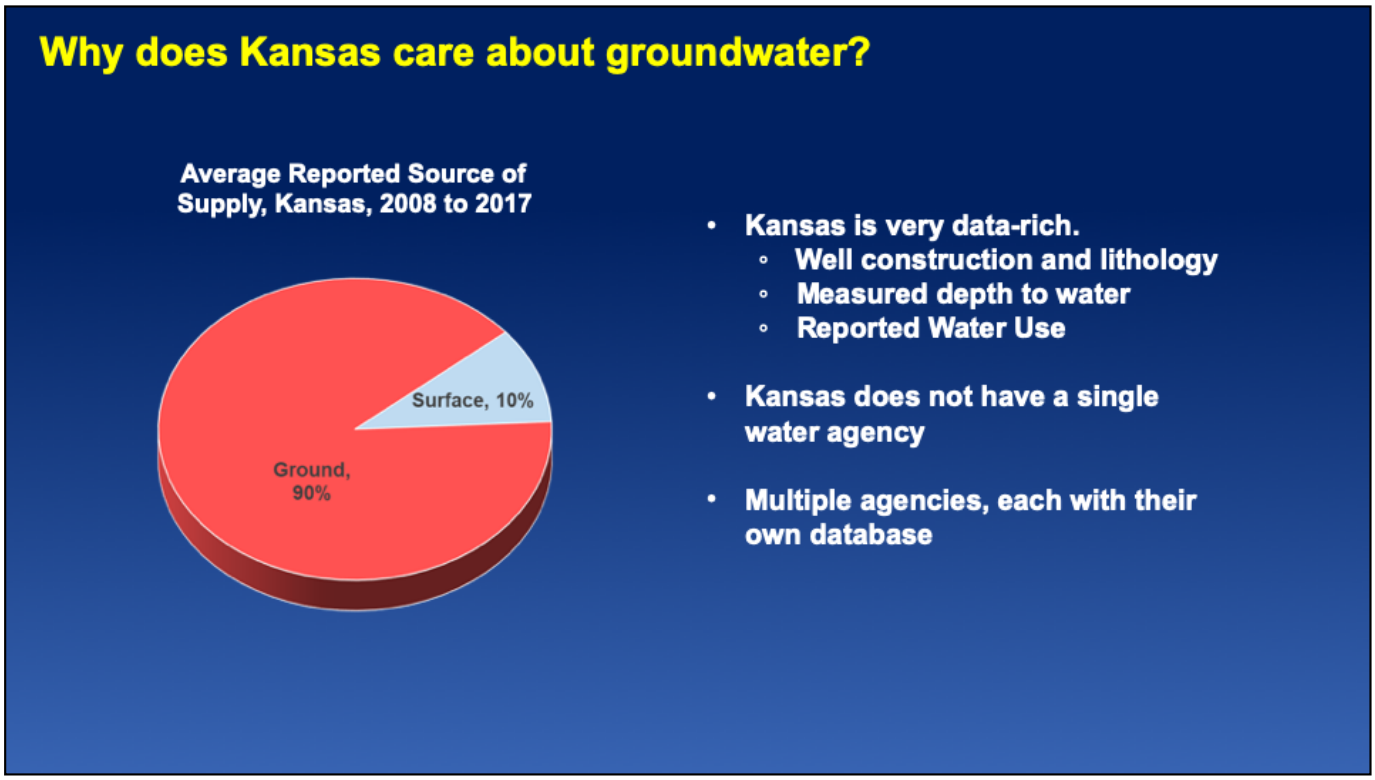
Slides and speaker notes for the Kansas Geological Survey's (KGS) Tuesday Rocks and Rolls Lecture Series

by Brownie Wilson of the Geohydrology Section, KGS.

Kansas Geological Survey

Open-File Report 2019-4

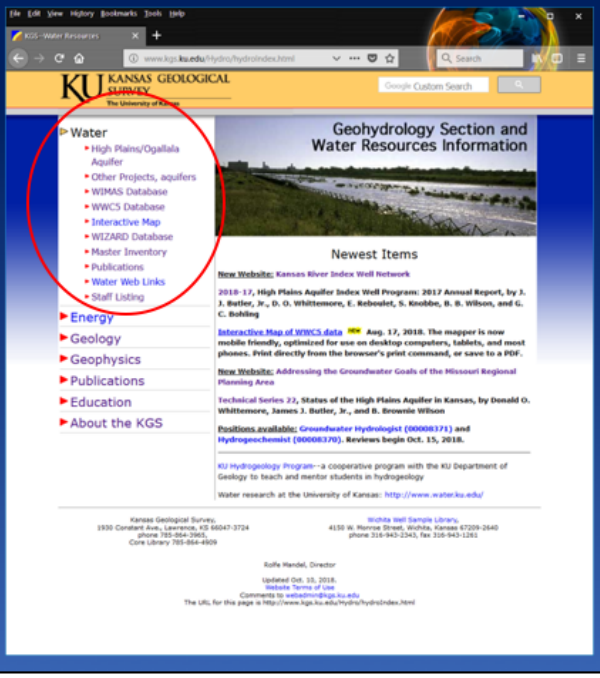
May 2019



Over the last 10 years, 90% of the water used in Kansas each year originated from a groundwater source. Given the importance of groundwater as a resource to the state, Kansas has several freshwater databases containing data on well construction and lithology, measured depths to water, and reported water use.

Kansas is unique in relation to other states in that it does not have a single water agency that is typically found in a Department of Natural Resources. Rather, water regulation has been assigned across multiple agencies, each with its own unique goals and responsibilities and, in some cases, its own groundwater databases.

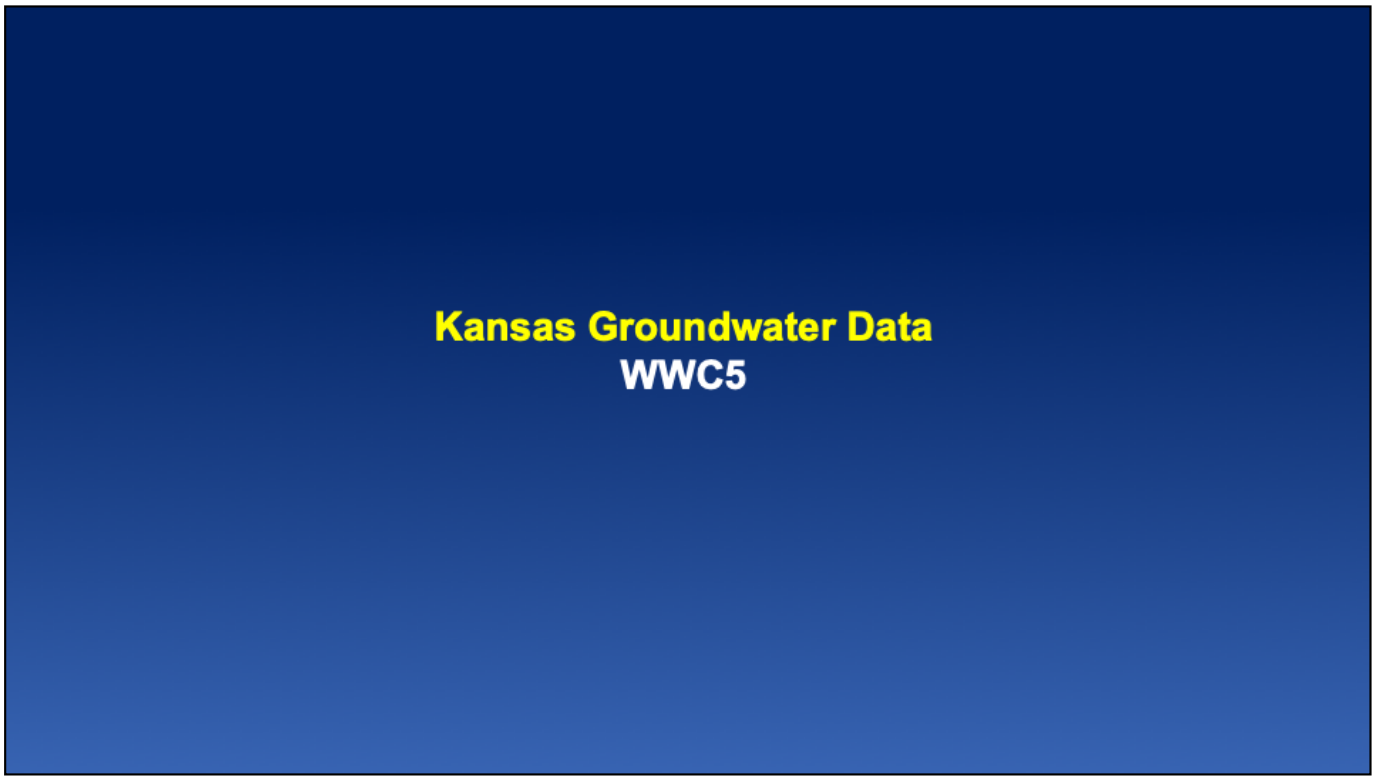
KGS Website- www.kgs.ku.edu



KGS Mission:

- **Conduct geological studies and research in Kansas**
- **Collect, correlate, preserve, and disseminate information leading to a better understanding of the geology of Kansas**
- **Special emphasis on natural resources of economic value, water quality and quantity, and geologic hazards**

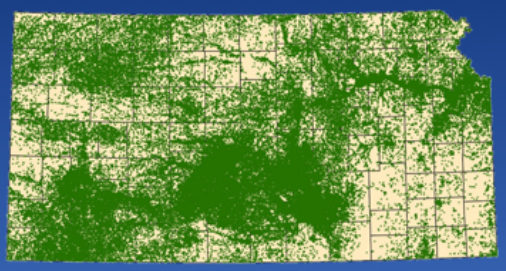
The KGS, as part of its core mission, hosts three of the state's primary freshwater groundwater databases. This presentation will address each of these data sets, all of which can be found under the "Water Section" of the KGS's website at www.kgs.ku.edu, and will show examples of how the data are being applied.



WWC5

WWC5- Well Construction and Lithology

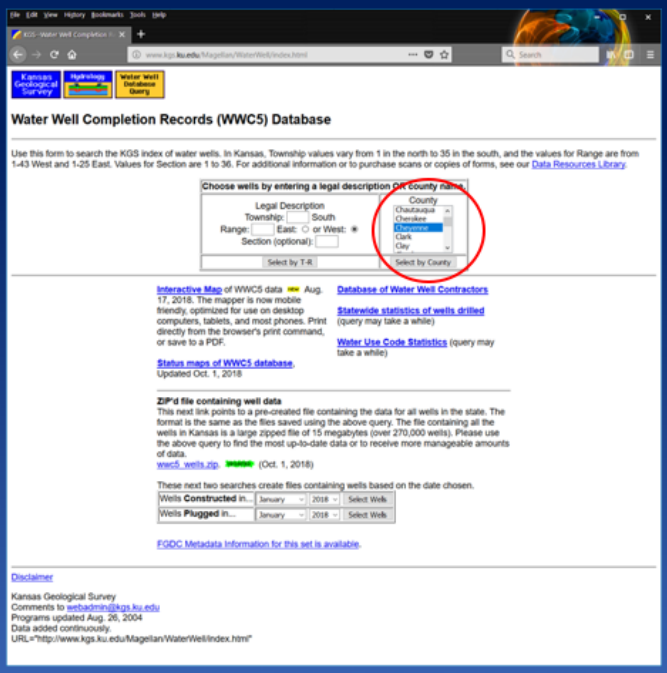
- Water Well Completion Records
- Kansas Department of Health and Environment
- KGS directed, by statute, to serve and maintain the data
- WWC5 forms are required for any constructed, reconstructed, or plugged well in Kansas since 1975
- Over 276,000 records



The Water Well Completion Records database—or as it is often referred to, WWC5—is a collection of water well construction and lithology records. The Water Well Program of the Kansas Department of Health and Environment oversees groundwater well development and provides data about potential water supplies in Kansas. Through this program, well drillers have been required to submit a WWC5 form each time a groundwater well is drilled, reconstructed, or plugged in Kansas since 1975.

The KGS is directed under state statute 2-1212 to keep these records on file and available to the public. There are more than 276,000 records on file.

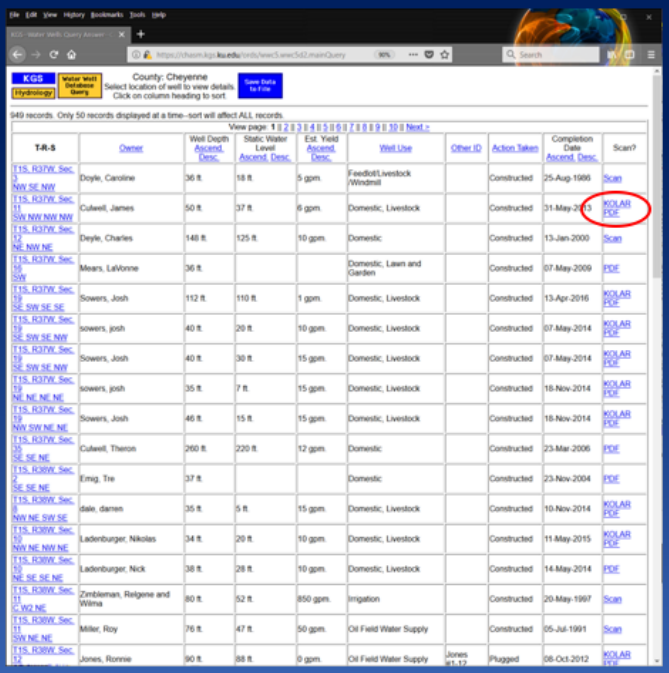
WWC5- Well Construction and Lithology



The WWC5 database can be accessed at this URL: http://www.kgs.ku.edu/Magellan/WaterWell/index.html. Records can be selected by a Public Land Survey System (PLSS) description or a county name. Records also can be accessed through the WWC5 map viewer (to be discussed later in the presentation) or downloaded in their entirety via a compressed zip file.

For this presentation, Cheyenne County is selected for an example query.

WWC5- Well Construction and Lithology



KGS Hydrology | Water Well Database Query

County: Cheyenne
Select location of well to view details.
Click on column heading to sort.

949 records. Only 50 records displayed at a time--sort will affect ALL records.

View page: 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9 10 10 Next >

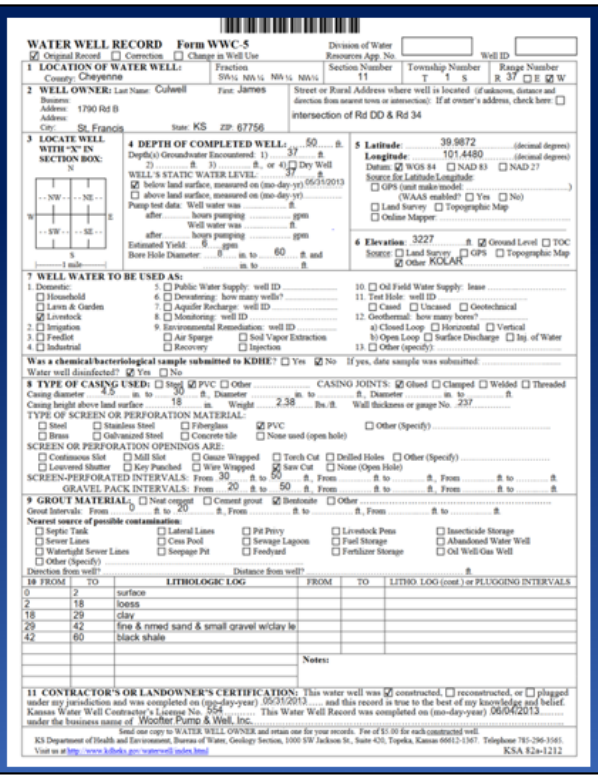
T-R-S	Owner	Well Depth Ascend. Desc.	Static Water Level Ascend. Desc.	Est. Yield Ascend. Desc.	Well Use	Other ID	Action Taken	Completion Date Ascend. Desc.	Scan?
T1S, R37W, Sec. 3 NW SE NW	Doyle, Caroline	36 ft.	18 ft.	5 gpm.	Feedlot/Livestock /Windmill		Constructed	25-Aug-1986	Scan
T1S, R37W, Sec. 11 SW NW NW NW	Culwell, James	50 ft.	37 ft.	6 gpm.	Domestic, Livestock		Constructed	31-May-2013	KOLAR PDF
T1S, R37W, Sec. 12 NE NW NE	Doyle, Charles	148 ft.	125 ft.	10 gpm.	Domestic		Constructed	13-Jan-2000	Scan
T1S, R37W, Sec. 16 SW	Mears, LaVonne	36 ft.			Domestic, Lawn and Garden		Constructed	07-May-2009	PDF
T1S, R37W, Sec. 19 SE SW SE SE	Sowers, Josh	112 ft.	110 ft.	1 gpm.	Domestic, Livestock		Constructed	13-Apr-2016	KOLAR PDF
T1S, R37W, Sec. 19 SE SW SE NW	sowers, josh	40 ft.	20 ft.	10 gpm.	Domestic, Livestock		Constructed	07-May-2014	KOLAR PDF
T1S, R37W, Sec. 19 SE SW SE NW	Sowers, Josh	40 ft.	30 ft.	15 gpm.	Domestic, Livestock		Constructed	07-May-2014	KOLAR PDF
T1S, R37W, Sec. 19 NE NE NE NE	sowers, josh	35 ft.	7 ft.	15 gpm.	Domestic, Livestock		Constructed	18-Nov-2014	KOLAR PDF
T1S, R37W, Sec. 19 NW SW NE NE	Sowers, Josh	46 ft.	15 ft.	15 gpm.	Domestic, Livestock		Constructed	18-Nov-2014	KOLAR PDF
T1S, R37W, Sec. 35 SE SE NE	Culwell, Theron	260 ft.	220 ft.	12 gpm.	Domestic		Constructed	23-Mar-2006	PDF
T1S, R38W, Sec. 2 SE SE NE	Emig, Tre	37 ft.			Domestic		Constructed	23-Nov-2004	PDF
T1S, R38W, Sec. 3 NW NE SW SE	dale, darren	35 ft.	5 ft.	15 gpm.	Domestic, Livestock		Constructed	10-Nov-2014	KOLAR PDF
T1S, R38W, Sec. 10 NW NE NW NE	Ladenburger, Nikolas	34 ft.	20 ft.	10 gpm.	Domestic, Livestock		Constructed	11-May-2015	KOLAR PDF
T1S, R38W, Sec. 10 NE SE SE NE	Ladenburger, Nick	38 ft.	28 ft.	10 gpm.	Domestic, Livestock		Constructed	14-May-2014	PDF
T1S, R38W, Sec. 11 C W2 NE	Zimbleman, Relgene and Wilma	80 ft.	52 ft.	850 gpm.	Irrigation		Constructed	20-May-1997	Scan
T1S, R38W, Sec. 11 SW NE NE	Miller, Roy	76 ft.	47 ft.	50 gpm.	Oil Field Water Supply		Constructed	05-Jul-1991	Scan
T1S, R38W, Sec. 12	Jones, Ronnie	90 ft.	88 ft.	0 gpm.	Oil Field Water Supply	Jones #1-12	Plugged	08-Oct-2012	KOLAR

Once a query is submitted, the WWC5 website returns all matching records as a sortable table. Records, shown in groups of 50 wells at a time, can be sorted by the PLSS description, owner name, well depth, static water level (at the time the well was constructed), estimated yield, intended use of water, other identification numbers, well action (constructed, reconstructed, or plugged), date of the well action, and availability of scanned WWC5 forms.

In this example, the scanned form for the WWC5 record in the SWNWNWNW of 11-01S-37W is selected.

Submitted Driller's Log

- Forms vary in layout over the years
- Location and Owner Information
- Well depth, static water level, and expected flow rate
- Casing and screening information
- Lithology



WATER WELL RECORD Form WWC-5

Original Record ☐ Correction ☐ Change in Well Use

1 LOCATION OF WATER WELL: County: Cheyenne | Fraction | Section Number 11 | Township Number T 1 S | Range Number R 37 E W

2 WELL OWNER: Last Name: Culwell First: James
Address: 1790 Rd B
City: St. Francis State: KS ZIP: 67756
Street or Rural Address where well is located: intersection of Rd DD & Rd 34

3 LOCATE WELL WITH "X" IN SECTION BOX:

4 DEPTH OF COMPLETED WELL: 50 ft.
Depth(s) Groundwater Encountered: 1) 37 ft.
WELL'S STATIC WATER LEVEL: 37 ft. 05/31/2013
Pump test data: Well water was ft. after hours pumping gpm
Estimated Yield: 6 gpm
Bore Hole Diameter: 0 in. to 60 ft. and in. to ft.

5 Latitude: 39.9872 (decimal degrees)
Longitude: 101.4480 (decimal degrees)
Datum: ☑ WGS 84 ☐ NAD 83 ☐ NAD 27
Source for Latitude/Longitude: ☐ GPS ☐ Land Survey ☐ Topographic Map ☐ Online Mapper

6 Elevation: 3227 ft. ☑ Ground Level ☐ TOC
Source: ☐ Land Survey ☐ GPS ☐ Topographic Map ☑ Other KOLAR

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
9. Environmental Remediation: well ID ☐ Air Sparge ☐ Recovery ☐ Soil Vapor Extraction ☐ 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 4.5 in. to 30 ft., Diameter in. to ft., Diameter in. to ft.
Casing height above land surface 18 in., Weight 2.38 lbs./ft. Wall thickness or gauge No. .237

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 30 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? Distance from well? ft.

10 FROM	TO	LITHOLOGIC LOG	FROM	TO	LITHO. LOG (cont.) or PLUGGING INTERVALS
0	2	surface			
2	18	loess			
18	29	clay			
29	42	fine & mmed sand & small gravel w/clay le			
42	60	black shale			

Notes:

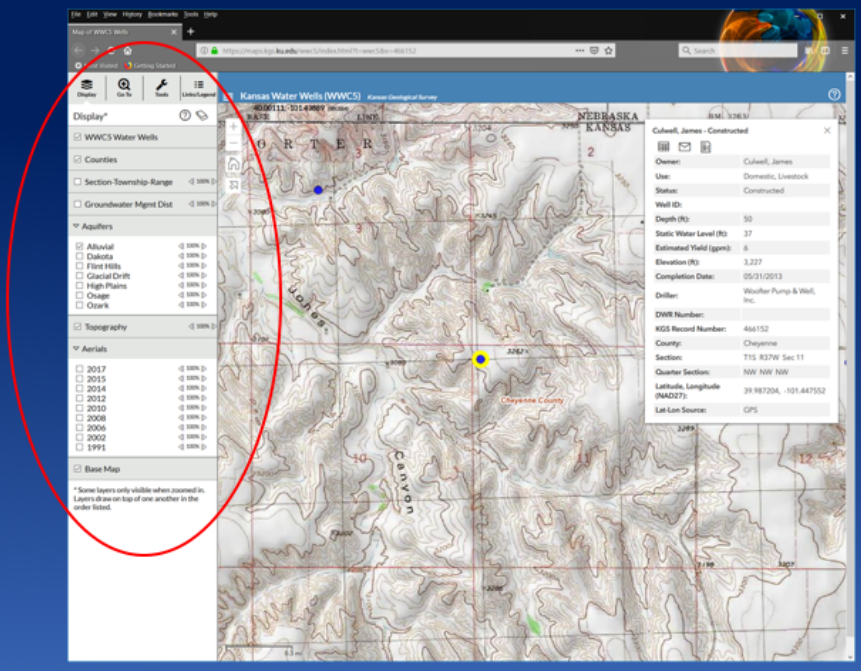
11 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was ☑ constructed, ☐ reconstructed, or ☐ plugged under my jurisdiction and was completed on (mo-day-year) 05/31/2013 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. 554 This Water Well Record was completed on (mo-day-year) 06/04/2013 under the business name of Woofter Pump & Well, Inc.

Send one copy to WATER WELL OWNER and retain one for your records. Fee of $5.00 for each constructed well.
KS Department of Health and Environment, Bureau of Water, Geology Section, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367. Telephone 785-296-3565.
Visit us at http://www.kdheks.gov/waterwell/index.html KSA 82a-1212

Example of the selected driller's log. The traditional use of the WWC5 website has been to access these scanned images. The WWC5 forms vary over the years in terms of layout, but they all contain key data elements:

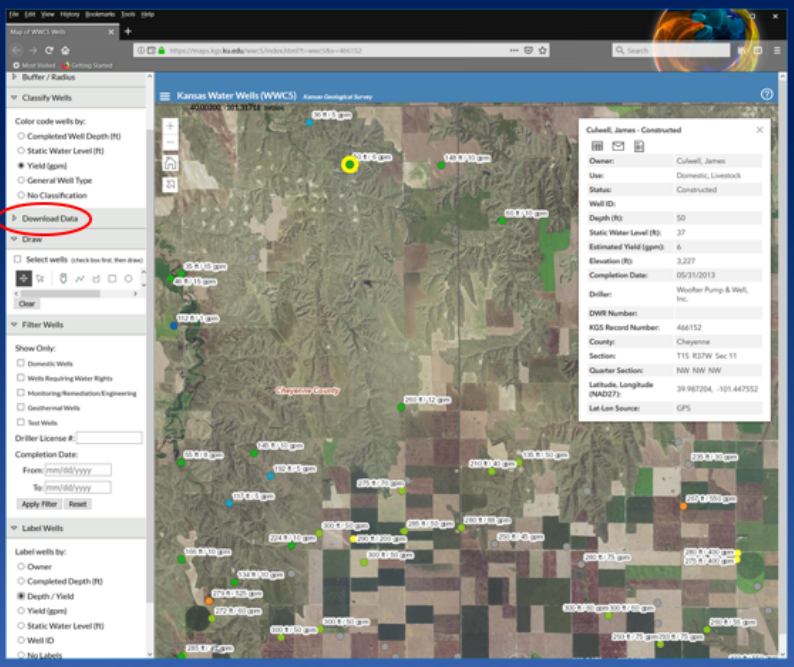
- Location and owner Information.
- Well depth, measured static water level, and expected flow rate.
- Well casing, borehole diameter, casing, screening, and gravel pack information.
- Lithologic descriptions of the subsurface material the well penetrates.

WWC5- Mapping Page



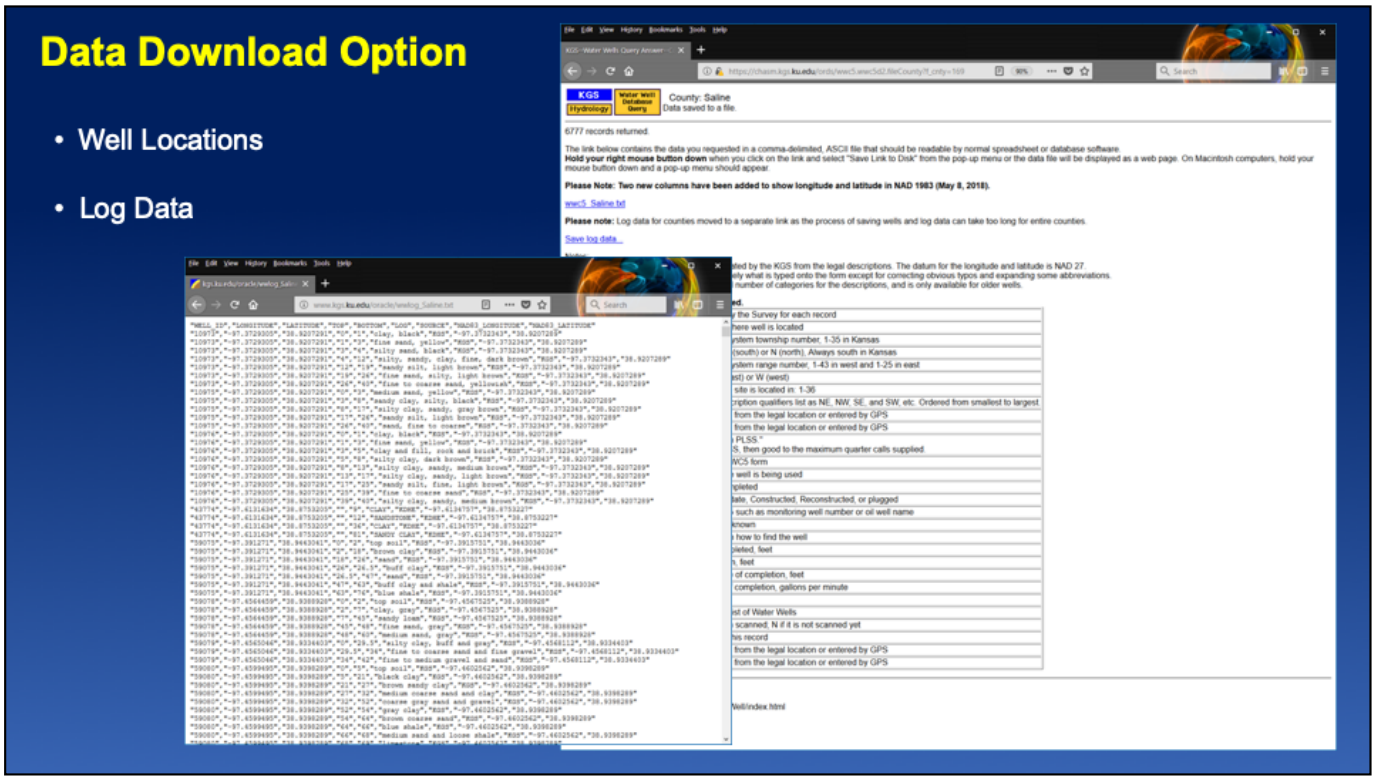
The mapping portion of the WWC5 website has recently been updated. The mapper can be accessed from an individual well listing or the initial WWC5 web page. WWC5 records can be plotted and overlain with other spatial datasets—specifically Kansas counties, PLSS sections, groundwater management district boundaries, major and minor aquifer system extents, topographic maps, and several years of aerial photos.

WWC5- Mapping Page



The WWC5 mapping page allows WWC5 records to be displayed and labeled in a variety of fashions. In this example, the WWC5 points are color-coded based on estimated flow rates—cooler colors (blues and greens) indicate lower flow rates relative to warmer colors (oranges and yellows), which represent higher rates. Each well is labeled by its well depth and estimated flow rate. The WWC5 mapping page allows users to quickly and easily explore existing groundwater well development across an area or region of the state.

The WWC5 site has options to download WWC5 data.



WWC5 data can be downloaded into comma-delimited, ASCII files that are readable by spreadsheets and database software.

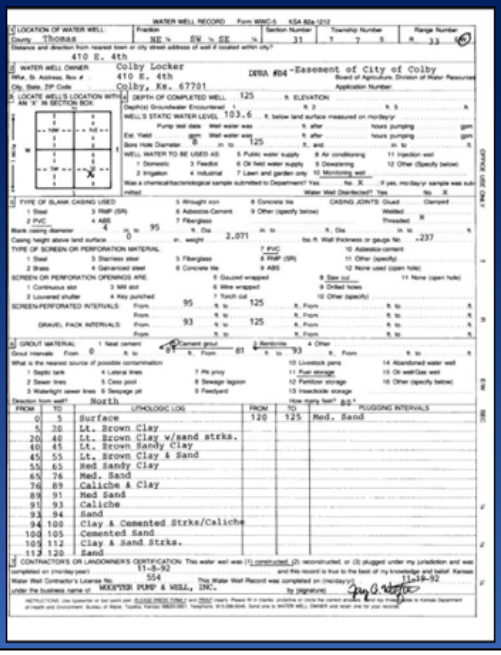
One file represents groundwater wells with geographic coordinates along with site-specific information, such as well depth, completion date, and owner.

The second file provides a link that generates the lithologic log data file, which describes the subsurface material the well is passing through along with the depth intervals of each category.

The two files can be related or joined via the WELL_ID field.

Not all forms/logs are created equal

Excellent



WATER WELL RECORD Form WWC-5 KSA 82a-1212

1 LOCATION OF WATER WELL: County: Thomas; Fraction: NE ¼ SW ¼ SE ¼; Section Number: 31; Township Number: T 7 S; Range Number: R 33 W

410 E. 4th

2 WATER WELL OWNER: Colby Locker; RR#, St. Address, Box #: 410 E. 4th; City, State, ZIP Code: Colby, Ks. 67701

DWR #84 - Easement of City of Colby

3 LOCATE WELL'S LOCATION WITH AN "X" IN SECTION BOX

4 DEPTH OF COMPLETED WELL: 125 ft. ELEVATION:

Depth(s) Groundwater Encountered 1: 103.6 ft. 2: ft. 3: ft.

5 WELL STATIC WATER LEVEL: 103.6 ft. below land surface measured on mo/day/yr

Pump test data: Well water was ft. after hours pumping gpm

Est. Yield gpm: Well water was ft. after hours pumping gpm

Bore Hole Diameter: 8 in. to 125 ft., and in. to ft.

WELL WATER TO BE USED AS: 1 Domestic 3 Feedlot 5 Public water supply 8 Air conditioning 11 Injection well; 2 Irrigation 4 Industrial 7 Lawn and garden only 9 Dewatering 10 Monitoring well 12 Other (Specify below)

Was a chemical/bacteriological sample submitted to Department? Yes No X; If yes, mo/day/yr sample was submitted

Water Well Disinfected? Yes No X

6 TYPE OF BLANK CASING USED: 1 Steel 3 RMP (SR) 5 Wrought iron 8 Concrete tile; 2 PVC 4 ABS 6 Asbestos-Cement 9 Other (specify below); 7 Fiberglass

CASING JOINTS: Glued Clamped; Welded; Threaded X

Blank casing diameter 4 in. to 95 ft. Dia. in. to ft. Dia. in. to ft.

Casing height above land surface 0 in., weight 2.071 lbs./ft. Wall thickness or gauge No. .237

TYPE OF SCREEN OR PERFORATION MATERIAL: 1 Steel 3 Stainless steel 5 Fiberglass 8 RMP (SR) 10 Asbestos-cement; 2 Brass 4 Galvanized steel 6 Concrete tile 9 ABS 7 PVC 11 Other (specify); 12 None used (open hole)

SCREEN OR PERFORATION OPENINGS ARE: 1 Continuous slot 3 Mill slot 5 Gauzed wrapped 8 Saw cut 11 None (open hole); 2 Louvered shutter 4 Key punched 6 Wire wrapped 9 Drilled holes; 7 Torch cut 10 Other (specify)

SCREEN-PERFORATED INTERVALS: From 95 ft. to 125 ft., From ft. to ft.; From 93 ft. to 125 ft., From ft. to ft.

GRAVEL PACK INTERVALS: From 95 ft. to 125 ft., From ft. to ft.; From 93 ft. to 125 ft., From ft. to ft.

7 GROUT MATERIAL: 1 Neat cement 2 Cement grout 3 Bentonite 4 Other

Grout Intervals: From 0 ft. to 81 ft., From ft. to ft.; From 81 ft. to 93 ft., From ft. to ft.

What is the nearest source of possible contamination: 10 Livestock pens 14 Abandoned water well; 1 Septic tank 4 Lateral lines 7 Pit privy 11 Fuel storage 15 Oil well/Gas well; 2 Sewer lines 5 Cess pool 8 Sewage lagoon 12 Fertilizer storage 16 Other (specify below); 3 Watertight sewer lines 6 Seepage pit 9 Feedyard 13 Insecticide storage

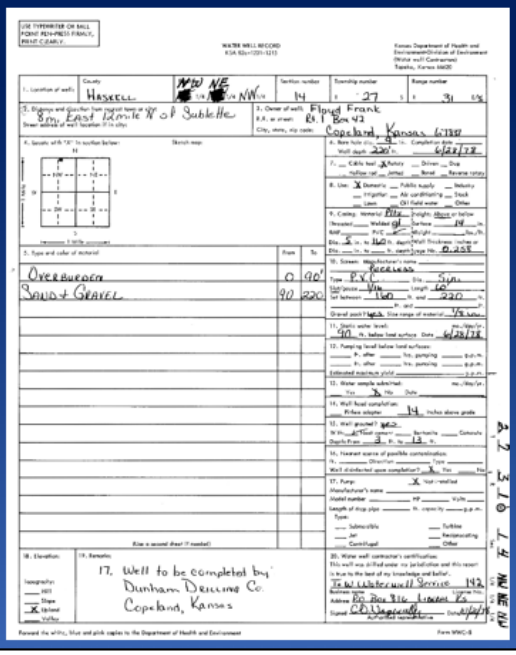
Direction from well? North; How many feet? 60'

FROM	TO	LITHOLOGIC LOG
0	5	Surface
5	20	Lt. Brown Clay
20	40	Lt. Brown Clay w/sand strks.
40	45	Lt. Brown Sandy Clay
45	55	Lt. Brown Clay & Sand
55	65	Red Sandy Clay
65	76	Red. Sand
76	89	Caliche & Clay
89	91	Red Sand
91	93	Caliche
93	94	Sand
94	100	Clay & Cemented Strks/Caliche
100	105	Cemented Sand
105	112	Clay & Sand Strks.
112	120	Sand

FROM	TO	PLUGGING INTERVALS
120	125	Red. Sand

8 CONTRACTOR'S OR LANDOWNER'S CERTIFICATION: This water well was (1) constructed, (2) reconstructed, or (3) plugged under my jurisdiction and was completed on (mo/day/year) 11-8-92 and this record is true to the best of my knowledge and belief. Kansas Water Well Contractor's License No. 554. This Water Well Record was completed on (mo/day/yr) 11-19-92 under the business name of MOEPPER PUMP & WELL, INC. by (signature)

Not so Excellent



WATER WELL RECORD KSA 82a-1201-1213

Kansas Department of Health and Environment-Division of Environment (Water well Contractors) Topeka, Kansas 66620

1. Location of well: County: Haskell; NW NE ¼ ¼ NW ¼; Section number: 14; Township number: T 27 S; Range number: R 31 E

2. Distance and direction from nearest town or city: 8mi. East 1/2mile N of Sublette

3. Owner of well: Floyd Frank; R.R. #, or street: Rt. 1 Box 43; City, state, zip code: Copeland, Kansas 67837

4. Locate with "X" in section below:

5. Type and color of material:

From	To	
Overburden	0	90'
Sand + Gravel	90	220

6. Well log: Depth drilled 220 ft. Completion date 6/23/78

7. Cable tool X Rotary Driven Dug; Hollow rod (mfg.) Bored Reverse rotary

8. Use: X Domestic Public supply Industry; Irrigation Air conditioning Stock; Lawn Oil field water Other

9. Casing: Material PVC Height: Above or below; Threaded Welded Surface 18 in.; Rmf PVC Weight; Dia. 5 in. to 160 ft. Wall Thickness: inches or Dia. in. to ft. Gage No. 0.258

10. Screen: Manufacturer's name Reeves; Type PVC Dia. 5 in.; Slot size .010 Length 60; Set between 160 ft. and 220 ft.; Gravel packed Yes No Size range of material 1/8 to

11. Static water level: 90 ft. below land surface Date 6/28/78

12. Pumping level below land surface: ft. after hrs. pumping gpm; ft. after hrs. pumping gpm; Estimated maximum yield gpm

13. Water sample submitted: mo./day/yr. Yes X No Date

14. Well head completion: Pitless adapter 14 inches above grade

15. Well grouted? Yes; In what material? Bentonite Concrete; Depth from 3 ft. to 13 ft.

16. Nearest source of possible contamination: Direction Type; Was it disinfected upon completion? X Yes No

17. Pump: X Not installed; Manufacturer's name Model number HP Volts; Length of drop pipe ft. Capacity g.p.m.; Type: Submersible Turbine; Jet Reciprocating; Centrifugal Other

18. Elevation: Topography: Hill Slope X Upland Valley

19. Remarks: 17. Well to be completed by Dunham Drilling Co Copeland, Kansas

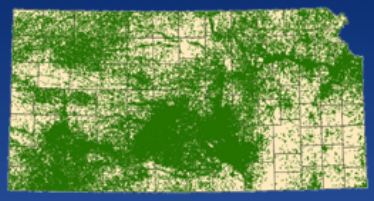
20. Water well contractor's certification: This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief. To (1) Water well Service 142; Address Box Box 916 Liberal Ks; Signed CD Dunham; Date 7/5/78

Forward the white, blue and pink copies to the Department of Health and Environment Form WWC-5

WWC5 forms provide a great wealth of information describing groundwater wells and the sources of supply the well accesses. However, the submitted information can vary in terms of quality and detail. Many WWC5 forms are excellent, both in quality and detail of the submitted information, but others are not. The Kansas Groundwater Association works to educate and assist licensed drilling companies on submitting forms; however, most of the submitted information is based on on-site observations with virtually no regulatory oversight.

WWC5- Why do people care?

- I just bought 20 acres, is there any water?
- How many private wells are drilled in town?



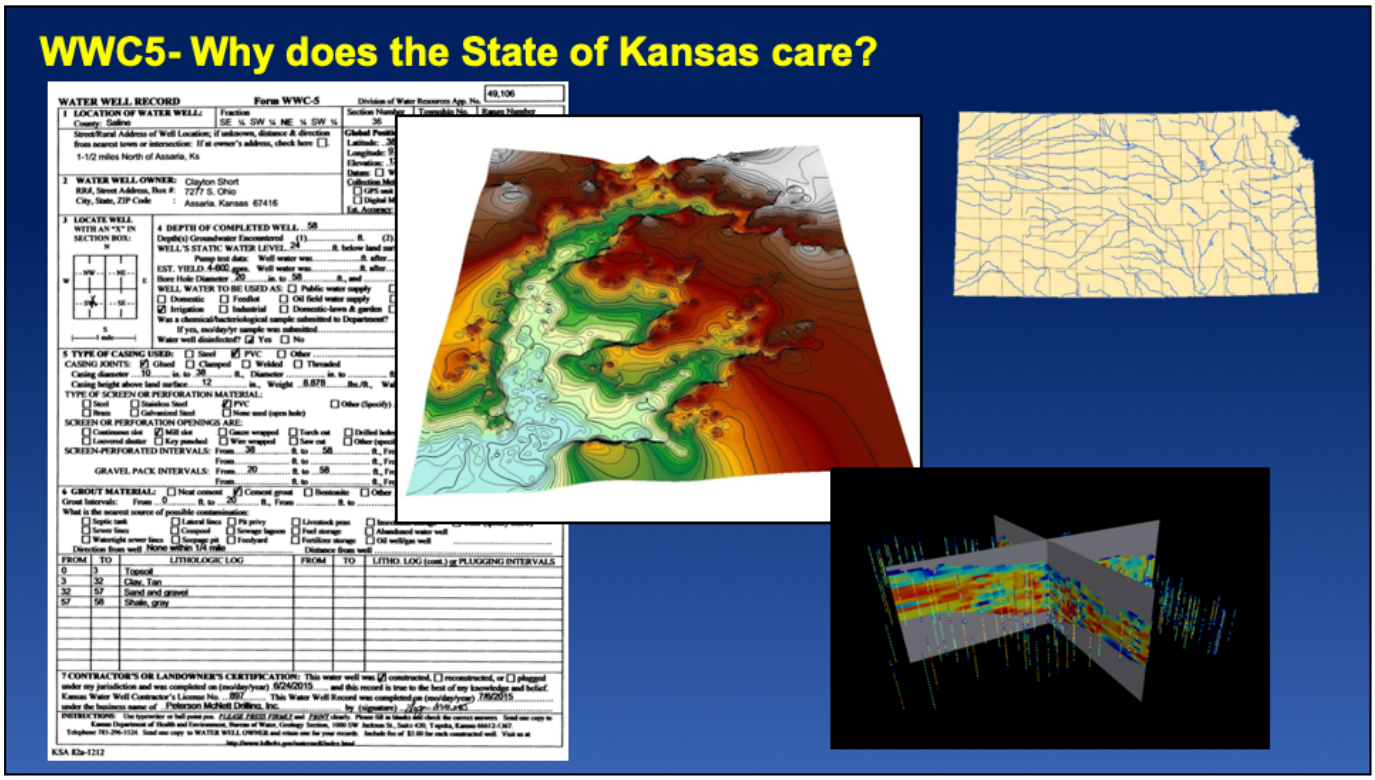
- What is the depth to groundwater in eastern Kansas?

Question: Why do people care whether there is a WWC5 database? WWC5 records can be used to answer a multitude of questions:

- Are there any groundwater sources available on or near a particular property? In rural environments, domestic water needs are either provided by rural water districts or private wells. WWC5 is a great source to quickly investigate water availability.

- How many private lawn/garden wells are drilled within a town? If a metropolitan area overlies a shallow, accessible aquifer system, there are often thousands of private wells drilled within the city limits. Although generally small in terms of use, together these wells can have a notable impact on the local source of supply.

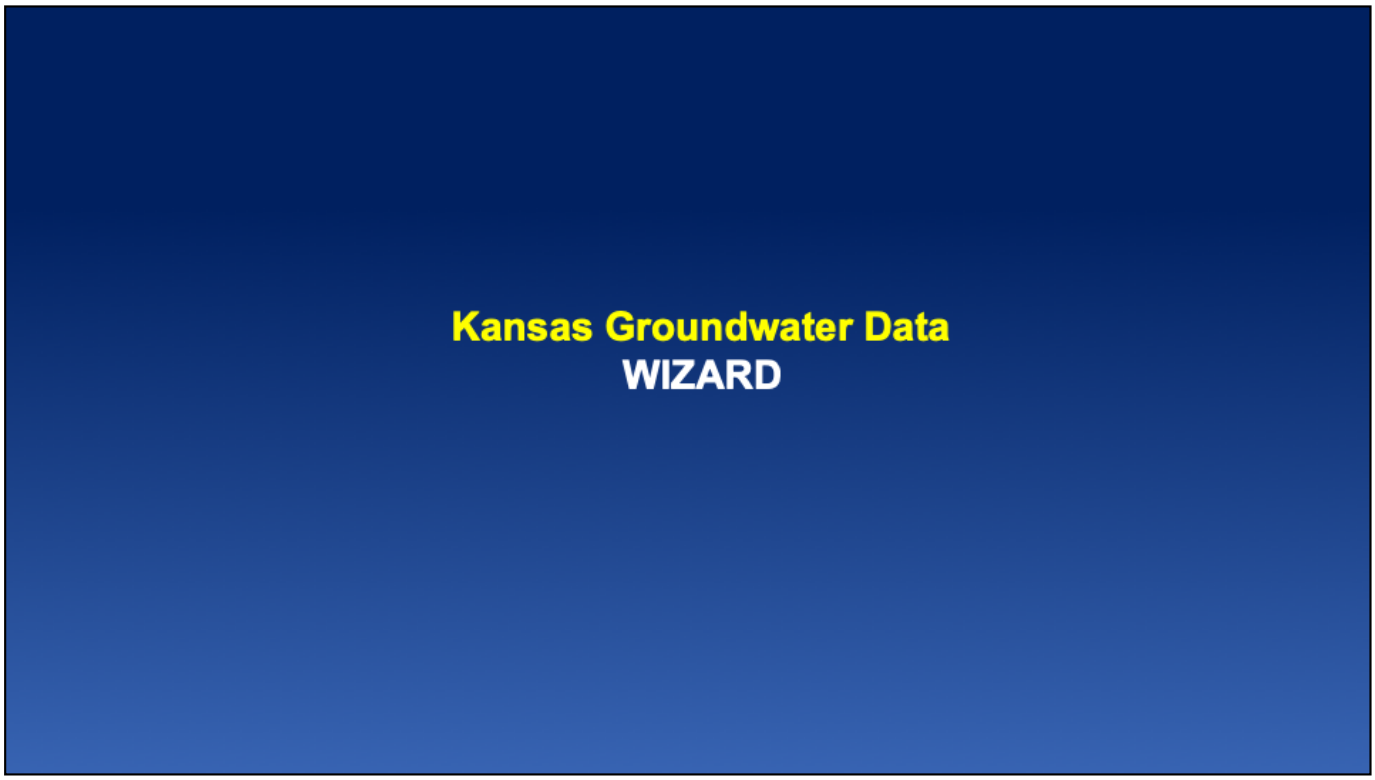
- What is the depth to water for locations in eastern Kansas? The State of Kansas does not have a statewide water-level network (to be discussed in the next section of this presentation). WWC5 forms are often the only source that lists the depth to water across many areas of eastern Kansas.



The KGS uses WWC5-based records to characterize aquifer parameters and conditions.

The Smoky Hill River Valley Groundwater Model is a numerical flow model designed to help test ground and surface water management proposals in the Smoky Hill River valley between Kanopolis Reservoir and the City of Salina. WWC5 forms were used to identify shale and other non-permeable materials, which were interpolated into a continuous surface of the underlying aquifer bedrock.

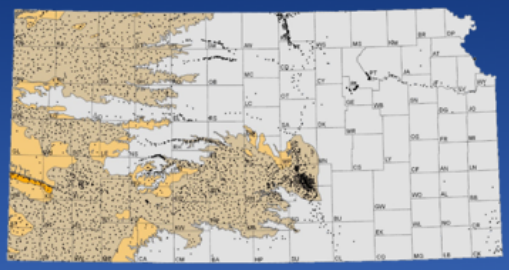
The KGS is also investigating approaches to develop quantitative aquifer models by reclassifying the tens of thousands of submitted lithologic descriptions into 71 synonymy classes. The synonymy classes are, in turn, interpolated into permeability groupings that are dynamically linked to groundwater flow models. As the simulated water levels change within each model iteration, they are intersected with a three-dimensional representation of the simplified WWC5 permeability classes, and aquifer parameters, such as the hydraulic conductivity and specific yield, are dynamically assigned to model cells.



WIZARD

WIZARD- Depth to water measurements

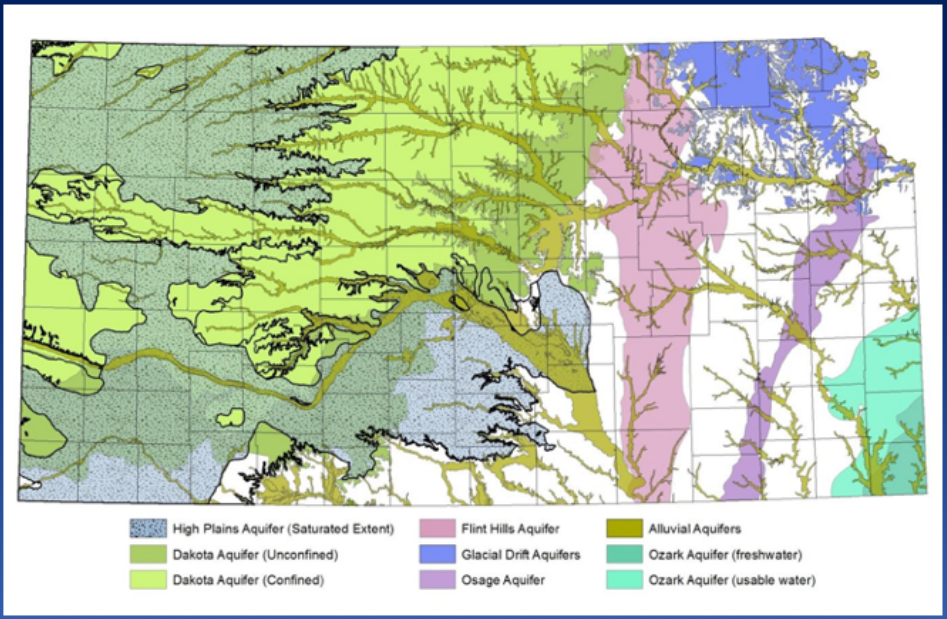
- Water Information Storage and Retrieval Database
- Kansas Geological Survey
- State's largest repository of depth-to-water measurements
- Data evolved from US Geological Survey and is populated from the KGS, KDA-DWR, local management districts and the USGS
- Over 57,000 well sites (12,617 wells and 636,693 measurements)



The KGS-administered database WIZARD is an acronym for Water Information Storage and Retrieval Database (if you say "WISARD" three time fast it sounds like "WIZARD") and represents the state's largest repository of depth-to-water measurements in Kansas. WIZARD evolved in the mid-1990s from the U.S. Geological Survey's Groundwater Site Inventory and today is used to store measured water levels from the KGS, Kansas Department of Agriculture, Division of Water Resources (KDA-DWR), local groundwater management districts, and the USGS.

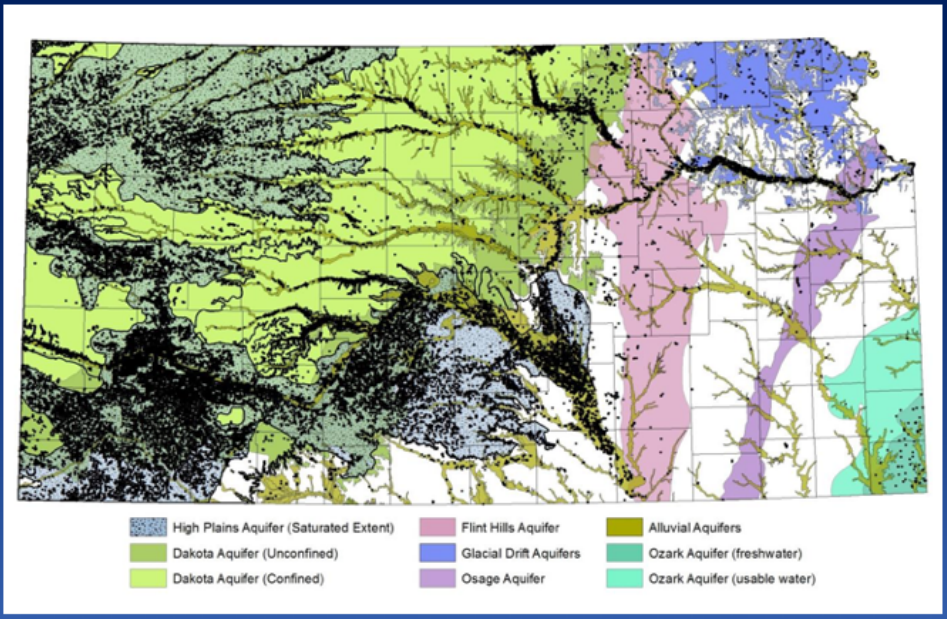
The map shows the distribution of wells with a depth-to-water measurement taken in the last 20 years. Many of the measured wells are found along major alluvial valleys, such as in the Republican River alluvium and in the High Plains aquifer (HPA) region of Kansas, shown by the tan shaded areas.

Major and Minor Aquifers in Kansas



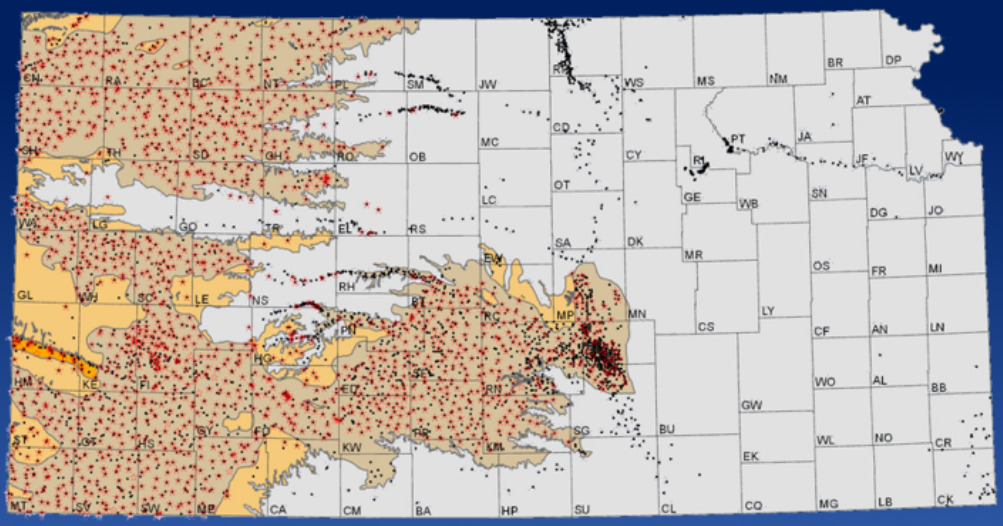
This map shows the major and minor aquifer units in the state.

Groundwater-based Water Right Wells (aka “Big Wells”)

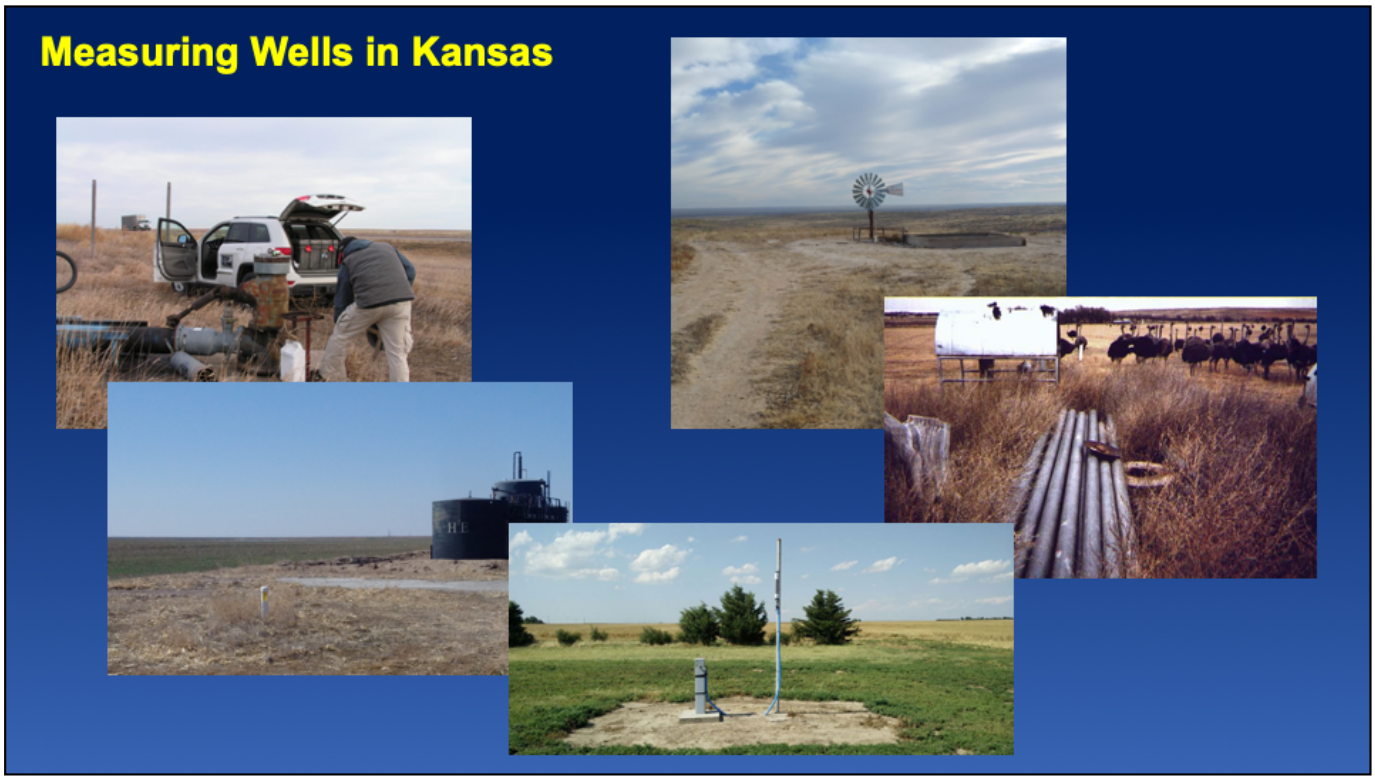


The HPA is the most-used aquifer in the state and supplies most of the groundwater used each year. This is illustrated by the distribution of groundwater-based water right wells (typically non-domestic, large capacity wells).

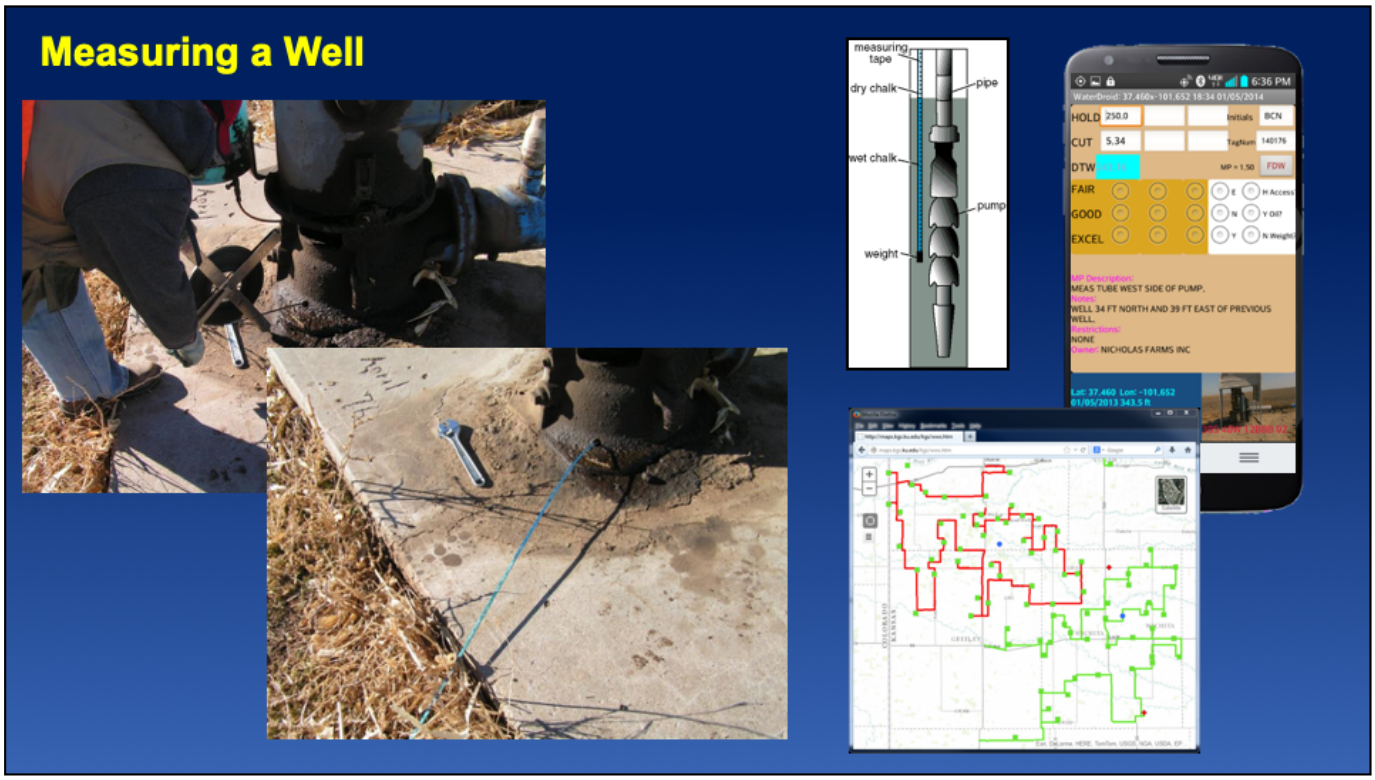
Kansas Cooperative Water Level Network



Given the importance to Kansas, each January, the KGS in cooperation with the KDA-DWR measures roughly 1,400 water wells across the HPA region, shown as red stars on the map, to provide regional characterizations of the aquifer. Collected depths to water measurements can be obtained from the WIZARD site.



The majority of depth-to-water measurements are taken from actual production wells, usually irrigation wells. Other types of wells measured each year include windmills, abandoned wells, oil-supply wells, and observation wells constructed solely for the continuous monitoring of water levels.

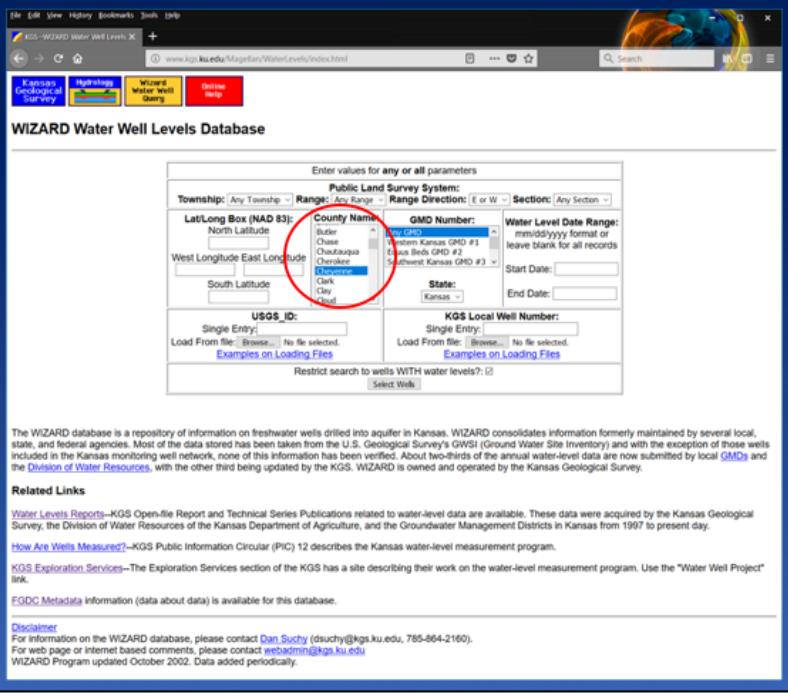


The Exploration Services Section heads up the field collections effort for the KGS portion of the Cooperative Water Level Program. Steel tapes are lowered down access points between the well casing and pump column into the water column and held at specific depths, called the "hold." The bottom 20 or 30 feet of the tape is incremented to the thousandths of a foot and covered in blue chalk, which makes a distinct "cut" mark where the tape is wet from crossing into the water table versus where it is dry. The depth to water from the measuring point is then computed by subtracting the "cut" from the "hold."

KGS staff use internally customized software, called Water Droid, to navigate the network of groundwater wells and store collected measurements using Android-based mobile devices (e.g., phones and tablets). Water Droid provides on-site data checks and transmits the measurement back to KGS servers via cloud-based storage. Additional customized web applications then display the network wells in terms of their measurement status and any missed wells can readily be identified along with wells tagged as "UTM" (unable to measure).

Every year, a small percentage of wells are classified as UTM—unable to measure. In most cases, this happens because of simple hazards such as blocked road access or adverse field conditions caused by winter precipitation. In other situations, blockages can occur from shifts in the well casing or other down-hole obstructions, such as rodents and other critters that met unsavory ends after becoming stuck in downhole access points. The Cooperative Water Level Program is completely voluntary and landowners (or their monkeys) can opt out of the program at any time.

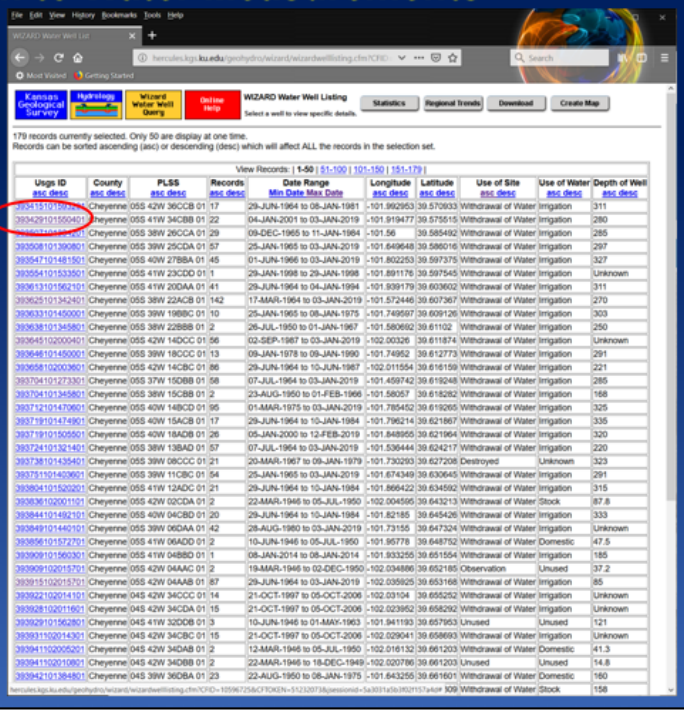
WIZARD- Depth to Water Measurements



The WIZARD website can be accessed from this url: http://www.kgs.ku.edu/Magellan/WaterLevels/index.html. It has the same look and feel as the WWC5 page but has expanded query options. In addition to PLSS and county-based queries, water levels can be selected by latitude and longitude box, local groundwater management districts, or specific ID numbers. Water levels can be filtered to limit results to a specified range of dates.

WIZARD- Depth to Water Measurements

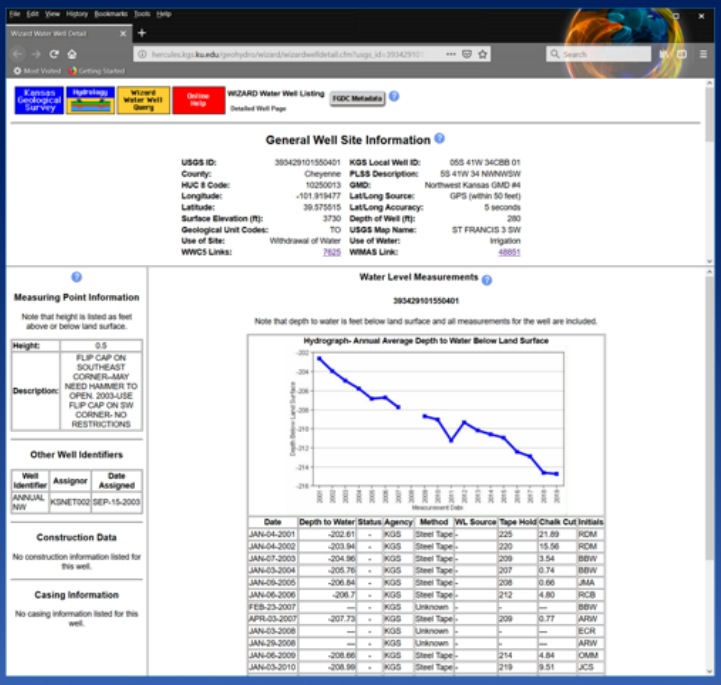
Primary Key



Once a query is submitted, the WIZARD website returns all matching records as a sortable table. Well records, shown in groups of 50 at a time, can be sorted by the USGS_ID, county designation, PLSS description, number of depth-to-water measurements, longitude, latitude, use of the well site, use made of water, and well depth.

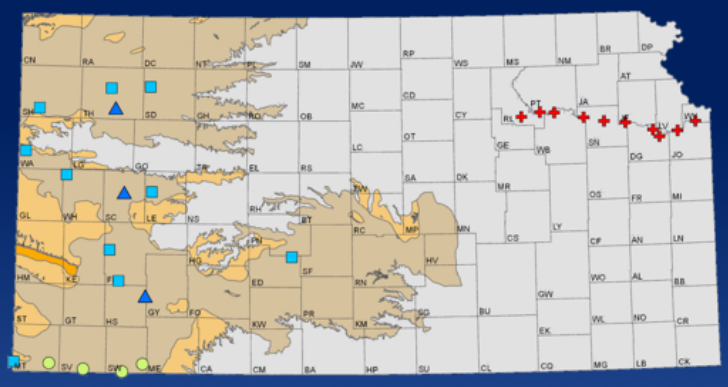
The USGS_ID (aka the Site Number in today's federal USGS database) is still maintained as the primary key in the WIZARD schema. Each ID is hyperlinked to specific well pages.

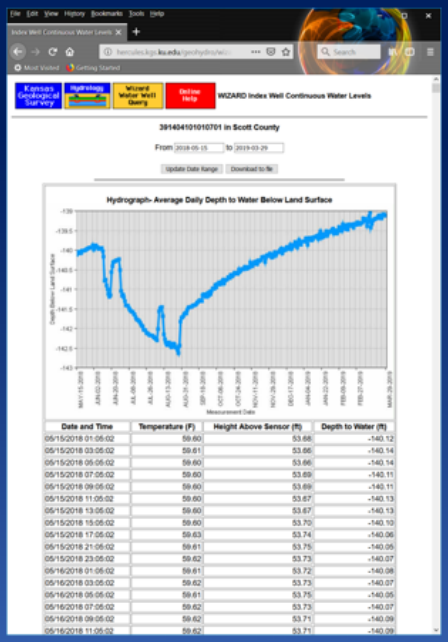
WIZARD- Depth to Water Measurements



Specific well pages in WIZARD are dynamically populated from WIZARD based on submitted USGS_ID values. Information is provided in three frames within a single web page that outline well-specific information, measuring point descriptions, and all recorded depth-to-water measurements, which are displayed in graph form (annual averages) and a tabular listing of each unique measurement, the date the water level was obtained, the method of collection, and which agency measured the well.

WIZARD- Kansas Index Wells





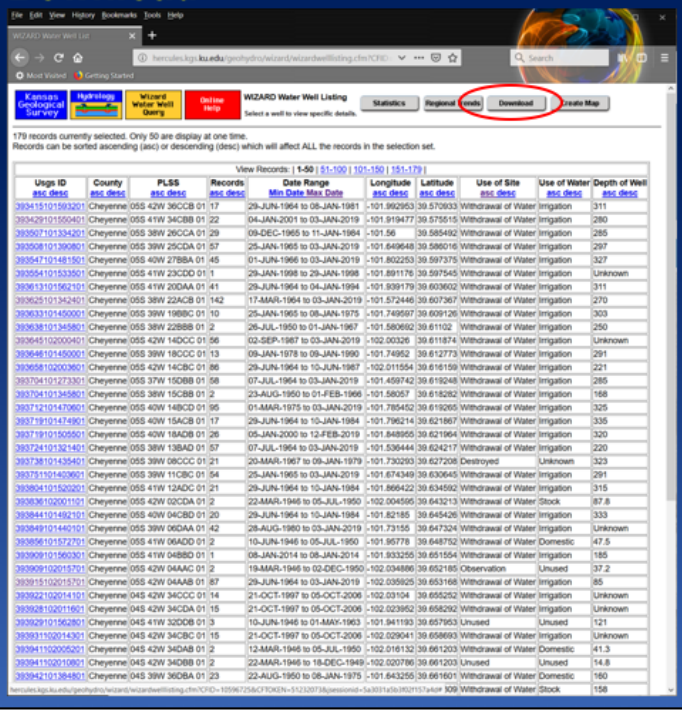
The Kansas Index Well Program is a collection of groundwater wells equipped to provide real-time and continuous water-level recordings at selected sites across Kansas. All sensor-derived and manually conducted measurements are provided through WIZARD or can be accessed from these websites:

HPA: http://www.kgs.ku.edu/HighPlains/OHP/index_program/index.shtml

KS River Valley: http://www.kgs.ku.edu/Hydro/KansasRiver/index.html

The web page shown on the right side of the slide shows hourly recorded water levels from mid-May 2018 to late March 2019 recorded by a pressure transducer installed at the index well north of Scott City, Kansas. Water-level responses during the pumping season occurring in the spring/summer months can readily be compared to that in the fall and winter months when water levels recover. Reviewing these types of responses in the aquifer has provided the KGS better insights into how we characterize the aquifer.

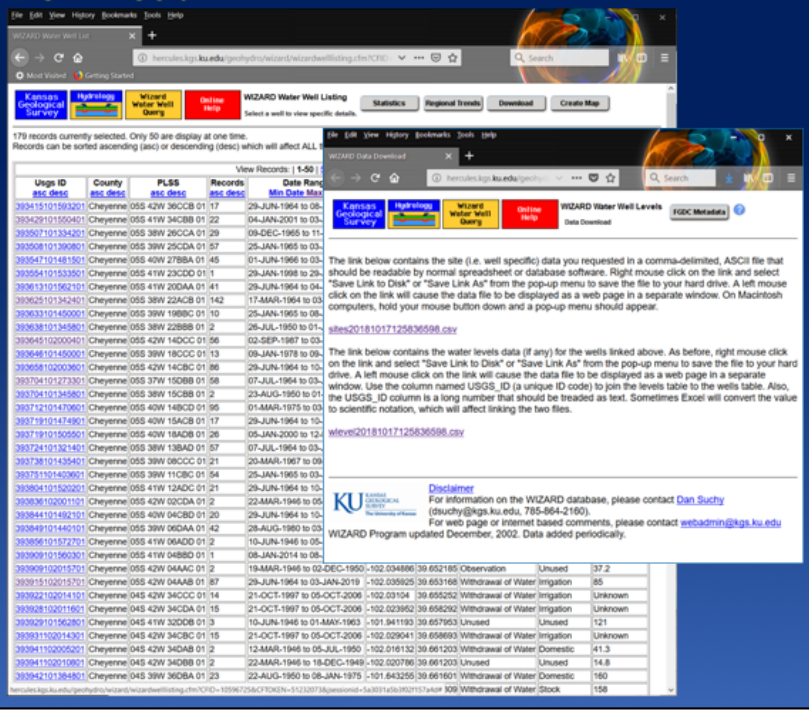
WIZARD- Data Download



Usgs ID asc desc	County asc desc	PLSS asc desc	Records asc desc	Date Range Min Date Max Date	Longitude asc desc	Latitude asc desc	Use of Site asc desc	Use of Water asc desc	Depth of Well asc desc
393415101593201	Cheyenne	05S 42W 36CCB 01	17	29-JUN-1964 to 08-JAN-1981	-101.992953	39.570933	Withdrawal of Water	Irrigation	311
393429101550401	Cheyenne	05S 41W 34CBB 01	22	04-JAN-2001 to 03-JAN-2019	-101.919477	39.575515	Withdrawal of Water	Irrigation	280
393507101334201	Cheyenne	05S 38W 26CCA 01	29	09-DEC-1965 to 11-JAN-1984	-101.56	39.585492	Withdrawal of Water	Irrigation	285
393508101390801	Cheyenne	05S 39W 25CDA 01	57	25-JAN-1965 to 03-JAN-2019	-101.649648	39.586016	Withdrawal of Water	Irrigation	297
393547101481501	Cheyenne	05S 40W 27BBA 01	45	01-JUN-1966 to 03-JAN-2019	-101.802253	39.597375	Withdrawal of Water	Irrigation	327
393554101533501	Cheyenne	05S 41W 23CDD 01	1	29-JAN-1998 to 29-JAN-1998	-101.891176	39.597545	Withdrawal of Water	Irrigation	Unknown
393613101562101	Cheyenne	05S 41W 20DAA 01	41	29-JUN-1964 to 04-JAN-1994	-101.939179	39.603602	Withdrawal of Water	Irrigation	311
393625101342401	Cheyenne	05S 38W 22ACB 01	142	17-MAR-1964 to 03-JAN-2019	-101.572446	39.607367	Withdrawal of Water	Irrigation	270
393633101450001	Cheyenne	05S 39W 19BBC 01	10	25-JAN-1965 to 08-JAN-1975	-101.749597	39.609126	Withdrawal of Water	Irrigation	303
393638101345801	Cheyenne	05S 38W 22BBB 01	2	26-JUL-1950 to 01-JAN-1967	-101.580692	39.61102	Withdrawal of Water	Irrigation	250
393645102000401	Cheyenne	05S 42W 14DCC 01	56	02-SEP-1987 to 03-JAN-2019	-102.00326	39.611874	Withdrawal of Water	Irrigation	Unknown
393646101450001	Cheyenne	05S 39W 18CCC 01	13	09-JAN-1978 to 09-JAN-1990	-101.74952	39.612773	Withdrawal of Water	Irrigation	291
393658102003601	Cheyenne	05S 42W 14CBC 01	86	29-JUN-1964 to 10-JUN-1987	-102.011554	39.616159	Withdrawal of Water	Irrigation	221
393704101273301	Cheyenne	05S 37W 15DBB 01	58	07-JUL-1964 to 03-JAN-2019	-101.459742	39.619248	Withdrawal of Water	Irrigation	285
393704101345801	Cheyenne	05S 38W 15CBB 01	2	23-AUG-1950 to 01-FEB-1966	-101.58057	39.618282	Withdrawal of Water	Irrigation	168
393712101470601	Cheyenne	05S 40W 14BCD 01	95	01-MAR-1975 to 03-JAN-2019	-101.785452	39.619265	Withdrawal of Water	Irrigation	325
393719101474901	Cheyenne	05S 40W 15ACB 01	17	29-JUN-1964 to 10-JAN-1984	-101.796214	39.621867	Withdrawal of Water	Irrigation	335
393719101505501	Cheyenne	05S 40W 18ADB 01	26	05-JAN-2000 to 12-FEB-2019	-101.848955	39.621964	Withdrawal of Water	Irrigation	320
393724101321401	Cheyenne	05S 38W 13BAD 01	57	07-JUL-1964 to 03-JAN-2019	-101.536444	39.624217	Withdrawal of Water	Irrigation	220
393738101435401	Cheyenne	05S 39W 08CCC 01	21	20-MAR-1967 to 09-JAN-1979	-101.730293	39.627208	Destroyed	Unknown	323
393751101403601	Cheyenne	05S 39W 11CBC 01	54	25-JAN-1965 to 03-JAN-2019	-101.674349	39.630645	Withdrawal of Water	Irrigation	291
393804101520201	Cheyenne	05S 41W 12ADC 01	21	29-JUN-1964 to 10-JAN-1984	-101.866422	39.634592	Withdrawal of Water	Irrigation	315
393836102001101	Cheyenne	05S 42W 02CDA 01	2	22-MAR-1946 to 05-JUL-1950	-102.004595	39.643213	Withdrawal of Water	Stock	87.8
393844101492101	Cheyenne	05S 40W 04CBD 01	20	29-JUN-1964 to 10-JAN-1984	-101.82185	39.645426	Withdrawal of Water	Irrigation	333
393849101440101	Cheyenne	05S 39W 06DAA 01	42	28-AUG-1980 to 03-JAN-2019	-101.73155	39.647324	Withdrawal of Water	Irrigation	Unknown
393856101572701	Cheyenne	05S 41W 06ADD 01	2	10-JUN-1946 to 05-JUL-1950	-101.95778	39.648752	Withdrawal of Water	Domestic	47.5
393909101560301	Cheyenne	05S 41W 04BBD 01	1	08-JAN-2014 to 08-JAN-2014	-101.933255	39.651554	Withdrawal of Water	Irrigation	185
393909102015701	Cheyenne	05S 42W 04AAC 01	2	19-MAR-1946 to 02-DEC-1950	-102.034886	39.652185	Observation	Unused	37.2
393915102015701	Cheyenne	05S 42W 04AAB 01	87	29-JUN-1964 to 03-JAN-2019	-102.035925	39.653168	Withdrawal of Water	Irrigation	85
393922102014101	Cheyenne	04S 42W 34CCC 01	14	21-OCT-1997 to 05-OCT-2006	-102.03104	39.655252	Withdrawal of Water	Irrigation	Unknown
393928102011601	Cheyenne	04S 42W 34CDA 01	15	21-OCT-1997 to 05-OCT-2006	-102.023952	39.658292	Withdrawal of Water	Irrigation	Unknown
393929101562801	Cheyenne	04S 41W 32DDB 01	3	10-JUN-1946 to 01-MAY-1963	-101.941193	39.657953	Unused	Unused	121
393931102014301	Cheyenne	04S 42W 34CBC 01	15	21-OCT-1997 to 05-OCT-2006	-102.029041	39.658693	Withdrawal of Water	Irrigation	Unknown
393941102005201	Cheyenne	04S 42W 34DAB 01	2	12-MAR-1946 to 05-JUL-1950	-102.016132	39.661203	Withdrawal of Water	Domestic	41.3
393941102010801	Cheyenne	04S 42W 34DBB 01	2	22-MAR-1946 to 18-DEC-1949	-102.020786	39.661203	Unused	Unused	14.8
393942101384801	Cheyenne	04S 39W 36DBA 01	23	22-AUG-1950 to 08-JAN-1975	-101.643255	39.661601	Withdrawal of Water	Domestic	160
								Withdrawal of Water	Stock	158

There are two methods to download or access data from WIZARD. The first is the traditional method of clicking the download button.

WIZARD- Data Download



This provides two comma-delimited, ASCII files that are readable by spreadsheets and database software.

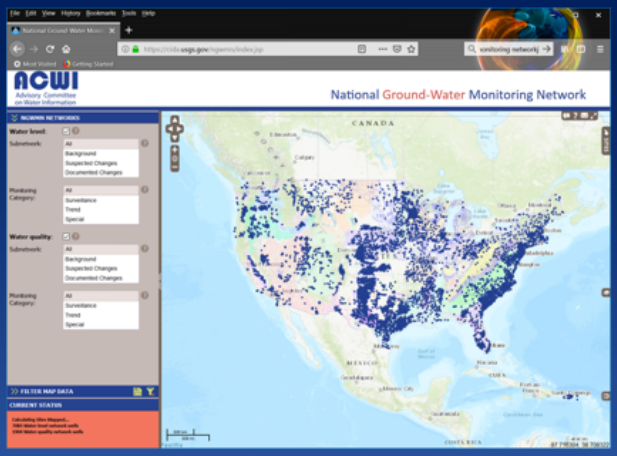
One file represents groundwater wells with geographic coordinates along with site-specific information, such as well depth, use of the site, and geologic unit codes.

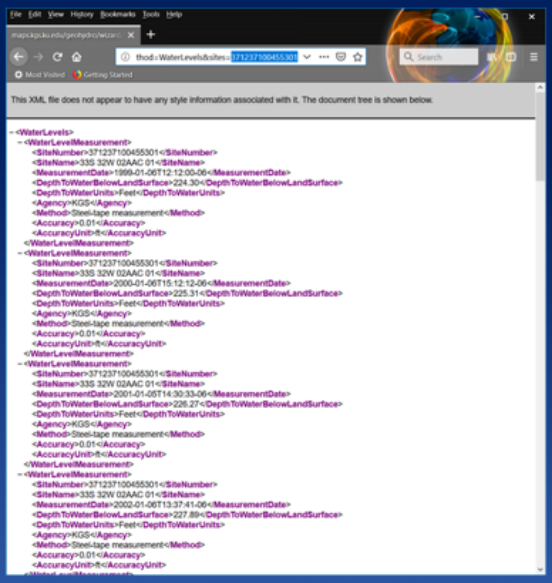
The second file provides a link to the manually collected depth-to-water measurements.

The two files can be related or joined via the USGS_ID.

WIZARD- Web Service

USGS National Groundwater Monitoring Network





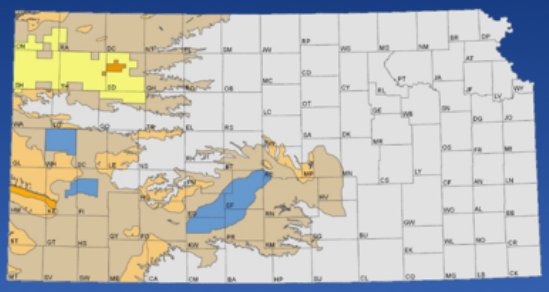
http://maps.kgs.ku.edu/geohydro/wizard/services/data.cfc?method=WaterLevels&sites=371237100455301

The second method to access WIZARD-based data is through a web service. Although designed specifically for the KGS involvement in the USGS National Groundwater Monitoring Network program, this web service is publicly available and returns water levels in a machine-readable, XML-formatted document. If you are a programmer/developer, this is the most exciting slide of the whole presentation (or not….).

For more information, check out KGS Open-File Report 2016-28.

WIZARD- Why do people care?

- Landowner interest
- Water conservation and management
- Land pricing and loan availability
- Tax returns



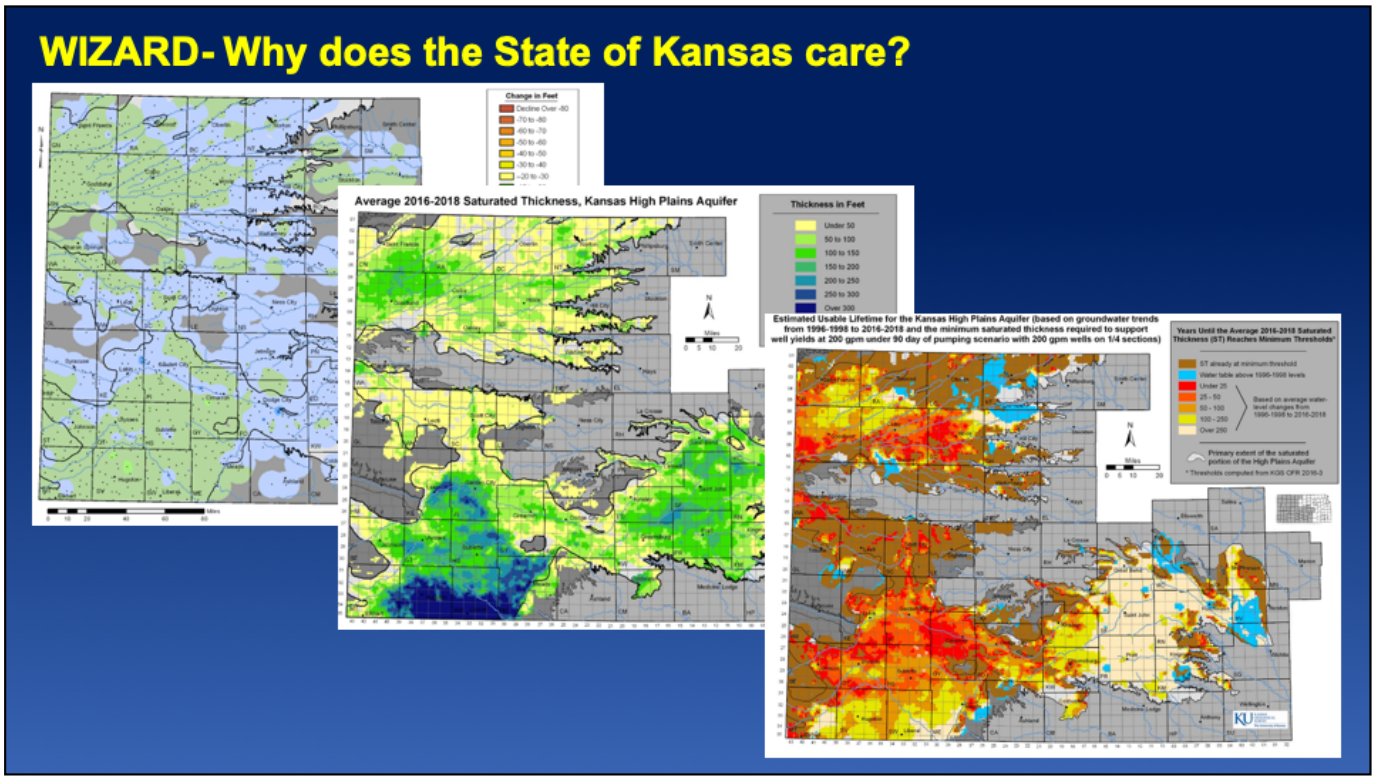
Question: Why do people care that there is a WIZARD database?

- Land- and groundwater-based water right owners often like to know the depth to water in their wells.

- Enhanced water management. The State of Kansas has several water initiatives underway that seek to reduce water use/consumption from the HPA. Some of these programs are voluntary while others are mandated through local groundwater management districts. Changes in the water table are used to both identify priority areas and trigger action items listed under the management plans.

- Banks and financial institutions are starting to use estimates of the usable lifetime of the aquifer as a consideration for loans.

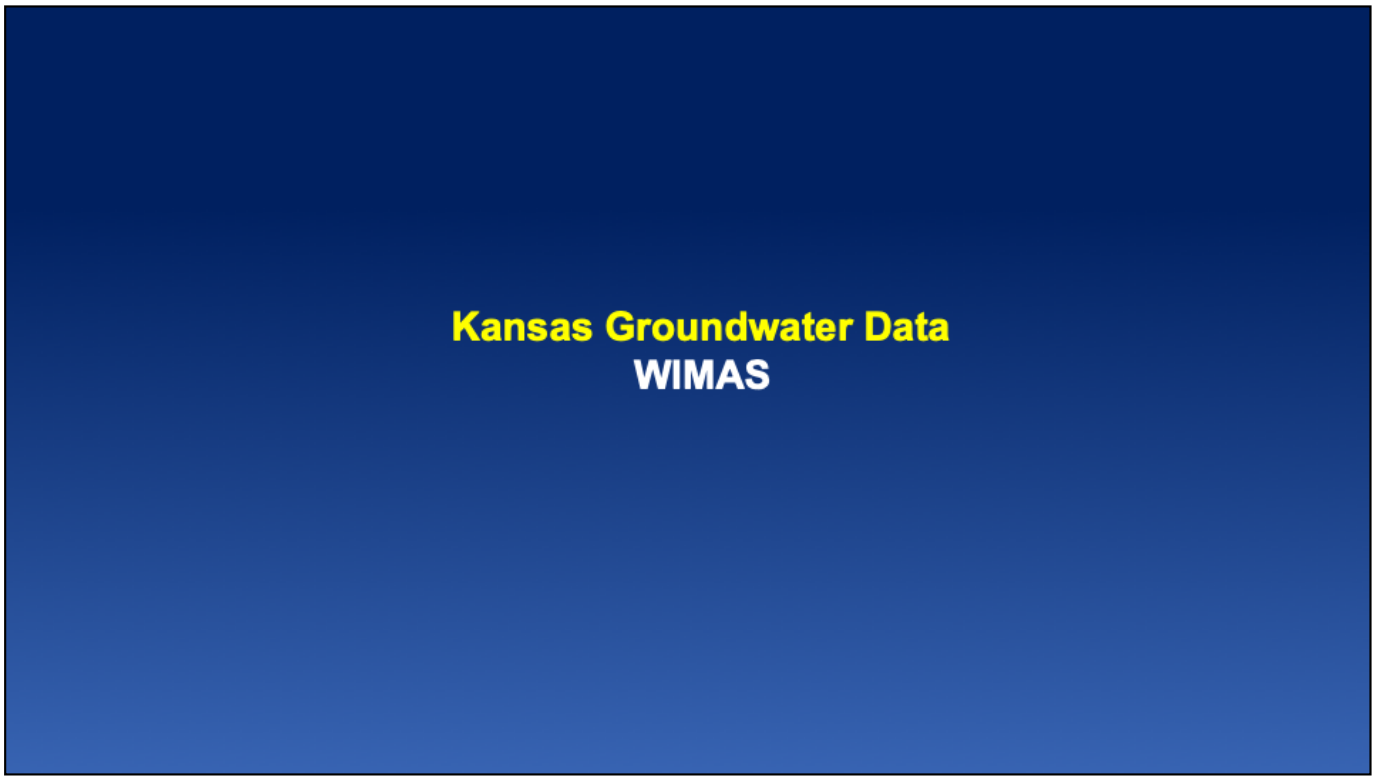
- Lastly, accountants and tax professionals are often the first to inquire about the annual water-level results as tax deductions can be applied for “depleted assets” in the aquifer.



The KGS uses water-level data from WIZARD to track regional changes in the water table. The animated map in the upper left shows the accumulated change in the Kansas HPA from 1996 to 2018.

Interpolated surfaces of the water table elevation can be combined with interpolated bedrock elevations (created from WWC5-based lithology data) to produce estimates of the aquifer thickness.

The map in the lower right shows a simple approach to estimate the usable lifetime of the Kansas HPA based on decline rates and aquifer thickness. The measured rate of water-level change is applied as an average annual change against the present-day saturated thickness and the number of years it will take before the aquifer reaches the minimum thickness needed to support 200-gpm flow rates over the summer pumping season. Red areas on the map indicate that if the annual average groundwater decline measured from 1996 to 2018 continued in the future, the aquifer would reach that 200 gpm threshold in less than 25 years.



WIMAS

WIMAS (WRIS)- Water Rights

- Water Information Management and Analysis System
- Kansas Department of Agriculture, Division of Water Resources
- Water Rights Information System (WRIS)
  - Permits/Certificates to use water
  - Typically large uses (domestic excluded)
  - Diversions include both ground and surface water
- WIMAS is a set of tools using a snapshot of WRIS data

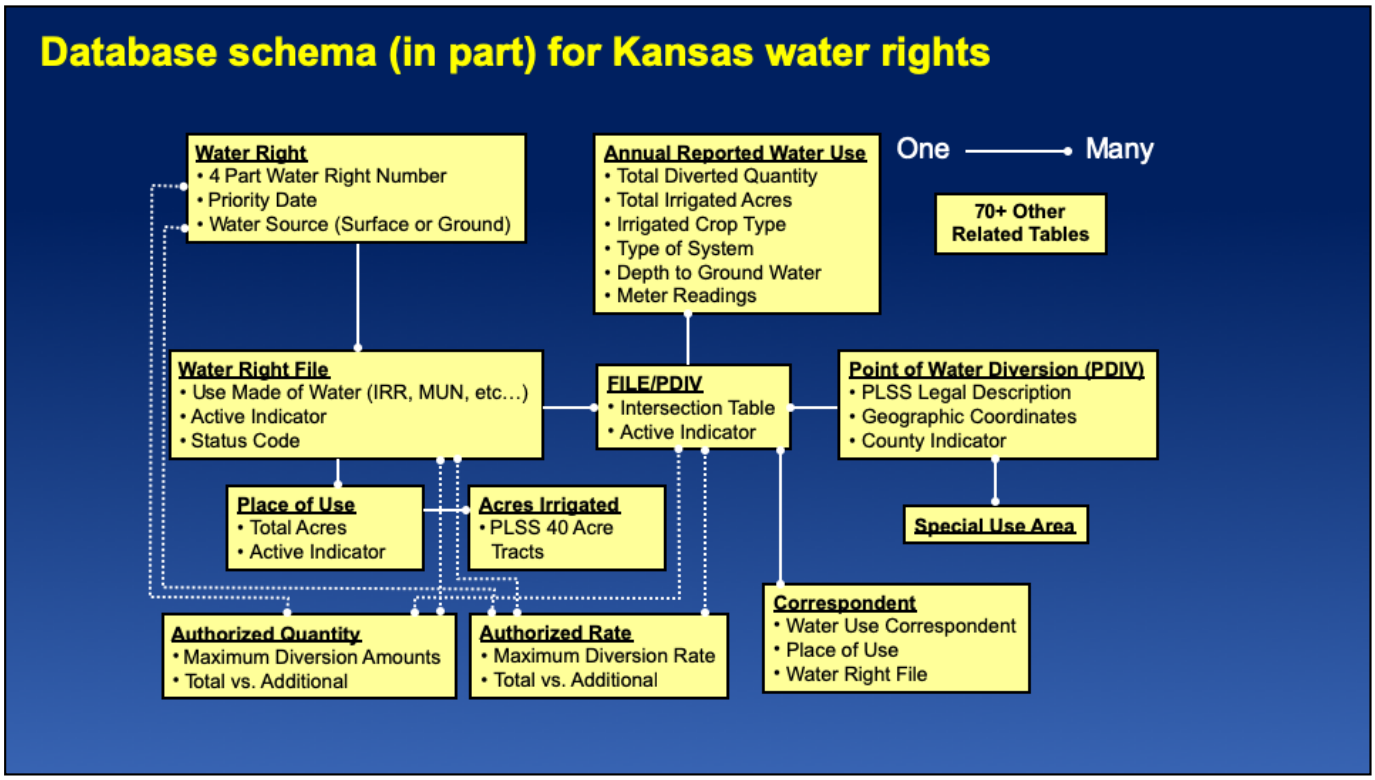
WIMAS stands for Water Information Management and Analysis System and uses water-right data maintained by the Kansas Department of Agriculture, Division of Water Resources (KDA-DWR). Water rights are required in Kansas for most non-domestic uses of water. A water right permit or certificate allows water, either from a surface or ground source, to be diverted so long as it is applied to a beneficial use. The color-infrared aerial photo above shows the development of center pivot irrigation systems between Garden City and Dodge City, all of which are permitted through a water right.

Water right information is stored internally by the KDA-DWR in a database known as the Water Rights Information System or WRIS. WIMAS is a set of tools that uses a subset of WRIS-based data to facilitate access to and analysis of Kansas water right data.

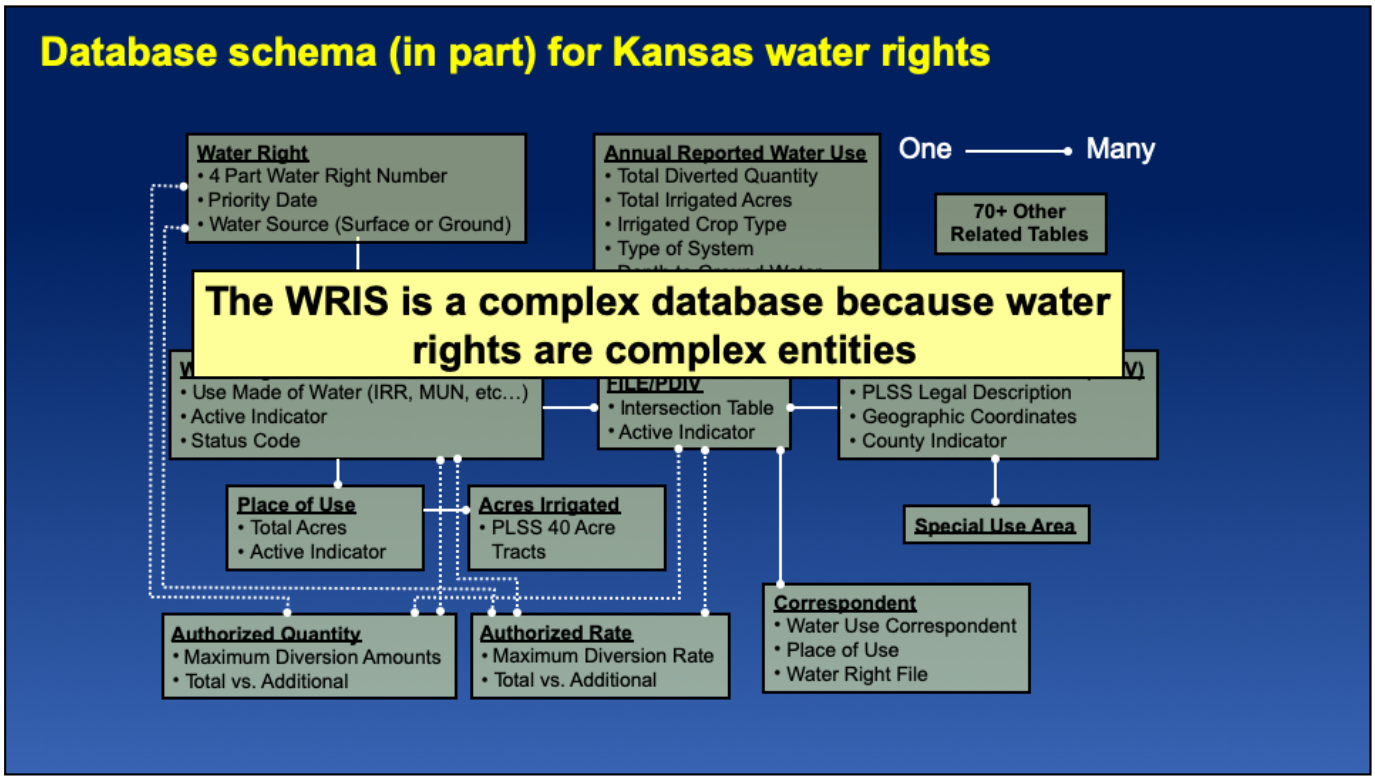
The KDA-DWR administers water rights through the Kansas Water Appropriation Act, which is based on the principle of "first in time, first in right" for both ground and surface water uses. Western Kansas is dominated by groundwater use (red dots on the map are water-right permitted groundwater wells) whereas eastern Kansas is primarily a surface water regime (blue dots on the map). Uses made of water in Kansas include irrigation, municipal, recreational, stockwater, and industrial. However, regardless of the use made of water, the date that water was first put to beneficial use determines which water right is "senior" to other "junior" water rights that were established later in time if a particular water supply ever becomes in short supply.

Kansas water rights are highly regulated. Water-right permits and certificates set annual authorized levels on the amount of water that can be pumped, how fast water can be diverted, and where it can be used. Kansas is unique compared to other western states (those north, south, and west of Kansas that also follow the appropriation doctrine for water management) in that water use is required to be reported each year as a stipulation of the water-right permit or certificate. Failure to report or knowingly falsifying water-use reports is subject to regulatory consequences. Over the Kansas HPA, more than 95% of permitted groundwater wells have a totalizing flow meter installed to quantify annual water usage.

Kansas water rights can be very complex entities. A single water right may have multiple uses of water and can divert water from multiple points of diversion. In turn, individual points of diversion might be associated with more than one water rights. These relationships can make representations in database systems challenging.



This is a diagram of a portion of the WRIS database schema. It is full of many-to-many relationships among various data tables and contains numerous status codes and indicators that determine various states of water rights. Users must have an understanding of the nuances and business rules associated with WRIS to successfully query and use the vast amount of information that it provides.



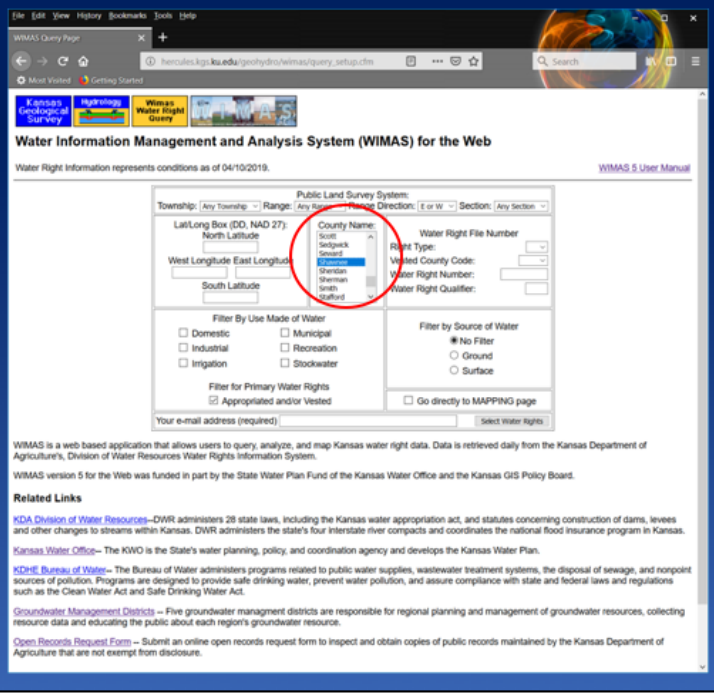
WRIS is complex because water rights are complex entities.

Enter WIMAS

- WIMAS is equivalent of a data interpreter
- Allows querying and analysis of WRIS data without the knowledge of database structure and relationships
- Several version ranging from the desktop to web-based

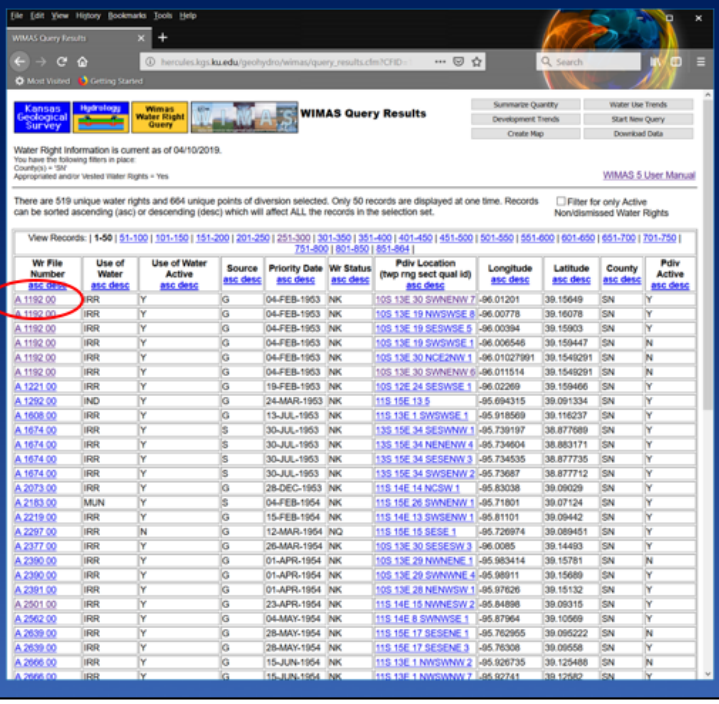
WIMAS acts as data interpreter for WRIS-based data as it allows users to query and analyze WRIS data without a working knowledge of the underlying database. WIMAS traditionally has been a GIS-based software package developed in 1991 by the USGS. Several versions and iterations of this software concept have been developed over the years by the KDA-DWR and KGS with the latest web-based version being hosted through the KGS website.

WIMAS- Water Rights



WIMAS can be accessed at this url: http://hercules.kgs.ku.edu/geohydro/wimas/index.cfm. The page allows water rights to be queried by a PLSS description, latitude and longitude box, Kansas county, or individual water-right number and then further filtered to include only certain uses of water, particular water rights, and source of supply. Unlike the other database web applications, WIMAS requires an email address to be submitted with each query to serve as a digital signature instead of a formal public records request.

WIMAS- Water Rights

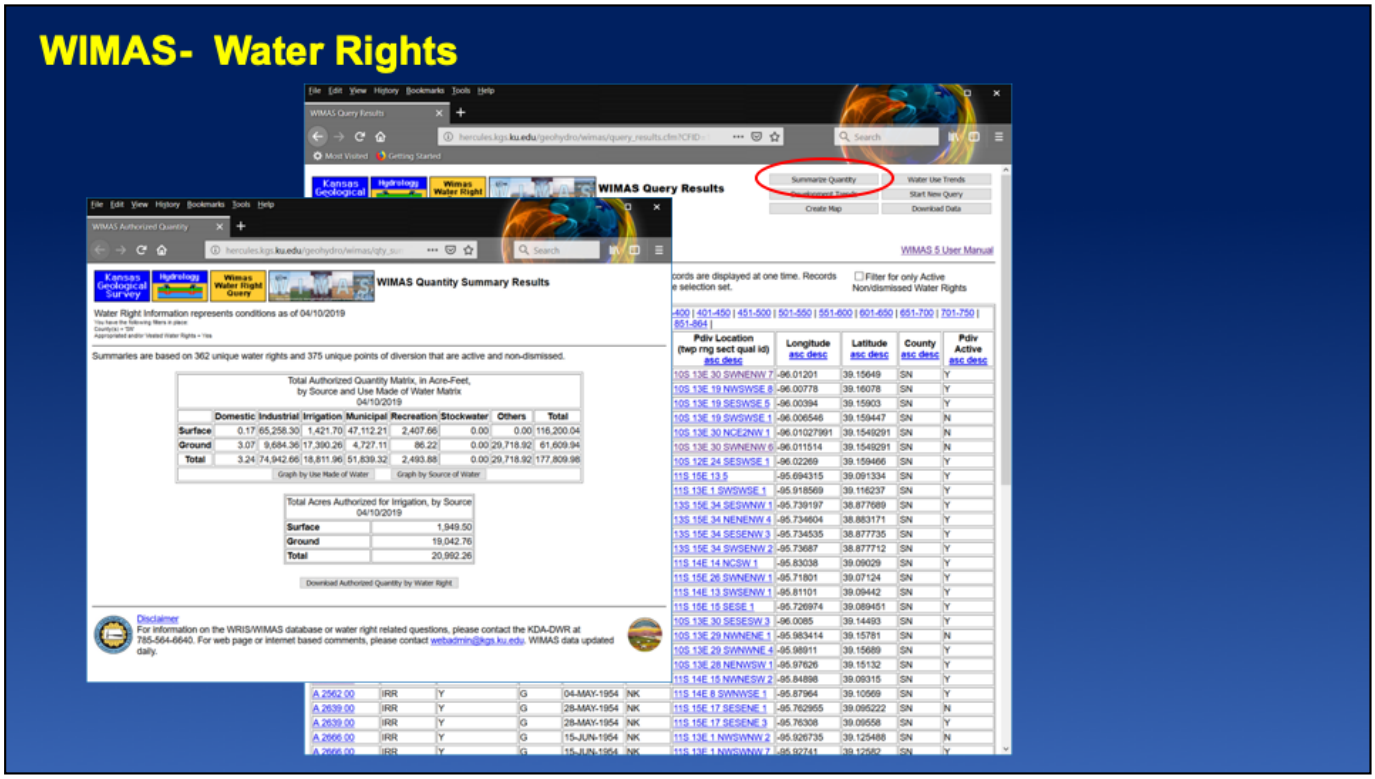


WIMAS queries return the water-right numbers associated with the permits or certificates (often referred to as the File Number), the use(s) made of water under those rights, the source of supply, an indicator of whether that use is active or inactive, the priority date of the water right, and current status code. In addition, a PLSS description of each point of diversion of each water right is listed along with lat/long coordinates, county the diversion is located in, and whether it is active or inactive. The page includes a link to a WIMAS user manual, where users can find descriptions of several of the WRIS database codes.

WIMAS- Water Rights

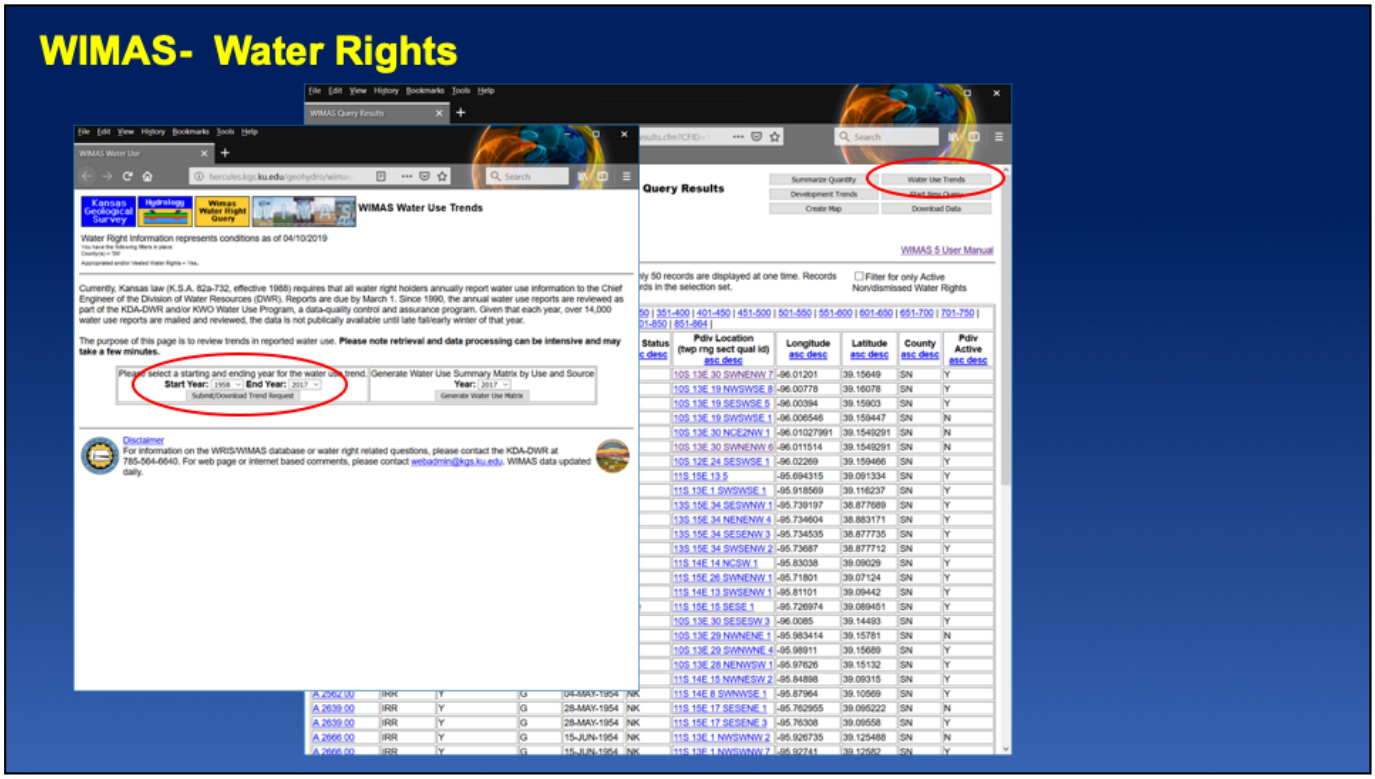
Water-right information can be displayed as individual water rights (shown here) or as an individual point of diversion. Depending on the selected water right, the use made of water, and point of diversion, the page will update to show how much water could be diverted each year and the reported water usage. Authorized quantities and rates along with water use will change depending on the selected water right, use, and point of diversion.

WIMAS- Water Rights



WIMAS allows some analysis options using the entire set of queried records. In this example, the total amount of water authorized (e.g., what could be pumped each year) in Shawnee County, Kansas, is totaled using a matrix of water source and use made of water. The total number of acres authorized by source for irrigation uses also is listed.

WIMAS- Water Rights



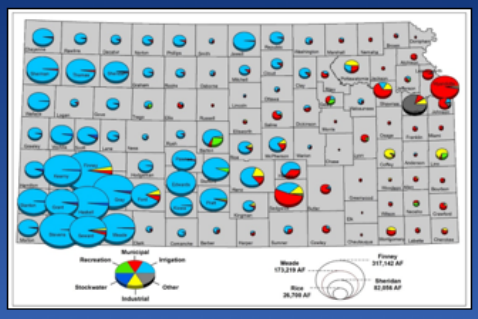
A similar summary matrix can be generated for individual years of water use, along with options to compute simple trends in usage.

WIMAS- Water Rights

With user-specified starting and ending years, WIMAS provides the total amount of water reported used and the total number of acres reported irrigated for the queried water rights in both graph and tabular form. At this point, the individual years of water use for each water right/point of diversion can be downloaded.

WIMAS- Why do people care?

- Mark Twain, "Whiskey is for drinking, water is for fighting."
- Water Management
- Required for larger uses of water (exclude domestic)
- Much of the state is closed to new rights

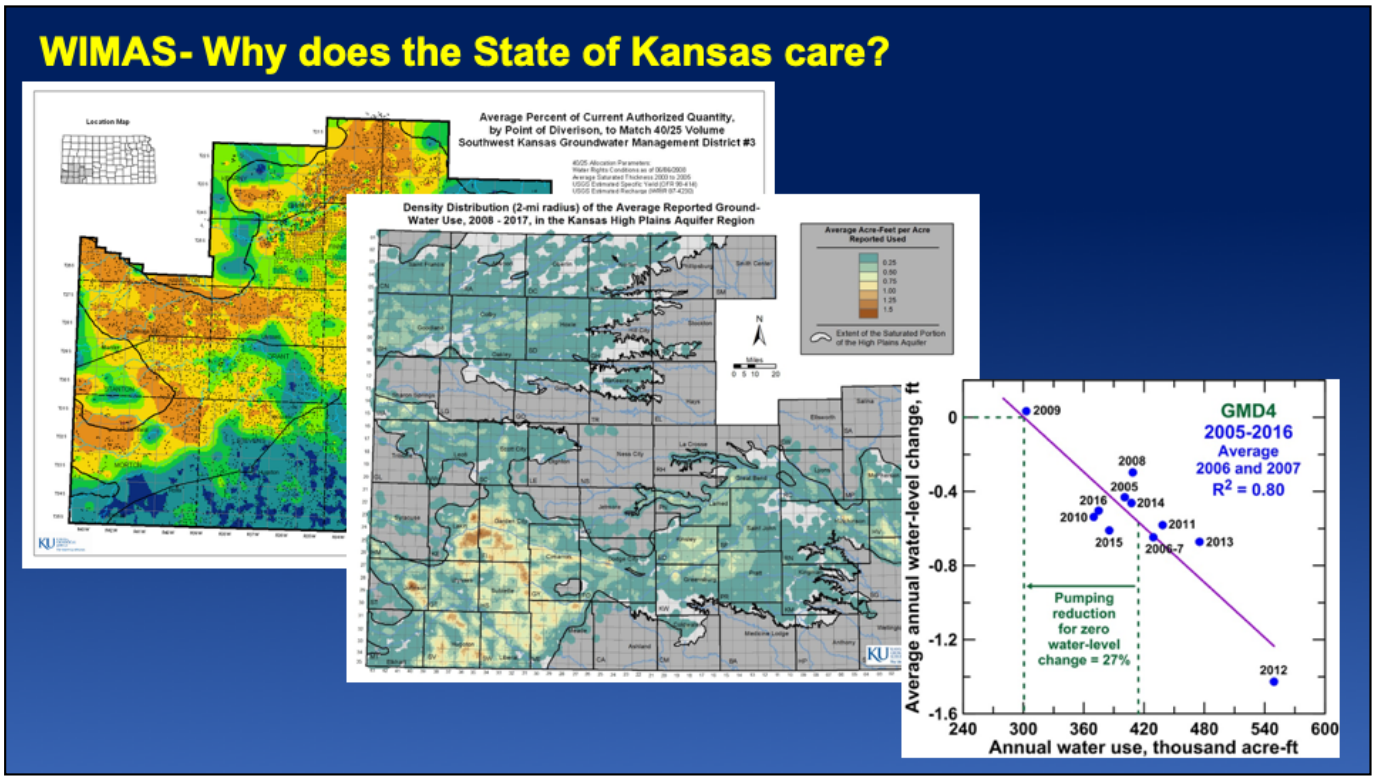


Question: Why do people care that there is a WIMAS database?

- Mark Twain's quote that "Whiskey is for drinking, water is for fighting" is applicable to many water management situations. Water management, whether in an environment of stressed supplies or one of surplus, can be very cantankerous with conflicts that range from the local to regional and even national scale.

- Water usage in Kansas is dominated by irrigated, groundwater use in the western half of the state and primarily municipal/industrial uses in eastern Kansas, where both ground and surface water supplies are used. All are governed under the same Kansas Water Appropriation Act.

- Larger, non-domestic users of water are required to obtain a water right; however, most of the state is officially closed to new water-right development. This leads to using the marketplace to buy and sell water rights to obtain additional water allocations. WIMAS is a free public portal for that water-right-based information.



The KGS uses water-right information to assist other agencies and local groundwater management districts in evaluating various management activities and proposals. The map in the upper left was developed for Southwest Kansas GMD 3, where a two-mile circle analysis was applied to every unique water right/use made of water/point of diversion combination to quantify how much of the existing annual allocations would need to be reapportioned to match the district's 40/25 policy (e.g., 40% of the amount of water in storage expressed as an annual value).

The middle map shows the density of average reported groundwater use from 2008 to 2017 over the Kansas HPA. In the Ogallala portion of the HPA (the western third of Kansas), areas of higher reported groundwater use generally correspond to areas of greater water-level decline. Reported water use in Kansas can be found for some water rights going back to 1958. However, 1990 is often used as a starting point for temporal analyses since this was the first year Kansas had a water-use quality control program in place.

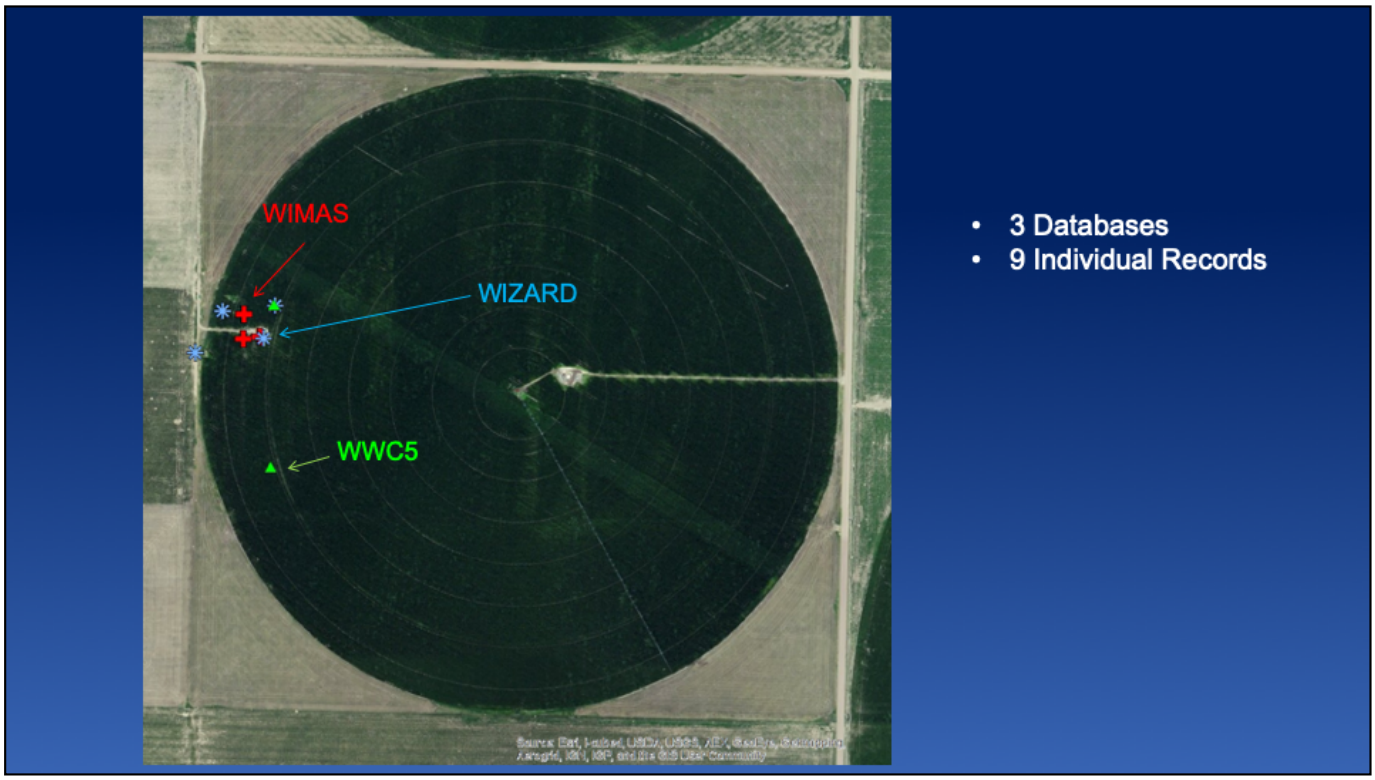
Using the relationship between water use and water-level change within the context of a water balance approach, the KGS has developed a method that allows for quick evaluations of changes in groundwater usage and what rate of groundwater decline can be expected as a result. In many cases, the reduction in pumping needed to stabilize water levels in the short term (a decade or two) is much less than traditional estimates. This data-driven approach is also being used to better calibrate regional flow models.

Master Well Inventory

The Issue That Was….

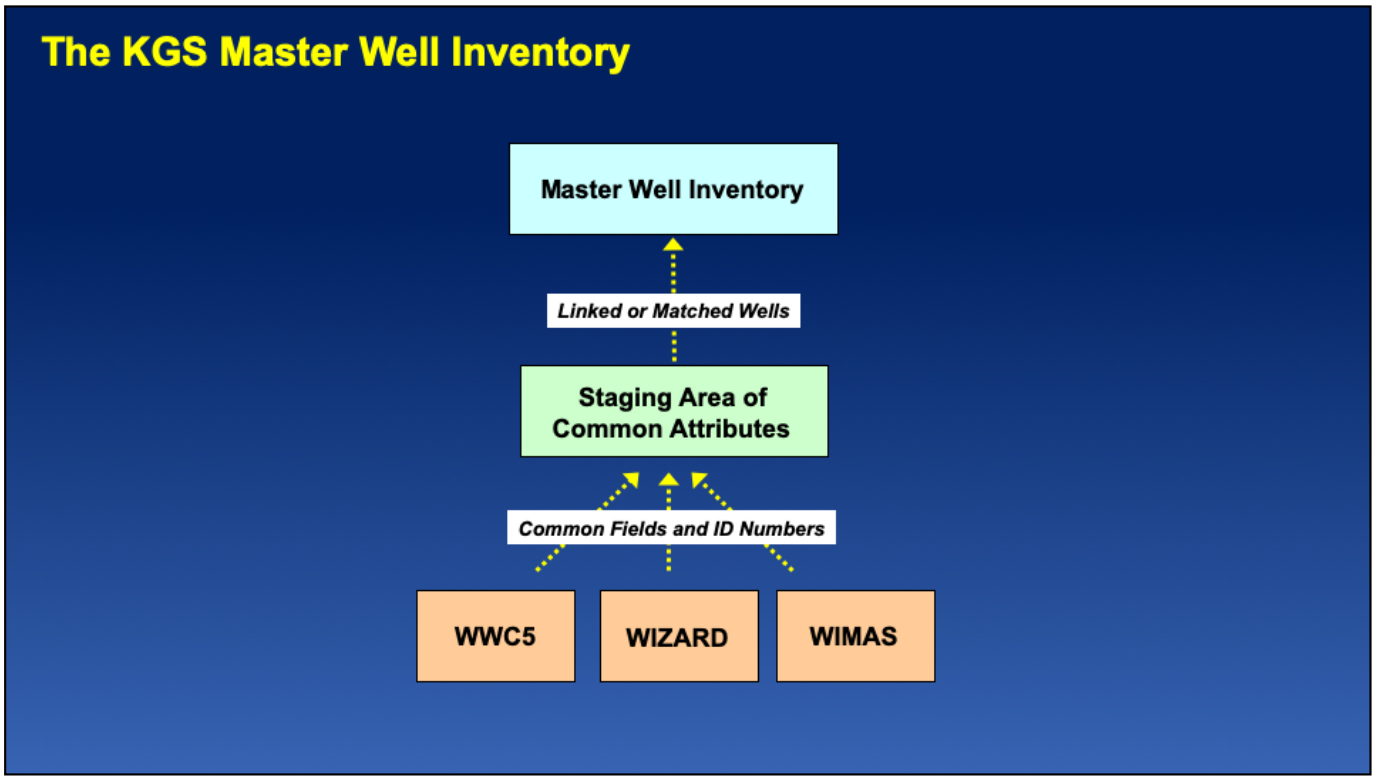
- Kansas is very data-rich.
  - Well construction and lithology
  - Measured depth to water
  - Reported Water Use
- Kansas does not have a single water agency
- **Multiple agencies, each with their own database**

The issue that was—multiple agencies with multiple groundwater databases.



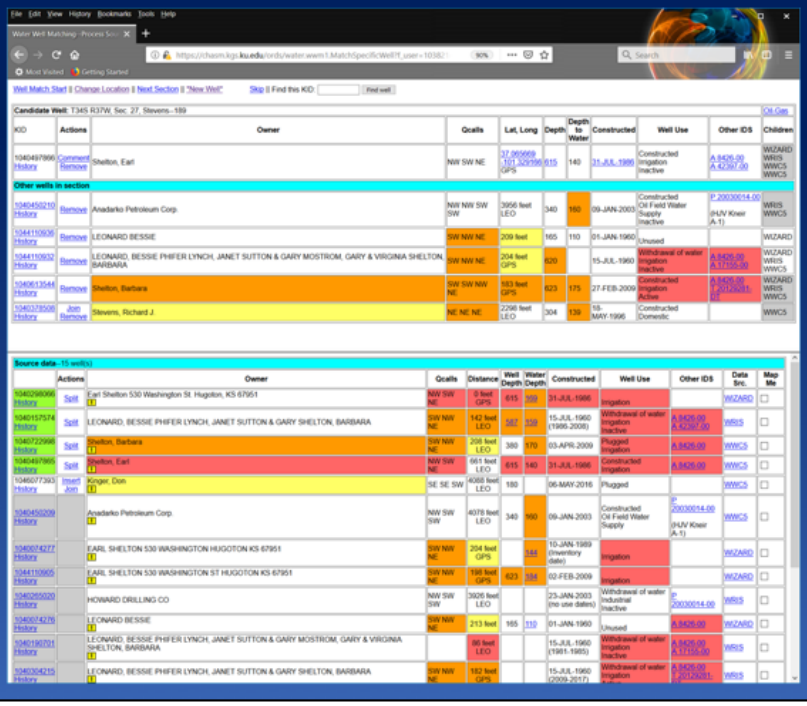
Example of a quarter section of ground somewhere in Kansas. If a person was investigating the amount of groundwater development that has taken place in this parcel of land, they would have to separately query three databases, from which nine individual database records would be returned. In this example, the records returned would be three records from WIMAS representing the known water-right activities, four from WIZARD representing measured wells (or wells historically archived in the older USGS system), and two from WWC5 for submitted driller logs.

Several of these database records reference the same groundwater well but it would be up to the user to associate any matching records.



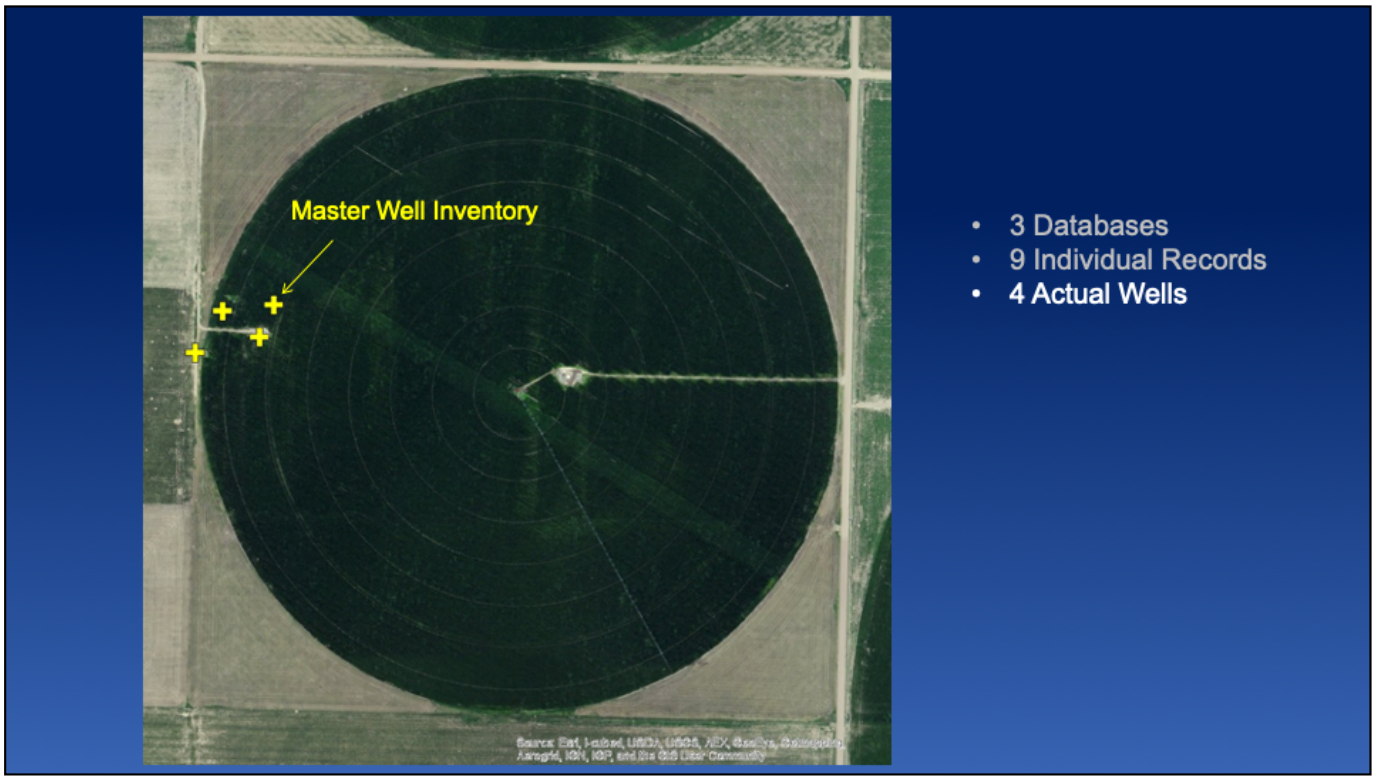
The Master Well Inventory was a project funded by the state water plan by which common fields and ID values from each of the source databases—in this case WWC5, WIZARD, and WIMAS—were inserted into an individual database table, which acts as a staging area to identify commonality among the database records. Matched database records and those determined to be unique well listings are then populated into another table referred to as the Master Well Inventory (MWI). The MWI represents well site locations and is composed of one or more source records. This removes duplication and allows information between the source records to be readily merged together.

Water Well Matcher



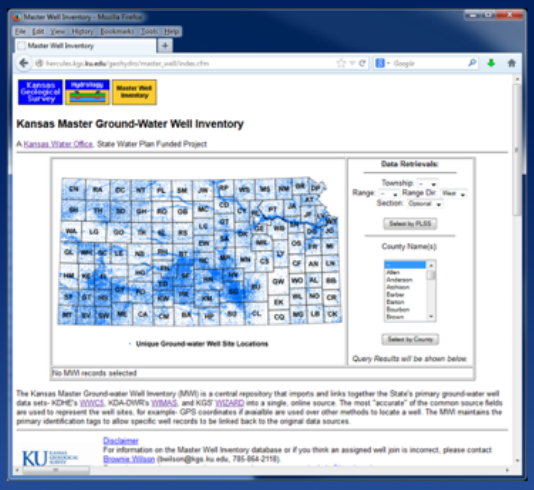
This is an example of a well matching page developed at the KGS. The upper frame displays records in the MWI. Records here can exist only if they are present in the lower frame, which displays source records from WWC5, WIZARD, and WIMAS. The well matching page facilitates well matching using various color shadings based on the common database attributes.

The top selected record in the MWI shows results for a single well location composed of four source database records. The MWI uses the best information available to describe a well's location. For example, if GPS coordinates are present in one of the source database records, they will be used to spatially plot the well's location.



With the MWI in place, there are really only four actual wells in this plot of ground. They are composed based on nine records from the three source databases, but the MWI has removed the duplication and allows users to seamlessly integrate data from WWC5, WIMAS, and WIZARD.

Master Well Inventory

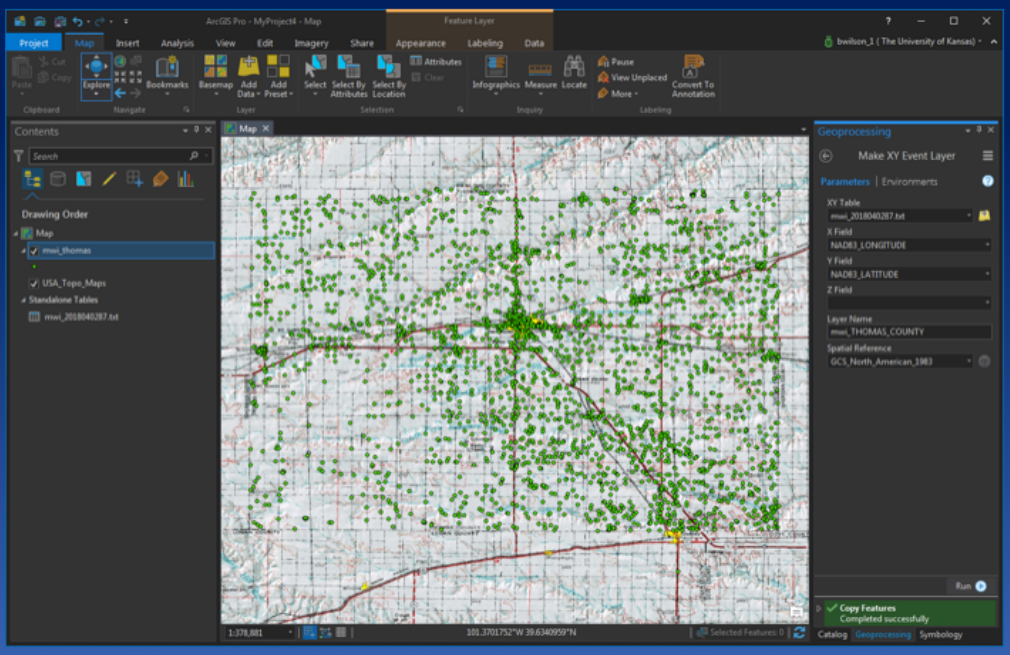


Map Service-
http://services.kansasgis.org/arcgis1/rest/services/water_wells/KansasWells/MapServer

Feature Service-
http://services.kansasgis.org/arcgis1/rest/services/water_wells/KansasWells/FeatureServer

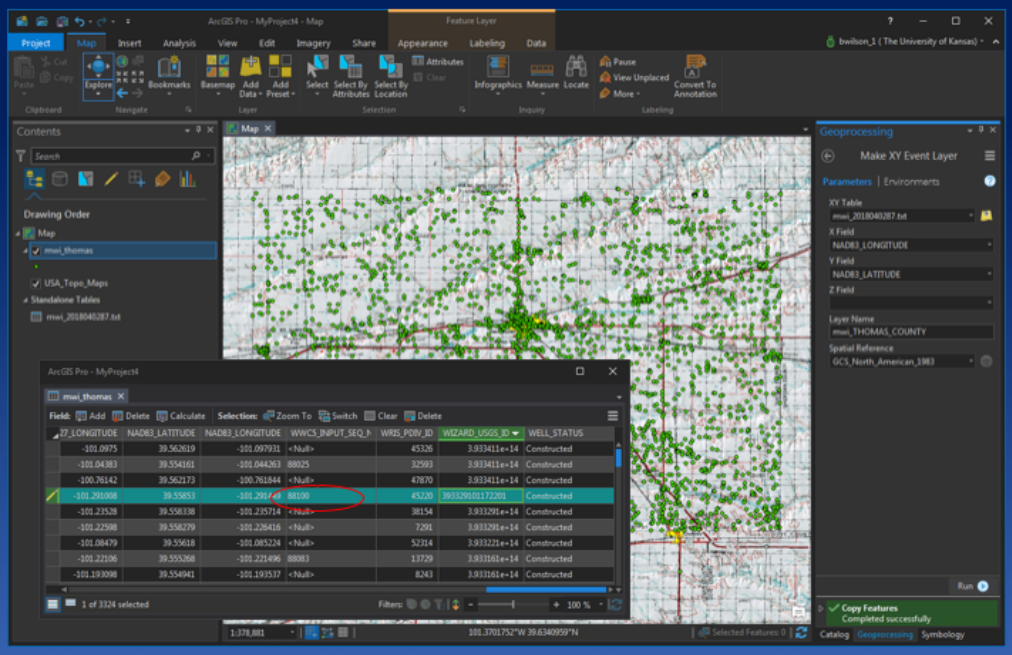
The KGS plans to greatly enhance the MWI but for now, static downloads can be made based on PLSS descriptions or county designations. For ArcGIS desktop or Pro users, map and feature services are created and published nightly, allowing the MWI points to be incorporated directly into data frames.

MWI in Action

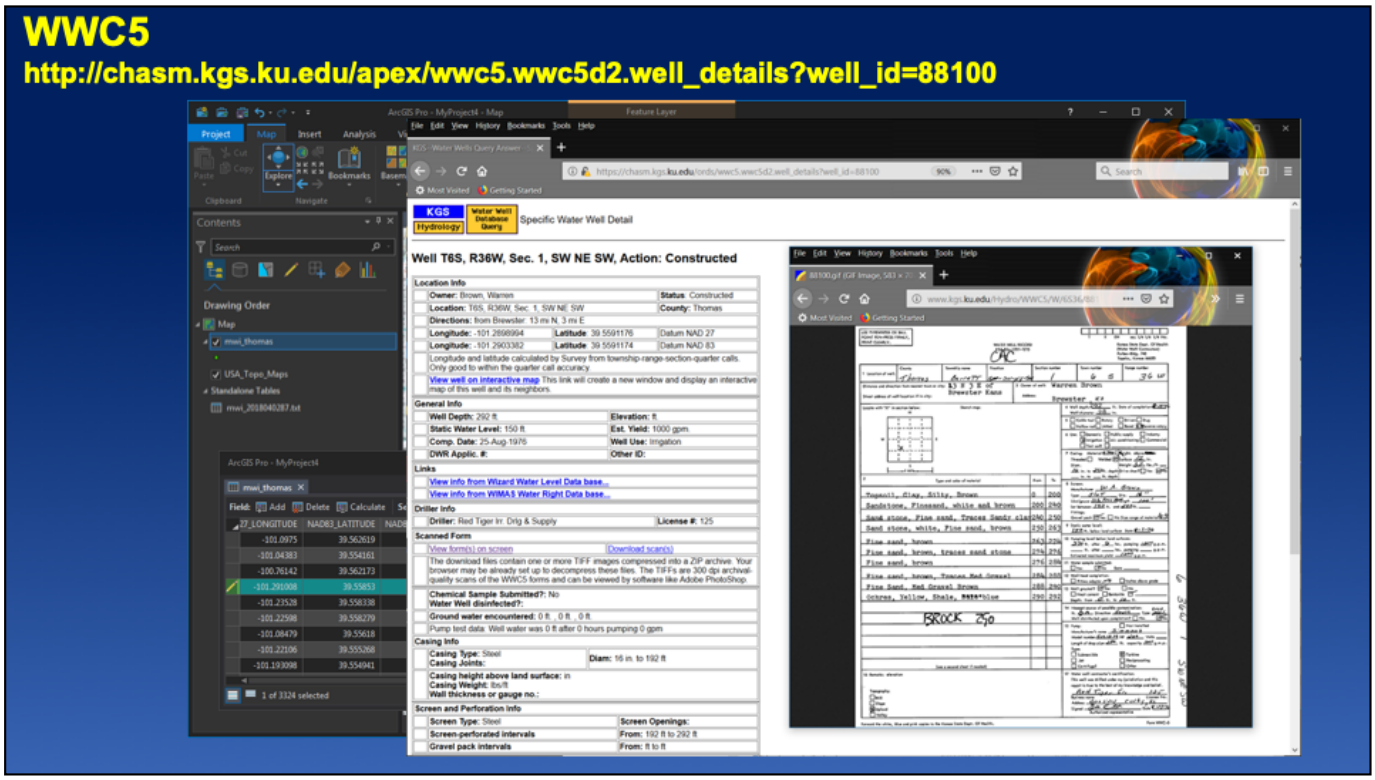


This is an example of using a comma-delimited ASCII download of wells selected in Thomas County, Kansas, from the MWI. Given the MWI has several coordinate options (geographic, UTM), the wells can readily be mapped using GIS software, in this case, ESRI's ArcPro GIS.

MWI in Action

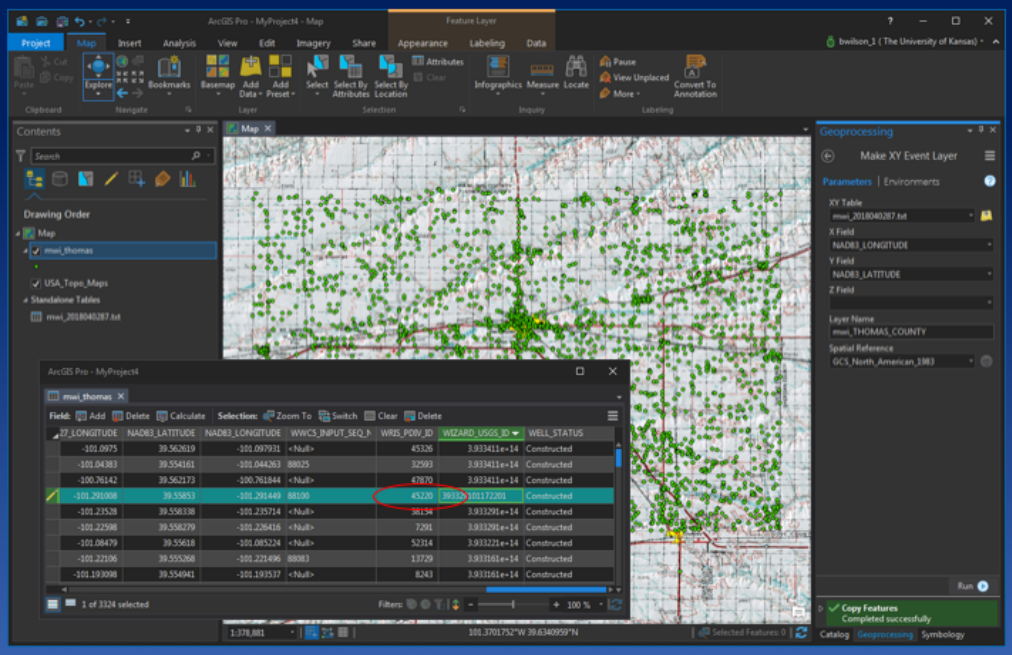


MWI downloads are populated with the common attributes from the source database, such as PLSS legal descriptions, county designations, well depth, construction date, and use(s) made of water. In addition, the primary key identifier from each of the source databases is also stored. In this example, the primary key for the WWC5 database for the selected well is 88100. This number can be used to quickly look up this specific source record from the WWC5 database directly, either through the use of hyperlinks within ArcPro or through cutting/pasting a URL into a web browser.

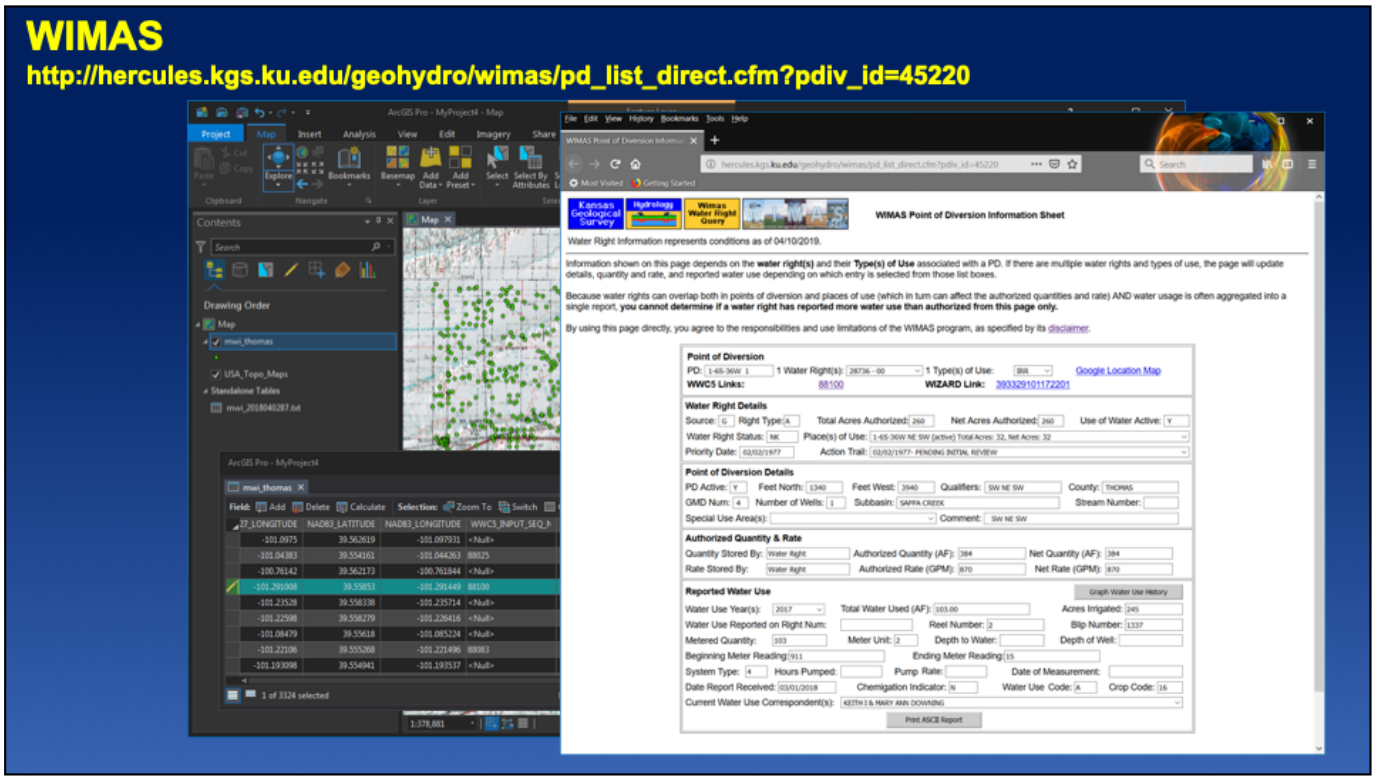


Example of the URL that uniquely identifies an individual WWC5 record. The URL calls data from the WWC5 database based on the listed well_id—in this case, 88100.

MWI in Action

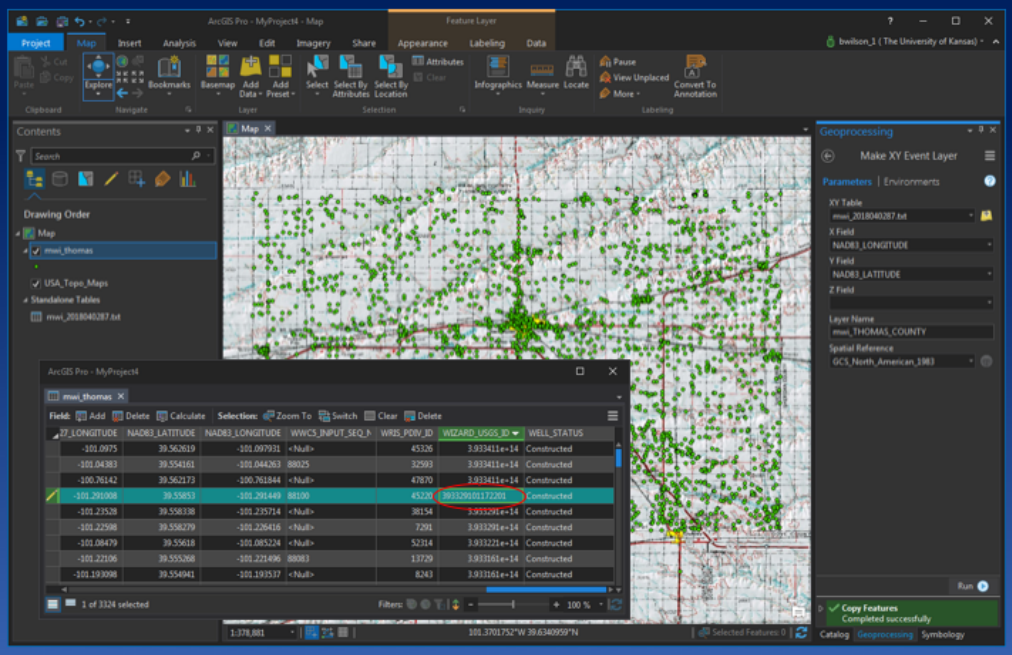


The primary key for the WIMAS (or WRIS) database for a point of diversion is the pdiv_id, which for this selected well MWI record is 45220. This number can be used to quickly look up specific information directly from the WIMAS database, either through the use of hyperlinks within ArcPro or through cutting/pasting a URL into a web browser.

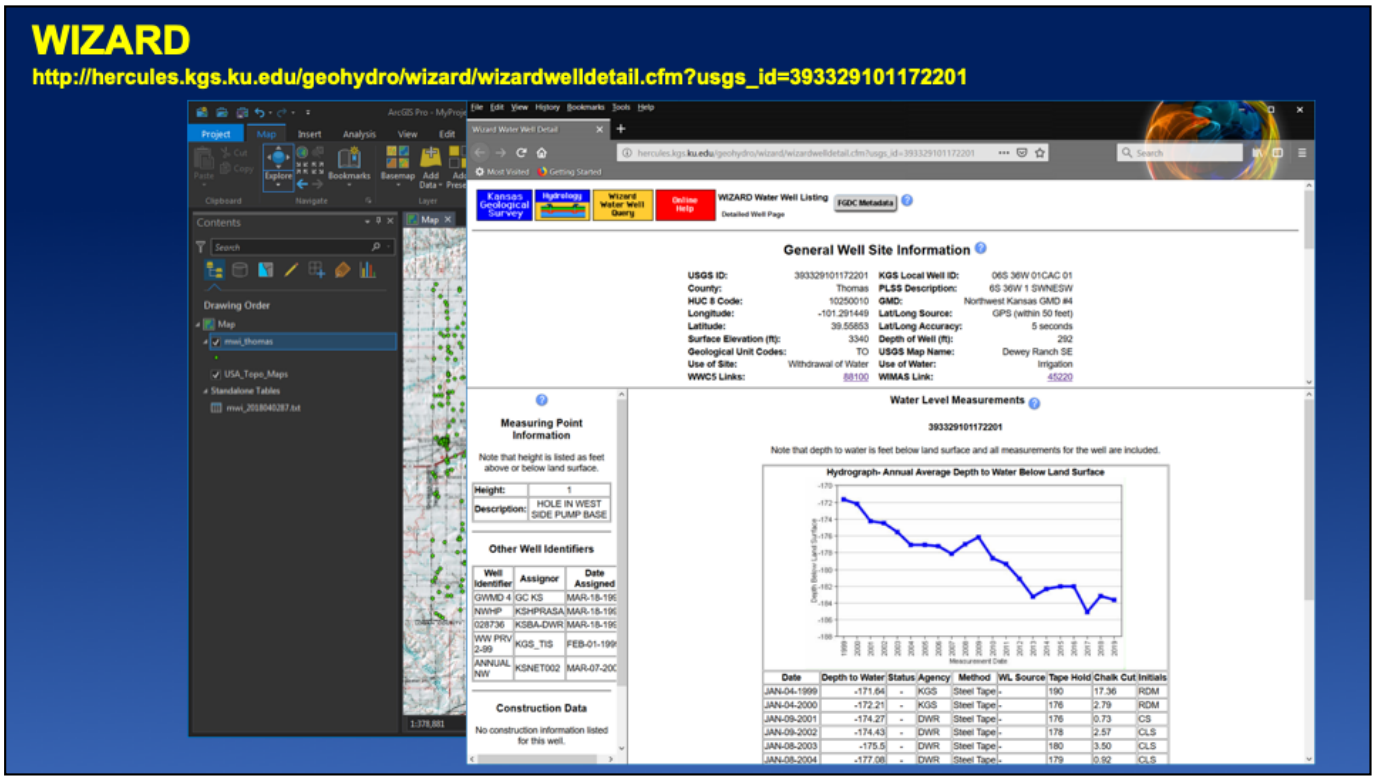


Example of the URL that uniquely identifies an individual WIMAS point of diversion record. The URL calls data from the WIMAS database based on the listed pdiv_id—in this case, 45220.

MWI in Action



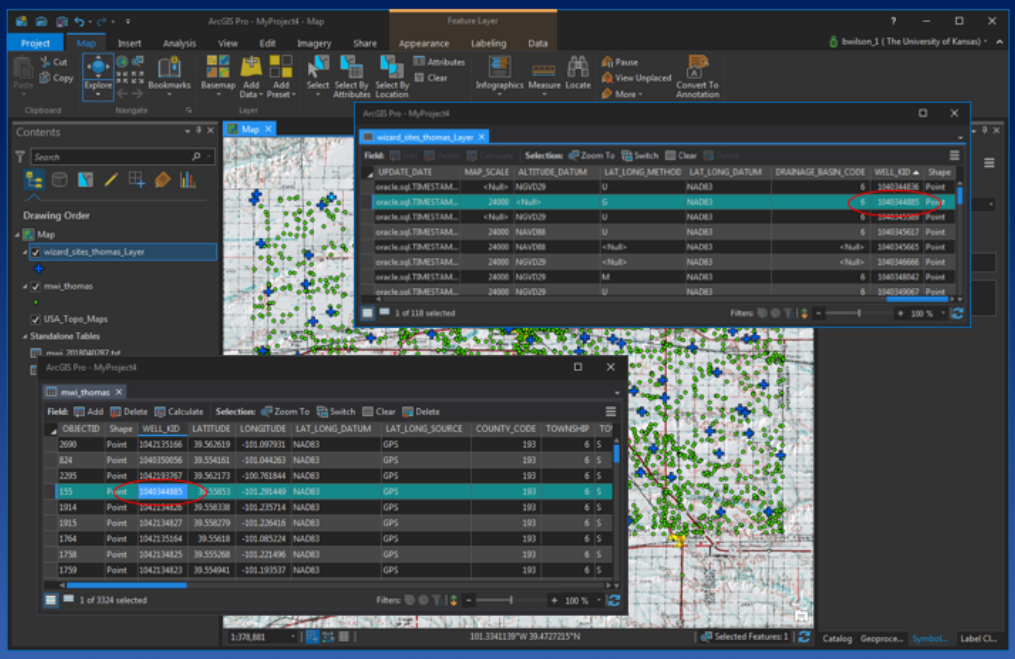
The primary key for the WIZARD database is the USGS_ID, which for the selected MWI well in this example is 393329101172201. This number can be used to quickly look up this record from the WIZARD database, either through the use of hyperlinks within ArcPro or through cutting/pasting a URL into a web browser.



Example of the URL that uniquely identifies an individual WIZARD record. The URL calls data from the WIZARD database based on the listed usgs_id.

This example from the WIZARD website shows how the MWI has been integrated within the web applications of each of the source databases. This WIZARD site/web page allows users to quickly bring up information from WWC5 and WIMAS using the provided links.

WELL_KID is the Primary Key



The primary key for the MWI is a field called WELL_KID. This number uniquely identifies well records in the MWI and is also added to downloads for WIMAS, WIZARD, and WWC5. In the example above, additional data from WIZARD for wells in Thomas County, Kansas, were downloaded and displayed within ArcPro along with the MWI wells. You can see the WELL_KID field is part of the WIZARD well's attribute table. The WELL_KID field can be used to relate or join data among all the source databases and MWI.

Questions????

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Lawrence, KS 66047
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Visit our site at
http://www.kgs.ku.edu

Thank You!