

Statewide Characterization of Oklahoma's Major Aquifers

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Oklahoma Clean Lakes & Watersheds Conference

April 5-6, 2017

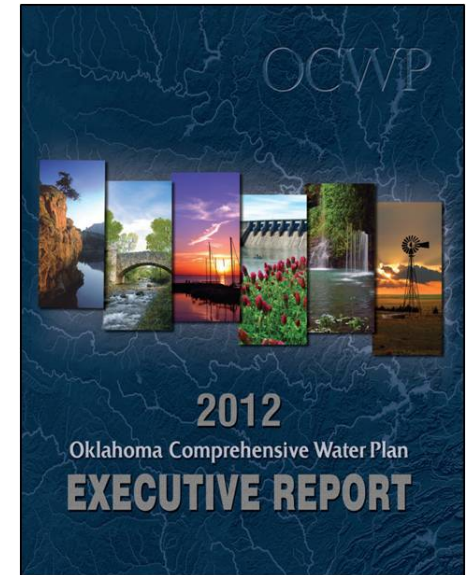


Groundwater Monitoring Background

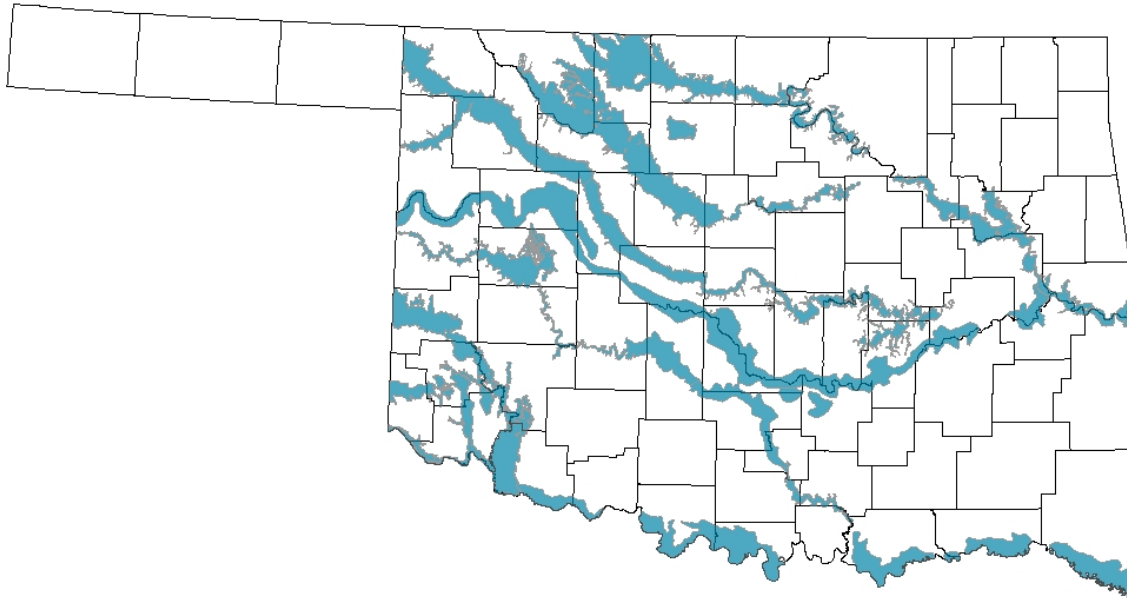
- Majority of Groundwater Monitoring: Compliance
- Water level monitoring since 1950s
- Ambient water quality monitoring piecemeal, largely unfunded
- No holistic, long-term, aquifer-based, statewide groundwater quality/quantity monitoring program prior to 2012

Groundwater Monitoring & Assessment Program (GMAP)

- Legislative funding following adoption of OCWP High Priority Recommendations (2012)
- Baseline of water quality and quantity
- Random, spatially distributed network
- Characterize aquifers and identify concerns

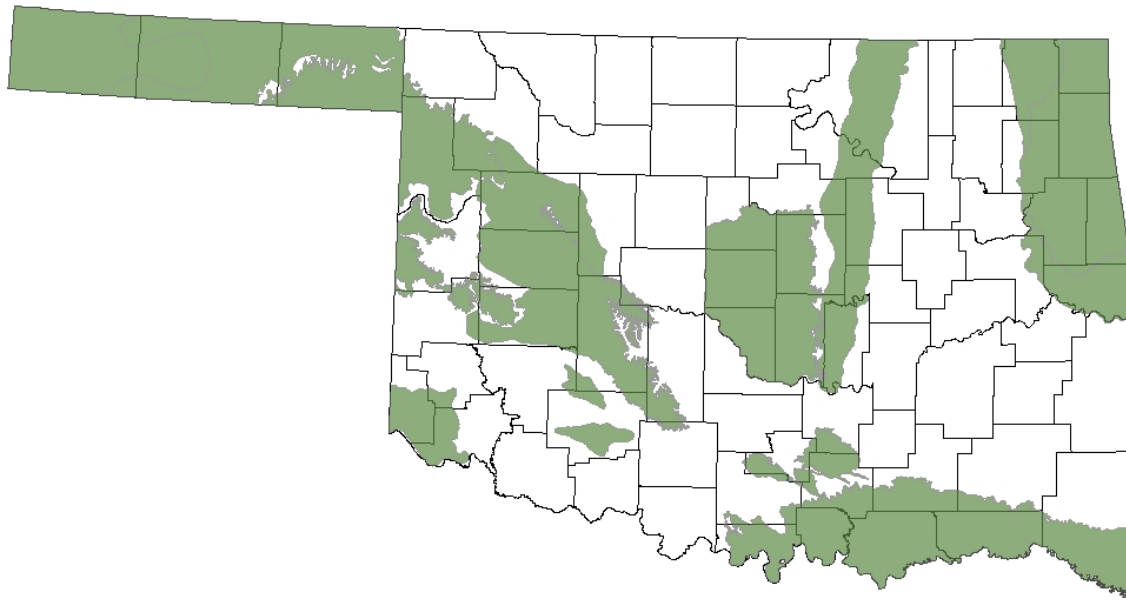


Oklahoma's Aquifers: Alluvium & Terrace



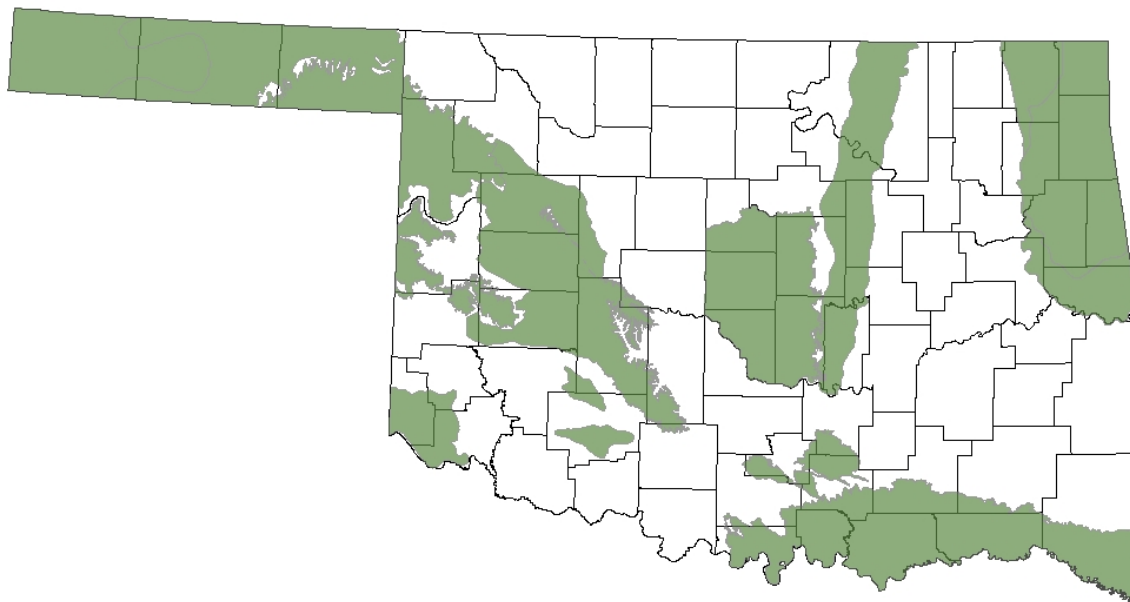
- › Shallow, unconsolidated sand & gravel aquifers
- › Generally in communication with a river or stream, but not always (e.g., Enid Isolated Terrace)
- › Highly vulnerable to surface contamination

Oklahoma's Aquifers: Bedrock



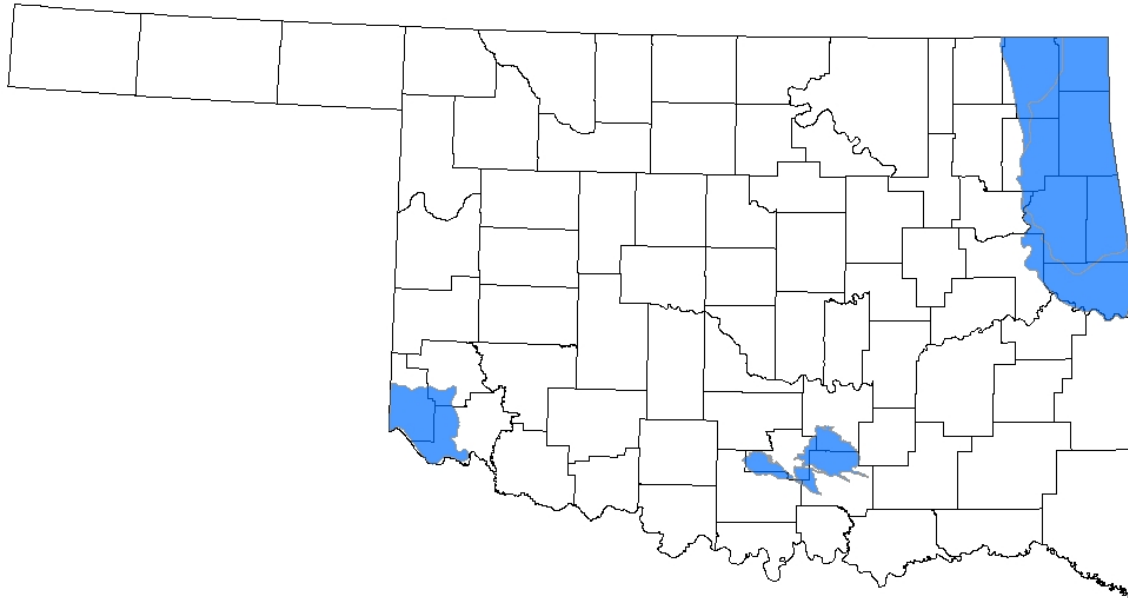
- › Made of water-bearing rock formations underlying surface
- › Semiconsolidated or consolidated
- › Unconfined, confined, or both
- › Characteristics vary widely based on hydrogeology

Oklahoma's Aquifers: Bedrock



- › Massive sandstone
- › Interbedded sandstone/shale
- › Semi-consolidated sand/silt/caliche
- › Gypsum
- › Dolomite
- › Limestone

Oklahoma's Aquifers: Karst



› Formations dominated by limestone, dolomite, or gypsum

› Fractured or cavernous

› Karst areas home to caves, springs, can hold large quantities of water

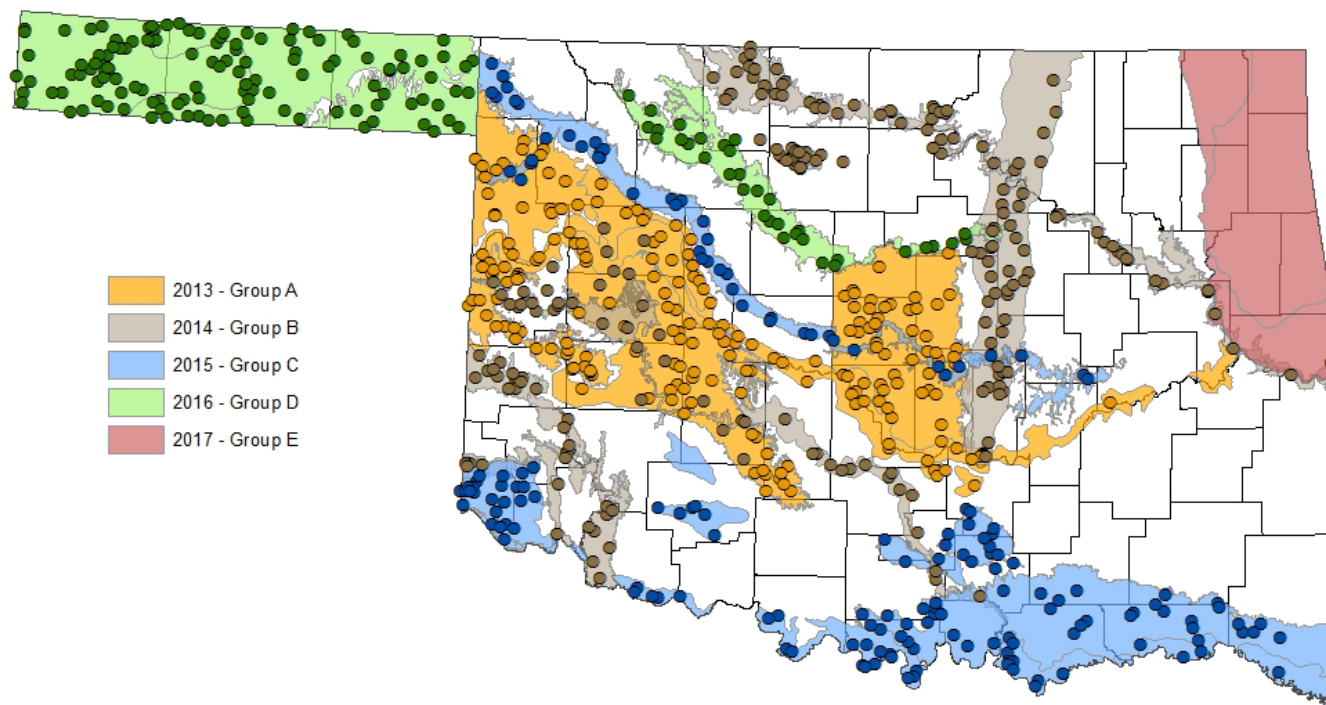
› Responsive to weather, vulnerable to surface contamination

Laboratory and Field Parameters

General Chemistry						
Dissolved Oxygen (mg/L)		Well Depth (ft)	Depth to Water (ft)		Total Diss. Solids (mg/L)	
Specific Conductance (µS/cm)		pH	Hardness (mg/L)		Alkalinity (mg CaCO3/L)	
Major Ions (mg/L)						
Calcium	Magnesium	Potassium	Sodium		Silica	Bromide
Chloride	Fluoride	Sulfate	Calculated Bicarbonate (mg/L)			
Nutrients (mg/L)						
Nitrate + Nitrite		Total Dissolved Phosphorus			Ammonia	
Isotopes (‰)						
Deuterium			Oxygen-18			
Metals & Trace Elements, Dissolved (µg/L or mg/L)						
Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium
Chromium	Cobalt	Copper	Iron	Lead	Lithium	Manganese
Mercury	Molybdenum	Nickel	Selenium	Silver	Strontium	Titanium
Thallium	Thorium	Uranium	Vanadium	Zinc		

Baseline Sampling Schedule

Trend network
implementation
scheduled for
Fall 2018



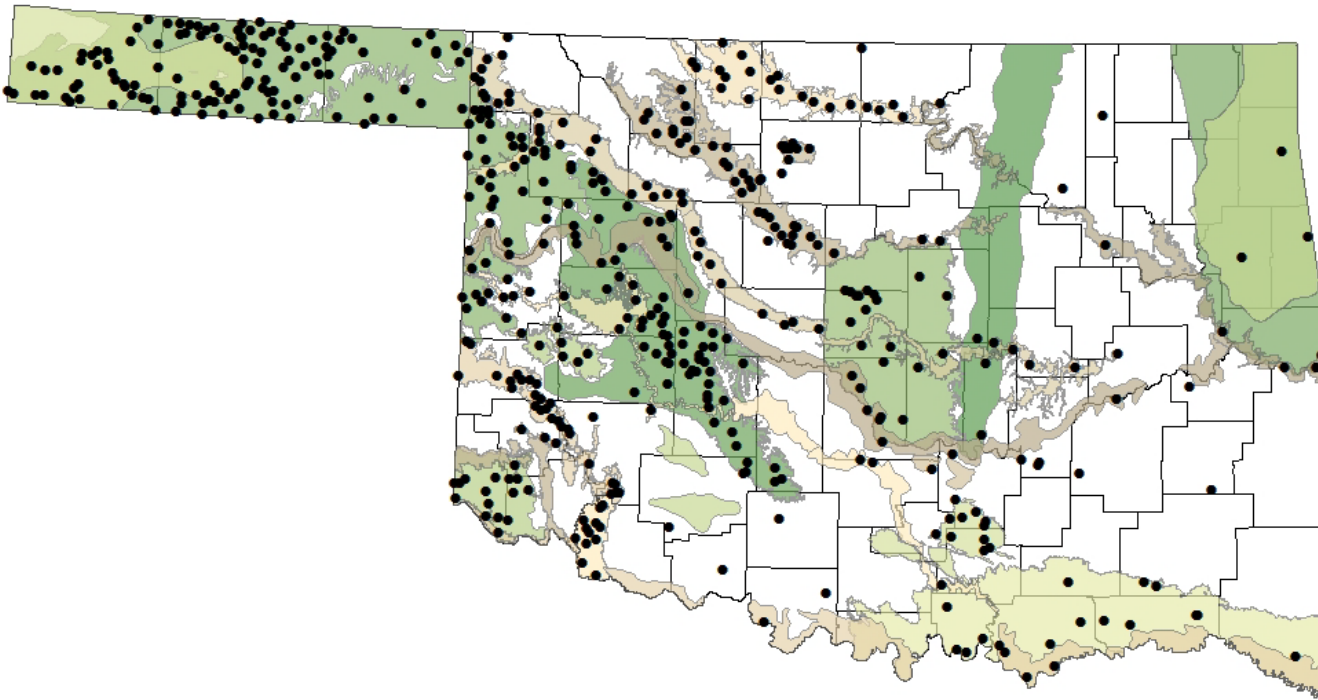
Quantity Program Expansion

Water level network
in 2013

Number of wells
doubled in capacity
from historical
network

(530 to 1,100 wells)

Spatially
representative
distribution of wells



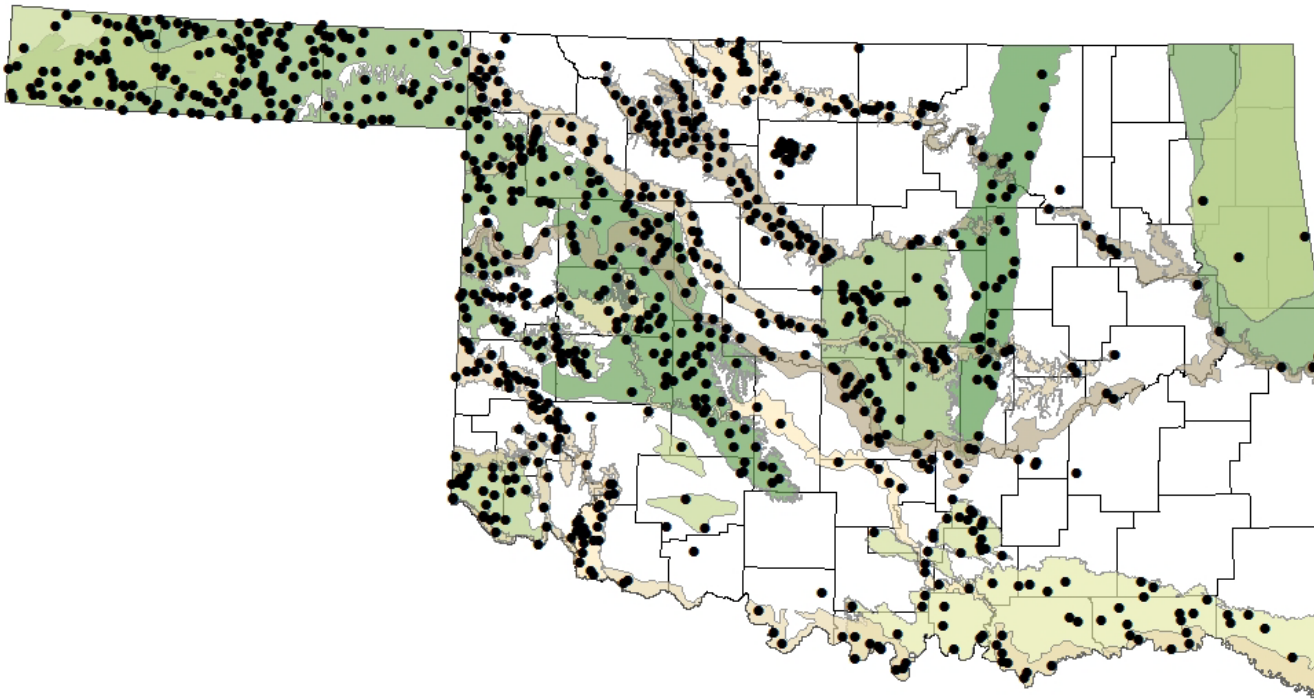
Quantity Program Expansion

Water level network
in 2017

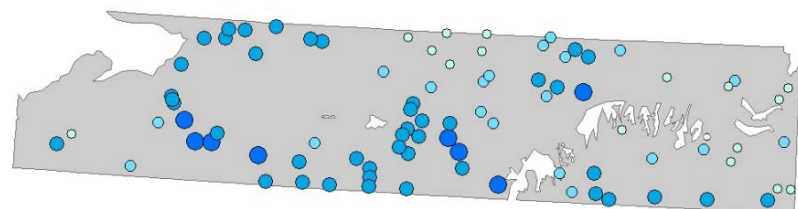
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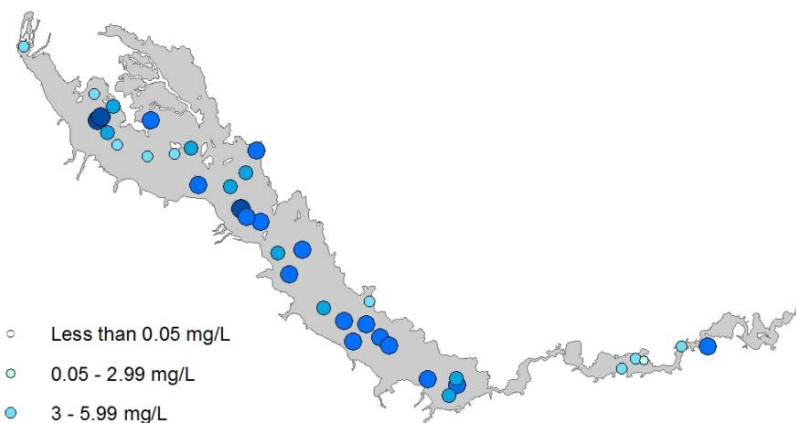
Quality Data



- Less than 0.2 mg/L
- 0.2 - 0.49 mg/L
- 0.5 - 0.99 mg/L
- 1 - 1.99 mg/L
- 2 - 3.99 mg/L

Fluoride concentrations in the panhandle portion of the Ogallala aquifer (sampled 2016)

SMCL=2 mg/L, MCL=4 mg/L

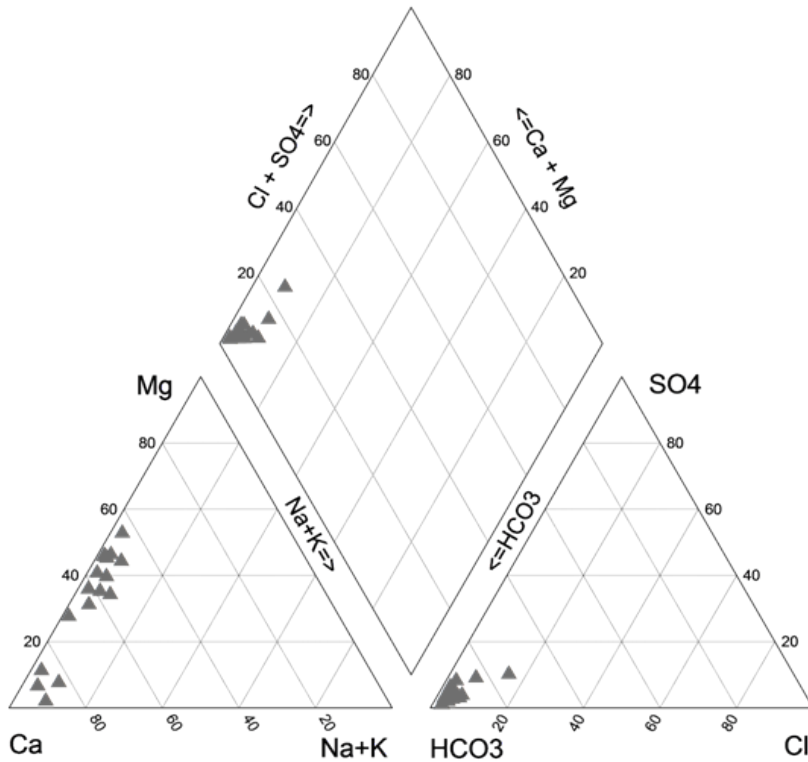


- Less than 0.05 mg/L
- 0.05 - 2.99 mg/L
- 3 - 5.99 mg/L
- 6 - 9.99 mg/L
- 10 - 19.9 mg/L
- 20 mg/L or greater

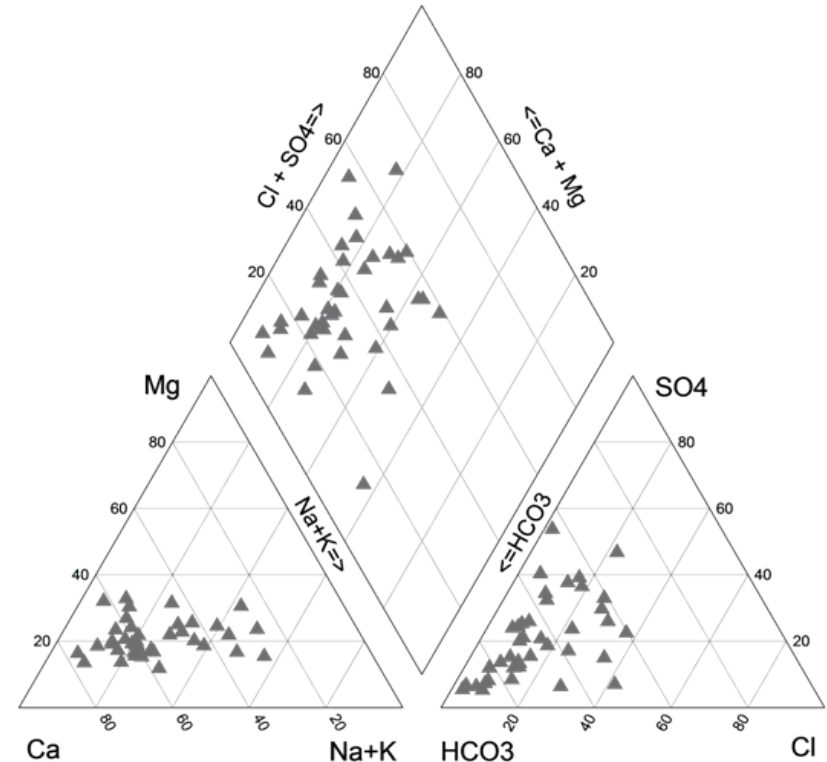
Nitrate + nitrite concentrations in the Cimarron alluvial & terrace aquifer (sampled 2016)

MCL=10 mg/L (as nitrate)

Quality Data



Piper plot of the Arbuckle-Simpson aquifer (sampled 2015)



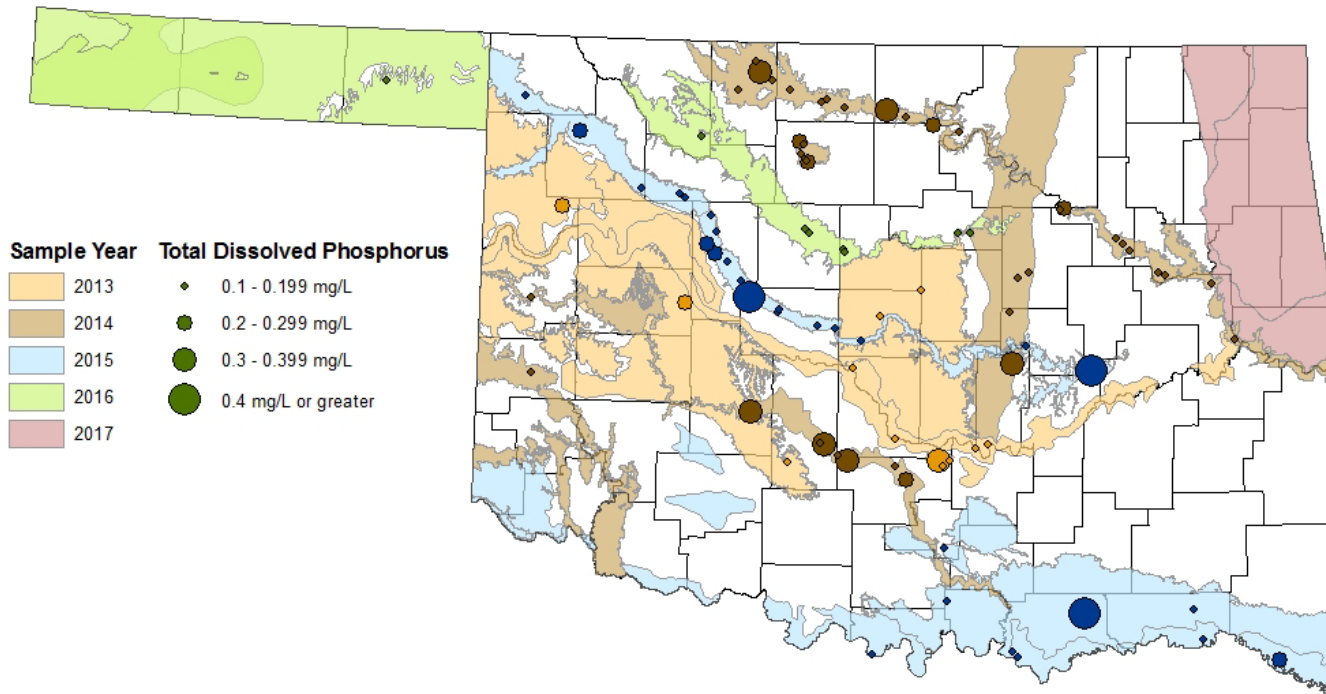
Piper plot of the North Canadian alluvial & terrace aquifer (sampled 2015)

Quality Data

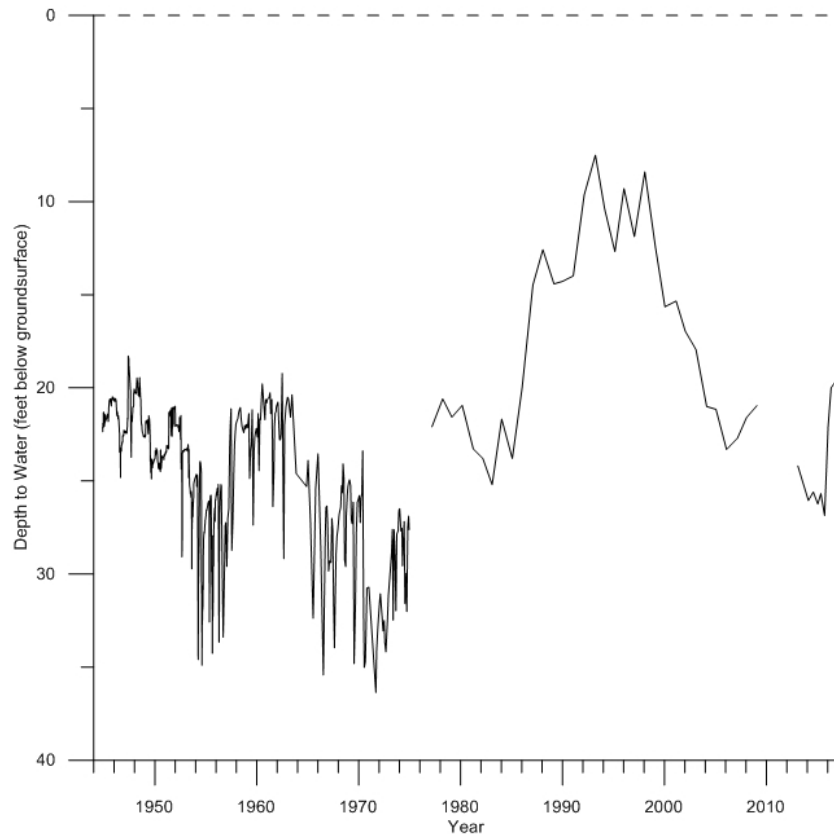
- Common water quality concerns:
 - Nitrate + nitrite: >MCL in 16/22 aquifers
 - Arsenic: >MCL in 6 aquifers
 - Uranium: >MCL in 4 aquifers
 - Other >MCL: fluoride, lead, selenium (1 aquifer ea.)
 - TDS, pH, chloride, sulfate, iron, manganese: >SMCL in 10 or more aquifers
 - 16 aquifers classified very hard or extremely hard (mean hardness >180 mg/L)

Quality Data

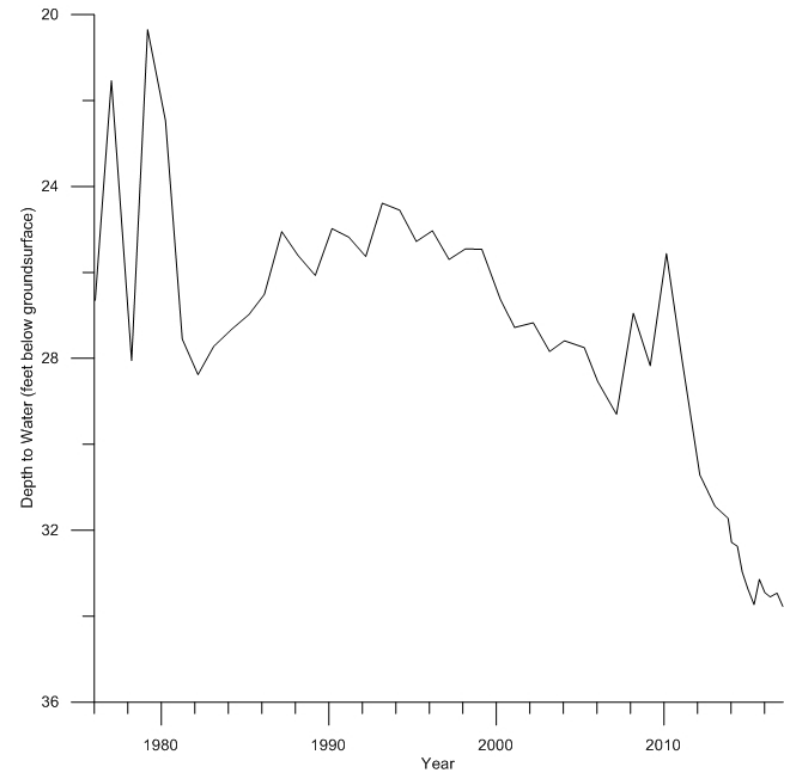
Occurrence of
total dissolved
phosphorus
values 0.1 mg/L
or greater



Quantity Data

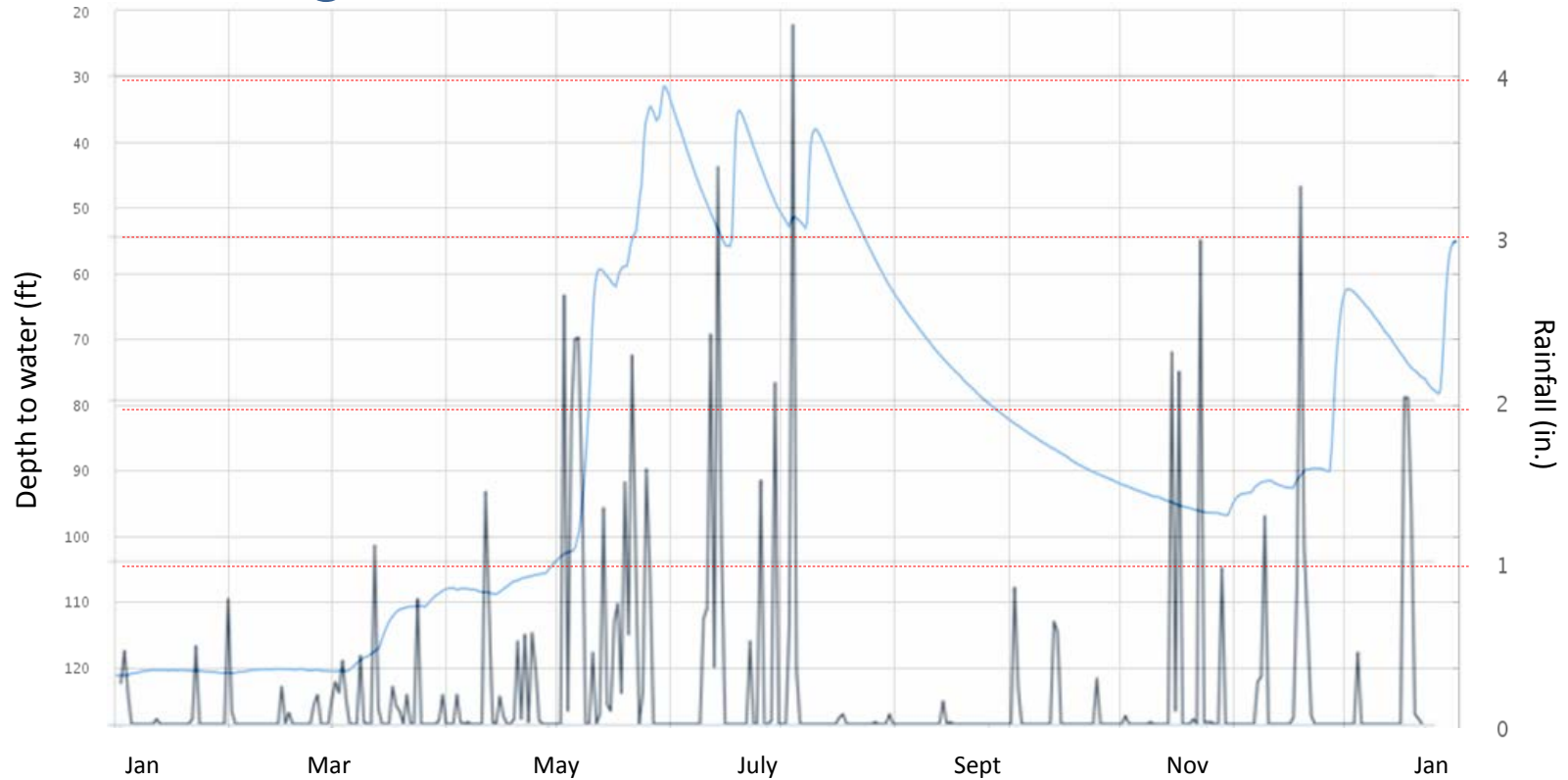


Hydrograph of a long-term monitoring well drilled in Tillman Terrace aquifer, Tillman County



Hydrograph of a long-term monitoring well drilled in Garber-Wellington aquifer, Oklahoma County

Quantity Data

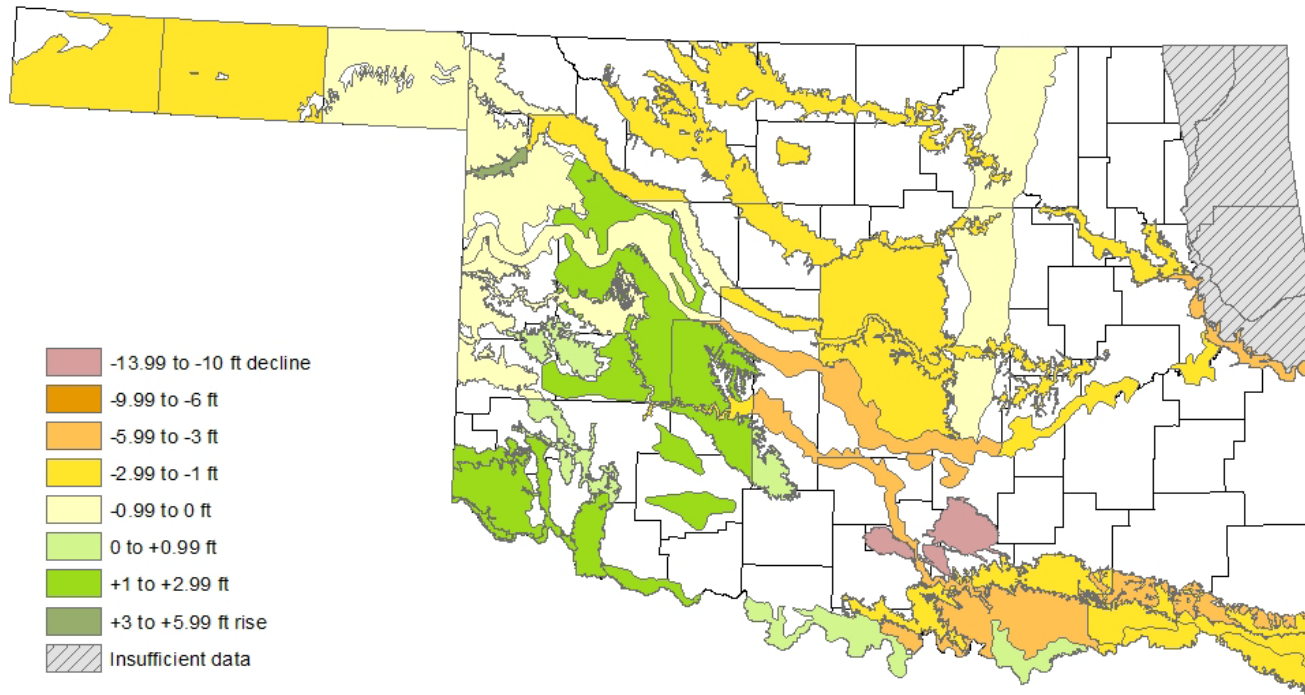


2015 water levels at Fittstown Mesonet site, Pontotoc County

2015 precipitation at Fittstown Mesonet site, Pontotoc County

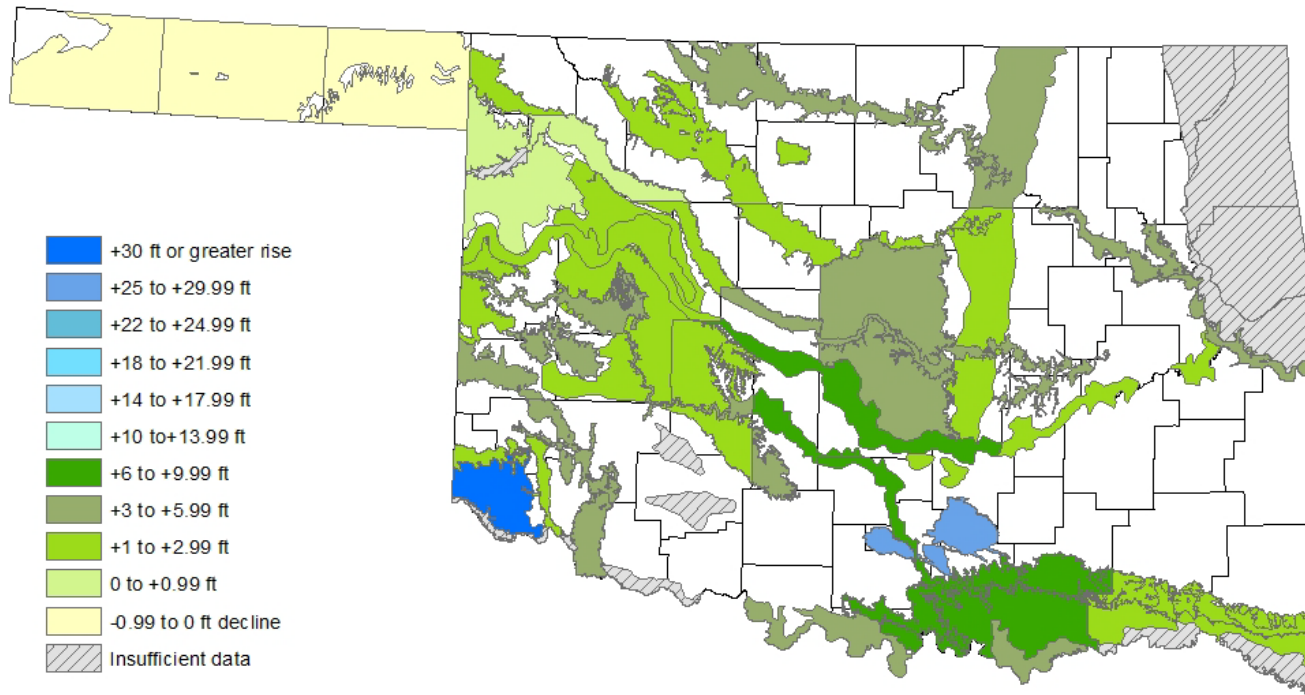
Quantity Data

Statewide one-year changes in water level by aquifer and climate region, 2016-2017



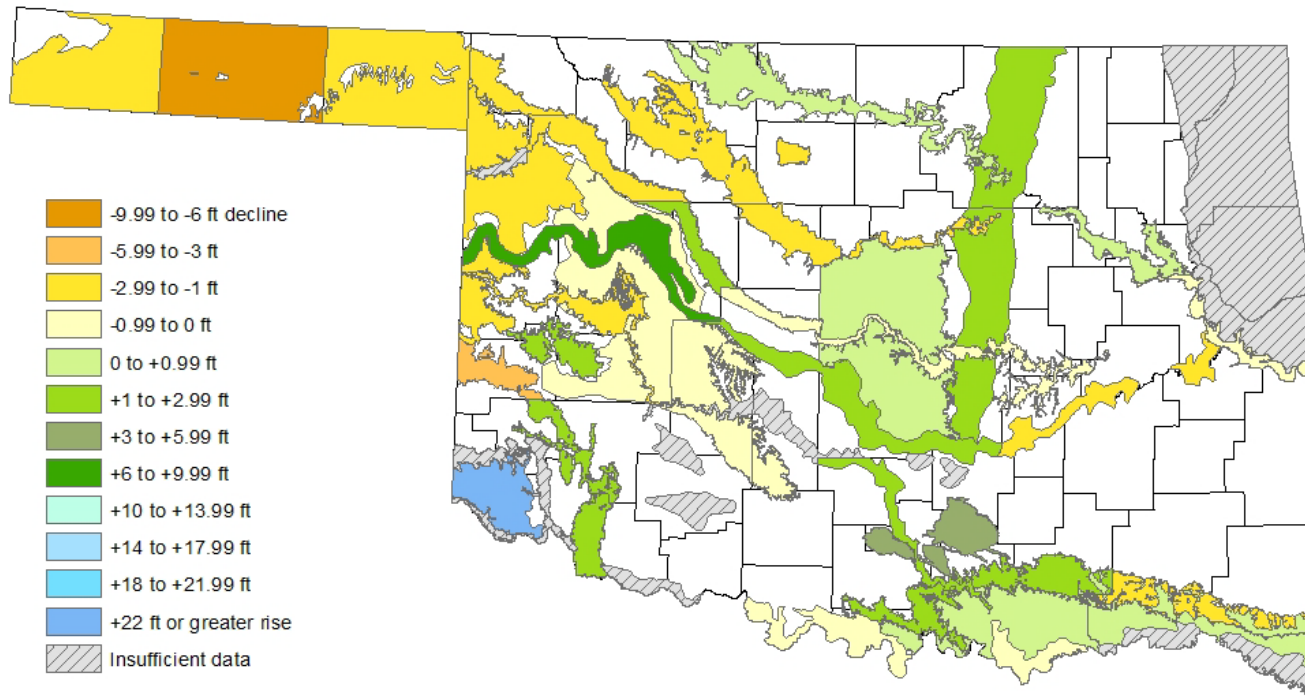
Quantity Data

Statewide one-year changes in water level by aquifer and climate region, 2015-2016



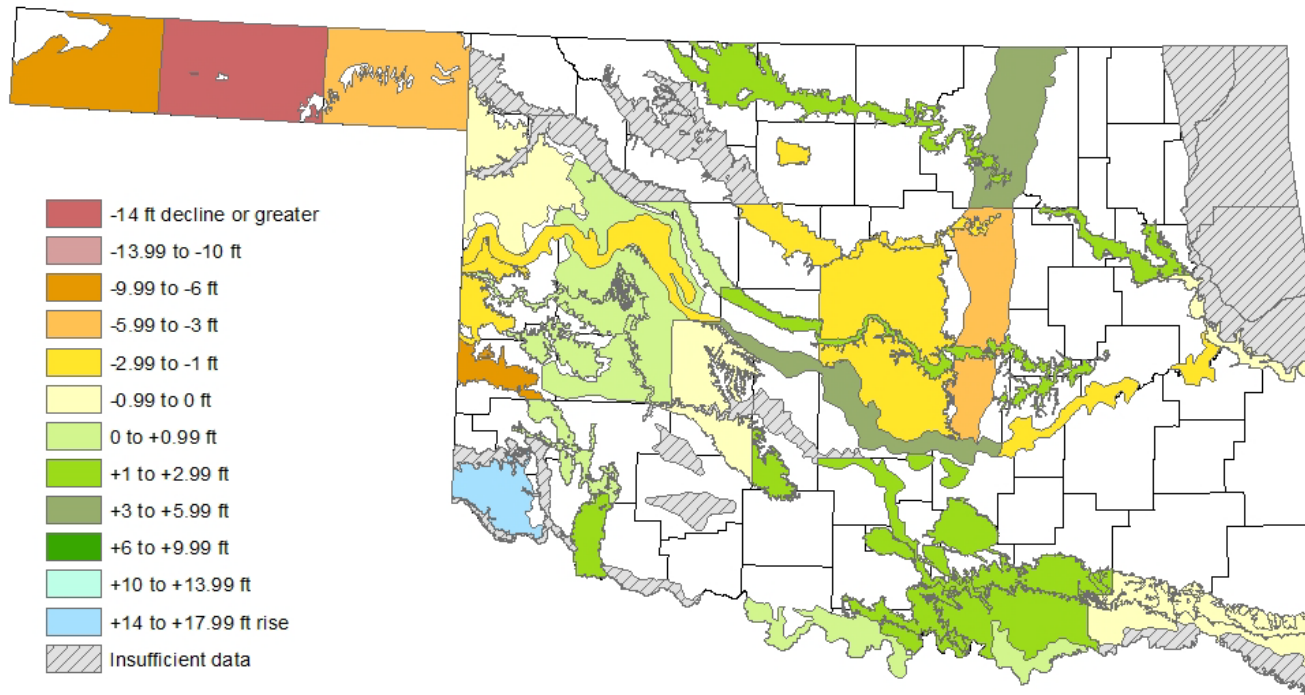
Quantity Data

Statewide five-year changes in water level by aquifer and climate region, 2012-2017

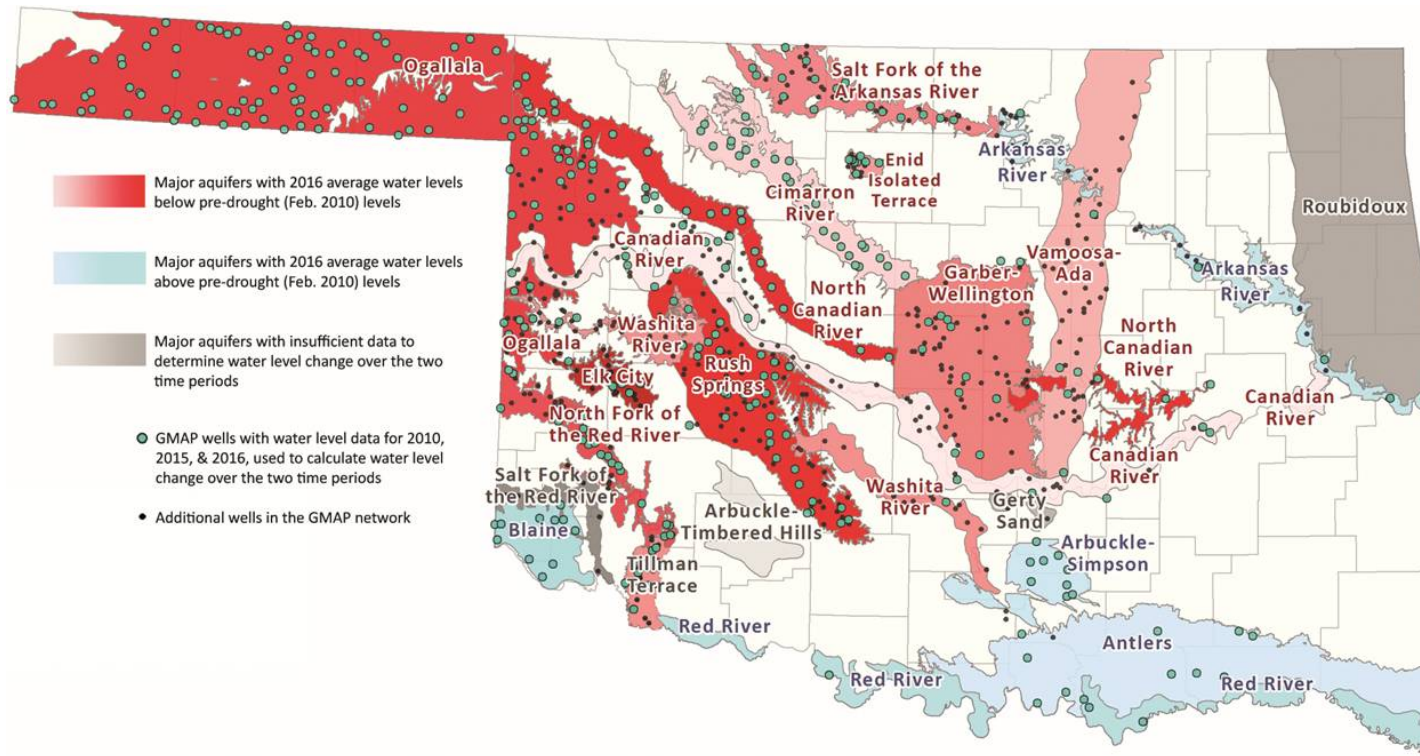


Quantity Data

Statewide ten-year changes in water level by aquifer and climate region, 2007-2017

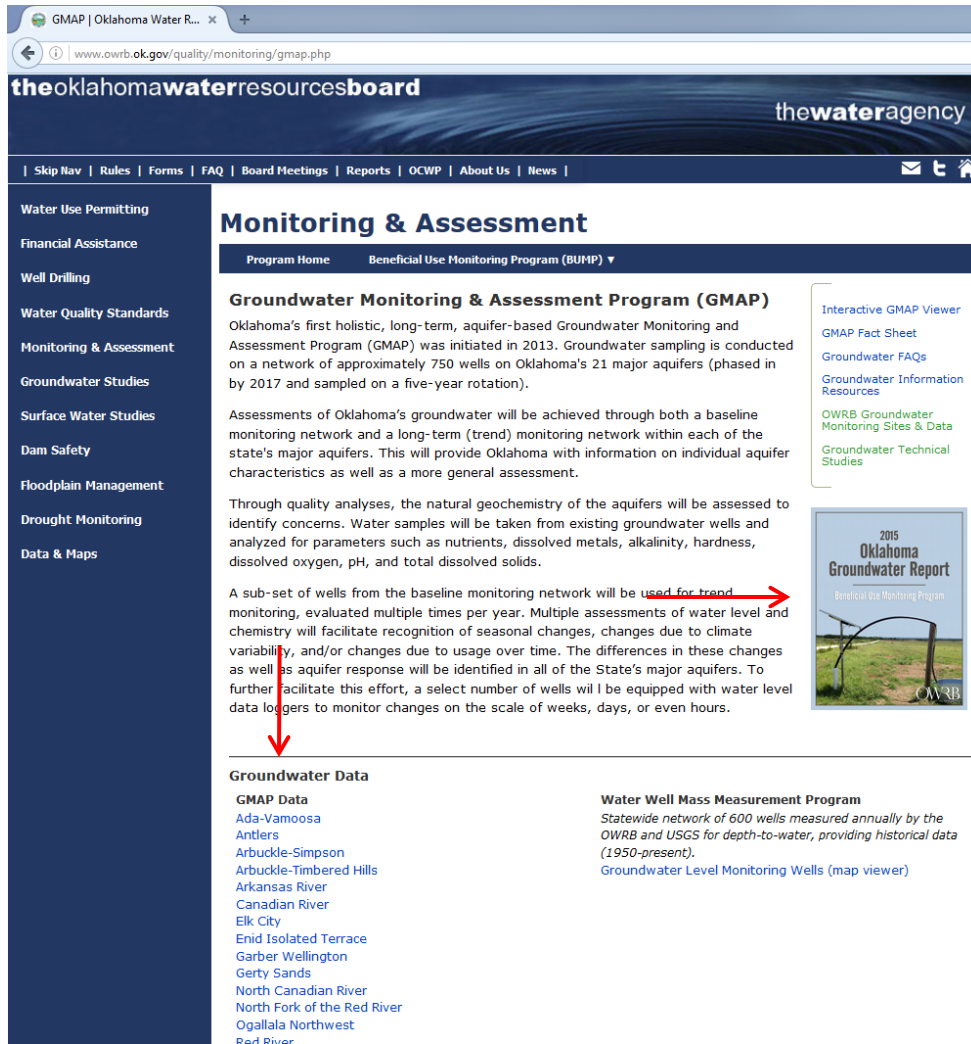


Quantity Data



Aquifer response to historic 2015 rainfalls compared to pre-drought (Feb. 2010 levels)

Where to Find Data



GMAP | Oklahoma Water Resources Board

www.owrb.ok.gov/quality/monitoring/gmap.php

theoklahomawaterresourcesboard thewateragency

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Program Home Beneficial Use Monitoring Program (BUMP) ▼

Groundwater Monitoring & Assessment Program (GMAP)

Oklahoma's first holistic, long-term, aquifer-based Groundwater Monitoring and Assessment Program (GMAP) was initiated in 2013. Groundwater sampling is conducted on a network of approximately 750 wells on Oklahoma's 21 major aquifers (phased in by 2017 and sampled on a five-year rotation).

Assessments of Oklahoma's groundwater will be achieved through both a baseline monitoring network and a long-term (trend) monitoring network within each of the state's major aquifers. This will provide Oklahoma with information on individual aquifer characteristics as well as a more general assessment.

Through quality analyses, the natural geochemistry of the aquifers will be assessed to identify concerns. Water samples will be taken from existing groundwater wells and analyzed for parameters such as nutrients, dissolved metals, alkalinity, hardness, dissolved oxygen, pH, and total dissolved solids.

A sub-set of wells from the baseline monitoring network will be used for trend monitoring, evaluated multiple times per year. Multiple assessments of water level and chemistry will facilitate recognition of seasonal changes, changes due to climate variability, and/or changes due to usage over time. The differences in these changes as well as aquifer response will be identified in all of the State's major aquifers. To further facilitate this effort, a select number of wells will be equipped with water level data loggers to monitor changes on the scale of weeks, days, or even hours.

[Interactive GMAP Viewer](#)

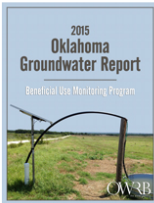
[GMAP Fact Sheet](#)

[Groundwater FAQs](#)

[Groundwater Information Resources](#)

[OWRB Groundwater Monitoring Sites & Data](#)

[Groundwater Technical Studies](#)



Groundwater Data

GMAP Data

- [Ada-Vamoosa](#)
- [Antlers](#)
- [Arbuckle-Simpson](#)
- [Arbuckle-Timbered Hills](#)
- [Arkansas River](#)
- [Canadian River](#)
- [Elk City](#)
- [Enid Isolated Terrace](#)
- [Garber Wellington](#)
- [Gerty Sands](#)
- [North Canadian River](#)
- [North Fork of the Red River](#)
- [Ogallala Northwest](#)
- [Red River](#)

Water Well Mass Measurement Program

Statewide network of 600 wells measured annually by the OWRB and USGS for depth-to-water, providing historical data (1950-present).

[Groundwater Level Monitoring Wells \(map viewer\)](#)

<http://www.owrb.ok.gov/gmap>

Where to Find Data

Oklahoma Water Resource... x +

www.owrb.ok.gov/maps/index.php

Interactive Maps & GIS Data

Water Use Permitting

Financial Assistance

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Drought Monitoring

Data & Maps

OWRB General Viewer
This map includes layers from the old WIMS viewer.
OWRB GIS Data

Dam Inventory of Oklahoma
Dam Inventory GIS Data

Floodplains in Oklahoma
Floodplain GIS Data (FEMA)

Garber-Wellington Groundwater Wells with Maximum Trace Metal Concentrations
Groundwater GIS Data

Groundwater Level Monitoring Wells in Oklahoma
Groundwater GIS Data

Groundwater Monitoring & Assessment Program (GMAP)

Frequently Requested Maps

Lakes of Oklahoma

Rural Water Systems

National Wetlands Inventory (NWI) Mapping Project

Historic Flood Maps

Bathymetric (Contour) Lake Maps

Arbuckle-Simpson Hydrology Study GIS Data

Viewing GIS Data

Cooperative Water Planning Tool (DEQ) **NEW!**

Spatial Data Sets for Water (USGS)

Center for Spatial Analysis (OU)

Oklahoma GIS Council

USGS Oklahoma District GIS

South Central Arc Use Group

<http://www.owrb.ok.gov/maps>

Where to Find Data

The screenshot shows the Oklahoma Water Resources Board website. The header includes the board's name and logo, along with navigation links like Skip Nav, Rules, Forms, FAQ, Board Meetings, Reports, OCWP, About Us, and News. A sidebar on the left lists various categories: Water Use Permitting, Financial Assistance, Well Drilling, Water Quality Standards, Monitoring & Assessment, Groundwater Studies, Surface Water Studies, Dam Safety, Floodplain Management, Drought Monitoring, and Data & Maps. The main content area is titled 'Technical Reports & Publications' and contains a paragraph about the availability of reports. Below this is a table listing groundwater reports with their titles and publication dates.

Technical Reports | Oklaho... x +

www.owrb.ok.gov/studies/reports/reports.php

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Water Use Permitting

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Data & Maps

Technical Reports & Publications

OWRB technical reports and publications are listed by topic and publication date below. Out of print publications may be available for loan from your public library.

Groundwater | Stream Water Availability | Water Quality Monitoring | Lake Restoration | Water Quality Standards
Bathymetric Surveys | Oklahoma Comprehensive Water Plan | Drought | OWRB Annual/Status Reports | Out of Print Publications

Groundwater	Date
Hydrogeological Framework, Numerical Simulation of Groundwater Flow, and Effects of Projected Water Use and Drought for the Beaver-North Canadian River Alluvial Aquifer, Northwestern Oklahoma	2015
Hydrogeology and Simulation of Groundwater Flow in the Garber-Wellington Aquifer	2013
Hydrogeology and Simulation of Groundwater Flow in the Arbuckle-Simpson Aquifer	2011
Arbuckle-Simpson Hydrology Study Final Report to the US Bureau of Reclamation	2009
Hydroclimatic Reconstruction of the Arbuckle-Simpson Aquifer using Tree Rings	2009
Arbuckle-Simpson (FFY 2007) Hydrology Study Annual Report	2008
Arbuckle-Simpson (FFY 2006) Hydrology Study Annual Report	2007
Arbuckle-Simpson (FFY 2005) Hydrology Study Annual Report	2006
Hydrogeologic Investigation of the Ogallala Aquifer in Roger Mills & Beckham Counties, Western Oklahoma	2002
Update of the Hydrologic Survey of the Tillman Terrace Groundwater Basin, Southwest Oklahoma	2002
Impact of Concentrated Animal Feeding Operations on Oklahoma City's Water Supplies	2002
Hydrogeologic Investigation Report of the Boone Groundwater Basin, Northeast Oklahoma	2001
Hydrogeologic Investigation Report of the Kiamichi, Potato Hills, Broken Bow, Pine Mountain, and Holly Creek Minor Groundwater Basins in Southeast Oklahoma	2001
Groundwater Levels in Observation Wells in Oklahoma, 1998-2000	2001
Hydrologic Report of the El Reno, Fairview, Isabella and Loyal Minor Groundwater Basins in Central Oklahoma	2000
Rapid Recharge of Parts of the High Plains Aquifer Indicated by a Reconnaissance Study in Oklahoma (OWRB/USGS)	2000
Water Flow in the High Plains Aquifer in Northwestern Oklahoma (OWRB/USGS)	2000
Groundwater Level Changes in Oklahoma, 1978-1998	1999
Hydrologic Report of the Woodbine, Marietta, and Texoma Minor Bedrock Groundwater Basins and the Haworth Terrace and Utile River Alluvial and Terrace Minor Groundwater Basins	1998
Statewide Groundwater Vulnerability Map of Oklahoma	1999
Vulnerability Assessment of Twelve Major Aquifers in Oklahoma	1998
Hydrologic Report of the Southwest Oklahoma Groundwater Basin in Caddo, Kiowa and Jackson Counties	1998

<http://www.owrb.ok.gov/reports>

Groundwater Quality Contacts

- Data Requests
 - WQDataRequest@owrb.ok.gov
- Mark Belden, GMAP Manager
 - mark.belden@owrb.ok.gov
- Chris Adams, WQ Data Manager
 - chris.adams@owrb.ok.gov

Thank you

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