GROUNDWATER MONITORING AND ASSESSMENT PROGRAM

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Oklahoma Clean Lakes and Watersheds
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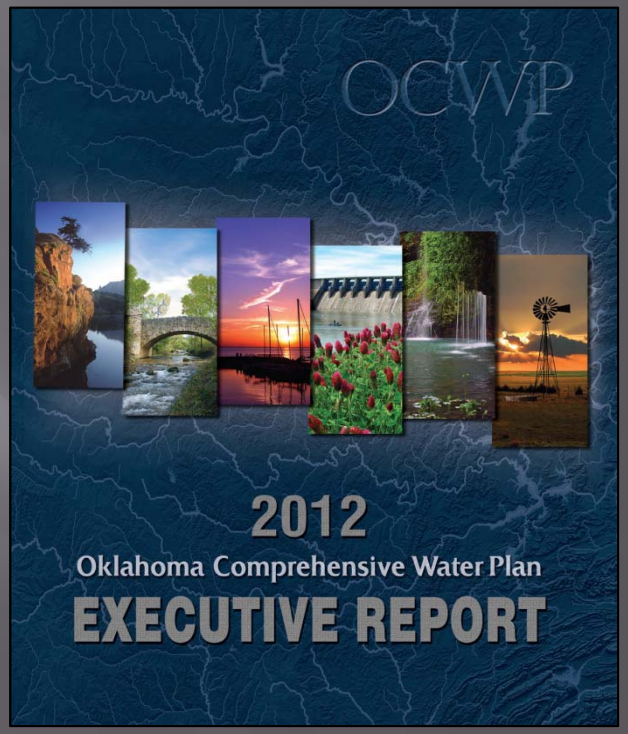
State of Oklahoma
OWRB
WATER RESOURCES BOARD
the water agency

Groundwater Monitoring Initiative

- Made possible through legislative adoption of Oklahoma's Comprehensive Water Plan Update (OCWP) and its High Priority Recommendations (2012).
- Second key ingredient: obtaining a secure funding source
  - OK Legislature funded this new initiative
  - Also restored funding levels for the state's "BUMP" program
  - Added an additional 1.5M/year



OCWP Recommendations

PRIMARY RECOMMENDATIONS

- Water project & infrastructure funding (81 B)
- Regional planning groups
- Surplus/Excess water
- Instream flows (Bio-Rec)
- State/Tribal water consultation & resolution
- Water conservation
- Water supply reliability
- **Monitoring**

MONITORING RECOMMENDATIONS

- Integration of SW/GW quality monitoring programs.
- Stable funding to support.
  - Gaging
  - BUMP
  - Non-Point Source
  - Point Source (agriculture, mining & oil and gas)
- Creation of an ambient groundwater quality program.
- Fully implement state-wide program for the collection of biological data.

Data for Decision Making

- Contrasted with "BUMP", the OCWP cited the lack of an ambient groundwater monitoring program as a weakness in Oklahoma's ability to evaluate future groundwater supplies for beneficial use.

Decisions don't *require* data
But *GOOD* decisions do!

Program Development

- 7-1-12 Effective date of the new program
- Program development (12 months in the making)
  - Monitoring proposal/Stake holders/Public Meeting
  - Personnel (hiring/training)
  - QA/Laboratory/Data Base
  - Core data elements and associated metadata
  - Well selection/landowner contacts/site recons
  - Implementation of GMAP: Year 1 Group "A" Aquifers (7-1-13)

Monitoring Objectives

- Obtain data on current conditions of groundwater levels and quality (baseline)
- Describe the spatial distribution, occurrence and magnitude…….. over different "seasons"
- Collect long-term data to observe changing conditions over time (trends)

How will GMAP Data Advance the Cause of Aquifer Resource Management?

Groundwater Level

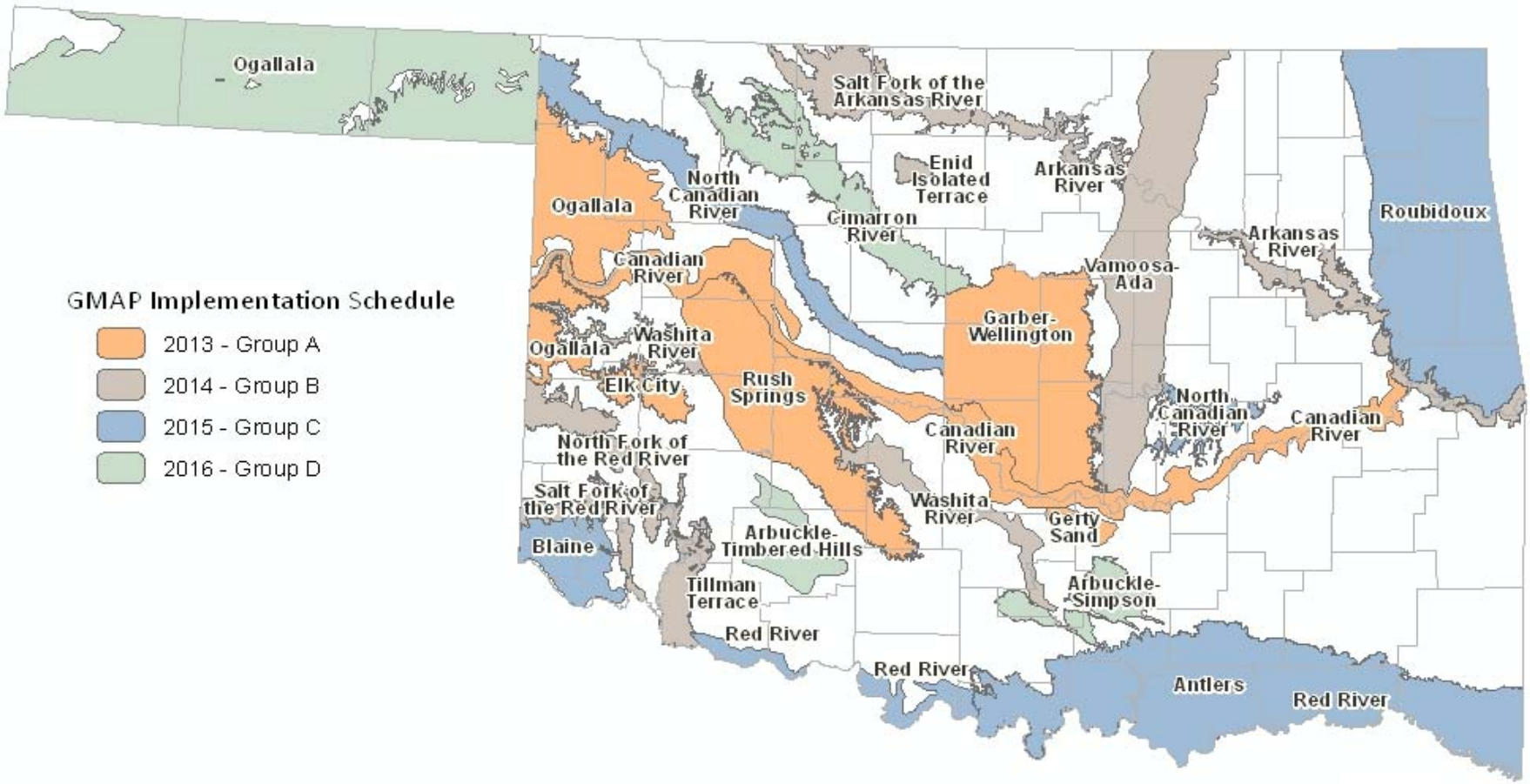
- Availability
- Vulnerability
- Hydrologic boundaries
- Drought or seasonal effects
- Support technical water allocation studies

Groundwater Quality

- Beneficial uses
- Water quality standards
- Aquifer classification
- Private wells
- Baseline to measure future change
- PWS/industrial expansion

Groundwater Monitoring and Assessment Program (GMAP)

Implementation Schedule



This map shows the Groundwater Monitoring and Assessment Program (GMAP) implementation schedule. GMAP is designed to examine the ambient quality and quantity of Oklahoma's groundwater resources. Assessments of Oklahoma's groundwater will be achieved through both a baseline surveillance network and long-term (trend) monitoring network within each of the state's major aquifers.
For more information please visit the OWRB's web site at: (http://www.owrb.ok.gov) (12/11/2013)

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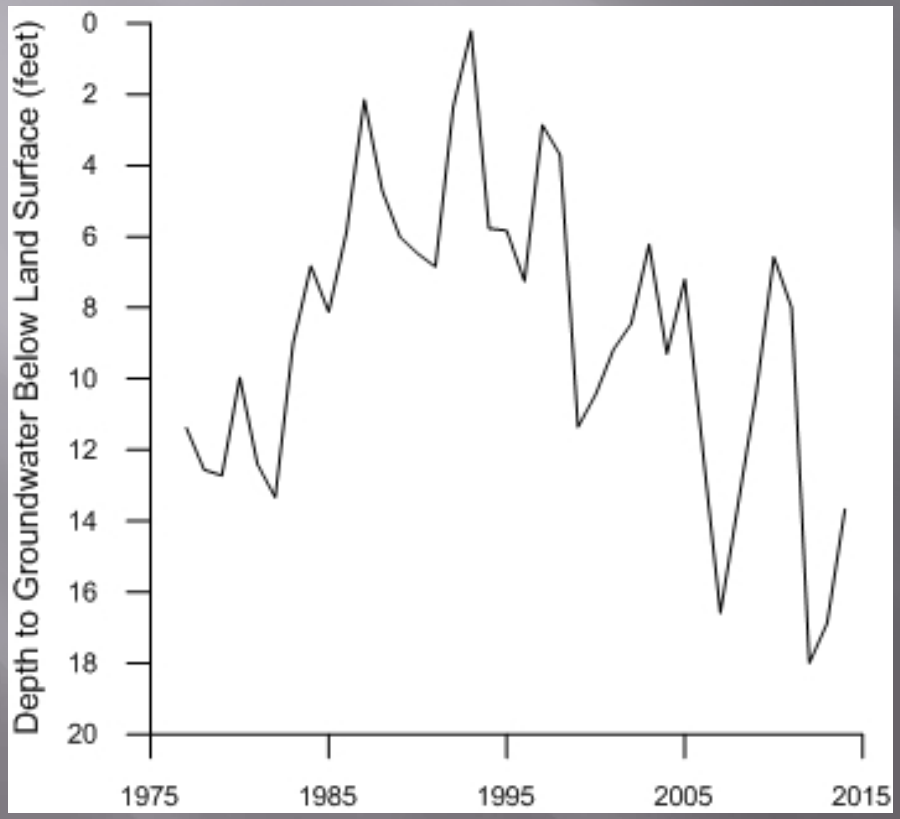
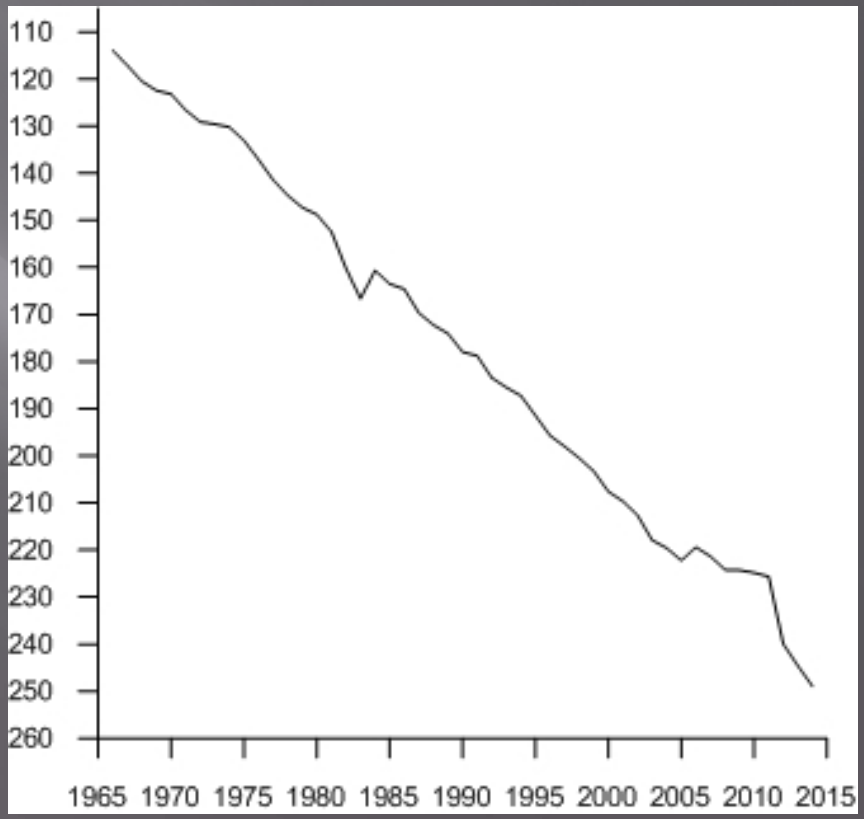
Time Series Data

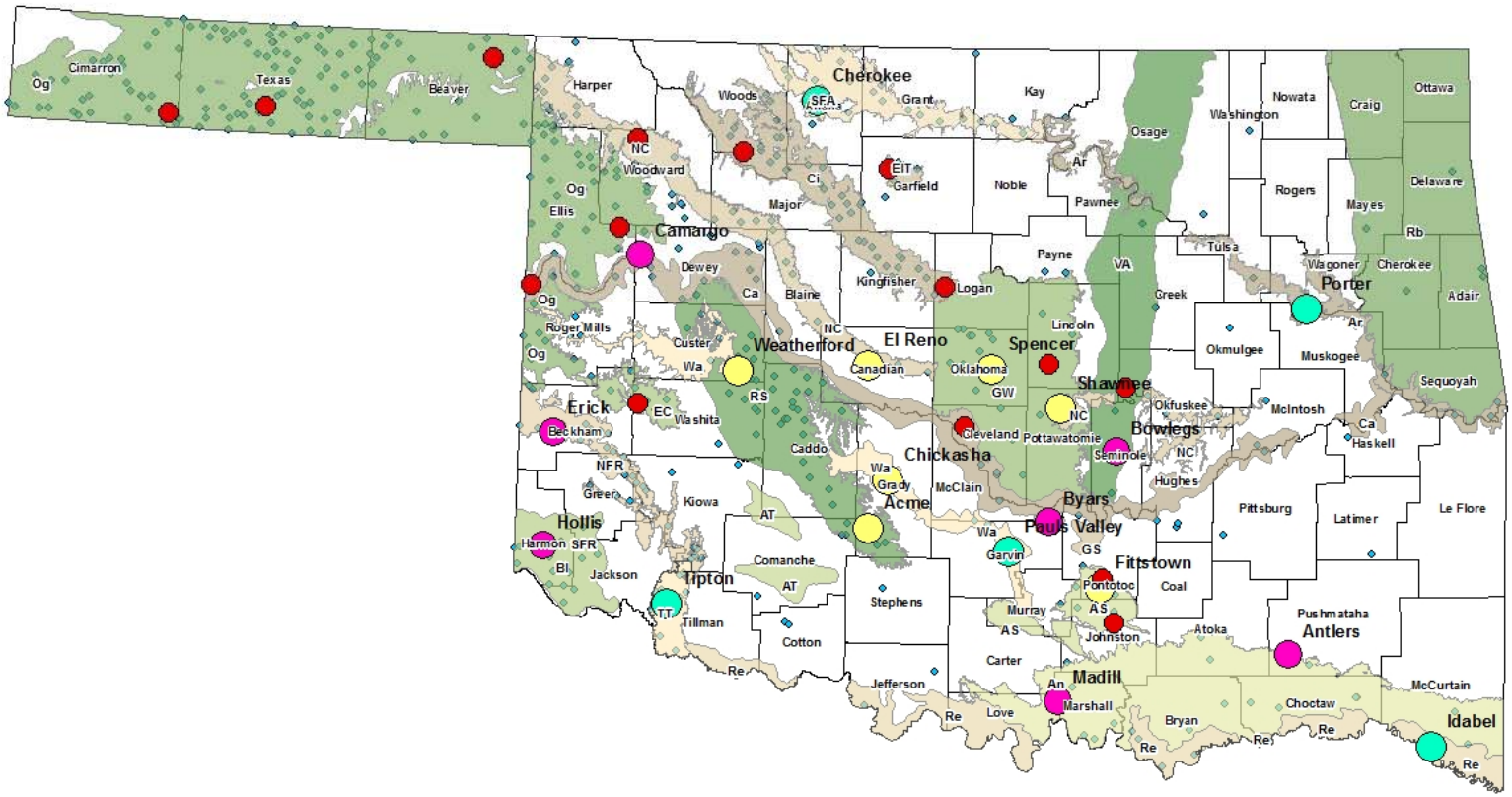




Groundwater Level Changes

Aquifer	Wells	2012-2013 (1 year)	2013-2014 (1 year)	2009-2014 (5 year)	2004-2014 (10 year)	POR(?--2014)
Arkansas River	6	-1.84	0.43	-2.13	-5.91	-4.19
North Can.	29	-2.11	0.73	-4.47	-2.34	-0.12
Cimarron River	34	-1.92	1.66	-5.72	-3.43	-1.63
Canadian River	10-34	1.20	3.58	-1.97	-2.74	-2.87
N Fork Red R.	32	-1.80	-1.32	-6.20	-5.57	-2.20
Salt Fork Ark.	17	-1.33	0.04	-6.70		-6.78
Washita River	6	-3.19	0.75	-3.51	-3.21	-4.54
Enid Terrace	9	-1.71	-0.23	-4.24		0.08
Antlers	13	-1.61	0.06	-1.32	-2.11	-4.04
Arbuckle	11	-8.71	7.1	-21.74	1.71	-10.38
Blaine	15	-6.36	-5.44	-20.99	-17.71	-24.48
Elk City	6-23	-1.33	-1.03			-4.54
GWellington	15-45	-3.45	1.83	-5.19	-4.2	-5.21
Rush Springs	59-82	-1.59	-1.02	-5.67	-3.34	1.26
OG-NW	33-51	-0.45	-0.52	-3.01	-2.32	2.51
OG-Panhandle	112	-2.11	-1.86	-8.71	-10.41	-23.57

Continuous/Real Time Recorder Sites



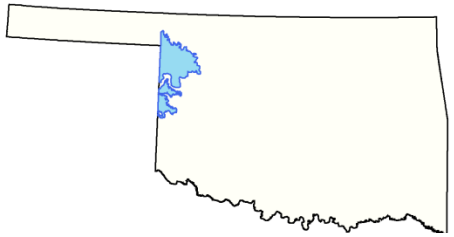
GMAP Network Design

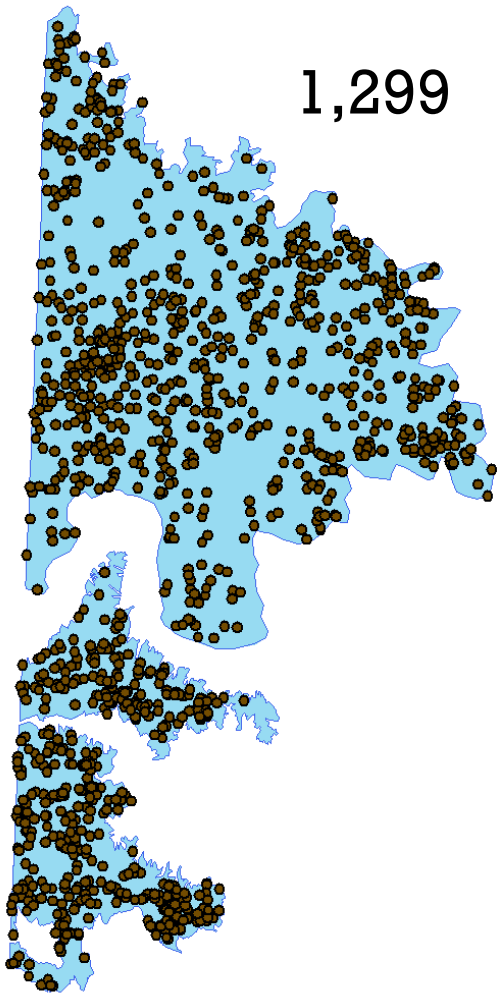
- Number of wells
- Density of wells
- Aquifer type, lithology, thickness
- Depth to water, stratification of aquifer
- Surface water features
- Land and water use
- Groundwater recharge/discharge areas
- Holistic versus targeted monitoring

Sampling Sites

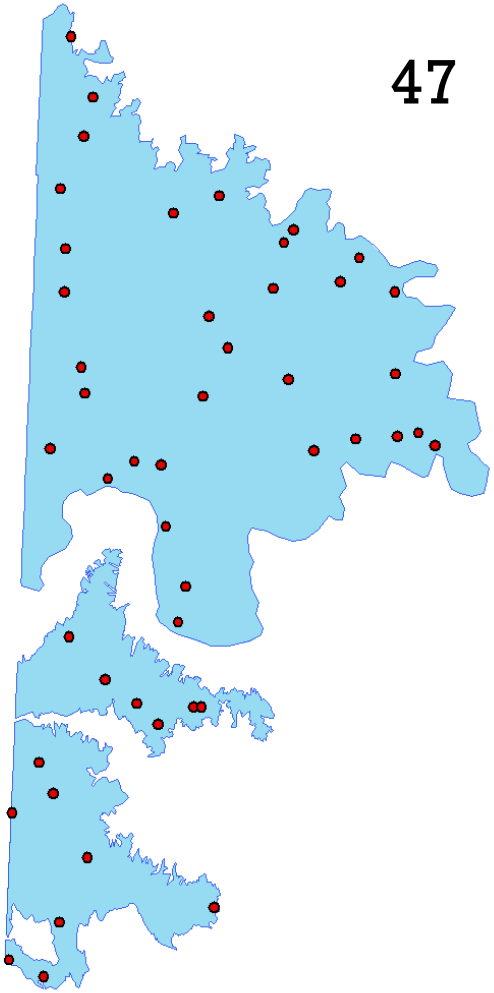
- Stratified by aquifer
  - Areal extent of aquifers determined well design numbers
- Selection probabilities weighted based on well density
- Random but spatially balanced population of wells (Olsen, 2003, "Spatially-Balanced Survey Design for Groundwater using Existing Wells")
- Make statistically valid assumptions about population by measuring the characteristics of a representative subset

Ogallala Northwest

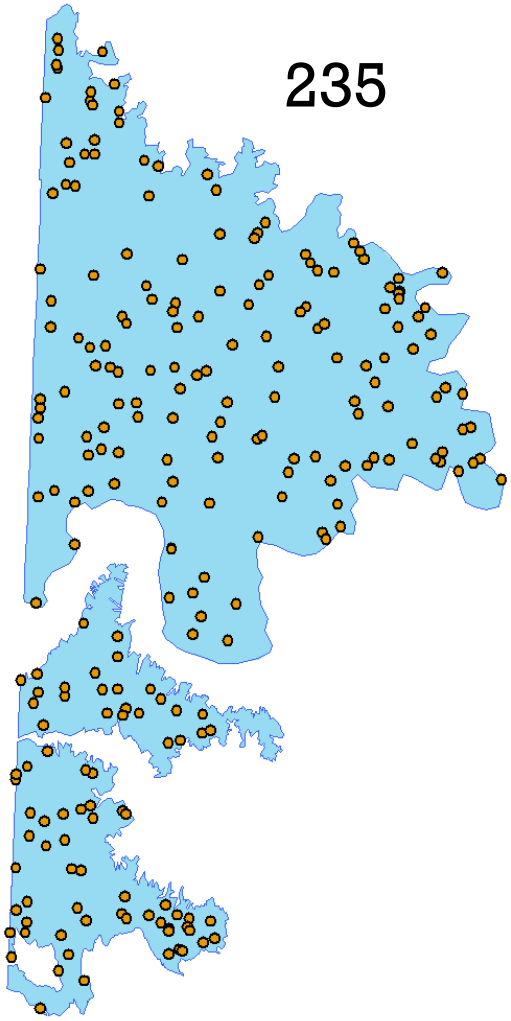




All eligible wells

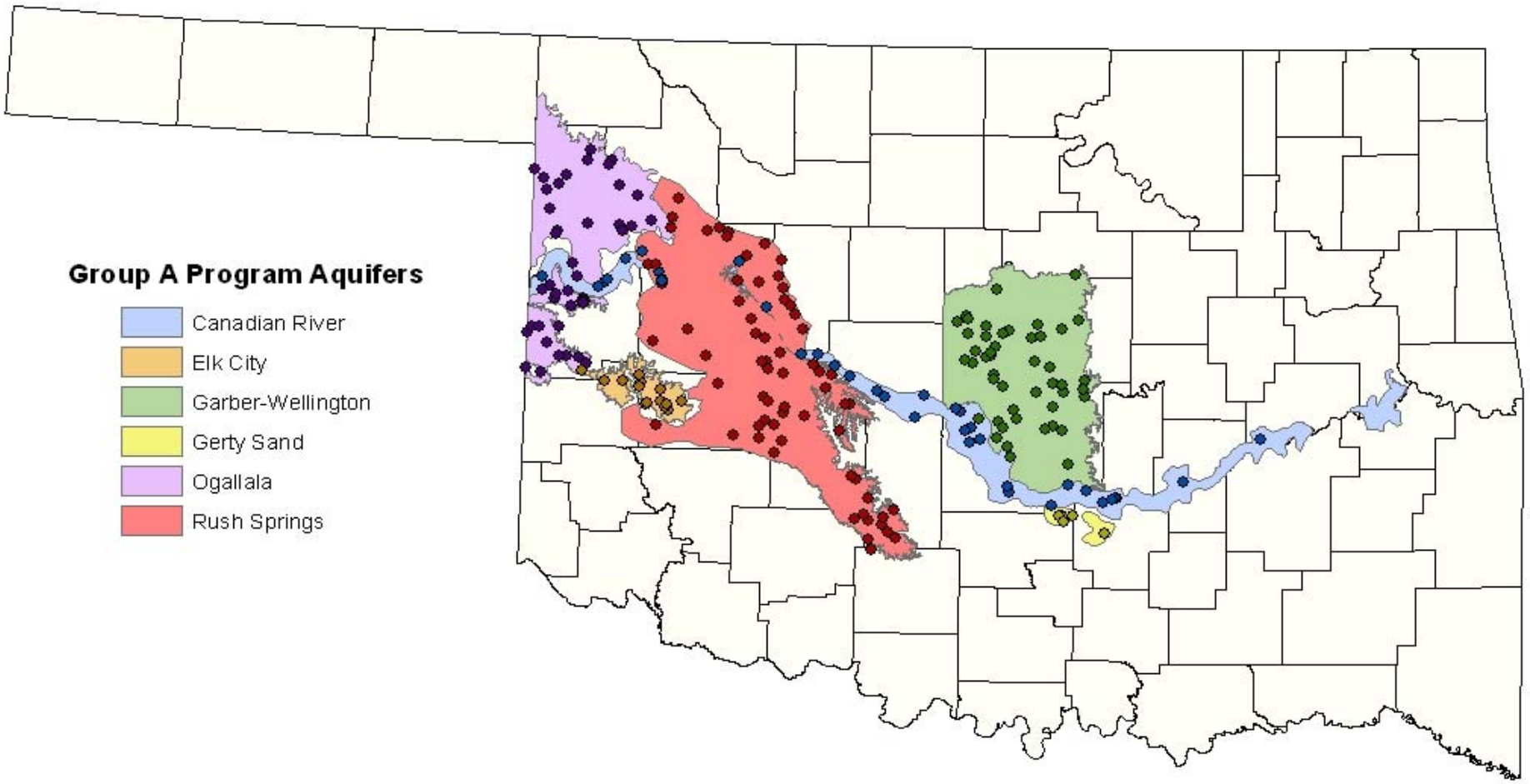


Sampling sites

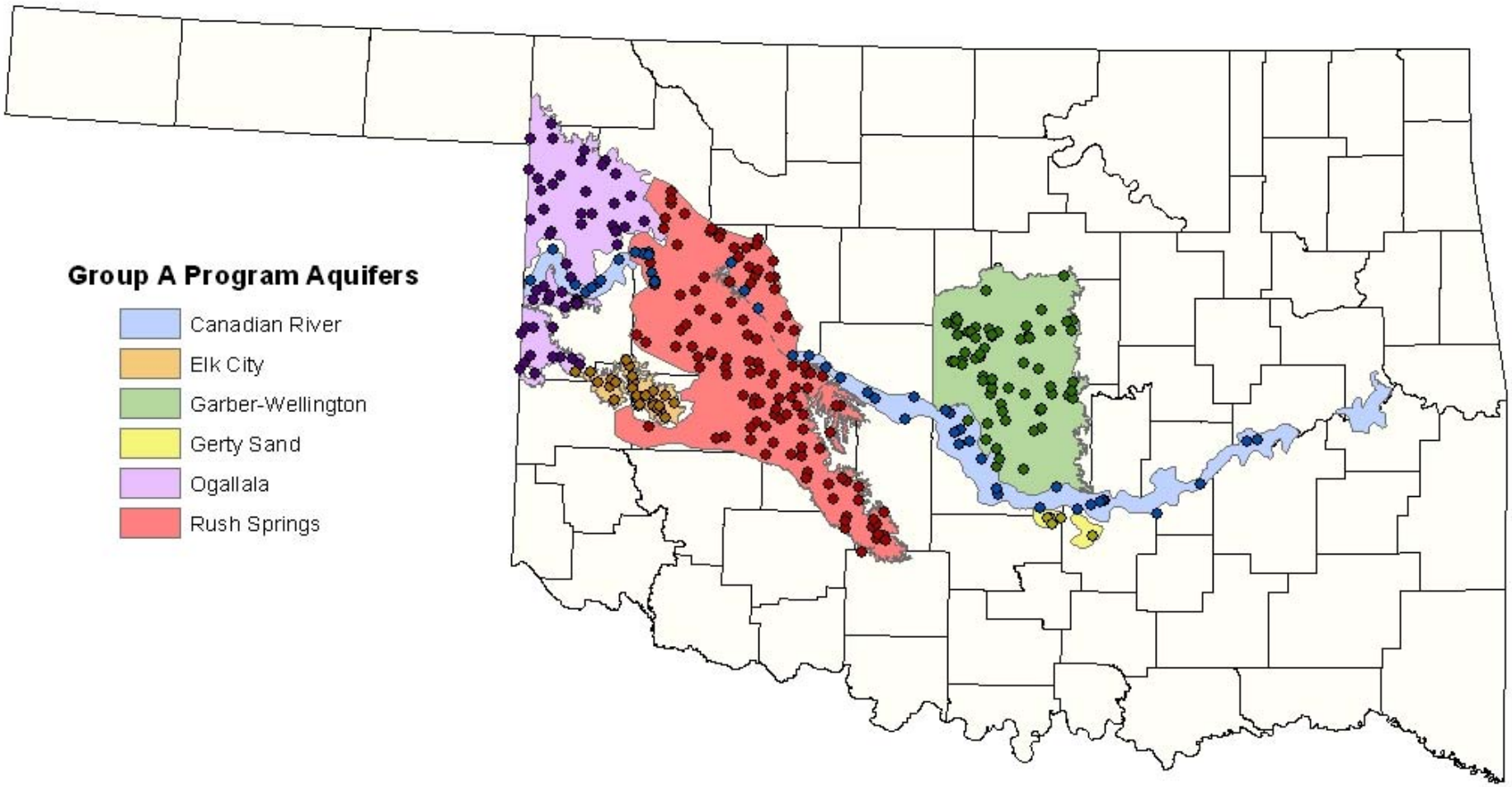


Alternate sites

Final Water Quality Network



Final Water Level Network



Network When Fully Implemented

Long-term monitoring of Oklahoma's Major Aquifers

Water Quantity

- 1,068 wells in the main Baseline Network
- 530 of those wells in the long-term Trend Network

Water Quality

- 700 wells in the main Baseline Network
- 140 of those wells in the long-term Trend Network

Metadata

- Geographic location/altitude
- Well type
- Well depth/screened interval
- Land use
- Weather conditions
- DTW pre/post sampling
- Purge or sample stabilization parameters
- Field chemistry

Laboratory Analytical Parameters

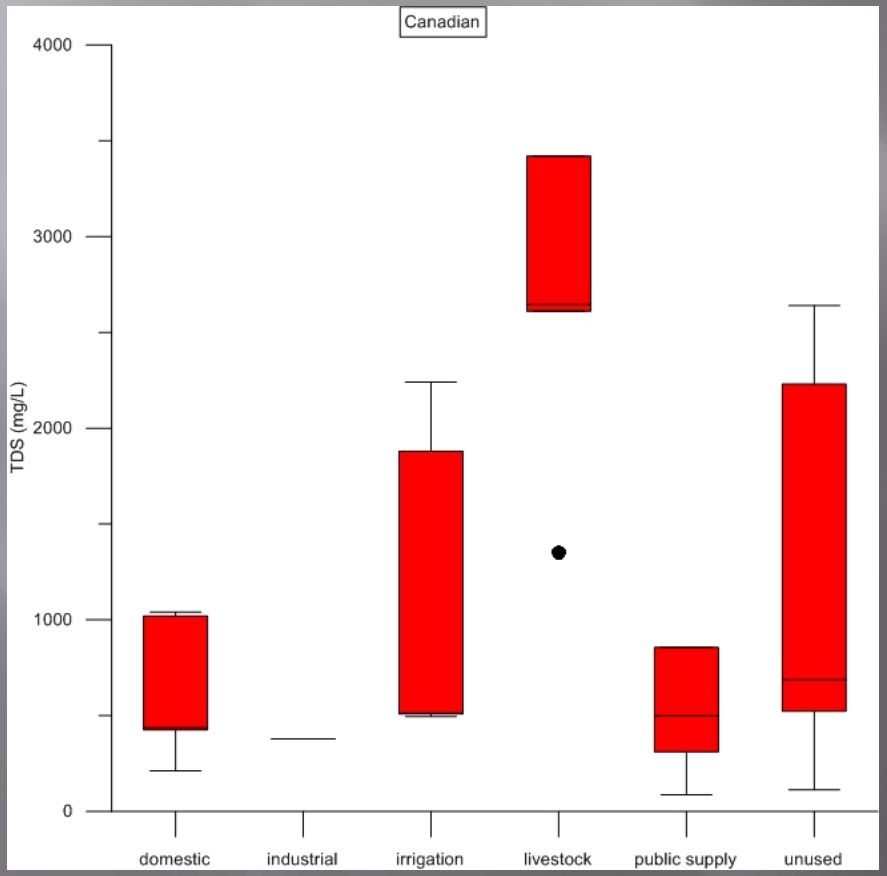
- Common ions (Na, Ca, Mg, K, HCO_3, SO_4, Cl)
- Nutrients (NH_3, NO_3, P)
- Trace metals (Cr, Mn, U among others)
- Trace elements (Br, F, Se among others)
- TDS

Well Types Used in the Program

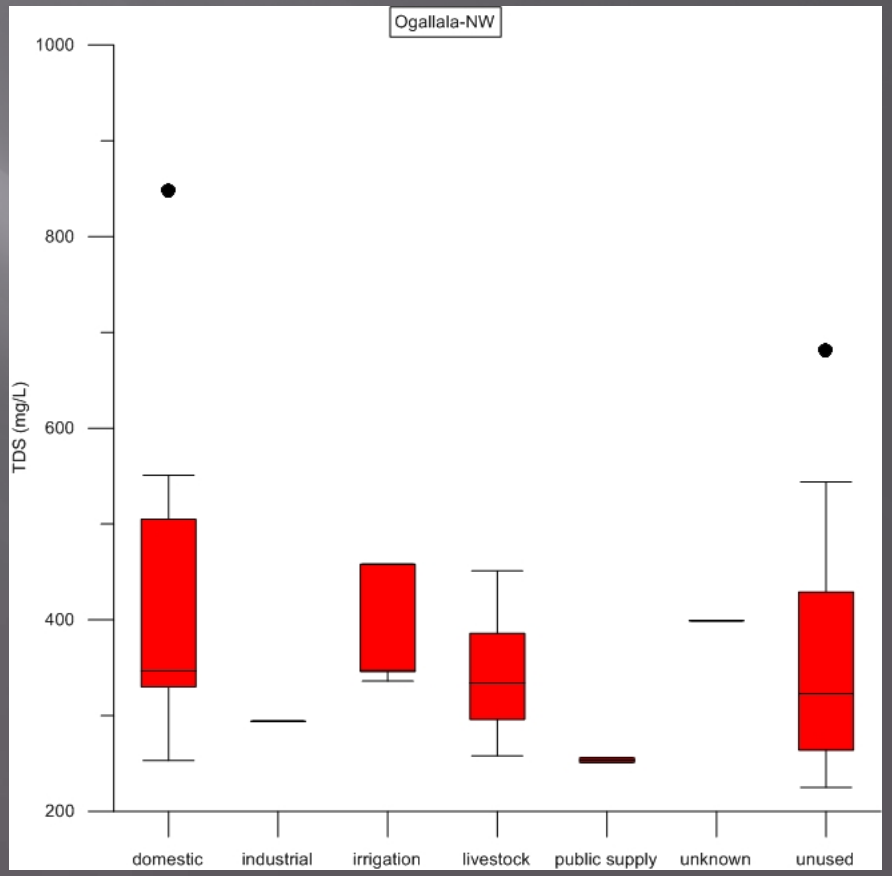
- Most well types are permissible
  - Meets minimum construction standards
  - Geology/lithology
  - Well depth and screen length and placement
- Wells excluded from the program:
  - Point source monitoring wells
  - Potential (non-regulated) pollution source
- Majority of network
  - Irrigation, public water supply, domestic, stock, industrial, oil and gas exploration

BOX Plots of TDS by Well Type

CANR – most mineralized



OG-NW – least mineralized



Group A Summary Results

- 203 environmental samples
- 399 water level measurements
- 110 well tri-annual (seasonal) water level in place
- 15 Continuous water level recorders installed
- Higher TDS areas related to $CaSO_4$ & NaCl water types; >gypsum, anhydrite and halite bearing Permian bedrock
- Locally high nitrates found in Rush Springs and Ogallala-NW aquifers
- Trace metal occurrence in excess of EPA Safe Drinking Water limits occurred in 5 percent of the samples (As-7, U-3, Pb-1)
- Most mineralized aquifer – CANR; Least – OGLA-NW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