



Equus Beds Water Quality 1940-2009

Preliminary results of passive recharge well



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Presentation to GMD2 Board
July 14, 2009

Continued Baseline water quantity and quality for ASR Phase 1 and 2 monitoring (1995-2015+)

- Annual sampling of 38 shallow and deep index well locations to define current and after recharge conditions (2001-present)
- Continuous streamflow and water-quality monitoring to define water quality of source water and to assist with design information (1995-present)
- Monitoring of ASR water quality before and after– Phase 1 results (2006-present)
- Passive recharge well monitoring at RB-1 (2008-2009)
- Model of chloride and water -level changes
- Phase 2 begins 2010+



Less clay in the *Equus* beds in the south

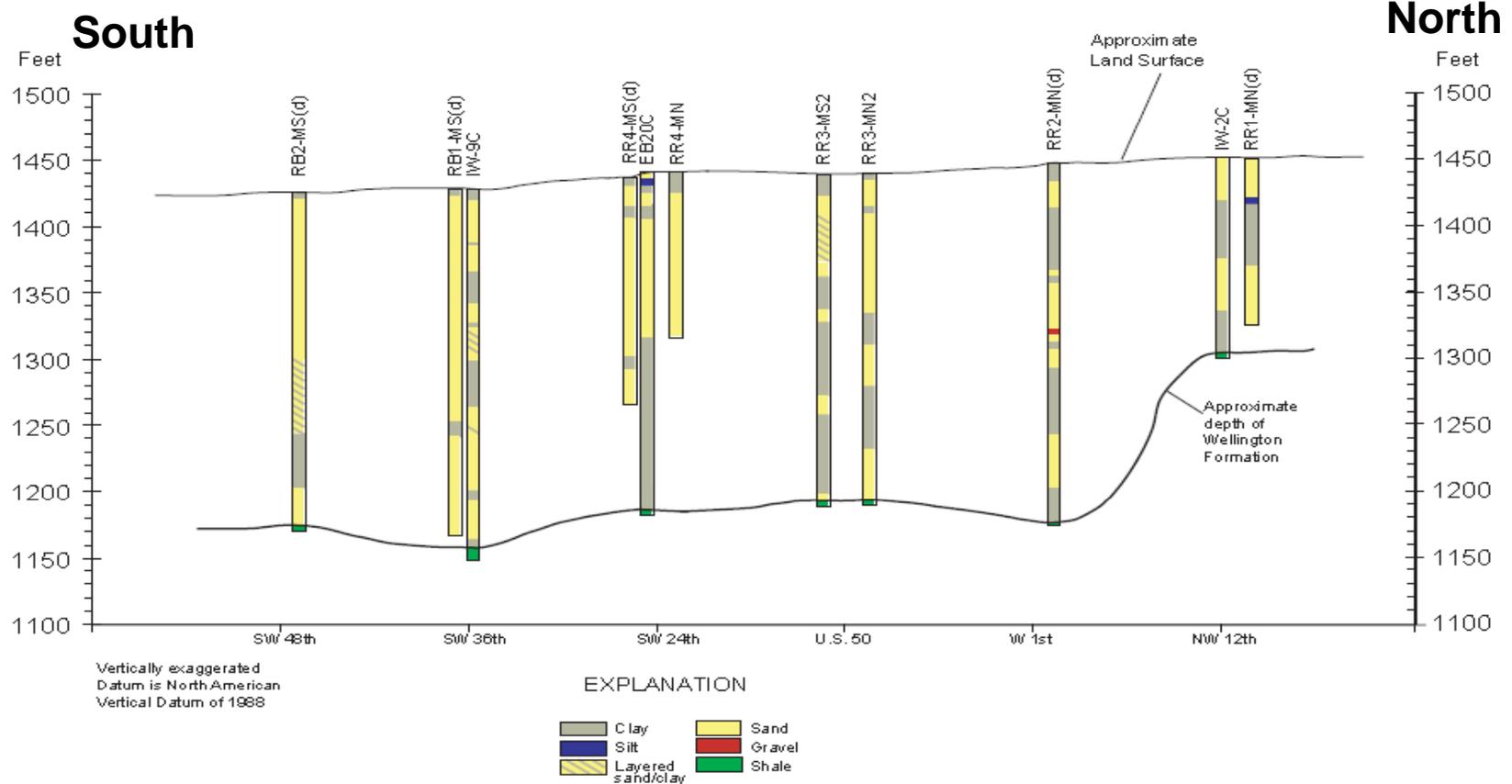


Figure X. Cross section along Willow Lake Road. Lithology from select wells located on Phase 1 recharge sites.

Preliminary evaluation of passive well recharge at RB-1

- Water from the Little Arkansas River is treated and then recharged at recharge basin 1
- Passive well installed to enhance recharge rates in December 2008.
- An evaluation into the feasibility of the passive recharge system began in January 2009.
- Primary concern was transport of bacteria, viruses, geochemical reactions plugging the aquifer material, and other chemicals.

RB-1 site





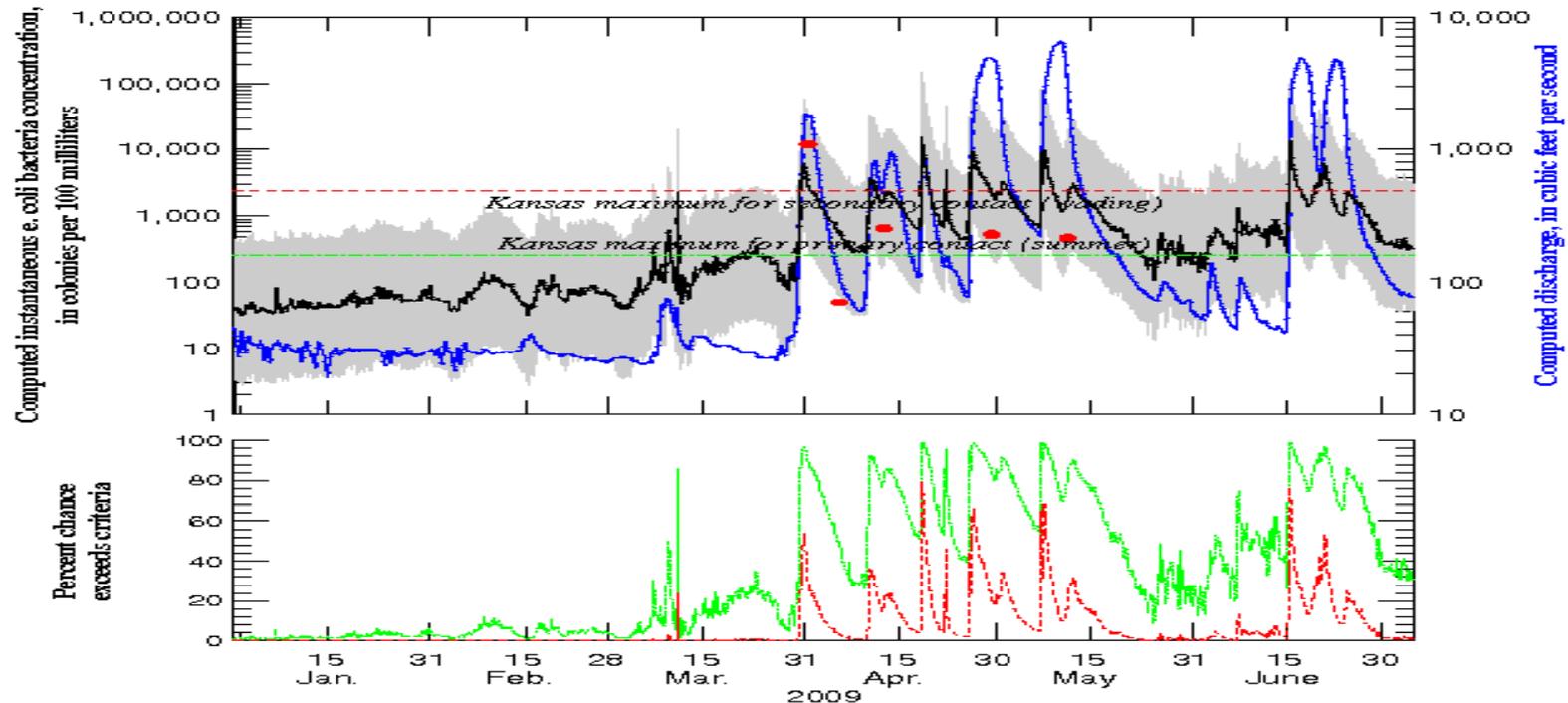
6" passive recharge well

RB-1 PMS shallow and deep monitoring wells

Hydrogeologic testing shows that in RB1:

- the sediment is very heterogeneous.
- the most productive zone in the entire thickness is about 5 ft thick at about 50 ft below the basin elevation.
- under ambient conditions, water flows into the passive well from the productive zone.

Artificial recharge occurs during storm events when streamflow increases. When streamflow increases, turbidity increases, and bacteria increases.



Computed instantaneous e. coli bacteria concentration in Little Arkansas River at Highway 50 near Halstead, KS

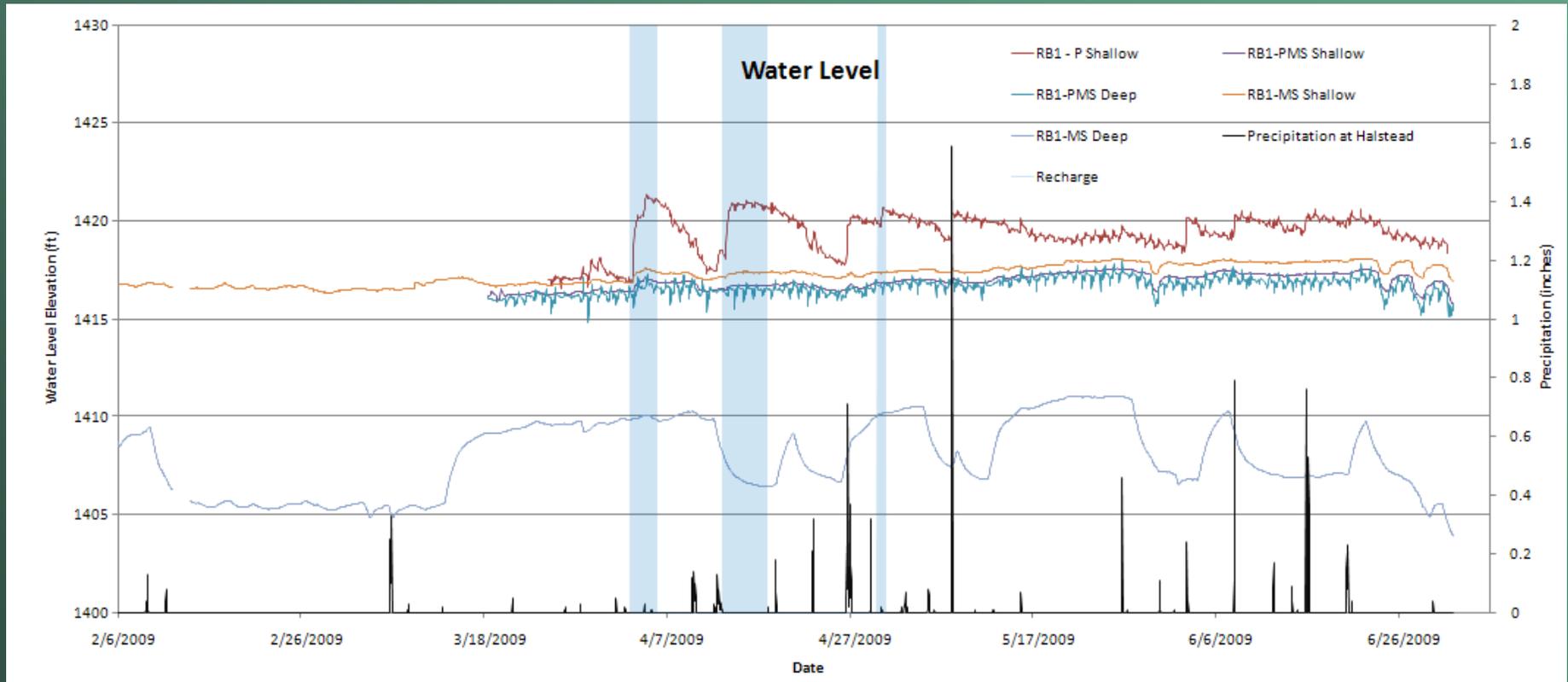
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EXPLANATION

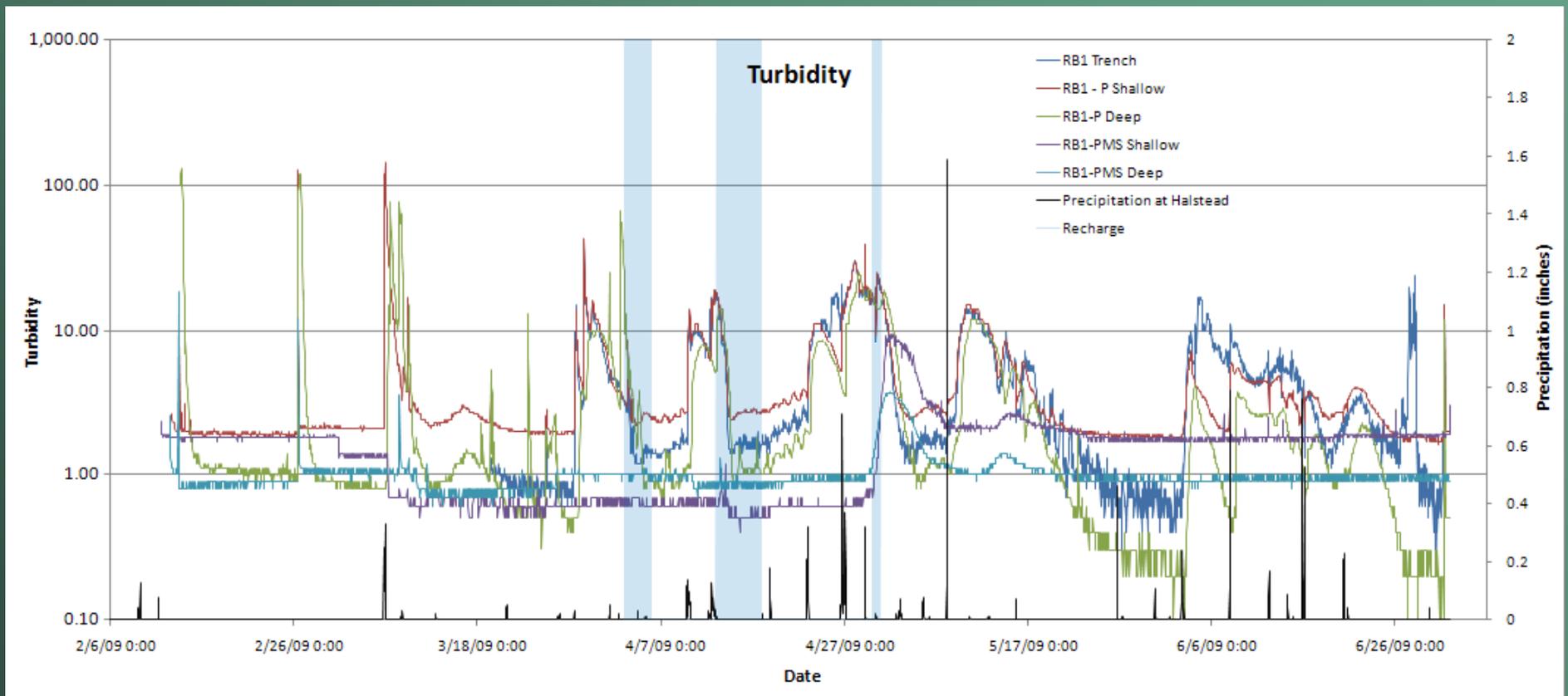
- Discharge
- Measured or computed water-quality constituent
- 90-percent prediction interval for computed value
- Value obtained from discrete sampling and analysis
- Load calculated using laboratory analysis and discharge
- ⋯ Water-quality criteria



Water levels fluctuate and respond to both recharge through rainfall and artificial recharge. The passive well enhanced recharge.



Turbidity increases in trench and wells after precipitation. Bacteria counts are larger when turbidity is high, resulting in bacteria entering the aquifer.



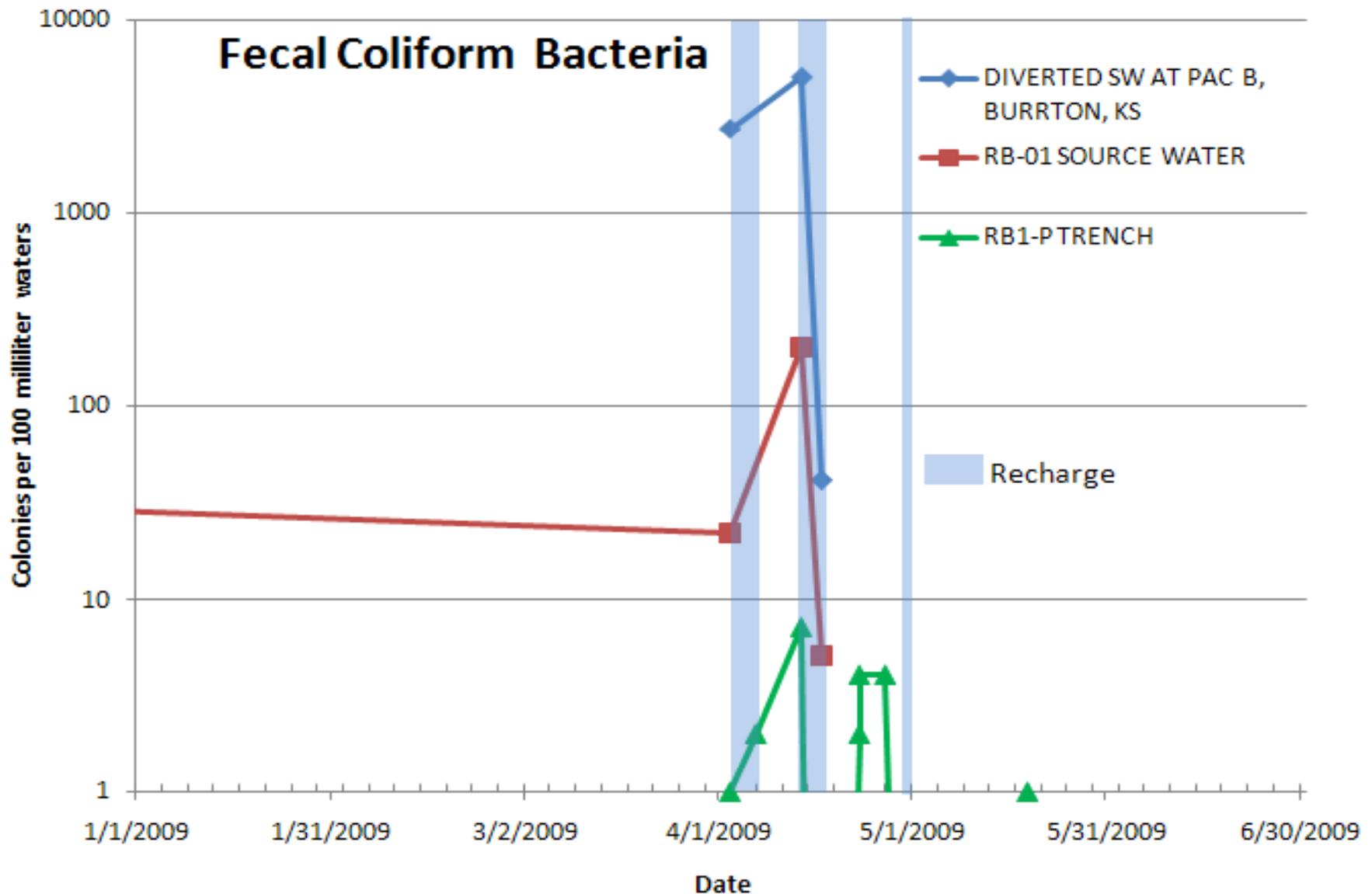
The trench/infiltration are sources of turbidity and bacteria



Bacteria

- Water samples from RB-1 sites are tested for:
 - Total coliform: Coliform is a very common bacteria. It is present in soil. We test for coliform to understand the overall level of bacteria in a system.
 - Fecal coliform: Fecal coliform is a specific type of coliform. It comes from feces.
 - Escherichia coli (E. coli): E. coli is a single species in the fecal coliform group. It can cause illness in humans.

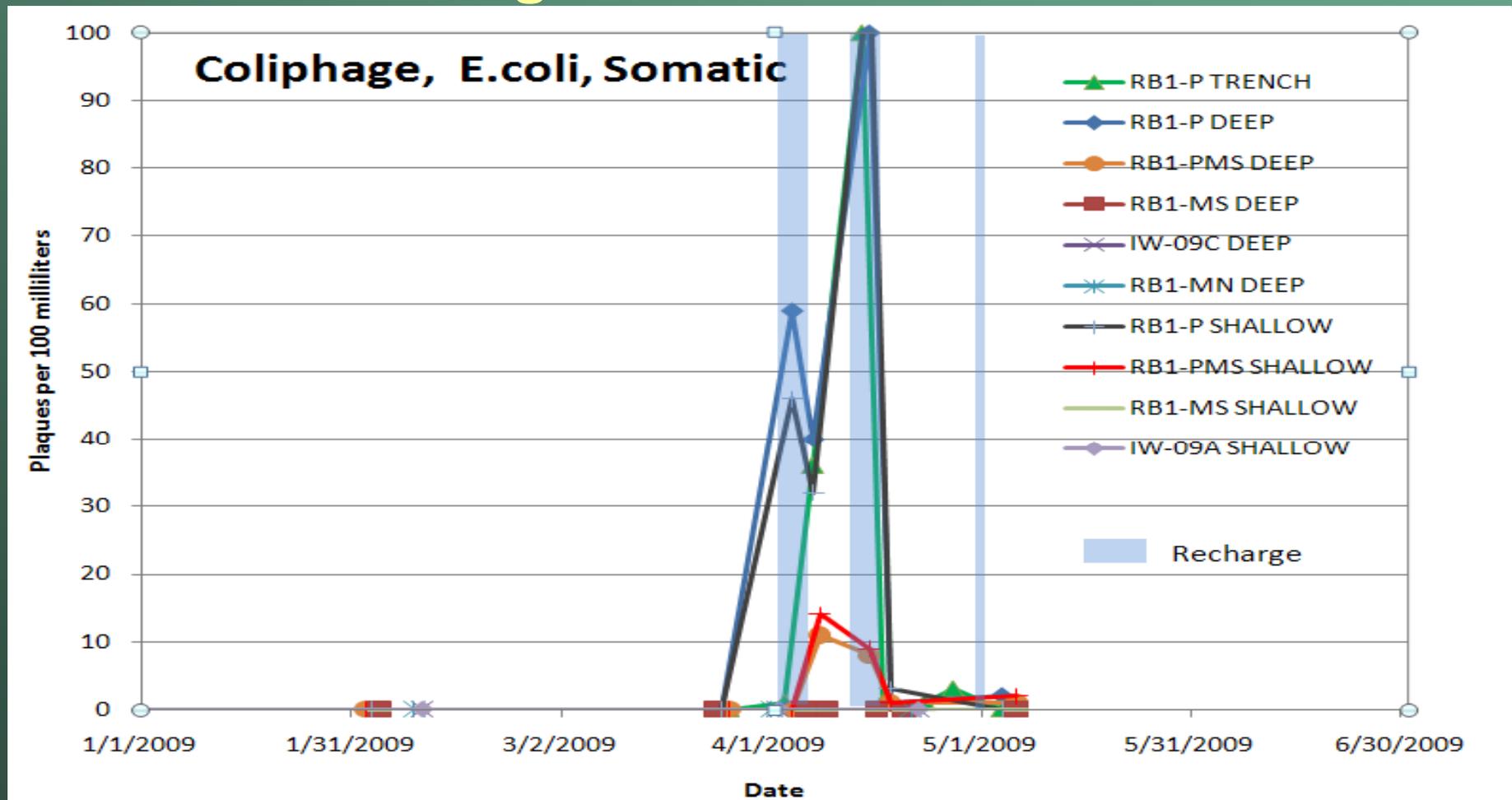
Bacteria is present in surface water, treated surface water, and in the recharge trench.



Viruses and Viral Indicators

- Coliphage virus infects coliform bacteria
- If coliphage is present, coliform bacteria is present
- It is also possible to infer how other viruses (*for example viruses that cause human enteric illness*) will be transported in an aquifer setting by measuring coliphage virus or *Clostridium perfringens* (a type of bacteria)
- We test for two types of coliphage virus
 - Somatic
 - F+ Specific
- and the viral indicator:
 - *Clostridium perfringens*—found in soils, animal gut, anaerobic bacteria

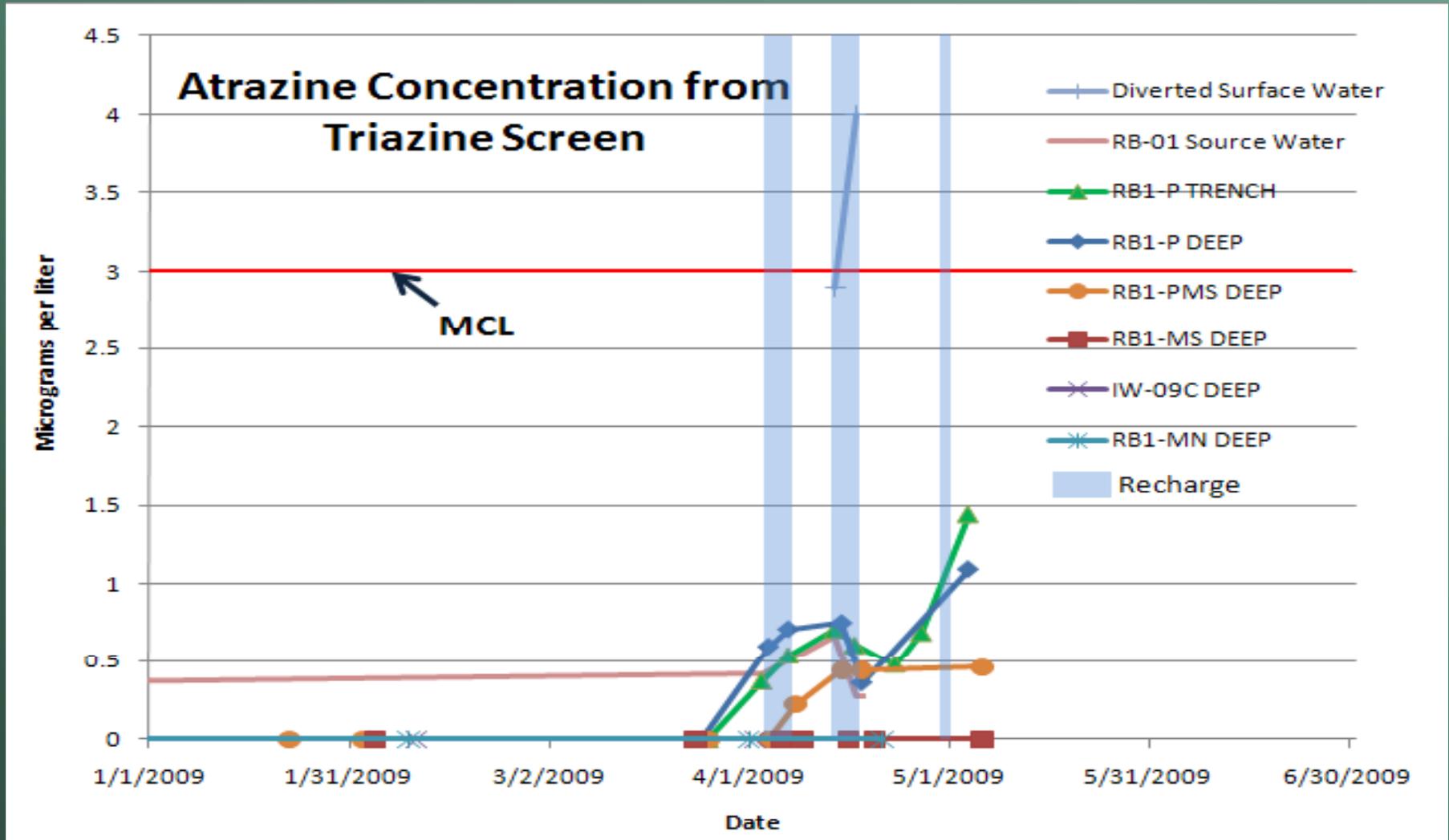
Somatic and F+ Specific Coliphage increased in RB1 trench, passive well and PMS wells during and after recharge.



Atrazine

- Atrazine concentrations increased during and after passive well recharge in RB-1.
- Sources of atrazine to the aquifer are treated recharge water and infiltration from nearby fields.
- The Maximum Contaminant Level (MCL) for atrazine is 3 micrograms per liter. This level has not been exceeded in RB-1.

Atrazine increased after recharge ended



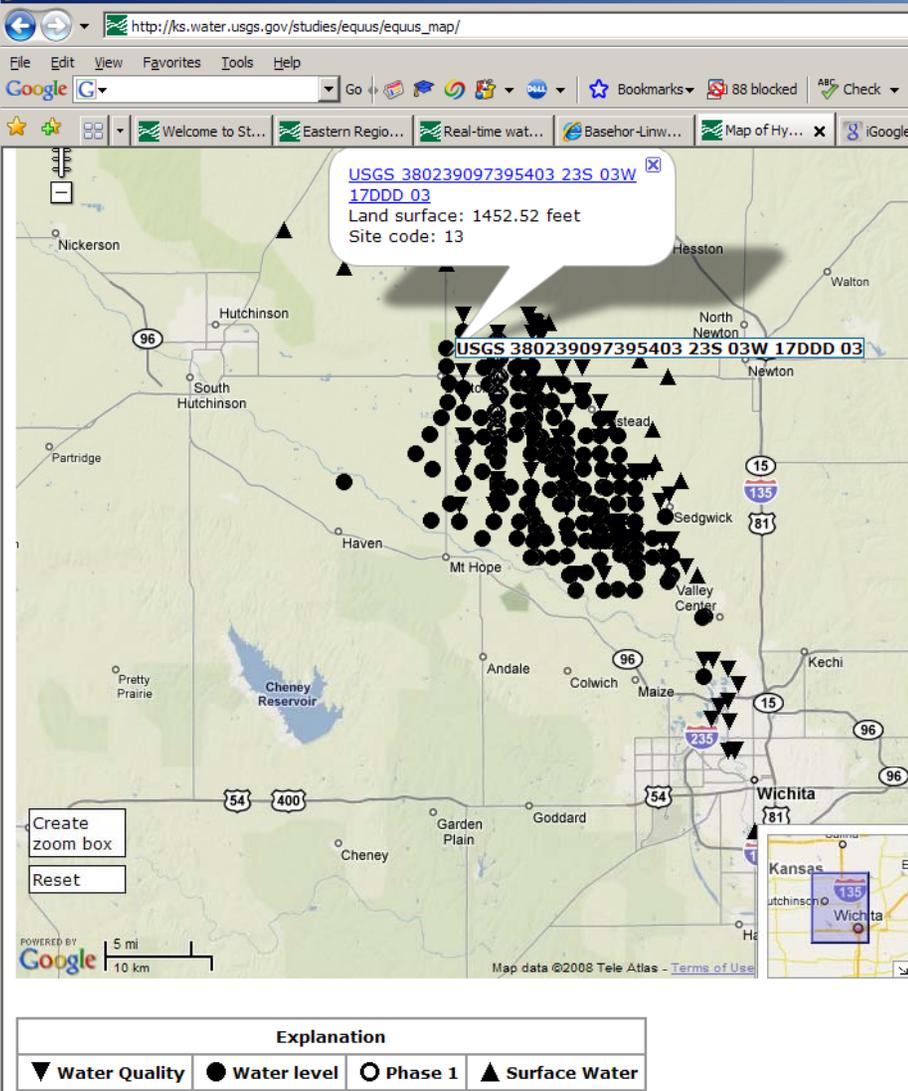
Preliminary conclusions for Passive Recharge Well experiment at RB-1:

- Bacteria present in some wells and recharge trench before recharge.
- Bacteria, viruses, and atrazine increased in passive recharge and nearby monitoring wells with recharge and rainfall.
- No detections in wells 100 feet away.
- Atrazine increased in RB-1 monitoring wells after recharge, but was below the EPA Maximum Contaminant Level (MCL).
- In early May, recharge was discontinued and the 600,000 gallons recharged are being pumped out of the passive recharge well into RB-1 basin.
- Samples are being collected as the water is pumped out to analyze for bacteria, viral indicators, and atrazine. Samples collected on 7/9 (after 202,000 gallons was pumped out) had no viral detections, no fecal coliform detections, and 17 colonies per 100 ml total coliform. After 600,000+gallons pumped as of 7/13, Total coliform concentrations in the pump discharge were 10 colonies per 100ml.

Bottom line:

- The passive recharge well enhanced artificial recharge substantially at RB-1
- The water quality of the receiving groundwater is determined by:
 - The original water quality
 - The quality of the source water for recharge
 - The quality of the trench/soils the water infiltrates through and their “cleanliness”

How do you get data or information?



Highlights of *Equus* Beds Groundwater Recharge Project

Gallons of Water Recharged Through Recharge Basins and Wells

RB-1, RB-2, RRW-1, RRW-2, RRW-3, and RRW-4

(click site name for individual site recharge summary)

[Click here for site map](#)

Month	Calendar Year				Cumulative Total
	2006	2007	2008	2009	
January	---	0	23,359,000	0	
February	---	0	27,007,300	0	
March	---	36,670,000	51,928,000	13,260,000	
April	---	34,700,000	58,824,500	58,939,000	
May	---	69,010,000	48,955,400	40,924,768	
June	---	64,386,000	39,416,600	20,697,584	
July	---	82,828,300	11,567,800	---	
August	---	36,488,600	0	---	
September	0	7,838,100	20,992,000	---	
October	0	18,587,500	36,516,200	---	
November	0	0	23,400	---	
December	0	18,265,700	331,900	---	
Sum	0 MG	369 MG	319 MG	134 MG	801 MG

MG - Million Gallons

The following link provides a summary of artificial recharge activities as part of the *Equus* Beds Groundwater Recharge Demonstration Project. [Equus Beds Groundwater Recharge Demonstration Project 1997-2002](#).

[http:// ks.water.usgs.gov/studies/equus/](http://ks.water.usgs.gov/studies/equus/)

OR



http://ks.water.usgs.gov/studies/equus/

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Ground Water

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- KS Water Info by County(KWIN) (5)
- Active GW Map of Sites in KS
- Ground water Data

Studies

- Equus Beds Recharge
- Ground Water Atlas
- High Plains Water Levels
- High Plains Water Quality
- Ozark Aquifer

Water Quality

Data

- KS Water Info by County(KWIN) (5)
- Kansas Water Data
- Continuous Real-Time Water Quality

Studies

- Cheney Res. Water Quality
- Cyanobacterial Tastes-and-Odors and Toxins
- Equus Beds Recharge
- High Plains Water Quality
- Johnson County Water Quality
- Kansas River TMDLs

Equus Beds Ground-Water Recharge Project

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Highlights

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- [Surface-Water Quantity](#)
- [Real-Time Streamflow](#)
- [Water Quality](#)
- [Real-Time Water Quality](#)

Maps of Equus Beds Recharge Data-Collection Sites

- [Google map of all data-collection sites](#)
- [Little Arkansas River Basin](#)
- [Areal Assessment Wells](#)

Publications

- [Water Quality](#)
- [Ground Water](#)

Additional Equus Beds Information

- [Equus Beds Information Resource](#)
- [Equus Beds Mineral Intrusion Project](#)

Equus Beds Aquifer—Artificial Recharge Process

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