

Influence of Weather, Well Construction and Sampling Strategy on Bacterial Contamination of Private Water Wells in Pennsylvania

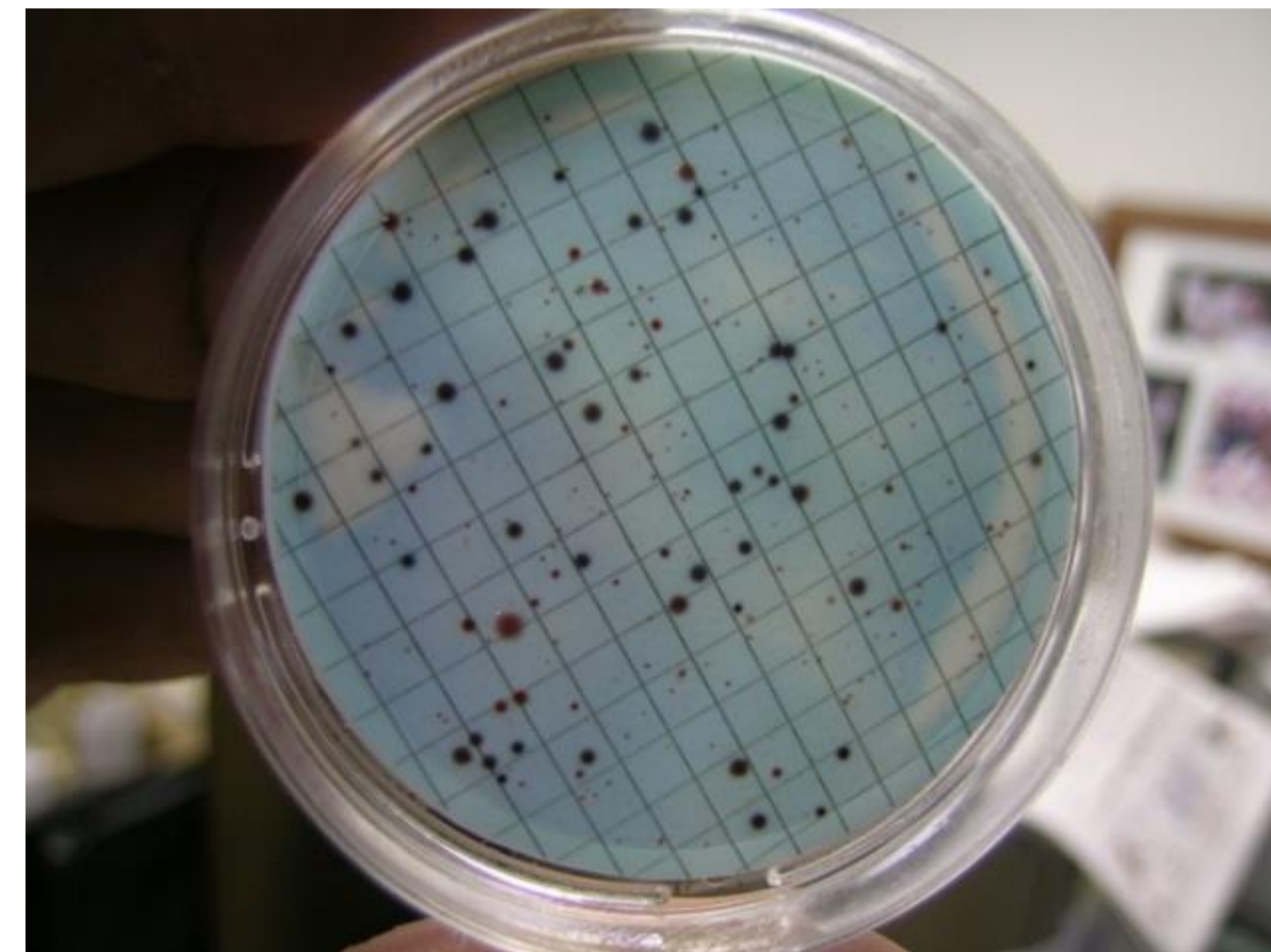
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Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

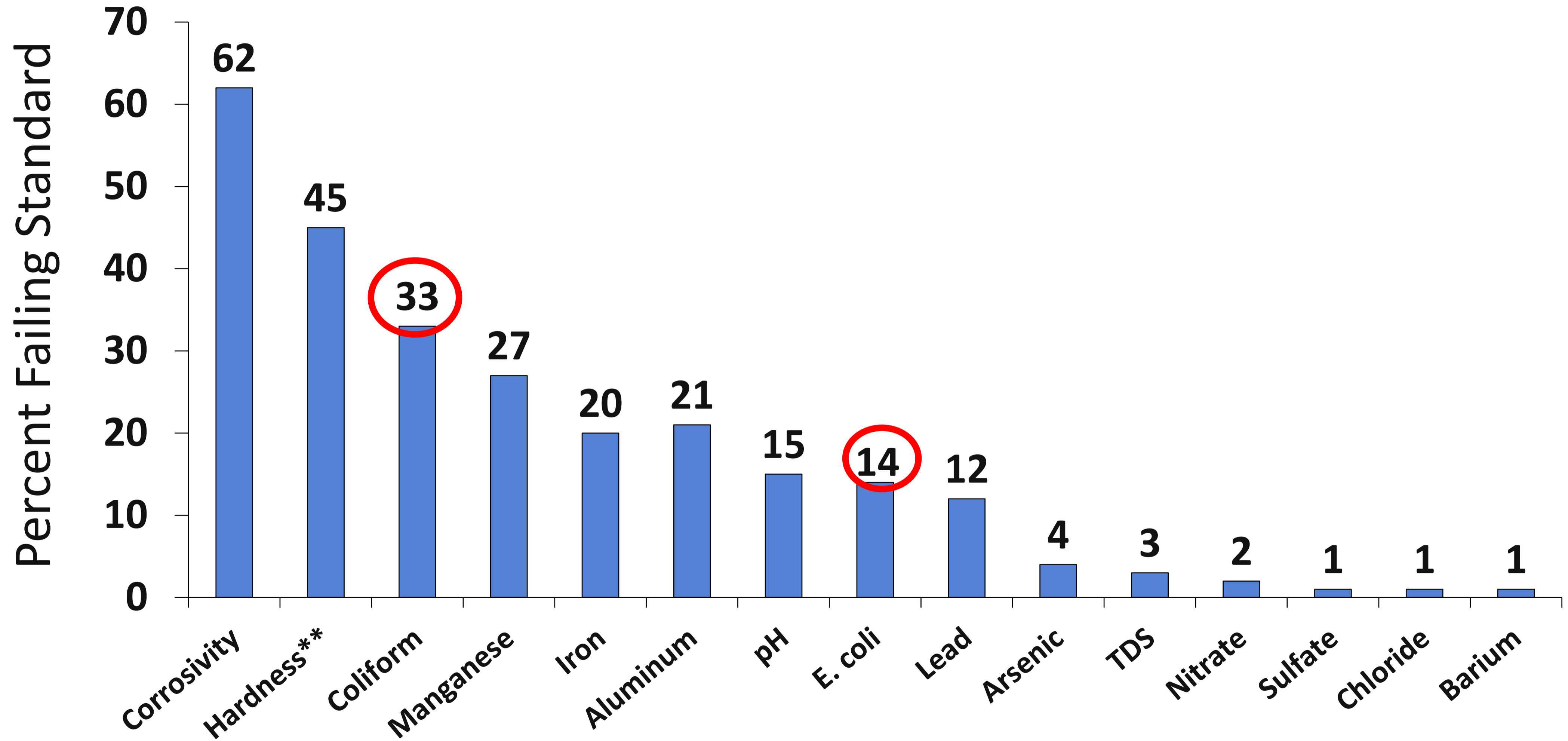
Occurrence of Bacterial Contamination and Known Important Variables

Coliform and *E. coli* Bacteria

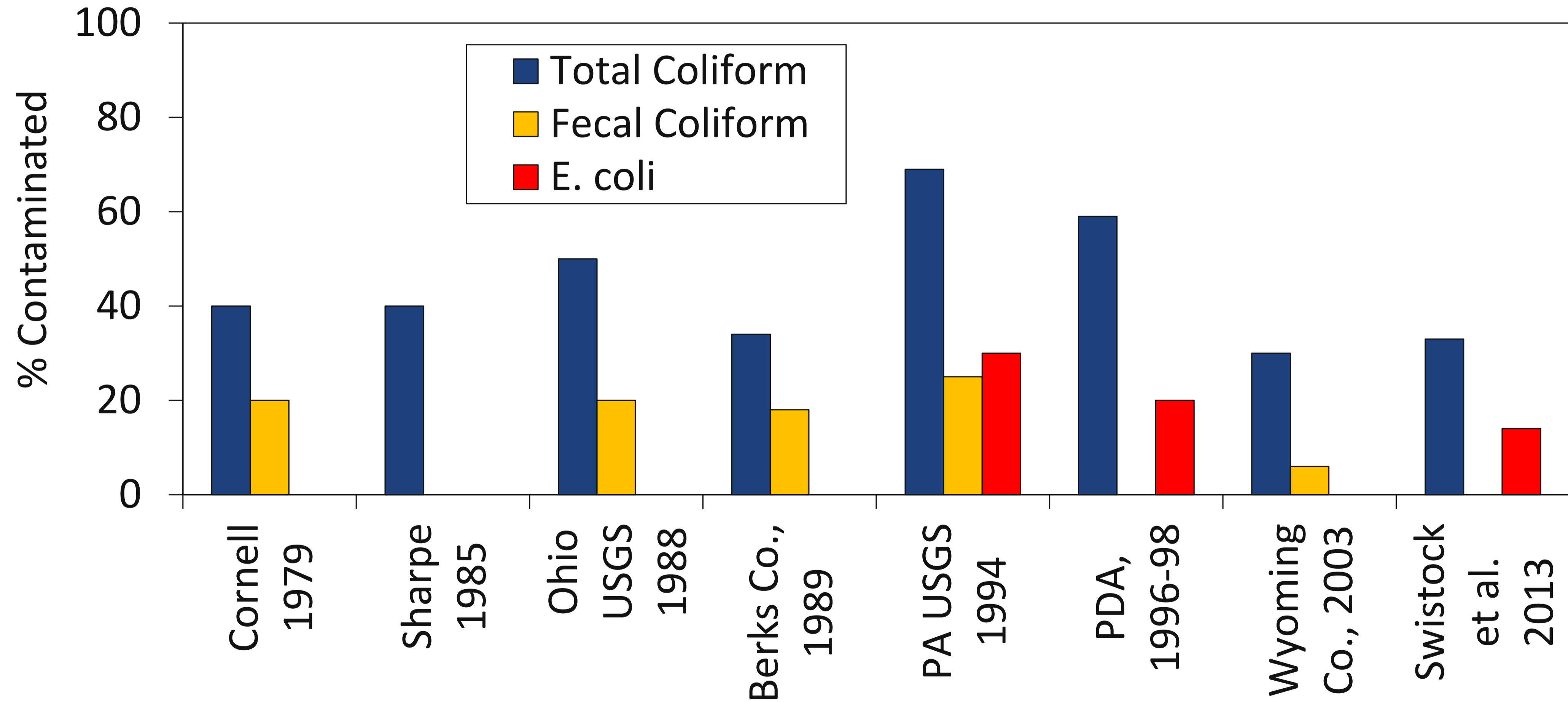
- Most common water tests used for water potability
 - Frequently used in real estate transactions
- Why worry about bacterial contamination?
 - Cause of most reported waterborne illnesses
 - General, non-specific gastrointestinal symptoms
 - Immune-suppressed at greater risk
- Coliform are “indicator organisms” for surface water
 - Surface runoff reaching well, insects, etc.
- *E. coli* are a specific type of coliform bacteria
 - Waste from warm blooded animals
- Both should be zero in drinking water



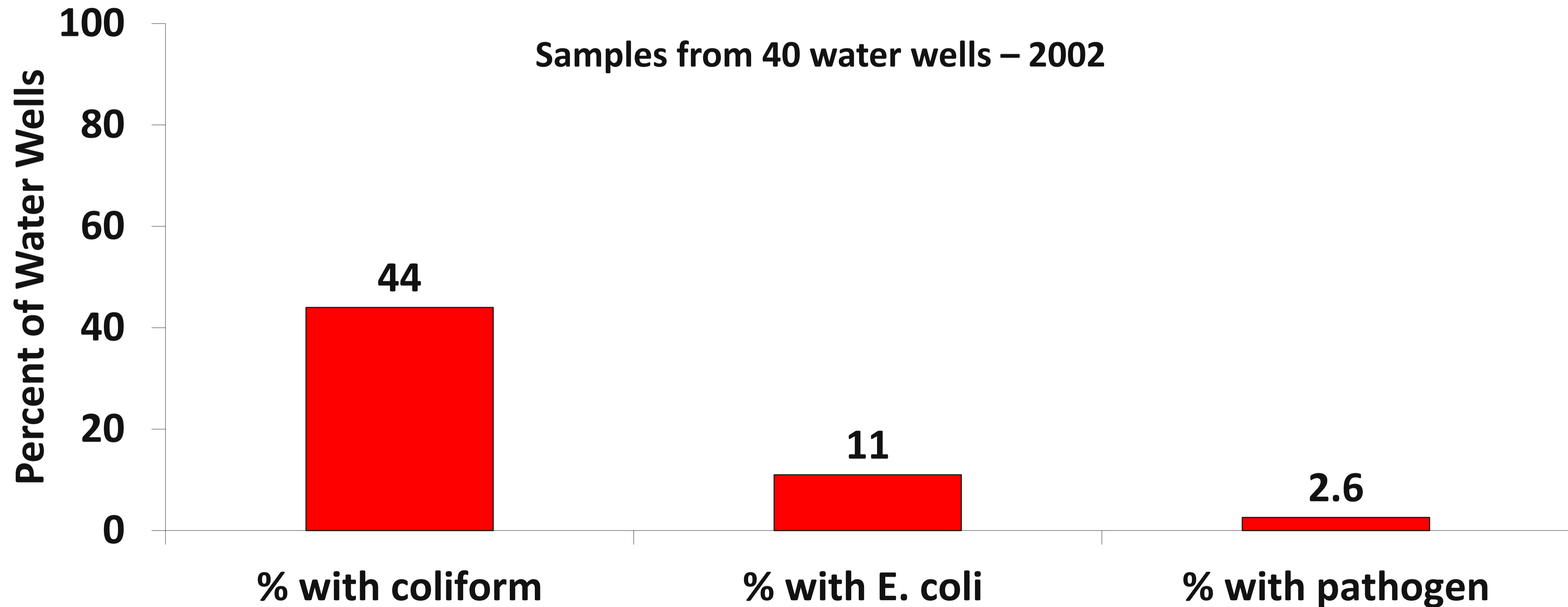
Two of the Most Common Problems in Wells/Springs



Regional Studies of Bacteria in Wells

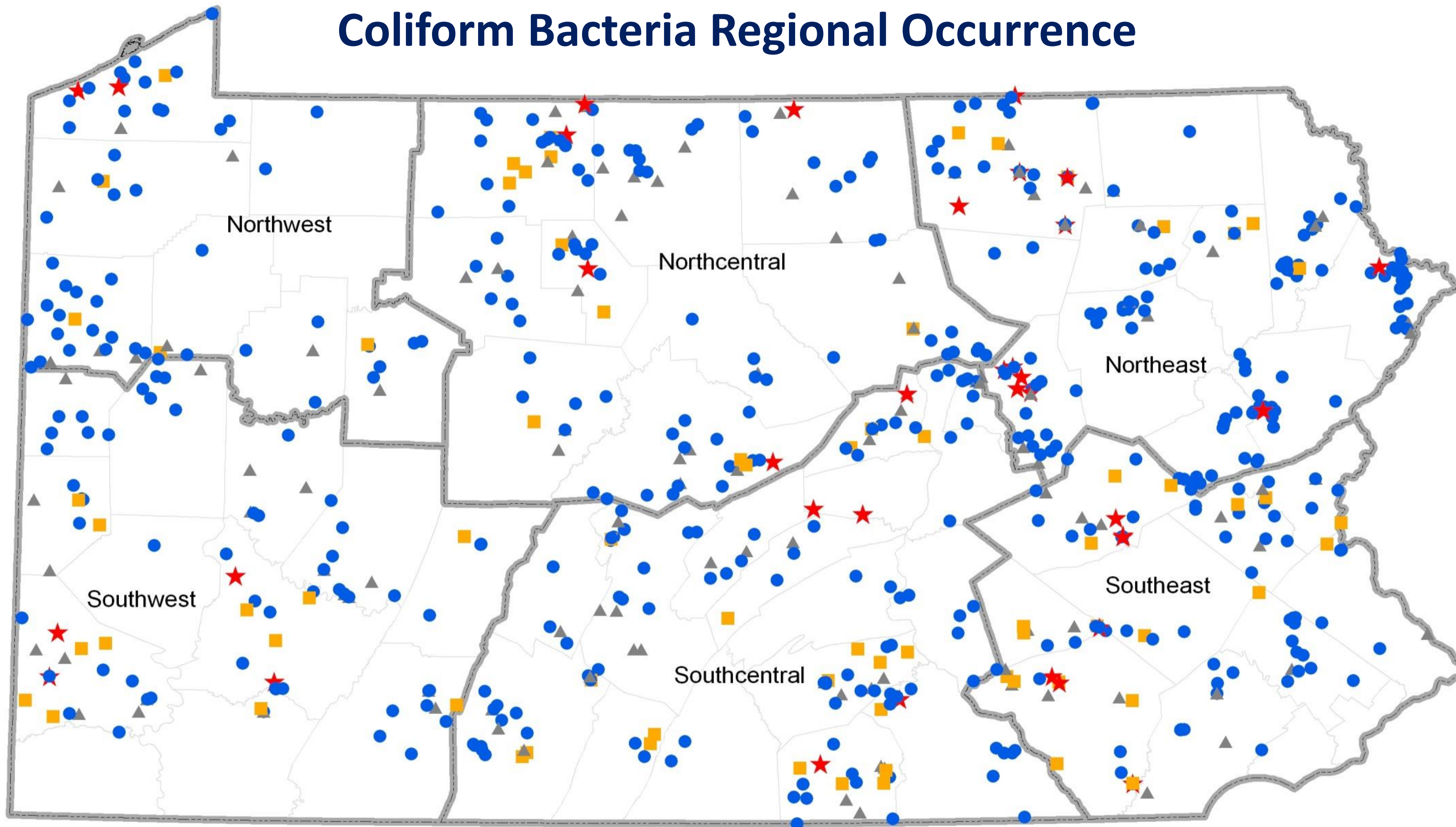


How Indicative are Coliform/*E. coli* of Pathogens?



Swistock et al., 2005 – *Journal of Environmental Health*

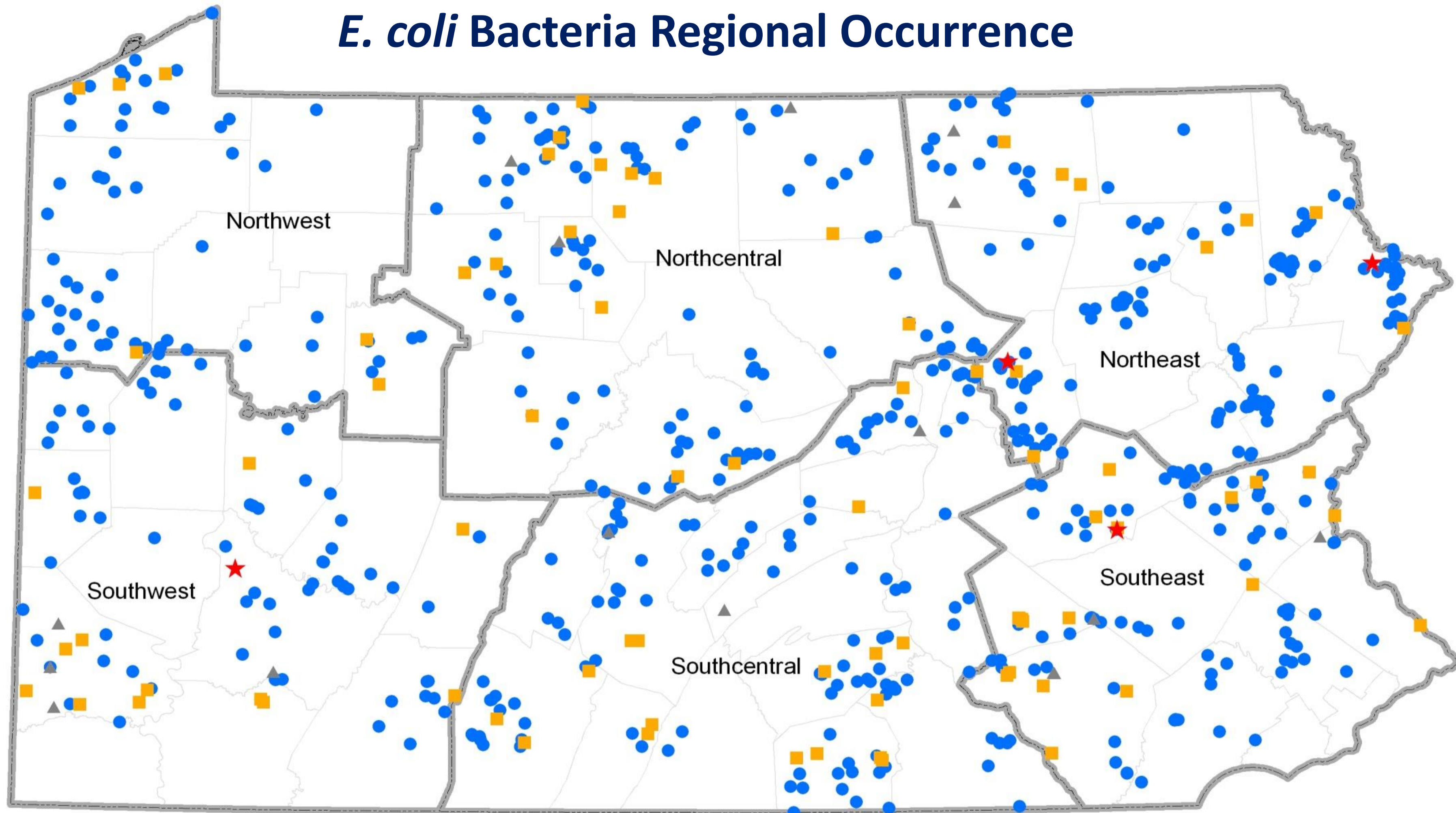
Coliform Bacteria Regional Occurrence



Well Coliform Bacteria Concentration (Colonies/100mL)		Scale
● 0	■ 11 - 50	0 20 40 80 Miles
▲ 1 - 10	★ 51 - 344	

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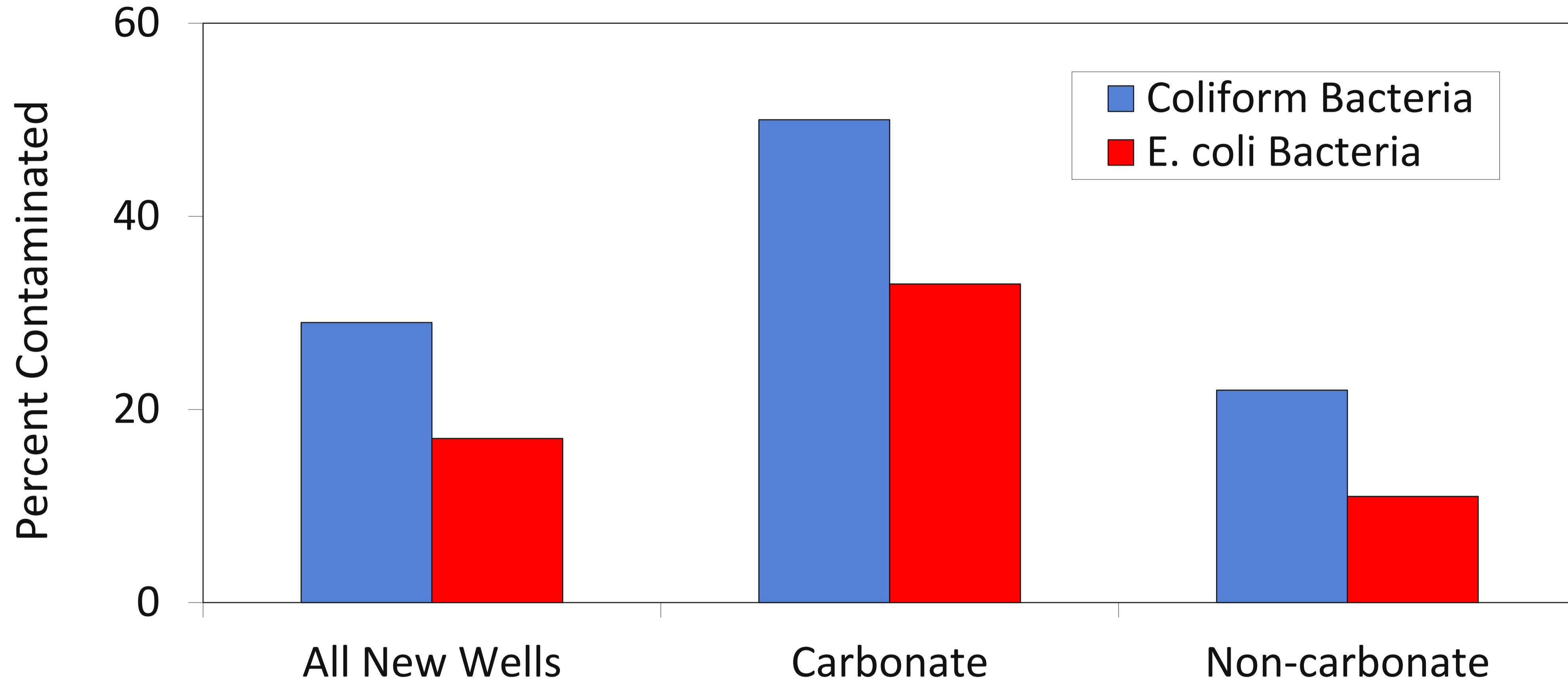
E. coli Bacteria Regional Occurrence



Well <i>E. Coli</i> Bacteria (Colonies/100mL)		Scale	
● 0	▲ 11 - 50	0	20 40 80
■ 1 - 10	★ 51 - 208	Miles	

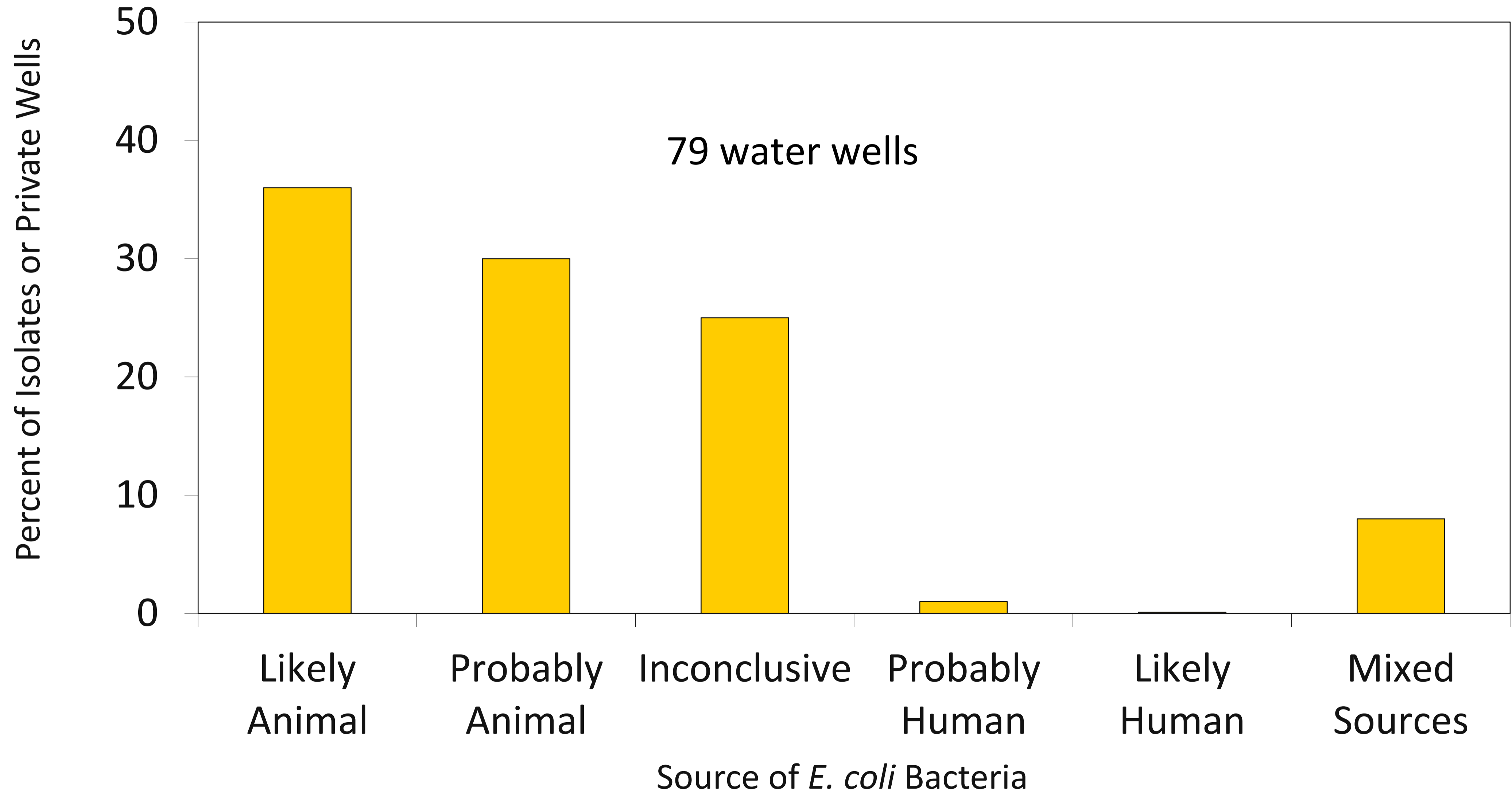


Importance of Geology in Bacterial Contamination of New Wells



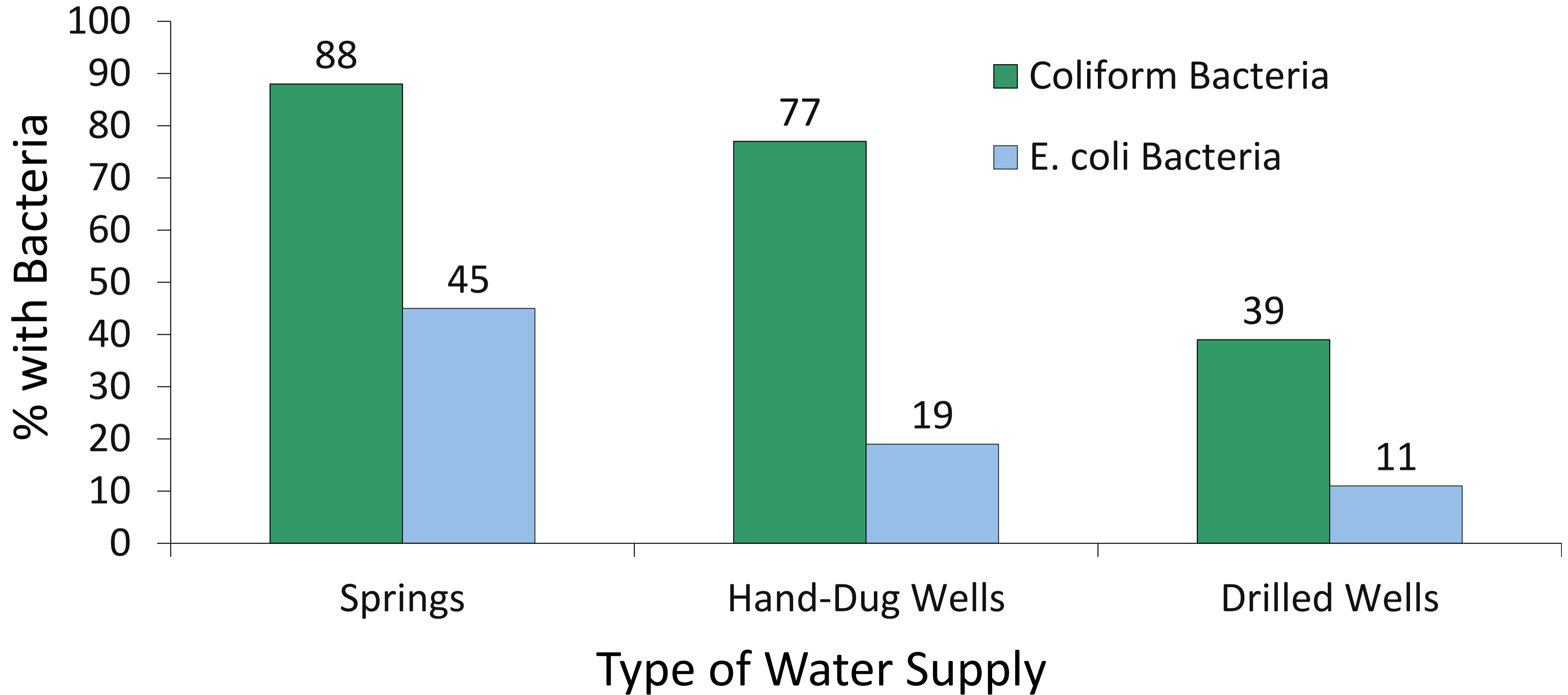
Swistock, B.R. and W.E. Sharpe. 2005. The influence of well construction on bacterial contamination of private water wells in Pennsylvania. *Journal of Environmental Health*, 68(2):17-23.

Nearby Land Uses - Sources of *E. coli* Bacteria



Influence of Depth/Water Supply Type

Study of 700 private water supplies in northcentral PA - 2012



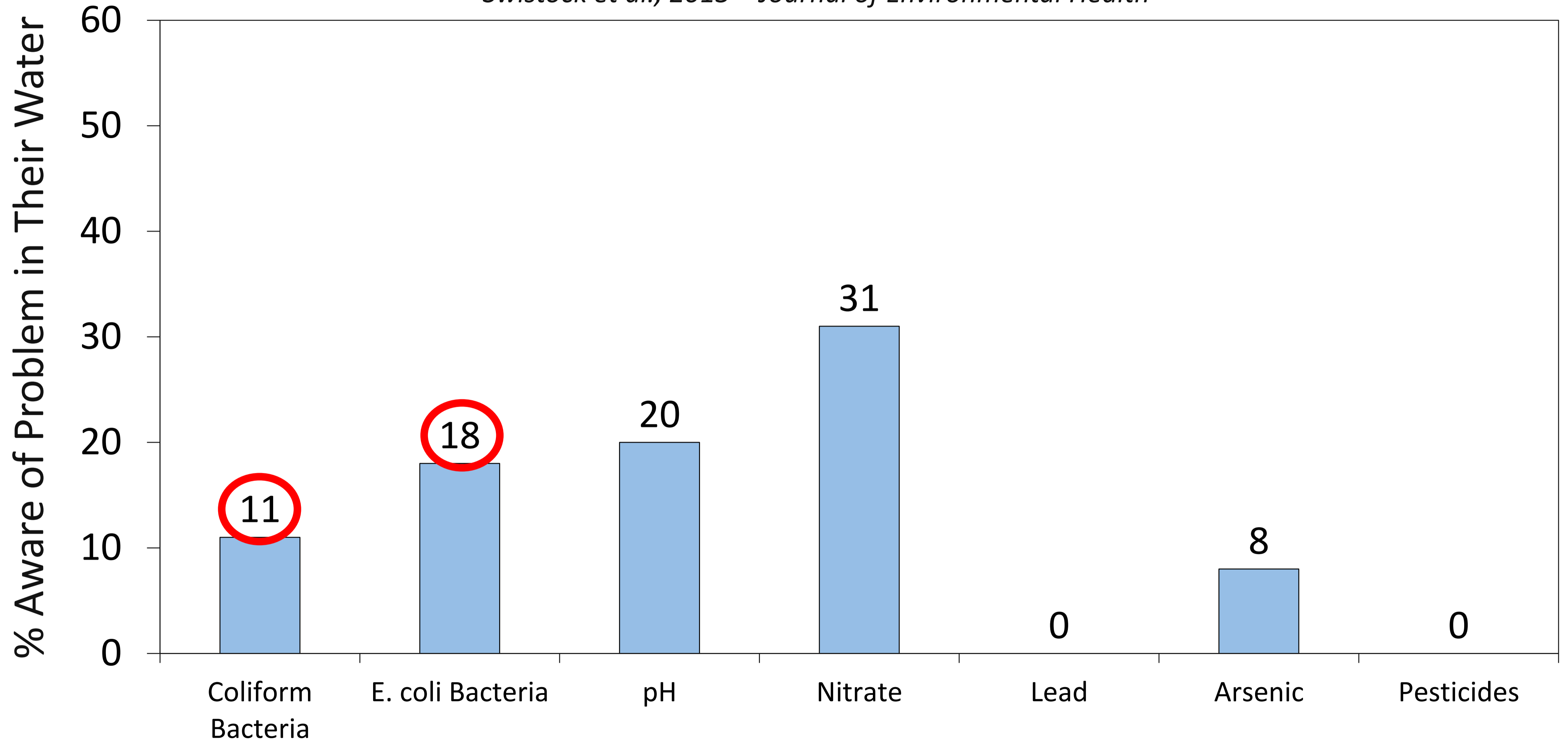
How Do Homeowners Respond to Bacterial Contamination?

- 450 water well owners received bacteria testing
- Specific recommendations provided on solving problems
- Follow-up post card sent months later - 64% return
- Of those with coliform bacteria
 - 54% with coliform did shock chlorination and installation of sanitary well cap
 - 25% installed treatment
 - 18% developed new source
 - 13% removed source of bacteria
 - **76% overall response**

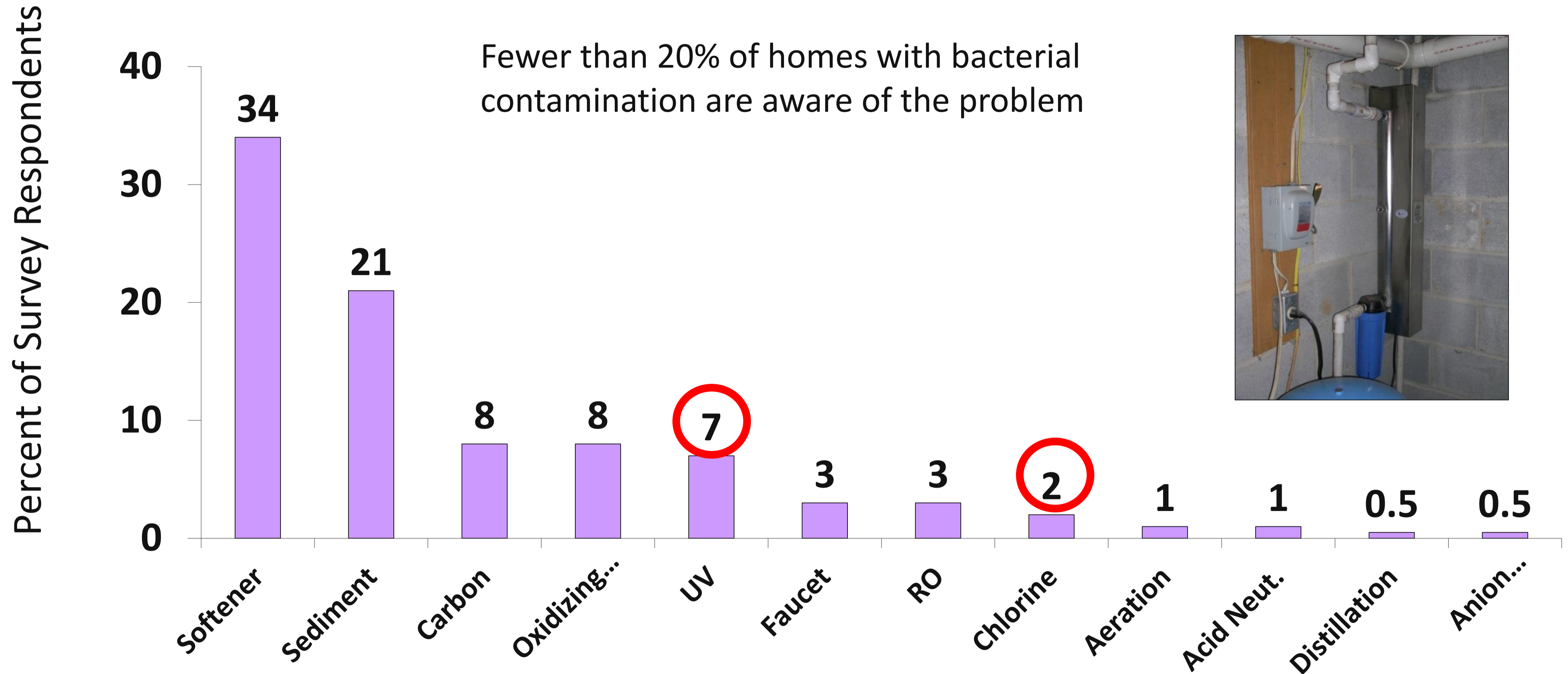


But, Most Water Supply Owners are Unaware...

Swistock et al., 2013 – Journal of Environmental Health



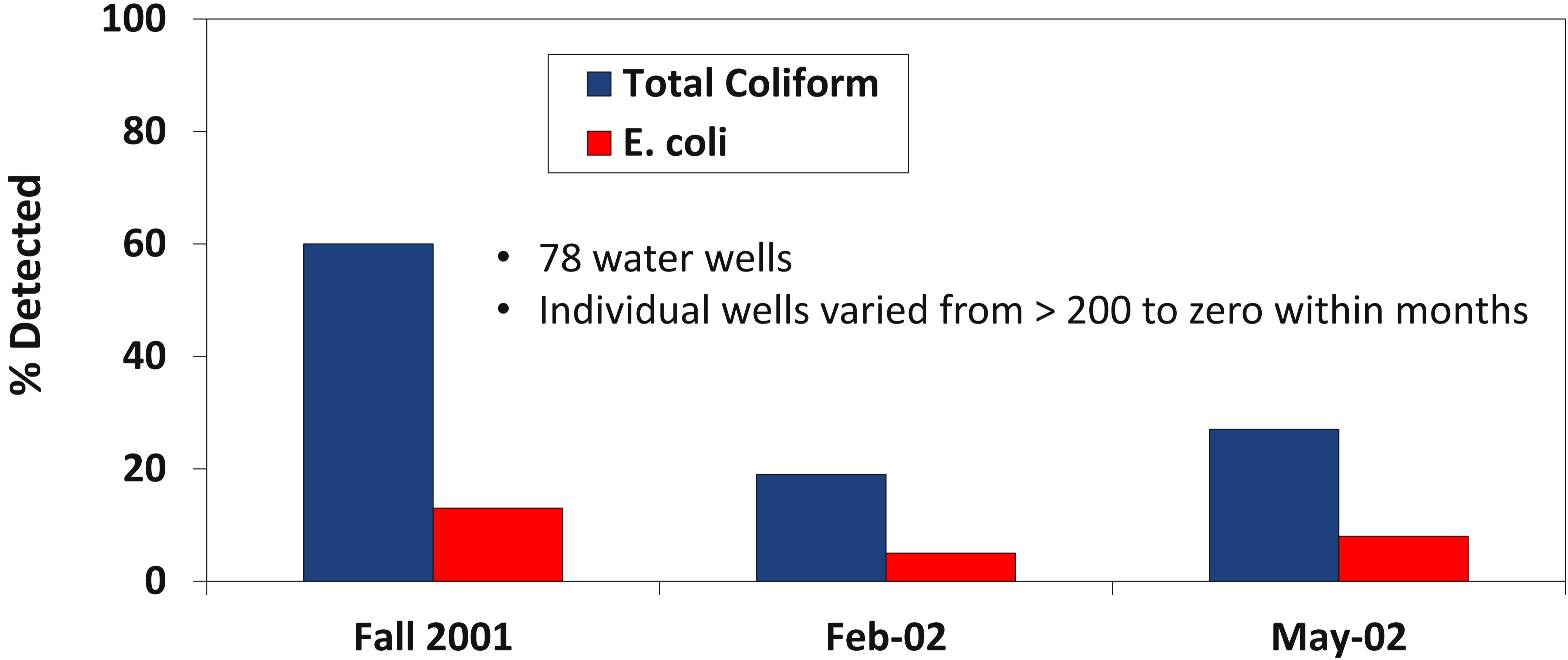
Bacteria Treatment is Not Common



What About Some Less Known Variables?

Weather / Climate

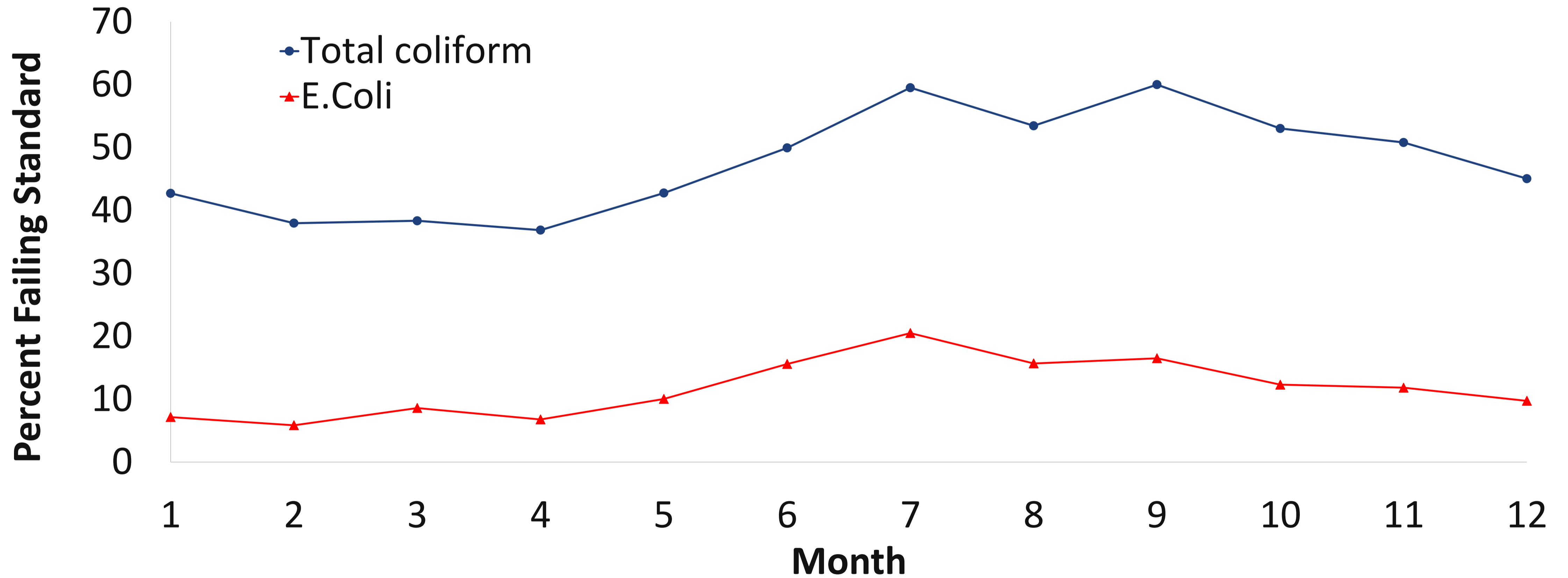
An Example of Bacterial Variability Over Time



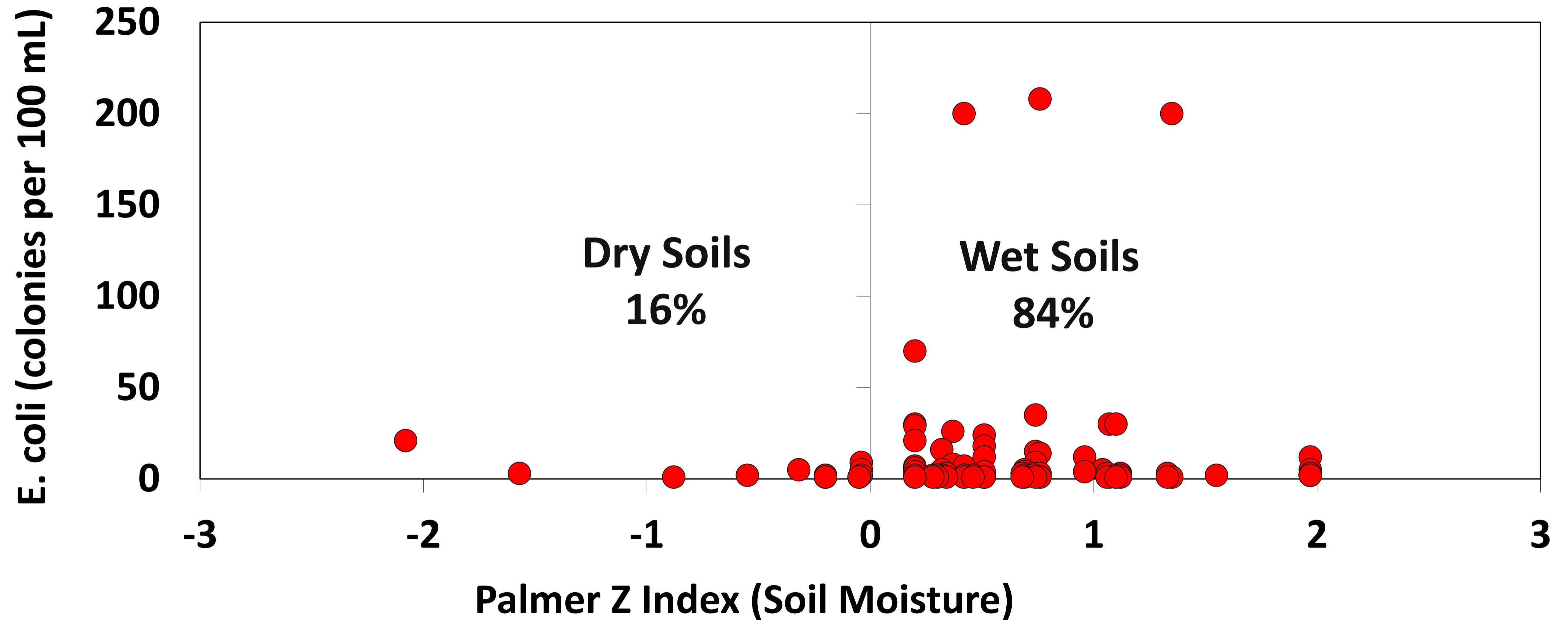
Swistock et al., 2005 – Journal of Environmental Health

Overall Monthly Bacteria Prevalence

(500 to 1,200 samples annually – AASL Penn State Lab)



Effect of Moisture Conditions on Bacterial Contamination



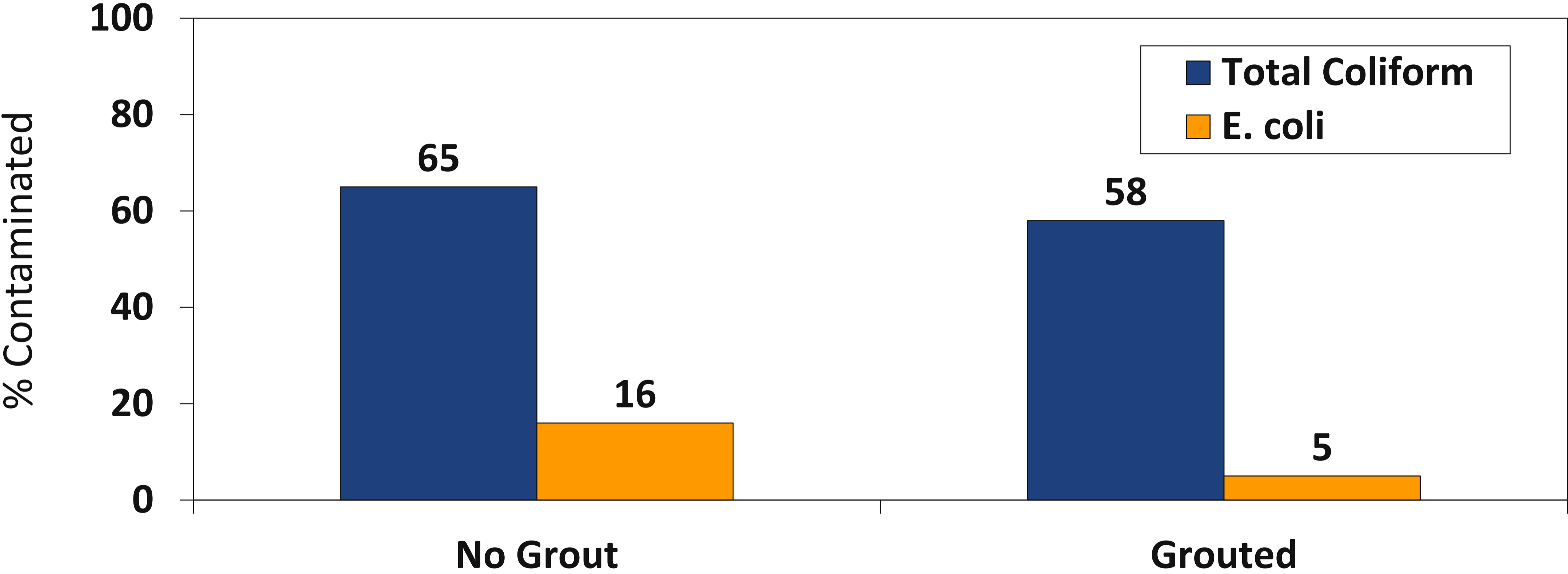
Influence of Water Supply Construction

Anecdotal Evidence of the Importance of Construction is Common





USGS Study of Well Construction



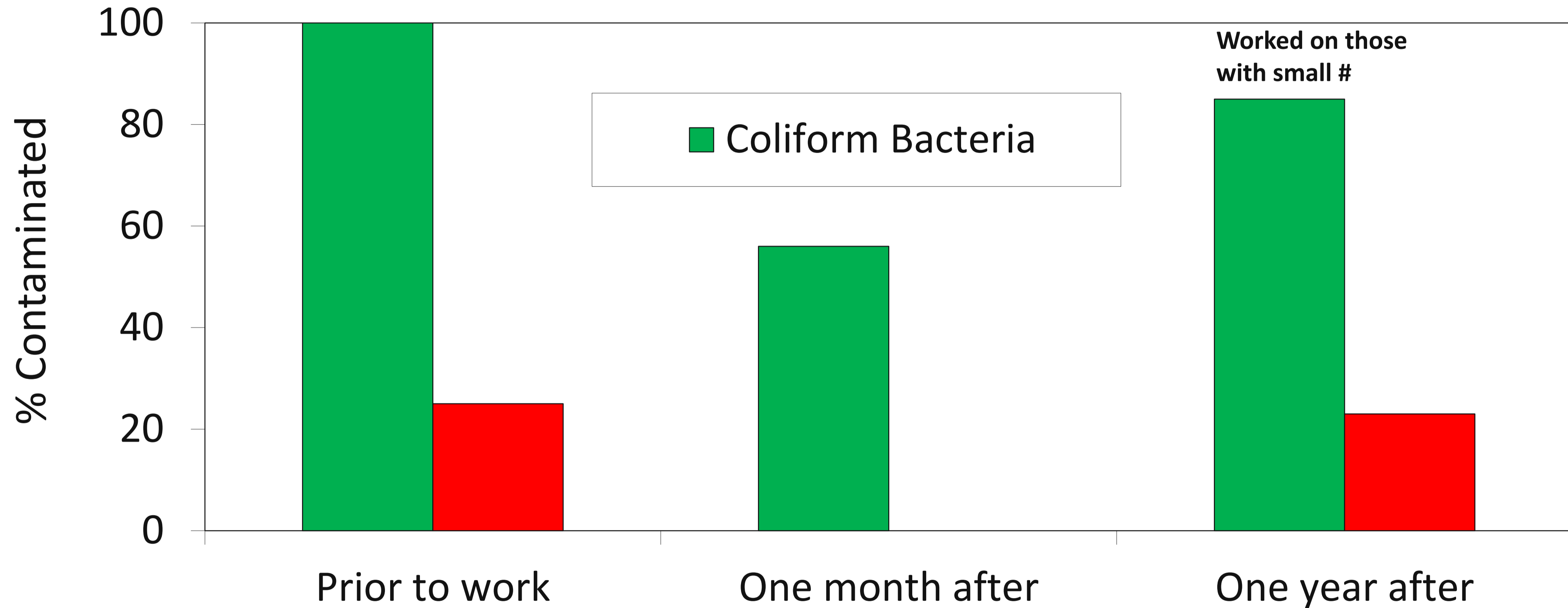
(Zimmerman et al., 2001)

Shock Chlorination/Sanitary Well Cap Study

- 16 wells with coliform from USGS study
- All wells lacked sanitary well cap
- 9 had grout seal, 7 without grout seal
- Collected initial sample to confirm coliform contamination
- Each well was shock chlorinated and fitted with sanitary well cap
- Follow up sampling at 30 days and one year



Effect of Chlorination and Sanitary Cap



Swistock, B.R. and W.E. Sharpe. 2005. The influence of well construction on bacterial contamination of private water wells in Pennsylvania. *Journal of Environmental Health*, 68(2):17-23.

Cumulative Effect of Well Construction



“sanitary” well cap

Fewer than 20% of home and farm wells in PA have this “sanitary” construction

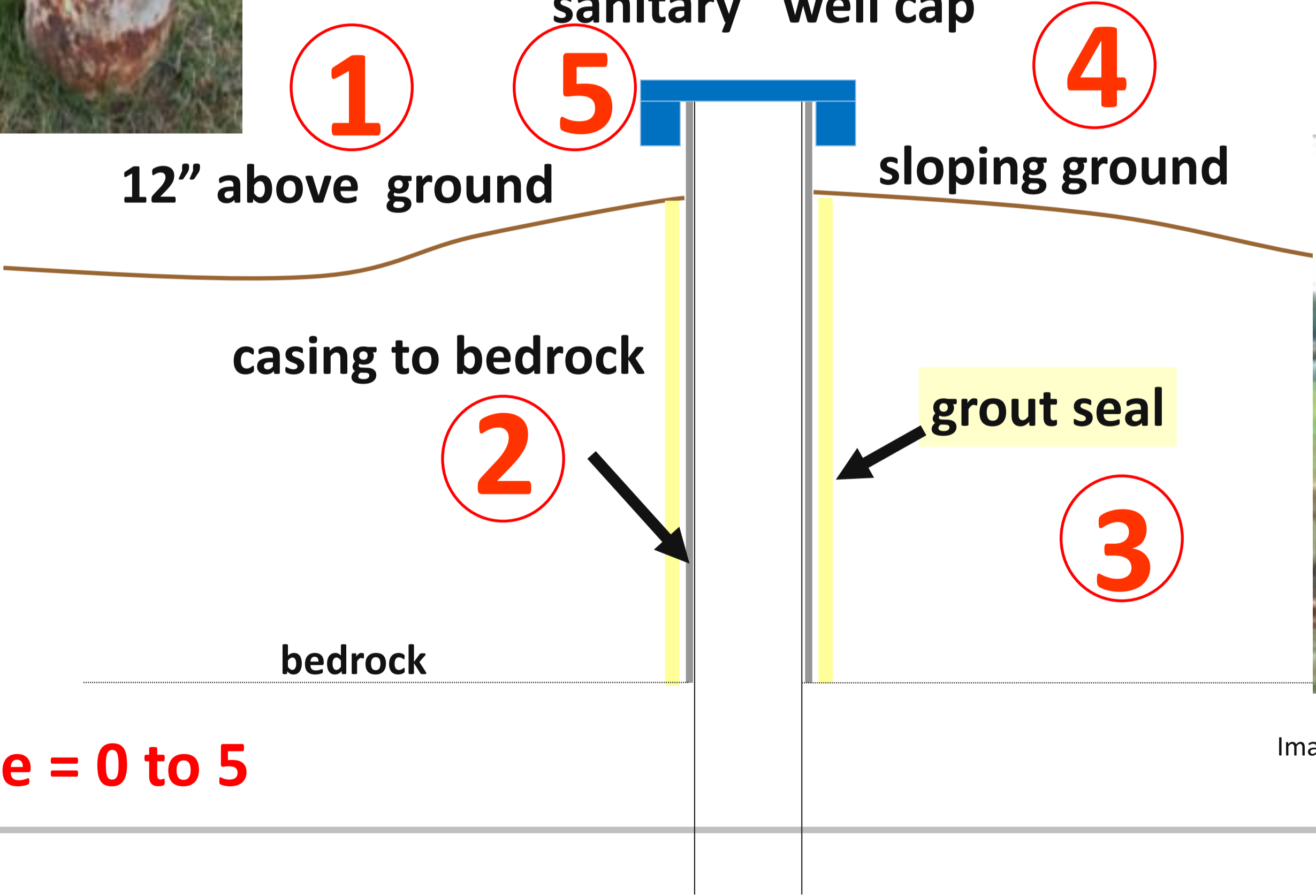
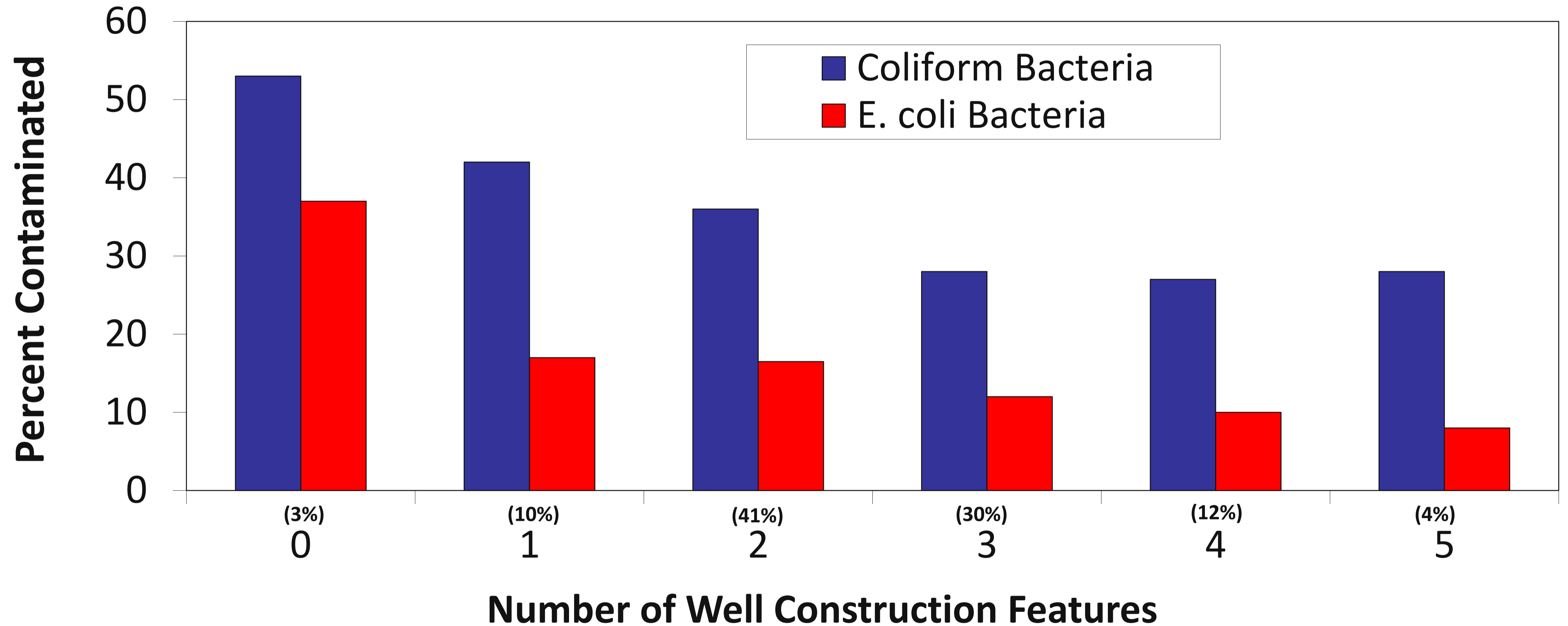


Image: Todd Giddings, Pennsylvania Ground Water Association

Well score = 0 to 5

Effect of Well Construction on Bacterial Contamination

(N=701 water wells)



Swistock et al., 2013 – Journal of Environmental Health



BUT: there are no statewide standards or requirements for private water well construction in Pennsylvania!

Influence of Sampling Procedures and Other Factors

Sample Collection Factors

- Careful sample collection
 - PSU study found lack of gloves and touching inside of bottle or cap easily caused bacterial contamination of sterile water samples
- Effect of sterilizing faucet
 - 49 water wells with coliform bacteria
 - Duplicate samples
 - Aerator removal, bottle rinsed, no sterilization
 - Sterilized faucet for duplicate
 - No statistically significant difference in results
- Plumbing system contamination?
 - Pressure tank vs. faucet samples
 - No statistically significant difference



Sample Collection Factors

- Membrane filtration sample protocol
 - Coliform testing of 120 well samples
 - Membrane filtration of 100 and 200 mL
 - 71 produced negative results for both
 - 39 positive for both, no significant difference in numbers
 - 10 (8%) produced negative result at 100 mL but positive at 200 mL (up to 5 colonies per 100 mL)



Summary

- Coliform and *E. coli* bacteria are important water quality parameters that are used almost exclusively to determine drinking water potability
- Large-scale variables affecting bacterial contamination include geology, moisture conditions and season
- Smaller-scale variables include well construction, sample collection procedure, and type of water supply
- This variability needs to be communicated to homeowners and should be considered when assessing bacteria contamination of private wells and springs

Questions?

