Lead in Homes with Domestic Wells in Three Illinois Counties

Walt Kelly
Sarah Geiger
Dave Jacobs
Saria Awadalla
Jonathan Bressler
Sam Dorevitch

ILLINOIS
Illinois State Water Survey
PRAIRIE RESEARCH INSTITUTE

UIC

Northern Illinois University

Funding by:

ILLINOIS
Illinois Sustainable Technology Center
PRAIRIE RESEARCH INSTITUTE

Domestic Wells and Lead

- Lead and Copper rule: If Pb exceeds 15 ppb in > 10% of customer taps sampled, the system must undertake actions to control corrosion
- In Illinois (and most states), domestic well water quality is not regulated: the owner and user is responsible for making sure water is safe to drink and the system is maintained
- Studies in several states (VA, PA, WI, NC) suggest a significant number of homes with domestic wells may have elevated Pb levels in tap water

Sources of Lead into Well Water

- Lead pipes are typically worst contributor; banned in 1986
- Lead solder used to join copper pipes (50% lead, 50% tin until 1986)
- Brass components such as faucets, coolers, and valves
  - Could be 8% Pb until 2012
  - Pipe and plumbing fittings and fixtures installed in potable water-supply systems after January 2014 must contain no more than 0.25% lead
  - Especially an issue during the first few months of use

Sources of Lead in Wells

- Lead "packers" above the well screen may have been used in wells that were drilled over 20 years ago
- Some submersible pumps manufactured before 1995 may contain leaded-brass components
- Galvanized metal (zinc & lead coating)
  - Has a minimum lead requirement
  - Forms iron scale that can sorb lead (particulates)
  - Well casing, drop pipe for pump, premise plumbing, fittings

Water Quality Factors Affecting Release of Lead

- pH and Alkalinity
- Chloride and Sulfate
- Hardness (Calcium and Magnesium)
- Dissolved Oxygen
- Oxidation Reduction Potential
- Natural Organic Matter
- Iron, Aluminum, Ammonia
- Temperature

Main factors for determining corrosivity

Corrosivity Measurements used in this Study

- Larson-Skold Index (LSI):
  - $$LSI = \frac{(epm\ Cl^{-} + epm\ SO_4{}^{2-})}{(epm\ CaCO_3)}$$

epm = equivalents per million

- Chloride-Sulfate mass ratio (CSMR)

Lead in Water in Homes with Domestic Wells in Illinois: Pilot Study

- 3 counties: Jackson, Peoria, Kane, with 151 participants
- Focused on older homes (pre-1986)
- Phase I: sample at the tap, 1st liter (first draw) and 7th liter (flushed)
  - Analyze for Pb (total in all, dissolved in subset) and corrosivity (alkalinity, chloride, sulfate)
  - Questionnaire for well owners
- Phase II: re-sample homes with highest hits, collect well water sample
  - Pb and Cu analysis at tap
  - Complete inorganic chemistry for well water including field parameters

Questionnaire: People

Question/Item	Total (N)	Total (%)
Awareness of Flint, MI	138	93.2
Concern about Flint, MI	32	21.6
Aware water is possible Pb source	95	64.2
Ever tested water for Pb	14	9.5
Previous positive Pb water result	1	0.7
Use infant formula	21	14.2

Questionnaire: Well and Home Characteristics

Question/Item	Total (N)	Total (%)
Drilled	86	58.1
Sandpoint	1	0.7
Bored	8	5.4
Dug	4	2.7
Other	1	0.7
Don’t know	47	31.8

Question/Item	Total (N)	Total (%)
Aware of Pb in well/plumbing	26	17.6
Pre-1986 well	78	52.7
Pre-1986 home	92	62.2
Well upkeep < $100 per year	131	88.5

Questionnaire: Water Use

"My tap water is safe to drink"

Question/Item	Total (N)	Total (%)
Strongly agree	72	48.6
Somewhat agree	38	25.7
Neutral	20	13.5
Somewhat disagree	12	8.1
Strongly disagree	4	2.7
Missing	2	1.4

"Bottled water is safer than my tap water"

Question/Item	Total (N)	Total (%)
Strongly agree	28	18.9
Somewhat agree	31	20.9
Neutral	53	35.8
Somewhat disagree	19	12.8
Strongly disagree	15	10.1
Missing	2	1.4

Total Water Lead Levels in Phase I Sampling

County	Sample	Number of samples	Detectable Pb (> 0.76 µg/L)	Pb > 15 µg/L	Maximum value (µg/L)
Jackson	1st liter	38	20	2	76.2
	7th liter	38	11	0	3.93
Kane	1st liter	62	27	2	47.0
	7th liter	62	8	0	3.37
Peoria	1st liter	51	26	1	15.4
	7th liter	51	15	0	5.00
Total	**1st liter**	**151**	**73**	**5**	**76.2**
	7th liter	**151**	**34**	**0**	**5.00**

Corrosivity Data for Phase I Sampling

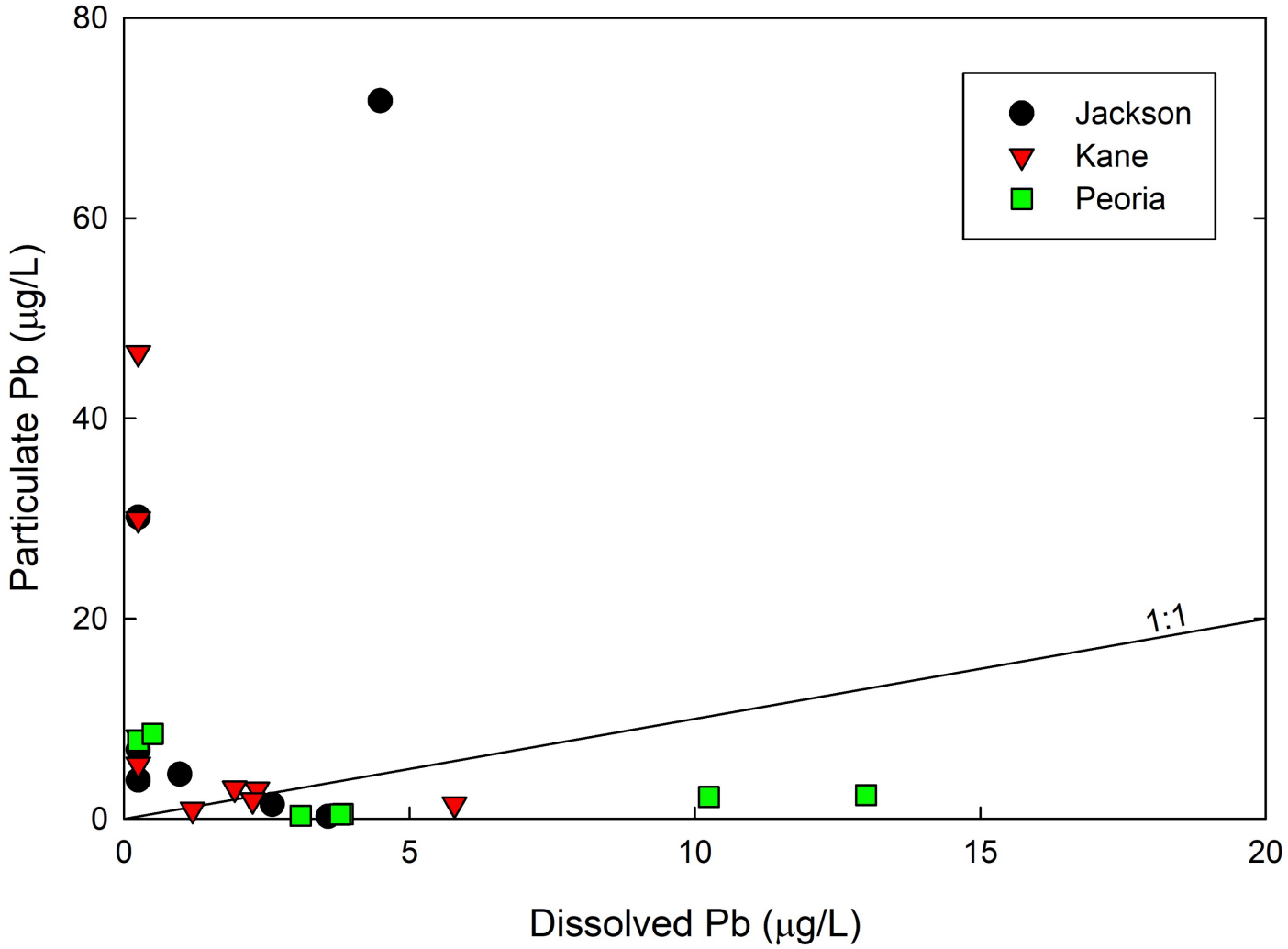
County	Alkalinity (mg $CaCO_3$/L)			Chloride (mg/L)			Sulfate (mg/L)		
	Median	Min.	Max.	Median	Min.	Max.	Median	Min.	Max.
Jackson	305	65	726	8.9	2.7	1022	37.3	< 0.21	319
Kane	356	148	581	39.2	0.8	515	19.1	< 0.21	192
Peoria	385	197	1222	28.6	0.6	1337	33.6	< 0.21	710

County	Larson-Skold Index				CSMR	
	Median	% Low (< 0.8)	% Intermed. (0.8 – 1.2)	% High (> 1.2)	Median	% > 0.6
Jackson	0.22	79.0	7.9	13.2	0.32	29.0
Kane	0.28	80.7	14.5	4.8	4.69	93.6
Peoria	0.25	80.0	10.0	10.0	1.62	70.0

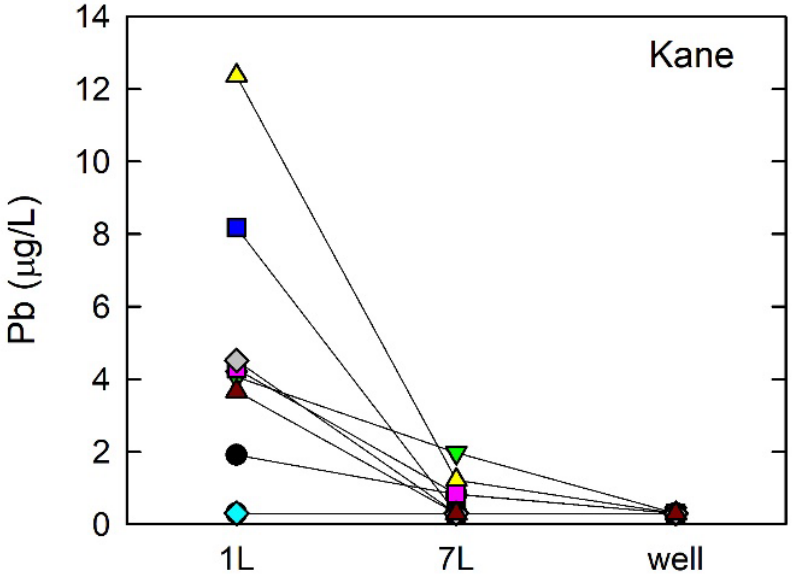
Statistical Results, Phase I

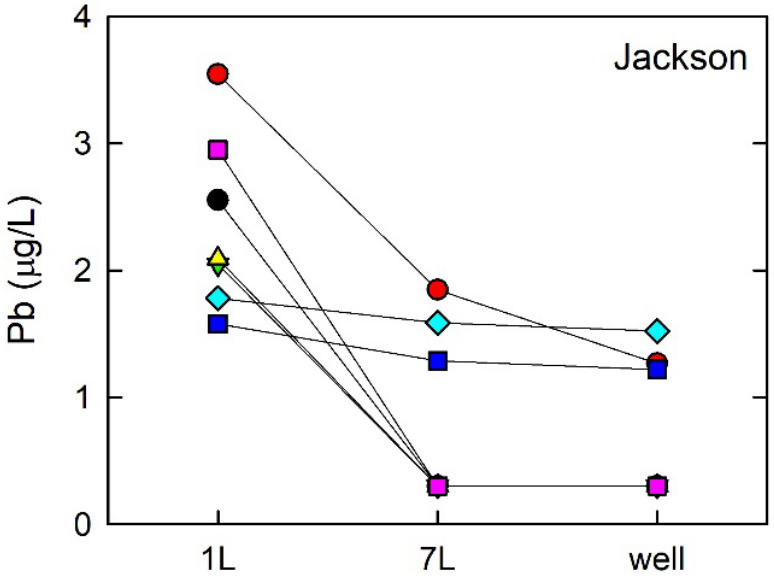
- Homes built pre-1987 were more likely to have detectable Pb and far more likely to have Pb levels ≥ 2 µg/L than homes built post-1986
- Homes built pre-1987 that had corrosive groundwater were 11 times more likely than new homes with non-corrosive water to have detectable Pb
  - For LSI
  - CSMR not predictive

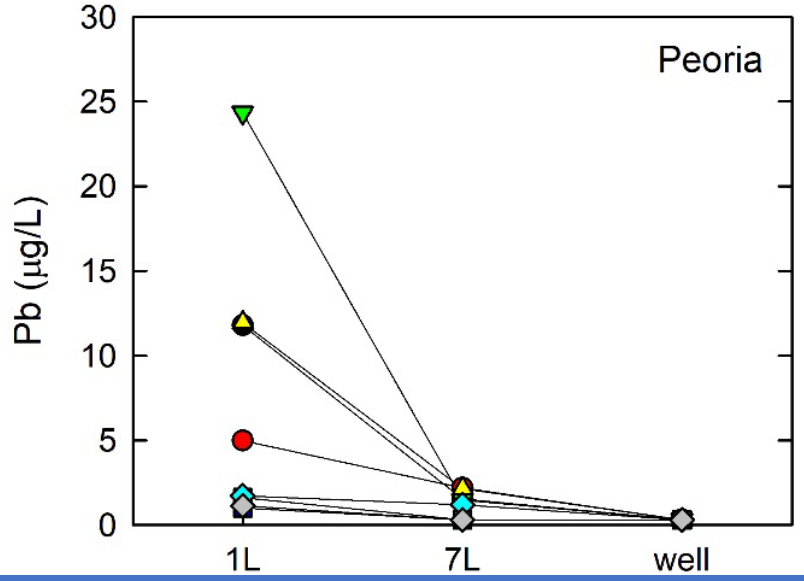
Particulate vs. Total Pb for Phase I, First Draw Samples



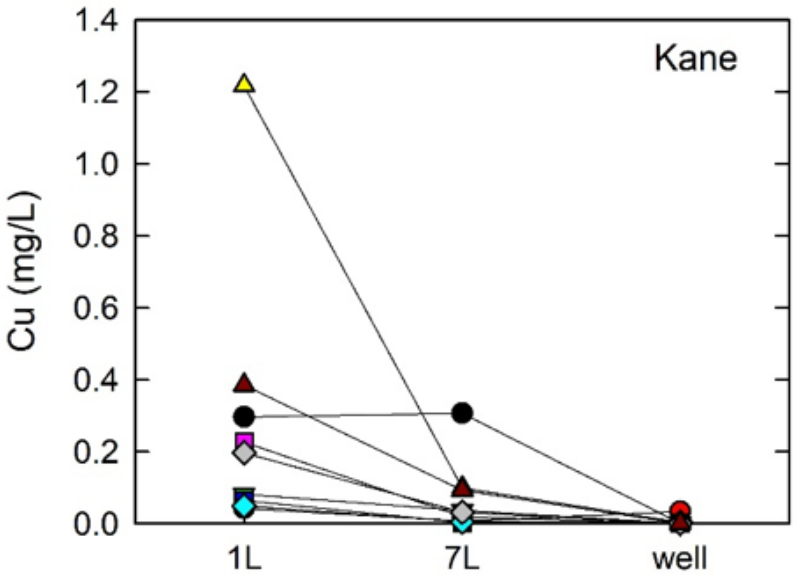
Lead Concentrations in Phase II Sampling

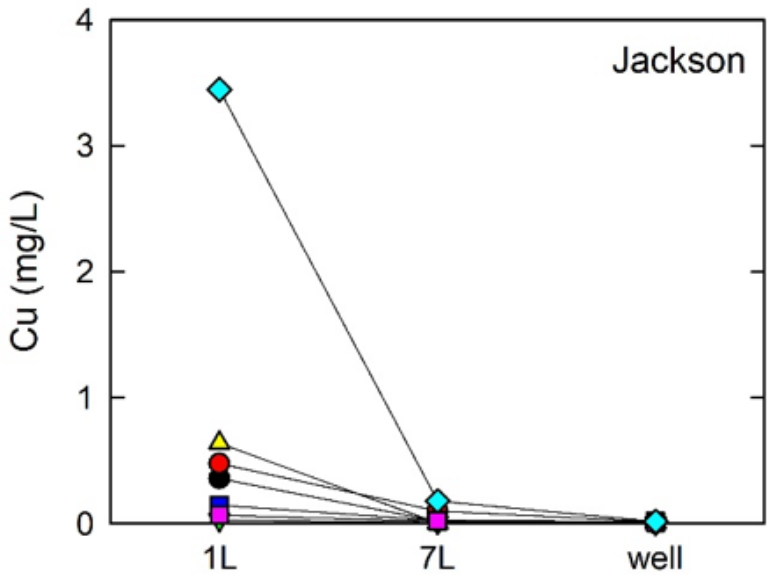


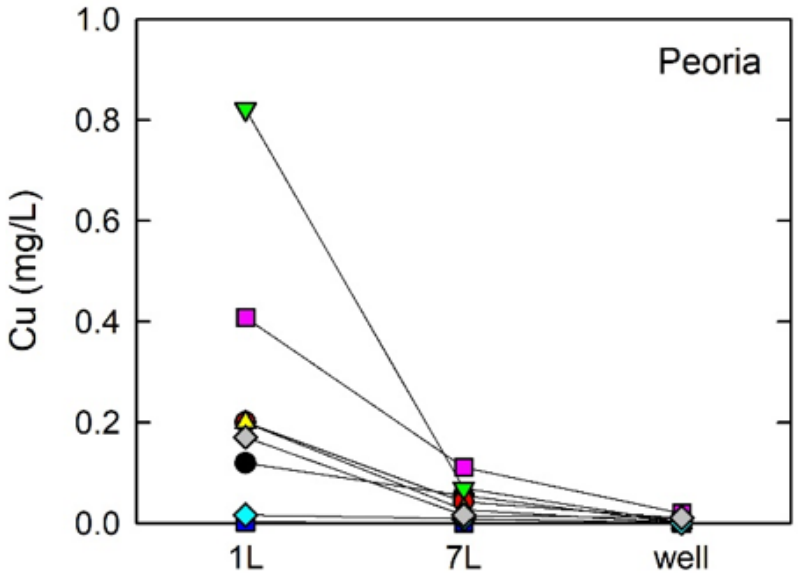




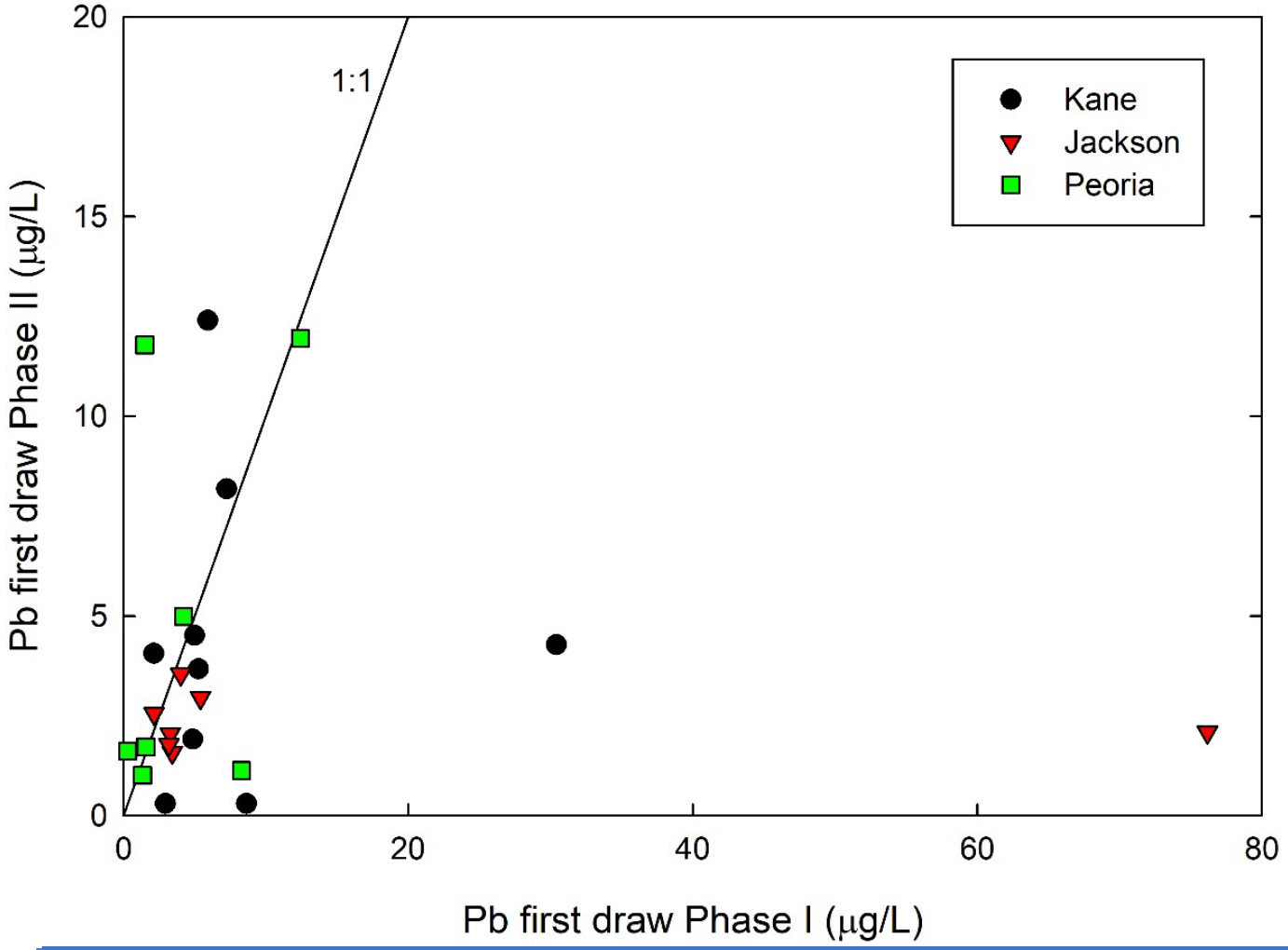
Copper Concentrations in Phase II Sampling



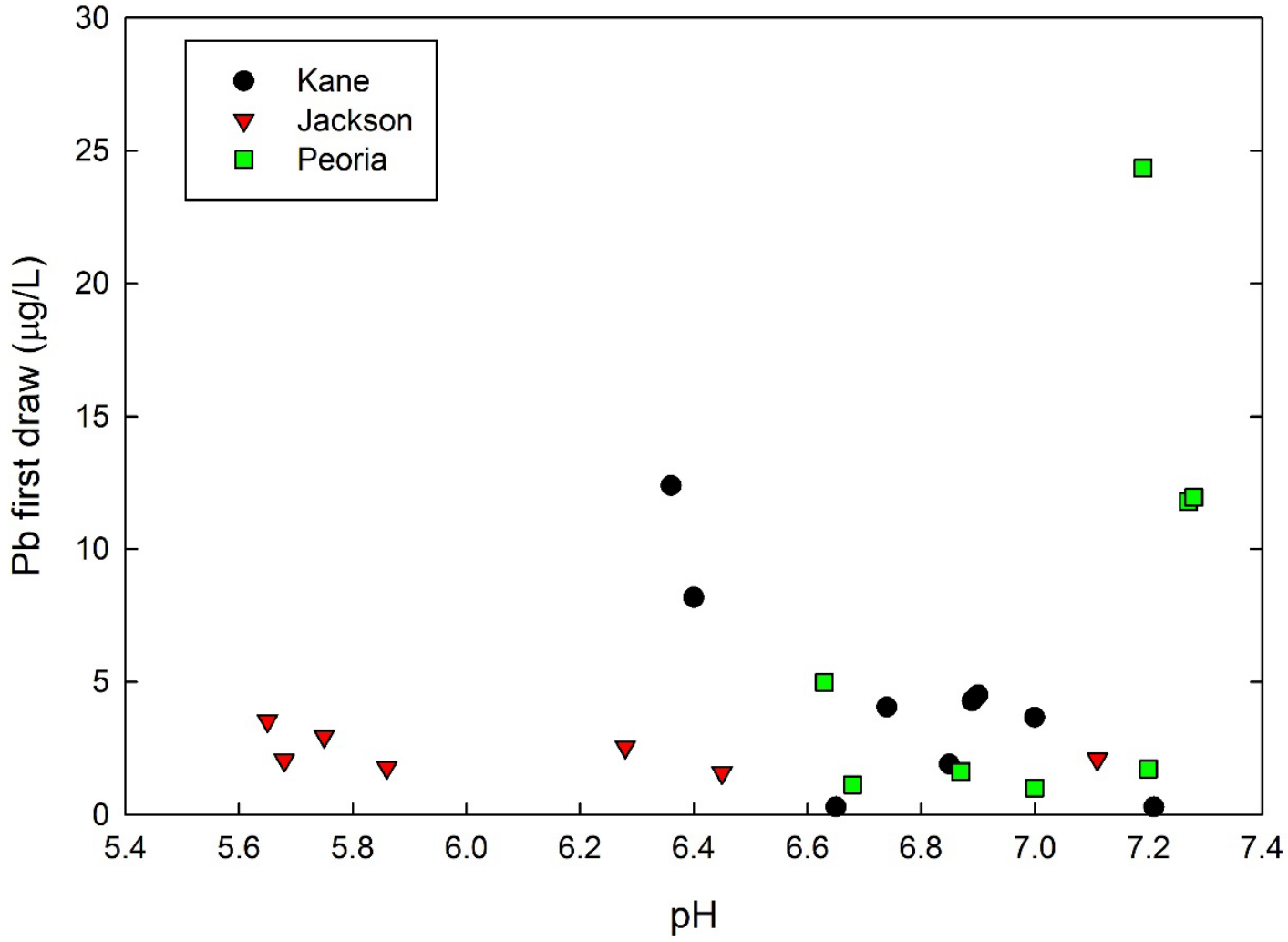




Pb in 1st Draw Samples for Homes Sampled in Both Phase I and II



First Draw Pb vs. pH for Phase II



- Low pH samples tended to have elevated DO and nitrate and low alkalinity
- Young, corrosive water in karst aquifer (Jackson Co.)

Conclusions

- Homes with domestic wells can be vulnerable to Pb contamination in a variety of settings, especially older homes
- Hydrogeological settings and geochemical conditions can be important variables affecting Pb and water corrosivity
- Domestic well owners need assistance in protecting their water quality

Geiger, S.D., et al., in press. Predictors of water lead levels in drinking water of homes with domestic wells in 3 Illinois counties. *Journal of Public Health Management & Practice*.

Future Work

- New funding from HUD (project currently on hold due to COVID)
- Expand to include 2 new counties (Champaign, Whiteside)
- Provide plumbing assessment and evaluate 4 remediation types
  - Replacement of Pb pipes and Pb-containing components
  - Reverse osmosis
  - Certified POU filter device
  - Brita-type filter
  - Evaluate performance for 1 year