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State-level policies concerning private wells in the United States

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Abstract

Currently, no federal policies exist in the United States regarding private wells; this authority is devolved to states. This study inventoried state-level policies governing private wells in the United States in order to identify the topics addressed by each state, division of responsibilities across state agencies, and geographic differences in policy comprehensiveness. From May to August 2018, two independent reviewers conducted an online search followed by directly contacting state agencies (98% response) to identify all state-level policies in the United States that directly reference private wells. The search, updated in April 2018, confirmed the existing water policy list and identified 23 additional policies. Policies were then coded according to nine not-mutually-exclusive classifications. The results indicate that all states had at least one policy addressing private well drilling or construction. Significant geographic differences exist in maintenance related policies. In conclusion, although drilling and construction safety are addressed by each state, some policy domains are addressed inconsistently across states, and other policy domains are absent in most states.

Keywords: Domestic well; Drinking water; Groundwater; Safe water; Spatial analysis

1. Introduction

Private wells are not federally regulated or protected by the U.S. Environmental Protection Agency's (EPA) Safe Drinking Water Act, despite the fact that an estimated 43 million people (15% of the population) in the United States rely on private wells for drinking water (DeSimone *et al.*, 2009). The laws regulating these wells are geographically inconsistent because they are promulgated by individual states. Without construction or management standards, wells may be susceptible to contamination by chemicals, bacteria,

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viruses, and parasites (Craun *et al.*, 2010; Wallender *et al.*, 2014). For example, improper well design, inadequate well maintenance, older well age, and the improper location of the well may facilitate contamination of well water (Swistock *et al.*, 2013; Wallender *et al.*, 2014; Stillo & MacDonald Gibson, 2016).

Little is known about the quality of water from private wells because there are few regulations requiring homeowners to test and, if needed, treat their well water (Flanagan *et al.*, 2015). As a result, testing occurs infrequently (Jones *et al.*, 2006; Katner *et al.*, 2015; Paul *et al.*, 2015; Malecki *et al.*, 2017). In addition to the lack of legal requirements for private well water testing and treatment, other major barriers for ensuring uncontaminated well water include limited knowledge of water testing by well owners, inconvenience to owners, cost of testing, privacy concerns, property value concerns, and lack of perceived health concerns (Kreutzwiser *et al.*, 2011; Morris *et al.*, 2016; Malecki *et al.*, 2017).

Currently, there is no consolidated summary of state-level laws and regulations for private wells in the United States. To address this gap, the objective of this study was to identify the current state-level laws and regulations concerning private wells and to characterize the heterogeneity in private well regulations across the United States.

2. Methods

2.1. Data collection

For this study, we defined a 'private well' as a private, domestic, or nonpublic well that delivers water to one household with approximately 10 gallons of water per minute, or less than 100,000 gallons of water per day, and serves no more than 25 people at least 60 days of the year (Virginia Water Resources Research Center, 1995; North Carolina Department of Environment and Natural Resources, 2009; Centers for Disease Control and Prevention, 2014; Oregon Water Resources Department, 2015). This definition is in contrast to the EPA's definition of a public water system as a water system serving at least 25 people for at least 60 days a year with at least 15 service connections (EPA, 2017a).

To generate a preliminary list of private well policies, we conducted internet searches from May 15 to August 30, 2016 in Google™ using the search terms (*private well + state name; e.g., private well + New York)*. An additional search was conducted in April 2018. Terms such as law, statute, and regulation were excluded to avoid limiting the search results. We included only current policies that directly referenced private wells. For example, legislative bills and policies regulating public water were excluded. State agencies identified as responsible for regulating private wells were contacted through email to confirm that all relevant statutes had been identified for each state by the study.

Information from each policy was collected and it was recorded if a policy addressed one of nine prespecified classifications. To fall within a classification, the policy must have stated a recommendation, procedure, or requirement within the scope of the classification. We defined **drilling or construction** policies as containing rules, regulations, or standards for the act of drilling or constructing a private well, such as the installation method and the requirement for installation by a licensed well driller. Policies pertaining to the term **design** outlined the depth, dimensions, and specific materials used for the construction of a private well. The term **permits** referred to whether a permit is required or not. We defined that the term **maintenance** as policies defining specific, required actions the owner, driller, or agency must take to maintain the private well. We used the term **inspection** to define policies granting the agency the authority to inspect the private well. We defined the term **water quality** to refer to

requirements or procedures for testing of the private well. We defined **abandonment** polices as procedures for decommissioning, filling, or sealing of an abandoned well. **Selling a home or property** policies outlined procedures for selling a home or the transfer of property with a private well on site. The **rental** category provided rules or requirements for the landlord to follow when leasing their property with a private well on site. These policy classifications were assigned by two independent reviewers and discussed until consensus was achieved. The abstracted information included the policy classifications and the state agency responsible for regulating private wells, as noted by the statute authority or department definition.

2.2. Analysis

We graphically summarized which policy categories were present in each state using R Studio v.1.0.136 (R Studio Inc., Boston, MA). The graph clarifies the major differences between states within a category and provides a visual representation of the prominent patterns across state-level private well policies (Figure 1).

To assess any differences in the presence of private well policies due to a state's region and similar geological features, we used Fisher's exact test (Stata/SE 14.2, StataCorp, College Station, TX). This method was selected to identify significant associations between the type of private well policy and the state region. We referred to the EPA service regions as the foundation for defining our regions for analysis (EPA, 2017b), but combined some regions for stability of estimation and included only the 50 states. Our eight regions for this analysis were defined as follows: (1) Connecticut, Maine,

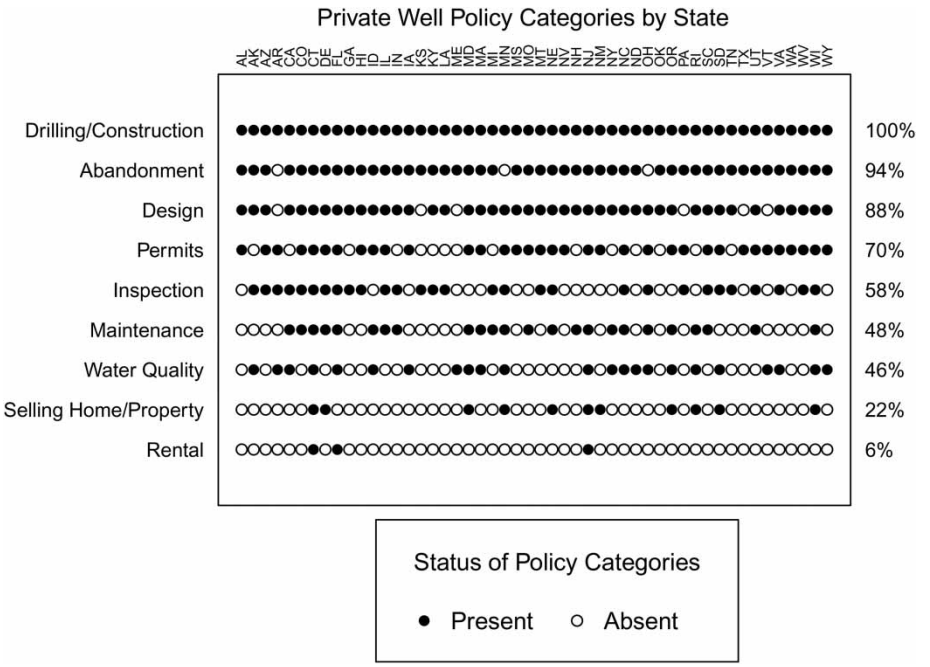

Fig. 1. Private well policy categories by state. A hollow circle represents the absence of a given policy category. A filled circle indicates the presence of one or more policies addressing the given category for a particular state. The percentage of states with a policy in a specific category is indicated on the right.

Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont; (2) Delaware, Maryland, Pennsylvania, Virginia, and West Virginia; (3) Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee; (4) Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin; (5) Iowa, Kansas, Missouri, and Nebraska; (6) Arkansas, Louisiana, New Mexico, Oklahoma, and Texas; (7) Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming; (8) Alaska, Arizona, California, Hawaii, Idaho, Nevada, Oregon, and Washington.

We created a map of the agencies involved in regulating wells for each state in ArcGIS 10.4.1 (Esri, Redlands, CA) using a standard basemap for the United States (pcs: WGS_1984_Web_Mercator_Auxiliary_Sphere; gcs: GCS_WGS_1984). We obtained the shapefile of our basemap from the U.S. Forest Service, Conservation Biology Institute through Data Basin (data layer *total carbon in U.S. forests by state* from Ryan *et al*. (2010)). Eight different types of state agencies involved in regulating private wells were identified: the Department of Natural Resources, the Department of Health, the Department of Environmental Quality, the Water Well Board, the Office of State Engineer, Department of Consumer Protection, the Energy and Environment Cabinet, and the (Texas) Department of Licensing and Regulation (Figure 2).

3. Results

Our search identified 182 policies. Forty-nine (98%) of the 50 contacted agencies responded to the email and identified 23 additional policies (Figure 3). A total of 127 policies met the inclusion criteria and were included in the analysis (Supplemental Table, available with the online version of this paper). Duplicate policies and policies for public water supplies were excluded.

States varied in their private well policies (Figure 1). Although every state had policies addressing two or more policy categories, Connecticut was the only state that had policies addressing all nine categories. All states had at least one policy addressing well drilling or construction. Fewer states had policies governing rental properties (6%) or addressing selling a home or property (22%) with a private well. Geographic analysis of policy types showed that the presence of maintenance polices differed significantly across regions ($p = 0.027$); there was no statistical difference for other policy categories (Table 1). We identified eight different types of state agencies responsible for regulating private wells. Agencies varied from the Water Well Boards and Departments of Health to the Department of Consumer Protection. In total, 14 states had more than one agency responsible for regulating private wells and Texas was the only state with three responsible agencies (Figure 2).

4. Discussion

This is the first study to summarize and compare private well policies across the United States. We identified topics that are unaddressed in many jurisdictions, and the extent to which states differ in policy comprehensiveness. We found that all 50 states have legal requirements regarding the drilling or construction of new wells, but beyond that, states can differ dramatically in their requirements for private wells. For example, Connecticut, Wisconsin, and Florida have more comprehensive private well policies, while Maine only has policies for drilling/construction, water quality, and abandonment of wells. The policy search also indicated 14 states with more than one agency responsible for regulating private wells.

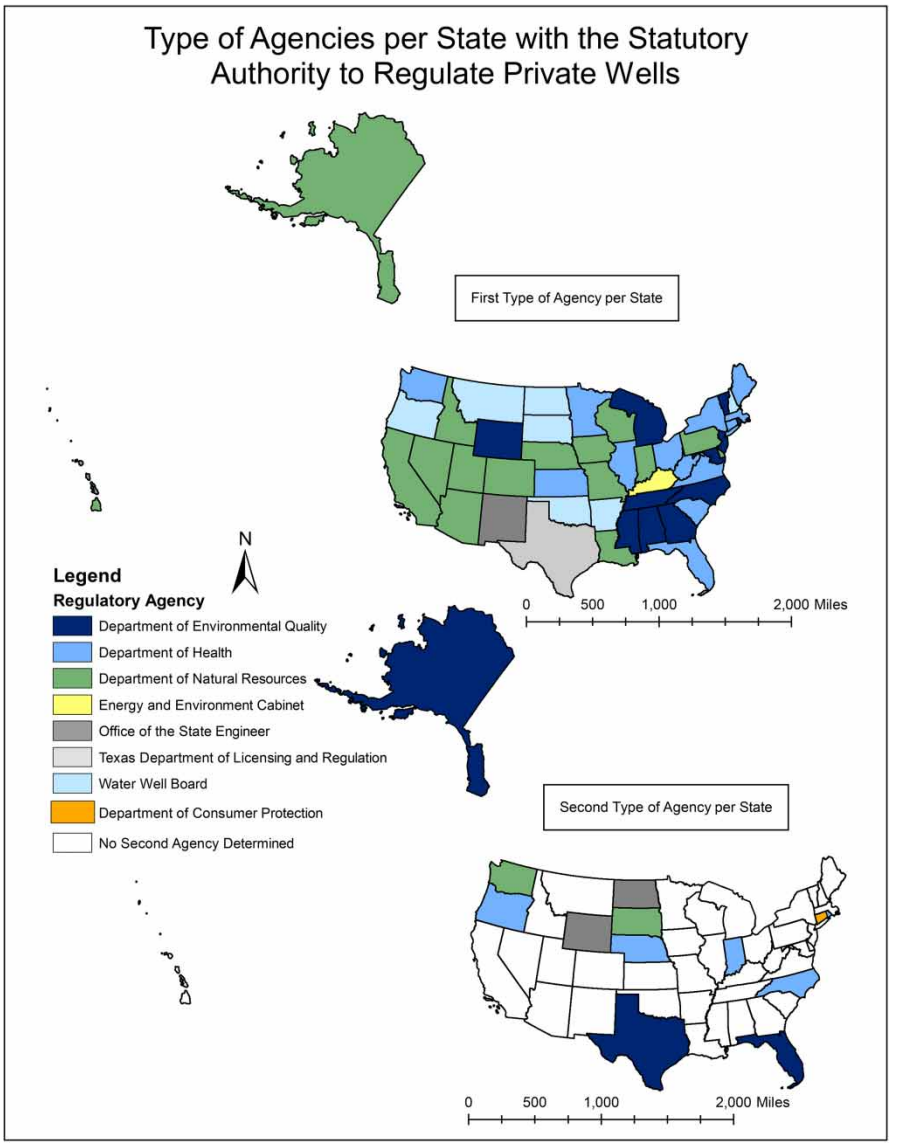

Fig. 2. Choropleth map of the type of state agencies responsible for private well regulations. The Department of Natural Resources included the Department of Water Resources, Department of Land and Natural Resources, Water Resources Commission, Department of Conservation and Natural Resources, Department of Environment and Natural Resources, and the Department of Ecology. The Department of Health included the Department of Public Health, Board of Health, Department of Health and Environmental Control, Bureau for Public Health, Department of Health and Human Services, and the Oregon Health Authority. The Department of Environmental Quality encompassed the Department of Environmental Management, Department of Environmental Protection, Department of the Environment, Department of Environment and Conservation, Department of Environmental Conservation, and the Texas Commission on Environmental Quality. The Water Well Board included the Water Well Construction Commission, Board of Water Well Contractors, and the Water Management Board. The agency titles for the Office of State Engineer, Department of Consumer Protection, Energy and Environment Cabinet, and the Texas Department of Licensing and Regulation did not vary by state. Texas is the only state to have three different responsible agencies (Texas Department of Licensing and Regulation, Texas Alliance of Groundwater Districts, and Texas Commission on Environmental Quality).

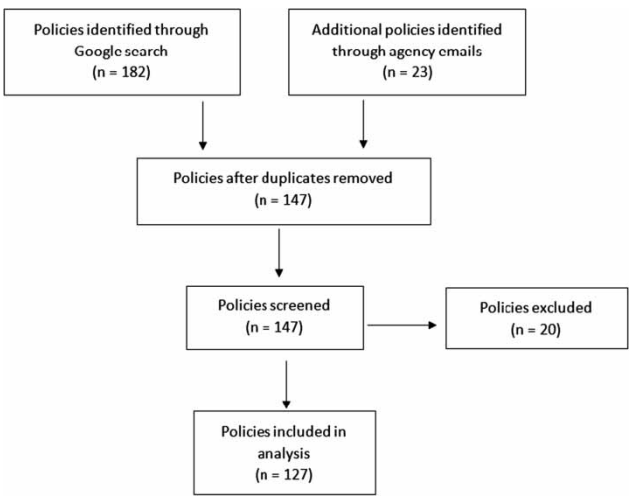

Fig. 3. Ascertainment of state policies for private wells. Policies were excluded if they were not current or did not directly reference private wells.

Table 1. Fisher's exact test for independence of geographic region and presence of private well policies by policy category.

Policy category	*P*-value for region
Abandonment	0.069
Drilling/construction	–
Design	0.113
Inspection	0.124
Permits	0.864
Maintenance	**0.027**
Rental	0.528
Water quality	0.243
Selling home/property	0.581

Drilling/construction policies were present in every state and were excluded from this analysis.

The presence or absence of a certain type of private well policy did not significantly differ between regions with the exception of maintenance policies. It is important to note that the regions for this analysis were defined by EPA service regions, not geological or other groundwater boundaries. Drilling and construction policies were not included in the geographical analysis because this type of policy was present for every state.

Different policies emphasize the protection of distinct populations at risk from drinking contaminated water. For example, a policy requiring a private well inspection and water quality test before selling a home protects the *future* property owner from problems with an *existing* well. Design policies protect *current* property (well) owners by ensuring that their well is constructed from the appropriate materials and drilled at the proper depth to obtain water from a viable source.

The existence of a state-level policy does not necessarily translate to a real-world change in well water quality control procedures. Even in states with standards for water quality testing, testing is typically infrequent or not conducted at all (Sabogal & Hubbard, 2015). However, states such as Wisconsin require

testing when submitting permit applications (Wisconsin Department of Natural Resources, 2013). Determining levels of policy compliance and assessing the effectiveness of private well policies for ensuring adequate water quality require an additional study (Chappells *et al.*, 2014; Nelson & Perrone, 2016).

We limited our review to state-level policies for this study. However, the real-world policy context for private well management also includes local-level government regulations. For example, in Kansas, well locations are approved by municipal and county governments pursuant to local regulations (Kansas Department of Health and Environment, 2013). Counties in Kansas, such as Johnson County, outline more specific minimum lateral distances for well locations from landfills and septic tanks (Johnson County Public Health, 2009). In addition to siting, states such as California also provide local authorities the power to control the amount of groundwater extraction (Nelson & Perrone, 2016). The policy landscape is constantly changing and merits continued and ongoing investigation.

5. Conclusion

The policy heterogeneity identified in this study is a patchwork of regulatory policies and practices across the 50 United States, which could contribute to heterogeneous environmental health hazards for private well users. State-level regulations requiring periodic testing of private well water could reduce the risk of drinking contaminated well water. Future research can explore the intersections of local-level and state-level policies, monitor trends over time, and track compliance with official policies for drinking water quality outcomes.

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Disclaimer

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