

## Analysis of Kansas Water Well Policies and Proposal of Nonpublic Household Water Well Recommendations

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**BACKGROUND:** Many nonpublic water well users unknowingly consume contaminated groundwater containing unsafe levels of pollutants. This has important implications for more than 13 million households in the United States that rely upon nonpublic water wells for drinking, cooking, and other household uses. Although public water quality is regulated through the Safe Drinking Water Act, there are no drinking water standards for nonpublic water well quality in Kansas, nor is there an adequate public health infrastructure in place to prevent or address potential exposures to contamination.

**OBJECTIVES:** This project was conducted to identify promising action steps that would protect Kansans relying on nonpublic water wells for drinking, cooking, and other household purposes.

**METHODS:** The project team consisted of public health, environmental health, and legal professionals with experience working on groundwater quality issues impacting nonpublic water wells in Kansas. From 2015 through 2018, the team established and convened an advisory group; reviewed relevant state statutes and regulations, all Kansas county environmental codes, and a representative sample of 23 city water well codes; conducted an extensive review of academic literature to identify best practices; conducted dozens of key informant interviews; proposed recommendations; engaged dozens of stakeholders through a survey of these proposed recommendations; and conducted interactive webinars to identify which organizations need to lead each of the recommendations.

**DISCUSSION:** The project team developed 18 recommendations. The recommendations are organized by survey respondents' perceptions of potential public health impact. There are very few standard practices in Kansas that ensure safe water for nonpublic household water wells. Although not all of the 18 recommendations may be applicable to other communities and states, many likely would be useful for governmental agencies, academic institutions, nonprofit organizations, and others to consider. These recommendations offer more protections for nonpublic household water well users than any resource we have found. <https://doi.org/10.1289/EHP5507>

### Introduction

Many nonpublic well water users are unknowingly consuming water contaminated with industrial solvents, pesticides, or other contaminants at levels that are unsafe. In a study conducted by the U.S. Geological Survey in 48 states from 1991 to 2004 that sampled 2,100 private wells, 1 in 5 wells contained one or more contaminants that exceeded the U.S. Environmental Protection Agency's (EPA's) Safe Drinking Water Act standards (DeSimone et al. 2009). This has important implications for the more than 13 million households in the United States that are reliant upon their nonpublic water wells to access drinking water (U.S. Census Bureau 2017).

The federal Safe Drinking Water Act (SDWA) has established water quality standards for public drinking water supplies, yet there are no parallel standards for nonpublic well water quality at a national level [Safe Drinking Water Act, 42 U.S. Code § 300f, et seq. (2018)]. Kansas state law defines a public water supply system as "... a system for the provision to the public of piped water for human consumption, if such system has at least ten (10) service connections or regularly serves an average of at least twenty-five (25) individuals daily at least sixty (60) days out of the year" [Public water supply systems, Kan. Stat. Ann. § 65-162a (2018)]. Nonpublic residential groundwater wells addressed by this research are those water wells that are specifically not covered by

Kansas laws governing public water supply systems—those water wells that have <10 service connections or regularly serve <25 individuals daily 60 d of the year.

Historically, state and local governmental infrastructure (e.g., public health, public utilities, legal, land-use planning) in place has generally been insufficient to prevent or address potential exposures to contamination among nonpublic water well users across the United States, in Kansas, and in local communities. There are few state policies that protect nonpublic well users, and although local laws vary, most have little to do with nonpublic well water quality, let alone protecting nonpublic well users.

According to the Kansas Geological Survey (KGS) Water Well Database, from 2013 to 2018, there were more than 71,000 nonpublic groundwater wells used in Kansas for drinking purposes (KGS 2018). Compounds such as trichloroethylene, arsenic, nitrate, and atrazine are often found in Kansas groundwater (KDHE 2018). Groundwater is susceptible to contamination from multiple sources, including industrial solvents, agricultural chemicals, confined animal feeding operations, and naturally occurring minerals. Industrial solvents and agricultural chemicals can migrate into groundwater from the earth's surface from spills, leaky sewer connections, and poor disposal practices.

Broad-based and site-specific water quality studies indicate the need for development of a better system-wide approach to ensuring groundwater quality in Kansas for nonpublic well users (DeSimone et al. 2009; KGS 1993; KSU Agricultural Experiment Station and Cooperative Education Services 1998), yet little is known about the practices, programs, or policies that can protect nonpublic household water well users. As such, the University of Kansas School of Medicine-Wichita (KUSM-W), in collaboration with the Public Health Law Center, initiated and led a 3-y project funded by the Kansas Health Foundation to identify promising action steps that would protect Kansans relying on nonpublic water wells for household purposes.

### Methods

The project team consisted of public health, environmental health, and legal professionals with experience working on groundwater

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quality issues impacting nonpublic water wells in Kansas. From 2015 through 2018, the team established and convened an advisory group; reviewed relevant Kansas state statutes and regulations, all 105 county environmental codes (predominately sanitation codes), and a representative sample of 23 city codes; conducted an extensive review of the academic literature to identify best practices; conducted dozens of key informant interviews; proposed recommendations; engaged dozens of stakeholders in Kansas with a survey of these proposed recommendations; and conducted interactive webinars to identify which organizations need to lead each of the recommendations.

### **Advisory Group**

In early 2016, the project team established an advisory group of organizational experts and stakeholders across Kansas to provide direction to the project team on priority issues impacting nonpublic household water well quality. Members included representatives from the Kansas Farm Bureau, Kansas State University (KSU) Geology Department, KSU Biological and Agricultural Engineering Department, Kansas Environmental Health Association (KEHA), Kansas Rural Center, Kansas Water Office (KWO), Kansas Groundwater Association, Reno County Health Department, Kansas Department of Health and Environment (KDHE), Kansas Department of Agriculture Groundwater Management Districts, Kansas Biological Survey, KGS, U.S. Geological Survey, Kansas Water Resources Institute, Kansas Farmers Union, U.S. Department of Agriculture (USDA), Midwest Assistance Program, and nonpublic well owners (Table 1). The advisory group met twice over the course of the project, in 2016 and in 2017. The advisory group provided input and feedback on the development and implementation of the project. To improve representation of stakeholders across the state, the project team and advisory group members developed a stakeholder, or faction, map to guide the project team in engaging diverse stakeholders. The goal of the faction map was to identify stakeholders by sector including city and county government, state legislatures, private well owners, real estate agents, water testing labs, well drillers/contractors, and homebuilders, among others, as well as each stakeholder's relevance to the project. The project team and advisory group discussed these key points and made recommendations on which stakeholders to include in the project. In addition to the meetings, the advisory group provided input via email on the problems associated with nonpublic water wells in Kansas and provided feedback on the project's recommendations.

### **Review of Policies, Academic Literature, and Other Resources**

From March 2016 through March 2018, the team conducted a review of Kansas state laws regulating nonpublic water wells and all county sanitation codes in Kansas. In addition to state laws and county sanitation codes, the nonpublic water well codes of several cities were selected for review. Because of the large number of city governments in Kansas, the project team asked the advisory group to identify parameters that could be used to develop a representative sample of 23 city codes (city size, geographic region, subsurface geologic formation, and unique water access challenges). The project team used those parameters to select cities of different sizes located in six geographical regions of the state that used groundwater wells with differing subsurface geological formations and faced water access challenges unique to their location. Using the criteria developed by the advisory group, the team reviewed the nonpublic water well codes and ordinances of the following cities: Wichita, Abilene, Arkansas City, Colby, Dodge City, Garden City, Great Bend, Hays, Hutchinson, Independence, Lakin, Manhattan,

Ottawa, Pittsburg, Salina, Scott City, Stafford, Hiawatha, Partridge, Lawrence, Olathe, Peabody, and Hillsboro.

The project team developed a list of the identified cities' municipal nonpublic water well ordinances for review. Publicly available databases of municipal ordinances were used, including MuniCode, Sterling Codifiers, and city websites when available. The project team also made direct contact with city officials to access their local ordinances and codes when they were not available electronically.

The project team reviewed all county sanitary codes impacting nonpublic well water quality and completed a review of Kansas state statutes and regulations governing nonpublic water wells and any case law interpreting these statutes and regulations. The county sanitation codes were obtained from the website of the KDHE at <http://www.kdheks.gov/nps/lepp/CountyCodes.html>. The Kansas statutes reviewed were obtained from the website of the Kansas Revisor of Statutes at <http://www.ksrevisor.org/ksa.html> and included the following: Solid and Hazardous Waste, Kan. Stat. Ann. §§ 65-3401 to 3411 (2018); the Kansas Drycleaner Environmental Response Act, Kan. Stat. Ann. § 65-34, 142 (2018); the Kansas Groundwater Exploration and Protection Act (aka the Kansas Water Well Act), Kan. Stat. Ann. §§ 82a-1201 to 1219 (2018); Public Water Supply Systems, Kan. Stat. Ann. § 65-162a (2018); Special Benefit Districts; creation or enlargement; approval of board of county commissioners, required, Kan. Stat. Ann. § 19-270 (2018); Water Districts, Kan. Stat. Ann. §§ 82a-601 to 650 (2018); Appropriation of Water for Beneficial Use, Kan. Stat. Ann. §§ 82a-701 to 773 (2018); and Sanitation Controls, Kan. Stat. Ann. § 19-3701 to 3709 (2018). Kansas regulations that were reviewed were obtained from Thomson Reuters Westlaw and included the Water Well Contractor's License; Water Well Construction and Abandonment, Kan. Admin Regs. §§ 28-30-1 to 28-30-10 (2018) and the Equus Beds Groundwater Management District No. 2, Kan. Admin Regs. §§ 28-30-200 to 207 (2018).

The team conducted in-depth legal analyses on the existing policies impacting the water quality of nonpublic household water wells in Kansas to identify promising practices and existing gaps in local regulations for protecting and improving the water quality of existing nonpublic household water wells.

Concurrent with the policy review, an extensive review of the academic literature was conducted, using PubMed, to identify promising policy mechanisms at multiple levels of government and to address water quality priorities impacting nonpublic water wells. Search terms included domestic, private, nonpublic, water supply, well water, water well, ground water, groundwater, household, drinking water, policy, code, regulation, prevention, and protection. Internet search engines were also used to identify additional resources such as the Centers for Disease Control and Prevention, the U.S. EPA, and ChangeLabSolutions. Resources that offered recommendations to protect nonpublic water well users were used to inform the recommendations (Chappells et al. 2014; Kreutzwisser et al. 2011; Ridpath et al. 2016; Simpson 2004; Zheng and Flanagan 2017), as were policies and practices from other states (Convery 2005; Flanagan et al. 2015, 2016; MacDonald Gibson and Pieper 2017; Law et al. 2017; Rhode Island Department of Health 2008), recommendations from an expert panel (Fox et al. 2016), and a publication from ChangeLabSolutions, "Closing the Water Quality Gap" (ChangeLabSolutions n.d.).

### **Key Informant Interviews and Surveys with Stakeholders**

In October and November 2017, the project team supplemented the legal research and analysis of existing resources with 22 key informant interviews with experts and stakeholders in Kansas involved with nonpublic household water wells (Table 1). Participants included nonpublic household water well users and representatives

**Table 1.** Stakeholder table.

Organization	Advisory group	Key informant interviews	Survey participant(s)
Kansas Farm Bureau: supports agriculture and the lives of Kansans through advocacy, education, and service	X	—	X
Kansas State University (KSU) Geology Department: active research programs in a wide range of geoscience subdisciplines, including chemical hydrogeology. Collaborates with the Kansas Geological Survey (KGS) and the U.S. Geological Survey	X	—	X
KSU Biological and Agricultural Engineering Department: develops ways to protect and manage natural resources and develops alternative energy sources and systems to provide food and fiber to a growing global population	X	—	X
Kansas Environmental Health Association (KEHA): advances the environmental health and protection professional for the purpose of providing a healthful environment	X	X	X
Kansas Rural Center, Kansas Water Office (KWO): water planning, policy, coordination, and marketing agency for the state of Kansas	X	—	X
Kansas Groundwater Association: fights for and against legislation in order to protect both the water and the water well driller	X	—	X
Reno County Health Department: works to improve the health of Reno County (KS) residents	X	—	X
Kansas Department of Health and Environment (KDHE), Division of Environment: works toward safe and sustainable environments	X	X	X
Groundwater Management Districts: provide water-use administration, planning, and information; governed by local boards	X	—	X
Kansas Biological Survey: pursues understanding of and appreciation for biological resources	X	—	X
KGS: investigates and provides information about the state's geologic and groundwater resources	X	—	X
U.S. Geological Survey: provides science about natural hazards that threaten water, energy, lives, livelihoods, minerals, other natural resources, health of ecosystems and environment, and impacts of climate and land-use change	X	—	X
Kansas Water Resources Institute: develops and supports research on high-priority water resource problems and objectives	X	—	X
Kansas Farmers Union: works to protect and enhance the economic interests and quality of life for family farmers, ranchers, and rural communities	X	—	X
U.S. Department of Agriculture (USDA): provides economic opportunity through innovation, helping rural America to thrive	X	—	X
Midwest Assistance Program: helps communities and tribal nations find solutions to infrastructure and development needs	X	—	X
Nonpublic well owners: those who own property that has a nonpublic water well that is used for household purposes	X	X	X
Household water well users: those who rely on nonpublic water wells for household water use	—	X	X
Kansas Public Health Association: a professional organization for Kansas public health practitioners, professionals, and advocates	—	X	X
Local environmental health department staff: provide public health services to both rural and urban communities	—	X	X
Health organizations	—	X	—
Other experts, decision-makers, policy-makers	—	X	—
Kansas Association of Counties (KAC): a quasi-public agency, seeking to advance public interest by promoting responsive county government	—	X	X
KDHE-certified drinking water laboratories: labs certified by KDHE to perform analysis to comply with permit requirements	—	—	X
League of Kansas Municipalities (LKM): a membership association that advocates on behalf of cities	—	—	X
KWO's Regional Advisory Committees: provide advice to KWO and the Kansas Water Authority regarding formulation and revision of the Kansas Water Plan, its implementation, and other matters	—	—	X
Kansas State Realtors Association: supports members and the real estate industry	—	—	X
Kansas Bankers Association: supports banks and bankers with leadership, advocacy, and education	—	—	X
Community Bankers Association of Kansas: trade association that serves the interests of community banks through advocacy, education, and services	—	—	X

Note: Descriptions taken from organizations' websites. —, not applicable.

from the KDHE, KEHA, Kansas Public Health Association (KPHA), local environmental health departments, local health departments, and nonpublic water well experts. In addition, the project team facilitated a discussion with approximately 75 members of the Kansas Association of Counties (KAC). These interviews were designed to build on the recommendations formed by the advisory group, policy review, analysis of existing resources, and literature reviews to identify emerging and promising actions that would protect nonpublic water well

supplies and to further develop and evaluate the proposed recommendations.

From May through September 2018, the project team developed a survey that consolidated all of the recommendations, including the interviews and discussion with KAC members. The survey was administered via Survey Monkey to the following experts and stakeholders: the project advisory group, nonpublic well water users/former users, KDHE, KDHE-certified drinking water laboratories, KEHA, local health departments, KAC, KPHA, League of Kansas

Municipalities (LKM), KWO and the KWO's Regional Advisory Committees, Kansas State Realtors Association, Kansas Bankers Association, Community Bankers Association of Kansas, KGS, and Kansas Department of Agriculture's Groundwater Management Districts (Table 1).

The 148-item online survey presented each of the recommendations in conjunction with background information and a rationale for the need for the proposed recommendation. After each recommendation was described, respondents were prompted to use a one-to-five scale to indicate if the problem is worth addressing, how well the recommendation addresses the problem, how much it would improve health/public health, and how feasible the recommendation would be to implement in 3–5 y if adequate funding were available and relevant organizations would advance the issue. In addition, for each recommendation, respondents were asked to describe any barriers to and suggestions for implementation. To encourage broad participation, anonymous surveys were sent with de-identified links so that potential respondents could distribute the survey to colleagues. A total of 113 respondents participated in the survey. The results of this survey were used to prioritize the recommendations based on participants' responses to "how much the recommendation would improve health/public health."

In September 2018, the project team presented the proposed recommendations to KEHA, and in October 2018, the project team conducted four interactive webinars for respondents to identify which Kansas organizations need to take the lead in advancing each recommendation. Stakeholders from the following organizations were invited to participate in the webinars: the Wichita State University Environmental Finance Center, KWO, Kansas Department of Agriculture Groundwater Management Districts, KWO Regional Advisory Committees, KAC, KDHE, KEHA, Kansas Farm Bureau, Kansas Farmers' Union, KGS, Kansas Ground Water Association, the Kansas Legislature, KPHA, Kansas Rural Water Association, KSU, Kansas Water Resources Initiative, KDHE-certified drinking water laboratories, League of Kansas Municipalities, local

environmental health professionals, Midwest Assistance Program, USDA-Rural Development, water well contractors and drillers, and water well owners and others.

A total of 47 respondents participated through the KEHA meeting ( $n = 17$ ) and four webinars ( $n = 30$ ). Each recommendation was presented, and participants were asked to indicate, via Poll Everywhere, which agency or agencies needed to lead each recommendation. After the results from the webinars were analyzed, fact sheets were created for each recommendation. Each fact sheet included a background, potential funding sources, and identified the most appropriate agency or agencies to initiate governmental policy or legislative action for each recommendation. These fact sheets were then presented to various agencies, such as KDHE, to spearhead these recommendations.

## Discussion

After reviewing the legal and academic research and considering all of the input and feedback from the advisory group, interviewees, and survey respondents, the project team developed 18 recommendations. For the purposes of this paper, the term "we" represents the consensus from this entire process. These recommendations were organized by the potential impact each recommendation could have on protecting public health, as reported by survey respondents, from the greatest impact to least impact (Table 2). Full descriptions of each recommendation can be found at <http://wichita.kumc.edu/improving-and-protecting-water-well-quality/project-recommendations.html>. The exception to the prioritized order is the first recommendation. Although the first recommendation was not identified as the first priority as part of the feedback process, the project team identified the creation of a clear and widely accepted definition of "nonpublic household water well" as the first needed action, chronologically. The creation of this designation of nonpublic water well used for household purposes is critical to the implementation of the other recommendations.

**Table 2.** Final prioritized list of recommendations with lead organizations.

No.	Recommendation	Key organizations to lead
1 <sup>a</sup>	Create a "nonpublic household water well" designation	KDA, KDHE, KWO, Kansas Legislature
2	Provide notice when specific groundwater contamination is found and when there is an event potentially impacting groundwater quality	KDHE, Kansas Legislature, LEHP
3	Establish triggering events to inspect wells and test water quality	KDHE, LEHP
4	Develop standardized water sampling and analysis protocol and form	KDHE, KDHE-certified drinking water labs, LEHP
5	Create a statewide group focused on advancing nonpublic household water well quality	KDA, KDHE, KWO, Kansas Legislature
6	Revise the Kansas Dry Cleaner Environmental Response Act	KDHE, Kansas Legislature
7	Limit the use of some nonpublic household water wells	KDHE, KWO, Kansas Legislature, LEHP
8	Create funding mechanisms to offset costs of inspection, water quality testing, corrective action, and/or plugging of nonpublic household water wells for those unable to pay	KDA, KDHE, KWO, Kansas Legislature
9	Establish a three-part process: permitting, inspection, and water quality testing	KDHE, KEHA, KDHE-certified drinking water labs, LEHP
10	Standardize environmental health professionals' training	KDHE, KEHA, LEHP
11	Track and provide information about abandoned wells in property transactions	KDHE, LEHP
12	Create standards to determine when connecting to a public water supply must be required	KAC, KDHE, KWO, Kansas Legislature, LEHP
13	Establish frequency of inspection and water quality testing after an initial triggering event	KDHE, LEHP
14	Establish licensing requirement for the installation of water well pumps	KDHE, LEHP, water well contractor/driller
15	Update key nonpublic household water well resources	KDHE, KGS, KWO, LEHP
16	Develop remediation training and certification standards	KDHE, KEHA
17	Update county sanitary codes	KAC, KDHE, LEHP
18	Assess interest in a water well maintenance subscription service	KDA, KDHE, KEHA, KWO, LEHP, water well contractor/driller

Note: Adapted with permission from University of Kansas School of Medicine-Wichita (2019). KAC, Kansas Association of Counties; KDA, Kansas Department of Agriculture; KDHE, Kansas Department of Health and Environment; KEHA, Kansas Environmental Health Association; KGS, Kansas Geological Survey; KWO, Kansas Water Office; LEHP, Local Environmental Health Professional.

<sup>a</sup>The first recommendation was not ranked as the first priority; however, it is likely the first step that needs to happen chronologically.

At the state level, there are two broad categories for water supply wells: public or nonpublic. Kansas state law defines public water supply as a “system for delivery to the public of piped water for human consumption that has at least ten (10) service connections or regularly serves an average of at least twenty-five (25) individuals daily at least sixty (60) days out of the year” [Public water supply systems, Kan. Stat. Ann. § 65-162a (2018)]. Water supply wells that do not meet this definition are considered nonpublic water supply systems. There is no standard legal definition or standard for nonpublic water wells used for drinking, cooking, and other household purposes separate from nonpublic water wells used for other purposes such as irrigation, livestock, and other uses that do not directly impact the health of nonpublic water well users relying on these wells for drinking, cooking, and other household purposes. The state of Kansas does not regulate or test private wells; that task is entrusted to city and county governments. The state does, however, license water well contractors and maintains a record of water well completions (KGS 2004).

The analysis of Kansas county and city codes determined that counties and cities take a wide range of approaches to defining and describing water wells that are not regulated under the SDWA. These categories include nonpublic wells, semipublic wells, and private wells. These categories are defined by individual local governments, usually based on the number of users of a well. However, there is no consistency or standardized approach in defining these categories across counties or cities. Without consistent definitions, it is challenging to protect those who rely on nonpublic water wells for household purposes. Therefore, the first recommendation is to create a new designation “nonpublic household water well” for those nonpublic water wells used for drinking, cooking, bathing, and household pets. The designation of “nonpublic household water well” is inclusive of all active water wells that are not regulated under the SDWA (e.g., nonpublic, semipublic, private) or the Kansas state designation of a public water supply system. “Household purposes” includes water used for cooking, bathing, drinking, and sanitation; it does not include water used for irrigation or watering livestock.

For ease of reading, the remaining project recommendations are organized thematically rather than according to the priority of the recommendation (determined through the feedback from research participants). This thematic organization of the recommendations provides a more cohesive discussion of the recommendations for the reader than a discussion of recommendations based on priority ranking allows. At the same time, the prioritization of the recommendations is included in parentheses to reflect the results of the prioritization process as identified by research participants.

### ***Recommendations regarding Testing Water Quality and Collecting Data***

A fundamental recommendation is to establish a three-part process: permit, inspect, and test water quality after a nonpublic household water well is constructed or reconstructed (Recommendation 9). This would allow for a local environmental health professional to ensure that safety and health standards are met before the well is used. Although Kansas administrative regulations provide standards for the location and construction of nonpublic water wells (KDHE 1997, 2011, 2013), there are no requirements for water quality testing of nonpublic water wells.

Without a state requirement for sampling and analysis of nonpublic water wells, individual well owners and users in Kansas are solely responsible for ensuring the safety of their water. Because of potential groundwater vulnerabilities that may negatively impact groundwater quality (DeSimone et al. 2009) and because about one-quarter of Kansas well owners check their

wells every 1–2 y (Ternes 2018), we recommend the establishment of triggering events for water well sampling and analysis (Recommendation 3). The recommended water quality tests [e.g., bacteria, nitrates, volatile organic compounds (VOCs)] would be based on the triggering event (e.g., real estate transaction, well construction, flooding of wellhead). Then, after the initial triggering event, the frequency of ongoing inspection and water quality testing must be established (Recommendation 13). Because groundwater contamination can be localized at a particular well or involve an entire neighborhood, it is recommended that well sampling and analysis include physical inspection of the well in addition to sampling for bacteria and nitrates yearly and VOCs and/or pesticides every 3 y.

KDHE has some online resources available that provide information about contaminated sites [i.e., the KDHE Identified Sites List (KDHE 2019), the Environmental Interest Finder (KDHE n.d.)]. These resources provide site-specific information regarding environmental assessments and investigative reports regarding contaminated sites in Kansas. Although this information is helpful, considering the extent of groundwater contamination, it may not be inclusive enough to provide sufficient information for local governments’ use regarding determinations of groundwater quality and the safety of nonpublic water wells used for household purposes. We presume there are other groundwater contaminants that have yet to be identified. Therefore, a recommendation is to develop a standardized water sampling and analysis protocol and data entry system for use across the state (Recommendation 4). KDHE currently uses a Water Well Completion Record Form WWC-5, which is required to be submitted by well drillers when any type of groundwater well is constructed, reconstructed, or plugged. This form is a record of the well location, well owner, well use, groundwater depth, completion date, and other identifiers associated with the physical structure and location of the well. This form does not require any information or data regarding water quality. Updating the Water Well Completion Record Form WWC-5 to include fields for water quality sampling and analysis data would allow for the development of a nonpublic well water quality database that would be critical to preventing exposure to contaminated water (Recommendation 4). This could address the dearth of information available to protect and inform citizens about potential exposures to contaminated well water. Furthermore, by switching to electronic submission of this form and an online database, multiple stakeholders (e.g., local environmental health professionals, well drillers, well users) could efficiently enter and/or access relevant data.

### ***Recommendations regarding Workforce Development***

Local environmental health professionals currently are not offered standardized training on nonpublic water wells. Professionals from KEHA, KDHE, and KDHE-certified drinking water laboratories could provide training to local environmental health professionals regarding construction, management, maintenance, sampling protocols, interpretation of analyses, potential health implications of analyses, remediation, and the provision of technical assistance (Recommendation 10). Standardized training could enhance competency among local environmental health professionals and provide consistent outcomes in the design, construction, location, and water quality associated with nonpublic water wells.

Consistent with the standardized training recommendation is the recommendation to update key nonpublic household water well information and technical resources (Recommendation 15). For example, two primary technical documents used by local environmental health professionals are the *Environmental Health Handbook* (Kansas Association of Sanitarians Handbook Revision Committee 2002), last updated in 2002, and Bulletin 4-2 (KDHE 1997), last updated in 1997. We recommend that local and state

environmental health professionals, water well contractors, and geologists review and update key resources for environmental health professionals. In addition, the group needs to provide consistent and updated resources for nonpublic household water well users. Once these resources are updated and approved, they need to be distributed across the state.

Kansas state law has established specific requirements for licensed water well contractors who construct or reconstruct water wells, but there are no state requirements for those installing water well pumps. To ensure that nonpublic household water well users have qualified individuals available to install, repair, or modify a well or a water well pump, we suggest that licensing requirements be established (Recommendation 14). Similarly, when a nonpublic well is found to be contaminated by a contaminant other than coliform bacteria, there is no system in place at the local level to make recommendations or implement corrective action to address the contamination. Therefore, we recommend that training and certification standards be developed for those individuals seeking to correct groundwater quality contamination in nonpublic wells (Recommendation 16). This training would be a workforce development initiative that would ensure that qualified individuals can be available to address individual or multiple nonpublic well contamination issues.

### ***Recommendations to Support Nonpublic Household Water Well Users***

There are few visible nonpublic water well experts across most Kansas communities, and most nonpublic water well users do not have a clear entity (private or public) that provides consistent well service and maintenance to ensure that water quality standards are met. Therefore, it could be beneficial to determine if a subscription service would be of interest to nonpublic household water well users and develop a list of trained individuals in nonpublic household water well inspection, water quality sampling, and remediation (Recommendation 18). Such a list could be made publicly available and widely distributed every year by a statewide group focused on advancing nonpublic household water well quality (discussed below).

Currently, when groundwater contamination such as a VOC is identified, there is no requirement for state officials to notify local environmental or public health professionals, or for state or local officials to notify nonpublic household water well owners, users, or other potentially affected individuals or groups. In the last few years in Kansas, nonpublic household water well users affected by groundwater contamination from former dry cleaning facilities unknowingly used contaminated water for drinking and household purposes for years after the contamination had been initially identified (Ablah et al. 2018). Requiring state officials to notify local officials, and state or local officials to notify individuals within the affected area (Recommendation 2), will give water well users opportunities to treat their water or find alternate water sources.

The Kansas Drycleaner Environmental Response Act (DERA), passed in 1995, created a dry cleaning facility release trust fund to address contamination resulting from the release of dry cleaning solvents from dry cleaning operations [Kansas Drycleaner Environmental Response Act, Kan. Stat. Ann. § 65-34, 142 (2018)]. However, there are three public health concerns related to DERA. First, the act discourages KDHE from involving local and federal units of government “from becoming involved in contamination problems resulting from releases from dry cleaning facilities.” This is problematic, as we recommend that intergovernmental cooperation in groundwater contamination issues needs to be encouraged rather than discouraged for a host of

reasons related to intergovernmental cooperation, transparency, and public awareness.

Second, the act encourages KDHE to “make every reasonable effort to keep sites where dry cleaning solvents are involved off of the national priorities list.” Although this allows for state and local control, it is problematic in that it assumes that the human and financial resources at the state and local level are available to effectively address contaminated sites. In reality, the dry cleaner trust fund has been insufficient compared with the need: The investigation and connection to public water for one site depleted the entire fund in 1 y (Wichita State University’s Hugo Wall School of Public Affairs and University of Kansas School of Medicine-Wichita 2016).

Furthermore, one could interpret this as extending beyond dry cleaning sites and including any contamination site in Kansas given that it specifies “where dry cleaning solvents are used.” Dry cleaning solvents (tetrachloroethene) have uses other than in dry cleaning processes.

Third, and potentially of greatest concern, the act directs KDHE to “not seek out contaminated dry cleaning facility sites because of the existence of the fund or other provisions of this act. The moneys are made available for use as sites are discovered in the normal course of the business of the agency.” We assert that directing KDHE to avoid proactively investigating potential contamination near current and former dry cleaning facilities, where contamination is likely, is problematic in that it protects dry cleaners more than the public’s health. We assert that it allows for contaminated areas to increase in size, thus becoming more costly to clean up. This increases the likelihood of human exposure to groundwater contamination through nonpublic wells and vapor intrusion (the migration upward of vapors from contaminated groundwater to indoor living spaces). Therefore, revisions to DERA are recommended (Recommendation 6).

When nonpublic household water wells are located in a contaminated area, point-of-use treatment systems may be employed that may not reduce contamination levels to acceptable standards. In these situations, we recommend that the use of these wells for drinking purposes be limited. In addition, under our recommendation, permits would not be issued for the construction or reconstruction of a new nonpublic household water well in such a contaminated area (Recommendation 7).

Some nonpublic household water well users are unable to pay for the costs of inspection, water quality testing, corrective action, and/or plugging of nonpublic water wells. Therefore, we recommend that funding mechanisms be developed to support such water well users (Recommendation 8). In addition, given that improperly plugged wells can serve as a source point for contamination of soil and/or groundwater (National Groundwater Association 2017), a Kansas-specific fund could be established to provide grants, cost-sharing loans, and other incentives to support the proper plugging of abandoned water wells.

Similarly, we recommend that information about abandoned wells needs to be tracked and provided during property transactions (Recommendation 11). This recommendation would also allow for KDHE to maintain records of abandoned wells and for local environmental health professionals to inspect properties with a new or existing well for abandoned wells.

### ***Recommendations to Strengthen Government Agencies’ Focus***

Three recommendations addressed the need to provide additional support to local and state governments regarding nonpublic water wells. For instance, Kansas county sanitary codes have not been regularly updated. Many of these codes have not been updated in more than 20 y. Accordingly, we recommend that county sanitary

codes be reviewed and updated every 10 y to reflect changes in state and local knowledge about best practices, nonpublic household water wells, groundwater levels and quality, and known areas of contamination, as well as technology updates (Recommendation 17).

Often suburban subdivisions and rural land is developed and platted outside the service area of public water and sewer systems. These developments typically rely on water wells and on-site wastewater systems. Unfortunately, during the platting process for these developments, they may not be configured and designed in a manner conducive to future connection to public services. To make the accommodation for public services at such time as they become available may result in extremely difficult and costly engineering designs for connection to public services for property owners. Accordingly, we recommend that local governments have provisions within their platting regulations for construction of new developments that allow for future connection to a public water supply and other public services (Recommendation 12).

Because there are many gaps in protections for nonpublic household water well users, we recommend that a statewide group needs to be formed to focus on advancing nonpublic household water well quality (Recommendation 5). We recommend that the group would be represented by multiple agencies, with a full working agenda, including (but not limited to) several of the project's recommendations such as identifying funding for nonpublic water well initiatives and developing electronic statewide maps and databases such as probable sources of groundwater contamination and the location of nonpublic household water wells.

Contamination of groundwater from natural sources, agricultural practices, former dry cleaner sites, industrial processes, underground storage tanks, landfills, Superfund, and identified contamination sites through various chemical usage and disposal practices is in no way limited to Kansas: Groundwater contamination is pervasive worldwide. Those who are reliant on nonpublic water wells for household purposes are vulnerable to these contamination sources. Although several groundwater contamination events in Kansas prompted the initiation of this study, the implications exist for areas far beyond the state of Kansas. In fact, Kansas has the eighth fewest nonpublic water wells in the country (Dieter et al. 2018). There are very few standard practices or policies designed to ensure safe water for those using nonpublic household water wells in Kansas or other states and communities.

In practice, the State of Kansas has relied on local governments, both city and county, to develop their own nonpublic water well policies and regulations. The authority of Kansas counties to adopt local regulations regarding nonpublic water wells in unincorporated areas of counties is provided for in Kansas state law giving counties authority over county sanitation issues [Sanitation Controls, Kan. Stat. Ann. § 19-3701 to 3709 (2018)]. Kansas home rule allows a city to legislate by adopting a local ordinance if no applicable state statute specifically addresses a particular subject such as nonpublic water wells. This authority allows local governments and local health departments to establish inspections, testing, and treatment of nonpublic wells. In Kansas, 103 of the 105 counties have established some type of code to address issues in the unincorporated areas of their county relating to water wells and public health. However, despite the fragmented approach by counties and cities in Kansas, there is ample authority for improvement in the existing system regarding nonpublic water well safety.

Although not all of the 18 recommendations may be applicable to other communities and states, many likely are. Based on research, the issues found in Kansas mirror those found in other localities across the United States (Schneider 2019). These results, therefore, have great potential applicability across the United States.

In discussing the implementation of these recommendations, an interesting theme developed, especially during the key

informant interviews, KAC discussion, and surveys. Dozens of stakeholders discussed concerns that they would be “infringing on the rights” of private land and/or well owners by implementing some of these recommendations. One environmental health department representative reported how a community member was knowingly consuming water contaminated with VOCs and pleaded with the environmental and public health professionals and county commissioners to not require him to switch to the public water service. Although this is an extreme case, it illustrates the underlying need to balance Kansans’ general resistance to perceived government interference with public health realities. If one is an adult and of sound mind, it may be one’s right to continue consuming contaminated water, but is this right forfeited when a child resides in the home?

To complicate matters, Kansas state and local governments have experienced extreme budget constraints, resulting in fewer personnel and increasing responsibilities. If the safety of nonpublic household water well users is a public health concern, public and environmental health departments need funding mechanisms that are commensurate with their responsibilities and the current needs, and trust must be developed with the public.

Finally, these recommendations were derived from multiple sources, reflecting different perspectives on issues impacting water quality of nonpublic household water wells. These different perspectives revealed some lack of clarity or consensus around who had the authority and responsibility to address each recommendation. At the same time, the range of perspectives and experiences of these sources provided insight into the interplay among different levels and arms of government and potential opportunities for collaboration among governmental entities to make progress on recommendations to improve water quality of nonpublic water wells. These recommendations are not comprehensive, nor are they perfect. Yet, these recommendations offer more protections for nonpublic household water well users than any resource we have found. Based on our work, these recommendations should provide guidance to other communities and states.

An important limitation of the project was the distribution of our surveys. The project team worked with organizations’ representatives (e.g., KAC) who wanted to distribute our surveys to stakeholders in their organizations. This was done to ensure anonymity, which was very important due to the highly politicized nature of the topic. However, it did not allow the project team to track response rates.

## Conclusions

There are few protections at the state, county, or municipal levels in Kansas and in other states to ensure that groundwater drawn from nonpublic water wells is safe for household use. The recommendations derived from this project provide concrete, research-based, and expert-informed actions that, if implemented, are likely to provide increased protections for persons relying on nonpublic household water wells.

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