

## RESEARCH ARTICLE

# Barriers to water infrastructure investment: Findings from a survey of U.S. local elected officials

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## Abstract

Investment in U.S. drinking water infrastructure is not keeping pace with need, contributing to water service failures that threaten public health, economic development, and community water security. Many explanations for lagging investment focus on the motivations of local elected officials, but those explanations are not rooted in research on elected officials' own expressed views. We surveyed a representative nationwide sample of approximately 500 city and county officeholders about their perceptions of need for investment and barriers to meeting that need. Analysis of closed-ended and open-ended question responses reveals that the main barriers to investment are financial: incumbents weigh the cost of capital projects against the debt burden and affordability challenge created by those investments. Their concern about public opposition to rate increases is an important constraint on decisions to invest in water infrastructure. Our results also demonstrate disparities across communities in the perceived fiscal burden of water infrastructure. The great majority of elected officials expressed little concern about the condition of infrastructure in their own communities, but concern about infrastructure condition was positively correlated with concern about making investments, pointing to the financial stress for decision makers who bear the expense of deteriorating water systems.

## Introduction

A central challenge for water governance in the United States is deterioration of the built infrastructure that is necessary to provide drinking water services. Repairs and replacement have not kept pace with need as water infrastructure across the country reaches the end of its expected lifespan [1]. External stressors—including population shifts, threats to water quality, and drought, storms, and other climate change impacts—amplify the pressures on a physical infrastructure that is increasingly falling into disrepair [2–4]. The consequences of underinvestment are becoming more visible. Water main breaks, boil water orders, and other service disruptions are on the rise, threatening public health, economic development, and local resilience [5,6].

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Explanations for underinvestment in water infrastructure often focus on the motivations of local elected officials. The provision of U.S. drinking water services is overwhelmingly a local responsibility. Whereas all levels of government invest in highways, rail, and aviation, almost 95 percent of water infrastructure investments are funded at the local level [7]. Local elected officials, who must approve capital spending plans and bond issues, might worry about losing electoral support if they increase water fees to pay for capital projects. Scholars and practitioners often cite politicians' fear of electoral punishment as a leading contributor to infrastructure underinvestment [8–11], but this explanation is not rooted in research on elected officials' own expressed views. There is a gap in knowledge about the perceptions of elected officials on the need for investment and the barriers to meeting that need.

We surveyed a representative sample of more than 500 U.S. city and county officeholders to assess the nature of their concerns about investing in drinking water infrastructure and identify characteristics of officeholders and communities they represent that are associated with more pronounced investment concern. Responses to closed-ended and open-ended questions revealed that the main barriers to investment are financial: elected officials weigh the cost of needed improvements against the debt burden and affordability challenge created by those investments. Politicians seek to avoid budgetary shocks that sharply increase water bills and could incite electoral punishment. Concern about investment does not seem to reflect satisfaction with the status quo. Instead, elected officials who perceive the highest barriers to investment also are most concerned about the condition of drinking water infrastructure in their own communities, and they are more likely to represent communities with low household income. Political partisanship also is associated with local elected officials' attitudes about investment, with Republican officeholders expressing less concern about infrastructure condition and more concern about the impacts of investment.

Our results add to burgeoning evidence on the disparities across communities in financial capacity to support the provision of safe, reliable, and affordable drinking water [12–14]. We show that the challenge of providing robust water services while maintaining affordable rates is not just financial and managerial; it is also political. For elected officials, potential public opposition to water rate increases lends an urgency to broader concerns about the financial impacts of infrastructure investment.

## The local context for water infrastructure investment

A large majority of residents in the United States rely on drinking water service from a local government—a municipality, county, or special district [15]. Local governments collect revenue from residential, commercial, and industrial ratepayers to fund capital projects as well as ongoing water system operations and maintenance. Unlike other local government functions that draw from a general fund, drinking water is funded by revenues generated from fees for service. Water rates typically include fixed and volumetric charges that vary widely for different types of customers [16]. Most local governments take on debt to finance capital projects: about 65 percent of water infrastructure investments are financed with loans [17]. Grants from state and federal funding programs cover less than 3 percent of investments in drinking water systems [18].

Although government spending on water garners widespread public support [19,20], investment has not kept pace with necessary water system repairs. The federal government estimates a capital improvement need of \$472 billion by 2035 to ensure reliable water service and regulatory compliance [21]. Current levels of spending will cover only one-third of the estimated need, contributing to a large and growing investment gap [22]. The consequences are becoming more visible. Corroding service pipes have exposed millions of Americans to

lead in their drinking water. Water main breaks, which disrupt service and allow potential contamination, are occurring more frequently [5]. Drought and severe storms sometimes knock out water service for days or weeks, especially where the infrastructure has already deteriorated.

In extreme cases, this failure to maintain water infrastructure has manifested in sustained household water insecurity. In Jackson, Mississippi's state capital and its largest city, decades of underinvestment have resulted in regular water outages and contamination from lead and other pollutants due to corroding pipes and low water pressure [23]. Widespread contamination and lengthy service shutoffs have persisted for years in Martin County, Kentucky, where as much as 65 percent of treated water leaks from pipes rather than reaching the tap [24,25]. In both cases, local officials have received criticism for deferring maintenance and repair. According to a Kentucky state regulator, "For too long, county officials and Martin District board members have deliberately allowed the utility's assets to deteriorate in order to keep rates artificially low" [26]. Local officials have now steeply increased rates to fund infrastructure repairs. Because poverty rates in both Jackson and Martin County are high, financing these repairs jeopardizes water affordability.

Why have localities failed to invest at levels needed to maintain basic water service? Answering this question requires a focus on local elected officials. Planners and water system managers can evaluate needs and prioritize projects, but it is local elected officials who make decisions about capital planning, debt issuance, and water rates. We focus on the perceptions and concerns of local elected officials to build understanding about the barriers to investing in water infrastructure.

## Concerns about infrastructure condition and investment

We aimed to characterize elected officials' concerns about infrastructure condition and investment and to analyze how these concerns vary across elected officials' political affiliations and community contexts. Our survey questions were informed by academic and practitioner literature on the financial, political, and logistical challenges associated with capital projects.

### Characterizing concerns

We expected financial considerations to be elected officials' main concern about investment. The capital-intensive, debt-financed, fee-based nature of water service requires decision makers to balance the benefits of infrastructure investment against increases in debt or water rates. Excessive debt can lower a local government's credit rating, reducing access to credit and increasing the costs of future borrowing. Debt constrains spending in other areas and can cause financial distress. At the extreme, debt-ridden cities are at risk of default and heightened state supervision [27]. Whether financed by debt or by revenue, investment often requires an increase to water rates, which reduces affordability for low-income households and struggling businesses [28,29]. Unpaid bills often lead water utilities to charge late fees for arrearages or to shut off service, creating immediate hardship and health risks for those who lose access to water. Disconnecting and reconnecting service also add to the operating costs for water systems [30].

Elected officials may also have political concerns about rate increases, based on the belief that voters will respond to higher costs by punishing incumbents at the ballot box [8]. Investment in infrastructure is a form of preventive spending: it requires paying for repairs and replacements in the short term to avoid larger expenditures in the future. The benefits of investment may never become visible to voters. Electoral incentives are an important constraint on preventive spending [31]. Politicians seek to garner support by satisfying voters'

short-term preferences for lower taxes and fees, even if the politician personally believes that investment would offer long-term benefits for the community [32].

Financial and political impacts are not the only reasons to oppose or delay investment. Elected officials may doubt whether investment is truly needed. Capital projects entail risk, whether from uncertainty about the benefits or implementation challenges [33]. Water infrastructure projects require coordinated and complementary efforts between elected decision makers and local government administrators. Trust is crucial for politicians and administrators with overlapping responsibilities to coordinate. In its absence, elected leaders might seek to exercise more control over evaluating projects and setting spending priorities [34–36].

Finally, politicians may have concerns about the logistical impacts of infrastructure investment. Construction can disrupt traffic and business activity. Elected officials seeking to attract economic development and new residents might also worry about reputational harm from acknowledging that a community's infrastructure has deteriorated [37]. As representatives for their communities in broader regional and economic development settings, elected officials may be sensitive to the complaints and reputational damage caused by short-term disruptions.

### Predicting concerns

The possible concerns about water infrastructure investments that have been outlined in the literature are likely to be more pronounced for some local officials than for others. The urgency of financial considerations may be conditional on a community's size and wealth, and financial, political, and logistical constraints on investment all may vary in resonance based on a politician's partisan predispositions. In addition to identifying the overall nature of investment concerns across communities, we also sought to uncover where, and for whom, concern about investment is highest.

Elected officials' attitudes toward infrastructure may depend on local context. Localities vary widely in their investment needs, based on the size and condition of current infrastructure, quality and quantity of water supply, impacts from contaminants and changing climate, and infrastructure demands associated with land use, local economy, and population growth or decline. Ability to fund and finance investment also varies. Due to institutional fragmentation, there are thousands of drinking water systems, most serving small or very small populations with limited revenue bases [3]. The size of the community served affects the costs of providing water. In communities that have experienced population loss, fewer residents are left to pay for oversized systems that were built to serve larger populations [38]. Economic segregation between jurisdictions produces wide disparities in the wealth of revenue bases [39], which affects the financial capacity to hire staff with sufficient technical and managerial expertise [40,41]. Because of the importance of these locality conditions in shaping the challenges and costs of water service, we expected them to contribute to politicians' attitudes about investment. In particular, we expected concern about both the quality of existing infrastructure and the impacts of investment to be highest in jurisdictions with small populations and low household income.

We also were interested in testing how infrastructure attitudes vary with an officeholder's political partisanship. Recent literature demonstrates that partisanship drives the behavior and decisions of elected officials even at the local government level [42–44]. As Americans' political attitudes have become more nationalized [45], local elected officials have stronger incentive to hew to national party positions. How this incentive translates to local policy is not always clear [46]. Republican elected officials following partisan positions are likely to favor less public spending and less debt accumulation. Democratic elected officials are likely to favor higher spending on public services, but that preference may compete with concern about water

affordability for low-income residents. We expected Democratic politicians to have more concern about infrastructure condition. We did not have a directional prediction for the relationship between partisanship and concern about investment, because we expected that concerns about public spending and affordability may compete against each other.

## Data and methods

To measure the perceptions of local elected officials about infrastructure condition and investment, we conducted an online survey through the nonprofit organization CivicPulse. CivicPulse maintains comprehensive, updated lists of publicly available contact information for government officials in municipalities, townships, and counties with populations of 1,000 or more. They randomly selected a set of elected officials—mayors, county executives, and council or commission members—to participate in this survey from April 2 to May 14, 2020. The survey was in the field during the early weeks of COVID-19's spread in the United States, before the start of public conversations about water affordability and service shutoffs. The study was deemed exempt by the Institutional Review Board at Duke University (protocol 2020–0439), and consent was granted by voluntary survey completion.

A total of 818 elected officials viewed the module on water infrastructure (from 14,440 solicitations), and 525 answered the set of questions about investment concerns that are the primary focus of this paper. The survey respondents came from 49 states. To protect respondents' confidentiality, CivicPulse did not provide data about specific jurisdictions, but it did provide aggregated information on sample representativeness. As shown in the upper section of [Table 1](#), the sample modestly overrepresents more populous or urban municipalities, while closely representing the population of counties nationwide. Overall, the sample is more representative than those used in most local government research, which typically samples from jurisdictions using a much higher minimum population threshold. The demographic characteristics of respondents, shown in the lower section of [Table 1](#), are generally consistent with what is known about who runs for office [47].

**Table 1. Survey of U.S. local elected officials, sample characteristics.**

	Sample: City	Population: City	Sample: County	Population: County
City or county:				
Population, mean	27,439	15,046	98,964	96,787
% college graduate, mean	30%	26%	22%	21%
% urban, mean	71%	57%	46%	41%
	Sample: Overall			
Elected official:				
Democrat or lean Democrat	38%			
Republican or lean Republican	51%			
Female	30%			
White, non-Hispanic	87%			
College graduate	66%			
Years worked in government	12.4			
Observations	468			

Sample and population characteristics for geographic units were provided by CivicPulse. Sample mean for city population size is inflated by one observation from a very large city; omitting that observation, the sample mean is 23,564. Elected official characteristics are for the sample included in the mean investment concern model (2) in [S3 Table](#).

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The survey consisted of questions on perceptions and attitudes about water infrastructure. We report on concerns expressed by respondents about making infrastructure investments. Although some local government officials do not directly oversee a water system, drinking water service is largely a local function: local governments own 84 percent of water systems that serve more than 3,300 people [48]. Many respondents who indicated in open-ended survey responses that their jurisdictions do not provide water service nonetheless answered questions about their investment concerns. We also used questions from CivicPulse's standard survey content on the demographic and political characteristics of respondents and information about their jurisdictions. CivicPulse provides access to data on locality characteristics for population, urbanicity, education, and household income only in terciles in order to protect respondents' confidentiality. We used these terciles in our analyses.

The survey opened with a question on respondents' level of concern about the condition of drinking water infrastructure in their own communities. We then presented an experimental vignette about a water infrastructure investment that has been reported in a separate paper [49]. Next, we asked two questions to measure concerns about investment. We first used an open-ended question to elicit the concerns at the top of respondents' minds. Following the open-ended question, we asked respondents to rate on a Likert matrix their level of concern about each of six impacts that academic and practitioner literatures have identified as potential impediments to local investment in infrastructure. Lastly, we included a question on respondents' perceptions about electoral considerations in raising water rates. Fig 1 shows the question wording for relevant items.

Our analysis proceeds as follows. First, we report descriptive responses to the closed-ended questions about infrastructure condition and investment concerns. We then further characterize the nature of elected officials' investment concerns using results from an exploratory factor analysis and responses to the open-ended question about barriers to investment. Next, we report results from regression analyses estimating how infrastructure concern, overall investment concern, and electoral perceptions are related to respondents' personal and locality characteristics. All figures and data analyses use probability weights provided by CivicPulse to increase sample representativeness.

## Results and discussion

### Characterizing concerns

**Closed-ended responses.** Fig 2 shows the distribution of all responses on the question about drinking water concern. In the context of a national conversation emphasizing the deterioration of drinking water infrastructure, few local officials are worried about the infrastructure in their own communities. Half of respondents reported no concern at all, while only a quarter expressed anything more than slight concern. In the great majority of U.S. communities, drinking water does not seem to be high on the agenda of pressing problems, as perceived by local elected officials.

Turning to the closed-ended question about investment concerns, responses reveal that many local elected officials view investment in water infrastructure as a strain on water affordability and debt. Fig 3 displays distributions in respondents' reported concern about each of six potential investment impacts. Elected officials expressed the most concern about affordability of water rates, followed closely by outstanding debt obligations. Nearly half of respondents reported being very or extremely concerned about those issues if they were considering an infrastructure investment. Concern about public opposition to rate increases was squarely in the middle of the five-point scale, with the number of respondents expressing that they were not at all or slightly concerned equal to the number expressing that they were very or extremely

**Infrastructure condition concern:**  
 How concerned, if at all, are you about the condition of drinking water infrastructure in your own community?  
 not at all concerned / slightly concerned / moderately concerned / very concerned / extremely concerned

**Investment concerns (open-ended):**  
 When you consider investments to improve water infrastructure in your own community, what might keep you from making those investments? Assume that your local government operates its own water system.

**Investment concerns (closed-ended):**  
 Below are some concerns that other local elected officials have mentioned about investing in water infrastructure. How concerned would you be about each of these issues if you were considering water infrastructure investments?  
 [random order:] affordability of water rates; disruption to traffic and businesses; outstanding debt obligations; potential harm to community’s reputation; public opposition to rate increases; uncertainty about need for investment  
 not at all concerned / slightly concerned / moderately concerned / very concerned / extremely concerned

**Electoral perception:**  
 How often, if at all, do you think local elected officials worry about their reelection when deciding whether to approve water rate increases?  
 never / rarely / sometimes / usually / always

Fig 1. Survey question wording.

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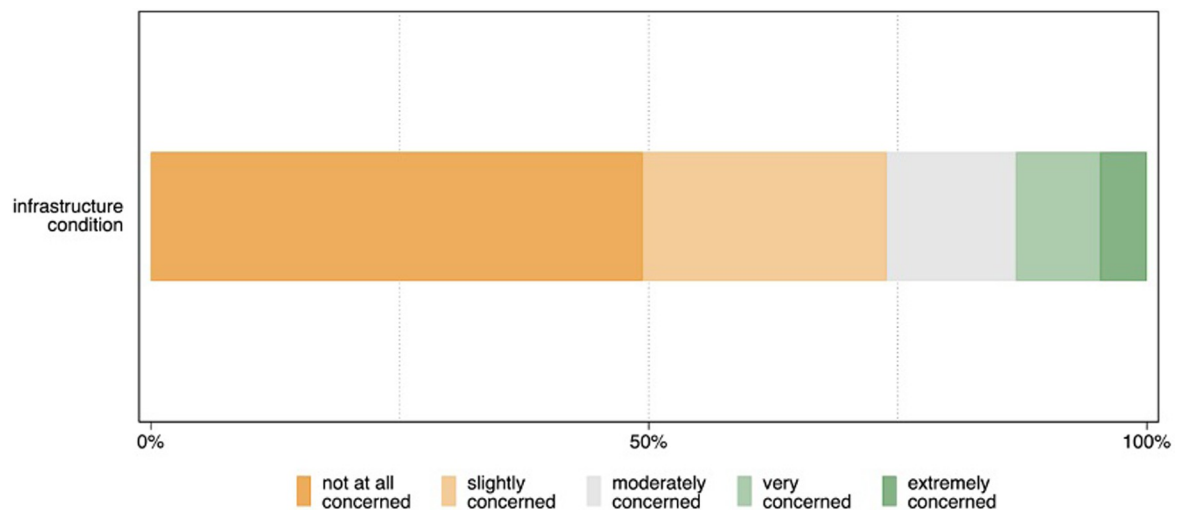
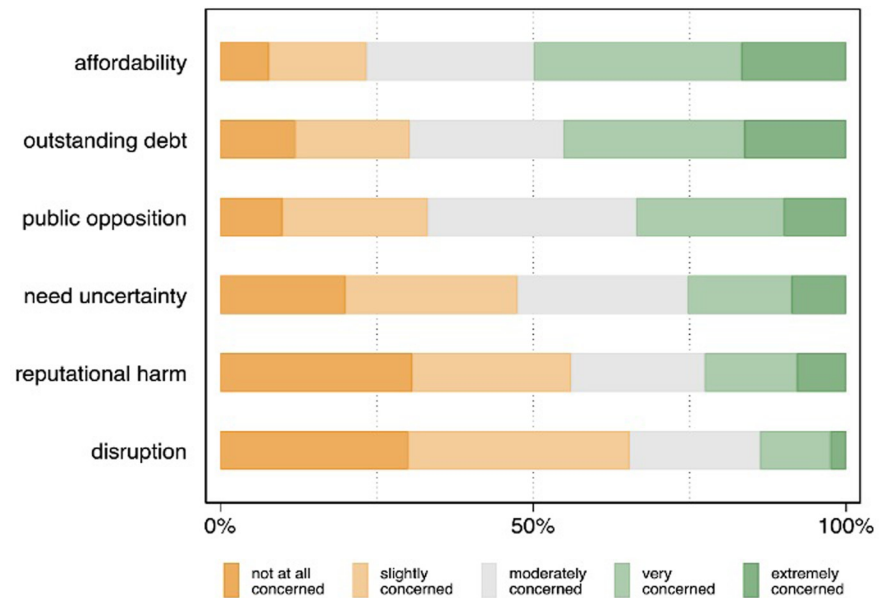


Fig 2. Concern about the condition of drinking water infrastructure in respondent’s own community. N = 525.

<https://doi.org/10.1371/journal.pwat.0000039.g002>



**Fig 3. Concerns about water infrastructure investments.** N = 525.

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concerned. Uncertainty about the need for investment or potential harm to the community's reputation were less prevalent considerations, with only about one-quarter of respondents indicating that they were very or extremely concerned about these issues. Our survey showed little concern from elected officials about the traffic and business disruptions that a project to replace pipes or upgrade water infrastructure can cause.

We expected responses on the different concerns to be related to one another because of respondents' local contexts as well as their individual predispositions toward expressing concern. Indeed, we find a high degree of interitem correlation, summarized by a Cronbach's alpha of 0.82. The consistency does not reflect inattention by survey respondents or their failure to differentiate across items. Only 8% of respondents assigned the same score to all investment impacts listed in the question, over half of whom reported no concern about any of the impacts. The overwhelming majority of elected officials drew distinctions across considerations, but their responses reflected a strong latent orientation toward some level of investment concern.

We conducted an exploratory factor analysis to assess whether any additional underlying dimension explained patterns of responses. Factor analysis allows us to detect correlations among responses that may indicate some common, unmeasured attitudinal factor that contributes to those responses. Based on results from parallel analysis, we extracted two factors from investment concern responses. The loadings for these two factors, indicating the strength of relationships between each latent factor and measured variables, appear in Table 2. Results reveal that a first factor of generalized concern about investment is the dominant source of collinearity in responses to questions about specific investment impacts. It explains the overwhelming portion of the common variance among the scores on investment concerns.

Although substantially weaker in explanatory power, a second latent factor serves to separate responses on debt, affordability, and public opposition to rate increases from responses on community reputation, disruption, and uncertainty about need. In other words, responses about debt, affordability, and public opposition each predicted responses about the other two concerns more strongly than they predicted responses about disruption, community



**Table 2. Factor loadings from exploratory factor analysis on investment concerns.**

	<b>Factor 1: Generalized concern</b>	<b>Factor 2: Non-financial</b>
Affordability of water rates	0.75	-0.24
Outstanding debt obligations	0.66	-0.17
Public opposition to rate increases	0.72	-0.15
Disruption to traffic and businesses	0.57	0.26
Potential harm to community's reputation	0.55	0.28
Uncertainty about need for investment	0.68	0.14
Eigenvalue	2.61	0.28

Number of factors selected using parallel analysis. N = 525.

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reputation, or uncertainty about investment need. Politicians seem to recognize the financial tradeoffs between investment, debt, and affordability and to anticipate that shifting the balance could mobilize public resistance.

**Open-ended responses.** Open-ended responses largely reinforce results from the closed-ended survey questions. When asked what might keep them from making investments to improve infrastructure in their own communities, respondents overwhelmingly pointed to financial considerations. Most commonly, these were general comments that mentioned “funding,” “costs,” “financial resources,” or “the state of the economy.” For those who were specific about the financial concerns related to investing, the strongest theme was the prospect of rate increases that would threaten water affordability. Many of these comments mentioned the particular burden for low-income or unemployed residents, while some framed the problem more broadly in terms of the respondent’s “poor community” or “low tax base.” Correspondingly, one respondent noted that investment was possible because affordability was not a concern: because “we are a very wealthy community with a healthy tax base,” the respondent “would invest in our water system as much \$ as it takes.”

A second major theme in the open-ended responses related to public opposition to rate increases. Some respondents tied public opposition to affordability issues, expressing concern that rate hikes would strain residents’ household budgets and spur discontent. More commonly, the public opposition barrier was expressed as a matter of public preferences, using language including “resident sentiment,” “public protest,” “too much resistance,” “lack of public support,” “voters would not approve,” and “reluctance by our residents to accept reality.” As demonstrated by the response examples listed in [S1 Table](#), we observed a distinction between responses that characterized affordability or cost as the intrinsic barrier to investment and those that focused on public opposition that may or may not be rooted in affordability concerns.

In contrast with the closed-ended results, numerous respondents volunteered that uncertainty about need might keep them from making investments to improve water infrastructure. Some of these comments related to balancing water investment against other local priorities, most commonly stormwater management or public safety. Others had a skeptical tone about whether an investment would be justified, with one noting that it may be “a WANT not a need.” Skepticism in some cases was rooted in distrust, either of “consultants with a sudden need” or of city departments: “In our City—the utility rates have been skewered with Capital Projects put in by the PW [Public Works] Director and some are necessary and some need further refinement for Council to understand.”

Open-ended responses emphasized the importance of planning so that the financial impacts of investment could be spread out over time. Many respondents expressed

dissatisfaction about large, unanticipated investments and perceptions that they were receiving incomplete or unreliable information from city staff. The following comments were representative:

“Verifying that there is an appropriate plan in place and being followed by the Water department to maintain and keep the system protected from possible failures. Without this plan and oversight / accountability, I would not support more funds to the water department.”

“I’m less concerned about the need for improvements than how long the cost if it can be spread out. Assuming that the materials to replace a system have improved since it was installed, it would seem you could spread it out over a long period of time and lower monthly increase in service. Also, I’d make sure there is a sunset policy to the increase, or at least if it’s continued, the cost to resident is reduced, but the money saved and earmarked for future system repairs.”

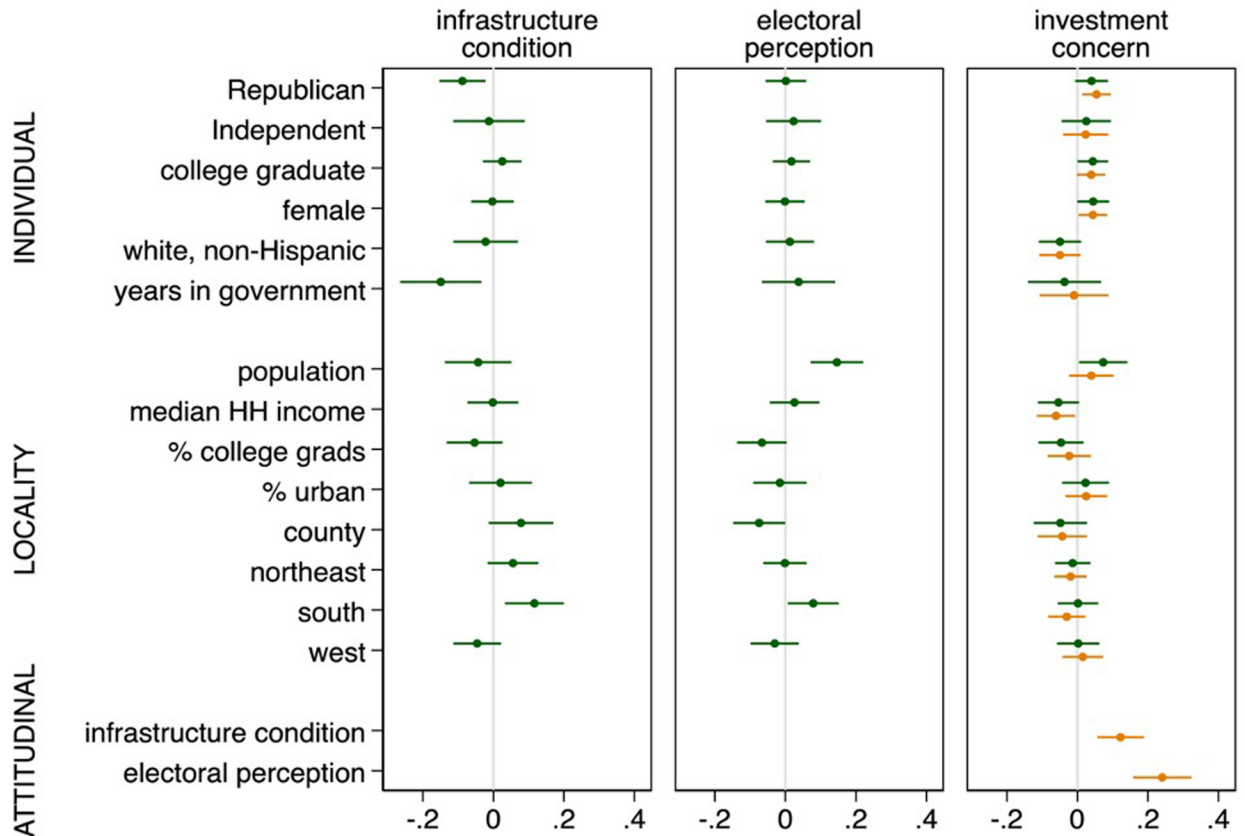
“We need to work within our current budget. We can’t always go to the consumer for a rate increase. Yes expenses go up, but they also sometimes go down, yet we never really see any price reductions. We need to invest in infrastructure, but that money needs to come from the same pool of funds we already have, therefore, I think we need to tighten our belt, minimize and even eliminate unnecessary spending, cut down consulting costs, renegotiate some labor contracts, and work within our means.”

An undercurrent in the comments was the relationship between water infrastructure and growth. Some respondents noted recent large expansions in water infrastructure to support their communities’ rapid growth, while others cited population decline and long-term economic hardship as barriers to infrastructure investment. A few mentioned relationships with developers, for example by offering “lack of communication and strategic planning with developers” as something that might stand in the way of investment. Even as elected officials were commenting on barriers to investment, some took the opportunity to highlight the importance of maintaining high-quality water service, with one noting that it’s “a necessity and ultimately builds trust with the community.” For others, financial costs and anticipation of public response seemed substantial obstacles to investment in a community’s long-term water security.

### Predicting concerns

We next sought to understand more systematically where concerns about infrastructure condition and investment were most pronounced among local elected officials. [Fig 4](#) displays results from analyses estimating how these concerns relate to respondents’ personal and locality characteristics. Our goal is not to estimate unbiased causal effects, but rather to assess descriptively how concerns correspond to community conditions and to the political predispositions of respondents. All variables are scored 0 to 1. (See [S2](#) and [S3](#) Tables for summary statistics and full results.) For ease of interpretation, we estimated the models using ordinary least squares, treating the ordered outcome scale as continuous; results are very similar when estimating with ordered probit. Cases were dropped from the analysis using listwise deletion for missing covariates on questions asked at the end of the survey.

The first panel of [Fig 4](#) shows the correlates of concern about infrastructure condition in the respondent’s own community. Politicians self-identifying as Republicans scored 0.09 points lower on concern about infrastructure condition than Democrats (the excluded base



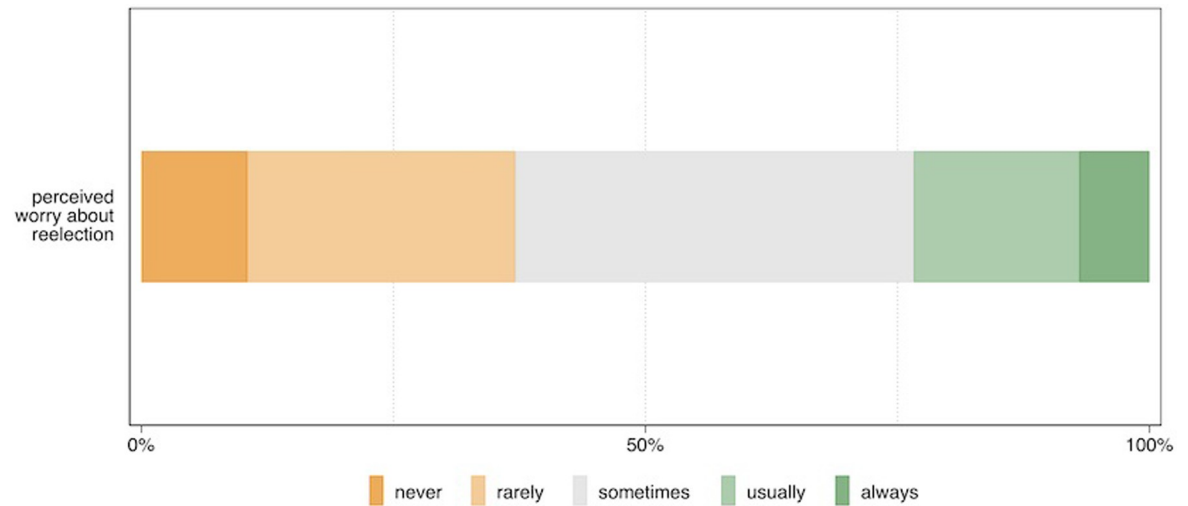
**Fig 4. Predicting concerns and perceptions about infrastructure condition and investment.** OLS estimates with 95% confidence intervals calculated using standard errors adjusted for sampling weights. Full results appear in [S3 Table](#).

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category), holding constant other individual and locality characteristics. The partisan difference in concern is significant ( $p < 0.01$ ) and over one-quarter the size of the standard deviation in the concern variable. We did not find significantly higher levels of concern about infrastructure condition among those representing small communities or communities with lower median household (HH) incomes, null results that persisted even when estimating the model without controls for region and county government. These results were surprising in light of research that emphasizes the particular challenge of maintaining a functional infrastructure where tax bases are low [13]. Our data measure only politicians' concerns, however, and not how those concerns correspond to objective infrastructure conditions in their communities. For our respondents, the only significant locality-level predictor of infrastructure concern was geographic region, with politicians in the South expressing notably higher concern than those in the Midwest, the excluded base category.

Our second outcome of interest was respondents' perceptions about the importance of electoral considerations in water rate decision making. We asked this question to understand whether politicians think of public opposition to rate increases as a constraint on investment decision making and to identify which politicians perceive the most constraint. To avoid social desirability bias, we used an indirect question asking respondents to project about decision making by other elected officials. The distribution of responses in [Fig 5](#) shows that the majority of respondents perceive that electoral considerations play a role in rate decisions at least sometimes.

Estimation results in the second panel of [Fig 4](#) show that locality characteristics play a role in predicting electoral perceptions: in particular, politicians from more populous localities



**Fig 5. Perceptions of how often local elected officials worry about reelection when deciding whether to approve water rate increases.** N = 525.

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perceived that reelection concern more frequently influences decision making about water rate increases. This relationship, as well as the lesser perception of electoral considerations among elected county officials, likely reflects the higher levels of political competition in the elections of larger cities [50]. Where politicians are more assured of reelection, electoral considerations play a smaller role in infrastructure decision making.

Estimates from a model predicting concern about the impacts of infrastructure investment appear in Fig 4's third panel. Because concerns about the six investment impacts identified in our closed-ended question were highly intercorrelated, we averaged them into a single scale of overall investment concern. Appearing in green are results from a model including only individual and locality attributes that can be strongly argued to be causally prior to investment concern. The model depicted in orange adds the other attitudinal measures that may be coincident with investment concern. Analyses predicting concern about each individual investment impact appear in S4 Table.

Results show that political partisanship is a modest but significant predictor of elected officials' attitudes about investment. Republicans are more concerned than Democrats about making investments overall—and especially because of debt impacts, uncertainty about investment need, and the potential for public opposition (S4 Table)—but partisanship has about half the explanatory power in predicting investment concern as it has in predicting concern about infrastructure condition. These are small differences as compared to the powerful role of partisanship in shaping politicians' attitudes on other policy issues, lending support for arguments that infrastructure's appeal reaches across party lines [51].

Turning to locality characteristics, investment concerns were associated with larger population size and lower household income. Elected officials representing the top third of jurisdictions in population size scored 0.07 points higher on the scale of concern than those in the bottom third, a difference that is equivalent to 37% of a standard deviation in the dependent variable. That investment concerns are stronger among elected officials from larger localities counters expectations based strictly on infrastructure cost, because spreading the costs of capital investment across a larger population should offer a financial advantage over communities that must fund investments using revenue from smaller customer bases. The results in orange reveal that electoral considerations in larger jurisdictions may be part of the explanation.

When controlling for politicians' electoral perceptions, the relationship between population and investment concern shrinks and loses significance.

Respondents from jurisdictions with lower household incomes also expressed more investment concern. For communities where incomes are low, the consequences of investment for water affordability are particularly acute. As shown in the [S4 Table](#), locality household income was most strongly related to specific concerns about public opposition and affordability. Although the coefficient on locality education levels is not significant, this relationship operates in the same direction as household income; in combination, concern about investment impacts appears particularly strong in places with low overall socioeconomic status.

Turning to other attitudinal variables, we found that respondents who were more concerned about the condition of drinking water infrastructure in their own communities also expressed higher levels of concern about infrastructure investments. Although concern about infrastructure condition is not widespread among elected officials, it is associated with a perception of higher barriers to investment. This finding counters criticisms of public officials suggesting that their unwillingness to invest is rooted in satisfaction with the status quo. Instead, it may be evidence of financial stress among those elected officials bearing the expense of deteriorating water systems.

The variable that most strongly predicts investment concern is the respondent's perception about the electoral context for water rate decision making. Those who perceive that politicians always worry about reelection when deciding whether to approve water rate increases score a full quarter point higher on the 0–1 investment concern scale (more than one unit of the five-point Likert scale) than those who perceive that politicians never worry. For many officeholders, the costs of an infrastructure project extend beyond the dollars spent to include their political futures as well.

## Conclusion

Significant public investment is needed to provide safe drinking water as the climate, population, and land uses shift and existing infrastructure deteriorates. Yet despite broad public support, local investment in water infrastructure has not kept pace with need. We focus on the stated concerns of local elected officials in an effort to explain underinvestment.

Based on results from a nationally representative sample survey of city and county officeholders, we find that concern about the impacts of infrastructure investment are more widespread among local elected officials than concern about the condition of existing infrastructure. Concern about investment is most commonly rooted in financial considerations. Elected officials balance the benefits of investment against concerns about debt and water affordability, which can mobilize public resistance to rate increases needed to fund infrastructure maintenance and repair. Even though water is funded separately from other local services, it still competes with other priorities when politicians consider how new investments will affect household budgets. Especially in low-income communities, concern about affordability can be a barrier to needed investment. Political considerations can serve as a barrier as well, as politicians who are Republican and those who perceive an electoral cost to water rate decisions both express more concern about investment.

Our results lend support for the enduring conjectures by scholars and practitioners that electoral considerations are an important constraint on decisions to invest in water infrastructure. The financial implications of infrastructure investments are unquestionably an important consideration for everyone engaged in water planning, but elected officials view these implications through the lens of short-term impacts on constituents. With crowded issue agendas and short election cycles, politicians focus on the immediate issues that are most salient to the

people they represent. That orientation leads to overemphasis on the costs of investment. Active engagement between politicians and professional planners can help loosen this constraint. Open-ended responses indicated that uncertainty about need prevents some local elected officials from making investments. Planners and water managers can use their training in prioritization, budgeting, and collaboration to build trust with elected officials to secure and communicate the long-term benefits of investment. With sound asset management and capital improvement plans, they can work with officeholders to develop funding strategies that balance investment with manageable debt and water rates.

We note two limitations of our study. First is an issue of timing. Because elected officials were responding to the survey during the early weeks of COVID-19's spread in the United States, when many Americans were experiencing wage loss and employment insecurity, reported concerns about financial impacts and water affordability may be higher than during times of more stable economic conditions. Second, the confidential nature of the survey prohibits us from connecting respondents' perceptions about water system conditions to detailed information about their communities and the water stress they face.

Still, these survey results can provide a foundation for future studies on local investment in infrastructure. Future studies could focus on discrepancies between the level of concern about infrastructure and need to invest. These studies will require a stronger data foundation on the condition of water infrastructure across communities than is currently available [12,14]. Building this data foundation is essential for understanding the political and managerial response to external stressors on a water system. Do local elected officials' priorities shift as disruptions to the safe, reliable provision of drinking water become more visible and salient? Comparative case studies that detail when, why, and how elected officials fund capital projects while mitigating the financial consequences for households and localities would advance understanding about political pathways for infrastructure investment. Future studies could also explain the relationship between water infrastructure and growth. Open-ended responses underscore how economic decline and aspirations to boost development spur infrastructure investments, yet these aspirations can sometimes result in financially harmful overexpansion of water system [52].

Ultimately, local governments' ability to support water system operations hinges on local financial conditions. In most communities, ratepayers can provide the revenue or fund the debt service that allow drinking water systems to repair aging infrastructure and meet emerging challenges. But some water systems sit on the brink, and decision makers are torn between concern about infrastructure condition and concern that making necessary investments will threaten fiscal health or the disconnection of households from water service. Local officials recognize that precarious balance and try to find ways to stretch scarce revenues further while responding to the demands of their constituents. Satisfying constituent concerns while making crucial investments is essential for maintaining water systems that secure public health and economic development.

## Supporting information

**S1 Table. Infrastructure costs and public opposition as barriers to infrastructure investment.** Example responses from the open-ended question about investment concerns (Fig 1). (PDF)

**S2 Table. Summary statistics.** (PDF)

**S3 Table. Predicting concerns and perceptions about infrastructure investment (Fig 4).** OLS estimates with standard errors adjusted for sampling weights in parentheses. \*  $p < .1$ ,

\*\*  $p < .05$ , \*\*\*  $p < .01$ .

(PDF)

**S4 Table. Predicting individual investment concerns.** Estimates from seemingly unrelated regressions to address correlation in errors across equations. Standard errors adjusted for sampling weights in parentheses. \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ .

(PDF)

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## References

1. Schanzenbach DW, Nunn R, Nantz G. If you build it: a guide to the economics of infrastructure invest-ment. Washington, DC: Brookings Institution; 2017.
2. Morckel V. Flint (MI) missed an opportunity to “right size” with its water crisis. *J Am Plann Assoc* 2020; 86(3): 304–10.
3. Mullin M. 2020. The effects of drinking water service fragmentation on drought-related water security. *Science* 2020; 368(6488): 274–77. <https://doi.org/10.1126/science.aba7353> PMID: 32299948
4. Sadler RC, Furr-Holden D, Greene-Moton E, Larkin B, Timlin M, Walling D, et al. Right sizing Flint's infrastructure in the wake of the Flint water crisis would constitute an additional environmental injustice. *J Am Plann Assoc* 2021; 87(3): 424–432. <https://doi.org/10.1080/01944363.2020.1864226> PMID: 34650317
5. Folkman S. Water main break rates in the USA and Canada: a comprehensive study. Logan: Utah State University; 2018.
6. Woodruff SC, Meerow S, Stults M, Wilkins C. Adaptation to resilience planning: alternative pathways to prepare for climate change. *J Plan Educ Res* 2022; 42(1): 64–75.
7. Congressional Budget Office. Public spending on transportation and water infrastructure, 1956–2017. Washington, DC: CBO; 2018.
8. Hansen K, Eskaf S, Mullin M. Avoiding punishment? Electoral accountability for local fee increases. *Urb Aff Rev* 2022; 58(3): 888–906.
9. Levin RB, Epstein PR, Ford TE, Harrington W, Olson E, Reichard EG. U.S. drinking water challenges in the twenty-first century. *Environ Health Perspect* 2002; 110(suppl 1): 43–52. <https://doi.org/10.1289/ehp.02110s143> PMID: 11834462
10. Hughes S, Pincetti S, Boone C. Triple exposure: regulatory, climatic, and political drivers of water man-agement changes in the City of Los Angeles. *Cities* 2013; 32: 51–59.
11. Teodoro MP, Zhang Y, Switzer D. Political decoupling: private implementation of public policy. *Policy Stud J* 2020; 48(2): 401–24.
12. Hughes S. A multidimensional approach to evaluating the vulnerability of drinking water systems. *J Environ Policy Plan* 2022; 24(2): 210–226.

13. Smull E, Patterson L, Doyle M. Rising market risk exposure of municipal water service providers in distressed cities. *J Water Resour Plan Manag* 2021; 148(2), 05021032.
14. Bell EV, Hansen K, Mullin M. Assessing performance and capacity of U.S. drinking water systems. *J Water Resour Plan Manag* 2022; forthcoming.
15. U.S. Environmental Protection Agency. Community water system survey, volume II: detailed tables and survey methodology. EPA 815-R-09-002. Washington, DC: Office of Water; 2009.
16. Beecher JA, Mann PC, Landers JR. Cost allocation and rate design for water utilities. NRRI 90–17. Columbus, OH: National Regulatory Research Institute; 1990.
17. Cesanek W, Elmer V, Graeff J. Planners and water. PAS Report 588. Chicago: American Planning Association; 2017.
18. Greer RA. A review of public water infrastructure financing in the United States. *WIREs Water* 2020; 7: e1472.
19. Newport F. The singular appeal of a government focus on infrastructure. *Polling Matters*. 2019 May 2. Gallup.
20. Tompkins F. Overwhelming majority of Americans support spending more for flood-ready infrastructure. The Pew Charitable Trusts. 2020 February 24.
21. U.S. Environmental Protection Agency. Drinking water infrastructure needs survey and assessment, sixth report to Congress. EPA 816-K-17-002. Washington, DC: Office of Water; 2018.
22. Value of Water Campaign and American Society of Civil Engineers. The economic benefits of investing in water infrastructure: how a failure to act would affect the US economic recovery. 2020 [cited 2022 July 30]. Available from: [http://www.uswateralliance.org/sites/uswateralliance.org/files/publications/The%20Economic%20Benefits%20of%20Investing%20in%20Water%20Infrastructure\\_final.pdf](http://www.uswateralliance.org/sites/uswateralliance.org/files/publications/The%20Economic%20Benefits%20of%20Investing%20in%20Water%20Infrastructure_final.pdf).
23. Rowe K, Sanderlin LO. How Jackson's water system made it a focus in America's infrastructure crisis. *Mississippi Today*. 2021 December 8.
24. Ragusa J. Martin Co. seeks water rate increase to improve decrepit system. *Spectrum News* 1. 2021 June 7.
25. Roberts B. Letter sent to Martin County residents suggests 'cloudy' water is safe. *Spectrum News* 1. 2021 July 1.
26. Wright W. Kentucky approves another rate increase for embattled eastern Kentucky water district. *Lexington Herald Leader*. 2018 November 6.
27. Hughes S, Dick A, Kopec A. Municipal takeovers: examining state discretion and local impacts in Michigan. *State Local Gov Rev* 2021; 53(3): 223–247.
28. Teodoro MP. Measuring household affordability for water and sewer utilities. *J Am Water Works Assoc* 2018; 110(1): 13–24.
29. Pierce G, El-Khattabi AR, Gmoser-Daskalakis K, Chow N. Solutions to the problem of drinking water affordability: a review of the evidence. *WIREs Water* 2021; 8:e1522.
30. Swain M, McKinney E, Susskind L. Water shutoffs in older American cities: causes, extent, and remedies. *J Plan Educ Res* 2020. <https://doi.org/10.1177/0739456X20904431>
31. Healy A, Malhotra N. Myopic voters and natural disaster policy. *Am Political Sci Rev* 2009; 103(3): 387–406.
32. Canes-Wrone B, Herron MC, Shotts KW. Leadership and pandering: a theory of executive policymaking. *Am J Political Sci* 2001; 45(3): 532.
33. Hansen K, Mullin M, Riggs EK. Collaboration risk and the choice to consolidate local government services. *Perspect Public Manag Gov* 2020; 3(3): 223–238.
34. Grøn CH, Salomonsen HH. In the mayor we trust? Trust as the micro-foundation of complementary politico-administrative relations in local governments. *Adm Soc* 2019; 51(4): 581–606.
35. Svara JH. The myth of the dichotomy: complementarity of politics and administration in the past and future of public administration. *Public Adm Rev* 2001; 61(2): 176–83.
36. Throgmorton J. Planners in politics, politicians in planning. *Plan Theory Pract* 2021; 22(3): 495–502.
37. Wolman H, Spitzley D. The politics of local economic development. *Econ Dev Q* 1996; 10(2): 115–150.
38. Faust KM, Dulsey MA, McElmurry SP. Water and wastewater infrastructure management in shrinking cities. *Public Work Manag Policy* 2015; 21(2): 128–156.
39. Pierce G, Lai L, DeShazo JR. Identifying and addressing drinking water system sprawl, its consequences, and the opportunity for planners' intervention: evidence from Los Angeles County. *J Environ Plan Manag* 2019; 62(12): 2080–2100.



40. Shih J-S, Harrington W, Pizer WA, Gillingham K. Economies of scale in community water systems. *J Am Water Works Assoc* 2006; 98(9), 100–108.
41. Scott TA, Moldogaziev T, Greer RA. Drink what you can pay for: financing infrastructure in a fragmented water system. *Urban Stud* 2018; 55(13): 2821–2837.
42. De Benedictis-Kessner J, Warshaw C. Mayoral partisanship and municipal fiscal policy. *J Polit* 2016; 78(4): 1124–38.
43. Burnett CM. Parties as an organizational force on nonpartisan city councils. *Party Politics* 2019; 25(4): 594–608.
44. Homsy GC, Warner ME. Does public ownership of utilities matter for local government water policies? *Util Policy* 2020; 64: 101057. <https://doi.org/10.1016/j.jup.2020.101057> PMID: 32351260
45. Hopkins DJ. *The increasingly United States: how and why American political behavior nationalized*. Chicago: University of Chicago Press; 2018.
46. Anzia SF. Party and ideology in American local government: an appraisal. *Annu Rev Polit Sci* 2021; 24(1): 1–18.
47. Motel S. Who runs for office? A profile of the 2%. Pew Research Center. 2014 Sept 3.
48. Humphreys E, Tiemann M. Safe Drinking Water Act (SDWA): draft amendment authorizing voluntary water partnerships and related sdwa compliance development provisions. Congressional Research Service. 2020 July 17 [cited 2022 July 30]. Available from: <https://www.duckworth.senate.gov/imo/media/doc/Voluntary%20Water%20Partnerships%20for%20Distressed%20Communities%20Act%20Congressional%20Research%20Service%20Analysis.pdf>.
49. Mullin M, Hansen K. Local news and the electoral incentive to invest in infrastructure. *Am Political Sci Rev* 2022; forthcoming.
50. Lappie J, Marschall M. Place and participation in local elections. *Polit Geog* 2018; 64: 33–42.
51. Bipartisan Policy Center. Understanding America's water and wastewater challenges. 2017 May [cited 2022 July 30]. Available from: <https://bipartisanpolicy.org/download/?file=/wp-content/uploads/2019/03/BPC-Infrastructure-Understanding-Americas-Water-and-Wastewater-Challenges.pdf>.
52. Mullin M. *Governing the tap: special district governance and the new local politics of water*. Cambridge, MA: MIT Press; 2009.