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The State of New Hampshire
Department of Environmental Services

Robert R. Scott, Commissioner

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February 15, 2022

His Excellency, Governor Christopher T. Sununu
and the Honorable Council
State House
Concord, NH 03301

REQUESTED ACTION

Authorize the Department of Environmental Services (NHDES) to enter into a **SOLE SOURCE** Joint Funding Agreement with the U.S. Geological Survey (USGS), Pembroke, NH, (VC # 175772-R003), in the amount of $40,000 to investigate associations between socioeconomic status (SES) and well water quality and availability, effective upon Governor & Council approval through September 30, 2024. 100% federal funds.

Funding is available in the following account, with the authority to adjust encumbrances in each of the State fiscal years through the Budget Office if needed and justified. Funding for FY 2024 is contingent upon continuing appropriation and availability of funds.

	FY 2022	FY 2023	FY 2024
03-44-44-441018-47180000-102-500731	$12,000	$16,000	$12,000

Dept Environmental Services, DWSRF Administration, Contracts for Program Services

EXPLANATION

This is **sole source** because USGS is uniquely qualified to carry out this work due to their familiarity with the data sources to be used and it is providing matching funds towards this project. Previous work in New Hampshire has found that SES has some bearing on the quality of drinking water from private wells. These SES factors include income, housing type, and education. This investigation will explore associations between existing New Hampshire data on private well construction (depth, casing length, water level, and yield), aquifer type, land use, and chemistry (MTBE, arsenic, iron, lead, manganese, and uranium) with demographic and SES data or their proxies. The results will inform NHDES in two ways: (1) indicate where the extension of public water service areas might be prioritized to serve environmental justice and environmental health objectives and (2) identify how SES or race factors into whether a household is served by a private well vs. a public water system.

Under this agreement the USGS will provide $220,000 (approximately 85%) in funds towards the total cost of $260,000 to conduct the investigation, with the balance of $40,000 (approximately 15%) being provided by NHDES using federal Safe Drinking Water Act State Revolving Fund setasides.

In the event that federal funds no longer become available , General Funds will not be requested to support this program. This Agreement has been approved by the Department of Justice as to form, content and execution.

We respectfully request your approval.

Robert R. Scott, Commissioner

Form 9-1366
(May 2018)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000000093
Agreement #: 22LGJFANH000010
Project #:
TIN #: 02-6000618

Fixed Cost Agreement YES[X] NO[ ]

THIS AGREEMENT is entered into as of the March 1, 2022, by the U.S. GEOLOGICAL SURVEY, New England Water Science Center, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the New Hampshire Department of Environmental Services party of the second part.

1. The parties hereto agree that subject to the availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation the project "Investigating triggers to private well vulnerability to water quality and availability issues using socioeconomic data in New Hampshire" (per attachment), herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50, and 43 USC 50b.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) include In-Kind-Services in the amount of $0.00

(a) $220,000 by the party of the first part during the period March 1, 2022 to September 30, 2024

(b) $40,000 by the party of the second part during the period March 1, 2022 to September 30, 2024

(c) Contributions are provided by the party of the first part through other USGS regional or national programs, in the amount of: $0

Description of the USGS regional/national program:

(d) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

(e) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.

4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.

5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.

6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

8. The maps, records or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program, and if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at cost, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records or reports published by either party shall contain a statement of the cooperative relations between the parties. The Parties acknowledge that scientific information and data developed as a result of the Scope of Work (SOW) are subject to applicable USGS review, approval, and release requirements, which are available on the USGS Fundamental Science Practices website (https://www.usgs.gov/about/organization/science-support/science-quality-and-integrity/fundamental-science-practices).

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000000093
Agreement #: 22LGJFANH000010
Project #:
TIN #: 02-6000618

9. Billing for this agreement will be rendered **quarterly**. Invoices not paid within 60 days from the billing date will bear Interest, Penalties, and Administrative cost at the annual rate pursuant the Debt Collection Act of 1982, (codified at 31 U.S.C. § 3717) established by the U.S. Treasury.

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Name:	Melissa Shaffer Budget Analyst
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U.S. Geological Survey
United States
Department of Interior

Signature

By JOHNATHAN BUMGARNER Digitally signed by JOHNATHAN BUMGARNER Date: 2022.01.24 15:23:44 -05'00' **Date:** 01/24/2022

Name: Johnathan Bumgarner

Title: Director

New Hampshire Department of Environmental Services

Signatures

By ______ Date: 2/16/22

Name: Robert R Scott

Title: Commissioner

By ______ Date: 2/22/2022

Name: Joshua Harrison

Title: Assistant Attorney General
As to form, Substance, and Execution.

By______________ Date: ________

Name:

Title:

TITLE Directed CMF: Investigating triggers to private well vulnerability to water quality and availability issues using socioeconomic data in New Hampshire

BACKGROUND A systematic underfunding of fundamental private well research has prevented adequate characterization of risks for private well owners, resulting in a poor understanding of private well vulnerability to water availability and contaminant exposures across the United States. Few published studies on private wells that examine whether socioeconomic status (SES) or demographic variables are associated with vulnerability to water scarcity or contamination issues use data entirely from individual homeowners (Pieper and others, 2018; George and others, 2018; Nigra, 2020; Flanagan and others, 2016). A few additional studies have linked SES or demographic data with well chemistry data where some of the explanatory variables were based on source data that were aggregated or generalized (Tariqi and Naughton, 2021; Washington State Department of Ecology, 2009).

In January 2021, with Whitehouse Executive Order 14008 to advance an environmental justice agenda, questions of environmental disparity received an infusion of federal attention and resources. Section 219 of E.O. 14008 seeks to turn historically marginalized, overburdened, and disadvantaged communities into healthy and thriving communities. The Department of Interior issued a mission statement on the topic, "To provide outstanding management of the natural and cultural resources entrusted to us in a manner that is sustainable, equitable, accessible, and inclusive of all populations." Other federal agencies, such as CDC, EPA, and NIH are likewise developing programs to comply with E.O. 14008.

In 2009, the New England WSC was asked by the New Hampshire Department of Environmental Services (DES) to evaluate water-level data on all wells in the state water-well inventory because average water levels had a declining trend of more than 1 ft per year over 10-15 years. That study found associations between factors such as well depth, casing length, and hillslope position to water levels and yields (Ayotte and others, 2010). New Hampshire DES was interested in exploring whether there might be SES factors related to the disparity of yields but did not have the means to pursue that question.

PROBLEM Evidence from a Dartmouth College study of New Hampshire homeowners found that SES factors have some bearing on the quality of drinking water from private wells. Using a design for which community focus groups were consulted, Dartmouth researchers identified barriers to homeowners testing or to successful treatment of private wells for arsenic (Borsuk and others, 2014). Factors identified as barriers related to race (non-white versus white), housing type (multi-family vs single-family), income, lack of understanding of actions to take as a result of testing, and lack of communication with treatment companies. The potential for arsenic contamination is not trivial—about 5 percent of New Hampshire has at least a 50 percent chance of groundwater from bedrock wells to have concentrations at or above the EPA MCL of 10 μg/L and about 7 percent of the bedrock groundwater in the State has at least a 50 percent chance of concentrations at or above 5 μg/L, the New Hampshire standard (Ayotte and others, 2012). New Hampshire lowered its standard for arsenic in 2019 from the EPA guideline, recognizing the cost associated with potential health impacts due to exposure. Some studies have suggested links between arsenic exposure in New Hampshire and cancer and adverse birth outcomes (Baris and others, 2016; Shi and others, 2015).

In New Hampshire, about 37 percent of the population used private wells in 2015 (Dieter and others, 2018). Most of the population on private wells are in the southern counties of Hillsborough, Merrimack, and Rockingham, in which are located the most populous cities of Manchester, Nashua, and Concord (fig. 1), and where arsenic-contaminated groundwater is most prevalent (Ayotte and others, 2012). A common belief is that private wells predominate in rural areas, but many well users are located in or near urban settings – outside city boundaries where water lines have not been extended. These peri-urban settings are likely home to lower SES populations, as well as black, indigenous, and people of color (BIPOC) communities (fig. 2).

We propose to address the need to investigate potential demographic and SES disparity in vulnerability to quality and availability of water from private wells by exploring associations between existing New Hampshire data on private well construction (depth, casing length, water level, and yield), aquifer type, land use, and chemistry (MTBE, arsenic, iron, lead, manganese, and uranium) with demographic and SES data or their proxies. High concentrations of these chemical constituents are often found in groundwater in New Hampshire and may have deleterious health effects (Moore, 2004; Ayotte, 2008; Ayotte, 2012). Water availability can be an issue for homeowners with private wells during increasingly common dry conditions in New Hampshire (New Hampshire DES, 2021). Many homeowners with dug or shallow bedrock wells that are more susceptible than deeper wells to lack of water from drought conditions attempt to deepen or drill replacement wells into bedrock, which is expensive and has greater potential for water-quality issues from arsenic and uranium (oral commun., S. Roy, New Hampshire DES Drinking Water Bureau). The central question is whether we can identify specific triggers or combinations of triggers that signal vulnerability in drinking water availability and quality from private wells in New Hampshire.

OBJECTIVES The goals of this work are to: (1) investigate homeowner-level statistical associations between datasets on private wells (geology and land use, construction, hydraulics, and chemistry) and SES (and SES proxy) data; (2) investigate statewide census block-group level statistical associations between datasets on private wells (geology and land use, construction, hydraulics, and probabilities of arsenic and uranium contamination) and demographic and SES (and SES proxy) data; (3) identify indicators or triggers of vulnerability to private well water availability and quality in New Hampshire; and (4) broadly disseminate information from this study to scientific and general audiences, as well as to targeted community groups.

RELEVANCE AND BENEFITS This project provides benefit to the USGS by providing tools to use for quantifying the vulnerability of human populations and ecosystems to water shortages, surpluses, and degradation of water quality, which is one of the visions for USGS science (Evanson and others, 2013). Federal agencies such as the DOI, CDC, EPA, and NIH have written mission statements and strategic plans to address the environmental justice component of Executive Order 14008. Approaches and scripts developed in this study have the potential to be upscaled or to serve as models for applications to larger areas.

This project also has relevance to the cooperator, the New Hampshire Department of Environmental Services, Drinking Water and Groundwater Bureau, in two ways: (1) areas with low income and/or BIPOC communities identified by this study as vulnerable to private well water contamination or availability could be prioritized for state programs or funding; and (2) this study may help inform the recommendations made by the Seacoast Commission on Long-Term Goals and Requirements for Drinking Water about public water supply needs and anticipated needs. Environmental justice is also of paramount interest to several state agencies and community level advocacy groups in New Hampshire.

APPROACH Datasets to compile for the first goal are (1) well chemistry data (MTBE [500 wells sampled in 2005]; arsenic, iron, lead, manganese, and uranium [350 wells sampled in 2017]) from USGS project files (data to be published in a data release associated with this study); (2) updated information on private well construction and hydraulics in New Hampshire for over 100,000 wells across the state from the New Hampshire DES water well inventory; (3) SES proxy data for households from an online source (Avitar Associates of New England or Vision Government Solutions) or by contacting town assessor's offices; and (4) spatial datasets for NH such as land use and surficial and bedrock geology and aquifer maps. SES proxy data include assessed home value, purchase price, year built, square footage, style, lot size, garage/no garage, irrigation system (if available), and possibly other data. Property value has been used as a proxy for socioeconomic status (SES) in past studies and is hypothesized to have utility in this investigation (Ware, 2019). For example, as value increases, a larger portion of the population is excluded from particular areas of residence (fig 3). A point dataset with chemistry data of 109 homeowners distributed throughout the state who have received funding from the New Hampshire DES Emergency Drought Assistance to Low-Income Residential Well Owners program (New Hampshire Drinking Water and Groundwater Trust Fund, 2021) has already been provided. If available, we also will integrate other household-level datasets furnished by state agencies, such as the New Hampshire Department of Health and Human Services (DHHS) Women Infants & Children Nutrition program and the DHHS Biomonitoring Tracking and Assessment of Chemical Exposures Study. These datasets could be highly relevant to this study (but are not required); our state agency partners have expressed willingness to make the data available and are checking with their legal departments about the possibility of entering into data sharing agreements with USGS. This household-level assessment will be done for as many towns as are feasible in New Hampshire to be selected based on demographic relevance and availability of data.

We will explore several statistical approaches to determine whether geologic, land use, and SES proxy factors from homeowner property assessments (home value, size, age, lot size) result in differences in water availability; and whether these factors combined with well chemistry data result in different vulnerabilities to drinking water contamination. Potential correlations among explanatory factors will be identified. Initial data exploration will be done using conventional multiple regression in R or python and spatial analysis techniques in ArcGIS Pro. Once we have a better understanding of the data, we will investigate machine learning (ML) methods, such as gradient tree-boosting or K-means clustering, or others to be determined. Our experience with applying ML methods has shown that they improve prediction sensitivity and overall accuracy, and we expect that these methods would be useful here (Lombard and others, 2021; Ayotte and others, 2015). The most robust results are likely to be achieved by applying a combination of these approaches.

To achieve the second goal, the private well construction and yield data from the water well inventory collected for the first goal will be spatially distributed across census block groups. There are 922 census block groups in New Hampshire and 221 towns. Well data might be averaged (as median or mode) across block groups, but other metrics that are likely to make more sense, such as percent of wells less than some relevant depth threshold, also will be investigated. Census demographic data (including percent low-income, percent people of color, less than high school education, linguistic isolation) for block groups from the American Community Survey (ACS) will be downloaded from the USEPA's environmental justice screening and mapping tool, EJSCREEN, or from an ACS portal. Statewide census-tract level data on race/ethnicity and language, SES (education, employment, income, and poverty), and a Social Vulnerability Index (considers 16 social determinants of health) from the New Hampshire Environmental Public Health Tracking (EPHT) website (New Hampshire DHHS, 2021) will be examined as a possible backdrop to block-group level data, although it's unclear whether the resolution will be adequate for meaningful results. Statewide probabilities of arsenic and uranium concentration exceedances in groundwater from bedrock aquifers (Ayotte and others, 2012; Moore and Hayes, 2021) will be apportioned to block groups. As a check for block groups where well chemistry data are dense, chemical results will be aggregated (as averages) to eliminate prediction errors. The statistical approaches will be similar as those described for the first goal.

The third goal of identifying indicators or triggers of vulnerability to private well water availability and quality will first be addressed by initiating conversations with local community immigrant and racial justice groups in NH. The New England WSC already has a workgroup with state leaders from the New Hampshire DES and DHHS, which will also be involved with communication with local groups. This step is important to make sure we have a solid understanding of local issues related to private well vulnerabilities. Community groups with whom we may consult include several concerned about immigrants and refugees: Welcoming New Hampshire, the Organization for Refugee Immigrant and Success, Building Community in NH, or Overcomers; and several concerned with racial issues: area NAACP chapters and Black Lives Matter chapters, Conservation Law Foundation, and the University of New Hampshire (Semra Aytur of UNH Department of Health Management and Policy). Results from those conversations, as well as statistical findings from the first two objectives, will be translated into meaningful metrics related to vulnerabilities in consultation with experts in the USGS Social and Economic Drivers Program.

The fourth goal, to disseminate findings from this study to a wide audience, will be accomplished through 4 outlets. The first outlet, publishing results in a peer-reviewed journal, is for technical audiences. The second outlet geared toward reaching a broader audience, will integrate findings with an existing public-health dashboard of the New Hampshire DHHS or the CDC. Both agencies fully endorse this project. Well construction, hydraulic, and chemical information at the New Hampshire Environmental Public Health Tracking (EPHT) website (New Hampshire DHHS, 2021) is currently displayed as average conditions in towns across the state. By including statewide block-group level analyses and some form of household-level data (displayed without releasing sensitive information) for select areas, information from this study will provide detail to disentangle and augment the averaged information and to provide context for interpretation. The third outlet, designed to reach a still broader audience, will be a USGS geonarrative or online fact sheet, or some other web product designed to fully describe the background, objectives, and results of this study to a non-technical audience. The fourth outlet will be to targeted community groups that are identified through the communication process discussed above in the approach for the third goal.

QUALITY ASSURANCE/QUALITY CONTROL All data used in this study will be provided from existing sources (i.e. no new data will be generated) and will generally be accepted as is, although verification for extremely gross outliers in well construction or chemistry data will be attempted. Standard diagnostics for all statistical analyses will be examined and used to describe suitability of model outputs for interpretation. A data management plan (DMP) will be developed prior to collection of data for this project.

PRODUCTS We will publish the data associated with the study in a data release, in accordance with USGS policy for sensitive or PII information. The chemistry data for individual wells, not previously published, will be included in the data release. We will publish one or more journal articles to describe the findings of the study. Summaries of findings will be posted on the New Hampshire Environmental Public Health Tracking Dashboard (https://www.nh.gov/epht/), which has the potential to serve as an example for this type of work in other states or for national agencies. We will develop a geonarrative or online product hosted on a USGS web page to distribute these findings to a wider audience.

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TIMELINE

Task	2022		2023		2024	
	Oct-Mar	Apr-Sept	Oct-Mar	Apr-Sept	Oct-Mar	Apr-Sept
Compile data	X					
Organize and format data	X					
Liaise with community groups	X	X	X	X	X	X
Spatial analysis	X	X				
Statistical analysis		X	X	X		
USGS geonarrative or fact sheet				X	X	
Write and publish report and data release				X	X	X
Integrate findings with dashboard				X	X	X

PERSONNEL

The majority of the work will be done by a GS12 hydrologist in the New England WSC who has extensive experience with project management, GIS, and water-quality and statistical analysis. A data visualization specialist in the New England WSC will aid with design and execution of the geonarrative. Cooperator in-kind services, in addition to the monetary contribution indicated in the budget table, will be provided to help organize and participate in conversations with community groups and to integrate findings with the New Hampshire DHHS Environmental Public Health Tracking dashboard.

BUDGET – All salary

Task	FY2022	FY2023	FY2024
Compile data	$40,000		
Organize and format data	$40,000		
Liaise with community groups	$10,000	$5,000	$5,000
Spatial analysis	$10,000		
Statistical analysis		$60,000	
USGS geonarrative or fact sheet		$5,000	$5,000
Write and publish report and data release		$10,000	$45,000
Integrate findings with dashboard		$10,000	$15,000
Total	$100,000	$90,000	$70,000
USGS contribution	$80,000	$70,000	$70,000
Cooperator contribution	$20,000	$20,000	$0

Figure 1. Counties and major cities in New Hampshire (colors not germaine).

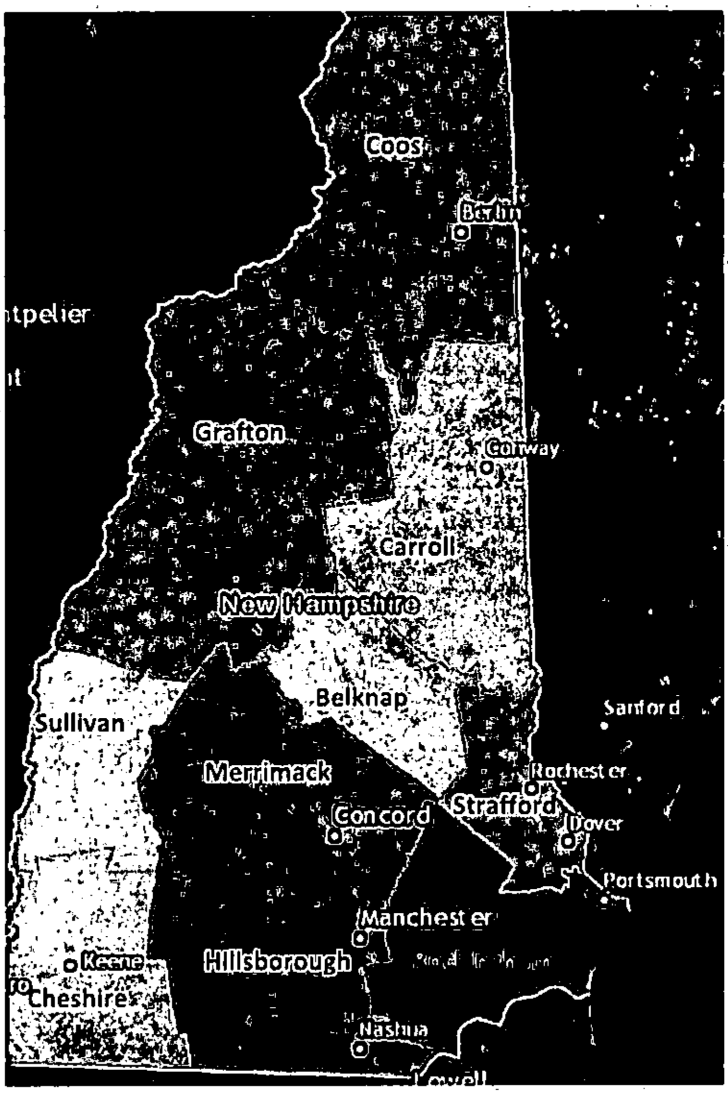


Figure 2. The size of the yellow circles within each magenta-bounded block group is associated with the proportion of the population that is a minority population. The position of circles within block groups is not meaningful. Shading of block groups from light green to dark blue indicates increasing poverty.

The message of this figure is that although most of the area is served by public supply, there are sections of many block groups served by private wells and with up to 73% and 63% of the populations that are minority and/or in poverty.

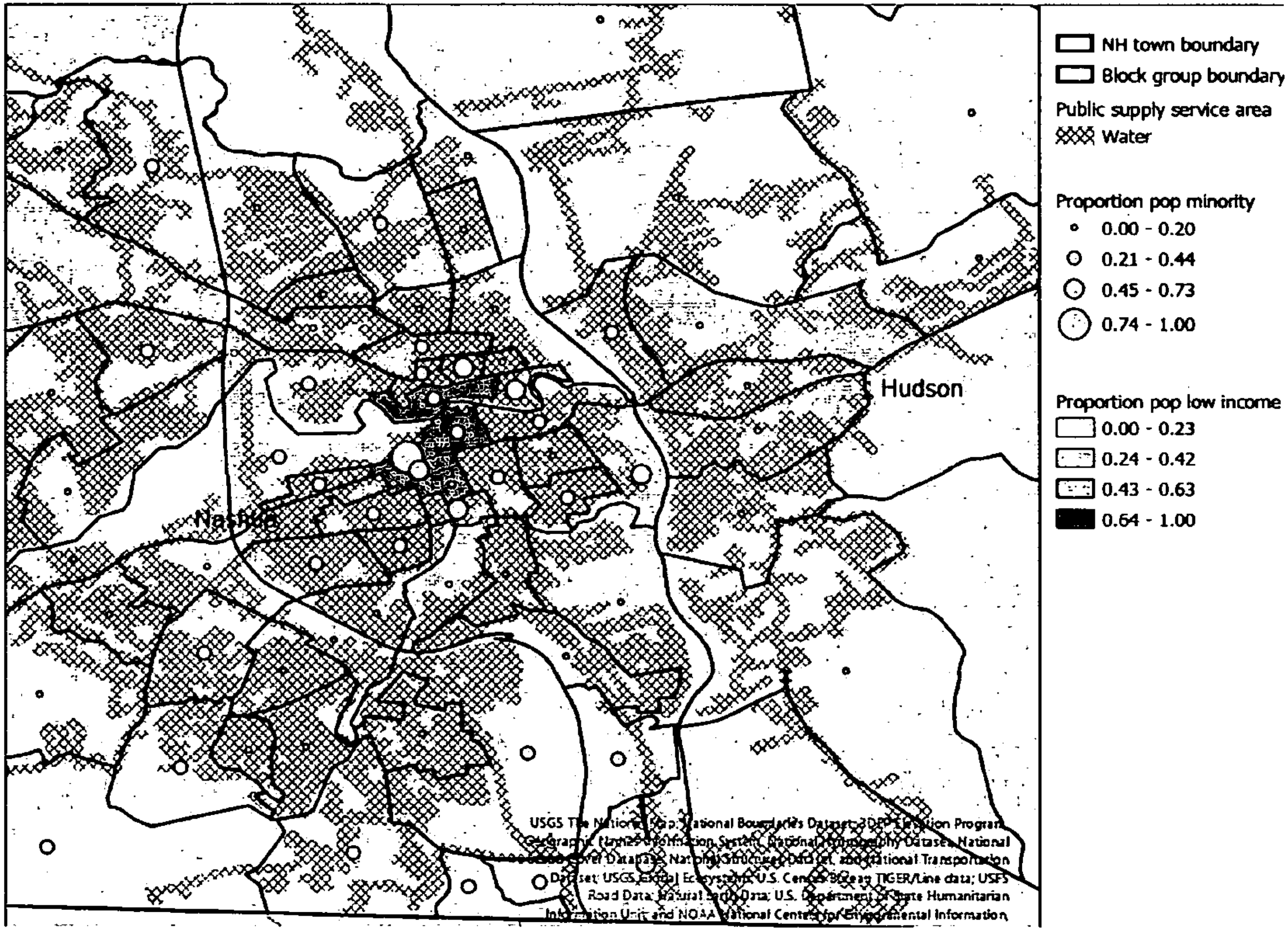
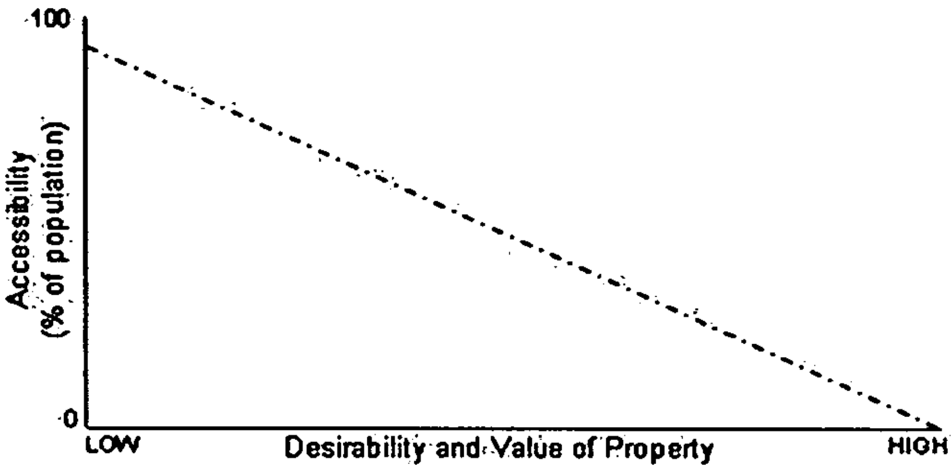


Figure 3. Property value as a proxy for socioeconomic status resulting in differential access to desired resources in a midwestern US city (Ware, 2019).



NOTE: The following JHA is missing the signature of the Safety Officer who is not available. We will send a signed copy ASAP.

Job Hazard Analysis For New Projects

- Check the numbered box(es) for all significant safety concerns this project should address. Significant safety concerns are commonly those that require training, purchase of safety equipment, or specialized preparation to address potentially hazardous conditions.
- On the next page, identify any unlisted safety concerns and provide details for each checked safety concern.

Proposal Number: [ ] Project Title (Short): IWAAs private wells and SES project

Project Chief or Proposal Author: Medalie, L., Ayotte, J

The following persons have reviewed the proposal for this project and determined that this safety analysis adequately addresses all significant safety concerns:

	Name	Signature
Collateral Duty Safety Officer:	Jason Cyr	
Science Center Director:	Paul Barlow, AD for Hydrologic Investigatio	PAUL BARLOW
Area Safety Officer:		

Safety Concerns:

1.	☐	Wading, bridge, boat, or cableway measurements or sampling
2.	☐	Working on ice-covered rivers or lakes
3.	☐	Measuring or sampling during floods
4.	☐	Well drilling; borehole logging
5.	☐	Electrical hazards in the work area
6.	☐	Construction
7.	☐	Working in remote areas: communication and office call-in procedures
8.	☒	Ergonomics and carpal tunnel syndrome
9.	☐	Field vehicles appropriate for task? Presence/status of safety screens and equipment restraints
10.	☐	All-terrain vehicles, snowmobiles
11.	☐	Helicopter or fixed-wing aircraft usage
12.	☐	Site access
13.	☐	Hypothermia or heat stroke
14.	☐	Hantavirus, Lyme Disease, Histoplasmosis, Pfiesteria, others?
15.	☐	Contaminated water with sanitary, biological, or chemical concerns
16.	☐	Immunizations
17.	☐	Laboratory or mobile laboratory. Chemical hygiene plan.
18.	☐	Hazardous waste disposal
19.	☐	Hazardous waste site operations
20.	☐	Confined space
21.	☐	Radioactivity
22.	☐	Respiratory protection
23.	☐	Scuba diving
24.	☐	Electrofishing
25.	☐	High-pressure compressed gas cylinders and their handling and transport
26.	☐	Boating: operator training, equipment, requirements, inspections
27.	☐	Special training
28.	☐	Other:

For each numbered box checked on the previous page, briefly:
A. Describe the safety concern as it relates to this project.
B. Describe how this safety concern will be addressed. Include training, safety equipment and other actions that will be required.
C. Estimate costs.

Box number	
8	8A. Improper positioning at a desk computer work station can result in permanent injuries. 8B. Work stations for all persons working on this project will be evaluated by the Project Chief and the WSC safety officer at the start of the project. Project personnel will also be informed of websites containing ergonomic safety information. Ergonomics JHA's are available for viewing in the following location: https://internal.usgs.gov/ops/safetynet/jhatemplates.html. 8C. No additional cost.

Please attach any relevant and specific Job Hazard Analyses to this form. Many useful Job Hazard Analyses are available at http://1stop.usgs.gov/safety/topic/jha/index.html.