Vermont Geological Survey's Impact on Public Issues: Geologic Mapping Applied to Hazards and Water

Presented by:
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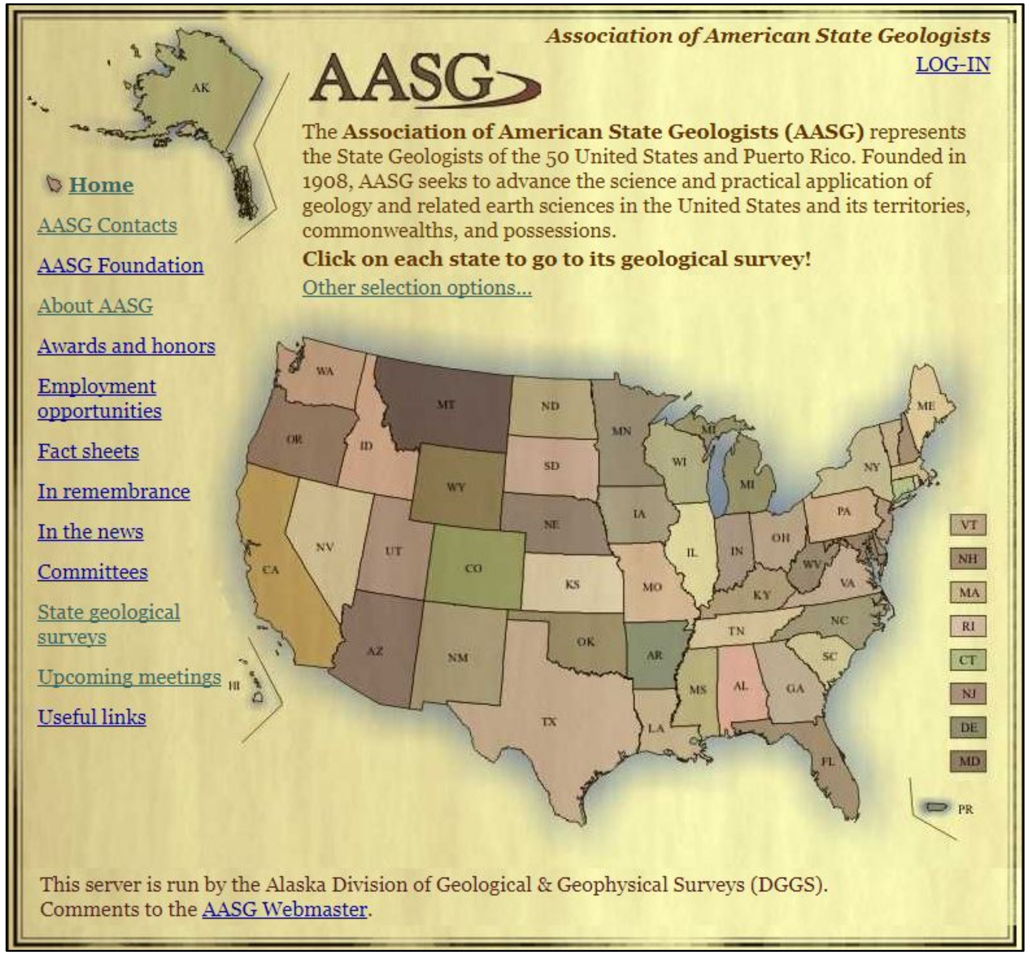
VERMONT
AGENCY OF NATURAL RESOURCES
Vermont Geological Survey



The big issues touch most states:

- Climate, Energy, Hazards, Mineral Resources, Water

State Geological Surveys:

- Source of state information
- Geologic mapping as a base for solutions

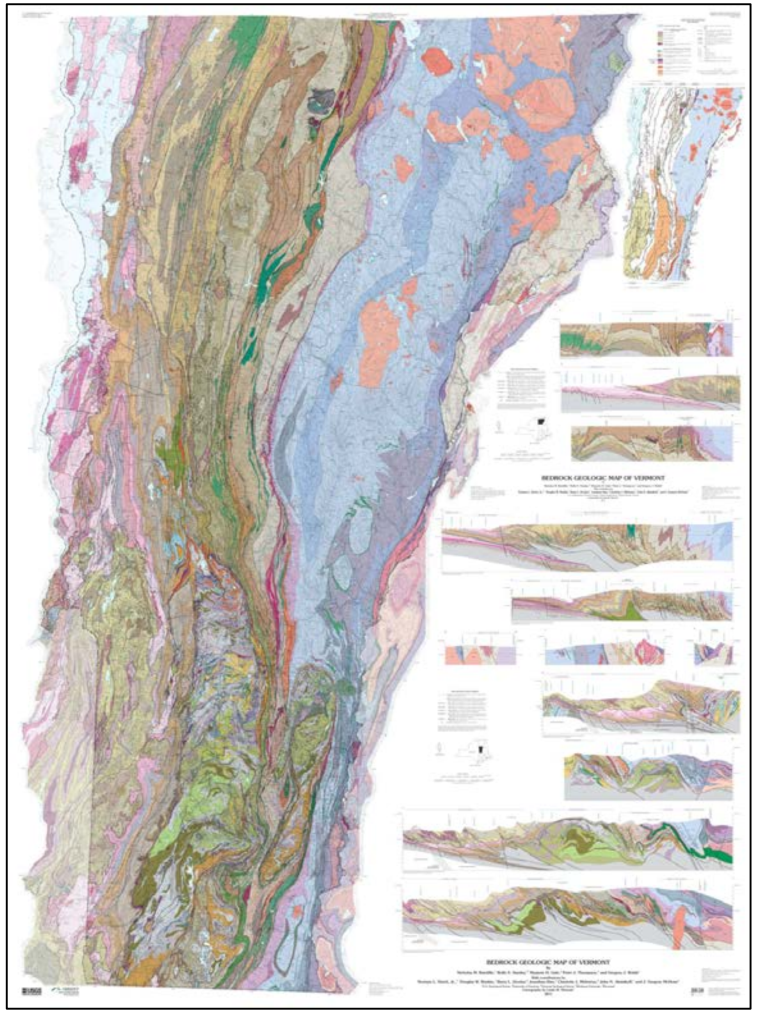
State Geological Surveys are in….

- Natural Resource Agencies
- Environmental Conservation Departments
- Universities

Making an Impact: Legislation, accessibility to and cooperation with federal partners (USGS, EPA,USFS, NGWA…), representation in member organizations (GSA, AGI)

MAPPING

Geological mapping is an essential service and the basis of our work

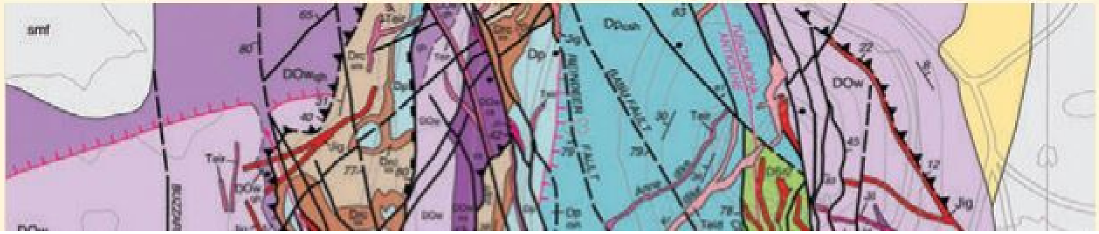


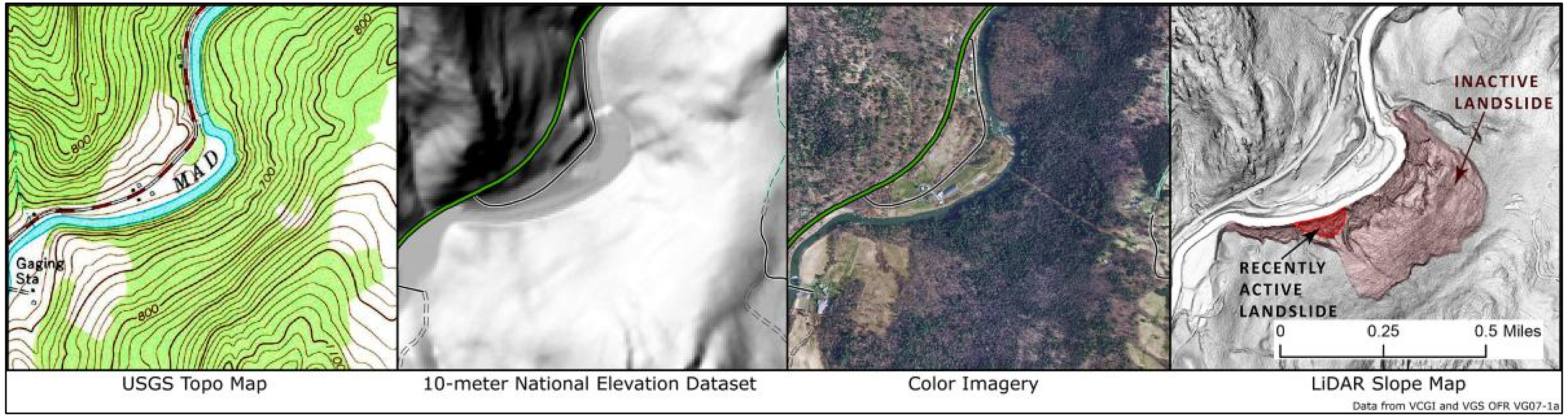
GEOLOGIC MAPPING Association of American State Geologists

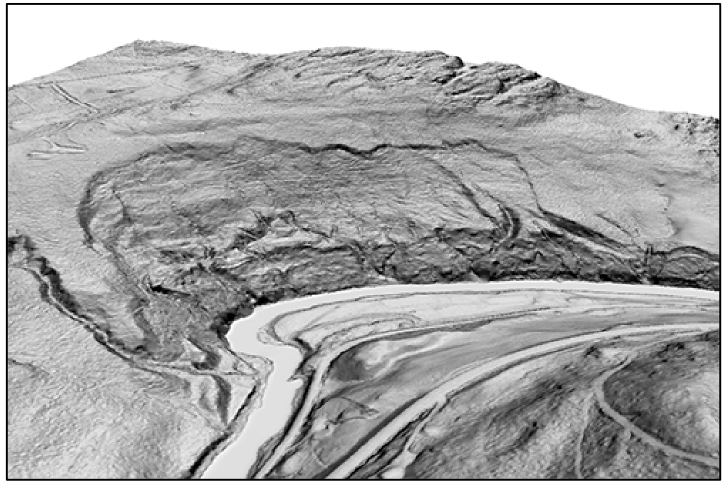
A National Vision for Geologic Mapping

AASG supports full funding of the **National Cooperative Geologic Mapping Program**. Since passage of the National Geologic Mapping Act by Congress in 1992, collaboration between the U.S. Geological Survey, State Geological Surveys, and universities has led to much new mapping and training of the next generation of qualified mapping professionals, although large areas remain unmapped geologically. Funding at the fully authorized level is vital to national efforts to ensure availability of needed geologic mapping. States and universities are capable of providing significantly more matching funds than are currently available from Federal appropriations.

AASG urges all government agencies with a stake in geologic mapping to actively support this crucial activity. The many Federal agencies that rely on geologic maps to ensure the success of their programs include **Agriculture** (Forest Service, Natural Resources Conservation Service), **Commerce** (National Oceanic and Atmospheric Administration), **Defense** (Army Corps of Engineers, military bases), **Energy** (related to applications in carbon sequestration, coal, oil and gas, geothermal, nuclear, solar, wind), **Interior** (Bureau of Indian Affairs, Bureau of Land Management, National Park Service, Bureau of Ocean Energy Management, Regulation and Enforcement, Office of Surface Mining, U.S. Geological Survey), **Homeland Security** (Federal Emergency Management Agency), **Transportation**, **Environmental Protection Agency**, **National Aeronautics and Space Administration**, **National Science Foundation**, **and others**. At State and local levels, departments of water, conservation, natural resources, emergency management, environment, health, land, parks, recreation, and transportation all need geologic maps.







We support complete topographic, geologic, and geophysical 3D mapping of the United States.
Partnership of U.S. Geological Survey with Universities, State Geological Surveys, and the private sector.

Topography (Lidar) – land surface features

Surficial materials

Bedrock

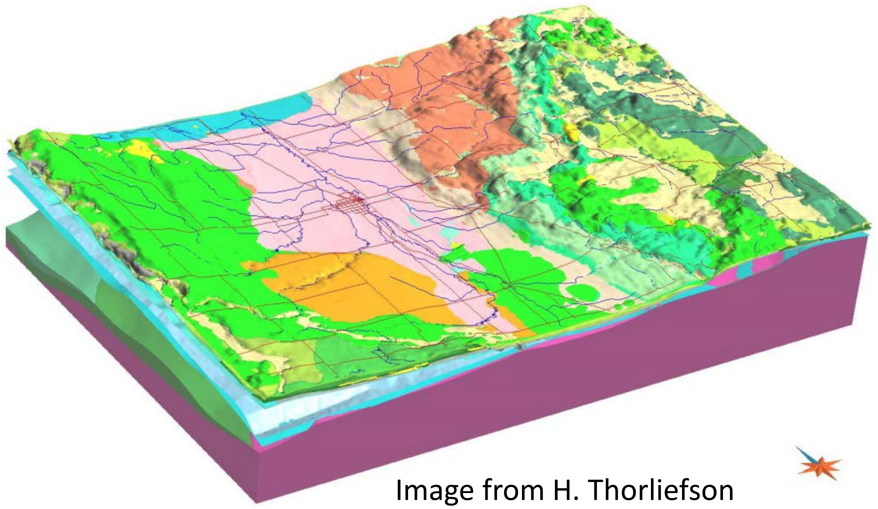
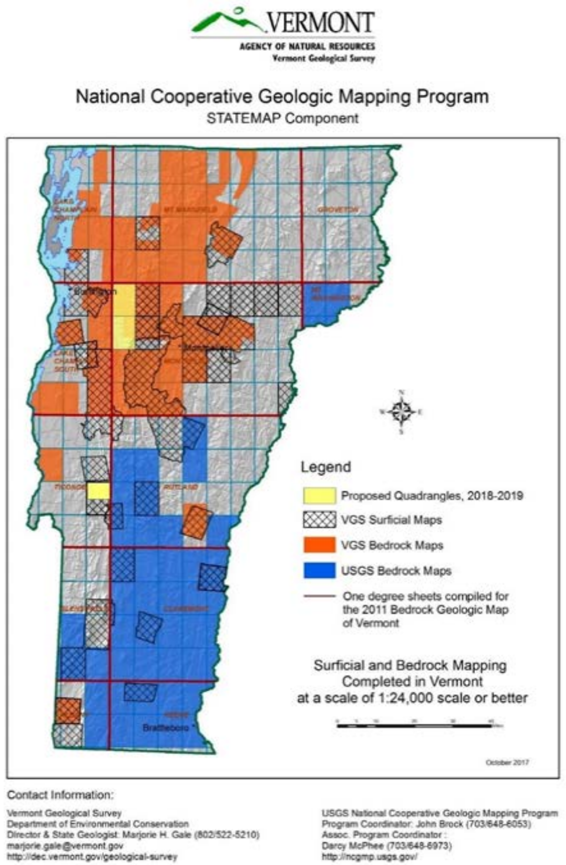
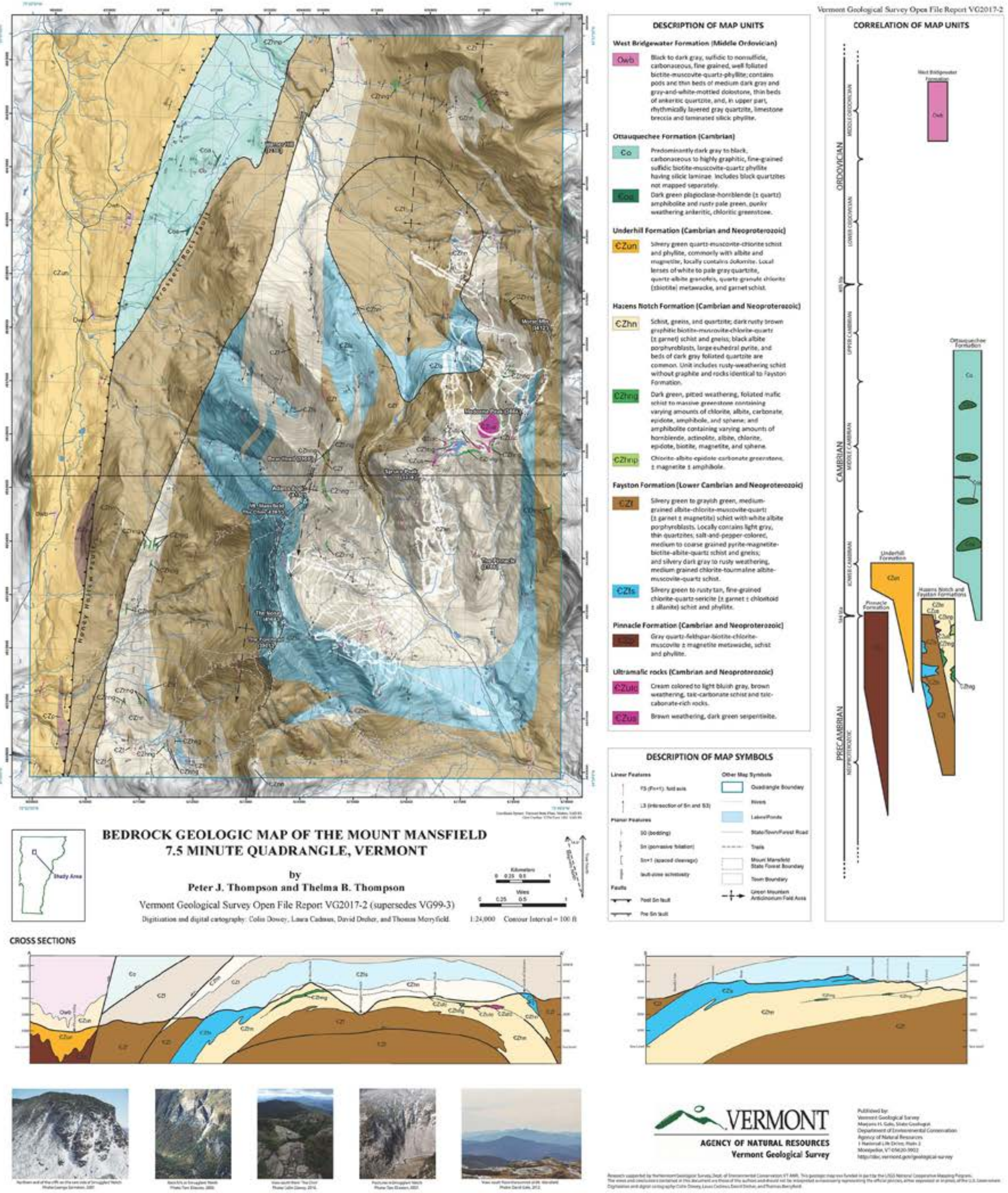
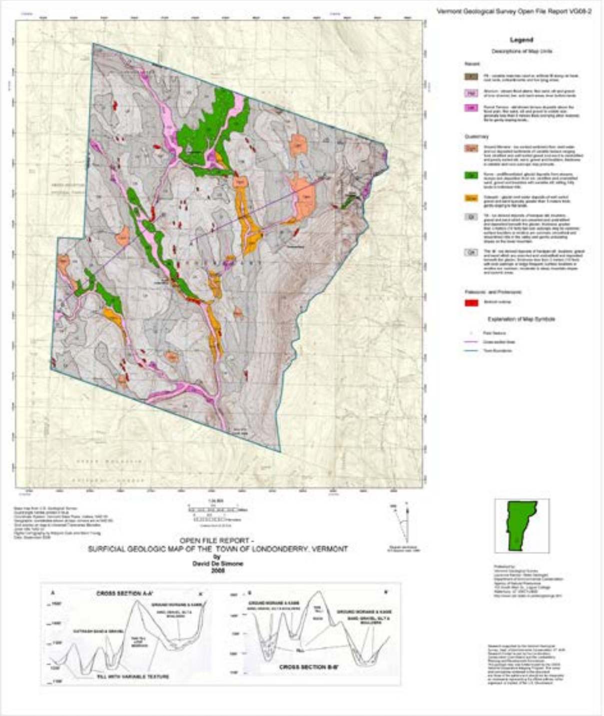


Image from H. Thorliefson







VERMONT GEOLOGICAL SURVEY, Division of Geology and Mineral Resources, VT DEC, Waterbury, VT

Vermont Geological Survey (VGS): Geologic maps applied to hazard identification, avoidance and groundwater quality and quantity.

DEPARTMENT OF ENVIRONMENTAL CONSERVATION **PERFORMANCE MEASURE**

WATER

Protect Public Health Through Aquifer Characterization

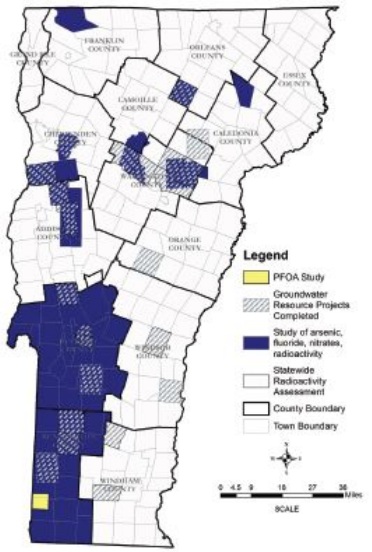
By providing essential geoscience for Vermont communities

21

Town Groundwater Projects Completed

PERFORMANCE TREND

Regions benefitting from geologic solutions



DATA ANALYSIS

Vermont's geology, characterized by deformed rock and unconsolidated glacial deposits, holds our valuable groundwater resources. Groundwater chemistry, including naturally occurring contaminants (ex. arsenic, radioactivity) is directly related to regional geology. By collecting data, interpreting the geochemistry from drinking water wells, and determining the influence of the local geologic materials, the Geologic Survey (VGS) can inform the public about potential risk.

The Division also informs understanding of groundwater contamination from non-geologic sources, like the ongoing investigation of per- and polyfluoroalkyl substance (PFAS) contamination in the state. An intense effort by staff and partners is on-going in the Bennington area to map bedrock and glacial deposits, characterize the aquifer, develop three-dimensional and temporal models, and understand the groundwater system. This type of work provides reliable advice to assist in reducing exposure to chemical and mineralogical contaminants, thereby serving to protect human health and the environment.

Another component of VGS's work is the collection and compilation of datasets used to support planning and protection of groundwater drinking supplies. Data from drilled water wells and geologic maps is used to develop aquifer favorability maps for counties and to identify priority areas for more detailed groundwater resource mapping. In 2017, with funding through a federal grant, the VGS initiated a project to upgrade datasets and evaluate statewide water use. This work will improve understanding of local groundwater recharge and water budgets and will better inform planning for drinking water supply.

VGS provides support to communities and state agencies through sampling, research and mapping. As seen in the map above, a variety of groundwater resource projects have been completed, but there is still significant work to be accomplished. Active collaboration with the Drinking Water and Groundwater Protection and Waste Management Divisions in DEC, university partners, non-profit organizations and federal partners (EPA and USGS) are key to our success.

NEXT STEPS

- Prioritize projects and document the extent of human induced contamination through well water sampling, data analyses, monitoring and field studies. This includes continuing investigative work in the Bennington area to address PFAS contamination.
- Collaborate with partners, to increase public awareness of geologic influences on groundwater to reduce exposure of Vermonters to these known hazards.
- Build statewide databases for groundwater and produce GIS maps as a planning tool for at risk public water supplies.
- Maintain funding for mapping programs and their application to groundwater resources.
- Develop water resource maps for three (3) towns in 2018-2019. These projects were identified during workshops held with partners in 2017. These workshops were targeted at learning about regional priorities and promoting groundwater protection and planning.

DATA SOURCE: Vermont Geological Survey Database

PREPARED BY: Vermont Geological Survey; dec.vermont.gov/geological-survey

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Department of Environmental Conservation

DEPARTMENT OF ENVIRONMENTAL CONSERVATION **PERFORMANCE MEASURE**

Healthy and Safe Communities

Identify Vulnerability to Geologic Hazards

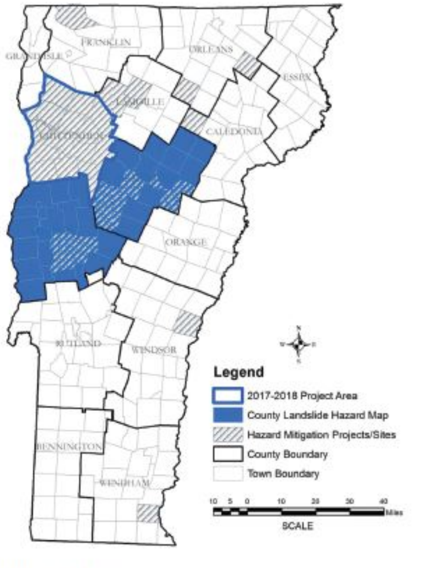
Geologic assessments of landslide, erosion, drought and seismic hazards

1

county landslide hazard map completed in 2017

PERFORMANCE TREND

Hazard mitigation sites and completed assessment projects



DATA ANALYSIS

The Vermont Geological Survey collects and interprets data about landslides, earthquakes, flood and drought to inform mitigation efforts and preparedness for these low frequency, high impact events. The Survey provides reliable, science-based information regarding frequency, magnitude, extent, and consequences of physical hazards, and when possible, hazard avoidance strategies.

A hazard map identifies areas of higher risk and is a primary tool for hazard avoidance and mitigation.

The Survey works with towns, Regional Planning Commissions, and Vermont Emergency Management to implement the landslide hazard mapping protocol. The above map shows areas where studies have been conducted, including local landslide sites and regional seismic hazard analyses. Sites of concern are often identified while mapping bedrock and glacial deposits; they are also identified through community reports and targeted hazard assessments. Mapping tools, like LIDAR and GIS, allow us to accelerate landslide hazard mapping at a planning level. In 2015 the Geological Survey began a program to provide planning-level landslide hazard maps for Vermont counties, completing Addison County in 2016 and Washington County in 2017. The maps help Vermont prepare for safer growth and development, develop mitigation and hazard avoidance strategies, avoid economic loss, and be prepared to respond to events.

By identifying regions sensitive to physical hazards and utilizing a scientific assessment to characterize the risks, the Survey provides a tool to protect Vermonters in vulnerable areas and guide land use planning. Communication of physical hazards and avoidance is facilitated through our hazards web pages which include a new on-line Report a Landslide feature in which the public can add to our landslide inventory. Information developed for landslides, earthquakes, flood and drought contributes to mitigation and preparedness for these low frequency, high impact events.

NEXT STEPS

- In partnership with the Central Vermont Regional Planning Commission and Norwich University, assess the hazard and produce a landslide hazard susceptibility map for Chittenden County.
- Evaluate LIDAR availability and begin planning for mapping of the fourth (4th) county in the state.
- Respond to and monitor landslide and rockfall events.
- Conduct surficial geologic mapping and identify areas prone to erosion and landslides.
- Conduct regional groundwater studies for drought resiliency and response.
- Continue coordination with Vermont Emergency Management, the Northeast States Emergency Consortium (NESEC), Regional Planning Commissions and universities to create hazard mitigation information.

DATA SOURCE: Vermont Geological Survey Database

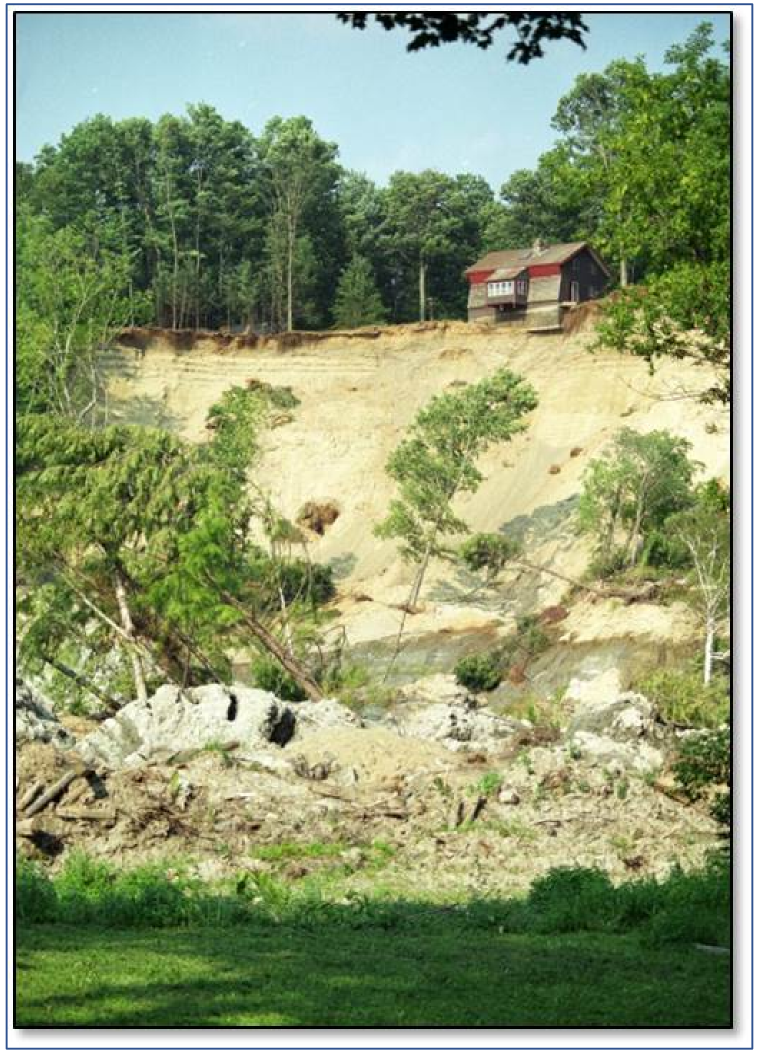
PREPARED BY: Vermont Geological Survey; dec.vermont.gov/geological-survey

VERMONT
AGENCY OF NATURAL RESOURCES
Department of Environmental Conservation

Response to Events
A site by site approach, 1999-

Develop protocol for mapping the hazard, 2004-

Adopt protocol and include in Vermont's Hazard Mitigation Plan, 2012



Vermont Geological Survey (VT DEC) in partnership with Norwich University, Green Mountain College, UVM, Vermont RPC, & VT DPS

Problem: Landslides occur throughout the State and pose risks to human safety, property, water quality and the environment.

The sites include rockfalls in high traffic areas such as Montpelier and Smugglers Notch, erosion of roads, landslides above and below precariously placed buildings, and unstable slopes along rivers. Traditional mapping can address site specific hazards but requires considerable time. People do not intuitively notice these features.

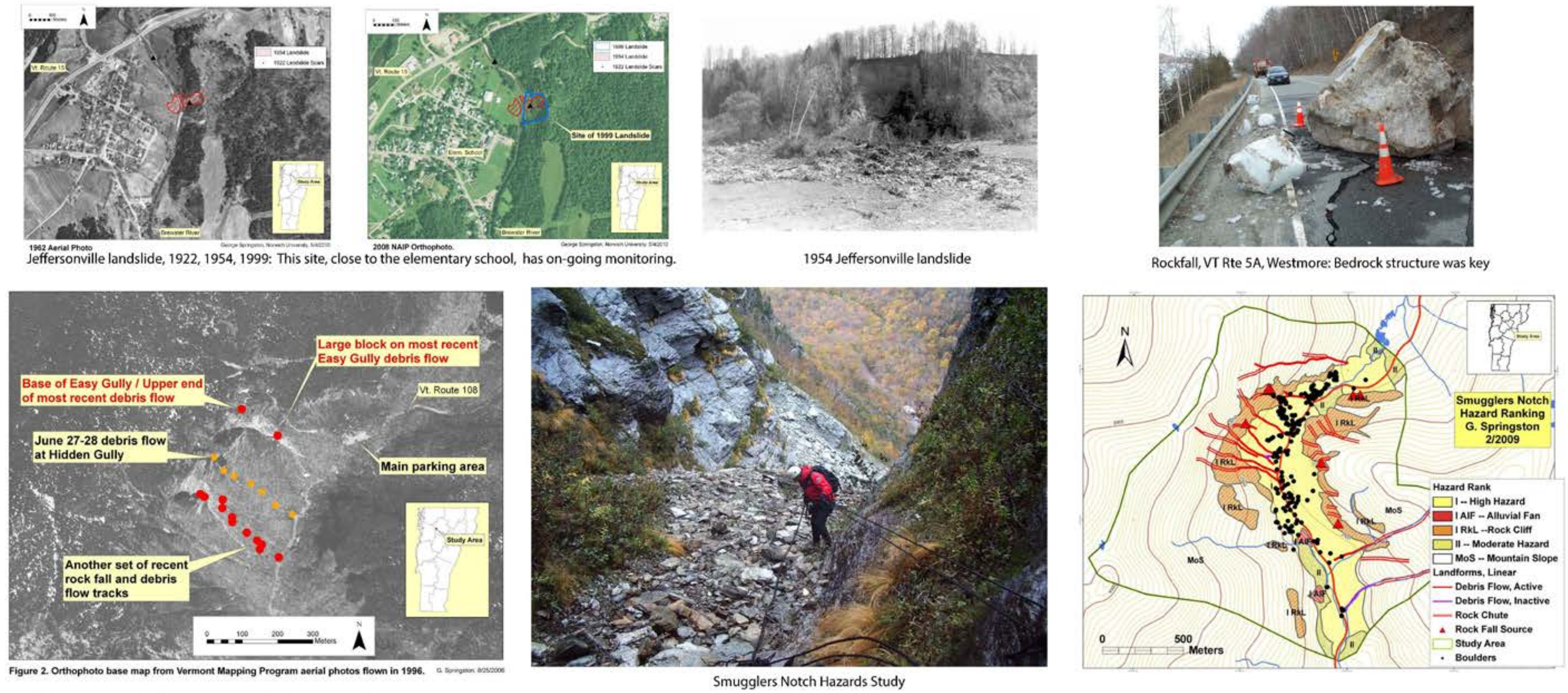
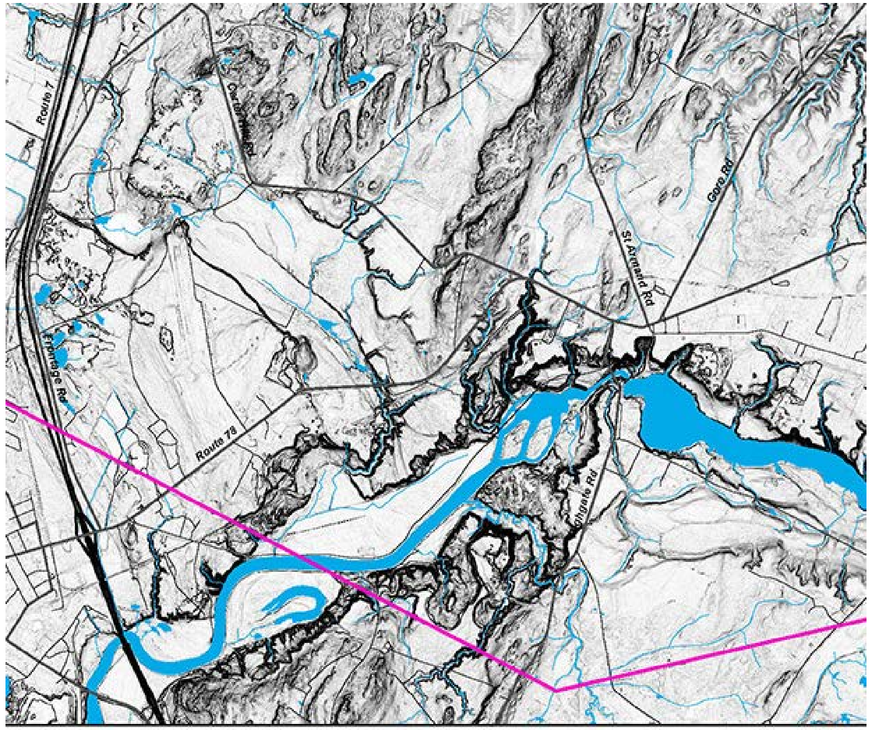


FIGURE 5. LANDSLIDES AND ROCKFALLS Steepness of slope, type of materials and their structures, and previous occurrences contribute to understanding landslide and rockfall hazards.



Slope Map of the Town of Highgate, Vermont

ACCELERATED SOLUTIONS :

- Complete Phase One assessments by county to help all Vermont towns understand susceptibility and plan for avoidance or mitigation.
- Lidar and GIS are tools which allow us to identify historic and current sites
- Crowd-source a landslide hazard locator to facilitate locating landslides
- Prioritize higher risk area and town needs

Final Report Summarizing the Efficacy of GIS-Based Modeling of Landslide Susceptibility Addison County, Vermont

John G. Van Hoesen, Olivia Anderson and Joshua Duncan
Green Mountain College
Department of Environmental Studies
Poultney, Vermont 05764

Vermont Geological Survey Open File Report VG2017-7

Landslide Inventory of Washington County, Central Vermont

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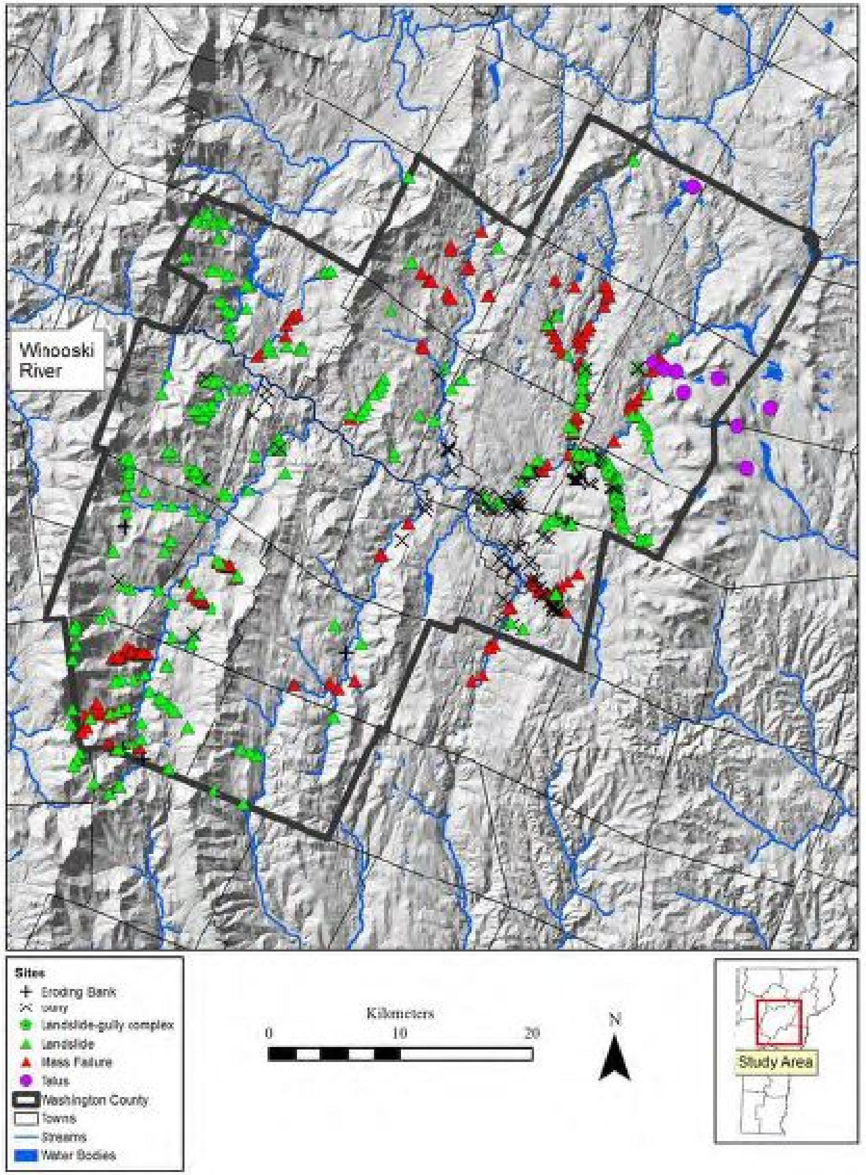
gsprings@norwich.edu

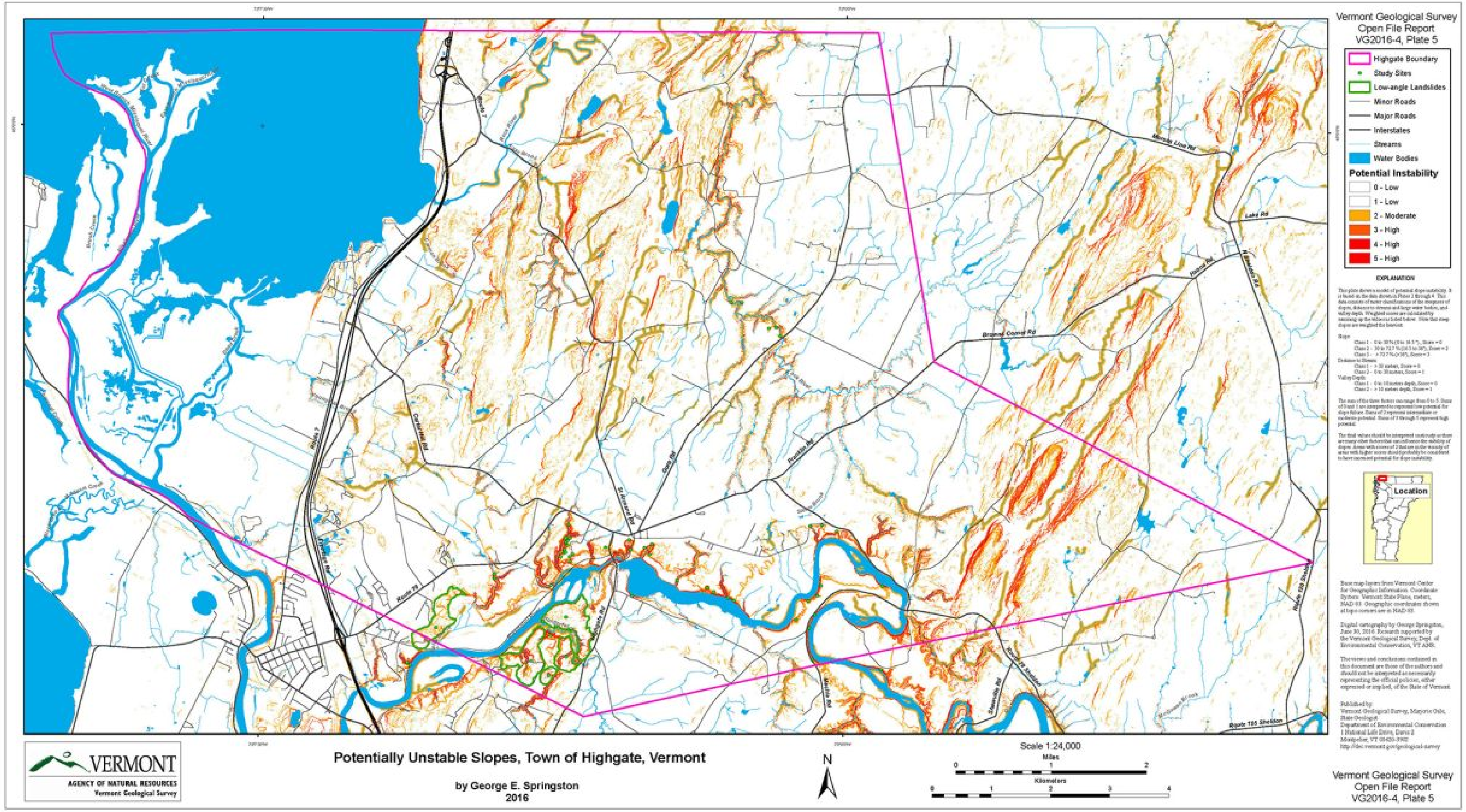


Addison County (2016)

Washington County (2017)
Chittenden County (2018)

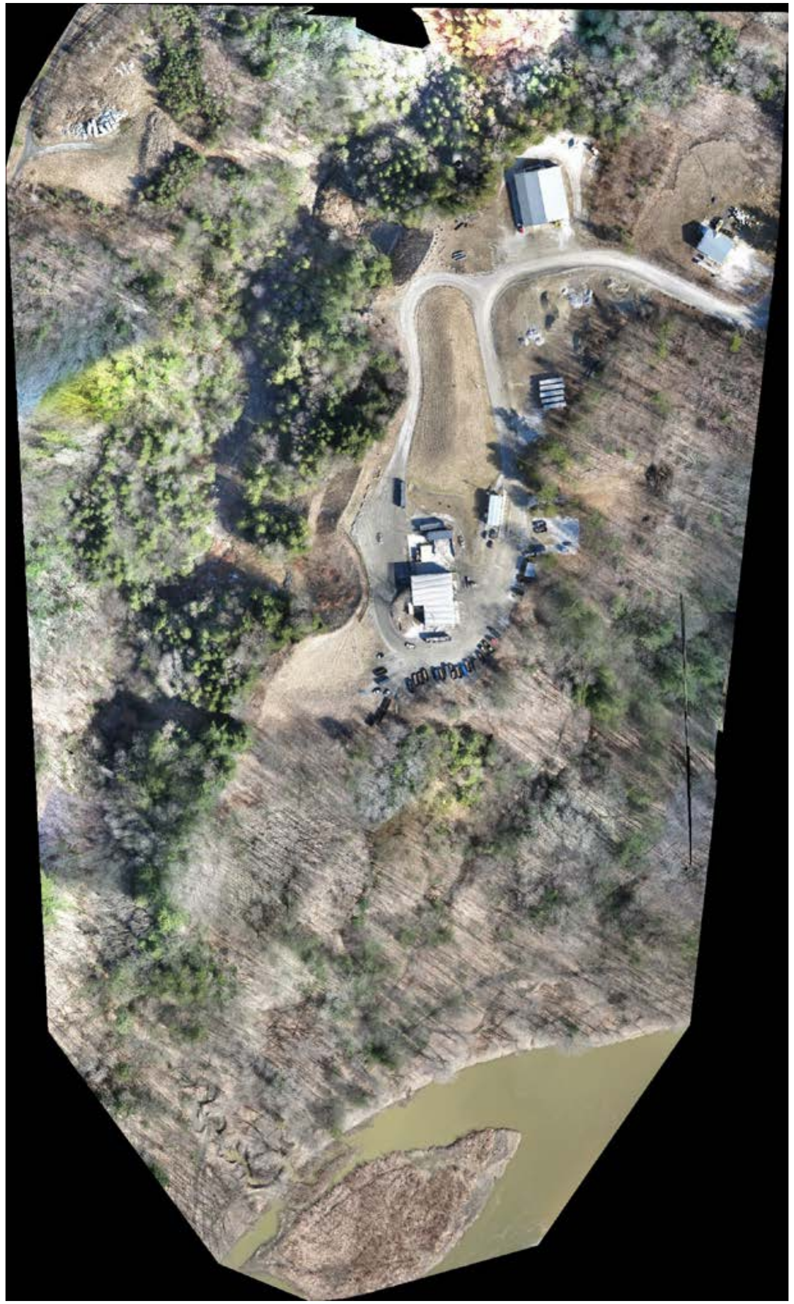
Lidar, GIS and county plan Planning and actionable level maps within a reasonable time (2022)

Vermont Geological Survey (VT DEC), in partnership with Norwich University, Green Mountain College, UVM, Vermont RPCs, & VT DPS



Town Map and reports for planning and prioritizing mitigation

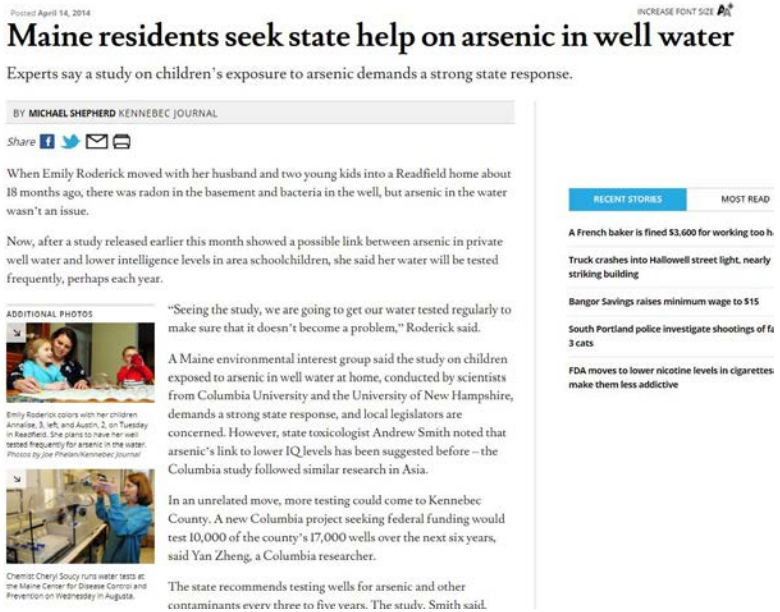
Some causes of landslides: Saturation of soil, Stream erosion causing over-steepening of banks, Reduction in strength of materials due to physical and chemical weathering, Addition of excess load onto slopes, usually from human activity. Land use contribution.



What is needed in order to have an impact?

- Communication of risk
- RPCs integrate data in regional planning
- Town Hazard Mitigation Plans
- Buffers, setbacks, buyouts
- Regulation


06/25/2005

Posted April 14, 2014

INCREASE FONT SIZE

Maine residents seek state help on arsenic in well water

Experts say a study on children's exposure to arsenic demands a strong state response.

BY MICHAEL SHEPHERD KENNEBEC JOURNAL

Share

When Emily Roderick moved with her husband and two young kids into a Readfield home about 18 months ago, there was radon in the basement and bacteria in the well, but arsenic in the water wasn't an issue.

Now, after a study released earlier this month showed a possible link between arsenic in private well water and lower intelligence levels in area schoolchildren, she said her water will be tested frequently, perhaps each year.

ADDITIONAL PHOTOS

Emily Roderick colors with her children Annalise, 3, left, and Austin, 2, on Tuesday in Readfield. She plans to have her well tested frequently for arsenic in the water. Photos by Joe Phelan/Kennebec Journal

Chemist Cheryl Soucy runs water tests at the Maine Center for Disease Control and Prevention on Wednesday in Augusta.

"Seeing the study, we are going to get our water tested regularly to make sure that it doesn't become a problem," Roderick said.

A Maine environmental interest group said the study on children exposed to arsenic in well water at home, conducted by scientists from Columbia University and the University of New Hampshire, demands a strong state response, and local legislators are concerned. However, state toxicologist Andrew Smith noted that arsenic's link to lower IQ levels has been suggested before – the Columbia study followed similar research in Asia.

In an unrelated move, more testing could come to Kennebec County. A new Columbia project seeking federal funding would test 10,000 of the county's 17,000 wells over the next six years, said Yan Zheng, a Columbia researcher.

The state recommends testing wells for arsenic and other contaminants every three to five years. The study, Smith said,

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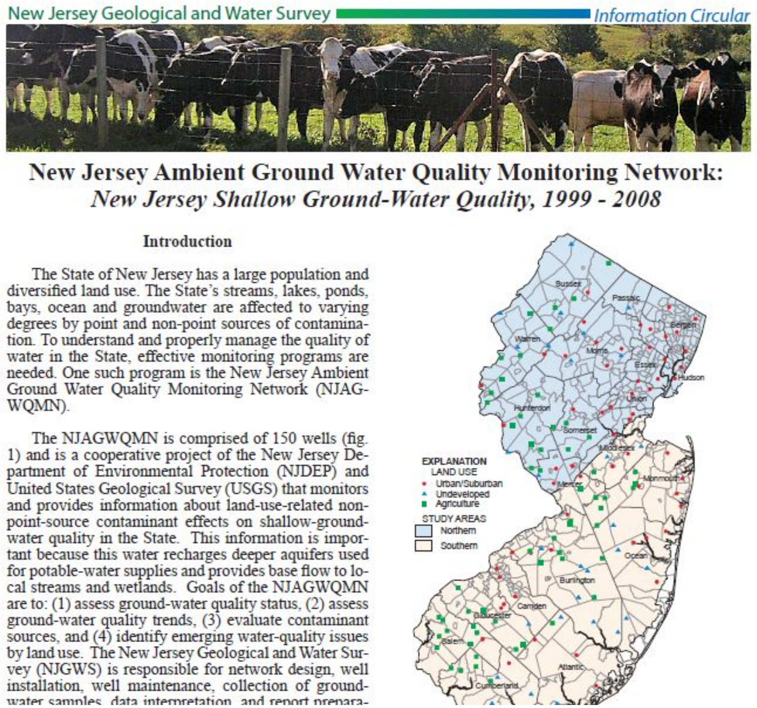
A French baker is fined $3,600 for working too h

Truck crashes into Hallowell street light, nearly striking building

Bangor Savings raises minimum wage to $15

South Portland police investigate shootings of fa 3 cats

FDA moves to lower nicotine levels in cigarettes make them less addictive



New Jersey Geological and Water Survey — Information Circular

New Jersey Ambient Ground Water Quality Monitoring Network: *New Jersey Shallow Ground-Water Quality, 1999 - 2008*

Introduction

The State of New Jersey has a large population and diversified land use. The State's streams, lakes, ponds, bays, ocean and groundwater are affected to varying degrees by point and non-point sources of contamination. To understand and properly manage the quality of water in the State, effective monitoring programs are needed. One such program is the New Jersey Ambient Ground Water Quality Monitoring Network (NJAGWQMN).

The NJAGWQMN is comprised of 150 wells (fig. 1) and is a cooperative project of the New Jersey Department of Environmental Protection (NJDEP) and United States Geological Survey (USGS) that monitors and provides information about land-use-related non-point-source contaminant effects on shallow-ground-water quality in the State. This information is important because this water recharges deeper aquifers used for potable-water supplies and provides base flow to local streams and wetlands. Goals of the NJAGWQMN are to: (1) assess ground-water quality status, (2) assess ground-water quality trends, (3) evaluate contaminant sources, and (4) identify emerging water-quality issues by land use. The New Jersey Geological and Water Survey (NJGWS) is responsible for network design, well installation, well maintenance, collection of ground-water samples, data interpretation, and report prepara-

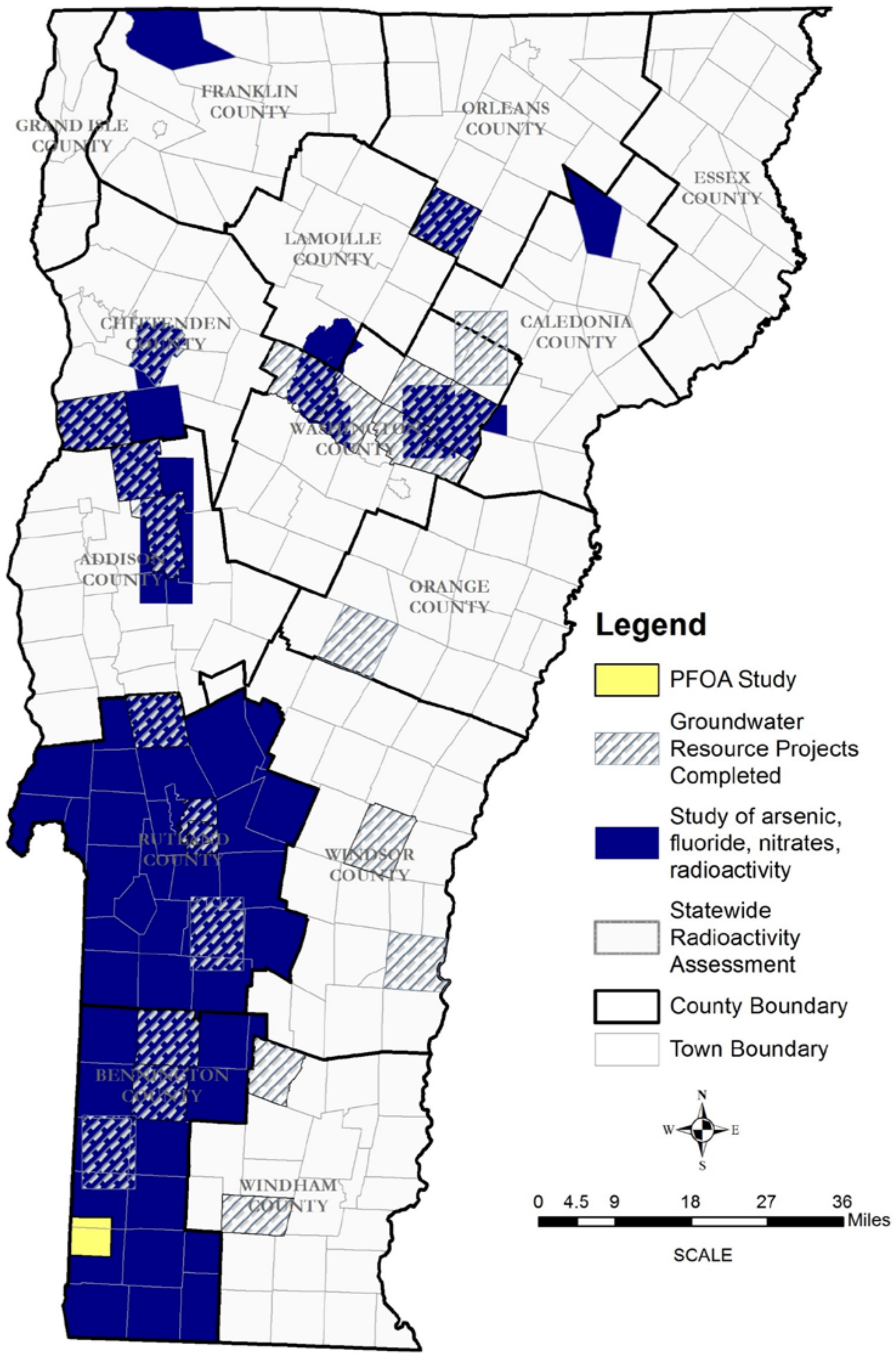
WATER

Groundwater

McNamara Spring, Dorset

Disappearing stream

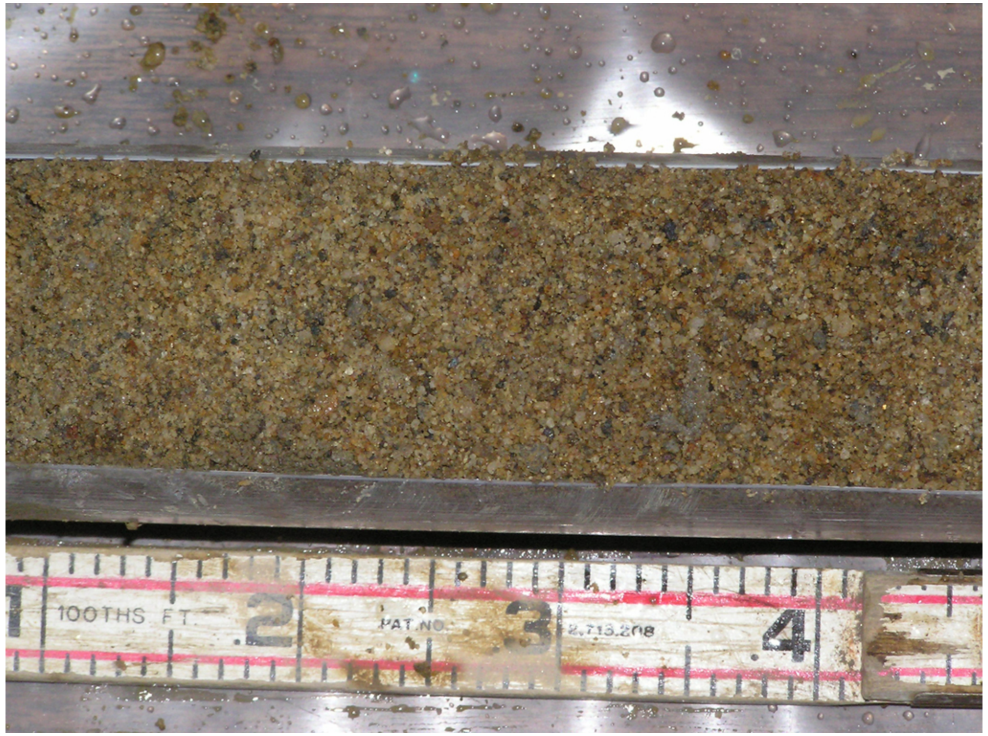
- Where does our water come from and go to?
- How much water do we have?
- Is the water safe (arsenic, radioactivity, manganese…)?
- Can my town support areas of more intense development?
- What are the anticipated depths and yields in my area? Helps with a cost estimate



Town Resource Maps

- Surficial and Bedrock Geology
- Locate Water Well Data
- Depth to Bedrock
- Flow Directions – Generalized
- Hydrogeologic Units – Bedrock
- Recharge Potential
- Favorable areas for new supply
- Plan, Map, Test, Protect

Impact: Avoid Nowater Town -
Town allocated over 100% of its permitted water supply



Consequences

Issued a “no expansion” moratorium
Stalled development
Jeopardized fire fighting capacity

Unexpected and increased costs
Lengthy process to find new source
Land acquisition
Permits

Groundwater Quality

Identify water quality issues and possible solutions to avoid or mitigate: salt, nitrates, arsenic, other naturally occurring and manmade contaminants/byproducts.

Source, fate, transport and impact on human and environmental health

Denitrification and dilution along fracture flowpaths influence the recovery of a bedrock aquifer from nitrate contamination

Jonathan J. Kim [a], Jeff Comstock [b], Peter Ryan [c], Craig Heindel [d], Stephan Koenigsberger [c]

Show more

https://doi.org/10.1016/j.scitotenv.2016.06.091

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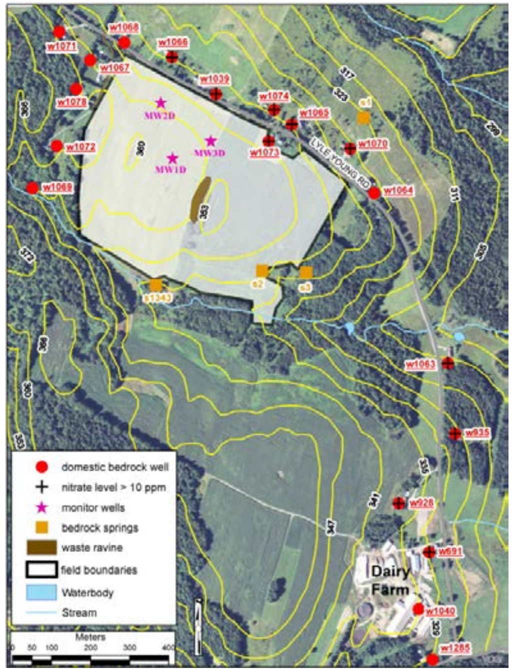
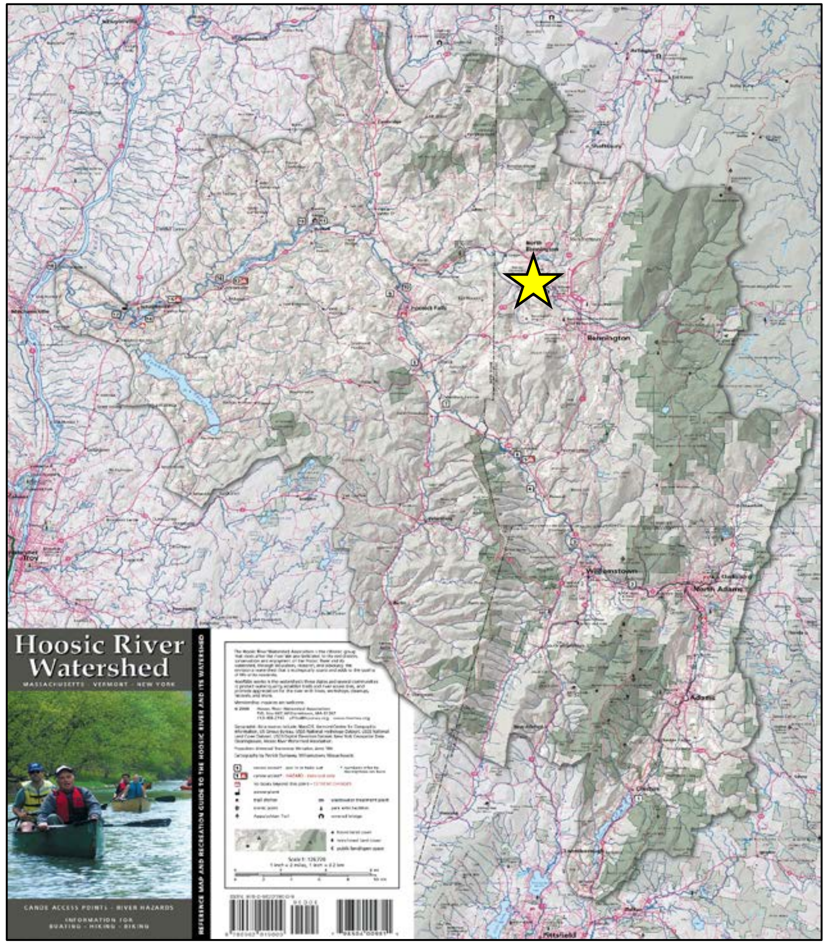
Highlights

- Bedrock wells contaminated with nitrates at a dairy farm in Vermont, U.S.A.
- Nitrate concentration vs. time patterns for wells were spatially separable.
- Multidisciplinary aquifer characterization used physical and chemical methods.
- Denitrification dominant over dilution along fracture flowpaths
- Conceptual model shows exhaustion of a nitrate point-source over 12 years.



Impact: Reduce exposure to contaminants

Problem: PFOA contamination of groundwater in fractured bedrock (2016)



Basemap: Hoosic River Watershed Association

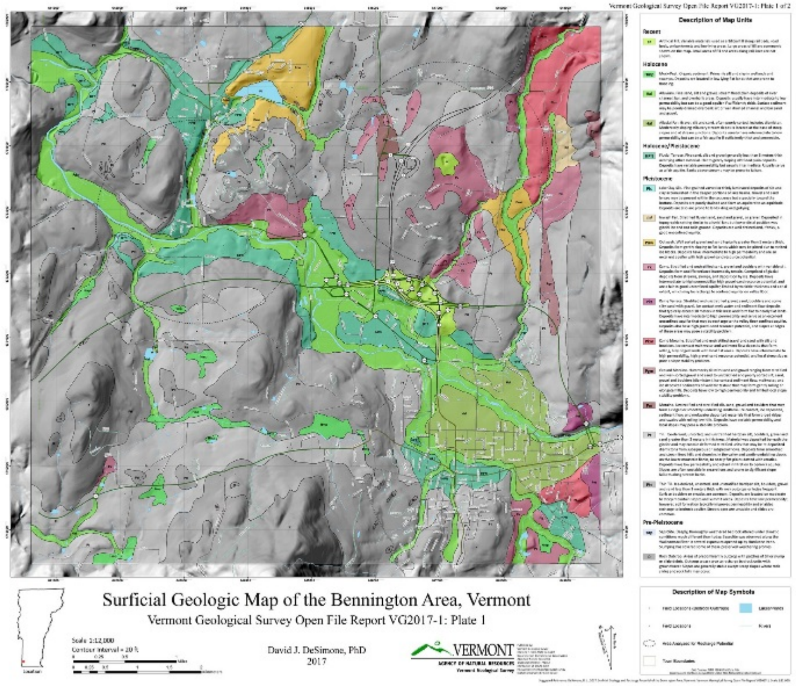
ChemFab: 1978-2002

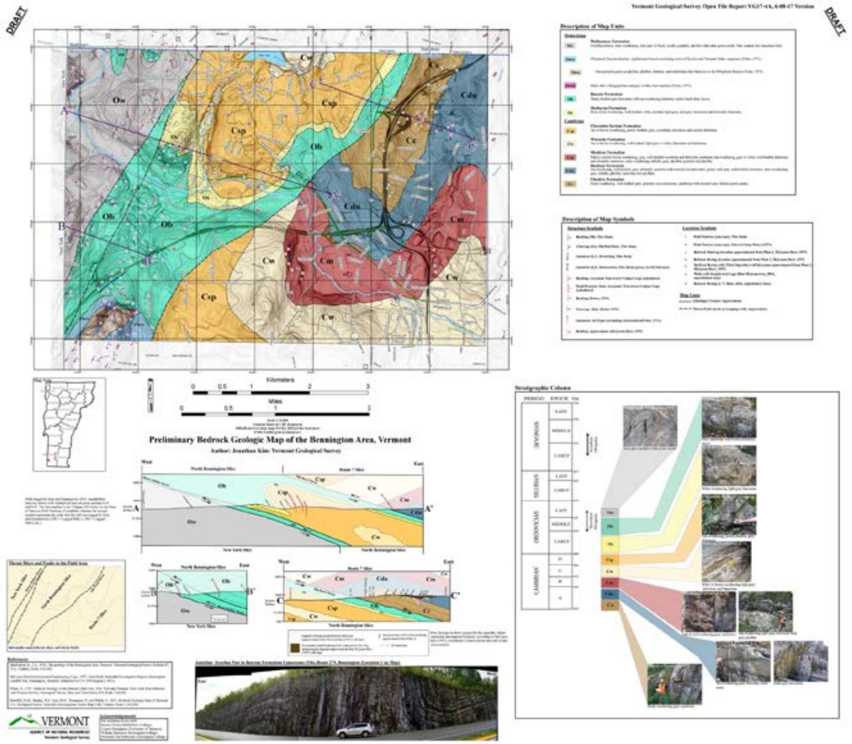
- Non-stick cookware (ex. Teflon) production
- Electronics coatings
- Stain-resistant and water-resistant fabrics/carpet
- Fire fighting foam, Food packaging, paper coatings

49% of the 556 wells sampled were above the VDH Health Advisory of 20 ppt.

Perfluorooctanoic Acid (PFOA) also known as C8: $C_8HF_{15}O_2$
Perfluorooctane sulfonate (PFOS): $C_8HF_{17}O_3$

- Geologic Mapping of bedrock and surficial materials
- Data in relation to geographic location – GIS
- Data integration
- 3D understanding of subsurface and aquifer characterization
- What is it, where is it, where is it going



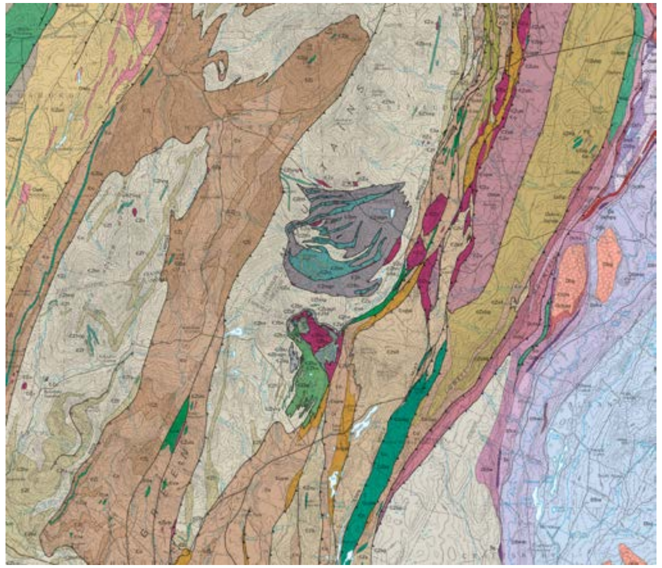


Impacts:

Daily lives - health of family, property values, businesses, gardens, animals, agriculture, maple syrup, milk, fish….

Economic: multi-million dollar infrastructure projects, financial settlements, engineering design and water projects

Find solutions to key problems at national, regional and local scales.



THANK YOU

Position Statement

The Association of American State Geologists urges Federal, State, and local governments and the private sector to reduce risks from geologic and seismic hazards in vulnerable areas by assessing the hazards and taking constructive actions to minimize the consequences of future damaging events.

Background

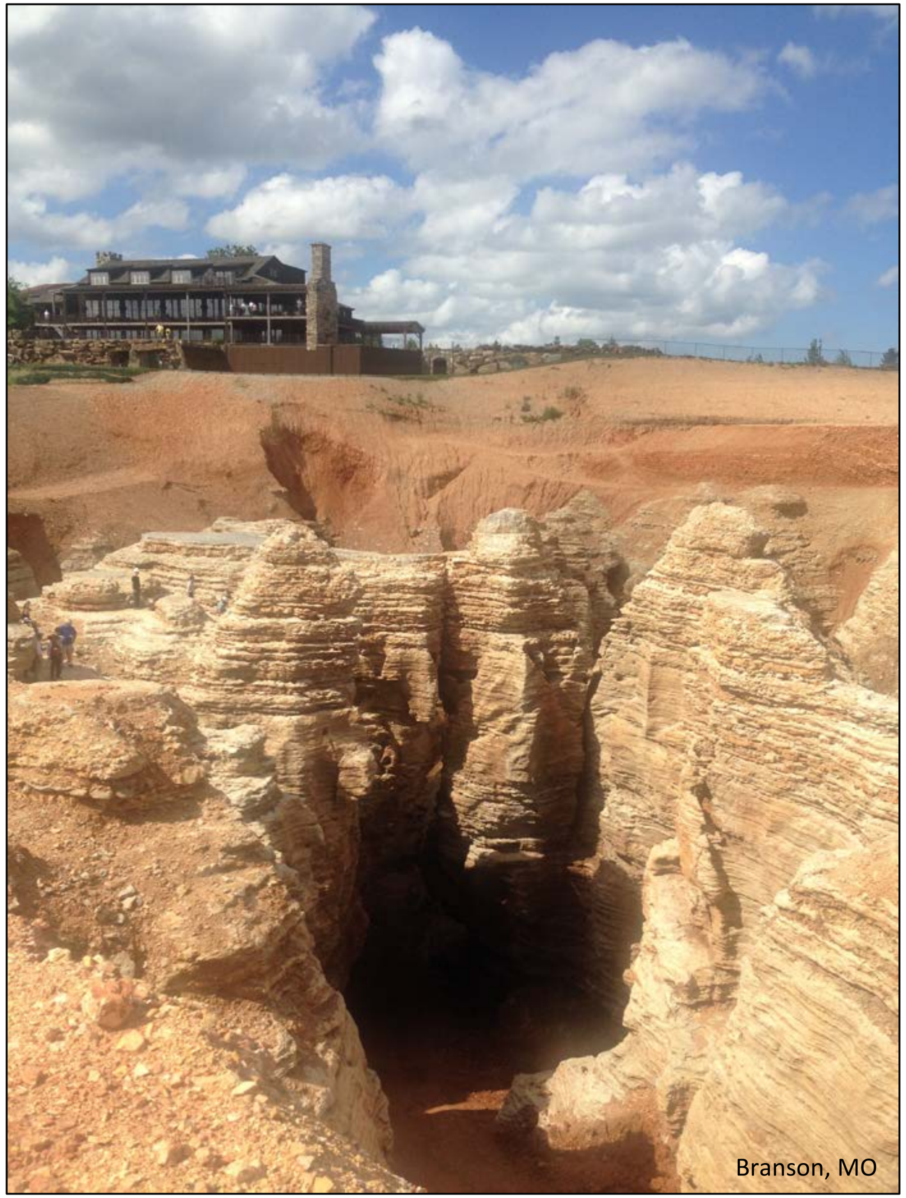
Most natural hazards either are geologic in character or have a significant geologic component, and many anthropogenic hazards have geologic aspects. Landslides (including debris flows, mudslides, and rock falls), earthquakes, tsunamis, volcanoes, swelling and collapsing soils, floods, erosion, sinkholes, and avalanches are examples of hazards that can have both local and regional effects. Dams that fail, abandoned mines that collapse, and ground that subsides because of excessive pumping of water from aquifers are examples of anthropogenic hazards for which geologic information is vital in risk reduction.

Geologic investigations assist in our understanding of natural processes that create hazards and can extend our knowledge of past events beyond the brief time for which direct human observations are available. This work is critical in assessing the extent, severity, and likelihood of future events. Wildfires can create conditions that intensify the potential for damage from debris flows and excessive erosion in burned-over areas. Hurricanes, floods, and tsunamis leave traces of their destruction in the geologic record (through both erosion and sediment deosition), thereby allowing asess-ment of long-term risk. These insights can facilitate risk reduction through opportunities to limit damage and loss of life through the design and placement of future structures. State Geological Surveys and the U.S. Geological Survey (USGS) play vital advisory roles in such loss-reduction activities. They also aid others in identifying the vulnerability associated with existing structures, which is necessary to facilitate cost-effective mitigation. Maps depicting site response to ground shaking provide essential background information for establishing building codes and defining mitigation strategies. The stakes are high because these hazards collectively cause tens of billions of dollars of physical damage and economic loss each year in the United States. Fortunately much can be done to lower the risks and reduce future damage. Preparing for inevitable natural hazards can also provide insight into mitigating acts of terrorism through understanding the structural vulnerabilities of buildings, bridges, and other manufactured structures.

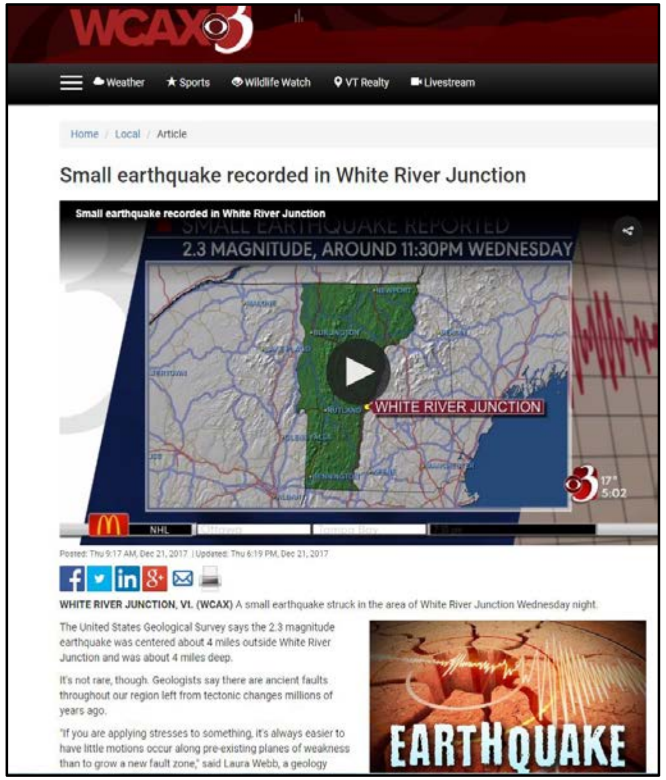
Top, Fire in San Francisco, California, after 1989 Loma Prieta (World Series) earthquake. **Bottom**, Damage to unreinforced masonry building from 1994 Northridge, California, earthquake. Photos courtesy Karl V. Steinbrugge Collection, University of California, Berkeley, Earthquake Engineering Research Center.

Debris flow in Olokele Canyon, Kauai, 1980. Photo courtesy U.S. Geological Survey Water Resources Discipline.

Eden, VT



Branson, MO



Small earthquake recorded in White River Junction

Posted: Thu 9:17 AM, Dec 21, 2017 | Updated: Thu 6:19 PM, Dec 21, 2017

WHITE RIVER JUNCTION, VI. (WCAX) A small earthquake struck in the area of White River Junction Wednesday night.

The United States Geological Survey says the 2.3 magnitude earthquake was centered about 4 miles outside White River Junction and was about 4 miles deep.

It's not rare, though. Geologists say there are ancient faults throughout our region left from tectonic changes millions of years ago.

"If you are applying stresses to something, it's always easier to have little motions occur along pre-existing planes of weakness than to grow a new fault zone," said Laura Webb, a geology

NATURAL HAZARDS IN VERMONT

FEMA statistics for Vermont

- 21 severe storm disaster declarations since 1953[7]
- 2 hurricane/tropical storm disaster declarations since 1953[7]
- 15 flooding disaster declarations since 1953[7]
- $26 million: individual assistance grants since 2005[7]
- $52 million: mitigation grants since 2005[7]
- $110 million: preparedness grants since 2005[7]
- $270 million: public assistance grants since 2005[7]
- 16 weather and/or climate events, each with costs exceeding $1 billion (inflation adjusted) 1980-2016[8]