Geohazards in Nova Scotia – An Overview of Program Activities for January 2016 to March 2017

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Introduction

There are several naturally occurring geohazards in Nova Scotia that can pose a risk to human health, infrastructure and the environment. Examples include radon gas in indoor air, arsenic and uranium in well water, karst terrain and acid rock drainage. The Nova Scotia Department of Natural Resource's (DNR) geohazard work focuses on identifying and mapping these hazards to ensure they are understood and mitigated through public education and land-use planning. Selected activities undertaken within DNR's Geohazard Program for the period from January 1, 2016 to March 31, 2017 are highlighted below.

Radon in Indoor Air

Radon gas occurs naturally in soil and rock, and it can migrate through cracks and openings in foundations and accumulate inside a home. Radon in indoor air is the leading cause of lung cancer after smoking. Health Canada (2015) estimates that radon causes more than 3,000 deaths in each year in Canada. In Nova Scotia, it is estimated that 11% of homes exceed the indoor air radon guideline and that more than 100 people die each year due to radon exposure (CAREX Canada, 2016).

In 2016, DNR's radon work focused on the provincial radon risk map, the provincial radon database, and public awareness about radon. Specific activities included organizing and participating in a radon workshop in Halifax in May 2016; providing support for a project at Dalhousie University to improve the provincial radon risk map; and participating on the Atlantic Radon Task Force, a group that collaborates to reduce radon exposure in Atlantic Canada (members include DNR, Health Canada, The Lung Association and Acadia University).

The 2016 radon workshop, titled "Radon Exposure in Nova Scotia: Challenges and Solutions," was held on May 26 in Halifax. It was co-hosted by DNR, Nova Scotia Environment, CAREX Canada, Health Canada, the Canadian Association of Radon Scientists and Technologists (CARST) and the Canadian National Radon Proficiency Program (C-NRPP). The workshop was an opportunity for attendees to connect with others interested in radon across multiple jurisdictions and discuss strategies for reducing exposures in Nova Scotia. The event was attended by approximately 50 people, including geoscientists, radon contractors, researchers, public health practitioners, occupational health and safety officers, epidemiologists, building engineers, home inspectors, non-government organizations and educators. The agenda included 12 speakers followed by a panel discussion. A broad range of topics were covered, including federal radon regulations and guidelines, results from cross-Canada and provincial radon-testing programs, radon mapping in Nova Scotia, and workplace exposures. Attendees also discussed home inspections and real estate transactions, professional training programs, and education and outreach strategies. For further information, please see the workshop report (CAREX Canada, 2016) and workshop presentations (Canadian Association of Radon Scientists and Technologists, 2016).

Results from the Dalhousie University radon-mapping project were presented at the Canadian Association of Geographers Conference in Halifax in June 2016. For further details, please see the presentation abstract (Bennett et al., 2016).

For further information about radon in Nova Scotia, please visit DNR's interactive radon map which includes links to information on how to purchase test kits and how to find certified radon contractors for radon mitigation work (Nova Scotia Department of Natural Resources, 2017).

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Arsenic in Well Water

Arsenic is a Class I human carcinogen and is considered the most prevalent naturally occurring groundwater contaminant in the province. Exceedance rates of the Health Canada maximum acceptable concentration of 10 micrograms of arsenic per litre in drinking water are generally around 12% for drilled wells (bedrock aquifers) across Nova Scotia, although much higher exceedance rates (>50%) have been reported in some communities using private wells. Most of these communities are in Halifax, Hants and Lunenburg counties (Kennedy and Drage, 2016).

A project was initiated in 2015 to expand our knowledge of the occurrence and mobility of arsenic in groundwater and to produce an arsenic risk map for well owners. An open file report, titled *A Review of Activities Related to the Occurrence of Arsenic in Nova Scotia Well Water* (Kennedy and Drage, 2016), was released by the Geoscience and Mines Branch in 2016. Four decades of activities conducted by the Province related to the assessment and mitigation of arsenic in well water are summarized in the report. In 2016, DNR work focused on developing linkages between arsenic in well water and various bedrock types in Nova Scotia. A second open file report and a refined risk map were developed during 2016 and are planned for release in 2017.

Uranium Mobility in Groundwater

Uranium is the second most common naturally occurring chemical contaminant in Nova Scotia well water. It is estimated that 4% of private wells across the province exceed the uranium drinking water guideline (Kennedy and Finlayson-Bourque, 2011). In 2013, DNR completed a project that looked at the mobilization of uranium in groundwater due to the influence of dissolved calcium (Drage and Kennedy, 2013). In 2015, a follow up project was initiated to develop a laboratory leachate test for evaluating the leachability of uranium in the presence of calcium.

The purpose of the 2015 project was to develop a tool for identifying sites where bedrock may release naturally occurring uranium into groundwater if calcium infiltrates into the ground. Examples of possible land-use activities that can potentially add calcium to groundwater include construction and demolition waste-handling sites (where wallboard waste is present) and agricultural operations where gypsum is used as a soil additive. Drill core samples from the DNR Core Library and outcrop samples from selected bedrock types were subjected to a series of leachate tests using variable pH, calcium, sulphate, bicarbonate and chloride levels. The project was a collaboration between DNR, Nova Scotia Environment and Dalhousie University. The work was completed in 2016 as an M.Sc. research project, and the results were published in a thesis in July 2016 (Letman, 2016). A journal paper based on the thesis has been submitted for publication.

Historical Gold Mine Tailings

Between the 1860s and the 1940s, gold mining in Nova Scotia produced more than three million tonnes of tailings at 64 historical gold-mining districts. During this period, no environmental regulations were in place and tailings were commonly discharged into streams, ponds, rivers, wetlands and surface depressions. This resulted in the formation of tailing deposits with high concentrations of arsenic, mercury and other metals. Recent land-use changes near historical mine sites, such as residential development, recreational development and shell fish harvesting, have raised concerns about the potential risks that these tailings pose to human health and the environment. The Nova Scotia Department of Natural Resources published an open file report in 2015 that summarized the results of investigations on the environmental impacts of the tailings (Drage, 2015).

In 2016, the Geohazard Program provided geoscience advice to other government departments and divisions to support tailings management activities. In November 2016, new health warning signs were installed at the Goldenville historical gold mine site to warn the public about high levels of arsenic in the soil. The Nova Scotia Department of Natural Resources also provided support in 2016 to on-going research by St. Mary's University to advance the understanding of the impacts of historical gold mine tailings on aquatic wetland

ecosystems. The DNR activities related to this research included technical advice, participation on research grant applications, co-ordination of access to Crown land, and support to an M.Sc. student project at St. Mary's that was initiated in the summer of 2016. The project aims to identify invertebrate species that can serve as biomonitors of contaminants in impacted wetlands and to assess the risk of biotransport of arsenic and mercury from key species of the insect orders Odonata and Ephemeroptera to terrestrial organisms that consume those species. Further information about historical gold mine tailings is available on the Nova Scotia Environment website (Nova Scotia Environment, 2017).

Karst Risk Mapping

Sinkhole development in karst terrane can cause extensive damage to buildings, roads and other infrastructure. In Nova Scotia, most natural sinkholes associated with karst are formed in areas where gypsum occurs. In 2015, a project was initiated to develop a new provincial karst risk map. The work has involved the compilation of existing geology maps and karst occurrence data, review of lidar data, and field verification of sinkhole occurrences. In 2016, the work involved assembling the most current geological mapping for the province and digitizing karst occurrences from historical maps and reports. The resulting karst occurrence database contains approximately 1,000 records of known locations with karst topography, sinkholes and karst springs. A new interactive karst risk map is planned for 2017.

Other Activities

Nova Scotia Department of Natural Resources continued efforts to develop quantitative information on background concentrations of various substances in soils in both rural and urban areas of the province. This information is needed to develop appropriate soil quality standards and to enhance science- and evidence-based decision making in relation to contaminated sites. In 2015, DNR participated in a project with Dalhousie University and Nova Scotia Environment to conduct soil sampling in urban areas of the Halifax Regional Municipality (HRM). Samples were analyzed for metals and polycyclic aromatic hydrocarbons. In 2016, statistical analyses of the HRM soil chemistry data were completed by Dalhousie University.

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