

# Activities of the Hydrogeology Program, 2010

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## Introduction

In 2010, the activities of the Nova Scotia Department of Natural Resources (DNR) Hydrogeology Program focused on improving the understanding of the distribution of surficial aquifer deposits in selected growth areas of the Halifax Regional Municipality (HRM), and on supporting provincial groundwater research and management initiatives, such as assessment of seawater intrusion vulnerability (under the Atlantic Climate Adaptation Solutions project) and community-based groundwater monitoring (under the Groundswell project). The program also provided advice to government and private sector clients, and continued its efforts towards the organization, compilation and mapping of provincial groundwater data.

## Program Highlights

### Groundwater Observation Well Network

The Nova Scotia Groundwater Observation Well Network, operated by Nova Scotia Environment (NSE), is a key source of information on background groundwater chemistry and groundwater levels in the province. One of the five new wells installed as part of the Atlantic Climate Adaptation Solutions (ACAS) project was fully incorporated into the observation well network. The well location is shown in Figure 1 and highlights of the ACAS project are discussed under a separate section.

### Groundwater Databases

The DNR Hydrogeology Program continued its efforts to organize and maintain provincial groundwater information in a centralized spatial database. Routine data entry and enhancements to provincial groundwater databases, such as the Nova Scotia Well Logs Database (Nova Scotia

Environment, 2010a), Pumping Test Database (Nova Scotia Environment, 2010b), and Nova Scotia Groundwater Chemistry Database (Nova Scotia Department of Natural Resources, 2010) was carried out.

### Groundwater Data Availability

The online interactive groundwater map service and portal for government groundwater information, originally launched in August 2008, was revised in June 2010 (version 3) ([gis4.natr.gov.ns.ca/website/nsgroundwater](http://gis4.natr.gov.ns.ca/website/nsgroundwater)). New layers on the interactive groundwater map include the Radionuclides Potential Map (O'Reilly et al., 2009) and inactive provincial observation wells.

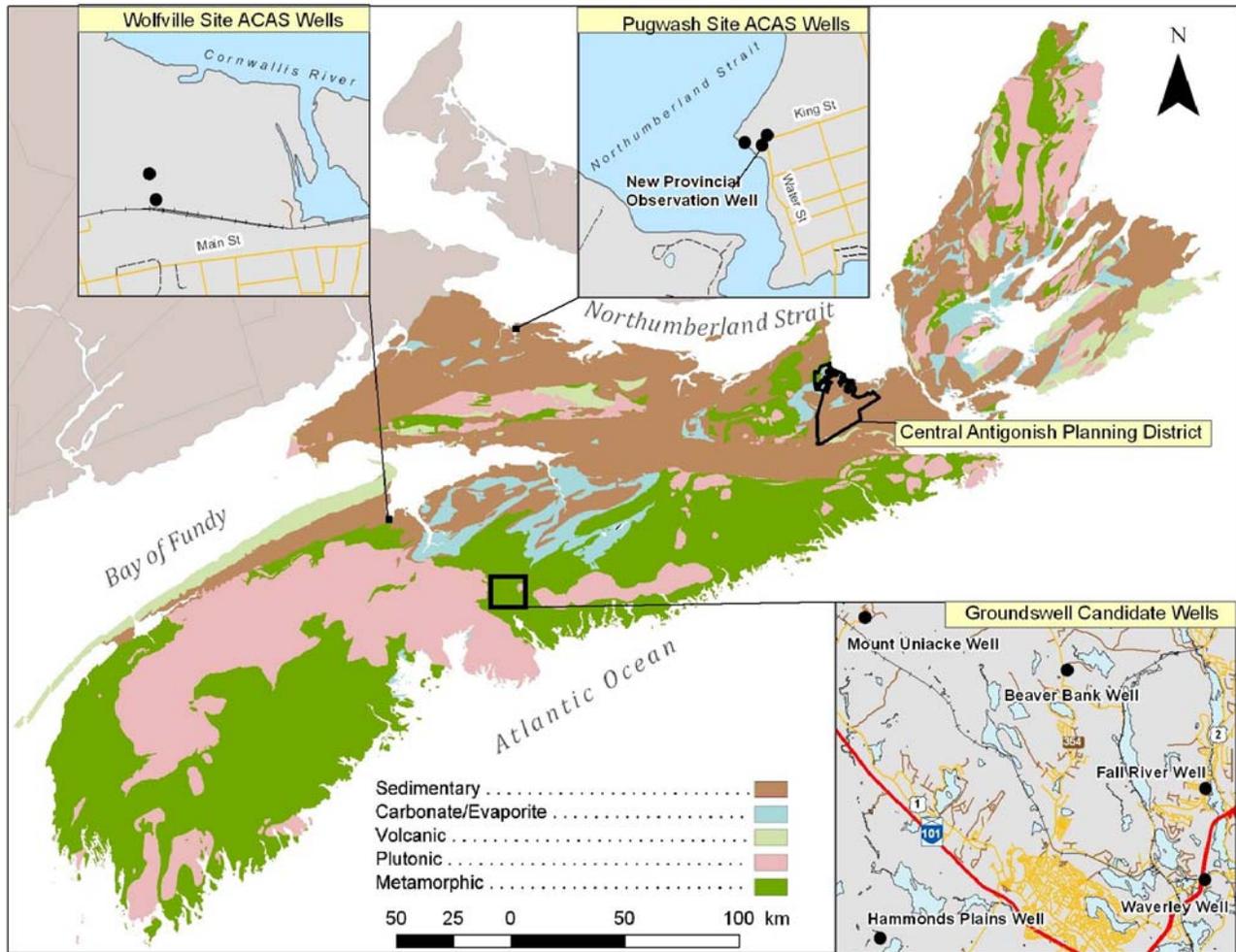
DNR continued its collaboration with Nova Scotia Environment (NSE) and Natural Resources Canada on the publication of a national scale interactive water well map and analysis system ([www.gw-info.net](http://www.gw-info.net)).

A Groundwater Chemistry Atlas, which shows the distribution of various water chemistry parameters across the province, is currently being prepared and is planned for release in 2011.

An historical hard copy water resource database for Cape Breton Island was obtained from NSE files (Nova Scotia Environment, personal communication). The database includes the location of water wells drilled prior to 1981 on a series of 90 hard copy maps. Work continues to scan the hard copy maps, digitize well location data, and enter the revised location coordinates into the Well Logs Database (Nova Scotia Environment, 2010a). The project is approximately 20% complete (Fig. 1).

### HRM Surficial Aquifer Mapping

A portion of the Halifax Regional Municipality's surficial geology was recently remapped based on



**Figure 1.** Map showing location of Atlantic Climate Adaptation Solutions (ACAS) project wells, Groundswell project candidate wells, central Antigonish planning district and new provincial observation well.

LiDAR bare-earth imagery. A zone of continuous surficial cover (i.e. where no bedrock is exposed, even between drumlins) was mapped, and areas of over-thickness of surficial material (i.e. where the depth to bedrock reported on water well logs exceeds the relief of surficial landforms) were identified within this zone, indicating the presence of buried, pre-glacial paleovalleys.

These paleovalleys are coincident with previously recorded locations of fluvial material above bedrock, which suggests that the paleovalleys may contain unmapped surficial aquifer systems. Water well data (Nova Scotia Environment, 2010a) in the vicinity of the zone of continuous surficial cover were spatially referenced using desktop methods. Bedrock elevation and surficial thickness maps were developed using depth to bedrock data

reported on the water well logs and surface elevation data extracted from the LiDAR digital elevation model. Wells intercepting buried (>12 m depth) sand and/or gravel were identified and high-potential surficial aquifer areas within the paleovalley systems were interpreted based on the observed locations of these aquifer materials. Test drilling was conducted in three of the interpreted high-potential surficial aquifer areas. Work is under way to characterize these potential aquifers. A planned Contribution Series report will provide additional details on this project.

### Groundswell

DNR collaborated with the Ecology Action Centre and NSE on the Groundswell project, which aims to develop a community-based groundwater

monitoring network and build awareness of groundwater issues at the community scale.

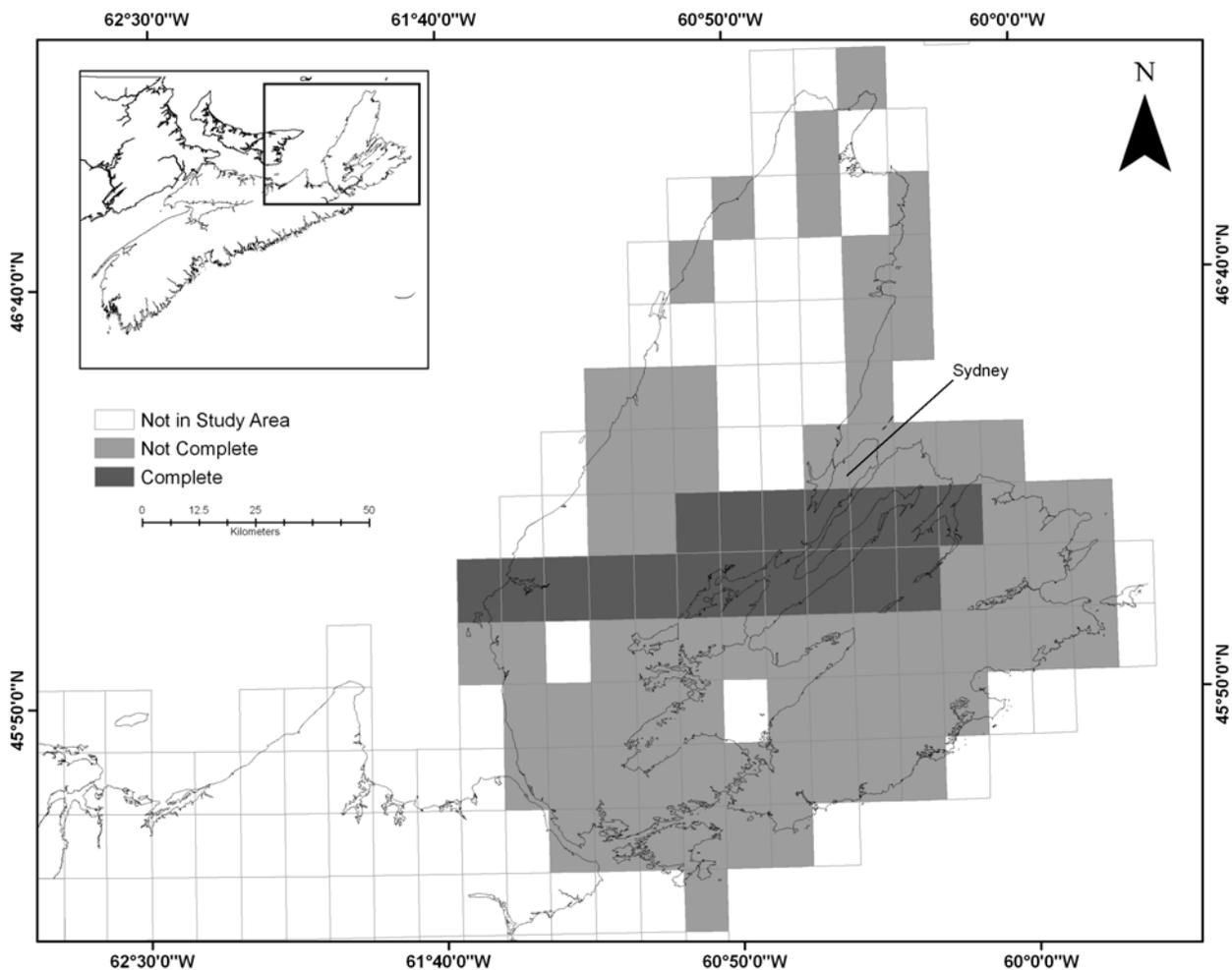
The approach of the pilot project is to identify unused wells in areas with significant groundwater use, and to provide equipment and training to volunteers from local watershed groups to conduct routine groundwater level monitoring that will compliment the provincial observation well network. The following criteria were used to identify high-priority areas for the implementation of community based monitoring:

1. Communities with reported groundwater supply issues (based largely on the responses of a survey of government and industry stakeholders and on the frequency of issues reported in the Nova Scotia well logs database, such as well deepenings);

2. Communities with significant groundwater use and increasing development activity;
3. Existence of a local watershed group willing to participate in the project; and
4. Existence of infrastructure for potential use in the project (unused wells).

Candidate wells were identified in Fall River, Hammonds Plains, Mount Uniacke, Waverley and Beaver Bank. The locations of candidate wells for the project are shown in Figure 2.

Groundswell, which is being funded through the Royal Bank of Canada Blue Water Project, was initiated in the spring of 2010 and has a two year term. The completion of a user manual, implementation of volunteer training, and deployment of equipment is planned for 2011.



**Figure 2.** Map showing coverage of the Cape Breton Water Resource Database mapping, and progress made on digitizing well location data.

## Atlantic Climate Adaptation Solutions

DNR participated in the design of a project to assess the susceptibility of coastal aquifers in Nova Scotia to saltwater intrusion. The project is led by Grant Ferguson at St. Francis Xavier University and is part of the Atlantic Climate Adaptation Solutions project to study the potential effects of climate change on groundwater resources in the Atlantic region. The study aims to provide an estimate of the current distribution of saline groundwater in Nova Scotia's coastal aquifers, assess the origin of this salinity, and assess how climate change may affect the distribution of saline waters in these aquifers.

DNR researched candidate study sites, participated in well construction supervision and testing, and provided mapping to the project team. Based on criteria such as community reliance on groundwater supply, documented seawater intrusion concerns, land ownership, and proximity to seawater, field study sites were established in Pugwash and Wolfville. A transect consisting of three wells was constructed in Pugwash and a transect consisting of two wells was constructed in Wolfville. Dataloggers have been installed in these wells to record continuous water level, temperature and conductivity. Figure 1 shows the locations of the wells. Reporting on the three year project is planned for 2012.

## Assistance to DNR Staff

Upgrades to Laurie Park, including a new comfort station, are being implemented. The DNR Hydrogeology program supervised the inspection and preliminary testing of the existing water supply well by Aquaterra Resource Services Ltd. The objective of this investigation was to assess whether the existing supply well could meet the anticipated increase in water demand at the park. Results of the pumping tests were interpreted (Table 1) and recommendations were made to DNR Parks staff with respect to the continued use of the water supply well.

## Central Antigonish Planning District Groundwater Map Layers

The Geological Services Division developed a project with the Municipality of the County of Antigonish to provide regional planners with geological information that can be understood and incorporated into planning decisions and policy development. As part of this project, the compilation and development of groundwater map layers, including the construction of aquifer vulnerability mapping based on the DRASTIC approach (Aller et al., 1987), was developed for the central Antigonish planning district. The location of the central Antigonish planning district is shown in Figure 1. A planned Open File Report will provide additional details on this project.

## DNR Input to Water Strategy and Policy Documents

The Hydrogeology Program provided technical input to various government policy and strategy documents, including the Nova Scotia Water Resources Management Strategy, which was released in December 2010.

## Publications

The following is a list of publications by the Hydrogeology Program released in 2010:

Open File Illustration ME 2010-002: Estimation of Regional Groundwater Budgets in Nova Scotia ([http://www.gov.ns.ca/natr/meb/download/mg/ofi/htm/ofi\\_2010-002.asp](http://www.gov.ns.ca/natr/meb/download/mg/ofi/htm/ofi_2010-002.asp)).

Open File Illustration ME 2010-003: Potential Controls on Uranium in New Production Wells Intercepting a Triassic Sandstone Aquifer ([http://www.gov.ns.ca/natr/meb/download/mg/ofi/htm/ofi\\_2010-003.asp](http://www.gov.ns.ca/natr/meb/download/mg/ofi/htm/ofi_2010-003.asp)).

Report ME 2010-001: Activities of the Hydrogeology Program, 2009 (<http://www.gov.ns.ca/natr/meb/pdf/10re01.asp>).

## Research Directions

The Hydrogeology Program will continue its efforts to organize and compile current and historical sources of groundwater information, and publish this information on the interactive groundwater map for public use. Work also continues on the online publication of provincial thematic groundwater maps, such as groundwater chemistry for selected parameters.

Areas of continued research include the development of mapping and characterization of salinity in coastal areas as part of the Atlantic Climate Adaptation Solutions project, and the development of an understanding of surficial aquifers in the Halifax Regional Municipality's growth areas experiencing groundwater stress.

## Acknowledgments

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## References

Aller, L., Bennett, T., Lehr, J., Petty, R. and Hackett, G. 1987: DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydro geologic Settings; EPA-600/2-87-035, National Water Well Association, Dublin, Ohio.

Finlayson-Bourque, D. S., Kennedy, G. W. and Bickerton, G. S. 2010: Potential controls on uranium in new production wells intercepting a

**Table 1.** Results of Laurie Park pumping test.

Parameter	Results
Well Depth	40.20 m
Casing Depth	3.96 m
Pumping Started	February 8, 2010 10:00 am
Pumping Ended	February 9, 2010 5:00 pm
Duration	29 hr
Recovery	Not completed due to power failure
Pumping Rate	27.24 Lpm (0 – 24 hours) 31.78 Lpm (24 – 28 hours) 36.32 Lpm (28-29 hours)
Pump Type	Webtrol 1/2hp, 1 ph, 230 v -10 gpm Series
Pump Setting	35.67 m
Initial Static Water Level	12.67 m
Available Drawdown	22.86 m
Total Drawdown	5.69 m
Percentage of Available Drawdown	25%
Apparent Transmissivity	16.5 m <sup>2</sup> /d
Apparent Hydraulic Conductivity	6.70 x 10 <sup>-1</sup> m/d
Average Specific Capacity	10.24 m <sup>3</sup> /d/m
Estimated Long-Term Well Yield (Q <sub>20</sub> )	203 m <sup>3</sup> /d

Triassic sandstone aquifer; Nova Scotia Department of Natural Resources, Mineral Resources Branch, Open File Illustration ME 2010-003, available online at [http://www.gov.ns.ca/natr/meb/download/mg/ofm/htm/ofm\\_2010-003.asp](http://www.gov.ns.ca/natr/meb/download/mg/ofm/htm/ofm_2010-003.asp).

Kennedy, G. W. and Finlayson-Bourque, D. S. 2010a: Nova Scotia Department of Natural Resources, Mineral Resources Branch, Report ME 2010-001, p. 45-53, available online at <http://www.gov.ns.ca/natr/meb/pdf/10re01.asp>

Kennedy, G. W., Garroway, K. G. and Finlayson-Bourque, D. S. 2010b: Estimation of regional groundwater budgets in Nova Scotia; Nova Scotia Department of Natural Resources, Mineral Resources Branch, Open File Illustration ME 2010-002, available online at [http://www.gov.ns.ca/natr/meb/download/mg/ofm/htm/ofm\\_2010-002.asp](http://www.gov.ns.ca/natr/meb/download/mg/ofm/htm/ofm_2010-002.asp).

Kennedy, G.W. and Drage, J. 2008: Groundwater regions map of Nova Scotia; Nova Scotia Department of Natural Resources, Mineral Resources Branch, Open File Map 2008-003, scale 1:500 000; available online as DP428, at <http://www.gov.ns.ca/natr/meb/download/dp428.htm>.

Nova Scotia Department of Natural Resources 2010: Nova Scotia groundwater chemistry database; available online as part of <http://>

[gis4.natr.gov.ns.ca/website/nsgroundwater/viewer.htm](http://gis4.natr.gov.ns.ca/website/nsgroundwater/viewer.htm).

Nova Scotia Environment 2010a: Well logs database; available online at <http://www.gov.ns.ca/nse/water/welldatabase.asp>.

Nova Scotia Environment 2010b: Pumping test database; available online as part of <http://gis4.natr.gov.ns.ca/website/nsgroundwater/viewer.htm>.

Nova Scotia Environment 2010c: Groundwater observation well network; available online at <http://www.gov.ns.ca/nse/water/groundwater/groundwaternetwork.asp>.

O'Reilly, G. A., Goodwin, T. A. and Drage, J. M. 2009: Map showing potential for uranium and related radionuclides in groundwater in Nova Scotia; Nova Scotia Department of Natural Resources, Mineral Resources Branch, Open File Map ME 2009-007, scale 1:1 000 000, available online at [http://www.gov.ns.ca/natr/meb/download/mg/ofm/htm/ofm\\_2009-007.asp](http://www.gov.ns.ca/natr/meb/download/mg/ofm/htm/ofm_2009-007.asp).