Developing a Water Monitoring Network in the Horn River Basin, Northeastern British Columbia (Parts of NTS 094I, J, O, P)

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Introduction

As part of the Horn River Basin Aquifer Characterization Project, a three-year water study was initiated in the summer of 2011. The study objectives are to collect accurate water flow, water quality and climatic data for the key watersheds in the Horn River Basin, with the goal of providing the necessary data to support sustainable use of water for shale gas development. The project partners include Geoscience BC, First Nations, the Horn River Basin Producers Group, the BC Oil and Gas Commission, the BC Ministry of Energy, Mines and Natural Gas and the BC Ministry of Environment. The project manager, Kerr Wood Leidal Associates Ltd. (Kerr Wood Leidal), began planning seven hydrometric and three climate stations in the summer of 2011 and installed them in late spring 2012. Additionally, one of the hydrometric sites is being investigated for a program to monitor wetland groundwater. Water quality and benthic invertebrates are also being monitored.

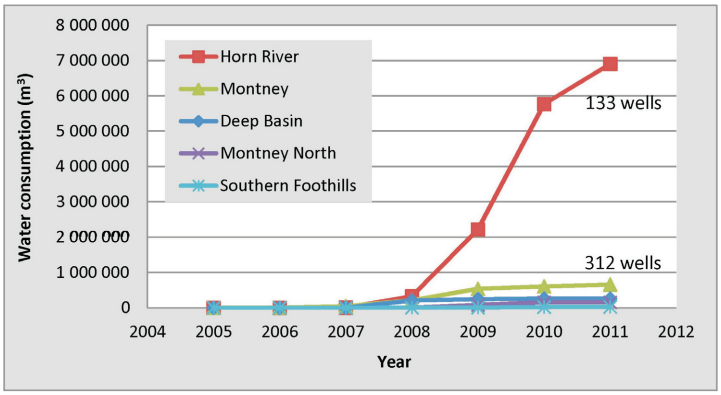

Figure 1. Yearly water utilization for various unconventional plays and areas in British Columbia. Reproduced with permission from Johnson (2012).

Background

In 2008, Geoscience BC received $5.7 million in funding from the BC Ministry of Energy, Mines and Natural Gas earmarked for oil and gas geoscience studies in northeastern British Columbia. The Horn River Basin covers an area of 11 000 km^2 in northeastern BC, much of it covered in muskeg, and spans 42 major watersheds. It also has a mean case estimate of 448 tcf of gas-in-place that is available to be produced (BC Ministry of Energy, Mines and Natural Gas and National Energy Board, 2010), making it one of the richest gas basins in North America. Unconventional gas development in the basin is water-intensive with an average well utilizing upwards of 80 000 m^3 of water (Johnson, 2012) in their slickwater completions (i.e., a high volume of water with a low concentration of sand and friction reducers). In 2011, a total of 133 wells used 7 million m^3 of water from the basin for oil and gas activities (Figure 1).

The Horn River Basin Producers Group recognized the need for a water management plan that would enable sustainable and responsible development of unconventional gas in the Horn River Basin. In late 2008, the Horn River Basin Producers Group and Geoscience BC, with support from the BC Ministry of Energy, Mines and Natural Gas, initiated the Horn River Basin Aquifer Characterization Project, which would aid in responsible development of the gas resource. Phase 1 of the project entailed the study of deep saline aquifers. Geotechnical information gathered from Phase 1 can be used, not only for the identification of saline aquifers suitable for hydraulic fracturing (i.e., fraccing), but also for disposal purposes. Phase 1 was managed by Petrel Robertson Consulting Ltd. and was completed by 2011 (Petrel Robertson Consulting Ltd., 2010).

A second phase of the project began soon afterward and comprises three components:

1) a pilot project managed by SkyTEM Canada Inc. to examine the applicability of airborne electromagnetic surveys for mapping near-surface groundwater;
2) the integration of new well data by Petrel Robertson Consulting Ltd. into the Phase 1 deep saline aquifer mapping project; and

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3) a three-year regional surface-water study managed by Kerr Wood Leidal, which would focus on collecting data with respect to quality and quantity; the Fort Nelson and Acho Dene Koe First Nations would also partner by providing personnel that could be trained as water monitors.

Components 1 and 2 are now complete and final results are available (Petrel Robertson Consulting Ltd., 2012; SkyTEM Canada Inc., 2012). This paper focuses on the ongoing work of developing the water monitoring network.

Development of Water Monitoring Network

The objectives of the water monitoring network are fourfold:

1) to collect accurate water flow, water quality and climate data, which will allow the characterization of baseline conditions and provide better accuracy and reliability for water use;
2) to train two First Nations representatives in all aspects of water monitoring;
3) to aid and support the sustainable planning and use of water in unconventional gas development; and
4) to provide the necessary data needed for informed decisions by the Horn River Basin Producers Group and the BC Oil and Gas Commission.

The water monitoring network includes three main components: 1) hydrometric and climate monitoring; 2) water quality and biological monitoring; and 3) data management and reporting. Shallow muskeg groundwater–surface water interaction is also a secondary project component, which is currently being investigated.

Station Site Selection Process

Technical screening for the placement of the hydrometric and climate stations needed to evaluate not only watershed characteristics but also operational and logistical issues. Key aspects of the watershed that were addressed included the geography (mountains, escarpments, etc.), areal extent of the watershed, aspect, median elevation, stream order and percentage of wetland cover. Additional operational issues also taken into account included locations of preexisting Water Survey of Canada, Environment Canada and BC Forest Service weather stations, or industry-operated hydrometric or climate gauges, First Nations traditional land use areas and the ability to obtain land tenure. The actual physical site selection accounted for logistical issues such as access, orientation and stream channel morphology. Once the draft sites were chosen, the Fort Nelson and Acho Dene Koe First Nations were informed and a review process was initiated. Input on the final site selection was also sought from stakeholders. In all, seven hydrometric stations and three climate stations were optimally located throughout the basin (Figure 2). The hydrometric stations were operational in time for this season's freshet (April 2012) and the climate stations in June 2012.

Instrumentation

The typical data collection platform has three main components:

1) a solar-powered battery and its housing;
2) sensors, which gather water level and flow information; and
3) a data logger, which captures the information.

Telemetry equipment, which transmits the information via satellite in four of the units, allows for real-time observation of stream water level. This information will ultimately be used to create ratings curves (i.e., stage-discharge relationship) for the hydrometric stations over the three-year length of the project.

The climate stations are solar powered and collect information on temperature, humidity, barometric pressure, precipitation, solar radiation and wind direction and speed. The climate stations are outfitted with snow pillows, which allow the measurement of snowpack and/or snow water equivalent.

Biological Monitoring

The biological monitoring program captures baseline information on the ecosystem's health, the hydrology of the basin and climate. The end result will be a dataset that will allow industry, First Nations and communities to responsibly use the water resources.

Hydrological baseline information from the basin is made up of quantity and quality components. The quantity component is captured via the hydrometric stations, as discussed in the previous section, while water quality monitoring is accomplished through grab samples at the hydrometric sites, following BC Provincial Resource Information Standards Committee Hydrometric Standards quality assurance–quality control procedures and BC Water Quality Sample Guidelines. This program is being co-ordinated alongside Environment Canada to help increase baseline coverage. Two First Nations personnel have been trained as part of the water monitoring team that will perform water quality sampling and biological monitoring.

In order to assess the linkages between shallow groundwater, the wetland and local surface waters, one hydrometric station location is being selected as a possible muskeg (wetland) shallow groundwater monitoring site. Surficial geological mapping and reports by the Geological Survey of Canada, BC Ministry of Energy, Mines and Natural Gas (Levson et al., 2005; D. Huntley and A. Hickin, pers. comm., 2012) and Ducks Unlimited are being used to assess the merit of each site. The end result will be a better understanding of surface-groundwater interaction in the

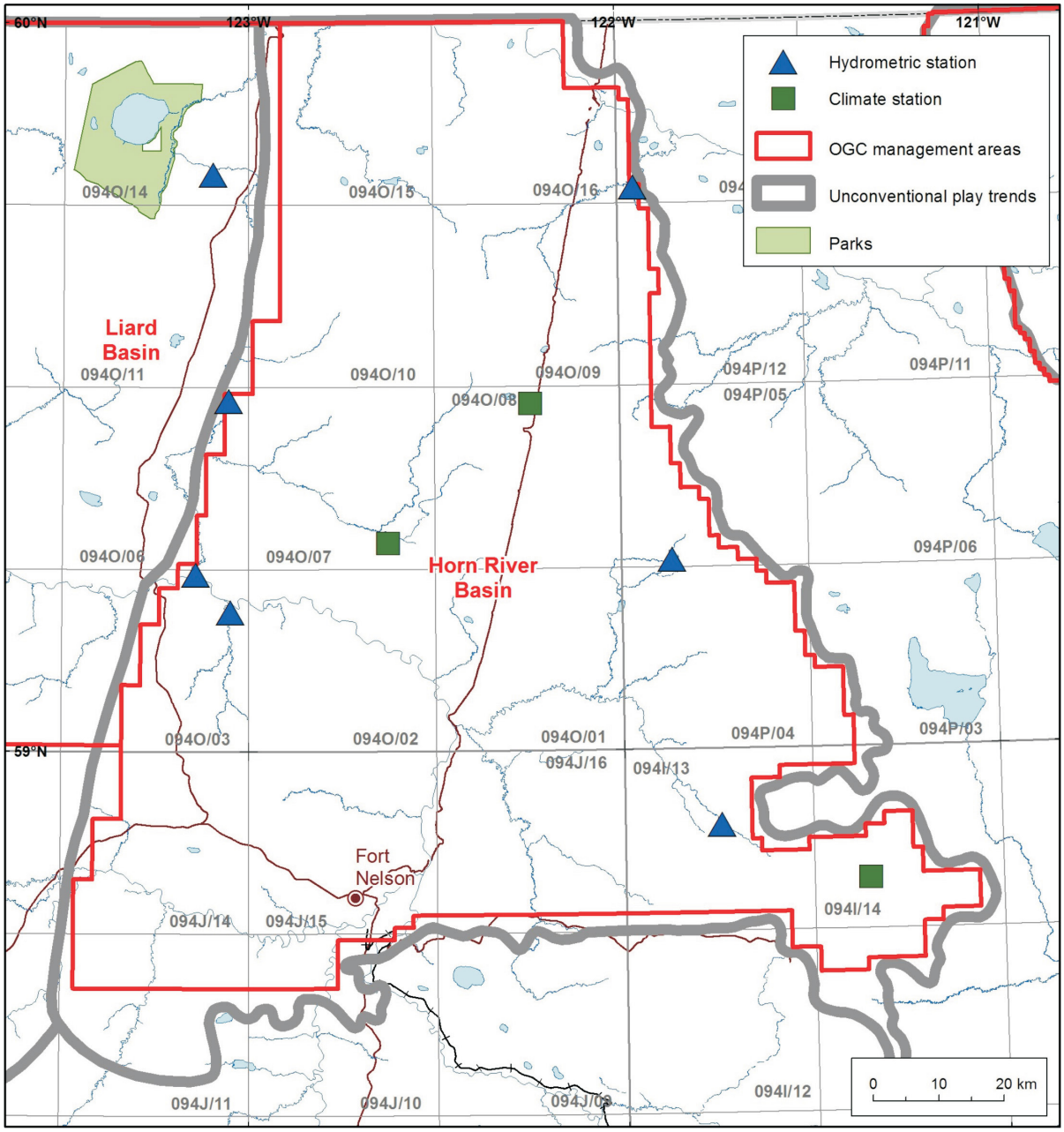

Figure 2. Location of Geoscience BC hydrometric and climate stations, Horn River Basin, northeastern British Columbia. Abbreviation: OGC, BC Oil and Gas Commission.

Horn River Basin, a critical piece of the puzzle when trying to devise responsible water management practices.

The biological monitoring of benthic invertebrates allows an assessment of the ecosystem's health. It involves the comparison of benthic fauna at a reference site, which has minimal human activity, to a test site, where human impact is suspected. Reference sites are established in areas that are primarily undisturbed. Test sites are then established and samples taken are compared statistically to the reference site to determine cumulative impacts. The collection of this data has begun to provide a baseline for biological monitoring in the basin.

Continuing Work

The installation of the seven hydrometric and three climate stations will allow monitoring of environmental conditions for the three-year span of the project. The data gathered will not only allow a better definition of baseline water quality and quantity it will also provide valuable information necessary for the development of hydrological ratings curves, better understanding of surface water–groundwater interaction, and a more accurate determination of runoff, which can ultimately guide responsible resource development in the region.

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