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Natural discharge and its role in Athabasca River quality: resolving complex systems

Jon W. Fennell
Integrated Sustainability Consultants Ltd.

Introduction

The Canadian oil sands are significant in size and development potential. Since the inception of surface mining activities in the late 1960s, overall production (mining and in situ) has increased to over 2 million barrels per day. The placement of large tailings ponds along the banks of the Athabasca River has long been a concern regarding potential impacts to the aquatic environment. Until recently, leakage of process-affected water from these structures was considered the main source of impact to the river. However, recent investigative work conducted by various individuals and agencies has revealed that natural discharge of low quality, saline groundwater from the sub-cropping bedrock formations has been responsible for the bulk of inputs to the river (Jasechko et al. 2012; Gibson et al. 2011, 2013; Gue 2012).

Theory and/or Method

To explore this further, a multi-disciplinary research team from the University of Alberta has been investigating various locations along the Athabasca, Clearwater, and major tributaries using electromagnetic imaging, drive point wells, seepage metres, and geochemical fingerprinting. The objective of this 3-year long study, co-funded by AI-EES and COSIA, is to elucidate the input of various oil sands related constituents to the Athabasca River, and where this has been occurring upstream and downstream of the mining footprint.

Thus far geophysical programs has revealed the presence of large (i.e., >5km long) zones of elevated terrain conductivity starting near the down-drop block feature immediately east of CNRL's Horizon Mine and extending downstream as far as the Firebag River. Upstream of this location zones of elevated terrain conductivity are more limited in size (i.e., up to 500 m in length). Discharge from these features is believed to be linked to the natural stress state of the basin, with those oriented in a SW-NE direction having a greater influence. Drive point wells have revealed the presence of naturally saline groundwater in the riverbed sediments (up to 65,000 mg/L TDS), as well as other constituents like ammonium and arsenic in excess of guidelines protective of aquatic life. Upward flow and discharge of this poor quality groundwater is therefore implicated in the changes to river water quality downstream of oil sands development. A number of these discharge features have been identified in front of active mines, thus complicating the issue. Seepage measurements have revealed discharge rates ranging from 0.2 to 12 $m^3/yr/m^2$, with some of the highest near developed areas.

Conclusions

The occurrence of significant natural discharge features within the Athabasca River system complicates understanding of the impacts that human development may be having on the area. This manifestation of the natural environment, combined with the erosion of exposed oil sand deposits along the river upstream of the active mining area, calls into question the efficacy of statements regarding how much oil sands development has influenced the aquatic environment. The fact that natural discharge is likely playing a significant role has been missing from the discussion. Geologic and geochemical complexity of the oil sands region may have led people, politicians, and the media to the wrong conclusion regarding industrial impacts, and thus needs to be reconciled.

Acknowledgements

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