

Synthesis of Boron Plant Toxicity Data, Irrigation Data, and Fate and Transport Modeling to Generate Boron Guideline Recommendations for Soil and Groundwater

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Boron is a metalloid co-contaminant common in produced water which may be toxic to plants at elevated concentrations beyond the nutritional requirements. Boron is thus highly relevant to the salinity impacts which have the largest total foot-print and potential environmental liability of all oil and gas-related impacts to soil and groundwater. Boron is also found naturally elevated above the current Tier 1 guidelines in several parts of Alberta, complicating the assessment and management of boron impacts due to oil and gas operations. Updated, risk-based boron guidelines for both soil and groundwater would benefit industry in terms of reduced investigation and remediation costs as well as improved environmental

performance. It would also improve soil conservation efforts and reduce the instances where natural boron concentrations which do not pose significant risk are disposed in a landfill.

Previous Alberta research projects will have generated a significant amount of information related to the toxicity of boron to both agricultural and boreal forest species in soils ranging from mineral to artificial to organic. This toxicity data is presented in terms of both the standard hot-water soluble ("HWS") methodology used in the current Tier 1 guidelines as well as the alternative saturated paste methodology which appears to be more relevant to plant toxicity and fate and transport of boron in soil and groundwater. This project proposes to synthesize this Alberta plant toxicity data along with toxicity data from other jurisdictions (such as the United States) and organizations (such as Environment Canada) where appropriate. This synthesis will also include considering other important soil pathways and receptors for guideline development as per Alberta Environment / CCME protocol such as soil invertebrates, human soil ingestion, and livestock soil and food ingestion. This synthesized information in combination with ongoing consultations with Alberta Environment and the PTAC Boron Working Group will be used to generate boron guideline recommendations for various pathways and soil textures (e.g., fine, coarse, organic). This project will produce a Tier 1 guideline document similar to the barium guideline,

though potentially with some deviations as described below.

Though boron is a metalloid, it is currently classified with metals in the Alberta Environment Tier 1 guidelines. Existing Alberta Environment policy does not recommend evaluating groundwater pathways for metals, primarily due to the complex interactions and insufficiently reliable data linking soil concentrations and groundwater concentrations (especially for highly sorptive metals). In some cases this may result in the use of increased safety factors to compensate for this large data gap for many metals. Boron appears to be in a grey area within the existing guideline framework, being a metalloid rather than a metal and having significant data generated through recent PTAC-funded boron research activities in Alberta regarding soil / groundwater interactions. Pending Alberta Environment policy decisions, boron groundwater pathways such as human drinking water, livestock watering, and irrigation water may potentially be calculated and used in overall guideline development. For example, the current Alberta Environment boron irrigation guideline of 0.5 mg/L is based on protecting the most sensitive species (blackberries), and this project will also examine this irrigation guideline and make recommendations for updating it based on risk-based criteria should it become necessary to evaluate groundwater pathways based on Alberta Environment consultations. The integration of the plant toxicity data combined with

fate and transport modeling for groundwater pathways such as irrigation would allow an integrated approach to recommending guidelines for both soil and groundwater.

Policy Issue

Natural versus anthropogenic Impacts. Natural concentrations of certain elements exceeding or contribute to an exceeding parameter identified in current regulatory guidelines can cause elevated remediation and reclamation costs that, with proper evaluation, could be reduced if they can be differentiated from anthropogenic impacts

Knowledge Gap

Update and development of risk-based, soil quality and remediation guidelines for boron including both agricultural (mineral) soils and muskeg/peat (organic) soils. Evaluation of different analytical methodologies to aid distinguishing between natural and anthropogenic boron impacts. Evaluation of current Alberta boron irrigation guideline compared to other Canadian and international guidelines.

DRAFT Boron Tier 1 Guideline Document

DRAFT Boron Tier 1 Supplemental Data Appendices