ELK VALLEY SELENIUM TASK FORCE (EVSTF) UPDATE AND OVERVIEW - 2009[1]

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ABSTRACT

Selenium (Se) concentrations in the Elk Valley have become elevated due to the weathering and mobilization of Se from seleniferous bearing rock, which is intensified as a result of mining practices. The Elk Valley Selenium Task Force (EVSTF) was established in 1998, to investigate the potential environmental effects of Se in the Elk River watershed. The EVSTF is a joint industry-government steering committee consisting of representatives from: the B.C. Ministry of Environment (MoE), the B.C. Ministry of Energy, Mines and Petroleum Resources (MEMPR), Environment Canada, representatives from each of the five Teck Coal (formerly, the Elk Valley Coal Corporation (EVCC)) coal mines (specifically: Fording River, Greenhills, Coal Mountain, Line Creek, and Elkview Operations), representatives of the corporate Environment, Health and Safety departments of Teck Coal and Teck Resources, and a Secretariat. In the past few years, the EVSTF has expanded its focus and direction beyond biological effects studies, to include a better understanding of the fate, speciation, and bioavailability of Se, and Se management and control opportunities; biological effects and biomonitoring studies continue in order to establish practical, site-specific criteria. Work plans for 2009 and beyond will focus on: biomonitoring trend studies, Se geochemical behaviour and modeling, Se treatment research and development, and the development of site-specific thresholds and management triggers for Se.

Keywords: selenium, toxicity, effects, fate, monitoring, management.

INTRODUCTION

Selenium (Se) is an essential and beneficial trace nutrient for all animals, including humans. Although Se is an essential micronutrient, it can yield toxic effects at certain concentrations. The mode of Se toxicity is somewhat unusual in comparison with other metals/metalloids. The primary pathway of Se bioaccumulation in fish and aquatic birds is dietary, and not directly from water. Bioaccumulated Se has little effect on the adult female but maternal transfer to the egg has the potential to result in malformations in the embryo, which can be fatal or lead to premature death through impaired fitness.

Selenium concentrations in the Elk Valley have become elevated due to the weathering and mobilization of Se from waste rock exposed through open-pit coal mining (McDonald & Strosher, 1998). The Elk Valley Selenium Task Force (EVSTF) was established in 1998, to investigate potential environmental effects of Se in the Elk River watershed. The objectives of this paper are three-fold. They are, to provide:

- an overview of the framework and objectives of the EVSTF;

[1] The authors wish to acknowledge contributions of EVSTF members, who assisted in the preparation of various sections of this presentation.

- some discussion of the processes and initiatives used by the Task Force to understand and manage Se in the Elk Valley; and,
- an update on recent and on-going activities conducted and commissioned by the Task Force.

EVSTF FRAMEWORK OVERVIEW

EVSTF Framework and Mission Statement

The EVSTF is a joint industry-government technical steering committee comprising representatives from: the B.C. Ministry of Environment, the B.C. Ministry of Energy, Mines and Petroleum Resources, Environment Canada, representatives from each of the five Teck Coal mines in the Elk Valley, representatives of the corporate Environment, Health and Safety departments of Teck Coal and Teck Resources, and a Secretariat.

The EVSTF Mission Statement is as follows:

> "***To support, implement and communicate selenium research for the purpose of protecting water quality and aquatic ecological resources in the Elk River Valley from adverse effects of selenium."***

Task Force Objectives – Evolving with Changing Priorities

The four original objectives of the EVSTF (originally developed in 1998) were to:

1. Determine if effects were occurring;
2. Determine if effects could occur in the future;
3. Provide input to the review of provincial or national guidelines/criteria for selenium; and,
4. Promote the development of site-specific environmental objectives, where possible or necessary.

In the past few years, the EVSTF and Teck Coal have begun to expand their focus and direction beyond biological effects studies, to include a better understanding of the fate, speciation, and bioavailability of Se, and Se management and control opportunities. An Expert Panel was commissioned by the MoE in late 2007 to evaluate the laboratory and field research conducted over the past 10 years, most of which was supported and directed by the EVSTF. A final report of the Expert Panel was released in August 2008 (Canton *et al*., 2008). As part of its deliberations, the panel recommended that resources be allocated to obtaining the data and information required to fully support the implementation of the monitoring and management framework for Se. In addition, it was recommended that resources be allocated to identify methods to reduce Se loadings to aquatic ecosystems. Based on the EVSTF's evolving direction towards Se management, and corroborated by the Expert Panel's recommendations, the Task Force has updated its objectives to reflect the new focus. These objectives will be modified over time to remain reflective of the purpose and goals of the EVSTF.

The new objectives of the EVSTF, developed through consensus-based discussions, are as follows:

1. Support the research and development of Se reduction and control technologies for use in the Elk River Basin;
2. Support research and monitoring to develop and refine Se management triggers for water, sediment and biota and effects thresholds appropriate for local ecological receptors in the Elk River Basin;
3. Provide scientific input to regulatory agencies for the development of site-specific environmental quality objectives for Se in the Elk River Basin;
4. Provide a scientific forum for input into Se management in the Elk River Basin; and,
5. Provide information on Se-related issues in the Elk River Basin to interested parties.

The new objectives are also conceptualized in a flow diagram, illustrated in Figure 1, below. The figure also captures selenium management and reduction functions, addressed by current Provincial legislation and regulatory processes.

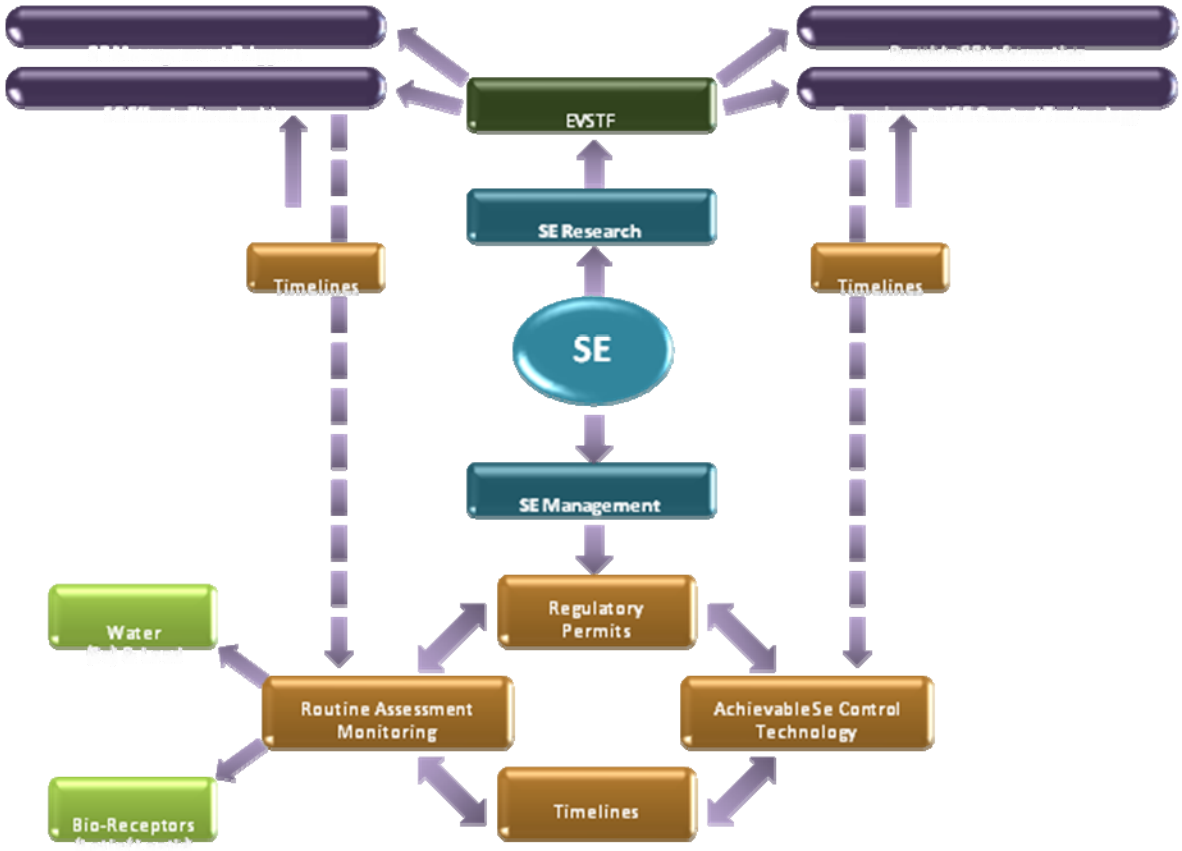

Figure 1 Conceptual diagram illustrating the relationship between selenium research and management and the EVSTF and regulatory functions.

PROCESSES AND INITIATIVES

The Task Force is in the process of updating its Terms of Reference (ToR), and will soon be operating according to the principles of the revised document. The ToR will be considered a "living document", intended to be modified and updated over time to remain reflective of the purpose, goals and activities of the Task Force, and responsive to changes in priorities and the knowledge gained from its research initiatives.

Task Force Structure

The EVSTF is unique in its focus, structure and composition (i.e., it is neither an industrial working group, regulatory body, nor public stakeholder committee). There has been a movement, over the years, given the status and profile of the Se issue in the Elk Valley (and other ecosystems in which Se has been demonstrated to be elevated), to formalize it to a greater degree, in order to establish processes that will ensure the group's effectiveness.

The Task Force is currently led, directed and represented by a Chair, but in future, the intention is to have two Co-Chairs: one representing industry (i.e., Teck Coal); and, another representing the government agencies. The Chair/Co-Chairs lead the committee in fulfilling its mandate through all activities of the Task Force, in particular: chairing and guiding the course of Task Force meetings, ensuring that annual work plans are in place, ensuring that project managers are assigned for specific studies, and ensuring that the work of the Task Force is appropriately communicated. The Task Force is also supported by a Secretariat, who prepares and circulates: agendas for all meetings in consultation with the Chair/Co-Chairs, background materials prior to meetings, and meeting minutes; moreover, the Secretariat also maintains overall communication among members through phone calls and e-mail.

As indicated above, the Task Force comprises technical representatives from both Provincial and Federal government agencies, Teck Coal and Teck Resources. Periodically, the EVSTF invites domain experts and external advisors to provide technical information or guidance, which enhances discussion and understanding on specific issues. Domain experts and external advisors are not members of the EVSTF.

Task Force Procedures

Meetings. EVSTF meetings are held to plan, review and direct research, development and monitoring programs to ensure that EVSTF objectives are addressed. Generally, the Task Force meets two to four times per year to allow for sufficient opportunity for discussion and input, and to facilitate timely completion of laboratory research and field components of the various programs. Meetings generally address issues relating to work planning, technical review of research and monitoring, external outreach and communications, an update on new results from the scientific literature, and other agenda items. Discussions and recommendations made at the EVSTF are based on input from all participating members. Assigned actions and recommendations made at meetings are fully documented in meeting minutes. Task Force members bring viewpoints of those they represent, as well as keeping colleagues within their programs informed of EVSTF activities, decisions and other developments. Issues and agenda items that

generate significant discussion or require further analysis and consideration are either tabled for a future meeting or assigned to smaller working groups/sub-committees. Sub-committees report back to the EVSTF to address those issues.

Communication and Outreach. The EVSTF is currently in the process of developing a website to make available relevant material generated by and through the Task Force. This website will be maintained and updated on a regular basis, as required. An up-to-date EVSTF membership list, including contact information, will also be maintained on this website. EVSTF members exemplify an open climate of information-sharing with respect to the work of the Task Force. For example, all material published or presented based on work directed by the Task Force, is reviewed and approved by all members prior to distribution externally. Studies undertaken under the auspices of the EVSTF, where possible and appropriate, are communicated in the scientific literature as journal articles, and, as appropriate, presented at workshops and conferences, such as the TRCR Annual Reclamation Symposium.

Project Management. EVSTF initiatives periodically require that a member take responsibility to oversee the activities undertaken in support of a specific project. A project usually takes the form of a funding agreement or a contract to be undertaken by an environmental consulting firm or a research institution. The EVSTF Project Manager's (a member of the Task Force) role is to represent the interests of the EVSTF in:

- addressing administrative matters pertaining to the project;
- working with the consultant/researcher to ensure that the project is within scope, schedule and budget;
- reporting project progress back to the EVSTF at meetings; and,
- ensuring the successful completion of the work, and assisting with coordinating the potential publication of results in the peer-reviewed literature.

UPDATE ON RECENT ELK VALLEY SELENIUM RESEARCH ACTIVITIES

In the past several years, the EVSTF has provided updates of its activities at the TRCR Annual Reclamation Symposium. Most of the previous studies conducted under the direction of the EVSTF are summarized in Status Reports, published over the last several years, the most recent example of which is the *Selenium Status Report 2007, Elk River Valley, BC* (Golder Associates Ltd., 2008).

Some recently-completed and on-going studies are summarized briefly below, with reference to some of the presentations (and papers herein) made during this session of the 2009 TRCR Annual Reclamation Symposium.

Biological Effects and Biomonitoring Studies

Two major studies have been completed recently in the area of biological effects/biomonitoring, as follows:

- A larval effects study conducted to evaluate the effects of Se associated with maternal transfer in Westslope Cutthroat Trout on the development of the larval fish collected from the Elk River Valley was recently completed (Nautilus Environmental, 2009). The investigation was designed to generate data necessary to derive a region/site-specific tissue residue guideline for Se for this species (both egg and whole-body), as well as to resolve differences in results from prior studies conducted on this species from lotic and lentic environments in the same region (Kennedy *et al*., 2000; Rudolph *et al*., 2008). [See: Elphick *et al*., 2009. Effect of Selenium on Early Life-Stage Development of Westslope Cutthroat Trout; this publication]

- A survey of Se in water, zooplankton and fish (i.e., kokanee) in Lake Koocanusa, upstream and downstream of the Elk River confluence, was conducted with the goal of determining metals concentrations, specifically Se, above and below inputs from the Elk River (McDonald, 2009). The study's main objectives were to determine: if there are risks to the aquatic environment, based on a comparison with current guidelines and thresholds; whether new data corroborate historical data; and, if there are significant differences in concentrations among the sites in the region. None of the data generated were found to exceed B.C. Se guidelines for the protection of aquatic life for water or fish tissue. Data were also evaluated using monitoring triggers from the recently-developed Elk Valley Selenium Monitoring and Management Framework (Canton *et al*., 2008). None of these triggers were exceeded in Lake Koocanusa in 2008.

Two additional studies have commenced and are on-going, as follows:

- A long-term monitoring and assessment program (updating earlier programs), is a comprehensive aquatic monitoring program, which sets out to compare and note changes in trends with past studies and to provide information necessary to assist in determining the status of the ecosystem specifically related to Se inputs. Key questions will include: Are Se concentrations and loadings changing? What are the trends? In addition, the program will include incidental observations, unusual occurrences or other factors not necessarily restricted to Se which may affect the status of biota. The information developed in this study will be used as part of weight-of-evidence determinations related to effects and impacts. The information obtained from this study will be used in a variety of ways; both by EVSTF to evaluate the status of the aquatic biological system related to Se and by each of the mines to assess what may be occurring related to their specific operations.

- Another study is setting out to develop site-specific bioaccumulation factors (BAFs) applied to a site-specific, tissue-based, chronic toxicity threshold for Se in fish (eggs and/or whole body), specifically for the following species: westslope cutthroat trout, mountain whitefish, and long nosed sucker. Bioaccumulation factors (BAFs) for Se will be developed for resident fish using data from existing sources, including regression equations for diet-to-egg Se uptake for selected species available from the literature, and/or site-specific data, where it is scientifically defensible; and to assess the utility and validity for developing a site-specific, water-column-based, chronic water quality objective by applying the BAFs to site-specific, tissue-based, chronic toxicity thresholds.

Selenium Fate and Geochemistry

Two major studies have been completed recently in the area of Se fate and geochemistry, as follows:

- As a component of the overall effort directed towards management and understanding the potential effects of Se originating from Teck Coal Ltd. mining operations in the Elk Valley, a Terms of Reference has been produced to develop a "Selenium Release Model". The intent of this model is to understand and quantify the mechanisms by which Se is mobilized from coal mining wastes, thereby providing a basis for predicting future release trends that includes water quality and the design of mitigation strategies under various mining scenarios.

- A study initiated in 2007, for which field work was completed in 2008, explored the biogeochemical behavior of Se in two lentic environments in the Elk River Valley. A final report was completed, and distributed in April 2009 (Lorax Environmental Services Ltd., 2009). Teck Coal has initiated the development of a follow up study on Goddard Marsh, one of the lentic areas studies previously. The goal of this upcoming study is to develop information specific to Se removal (i.e., through vegetation, sediment and other pathways). Depending on success of this study, the data may be used to support a potential wetland pilot test at one of the mine sites.

Selenium Management

Consistent with the new focus/objectives of the EVSTF, Teck Coal has recently developed and prepared Se Management Plans for each of the mines in the Elk Valley, and has submitted these to the government in late 2008. These management plans were developed to provide direction and information on site-specific actions that are or will be implemented at the mines, with the intention of reducing and influencing Se release and leaching processes. These plans are "living documents", as they are updated annually, to utilize and integrate new information, as it becomes available.

Selenium Treatment Research and Development

In anticipation of the need for Se treatment and removal, Teck Coal has developed an integrated test program with Applied Research & Technology in Trail, BC, to evaluate Se removal methods at Elk Valley coal mines. Teck Coal has utilized feedback from EVSTF members to develop the program. The laboratory-based program has been developed to ensure that results can be seamlessly integrated into any potential future on-site pilot testing and implementation. [for additional work in this area, See: Martin & Jones, 2009. Passive and Semi-Passive Treatment Alternatives for the Bioremediation of Selenium from Mine Waters; this publication].

PARTICIPATION IN INDUSTRY WORKING GROUPS

To complement and enhance the information available to the EVSTF, Teck Coal participates with other industries in Canada, in the Canadian Industry Selenium Working Group (CISWG), and with other industries in Canada and the US, in the North American Metals Council - Selenium Working Group

(NAMC-SWG). The NAMC is a registered US and Canada non-profit organization, with a solid reputation for conducting applied research. The NAMC-SWG has been financially supporting research programs of national and international interest, which are also relevant to selenium issues in the Elk River Valley. Some examples are as follows:

- development of a review and consensus document on aquatic effects selenium thresholds;
- preparation of an implementation manual for using a tissue based selenium water quality guideline including site-specific methods for assessing aqueous selenium; and,
- development of a manual delineating appropriate procedures for assessing selenium in water, tissue, sediment, soil and rock.

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