Removal of Selenium from Drainage Water in Lined Reduction, Attachment, and Open Oxidation Channels: A Field Study

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Executive Summary:
Irrigation in the San Joaquin Valley, California has produced selenium (Se)-impacted subsurface drainage water, which may contaminate nearby wetlands. Bioaccumulation of Se in these wetlands has caused deformities in waterfowl. In order to prevent Se contamination from the wetlands and protect wildlife, removal of Se from the drainage water before it enters the wetlands has become the most important task for scientists and wetland managers.

Two on-going projects in the San Joaquin Valley, California for removing Se from drainage water are the Tulare Lake Drainage District (TLDD) flow-through wetland system and the Broadview lined channel system. In the TLDD wetland, initial results have showed that about 65% of total Se entering is removed from drainage water. However, recent results reveal that the removal efficiency of e from drainage water in the TLDD wetlands has significantly decreased. The Broadview project consists of a site developed with shallow, fully lined open channels. Three different treatments were carried out in 1999. Analysis of water concentrations of Se indicates that up to 73% of the cumulative input of Se had been removed from drainage water in Treatment 3 (higher plants planted in straw bundles), compared to 10% and 15% of the Se in Treatment 1 (tile drain water alone) and 2 (algal material added), respectively. However, the effectiveness for removing Se from drainage water has significantly decreased with time in Treatment 3 because a reducing environment was not continuously maintained. Recently, another experiment was conducted with these open channels in which straw bails alone were placed within the channels. This treatment removed more than 50% of the cumulative input of Se, thus revealing how important a carbon source is needed for Se removal in drainage water.

We propose to investigate the removal of Se from drainage water in a lined channel system by enhancing Se reduction to Se[0]. This project will involve both a laboratory and field study. In the laboratory, we will test different natural organic materials such as straw, tomato, wheat, grape pulp, sugar beets, and alfalfa as electron donors in batch experiments to determine the most efficient carbon sources to promote microbial Se reduction. Once the optimum conditions are obtained in the laboratory for maximum removal of Se form drainage water, we will apply this information to the field lined channels. In the field study, we will have three lined channels connected in series serving as three different functional zones: a reduction channel, Se[0] attachment channel, and an open oxidation channel. The reduction channel will be covered with a black plastic sheet on the surface to limit air diffusion and increase the water temperature. The most optimum treatment (organic reducing materials) found in the laboratory that promotes Se reduction will be added to this channel. The organic amendments will be placed in metal screens at specific intervals within the reduction channel. This conceptual design will consist of micro-cassettes placed in series, porous enough to allow the drainage water to easily flow through. A biofilm of microorganisms utilizing the organic materials as a carbon and energy source will ultimately use ... ... and electron acceptors reducing these oxyanions to ... .../Se[0] and Se[0], respectively. The second channel is the attachment zone where Se[0] will be filtered out of the water. The third channel is the open oxidation channel consisting of a trickling filter to oxidize dissolved organic compounds that migrate out of the first two channels. Also this channel will remove any malodorous by-products and enhance volatilization of Se. Redox potential (Eh) and Se speciation in each channel will be monitored over time. Mechanisms for removing Se from the drainage water in the channels will be determined by analyzing Se speciation in drainage water, reducing organic materials, sediment, and solid materials. After we complete all the experiments described above, we will provide the growers with an effective technology to remove Se from the drainage water in the San Joaquin Valley, California.