2001 Toxicity Assessment of BTEX Compounds

The Canadian Council of Ministers of the Environment (CCME) Petroleum Hydrocarbon (PHC) Development Committee (DEVCOM) recently provided the scientific rationale for proposed Canada- wide Standards (CWS) for petroleum hydrocarbons (PHCs) in soil (CCME, 2000). These CWS were derived on a fraction-specific basis for different land uses and soil types, with consideration of the presence or absence of a groundwater exposure pathway and whether the location of the soil contamination was surface or subsurface. The four fractions for which standards were derived included the fraction of carbon constituents ranging from >C5-C10 (F1), nC10-C16 (F2), C17-C34 (F3), and >C34 (F4). In reality, F1 includes benzene, toluene, ethylbenzene, and xylene (BTEX); however, national and provincial standards for these compounds in soil already exist. It was decided that the BTEX compounds would be regulated based on the existing standards and, therefore, BTEX were not included in F1 (e.g., F1-BTEX).

The toxicity of fraction one was never determined directly; a surrogate mixture of additive-free motor gasoline (mogas) was evaluated along with naphthalene and hexane, all of which were highly volatile and believed to be representative of F1. The CWS for F1

were derived using the toxicity and effects data generated from tests with mogas, naphthalene, hexane, and the relevant literature values. BTEX comprised a significant portion of the mogas mixture (ESG, 2000a) and a significant part of the toxicity associated with mogas was likely attributable to the presence of these compounds.

There are established federal and provincial standards (e.g., guidelines) for each of the BTEX compounds. These standards were derived using an effects-based process and toxicity data from studies conducted in the early 1990s. Test procedures and methods for terrestrial toxicity testing were, at that time, in their infancy. Since then, test methods and procedures for assessing the toxicity of contaminants in soils to terrestrial organisms have been developed by Environment Canada (EC 1998a, 1998b, 1998c). The guidance provided in these test methods includes procedures and conditions specific to testing highly volatile organic substances, such as BTEX. In addition to methodological improvements, the statistical procedures used to describe the concentration-response relationships have also improved. Non-linear and linear regression models have been parameterized to include the determination of any ICp and the associated 95 % confidence intervals (Stephenson et al. 2000; EC 2001). These advances in the science of toxicity assessment have resulted in better tools with which to evaluate the fate and effects of contaminants in soils and, consequently, there is less uncertainty

associated with the accuracy and precision of the estimates of toxicity.

Concurrent with the technical improvements describe above, the approach for deriving soil quality guidelines (SQGs) has also advanced toward risk-based derivation of standards from effects-based standards. The process used to derive the new CWS for PHCs was unique and involved a rank sensitivity analyses of the response data for the different fractions or fraction surrogates. Therefore, the existing BTEX standards for soils were derived using an effects-based process and data generated from tests with “inferior” methodologies. As a result, there is some concern (e.g., uncertainty) regarding the merit (i.e., the capacity to protect soil environments) of the existing BTEX soil standards.

The CCME, under the direction of Dr. Ted Nason (Alberta Environment) contracted ESG International to conduct a battery of acute toxicity tests with the earthworm (Eisenia andrei) and a species of plant known to be sensitive to hydrocarbons, northern wheatgrass (Agropyron dasystachyum). The test organisms were exposed to a series of exposure concentrations of each of the BTEX compounds in two soil types, a formulated sandy loam soil and a field-collected clay loam soil. The test methods used to assess the toxicity of BTEX were those currently recommended by Environment Canada. The results of the terrestrial toxicity tests with BTEX are summarized in

this report.