VAPOUR TRANSFER OF SOIL CONTAMINANTS

The UK regime for the regulatory management of contaminated land follows a risk-based approach, in accordance with UK policy as set out in the 'Framework for Contaminated Land'. Thus control and remediation of contaminated land is determined using the 'suitability for use' approach.

Statutory guidance has been issued on the identification of contaminated land for the purposes of compliance with the new legislation. As part of this programme the Department of the Environment, Food and Rural Affairs (Formerly DETR) and the Environment Agency for England and Wales have undertaken and managed extensive research and development programmes to develop models, guidance and procedures for the management of contaminated land.

This has involved the development of a contaminated land exposure assessment (CLEA) model, which relates human tolerable daily intake levels to contaminant concentrations in soils. The CLEA framework incorporates a range of pathways for modelling human exposure to contaminants. One such pathway is indoor inhalation of soil vapour, following migration into buildings from volatile contamination sources. A variety of soil vapour intrusion models have been developed to describe this pathway, but few attempts have been made to evaluate the individual characteristics of these models or to calibrate them against site-specific data.

This research project (the subject of this report) has been conducted to:

1. Provide guidance on the suitability of individual soil vapour intrusion models.
2. Calibrate the output from a number of models with site-specific data.
3. Recommend the most appropriate model to be used in the CLEA framework.

The work described in this report examines vapour transfer of petroleum hydrocarbons from the unsaturated zone into buildings.

Ten soil vapour transport models are reviewed in terms of their contents, benefits, limitations and suitability for modelling UK conditions. Five models (GSI, BC, VOLASOIL, BPRISC (Johnson and Ettinger and modified Johnson sub-models) and the Ferguson model) were initially short-listed for comparison and to assess their sensitivity to changes in various input parameters. The Johnson and Ettinger, modified Johnson, Jury, VAPEX3 and Unocal models were not considered in detail.

The processes simulated by the GSI, BPRISC (Johnson and Ettinger sub-model), BC, VOLASOIL and Ferguson models were initially compared in relation to a The processes simulated by the GSI, BPRISC (Johnson and Ettinger sub-model), BC, VOLASOIL and Ferguson models were initially compared in relation to a simple generic scenario that describes soil contamination. In addition, these models were subject to sensitivity analysis of individual model parameters.

This was undertaken by varying the values for a number of the key input parameters (soil concentration, fraction organic carbon, water filled porosity, depth to contamination, Henry's Law constant, free air diffusivity, foundation crack ratio, biodecay rate, and soil permeability) while keeping all other variables constant. The results from this analysis were compared with expected (or theoretical) findings.

Following generic modelling, four of the models (GSI, BPRISC (Johnson and Ettinger and Modified Johnson sub-models), BC and Ferguson) were calibrated using site-specific data from three separate studies (Alameda, Paulsboro and Chatterton).

The findings of this modelling with respect to the performance, benefits and limitations of the four soil vapour models reviewed, are used to provide recommendations for the most appropriate soil vapour model to use in the CLEA model framework.

No single model was considered to satisfy all the criteria describing soil vapour intrusion into buildings. Nevertheless based on the findings of this research work it is concluded that the BPRISC model is the closest to satisfying the purpose of inclusion in the CLEA model framework. Whilst the models evaluated in this study were capable of describing the main transport and intrusion processes, further research is recommended to develop and improve biotransformation sub-models, the simulation of entry processes particularly those relating to advection and preferential pathways (e.g. service entries) and the significance of partitioning of vapour from free-phase NAPL source areas.

This R&D Technical Summary relates to information from R&D Project P5-018 reported in detail in the following output:-

R&D Technical Report P5-018/TR. Vapour Transfer of soil contaminants.
ISBN Number: 1 85705 151 3

Internal Status: **Released to Regions.**
External Status: **Public Domain**

Project Manager: Dr Raquel Duarte-Davidson Thames Region Centre
Research Contractor: Golder Associates

Copies of these documents are available from the Regional Libraries or the National Information Centre, c/o WRc, Frankland Road, Blagrove, Swindon, Wiltshire SN5 8YF, Tel: 01793 865138, Fax: 01793 514562
Website URL: www.wrcplc.co.uk/rdbookshop

Rio House
Waterside Drive
Aztec West
Almondsbury
Bristol BS32 4UD
Tel: 01454 624400
Fax: 01454 624409