1. URS GENERIC ASSESSMENT CRITERIA FOR PROTECTION OF HUMAN HEALTH FROM SOIL CONTAMINATION

The objective of this advice note is to set out the assumptions used in the derivation of the URS Generic Assessment Criteria (GAC) for screening soil contamination.

This note deals only with Generic Assessment Criteria (GAC) for the protection of human health from long-term exposure. It does not consider risks to controlled waters and users should be aware that an acceptable level for the protection of health might not be appropriate to protect water.

1.1. What are URS Generic Assessment Criteria?

URS Generic Assessment Criteria (GAC) are risk-based soil concentrations that are protective of chronic risks to human health for a broad range of site conditions and different *generic* land-uses. They represent the first tier of assessment (also commonly called "screening values"). If applied correctly to a site with a broadly consistent conceptual exposure model, it is recommended that an exceedance of a URS GAC triggers a need for further assessment of some form, such as a re-evaluation of the applicability of the conceptual site model relative to the GAC, further site investigation, more detailed quantitative risk assessment (also known as Tier 2), and potentially remedial action, subject to tests of cost-benefit, practicability and reasonableness.

URS GAC are not Soil Guideline Values although they have been developed according to the technical guidance issued by Defra and the Environment Agency (2002a – d) and subsequent modelling updates (Environment Agency 2004a – c). URS considers that URS GAC are consistent with the principles of health protection in the Defra and Environment Agency guidance.

1.2. How are URS Generic Assessment Criteria used?

URS GAC are used by URS professional staff to make screening judgements as part of an intrusive site assessment in accordance with internal guidance.

URS may prioritise potential contaminants of concern (PCOC) from a literature review and desk study, and may collect and/or review site investigation data on the spatial distribution of ground contamination. Investigation data on the concentrations of PCOC in soil are consequently then compared with generic assessment criteria in the following hierarchy:

- Soil Guideline Values from published guidance by Defra and the Environment Agency (currently limited to 7 substances);
- URS Generic Assessment Criteria;

- Other criteria from national and international organisations including VROM (2000) and US EPA (2001, 2004a and 2004b)[1].

1.3. How are URS Generic Assessment Criteria derived?

There are two principal components to the derivation of a URS GAC:

- Selection of appropriate toxicological benchmarks or Health Criteria Values (HCVs) according to guidance published by Defra and Environment Agency (2002c)
- Estimation of human exposure to soil contamination and comparison with HCVs in order to derive risk-based soil concentrations protective of human health.

1.4. Selection of Health Criteria Values for URS GAC Values

R&D Publication CLR 9 (Defra and Environment Agency 2002c) sets out the process of selecting human toxicology benchmarks for protection of health from soil sources. The principles of this document are described in URS guidance entitled "*Toxicological Data and Intake Values for Protection of Human Health*" (URS 2004) and written evaluations of the toxicology for each chemical are summarised in the *Chemical Directory* (URS 2004). It is important to note that the principles used in the UK differ markedly from those found in other countries when dealing with non-threshold contaminants such as genotoxic carcinogens.

1.5. Estimating Human Exposure to Soil Contamination for URS GAC Values

R&D Publication CLR10 (Defra and Environment Agency 2002d) and supporting briefing notes (Environment Agency 2004a – c) describe the Contaminated Land Exposure Assessment (CLEA) model used as the basis for establishing Soil Guideline Values. Although the Environment Agency published a software version of R&D Publication CLR10 called CLEA 2002, URS does not support its use for the derivation of URS GAC values because:

- both its vapour intrusion and dermal exposure algorithms are no longer consistent with the latest Environment Agency guidance (Environment Agency 2004a and b)
- its lack of functionality makes it impossible to use as a Detailed Quantitative Risk Assessment (DQRA) (that is, Tier II) risk assessment tool; and
- potential user problems have been reported with the addition of new contaminants and there is considerable doubt surrounding its reliability.

[1] It is recognised that US EPA guidance does not integrate the necessary pathways in accordance with the UK approach. URS has therefore taken the existing toxicological and physical-chemical data from this guidance and derived provisional UK values that take into account exposure and averaging time, the choice of pathways, and the integration of exposure.

It is important to note that the Environment Agency has never recommended CLEA 2002 for use as a site-specific risk assessment tool. Other software packages are available including RISC 4, RISC HUMAN, and GSI RBCA Toolkit, however, none of these packages have been designed to work within the CLEA framework and many have in-built functions that are contrary to the UK approach that cannot be altered. For example, GSI RBCA does not allow for exposure via consumption of homegrown produce, a critical pathway for the residential land-use scenario.

URS has developed an exposure model in MS Excel 2000© called "*Human7*" along the principles of CLEA but with significantly enhanced functionality for detailed quantitative risk assessment (DQRA). Human7 has been internally validated and is described in the *Human7 Technical Guide* (URS 2005). It is a deterministic tool, meaning that each parameter chosen is a single value. This is different to the approach adopted by R&D Publication CLR10, which proposes a distributional approach, that is up to seven of the hundreds of parameters used by CLEA 2002 are treated probabilistically (Defra and Environment Agency 2002d). In practice, this difference is not as significant as it first appears:

- deterministic approaches are simpler to understand, to audit and to evaluate interactions;
- deterministic approaches can provide a reasonable worst-case assessment provided that critical parameter choices such as direct soil ingestion rate, the proportion of homegrown produce, and skin-surface area are carefully selected;
- although R&D Publication CLR10 sets out a probabilistic approach this is not applied to all pathways of exposure. A critical pathway for many organic contaminants is inhalation of soil vapours. In estimating vapour inhalation, R&D Publication CLR 10 has only one probabilistic variable that is body weight, which appears on the top and bottom of the relevant equation. The net result of this is that the variation cancels out and the resulting assessment is in effect deterministic, based around the mean bodyweight

1.6. Integrating Assessment Criteria Based on HCVs for different Routes of Entry

In order to be consistent with the principles of health protection described in R&D Publications CLR9 and 10 (Defra and Environment Agency 2002c and 2002d), some account of chemical additivity between different routes of entry into the body should be made. The different routes of entry considered are via ingestion through the mouth, absorption through the skin, and inhalation through the nose. SNIFFER (2003) sets out an approach for integrating exposure via the different routes of entry with health criteria values (HCV) derived for two or more routes of entry. This approach is summarised in Table 1 and the guidance presented has been used in the derivation of URS GAC values.

Table 1: Approaches for Integrating Provisional Assessment Criteria for each Health Criteria Value

Situation	Method of Integration
A single HCV is available for either inhalation or oral routes of entry	If health effect is systemic, then compare HCV with sum of relevant exposure via all routes of entry. If health effect is local, then compare HCV only with relevant exposure from a single route of entry.
An HCV is available for both the oral and inhalation routes of entry	If health effect is systemic in both cases, then use equation to integrate exposure and HCV for different routes of entry. The following provisional criteria (AC) should be derived: • Comparison of relevant oral and dermal exposure with HCV based on oral routes of entry • Comparison of relevant inhalation exposure with HCV based on inhalation routes of entry $$GAC = \frac{1}{AC_{oral+dermal}} + \frac{1}{AC_{inhalation}}$$ If it is not possible to derive either of the provisional criteria, for example as a result of solubility or saturated vapour limits being exceeded, then consideration must be given as to whether it is health protective to ignore the relevant exposure. Review the dominant routes of exposure. Compare the HCV that relates to the dominant exposure pathway with relevant exposure from all routes of entry. If exposure is balanced, for example, 50% oral and 50% inhalation then use the most health protective HCV.
	If health effect for one route of entry is systemic and the other is local then: • In the case of the HCV based on a systemic effect, compare relevant exposure for all entry routes with HCV to derive provisional criteria. • In the case of the HCV based on a local effect, compare only relevant exposure from the local entry route with HCV to derive provisional criteria. The URS GAC is not integrated. It is the lower of the two provisional criteria.
	If health effect for both routes of entry is local then compare each HCV only with relevant exposure from the local entry route to derive provisional criteria. The URS GAC is not integrated. It is the lower of the two provisional criteria.

1.7. Rounding

The URS GAC values have been rounded to 1 or 2 significant figures in accordance with the rules set out in Table 2 below. Rounding has been applied so that the values reflect the degree of uncertainty in the underlying exposure assessment and thus misleading precision in the values reported is avoided.

Table 2: Rounding of URS GAC Values

Starting GAC Value ($mg.kg^{-1}$)	Rounding to Nearest ($mg.kg^{-1}$)
0 – 1	0.001
1 – 20	0.1
20 – 50	1
50 – 100	5
100 – 1000	10
1000 – 10,000	100
10,000 – 100,000	1000
100,000 +	10,000

1.8. What are the generic assumptions for behind the Conceptual Models for the URS GAC values according to Land-use?

URS GAC have been developed for each of the land-use scenarios described in R&D Publication CLR10 (Defra and Environment Agency 2002d), namely, residential with and without the consumption of homegrown vegetables, allotments and commercial / industrial (see Table 3 for a descriptive summary). URS has adopted the following from R&D Publication CLR10 for each conceptual model:

- critical receptor (a female child aged 0 – 6 years or a female worker aged 16 – 60 years);
- exposure pathways (see Table 3);
- exposure duration and averaging time;
- exposure frequencies.

Table 3: Descriptive Summary of Land-use Conceptual Models (adapted from Defra and Environment Agency 2002e)

Residential People live in a wide variety of dwellings including, for example, detached, semi-detached and terraced property up to two storeys high. This land-use considers a typical two-storey house without a basement. It assumes that residents have private gardens and/or access to community open space close to the home. Exposure has been estimated with and without a contribution from eating homegrown vegetables, which represents the key difference in potential exposure to contamination between those living in a house with a garden and those living in a house where no private garden area is available.
Allotments Provision of open space, commonly made by the local authority, for local people to grow fruit and vegetables for their own consumption. Typically, each plot is about a one-fortieth of a hectare, with several plots to a site. Although some allotment holders may choose to keep animals, including rabbits, hens and ducks, potential exposure to contaminated meat and eggs has not been considered.
Commercial/industrial There are many different kinds of workplace and work-related activities. This land-use assumes that work takes place in a permanent two or three storey office building where employees spend most time indoors involved in office-based or relatively light physical work. This land-use is not designed to consider those sites involving 100% hard cover (such as car parks) where the risks to the site-user are from ingestion or skin contact because of the implausibility of such exposures arising while the constructed surface remains intact. Further guidance on the limitations in applying this land-use to different industries can be found in DEFRA and Environment Agency (2002d).

In addition, URS has adopted the key exposure, soil and site characteristics from R&D Publication CLR10 (Defra and Environment Agency 2002d) and Briefing Notes 1 – 3 (Environment Agency 2004a – c). As mentioned earlier, the exception to this is the selection of a single deterministic value to be representative of probabilistic distributions. These decisions are summarised in Table 4.

Table 4: Summary of Decisions on Probabilistic Parameters

Parameter	Decision
Body weight (kg)	Value: mean for each age class Justification: Ensures consistency across all exposure pathways. Same as output from the CLEA model for all vapour pathways.
Exposed skin area (cm^2)	Value: 95th percentile of distribution based on mean bodyweight for each age class Justification: Adoption of conservative value consistent with health protection implicit within URS GAC
Consumption of homegrown vegetables (g FW)	Value: 75th percentile of homegrown fraction distribution based on mean bodyweight consumption rates for each age class Justification: Adoption of conservative value consistent with SNIFFER (2003) and the health protection implicit within URS GAC
Soil ingestion rate ($mg.day^{-1}$)	Value: 75th percentile of distribution for each age class Justification: Bench marked against existing SGV reports for 7 metals and 2 organic compounds, giving a value between 10 – 20% lower than SGV. Adoption of a conservative value consistent with health protection implicit within URS GAC.

In the conceptual model used to derive the URS GAC, URS has also made the following decisions to be broadly consistent with the derivation of Soil Guideline Values:

- a single, unsaturated soil layer (1 m depth) is assumed, consisting of the UK sandy soil described in Briefing Note 2 (Environment Agency 2004b). Soil organic matter contents have been chosen to be consistent with the reporting in the Soil Guideline Value reports;
- for the residential scenario, the "*typical residential house*" as described in Briefing Note 3 (Environment Agency 2004c) has been adopted;
- for the commercial and industrial scenario, the "*office building*" as described in Briefing Note 3 (Environment Agency 2004c) has been adopted;
- for vapour modelling to indoor and outdoor air, an infinite source of soil contamination has been assumed and with the top of the contamination located 1m below the surface.

As part of URS' internal QA/QC procedures, URS has benchmarked the Human7 model and URS GAC against published SGV so that the appropriateness of the methodology detailed above can be verified.

2. REFERENCES

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