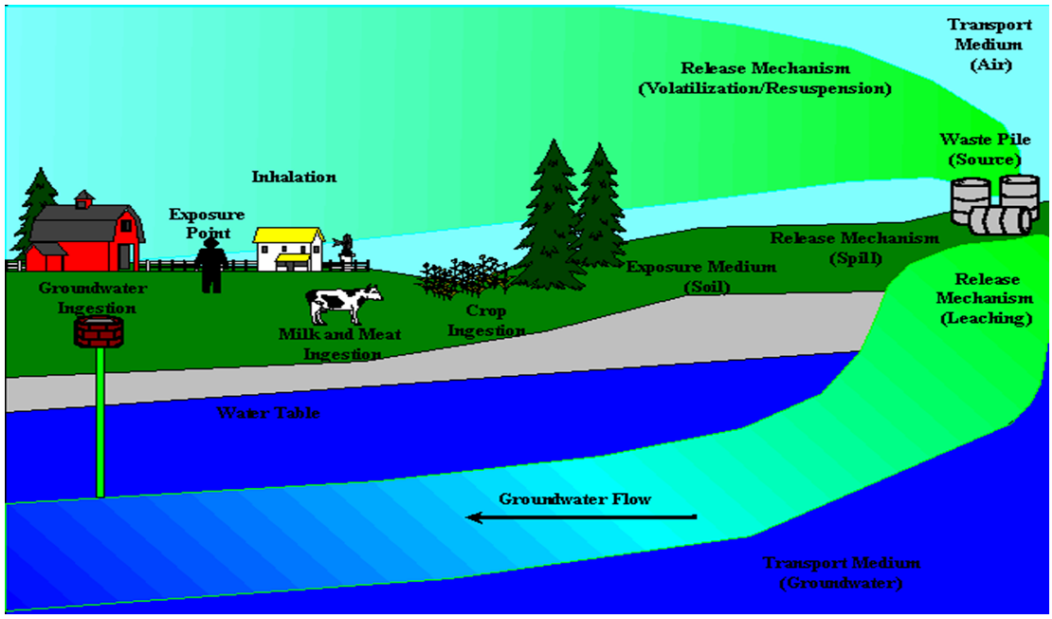
Chapter 17: Overview of Human Health Risk Assessment

Human health risk assessment refers to the estimation of carcinogenic risk and non-carcinogenic hazard caused by exposure to contaminated media. SADA's human health risk implementation is based on the EPA's Risk Assessment Guidance for Superfund. SADA provides a risk assessment module to calculate the risk of adverse health impacts on a population exposed to toxic chemicals found in groundwater, surface water, soil, and sediment. It also calculates risk-based screening values to quickly identify contaminants of concern. These results are integrated into the other modules, such as cost benefit analysis, geospatial analysis, and sampling schemes.

The risk of exposure to contaminants depends on three broad and interconnected factors: 1) the type of contaminant, 2) the severity of the contamination, 3) the method of exposure. The type of contaminant is a critical component. Each contaminant has a unique set of toxicity values that vary with the method of exposure, with health effects depending on whether the contaminant is classified as a radionuclide, or a carcinogenic or non-carcinogenic inorganic or organic chemical.

The level of exposure is also important. For exposed individuals, a positive relationship between level of exposure and health impact is estimated for carcinogenic contaminants. For non-carcinogenic contaminants, levels above a dose threshold are used to indicate the presence of a health hazard. Toxicity databases are packaged with SADA to assist in this calculation and determination. The presence of the contaminant in environmental media is usually summarized as a single value -- the representative exposure concentration – to assist with this calculation. This concentration is generally a summary statistical, such as the mean value or some upper confidence limit (e.g. 95^{th}) on the mean. This value is then used in the exposure model to determine the potential risk for cancer or other negative health outcomes.

The route of exposure is also a key determining factor. Contaminants can have greater health consequences for some exposure routes than others. Typical exposure routes include ingestion, inhalation, and dermal contact. Influencing exposure is the type of land use activity that will occur on the site. With all the input variables for exposure, toxicity, and routes of exposure, models can then be implemented to estimate potential or actual exposures along each exposure route for current or possible future land uses.



Current contaminant concentrations are often used for the on-site assessment of future exposure; however, modeled results that represent future contaminant concentrations can also be imported. The five land use scenarios considered in SADA include industrial, residential, recreational, excavation, and agricultural.

For residential land use, residents are expected to be in frequent, repeated contact with contaminated media. Residential exposures accounts for daily contact over a lifetime, including exposures for the receptor as child and adult, and typically produce the highest potential exposures and risk. Under the industrial land use scenario, workers are expected to be exposed routinely to contaminated media within a commercial area or industrial facility at the site. Estimate exposures are based on potential use of heavy equipment and related traffic in and around the contaminated soil and sediment. The recreational land use scenario addresses exposure to children and adults who spend limited time at or near the site while engaging in outdoor activities. For the excavation scenario, worker exposures to soil and sediment for a short period are considered appropriate. The exposure routes for soil and sediment for the excavation worker are similar to an industrial worker. The agricultural scenario assumes a resident is exposed to homegrown farm products. Exposure routes, in addition to the residential pathways include consumption of site-grown vegetables, milk, and beef. In the software, users select exposure pathways used to calculate total risk, and separate calculations are conducted for surface soil, sediment, groundwater, and surface water. SADA's risk models follow the EPA guidance (1989 et seq.) and model input parameters can be modified to fit site-specific exposure conditions.

These three factors can be brought together to produce two important calculations: 1) the preliminary remediation goal (PRG) and 2) the calculation of carcinogenic risk and/or health index. A PRG sometimes is referred to as a Risk Based Goal (RBG). In this calculation, an acceptable concentration limit is calculated that would be protective of an exposed group under a specific land use/exposure scenario for a given risk limit. PRGs are typically used to screen site data to determine if any exceedances have occurred. If no exceedances have occurred then the contaminant can sometimes be set aside and no longer considered. A

lengthy list of detected contaminants at a site often can be reduced by such risk screening. SADA contains additional screens and statistical tests that consider background, sample detection frequency, bioavailability, and whether detected contaminants are essential nutrients can be conducted; including specific functions such as univariate statistics and non-parametric comparison tests (e.g., Wilcoxon Rank Sum test for comparing data to background).

The calculation of risk (and hazard) runs the same models forward for risk assessment purposes. Instead of specifying the risk level, the representative exposure concentration is summarized and combined with exposure parameters and model assumptions. The model then produces the risk level associated with the concentration for given land use/exposure scenario. Additional decision support output includes comprehensive tables of forward calculations of exposure and risk, summarizing over all included contaminants at the site, used to support a full baseline risk assessment for the contaminants of concern.

If the site poses acceptable risk, no further evaluation and no remediation from a human health perspective may be warranted. If the site poses unacceptable human health risk, additional evaluation in the form of remedy development and evaluation would be appropriate. SADA produces tables of output that can be modified to support risk assessment documentation purposes. For identified contaminants of concern, it also can provide spatial data screens to visualize where exceedances are found and risk can be mapped using the available interpolation functions. These latter features can be used to drive remedial design and secondary sampling strategies.

The following chapters will demonstrate how to setup the risk model in your SADA file, perform PRG screens, forward risk calculations and how theses are integrated with the spatial tools in SADA.

