Site-Specific Background Concentrations

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Introduction

"Background" can be defined as concentrations of chemicals in soils or ground water in the immediate area of an environmentally impacted site. Background concentrations can be naturally occurring (i.e., the concentration is not due to a release of chemicals from human activities), or anthropogenic (i.e., the presence of a chemical in the environment is due to human activities, but is not the result of site-specific use or release of waste or products, or industrial activity).

Naturally occurring metals and other chemicals are found in natural soils and ground water at varying concentrations, depending upon the topography, geology, geography and physical, biological, and chemical properties of the soil and ground water. The source of these chemicals is typically from geomorphological processes, such as erosion, weathering, and dissolution of mineral deposits.

Anthropogenic impacts include lead from automobile emissions, arsenic from use of defoliants, pesticides in agricultural areas, and poly-nuclear aromatic hydrocarbons resulting from combustion of hydrocarbons). Specifically, for anthropogenic impacts, the chemicals have typically resulted from the use of a product in its intended manner and may be present at generally low levels over large areas.

In addition to natural and anthropogenic sources, chemical concentrations in soil and ground water may be the result of on-site activities at environmentally impacted sites. The assessment screening strategy and remediation strategy for cleanup of such sites, as well as implementation of institutional controls, requires that background concentrations of chemicals be determined in order to ascertain the extent to which the contamination can be attributed to on-site activities.

The determination of 'background' poses two fundamental challenges. First, 'background' inherently implies natural variability, thus creating a distribution or a range that varies with the spatial distribution of the samples. Defining a site-specific background concentration level for background concentrations is therefore difficult. Second, soils, ground water, and their constituents are heterogeneous in nature, and the need to replicate the 'background' as closely to the site characteristics minus the on-site activity, poses a number of challenges related to the selection of the background site as well as the sampling plan.

Determination of background concentrations for the chemicals detected at a site is very important for establishing the site-specific chemicals of concern (COC) for which cleanup levels must be determined. Since chemicals not related to the past or current site related activities may be present at a site, it is important to determine the background

concentrations for those specific chemicals. Further, for site related chemicals, if the background concentrations are greater than the target cleanup levels, a policy has to be established as to whether the site shall be cleaned up to background levels or risk-based levels to protect human health and the environment. It may not be feasible or practical to cleanup the site to the target cleanup levels due to cost-effectiveness, technical practicability, and the potential for recontamination of remediated areas by surrounding areas with elevated background concentrations.

Methodology

Prior to determining the site-specific background concentration for any chemical, the following approach should be followed to determine if background determination is necessary.

First, determine whether the chemicals detected on-site are due to site-related or nearby activities. This requires that historical research and interviews be performed to determine the past and current activities for the site and adjacent properties, in an effort to eliminate chemicals not related to site activities..

The DNR has established three levels of cleanup criteria:

a. Default Target Levels
b. Tier 1 Target Levels
c. Site-Specific Risk Assessment Target Levels

For soil and ground water, determination of background concentrations are necessary for chemicals that exceed both Default Target Levels and appropriate Tier 1 Target Levels.

If for certain chemicals the only applicable pathway is soil-to-ground water, then the Synthetic Precipitation Leaching Procedure (SPLP) may be used to determine if the chemical concentration in the soil has the potential to leach from the soil and migrate into the ground water causing impacts to the ground water at levels above the approved ground-water target level for that chemical. The procedure would be to perform the SPLP analysis on a number of soil samples with the highest levels of impact for the specific COC and compare the results to the target ground-water levels. The number of samples for SPLP analysis would be determined on a site-specific basis and approved by the DNR, considering the size of the impacted area, heterogeneity of the impacted soils, and other site conditions. Should all SPLP results be below the target ground-water levels, then those specific chemicals do not have to be considered in determining the cleanup objectives for the site.

The background area should be on the site or in close proximity to the site. It must be shown that the area selected has not been impacted by historical or current site activities, nearby activities, or fill materials thjat share similar physical, chemical, biological, and geological characteristics with the site.

There are a number of issues related to selection of a background area. The following points must be taken into consideration:

a) **Background soil samples must be taken from similar soil characteristics.** Because of the heterogeneity of soils, it may be necessary to establish more than one background concentration for a COC. Soils are essentially heterogeneous, and their particle size, pH, salinity, cation exchange capacity, and soil organic carbon content vary spatially – both with depth as well as laterally. It may be necessary to determine background concentrations for different stratigraphic intervals, or for areas of impact that are widely separated by non-impacted areas.

   Because of these considerations, it is important to ensure that factors that affect the concentration of chemicals in the soil are considered when collecting samples from the site and off-site. As much as possible, soil samples must be taken from identical soil depths, identical soil textures, identical pH values, and at the same time of the year, as for the impacted soil horizons.

   Grid sampling can be an effective way of obtaining representative background samples; however, care must be taken to avoid including samples from impacted areas, or samples from areas or intervals that are significantly dissimilar considering the physical, chemical, and biological characteristics.

b) **Background water samples must be taken from similar ground-water characteristics.** To determine background for ground water, sampling must be conducted for a minimum of one year in four consecutive quarters unless a different schedule is approved by the DNR. The wells used in the background determination must be:
   - Located in areas not affected by the release,
   - Screened in the same geologic unit that is contaminated on site,
   - Located up gradient from the release area(s),
   - Sufficient in number to account for all possible off-site releases; and
   - Sufficient in number to adequately characterize the hydrogeologic setting.

c) **Determination of background area:** Background area must reflect the soil and ground-water characteristics at the site, and the background area must be in close proximity to the site, without having been impacted by site or nearby activities. Background concentrations of chemicals can vary significantly from metropolitan to non-metropolitan areas.

d) **Evaluation of land use and prior history is important:** It is important to collect information of prior land use at and near the site, in order to determine whether prior human activities could have contributed to background concentrations, and to the presence of certain chemicals unrelated to activities at the site or from nearby sites. Similarly, in case the site contains fill materials, it is

important to recognize the potential for contaminants because of the fill materials, rather than because of site or nearby activities.

e) **Appropriate number of samples:** It is important to collect an appropriate number of samples for the statistical method being used, and considering the site-specific conditions. The sampling strategy should be designed to obtain background levels that are truly representative of the site. Care should be taken if composite sampling will be used to reduce the total number of samples, such that the composites are representative of background conditions, and do not create biased results. The number of samples to be obtained must be supported by a valid sampling strategy, which has been approved by the DNR.

Any statistically valid approach approved by the DNR can be used to develop site-specific background values. The approach must be appropriate for the characteristics of the data set being evaluated.

Approval

The basis for approval of a site-specific background concentration for a specific chemical shall be determined by review of the following criteria:

a) Evaluation of all samples used in the background data set to determine if appropriately representative of site conditions based on locations, depths, number of samples, sampling methods, and laboratory analysis methods.

b) Evaluation from a toxicology and risk-assessment standpoint to determine if the background levels are inherently too high from a potential exposure for the intended future land use.

c) Verification of statistical methodology and assumptions used and results obtained.

Application

An approved background concentration of a chemical may be used on a site-specific basis for the assessment screening strategy, or as the cleanup level under all three standards (Default Target Levels, Tier 1 Target Levels, Site-Specific Risk Assessment Target Levels). In some cases, the site-specific background concentrations can be higher than the health-based cleanup level. For example, the health-based concentration of a chemical in soil may be lower than the naturally occurring concentration of that chemical in a certain soil type or location. Therefore, it would not be practical to cleanup to the health-based level.

If the site-specific background concentration for a specific chemical is higher than the levels detected in all the samples obtained and analyzed from the site, then that chemical can be dropped from consideration in the site cleanup goals.