Summary of Oregon's Susceptibility Analysis Procedures

The susceptibility analysis process was developed for determining Use and Susceptibility Waivers for synthetic organic chemicals (SOCs) and volatile organic compounds (VOCs). The procedures use a combination of site-specific information pertaining to the monitoring history of the source, hydrogeological characteristics of the vadose (unsaturated) zone, and important chemical characteristics of the contaminants pertaining to their mobility and persistence in the environment. The format is a series of matrices in which related parameters are plotted against one another to determine their combined effect. The results of one matrix are passed on to the next matrix to obtain an estimate of their cumulative effect. Data used in the process are derived from well reports (well logs), soil survey reports, meteorological data and, as appropriate, chemical data on individual chemicals' tendency for sorption and field dissipation (half-life). In all cases, the system has the option of submitting additional data in support of low susceptibility.

The main components of the susceptibility analysis procedure are explained below.

1. History and nature of the source. The first step in evaluating the susceptibility of the aquifer is to characterize well construction and monitoring history for the specific well. The main target for well construction is whether the casing seal (grout seal) was emplaced in a manner that takes advantage of any natural protection (low permeability layers) that exist in the subsurface. If the grout seal is judged inadequate or if no well report is available, the aquifer in the vicinity of the well is determined to be susceptible.

    a. Abandoned and other wells. A ground survey is undertaken within 1000 feet (or 6-month time-of-travel, determined by the calculated fixed radius method, whichever is less), to determine whether there are wells that are either inadequately constructed or improperly abandoned within the area. If so, the aquifer is considered susceptible unless the system submits data to the contrary.

b. Nitrate/coliform bacteria. If the system has a history of coliform detections that are source related or has nitrate concentrations exceeding regional background (or 2 mg/L in absence of regional data), the aquifer is considered susceptible.

c. VOC/SOC/GWUDI. The aquifer is considered susceptible if there have been confirmed detections of organic chemicals or if the well is capturing groundwater under the direct influence of surface water (GWUDI), i.e., receiving unfiltered water from a surface water body or exhibiting rapid shifts in water characteristics that closely correlate to climatological or surface water conditions.

2. If the system makes it through the "history and nature of the source" consideration, the analyst moves on to evaluating the "environmental conditions," which are the parameters that have an impact on the ability of the soil and geologic materials to transmit water and the contaminant from the surface to the aquifer.

   a. Area of susceptibility analysis. The source water protection area is used in this phase. Different time-of-travel zones could be targeted as a function of the contaminant.

   b. Matrix evaluation. A series of matrices is used to evaluate the potential of (1) water migrating from the surface to the aquifer and (2) a given contaminant persisting and moving with the water. In each matrix, two parameters are plotted. Their intersection within the matrix yields a score from 1 to 10. The higher the score, the greater the potential that these parameters will contribute to aquifer susceptibility.

      1) Traverse potential. This matrix assesses the ability of the unsaturated zone to transmit water to the aquifer. The depth to the aquifer and the weighted vertical hydraulic conductivity of the vadose zone are evaluated. Higher scores (e.g., 10) are assigned to shallow wells and higher weighted hydraulic conductivity values. The matrix score is assigned as the traverse potential, which is carried to the next matrix.

      2) Infiltration potential. This matrix assesses the combination of the traverse potential and the availability of water at the surface. It plots the traverse potential against the hydraulic surplus, equal to rainfall + irrigation – evapotranspiration – runoff. These data are not always available, so methods of estimation are provided. The score produced by the intersection of the hydraulic surplus and the traverse potential is assigned to the infiltration potential.

The infiltration potential can be used as a general estimate of the susceptibility of the aquifer. If specific contaminants are involved, then the process continues with the mobility potential matrix, which takes into account the sorption characteristics of the chemical.

3) Mobility potential. This matrix is primarily designed for organic contaminants, but in practice could be used for others. In this exercise, the organic matter score, a number related to the percent organic matter in the various soil layers, is plotted against the organic-carbon partition coefficient (Koc) for the chemical of concern. The higher the organic matter content and the Koc value, the lower the susceptibility of the aquifer for that specific chemical. The matrix value obtained is referred to as the mobility potential.

4) Leach potential. This matrix combines the infiltration potential (hydrogeologic parameters) and the mobility potential (chemical-specific characteristics) to estimate the potential for the contaminant to leach to groundwater. Obviously, even a highly mobile contaminant is not likely to impact groundwater if the vadose is very thick and/or relatively impermeable. On the other hand, even a low-mobility component could impact groundwater under conditions of shallow aquifer and highly permeable vadose zone. The score from this matrix is referred to as the leach potential.

5) Susceptibility. The final matrix plots the leach potential against the persistence of the component in the environment. The shorter the half-life of the constituent is, the less the potential impact of the chemical will be, unless, of course, the leach potential is high. The matrix is divided into low-, moderate- and high-relative risk fields. Which relative risk applies to a given well will depend on the numerical values of the persistence and the leach potential.

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