

GROUNDWATER DILUTION EXAMPLE

OBJECTIVE: TO DETERMINE THE CONCENTRATION OF A PESTICIDE IN GROUNDWATER AFTER AND TO COMPARE THE RESULTING CONCENTRATION WITH VERMONT DRINKING WATER STANDARDS.

What you need to know:

- 1) Soil types on site and estimates of the areas they cover.
- 2) Annual precipitation amounts for your area.
- 3) Annual amount of active ingredient for each pesticide applied.

Soil types will allow you to estimate what portion of annual precipitation will go to groundwater recharge. Once this groundwater dilution factor is determined (the amount of annual precipitation which percolates to the water table) you can make assumptions as to the potential concentration of pesticides in groundwater. This exercise assumes a lot of 'worst case' type things will happen in order for a pesticide to leach in significant amounts to groundwater.

Example: We will use a 100 acre golf course as an example.

I) Soils: The percent of precipitation which may leach through the root zone and the saturated zone to groundwater is called recharge. Obviously, not all rain, snow etc. will end up in groundwater - runoff, evaporation, plant uptake, binding in the soil profiles etc. will intercept a great deal of the precipitation. There are two ways to make some guesses as to the recharge potential of various soils. One of the determining factors in how much goes to recharge is the 'parent material' of the soils or what type of organic and mineral material the soil was formed from. Basically, there are 2 broad parent materials in this area from which soils are formed - Glacial till and Glacial fluvial. Tills were deposited by retreating ice while fluvial materials were deposited by glacial meltwater.

One method used to determine recharge rates uses drainage classes of soils. The soil descriptions in the NRCS soil surveys will usually describe the **drainage class** of the various soil types. Based on these descriptions you can make some broad assumptions regarding recharge rates.

Excessively drained and **somewhat excessively drained** assume 16 inches of recharge per year.

Well drained and **moderately well drained** assume 12 inches per year

Somewhat poorly drained assume 10 inches per year

Poorly drained and **very poorly drained** assume 8 inches per year

After reviewing soils maps for our example golf course we found the site to contain the following soils. The areas that these soils cover are best guesses made by looking at the golf course boundaries on the soils maps:

Berkshire Fine Sandy Loam(8-15% slope) is **well drained** and covers approximately 12% of the golf course acreage (12 acres).

Berkshire Fine Sandy Loam(3-5% slope) is **well drained** and covers approximately 27% of the golf course acreage (27 acres).

Colton-Duxbury is **excessively drained** covering 44% of site (44 acres).

Lyman-Tunbridge is **well drained** covering 5% of the golf course acreage (5 acres).

Tunbridge-Lyman is **well drained** and covers 12% of site (12 acres)

56% of the site is well drained and 44% of the site is excessively drained. Therefore, 56% of the site provides 12 inches of groundwater recharge from precipitation and 44% of the site provides 16 inches of recharge from precipitation. By averaging these you arrive at an annual recharge of about 13.7 inches for the site. To continue with the calculation; 13.7 inches of water over 100 acres is equivalent to 140,797,412 liters of water: (13.7 inches/12 inches per foot) * 100 acres(43,560 sqft per acre) = 4,973,100 cubic feet of water. 4,973,100 cubic feet * 7.48 gallons per cubic foot = 37,198,788 gallons. 37,198,788 gallons * 3.785 liters/ gallon = 140,797,412 liters. This is the dilution factor for the 100 acre example golf course.

II) ADD THE PESTICIDE

We will use 2,4-D as an example. Referring to the label for a typical liquid three way herbicide we find that the recommended application rate is 3 pints per acre. We also determine that the product contains 1.24 pounds of active ingredient (2,4-D) per gallon of product. This equates to an application rate of 0.465 pounds of 2,4-D per acre. In our example we will make one application per year to 20 acres. That is equal to 9.3 pounds of 2,4-D per year. How much of that amount will leach below the root zone? For the purposes of this exercise we will assume 10% actually leaves the root zone - this is a very conservative assumption. 10% of 9.3 lbs is 0.93 lbs or 422 grams (454 grams per pound).

III) DILUTE THE PESTICIDE

The dilution calculation is simple division. Grams of pesticide lost to leaching divided by liters of water (your dilution factor):

422 grams of 2,4-D diluted in 140,797,412 liters of water equals .00000299 grams of 2,4-D per liter or 2.99 parts per billion. To convert from grams per liter to parts per billion multiply grams per liter by one million. The final concentration in parts per billion is then compared to the drinking water standard for 2,4-D from the list of non prescreened compounds. The "HAL" or Health Advisory Level for 2,4-D is 70 parts per billion. The use of 2,4-D according to label rates to 20 acres of turf at this golf course is within the drinking water standard for 2,4-D.

The information is then summarized on the attached charts.