Assessing the Risk of Groundwater Contamination from

Site Evaluation

Worksheet 11

EB1746-W11

Why is the site evaluation important?

How such homestead practices as pesticide handling or manure management affect your groundwater depends in part on the physical characteristics of your homestead site: soil type, bedrock characteristics, and depth to groundwater. That's why evaluating the soils and geologic characteristics of your homestead is an important step in protecting the groundwater you drink.

Although the focus of Home•A•Syst is on protection of the **groundwater**, preserving surface water quality is also important. Implementing the best management practices (BMPs) recommended in the factsheets can help protect **surface water** in two ways. First, implementing some BMPs may reduce runoff, which often carries significant amounts of contaminants to surface waterbodies. Second, because groundwater interacts with surface water, contaminants that are transported to an aquifer may end up in downstream rivers, lakes, or wetlands. The dynamic interaction between surface water and groundwater is called **hydraulic continuity**. More information concerning hydraulic continuity can be found in EB1622 and EB1633.

What's involved in completing this evaluation?

This evaluation has four parts:

Part 1: Evaluating your soil type and depth
Part 2: Evaluating subsurface and geologic materials, along with depth to groundwater
Part 3: Determining your overall site evaluation rank (combining parts 1 and 2)
Part 4: Doing a homestead diagram (optional)

Getting the information to complete parts 1 and 2 may require assistance from outside sources, such as your county Conservation District (CD) or Soil Conservation Service (SCS) or Cooperative Extension office. How long this takes will vary depending on availability of information in your county. Once you have the information, though, it should take about an hour to complete the first three parts of worksheet 11. The homestead diagram will take additional time.

For glossary, see page 2.

If some of the information you need isn't readily available, the worksheet contains instructions on how to proceed. The more information you can get the better, but some information is better than no information.

Glossary

Site Evaluation

These definitions may help clarify some of the terms used in Worksheet 11.

Apparent water table: A thick zone of free water in the soil. It is indicated by the level at which water stands in a uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Igneous: Rock formed by cooling and solidification of liquid parts of the rock portion of the earth.

Metamorphic: Rock formed by recrystallization of igneous or sedimentary rock under great pressure and heat, and by chemical reactions.

Organic matter: Matter containing compounds of plant or animal origin, measured by organic carbon content.

Perched water table: Water standing above an unsaturated zone. A perched water table is separated from a lower water table by an unsaturated zone.

Permeability: The quality that enables soil to transmit water or air.

Soil classification: A shorthand system to provide detailed soil descriptions. Includes such groupings as *order, suborder, subgroup,* and *family.*

Soil drainage class: The conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soils, as opposed to human-altered drainage. Different classes are described by such terms as *excessively drained, well-drained,* and *poorly drained.*

Soil horizon: A layer of soil, approximately parallel to the surface, that has distinct characteristics, such as color, structure, and texture. Described in shorthand form by letters, such as *A, B,* and *C.*

Soil-mapping unit: A soil or combination of soils delineated on a map and, where possible, named to show the taxonomic unit or units included.

Soil series: The basic unit of soil classification, consisting of soils that are essentially alike in all major profile characteristics.

Soil solum: The upper and most weathered part of the soil profile, consisting of the *A* and *B* horizons.

Soil texture: The relative proportions of the various soil separates (sand, silt, and clay) in a soil. Described by such terms as *sandy loam* and *silty clay.*

Subsoil: The *B* horizon, roughly the part of the solum below the depth of plowing.

Till: Unstratified glacial drift deposited by ice and consisting of clay, silt, sand, gravel, and boulders, intermingled in any proportion.

How do soils affect the potential for groundwater contamination?

Soil characteristics are very important in determining whether a contaminant breaks down to harmless compounds or leaches into groundwater. Because most breakdown occurs in the soil, a greater potential for groundwater contamination exists in areas where contaminants are able to move quickly through the soil.

While held securely to soil particles, contaminants are broken down by bacteria and other soil organisms and by chemical reactions with minerals and natural chemicals in the soil. Most of this chemical and biological breakdown takes place in the surface layers, where the soil may be warm, moist, high in organic matter, and well aerated. Soils vary in particle size (texture) from sandy to clayey.

- Sandy soils have large "pore" spaces between individual particles, and the particles provide relatively little surface area for "sorption," or physical attachment of most contaminants. Large amounts of rainfall can percolate through these soils, and dissolved contaminants can move rapidly down through the soil and into groundwater.

- Clay soils, on the other hand, are made up of extremely small particles that slow the movement of water and dissolved contaminants through the soil. Some contaminants may stick tightly to clay surfaces.

Finally, soil organic matter is important in holding contaminants. Soils high in organic matter provide an excellent environment for chemical and biological breakdown of these contaminants—before they reach groundwater.

The natural purification capability of the soil is limited. Under certain conditions, heavy rainfall and chemical spills may exceed the soil's purification capacity, allowing leaching to occur. In such cases, the subsurface geologic material and the distance a contaminant must travel to groundwater are important factors in determining whether a contaminant actually reaches the groundwater.

How do subsurface and geologic materials affect the potential for groundwater contamination?

Washington soils were formed over a variety of geologic parent materials. Upland soils formed from bedrock, wind blown silt and sand, or glacial drift. Bottomland soils formed in alluvial deposits of water deposited sand, silt, and clay.

Depth to groundwater is important primarily because it determines not only the depth of material through which a contaminant must travel before reaching an aquifer, but also the time during which a contaminant is in contact with the soil. As a result, where more clayey or silty soil and surficial deposits are fairly deep, contaminants are less likely to reach groundwater. Because water moves rapidly through sandy soils, depth to water has little impact upon contamination in these soils.

Bedrock geology influences groundwater pollution when the water table is below the bedrock surface. Sedimentary rocks have a wide range of permeability—from highly permeable sandstone to nearly impermeable shales and crystalline As with th As As with the results of the previous 10 assessment worksheets, use the rankings from this worksheet cautiously. Many factors affect whether or not a contaminant will leach to formations. Movement of pollutants in basalt is unpredictable, and pollutants can readily spread over large areas. Where bedrock material contains significant cracks and fractures, or is composed of basalt, the depth and characteristics of soil and surficial geologic deposits largely determine the potential for groundwater contamination.

A word of caution

ground water. There is no guarantee that a "low-risk" site will be uncontaminated—or that groundwater will become contaminated at a "high-risk" site. The type of contaminant involved, how you handle and store potential contaminants (such as pesticides and manure), the location and maintenance of your well, and many other factors can affect the potential for groundwater contamination.

Part 1: Evaluating the Soil on Your Homestead

To complete your soil evaluation, you will need a copy of your county's soil survey report. This report is available at most county Conservation District (CD), Cooperative Extension, or Soil Conservation Service (SCS) offices.

Step 1: Start by locating your homestead on the aerial photos in the soil survey. Note the soil mapping unit indicated on the photo and look up information related to that mapping unit in the written and tabular sections of the soil survey report. Soil surveys for different counties often differ according to number and location of tables, chapter titles, and so on. Take some time to become familiar with your soil survey and know where to locate different types of information.

If you have more than one soil mapping unit on your homestead, rank each soil individually using this worksheet. Transfer soil mapping unit boundary lines from the soil survey to the homestead diagram on page 14.

These rankings describe soil in native, undisturbed conditions. If your homestead soil has been altered by human activities such as tilling or ditching, contact your county Cooperative Extension, SCS, or CD office for assistance.

Don't skip any parts of the worksheet. If you are not familiar with using soil surveys, you may need help completing Part 1. Ask your county Extension agent or SCS or CD personnel to help you find the following information:

- Location of your homestead on the map and aerial photographs provided in the soil survey report.
- The soil mapping unit and soil series from the legend provided in the soil survey report.
- The soil series and/or soil mapping unit, including the profile description, as well as any other information in the report regarding depth to bedrock, depth to water, or organic matter content.

Step 2: With this information in hand, you are ready to rank your soil according to the seven characteristics found on the following three pages. For each of the seven characteristics in the left column, find information about your soil in the soil survey. Match your soil description to the description in the middle column to determine your score. (For example, if the soil survey tells you that the texture of your soil is a clay loam, your score for that category would be 8.) Remember to rank each soil if you have more than one soil mapping unit. Enter your score(s) in the space(s) indicated.

Soil characteristics

For characteristics 1–6a that follow, consult the tables for each soil mapping unit and the soil mapping unit or soil series text in your county soil survey. Help on where to locate information is found in the box on the left of each characteristic.

		Score
1. Texture of surface (A horizon)	loam, silt loam, sandy clay loam, silt clay, sandy clay, silty clay, clay loam, silty clay loam	9
	loamy fine sand, loamy very fine sand, fine sandy loam, very fine sandy loam	4
	sand, loamy sand, sandy loam, organic materials (all "O" horizons), and all textural classes with coarse fragment class modifiers (such as "gravelly loam")	1

HELP.
Map unit name will include texture of surface horizon.

Your score(s) soil 1 soil 2 soil 3

2. Texture of subsoil (B horizon). If there is no B horizon, consider the character of materials within approximately 2 feet below the A horizon.	clay, sandy clay, silty clay, silt	10
	sandy clay loam, loam, silt loam, clay loam, silty clay loam	7
	loamy fine sand, loamy very fine sand fine sandy loam, very fine sandy loam	4
	sand, loamy sand, sandy loam, organic materials, and all textural classes with coarse fragment modifiers (such as "gravelly loam")	1

HELP.
Information on subsoil texture can be found in the soil series description text in your soil survey.

Your score(s) _____ soil 1 _____ soil 2 _____ soil 3

3. pH-Surface (A horizon)	6.6 or greater (the A horizon description may include one of the following terms: neutral, mildly alkaline, moderately alkaline, or strongly alkaline)	6
	less than 6.6 (the A horizon description may include one of the following terms: slightly acid, moderately acid, or strongly acid)	4

HELP.
Consult table in your soil survey on estimated or chemical properties,or soil series description text, for information on surface pH. A soil test of soils on your farmstead may also contain this information.

Your score(s) _____ soil 1 _____ soil 2 _____ soil 3

		Score		
4. Thickness of A and B horizons	60 inches or greater	10		
	40-59 inches	8		
HELP. *Consult chapter in your soil survey on soil series descriptions for this information.*	30-39 inches	5		
	less than 30 inches	1		
	Your score(s)	soil 1	soil 2	soil 3
5. Soil drainage class	well drained	10		
	well to moderately well drained	7		
HELP. *Information on drainage class can be found in the chapter on soil mapping units or soil series descriptions.*	moderately well drained	4		
	somewhat poorly, poorly, and very poorly drained; somewhat excessively and excessively drained	1		
	Your score(s)	soil 1	soil 2	soil 3

6. Permeability of subsoil horizon

a. If bedrock is found within 20 to 40 inches of the surface, use the following rank:

HELP. *Depth to bedrock can be found in the chapter on soil series descriptions.*	bedrock at 21–40 inches	3
	bedrock within 20 inches	1

b. For soils other than those with near surface bedrock (6a), determine the permeability of the subsoil horizon. (Refer to answers to question 2.)

	very slow, slow, and moderately slow	10		
HELP. *Consult the chapter on soil mapping unit or soil series desriptions for information on permeability.*	moderate	8		
	moderately rapid	3		
	rapid to very rapid	1		
	Your Score(s)	soil 1	soil 2	soil 3

	Organic matter (%)	Score
7. Organic matter content (Ap horizon or 0–6" depth from surface)	high (4-10%)	10
	medium (2-4%)	7
	moderately low (1-2%)	5
	low (0.5-1%)	3
	very low (less than 0.5%)	1

HELP.

This information can be found in the table on "Physical and Chemical Properties of the Soil" in newer soil surveys. It can also be found in a soil test report if organic matter was requested, or by contacting your local SCS office.

Your score(s) _____ soil 1 _____ soil 2 _____ soil 3

Step 3: Add your seven scores together for each soil you ranked.

	soil 1	soil 2	soil 3
Totals			

Step 4: In the box below, find your score in the listed ranges in the left column. Identify your soil's "potential to protect groundwater" and find the risk rank number assigned to your score.

Total Score	Soil's Potential to Protect Groundwater	Risk Rank
51+	Good	4
41-50	Fair	3
31-40	Marginal	2
0-30	Poor	1

Step 5: Enter risk rank number(s) here:

Soil 1 Rank ☐

Soil 2 Rank ☐

Soil 3 Rank ☐

Step 6: Understand your soil's rank(s).

In a soil with a score of more than 50 points (rank #4), potential contaminants move slowly, allowing them to become attached to soil particles. Sunlight, air, and microorganisms then have the potential to break down the contaminants. The groundwater contamination risk level may be lowered.

In a soil with a score of 30 or less (rank #1), most contaminants move rapidly down toward the water table and are not degraded.

> Overall, the higher your risk rank number, the more likely that your soil conditions **will help to reduce** the risk of groundwater contamination from homestead practices.

Part 2: Evaluating Subsurface and Geologic Materials on Your Homestead

This part looks at the subsurface and geologic materials beneath your homestead's soils. Completing the worksheet will give you a much clearer picture of your site's potential for keeping pollutants out of groundwater.

For example, the soil evaluation might have indicated a moderate potential for protecting groundwater. However, if the soils are fairly shallow and lie over fractured bedrock, the potential for groundwater contamination at the site is probably higher than indicated by the soil evaluation alone.

This part requires only two items of information — your site's subsurface geologic material and depth to groundwater. Unfortunately, information on subsurface geologic material, as well as depth to groundwater, is often difficult to obtain.

- Limited information is available from the soil survey report, although this differs from county to county. This information is usually located in the chapter titled "Formation of Soils" or "General Soil Map Units."

- You can also obtain this information from your well construction report. If the well driller filled out the report correctly and submitted it to the Washington Department of Ecology (Ecology), it should be on file with the Water Resources Program of the appropriate regional office.

Ecology's regional office phone numbers are:

Northwest: 206-649-7235
Southwest: 206-664-0388
Central: 509-575-2800
Eastern: 509-456-2926

Be prepared to provide the legal description (county, township, range, section, and quarter section) of the well's location. If known, provide the year the well was installed and the owner's name at the time. A nominal amount will be charged for copying the logs.

- You can find additional information from other well construction reports in your area, hydrogeological reports and groundwater flow maps for some counties, which are also available from U. S. Geological Survey (USGS). These are generalized maps, though, and may not accurately reflect the depth to groundwater or direction of flow at your homestead.

- Published geological reports for your county may show the type of geologic material in your area. These reports may be available in your local library.

Try not to skip any steps in this section. If you need help, ask your SCS specialist or your county Extension agent or CD employee to help you gather the information and provide assistance in completing Part 2.

If the information for this part is not available, though, you may skip to part 3 on page 10. The instructions will tell you how to proceed without it.

Step 1: Find the information you need—from the soil survey, well construction reports, or USGS reports—to identify the geologic materials beneath your homestead and the depth to groundwater. (Note: The soil survey will indicate groundwater depths only if 6 feet or less from the soil surface.)

Step 2: Match the information on your site's geology to one of the descriptions in the left column on the following page. (You will be choosing **only one description** from the table.)

If your well construction report describes more than two types of geologic material below 5 feet, ask for help in filling out this section.

Step 3: When you have chosen the description that best matches your site's geology, read across to the right until you get to the appropriate "depth to
For example, you may determine from your well construction report that geologic material beneath your homestead consists of 30 feet of coarse-textured, unconsolidated material over fractured basalt bedrock, and that depth to groundwater is 15 feet. Looking down the left column to find your category, and then going across to the right, you see that your rank is "1."

groundwater" for your site. Circle that score for your homestead.

Geological Material (more than 5 feet below surface)		Depth to Groundwater (in feet)			
		0-10'	11-30'	31-50'	>50'
•Fine-textured materials (more than 45' of materials)					
silt, clay or shale		2	3	4	4
•Glacial till (more than 45' of materials)					
silty till, with hardpan (unsorted)	2	3	4	4	
sandy, gravelly till (unsorted)		1	2	3	4
•Unweathered or unfractured limestone or sandstone, igneous (basalt), or metamorphic		2	2	3	4
• Clayey to silty materials over fractured bedrock					
33–45' of materials		2	2	2	3
21–32' of materials		1	1	2	3
6–20' of materials		1	1	2	2
0–5' of materials		1	1	1	1
•Sandy, unconsolidated materials over fractured bedrock					
33–45' of materials		1	1	2	2
21–32' of materials		1	1	1	2
0–20' of materials		1	1	1	1

There may be other situations that do not fall into the above categories, such as unconsolidated materials over shale/sandstone sequence. Determining a rank for such situations requires a judgment call.

Step 4: Enter your circled number here: **Geologic Rank**

Step 5: Understand your geologic rank. The table below shows what your rank means.

Rank	Level of Risk of Groundwater Contamination
4	Low
3	Low/moderate
2	High/moderate
1	High

A rank of "4" shows that the subsurface material has the best potential to protect groundwater. This material has small pore spaces, groundwater is at least 30 feet from the soil surface, and the risk of groundwater contamination is low.

A ranking of "1" indicates a material with poor potential to protect groundwater. Its large pore spaces allow contaminants to move downward easily, increasing the risk of groundwater contamination. In highly fractured rock or in very gravelly materials, the depth to groundwater doesn't seem to matter, because some contaminants will flow through the pore spaces with very little slowdown.

Overall, the higher your rank number, the more likely that your homestead's geologic conditions and depth to groundwater **will help to reduce** the risk of groundwater contamination from homestead practices.

Part 3: Combining Your Homestead's Soil and Geologic Rankings

Combining the rankings from parts 1 and 2 will provide you with a good overall ranking of your homestead site's potential to keep pollutants from moving down to groundwater.

Step 1: Transfer your boxed rankings from the soil evaluation (part 1, page 7) and the geologic rank (part 2, page 10) to the boxes below:

Soil 3 Rank ☐

Soil 3 Rank ☐

Soil 1 Rank **Geologic Rank**

Step 2: The table below shows the overall level of groundwater contamination risk associated with your homestead site conditions. Find your two numbers **written in the correct sequence** (soils rank—geologic rank) and circle the sequence.

Level of Risk

Low Risk (Rank 4)	Low-Moderate Risk (Rank 3)	High-Moderate Risk (Rank 2)	High Risk (Rank 1)
1-4	1-3	2-2	1-1
2-3	3-2	4-1	1-2
2-4	4-2		2-1
3-3			3-1
3-4			
4-3			
4-4			

Step 3: Look above the sequence you circled to find your risk level and your rank. (For example, if your numbers are 3-2, your site is in the low-moderate risk column and your rank is 3.)

Step 4: Enter your combined rank here. (If you calculated more than one soils ranking, calculate a combined ranking for each soils ranking.)

Combined Rank 1

Combined Rank 2

Combined Rank 3

Step 5: Understand your combined rank.

For instance, a site with a combined rank of 4 (low groundwater pollution risk) will have a soil with a good capacity to hold and break down contaminants. Its subsurface conditions will also keep contaminants from reaching the water table. Under certain conditions, however, such as spills, heavy rainfall, or poor management, contaminants may reach groundwater.

On the other hand, if you carefully manage a site with a combined rank of 1 (high groundwater pollution risk), you may not affect your drinking water. **Both site characteristics and your management practices are of equal importance.**

Your three site ranks (soils rank, geologic rank, and combined rank) will be used again in worksheet 12. They will be combined with your risk rankings for specific activities from the 10 assessments (such as pesticide handling) to give you a more accurate assessment of potential groundwater contamination on your homestead.

If you have more than one soil on your homestead, you will need to transfer individual soil ranks and combined ranks to worksheet 12. It will be especially important for you to complete part 4 of this worksheet if you have more than one soil on your homestead, so that you can link particular site vulnerability with each homestead activity.

Part 4: Learning More About Your Site

You may now proceed with part 4 of this worksheet, or you may go directly to worksheet 12.

Sketching a diagram of your homestead can provide useful information to help you understand how the physical layout and site characteristics of your homestead may contribute to, or lessen, the effects of possible contaminants reaching your drinking water.

The diagram can show the location of wells, septic drainfields, manure storage areas, direction of groundwater flow, surface water, buildings, and other sites of activities that may contribute potential contaminants. Along with the soil and subsurface evaluations, the diagram will help point out aspects of your homestead that may present a hazard to your drinking water.

Step 1: Begin by looking at the sample diagram on page 13.

Step 2: Diagram your homestead on the blank grid provided on page 14. Include all of the following that apply to your homestead.

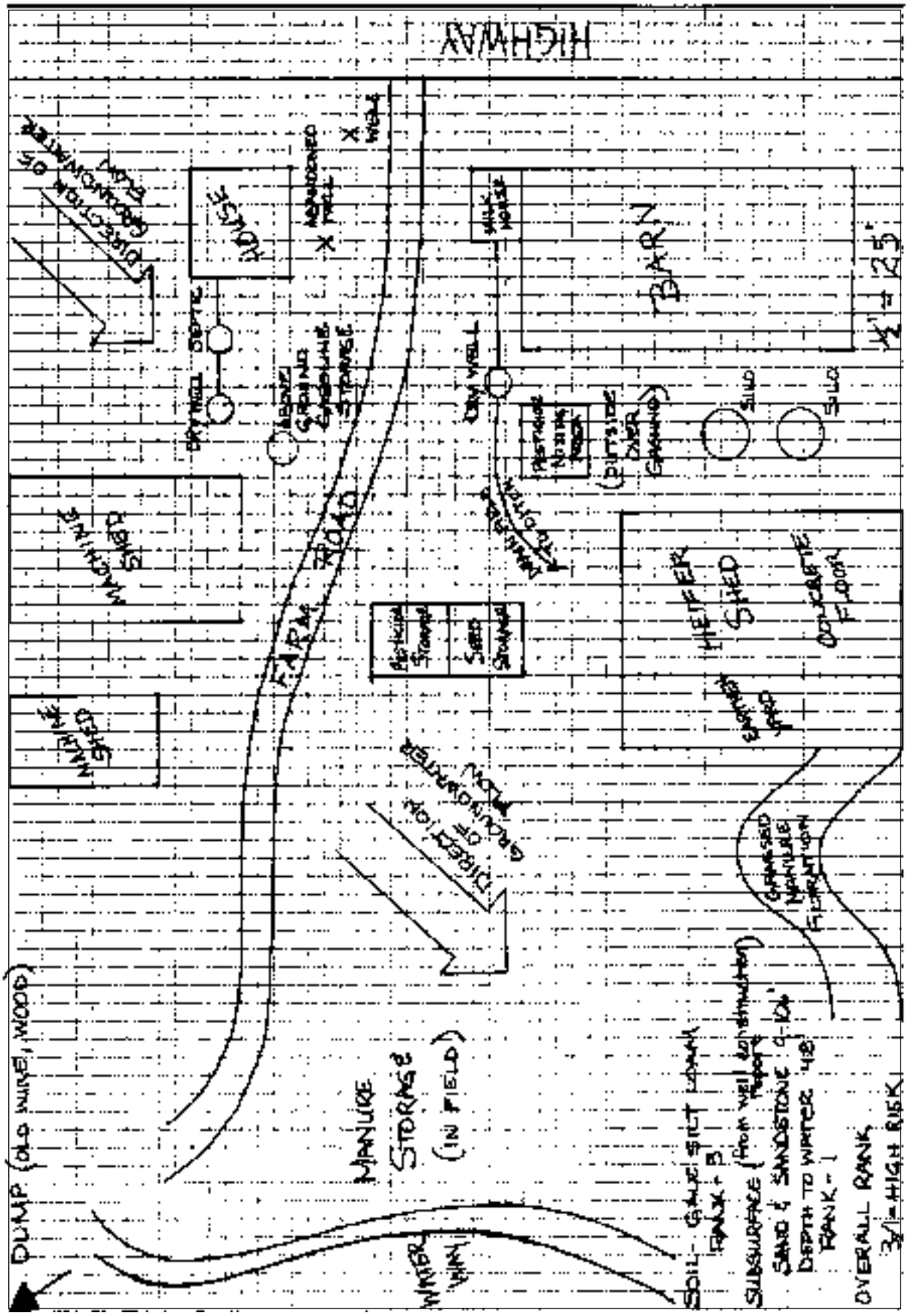
- all buildings and other structures (home, barn, machine shed)
- wells and unused wells
- septic system (tank, dry well, absorption field and/or ditch)
- animal lots (current and/or abandoned)
- manure storage (temporary and permanent)
- underground petroleum storage tank
- above-ground petroleum storage tank
- pesticide and fertilizer storage, handling, and mixing areas
- silage storage
- milkhouse waste disposal system (tank, field and/or ditch)
- farm dumps
- vehicle maintenance areas
- liquid disposal areas
- tiles, surface intakes, and open ditches

You can use the same diagram to indicate surface water (ponds and streams), direction of landslope, groundwater flow, and the different soil types found around your homestead. Generally, groundwater follows surface topography and moves downhill towards surface water.

Step 3: Use your diagram to note which activities or structures on your homestead have a greater likelihood of allowing contaminants to reach groundwater. This information should help prepare you to make better decisions about your homestead activities and structures and how they might be affecting your drinking water.

When you've completed the diagram of your homestead, go on to worksheet 12.

SAMPLE HOMESTEAD DIAGRAM



HOME•A•SYST
Homestead Assessment System

The Homestead Assessment System is a cooperative project of Washington State University Cooperative Extension, Washington Department of Ecology, and the U. S. Environmental Protection Agency-Region X.

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Information derived from Home•A•Syst worksheets is intended only to provide general information and recommendations to rural dwellers regarding their own homestead practices. It is not the intent of this educational program to keep records of individual results.

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