CUYAHOGA SOIL & WATER CONSERVATION DISTRICT

Improper Drainage

A Homeowner's Nightmare

cuyahoga SOIL&WATER conservation district

Improper Drainage: A Homeowner's Nightmare

The Reason Why

The purpose of this report is to provide home buyers insight on problems associated with improper drainage. Many of these problems might have been avoided if proper selection of a home site was made before construction.

There is a wide range of solutions to problems of water management. They are present here as concepts and feasible approaches; not as rules or quick fixes. Sound planning and well-designed water management practices make facilities safe, efficient, and useful.

In dry weather, a home may be free of problems. However, one sizeable storm or long period of wet weather may reveal that your house is in a flood plain or on soil with a high water table, causing basements to flood, surface water to pool, or cracks to form in outside walls of your home.

Building limitations exist for some soils. See page 2 of this report for more information on these limitations. Soil limitations do not always prohibit all types of structures. Instead, the limitations are often used to select the correct measures needed to prevent future damage. Remember that soil is the first foundation of your home.

Drainage Around Your Home

The degree and type of soil limitations that affect shallow excavations and dwellings with or without basements may vary from slight to moderate to severe. A **slight** limitation indicates that soil properties are generally overcome. A **moderate** limitation indicates that soil properties and site features are not favorable for specified uses. However, moderate limitations may be overcome or minimized with special planning or design. A **severe** limitation indicates that one or more soil properties or site features are unfavorable and may be difficult to overcome. Construction may require much more effort, special planning and design, and more intensive maintenance which increase costs and cause a project to become infeasible.

Slow soil permeability, excessive water, flooding, seasonably high water tables, surface water ponding, springs and seeps are all sources of wetness. These sources may cause damp or wet basements, flooded yards, ponding, and poor growth of landscaping.

Soil Problems and Solutions

How are soil limitations overcome? Although all soil problems and their solutions cannot be listed here, the following are the most important ones for Lake and Cuyahoga Counties.

Excessive Water

Home and property owners in Northeast Ohio commonly have too much water on their property and there are a number of issues associated with it. Unfortunately, many homes were built on flood plains. In other instances, large amounts of water will saturate soils and raise water tables. A higher water table may lead to basement flooding or increase the likelihood of surface flooding. In such

a case, there is a need for proper land use planning and design that can reduce the effects of flooding and high water tables.

When houses, streets, shopping centers, and parking lots cover large amounts of soil, rainfall infiltration into the ground is drastically reduced. The result is flooding and excess runoff. Adequate stormwater drainage control must be provided to reduce damages. Saturated soils are commonly artificially drained with **subsurface drainage systems** before being developed. (Fig. 1)

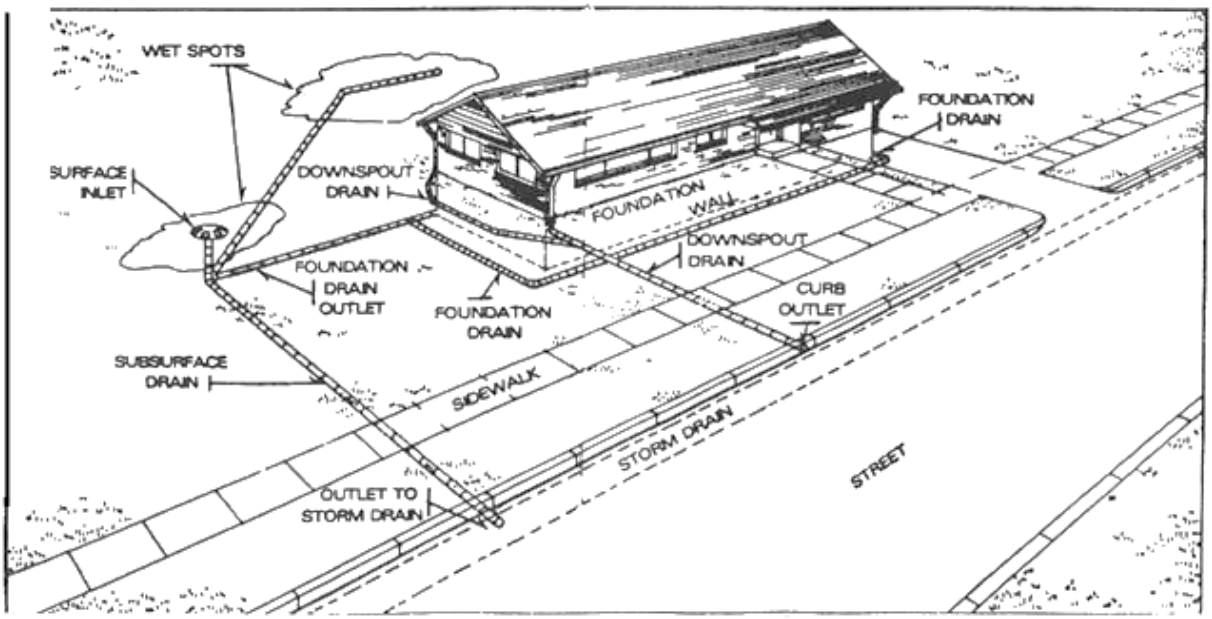

Figure 1: Subsurface drains can be used to remove excess water around your home.

Properly installed drainage tiles around homes can:

1. Improve soil stability
2. Enhance the appearance of lawns and landscaping
3. Make lawn care and maintenance easier
4. Increase property value
5. Eliminate wet basements

In addition to typically being expensive, a drawback to subsurface drainage systems is they can increase the amount of soluble phosphorus entering nearby water bodies. Subsurface drainage systems can also compromise groundwater resources and wetland habitats. Some alternative retrofit projects for dealing with excess water on your property include installing rain gardens and planting trees. Designing subsurface drainage systems so that they discharge into a vegetated swale or similar infiltration cell is another approach that could remove phosphorus and preserve wetland and groundwater resources.

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Ponding Surface Water

For surface water ponds on lawns and driveways, small diversions or ditches can be used to channel water off site. In developed residential areas, these structures are usually installed near back property lines and alongside houses. For low flows of surface water, surface inlets connected to subsurface drains may be installed. Drain outlets may empty into street gutter or storm sewers if permitted by local building codes. Outlets may also be drained into a rain garden, bioretention cell, or bioswale. This approach has additional benefits including reducing stress on sewer systems, which can increase the lifespan of this expensive infrastructure, removing pollutants before they reach nearby water bodies, and reduce treatment costs by diverting stormwater away from treatment facilities.

Grading yards so that water drains away from the house is advisable. A minimum grade of 1 foot per 100 feet of lawn is generally adequate. Use the most permeable soil available when filling in low areas of grade. Save topsoil and spread over newly filled and graded area to help establish vegetation. Vegetating slopes with native plants is a low-maintenance option that can also increase infiltration and, thereby, reduce runoff and erosion.

Installing suitable downspouts to control roof runoff can also prevent ponding in low areas of a lawn. Downspouts empty into subsurface drainage systems or into outlet spreaders, which discharge water into a thin layer over a grassy area. It may be beneficial to disconnect a downspout to drain into a rain garden. Rain gardens are filled with native plants and designed to hold runoff long enough so that it percolates into the soil instead of pooling on a lawn. Native plant roots typically go deeper, which increases infiltration rates.

Springs and Seeps

On many sites, natural springs and seeps occur because of existing soil, rock, or landscape characteristics. Water may flow throughout the year, seasonally, or only during periods of heavy rainfall.

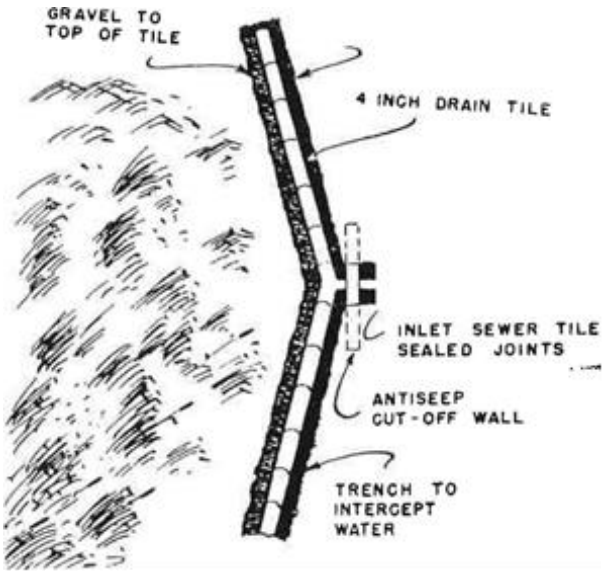

Figure 3: For Springs and Seeps

Water may flow into or around your home if it has been built near or over a spring or seep. For protection, it is good practice to install subsurface drains at least 4 inches in diameter and surrounded by 6 to 12 inches of gravel or gravel-sand mix along the outside of the foundation wall. (Fig. 3)

Springs and seeps also affect lawns and onsite septic fields. Subsurface drains may be installed to collect groundwater and divert it away from these areas.

Subsurface drains are commonly made of clay and concrete tile, perforated plastic, metal, asbestos-cement, or bituminous wood fiber. Check local building codes for approved materials and

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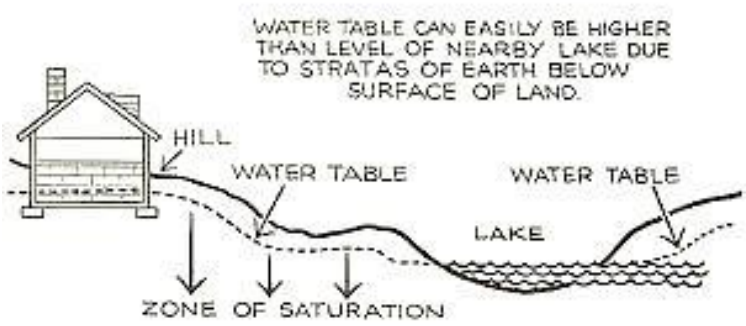
other drainage regulations.



Seasonal High Water Table

A water table can be defined as the upper surface of ground water or the ground level below which the soil is saturated with water. This level may fluctuate by several feet throughout the year depending on the soil, landscape, and weather conditions. In many areas of Northeast Ohio, the seasonal high water table can a foot or less below the ground surface in spring and late fall, and during periods of extended wet weather. On some sites, the seasonal high water table may be at or near the ground surface for long periods. (Fig. 4)

To select the best solution for a high water table, consider the following: 1) You can use a sump pump with a system of subsurface drains to lower the water table. You need a good outlet for the discharge flow from the pump. 2) You can install drains around the outside walls or under the basement floor if this was not previously done. Lowering the water table under the basement floor should be done with caution. On some soils, especially slow draining silts and clays, unequal settlement may cause walls to crack. In most homes that are already built, foundation drains were installed during construction. However, some of the tiles could be damaged or plugged causing improper or no drainage around the foundation walls. Damaged or clogged tiles will result in wet or damp basements and need to be replaced, usually opposite the areas of basement wetness.

Soil Permeability

If the soil at your home site has a dense layer, especially a layer of clay, flow of water through soil will be restricted and cause water to pond on your lawn.

If the dense layer is near the surface, you can dig a small trench through the layer and fill the trench with sand, gravel, or other course material to improve permeability in a small, low-lying wet spot.

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For large wet areas, subsurface 4 to 6 inch drains may be installed at a depth of 2 to 5 feet. Drains should be packed with 6 to 12 inches of porous materials, such as sand or gravel. If available, sand and gravel can be used to backfill the drain trench to within a foot of the ground surface. Topsoil can then be used to fill the surface layer. (Fig. 5)

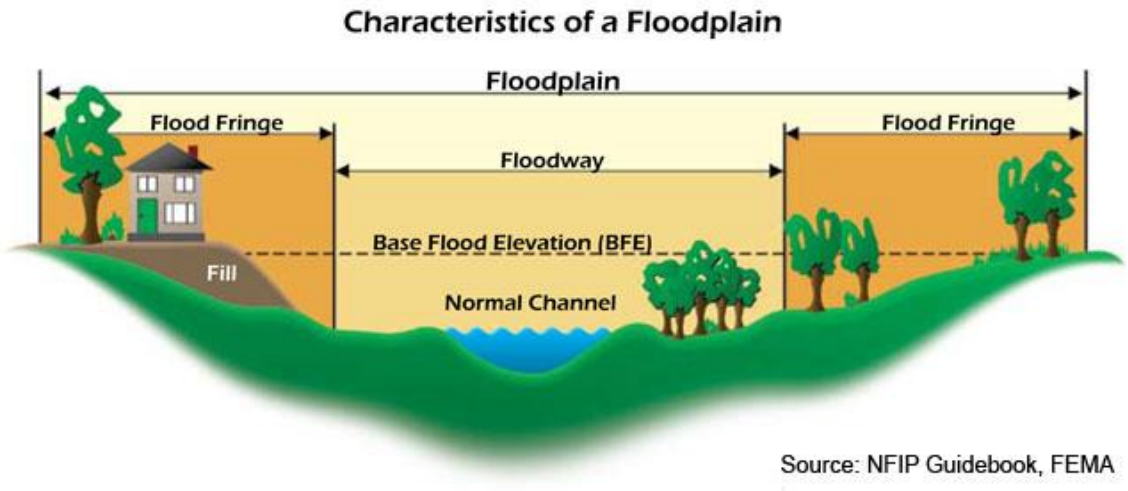
Figure 5: French drains can be used to improve permeability

Even on well-drained soil, heavy foot traffic during wet periods leads to soil compaction and reduces permeability. Restricting foot traffic in a wet yard helps prevent soil compaction.

Flooding

If your home is in the flood plain of a nearby stream or creek, it may be flooded if the stream overflows during periods of heavy rainfall or rapid snow melt. Usually, community-wide measures are needed to ensure adequate flood protection. Flood-proofing your basement may reduce damages, but not for all floods. Flood-proofing measures include diking, provisions for blocking openings such as windows and doors, regulating drain outlets, and waterproofing walls. Flood-proofing measures can be expensive and require careful evaluation to prevent structural damage.

Structural measures (dams, levees, channel improvements, dikes, walls and diversion structures) have been employed for protection from flood hazards. In spite of these efforts, average annual flood damages have continued to increase. (Fig. 6)



In upland areas, flooding can occur if your house is built in the path of a natural drainage way or in a pothole or site that is lower than surrounding landscape. A drainage way or low area may appear safe in dry seasons. In housing developments where the landscape has been greatly modified,

natural drainage ways are often blocked or altered. If the constructed drainage ways or storm sewers are not built to carry the seasonal flow of water, nearby homes may be flooded. Runoff from areas as small as one acre can cause flooding. Measures to remedy this kind of hazard usually require the cooperation of several homeowners or even multiple communities.

Wet Basements

Water generally enters a basement in one of two ways: 1) through the basement walls or 2) through the joint between the basement wall and the floor.

1) If water is entering through the wall, the parging (exterior mortar coat) or waterproof seal is cracked, too thin, or missing. This can be checked by digging a hole on the outside of the wall where the worst interior leakage is taking place. If you can identify where the parging or wall is cracked and it is concentrated, spot repairs can be made with a mortar mix followed by an asphalt sealing. If the parging or asphalt seal is missing and the leakage is widely distributed, a specialized contractor will need to be hired to expose the exterior wall and do the necessary coating. If the wall is merely damp on the inside or seeps can be located, a waterproof sand-cement coating can be applied to the interior wall.

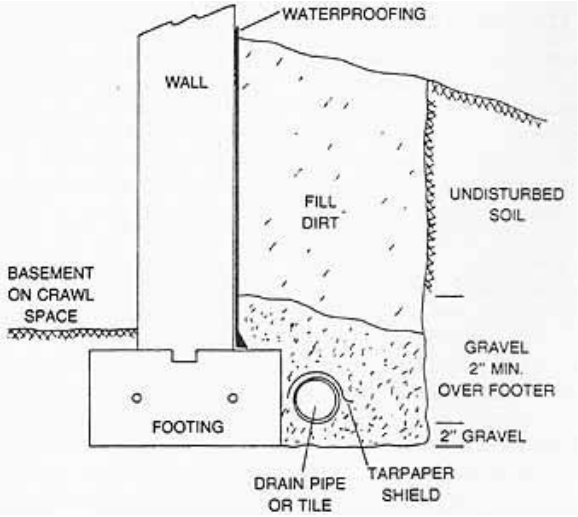


Figure 7

2) If water is entering through the joint between the wall and the floor slab, or through cracks in the floor, you have water under pressure beneath the floor. The first thing to do is check for the presence or absence of footing drains. If you don't have construction drawings of the wall footings, try to get them from the builder or your city's building inspector office. Footing drains may be installed inside or outside the footings, as shown in the following sketch: (Fig. 7) If improperly installed, subsurface drains should function well for many years. Most failures can be prevented with proper care and regular maintenance.

Trouble Spots

Being aware of problem spots is important. Soil that washes into subsurface drains can block the lines causing them to become ineffective. Also, small animals or tree roots can block drain lines if they are not properly protected. If tile lines are channeled into an open ditch, an animal guard should be placed at the end of the tile to keep out small animals.

Trees in the landscape can be destructive to subsurface drains because of the root system. This is especially true of elms, willow, and cottonwoods. Roots of trees a hundred feet away may block a subsurface line. To protect the drain, short of killing the trees, clear out the roots around the drain and

lay continuous pipe in the part of the line likely to be affected. (Fig. 8)

Avoid use of heavy equipment over or across tile lines. Heavy equipment may dislodge or break tile or tubing. Washouts occur when gaps between tile are too wide or where junctions are not properly made. Wet spots, usually form where a line is blocked, and a hole or cave-in over a drain line generally indicates that a tile is broken or dislodged. Wet spots over drains made of corrugated plastic tubing usually are caused by a crushed spot or puncture in the tubing.

Subsurface drains are working if water remains on your lawn for only a short time after a heavy rain. If water stands in low areas for a few days, the drain is partly or completely blocked. If the drainage system has inspection wells, silt wells, or manholes, watch them and the outlets after a heavy rain to check the amount or rate of flow.

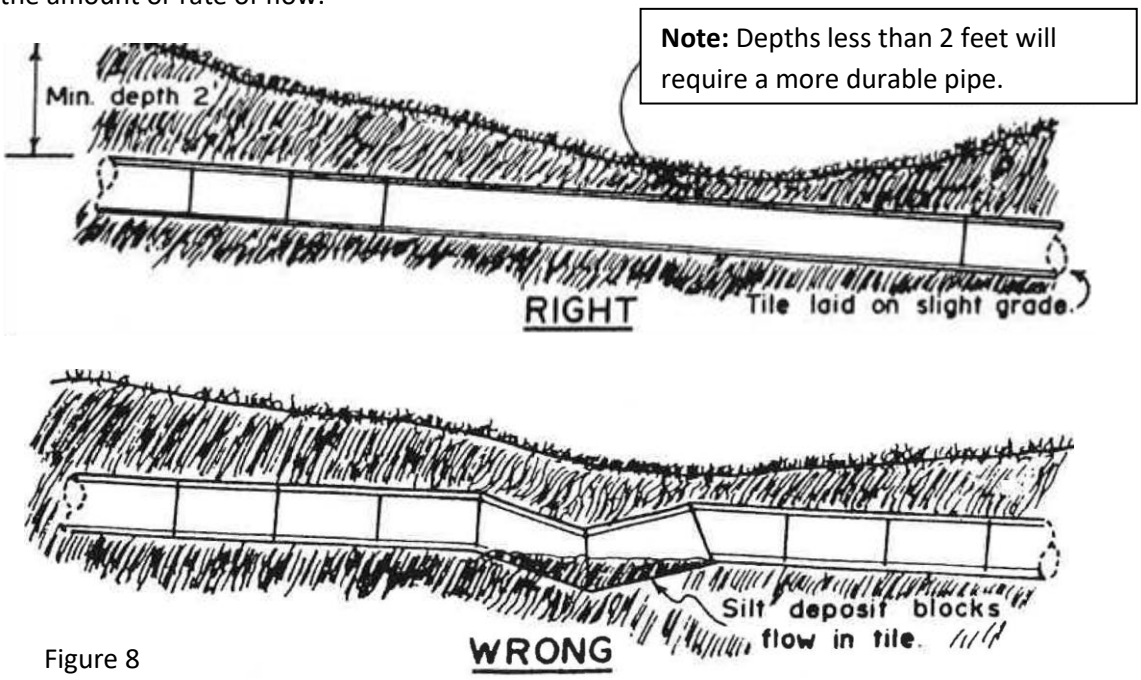
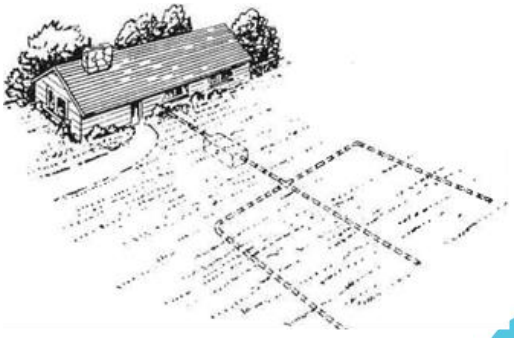


Figure 8

SOILS AND SEPTIC TANKS

How long and how well your sewage disposal system works depends largely on the absorption capacity of the soil. The effluent must be absorbed and filtered by the soil; otherwise unfiltered sewage may reach the surface or may contaminate the ground water. Unfiltered sewage that reaches the surface smells bad and attracts flies and insects. These fly- breeding areas can be the source of diseases.

WHY ABSORPTION FIELDS FAIL



Inspection by sanitary engineers have shown that sewage absorption fields fail to work properly mostly because the soils either are poorly drained or are so compacted that the absorption rate is very slow. (Fig. 9)

Poorly drained soils are saturated with water during wet weather and in some places for long periods

after heavy rains; there is no place left for septic- tank effluent. Absorption fields on such soils may function well in dry weather and fail to function in wet weather.

If a soil has a very slow absorption rate, the effluent may rise to the surface even in dry weather and in wet weather the absorption field usually is a boggy mess.

Absorption fields also fail because the land is too steep, there is a seasonally high water table, there is only a shallow layer of soil over bedrock, there is a cemented layer of soil just below the trench bottom, or the area is flooded periodically.

If any of these conditions exist on your property; contact your local health department.

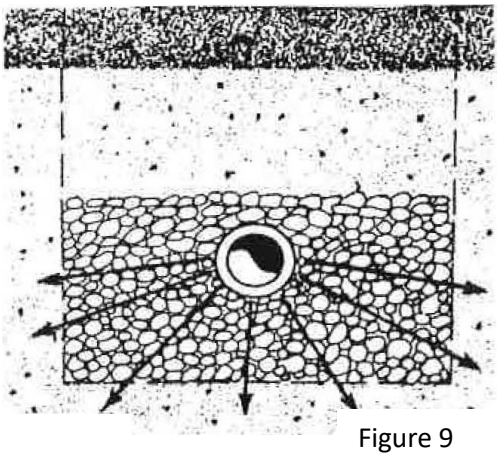


Figure 9

In a conventional septic-tank absorption field, drain tile is laid in trenches. (Top) The tank and tile are covered with soil, and the area is planted to grass (Middle). The effluent from the tank is carried through the drain tile to all points of the field where it is absorbed and filtered by the surrounding soil. (Above)

WHY LANDSLIDES OCCUR

Landslide is a common word meaning the mass movement of soil. The movement of soil on slopes may assume many forms. Landslides may be several hundred feet long and many feet high, causing hundreds or thousands of tons of soil to move. Minor landslides or soil slips may only be a few feet long and a few feet high.

Landslides occur when the forces that cause the soil to move overcome the resistance to movement. (Fig. 10)

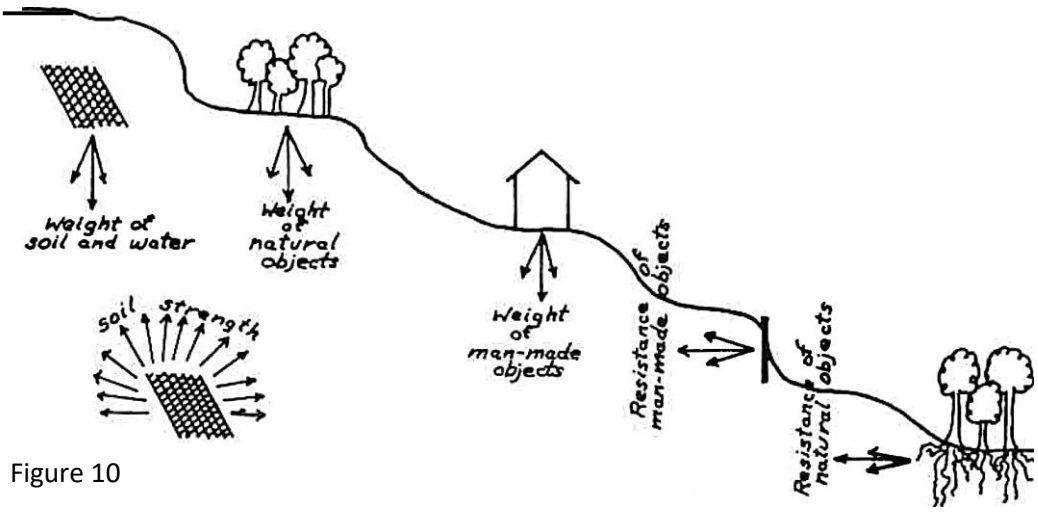


Figure 10

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A change in any of these factors can start a landslide. Heavy precipitation may increase the weight of the soil, and decrease soil strength at the same time. Buildings, highways, or deposits of fill material can increase the downward forces on soil. Man-made objects such as retaining walls can resist the movement of soil. However, the resistance of tree roots to soil movement is slight, and the weight of large trees usually is a greater hazard than any benefit from their root systems. Natural streams often undercut the base of slopes, removing basal support of the soil and starting landslides.

Human-related causes of landslides:

1) Steep cuts in hillsides while building roads and houses.
2) Allowing leaks in water and sewer lines to persist, saturating the soil over a long period of time.
3) Putting excessive weight on slopes by building structures, or spreading fill to develop more level land for buildings.
4) Changing the course of streams or adding to their flow, causing undercutting of slopes.

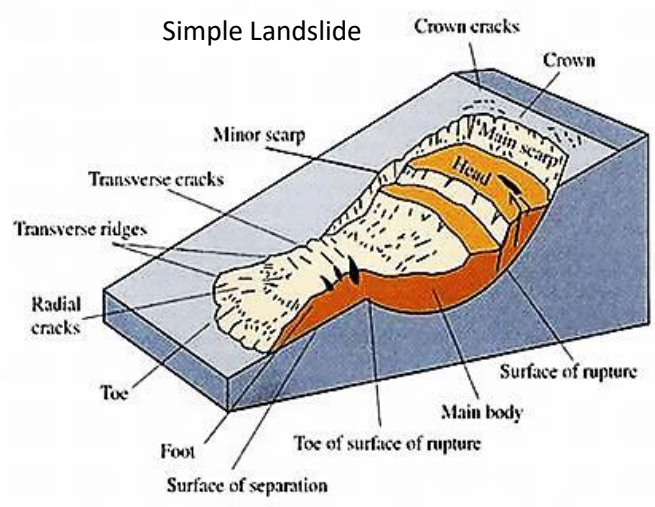
<u>How Landslides Occur</u>

Potentially weak zones occur in many soils on sloping land because of the natural structure of soil or the presence of layers of different kinds of material. For example, many clay soils contain layers of silt or very fine sand. During heavy precipitation, water percolates down to potentially weak zones, lubricating the soil and reducing its strength. The weight of the overlying soil then forces part of the slope to slide along the weakened slippage plane. There may be one or many such zones of weakness.

Slumping slope

Transverse cracks develop at the top of the slope, perpendicular to the direction of the slide. The slide may occur very slowly- even over a period of months or years- or it may occur rapidly within a few seconds. The soil moves down and out from the slope. Soil originally at the base of the slope may be pushed out and up, forming a ridge at the base of the slope. The top of the slope drops, forming a vertical cliff at the location of the transverse crack. In a complex slide, there may be several areas of the cliff-intermediate slide- basal ridge sequence.

Simple Landslide



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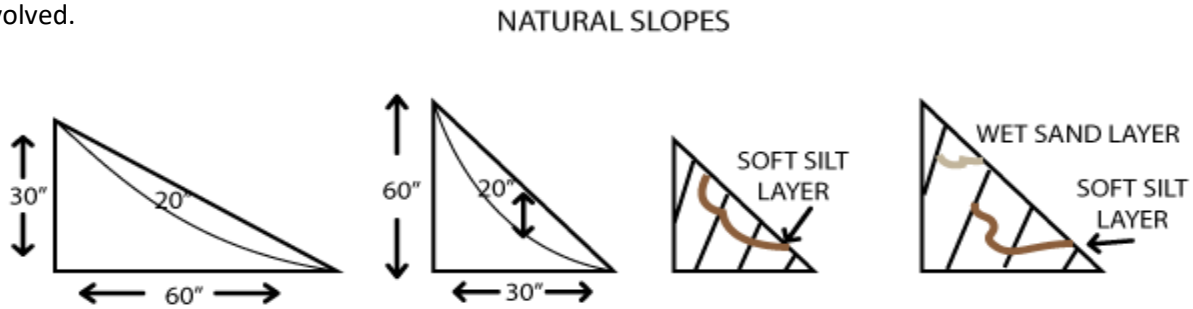
Slippage planes or potential zones of weakness may be very deep in the soil. Theoretically, the longer and steeper the slope, the deeper the slippage plane will be. In natural soils, with layers of different material, the slippage plane may actually occur at any position, depending upon the soil stratification. Soil slump is the breaking away of a mass of soil which falls away from the slope. There is no sliding involved.

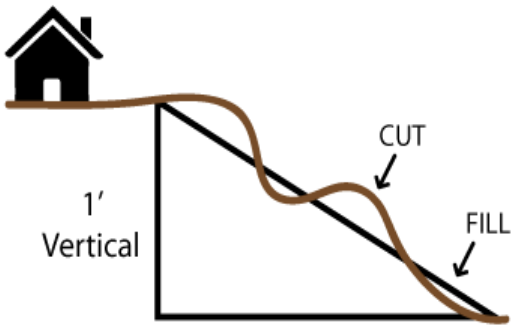


Precautions

1. Do not place structures on new fill material recently pushed over the edge of a slope.
2. The longer and steeper the slope, the greater the distance from the edge required for safety of structures.
3. Do not attempt to restore severe slides without technical assistance.
4. Do not attempt to regain land by filling on top of a slide.
5. Do not place organic debris or other lawn and garden waste on a slide. The organic material acts as a mulch and retains moisture in the soil.
6. Do not remove soil from the toe of a slope.

Alternatives

There may be alternatives for correcting landslides to the retaining wall if structures are not endangered and the slide area is not large. Re-grading the slope is one alternative if there is sufficient distance from immovable objects. Re-grade to no less than 2:1 slope and be sure to vegetate to prevent erosion.



Slopes can be benched or terraced to increase their stability with a retaining wall on each vertical lift. This also requires sufficient lateral distance from immovable objects. Drainage of seeps or springs may be necessary. In some cases, it may be possible to use established vegetation to stabilize regarded slope. This has the added benefit of preventing erosion.

These solutions are satisfactory only on short slopes and small slides. It is advisable to secure professional advice before selecting a method of preventing or correcting a landslide

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EVALUATING LANDSLIDES

Landslides are complex problems requiring solutions for soil drainage, unstable soil, reshaping of slopes, and vegetative cover. The technical knowledge necessary for the solution of landslides often requires the aid of civil engineers, soil conservationists, soil scientists, and agronomists. It is desirable to consult technical experts upon recognition of a problem.

SPOTTING POTENTIALLY UNSTABLE SLOPES

Analysis of the various causes of landslides has shown that the problem is complex; and it is difficult to predict if a specific site will slide, and when. Visual observations across a wide, broad area will determine if the area is landslide prone, and thus yield information having bearing on a particular site.

Slopes steeper than 15 percent - 15 feet of fall per 100 feet of distance - have a potential for sliding. In many areas, there are indications that landslides have occurred in the past. These surface features are:

- **Hummocky ground** - This is one of the easiest clues to recognize. On slopes, it forms irregular ripples, or surfaces that may even tilt backwards into the slope.
- **Bare scarps** - A steep scarp forms at the head of a rotational type slump. Subsequent erosion can obliterate it.
- **Tilted trees** - Tilted or leaning trees and utility poles indicate past or present soil movement.
- **Seepage** - Water plays an important part in causing landslides. It may be seen seeping out of the ground at the scarp and toe of a slide. Seepage of water is not by itself a clue of an impending slide, but is evidence to be used along with other clues.
- **Cracks** - Cracks may appear in the soil because of soil movement. They can be parallel to and/or perpendicular to the slope.

RETAINING WALLS

The basic solution for a landslide is the retaining wall. Walls consist of various types of materials, but there is one common pattern of construction sliding. The vertical supports provide the resistance to sliding. The supports commonly are steel piles driven into the slope by a pile-driver. They must extend a sufficient distance below the slippage plane to resist being overturned by the downslope forces of the soil. The horizontal wall spreads the resisting force of the steel piles over the face of the slope. Subsurface drainage may be needed behind the wall to remove excess soil water. Other materials often are employed in constructing retaining walls. Some other materials are reinforced concrete walls with concrete buttresses, combinations of steel and concrete, and wood.

Retaining walls are very expensive to construct. Concrete and steel walls may cost several hundreds or even thousands of dollars per linear foot, even for walls of moderate height. Design and construction of retaining walls require the technical assistance of soil and foundation engineers. Large retaining walls are not projects within the financial or technical scope of the average individual.