EXTENSION

Addressing Drainage Issues in the Urban Landscape

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The Problem

Weather and climate variability are expected to continue with increased and perhaps more intensive rainfall followed by short- or long-term dry periods. Urban landscapes (yards around houses and other areas within neighborhoods) are highly susceptible to increased rainfalls due to the presence of impervious areas (roofs, driveways, streets, sidewalks, etc.) where water cannot move into the soil, pushing more water downslope and into available channels or ponded areas (Figure 1). If drainage of the expected excess rainfall is not planned for in advance, the potential for increased flooding and perhaps erosion become an even greater problem. Poor drainage also can result in salt accumulation, which negatively impacts the health and appearance of vegetation if salinity levels exceed vegetation salt tolerance.

Drainage problems can be tied to a combination of factors including the hydrology, soil properties, grading, slope, vegetation and mulches being used in the landscape. Drainage issues can occur as a combination of runoff problems (with erosion), too much water in the soil (soil at saturation – no more space for water or air in the soil) or perhaps seeping of water from the soil near the bottom or toe of a slope (water in the soil exceeds saturation, cannot go deeper, so emerges back to the surface). A variety of options can be used to fix drainage problems, including ditches, culverts and drains, French drains, riprap, terraces and other low impact development approaches. These practices vary in cost, effectiveness and required maintenance. Appropriately addressing individual drainage problems, while not creating an even greater problem for a neighbor (especially those down-slope) is the goal of effective drainage management. If you are downslope from other landowners, the problems may be increased as those individuals upslope attempt to deal with their excess water issues. If the land surface is flat, water may have few options to leave your property, resulting in drainage problems that may require significant investment to help remove excess water or to build up the land surface above a high soil water table.

Figure 1. A landscape area with a significant ponding problem. Appropriate alternatives for this significant ponding problem, with existing large trees are discussed in drainage problem 1.

This document describes some consistent problems and potential solutions. Some background information is provided for those who wish to know more about why these problems are occurring. Drainage issues tend to get worse as the storm events become larger and as open lands upslope from your property are developed. In all cases, a qualified landscape contractor will be necessary to directly solve or improve drainage problems. How do you find a qualified and effective landscape contractor? Good question. In most cases, a qualified landscape contractor (including those specializing in grading land surfaces) has examples of problems they have helped solve in the past and can show you images of similar problem areas before and after installation of drainage practices. Such contractors should also have an understanding and will tell you what needs to be done to maintain improved drainage practices through time. Reading through the following problem scenarios and explanations below may generate some valuable questions to help you select an appropriate landscape contractor. Advice about drainage problems may be available through the local OSU Extension office.

Additional resources to this fact sheet are indicated in the Reference/Resource section below. Those resources that apply to other needs beyond drainage but relate to similar processes are not repeated in this document. Particular fact sheets of importance include: A Guide to Saving Water in the Home Landscape, Establishing a Lawn in Oklahoma, Selecting a Lawngrass for Oklahoma and Water Wise Landscape Principles for Oklahoma, which provide specific and general principles related to improved drainage conditions. Other resource materials are referred to in the following sections.

Selected Drainage Problems

The following scenarios have been investigated by several different individuals tied to the OSU Extension. Recommended solutions are not the only alternatives to deal with the problem. Good landscape drainage contractors should have more suggestion. Contractors also should provide a breakdown of the costs and effectiveness of each solution, along with an estimate of how long will take to complete. When characteristics/components are mentioned that might not be familiar to you, please refer to the listing of some definitions within this document and other sources (on-line or through a local library).

Problem 1

There are wet spots in my yard during the last few years when the rain has been more consistent and heavier. My dogs seem to increase the problem by tromping through the muddy areas and making the problem worse (Figure 2).

You could be experiencing several different problems at the same time. Your home and/or garage roof area are considered impervious, so all the rainfall hitting those surfaces must be spread out on the remaining landscape, or perhaps is concentrated through a gutter downspout system (Figure 3). Furthermore, if any areas of concern are shaded, those areas sometimes retain moisture longer during wet spells due to reduced air movement and reduced evaporation. Too much water coming off a roof in a single spot, or being downslope from a larger area can make the problem worse. Many soils in Oklahoma have little sand content (larger particles than silt or clay) and the soil structure is not solid (the soil does not hold together when wet). In many cases, you can attempt to remove the excess water or “build up” the soil in this area with sandy loam or loamy sand type soil with a better capability for drainage. Each alternative is costly, but adding a more drainable soil to the area can help reduce the visible problem. The water table will still exist, but the better structural soil above the water table will provide a firmer base for plants and animal traffic. The type of grass present in your yard also could be a problem. Some grasses stand up better to flooding, including improved yards and even natural grass mixes. No typical landscape grasses will hold up under long-term

Figure 2 Muddy yard with increased problems based on large dog traffic. Small moguls are sandier soil laid over clay soils.

Figure 3. Connecting downspouts with drains can help in routing water away from the foundation of the house to a location better suited to handle the large volume of water deposited on-site during heavy rainfall.

flooding, although Bermudagrass rhizomes (below the soil surface) and some other grasses will survive longer under surface flooding, allowing grass to re-emerge from the soil after flooding ends. Some grasses do better in direct sunlight while others work better under trees in more shaded situations (See: Lawn Management in Oklahoma, Lawn Watering Tips and Managing Turfgrass in the Shade in Oklahoma).

Problem 2

I live downslope from several neighbors, and the natural drainage pushes all the water from my neighbors properties through my yard. Some of my neighbors have raised their soil surface so the water ends up in my yard. Erosion and grass loss are occurring. I even had a French drain installed, but that system becomes overwhelmed very quickly during a rainstorm.

We realize this scenario may not perfectly fit your drainage situation, but the complexity of problems are consistent throughout many parts of Oklahoma. Many neighborhoods were not designed with a designated drainage pathway (or ditch), so the problems seem to get worse over time, especially as more houses are built upslope or new garages/out buildings are added. You can't really afford to build up your land sufficiently high to push all the drainage water away from your property.

First, you might accept the fact that you are in a position in the landscape where water flows through your backyard during rainstorms. Start with good soil structure and an appropriate mix of grasses and mulches. If the right grasses are selected (ones that are improved and maintained, or ones that handle shade and running water more effectively), some of the problems can be dealt with more easily. If water is ponding and the grass is dying, better grading or even a surface drain might be required. A surface drain would have a pipe to move that excess water to the road or an exit point not affecting neighbors. The worst case scenario would be to install a more structural drainage pathway (gravel, concrete, pavers, culvert, etc.) where the flow is concentrated and directly protects the surrounding land surface.

Problem 3

The drain field from my septic system is squishy all the time, but especially after extended or long-term rainfall periods. The location of my drain field is downslope from a large area from a neighbor's yard.

If the drain field has been present for a long time, the combination of a high water table from water infiltrating upslope and from the septic system can super-saturate the soil (where water comes to the surface). If the drain field area seems squishy all the time, even when other areas are dry, the drains may be clogged, forcing water upward instead of laterally and downward into the soil profile. First, have the septic system and drain field checked by a qualified individual. If the system is still functioning correctly, a high water table may exist from areas beyond the drain field. In such cases, an interceptor subsurface drain may be required upslope from the drain field, if such a space is available. The water table can be reduced in that area before reaching the drain field. The interceptor drain line will need an outlet (either back to the surface, or perhaps a dry well). If no alternatives for such an interceptor drain are available, raising the soil surface with a sandy loam or loamy sand type soil may be a practical solution.

Problem 4

I bought a home with an existing waste treatment system that includes sprinklers in the back yard. The system seems to run all the time, and creates a very wet/muddy area (also made worse by the presence of dogs). The sprinklers are those impact type, which are less expensive, but also a very desirable play toy for the dog(s) (Figure 4).

For this scenario, asking a few more questions might help determine a better course of action. How many individuals are now in the household compared to the previous owners? More individuals will put more pressure on the waste treatment system (regardless of the type), and it will spray more often or longer (based on a float valve and perhaps a timer on the sprinkler system). If you have the space to add another sprinkler, such an alternative is valuable to help spread the water application. Using gear driven rotor-type sprinklers may give you a little more throw distance for the sprinklers under the same pressure, thus spreading out the area of individual sprinklers. Raising the soil surface with a sandy loam or loamy sand type soil also may provide an alternative to muddy areas from this particular problem, especially if the soil type is primarily clay with less structural stability. Grass alternatives are mentioned in several other scenarios, the section on grasses below and in related fact sheets.

Figure 4. Waste treatment system impact-type sprinkler for distribution of treated waste. The dog has also broken the sprinkler head, causing added water problems.

Problem 5

I have a drainage problem next to the house. Water ponds adjacent to the house based on the roof and/or presence of downspouts from the gutter system.

Soils should slope outward from a house. In some cases, settling or other landscape activities might reduce the slope, causing water to pond adjacent to the house. Settling and perhaps subsidence (break down of organic matter in the soil) could also create the lack of slope away from the house. Care should be taken to not build up soil levels beyond the structural support for the house (cinder block or concrete). If brick, insulation and or wood studs are directly behind the area you intend to build up to create the slope, you may end up with even bigger problems as those surfaces remain moist. Interceptor drains may be required to help move water away from the house if the soil surface cannot be raised. As mentioned in previous sections, a good top soil (loamy sand or sandy loam) can help reduce the problems of cracking clays (high shrink/swell potential) directly adjacent to the house. Downspouts from gutters can be fixed with drains (inlets where water is transferred downslope) or other devices (reel-type socks) to help move water away from the house. Installing rain barrels also can help with capturing and storing part of the stormwater from rooftops. This stored rainwater can be used later for irrigating lawns and gardens. Be careful using rain barrels in areas with high annual rainfall and make sure a good bypass is available when the barrel is full/overwhelmed by particular rainfall events. Unfortunately, when rainfall is happening and filling a rain barrel, the need for the rain barrel water is delayed until the ground begins to dry out. Each alternative will have required maintenance and care to ensure water pathways remain open.

Problem 6

I have water under my house (foundation on piers).

This issue could have a variety of potential problems, and what follows will attempt to address the most common issues. Many houses on a downslope area may experience some water issues below a house based on recent long-term rainfall events and generally more wet conditions. If a high water table exists in the yard, a house on piers may exhibit those same high water table conditions under the house. If the water "resurfaces" under the house (seepage face back to the surface), problems can be created for wet conditions, termite and other pest habitats (see the next paragraph). Presence of water in a road with no other source (irrigation, recent rainfall, etc.) and wet soil surfaces near the curb are signs of high water table (Figure 5). If the water table is below the soil surface, but you can dig a small hole and reach that water table, the general suggestion is: don't dig holes under your house if you might have a high water table. Keep a dry soil surface under the house if possible. If soil is damp, cover the soil under the house in plastic sheeting (something thicker than a thin plastic drop-cloth for painting) to create a vapor barrier. Some recommend doing the vapor barrier directly under and attached to the floor joists. If you have below floor insulation, many of the bat-type insulation approaches have a vapor barrier included. Several companies may provide more expensive soil covering approaches designed to create a more consistent seal between the soil and the air volume between the soil and the floor joists. The goal is to minimize the moisture as much as possible around the floor joists and potential insulation. The vents provided for that sub-floor area can help manage air flow. During very wet and cold periods, the vents can be closed. During warmer periods, the vents can be opened to help dry out areas under the house.

If water is resurfacing under the house under natural conditions, an interceptor drain may be necessary (French drain or other approach) on the uphill side. Such interceptor drains must be sufficiently deep and have a good outlet so water will take the path of least resistance through the drain pipe and resurface away from the house.

Figure 5. Seepage faces exist at many areas, where the water table reaches the surface. Water in a road with no other source (irrigation, etc.) detected and a wet soil surface near the curb.

If water persists under the house and pier structural integrity becomes a problem (significant floor buckling or "waves" and/or plaster/sheetrock walls cracking) some effort will be required to remove water and stabilize piers by visiting with a qualified house structural specialist and a drainage specialist.

Problem 7

Soil structure is not good and soil seems to quickly become muddy with very little added water.

If you see a problem with soil swelling (seals the surface, resulting in little or no downward water movement) when it's wet and cracking when it is dry, the soil may have high sodium levels (which is a very common problem for Oklahoma soils). Water accumulates at this spot and salt builds up after water evaporates. Sodium in the soil disperses clay particles and makes it less permeable to water. To determine if this soil characteristic is adding to your landscape drainage problem, a soil sample can be taken and sent forward through the local OSU Extension office for the sodium adsorption ratio (SAR) analysis. Soil dispersion problems also will greatly reduce the infiltration rate by moving fine soil particles into available pore space, plugging up those pores and reducing the potential for water to move into the soil. If sodium level is high, solutions include adding organic matter, such as wheat straw or wood chips to loosen up the soil and improve soil structure, thus enhance infiltration. Since high amounts of sodium absorbed to the soil are the cause of the alkali problem, the sodium must be loosened from the soil before it can be leached out. An economical soil amendment to accomplish this is to add gypsum for removing sodium from the soil particles. Gypsum is a slightly soluble salt of calcium and sulfate. This means that gypsum will react in the soil slowly, but for a long time. The calcium in the gypsum will flocculate soil particles, improve soil structure and allow water to percolate through faster. The gypsum can either be mixed in the soil or surface applied, but the former is more effective. The soil test will recommend the amount of gypsum needed based on soil texture and the SAR. For more information, see PSS-2226 Reclaiming Slick Spots and Salty Soil.

Understand Why Drainage Problems Exist

Hydrology and Excess Rainfall

Understanding excess rainfall is very important to selecting appropriate options for drainage management. Oklahoma has a wide range of annual rainfall expectations. Based on data from the Oklahoma Mesonet, annual rainfall in the panhandle region of Oklahoma may be about 10 to 15 inches per year. Moving towards southeastern Oklahoma, rainfall expectations rise to 35 to 55 inches per year. In all cases, individual rainfall events may be sufficiently large to create drainage problems. Continued rainfall through a period of time may create drainage problems because soil becomes saturated and there is no place for water to go except up and out of the soil.

In a typical landscape (Figure 6), upland areas are where most crops are grown and where housing is usually established. As houses and other structures are placed closer to streams or downslope from the upland areas, issues with drainage can be more pronounced. The combination of factors that help define drainage problems can be complicated. As excess rainfall is defined, we look at the amount of water that does not infiltrate into the soil, or water that has infiltrated, but the soil water-holding capacity is not capable of retaining that water.

The flow of water in rivers and streams can be measured through time and plotted in a hydrograph to show the flood pulse due to a rainfall event (Figure 8a). When it has not rained for a while but the nearby stream keeps flowing, it is mostly because groundwater moves from high grounds to lower elevations, eventually feeding the stream in the form of baseflow. During rainfall events, the portion of unintercepted rainfall that does not infiltrate into the soil due to top soil saturation and elevated groundwater levels, also known as excess rainfall

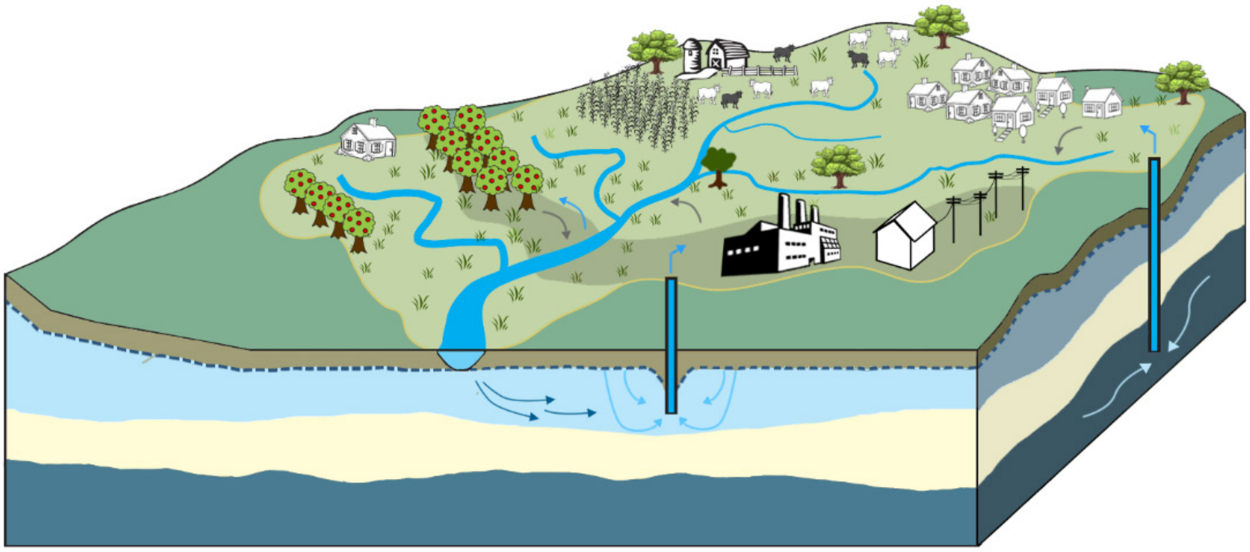

Figure 6. Typical landscape water flow system within a watershed (light green shade), which is an area where water drains to a common outlet. Excess rainfall runs off the land and forms overland flow, which ends up in streams or ponds (From Alian, 2017).

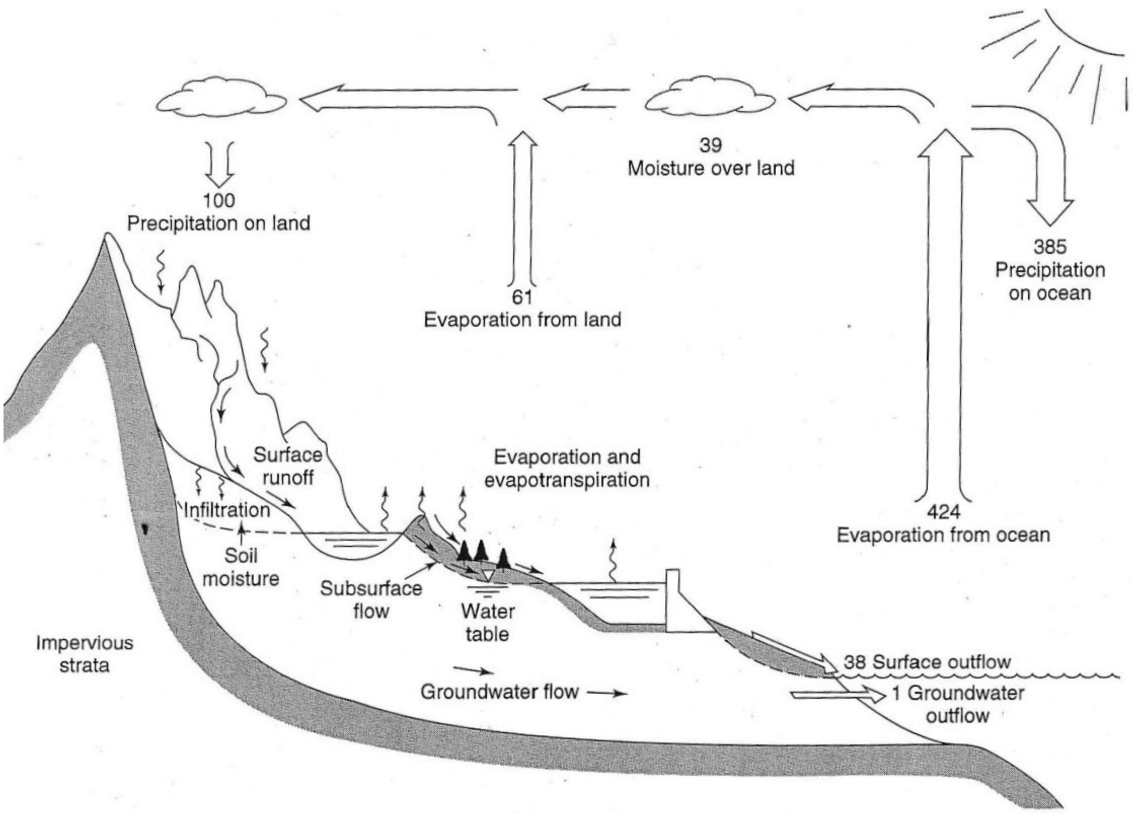

Figure 7. Hydrologic cycle with global annual average water balance given in units relative to a value of 100 for the rate of precipitation on land (From Chow et al., 1988)

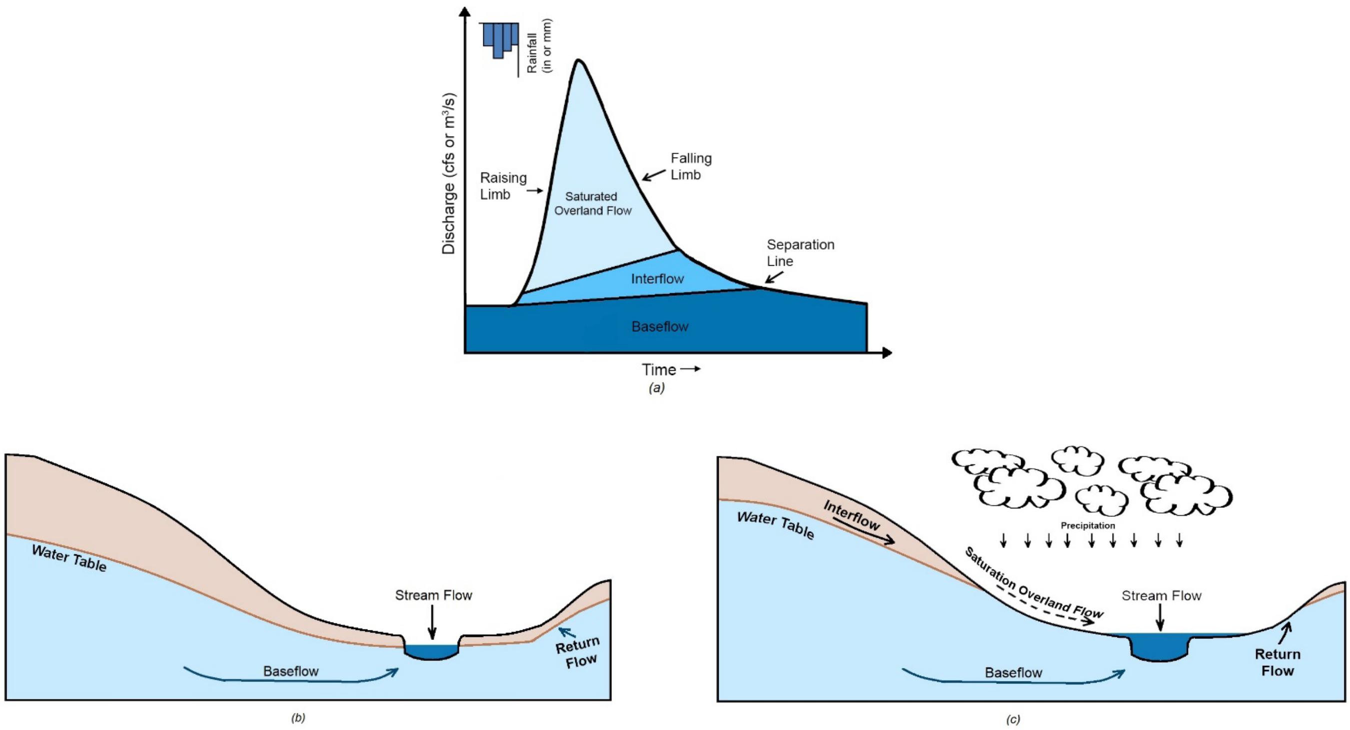

Figure 8. Characteristics of a typical runoff hydrograph (a) from a land area where excess rainfall is separated into different components outside of an excess rainfall event (b) and during an event (c).

(see Definitions on page 8), turns into overland flow (Figure 8b and c). Overland flow across landscape areas, especially poorly drained or saturated soils, causes the stream flow to rise (see rising limb of the hydrograph in Figure 8a). Sometime after the rainfall event, the stream flow starts to fall to go back to base flow condition (falling limb in Figure 8a). Maintaining good drainage conditions within the property will help route a larger portion of rainfall toward deeper soil and groundwater table, which will reduce the risk of downstream flooding.

Soil and Grading Effects

The soil type—especially soil texture (clay content)—and whether the land area was graded correctly have a significant impact on potential drainage problems. With heavier (clayey) soils, the ground typically does not infiltrate very fast, and with a long dry spell, large cracks form. The infiltration rate is directly associated with structure and porosity near the surface of the soil. Very flat soils and landscapes without good drainage design will have problems. In some cases, the soil surface may need to be raised with a loamy sand or sandy loam-type top soil to allow good drainage near the surface. An 8- to 12-inch layer of good top soil can help with surface infiltration and provide a more stable landscape to support plants and grass.

Slope Effects

As the slope of the land becomes greater, the velocity of surface runoff will be greater. If the ground surface is not well protected (grasses, mulches, etc.), the runoff problem can create erosion and sedimentation problems. The velocity of the flow will help determine whether erosion and sedimentation problems will occur. In most cases, keeping the flow velocity low will help reduce problems downstream, which may require creating a meandering pathway or an intermittent ponded area (see LID approaches) so that soil will remain where it is intended to remain.

Approaches should be a combination of different practices and opportunities to encourage infiltration, reduce rainfall impact, flow velocity and scour. And remember, any approach that encourages infiltration on Oklahoma soils could result in increased seepage in downslope areas.

French Drains or improved drainage may encompass a large cross-section of different practices to help move surface water and groundwater away from an area (see: https://en.wikipedia.org/wiki/French_drain, accessed: 03/11/2020). The original French Drain characteristic includes a more permeable material such as 1.5-inch diameter river rock sufficiently deep to help remove water and the permeable material extends to the ground surface. Sub-surface drains (or sub-soil drain or perforated pipe drainage) are variations of that original drainage characteristic, but the drainage medium (gravel, rock, synthetic envelopes, etc.) does not extend to the ground surface. Improved drainage may be necessary where subsurface water is seeping to the surface, creating muddy, squishy or fully saturated soil conditions. An outlet is needed for such drainage so excess soil water is removed from the soil. Alternatives for outlets include resurfacing a drainage pipe downslope, moving to a dry well (a soil cavity which remains dry under light rainfall conditions) or perhaps even a sump area where a powered pumping system moves the excess water back to a surface outlet, where the surface is too flat for a gravity flow outlet. All improved drainage systems have the potential for soil to move into drainage medium and pipes. Plans and approaches to allow maintenance (removal of any deposited soil) are necessary to make sure improved drainage systems continue to be effective. In some cases, improved drainage may drain too much water from a soil profile, and controlled drainage (reducing the rate at which water exits the soil) may be necessary.

Rip-rap is the general description of gravel, rock or other material to protect the soil surface against higher flow conditions along channels. The blocky structure of gravel and boulder-sized quarried rocks help keep rip-rap in place. The size of the rock/gravel is based on the slope and expected volume rate or flow of the water (engineered design). In very high flow conditions and where soil structure is poor, rip-rap may not be a permanent solution and will require replacement and reconstruction over time.

Terraces are a construction technique on higher-sloping soils to create soil-built barriers to flow directly downslope, where more extensive flow would create severe erosion. Flow is directed close to perpendicular to the slope to reduce the rate of flow, encourage infiltration and redirect flow to a more stable flow channel. Many land areas in Oklahoma (where agricultural production occurred in the early to middle 20th Century) can have residual terraces that are no longer maintained.

Grasses or other vegetation appropriate to help manage drainage or erosion problems in urban landscapes are described in the OSU Fact Sheet on "Selecting a Lawn Grass for Oklahoma" with the method of establishment described in the OSU Fact Sheet "Establishing a Lawn in Oklahoma" (see reference section). Specialty vegetation can be further discussed with the staff of the local OSU Extension office, landscape architect or landscape contractor. In all cases, the quality of the vegetation—whether that be grass or mixes of grasses, broadleaves, etc.—will help improve the resistance to erosion. Most all recommended turfgrasses do not have resistance to flooding for extended periods. Most grasses will recover from intermittent flooding of less than three days. Longer-term flooding will kill most turfgrasses, resulting in bare spots and disease issues. Some grasses will remain green in winter, allowing for increased uptake of nutrients and greater resistance to erosive forces during typical wet seasons. In all cases, check the types of grasses typically available (as seed or sod), and use those particular grasses and local knowledge to help establish and maintain grass condition for your site.

Mulches are valuable components to the landscape, with organic-type mulches such as wood chips, pine straw, hay and other materials to help reduce raindrop impact on the soil, reduce evaporation losses from the soil surface, encourage continued valuable infiltration of water from the soil surface and generally improve soil conditions over time. Inorganic mulches (shredded tire, gravel, etc.) also can be used. Inorganic mulches may not float as easily as some organic materials. All inorganic mulches touted as non-floatable can still be displaced by high flow/runoff conditions. Remember, any practices that encourage increased infiltration could result in problems downslope based on the presence of a high water table. Generally, organic mulches are the preferred solution when appropriate, as they are inexpensive, readily available and improve soil conditions as they break down. However, compared to inorganic materials, organic materials will need to be applied more frequently to maintain a constant soil cover.

Low-impact development includes a series of practices designed to take advantage of more natural processes and techniques for slowing or detaining storm flow (see an example hybrid low-impact development design in Figure 9). Swales, detention areas, water gardens, etc. can help return flow conditions to a more natural, but protected condition, with the understanding that such practices will also require annual or periodic maintenance (See: "A Guide to Saving Water in the Home Landscape" and "Understanding Stormwater Runoff and Low Impact Development.")

Drainage issues as tied to septic systems (drain fields and home treatment/spray systems). Drainage issues at the effluent dispersal area of on-site septic systems (including drain fields of conventional systems or spray areas of advanced systems) can be due to: 1) faulty installation, 2) misuse of the system, 3) poor maintenance of system components and of the dispersal area or 4) conditions significantly different from when the system was installed. Improper installation practices can lead to a compacted trench bottom, unleveled lateral lines and improperly-sized drain fields. If the system is used as intended and drainage issues are observed at the drain field within a few weeks or months after installation, then it is likely due to faulty system installation. When this happens, the homeowner should seek the advice of professional service providers.

To assess possible misuse of the system, the homeowner should initially monitor water use in the house and then compare the daily water use to the treatment capacity of the system. A septic system of a two-bedroom house in Oklahoma is normally designed to treat 200 gallons of wastewater per day (add 66 gallons for each additional bedroom). This capacity means that the drain field or the spray area is sized for an intended treatment capacity. If household water use consistently exceeds the daily treatment capacity of the system, it would eventually cause surfacing of water at the drain fields or ponding at the spray area. Leaking toilets and faucets also cause an unintended increase in wastewater that adds stress on the dispersal area.

Poorly-maintained systems also can cause drainage issues. An unmaintained septic tank causes solids to be carried to the lateral lines and build-up at the bottom of the trenches. This build-up can significantly reduce downward percolation, causing wastewater to show up at the surface. The dispersal area also should be properly cared for. Healthy growth of vegetation (e.g. Bermudagrass) should be encouraged on the spray area. Healthy vegetation helps prevent drainage issues by absorbing some water and by improving soil properties that encourage effective water infiltration. Heavy machinery (tractors, cars, etc.) should not be allowed on the dispersal area because they may cause soil compaction that eventually lead to drainage issues. Surface runoff during rain events and water from rain gutters should be routed away from the dispersal area. Clean-out brine from water softeners should not be disposed on the dispersal area because its high salt content could destroy soil structure, leading to reduction in infiltration and percolation rates. New owners to a previously established property may have significantly larger families and water usage, and the previous management and maintenance approaches will not maintain the septic system. Modifications to houses with additional bathrooms and bedrooms also can overtax the septic system, requiring expansion of the disposal area and new maintenance schedules (as per input from a wastewater or septic system specialist). New landscape irrigation systems upslope of the drain field or significantly greater rainfall from the recent past also may push a dispersal area toward saturation and surfacing of water.

Definitions

Dry well – an approach to creating an outlet for a drainage system when no surface alternative exists. Such conditions are usually when a perched water table exists (based on a confining layer) and soil layers below the confining layer will accept input of additional water. Essentially, a well is sufficiently deep to access a soil layer with available pore space for excess drainage. Such a method may be considered a "disposal" type activity since some water at deeper soil layers may not be easily accessed or may have high salt contents, making them impractical for future uses.

Erosion – the process of detaching soil from an existing soil location and moving it downslope. Erosion can occur by rainfall impact and water flow across the soil surface (dragging the soil particles along).

Excess rainfall – the amount of water during a rainfall event that does not infiltrate into the soil during the event. Some water will be intercepted by surface conditions (leaves, grass, mulch, etc.). Water beyond the interception may be ponded or become overland flow (runoff) depending on surface slopes, grading and other surface conditions.

Extended or long-term rainfall periods – when rainfall is typically above normal or sufficient to create a consistently high water table in the soil. When soil is saturated and rainfall cannot infiltrate into the soil, the only choice is for water to pond on the surface or become runoff.

Sedimentation – the process where soil being carried by surface runoff "drops out" of the water flow and piles up along the flow path. When the rate of water flow becomes much lower, the ability to continue moving sediment is reduced and the soil particles will settle to the ground surface.

Seepage – the process of a water table rising to and above the surface of the ground, creating wet conditions downslope as long as the water table remains high and water has no alternative but to reemerge to the surface.

Water table – the level of the water in the soil below the ground. The presence of a water table near or at the soil surface creates many of the drainage problems discussed in this document. Typically, the soil will have a confining layer (slow infiltration rate) that encourages water to move laterally or remain in place until sufficient evaporation and plant transpiration can reduce the water table.

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