Wetland Hydrology

CHAPTER 2

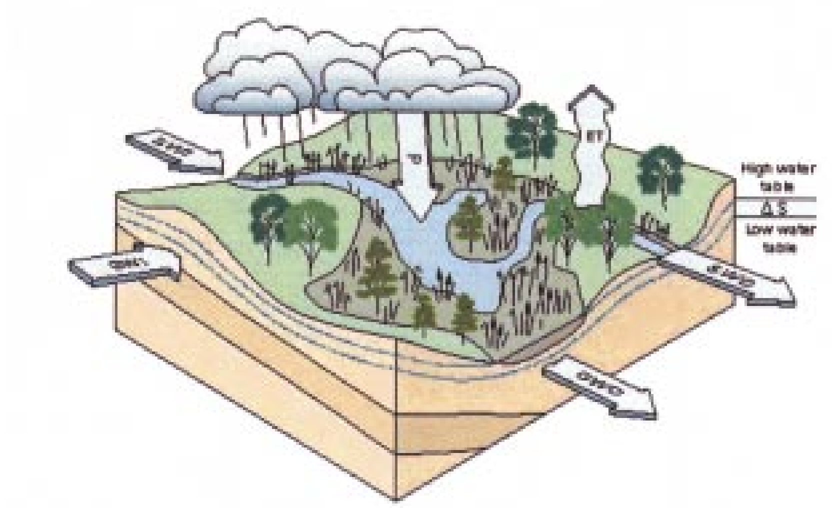
The term **“wetland hydrology”** generally refers to the inflow and outflow of water through a wetland and its interaction with other site factors. Land is characterized as having wetland hydrology when, under normal circumstances, the land surface is either inundated or the upper portion of the soil is saturated at a sufficient frequency and duration to create anaerobic conditions. The presence or absence of wetland hydrology may be determined through the on-site identification of established field indicators. While field indicators of wetland hydrology are at times difficult to identify, it is essential to determine that the area is periodically inundated or has saturated soils in order for the area to be characterized as meeting the wetland definition. For sites where there is a predominance of wetland plant species but there is no direct visible evidence that water is, or has been, at or above the soil surface, Part 303 directs the MDEQ to use the characteristics of soils to verify the presence or absence of wetland hydrology. Soils and field indicators of wetland soils are discussed in Chapter 4. If field indicators of hydrology are absent, such as in disturbed areas, evidence of hydrology may need to be established through the evaluation of recorded hydrologic data.

A. Site Factors that Influence Wetland Hydrology

Wetland conditions occur where topographic and hydrogeologic conditions are favorable and a sufficient, long-term source of water exists. Favorable topographic conditions refer generally to the presence of land-surface depressions in the drainage basin. These depressions may be located in upland areas, along hillsides where there may be a change in slope or geology, in floodplains of streams or rivers, or along the margins of lakes. Geologic conditions which may be favorable for wetland development include areas that have fine textured surficial soils with low **hydraulic conductivity** and sufficient thickness to store water. Also, the presence of impermeable bedrock near the land surface may favor the development of wetland hydrology.

The development of wetland conditions requires a persistent, long-term source of water. Figure 2.1 shows the different sources of water and possible outflows from a hypothetical wetland. The source of water may be precipitation (P) which falls directly on the wetland, surface water runoff during rainfall or snowmelt events within the catchment area surrounding the wetland (surface water inflow, or SWI), periodic flooding caused by elevated water levels in nearby surface water bodies (also SWI), **groundwater** inflow to the wetland (GWI), or a combination of any, or all, of these sources. Water may be lost from a wetland by evaporation from standing water or

Figure 2.1 - Wetland Hydrologic Cycle



Source: Carter, 1996, U.S. Geological Survey Water Supply Paper 2425.

saturated soils (E), **transpiration** from plants (T), or surface water or groundwater outflow (SWD or GWD).

The development of wetland conditions depends on a long-term balance between water inflow to the wetland and outflow from the wetland. During dry climatic periods, the rate of water inflow to the wetland (precipitation, groundwater inflow, and surface or near-surface inflow) may greatly diminish. In this instance, the amount of water lost through **evapotranspiration** may exceed the rate of all water inflow to the wetland. Water losses through evapotranspiration can result in extreme declines in the **water table** and a de-saturation of the wetland.

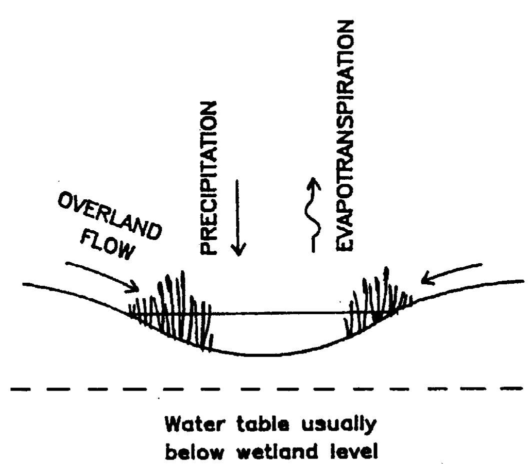
The relative importance of water inflow and water outflow, along with the topographic and geologic setting, determines the type and characteristics of the wetland that may form at a given location. A number of wetland classification systems have been developed that group wetlands based on topographic position in the landscape, water source, and hydrodynamics (Novitski, 1979; Brinson, 1993). Four commonly found wetland systems in Michigan are surface water depression wetlands, groundwater slope wetlands, groundwater depression wetland, and surface water slope wetlands (Figures 2.2 through 2.5). Wetlands that receive water primarily from precipitation have been classified as surface water depressional wetlands. Wetlands for which groundwater is the predominant source of water are classified as groundwater slope or groundwater depressional wetlands. Wetlands which are dependent upon surface water inflow are classified as either riverine or fringe wetlands along existing bodies of open water.

Figure 2.2 shows a wetland that has formed in a topographic depression. The primary sources of water are precipitation and surface water runoff from the catchment area surrounding the wetland. Since the water level elevation in the wetland is greater than the elevation of the water table, water in the wetland moves toward the water table, and groundwater is not a source of water for the wetland. The outflow of water from this category of wetlands is evaporation from the water surface, transpiration from plants, and movement of water to the underlying or adjoining aquifer. The soils or geologic sediments which underlie the wetland may be predominantly clay. The relatively low hydraulic conductivity of the sediment restricts, but does not prohibit, the movement of water from the wetland to the underlying aquifer. This category of wetlands is referred to as surface water inflow or depressional wetlands. This category of wetlands may be found at any elevation, even in otherwise predominantly upland areas. These wetlands are more dependent on precipitation than other types of wetlands.

Hillslopes between upland and lowland areas are another topographic setting in which wetlands may form. Wetlands forming in these areas are referred to as groundwater slope wetlands. An example of this type of wetland is shown in Figure 2.3. Groundwater which discharges along the hillslope as a seep or spring is the primary source of water to this wetland. Overland flow and precipitation may also contribute water to these wetlands. In this setting, sediments which have relatively low hydraulic conductivity such as clay or silt may underlie more permeable saturated sediments, forming a perched aquifer. Groundwater would flow laterally, along the clay or silt layer, toward the hillslope, where it discharges as a seep or spring. This is referred to as a groundwater seepage face. Groundwater slope wetlands may also occur where there are changes in the hillside slope and may not have perched groundwater conditions.

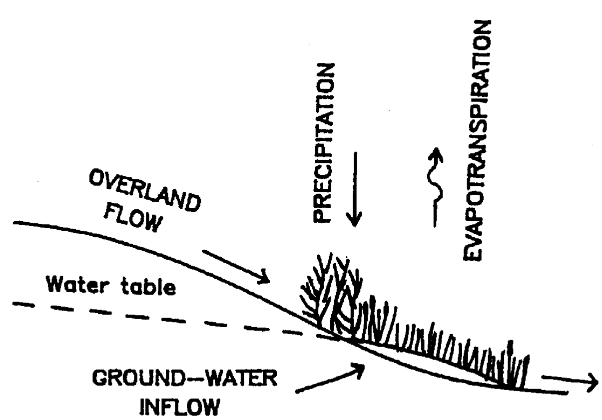
Groundwater slope wetlands tend to have relatively constant inflow of water if the aquifer responsible for the water source is readily recharged or groundwater moves through the aquifer at a relatively high rate. In this case, the wetland would be relatively unaffected by seasonal demands by evapotranspiration. If a shallow perched aquifer provides water to the seep, the wetland soils may become dry during portions of the **growing season** because of evapotranspiration in the seepage area.

Figure 2.2 – Surface water depression wetland



Adapted from Novitski, 1979.

Figure 2.3 - Groundwater slope wetland

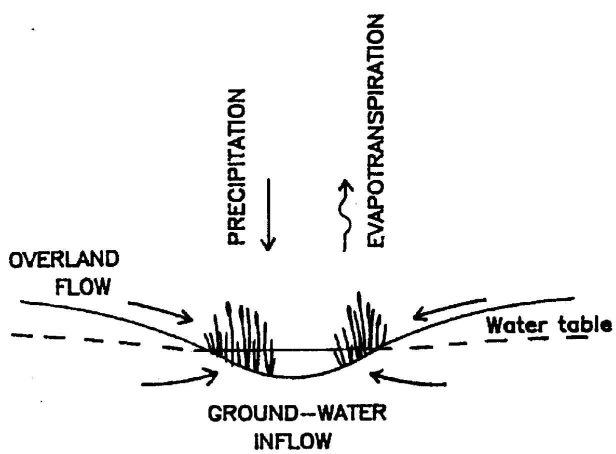


Adapted from Novitski, 1979.

Groundwater slope wetlands generally have a surface water outlet. The size of these wetlands depends on the quantity of groundwater discharge and the slope of land surface downgradient of the seepage face or spring.

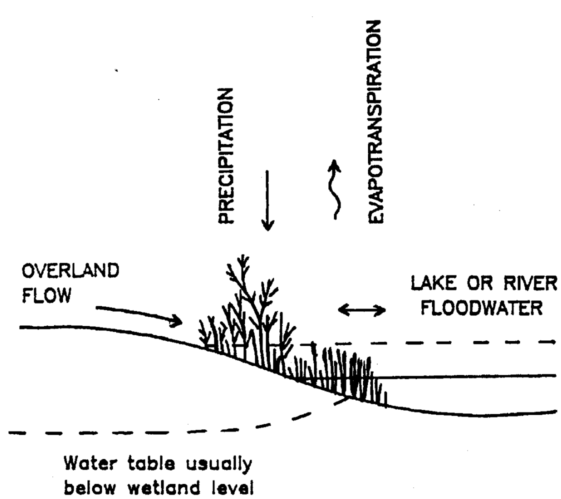
Figure 2.4 shows a wetland formed in a topographic depression which may be in a lowland area. For this category of wetlands, the primary sources of water are groundwater discharge to the wetland, precipitation, and surface water runoff from the catchment area surrounding the wetland. Since the water table elevation is higher than the water level elevation in the wetland, groundwater moves from the adjoining and underlying aquifer toward the wetland. The outflow of water is from evaporation from the water surface and transpiration from plants. These wetlands may not have any surface water outlets. This category of wetlands is referred to as groundwater depression wetlands. While they can exist at any elevation, these wetlands are typically found in relatively low-lying areas.

Figure 2.4 - Groundwater depression wetland



Adapted from Novitski, 1979.

Figure 2.5 - Surface water slope wetland



Adapted from Novitski, 1979.

Another category of wetlands is referred to as surface water slope wetlands (example shown in Figure 2.5). Surface water slope wetlands receive water primarily from the flooding of lakes or rivers, and the water can readily drain back into lakes or rivers as the surface water stages decline. Within floodplains, the flooding occurs infrequently. However, lakeside wetlands may be **flooded** permanently. These areas near surface water bodies are generally areas of regional or local groundwater discharge. The discharging groundwater is an important, consistent source of water to these wetlands.

Riverine wetlands form as linear strips, generally paralleling river and stream channels. These wetlands are found at lower elevations in a floodplain and tend to be more frequently inundated and for a longer duration than areas at slightly higher elevations.

Fringe wetlands occur adjacent to lakes where water moves in and out of the wetland from the effects of wind, waves, and **seiches**. This is especially true for wetlands that have formed near the Great Lakes. Lakes that are too small to develop frequent seiches would not support fringe wetlands; such lakeside wetlands would fall into either the surface water or groundwater inflow category described above.

It is possible for the source of water to wetlands to change during wet and dry climatic cycles. As an example, the wetlands shown in Figures 2.2 and 2.4 might depict the same wetland, but under different climatic conditions. Figure 2.2, with the low water table and inflow by surface water and precipitation only, may represent relatively dry or drought conditions. The conditions shown in Figure 2.4, with the high water table and surface water, precipitation, and groundwater inflow, may represent the same wetland during wet climatic periods.

B. Field Indicators of Wetland Hydrology

The following field indicators of wetland hydrology are from the USACE manual. The indicators can be quickly assessed and provide support that **inundation** or **soil saturation** has occurred at a site. Although some indicators are not necessarily indicative of hydrologic events that only occur during the growing season, they do provide evidence that inundation and/or soil saturation has occurred at a site. The use of these field indicators requires on-site observations.

1. Primary indicators of wetland hydrology:

a. <u>Visual observation of inundation</u> - The most obvious and revealing hydrologic indicator may be simply observing the areal extent of inundation. However, because seasonal conditions and recent weather conditions can contribute to surface water being present on a non-wetland site, both should be considered when applying this indicator.

b. <u>Visual observation of soil saturation</u> - Examination of this indicator requires digging a soil pit to a depth of 16 inches and observing the level at which water stands in the hole after sufficient time has been allowed for water to drain into the hole. The required time will vary depending on soil texture. In some cases, the upper level at which water is flowing into the pit can be observed by examining the wall of the hole. This level represents the depth to the water table. The depth to saturated soils will always be nearer the surface due to the **capillary fringe**.

For soil saturation to impact vegetation, it must occur within a **major portion of the root zone** (usually within 12 inches of the surface) of the prevalent vegetation. The major portion of the root zone is that portion of the soil profile in which more than one half of the plant roots occur. CAUTION: In some heavy clay soils, water may not rapidly accumulate in the hole even when the soil is saturated. If water is observed at the bottom of the hole but has not filled to the 12-inch depth, examine the sides of the hole and determine the shallowest depth at which water is entering the hole. When applying this indicator, both the season of the year and preceding weather conditions must be considered.

c. Watermarks - **Watermarks** are most common on woody vegetation. They occur as stains on bark or other fixed objects (e.g., bridge pillars, buildings, fences, etc.). When several watermarks are present, the highest reflects the maximum extent of recent inundation.

d. Drift lines - This indicator is most likely to be found adjacent to streams or other sources of water flow in wetlands. Evidence consists of deposition of debris in a line on the surface or as debris entangled in above ground vegetation or other fixed objects. Debris usually consists of remnants of vegetation (branches, stems, and leaves), sediment, litter, and other waterborne materials deposited parallel to the direction of water flow. Drift lines provide an indication of the minimum portion of the area inundated during a flooding event; the maximum level of inundation is generally at a higher elevation than that indicated by a drift line.

e. Sediment deposits - Plants and other vertical objects often have thin layers, coatings, or depositions of mineral or organic matter on them after inundation. This evidence may remain for a considerable period before it is removed by precipitation or subsequent inundation. Sediment deposition on vegetation and other objects provides an indication of the minimum inundation level. When sediments are primarily organic (e.g., fine organic material, algae), the **detritus** may become encrusted on or slightly above the soil surface after dewatering occurs.

f. Drainage patterns within wetlands - This indicator, which occurs primarily in wetlands adjacent to streams, consists of surface evidence of drainage flow into or through an area. In some wetlands, this evidence may exist as a drainage pattern eroded into the soil, vegetative matter (debris) piled against the thick vegetation or woody stems oriented perpendicular to the direction of water flow, or the absence of leaf litter. Scouring is often evident around roots of persistent vegetation. Debris may be deposited in or along the drainage pattern.

CAUTION: Drainage patterns also occur in upland areas after periods of considerable precipitation; therefore, topographic position must also be considered when applying this indicator.

Primary Indicators of Wetland Hydrololgy:

a. Visual observation of inundation
b. Visual observation of soil saturation
c. Watermarks
d. Drift marks
e. Sediment deposits
f. Drainage patterns within wetlands

2. Supplemental indicators of wetland hydrology:

In addition to the primary indicators of wetland hydrology, the MDEQ may also consider the following site conditions as supplemental indicators to support evidence of wetland hydrology:

a. Oxidized rhizospheres (root channels) associated with living plant roots in the upper 12 inches of the soil – Oxidized **rhizospheres** surrounding living roots are acceptable hydrology indicators on a case-by-case basis and may be useful in groundwater systems. Use caution that rhizospheres are not relicts of past hydrology. Rhizospheres should also be reasonably abundant and within the upper 12 inches of the soil profile. Oxidized rhizospheres must be supported by other indicators of hydrology, such as the FAC-neutral test if hydrology evidence is weak.

b. Water-stained leaves - The presence of stained vegetation can be used as a secondary indicator of wetland hydrology. The physical appearance of leaves resulting from the continued presence of water and anaerobic processes will often darken leaf surfaces. Comparisons can be made to leaves occurring within obvious areas of upland vegetation.

c. Local soil survey hydrology data for identified soils - In groundwater-driven systems, which lack surface indicators of wetland hydrology, it is acceptable to use local NRCS soil survey information to evaluate the hydrology parameter in conjunction with other information, such as the FAC-neutral test. Use caution in areas that may have been recently drained.

d. FAC-neutral test – The FAC-neutral test results in a positive secondary indicator of hydrology when more of the dominant plant species have a wetland indicator category that is wetter than FAC. (For an explanation of wetland indicator categories for plants, see Chapter 3). The FAC-neutral test considers FAC species (FAC-, FAC, or FAC+) as neutral and does not utilize them. Rather, the abundance of OBL, FACW+, FACW, and FACW- species are weighed against the abundance of UPL, FACU-, FACU, and FACU+ species (OBL + FACW species > FACU + UPL species) to determine whether the vegetation meets the FAC-neutral test.

e. Bare soil areas - Wetlands that contain standing water for a relatively long duration may have areas of bare or essentially bare soil. Bare soil areas can be a result of surface flows carrying away ground litter or the presence of standing water within local depressions for a relatively long time with limited inputs of plant litter material.

Supplemental Indicators of Wetland Hydrololgy:

a. Oxidized rhizopheres (root channels) associated with living plant roots in the upper 12 inches of the soil
b. Water-stained leaves
c. Local soil survey hydrology data for identified soils
d. FAC-neutral test
e. Bare soil areas
f. Morphological plant adaptations

f. Morphological plant adaptations – Some plant species have recognizable physical characteristics, such as butressed trunks, that reflect their ability to occur and survive in wetland conditions. Several types of **morphological adaptations** are listed and described in Appendix C.