NJ650.1405 Water Table Management

a) General

This subchapter describes water table management, which includes controlled drainage and subirrigation. See chapter 10, NEH part 624 for additional details. Controlled drainage and subirrigation have many benefits. Controlled drainage, as the name implies, is a modification of a drainage system that restricts or allows for management of outflow. Subirrigation is typically an additional refinement of controlled drainage in which a water source is added to maintain a water table at the desired stage to provide capillary water for plant use. Refer to figure 5-1.

Water table management systems not only improve crop production and reduce erosion, but also protect water quality.

Most water table management systems include water-control structures that raise or lower the water table, as needed. Lowering the water table in a soil increases the infiltration of water by providing more room in the soil profile for water storage. The result is less surface runoff, less erosion, and less sedimentation of surface water.

Nitrates (mostly from nitrogen fertilizer) commonly move in solution with water and have been measured in subsurface drain flows. Some studies suggest that ground water can be denitrified and the nitrogen returned to the atmosphere as a gas if the water table is maintained close to the soil surface. This is especially true during the nongrowing, dormant periods. The use of water table management practices to reduce the loss of nitrates to public water is being studied for various soil, cropping, and climatic conditions. Management of the systems to accomplish denitrification is critical.

Interest in water table management systems has increased in the Atlantic Coastal Plain and other humid areas. The NRCS has helped landowners install water-control structures in open drains in for water quality protection and water conservation. The drainage water management facilities are closely monitored to avoid conflict with the objectives of protection and enhancement of wetlands and to guide management of the systems to achieve the intended purpose.

Controlled drainage

Controlled drainage is beneficial for water quality protection and water conservation. This form of water table management does not include adding an outside water source. Controlled drainage has been used historically in organic and muck soils, but is also applicable in mineral soils. Some drainage systems may remove water needed for crop production later in the season. Structures that retard drainage water losses can partly overcome this problem. The conserved water is used as needed during the growing season.

In organic and muck soils, oxidation is slowed when the soils are saturated. By raising the water table in the soil when crops are not being grown, the rate of subsidence can be reduced. Water control structures can be installed in surface drainage channels and in subsurface drain lines to allow management of the water table elevation in the adjacent fields.

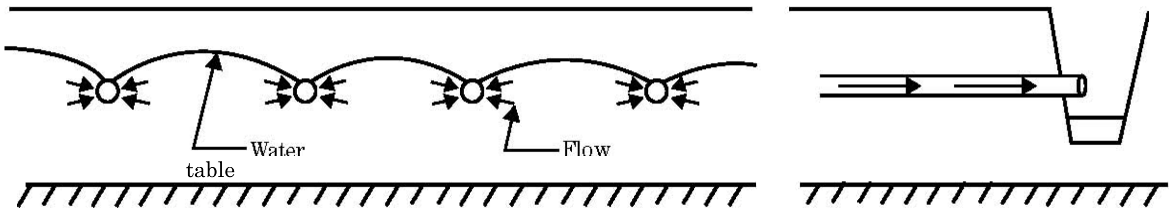
Structures for water control normally use spillways fitted with stoplogs or gates to control the water level. Control structures in conjunction with wells may be placed in the subsurface drain system. They generally are a type of manhole fitted with stoplogs or adjustable metal slides that control the flow of water in the subsurface drain system (fig. 5–2). Chapter 6 of the Engineering Field Handbook gives more information on using structures for water control.

Subirrigation

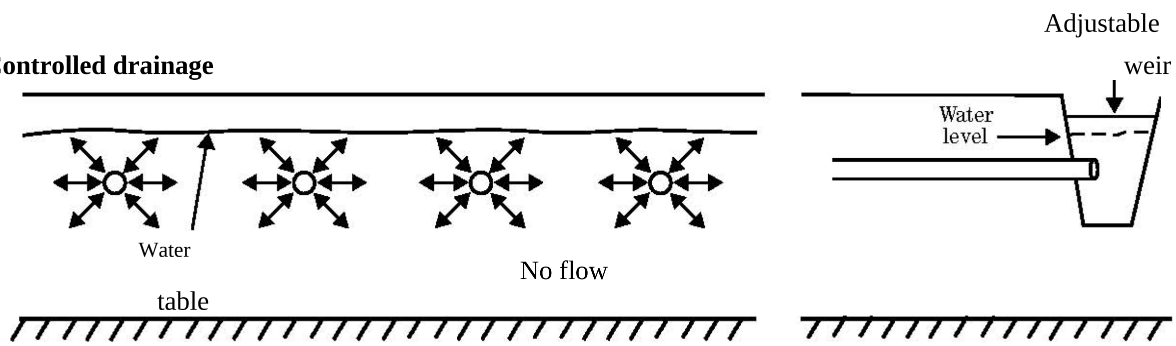
In subirrigation, the water table is artificially elevated by the input of irrigation water below the ground surface to a level where it is available to the crop roots. Although not a common practice in New Jersey, there are locations with suitable site conditions.

Figure 5-1 Water table management alternatives

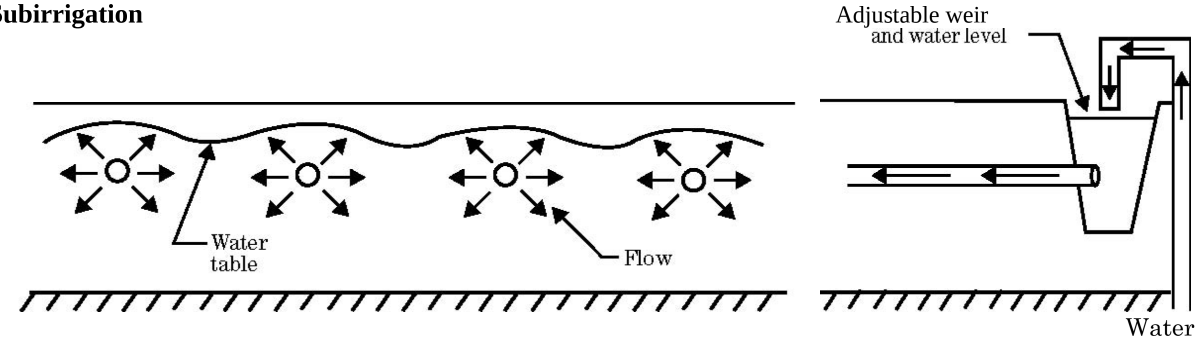
(a) Subsurface drainage



(b) Controlled drainage

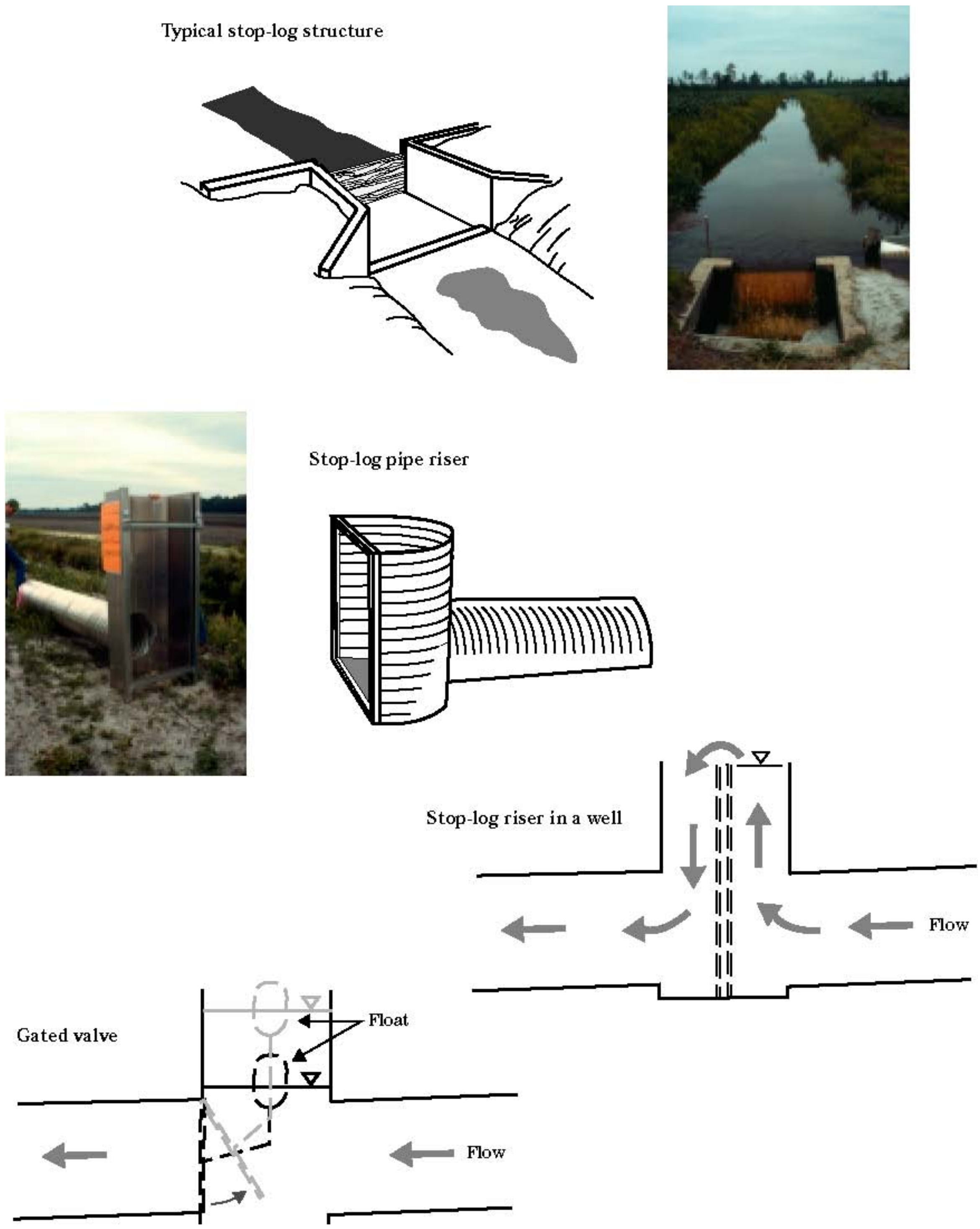


(c) Subirrigation



supply

Figure 5-2 Water control structures



B) Water table management

Water table management (WTM) is the control of ground water level by regulating the flow of water in the drainage and subirrigation modes. It is accomplished by the use of structures that control the rate of flow or maintain a desired water surface elevation in natural or artificial channels. A source of water along with a pumping plant may be needed to satisfy the subirrigation objective. Figure 5-1 shows the effect of using these water management alternatives with a subsurface drainage system.

General requirements

For water table management to be successful, the following conditions generally must be met.

- The site has a relatively flat surface and the slope is no greater than 1 percent.
- The soils at the site have a moderate-to-high hydraulic conductivity.
- The soil has a natural high water table or a shallow, impermeable layer. Deep seepage losses should not be a problem where these conditions exist.
- The site has a satisfactory drainage outlet. This can be a pumped or natural gravity outlet.
- An adequate water supply is available.
- Saline or sodic soil conditions can be maintained at an acceptable level for efficient production of crops.
- Unacceptable degradation of offsite water will not result from operation of the system.
- Benefits of the proposed water table control will justify installation of the system.

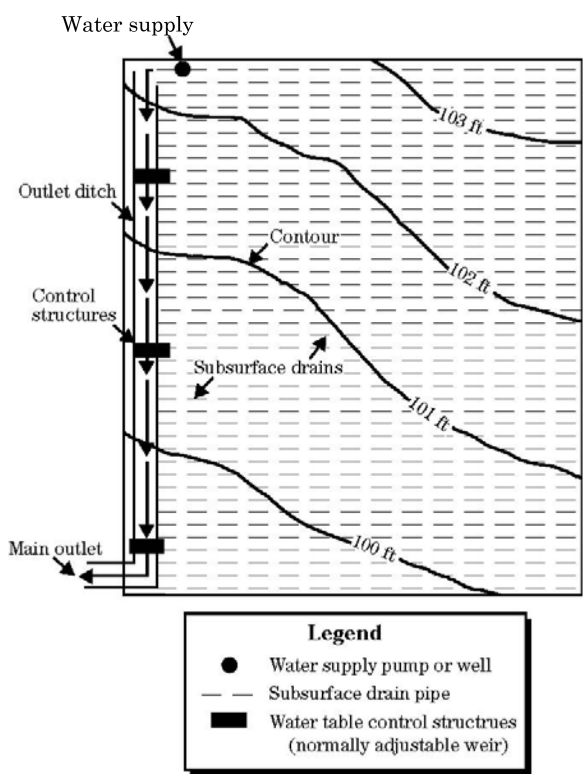
Planning considerations

The entire area impacted by the management of the WTM system must be evaluated. The control of the water table by an adjustable weir or gates may impact adjoining fields. Figure 5-2 shows typical water table management structures. A topographic survey of the field or fields is needed to plan the system, including avoiding an adverse impact on adjacent fields and drainage systems. Figure 5-3 depicts basic layout features of a WTM system.

The type of system that can be used must be determined. It should be consistent with the landowner's needs and management requirements. Planning considerations include:

- Type and layout of the surface and subsurface drainage system.
- Need for land smoothing or precision leveling.
- Alignment of system to best fit topography, spacing, and location of structures. Structures should be located to maintain the water table within an acceptable level below the root zone so that good drainage is provide when needed and water is furnished by capillary movement from the water table throughout the growing season.

Figure 5-3 Field layout of WTM system



The most critical factor is the feasibility of maintaining a water table, which is often dependent on the presence of a barrier. This is discussed later as well as hydraulic conductivity and determining spacing of subsurface drain laterals to provide for both drainage and subirrigation.

Water table location

The location of the natural seasonal high water table in the soil profile is critical. A seasonal high water table indicates that the soil can maintain the water table required for subirrigation during dry periods. If the seasonal high water table is more than 30 inches below the surface (with natural drainage), the soil is considered to be well drained, and a water table may be difficult to develop and maintain close enough to the root zone to supply the plant's water needs because of excessive seepage.

In most areas where water table control systems will be used, the natural seasonal water table has been altered by artificial drainage, and the depth of the drainage channels control the depth to the modified seasonal water table. Excessive lateral seepage can be a problem if the proposed system is surrounded by drainage channels that cannot be controlled or by fields that have excessively deep seasonal water tables. The depth to the seasonal water table during periods of a crop’s peak demand for water must be evaluated and potential seepage losses estimated.

Barrier

If water table management is successful, a barrier on which to build the artificial high water table during the growing season must occur at a reasonable depth. An impermeable layer or a permanent water table must be reasonably assured.

Hydraulic conductivity

Hydraulic conductivity is the most important soil property affecting the design of a water table management system. The final design must be based on actual field measured conductivity. A soil hydraulic conductivity of 0.75 inches per hour should be used as a benchmark for planning. If the flow rate is less than 0.75 inches per hour, the cost of installing the system may be the limiting factor. However, all costs should be evaluated before rejecting the site. If other system costs, especially that of water supply, are low, soils that have a hydraulic conductivity of less than 0.75 inches per hour may still be economical.

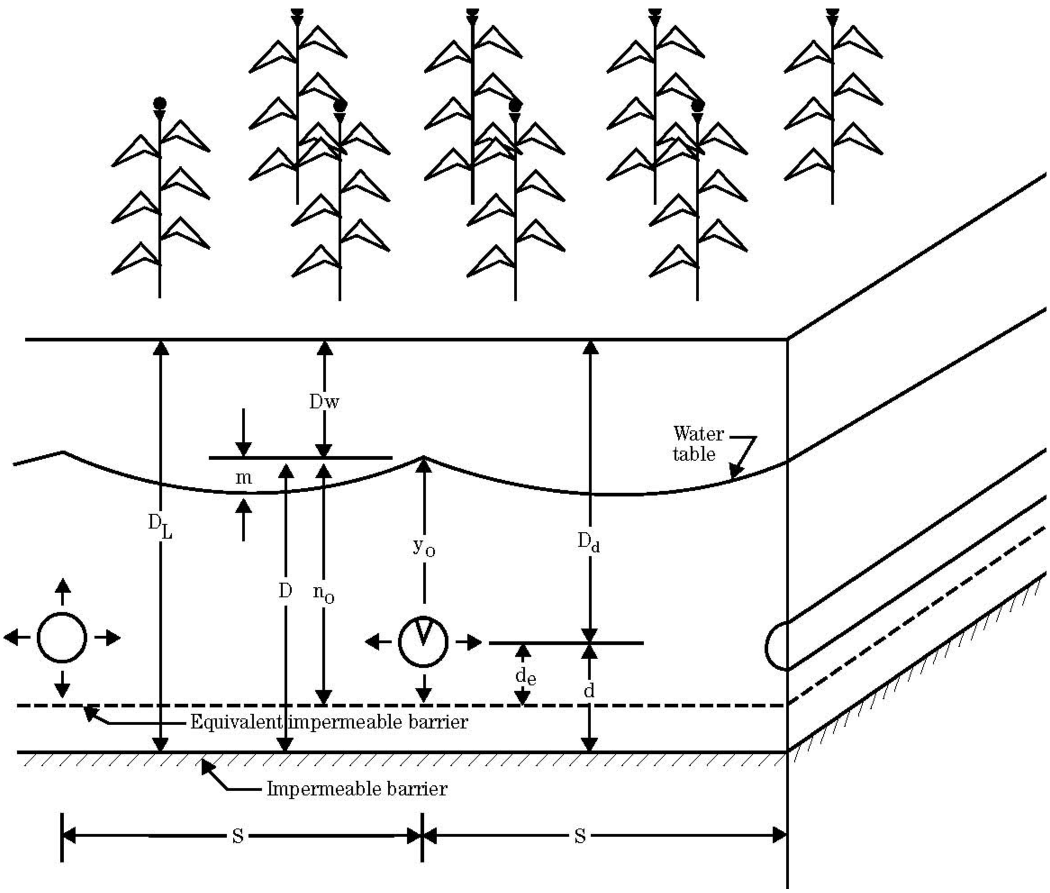
Engineering Field Handbook, Chapter 14, Appendix 14D provides detailed information on the auger-hole method of determining hydraulic conductivity.

Lateral spacing

If water is being added to the system, the water level over the drains must be maintained higher to create sufficient head to cause water to flow laterally outward from the drain. Figure 5-4 depicts the water table in the soil during subirrigation while water is being supplied to the laterals and at the same time is being withdrawn from the soil by evapotranspiration. It also details the notation to use in the design process and the terminology used to relate the position of the water table in relation to the ground surface, the laterals, and the barrier.

The spacing of subsurface drain laterals is less (placed closer together) for either controlled drainage or subirrigation than for drainage alone. This is basically because the restricted drainage effect of holding the water table above the drains causes the drains to be less efficient. Further the subirrigation mode of moving water horizontally to the midpoint between laterals requires less space than for drainage alone. For the numerous systems designed and installed, the average lateral spacing is about 70 percent of the recommended drainage spacing from local drainage guides. Because of the many variables, it is recommended that the DRAINMOD computer program be used for the spacing of laterals. For additional details refer to NEH Part 624, Chapter 10, Water Table Control.

Figure 5-4 Subirrigation lateral spacing and water table position



System operation

Operation of a water table management system can be automated. However, until experience has proven the timing and selected stages for the structure settings that give the desired results, frequent observations, manual structure setting, and pump operation should be used. To conserve water and minimize the amount of pumping necessary, the controlled drainage mode should be used to the greatest extent feasible. Monitoring wells in the field can provide for direct reading of water table levels that are correlated to stage settings of the control structures. As experience is gained, fewer well readings are needed to provide the information to operate the system. The water table should be maintained close enough to the root zone so that capillary upward flux provides all the water needed for evapotranspiration. If the water table is too far below the root zone, sufficient water may need to be provided at the source or moved through the soil profile rapidly enough to reestablish the desired water table level. Adequate drainage is needed at all crop stages.