

5. Subsurface drainage

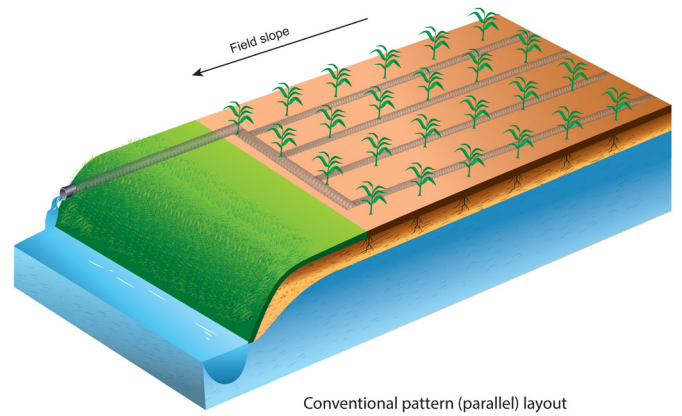
Surface drainage may be insufficient in poorly drained soils where the water table is naturally near the ground surface. In these cases, subsurface (tile) drainage is installed to remove the excess water and lower the water table (Figure 6). A drainage system should be able to lower the water table from the soil surface to 1-ft depth in less than 48 hours following a heavy rainfall (Ghane, 2023b).

In subsurface drainage systems, there are three general layouts: conventional pattern (parallel), contour, and targeted layouts (Figure 7). The contour layout is a subset of the pattern layout, which is used when laterals are following the contours to allow for controlled drainage.

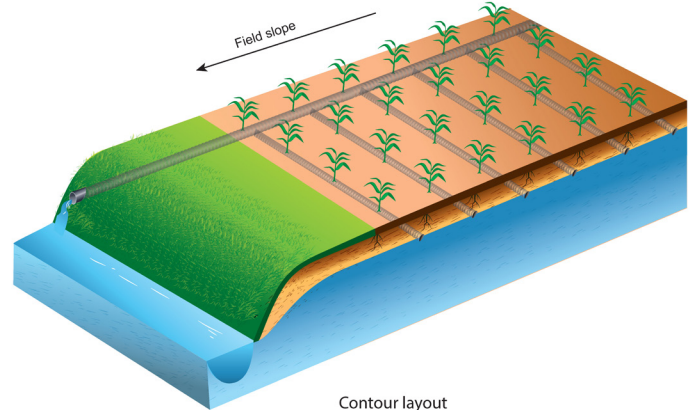
A targeted layout is common in rolling landscapes where surface drainage provides enough drainage for field operations on most of the field except in isolated depressional areas where removal of excess water is needed for uniform field operations (Huffman et al., 2013). If the source of water is a naturally shallow water table, a targeted subsurface layout is suitable.

Blind inlets can drain excess water from depressional areas. They are suitable in places where the source of the excess water is mainly surface runoff. To learn about blind inlets, see Ghane (2022).

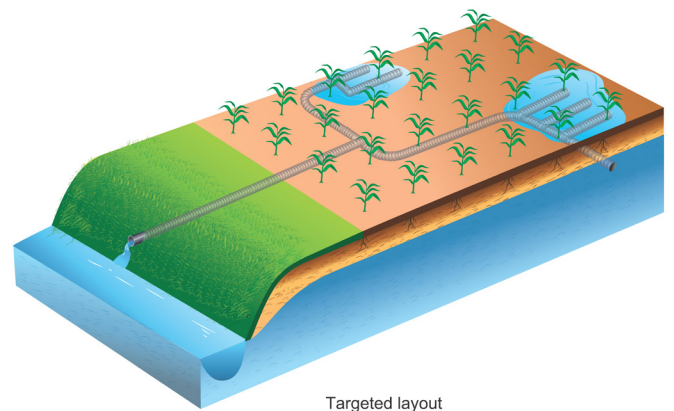
If a drainage layout map is unavailable, locate the drain pipes using these: Ground penetrating radar, tile locator, robotic pipe crawler, Google Earth images, and drone aerial imagery. In some cases, the soil above the pipe is drier and yield is greater.



Conventional pattern (parallel) layout



Contour layout



Targeted layout

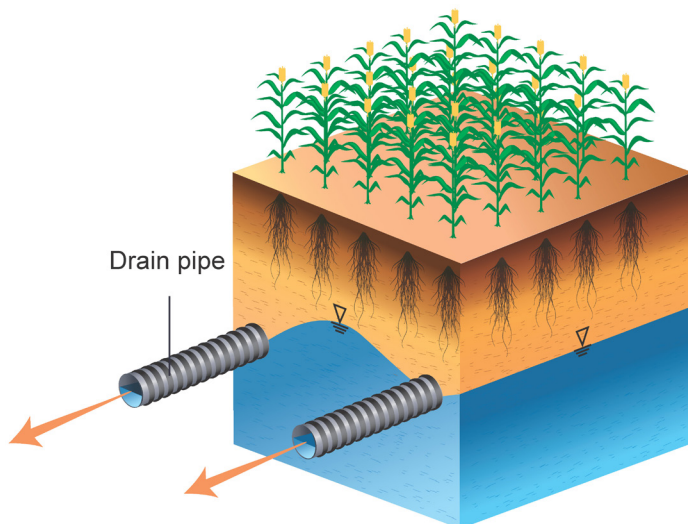


Figure 6- Diagram of a soil profile with subsurface drainage.

Figure 7- Subsurface drainage system layouts.



8. Midwest Drainage

In the Midwest USA, subsurface drainage is mostly concentrated in the corn belt (Figure 9). In Michigan, subsurface drainage is more concentrated in the southeast and the Thumb region where the dominant natural drainage classes are very poorly drained, poorly drained, and somewhat poorly drained. Drainage class identifies the frequency and duration of wet periods under natural conditions.

In the Midwest USA, the depth of lateral drain pipes range from 2.5 to 5 ft. In Michigan, shallow drain pipes are typically installed at a depth of 28 to 30 inches. In general, narrower drain spacing is needed for fine-textured soils (clay, clay loam, and loam) and the wider spacing is needed for coarse-textured soils (sand and sandy loam). Overall, there has been a trend for narrower drain spacing, which allows for a quicker water removal from the field.

The 2017 Census of Agriculture showed 3.0 million acres of subsurface-drained farms in Michigan, which is a 17% increase from the 2.5 million acres in 2012. This value is estimated to be around 3.5 million acres in 2022. This is mainly because high-intensity, heavy rainfall is becoming more frequent. Also, subsurface drainage pays well.



9. Economics of drainage

Subsurface drainage has a clear economic advantage. Percent corn yield increase can range from 20% to 80%. Payback period can range from 2 to 6 years for corn (Ghane et al., 2021).

The site-specific payback period depends on:

- (1) Climate (temperature and rainfall).
- (2) Drainage design (drain depth and spacing).
- (3) Soil properties (saturated hydraulic conductivity and depth to restrictive layer).
- (4) Economics (interest rate, depreciation, maintenance cost, pipe cost, installation cost, crop price).

Typically, drainage investment is done by the landowner because it increases the value of the land. When the land operator wants to invest in the drainage system, the rental value should not increase as the operator is paying for the drainage system. In addition, the operator and landowner should agree on having a long-term lease that provides enough time to pay off the loan (FarmProgress, 2010). The lease term should be greater than the amortization period of the drainage installation loan. Otherwise, a buyout clause should be added to the lease agreement.

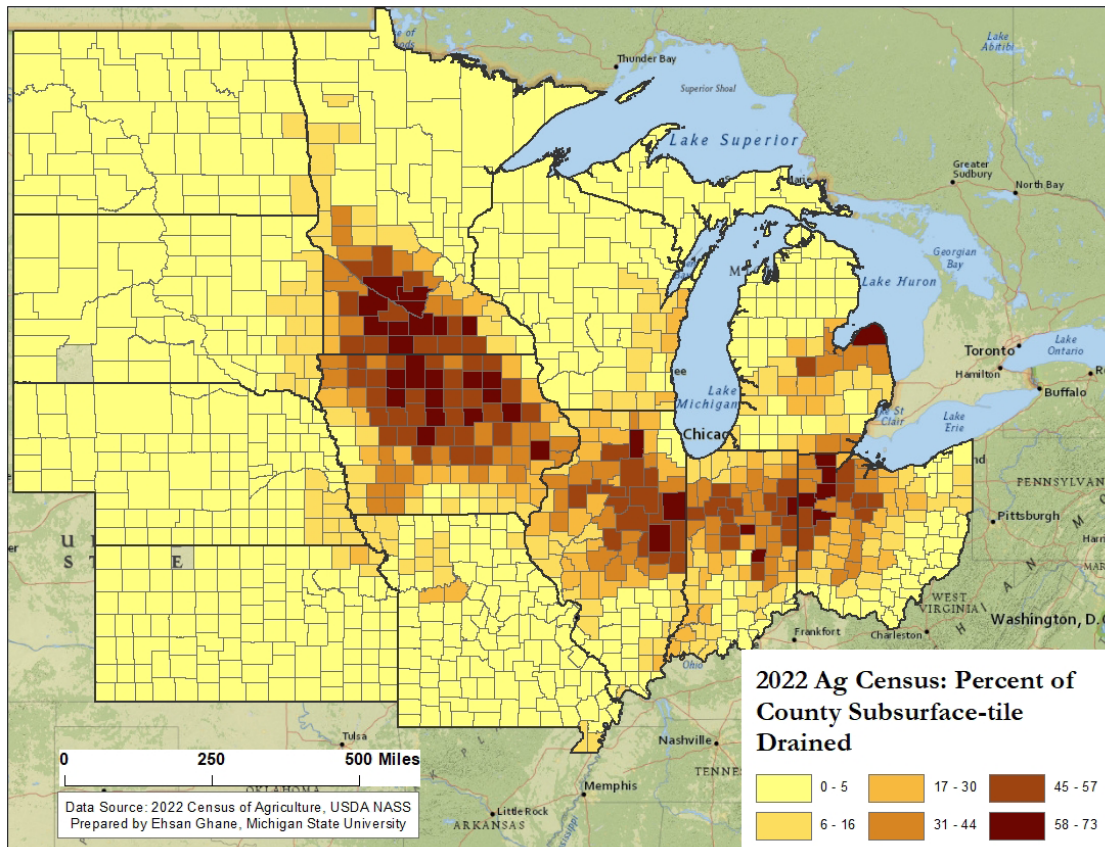


Figure 9- Map of the Midwest USA with the percent of county area that is subsurface drained.

