

A SHORT SUMMARY OF TRAIL CONSTRUCTION PRINCIPLES with special attention to drainage and erosion control measures.

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A. The Three Major Aims in Trail Construction:

- 1) Find the most interesting and enjoyable route. This is best done in the field; it is impossible to do with just a map in the office!
- 2) Build a route that takes account of users' psychology. Make sure users will go where you want them to, to avoid users making short-cuts.
- 3) Design that route so it can be sustainable over time, to protect the natural resource. Grades must not be too steep, to avoid erosion; rise/run formulas work, but experience may be the best guide.



B. Drainage Principles.

The biggest challenge of building a trail is making it last, to avoid destruction and costly rebuilding. Erosion of a trail surface is what destroys it. Water, in the form of rain or cross-slope drainage, is the enemy. Water collecting on a trail turns the trail into a stream, causing the soil to wear away. Designing proper drainage requires careful planning.

Trail builders who work on rocky terrain have a great advantage over those who build trails on dirt. Rain water does not erode rock much, but will begin to destroy a dirt trail as soon as it is built if water is not properly directed off the trail. So when finding the best trail route, it must be evaluated constantly to ensure that a well-drained, not too steep route can be constructed where desired. **The direction water travels on a slope is called the "fall line;" always avoid it!**

Trail use determines construction techniques. If horses are to use a trail, trail soils will wear away much more quickly. Horse trails are best on rocky or graveled trail surfaces.

Drainage features should be built into trails as they are constructed, and not added later when problems develop. Drainage techniques involve various stone, log, or trail dip or tilt features which actually route **the trail and water** off the slope. This is in contrast to water bars, built into a straight-line trail, which eventually fill up with leaves or silt and become ineffective if not cleared. Water bars are no longer commonly used. The benefit of water-*diverting* designs is that they need little or no maintenance. Modifying existing straight-line trails with drainage features is possible, but time-consuming and worth it. The pay-off is, of course, that such improvements extend the life of trails by decades.

Drainage concepts are simple, but application requires training. **The aim is to plan regular, periodic water diversion the entire length of the trail.** Different grades and types of slopes demand different techniques. It takes practice to develop one's eye to see where to apply drainage dips or switch-backs, and to **apply these principles to open grassy slopes as well as forest.**

C. Drainage Features. See "Terms" on website for illustrations.

1. Place a trail at the outside edge in any fairly flat section, and crossing contours, not in the middle, of a descending ridge. This will enable water to drain off to the side, instead of in the direction of flow down a slope, called the "fall line," which will turn the trail into a stream.

2. Cross Drainage: It is useful to promote drainage across the trail. If the *side slope* is very steep, rain will normally run off the outer side of the trail. But if the *trail* is too steep, rain will collect on the trail anyway. Calculations can be made to determine what grade to use to avoid catching water on the trail. Experienced hikers can usually determine this visually.

3. **Water Diversion:** directing rain or other water drainage off trail; prevent “stream” development **down** the trail, which wears away the trail “bed.”

a. **Use self-cleaning reverse-grade** dips, 2-m diversions of the trail leading down a slope. This changes the downward direction of the trail momentarily, and sends water off the trail. Send the trail down around a tree, or pile some rocks and plant a fern, so hikers must follow the dip. The trail must then go uphill for a short distance (reversing the trail grade briefly), so water leaves the trail, before continuing the downhill direction of the trail down the slope. Dipping the trail a bit before natural small depressions on both sides of a big tree makes a nice not very obvious dip.

b. **Grade dips:** lowering of trail a bit below grade for 10 feet, with a tilt down slope. Watch for naturally occurring dips, which can be accentuated, to drain water off long, straight, sloping descending sections. Holes vacated by root masses of uprooted trees are useful for this purpose!

4. **Contour trails.** A slowly descending trail design wrapped around the hill’s contours, should be divided into segments by drains, to prevent the accumulation of rainwater on the trail. With reverse-grades built into the trail, it looks like a series of giant scallops traced across the side of the hill.

D. Other Trail Construction Concerns:

1. **Tread wear:** Some eroding of the path’s surface or “tread” is inevitable. Ways to limit it:

a. Slopes: the tread always deepens slowly over time, forming a depression in the middle and causing a “berm” or raised edge to develop on the downslope side. In the Midwest, leaves collect in drains. Eventually, leaves and dirt in berms needs to be kicked off to the side. Otherwise cross-drainage of water off the trail will be impeded. Never line a trail with rock without drainage gaps.

b. Meadows: Locate trails at edge of meadows, if at all possible.

c. Stream bottom lands: look for solid soil; if boggy, locate trail away from stream, slightly up any nearby slope if possible. Raised log boardwalks, or filled in raised “turnpikes” may be required.

d. Horse trail: graveling may be necessary, as soil pulverized in dry weather on a flat surface becomes mud when it rains.

2. **Outsloping.** Trail surface should be **out sloped** or tilted slightly outwards, so water drains off to the side instead of being channeled down the trail as in a stream bed. Trails tend to deepen and channel with wear over time; out sloping may have to be renewed periodically, and berms removed.

3. **Trail may be graveled** in wet places, e.g., where water intermittently seeps across it, if trail cannot be relocated to dryer ground. Dig a small cross-path ditch, and fill with gravel for passage of water.

4. **Switchbacks** are used to wind a trail across and down a slope, to lengthen it, reducing the grade.

a. On grassy slopes, bends should be designed to occur at rock outcroppings, bushes, or any structure to prevent short-cutting and keep hikers on the trail. The number of bends in the switchback should be kept to a minimum, and the distance between them to a maximum, to reduce short-cutting.

b. **Install drains** at bend of switchback above turn to send water off the trail, using stone, treated timber or available logs. This results in a step down at the turn; the stone or wood “step” functions as a chute to send the water off the slope, instead of continuing on down the trail. Stone or strong timbers well anchored must be used for horse trails. Sometimes the slope allows the water to “fan” off the trail at the bend, and a chute is not necessary. Experience will help you determine the appropriate design.

5. **Prevent, divert, or slow** naturally occurring water drainage **across** trail from seep or

occasional drainage from a heavy downpour.

a. Pack a gully above the trail with logs across the flow to slow water moving across the trail; pack the gully below the trail with cross-wise log sections to prevent it from undercutting the trail.

b. Pave the trail with rock slabs or gravel to prevent water from washing it away as it crosses. Be sure to make rocks level with tread.

6. **Unavoidable water on trail:** Slow the movement of water **on** the trail where keeping it off is impossible. Water bars or weirs--log or rock-- across the direction of flow may have to be installed in sections of trail where no other drainage option is possible, in old road beds with high sides, for example. Just slowing the flow can help to control damage. Downed trees may be trimmed and left in place to slow rain flow, and also interfere with and slow any illegal uses of trail.

E. Experience:

Experience is the best teacher. If you would like some, join in one of the KHTA trail-building projects. Work day schedules are posted on the KHTA website.