Trail Construction and Maintenance Notebook

Trail Foundation

The Trailbed

On hillside trails, the trailbed is excavated into the side of the hill to provide a slightly out-sloped travel path. Depending on the slope of the hill, the amount of excavation and the use of the excavated material varies (Figure 10).

Typical Trail Cross Sections

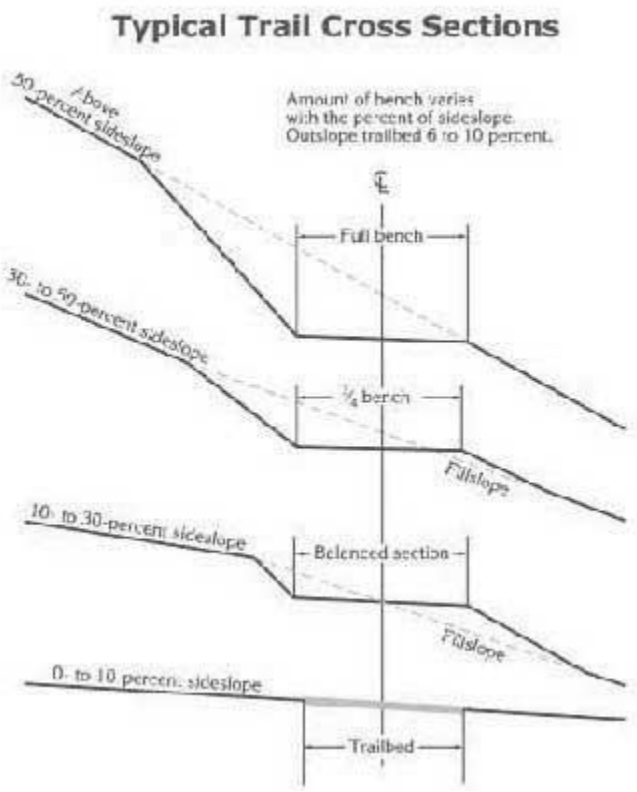


Figure 10--Typical trailway cross sections. Full-bench construction will give you the fewest problems--especially on steep slopes

On steep slopes, **full-bench** construction is usually needed. Soil excavated from the hill is cast aside as far as possible from the trail and not used at all in the fillslope. Especially on steep slopes, relying on fill for part of the trailbed is a bad idea. This soft material is likely to erode away quickly, creating dangerous soft spots on the downhill edge of the trail. If fill is used, it often needs to be reinforced with expensive crib or retaining walls. As the slope of the hillside decreases, it becomes more feasible to use fill material as

part of the trailbed. However, even though it requires more hillside excavation, full-bench trailbeds will generally be more durable and require less maintenance than partial bench construction. There is a tradeoff, though. Full-bench construction is often more costly because more excavation is needed, and it also results in a larger backslope. Most trail professionals will usually prefer full-bench construction.

Constructing Sidehill Trails

Looking at construction plans is one thing, but going out and building a sidehill trail is quite another. Here is a proven method that works even for the complete novice. This is for the actual digging part once vegetation has been cleared.

- Mark the centerline of the trail with wire flags no more than 3 m (10 ft) apart. These wire flags are the key to explaining how to dig the tread, and they keep the diggers on course.
- Remove leaf litter, duff, and humus down to mineral soil. To mark the area to be cleared, straddle the flag facing the uphill slope. Swing your Pulaski or other tool. Where the tool strikes the ground is approximately the upper edge of the cut bank. The steeper the slope, the higher the cut bank. Do this at each centerline flag, then scratch a line between them. This defines the area to be raked to mineral soil. Clear about the same distance below the flag. Keep the duff handy, as it will be used later. Don't clear more trail than can be dug in a day unless you know it isn't going to rain before you can complete the segment.
- For a balanced bench trail, the point where the wire flag enters the ground is the finished grade. Scratch a line between flags to keep yourself on course. Facing the uphill slope, begin digging about 150 mm (6 in) from the flag cutting back into the slope. Imagine a level line drawn from the base of the flag into the bank. Dig into the bank down to this line, but not below (Figure 11). Pull the excavated material to the outer edge. Tamp this fill material as you go. On a full-bench trail, the wire flag essentially ends up at the outside edge of the trail. For less than a full-bench trail, the flag ends up somewhere between the centerline and outside edge. Keep this in mind when you place the wire flags.

Cut and Fill

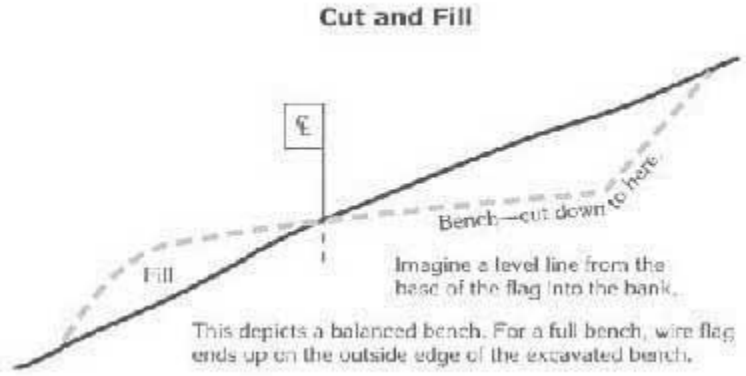


Figure 11--Basic sidehill trail building.

- There is a tendency to want to stay facing uphill. To properly shape the tread, you need to stand on the trail and work the tread parallel to the trail direction to level out the toe of the cutslope and to get the right outslope.
- There is a tendency to make the trail too narrow. If the width of rough tread equals the length of a Pulaski handle, the narrower finished tread will be about right for a good hiking trail.
- Make sure grade dips and other drainage structures are flagged and constructed as you go.

- If you try to slope the cut bank close to the original surface, you will usually get somewhere close to what is needed. Slope ratios are hard to understand. Instead, look at the natural slope and try to match it.
- Round off the top of the cutslope. The easiest way to do this is to rake parallel to the cut edge with a fire rake.
- The best way to check the outslope is to walk the tread. If you can feel your ankles rolling downhill, there is too much outslope (Figure 12). The outslope should be barely detectable to the eye. If you can see a lot of outslope, it's probably too much. A partially filled water bottle makes a good level.

Figure 12--If your ankles start to roll, there is too much outslope.

Once the bench construction is finished, stand on the tread and pull the reserved duff up onto the fillslope with a fire rake. This helps stabilize the fill (especially important in high rainfall areas), and makes the new trail look like it has been there for years. Be careful not to create a berm with the duff. On full-bench trails there will be no need for the duff, as the outside edge of the trail has not been disturbed. Sometimes contract specifications call for scattering rather than reserving the duff.

While often described as a percent, slopes are also described as a ratio of vertical to horizontal, or "rise" to "run." The protocol for metric (SI) notation continues this tradition, with the additional change of eliminating fractions from the notation. For slopes flatter than 1:1, express the slope as a ratio of one unit vertical to the number of horizontal units. For slopes steeper than 1:1, express the slope as the ratio of the number of vertical units to one unit horizontal. Figure 13 shows examples.

TRANSPORTATION ENGINEERS HAVE USED A DIFFERENT SYSTEM--AND STILL DO--FOR NONMETRIC SLOPE MEASUREMENTS. MAKE SURE YOU UNDERSTAND WHICH SYSTEM IS BEING USED.

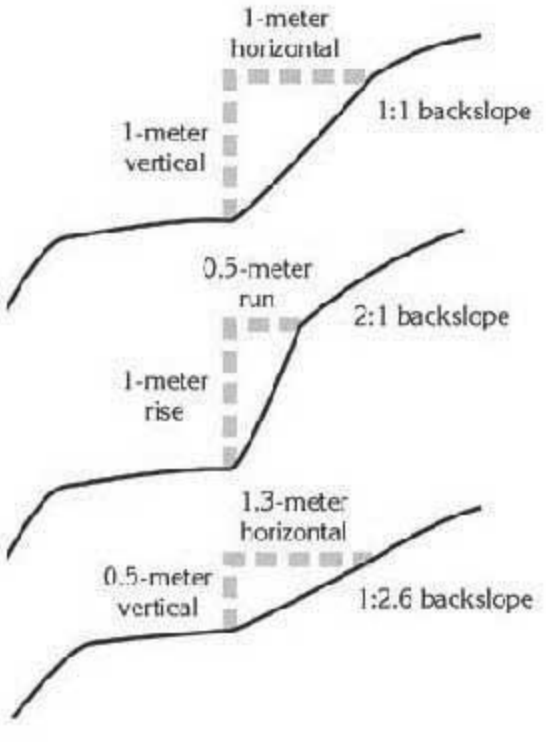


Figure 13--Slopes are noted in metric as a ratio of vertical to horizontal, or "rise" to "run."

Backslope

The backslope is the excavated, exposed area of the trailway above the tread surface. Backslopes range from near vertical (in rock) to 1:2 in soils having little cohesion. Backslopes cannot be steeper than the exposed material's ability to stay put during typical climatic conditions. Most inexperienced crews construct backslopes that exceed the parent material's angle of repose. Translation? The slope usually fails within a year, blocking the tread.

A second option is to construct a crib wall and use fill to support the entire tread surface. This can be less obtrusive than huge backslope excavations and more stable, if the wall is well constructed. Much less backslope, if any, may be needed.

> Look at the surrounding landscape and soil to see what is stable. A handy rule of thumb is to create a somewhat gentler slope than you think necessary. Although you will initially expose more raw soil, the chances of it remaining stable and revegetating are greater than if you leave a backslope so steep that it keeps sloughing.

Fillslope

The fillslope is that area of the trail below (downslope from) the tread surface. A full- bench tread, of course, will not have any fill associated with this side of the trail. Fillslopes are critical. If you take care of the downhill side of the trailway, you'll avoid the vast majority of problems associated with trail maintenance.

Borrow Pits

Often you will need fill material. The hole you dig is called a borrow pit. It should be as close to the work site as possible, but screened from view. The material in the pit also needs to be suitable for the desired use. Good choices are soils with a balanced mixture of different size particles. Sand and gravel work well. So do small, well-graded angular rocks.

Compare existing trail tread materials with borrow sources. Consider the proportions of gravel, sand, and fines. Individual "fine" particles are not visible to the naked eye and are classified as silt or clay. If the proportions of gravel, sand, and fines are similar, you can expect the borrow materials to perform as well as the existing trail tread materials. If the borrow source has a smaller proportion of fines, you can expect better performance under wet conditions.

Soils from bogs are normally not suitable for tread fill because they lose strength when they become wet. These dark organic soils are identified by musty odor when damp. In temperate parts of the country you'll want to avoid organic soils. In the arid South-west, however, organic material can be added to dry clay to keep it from blowing away.

Creek bottoms that are replenished by storms and seasonal water flow, and the base of slopes or cliffs where heavy runoff or gravity deposit sand and gravel, are good places to look. Don't destroy aquatic or riparian habitat with your pit.

Save all squares of vegetation removed from the top of the pit. You'll need them for restoration. Place them in the shade and keep them moist by covering them with wet burlap. To rehabilitate, grade the pit out to natural contours with topsoil and debris, then revegetate. Camouflage the area and access trails with boulders and dead wood.

Build Contour Trails With Full Bench Cut And Outslope

Jan and Mike Riter, Subaru/IMBA Trail Care Crew

Every person engaged in trail building and maintenance should understand the interrelated concepts of bench cuts and fill slopes, outslope, fall-line versus contour routes, and maintenance by deberming.

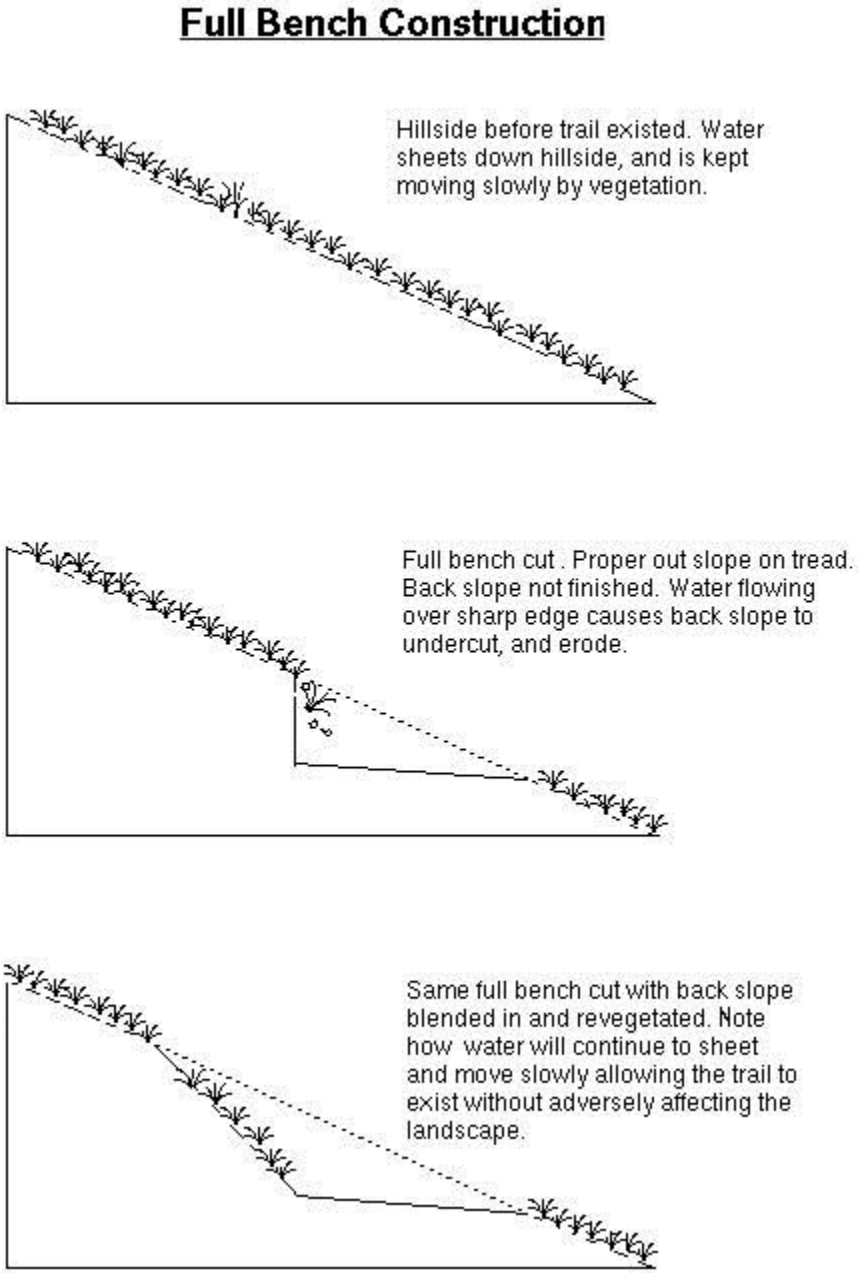
A bench cut is the result of cutting a section of tread across the side of a hill. If you look at the side profile of this cut it looks like a bench, hence the name. The two basic designs are known as "full bench" and "partial bench." Full bench construction means that the full width of the tread is cut into the side of a hill. The entire tread is dug down to compacted mineral soil. Viewed in cross-section, the tread angles slightly downhill at 3-5%. This is known as outslope. A partial or balanced bench means that part of the hill is cut away and the soil that has been removed is placed at the lower edge of the trail to try to establish the desired width. This is known as a fill slope.

We have yet to run into an area that did not require a full bench cut.

Full bench design avoids problems inherent in partial bench cuts. Partial bench often requires problematic cribbing (the act of putting logs or rocks on the downhill edge of the trail) to hold the fill soil that is added to the edge of the trail. The fill soil is soft and uncompacted, often forming a berm, which will cause water to flow down the trail rather than across it. The end result: Your new or reconditioned trail ends up being the poster child for erosion damage. And if a user finds their way onto this soft edge, they can lose their balance and end up off the trail, or push the soft dirt down the side slope causing the tread to terrace or become uneven.

Bench cut and fill relates directly to trail layout. We always recommend building trails that contour across a slope, climbing and descending gradually, rather than running directly up and down the fall line. (The fall line is the most direct route downhill from any particular point.)

Water generally runs down the fall line, and fall line trails provide a conduit to move a lot of water down a hill. Water flowing down a trail will build velocity and will quickly erode deep ruts into the tread. Fall line constructed trails



erode at a terribly fast rate, are nearly impossible to maintain, and fuel the fires of people who are looking to ban bikes from trails. Too many unskilled riders skid or ride out of control on fall line trails.

On the other hand, contour trail are curvy, fun to ride, easier to maintain, yet still provide significant challenge for even the most skilled riders. Contour trails should be built with outslope so water will sheet across the trail and continue down the hill, rather than diverting into the trail tread and causing erosion. If a drainage problem does develop on a contour, full bench trail, it can be dealt with easily and effectively.

Contour, full bench, and gradual trails will require less maintenance and fewer water diversion dips than fall-line, partial bench, or steep trails.

Some time after a trail tread has been properly cut in and outsloped, the tread will settle from compaction. This is normal. However, the lower edge of the tread will not compress as much as the center, creating a berm. Berms can also form from erosion. Fortunately the cure is simple and very effective. Using simple hand tools (McLeod, Pulaski, adz hoe, pick, etc.), remove the berm to create outslope, being careful not to disturb the already compacted center of the trail any more than necessary. Varying by soil types and climate, many trail segments will require another deberming five or more years later. This is perhaps the most common maintenance needed on trails, but also the easiest and most effective.

Sandy Soil Solutions

We have been asked by folks in areas that have a lot of sand if it is a good idea to build a bench trail, as opposed to just raking back the surface vegetation and letting the users establish the tread. It is especially important to bench and outslope the trails in these areas. If not, the thin layer of topsoil will quickly punch through and cause the tread to become cup shaped, channeling water down the trail.

In sandy areas, it helps to add something to harden the tread surface and make it sustainable. If there is a layer of compactible soil on the surface and sand or glacial till (the debris left when a glacier retreats) underneath, then the upper layer can be removed and set aside, then mixed with the sand for the top of the tread. If there is no compactible layer, then other hardening techniques must be applied (see ITN Trail Tips, July-August, 1998).