

Why the City of Portland's current Trail Design Guidelines (2009) are substandard & need to be updated.

For purposes of this discussion we will be referring to the following natural surface trail guidelines:

- Trail Solutions: A Guide to Building Sweet Singletrack, published by the International Mountain Bicycling Association (IMBA) in 2004
- Trail Construction and Maintenance Notebook: 2007 Edition, published by the United States Forest Service (USFS) in 2007
- Trail Planning, Design, and Development Guidelines, published by Minnesota Department of Natural Resources (MNDNR), Parks and Trails Division in 2007
- Trail Design Guidelines for Portland's Park System, published by Portland Parks & Recreation (PPR) in 2009

Why we will be using the above references:

- We will be referring to IMBA's Trail Solutions: A Guide to Building Sweet Singletrack guidelines because it is designed specifically for trails that will have mountain biking uses.
- We will be referring to USFS's Trail Construction and Maintenance Notebook: 2007 Edition guidelines because it is a national standard, directly or indirectly, referenced by most cities and states.
- We will be referring to the MNDNR's Trail Planning, Design, and Development Guidelines because it is considered a very high standard in sustainable trail design and building, to the point many other states simply reference or use Minnesota's guidelines as their own, see Massachusetts's Department of Conservation and Recreation Trail Guidelines and Best Practices (<http://www.mass.gov/eea/docs/dcr/stewardship/greenway/docs/dcrguidelines.pdf>), pages 12, 17, 18, 20 & 25.
- We will be referring to Portland Parks & Recreation's Trail Design Guidelines for Portland's Park System (2009) as they are currently being used in Portland and would be used in future trail construction that may be initiated by the Portland Off-Road Cycling Master Plan (ORCMP).

General Issues with the Portland Parks & Recreation Trail Design Guidelines for Portland's Park System ("Portland Guidelines")

1. **The Portland Guidelines are based on standards that are no longer used or were superseded by the time the Portland Guidelines were published.** Appendix A of the Portland Guidelines (pg. 75 & 76) contains a list of other guidelines, standards and best practice essays that informed the Portland Guidelines. While many of these are Oregon specific, more than a few are based on guidelines from other entities, such as the United States Forest Service or Minnesota's Department of Natural Resource. However, many of these external guidelines had been superseded by or replaced by updated guidelines years **before** the Portland Guidelines were published. Examples:
 - a. Portland Guidelines cite *USFS Trail Design Parameters, United States Department of Agriculture, Forest Service, June, 2002*. Said guideline was seven (7) years old at the time

the Portland Guidelines were published in 2009, and the USFS document had been superseded two (2) years prior by the *Trail Construction and Maintenance Notebook: 2007 Edition*.

- b. Portland Guidelines cites *Minnesota Department of Natural Resources, Trails & Waterways Trail Planning, Design, and Development Guidelines: Shared Use Paved Trails, Natural Surface Trails, Winter-Use Trails, Bikeways, 2006*. Said guideline was three (3) years old at the time the Portland Guidelines were published in 2009, and the USFS document had been superseded two (2) years prior by the *Trail Planning, Design, and Development Guidelines*.
2. Portland Guidelines do not use guidelines specific to uses that occur (or could occur) on Portland Parks & Recreation's trails. Example:
 - a. Portland Parks & Recreation did not use the International Mountain Bicycling Association's trail guidelines published in *Trail Solutions: A Guide to Building Sweet Singletrack, 2004* even though Portland Parks & Recreation has specified mountain biking as an acceptable use in Portland Parks & Recreation properties. In 2009, the IMBA document was already five (5) years old.
3. The Portland Guidelines' text and the detail drawings for corresponding trail types often conflict with each other, not only in measurement, but also in terminology. The Trail Type Matrix or individual trail type table lists an acceptable dimension for an item, such as a "width" of the trail of X'. What is that referring to? The bench (the part that has been graded down to create a flat slope), the treadway (the area users actually travel across) or the total width of the bench cut (the distance from the soil cut of the backslope to its intersection with the foreslope)? What makes this more confusing is that the Trail Type Matrix table, individual type information and details use different terms for the same thing, often neither of which used are accepted terms for that item (see "trailbed" versus bench). Everything is a mish-mash of terms and ambiguous measurements that creates confusion. Examples:
 - a. On Trail Type G – Mountain Bike Trail, the table lists acceptable widths of trail from 18" to 4' (48"), yet the detail for Type G trails shows a single width of 24".
 - b. On Trail Type J – Hiking & Mountain Bike Trail suffers from the issues mentioned above but adds extra confusion with the detail. Not only does it call out the "trailbed" (actually the bench) as 48" (4') it also adds 12" (1') area to the bench for a total bench width of 60" (5'). The table on page 31 shows that 12" area as the Horizontal Clearance and shows that it should be "1' from side of tread". However, the treadway is often much narrower than the bench, meaning the 1' distance would often be inside the limits of the bench. Current best practices say this clear zone should be outside the bench on the foreslope, meaning the resulting bench width would be 48" (4') not 60" (5') as shown in the detail.
4. Dimensional (length or width) notations are often not called out as minimum, maximum or preferred. Nor are these dimensional distances defined as to what, specifically, they are a measurement of. For paved trails this is often not an issue as the paving equipment has dimensions that are integral to the equipment itself. Specifying a 6' width would just mean using a 6' paver. However, on soft surface (dirt) trails, this is an important number as the width can vary based on how the trail is constructed and post-construction soil movement and vegetation growth, as well as the need to deal with irregular encumbrances (trees or rock) or safety concerns (widening on climbing and descending turns or narrowing the trail to control speeds). Example:

- a. As mentioned above, there are various reasons that a trail may vary in width. As currently defined, however, many of these dimensions are not defined as minimum or maximum, thereby becoming a legal and unchangeable width. If the trail is going to go between two trees that are 36" from edge of trunk to edge of trunk, the current dimensional callouts do not allow for that. One of those two trees would have to be removed because the guidelines say the trail should be 4' (48") at all times.
5. The guideline regularly specifies half-bench cut trails. The International Mountain Bicycling Association calls them "half-baked trails" for a reason. No modern trail building guideline (IMBA, USFS or MNDNR) recommends half-bench cut trails, nor have they for nearly a decade, for a reason. They are not sustainable, often exacerbate drainage issues and are more likely to have trail tread collapse, especially when wet. All these are important considerations for Portland's high clay content soil, steep slopes and high annual rainfall amounts. See: <https://www.imba.com/resources/trail-building/10-most-common-trailbuilding-mistakes>
6. The grades for trail longitudinal slope and bench cross slope are no longer recommended in modern sustainable trail building guidelines. This is likely an artifact of the Portland guideline referencing previous standards that had been superseded at the time of publishing. Examples:
 - a. Maximum longitudinal slope is often called at 12% or as high as 15%. (See Trail Types A, G, I, J, K & N.) No modern trail building (IMBA, USFS or MNDNR) guideline allows for an overall or aggregate longitudinal slopes to exceed 10%. While these guidelines all allow for short steeper segments this is only allowed if a) the longitudinal slope still maintains 10% in total and b) the soil in the location of that steeper slope can handle the increase in slope (i.e. high rock/gravel content).
 - b. The bench cross slope is too shallow, being 0% to 5%. (See Trail Types A, B, C, D, G, I, J & K.) Modern trail building (IMBA, USFS or MNDNR) guidelines recommend a minimum cross slope of 5% with up to 15% for grade knicks, grade steps and other erosion and runoff control features. In the Midwest, where high volume, low duration rainfall events ("gully washers") occur on a regular basis, they use a minimum cross slope of 5% on grade reversal slopes and 10% on grade reversal tops and bottoms. With Portland's high clay content soils and high volume, long duration rainfall events, it would be even more important to get the water to sheet flow across the trail as quickly as possible to slow saturation of clay soils and the shallow cross slopes do not allow this.

Specific Issues with the Portland Parks & Recreation Trail Design Guidelines for Portland’s Park System

- For Trail Type G – Mountain Bike Trail does not defer to the IMBA guidelines for mountain bike trails. This leads to a conflict between the Portland Parks & Recreation guidelines and the IMBA guidelines as to what would be acceptable in construction of a mountain bike trail. Examples:

Figure 1 - IMBA Trail Rating System

Trail Difficulty Rating System					
	Easiest White Circle	Easy Green Circle	More Difficult Blue Square	Very Difficult Black Diamond	Extremely Difficult Dbl. Black Diamond
Trail Width	72" or more	36" or more	24" or more	12" or more	6" or more
Tread Surface	Hardened or surfaced	Firm and stable	Mostly stable with some variability	Widely variable	Widely variable and unpredictable
Average Trail Grade	Less than 5%	5% or less	10% or less	15% or less	20% or more
Maximum Trail Grade	Max 10%	Max 15%	Max 15% or greater	Max 15% or greater	Max 15% or greater
Natural Obstacles and Technical Trail Features (TTF)	None	Unavoidable obstacles 2" tall or less Avoidable obstacles may be present Unavoidable bridges 36" or wider	Unavoidable obstacles 8" tall or less Avoidable obstacles may be present Unavoidable bridges 24" or wider	Unavoidable obstacles 15" tall or less Avoidable obstacles may be present May include loose rocks Unavoidable bridges 24" or wider	Unavoidable obstacles 15" tall or greater Avoidable obstacles may be present May include loose rocks Unavoidable bridges 24" or narrower
			TTF's 2' high or less, width of deck is greater than 1/2 the height	TTF's 4' high or less, width of deck is less than 1/2 the height Short sections may exceed criteria	TTF's 4' high or greater, width of deck is unpredictable Many sections may exceed criteria

- The IMBA guidelines indicate criteria like width, longitudinal slope, and surface roughness according to the rating of the trail. The Portland Guidelines lack this level of detail that has critical implications for proper trail design. (See Figure 1)
 - As mentioned previously, the longitudinal slope and bench cross slope as listed in the Portland Guidelines do not match the IMBA guidelines. This places trail builders, volunteers or contractors, in a difficult position: Do they build to the more sustainable and modern IMBA guidelines or do they build to the substandard guidelines from Portland Parks & Rec, whose land(s) they are building on and whose permissions they obtained?
 - These types of trails are specifically called out for mountain biking only. However, the Portland Guidelines currently offer no way to define where a mountain biking only trail should exist. While it's possible the Off-Road Cycling Master Plan will help define this parameter, at this time the Portland Guidelines offer no evaluation criteria. Other cities that have urban mountain biking trails have a method of evaluating where this type of trail would be used and that type of usage is usually part of a post-construction management methodology. In fact, in cities that have urban mountain biking, mountain biking only trails are the exception, not the norm.
- For Trail Type J – Hiking & Mountain Biking does not defer to the IMBA guidelines for mountain bike trails or to the best practices as defined and refined in other cities with urban mountain biking on their shared trails. In fact, the current guideline for Trail Type J includes practices long abandoned in other cities over concerns of safety and sustainability. Examples:

- a. As mentioned above in 6a & 6b, the Portland Guidelines include defects with respect to longitudinal and bench cross slope. Type J also suffers from these issues.
- b. Trail Type J also suffers from a series of choices that run counter to modern trail design. Those choices are expressed on page 31 of the Portland Guidelines in the following manner:

Figure 2 – City of Phoenix Trail Rating System

Trail Rating Guide <small>The symbols marking the trail difficulty have very specific meaning.</small>				
RATING SYMBOL	BRIEF DEFINITION	SURFACE	GRADE	OBSTACLES /STEPS
Easiest ○	Paved Accessible Trail	Paved or hard and smooth	< 5%	None
Easy ●	Mostly smooth and wide	Dirt with occasional unevenness	< 10%	≤ 2-inch rocks and ruts
Moderate ■	Mostly smooth, variable width	Dirt with occasional unevenness	< 15%	8-inch rocks and ruts, loose material
Moderately Difficult ◇	Mostly uneven surfaces	Dirt and rock	< 20%	< 12-inch rocks and rust, loose material
Difficult ◆	Long rocky segments with possible drops and exposure	Dirt and loose rock with continual unevenness	> 20%	≥ 12-inch loose rocks, exposure to drops
Extremely difficult ◆◆	Long rocky segments with possible drops and exposure	Dirt and loose rock with continual unevenness	> 20%	≥ 12-inch loose rocks, exposure to drops, and ≥ 90-degree heat.

SOURCE: City of Phoenix

- “The hiking and biking trail requires moderate balance and fitness... Since this trail does not have the obstacles desired by expert riders, it is more suitable for beginning and less experienced mountain bikers.” It’s not just experienced mountain bikers that desire more grade and more challenge. Hikers and trail runners do also. The modern method of creating hiking trails follows a similar difficulty rating system as IMBA’s Trail Difficulty Guideline mentioned above. (See Figure 2) Where trails are shared, often cities just default to IMBA’s guideline. Cities that successfully share trails between hikers and mountain bikers understand that the difficulty rating of the trails “self-sort” users. Users wanting a more relaxed experience, whether hiker or mountain biker, will gravitate to trails with lower ratings and users that want a more technical experience will gravitate to trails with higher ratings. Essentially what Trail Type J does is create a hybrid that no one wants. It doesn’t contain the technical elements of Trail Type G, but it doesn’t make safer trails (for reasons discussed below) because it allows higher mountain bike speeds. So it’s the worst of both worlds. It’s a snooze for most hikers and mountain bikers, and creates conditions that breed trail user conflict.
- c. Trail Type J encourages unsafe conditions on shared trails in three ways. First, it sets a arbitrarily wide width that is not controlled by post-construction management. Second, that arbitrary width removes the ability to use two of the best techniques for managing mountain bike speeds: choke points and variable bench width. Third, its minimizing of bench roughness (remember “does not have the obstacles desired by expert riders”) means there are no surface features to reduce the speeds of mountain bikers in lieu of the other two methods that Type J also excludes. It is important to remember that a trail can’t be just safe; it needs to feel safe as well. Hikers can become anxious around objects traveling 3-4 times their speed. So a hiker traveling 3mph will likely not feel safe with mountain bikers traveling over 12mph. Examining the Strava data from trails at the city’s Powell Butte Nature Park that use this cross section, the KOM/QOM downhill speeds range from 15 mph to 20mph. See Figure 3

Rank	Name	Date	Speed
1	ZACH ROSATO	Jun 26, 2015	19.5mi/h
2	Dan Swan	Apr 18, 2016	18.7mi/h
3	BreakAway Berne	Apr 29, 2015	17.4mi/h
3	Josh Kelley	Oct 12, 2015	17.4mi/h
5	Nate Youngs	Feb 26, 2014	17.1mi/h

Figure 1- Capture from Strava for Elderberry Trail in Powell Butte on March 1st, 2017

for an example of just one trail. These unsafe high speeds are a direct result of the defects contained in the Portland Guidelines, including Trail Type J.

- d. If you look at successful shared (hiker & mountain biker) trails across the country, you find some commonalities between them. Almost all use some form of post-construction management (often called “user management techniques”) that define the maximum or minimum width of the trail (but often not both for flexibility) and manages how users will interact on that trail via travel direction. Trails therefore often contain variable bench width and choke points at regular intervals. Notice Figure 4, a screen capture from Strava of the five fastest men on the Theodore-Wirth North Loop trail in Minneapolis, MN. The KOM rider never broke 10mph and no one has gotten faster in nearly 2 years. The North Loop of Theodore-Wirth is a very narrow, shared trail system with a maximum width of 36” without the need for passing zones, and has existed without any hiker/biker collisions since its inception in 2005. Notice in Figure 5, the photo of a mountain biker on Theodore-Wirth’s North Loop, that there is a variation in the surface of the trail (fallen log with step sawed out) that leads directly into a tight turn and choke point. All this is designed to provide interest to the mountain biker or the hiker but also to generate a bicycle speed that hikers are comfortable with. Remember, all these methods of making a trail fun for all users and managing the speeds of mountain bikes to allow hikers to feel more comfortable are **forbidden** in Trail Type J.

Rank	Name	Date	Speed
1	Jason Colestock	Sep 29, 2015	9.2mi/h
2	Owen Thoele	Jun 2, 2015	9.1mi/h
3	Jesse LaLonde	Jul 24, 2014	9.0mi/h
4	Matt Dowling	Oct 7, 2015	8.9mi/h
5	John Wessling	Aug 27, 2015	8.8mi/h

Figure 2-Capture from Strava for North Loop Trails on March 1st, 2017

The North Loop of Theodore-Wirth is a very narrow, shared trail system with a maximum width of 36” without the need for passing zones, and has existed without any hiker/biker collisions since its inception in 2005.

Notice in Figure 5, the photo of a mountain biker on Theodore-Wirth’s North Loop, that there is a variation in the surface of the trail (fallen log with step sawed out) that leads directly into a tight turn and choke point. All this is designed to provide interest to the mountain biker or the hiker but also to generate a bicycle speed that hikers are comfortable with. Remember, all these methods of making a trail fun for all users and managing the speeds of mountain bikes to allow hikers to feel more comfortable are **forbidden** in Trail Type J.



Figure 3-Mountain biker on North Loop at Theodore-Wirth Park in Minneapolis, MN

- e. Trails with arbitrary widths are not as ecologically sound as trails with varying widths. Creating a trail that must be X’ wide, regardless of topographic or ecological realities, creates undue impacts. Also, the trail widths for many of the trail types in the Portland Guidelines, especially Trail Type J, are considered too wide by modern trail design, construction and management standards. Those differences create negative impacts, and quickly. Compare the following trail widths (we will assume maximum, even though, as discussed above in 2d the bench width likely will vary):

- i. 36" (3') bench on a 3:1 sideslope has an impact width of 54" (4.5') or an area of 23,760ft² per a mile with a volume of 2.8ft³ resulting in a soil movement of 11,880ft³ per a mile.
- ii. 48" (4') bench on a 3:1 sideslope has an impact width of 72" (6') or an area of 31,680ft² per a mile with a volume of 4.0ft³ resulting in a soil movement of 21,120ft³ per a mile.
- iii. So 12" (1') of bench width change resulted in an 33% percent increase in impact above the narrow trail width and a 78% increase in soil movement.

How to Fix the Portland Parks & Recreation Trail Design Guidelines for Portland's Park System

For at least the reasons detailed above, an update of the Portland Guidelines is clearly warranted. Meanwhile, the city's current Off-Road Cycling Master Plan process could help deliver critical improvements calling for a set of guideline amendments. Amending a current set of guidelines should be much easier than a full update because city staff can simply recommend adding to or striking items already within the guidelines.

Those amendments should include the following changes:

- Review all longitudinal slope recommendations with an eye to reducing the maximum longitudinal slopes to the modern and sustainable 10%, as well as making clear that slope segments can only exceed 10% where soil or construction conditions allow.
- Review all bench cross slope recommendations with an eye to increasing the minimum cross slopes to the modern and sustainable 5%, as well as making bottom portion of grade reversals a steeper slope than other cross slopes.
- Adopt the IMBA trail rating system for all natural surface trails that contain hikers, mountain bikers or both.
- Remove any preference, explicit or implied, for half-cut bench trails. These should only be used in areas where no other alternative (including boardwalking) will work.
- Remove Types G & J Trails as currently defined and create a set of user management techniques that are based on the best practices as found in locations with extensive shared use mountain bike trails with high mileage, i.e. Minneapolis/St. Paul (MN), Knoxville (TN), Bentonville (AR) or Kansas City (KS/MO). These user management techniques should include bench width maximums, choke point distances, and directionality. IMBA's trail difficulty guidelines will continue to specify preferred bench widths, trail roughness, maximum longitudinal slopes and vertical edge maximums.
- Require any trail that will have mountain biking added as a shared use be completely upgraded to the new standards before the trail is opened to mountain bikers.

One of best things Portland Parks & Recreation could do for its staff engineers, designers and construction managers is to have them all receive training in modern sustainable trail building techniques, such as those used by the International Mountain Bicycling Association, United States Forest Service or the Minnesota Department of Natural Resources. It also might be a good idea for these staff members to attend at least three (3) trail work days at a local mountain bike trail. Additionally, the city should strongly consider sending a small number of key staff members to visit and learn about some of the cities

mentioned above to experience how other cities successfully share large amounts of trails without incident.

It is likely that had Portland Parks & Recreation staff had these types of training and experiences before 2008-2009 when the Portland Guidelines were being assembled they would have pushed for the Portland guidelines to reflect the most modern and sustainable standards that had been release in the years prior. Whatever the reasons for Portland Parks & Recreation choosing outdated standards in 2009, the fact of the matter is that almost a decade has passed since then. Clearly, it is time update or replace the guidelines to reflect more modern, sustainable and, ultimately, more successful standards.