# New Zealand Mountain Bike
# Trail Builders Handbook

Recreation Aotearoa
Te Whai Oranga

Department of Conservation
Te Papa Atawhai

He Kaupare. He Manaaki. He Whakaora.
prevention. care. recovery.

SPORT NEW ZEALAND
IHI AOTEAROA

# Contents



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All other photos by Jonathan Kennett unless stated otherwise.

We would like to acknowledge the land managers, trail designers and track builders around the country who have provided their valuable insights into this publication, especially Jeff Carter, Chris Mildon, Nick Sutcliffe, Steven Peters and the Kennett Bros.

# About this handbook

This small guide is for use on the ground, in the forests and mountains at the time a trail is being designed or built. It has been produced by Recreation Aotearoa in collaboration with the Department of Conservation, New Zealand Cycle Trails, ACC and Sport New Zealand.

This handbook is available in paper and PDF versions. Google **MTB Trail Builders Handbook** to download.

This handbook provides detailed and defined specifications for each of the six trail grades in Aotearoa New Zealand. Any organisation involved with building, grading or maintaining a trail is encouraged to use this handbook. Trail grade consistency around the country will help ensure a fun and safer riding experience.

For more information about designing and building trails, including sign guidance, refer to the much larger and more detailed ***New Zealand Mountain Bike Trail Design Guidelines***. As well as everything in this handbook, the design guide has technical drawings for switchbacks, berms, jumps, boardwalks, retaining walls and more.

Refer to the Auditing Guidelines within the ***New Zealand Mountain Bike Trail Design Guidelines*** to assess, audit or grade a trail.

## Is your trail shovel ready?

| | |
|---|---|
| **Land access** | Has the landowner and/or manager given approval for your trail build? |
| **Design** | Has a plan has been drawn up and is the trail marked out on the ground? |
| **Safety** | Do you have a safety plan that identifies any potential hazards and explains how they will be mitigated or removed? Do you also have a plan for responding to incidents? |
| **Structures** | Refer to the ***New Zealand Mountain Bike Trail Design Guide*** for information about structures. They may require professional designs, a building consent and a resource consent. |

# Grades

## Grade 1 Easiest

Fairly flat, wide and smooth track. Includes rail trails and gentle gravel roads. These trails are ideal for family groups and non-cyclists, as well as gravel bike riders. There are no jumps or technical trail features. Refer to page 4.


## Grade 2 Easy

Mostly flat with gentle climbs on smooth tracks with easily avoidable obstacles, such as the occasional rock, tree root or pothole. Grade 2 trails are suitable for most ages and fitness levels, but not all. There may be some technical trail features, but they will all be easily rollable. Refer to page 6.

## Grade 3 Intermediate

Steeper, narrower tracks, with loose surfaces in places and possibly tricky technical trail features and jumps, but they should all be rollable with care at a slow 'pre-ride' speed. There may be exposure at the outside edge of the track. Users need the skills to ride on narrow trails around tight corners. Refer to page 8.

## Grade 4 Advanced

A mixture of steep climbs/descents, loose track surfaces and obstacles that are tricky to avoid or roll over. Often exposed at the edge of the track. In MTB parks, there may be jumps that are only rollable at slow 'pre-ride' speeds. Switchbacks are tight. Backcountry trails may include walking sections. Refer to page 10.

## Grade 5 Expert

Prolonged steep climbs and/or fast, steep descents. Generally exposed at the outside edge of the track. Expect many technical trail features, sharp corners and possibly jumps. Not all features will be rollable. Riders must have high levels of skill and experience. Refer to page 12.

Credit: Matthew Wood

## Grade 6 Extreme

Downhill or free-ride specific tracks. Extremely steep sections with large drop-offs and other unavoidable obstacles. May include huge man-made structures and jumps catering for exceptionally skilled riders. Can also include steep and technical uphills. Refer to page 14.

Credit: Jan Fearnley

# Grade 1 Easiest

Flat, wide and smooth trail without obstacles or technical challenges. An easy ride for beginners, families and almost all types of bikes.

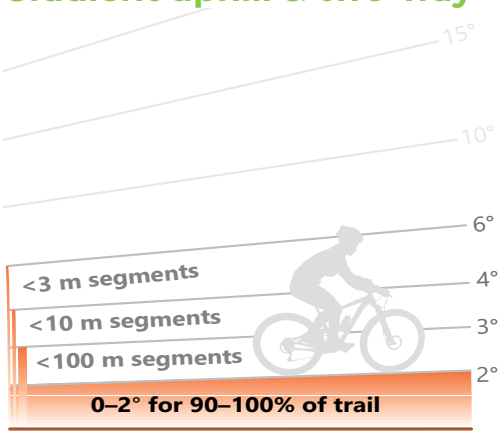
| Key trail features | |
|---|---|
| **Track width** | |
| Absolute minimum (m) | 1.2 m one-way and 2.2 m two-way |
| Preferred minimum (m) | 1.5 m one-way and 2.5 m two-way |
| **Track surface** | Well formed with compacted aggregate (AP20 or finer).<br>No mud. No loose gravel on corners. |
| **Obstacles** | Up to 30 mm high, perpendicular to track |
| **Berms** | Up to 10° for fast corners |

| Technical trail features | |
|---|---|
| **Jumps** | None |
| **Downhill drops** | Maximum 50 mm with gentle transition |
| **Uphill steps** | None |
| **Concurrent features** | None |

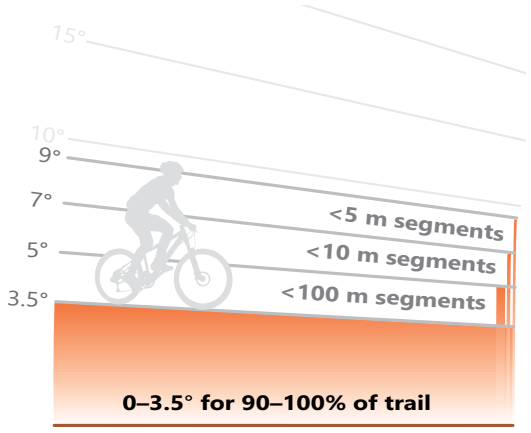
| Vegetation |
|---|
| Assess and protect valuable native trees. |
| Limbs/stumps must be cut flush to the main branch or ground. |
| Move cut vegetation out of sight. |
| On two-way trails, ensure vegetation clearance allows for good visibility. |

Tracks on steeper terrain should have extra width, or a bund, or a barrier to fall or have the fall zone planted with shrubs (see page 26).

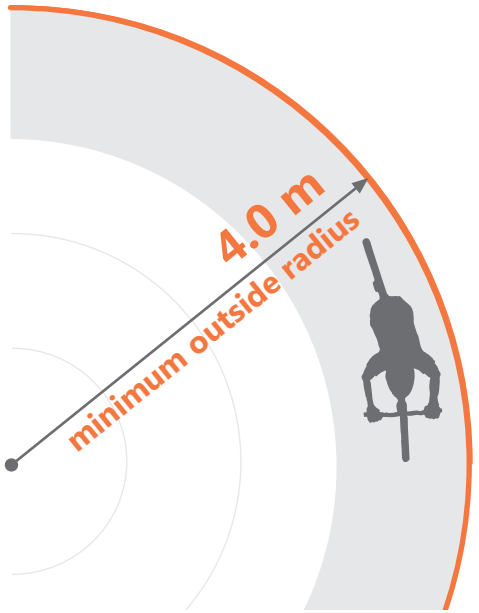
## Gradient uphill & two-way




## Gradient downhill



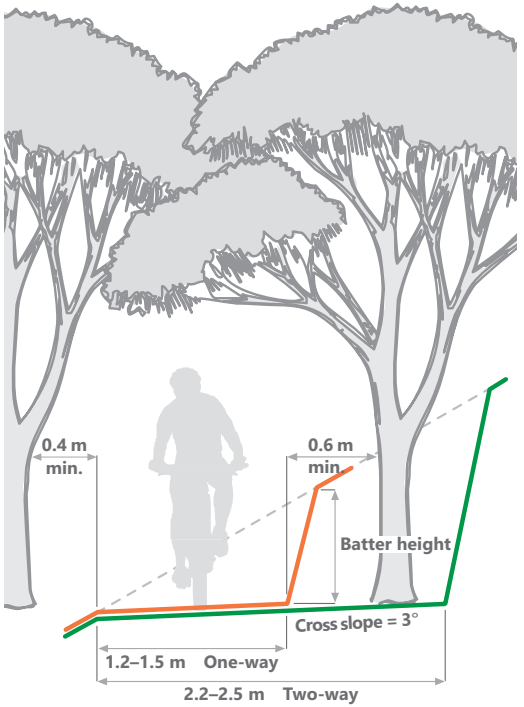

## Radius at outside edge




More vegetation clearance is needed around the inside of corners.

You can allow half the clearance passing individual trees, rocks or handrails.

## Width



# Grade 2 Easy

Relatively smooth and wide track with some gentle climbs. Any obstacles are easy to avoid. An easy ride for most beginners and families on any mountain bike.

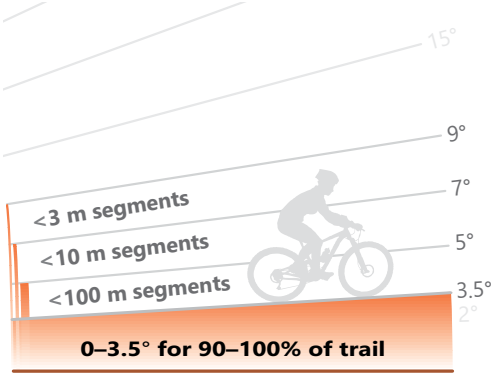
| Key trail features | |
|---|---|
| **Track width** | |
| Absolute minimum (m) | 1.0 m one-way and 2.0 m two-way |
| Preferred minimum (m) | 1.2 m one-way and 2.2 m two-way |
| **Track surface** | Well formed with compacted aggregate (AP40 or finer)<br>No loose gravel on corners. Minimal mud. |
| **Obstacles** | Up to 50 mm high |
| **Berms** | Up to 20° for fast corners |

| Technical trail features All features will be rollable | |
|---|---|
| **Jumps** | Elongated rollers with 5°–20° linear ramps |
| **Downhill drops** | Maximum 100 mm with gentle transition |
| **Uphill steps** | Maximum 50 mm with gentle transition |
| **Concurrent features** | 1 feature at a time |

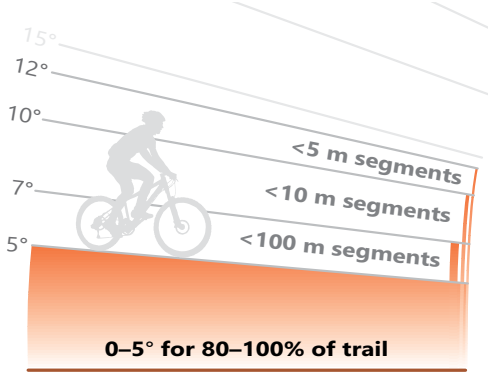
| Vegetation |
|---|
| Assess and protect valuable native trees. |
| Limbs/stumps must be cut flush to the main branch or ground. |
| Move cut vegetation out of sight. |
| On two-way trails, ensure vegetation clearance allows for good visibility. |

Tracks on steeper terrain should have extra width, or a bund, or a barrier to fall or have the fall zone planted with shrubs (see page 26).

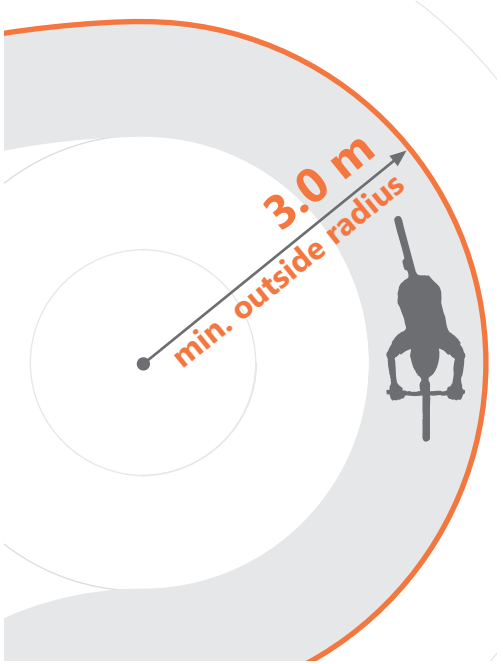
## Gradient uphill & two-way




## Gradient downhill



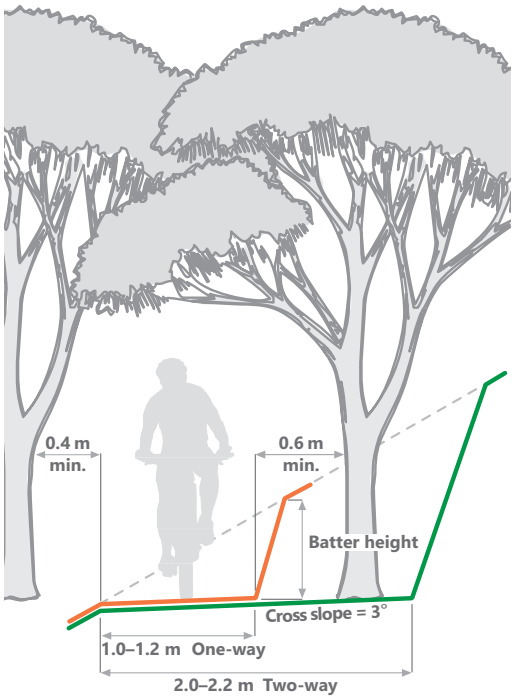

## Radius at outside edge




More vegetation clearance is needed around the inside of corners.

You can have half the clearance passing individual trees, rocks or handrails.

## Width



# Grade 3 Intermediate

Steeper climbs and descents, looser surfaces, narrower track with some exposure at edge. Riders need to have fitness and skill to avoid obstacles and loose sections on a narrow track. Jumps and obstacles can be rolled at slow 'pre-ride' speed.

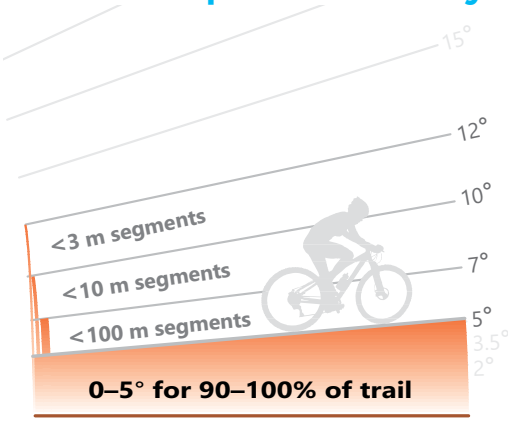
| Key trail features | |
|---|---|
| **Track width** | |
| Absolute minimum (m) | 0.8 m one-way and 1.0 m two-way |
| Preferred minimum (m) | 1.0 m one-way and 2.0 m two-way |
| **Track surface** | Generally well formed. May be some rocks and roots.<br>Loose surface in places |
| **Obstacles** | Up to 100 mm high |
| **Berms** | Up to 30° for fast corners |

| Technical trail features All features will be rollable | |
|---|---|
| **Jumps** | 1–4.5 m long, with 10°–25° linear ramps |
| **Downhill drops** | Maximum 300 mm with gentle transition |
| **Uphill steps** | Maximum 100 mm with gentle transition |
| **Concurrent features** | 1–2 features at a time |

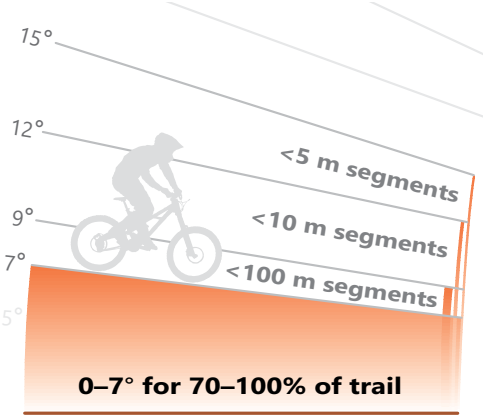
| Vegetation |
|---|
| Assess and protect valuable native trees. |
| Limbs/stumps must be cut flush to the main branch or ground. |
| Move cut vegetation out of sight. |
| On two-way trails, ensure vegetation clearance allows for good visibility. |

Tracks on steeper terrain should have extra width, or a bund, or a barrier to fall or have the fall zone planted with shrubs (see page 26).

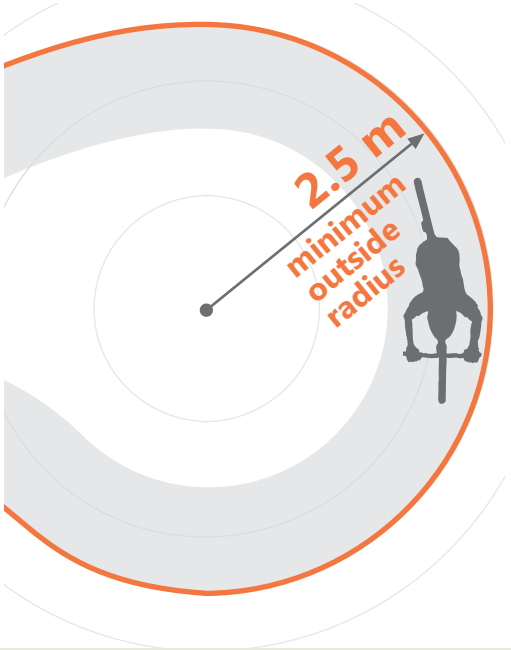
## Gradient uphill & two-way




## Gradient downhill



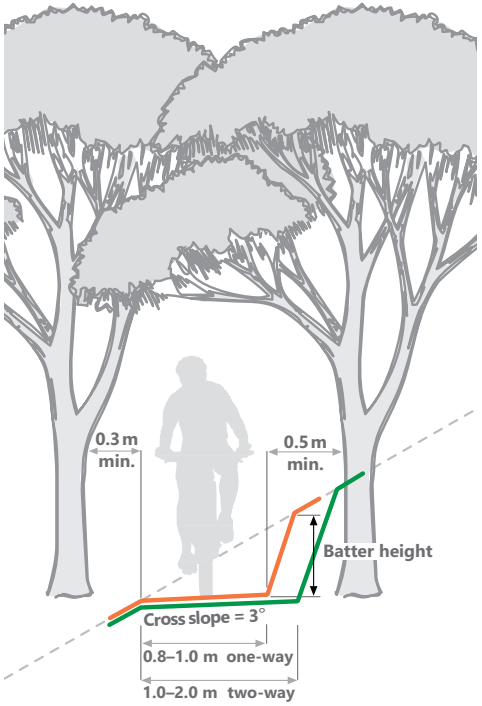

## Radius at outside edge




More vegetation clearance is needed around the inside of corners.

You can have half the clearance passing individual trees, rocks or handrails.

## Width



# Grade 4 Advanced

A track that may be narrow, have steep climbs/descents, loose surfaces, big obstacles and jumps. Only suitable for riders with excellent skills, years of experience and a quality mountain bike.

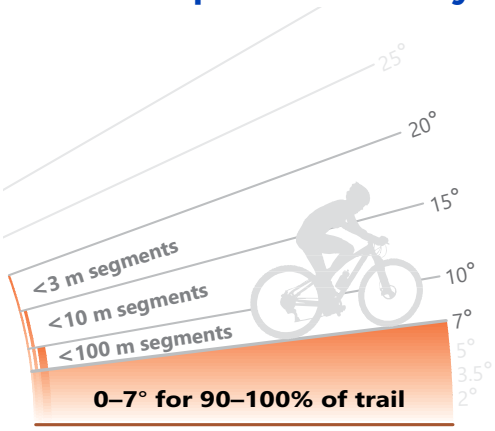
| Key trail features | |
|---|---|
| **Track width** | |
| Absolute minimum (m) | 0.6 m one-way and 1.0 m two-way |
| Preferred minimum (m) | 0.8 m one-way and 1.8 m two-way |
| **Track surface** | Mostly stable, some variability<br>Loose rocks possible in places |
| **Obstacles** | Up to 200 mm high |
| **Berms** | Up to 40° for fast corners |
| **Technical trail features** All features will be rollable | |
| **Jumps** | 1–7 m long with 10°–30° linear ramps |
| **Downhill drops** | Maximum 400 mm (rollable) |
| **Uphill steps** | Maximum 200 mm |
| **Concurrent features** | 1–3 features at a time |

| Vegetation |
|---|
| Assess and protect valuable native trees. |
| Limbs/stumps must be cut flush to the main branch or ground. |
| Move cut vegetation out of sight. |
| On two-way trails, ensure vegetation clearance allows for good visibility. |

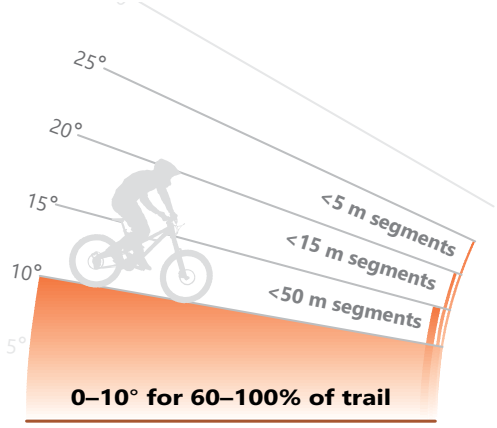
Tracks on steeper terrain should have extra width, or a bund, or a barrier to fall (see page 26). Steep gradients will need frequent grade reversals and rock armouring to be sustainable.

Some sections of trail may not be formed, and the actual width may not be discernible in rooty or rocky areas.

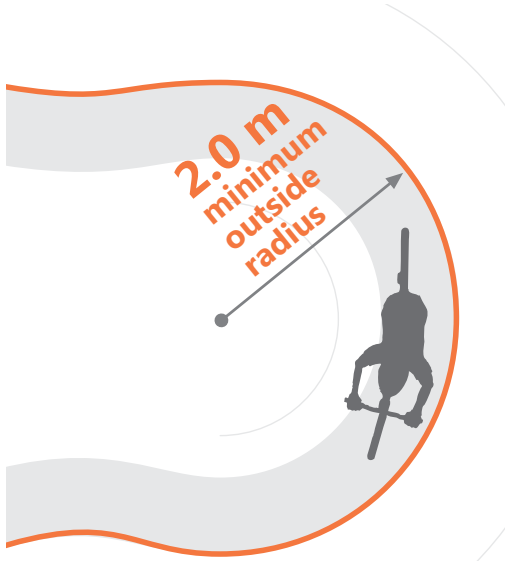
## Gradient uphill & two-way




## Gradient downhill




## Radius at outside edge

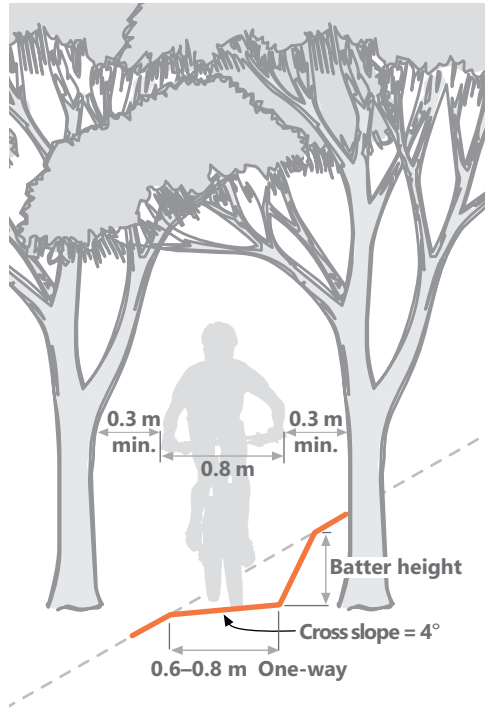



More vegetation clearance is needed around the inside of corners.

You can have half the clearance passing individual trees, rocks or handrails.

Always provide reset sections and grade reversals after steep features.

## Width



# Grade 5 Expert

A track with a mix of monster climbs/descents, narrow sections, exposed edges, technical obstacles and possibly huge jumps. Expect dangerous drops and poor traction in places. Only suitable for very fit, experienced and coordinated riders on quality bikes. Walking may be advisable in places.

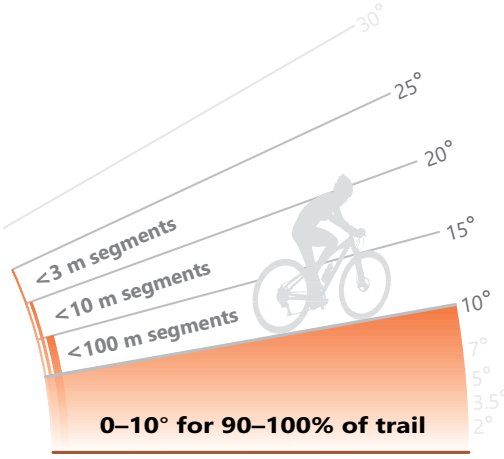
| Key trail features | |
|---|---|
| **Track width** | |
| Absolute minimum (m) | 0.4 m one-way |
| Preferred minimum (m) | 0.8 m one-way |
| **Track surface** | Widely variable (roots, rocks, ruts) |
| **Obstacles** | Up to 500 mm high |
| **Berms** | Up to 50° for fast corners |
| **Technical trail features** Rollable or have a b-line | |
| **Jumps** | 1–12 m with 15°–35° linear or curved ramps |
| **Downhill drops** | Maximum 1,000 mm |
| **Uphill steps** | 500 mm high |
| **Concurrent features** | 1–4 features at a time |

| Vegetation |
|---|
| Assess and protect valuable native trees. |
| Limbs/stumps must be cut flush to the main branch or ground. |
| Move cut vegetation out of sight. |
| On two-way trails, ensure vegetation clearance allows for good visibility. |

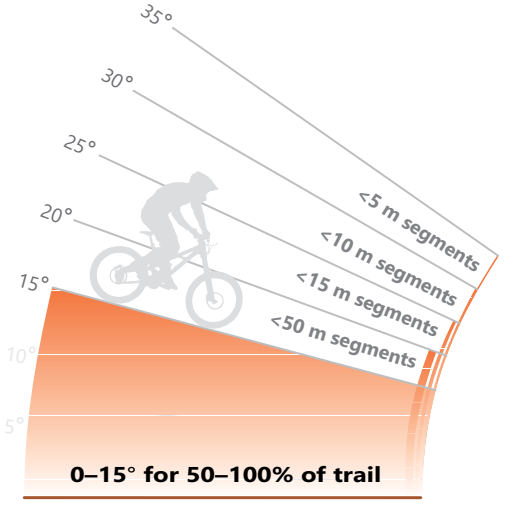
Tracks on steeper terrain should have extra width, or a bund, or a barrier to fall (see page 26). Steep gradients will need frequent grade reversals and rock armouring to be sustainable.

Some sections of trail may not be formed, and the actual width may not be discernible in rooty or rocky areas.

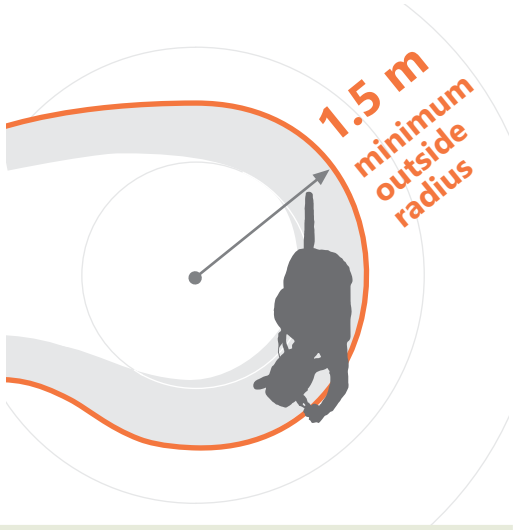
## Gradient uphill




## Gradient downhill




## Radius at outside edge

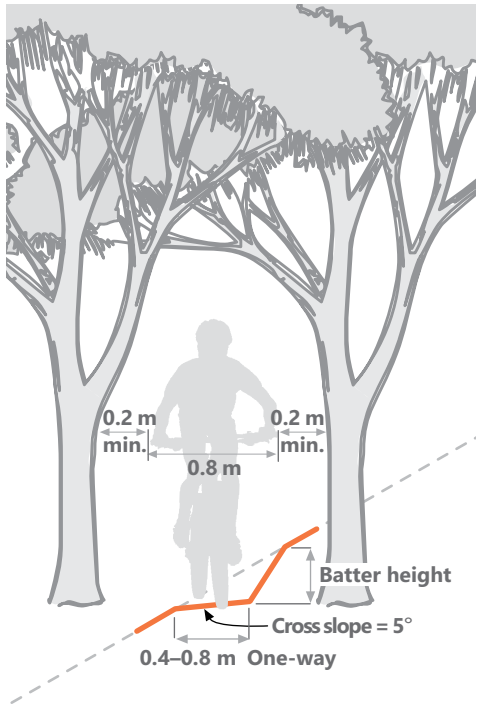



More vegetation clearance is needed around the inside of corners.

You can have half the clearance passing individual trees, rocks or handrails.

Always provide reset sections and grade reversals after steep features.

## Width



# Grade 6 Extreme

Downhill or free-ride specific tracks with extremely steep sections and dangerous drop-offs. Extremely skilled adrenalin junkies who are willing to take abnormal risks for a buzz. Requires years of experience.

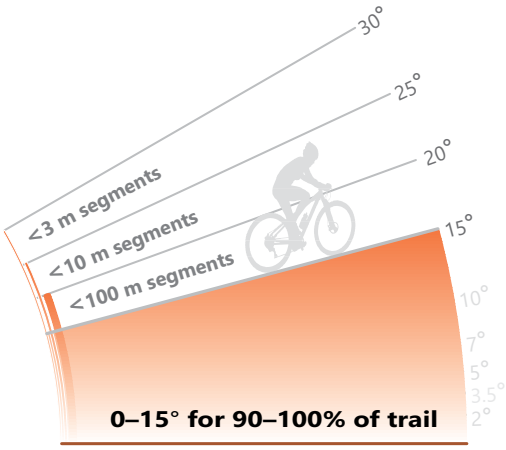
| Key trail features | |
|---|---|
| **Track width** | |
| Absolute minimum (m) | 0.2 m one-way |
| **Track surface** | Rough as guts. Big rocks, ruts, jumps, drops and wooden obstacles. |
| **Obstacles** | No limit |
| **Berms** | No limit |
| **Technical trail features** Unrollable features with no b-line | |
| **Jumps** | No limit |
| **Downhill drops** | No limit |
| **Uphill steps** | No limit |
| **Concurrent features** | 4 or more features at a time |

| Vegetation |
|---|
| Assess and protect valuable native trees. |
| Limbs/stumps must be cut flush to the main branch or ground. |
| Move cut vegetation out of sight. |
| Ensure vegetation clearance allows for good visibility. |

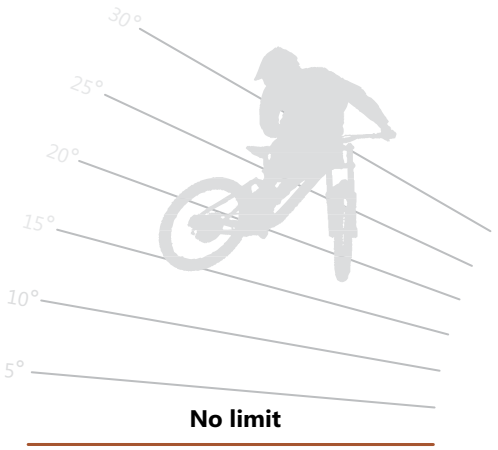
Tracks on steeper terrain should have extra width, or a bund, or a barrier to fall (see page 26). Steep gradients will need frequent grade reversals and rock armouring to be sustainable.

Some sections of trail may not be formed, and the actual width may not be discernible in rooty or rocky areas.

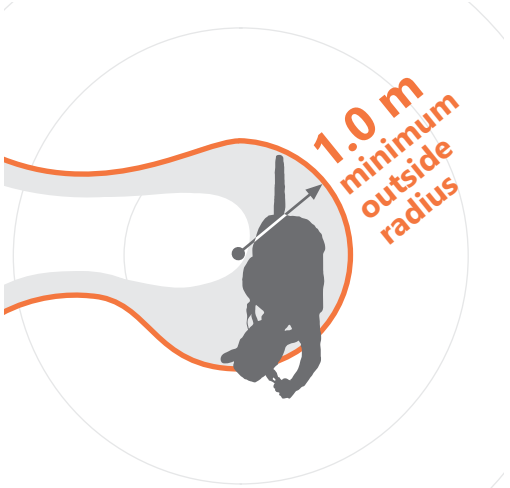
## Gradient uphill




## Gradient downhill




## Radius at outside edge

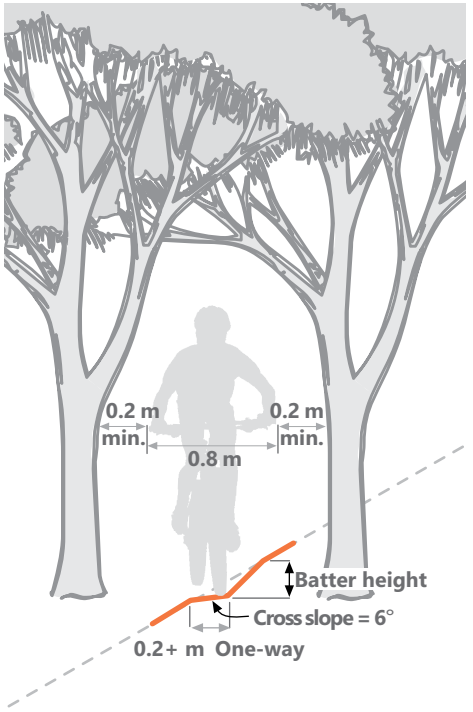



More vegetation clearance is needed around the inside of corners.

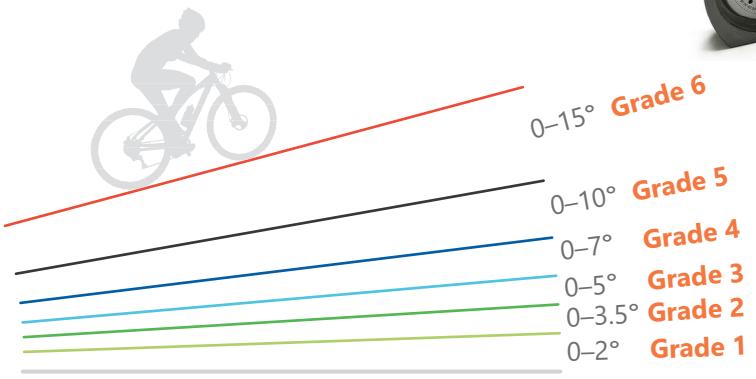
You can have half the clearance passing individual trees, rocks or handrails.

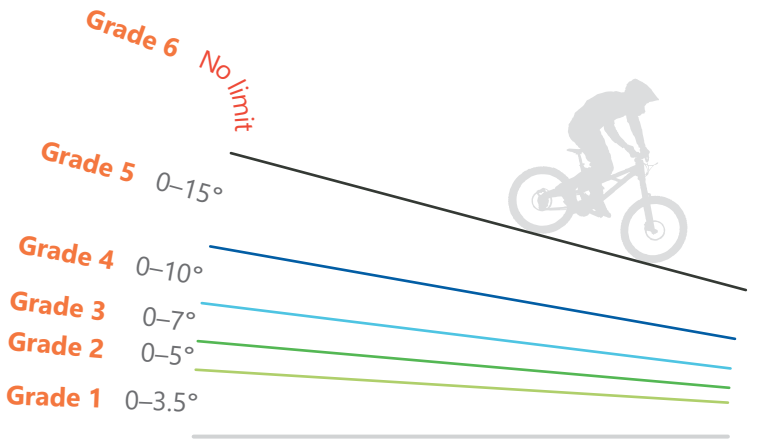
Always provide reset sections and grade reversals after steep features.

## Width



# MTB trail gradient


**Gradient:** The steepness or slope of a trail, which is expressed as degrees.

Gradient is the most important design element to get right, and also the hardest thing to change after a track has been built. It is easy to widen a track or increase the radius of a corner, but changing the gradient involves building new track.

There is a gradient conversion table at the back of this handbook for those who prefer to work in percent or ratio.

**Gradient for 90–100% of a two-way trail:** Indicates to the designer (and the rider) that, for 90–100% of the trail length, the gradient will be within a certain band (e.g., Grade 3 two-way tracks will be 0°–5°).

**Maximum gradients:** A specified percentage of the trail length (depending on the trail grade) can be made up of steeper segments. Only resort to these steeper segments if you have to (i.e., to get around a tree or massive boulder, etc) and always provide reset sections afterwards.

For example, a Grade 3 two-way trail can include segments that are:

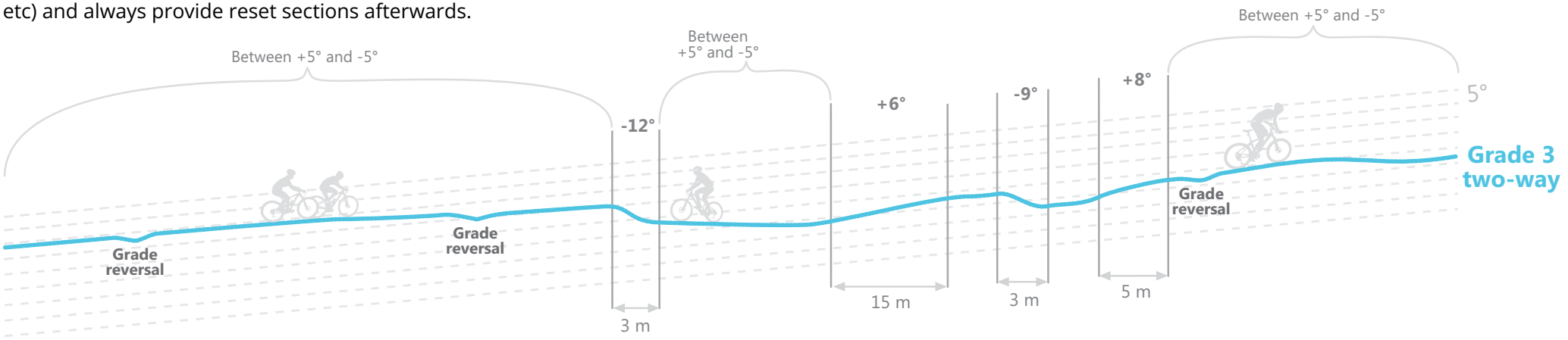
A. 5–7° for up to 100 metres at a time

B. 7–10° for up to 10 metres at a time

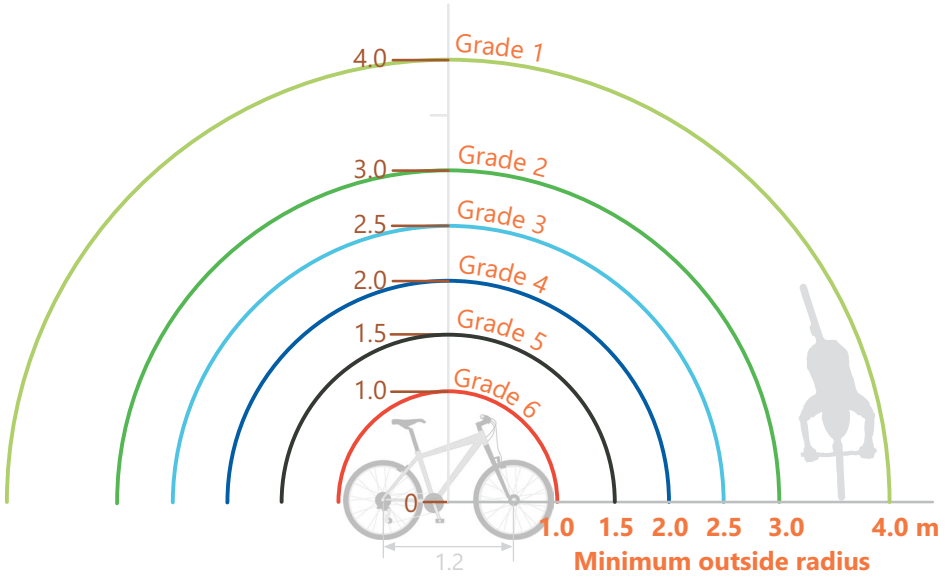
C. 10–12° for up to 3 metres at a time.

All the segments of A + B + C added together must be less than 10% of your trail length.

Mitigate steep segments with a flat stretch or big grade reversal at both ends, to give riders time to prepare for, or recover from, the steep bit.



# MTB switchback radius




This is the second-most important thing to consider during design because finding flattish spots for switchbacks makes them easier to build. Much easier!

Switchbacks are measured from the centre of the turn to the outside of the track.

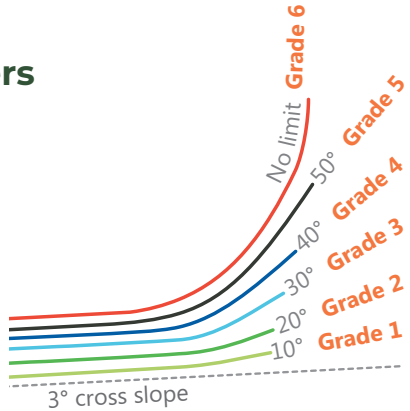
Mark the outside of the switchback all the way around, using survey tape or bamboo stakes or pigs tails.

Once you've done that, you can calculate the height of your uphill cut and downhill fill, and you'll know if you need a retaining wall, and if you do, how high it will be.

Note: Adaptive MTBs need a minimum radius of 4–6 metres (see page 24).

**Top tip!** It is important to have reset sections (incorporating grade reversals) after every steep section. This is where riders recover and settle their bikes and water is diverted off the track.

## Cambered and bermed corners




Camber is the cross slope on a track. Use camber to make it easier to ride around a corner and drain water off the track. For higher speeds, you'll need to build a berm on the outside of the corner.

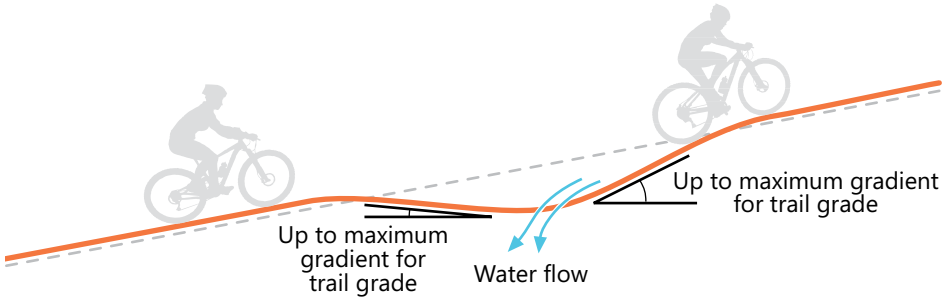
Note: Less confident riders and adaptive MTBs cannot ride steep berms. They need a flatter bit of track on the inside.

## Grade reversals

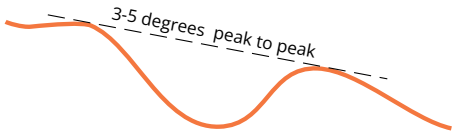
Water scour is the enemy of your track formation!

Combat water scour by building lots of grade reversals anywhere that water will flow onto/along the track. The bigger the better. Make them fun little rollers or big dippers.

Grade reversals can be retrospectively added, but it is best to plan them before you begin digging. That way you can make them fit the landscape. Anywhere that water will flow across/along the track when it's raining should have a grade reversal.



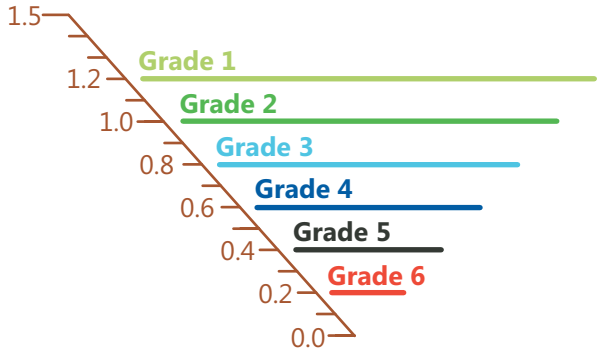

Jumps, rollers and dippers also act as effective grade reversals. Gradient between the peaks of a dipper should be 3–5°.




**Top tip!** Regardless of everything else, the most fun and sustainable trail you can build will flow so well that you can ride it with no brakes.

# MTB trail width

**One-way track width:** This handbook gives absolute minimum widths for each trail grade. You can build wider if you want to, and if you're on a digger, you probably will. But most landowners will have maximum allowable widths (e.g., in Wellington a resource consent is needed to build wider than 1.5 m).




A common width for jumps tracks is 1.5 m.

Adaptive MTBs need 1.0–1.5 m width, depending on the grade.

New Zealand Cycle Trails are generally 1.5–2.5 m wide.

**Two-way track width:** It all depends on location and rider numbers. In a mountain bike park, or on a popular cycle trail, two-way tracks need to be twice as wide to allow safe passing and comfortable riding side by side.

# Definitions

**Tread obstacles:** Roots, rocks and ruts are common features on technical tracks, especially Grades 4, 5 and 6. On the easier grades and flow trails, they are usually dug out, or covered over.

**Shared use:** Means riders should expect to encounter walkers and runners (sometimes even horses) on a trail. You should not expect to meet motorised traffic like cars or motorbikes. Land managers should be aware that horses and motorised vehicles will damage most mountain bike tracks.

**Downhill drops:** These are jumps or drops that are often built out of wood, although they can be located naturally where there is a big boulder or root.

Step downs can grow over time if they are not rock armoured at the landing.

**Rollovers/chutes:** A steep downhill section, usually 2–10 m long, where riders may let go of their brakes as they roll over the top.



**Power climbs:** Technically challenging climbs with trail features to make them interesting, especially on an e-bike.

**B-lines:** A track built around the side of a difficult feature that may be out of grade. This is often retrospectively built, once people realise a feature is too hard for the track it was built on. B-lines need to be obvious and well signposted in advance.

It is better for the main line (the A-line) to be the correct grade and out-of-grade features to be on the B-line (or have no out-of-grade features).

**Technical trail features:** Specific elements or obstacles that are intentionally added to the trail to provide variety and challenge. This can include elements such as jumps, drops, berms, rollers, rocks, tree roots, switchback corners, boardwalks and bridges.

**Jumps:** There are a whole range of jumps to consider. Start at Grade 2 with rollers that aren't even jumps at slow speed and flat ramps leading to a small drop. At Grade 6, the sky is literally the limit, and emergency vehicle access should be considered.

**Sustainability (environmental and financial):** Soil strength varies around the country. If there isn't much rock in your soil, then you shouldn't build to the maximum gradients. Steeper tracks will blow out and be washed away. Soil erosion leads to sedimentation of streams/rivers/estuaries, which damages water ecosystems.

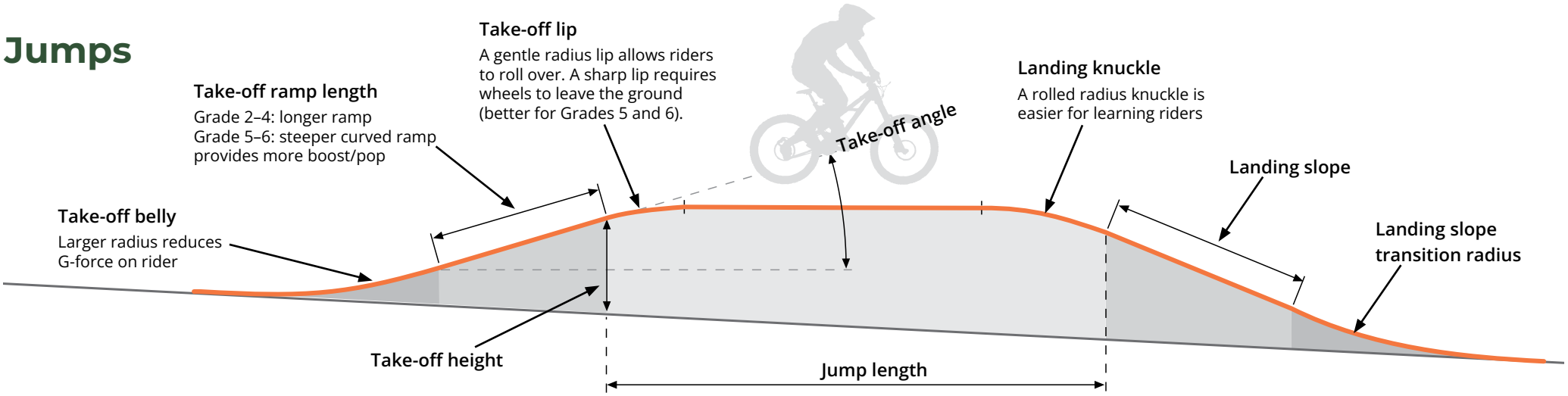
Steeper tracks also cost a lot, as they need to be repaired and resurfaced more regularly. Often the best long-term solution is rock armouring.

If you are building a trail for the long term, dial back the average gradient. Follow these priceless IMBA rules.

1. Don't build a fall-line track. It will become a watercourse that rips away all your track soil.
2. Sustainable average gradients are less than 5°. Soil on trails over 10° will erode away unless rock armoured. Steep trails require endless ongoing maintenance to keep to grade.

**Concurrent features:** Multiple features happening all at once or in very quick succession. A Grade 2 trail only has one feature at a time. Higher grades have increasingly more concurrent features (i.e., Grade 5 may have a stepped drop, on a corner, landing in a rock garden).

# Jumps




| Rider expectations for jumps | | | | | | |
|---|---|---|---|---|---|---|
| | Grade 1 | Grade 2 | Grade 3 | Grade 4 | Grade 5 | Grade 6 |
| Horizontal tabletop jump length lip to lip | None | None | 1–4.5 m | 1–7 m | 1–12 m | Unlimited |
| Take-off height belly to lip | None | None | Up to 1.5 m | Up to 2 m | Up to 4 m | Unlimited |
| Minimum linear take-off ramp length | None | None | 2.5 x height | 2x height | Can be curved all the way to the lip, i.e., no linear ramp | Can be curved all the way to the lip, i.e., no linear ramp |
| Types of features | Rollers | Rollers | Rollers, tabletop, rollable double | Rollers, tabletop, rollable double | Rollers, table-top, rollable double | Rollers, table-top, rollable double |
| Gap jumps | None | None | None | None | Optional gap up to 8 m, with bypass line | Gaps of un-limited size, no bypass line required |

**Guidance:** The aim of a good progressive jumps trail is to have a range of jump sizes to suit the speed of the trail. Not all jumps should be at the maximum length. For example, a Grade 3 jumps trail, could have 80% of the jumps at 1–3 m long, with the remaining 20% of jumps at 3–4.5 m long.

Curved ramps should follow a 'clothoid' form.

| Calculated jump lengths (metres) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Speed at take-off | Take-off ramp angle | | | | | | | | |
| | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° |
| 10 km/h | | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.7 | 0.8 | 0.8 |
| 15 km/h | | 0.6 | 0.9 | 1.1 | 1.4 | 1.5 | 1.7 | 1.7 | 1.8 |
| 20 km/h | 0.5 | 1.1 | 1.6 | 2 | 2.4 | 2.7 | 3 | 3.1 | 3.1 |
| 25 km/h | 0.9 | 1.7 | 2.5 | 3.2 | 3.8 | 4.3 | 4.6 | 4.8 | 4.9 |
| 30 km/h | 1.2 | 2.4 | 3.5 | 4.6 | 5.4 | 6.1 | 6.7 | 7 | 7.1 |
| 35 km/h | 1.7 | 3.3 | 4.8 | 6.2 | 7.4 | 8.3 | 9.1 | 9.5 | 9.6 |
| 40 km/h | 2.2 | 4.3 | 6.3 | 8.1 | 9.6 | 10.9 | 11.8 | 12.4 | 12.6 |
| 45 km/h | 2.8 | 5.4 | 8 | 10.2 | 12.2 | 13.8 | 15 | 15.7 | 15.9 |
| 50 km/h | 3.4 | 6.7 | 9.8 | 12.6 | 15.1 | 17 | 18.5 | 19.4 | 19.7 |
| 55 km/h | 4.1 | 8.1 | 11.9 | 15.3 | 18.2 | 20.6 | 22.4 | 23.4 | 23.8 |
| 60 km/h | 4.9 | 9.7 | 14.2 | 18.2 | 21.7 | 24.5 | 26.6 | 27.9 | 28.3 |
| 65 km/h | 5.8 | 11.4 | 16.6 | 21.4 | 25.5 | 28.8 | 31.2 | 32.7 | 33.2 |
| 70 km/h | 6.7 | 13.2 | 19.3 | 24.8 | 29.5 | 33.4 | 36.2 | 38 | 38.5 |

Assumes lip and landing at same elevation.

Key: Grade 3 | Grade 4 | Grade 5 | Grade 6

# Adaptive bike trail specs

Adaptive bikes are two, three or four-wheeled cycles. Most adaptive bikes have electric motors and are 800–950mm wide, though some can be up to 1.1m wide. They have large turning circles, and some three-wheeled bikes can be unstable on off-camber sections. There is a wide range of designs, with narrower and lower equipment often used on higher-grade trails.

Adaptive mountain bikes create opportunities for a range of users with broad physical, intellectual, neurological and sensory abilities. Inclusive trails built to the adaptive mountain biking specifications create quality experiences for all trail users.

Accessibility to and from the trail car park needs to be carefully considered and allowed for, including any transition to trails, amenities and facilities (i.e., toilets).

| | Grade A1 | Grade A2 | Grade A3 | Grade A4 | Grade A5 | Notes |
|---|---|---|---|---|---|---|
| **Gradient (at least 90% of length of trail)** | 0–2° for over 90% of the trail | 0–4° for over 90% of the trail | 0–5° for over 90% of the trail | 0–5° for over 90% of the trail | 0–7° for over 90% of the trail | Do not built at a constant gradient.<br>Add lots of gentle grade reversals to make the track fun and sustainable. |
| **Gradient (max)** | 2–5° for up to 10 m section | 4–7° for up to 10 m sections | 5–10° for up to 10 m sections | 5–15° for up to 10 m sections | 7–20° for up to 10 m sections | |
| **Width** | 1.5 m minimum | 1.5 m minimum | 1.2 m minimum | 1.0 m minimum | 1.0 m minimum | No pinch-points less than 1.0 m wide. |
| **Cross slope** | Level, 1–2° | Max 3° | Max 3–5° | Max 5° | Max 5° | Keep track cross-slope camber to less than 3°, to avoid the risk of trikes rolling. |
| **Radius at outside edge** | 6.0 m plus | 6.0 m minimum | 6.0 m flat, and 4.5m bermed | 4.0 m flat, and 4.0 m bermed | 3.5 m flat, and 3.5 m bermed | Trikes will tip over on off-camber corners.<br>It is always better to have corners slightly bermed or flat. |
| **Berms** | Level | 10° maximum | 10–20° maximum | 20–30° maximum | No camber restrictions | |
| **Surface** | AP20 compacted. Loose material less than 5 mm | Firm and stable | Mostly stable, some variability | Mostly stable, some variability | Widely variable | |
| **Tread obstacles** | None | 50 mm maximum | 100 mm maximum | 200 mm maximum | 250 mm maximum | |
| **Technical trail features (i.e., jumps and drops)** | All features rollable.<br>No drops or jumps.<br>If shared use, handrails are recommended where the gradient is steeper than 4°. | All features rollable.<br>Drops maximum height of 100 mm with gentle downhill transitions.<br>No jumps.<br>1 feature at a time. | All features rollable.<br>Drops maximum height of 200 mm with gentle downhill transitions.<br>Jumps with ramp angle maximum of 20°.<br>2 features at a time. | All features rollable.<br>Technical features such as gap jumps must have clearly identified alternative line.<br>Drops 200 mm maximum height.<br>Jumps with ramp angle maximum of 25°.<br>3–4 features at a time. | All features rollable.<br>Technical features such as gap jumps must have clearly identified alternative line.<br>Drops 200 mm maximum height.<br>Jumps with ramp angle maximum of 30°.<br>4 or more features at a time. | All technical trail features must be rollable. |

Refer to the **Outdoor Accessibility Design Guidelines** for more detail.

# Fall hazards

| Step One: Fall hazard consequence | |
|---|---|
| **Key questions** | **Answer** |
| Is the height and/or length of the fall likely to result in serious injury or death? | **Yes / No?** |
| Are there secondary consequences present that are likely to lead to serious injury or death? For example, being swept away in a river, landing on rocks, or falling in boiling mud.<br>See **Fall zone surface assessment** table on page 28. Answer **No** for **benign** or **favourable**. Answer **Yes** for **unfavourable** or **hazardous**. | **Yes / No?** |

If **Yes** to either of the above, continue with **Likelihood Assessment**

| Step Two: Likelihood assessment score | | | | |
|---|---|---|---|---|
| **Key questions** | **Likely = 3** | **Possible = 2** | **Unlikely = 1** | **Very unlikely = 0** |
| How wide is the track? | <0.6 m | 0.6–1.5 m | 1.5–2.4 m | >2.5 |
| How technically difficult is the track surface? | Unstable, rough, out-sloping and/or slippery | Stable, loose and rough | Stable, firm and relatively smooth | Sealed or wood with netting |
| Is there vegetation on the fall zone? | None | Some – may stop/slow a person's fall | Abundant, sturdy, likely to stop a person's fall | Thick and will stop a person |
| What is the alignment of the track and the visibility of the hazard? | Blind corner leading into drop-off | Curvy trail but sight line is more than stopping distance | Curving trail with ample line of sight | Straight, ample line of sight |
| Expected level of rider? | Grade 1, 2 | Grade 3 | Grade 4, 5 | Grade 6 |

**Total likelihood score (level of risk):**

| Step Three: Recommended mitigations | | | |
|---|---|---|---|
| **Level of risk** | **Low (score 5–7)** | **Moderate (score 8–10)** | **High (score 11–15)** |
| Suggested treatment | Generic advisory and communication (i.e., signs at car park or trail head and trail website, social media, email list). | Physical treatment using any, or all, of the following:<br>• Outer bunds<br>• Natural barriers (i.e., rocks, shrubs, trees)<br>• Physical impediments (i.e., gate system). | Engineered safety fence as per design code (see note below)*<br>Add 1 metre shy space between the track and the fall hazard. |

Note* This is generally the best practice, however it might not be feasible due to a lack of anchors or being on an active slip zone. In cases where it is not feasible, other options such as walk-only zones can be considered. Regardless of the chosen treatment, it is crucial to identify how the treatment will be maintained and who will do it.

### Definitions

***Unstable:*** a section of track that may collapse (i.e., especially the edge).

***Rough:*** a surface that exceeds the height of trail obstacle for the given grade (see pages 4–14).

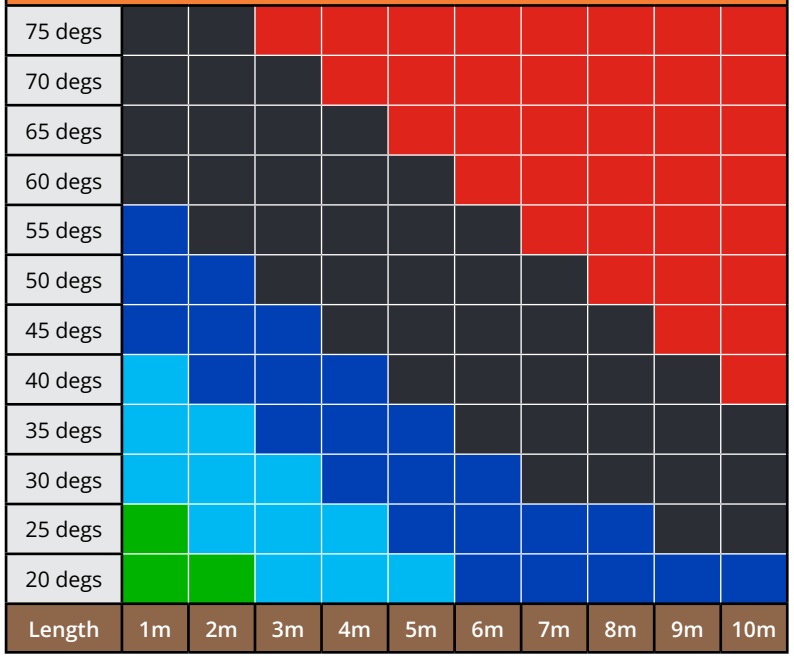
***Serious injury:*** a fracture, concussion, severe cuts or other injuries requiring medical treatment/hospitalisation for at least three hours.

**Examples of risk treatment**

- Grade 2 track with 35 degree fall slope was densely planted with shrubs.
- Sections of Grade 4 track with vertical fall to riverbed had a barrier to fall installed.
- Many tracks have had specific warning signs installed, but please note that signs are often not as effective as other physical treatments.
- Add 'shy space'. As the side slope below the track becomes steeper and scarier, add some 'shy space' (extra width). For example, on a 45° side slope, add 1.0 m for Grade 1 trails and 0.6 m for Grade 2 and 3 trails.

| Fall zone surface assessment | | |
|---|---|---|
| **Fall surface** | **Description of surface** | **Examples of surfaces within category** |
| Benign | A surface with features that will tend to reduce the effect of impact. | Deep moss, soft vegetation, shallow still water deep enough to cushion a fall, or swamp. |
| Favourable | A surface with features that neither reduce nor amplify the effect of impact. | Gravel, sand, deep water with reasonable means of exit, or grass. |
| Unfavourable | A surface with features that will tend to amplify the effect of impact. | Jagged stones, concrete pavement, deep water without reasonable means of exit, sharp cut-off branches. |
| Hazardous | A surface with features that will result in serious harm regardless of the initial impact. | Swiftly flowing water without means of exit, boiling mud or water, extended falls arising from rolling or sliding, following initial impact on terrain whose slope exceeds 35°. |

**Rollover and chute design guidance**




Key: Grade 2 | Grade 3 | Grade 4 | Grade 5 | Grade 6

Notes: Must have a good roll in and roll out. If it has a technical roll out, add one grade. Rollovers are often rock armoured to eliminate erosion.

# Gradient conversion

| Degrees | Percent (%) | Ratio (rise:run) | Relevance |
|---|---|---|---|
| 1° | 1.7% | 1:57 | |
| 2° | 3.5% | 1:29 | Max climb Grade 1 |
| 3° | 5.2% | 1:19 | |
| 3.5° | 6.1% | 1:16 | Max climb Grade 2 |
| 4° | 7.0% | 1:14 | |
| 5° | 8.8% | 1:11 | Max climb Grade 3 |
| 6° | 10.5% | 1:9.5 | |
| 7° | 12.3% | 1:8 | Max climb Grade 4 |
| 8° | 14.1% | 1:7 | |
| 9° | 15.9% | 1:6 | |
| 10° | 17.5% | 1:5.7 | Max climb Grade 5 |
| 11° | 19.4% | 1:5.2 | |
| 12° | 21.3% | 1:4.7 | |
| 13° | 23.1% | 1:4.3 | |
| 14° | 24.9% | 1:4 | |
| 15° | 27.0% | 1:3.7 | Max climb Grade 6 |
| 20° | 36.0% | 1:2.7 | |
| 25° | 46.6% | 1:2.2 | |
| 30° | 58.5% | 1:1.7 | |
| 35° | 70.0% | 1:1.4 | |
| 40° | 83.9% | 1:1.2 | |
| 45° | 100.0% | 1:1 | |

# Trail Builders Handbook

**An essential resource for trail builders wanting to build awesome trails from Grade 1 (easiest) to Grade 6 (extreme).**


**This handbook is a concise version of the larger and more detailed New Zealand Mountain Bike Trail Design Guidelines. It will help you build fun, consistent and sustainable trails for all types of off-road biking.**