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1 INTRODUCTION

The Queenstown Lakes District Council administers over 180km of cycle trails and tracks. These trails and tracks are a valuable asset to the Lakes District and the purpose of this standard is to ensure greater consistency and quality in the development of all new trails. For simplicity, trails (as called in Wakatipu) and tracks (as called in Wanaka) will collectively be referred to as trails by this document.

The development of a cycle trail design standard is being driven by the increasing development of cycle trails in the Queenstown Lakes District and in particular trails developed as part of private land development projects as well as those created by volunteer organisations.

The Council has recently taken over ownership of numerous sections of cycle trail in both Wanaka and Queenstown and many of these have been built with significant design and construction defects which results in the ratepayer funding realignment and repair works. Council is looking to minimise this cost and ensure better quality trails are developed in the future to be fit for purpose.

This standard is intended to guide cycle trail designers and developers to achieve consistently high standards of cycle trail best suited to meet long term community needs (network connections and latent demand) and minimise ongoing maintenance costs to Council, as the trail owner.

The guide has been developed to closely mirror the New Zealand Cycle Trail (NZCT) "Cycle Trail Design Guide", 2010 with minor changes to take into account changes in design and construction that have arisen during the course of the National Cycle Trail projects. The changes are in maximum gradients, surface finish and additional detail on trail geometry that was not dealt with by this previous standard.

The NZCT guide implemented and widely publicised the 1-6 trail grading system used by the mountain biking community. In terms of trails developed within the QLDC, these will be graded 1-3 with tracks graded 4-6 being purpose built mountain bike tracks and not cycle trails. Development of mountain bike tracks is outside of the scope of this standard.

Additionally, the Department of Conservation (DOC) also have track design guides. These mainly relate to walking track construction and are available on the DOC website. DOC has adopted the NZCT grading system of rating trails as 1-6.

2 OVERARCHING GOAL OF THIS DESIGN STANDARD AND CONSTRUCTION SPECIFICATION

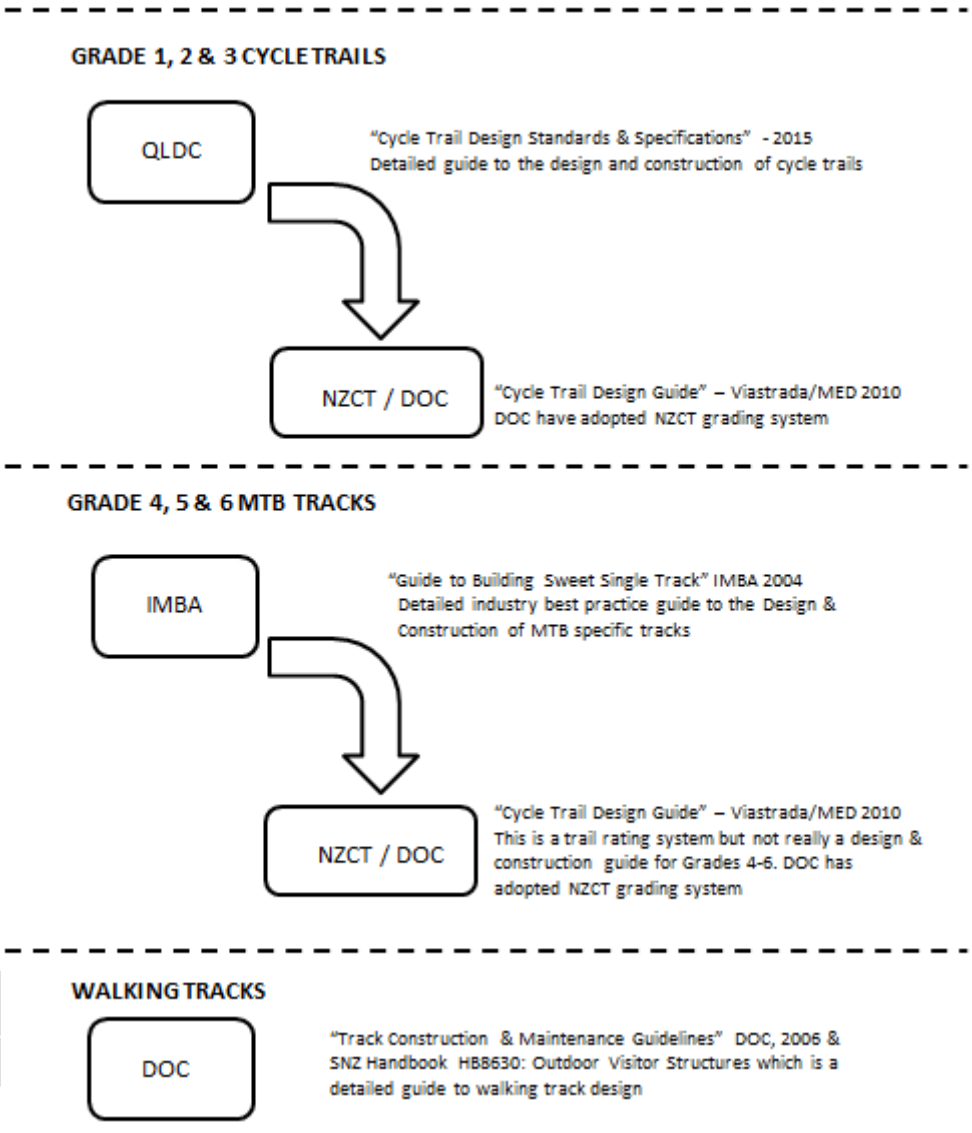
To guide land developers and trail designers to achieve a high quality cycle trail specifically designed and built to cater to the needs of the community(s) it connects and serves and that minimises future maintenance costs to Council.

3 SCOPE OF THIS GUIDE

The design and construction of Grade 1-3 cycle trails. The design and construction of 'mountain bike' tracks (Grades 4-6) is very well covered by the IMBA "Guide to Building Sweet Singletrack" 2004 design guide (Refer references section). DOC's track design guides are best suited for the design of walking tracks only.

The design and construction of trails suited to horses has not been considered as part of this guide.

4 OVERVIEW OF TRAIL AND TRACK DESIGN STANDARDS



5 TRAIL GRADING & USER GROUPS

The New Zealand Cycle Trail Project (NZCT) commissioned a design guide in 2010 as part of the nationwide cycle trail development project. Completed by Viastrada this guide is the best starting point in the identification of a cycle trail grading system. (See Cycle Trail Design Guide 2010 – Ministry for Economic Development)*1*.

Over the intervening 5 years we have refined this system and present the refined grading technical specifications as follows:

I. Grade 1 – Easiest; gentle grades up to 2 degrees (1: 28) with short sections <100m up to 3 degrees, wide (2.5m+) and smooth trail ideal for all user groups. No fall hazards. These are ideal for connecting communities and where families and novice cyclists are likely to be present.

II. Grade 2 – Easy; Some gentle hills up to a maximum of 4 degrees (1: 14), wide (2-2.5m) with some short (<50m) narrow sections of minimum width 1.5m, smooth surface with critical fall hazards within 2m of track edge fully protected. These are ideal for connecting communities and where families and novice cyclists are likely to be present but where Grade 1 gradients cannot be achieved due to terrain constraints.

III. Grade 3 – Intermediate; gradients 0-4 degrees typically, more regular hills acceptable up to a maximum 6 degrees (1: 10) where unavoidable terrain, width 1.2-1.5m and extended narrower sections of minimum width 1.2m. Critical fall hazards at track edge protected only. This is essentially an easy mountain bike track.

The majority of trails within the QLDC network are classed as Grade 1-2 with a few being Grade 3. Table 1 gives a breakdown of the various grades for existing local trails.

In order to provide the greatest accessibility to any new trails, every trail should be designed to meet Grade 1 or 2. Grade 3 should only be considered where the users are predominantly not commuters, families or novice cyclists and the trail is not forming part of a connective network to link communities or part thereof. In other words, not a critical linkage to the cycling network.

6 COMPARISON WITH NZCT/DOC GRADING SYSTEM

DOC has adopted the now widely used Kennet Brothers/NZCT trail grading system using numbers 1 to 6 to classify trails according to trail difficulty. Below is a brief overview of the difference to this standard:

- NZCT Grade 1 – Same except grades not allowed to be steep if ridden in one direction only.
- NZCT Grade 2 – Allows maximum grade of 6 degrees (leading developers to use this as a default grade), allows surface roughness like roots and rocks (not suited to rider group), topcourse aggregate of 30mm particle size (too course for good surface finish – Max 20mm)
- NZCT Grade 3 – Allows grades up to 5 degrees (too steep, likely to cause rutting) and maximum grades of 9 degrees (too steep for most riders, ruts badly)

In summary, this new standard responds to the desire of many trail developers to seek the shortest and steepest line for their trails. Setting lower grade limits and including trail geometry and cross fall details in the design specification is aimed at reducing the most common trail defects noted in this region.

1 http://www.nzcycletrail.com/about/resources

7 DETAILED TRAIL GRADE SPECIFICATIONS

The minimum specifications for each trail grade can be expanded as follows:

Grade 1

- A minimum width of 2.5m allowing for side by side riding. This makes passing and overtaking easy, and provides sufficient width for novice riders to feel secure. The minimum width may be reduced to protect historic features, or for environmental or visual amenity reasons. Width also caters for 4wd vehicle access for maintenance purposes.
- Maximum prolonged gradient of 2 degrees (1:28). Maximum gradient of 4 degrees (1: 14)
- Maximum out-slope cross fall of 3% for straight sections of track.
- Corners shall have a minimum inner radius of 6.0m and in-slope gradient or cross-fall of 6-8% except hair pins which must not exceed Typical Detail Sheet R4030_E3_3 of 2.5m
- Minimum structure width of 2.0m clear. Clear means between the closest parts of the barriers.
- A clearly sign posted, well defined trail from beginning to end so visitors can easily find their way in both directions and during inclement weather
- A compacted, well bound smooth riding surface with suitable camber to provide a pleasurable and easy riding experience. Riders should never feel they are going to slide off the trail. Minimum compacted aggregate depth of 75mm
- All water courses to be culverted or bridged
- All areas of fall hazard (exposure) shall be protected with barriers that meet the building code.
- No stiles are to be used. All fences are to be crossed using cattle stops/bollards
- Sight lines – a minimum of 15m clear sight distance is to be achieved around all corners

Grade 2

- A minimum width of 2.0m but generally 2.5m wide allowing for side by side riding. This makes passing and overtaking easy, and provides sufficient width for novice riders to feel secure. The minimum width may be reduced to protect historic features, or for environmental or visual amenity reasons. Width also caters for 4wd vehicle access for maintenance purposes.
- Maximum prolonged gradient of 4 degrees (1:14) but where length >100m it must be broken with flat recovery sections 10m long minimum at 50-75m spacing's. Maximum gradient of 6 degrees (1: 10) for no more than 30m without a flatter recovery section of equal or greater length
- Maximum out-slope cross fall of 3% for straight sections of track.
- Corners shall have a minimum inner radius of 6.0m and in-slope gradient or cross-fall of minimum 6-8% (to be suited to the trail geometry to ensure slip free riding at design speed) except hair pins which must not exceed Typical Detail Sheet R4030_E3_3 of 2.0m
- Minimum structure width of 2.0m clear. Clear means between the closest parts of the barriers.
- A clearly sign posted, well defined trail from beginning to end so visitors can easily find their way in both directions and during inclement weather
- A compacted, well bound smooth riding surface with suitable camber to provide a pleasurable and easy riding experience. Riders should never feel they are going to slide off the trail. Minimum compacted aggregate depth of 75mm

- All water courses to be culverted or bridged
- Areas of significant fall hazard shall be protected with barriers that meet the building code. Areas of exposure where there is not a significant hazard may be protected with fencing, bunding, vegetation or signage
- No stiles are to be used. All fences are to be crossed using cattle stops/bollards
- A minimum of 10m clear sight distance is to be achieved around corners, or additional warning/speed calming measures may be required to avoid user conflict.

Grade 3

- A minimum width of 1.2m but generally 1.5m wide allowing for comfortable single file riding only. The minimum width may be reduced to protect historic features, or for environmental or visual amenity reasons over short (50m) sections. Width caters for quad bike access for maintenance purposes.
- Maximum prolonged gradient of 6 degrees (1: 10) for sections not longer than 100m with flat sections of minimum 25m length between. Maximum gradient of 9 degrees (1: 6) for no more than 30m without a flat recovery section of equal or greater length
- Maximum out-slope cross fall of 3-6% for straight sections of track.
- Corners shall have a minimum inner radius of 3m and in-slope gradient or cross-fall of minimum 8-15% (to be suited to the corner, speed and trail geometry) except hair pins which must not exceed Typical Detail Sheet R4030_E3_3 of 1.2m
- Minimum structure width of 1.2m clear. Clear means between the closest parts of the barriers to ensure quad bike access.
- A clearly sign posted, well defined trail from beginning to end so visitors can easily find their way in both directions and during inclement weather
- A compacted riding surface of either insitu gravels or imported gravel to provide an all-weather surface. Minimum depths to suit ground conditions
- Trail cross fall to provide an enjoyable riding experience for intermediate riders. Riders should never feel they are going to slide off the trail due to incorrect cross slope.
- Water courses may be crossed with fords or be culverted or bridged if required. Any areas of soft or boggy ground shall be made all weather to prevent mud and damage to the trail surface
- Areas of significant fall hazard shall be protected with barriers that meet the building code. Areas of exposure within 1m of the trail edge where there is not a significant fall hazard may be protected with fencing, bunding, vegetation or signage
- Stiles may be used but preference should be given to using Cattle stops for convenience and maintenance purposes. Where a stile is used a gate is required adjoining for maintenance use.
- A minimum of 5m clear sight distance is to be achieved around corners, or additional speed calming measures (trail alignment, sag, etc.) are required to avoid user conflict.

8 CYCLE TRAIL DESIGN CONSIDERATIONS

8.1 STEP 1: IDENTIFY THE USER GROUP & REQUIRED TRAIL GRADE

If the proposed trail is connecting communities and will form part of a larger network, then the minimum standard will be Grade 2 (Always design to achieve the best grade where possible).

The user groups for Grades 1 and 2 are as follows:

a) Families including small children

b) Novice riders who either have never ridden or ride infrequently

c) Cycle tourers and commuters*

d) Mountain bike riders

e) Accessibility users

Groups (a) and (b) require a safe enjoyable cycling experience that is accessible with limited/no cycling skill. The trail must be designed with the needs of the most discerning user group in mind. For the above this would be families and novice riders. Cycle tourers, commuters and mountain bikers have a higher degree of skill and experience making them able to handle less well formed trails2.

Having identified the user group, the designer should aim to achieve the flattest grade possible to meet the highest Grading. This ensures the maximum utility and accessibility to the community irrespective of other aspects of the design.

8.2 STEP 2: DESIGN ALIGNMENT

The designer needs to consider how to fit the trail into the land to minimise gradients, minimise hairpins, control storm runoff and drainage, climb hills, design and integrate structures and achieve the required width and finish that creates or results in a desire line.

8.3 DESIRE LINE

The designer needs to understand where the trail users are coming from (How do they access the trail) and going to (where will they leave the trail network) as well as how will the riders respond to the trail alignment in order to understand the desire line. Desire line refers to the preferred alignment for trail users and manifests itself in riders cutting corners or short cutting sections of trail they consider 'undesirable' when it has not been achieved.

An example of an error in desire line is making curves across a flat open section of terrain when a straighter piece of trail would suffice. Riders are likely to cut corners in this situation. Each section of trail should be considered from the rider's perspective to ensure that desire line is achieved as much as possible.

Ultimately desire line can be hard to predict. A designer needs to consider this especially in open country where riders can see the destination.

8.4 HAIR PINS OR SWITCHBACKS

It is often necessary to use hair pins (corners of ~180 degrees) to negotiate steep terrain. The use of hairpins needs very careful consideration to avoid rutting, erosion damage and safety issues for novice or inexperienced riders.

Hairpins should be graded such that the longitudinal grade through the corner is no more than 2 degrees with the cross-fall sloped to the inside to match the speed of travel such that the corner at the design speed feels safe and secure without sideways slipping.

2 Commuter tracks require slightly different design considerations outside of the scope of this guide

Hairpin radius should be as wide a possible within the terrain constraints but not less than the minimum specified in design drawing R4030_E3_3 attached in Appendix A.

The approach to a hairpin should provide enough sight distance for riders to slow down prior to the corner without locking their brakes and skidding. This requires that the approach gradient is quite flat (0-2 degrees) and the surface is well compacted. It is unacceptable to have a constant 4 degree grade into and through a hairpin as the approach will rut causing operational and maintenance issues. Designers may use a rolling-up grade dip (sag) to slow riders naturally prior to a corner. This reduces the likelihood of skidding and loss of control through the corner.

8.5 CURVES, HILLS AND CROSS-FALL

In hilly terrain, curves should follow the terrain. Additionally the terrain should be used to assist drainage with low points in gullies and higher points near ridges. This promotes drainage towards gullies.

The trail surface cross-fall should reflect the terrain and trail geometry. Out sloped corners (very dangerous) are to be avoided at all costs. When a corner is properly designed and built a rider feels well connected to the trail through adequate cross-fall for the design speed and side friction. Refer to the typical cross sections attached for guidance. There are no set rules, but the designer must ensure that the completed trail rides without inducing side slip or fear in the target user group.

8.6 GEOTECHNICAL ASSESSMENT OF TRAILS

At the initial scoping stage it is desirable to undertake a desktop assessment of available information to pin point any possible areas of instability where a trail is proposed. This allows appropriate planning and funding to be included at the design stage. Additionally the designer should walk the trail alignment to confirm no obvious areas of instability

During the design stage known areas of instability should be addressed by specific design or alignments. If avoidable, this is the preferred option. However, as most trails are built on public land adjoining water ways, often the only option is to build over these areas.

As part of the following approval process, areas of instability should be clearly identified on the design plans together with site assessment and solutions. Council wish to avoid ongoing maintenance issues relating to instability in cycle trails and it is hoped such planning will reduce the incidence.

8.7 DESIGN APPROVAL BY QLDC

Prior to any works commencing on the site, the trail designer shall submit the trail design plan, long section (if available – for large projects it is often not possible or cost effective to prepare detailed terrain models), typical cross section, trail design user group and outline of how the trail caters to the user group and fits the trail network together with construction specifications to QLDC for approval prior to commencing any trail works on site.

Additionally the designer shall ensure the proposed trail is marked out on site with flagging tape at no more than 20m intervals and staked in detail for hairpins and curves to ensure the proposed alignment is able to be assessed in detail. The assessment will include a minimum of alignment and gradient checks.

QLDC shall have the opportunity to inspect the trail alignment on site with the designer. Any amendments requested by the Council shall be addressed to Council's satisfaction prior to approval of the works.

While the approval process is designed to identify errors in the design and layout of the trail, it is not possible to anticipate every issue. Further, due to terrain constraints, vegetation cover and access, it may not be possible to assess and design every section of trail in a cost effective manner. Therefore, the design approval does not in itself reduce any liability on the trail developer to achieve the standards and riding requirements detailed in earlier sections of this standard.

8.8 TRAIL CONSTRUCTION & COMPLETION

At the completion of works, the trail contractor and developer shall certify the works as complete and issue a completion certificate in the form of NZS 4404:2010 Schedules 1B & 1C. The Council shall then inspect the works to confirm the completed trail meets the needs of the user groups/community the trail serves. This shall include test riding the completed trail, measuring grades and cross falls and corner radius. The completion inspection is not solely a compliance check but a confirmation of achieving the needs of the trail user.

Where the trail is found to be deficient in terms of grades, alignment, cross fall or other defects (see defects section), the

trail developer shall remedy the defect prior to Council signing the s224c certificate and/or taking over the trail asset. Alternatively the trail developer may enter into a cash bond for the value of the works in accordance with Council's bonding policy for land development works.

For trails involving structures that do not require a building consent the trail developer shall submit the following to Council:

- NZS 4404:2010 Schedule 1B (contractors completion)
- NZS 4404:2010 Schedule 1C certificate (Construction review)
- Typical design details for the structure

Where a structure requires a building consent, the trail developer shall supply Council's Parks Department a copy of the building consent documents including PS1, PS3, PS4 and Code Compliance together with design drawings and/or as-built drawings prior to sign off/acceptance of the asset. While this may be a double up on the BC process, often the design detail is not readily accessible and the purpose is to ensure the Parks Department has a complete set of documents for ongoing operation and maintenance.

Additionally all trails and structures including bridges, culverts, signs, bollards, cattle stops, fences etc. shall be accurately surveyed and an as-built plan prepared and submitted in accordance with Council's land development standards to detail all trail related assets being taken over by Council.

8.9 THE DEFECTS PERIOD

Once the works have been signed off by Council as complete, the trail developer shall be responsible for a 12 month defects period. At the completion of the defects period, Council shall be advised and a final inspection undertaken. The final inspection shall assess the trail as if it were in the new as-built state. That is the trail developer shall be required to present the trail in an as-new condition at the end of the defects period.

If the trail requires changes to alignment to avoid or remedy rutting, surface erosion or desire line errors, the trail developer shall be responsible for such modifications at their cost prior to Council taking over responsibility irrespective of whether these were noted at the time of the design approval or completion inspection as often it takes time for errors in design and construction to manifest through use of the trail.

The following parameters shall be achieved for completed trails at the end of the defects period:

- The trail shall have good flow and speed control that does not result in rutting or surface erosion from skidding
- Finished surface shall be interlocking at the end of the defects period and free from loose gravel.
- The surface of the gravel and +0.5m either side of the formation edge shall be clear of all weeds. If there are weeds within the surface gravel, this shall be considered a defect and the developer shall be liable to remedy by mechanical removal.
- Within all the earthworked areas adjoining the trail, all noxious weeds shall be removed
- All verges shall be mown/cut to a maximum 350mm height up to +0.5m off the edge of the formation
- Any stormwater erosion shall be stabilised with rock protection or matting
- Adverse cross fall shall be rectified
- Any silting of culverts or debris in culverts or water tables shall be cleared
- Full design width shall be presented
- Vegetation shall be clear 1.0m beyond the edge of the trail and 2.5m above the trail

9 TRAIL CONSTRUCTION SPECIFICATION – GRADE 2

Attached as Appendix A is the standard Construction Specification for a Grade 2 Trail. The specification outlines the standard work methodologies required to complete a cycle trail to Council standards.

Where designers are forming a Grade 1 or Grade 3 trail, the specification shall be modified in accordance with the section "Detailed Trail Grade Specifications" to take account of differing maximum gradients, curve radius, surface and so forth.

10 TRAIL CONSTRUCTION – TYPICAL CROSS SECTIONS & DETAILS

Attached as Appendix B are typical cross section and detail plans ref R4030_E3_1-4. These provide design detail in relation to typical cross sections in different terrain, use of curves and hairpins and other typical details used in cycle trail construction but are not intended to cover every aspect of trail construction.

11 REFERENCES

- International Mountain Bicycling Association (IMBA) "Guide to Building Sweet Single Track"
- Standards New Zealand NZS HB 8630:2004 – Tracks and Outdoor Visitor Structures
- "Cycle Trail Design Guide" 2010 Viastrada/MED, prepared for the New Zealand Cycle Trail Project
- QLDC Cycleway Maintenance Specifications c.2010
- Standards New Zealand NZS 4404:2004 – Land Development & Subdivision Engineering
- "Track Construction & Maintenance Guidelines" 2006, Department of Conservation