Mountain Bike Training Facility Report

Development, design and construction

sportscotland

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Introduction

On 22 June 2005 **sport**scotland National Centre Glenmore Lodge opened its mountain bike training facility.

Glenmore Lodge is located in the Cairngorms National Park, seven miles east of Aviemore and provides coaching and instruction in a range of outdoor pursuits, including mountain biking.

The mountain bike facility was developed with £37,000 of funding from **sport**scotland's Demonstration Programme. The Demonstration Programme was established to fund innovative and best practice sports projects, which will provide lessons for others to learn and benefit from.

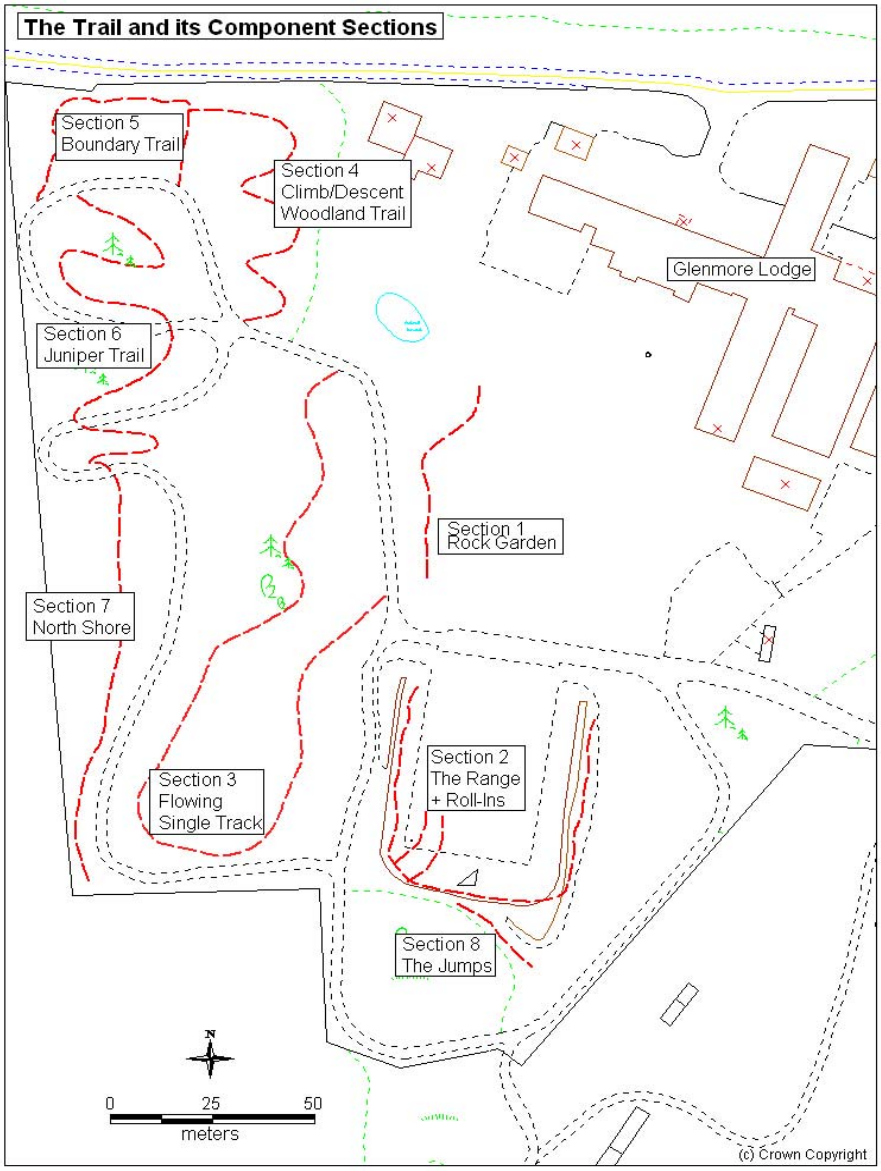
This report gives details on the development of the Glenmore Lodge mountain bike facility and the lessons and best practice that have been learned from the project.

It is important to note that the mountain bike trail has been developed primarily as a teaching facility. While the trail can be ridden recreationally, its design is focussed on training and teaching requirements rather than on providing a mountain bike circuit for general recreational use. That said, most of the lessons in this report are relevant to the development of a recreational mountain bike trail.

Section 1: The Trail

The mountain bike facility comprises 8 distinct sections, each featuring a different component of mountain bike trail riding and design commonly found on natural and manmade trails throughout Scotland. The trail consists of:

- The boulder field/rock garden, 'Fincham's fingers', 62m.
- The range, including the roll-ins, 270m.
- Flowing singletrack, 'Juniper jolly', 217m.
- Climb/descent woodland Trail, 127m 'The woods' and 'Rat run'.
- Boundary trail, 104m.
- Juniper trail, 'The berms' 205m.
- North Shore section, a raised wooden platform trail, 106m.
- Jumps area, 125m.



Technical Appendix

For technical details on the trail, please see the Technical Appendix. The Appendix provides details on the skills intended to be taught, the design and construction considerations for each section of the course, and how they were approached and implemented. The Appendix also gives information on material specifications and the time and labour used to develop the facility. The Appendix provides photographs and diagrams and a written explanation of the various technical features of the trail referred to in this report.

Section 2: Purpose of the Facility

Inception

The idea for the facility was proposed by course instructors at Glenmore Lodge. It was apparent that with the progression and development of mountainbikes and mountain biking, it was becoming difficult to find natural features which could be used to teach the full range of skills required of students attending mountain bike courses at Glenmore Lodge. The natural features that were used were often distant from Glenmore Lodge and from each other and were often less than ideal for teaching purposes.

The development of the mountain bike facility was, therefore, a response to the need to provide suitable mountain bike training features that were also in close proximity to Glenmore Lodge.

As part of the push to develop a trail, it was considered that it could also be beneficial to demonstrate some innovative and best practice ideas of trail construction and design.

The purpose of the mountain bike facility therefore evolved from the following two goals:

1. A teaching facility

The development of the mountain bike track was closely linked to the requirements of mountain bike courses run at Glenmore Lodge. These courses include Mountain Bike Leader Association national award courses and some weekend mountain bike skills workshops. It was important, therefore, that the trail was able to teach skills and techniques for the following: riding a mountain bike, leading mountain bike trips and groups, and coaching mountain bike skills and techniques to others.

2. Demonstrating design and construction techniques

The facility was intended to be used to demonstrate design and construction considerations and techniques involved in developing a mountain bike trail. As part of this, there was a conscious attempt to demonstrate up to date sustainable trail building techniques based on International Mountain Bicycling Association (IMBA) principles (see Section 4 Design and Construction) and their application in the conditions present in northern Scotland. It was intended to demonstrate a range of different design features on the course which could be viewed at first hand on an accessible and compact working trail.

Section 3: Planning Process

Before work could start on construction of the trail planning consent was required.

A planning application was submitted to Highland Council on 26 January 2005. A letter of support for the application was submitted by Scottish Cycling, the sport's governing body. The application was subsequently called-in on 11 February 2005 for determination by the Cairngorms National Park. The National Park called in the application on the grounds that it raised a planning issue of 'general significance' to the aims of the National Park. This related to the aims of conserving and enhancing the natural heritage of the area and promoting sustainable use of its natural resources.

The mountain bike facility lies within a National Scenic Area, a Site of Special Scientific Interest, a Special Protection Area and a Special Area of Conservation.

The National Park Authority consulted with a range of partners on the planning application including Scottish Natural Heritage (SNH). SNH indicated that they had no objection to the application, provided it complied with a number of conditions protecting the natural heritage interests of the site. In particular these related to Scots pine, juniper, capercaillie, Scottish crossbill and wood ant. SNH did not consider that the proposal would have a significant impact on the landscape interests of the National Scenic Area, and were supportive of the environmental education components of the proposal.

The application was given conditional approval by the National Park Authority on 29 March 2005. The conditions of consent required that pine trees and juniper bushes be protected and retained in the development of the facility, and that a scheme be approved to protect other trees and shrubs from accidental collisions by trail users. The conditions also required a wood ant survey to be carried out. The subsequent ant survey revealed a wood ant colony to be present on one of the proposed sections of the trail. The trail was consequently realigned to protect the wood ant interests.

The Park Authority noted that the underlying environmental principles involved in the development of the mountain bike facility could help inform the mountain bike training courses at Glenmore Lodge. It was considered that such principles could be used to foster greater understanding of the potential environmental impact of mountain biking. Such principles now form part of course content on mountain biking at Glenmore Lodge.

Section 4: Design and Construction

There were a number of considerations integral to the design and construction of the mountain bike facility.

1. Physical considerations

The site is small (200 x 300m) and is crossed by a biathlon (skiing and shooting) training track which could not be compromised by any new mountain bike trail. The site also contains a small-bore rifle range, which, although rarely used, was still operational – with obvious health and safety implications. The mountain bike trail had to 'fit' into a small site and integrate with the existing uses.

The trail had to respect the environmental quality of the site, including both biodiversity and landscape qualities. It was crucial therefore that the facility was able to limit any impact it might have on the important natural heritage features and landscape qualities of the site.

In addition, the site had to contend with the Scottish weather, including the implications of low temperatures (frost heave) and, in particular, high rainfall. Drainage and water management were integral to the design and construction of the trail.

On the positive side, the site had good access for machinery and materials. And with the trail being primarily for the use of Glenmore Lodge students and the land being owned by Glenmore Lodge, the development of the facility did not need to account for the implications of use by other recreational interests or for other land management operations.

2. Sustainable trail construction

The trail's construction was based on International Mountain Bicycling Association (IMBA) guidelines, applied to the particular circumstances of the site at Glenmore Lodge.

IMBA is a non-profit educational association whose mission is to create, enhance and preserve trail opportunities for mountain bikers worldwide.

Since 1988, IMBA has been encouraging low-impact riding, volunteer trail work participation, cooperation among different trail user groups, grassroots advocacy and innovative trail management solutions. IMBA is recognised as an authority on trail design and construction techniques.

The IMBA basic requirements are that trails should be sustainable, i.e. provide a stable trail surface that can withstand current and future use with minimal maintenance. Preventing trail erosion and trail widening, both of which damage the surrounding ecosystems, are the two main goals of sustainable trails.

The following trail building techniques, which exemplify sustainable trail construction, can be seen at points along the trail:

- Contour trail; a trail flowing across a sideslope.
- Outsloping trail; allowing cross trail water sheeting.
- Grade reversals; preventing water running down a trail.
- 10% rule; trails should have an average gradient less than 10%
- 50% rule; a trail's average gradient should be less than half of the sideslope gradient.
- Good flow of trail; helps to control riders to prevent trail widening/short cutting.
- Armouring techniques (rock/wood); used when working outside the above rules/parameters to protect the trail.

Please see the Technical Appendix for explanation, photographs and diagrams of these different trail features.

The terrain and soils at Glenmore Lodge were not always suitable for 'classic' IMBA style trail construction, particularly in relation to contour trail. Mountain bike trails are generally easier and cheaper to build if the site has stable subsoils and if the ground can be used without importing any quarried materials to help form a hard-wearing trail surface. Unfortunately, the site did not have stable subsoils or materials that would form a hard wearing trail surface. The mainly sand-based subsoils found on the trails, although well draining, were unstable (non-cohesive) and susceptible to erosion. However, the alternative methods used at Glenmore Lodge are a useful demonstration of trail building on less than suitable terrain (see the Technical Appendix for details).

3. The need to teach mountain bike and mountain bike leader skills and techniques

3.1 Mountain bike skills

The trail had to be suitable for teaching the skills required to ride a range of features/terrain commonly encountered as part of mountain biking – both on natural and on purpose-built mountain bike trails. There was no conscious decision to teach a particular discipline, e.g. cross-country, downhill, freeride or 4X, however, the trail includes features common to all of these disciplines and is used to teach skills applicable to each.

Prior to development, it was agreed that the trail should provide for the following:

- Steep 'fall-line' runs;
- Narrow sections of trail;
- Rocky sections;
- Challenging sections; and
- Purpose-built trail features, e.g. jumps and berms.

3.2 Coaching and leadership skills

In addition to being able to teach skills and techniques common to mountain biking, the course also had to be able to teach coaching and leadership skills to students who would be teaching mountain bike skills to others and leading groups of cyclists on mountain bike outings.

The teaching requirements of the facility necessitated the following design and construction considerations.

- **Risk assessment**
  It is important that students are able to assess risk on the trail. This means that a balance had to be met between making a trail that is safe and, in places, creating real, objective danger. Some of the trail therefore needed to be relatively safe and simple to ride with easy technical features, while other sections needed to be more technically and psychologically demanding, with consequences for errors of judgement or poor technique.

- **Gradation of difficulty**
  To cater for risk assessment requirements and to ensure that the trail could be ridden by and develop a range of skill levels, rider line options and a gradation of technical difficulty was required in the trail. The three descents or roll-in options at the range (Section 2) and the three rock garden line and drop-off options (Section 1) are examples of this inclusive style of trail build, with routes of varying degrees of difficulty, providing easy, intermediate and advanced options.

  Such design, as well as catering for a range of skill and confidence levels, also allows students to progress from one route option to another as their skills improve.

- **Observation**
  The trail had to be designed so that it would allow teaching to be easily demonstrated, and for students to be easily observed. Consideration also had to be given to providing safe fall areas, providing enough space for a group to ride, and ensuring that the trail was durable enough to cope with repeated use.

  The layout of the trail in a compact area makes it very accessible and allows different features and riders to be observed at the same time and in close proximity to each other.

  The harder sections of the trail, i.e. the rock garden, the roll-ins, the North Shore and the jumps (Sections 1, 2, 7 and 8) have no blind spots, allowing a tutor to safely observe students throughout the whole section.

- **Reversibility**
  Large sections of the trail were designed so that they could be ridden in either direction. This allows more metres of rideable trail and means that most trail features present a different challenge and can teach different skills when ridden in reverse.

  It was not practical to extend this reversibility to the whole trail as it would have limited the design of some features, such as the steepest roll-in and the hardest section of the rock garden (although in practice these can be ridden in reverse by the more technically proficient riders). Furthermore, having a trail that people can ride in both directions creates a situation where collisions are possible. This would be most likely in areas where visibility is limited, such as in the woodland trail (Section 4). The risk of collision is managed, however, by controlling the direction of students on the trail.

- **Repetition loops**
  A series of distinct loops were designed into the course to allow students to repeat sections of the course easily and quickly, allowing them to practice and develop skills and confidence on that section before moving on to another.

- **Linkage and flow**
  On a mountain bike trail the 'flow' of the trail is critically important. The trail, whether easy or difficult, must fit together with the right lines, allowing the whole trail to be ridden without being thrown off line, causing unnecessary erosion or allowing for desire lines to develop. Fundamental to flow is that the trail must be fun to ride.

  Each section of the trail, although designed as a distinct unit, can link up to provide a longer complete ride that requires a good progression of skills. The trail as a whole gets progressively harder. The final sections, i.e. the North Shore and jumps, are for the more technically capable rider and are only used after competence and confidence has been built up on the other sections of the trail.

Section 5: Users

In 2005 the trail had a total of 59 users, which included those on Glenmore Lodge courses and other general users. It is estimated that the track had approximately 130 user days. Ninety percent of these days were in the months of May to October. This gives an average usage of 22 user days per month in the track's first summer.

In 2005 there were 39 students on mountain bike training courses at Glenmore Lodge. 33 of these were students on the five day mountain bike leader courses, four were on mountain bike leader assessment courses and two students were on a mountain bike skills weekend. There were nine female students in total on these courses. Students ranged between 25 and 40 years old. The abilities of the students tended to be at the lower end of the spectrum, with little technical skill. There were a few exceptions, and the track catered well for these differences.

Most of the students on the mountain bike courses come from the surrounding area, Highland region and Moray.

Those not on Glenmore Lodge mountain bike courses tended to be groups from other local outdoor centres (led by a qualified instructor) or visitors during the summer period. Local mountain bikers tend not to use Glenmore Lodge trail, instead using the surrounding forests or purpose-built trails at Laggan, the Black Isle, Fort William or Contin, all within one to two hour's drive from Glenmore Lodge. This suggests that the Glenmore Lodge track is (rightly) seen by local mountain bikers as a coaching track rather than as a leisure facility.

Trail management

Due to initial worries of uncontrolled use, Glenmore Lodge felt it necessary to manage use of the track. This is in line with other facilities at Glenmore Lodge which are open to general use, such as the climbing wall and canoe rolling pool. Consequently, a number of conditions of use apply to the trail:

- use of safety equipment (helmet and gloves) is required;
- the completion of an induction process by an appointed member of staff;
- users must be 16 or older unless with an inducted adult;
- time restriction to daylight hours only or between 9.00am and 9.30pm in summer;
- no solo riding; and
- a £2.00 charge for non training course riders to ride the trail.

Anyone wishing to use the facility must undergo an induction session run by Glenmore Lodge. After induction each rider must sign in before and sign out after using the facility. While this does not significantly deter other centres and tutors from using the track, visitors during the summer months are definitely put off by the induction process. The cost of £2.00 per person (tutors go free) has not so far been seen as an issue.

Section 6: Lessons

One year on

The facility has stood up well to the demands placed on it. The trail shows little sign of erosion either through natural forces – rain, frost heave etc – or through rider usage. This, of course, is in part attributable to the limited number of users on the course. The areas to the side of the trail show no signs of users running wide and there is no evidence of 'desire lines' developing as short cuts or as better lines or around difficult parts of the trail.

The North Shore structure has no signs of erosion, either on the decking or in the chassis. There is no sign of surface growth and grip levels remain good.

Discussions with users indicated that the trail is well suited for its designed purpose. Sections one, two and four, in particular, are well used.

Users describe the trail as great fun to ride, presenting challenges to the range of abilities of the users who ride it. It has proven to be successful as a coaching facility and has become a real asset to Glenmore Lodge.

Features of the course

Rock Garden (Section 1)

The drop-offs at the end of the rock garden were designed to be easy, medium and difficult. The level of difficulty of crossing the rock garden itself, however, has made it difficult to use the drop-offs properly, which tend instead to be rolled off. It is clear that the drop-offs are not working well for teaching drop-off skills (although they do provide a valued feature of the rock garden). In addition, it is recognised that the drop-offs are not really the sort of drop-offs that are commonly encountered on other purpose-built trails. A new, more representative drop-off section would be a useful addition to the trail.

Roll-ins (Section 2)

The roll-ins on the range were also designed to be easy, medium and difficult. The medium roll-in, although intimidating, is the easiest to ride, whilst the easy roll-in is more difficult, requiring additional skills to ride it. At the end of Section 3 there is a climb which meets the start of the rock garden; this is now used as an additional easy roll-in teaching option.

North Shore (Section 7)

There is a perceived danger of the surface of the North Shore becoming slippery when wet. However, even when wet, the logged surface seems to maintain a high percentage of grip. Regardless, riders are discouraged from using the North Shore section in wet conditions.

The first section of North Shore, up to the see-saw, has proved quite demanding. After the see-saw the North Shore is relatively simple to ride and can be ridden in either direction. This easier second section gives the less proficient rider a good introduction to North Shore riding and an opportunity to develop skills and confidence. A quarter of students manage to ride the whole North Shore section and the others find it aspirational. It would be beneficial to provide an easier, less intimidating section of North Shore in the same area.

Jumps (Section 8)

The two jumps, a table top and a double, have not been well used. They are too big for the majority of students and the ride in and ride out areas before and after the jumps are too short to tackle the jumps effectively and safely. The jumps are ridden, but in most instances are rolled over rather than used to get air.

Design and construction considerations

A number of lessons which can inform other trail build projects have become apparent from the design and construction of the trail.

Clarity of design brief

The development of the trail benefited from a clear design brief from the outset. Glenmore Lodge instructors (the clients) were clear on what they wanted the trail to do and what features they wanted. The designer, therefore, had a clear vision of the style and type of trail required. This clarity of the design brief avoided any misunderstandings and ensured the client was receiving an accurate interpretation of their requirements.

Common language

Mountain biking is a relatively new and quickly evolving sport. The language of mountain biking, including the names of trail features (drop-offs, bus stops, doubles etc) and names of techniques mountain bikers use on them (hucks, manuals, whips etc), are also evolving rapidly. Clients, design consultants and contractors have more chance of getting things right if they have a common understanding of mountain bike terminology.

Trail building also has its own language and terms. Terms such as “grade-reversal”, “rolling crown switchback”, “crib-wall” and “full bench cut” are not commonly used expressions for the majority of Scottish path contractors. The contractor and designer therefore need to work through design specifications to avoid any potential for misunderstanding by the use of “in-house” terms.

Adaptive/flexible approach to design and build

The flexible approach taken to the construction of the trail was a major benefit. As the trail developed, the client was able to assess the work and liaise with the designer to request the possibilities for “tweaking” and improving the design and layout of the trail. The designer would then negotiate the changes with the contractor (i.e. the company used to actually construct the trail) and in this project the alterations were always agreed. This approach ultimately ensured the best possible trail was produced and that all parties were happy with the work.

An important part of this process involved the designer and client actually riding parts of the course as they were developed to ensure they performed well and fitted the purpose for which they were being developed.

The contractor

During construction, the contractor was being taught new design and build techniques specific to mountain bike trails. The ability to adapt to new techniques and to work materials (particularly rock and wood) in new ways may not suit some contractors. This is a situation that the designer would need to assess quickly and resolve early on in the development process.

Pricing

The pricing of mountain bike trail builds is a difficult process due to the complexity of the trails. In this project, the level of pricing enabled the contract to attract the interest of a contractor with a proven record of work. This is a key point for future developments; the trail will provide challenges to operators and their machinery. It is important, therefore, to have a realistic price per metre to avoid poorly built trails that may under perform and may ultimately prove costly to maintain.

The successful relationship between the contractor and designer on the Glenmore Lodge project was due in part to the shared knowledge of the build pricing structure, which enabled the contractor to successfully see the job through whilst making a profit. In addition, this relationship avoided the designer making unreasonable financial demands

Materials

The surfacing material was chosen to sympathetically blend in with the local rock types. Although this material blended with the landscape, a less mobile surfacing material would have been preferable – crushed whinstone, for example. However, staff and riders have had no problems with the trail surface and where skidding has eroded the trail this is used to highlight poor bike control and improve technique.

Credibility of the designer

The designer's ability to work alongside the labourers/operators, demonstrating how s/he wants features to look, is an important part of any trail building project. A level of hands-on ability with tools, chainsaws, etc does help the contractor relax in the knowledge that the designer can practise what they preach. Knowledge of what is possible with an excavator, for example, also allows the designer to avoid making unreasonable and unrealistic demands, but also to know when an operator is perhaps not that proficient.

Integration with the environment

The fact that the trail was able to be integrated successfully with the landscape and the natural heritage qualities of the site demonstrates that although a site may lie within an area designated for its natural heritage and landscape qualities, it is possible to successfully integrate sport and recreation interests with the environmental interests of the site. The approach to the development of the mountain bike facility involved a range of different agencies and interest groups and demonstrated how such interests can work together in a positive way to achieve an outcome that suits all parties.

The main environmental considerations and principles employed as part of the project included:

- site survey – awareness of important features to be safeguarded before any building work commences;
- use of local materials from sustainable sources;
- use of rock and wood – to prevent erosion, protect fragile sections of trail and for drainage purposes;
- reinstatement of vegetation to ameliorate visual impact of trail, stabilise the soil and reduce water sheeting;
- use of natural features to form part of the course – e.g. trees left in to teach tree dodging skills;
- trail cutting techniques – e.g. use of backfilled tray rather than full bench cut;
- flow – keeping riders on the trail;
- water management – good drainage of a trail is essential;
- gradient management/awareness;
- trail routing;
- contactor/designer with understanding of environmental principles;
- working with the relevant authorities from the outset – local planning authority, SNH etc; and
- how to limit environmental impact, incorporated into mountain bike courses taught at Glenmore Lodge.

Maintenance

The track is sustainable within its present usage. Repair is on an ad hoc basis with Glenmore Lodge staff maintaining the trail where necessary. The main areas of concern are the top corner on the entry trail to Section 2 and on Section 6, which needs more traffic to bed down the loose surface material. Erosion on the trail does, however, reflect realistic encounters in general trail riding, so knowing how to ride eroded sections becomes a skill in its own right, as well as an opportunity to teach students how best to ride to avoid erosion.

The limited trail erosion makes it unnecessary to draw up a maintenance schedule. However, pruning of the encroaching foliage, raking/compacting skidded surfacing and regular checks of the North Shore are required as a minimum. It is clear that the ability to manage user numbers on the trail also allows a level of control over the levels of erosion and consequent maintenance requirements.

Section 7: Future Development of the Trail

North Shore

It would be beneficial to provide an easier, less intimidating section of North Shore in the same area as the existing section. A wider and lower section would be utilised more and offer progression to the existing North Shore section.

Jumps

Jumping is a very popular part of mountain biking and a particular mountain bike skill. A new jump area that demonstrates the range of jumps encountered on mountain bike trails and provides a progression from small to larger jumps would be beneficial. There are space constraints on the site, however, and the best way forward may be to remodel the existing jumps section to create one smaller jump with a longer ride in and ride out area. This will also address issues with safety and interference with the biathlon trail. If there is space, a larger, aspirational jump could be developed, potentially alongside any smaller one.

Signage

The trail would benefit from the development of signage. There is some existing signage on the trail related to the conditions of use. Additional signage could be used to demonstrate conventional signage used on modern purpose-built mountain bike trails, and interpretive signage could be used to explain different aspects of the trail to riders and trail builders and designers. Signage could also be used to promote messages on responsible use, linking to the Scottish Outdoor Access Code. A subtle and unobtrusive approach would be appropriate and could provide a model for other trails.

Drop-offs

The rock garden drop-offs are difficult to use properly and consequently do not really serve their intended purpose. With the evolution of purpose-built trails, drop-offs in a range of different styles have become an integral feature of mountain bike trails. The current rock garden drop-offs do not really represent the types of drop-offs that are being developed on purpose-built mountain bike trails. The course would benefit from a new section, more representative of other purpose-built trails, which demonstrates a variety of types of drop-off and allows students to progressively develop skills and confidence.

Water splash

Water splashes are a common feature of natural trails which require particular riding skills to negotiate. The course would benefit from adding such a feature.

Increased use

The track was not designed or intended for high usage. However, the track has capacity for greater use than at present. Consideration of how best to promote the trail is required (although this report will address that to a certain degree). It is recognised that the induction process, charges and conditions attached to use of the trail may limit use and this may be something that can be revisited by Glenmore Lodge. If the facility is improved, e.g. in terms of the jumps and drop-off sections, this may result in greater usage.

There has only been one year to assess use of the trail, so early results may not be indicative of long term use. It is anticipated that greater use of the trail will emerge as more people learn about its existence.

Future plans

sportscotland is seeking to positively address the development needs outlined above. Discussions on how to improve the facility and best address the design issues that have been identified are ongoing. Work will be carried out to address the trail's development issues during 2006/07.

It is important to bear in mind that no purpose-built mountain bike trail is ever considered "finished". Mountain bike trails throughout Scotland are in a constant state of evolution and development as the sport changes and develops. The trail at Glenmore Lodge will follow this same approach to the future development of the facility.

End Note

It is important to appreciate that the trail developed at Glenmore Lodge represents one trail designer's approach to trail construction and design on that particular site. There are a range of approaches to mountain bike trail construction, and different techniques design methodologies and ideas are employed. This report is not advocating that the approach taken at Glenmore Lodge is the best or only approach to take. We are reporting on the approach that was taken at Glenmore Lodge and the useful lessons that can be learned from that. Many of the lessons learned from the Glenmore Lodge project will be relevant to a range of trail building circumstances throughout Scotland.

Acknowledgements and Contacts

Acknowledgements

Client
Glenmore Lodge and, in particular, instructors Julian Fincham (now of Cyclewild Scotland) and Carl Haberl.

Designer
Paul Masson, Cycle Therapy

Contractor
Conserve Environmental Consultants Limited

This report is based on information provided by Cycle Therapy and Cyclewild Scotland and staff from **sport**scotland and Glenmore Lodge.

Contacts
Anyone wishing to use or view the mountain bike facility and its features please contact Glenmore Lodge on 01479 861 256, enquiries@glenmorelodge.org.uk.

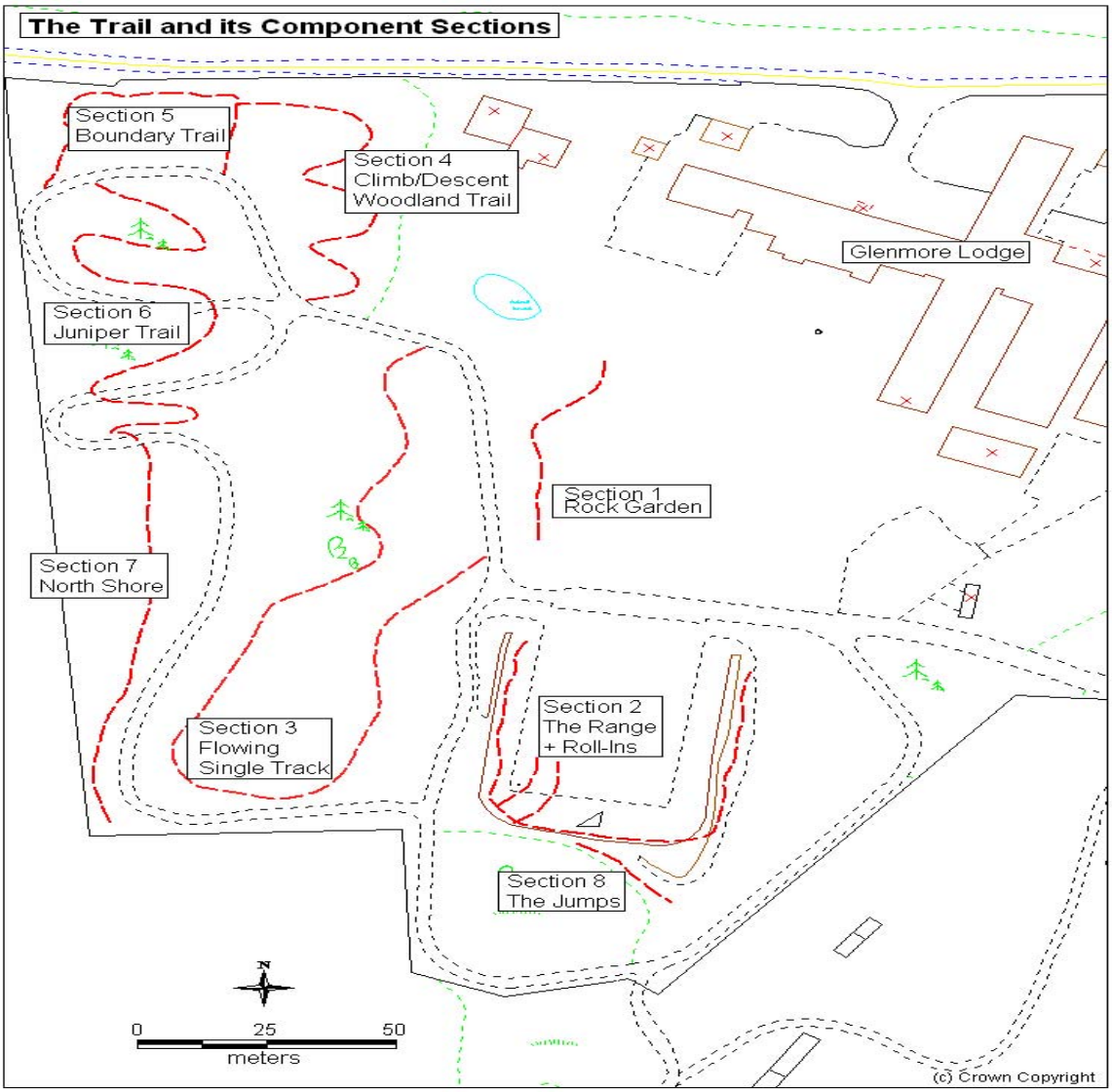
For more information about this project please contact the **sport**scotland Facilities Development Team on 0131 317 7200.

Technical Appendix

Introduction

The purpose of this appendix is to provide technical and illustrative detail about the Glenmore Lodge mountain bike facility. This part of the report provides details on the skills intended to be taught and the design and construction considerations relevant to each section of the course. It gives details on materials and specifications, and provides plans, diagrams and photos to illustrate and explain different aspects of the course.

The Trail



Section 1: The boulder field/rock garden (Fincham's Fingers)

The boulder field is basically a raised causeway constructed from suitable quarried rocks. It is approximately 1.5m wide by 62m long, with a number of different riding lines finishing in drop-offs of differing heights. The fall area immediately around this feature is free of obstacles and is grassed.

This section is used to highlight and develop the skills necessary to cross rocky ground and successfully negotiate sheer drop-offs.

The construction of the boulder causeway and related stone features provides a useful example of the differences in mountain bike trail stone work compared to upland path stone pitching.

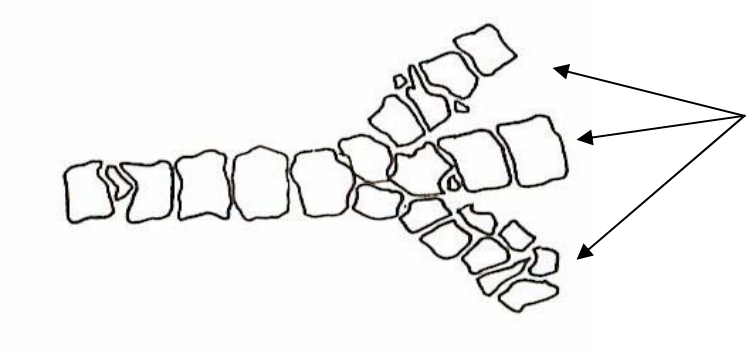


Diagram showing three different lines and drop off heights

Boulder field / rock garden

Section 2: The Range (and Roll-ins)

This section utilises the shooting range's sidewalls and backstop to construct a narrow climbing trail (maximum width 0.60m), a rolling exit trail and a number of different steep descents, which have to be carefully and slowly rolled-in to.

The key riding elements on the steep descents are control of braking to allow a controlled, skid-free descent, body positioning on the bike, track-standing to assess a steep slope, and control of the bike on narrow, steep-sided trails. The level of risk on the roll-ins has been reduced by keeping the slope free of obstacles and providing a clear and open run-out area.

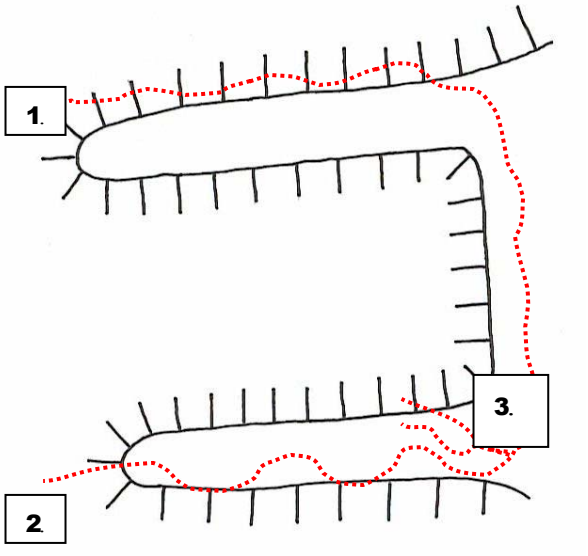


Diagram showing range and roll-in

1. Climbing/entry trail
2. Exit
3. Roll-in points of varying steepness

Roll-ins / descent

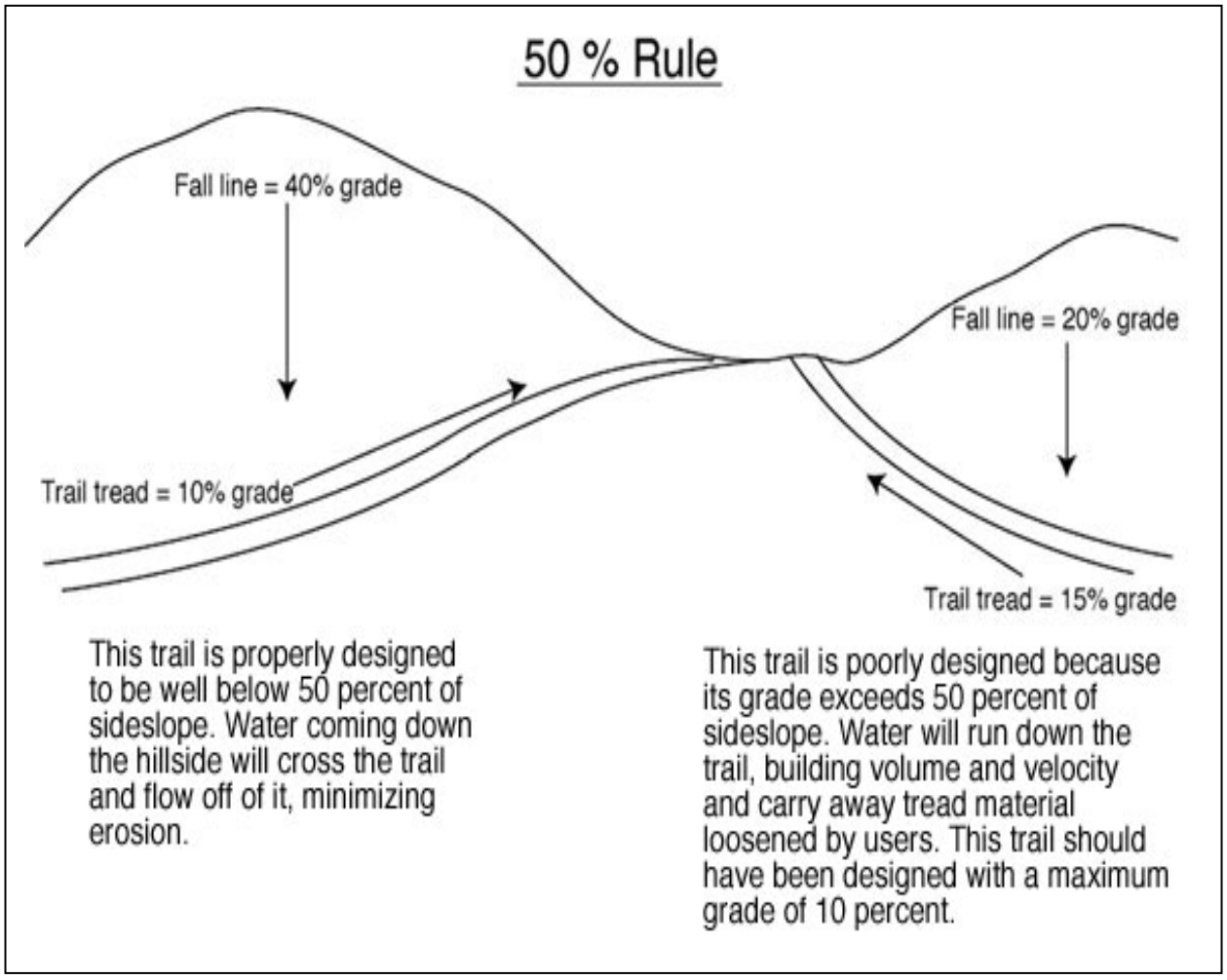
Descending skills

The steep descents are also used to demonstrate and teach technical climbing techniques.

Climbing skills

The natural amphitheatre shape of the range allows the instructor to watch and control the class as they try a number of different exercises.

The steep descents are constructed from suitably large pieces of imported rock to give an erosion-free trail on what is essentially a 'fall-line' trail (i.e. using the cross section gradient of the trail). IMBA guidelines state that a trail should generally never be steeper than 50 per cent of the side slope gradient (see below). This prevents water diverting from a side slope and eroding a trail.
On the range, rock armouring is therefore used to demonstrate what to do if a trail, either due to terrain restrictions or specific user requirements, has to be steeper than IMBA recommendations.

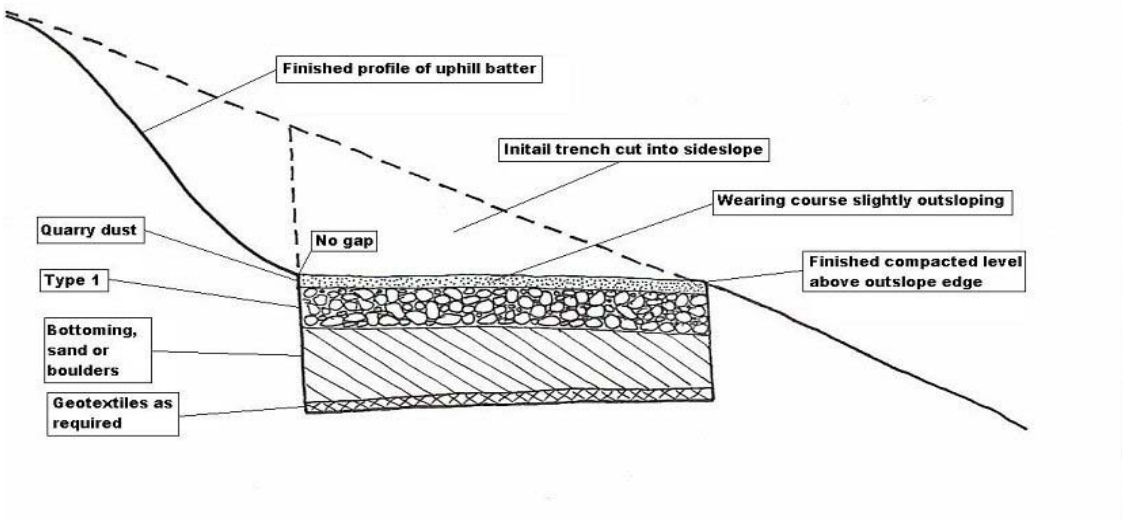


Source: Building Better Trails, IMBA 2001

The entry/climbing trail on the range traverses a steep side slope, which was unsuitable for full bench cut (see diagram below). Instead, the backfilled tray technique was implemented to reduce the scarring of a full bench cut and retain as much of the turf cover as possible, helping to stabilise the area around the trail.

FULL BENCH CUT CONSTRUCTION (FBC)

FBC involves cutting a right-angled shelf into the gradient of a side slope, and battering back the upslope to facilitate sheeting of water from the trail. The shelf is cut into the mineral base of the subsoil and the mineral base used to form the wearing course of the trail. A tray is then cut for the trail, and filled with appropriate materials (see diagram below) to form the trail.



Backfilled Tray

This involves the same technique as FBC. However, instead of using the mineral base to form the wearing surface of the trail, a tray is cut into the shelf and filled with appropriate materials (see above diagram).

Trail margins and areas of disturbed ground on the up and down slope are reinstated with the turfs and vegetation removed during initial excavation. This retains slope stability and reduces sheeting of water across the trail. It also reduces the visual scarring caused by cutting into a side slope.

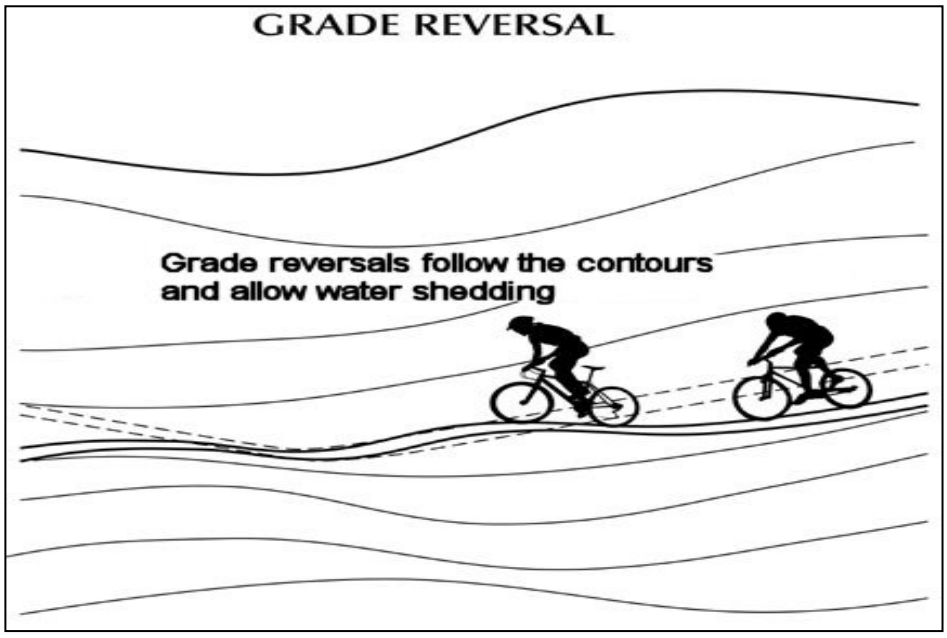
The finished surface level of the trail must allow water to shed unimpeded across the trail.

Backfilled tray was used on the entry trail to the range, whereas full bench cut was used on the exit trail. However, because the gradient of the slope on the entry trail was so steep, no right-angled shelf was cut; instead a tray was simply cut into the slope and filled, with adjacent vegetation then reinstated.

Left: Exit trail from the range showing full bench cut technique
Right: Entry trail showing backfilled tray and 50% rule

Of particular relevance to this site in northern Scotland is the occurrence of frosts in the winter and the resulting “frost heave” that damages trail surfacing. With this in mind all the trails at Glenmore Lodge were surfaced with locally quarried crushed rock, which has greater resistance to frost heave

Grade reversals were used on the exit trail from the range. This prevents water flowing down the length of the trail.



Source: Building Better Trails, IMBA 2001.

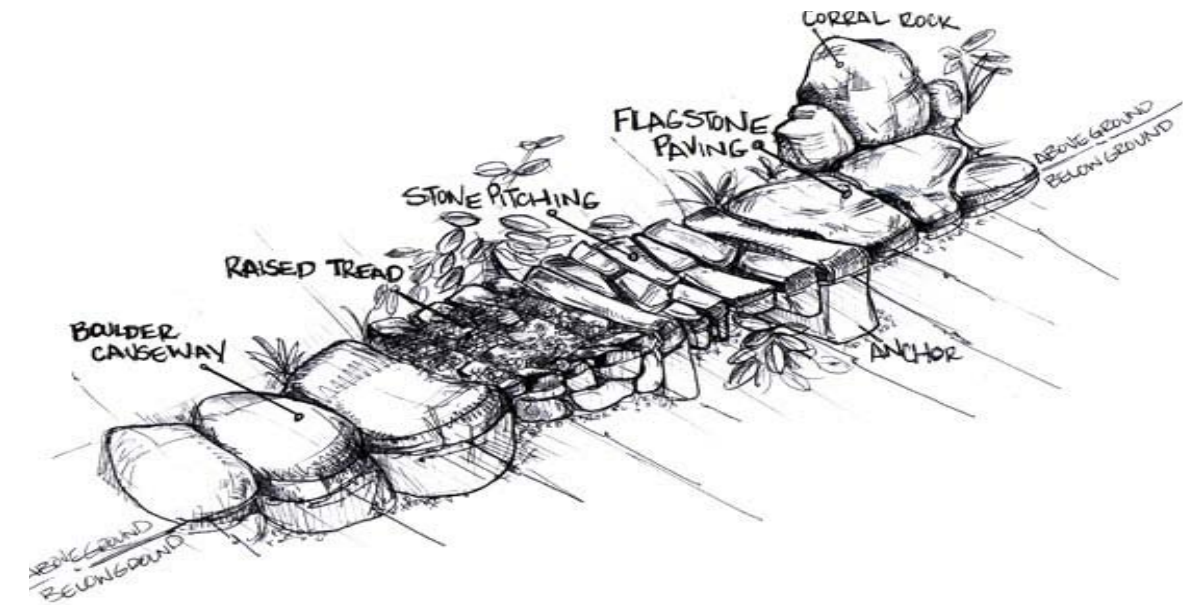
Exit trail showing grade reversals

Stone pitching/armouring was used at the bottom of the grade reversals on the range, allowing an in-sloping trail good flow through the feature, and protecting the trail from erosion as bikes compress into the bottom of a grade reversal. Water can shed out of the grade reversal through gaps in the rocks used to armour the bottom of the grade reversal.

ARMOURED TRAIL

The wetter and more vulnerable and delicate parts of trail required rock to be imported to build up the trail. This protected the trail from erosion and allowed water to drain more readily. Unlike traditional stone pitched footpaths, mountain bike trail can be constructed of bigger rocks. The challenge of an irregular finished surface is often more desirable to mountain bikers. Blocking boulders can be positioned along trail margins to control the line choice and speed of riders.

Rock armouring styles



Section 3: Flowing Single Track (juniper jolly)

This section runs around a slight side slope, roughly paralleling the line of the biathlon track. The trail presents a challenge to students as a climb and descent. Low branches have been left in to demonstrate and teach ‘limboing’ and risk assessment.

This section allows for single track (maximum 0.75m wide) riding on a variety of surfaces, from smooth Type 1 hardcore to a bumpier, rockier, surfaced trail.

Rocky trail section

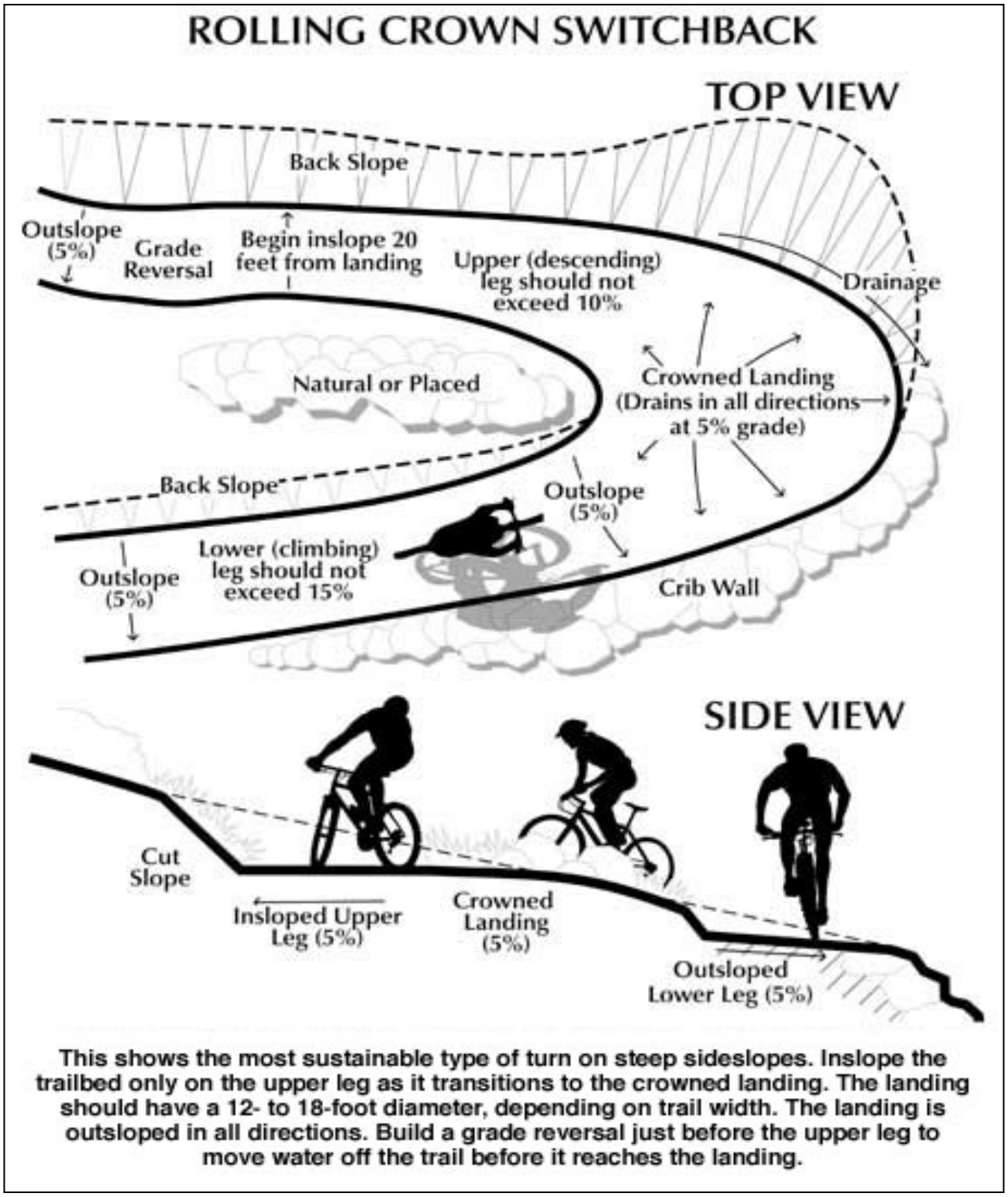
In addition, Section 3 demonstrates ‘raised bench’ construction, i.e. an overlaid/rock armoured path using imported materials.

Above left: Raised bench / rock armouring construction
Above right: Right: Raised bench / armouring construction

Section 3 features a hairpin turn (a ‘rolling crown switchback’) to demonstrate the most sustainable type of turn on a steep side slope to manage surface water.

The switchback turn, when ridden in reverse, offers an opportunity to practice slow speed bike control and shows the consequences of careless line choice, both for rider and erosion of the trail edges.

Rolling crown switchback



Source: Building better trails, IMBA 2001.

The trail finishes with a pitch steeper than ten per cent and greater than fifty per cent of the 42% side slope. This finish, being steeper than two IMBA guidelines, required stone pitching, demonstrating rock armoured trail.

Section 4: Climb/Descent Woodland Trail (the woods and the rat run)

This section uses a pine covered slope to construct a single track trail (maximum width 0.75m). The trail was designed to be ridden in both directions, teaching climbing skills over small trail obstacles and around tight hairpins and, in descent, the skills necessary for a smooth and safe descent. Tree removal was minimal as 'tree dodging' is an integral feature of this section in descent. Section 4 can be ridden as a 'mini-circuit', allowing a class to circulate whilst the instructor observes/coaches.

Singletrack trails

The trail was constructed by excavating a tray to a depth of 250mm and the bottom lined with Terram Geotextile material. The bottoming was locally won sand; sub-base Type One was imported and compacted before surfacing with imported quarry dust. This was raked to give a crossfall (outslope) to shed water before being compacted to refusal.

The need to cross a small burn allows culvert construction to be demonstrated. The culverts are constructed of twin wall polypropylene pipe of suitable diameter, protected at both ends with stone headwalls. These techniques, although outside of the classic IMBA construction methods, are an important feature of protecting trails in poorly drained areas and an example of the evolving nature of trail building. An armoured ford here would not be suitable due to the winter ice risk.

Culverts

Section 5: Boundary Trail

This section parallels the boundary fence beside the main road, finishing in a small section of stone pitched fall-line trail onto the biathlon track. A section of stone armoured trail weaves tightly between the protected junipers, avoiding damage to the roots. The final pitched exit to the biathlon track controls speed and prevents surfacing being dragged onto the track.

Rock armouring on trail exit to biathlon track

Section 6: The Juniper Area (the berms)

This is a twisting, flowing trail, weaving in and out of the juniper bushes. Corners are slightly bermed, i.e. banked, to allow different cornering skills to be taught.

Careful construction and reinstatement were required to blend the trail into the surrounding junipers. The trail crosses the biathlon track at points; speed and sight lines of the cyclists and biathlon track users were planned accordingly.

The trail was constructed by excavating a tray to a depth of 250mm and the bottom lined with Terram Geotextile material. The bottoming, to form the shape of the berms, was locally won sand with extra strengthening from more Terram Geotextile. Sub-base Type 1 was imported and compacted before surfacing with imported quarry dust, which was raked to give a cross fall (outslope) to shed water before being compacted to refusal.

From a design and construction perspective, this section had to be carefully routed to leave a one metre undisturbed area around protected wood ant colonies, demonstrating how trails can be routed sympathetically to avoid negative impact. The contractor had to tie back juniper bushes during construction of the trail to prevent any damage.

Berm

Section 7: North Shore

This section comprises a raised wooden platform trail, 109m in length, over ground that would otherwise be too boggy to build on. North Shore elevated wooden trails are becoming an increasingly familiar feature on purpose-built mountain bike trails.

The raised platform boardwalk has taken into account the need for safe fall-zones free of stumps, branches, rocks, etc.

The North Shore has a technical first section and an easier second section which can be ridden in both directions, and a see-saw in the middle.

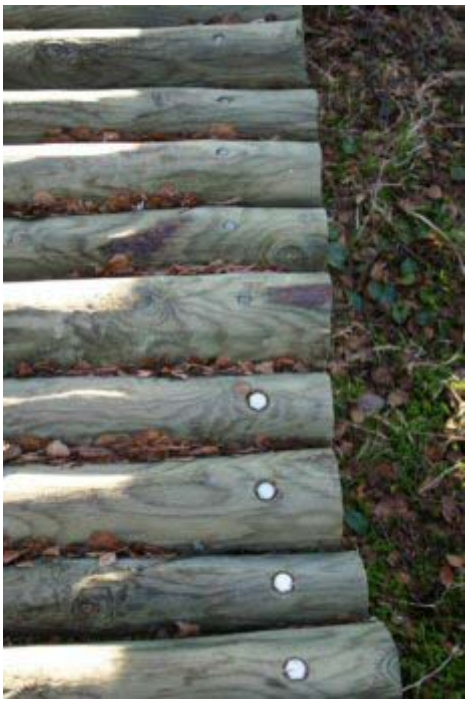
Technical section of the North Shore

Left: Easier North Shore Section
Right: See-saw

This section of the trail illustrates some best practice North Shore trail building techniques, such as no fixings to live trees, the use of good quality timber (treated in this case) and rust-free fixings. The fixings also highlight the need for the North Shore “chassis”, i.e. supporting frame, to be bolted and not nailed together. The frame should not rely on the strength of the fixing; instead, supporting rails should be set into slots cut out of the uprights. The slats that form the decking of the structure are fixed with a combination of screws and ring annular nails.

Chassis

The decking does not have an anti-slip surface applied. The use of chicken wire has proven unsatisfactory at many mountain bike trail centres and there has not yet been a definitive way of treating decking to completely leave a reliably slip free surface. With this in mind, the design of the decking limits the sideways slipping of tyres with the use of appropriate cambers. The chemically treated wood is intended to resist algae, moss, mildew, etc.



Treated timber decking

The North Shore section of the trail introduces many leadership and risk assessment issues and provides useful opportunities for trail builders/designers to study different techniques for building good wooden trails.

Section 8: Jumps

This section, immediately behind the range, provides an introduction to jumps. Jumping and landing are mountain bike skills that can be very hard to coach safely in a natural environment. The open area at Section 8 allows fall zones and the opportunity to safely get it wrong. Consideration in the design was also given to preventing cyclists running over onto the biathlon track.

Jumping the double

Double in foreground, table top in background

Construction Details

Contractor details

The contractor used was an experienced path builder with considerable experience on upland paths and an excellent record on environmentally sensitive sites.

The contractor supplied the following:

- Workforce: Machine operator plus two labourers;
- Machinery: 2 x 360° tracked excavators plus 3-ton tracked dumper;
- All hand tools plus power barrow, whacker plate (for compacting path materials), chainsaws, generators, drills, spill kits and first aid kits;
- Secure storage container for equipment;
- All materials: Type 1, dust, rock, wood, fixings, geotextiles and drainage pipe; and
- Risk assessment, HSE documents and all certificates.

Method of working

Section 1: Rock garden

The area to be used for the rock garden was stripped back of turf, which was used for later reinstating. The rough shape of the trail was then formed using sand. The rocks were positioned using the smaller digger under guidance from the trail designer.

Positioning rocks using the digger

Section 2: The Range

This section required the building of trail on the range side slopes and was completed using the smaller excavator (5-ton), and the large excavator (13-ton) for the rock sections. All tray was excavated by the machine sitting off to one side of a flagged line, either from below or by sitting at the top of the range.

This method of working prevented damage to the delicate side slope and was made possible by the 180° slew of the digger arm plus the 'swivel hitch' fitted to the digger.

Section 2: Roll-ins

The rock work for the roll-ins was started by positioning the rock required at the top and bottom of the slope using the 13-tonner. The digger was then manoeuvred part-way up the slope onto a level platform; from here all three lines were worked on simultaneously. Once the upper lines were completed the digger finished the build from the floor of the range.

Work on the roll-ins

Sections 3,4,5 and 6

These sections required tray to be excavated before being built up with aggregate. The trail sections were all flagged out at 1-3m intervals, with the trail designer on hand to guide the operator as required, particularly through the bermed sections.

The excavated tray was then built up using bottoming, Type 1 and quarry dust. The two labourers, being qualified machine operators, were able to use the second larger excavator on site to load materials into the tracked dumper and power barrow.

Sections, 3,4,5 and 6: Rock features

Whilst the path squad worked on building up the various paths, the rock features were completed by the main operator on the 5 ton machine with the help/guidance of the designer. The various rock features were test ridden by the designer to ensure the success of the finished product.

During this phase the rolling crown switchback was also constructed. The main crib-wall to support the turn was built up using boulders, with the shape of the turn formed with rubble/Type 1/quarry dust.

All these demanding sections were test ridden as they developed by the designer.

Landscaping was completed by the squad after they came off the range work.

Section 7: North Shore

This section was worked on by the whole squad plus the designer. The posts (125mm x 2m) were hammered into the ground until secure, with the see-saw posts (150mm x 2m) being placed in dug-out holes and secured with rocks/dirt. The posts were then sawn to the required heights by the designer. The rails – half sawn 125mm posts of various lengths, were placed into checks cut out of the uprights. This part of the build was crucial, as the depth and angle of cuts determines the ‘flow’ of the trail. The rails were then bolted to the uprights using galvanised coach bolts. The finished chassis then had sections of slats laid on it to help the designer see the shape and, where necessary, “tweak” the chassis by modifying some of the upright heights. The slats – half round 100mm posts, were fixed to the rails using coach screws and ring annular galvanised nails.

The see-saw was constructed from a telegraph pole sawn in half along its length. The pivot was constructed using a 30mm x 400mm stainless steel bar drilled through the pole and fixed into fabricated brackets bolted onto the uprights. The pivot was covered by wooden caps to prevent the potential for users’ fingers being trapped. The wooden caps can be removed for routine inspections.

Once this structure was rideable the designer tested the see-saw and alterations were made to ensure the correct rocking of the pole back to a starting position.

The areas around the trail were cleared of debris, stumps taken down to ground level and any low branches pruned back to ensure a safe fall area.

Section 8: The Jumps

Turfs were stripped back for later re-instatement on the jump sides then the shape of the jumps were formed using sand. Once the rough form was correct the trail was made rideable and tested by the designer. The jumps were surfaced by the larger digger using a tilting bucket.

Table top under construction

Total build time for the facility = 34 days.

Costs

There are a range of trail construction techniques. At the most basic level, trails can be constructed by simply cutting and removing topsoil material to leave a trail formed out of the compacted mineral base material. At the other end of the scale, trails involving hand pitched imported rock can cost £60+ per metre. Costs will vary depending on, for example, trail specifications, whether materials have to be imported or not, trail width, side slope gradients, whether trees have to be cleared from the trail line, drainage and on anticipated number of users. Costing a trail is very specific to a site and its conditions.

As a general guide, based on 2006 Scottish prices and inclusive of labour, a basic mineral base trail could cost £10 per metre, a trail using ASDUG (i.e. the material that has been dug out the ground to form the tray), imported Type 1 and quarry dust, could cost £20 - £30 per metre, rising to £40+ a metre for the inclusion of rock armouring.

For North Shore, using treated timber and including the price of fixings and labour, an indicative cost at 2006 prices would be £30+ per metre.

The actual trail costs at Glenmore Lodge were as follows:

Section 1	The boulder park	62m	£3,077.00
Section 2	The range	217m	£7,360.00
Section 3	Flowing single track	270m	£5,241.75
Section 4	Climb/descent trail	127m	£2,672.50
Section 5	Boundary trail	104m	£3,321.00
Section 6	Juniper trail	205m	£3,931.00
Section 7	North Shore	106m	£3,426.00
Section 8	Jumps	125m	£3,016.00

Acknowledgement
Diagrams and some of the technical descriptions used in this report are taken from Building Better Trails (2001) and Trail Solutions (2004) produced by the International Mountain Bicycling Association. http://www.imba-uk.com/