4. RISK ASSESSMENT

4.1. Introduction

The purpose of this Risk Assessment is to quantitatively assess the risks presented by the mountain bike trail network, provide treatments to mitigate those risks and prioritise the risks according to their severity. Once all recommended treatments have been implemented, the mountain bike trail network at Glenrock SCA can be 'officially' opened to the public.

The majority of mountain bike trails at Glenrock are informal. That is, mountain bike users have utilized existing trails, fire roads and walking tracks that were not purpose-built for mountain bike riding. The majority of these tracks have been in place for many years and many are badly eroded, creating an ongoing risk to users and the environment.

4.2. Risk Assessment Methodology

During the Condition Inspection, all trails and routes were carefully inspected and any problems identified.

These problems were then classified as Safety Hazards, Environmental Hazards or problems relating to the Recreational Experience of the trail user. Only Safety Hazards are assessed in this Risk Assessment. Problems classified as Environmental Problems or relating to the Recreational Experience of the trail user are addressed in the Works Documentation.

Safety Hazards can be either site-specific or non-site specific. A site-specific Safety Hazard is an actual physical hazard found at a particular site or sites, such as a cliff or a low hanging tree branch. Non-site specific Safety Hazards are hazards that are inherent in the sport of mountain biking and occur right across the entire trail network. An example of a non-site specific Safety Hazard is two riders travelling towards each head-on. Hazards such as these are not linked to any sites, but are also assessed in this Risk Assessment.

In total, 20 unique Safety Hazards relating to the mountain bike trails at Glenrock SCA were identified. Each unique Safety Hazard was allocated a single letter. Most hazards occurred at multiple sites and many sites had multiple hazards.

Once the hazards had been identified, the following procedure was applied to assess the risk associated with each hazard:

- Identify the risk posed by that hazard;
- Estimate the likelihood of that risk occurring;
- Estimate the consequences if that risk occurs;
- Determine the Risk Rating Score.

The Risk Assessment Matrix in Table 10 provides the descriptors that were used to evaluate the likelihood of that risk occurring, the consequences if that risk occurs and the subsequent Risk Rating Score (Extreme, High, Moderate or Low).

Table 10. Risk Assessment Matrix

Likelihood	Consequences				
	Insignificant Minor injury requiring first aid but no lost time or a few incidents which do not result in injury.	**Minor** Single injury requiring medical treatment resulting in some lost time or a large number of incidents resulting in minor injuries.	**Moderate** Single serious injury or illness requiring hospitalisation and rehabilitation due to a single cause at one location.	**Major** Single fatality, multiple injuries or major incapacity or series of single fatalities or major injuries due to a single cause at one location.	**Catastrophic** Multiple deaths from a single event or serial deaths over one year or cumulative and delayed disability due to single cause at one location.
Almost Certain Likely to occur about once a month	**HIGH**	**HIGH**	**EXTREME**	**EXTREME**	**EXTREME**
Likely Expected to occur once every year	**MODERATE**	**MODERATE**	**HIGH**	**EXTREME**	**EXTREME**
Possible Expected to occur once every 10 years	**LOW**	**MODERATE**	**MODERATE**	**HIGH**	**EXTREME**
Unlikely Expected to occur once every 100 years	**LOW**	**LOW**	**MODERATE**	**HIGH**	**EXTREME**
Rare Expected to occur once every 1000 years	**LOW**	**LOW**	**MODERATE**	**HIGH**	**HIGH**

Once a Risk Rating Score was determined for each risk, treatments were identified to ameliorate that risk.

Treatments are categorised into a control hierarchy. The categories are:
- Elimination;
- Substitution;
- Isolation;
- Engineering;
- Administration;
- Personal Protective Equipment.

Elimination is the best type of treatment – eliminate the hazard and/or risk altogether. Substitution occurs where the hazard is removed and replaced with a different object that performs the same task – this type of treatment doesn't really apply in this assessment. Isolation occurs where the hazard or risk is isolated from people. Engineering treatments are those that use a man-made object to reduce the risk. Administration treatments use procedures or policies to restrict the likelihood of the risk occurring. Personal Protective Equipment doesn't really apply in this context.

For some risks, more than one treatment was identified. These are listed in priority order according to how effectively they reduce the risk. No consideration is given to the cost effectiveness of these treatments. NPWS should consider the effectiveness of each treatment, in relation to their budgets and the urgency of the risk. In some cases it may be prudent to implement more than one of the treatments identified.

Following the identification of treatments, the same process was then performed again to determine the risk that is likely to remain after the treatment has been applied.

It must be noted that there is some subjectivity in this process – the assignment of likelihood and consequences is not a strongly rigorous process and relies on the experience and knowledge of the person making the assessment. However, the aim of this process is not to produce a universal assessment of each risk that can be used to compare it with other risks outside the scope of this project. Rather it is to assess each risk in relation to the other risks presented by the mountain bike trails at Glenrock SCA and to prioritise them so that they can be addressed in a logical and thorough fashion that ensures that the greatest risks are addressed first.

4.3. Risk Assessment Results

Table 11 shows all the scores and ratings for each and every hazard identified.

The sites where these hazards were identified are provided so that it is possible to refer back to the Condition Inspection to see a photo of the site and a description of the hazard.

Treatments are suggested for each risk. These are very generic. It is not possible to offer precise treatments for every hazard/risk in each hazard category, because the extent of each hazard/risk varies. For example, for hazard category S, 'Water/mud pooling on trail', at the majority of sites where this problem occurred, only very minor works will be required to allow the water to drain off, but in one or two sites, substantial works will be required to re-route the trail.

The risk caused by most of the hazards identified is that a rider will crash and consequently injure himself/herself. Injuries incurred during a mountain bike crash are hard to predict. Speed, rocks, vegetation, the distance the rider falls, the size, weight, experience level and fitness of the rider can all influence the severity of the injuries incurred by the rider. High-speed crashes and jumps or drops where a rider can fall from height generally cause worse injuries than low-speed crashes. Bruising, lacerations and fractures are the most common injuries, but death is a possibility even in seemingly minor accidents. Cyclists have died from minor accidents on straight, flat, low-speed, low-skill trails including sealed, urban bike paths.

In order to maintain consistency and deliver a useful, logical risk assessment, when attempting to estimate the consequences of riders crashing their mountain bikes, the following assumptions were made:

1. Crashes involving a single rider that loses control of their mountain bike, will not result in a fatality and therefore can not be rated as having consequences any higher than 'Moderate'[7]. The only exception to this is if the rider falls off a cliff, which could clearly result in a fatality, thus justifying a consequence score of 'Major'.
2. Crashes involving a single rider colliding with another rider, walker, horse rider, or vehicle are likely to have worse consequences than crashes involving a single rider that loses control of their mountain bike. Thus any risks involving a single rider colliding with another rider, walker, horse rider, or vehicle should be rated as having 'Major' consequences.
3. None of the risks identified at Glenrock appear to fit into the 'Catastrophic' category.

[7] Although death is a possible outcome of every crash involving a single mountain biker, it should not be considered a realistic possibility as almost all the hazards would end up receiving a rating of 'Major' for consequences. This would cause all the hazards to be clustered at the 'High' or 'Extreme' end of the spectrum, when clearly some hazards involving factors like high speed or vehicles are more likely to have more serious consequences.

Table 11. Results of Risk Assessment

Hazard Category	Hazard Description	Sites Where Hazard Occurs	Risk/s	Likelihood of Risk Occurring	Consequences if Risk Occurs	Risk Rating Score	Suggested Treatment (where two or more treatment options are provided they are listed in priority order)	Control Hierarchy	Risk Rating Score After Treatment
A	Cliff edge.	48, 75	Rider falls off edge of cliff.	Possible	Major	High	1. Re-align trail away from cliff edge and close old trail; 2. Install barriers or fences preventing access to cliff edge. 3. Install warning signs.	Isolation Engineering Administration	Eliminated High High
B	Fallen tree across trail.	5, 33	Rider crashes into fallen tree or crashes while trying to avoid tree.	Likely	Moderate	High	1. Remove tree.	Elimination	Eliminated
C	Steep downhill.	7, 25, 74, 84, 102	Rider travels too fast, loses control and crashes.	Likely	Moderate	High	1. Re-align trail to remove the steep downhill. Close old trail. 2. Install obstacles such as rocks or logs to slow down riders. 3. Install warning signs.	Elimination Engineering Administration	Eliminated Moderate Moderate
D	Heavily eroded trail with deep erosion ruts and loose rocks.	6, 7, 15, 18, 22, 26, 56, 57, 65, 84, 85, 88, 93, 106	Rider loses control due to loose rocks or erosion ruts and crashes.	Likely	Moderate	High	1. Re-align trail, removing eroded section and ensuring a more sustainable alignment. 2. Remove loose rocks and fill in erosion ruts. Install drainage to prevent water-caused erosion.	Elimination Elimination	Eliminated Eliminated
E	High risk technical trail feature, or technical trail feature which is more difficult than the designated Trail Difficulty Rating.	16, 63, 73, 75	Rider unable to correctly negotiate the technical trail feature and crashes.	Likely	Moderate	High	1. Ensure that an easier line around the feature exists and install signs advising trail users of the difficulty ratings of the two lines.	Engineering	Low
F	High speed, straight, vehicle track with loose graveled surface.	102	Rider loses traction in loose gravel and crashes.	Likely	Moderate	High	1. Install warning signs if on ‘Easy’ trail.	Administration	Moderate

G	Inexperienced riders attempting trails beyond their ability.	All trails	Rider does not possess skills necessary for the trail and crashes.	Likely	Moderate	High	1. Implement a trail difficulty rating system, backed up with effective signage.	Administration	Moderate
H	Motorbikes and four-wheel drives on mountain bike trails.	All trails	Rider collides with motorbike or four-wheel drive.	Possible	Major	High	1. Install barriers to prevent motorbike and four-wheel drive access to mountain bike trails. 2. Install signage prohibiting motorbike and four-wheel drive use on mountain bike trails.	Engineering Administration	Eliminated High
			Rider crashes, due to damage done to the trail by motorbikes or four-wheel drives.	Unlikely	Moderate	Moderate	1. Install barriers to prevent motorbike and four-wheel drive access to mountain bike trails. 2. Install signage prohibiting motorbike and four-wheel drive use on mountain bike trails.	Engineering Administration	Eliminated Low
I	Mountain bike trail and horse trail intersect.	8, 9b, 10, 34b, 35, 36b, 41, 42, 43, 69, 79, 80	Rider collides with horse, causing injury to both riders and/or horse.	Possible	Major	High	1. Install signage warning both user groups. 2. Implement a code of conduct, indicating which users should give way.	Administration Administration	Moderate Moderate
J	Riders not aware of recommended travel direction.	All trails	Riders travelling in opposite directions collide.	Possible	Major	High	1. Implement a 'preferred travel direction' system, backed up with effective signage.	Administration	Moderate
K	Slippery surface.	6, 22, 40, 43, 53, 54, 93, 100	Rider loses traction and crashes.	Likely	Moderate	High	1. Treat slippery surface. Cap slippery clay trails with crushed rock. Paint all bridges/boardwalks with non-slip paint. 2. Install signage warning of the slippery surface.	Engineering Administration	Moderate Moderate
L	Trail crosses or travels along a road or other area used by public vehicles.	17, 28, 45	Rider collides with a vehicle causing injury to rider and damage to vehicle.	Possible	Major	High	1. Install signage warning riders of vehicles and warning motorists of riders. 2. Install barriers/obstacles forcing riders to slow down before entering road.	Administration Engineering	Moderate Moderate

							3. Cut back vegetation to improve vision for both riders and motorists.	Engineering	Moderate
M	Trail crosses watercourse.	40, 43, 53, 54	Rider swept away by strong currents following heavy rain.	Possible	Major	High	1. Install signage warning of danger after heavy rain. 2. Close mountain bike trails following heavy rain.	Administration Administration	Moderate Moderate
			Rider loses control due to unseen obstacles beneath water and crashes.	Possible	Moderate	Moderate	1. Install signage warning of possible obstacles beneath water.	Administration	Moderate
N	Two trails use the same section of narrow singletrack, but in opposite directions.	72	Riders travelling in opposite directions collide.	Possible	Major	High	1. Re-align one of the trails so that each trail only has riders travelling in one direction only.	Elimination	Eliminated
O	Unexpected or dangerous obstacle.	6, 17, 94, 99	Rider crashes into obstacle.	Possible	Moderate	Moderate	1. Remove obstacle.	Elimination	Eliminated
P	Unsigned trail intersection.	2, 8, 10 ,12, 14, 17, 18, 19, 21, 23, 27, 28, 30, 32, 34, 35, 36, 37, 38, 39, 41, 42, 44, 45, 46, 47, 48, 50, 52, 53, 54, 55, 56, 58, 59, 60, 64, 68, 69, 72, 79, 80, 87, 90, 95, 96, 97, 98, 99, 101, 104	Rider becomes lost.	Likely	Minor	Moderate	1. Implement a signage plan, ensuring that all trail intersections have adequate signage.	Administration	Low
			Rider travels in the wrong direction along a trail, colliding with another rider travelling towards him/her.	Likely	Moderate	High	1. Implement a signage plan, ensuring that all trail intersections have adequate signage.	Administration	Low
Q	Vegetation adjacent to trail grows into trail corridor.	70 All trails	Rider unable to see the trail properly and crashes into unseen obstacle.	Likely	Moderate	High	1. Clear trail corridor.	Elimination	Eliminated
			Sharp stick or branch protruding into trail corridor causes injury to rider.	Likely	Moderate	High	1. Clear trail corridor.	Elimination	Eliminated

			Rider snagged by branch or shrub, loses control and crashes.	Possible	Moderate	Moderate	1. Clear trail corridor.	Elimination	Eliminated
R	Walkers or horse riders using designated mountain bike trail.[8]	All trails	Rider collides with walker or horse rider.	Possible	Major	High	1. Install signage to identify mountain bike trails and horse trails. 2. Install signage prohibiting horse riders from using narrow singletrack mountain bike trails. 3. Implement a code of conduct, indicating which users should give way.	Administration Administration Administration	Moderate Moderate Moderate
S	Water/mud pooling on trail.	4, 51, 57, 61, 62, 67, 73, 75, 76, 77, 78, 99, 107	Rider suddenly loses traction and crashes.	Likely	Moderate	High	1. Identify what is causing water to pool on the trail. Treat the cause. 2. Install bridge or rock armouring across the wet section. 3. Re-route the trail to a more sustainable alignment.	Elimination Engineering Elimination	Eliminated Eliminated Eliminated
T	Unauthorised and dangerous modifications made to trail.	73, 75	Rider unable to correctly negotiate the modifications and crashes.	Possible	Moderate	Moderate	1. Remove modifications. 2. Engage local mountain bikers in maintenance programs, fostering sense of ownership of trails, and thus reducing incidence of trail modification.	Elimination Administration	Eliminated Low

[8] It is assumed that walkers will not be prohibited from any of the designated mountain bike trails.

Of the twenty-five risks assessed in the Risk Assessment Matrix there are, before treatment:
- 19 'High' risks;
- 6 'Moderate' risks.

If the recommended treatments are applied, thirteen of the risks will be eliminated completely, leaving:
- 10 'Moderate' risks;
- 2 'Low' risks;

Treatment works should be prioritized according to the urgency of the risk. That is, the risks that score the highest risk ratings should be addressed first, although practicalities such as cost should also be considered.

Once all the hazards and risks identified herein have been assessed and treated, there still remains some residual risk in the mountain bike trail network – risk is inherent in the sport of mountain biking.

In undertaking this process to formalize the mountain bike trails at Glenrock SCA, the aim is firstly to eliminate the most serious risks and secondly to ensure that all minor risks that remain are appropriate to the sport of mountain biking. Using trail difficulty ratings[9], these remaining risks can be categorized, thus ensuring that the risks are matched to a trail difficulty rating. Finally, a signage system ensures that all trail users are presented with sufficient information to enable them to make an informed choice about the trails they choose to attempt.

[9] An important tool used to manage risks associated with mountain bike trails is the IMBA Trail Difficulty Rating System (see Appendix 9.2). As there is no Australian standard for mountain bike trail classification, IMBA's system has been utilized to rate the difficulty of trails in the Glenrock reserve. The use of the IMBA system has been well used in Australia and around the world and is the most frequently used classification system recognised by the mountain biking community.