



PIC 224 Holyrood Park, Edinburgh

Salisbury Crags Rock Risk Management
Options Appraisal 2021

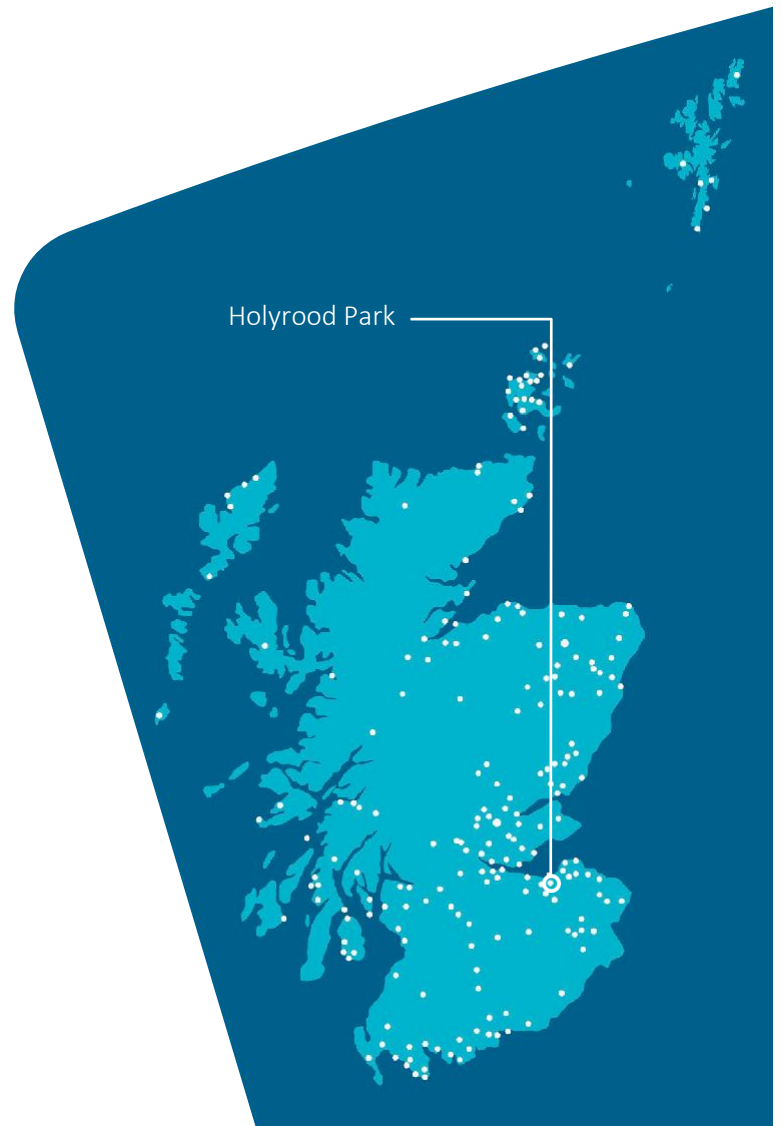


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I. Setting and Historical Background

The Royal Park of Holyrood is of great importance to the city of Edinburgh, a unique landscape with a backdrop of rugged crags and slopes.

The distinctive volcanic geology, known world-wide by scientists and academics, inspired the 18th century philosopher James Hutton to write "The Theory of the Earth", a book which turned geology into a science.

The footpath below the Salisbury Crags is known as the Radical Road, due to its historical connections with Sir Walter Scott and the politics of the unemployed weavers linked to its construction and previous use as an access roadway for quarrying. Climbing groups and the emergency and rescue services request access to make use of the southern abandoned quarry faces for rope access training. Hutton's Rock and Hutton's Section, also towards the southern end, are both historically and geologically important to students and academics.



2. Official Designation Scheduled Monument SM I 3032

Holyrood Park is managed and maintained by Historic Environment Scotland for Scottish Ministers as a Property in Care PIC 224. The scheduled area for the 650-acre Park includes two sites of Special Scientific Interest (SSSI's) Arthur's Seat Volcano SSSI 91 and Duddingston Loch SSSI 547 with legal protection under the remit of Scotland's Nature Agency, NatureScot.

3. Public Accessibility

Holyrood Park is an open Monument with over 17 access points. The high visitor numbers cannot be accurately quantified due to its open nature and city centre location but are estimated at more than two million visitors per year. Roads through the Park also managed by HES have over 6,000 vehicles passing through each day.

HES Ranger Services are located within the Park operating from the Holyrood Park Education Centre. HES Rangers provide the primary conduit for interaction with the public and provide education and outreach functions.



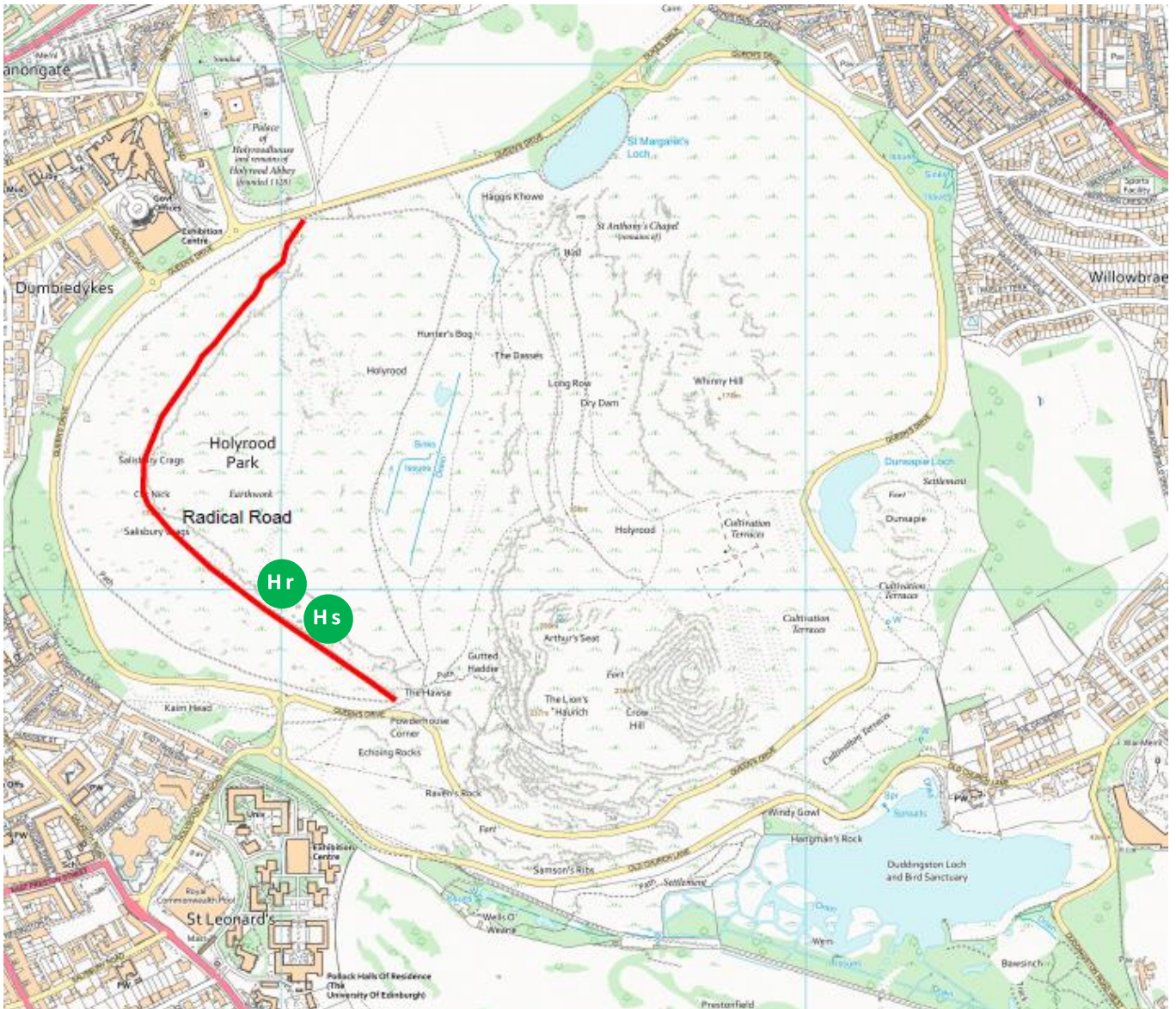
4. Landscape and Climate Hazards

The Park includes many very elevated natural crags and rocky outcrops, some immediately adjacent to footpaths and roads. Arthur's Seat an extinct volcano at 250 metres high and the Salisbury Crags at 50 metres high provide iconic visitor draws and backdrops to the City. The Radical Road footpath runs for 1.25 kilometres / 0.77 miles immediately below Salisbury Crags and this proximity represents one of the highest rockfall risk areas for visitors in Holyrood Park.

The prevalent rock is Basalt, a very durable but often naturally fractured and fissured material. This composition can make it vulnerable to erosion. All rock surfaces and fissures are subjected continuously to the natural and unavoidable mechanisms of heavy rainfall and repeated freeze/thaw cycles and the damage caused by aggressive root systems of invasive plant species, such as Ivy and Valerian, which can collectively contribute to or cause rockfall.

Recent climate changes affecting Eastern Scotland such as increasing and more intense periods of rainfall with milder Winter temperatures are perhaps contributing to increasing rockfall activity.

5. Salisbury Crags Rock Risk and HES Duty of Care



Radical Road path is below Salisbury Crags rock slope areas 1a to 3c
 Radical Road is path access to Hutton's Rock - Hr - and Hutton's Section - Hs - below the rock slope areas 3b to 3c

5.1 Rock Risk

The Radical Road footpath in Holyrood Park runs for 1.25 kilometres / 0.77 miles immediately below the Salisbury Crags.

This iconic location with its panoramic views over the city can attract hundreds of walkers and joggers on any day, often pausing below the Crags to gather in groups.

The height of the Crags at 50m / 164 feet and its proximity to a very busy footpath mean that this area presents the highest risk to visitors of injury from rockfall.

5.2 Legal Position

HES owes various legal duties to staff and visitors, and anyone who may be affected by HES's activities, under the Health and Safety at Work Act 1974, the Occupiers Liability (Scotland) Act 1960, and at common law. This includes staff and visitors at properties in care, as a consequence of HES's delegated general function to manage the properties in care and provide public access. Under the 1974 Act, HES has duties to ensure the health, safety and welfare at work of its employees. HES also must ensure that, so far as reasonably practicable, non-employees (including visitors, neighbouring proprietors etc) are not exposed to risks to their health & safety. Under the 1960 Act, the duty owed by the occupier is to show reasonable care towards persons entering the premises in respect of dangers which are due to the state of the premises or to anything done or omitted to be done on them and for which the occupier is legally responsible. The occupier must take reasonable care to ensure visitors will not suffer injury or damage as a result of any such dangers. An occupier of the premises in terms of the Act is anyone occupying or having control of land or premises. HES is an occupier of PICs for this purpose. At common law, HES has a duty to take reasonable care for the safety of those who enter onto its premises. This duty is potentially broader than the 1960 Act duty.

HES Compliance Assessment Framework provides template to manage risk at properties in care; to review, assess, record and report, take appropriate action and propose further action.



The risk of rockfall at Holyrood Park is currently based on a proactive annual programme of expert led inspection and intervention, with post-incident investigation for unforeseen rockfall occurrences. We have identified a risk, assessed this risk, the data we have is reasonable and the mitigation undertaken was previously deemed sufficient until recently. However the increased frequency and greater size of rockfall events, together with the increasing volume of visitors, is now assessed as presenting increased higher risk.



5.3 Rock Risk Management

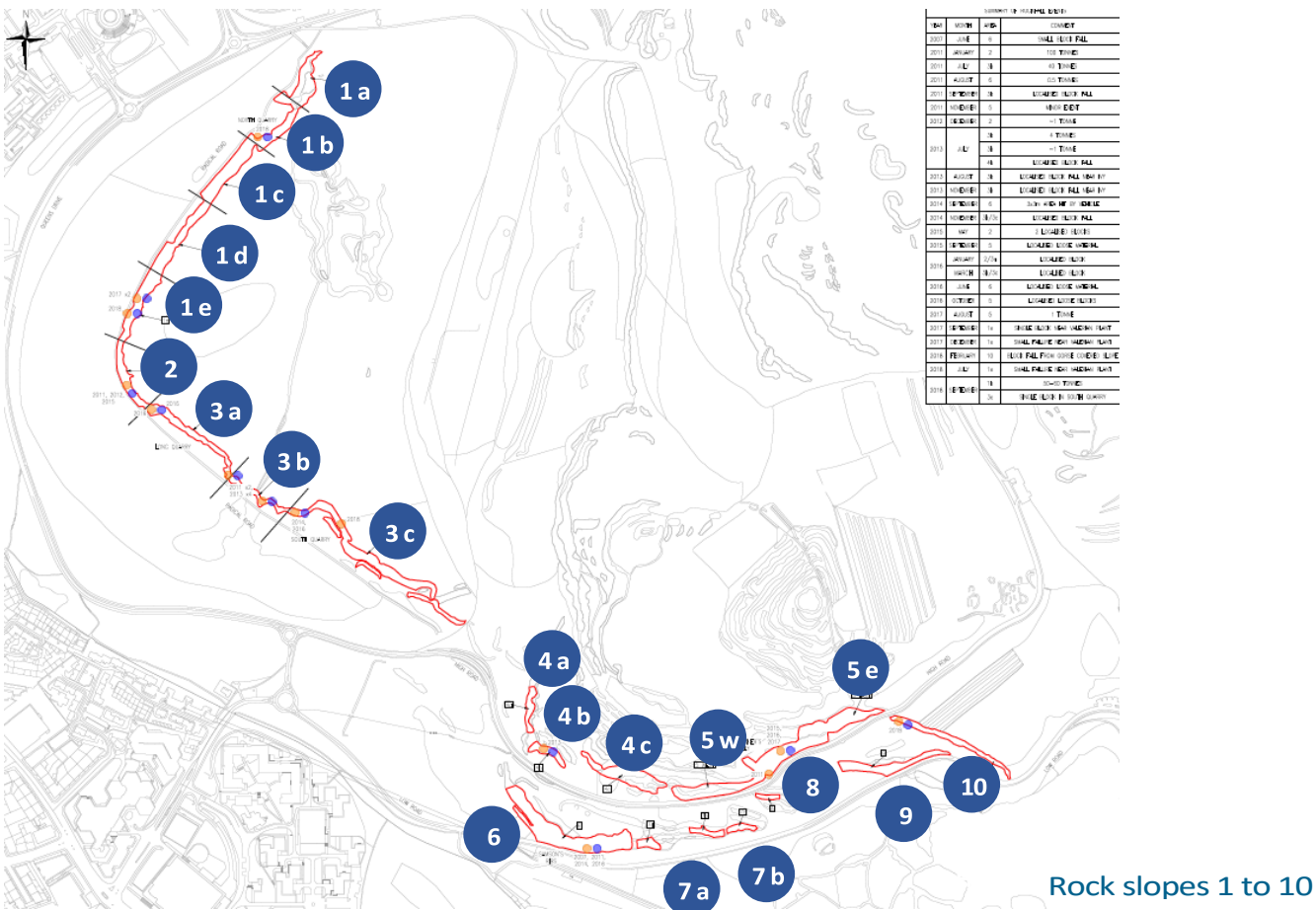
Natural rock safety management is an obligation; doing nothing is not an option. There will always be a residual risk, but risk will reduce relative to intervention and HES shall determine how much risk it is prepared to accept. Risks involved in not taking adequate action:

- death or injury to staff or public
- criminal action being brought against HES and/or possibly against staff with potentially significant financial penalties
- personal injuries actions being brought against HES with the potential for significant damages being awarded against HES
- impact on resources following incident or during investigation
- reputational damage

5.4 Rock Risk Mitigation

Since 2009, HES has worked with specialist Geo-technical Engineers Fairhurst to develop and implement a pro-active Holyrood Park Rock Risk Management Plan which delivers an annual programme of expert inspection and physical interventions to mitigate rock risk. The Park has been broken down into risk zones- each individually risk assessed by Fairhurst.

5.5 Park Rock Risk Zoning



Rock slopes 1 to 10

HOLYROOD PARK SALISBURY CRAGS ROCK RISK MANAGEMENT

In Holyrood Park, areas with perceived rock risk have been broken down into 10 zones, each individually risk assessed by Fairhurst. The Radical Road footpath has been split into nine distinct sub-sections 1a - 3c to reflect its varying characteristics and structures. Inspection regularity reflects the level of risk identified by Fairhurst using an industry standard risk scoring matrix. Areas of potential higher risk are inspected more regularly.

HES Edinburgh Region Conservation team manages this programme using in-house professional and technical resources, including the HES rope team under the guidance and direction of external geo-technical engineering consultants Fairhurst. Fairhurst have been involved on a call-off contract basis since 2009. This continuous and on-going involvement has given Fairhurst an excellent understanding of rock risk within the Park and HES protocols. Fairhurst covers both programmed and reactive rockfall events.

Annual visual and tactile inspections have been carried out by Fairhurst, using rope access coupled with the removal of invasive vegetation and potential loose rock (known as scaling). Fairhurst have advised this is a reasonable and effective risk mitigation approach to rock risk management in the Park. This has maintained visitor access whilst retaining the natural appearance of the Crag. This approach reduces risk but is not risk avoidance. Residual risk remains.



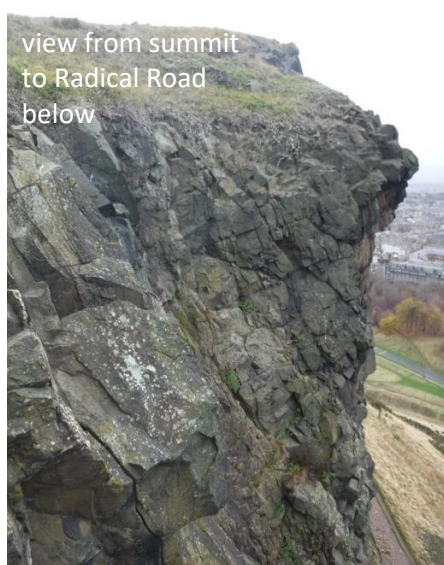
typical rock scaling operation



typical failure



typical roots found behind rock failure



view from summit
to Radical Road
below



vegetation growth
at rockface



substantial root
systems at rockface

5.6 Increased Risk at Radical Road

Despite these measures, on the afternoon of the 11th September 2018 a significant rockfall event occurred in area 1b /1c above the Radical Road.

Around 50 tonnes of rock fell from Salisbury Crags directly onto and past the footpath.

The largest individual rock weight was estimated at 5.5 tonnes.

Although visitors were observed in the vicinity at the time, fortunately no-one was injured. This was categorised in health and safety terms as a near miss.

Steps were taken to immediately close the footpath pending specialist inspection.



The Radical Road was inspected by Fairhurst who advised that closure should remain in place pending review. It was considered that the rockfall risk at Salisbury Crags had increased compared with previous assessments, driven by an increase in rockfall frequency (more hazards) in conjunction with an apparent increase in visitor numbers (greater exposure to the hazards).



barriers and signs across Radical Road at north end

Temporary barriers without any ground or rock face fixings were put in place under Class V consent (applicable for six months) and submission was granted for Scheduled Monument Consent. All barriers require regular checks to reinstate in position.



typical barriers across many informal routes up to Radical Road

5.7 HES Estate Risk Comparison

This assessment by geotechnical engineers for the rock slopes in 38 HES properties in care indicates that the three rock slope areas above the Radical Road have the highest risk value over all of the 118 rock slopes in the HES Estate; refer HES 2020-21 Project Requirements draft status September 2020.

extract from Fairhurst HES 2020-21 Project Requirements.

MOST RECENT ASSESSED RISK LEVEL										
Sites	Slope 1	Slope 2	Slope 3	Slope 4	Slope 5	Slope 6	Slope 7	Slope 8	Slope 9	Slope 10
Edinburgh Castle	Area 1 Johnston Terrace M-H	Area 2a-2c W slopes M-H	Area 3 NW slope M	Area 4 N slopes M	Area 5 Esplanade L-M	Area 6 Half Moon Battery L-M	Area 7 Forewall Battery L-M	Area 8 Lang Stairs L	Area 9 Old Guard House M	Area 10 Hawk Hill L
Holyrood Park	Area 1a-1e H-VH	Area 2 H-VH	Area 3a-3c H-VH	Area 4a-4c M-H	Area 5W-5E H	Area 6 H	Area 7 L-M	Area 8 L	Area 9 L-M	Area 10 M

RISK LEVELS	
N	Negligible
VL	Very Low
L	Low
M	Moderate
H	High
VH	Very High
U	Unable to cat

MOST RECENT ASSESSED RISK LEVEL										
Sites	Slope 1	Slope 2	Slope 3	Slope 4	Slope 5	Slope 6	Slope 7	Slope 8	Slope 9	Slope 10
Edinburgh Castle	Area 1 Johnston Terrace M-H	Area 2a-2c W slopes M-H	Area 3 NW slope M	Area 4 N slopes M	Area 5 Esplanade L-M	Area 6 Half Moon Battery L-M	Area 7 Forewall Battery L-M	Area 8 Lang Stairs L	Area 9 Old Guard House M	Area 10 Hawk Hill L
Holyrood Park	Area 1a-1e H-VH	Area 2 H-VH	Area 3a-3c H-VH	Area 4a-4c M-H	Area 5W-5E H	Area 6 H	Area 7 L-M	Area 8 L	Area 9 L-M	Area 10 M

A key comparison across HES sites is the serious injury from rockfall incident to a member of public below the western rock slopes at Edinburgh Castle in 2018. That rockfall was in an area previously characterised as being lower risk than the Radical Road; the block which fell was of a much smaller size than those which can and do fall onto the Radical Road, and it was in an area where there is some separation of visitors from the rock slope (grass lower slopes with localised bushes and trees). By contrast, there have been a number of recorded rockfalls impacting the Radical Road over the last 10-15 years, as indicated by records kept by HES and Fairhurst. These rockfalls have varied in size from hand-sized blocks to multi-tonne failures.

The rock slopes above the Radical Road are often very high (>40m) and are, in places, located immediately adjacent to the path, meaning most if not all falling material can reach the path. Visitors can be observed lingering beneath the rock slopes to admire the view, further increasing their exposure. Together, the frequency and size of rockfall hazards and the potentially severe consequences of a rockfall occurring have led to the high to very high risk classification.

6. Current Position – 2021

The geotechnical engineers' advice is that the risk posed by rockfall to visitors on the Radical Road, and by default the risk of injury to visitors and staff in the area, has clearly increased. The perception of an increasing number of visitors to Holyrood Park also continues.

Fairhurst assessment includes standards for event tree calculation; rockfall trajectory for rock type and formation, slope angle and height alongside estimated visitor numbers; for detail method and outcomes refer Radical Road Rockfall Risk Assessment draft September 2019.

- **Risk Management**

Risk to visitors is still mitigated by the temporary full closure of the Radical Road footpath but given the topography it is not feasible to fully restrict access with temporary barriers; visitors are bypassing and moving the signage and barriers, forming new routes.

- **Public Perception in Media and Communications**

The continued current closure is not well received by some Park visitors, including geologists and climbers. HES receive regular complaints from members of the public, city Councillors, MSPs and MPs as well as regular Press enquiries. Some take the stance that the risks are self-apparent and that HES should accept the risk; HES has not agreed with these viewpoints.

HES Park Rangers regularly report sightings of visitors ignoring clearly signed closures at the temporary barriers. Interactions with visitors at the Radical Road have included academic groups intent on access to below Salisbury Crags. Rangers were recently verbally abused by a visitor at the High Road during rock slope inspection and scaling works; the visitor refused to comply with signage and continued to jog through the area forcing works to stop.

- **On-going Programmed works**

Fairhurst programme of rope inspection and scaling has been tendered, and contractor Geo-structural appointed under the direction of Fairhurst for rock slope works above the Radical Road path to be completed by end of this financial year 20-21.



rock scaling Salisbury Crags from ropes March 2021



scaled material reaching Radical Road March 2021

The Radical Road path closure will remain pending consideration of this Options Appraisal.

7. Additional Mitigation Options and HES Risk Appetite

Mitigation with rock slope management and remedial works can be categorised under Avoidance, Removal, Containment or Strengthening.

Avoidance is, as the word suggests, taking measures to prevent exposure to rockfall hazards. This would imply a permanent closure of the footpath with HES actions to ensure no staff or visitors are able to access below the Salisbury Crags by other less formal routes.

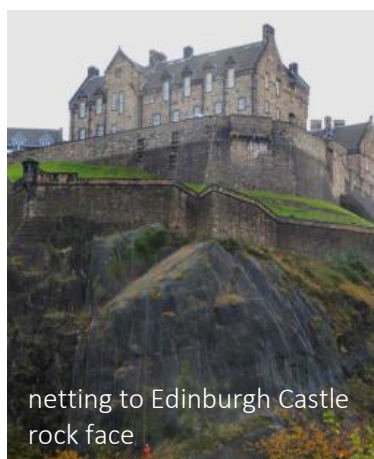
Removal of rockfall hazards by regular scaling is a feasible option, but this would have to be repeated on a regular timescale. Between these periods of scaling, a risk of rockfall would remain.

Containment techniques allow rockfalls to occur but prevent the failed debris from impacting visitors; this can comprise physical containment of the debris by mechanical means (such as mesh netting), and by creating visitor exclusion areas (such as fenced or bunded rock traps), adding permanent fixtures to separate visitors from the rockfall risk.

Strengthening techniques with dowel anchors and/or render cover have been discounted as technically inadequate options for the rock formation at these slopes.

Risk reductions by mitigation interventions are explored in more detail in Section 8. Each option has separate implications.

Similar interventions to mitigate the risk of injury from rockfall were successfully implemented at Edinburgh Castle at the rock slopes with highest risk: partial mesh containment to the north face adjacent the railway line 2008/2009 and an exclusion area for 180m formed on Johnstone Terrace in 2017/18 at costs of over £1M.



netting to Edinburgh Castle rock face



Johnstone Terrace wall and railings to rock slope below Edinburgh Castle

8. Options Appraisal

Options for additional mitigation at the Salisbury Crags have been explored with Fairhurst and considered and assessed in terms of HES Risk Appetite for access to the Radical Road and rock risk management at the rock slopes above the Radical Road:

Considerations:

- **visitor risk**
- **visitor accessibility**
- **physical/visual impact on monument, and**
- **cost estimate**

This assessment can be applied to potential additional interventions in the five mitigation options considered.

- **Risk avoidance by excluding access**

Option 1- remove visitors from the risk by the physical removal of footpath to below the crags with permanent exclusion to footpath and area below the crags

Secured gates and fixed high barriers to ringfence routes towards the area below Salisbury Crags could provide an increased visual and physical warning that HES would not permit access to the Salisbury Crags. Barriers would exclude access to all visitors, including academic studies, training and climbing activities. There would be no direct impact to the surface of the Salisbury Crags, the visual impact would be to the setting around the rock formation.

- **Risk reduction by removal**

Option 2 - re-open Radical Road following planned scaling operations (Feb-March 2021)

Increase the frequency of inspection and assessment with scaling works and invasive vegetation control to remove potential areas of loose rock.

- **Risk reduction by containment at the rock slopes**

Option 3 - full mesh containment to rock slopes

Containment across the rockface with cable and anchor attachments to hold tensile mesh would require maintenance and repair. Tensile mesh would distend as rocks detached; a very large rockfall may be slowed by the containment but may also inevitably tear through the mesh.

Option 4 - partial mesh containment to rock slopes (at highest risk areas closest to footpath)

and

partial exclusion with bund rock traps (at lower risk areas where there is some distance between rock slope and footpath)

- **Risk reduction by contained separation for staff and visitors**

Option 5 - change the nature and experience of the visitor footpath:

form protective structure over the Radical Road footpath

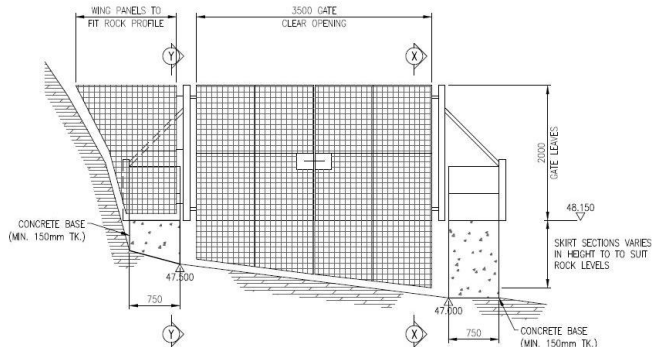
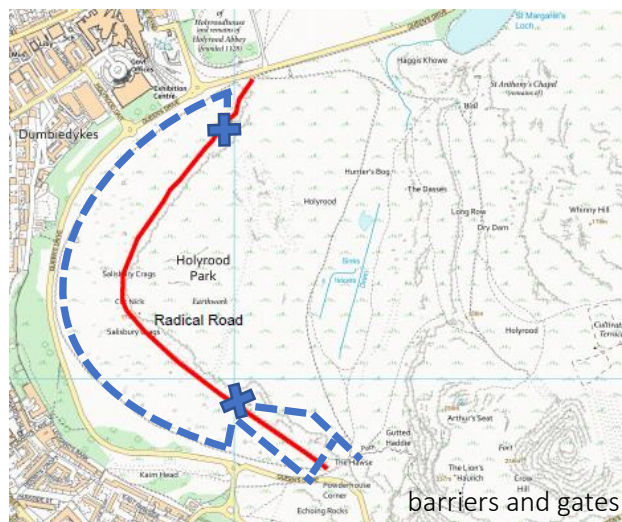
or

re-route visitors away from Radical Road with a new cantilevered structure

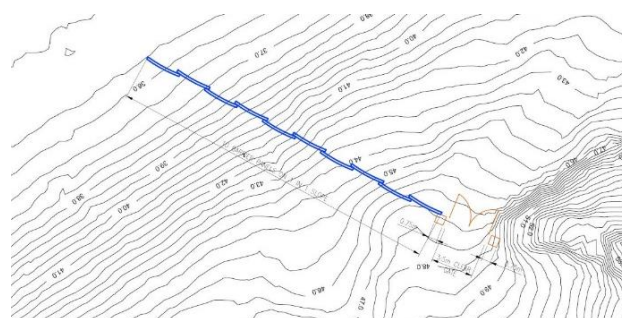


Option 1 – removal of footpath with permanent closure of Radical Road to visitors – install new exclusion barriers

access for inspection, scaling and vegetation control, and emergency and rescue call-out



north gate closure technical requirements; the arrangement at a south gate would be similar



barrier from north gate to foot of grass slope; the arrangement would be similar along the slope, up to and above a south gate

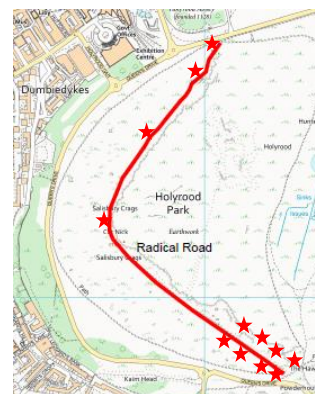
<ul style="list-style-type: none"> Visitor risk 	<p>Visitors excluded from Radical Road footpath at each end, along foot of slope and at routes from above at south</p>	<p>significant reduction</p> <p>low</p>
<ul style="list-style-type: none"> Visitor accessibility 	<p>full permanent exclusion with visitors' information</p>	<p>very poor</p>
<ul style="list-style-type: none"> Physical/visual impact 	<p>on-going scaling some material loss and the visual impact from gates and fence barriers</p>	<p>moderate</p>
<ul style="list-style-type: none"> Costs estimate 	<p>£50 -150k capital for permanent barriers plus maintenance costs. Possible reduced scaling frequency to visitor exclusion area</p>	<p>moderate to low</p>



Option 2 – accept known increased risks – re-open Radical Road following planned scaling operations (Feb-March 2021)



Radical Road path at area 2 close to rock slope – guided walk prior to 2018



- Visitor risk

Fairhurst advice is that risk of injury from rockfall has increased

some reduction with an increase to scaling

high to very high
- Visitor accessibility

fully open between more frequent closures for inspection, rock scaling and vegetation control; closures would be for longer periods

good
- Physical/visual impact

some material loss/ minimal visual impact with continued inspection and scaling

low
- Costs estimate

£50 -100,000 for each inspection, scaling and vegetation control operation plus Fairhurst fees

moderate

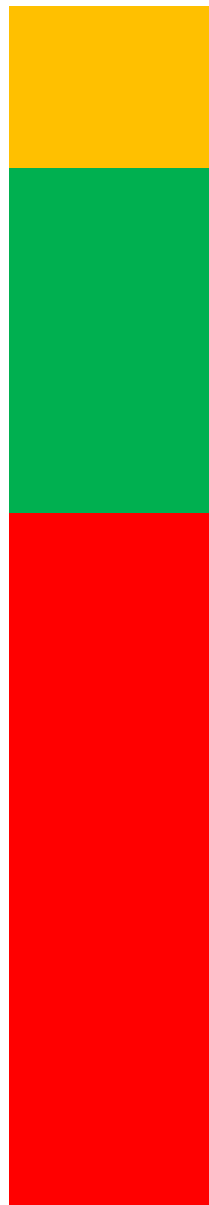
low



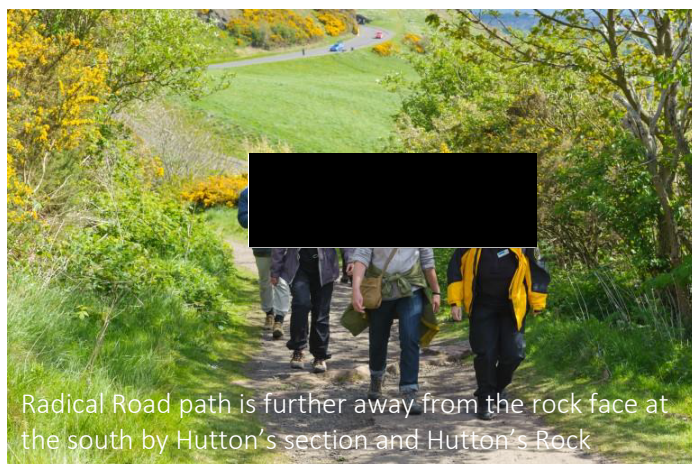
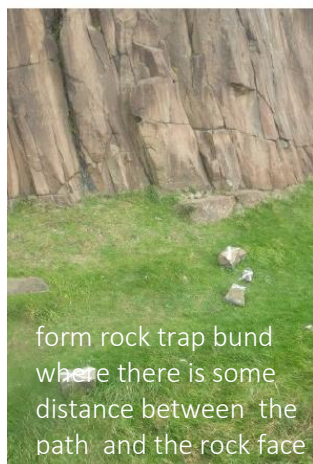
Option 3 - full mesh containment (average material lifespan circa 100 years)



<ul style="list-style-type: none"> • Visitor risk 	<p>rock slope fully contained behind mesh mechanically fixed to rock</p>	<p>some reduction</p>
	<p>tensile mesh rather than netting mesh reduces risk of sudden impact</p>	<p>moderate to low</p>
	<p>specialist design detail at head and toe of slope required</p>	
<ul style="list-style-type: none"> • Visitor accessibility 	<p>good</p>	<p>good</p>
<ul style="list-style-type: none"> • Physical/visual impact 	<p>very high impact to setting for unique and iconic landscape</p>	<p>very high</p>
<ul style="list-style-type: none"> • Costs estimate 	<p>initial over £2.5M capital outlay plus maintenance</p>	<p>high to very high</p>



Option 4 – partial mesh containment and partial exclusion with rock trap bunds -
 – the distance between footpath and rock slope varies along the crags



- Visitor risk

reduced risk at meshed areas, advisory to stay on footpath and away from inner areas behind rock trap bunds

some reduction

moderate to low

- Visitor accessibility

good

good

- Physical/visual impact

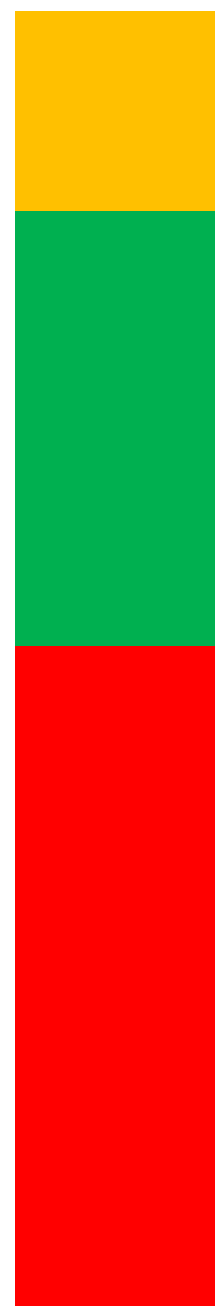
high impact to setting for unique and iconic landscape

high

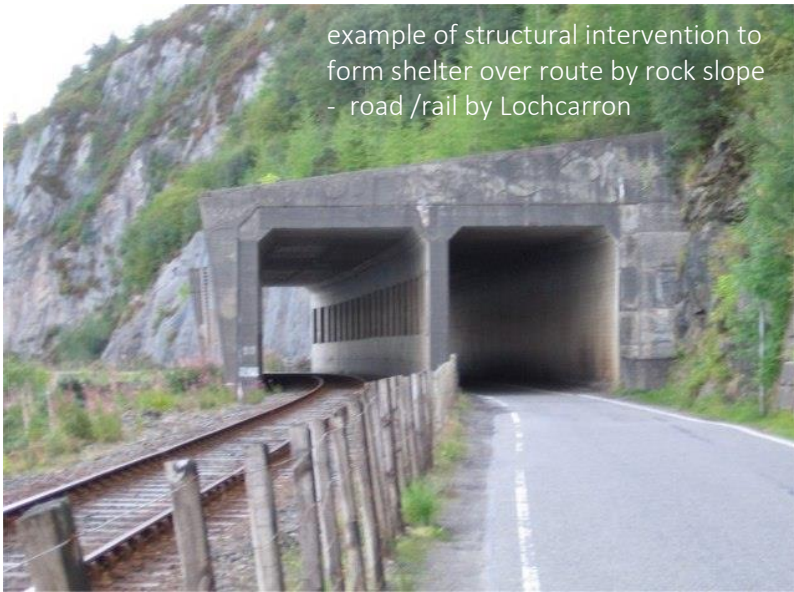
- Costs estimate

initial costs over £2.5M capital outlay plus maintenance

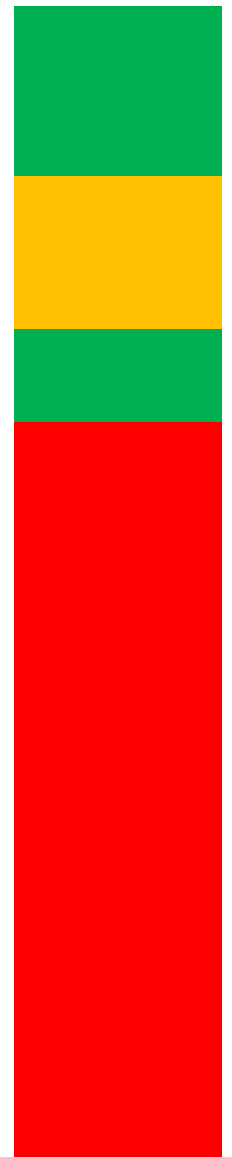
high to very high



Option 5 – re-route visitors away from rock slope –
 form structure over Radical Road or cantilever out from Radical Road



• Visitor risk	provide shelter over footpath or avoid rock slope area	significant reduction
		low
• Visitor accessibility	shelter points would limit vista across city	moderate
	cantilever walkway would provide different vista experience	good
• Physical/visual impact	lengthy consultations for impact on city skyline - unlikely to gain consent from all parties	very high
• Costs estimate	initial capital outlay not known, likely well over £2.5M plus maintenance	very high



9. Summary and Recommendations

In summary Fairhurst have advised HES of an increase in risk of injury from incidence of rockfall at Salisbury Crags; additional mitigation is required, there is not an option for HES to do nothing. Mitigation options are categorised as avoidance, removal and containment.

Health and safety for HES staff and our visitors is a priority; the current mitigation measure with temporary barriers and advisory signage is not satisfactory in the park setting, and most importantly it is not proving to be effective, the increase in risk of injury is unchanged for those intent on access to this area.

HES should consider the risk appetite for the organisation to determine a response with intended action and outcomes. HES can decide to permanently prohibit all access around this area of possible rockfall with additional and more robust measures, or HES can decide to provide some access and select between additional mitigation measures at the rock slopes. Some residual risk remains to be managed in each scenario.

Avoidance – Option 1 a permanent closure of the Radical Road footpath would achieve the highest reduction in residual risk of injury to visitors and staff, and would allow Salisbury Crags to remain fundamentally unchanged, preserving the fabric and iconic setting within gates and high barriers. On-going monitoring and management of the rock slopes would still be required. Loss of this established footpath and the installation of permanent prohibition measures across all routes above and below the crags is likely to attract some negative public response.

Removal and Containment – reduction in residual risk is achievable by additional mitigation measures at the rock slopes; Options 2-5 achieve varying degree of risk reduction for visitor safety, each of these options affects the access for visitors in some way throughout the year and each option differs in the degree of visual/physical impact on the Crags.

Submissions for Scheduled Monument Consent and SSSI consent for annual rock scaling and vegetation control operations have been granted to date. Public consultation in addition to submissions for consent would be expected for all options.

Recommendations based on this report are as follows:

- Consider Options 1 to 5 in terms of HES Risk Appetite v visitor risk, visitor accessibility, physical and visual impacts, and costs
- Agree a preferred way forward
- Establish a project development / delivery team
- Consent pre-application discussions for statutory consents
- Consider comms messaging / public consultation
- Develop scheme to indicative cost /consent/ programme stage
- Seek HES funding approval
- Deliver project

10 Stakeholders

HES HMD

- for significance impact to scheduled monument and setting

NatureScot

- for SSSI including habitat on and under the rockface

Heritage and conservation bodies

- for retention of unique landscape setting and historic connection

Residential neighbourhood and community groups

- for amenity of green space and landscape outlook

National Climbing Groups

- access to South Quarry and Training Quarry

Emergency Services

- access to South Quarry and Training Quarry for training purposes
- call-outs for assistance and rescue to all area below the crags; to assist with persons in distress and rescue recovery of injured persons

Academic Institutions

- access to area below crags for education and research, including study of the recognised importance of Hutton's Rock and Hutton's Section

City of Edinburgh Council and Scottish Government

- for active green space access

Tourist industries and local businesses

- for unique visitor attraction

Climate change, sustainability and carbon reduction groups

- planning for resilience to environmental conditions, considering minimal consumption during procurement, fabrication and maintenance

II. References

Scheduled Monument:

<https://portal.historicenvironment.scot/designation/SM13032>

Sites of Special Scientific Interest:

<https://sitelink.nature.scot/site/91>

<https://sitelink.nature.scot/site/547>

Climate Change:

Current and Past Climate Data, Holyrood Park Rockfall Supplement draft report June 20189 HES D Harkin

Geotechnical Engineers:

Radical Road Rockfall Risk Assessment draft version 02 September 2019

Geotechnical Engineers:

HES 2020-21 Project requirements draft version 17 September 2020



vista from Radical Road looking north west

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