

A890 Maman Hill

Annual Slope Inspection Report 2022

The Highland Council

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The methodology adopted and the sources of information used by AECOM in providing its services are outlined in this Report. The work described in this Report was undertaken on 22nd June 2022 and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances. AECOM disclaim any undertaking or obligation to advise any person of any change in any matter affecting the Report, which may come or be brought to AECOM's attention after the date of the Report.

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1. Introduction

1.1 General

AECOM Limited (AECOM) was appointed by The Highland Council (THC) on 29th April 2022 (THC letter ref. YEHAS6098) to undertake annual inspections of rock faces along part of the A890 in Wester Ross in the Scottish Highlands. The main site extends between the properties of Attadale and Ardnarff, known locally as the Stromeferry Bypass, but also includes rock slopes to the north of Attadale at Maman Hill that form the subject of this report. The works were commissioned under the Scotland Excel Framework for Engineering and Technical Consultancy Services: Ref. 0820 – A890 Stromeferry Bypass Rockworks, Job No: YEHAS6098 which runs until 2026.

AECOM (formerly URS) first undertook a detailed inspection of the slopes between Ardnarff and Attadale in May 2012. AECOM first undertook additional inspections of the slopes located alongside the A890 to the immediate north of Attadale (on Maman Hill) in April 2019 following discussions with THC on the potential risk associated with other rock slopes beyond the extents of the Attadale to Ardnarff section of the A890. It is not known if these rock slopes were subject to earlier inspections and/or risk assessments, although the localised presence of rock fall netting suggests a potential risk had been identified at this location in the past.

Applying the same risk assessment methodology as used on the Stromeferry Bypass between Attadale and Ardnarff, one very high risk slope and one high risk slope were identified within the Maman Hill site in 2019. It was therefore recommended that a similar risk management approach to that currently in place for the slopes between Attadale and Ardnarff be adopted, including monthly inspections by THC and annual inspections by suitably qualified and experienced engineering geologists. The last annual inspection, which included rope access inspections, was carried out in May 2021 and reported in AECOM report 60626417, 'A890 Maman Hill, Annual Slope Inspection Report, 28 July 2021'.

AECOM undertook the 2022 annual inspection on 22nd June. On the basis that no rock falls had been reported in the locale since the last inspection in 2021, and given the high level of vegetation growth at the time of year, it was agreed with THC that the inspections of the rock slopes at Maman Hill would be limited to a road level assessment initially. Should this identify any significant changes or areas of concern that warrant targeted inspection at height then a separate rope access inspection could then be arranged.

This report summarises the findings of the 2022 inspection, with further details provided within the appended geotechnical data sheets. The report objectives are to:

- Provide a summary of any significant events that have occurred at the site since the 2021 annual inspection;
- Present the findings of the 2022 inspection, including comment on the condition of the rock slopes and any existing remedial measures;
- Comment on the level of risk associated with the rock faces; and
- Provide recommendations for ongoing management and risk reduction, where appropriate.

1.2 Background

The site is located along the A890 between approximately 130m and 600m north of Attadale Station (between National Grid References (NGRs) 192443 839288 and 192616 839683). A site location plan included in Appendix A.

Within the site extents the A890 is single carriageway and rises steeply from approximately 5m above ordnance datum (AOD) in the south to approximately 55m AOD in the north. The road is located on sidelong ground with a series of predominantly man-made rock slopes ranging in height from 2m to 20m on the upslope (eastern) side of the road.

At the southern extent of the site the road runs adjacent to the railway, which continues around the coastline of Loch Carron as the road rises up the slopes of Maman Hill. The land between the road and the railway is undeveloped heath and woodland, whilst the land immediately upslope of the road comprises a commercial forestry plantation. No surface water flows or groundwater flows were observed within the site, however it should be noted that groundwater levels may vary owing to seasonal or other effects.

The construction of the A890 in the 1960s involved the widening of an existing track / road at Maman Hill and the creation / widening of several rock slopes along the eastern (upslope) side of the road. It is considered that over-blasting during construction resulted in the rock cutting slopes being left in a fractured state prone to rock falls. These conditions have also left the exposed rock mass susceptible to weathering, frost and root action.

Further details on the site history and geology are included in the 2019 inspection report¹. The site has no environmental or historical designations, and AECOM is not aware of any ecological constraints affecting the site. This should, however, be confirmed during the planning of any physical works.

1.3 Works Since the 2021 Inspection

1.3.1 THC Inspections

The ongoing management of the slopes alongside the A890, including at Maman Hill, involves the completion of daily 'drive through' inspections and more detailed monthly 'walk through' inspections by local THC personnel familiar with the site. Any new slope movements or hazards are reported directly to AECOM. The THC inspections have not recorded changes to the slopes at Maman Hill between May 2021 and June 2022.

1.3.2 Maintenance / Remedial Works

AECOM is not aware of any work having been carried out on the slopes at Maman Hill since the May 2021 inspection.

¹ AECOM report 60598147, 'A890 Maman Hill, Rock Slope Inspection Report, 26 July 2019'.

2. 2022 Annual Inspection

A team of two AECOM geologists inspected the rock slopes at Maman Hill on the 22nd June 2022. The weather during the inspection was mild, dry and overcast.

During the 2019 inspection, a local chainage system was established and the rock slope was divided into six zones of similar rock slope geometry, slope bearing and rock mass structure (referenced Slopes M1 to M6). Chainage 0 was positioned opposite the northern end of the layby at the top of the hill (NGR 192616 839683). The chainage system and the approximate location and extent of each rock slope zone are shown on Figure 2 in Appendix B.

Each zone of the rock slope was inspected from road level with the aim of identifying potential stability issues. Traffic management was provided by Alba Traffic Management Ltd. (a sub-contractor of Geo-rope Ltd.) for the duration of the inspection. Due to the dense vegetation on the slopes at the time of year the inspection was undertaken, it was agreed with THC that rope access inspections were impractical and so none was carried out.

The risk assessment approach adopted to rank the relative rock fall risk presented by each slope to the road and its users is detailed below. This is the same methodology used to assess the slopes along the nearby Ardnarff to Attadale section of the Stromeferry Bypass. The relative risk level for each slope at Maman Hill is therefore directly comparable.

The risk assessment considers the size of a potential rock fall (the hazard), the potential likelihood of debris from the rock fall reaching the carriageway (the pathway) and the available sighting distance on the carriageway (the receptor). The ratings assigned to each of these criteria are multiplied together to give a risk rating. Further details are provided in Sections 2.1 to 2.4.

The potential consequence of a rock fall will clearly vary depending on the presence/absence of road users beneath or approaching the slope at the specific time. It must be appreciated that due to the number of variables involved this is impossible to predict. It should be recognised that the assigned level of risk takes a conservative approach and assumes the potential presence of road users beneath or approaching the slope at the time of rock fall. A more likely scenario is that a rock fall occurs when no road users are directly beneath and fallen blocks which have come to rest on the road present a hazard to road users after the event. To differentiate and risk rank the slopes, (e.g. to prioritise remedial works) sightlines and stopping distances are also factored in to the assessment to recognise the higher potential for road users to interact with rock fall debris on the road at locations with poorer sightlines as opposed to straight sections of road (see section 2.3).

Following the initial risk assessment the inspecting geologists reviewed the relative risk rankings and, where necessary, adjusted the scoring to reflect the overall setting and their professional judgement.

2.1 Hazard Rating

Four categories of hazard rating have been selected based on the main sizes of rock falls (and potential rock falls) identified at the site, as detailed in Table 2-1. During the risk assessment the hazard rating representative of the scale of observed or potential rock falls at each slope was selected.

Table 2-1: Hazard Rating

Hazard Rating	Description
1	Small ravelling type rock falls (typically up to 0.02m ³).
2	Moderate rock falls (typically between 0.02m ³ and 1m ³).
3	Large rock falls (typically between 1m ³ and 10m ³).
4	Very large rock falls (typically greater than 10m ³)

2.2 Pathway Rating

Each slope has been assigned a pathway rating (Table 2-2) based upon a qualitative inspection of the slope form (height, angle, profile/roughness, vegetation cover, and presence or absence and suitability of existing remedial measures) between the position of a potential rock fall and the road. The rating also takes into account an estimated

termination location of fallen material. If debris from previous rock fall events was evident, the location of this was considered during this assessment.

Table 2-2: Pathway Rating

Pathway Rating	Description
1	No falling blocks are expected to reach the road (e.g. effective remedial measures and/or a wide verge or rock trap ditch).
2	Most falling blocks are not expected to reach the road (e.g. largely effective remedial measures/verge/rock trap ditch).
3	Approximately half of the falling blocks are expected to reach the road (e.g. partially effective remedial measures/verge/rock trap ditch).
4	Most falling blocks are expected to reach the road (e.g. no or ineffective remedial measures and/or narrow verge/shallow rock trap ditch).
5	All falling blocks are expected to reach the road (e.g. no or ineffective remedial measures and no verge or rock trap ditch - fallen blocks are likely to free fall or bounce directly onto the road).

2.3 Receptor Rating

For slopes with pathway ratings of ≥ 2 (i.e. at least some blocks are expected to reach the road), a receptor rating is included in the assessment to reflect the potential of a vehicle coming into contact with, or having to take action to avoid, rock fall debris. The minimum sighting distance that a driver would have when driving adjacent to each of the slopes (in good weather conditions and during daylight hours) was estimated based on stopping distances from the Highway Code for cars travelling at 40mph and 60mph (36m and 73m respectively).

Table 2-3: Receptor Rating

Receptor Rating	Description
1	Sighting distance > 73m
1.2	Sighting distance 36 to 73m
1.4	Sighting distance < 36m

2.4 Risk Rating

The ratings assigned to the hazard, pathway and receptor were multiplied to give a risk rating for each of the slopes. The relative risk levels are described in Table 2-4, along with the colour coding used to depict these.

Table 2-4: Risk Rating

Risk Rating	Relative Risk Level	Description
<5	Low	Small to moderate sized rock falls with a low probability of causing damage to or closure of the road and/or injuries to road users. Risk normally acceptable.
5 to <10	Moderate	Moderate sized rock falls with potential to cause moderate damage to road and short term road closures (a few hours) but a low probability of causing injuries to road users. Risk likely to be tolerable but client needs to be made aware of hazards and monitor these.
10 to <15	High	Moderate to large sized rock falls with a higher probability of causing major damage to the road and/or road closures of a few days to a few weeks and potential of causing major injury or loss of life should road users be present beneath (or approaching) slope at time of rock fall. Risk likely to require remedial measures / risk management actions.
≥ 15	Very High	Large to very large rock falls which have a high probability of causing significant damage to road and/or long term road closures (weeks to months) and the potential of resulting in major injury or loss of life should road users be present beneath (or approaching) slope at time of rock fall. Risk likely to require remedial measures.

3. Inspection and Risk Assessment Findings

The findings of the inspection are summarised in Table 3-1, with more detailed records included in Appendix C and accompanying photographs included in Appendix D.

Table 3-1: Summary of Rock Slope Inspections

Rock Slope Ref.	Start Chainage	End Chainage	Annual Inspection Observations / Comments	Photographs	Hazard Rating	Pathway Rating	Receptor Rating	Risk Rating	Risk Level	Recommended maintenance/ remedial works			
			2019	2020	2021	2022							
M1	015	075	<p>Partially vegetated rock face up to 7m high with semi-mature coniferous trees growing along crest; Although localised blast damage was noted in the form of induced and dilated fractures, the rock mass structure is generally favourable with limited potential for kinematic failures. The potential exists for small scale rock fall (ravelling) of individual blocks typically <math> < 0.01\text{m}^3 </math> as the rock mass continues to weather and degrade. The potential for occasional larger block falls associated with root jacking also exists;</p> <p>Old chain-link drape netting is present locally but is highly corroded /damaged and should be considered ineffective. However, based on the current condition of the rock slope and the presence of a 0.9m verge at the toe of the slope the likelihood of debris from a rock fall landing on the road is considered to be relatively low.</p>	No significant change.	No significant change. Vegetation cover has increased slightly to ca. 30%. Risk level remains the same.	No significant change. Risk level remains the same. Observations include: - Ch. 018: trees at crest of slope presenting risk of root-jacking. Around 6 blocks of approx. size 0.2m x 0.1m x 0.1m are in the ditch. - Ch. 020: Block (c.2m x 1m x 1.5m) with dilated back fracture (low risk due to presence of ditch at this location). - Ch. 018 to 030: Vegetation in the ditch could be cleared to improve its capacity.	M1-1	2	2	1.2	4.8	Low	Ch. 018 to 030: Vegetation in the ditch could be cleared to improve its capacity.
M2	200	280	<p>Almost completely vegetated rock slope with only isolated exposures. Maximum height 2m; Rock mass locally exhibits dilated fractures due to weathering and root jacking and the potential for small scale rock falls exists, however, ditch and verge at toe are considered effective and the associated likelihood of debris reaching the road is therefore low.</p>	No significant change.	No significant change. Risk level remains the same.	No significant change. Risk level remains the same.	N/A	1	1	N/A	1.0	Low	None
M3	280	330	<p>Partially vegetated 4-8m high rock slope with semi mature trees growing along crest; Rock mass is generally favourable with limited potential for kinematic failures but localised dilated fractures (associated with weathering, blasting and root jacking) were observed as well as overhanging areas of rock mass. The potential for rock falls up to 0.5m³ exists;</p> <p>The ditch and verge at the toe of the slope are considered likely to retain debris from the majority of rock falls and the associated likelihood of debris reaching the road is therefore low</p>	No significant change. Minor rockfall in ditch at Ch. 304 originating from crest of slope beneath large fir tree. Caused by root jacking. Tree is considered unstable with potential to block road. Its removal was recommended and this was carried out by THC in December 2020.	Other than the felling of the tree at Ch. 304, no significant changes were observed. Marginally reduced root jacking potential as tree has been felled but risk assessment remains unchanged.	No significant change. Risk level remains the same.	N/A	2	2	1.2	4.8	Low	None

Rock Slope Ref.	Start Chainage	End Chainage	Annual Inspection Observations / Comments				Photographs	Hazard Rating	Pathway Rating	Receptor Rating	Risk Rating	Risk Level	Recommended maintenance/ remedial works
			2019	2020	2021	2022							
M4	335	395	<p>Partially vegetated 4-15m high rock slope with trees growing along crest;</p> <p>Rock mass in poor condition with dilated fractures and loose material frequently observed (blast damage). Potential for planar failures as well as ravelling, root jacking and block falls from above overhangs. Maximum individual rock fall volume estimated as around 5m³ but multiple potential rock falls observed;</p> <p>Localised chainlink and plastic 'geo-grid' style netting. Corroded and damaged and considered ineffective for retention of anything but the smallest blocks;</p> <p>Some small scale ravelling type rock falls were noted to be imminent with blocks readily dislodged by hand;</p> <p>Absence of ditch and presence of only a narrow verge beneath the highest area of the rock face where the majority of the potential rock falls were observed indicates that majority of rock fall debris is likely to reach road.</p>	No significant change.	<p>Ch. 370 to 380: some additional blocks observed behind netting resting on tree trunk (ca. 0.25m³).</p> <p>Ch. 370: Rope access inspections carried out to re-assess previously identified hazards. Condition remains unchanged.</p> <p>Ch. 374: Rope access inspection carried out to assess overhang at crest. Overhang observed to be 1.0-1.3m with a dilated fracture along the left hand side. "Supporting block" on 58° sliding plane with dilated fracture. Root jacking potential from trees at crest.</p> <p>Two loose blocks were removed by hand during the rope access inspections to make safe. Total volume ca. 0.25m³.</p> <p>Risk level remains the same.</p>	No significant change. Risk level remains the same.	M4-1	3	5	1.2	18.0	Very High	<p>Full de-vegetation (including felling of trees along crest) and light scaling;</p> <p>Targeted active netting system over highest section of slope where potential rock falls identified.</p>
M5	395	415	<p>Sub-vertical to overhanging 15-20m high rock slope, generally free from vegetation;</p> <p>Slightly set back from road and appears to be a natural crag rather than a man-made rock slope. Rock mass generally in good condition with tight fractures but occasionally noted to be very dilated suggesting historical movement. Ongoing ravelling of small blocks is evident, with several precarious blocks observed along the crest of the slope. Localised potential for larger scale rock falls up to around 3m³ observed;</p> <p>5m wide verge present at toe of slope and this is likely to retain debris from all but the largest of rock falls. However, due to slope geometry the trajectory of rock falls is hard to predict and the potential for debris to reach the road exists.</p>	No significant change.	<p>Ch. 400: Rope access inspection of block at crest carried out. 10-50cm wide release joint around overhanging block.</p> <p>Ch. 402: Rope access inspection of dilated block ca. 10m above toe of slope. Basal fracture dips into slope ("keyed in").</p> <p>Risk level remains the same.</p>	No significant change. Risk level remains the same.	N/A	3	3	1.2	10.8	High	<p>Installation of spot dowels in individual blocks / area of rock mass at risk of rock falls. Provisionally allow for 20 No. 4m long dowels.</p>
M6	415	460	<p>Partially vegetated 3-10m high rock slope, with trees growing along crest;</p> <p>Rock mass generally favourable with tight fractures but occasionally noted to be dilated where affected by blasting, weathering and/or root jacking. Potential for kinematic failures is generally low, although localised toppling potential observed (up to 1m³). Ongoing ravelling and root jacking of small blocks from crest should also be anticipated;</p> <p>Chain-link drape netting is locally present but this is corroded and locally damaged and should only be considered effective for small scale ravelling type failures. There is no ditch and only a narrow verge so some debris from larger scale rock falls could reach road, however, only one such potential rock fall was identified so the associated likelihood is low.</p>	No significant change.	No significant change. Risk level remains the same.	No significant change. Risk level remains the same.	M6-1	2	2	1.2	4.8	Low	None

4. Discussion and Recommendations

The inspection of the rock slopes at Maman Hill in June 2022 did not identify any hazards or features posing an immediate risk of rock fall affecting the operation of the road. However, one 'very high' risk slope (M4) and one 'high' risk slope (M5) were identified and, at these slopes in particular, frequent small scale raveling type rock falls should be anticipated along with the occurrence of occasional larger scale block falls as the rock mass continues to degrade through weathering, root action, etc. The potential for rock fall debris to reach the road, and therefore the relative risk level, is higher at M4 due to the narrow roadside verge.

The relative risk levels associated with the rock slopes at Maman Hill are ranked from highest to lowest in Table 4-1. It important to note that the risk ratings are relative and that a risk of 'low' does not mean that a rock fall will not occur, but that it is considered that the likelihood and/or consequences of a rock fall is lower than at other locations.

Table 4-1: Relative Risk Level of Slopes

Risk Ranking	Slope Ref.	Hazard Rating	Pathway Rating	Receptor Rating	Risk Rating	Risk Level
1	M4	3	5	1.2	18.0	Very High
2	M5	3	3	1.2	10.8	High
3	M1	2	2	1.2	4.8	Low
	M3	2	2	1.2	4.8	Low
	M6	2	2	1.2	4.8	Low
4	M2	1	1	1.2	1.2	Low

Although a form of drape netting is in place over some of the slopes at Maman Hill it is either highly corroded and damaged chain-link netting or plastic 'geo-grid' netting hung over the face (often with no connection between individual panels). It is not known when the netting was installed but based on the materials used it is likely to have been in place for at least 30 years. Although the netting may control the trajectory of very small blocks (up to cobble size) neither the chain-link netting nor the plastic geo-grid offers sufficient risk reduction to the road from larger blocks.

Given the identified level of risk associated with the slopes at Maman Hill it is recommended that a similar risk management approach to that currently in place for the slopes between Ardnarff and Attadale be adopted. This comprises:

Regular inspections by THC:

THC staff familiar with the site should undertake regular inspections of the rock slopes with the aim of identifying any rock falls / increased risk to the road. Elsewhere along the Stromeferry Bypass (between Ardnarff and Attadale) these inspections involve driving through the site each weekday morning and walking through the site on a monthly basis. Identified issues should be reported internally within THC and advice sought from a suitably qualified and experienced Engineering Geologist / Geotechnical Engineer where appropriate.

Annual inspection by suitably qualified and experienced Engineering Geologists / Geotechnical Engineers:

This should involve the roadside inspection of all slopes and targeted rope access inspections of selected higher risk slopes, particularly where potential hazards have been identified during previous inspections. The next inspection should be carried out in the Spring of 2023, when vegetation cover is at a minimum and rope access inspections are feasible. It is recommended that inspections at height by rope access are carried out at slopes M4 and M5.

Targeted remedial works at the highest risk slopes:

It is recognised that THC has a limited budget for remedial works and to achieve the maximum level of risk reduction it is recommended that works are prioritised to address the highest risk rock faces and hazards in the first instance. AECOM is in regular discussions with THC in relation to the budget and timing of planned remedial works along the A890 such that an appropriate scope of remedial work can be selected.


Appendix A Site Location Plan



SITE LOCATION



PROJECT
 A890 MAMAN HILL
 ROCK SLOPE INSPECTIONS
 CLIENT
 THE HIGHLAND COUNCIL

KEY:
 Approximate Site Boundary

PROJECT NUMBER
 60685712

SHEET TITLE
 Site Location Plan


SHEET NUMBER
 1 of 1

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Appendix B Slope Location Plan



Imagery © Microsoft Bing Maps, 2019.

Client:	The Highland Council	Project:	A890 Maman Hill Rock Slope Inspections		Title:	Rock Slope Extents	
	AECOM Ltd. 7th Floor, Aurora 120 Bothwell Street Glasgow G2 7JS	Drawn:	MT	Revision:	0	Figure No.:	2
		Designed:	MT				
		Checked:	PLM	Job Number:	60685712	Scale:	NOT TO SCALE
		Approved:	PLM				

Appendix C Geotechnical Assessment Sheets

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 – Maman Hill	Slope Ref: M1	Chainage: 015 - 075	Start Grid Ref: Not recorded.	End Grid Ref: Not recorded.	Elevation: ca. 50 - 55m AOD
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Rock Slope Characteristics:

Dip (°): 70	Azimuth (°): 310	Height (m): 7	Length (m): 60	Vegetation Cover: 30% of slope covered in heather and grass. Trees along crest.	Ditch Details: No ditch.	Roughness (Profile): Rough	Verge Width (m): 0.9
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Engineering Description of Rock:

Strong psammite.

Existing Netting Details or other remedial work details:

Localised chainlink drape netting between Ch. 030 and Ch. 070 (ca. 65% of slope). Highly corroded and locally damaged. Anchorages not inspected.

Other Comments:							
No surface or groundwater flows. Rock mass generally in good condition, although dilated fractures noted locally. Potential for kinematic failure is low. Ch. 018 to 030: there is vegetation in the ditch that could be cleared.							
Hazards Observed:							
Location		Comments					
Throughout M1		Small scale (<0.01m ³) raveling type rock falls likely as rock mass continues to weather.					
Throughout M1		Trees at crest have potential to cause root jacking (e.g. Ch. 018)					
Ch. 018		Approx. 6 blocks in verge c.2m x 0.1m x 0.1m					
Ch. 020		Block (c.2m x 1m x 1.5m) with dilated back fracture (low risk due to presence of ditch)					
SUMMARY			Comments				
Hazard Rating =		2		Generally limited to small scale raveling although locally potential for larger block fall(s) associated with root jacking. Block size not expected to exceed 1m ³ .			
Pathway Rating =		2		Most rock fall debris likely to land in verge.			
Receptor Rating =		1.2		Minimum sightline 45m.			
Risk Value =		4.8					
Risk Level =		Low					
Recommended Remedial Works / Actions							
Re-inspection by end of June 2023. Low risk so remedial works not deemed necessary, however, felling of trees along crest would reduce risk further. Recommend monitoring ditch and clearing when required to maintain its capacity.							
Assessed in field by:	JG/PLM	Date:	22/06/2022	Reviewed by:	PLM	Date:	26/08/2022

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 – Maman Hill	Slope Ref: M2	Chainage: 200 - 280	Start Grid Ref: Not recorded.	End Grid Ref: Not recorded.	Elevation: ca. 30-35m AOD
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Rock Slope Characteristics:

Dip (°): 60	Azimuth (°): 305	Height (m): 2	Length (m): 80	Vegetation Cover: 95% of slope covered in heather and grass and semi-mature trees.	Ditch Details: 0.5m deep, 1m wide ditch.	Roughness (Profile): Rough	Verge Width (m): 1.0
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Engineering Description of Rock:

Strong psammite.

Existing Netting Details or other remedial work details:

None observed.

Other Comments:							
No surface or groundwater flows. Isolated low height (2m max) rock exposures. Rock mass generally in good condition, although dilated fractures noted locally. Potential for kinematic failure is low. No debris at toe or other evidence of previous rock falls at this location. Presence of effective ditch and verge.							
Hazards Observed:							
Location		Comments					
Throughout M1		Small scale (<0.02m ³) ravelling / root jacking rock falls likely as rock mass continues to weather.					
SUMMARY			Comments				
Hazard Rating =		1		Generally limited to small scale ravelling.			
Pathway Rating =		1		Ditch considered effective.			
Receptor Rating =		N/A		Minimum sightline 65m. No falling blocks are expected to reach the road so receptor rating not applied.			
Risk Value =		1.0					
Risk Level =		Low					
Recommended Remedial Works / Actions							
Re-inspection by end of June 2023. Low risk so remedial works not deemed necessary.							
Assessed in field by:	JG/PLM	Date:	22/06/2022	Reviewed by:	PLM	Date:	26/08/2022

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 – Maman Hill	Slope Ref: M3	Chainage: 280 - 330	Start Grid Ref: Not recorded.	End Grid Ref: Not recorded.	Elevation: ca. 25-30m AOD
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Rock Slope Characteristics:

Dip (°):	65	Azimuth (°):	300	Height (m):	4 to 8	Length (m):	50	Vegetation Cover:	25% of slope covered in heather, grass and occasional small trees. Trees along crest.	Ditch Details:	0.4 to 0.75m deep, 1.2m wide.	Roughness (Profile):	Rough	Verge Width (m):	1.0
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Engineering Description of Rock:

Strong psammite.

Existing Netting Details or other remedial work details:

None observed.

Other Comments:							
No surface or groundwater flows. Rock mass generally in good condition, although dilated fractures associated with blast damage and root jacking noted locally. Potential for kinematic failure is low but ravelling, root jacking and block falls from above overhangs possible. Maximum rock fall size 0.5m ³ . Ditch and verge likely to retain debris from some small scale rock falls. Occasional blocks observed at toe – typical dimensions 0.1 x 0.1 x 0.1m.							
Hazards Observed:							
Location		Comments					
Throughout M3		Numerous small scale (<0.02m ³) ravelling type rock falls observed, some of which were deemed to be imminent (i.e. readily dislodged by hand).					
Ch. 304		Large fir tree growing from crest of rock face. Evidence of root jacking. Potential rock fall volume up to 0.5m³. Tree felled by THC in Dec 2020.					
Throughout M3		Localised overhangs with potential for rock fall of unsupported blocks. Individual block size typically <0.1m ³ .					
SUMMARY			Comments				
Hazard Rating =		2		Generally limited to small scale ravelling although locally potential for larger block fall(s) associated with root jacking. Rock fall volume not expected to exceed 0.5m ³ .			
Pathway Rating =		2		Most rock fall debris likely to land in ditch verge.			
Receptor Rating =		1.2		Minimum sightline 60m.			
Risk Value =		4.8					
Risk Level =		Low					
Recommended Remedial Works / Actions							
Re-inspection by end of June 2023. Low risk so remedial works not deemed necessary, however, felling of trees along crest would reduce risk further.							
Assessed in field by:	JG/PLM	Date:	22/06/2022	Reviewed by:	PLM	Date:	26/08/2022

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 – Maman Hill	Slope Ref: M4	Chainage: 335 - 395	Start Grid Ref: Not recorded.	End Grid Ref: Not recorded.	Elevation: ca. 15-20m AOD
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Rock Slope Characteristics:

Dip (°): 80	Azimuth (°): 300	Height (m): 4 to 15	Length (m): 60	Vegetation Cover: 15% of slope covered in heather, grass and occasional small trees.	Ditch Details: 0 to 0.4m deep, 0 to 1m wide.	Roughness (Profile): Rough	Verge Width (m): 0.5 to 1.0
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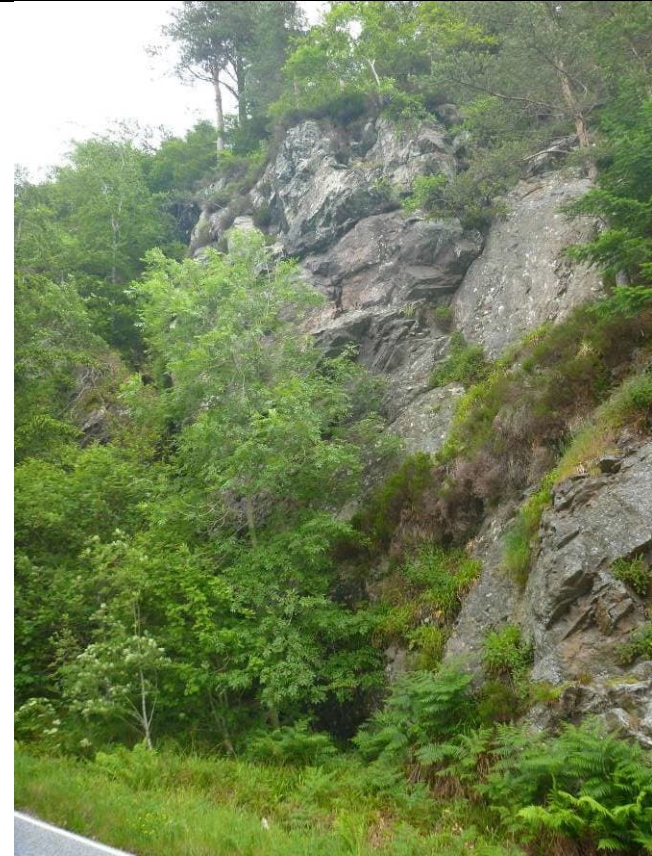
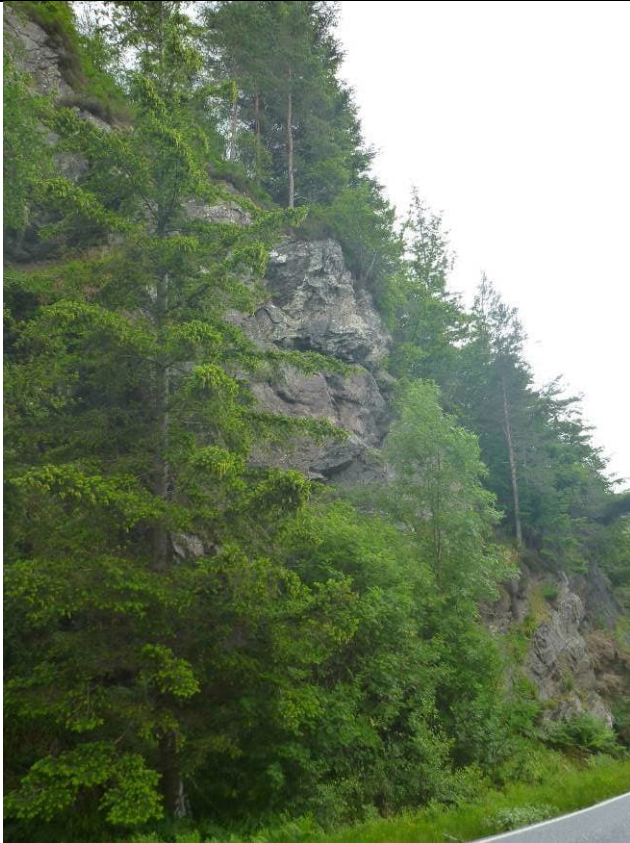
Engineering Description of Rock:

Strong psammite.

Existing Netting Details or other remedial work details:							
Chainlink drape netting between Ch. 360 and Ch. 375. Netting is corroded and damaged and should be considered ineffective for the retention of anything but the smallest blocks. Anchor points not inspected. Plastic 'geo-grid' style netting present over rock slope between Ch. 375 and Ch. 385. Individual panels unjoined and anchor points have not been inspected. This type of netting is not suitable for the retention of rock falls and should be considered ineffective.							
Other Comments:							
No surface or groundwater flows. Rock mass in poor condition with frequent dilated fractures associated with blast damage, weathering and root jacking. Potential for planar failures as well as raveling, root jacking and block falls from above overhangs. Some small scale raveling type failures were noted to be imminent with blocks readily dislodge by hand. Ditch and verge likely to retain debris from some small scale failures but locally absent / narrow. Occasional blocks observed at toe – typical dimensions 0.1 x 0.1 x 0.1m.							
Hazards Observed:							
Location		Comments					
Throughout M4		Numerous small scale (<0.02m ³) raveling type failures observed, some of which were deemed to be imminent (i.e. readily dislodged by hand).					
Ch. 370 to 380		A large overhang was observed ca. 3-5m below the crest of the rock face, however, joints were observed to be tight and no significant risk of failure identified.					
Ch. 370		A dilated sliding plane at 50° and with a 1.5m high x 2.5m wide x 1.5m deep block above was observed ca. 10m above road level. Loose rock noted along sliding plane. Risk of ca. 5m ³ plane failure. No ditch and narrow verge so failure debris likely to reach road.					
Ch. 370 to 380		Several areas of blast damage noted with dilated joints and loose rock observed. No ditch and only a narrow verge present beneath highest section of the rock slope. Debris noted along toe of slope in this area and potential for additional failures to occur.					
Ch. 374		Overhang at crest (1.0-1.3m) with dilated fracture along left hand side. "Supporting block" on 58° sliding plane. Root jacking potential.					
Ch. 378		Dilated plane observed 8m above road level. Slightly keyed in at left hand side but fractured rock mass ca. 3.5m wide x 0.5m deep x 1m high. Potential for failure exists and narrow verge below means this poses a risk to the road.					
SUMMARY				Comments			
Hazard Rating =		3		Potential failure volumes up to 5m ³ identified.			
Pathway Rating =		5		Existing remedial measures considered ineffective and there is no ditch and only a narrow verge beneath the largest potential failures. Due to potential rock fall trajectories, all rock fall debris is considered likely to reach road.			
Receptor Rating =		1.2		Minimum sightline 60m.			
Risk Value =		18.0					
Risk Level =		Very High					
Recommended Remedial Works / Actions							
Re-inspection by end of June 2023; High risk slope so remedial works recommended to reduce risk. Remedial works likely to comprise full de-vegetation and light scaling exercise with targeted active netting system over the highest portion of the rock slope where several significant potential failures have been identified.							
Assessed in field by:		JG/PLM		Date:		22/06/2022	
				Reviewed by:		PLM	
				Date:		26/08/2022	

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 – Maman Hill	Slope Ref: M5	Chainage: 395 - 415	Start Grid Ref: Not recorded.	End Grid Ref: Not recorded.	Elevation: ca. 10-15m AOD
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Rock Slope Characteristics:

Dip (°): 80 to 90	Azimuth (°): 315	Height (m): 15 to 20	Length (m): 20	Vegetation Cover: <10% of slope is vegetated. Localised heather and grass. Trees also present at crest.	Ditch Details: None	Roughness (Profile): Rough	Verge Width (m): 5.0
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Engineering Description of Rock:

Strong psammite.

Existing Netting Details or other remedial work details:						
None						
Other Comments:						
<p>No surface or groundwater flows.</p> <p>Rock slope set slightly back from road and appears to comprise natural crags rather than a man-made (blasted) rock slope. The slope is locally overhanging and a cave feature is present at the northern end of the slope, possibly a former sea cave.</p> <p>Rock mass generally in good condition with tight fractures but occasionally noted to be very dilated suggesting historical movement. Ongoing ravelling of small blocks is evident, with several precarious blocks observed along the crest of the slope. Localised potential for larger scale rock falls up to around 3m³ observed.</p> <p>Wide verge (5m) likely to retain debris from all but the largest of rock falls.</p>						
Hazards Observed:						
Location		Comments				
Throughout M5		Ongoing ravelling. Precarious blocks noted along crest.				
Ch. 398		Detached block ca. 2m x 2m x 0.7m. Open on left hand side and with a dilated back release joint. Keyed in on right hand side but difficult to see how well. Upper part of right hand side has 70mm dilated joint. Trajectory of blockfall hard to predict so doweling may be required to protect road.				
Ch. 400		Overhanging block at crest with 10-50cm wide dilated release joint.				
Ch. 405		Column of rock ca. 4-8m above road level. 1.5m wide, 0.5m deep. Potential for rock fall as unsupported but wide verge below likely to prevent debris reaching road.				
Ch. 407		Dilated crack to rear of lichen covered block 8-10m above road level. Keyed in below.				
SUMMARY			Comments			
Hazard Rating =		3	Potential rock fall volumes up to 3m ³ identified.			
Pathway Rating =		3	Majority of rock fall debris likely to land on roadside verge. Potential for some debris from larger scale rock falls to reach road. Trajectories of rock falls hard to predict due to slope profile so conservative value chosen for pathway rating.			
Receptor Rating =		1.2	Minimum sightline 60m.			
Risk Value =		10.8				
Risk Level =		High				
Recommended Remedial Works / Actions						
<p>Re-inspection by end of June 2023;</p> <p>High risk so remedial measures recommended. Consideration should be given to installation of targeted dowels to secure individual blocks / areas of rock mass at risk of rock fall and reduce risk further. Allowance for 20 No. 4m long dowels to be installed as required.</p>						
Assessed in field by:	JG/PLM	Date:	22/06/2022	Reviewed by:	PLM	Date: 26/08/2022

GEOTECHNICAL ASSESSMENT SHEET

Site: A890 – Maman Hill	Slope Ref: M6	Chainage: 415 - 460	Start Grid Ref: Not recorded.	End Grid Ref: Not recorded.	Elevation: ca. 5-10m AOD
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Rock Slope Characteristics:

Dip (°): 80	Azimuth (°): 285	Height (m): 3 to 10	Length (m): 45	Vegetation Cover: 15% vegetation cover – gorse, heather and grass. Trees at crest.	Ditch Details: None	Roughness (Profile): Smooth	Verge Width (m): 0.5 to 1.0
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Engineering Description of Rock:

Strong psammite.

Existing Netting Details or other remedial work details:

Chainlink drape netting between Ch. 415 and 435. Corroded and locally damaged but effective for small scale ravelling type rock falls.

Other Comments:							
No surface or groundwater flows. Rock mass generally favourable with tight fractures but occasionally noted to be dilated where affected by blasting, weathering and/or root jacking. Potential for kinematic failures is generally low, although localised toppling potential observed (up to 1m ³). Ongoing ravelling and root jacking of small blocks from crest should also be anticipated. No ditch and only a narrow verge so there is potential for some small blocks to reach road.							
Hazards Observed:							
Location		Comments					
Throughout M6		Ongoing ravelling and root jacking, particularly along crest.					
Ch. 420		Potential toppling failure identified ca. 6m above road level. Dilated fractures. 0.5-1.0m ³ .					
Ch. 455		Fallen tree c.3m back from crest of slope. Tree has been cut (unsure when this was completed but present when slope first inspected by AECOM in 2019). Not posing risk to road.					
Ch. 455		Fresh surfaces at crest of slope indicating recent rockfall (first observed by AECOM in 2019). Block not currently in ditch/verge so has been moved. Block anticipated to have been 0.3m x 0.2m based upon fresh surface.					
SUMMARY				Comments			
Hazard Rating =		2		Potential rock fall volumes up to 1m ³ identified.			
Pathway Rating =		2		Majority of rock falls likely to be small blocks which will land on roadside verge. Debris from larger potential toppling failure at Ch. 420 may reach road.			
Receptor Rating =		1.2		Minimum sightline 60m.			
Risk Value =		4.8					
Risk Level =		Low					
Recommended Remedial Works / Actions							
Re-inspection by end of June 2023. Low risk slope so remedial works not required, however, risk could be further reduced through scaling and felling of trees along crest.							
Assessed in field by:	JG/PLM	Date:	22/06/2022	Reviewed by:	PLM	Date:	26/082022

Appendix D 2022 Inspection Photographs



Photograph M1-1

Tree at crest with potential for root-jacking at Ch.018.
Block with dilated back fracture at Ch.020.



Photograph M4-1

General photo of hazardous area at rock slope including the large overhang c.3 to 5m below crest of slope.



Photograph M6-1

Fallen tree 3m back from slope posing no risk to the road.
Fresh surfaces indicating a relatively recent rock fall (at least before the 2019 inspection).

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