

A890 Maman Hill

Annual Slope Inspection 2024

The Highland Council

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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 Strome ferry 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 Strome ferry 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 Strome ferry 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 was carried out in April 2023 and reported in AECOM report 60658712, 'A890 Maman Hill, Annual Slope Inspection Report, 15th June 2023'.

This report summarises the findings of the 2024 inspection. The report objectives are to:

- Provide a summary of any significant events that have occurred at the site since the 2023 annual inspection;
- Present the findings of the 2024 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 is 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 2023 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 April 2023 and April 2024.

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 April 2023 inspection.

Since April 2023 AECOM has completed the design of rock slope remedial works for sections M4 and M5. The design and specification² was issued to The Highland Council on the 27th November 2023 and it is understood that works will be carried out later in 2024.

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

² AECOM report 60685712/GLRP0005, A890 Stroneferry: Phase 13 Rock Works, Maman Hill Record of Design. 27 November 2023.

2. 2024 Inspection and Risk Assessment Methodology

A team of three AECOM geologists inspected the rock slopes at Maman Hill on the 18th April 2024. The weather during the inspection was mild, wet and cloudy.

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 instability issues and changes since the 2023 inspection that may require further investigation (e.g. using rope access techniques). Traffic management was provided by Alba Traffic Management Ltd. (a sub-contractor of Geo-rope Ltd.) for the duration of the inspection.

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 to those for the slopes between Ardnarff and Attadale.

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 raveling 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.

2.5 Summary of Findings: Geotechnical Assessment Sheets

A Geotechnical Assessment Sheet for each slope reference is provided within the following sections of this report. They include the inspection findings and a summary of the slope risk rating. Within the Geotechnical Assessment Sheets, photo references are provided for key observations identified during the inspection. Each photo has a unique reference number which relates to the slope reference; for example, photos of features from slope reference M1 are referenced as 'M1-1, M1-2, M1-3' etc. The photographs are provided after each assessment sheet.

2.5.1 Slope Ref. M1

GEOTECHNICAL ASSESSMENT SHEET					
Site:	A890 Maman Hill	Slope Ref:	M1	Chainage:	015 - 075
				Start Grid Ref:	NG 92612 39681
				End Grid Ref:	NG 92572 39636
				Elevation:	ca. 50 - 55m AOD

Photo at Start Chainage (looking west)	Photo at End Chainage (looking east)
	

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:	Rough
								Verge Width (m):	0.9

Engineering Description of Rock:

Strong psammite.

Rope Access Inspections:

Year of Rope Access Inspection	Location	Purpose
N/A		

THC Monthly Inspection Observations:

Date	Location	Comments
N/A		

Existing netting or other remedial work details:

Year of Works	Description of Works	Comments	2024 Inspection Observations	Photo Reference
Unknown. Pre-dates AECOM's first involvement in the A890 Stromeferry Bypass in 2012.	Localised chain-link drape netting between Ch 030 to 070.	Netting covers c.65% of slope (anchorages have not been inspected). The netting is highly corroded and locally damaged and should be considered ineffective.	No change noted during the 2024 Inspection	N/A

Hazards Observed:

Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
Throughout M1	2019 Inspection: Small scale (<0.01m ³) ravelling type rock falls likely as rock mass continues to weather. 2023 Inspection: There are a few dilated blocks behind the netting (between Ch. 030 to 070) which look keyed in – could benefit from scaling.	No change noted during the 2024 inspection.	N/A
Throughout M1	2019 Inspection: Semi-mature coniferous trees growing at crest have potential to cause root jacking (e.g. Ch. 018)	No change noted during the 2024 inspection.	N/A

Hazards Observed:			
Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
Ch. 018	2022 Inspection: Trees at crest of slope presenting risk of root-jacking. Approx. 6 blocks c.2m x 0.1m x 0.1m are in the verge.	No change noted during the 2024 inspection.	N/A
Ch. 020	2022 Inspection: Block (c.2m x 1m x 1.5m) with dilated back fracture (low risk due to presence of verge)	No change noted during the 2024 inspection.	M1-1
Ch. 032	N/A	Tree root has rotated out from slope. Rock slope behind is clean and does not present a hazard.	M1-2
Ch. 053	N/A	Several small blocks present in the verge which have a source location 5m high, at the crest of the slope. There is potential for more blocks to fall and land on the verge or edge of the road.	M1-3

Other Comments:
<p>No surface or groundwater flows.</p> <p>Rock mass generally in good condition, although dilated fractures noted locally. Potential for kinematic failure is low.</p> <p>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>

RISK RATING		Comments
Hazard Rating =	2	Generally limited to small scale ravelling 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		
Large Scale Rock Fall Protection Works (Category 3)	Localised Targeted Rock Fall Protection Works (Category 2)	Ongoing Maintenance (Category 1)

Recommended Remedial Works / Actions							
N/A		N/A		<ul style="list-style-type: none">- Re-inspection by end of April 2025- Felling of trees along crest- Scaling of loose rock behind netting (between Ch. 030 to 070)			
Assessed in field by:	MT/SB/PLM	Date:	15/04/2024	Reviewed by:	PLM	Date:	28/05/2024



Photograph M1-1	Ch. 020 – block (c.2m x 1m x 1.5m) with dilated back fracture (poses low risk to road due to presence of verge).	Year observation first noted: 2022
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Photograph M1-2	Ch. 032– Rotated tree root protruding from rock slope.	Year observation first noted: 2024
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Photograph M1-3	Ch. 053 – Several small blocks at toe of slope.	Year observation first noted: 2024
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2.5.2 Slope Ref. M2

GEOTECHNICAL ASSESSMENT SHEET								
Site:	A890 Maman Hill	Slope Ref:	M2	Chainage:	200 - 280	Start Grid Ref:	NG 92536 39506	End Grid Ref: NG 92513 39431
						Elevation:		ca. 30 - 35m AOD

Photo at Start Chainage (looking east)	Photo at End Chainage (looking west)
	

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: Rough
									Verge Width (m): 1

Engineering Description of Rock:

Strong psammite.

Rope Access Inspections:

Year of Rope Access Inspection	Location	Purpose
N/A		

THC Monthly Inspection Observations:

Date	Location	Comments
N/A		

Existing netting or other remedial work details:

Year of Works	Description of Works	Comments	2024 Inspection Observations	Photo Reference
N/A				

Hazards Observed:

Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
Throughout M2	2019 Inspection: Small scale (<0.02m ³) ravelling / root jacking rock falls likely as rock mass continues to weather. However, ditch and verge at toe are considered effective and the associated likelihood of debris reaching the road is therefore low.	No change noted during the 2024 inspection.	N/A
Ch. 226 to 235	2023 Inspection: Ditch has been locally damaged by vehicle going off road. Maintenance works not required as ditch is not below an area of significant rock fall hazard.	No change noted during the 2024 inspection.	N/A

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.

RISK RATING		Comments
Hazard Rating =	1	Generally limited to small scale ravelling.
Pathway Rating =	1	Ditch considered effective.
Receptor Rating =	N/A	Receptor rating only applicable when pathway rating is ≥ 2 .
Risk Value =	1	
Risk Level =	Low	

Recommended Remedial Works / Actions		
Large Scale Rock Fall Protection Works (Category 3)	Localised Targeted Rock Fall Protection Works (Category 2)	Ongoing Maintenance (Category 1)
N/A	N/A	- Re-inspection by end of April 2025

Assessed in field by:	MT/SB/PLM	Date:	18/04/2024	Reviewed by:	PLM	Date:	28/05/2024
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2.5.3 Slope Ref. M3

GEOTECHNICAL ASSESSMENT SHEET								
Site:	A890 Maman Hill	Slope Ref:	M3	Chainage:	280 - 330	Start Grid Ref:	NG 92513 39431	End Grid Ref: NG 92469 39371
						Elevation:		ca. 25 - 30m AOD

Photo at Start Chainage (looking east)	Photo at End Chainage (looking west)
	

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:		Roughness:	1
						0.4 to 0.75m deep, 1.2m wide.		Rough	Verge Width (m):

Engineering Description of Rock:

Strong psammite.

Rope Access Inspections:

Year of Rope Access Inspection	Location	Purpose
N/A		

THC Monthly Inspection Observations:

Date	Location	Comments
N/A		

Existing netting or other remedial work details:

Year of Works	Description of Works	Comments	2024 Inspection Observations	Photo Reference
December 2020	Tree felled by THC at Ch. 304	There was a large fir tree growing from crest of rock face. Risk of root-jacking and potential rock fall volume up to 0.5m ³ .	No change.	N/A

Hazards Observed:

Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
Throughout M3	2019 Inspection: 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).	No change noted during the 2024 inspection.	N/A
Throughout M3	2019 Inspection: Localised overhangs with potential for rock fall of unsupported blocks. Individual block size typically <0.1m ³ (e.g. at Ch. 311)	No change noted during the 2024 inspection.	N/A
Ch. 304	2023 Inspection: Rock mass beneath tree exhibiting root-jacking potential	No change noted during the 2024 inspection.	N/A
Ch. 311	N/A	A tree has fallen away from the slope. Possibly due to a vehicle leaving the road and entering	M3-1

Hazards Observed:			
Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
		the ditch (evidence of disturbed verge and vehicle debris). No significant hazard.	

Other Comments:
<p>No surface or groundwater flows.</p> <p>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 0.5m³.</p> <p>Ditch and verge likely to retain debris from most small scale rock falls. Occasional blocks observed at toe – typical dimensions 0.1 x 0.1 x 0.1m.</p>

RISK RATING		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							
Large Scale Rock Fall Protection Works (Category 3)		Localised Targeted Rock Fall Protection Works (Category 2)		Ongoing Maintenance (Category 1)			
N/A		N/A		<ul style="list-style-type: none"> - Re-inspection by end of April 2025 - Fell trees along crest 			
Assessed in field by:	MT/SB/PLM	Date:	18/04/2024	Reviewed by:	PLM	Date:	28/05/2024




Photograph M3-1

Ch. 311 – Fallen tree.

Year observation first
noted: 2024

2.5.4 Slope Ref. M4

GEOTECHNICAL ASSESSMENT SHEET											
Site:	A890 Maman Hill	Slope Ref:	M4	Chainage:	335 - 395	Start Grid Ref:	NG 92469 39371	End Grid Ref:	NG 92452 39339	Elevation:	ca. 15 - 20m AOD

Photo at Start Chainage (looking east)	Photo at End Chainage (looking west)
	

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:	Rough	Verge Width (m):	0.5 to 1

Engineering Description of Rock:
Strong psammite.

Rope Access Inspections:		
Year of Rope Access Inspection	Location	Purpose
2019	Ch. 370 to 380	Rope access inspection carried out to assess potential hazards identified from road level behind netting. Findings – A number of hazards were identified including: a significant overhang (1.6m) c.3-5m below crest, a dilated sliding plane with 1.5m high x 2.5m wide x 1.5m deep block c.10m above road level, a block with dilated back fracture c.8m above road level at Ch. 378 and areas of blast damaged rock mass. Additionally, the netting was confirmed to be plastic 'geogrid' and adjacent panels are not attached.
2021	Ch. 370	Rope access inspection carried out to re-assess previously identified hazards. Condition remains unchanged.
2021	Ch. 374	Rope access inspection carried out to assess overhang at crest. Findings - 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. Two loose blocks were removed by hand during the rope access inspections to make safe. Total volume ca. 0.25m ³ .

THC Monthly Inspection Observations:		
Date	Location	Comments
N/A		

Existing Netting Details or other remedial work details:				
Year of Works	Description of Works	Comments	2024 Inspection Observations	Photo Reference
Unknown. Pre-dates AECOM's first involvement in the A890 Strome ferry Bypass in 2012.	Chain-link netting installed between Ch. 360 to 375.	Netting is corroded and damaged and should be considered ineffective for the retention of anything but the smallest blocks (anchorage have not been inspected).	No change noted during the 2024 inspection.	N/A
Unknown. Pre-dates AECOM's first involvement in the A890 Strome ferry Bypass in 2012.	Plastic 'geo-grid' style netting between Ch. 375 to 385.	Individual panels un-joined 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.	No change noted during the 2024 inspection.	N/A

Hazards Observed:			
Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
Throughout M4	2019 Inspection: Numerous small scale (<0.02m ³) ravelling type failures observed, some of which were deemed to be imminent (i.e. readily dislodged by hand).	No change noted during the 2024 inspection.	N/A
Ch. 370	2019 Inspection: 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 rock fall debris likely to reach road. (Repeat rope access inspection completed in 2021 – no change)	No change noted during the 2024 inspection.	N/A
Ch. 370 to 380	2019 Inspection: 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 rock fall identified.	No change noted during the 2024 inspection.	N/A
Ch. 370 to 380	2019 Inspection: 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 rock falls to occur.	An accumulation of small blocks at toe of netting and in verge. Individual blocks up to 0.2m in diameter and total volume of fallen blocks is approximately up to 0.75m ³ . The source of the fallen blocks appears to be from possibly two locations. One location is 1-2m above the toe of the slope and the other is 3-4m	M4-1 M4-2 M4-3

Hazards Observed:			
Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
		above the toe of the slope. Both show areas of fresh surfaces and root jacking potential is present. Further root jacking potential is possible and another 0.5-0.75m ³ of blocks could fall. Given absence of verge at this location there is potential for blocks to reach the road.	
Ch. 374	2019 Inspection: Overhang at crest (1.0-1.3m) with dilated fracture along left hand side. "Supporting block" on 58° sliding plane. Root jacking potential. (Rope access completed in 2021).	No change noted during the 2024 inspection.	M4-4
Ch. 378	2019 Inspection: 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 rock fall exists and narrow verge below means this poses a risk to the road.	No change noted during the 2024 inspection.	N/A
Ch. 388	2023 Inspection: 3 new blocks in ditch up to 0.3m side length.	No new blocks recorded in the 2024 inspection.	N/A

Oher Comments:
<p>No surface or groundwater flows.</p> <p>Rock mass in poor condition with frequent dilated fractures associated with blast damage, weathering and root jacking. Potential for planar failures as well as ravelling, root jacking and block falls from above overhangs. Some small scale ravelling type failures were noted to be imminent with blocks readily dislodge by hand.</p> <p>Ditch and verge likely to retain debris from some small scale rock falls but locally absent / narrow. Occasional blocks observed at toe – typical dimensions 0.1 x 0.1 x 0.1m.</p>

RISK RATING		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	
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Recommended Remedial Works / Actions						
Large Scale Rock Fall Protection Works (Category 3)			Localised Targeted Rock Fall Protection Works (Category 2)	Ongoing Maintenance (Category 1)		
<ul style="list-style-type: none"> - AECOM completed the design of the following rock fall remedial works for M4 in November 2023. It is understood that THC intends to progress works later in 2024. <ul style="list-style-type: none"> ▪ Ch. 347 to 362: drapery netting system. ▪ Ch. 362-415: active netting system. 			N/A	<ul style="list-style-type: none"> - Full de-vegetation (including felling of trees along crest) and light scaling (required as enabling / preparatory works for Category 3 works). - Re-inspection by end of April 2025 		
Assessed in field by:	MT/SB/PLM	Date:	18/04/2024	Reviewed by:	PLM	Date: 28/05/2024



Photograph M4-1

Between Ch. 370 - 380 – accumulation of rock fall debris at toe of slope and verge. Rocks are resting against small tree and beginning to spill out onto narrow verge.

Year observation first noted: 2024



Photograph M4-2

Between Ch. 370 - 380 – accumulation of rock fall debris at toe of slope and on narrow verge. Source areas circled.

Year observation first noted: 2024



Photograph M4-3	Between Ch. 370 - 380 – One of the two rock fall source areas with clear signs of root jacking.	Year observation first noted: 2024
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Photograph M4-4

Ch. 374 – overhang at crest of slope with dilated fractures along the left hand side.

Year observation first noted: 2019

2.5.5 Slope Ref. M5

GEOTECHNICAL ASSESSMENT SHEET											
Site:	A890 Maman Hill	Slope Ref:	M5	Chainage:	395 - 415	Start Grid Ref:	NG 92452 39339	End Grid Ref:	NG 92445 39309	Elevation:	ca. 10 - 15m AOD

Photo at Start Chainage (looking east)	Photo at End Chainage (looking west)
 A photograph showing a steep, rocky slope covered in dense evergreen trees. The slope is covered in a wire mesh for erosion control. A road is visible at the base of the slope, with a small orange and white traffic cone placed on the edge.	 A photograph showing a steep, rocky slope covered in dense evergreen trees. The slope is covered in a wire mesh for erosion control. A road is visible at the base of the slope, with a small orange and white traffic cone placed on the edge.

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:	No ditch
								Roughness:	Rough
								Verge Width (m):	5

Engineering Description of Rock:
Strong psammite.

Rope Access Inspections:		
Year of Rope Access Inspection	Location	Purpose
2019	Ch. 398	Rope access inspection carried out to assess potential hazards identified from road level. Findings: a detached block 2m x 2 m x 0.7m is open on left hand side and a dilated back release joint. Keyed in on right hand side but difficult to see how well keyed in.
2019	Ch. 405	Rope access inspection carried out to assess potential hazards identified from road level. Findings: c.8-10m above road level there is a dilated crack to rear of green lichen covered block. Keyed in below.
2021	Ch. 400	Rope access inspection of block at crest carried out. Findings: 10-50cm wide release joint around overhanging block.
2021	Ch. 402	Rope access inspection of dilated block ca. 10m above toe of slope. Findings: Basal fracture dips into slope ("keyed in").
2024	Ch. 390	Rope access inspection to access the source location of the rock fall that had occurred since the 2023 inspection. Findings: source area of large blocks identified, with up to 400mm wide blocks remaining loose on face. An additional 2m ³ of blocks is protruding to the north of the slope which could potentially also fall. Dilated release joints present at an angle of 55-60°, daylighting at the base of an irregular plane.

THC Monthly Inspection Observations:		
Date	Location	Comments
N/A		

Existing netting or other remedial work details:				
Year of Works	Description of Works	Comments	2024 Inspection Observations	Photo Reference
N/A				

Hazards Observed:			
Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
Throughout M5	2019 Inspection: Ongoing ravelling. Precarious blocks noted along crest.	No change noted during the 2024 inspection.	N/A
Ch. 398	2019 Inspection: 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 block fall hard to predict so doweling may be required to protect road.	No change noted during the 2024 inspection.	N/A
Ch. 400	2019 Inspection: Overhanging block at crest with 10-50cm wide dilated release joint.	No change noted during the 2024 inspection.	N/A
Ch. 405	2019 Inspection: 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.	No change noted during the 2024 inspection.	N/A
Ch. 407	2019 Inspection: Dilated crack to rear of lichen covered block 8-10m above road level. Keyed in below.	No change noted during the 2024 inspection.	M5-1
Ch. 393	N/A	<p>A rock fall has occurred and there are numerous large and small blocks which have landed in the verge and roadside ditch. Source location approximately 15m above road level at Ch. 396. The largest fallen block was 3.6m from the edge of the tarmac and measured 1.3 x 1.1 x 0.7m. Blocks behind this were 0.9 x 0.7 x 0.4m; 0.6 x 0.45 x 0.35m; 0.4 x 0.4 x 0.25m; 0.75 x 0.45 x 0.3m, plus ca. 20 blocks up to 0.3m in size.</p> <p>Blocks also landed in the ditch 1.2m from edge of tarmac. Largest block in ditch was 0.8 x 0.65</p>	<p>M5-2 M5-3 M5-4 M5-5 M5-6</p>

Hazards Observed:			
Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
		<p>x 0.6m. Plus 5 blocks up to 0.6 x 0.4 x 0.25m in size. Approximately 2-3m³ of blocks had fallen in total.</p> <p>Due to the verge now having numerous blocks contained within it, the risk for further rock falls is increased as other rocks could fall and hit the blocks sitting in the verge and potentially 'bounce' into the road. This could lead to a potential significant hazard.</p>	

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. A rock fall of this scale occurred between the 2023 and 2024 inspections.</p> <p>Wide verge (5m) likely to retain debris from all but the largest of rock falls when clear (needs cleared).</p>

RISK RATING		Comments
Hazard Rating =	3	Potential rock fall volumes up to 3m ³ identified.
Pathway Rating =	4	Verge and ditch have been partially filled by recent rock fall and so pathway rating has been increased from 3 to 4 to reflect the increased likelihood of rock fall debris reaching the road (most falling blocks are now expected to reach the road). Trajectories of rock falls are hard to predict due to slope and verge profile, which has changed following the recent rock fall – potential exists for falling blocks to hit existing rock fall debris and bounce onto road.
Receptor Rating =	1.2	Minimum sightline 60m.
Risk Value =	14.4	
Risk Level =	Very High	Score falls within the very upper of 'High'. Risk level increased to Very High due to observed loose material on slope, recent block falls and presence of blocks on verge introducing potential for random bounce trajectories.

Recommended Remedial Works / Actions						
Large Scale Rock Fall Protection Works (Category 3)		Localised Targeted Rock Fall Protection Works (Category 2)		Ongoing Maintenance (Category 1)		
N/A		<ul style="list-style-type: none"> - AECOM completed the design of the following rock fall remedial works for M5 in November 2023. It is understood that THC intend to progress works later in 2024. • Installation of spot dowels in individual blocks / area of rock mass at risk of rock falls. Provisionally allow for 20 No. 4m long dowels. • Localised scaling should occur to remove potentially loose blocks. 		<p>The works outlined below should be progressed as 'urgent' works, as soon as practicable:</p> <ul style="list-style-type: none"> - Scaling of loose and potentially loose material on face around Ch.396; - Removal of blocks from verge and roadside ditch and create catch bund from material; - Re-inspection during / following 'urgent' works to confirm is existing 'Category 2' works design remains appropriate. - Routine annual inspection by end of April 2025. 		
Assessed in field by:	MT/SB/PLM	Date:	18/04/2024	Reviewed by:	PLM	Date: 28/05/2024



Photograph M5-1

Ch. 407 - Dilated crack to rear of lichen covered block 8-10m above road level. Keyed in below.

Year observation first noted: 2024



Photograph M5-2	Between Ch. 393 – 395 – blocks originating from recent rock fall which have landed in the ditch and grass verge.	Year observation first noted: 2024
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Photograph M5-3

Ch. 393 – a large block which has landed in the verge from recent rock fall.

Year observation first noted: 2024



Photograph M5-4

Ch. 393 – a large block which has landed 1.2m away from the road from recent rock fall.

Year observation first noted: 2024



Photograph M5-5

Ch 396 – source location of recent rock fall circled in yellow.

Year observation first noted: 2024



Photograph M5-6

Ch 396 – source location of recent rock fall taken during rope access inspection. Source location circled.

Year observation first noted: 2024

2.5.6 Slope Ref. M6

GEOTECHNICAL ASSESSMENT SHEET

Site:	A890 Maman Hill	Slope Ref:	M6	Chainage:	415 - 460	Start Grid Ref:	NG 92445 39309	End Grid Ref:	NG 92450 39264	Elevation:	ca. 5 - 10m AOD
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Photo at Start Chainage (looking east)	Photo at End Chainage (looking west)
	

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:	No ditch	Roughness:	Smooth	Verge Width (m):	0.5 to 1

Engineering Description of Rock:

Strong psammite.

Rope Access Inspections:

Year of Rope Access Inspection	Location	Purpose
N/A		

THC Monthly Inspection Observations:

Date	Location	Comments
N/A		

Existing netting or other remedial work details:

Year of Works	Description of Works	Comments	2024 Inspection Observations	Photo Reference
Unknown. Pre-dates AECOM's first involvement in the A890 Stromeferry Bypass in 2012.	Chain-link drape netting installed between Ch 415 to 435.	Corroded and locally damaged. Only effective for small scale ravelling type rock falls.	No change noted during the 2024 inspection.	N/A

Hazards Observed:

Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
Throughout M6	2019 Inspection: Ongoing ravelling and root jacking, particularly along crest.	No change noted during the 2024 inspection.	N/A
Ch. 420	2019 Inspection: Potential toppling failure identified ca. 6m above road level. Dilated fractures. 0.5-1.0m ³ .	No change noted during the 2024 inspection.	M6-1
Ch. 455	2022 Inspection: Fallen tree c.3m back from crest of slope. Tree has been cut (unsure when this was completed). Not posing risk to road.	No change noted during the 2024 inspection.	N/A

Hazards Observed:			
Location	Description of Hazard (s) from Previous Inspections	2024 Inspection Observations	Photo Reference
Ch. 455	2022 Inspection: Fresh surfaces at crest of slope indicating recent rock fall. Block not currently in ditch/verge so has been moved. Block anticipated to have been 0.3m x 0.2m based upon fresh surface.	No change noted during the 2024 inspection.	N/A

Other Comment:
<p>No surface or groundwater flows.</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>No ditch and only a narrow verge so there is potential for some small blocks to reach road.</p>

RISK RATING		Comments
Hazard Rating =	2	Potential rock fall volumes up to 1m ³ identified.
Pathway Rating =	3	Increased from 2 in 2023 as now expected that half of falling blocks will reach road. Debris from larger potential toppling failure at Ch. 420 may reach road.
Receptor Rating =	1.2	Minimum sightline 60m.
Risk Value =	7.2	
Risk Level =	Moderate	

Recommended Remedial Works / Actions							
Large Scale Rock Fall Protection Works (Category 3)			Localised Targeted Rock Fall Protection Works (Category 2)		Ongoing Maintenance (Category 1)		
N/A			N/A		<ul style="list-style-type: none"> - Re-inspection by end of April 2025. - Fell trees at crest of rock face and scaling of loose rock 		
Assessed in field by:	MT/SB/PLM	Date:	18/04/2024		Reviewed by:	PLM	Date: 28/05/2024



Photograph M6-1

Ch. 420 – Potential toppling failure identified ca. 6m above road level.

Year observation first noted: 2019

4. Discussion and Recommendations

The inspection of the rock slopes at Maman Hill in April 2024 identified a recent rock fall originating from section M5 and landing between sections M4 and M5. Loose rocks remain on the slope in a precarious position and the verge / ditch below has a reduced capacity due to the presence of rock fall debris including numerous blocks ranging from small to large in size. The potential for blocks to fall and 'bounce' off other rocks within the verge, and potentially reach the road, is now assessed to be higher than during the 2023 inspection and sections M4 and M5 have both been assigned to the 'very high' risk category (this represents no change for M4, but an increase from 'high' for M5). At these locations 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.

AECOM completed the design of rock slope remedial works for sections M4 and M5 in November 2023 and it is understood THC intends to implement these works later in 2024. In advance of these works being carried out urgent maintenance works are recommended at M5 to remove loose rocks from the slope, clear rock fall debris from the verge / ditch and create a bund to reduce the potential for further rock falls to reach the road. Following these works the appropriateness of the current design will be re-assessed and adapted as required.

The assessed risk levels associated with the rock slopes at Maman Hill are ranked from highest to lowest in Table 4-1. It is 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	4	1.2	14.4	Very High*
3	M6	2	3	1.2	7.2	Moderate
4	M1	2	2	1.2	4.8	Low
	M3	2	2	1.2	4.8	Low
5	M2	1	1	1.0	1.0	Low

*Risk level increased by inspecting geologists.

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) i.e. not a product designed for rock fall control. 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 the risk management approach similar to that in place for the slopes between Ardnarff and Attadale be continued. 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 2025, 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.

Following recent discussions with THC it is understood that it is intended to undertake the designed remedial works at slopes M4 and M5 later in 2024. Additionally, the urgent remedial works already described are to be commissioned by THC imminently.

Appendix A Site Location Plan




SITE LOCATION



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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

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. 2nd Floor, 177 Bothwell Street Glasgow G2 7ER	Drawn:	MT	Revision:	0	Figure No.:	2
		Designed:	MT				
		Checked:	PLM	Job Number:	60685712	Scale:	NOT TO SCALE
		Approved:	PLM				

