FEARNA STORAGE

Fearna Pumped Storage Hydro Scheme

CAR Licence Report

Appendix E – Geomorphology Report – PSH Area

September 2025

Quality Information

Prepared by	Checked by	Approved by
[redacted]	[redacted]	[redacted]

Revision History

Revision	Revision Date	Details	Authorised
01	September 2025	Issue to SEPA	[redacted]

[redacted]
CONSULTANT FLUVIAL GEOMORPHOLOGIST

Fearna Pumped Storage Hydro Scheme Geomorphology Report:

B. Loch Fearna Reservoir

[redacted]

September 2025

INTRODUCTION

[redacted] was commissioned by Gilkes Energy Ltd to undertake geomorphic assessments relating to waterbodies influenced by the proposed Loch Fearna pumped storage scheme on the River Garry system, Inverness-shire. This is separated into three discrete elements:

A. The stream crossings of the Southern Access Route (SAR).
B. The streams captured by the proposed extents of the scheme reservoir (i.e. the extension of Loch Fearna).
C. The opportunities for mitigative habitat enhancement in the River Garry downstream from Loch Garry.

This report relates to element B, an assessment of the impact to streams draining the catchment of the proposed reservoir as a result of the works, with high-level identification of potential mitigation options. Elements A and C are addressed in separate associated reports.

Reservoir Stream and Slope Impacts

1. The proposed Loch Fearna pumped storage development requires the construction of a reservoir in the high ground to the north of Loch Cuaich. Through excavation and the construction of two substantial dam structures, this will significantly increase the extents of the existing Loch Fearna, both in terms of area (from ~10 Ha to ~95 Ha) and maximum water level (from ~540 m to ~600 m above sea level).
2. The extended footprint of the reservoir will intercept a number of small streams and this report aims to determine the impact to those streams in relation to this. Specifically, how the streams will be impacted over the proposed extents of drawdown and the risk of the effects of this propagating upstream through these channels beyond the upper reservoir level (e.g. through head-cut/ incision processes). Furthermore, the ground around the extents of the proposed reservoir is steep and the risk of landslides may be increased in response to the implemented design (especially if the impacted streams experience head-cut/ incision processes). However, further more detailed slope stability assessments/ modelling will be undertaken to quantify these risks and appropriate mitigative measures will be proposed as necessary (discussed below).
3. An assessment of the current condition of the streams passing into the proposed footprint of the reservoir was conducting in a walk-over survey undertaken in two site visits (Figures 1 to 3); on 2nd July 2025 the perimeter of the existing extents of Loch Fearna was surveyed (locations 101 to 111, Figures 1 and 2) and on 1st August 2025 the perimeter of the proposed extension of the reservoir to the north (locations 119 to 137, Figures 1 and 3) completed the onsite assessments. Both surveys were undertaken at an elevation within or above the proposed drawdown range and under fine weather conditions with good visibility.
4. Figures 1 to 3 identify all of the streams conveying water flow on the day of survey. There were also some other small gulley forms observed but these were not associated with any flow, showed minimal evidence of sediment transport and were likely only active during significant rainfall events. The identified streams are divided into those exhibiting appreciable alluvial form/ process (Type A, with evidence of sediment transport, generally the larger streams; indicated by red symbols) and those that were effectively colluvial with only water flowing over underlying lag sediment (Type B, typically smaller streams with limited evidence of sediment transport and often entrenched within overlying vegetation; indicated by green symbols)[1]. Examples of typical Type A and Type B streams are provided in Figures 4 (location 107) and 5 (location 129), respectively.
5. Although small streams were present, no data on their condition is presented within the footprint of the two proposed dam structures (i.e. since these waterbodies will presumably be removed during the process of dam construction).
6. None of the streams surveyed exhibit any evidence of recent instability. By their nature, the Type B (colluvial) streams generally do not erode or transport sediment through hydraulic processes. The alluvial channels (i.e. Type A) generally have a coarse and angular bed material, indicating stability. Furthermore, there was no evidence of bank erosion observed, with

[1] There is continuum of form/ process between these two conditions so the division between them is somewhat subjective in the assessment.

continuous vegetation cover in channel margins. Given that the area is one of net glacial erosion, there is little superficial sediment available to provide supply to the streams through bank and bed erosion processes, with extensive bedrock exposure; this 'supply limited' condition is generally associated with a stable low sinuosity channel character, as the survey has identified. Moreover, due to the very steep slopes, high rainfall and the efficient mountain drainage of the area, the stream will experience frequent high energy flow events that, in the absence of significant supply, will have transported the majority of smaller sediment to leave a stable, lag substrate over time.

7. In the southern region of the proposed reservoir extents (i.e. on the eastern side of existing Loch Fearna) there is some significant eroding peat, relating to drainage channels (locations 109 and 110, Figures 1 and 2, photograph in Figure 6). Earlier work by SLR identified that peat depths in this area are not particularly significant, with a coverage of generally 0.5 to 1.5 m thickness. However, this area will be significantly impacted in the development of the reservoir, with the intake to the tunnels connecting to Loch Cuaich being situated here. It is therefore assumed that all the peat in this area will be excavated as part of the works and no specific mitigation measures relating to its erosion need to be considered.
8. Although a Type B stream (Figure 7), location 131 is indicated as one exhibiting appreciable fluvial form/ process (i.e. Type A). This is due to the fact that the headwall of this stream near to the watershed has recently experienced a landslide, with the associated deposits evident on the lower slope extents of the channel downstream (Figure 8). While this is a very small, localised landslide and likely induced by channel processes, this confirms the general sensitivity of the area to landslides, presenting a greater risk of negative responses to the proposed development than adjustment of the channels themselves. It is therefore proposed that mitigative measures should be implemented around the entire shoreline of the reservoir and not just at intersections of significant streams.
9. Figure 9 provides a typical long section (B-B') through the proposed reservoir and the mountain slope above (the location of section B-B' is shown in Figures 1 and 3). It demonstrates that the proposed reservoir excavation extends down to 535 m elevation and intersects with the existing ground surface at 602 m elevation. This dictates that the maximum reservoir water surface elevation (i.e. 600 m) will lie below that of the existing ground surface, meaning that there will not be a sloping shoreline experiencing the effects of drawn down. Rather, drawdown will occur entirely over the excavated face of the reservoir, presumably bedrock. Therefore, it is concluded that the reservoir shoreline will entirely comprise of low erosion risk bedrock.
10. However, there will be a raised landslide risk as a result of reservoir excavation. As part of the excavation process, there will require to be a general removal of material that provides support to the superficial deposits (i.e. sediments, peat, soil etc) on the mountain slopes above, presenting an increased landslide risk[2]. This could also manifest as head-cuts extending upstream in the intercepted channels although, as described in point 6 (above), these channels appear to stable in character. However, further more detailed slope stability assessments/ modelling will be undertaken to explicitly quantify these risks and appropriate

[2] Potentially increased risk across the entire extents of the existing ground surface shoreline but particularly where slopes are highest.

mitigative measures will be proposed as necessary (discussed below), implementing appropriate design, monitoring and construction methodologies.

11. It is therefore proposed that erosion mitigation measures are incorporated through the perimeter of the reservoir shoreline[3] where the soils/ sediments supporting the upper slopes are to be removed (see outline design in Appendix A). This should extend 2-3 m vertically above the bedrock exposure associated with reservoir excavation and also apply to the identified intercepted channels. Specific measures will require to be carefully designed and include the expertise of a slope stability specialist (e.g. Salix Ltd). For the protection of the slopes, it is proposed that Aqua Rock Bags be used to provide fundamental support. These would require to be buried to sufficient depth to permit retained turfs to be reinstated over them to form the ground surface at the same elevation as currently. This will require the current superficial sediment/ soil to be excavated (retaining the overlying turfs to a depth of ~300 mm) to permit the replacement with the Aqua Rock Bags. The mass of Aqua Rock Bags will provide direct support to the retained slopes above, reducing landslide risk. In the transition between the Aqua Rock Bags and the retained ground, coir-based materials (e.g. coir rolls) could be used to integrate with the existing soils/ peat and vegetation (the coir providing a medium for vegetation establishment, which can be initiated with the planting of appropriate native species). For the intercepted channels, a potential design could transition from the excavation-exposed bedrock to a zone of interlocked rocks that grade from boulders (>250 mm diameter) to large cobble (150 – 200 mm diameter) in an upslope direction (these grades ideally providing a gradual transition into that of the existing channel bed substrate upstream). The surface elevation of this 'apron' would be equivalent to that of the existing bed of the respective stream channels. Given that existing channel locations are likely to represent the greatest landslide risk, it would also be prudent to also install Aqua Rock Bags as a foundation in these locations, underling the added rock. The final design of any slope/ channel stability measures would require to be informed by more detailed analyses, including local slope stability assessment/ modelling.
12. The rock comprising the apron structure could grade into that of the bed material of the larger (i.e. Type A) intercepted streams, to provide a gradual transition in terms of sediment size (thereby minimising the risk of sudden adjustment of the channel to a sharp change in bed material size, potentially resulting in erosion/ head-cut initiation). Type B streams could likely fall directly into this rock shoreline zone.
13. Both of the proposed dams have the potential to impact the morphology of the channels downstream (i.e. the Allt Fearna and the Allt a Mheil) through the disruption to sediment transport continuity. However, given the general erosional glacial environment upstream of the location of the proposed dams (as per point 6), there is not much sediment supply to these streams from this region. This is somewhat confirmed by the general 'supply-limited' form of the alluvial channels through the impacted section and downstream; it is unlikely that this stable channel form would change markedly as a result of the construction of the two dams. Only one location (134, Figures 3 and 10) was identified in the upper catchments (Allt a Mheil) where appreciable amounts of stored sediment was observed that could potentially supply downstream reaches. Rather, both the Allt Fearna and Allt a Mheil appear to recruit more sediment downstream of the proposed dam locations, with the only evidence of significant

[3] Perhaps focussing on the sections of the shoreline identified to being at greatest risk of landslide.

storage at the small hydropower intake structure located at OS NGR NH 0465 0315 on the Allt a Mheil (Figure 11). However, although small, there will be some degree of sediment supply from the upper catchments and this will likely require consideration in a specific sediment management plan (even though the outcome of the detailed assessments supporting this may conclude that no practical sediment management is necessary).

14. There is also some concern as to the effect the alteration of the Loch Cuaich draw-down regime as a consequence of the addition of Loch Fearna scheme operation could have on the on the margins of Loch Cuaich, particularly the larger streams entering the loch (e.g. River Quoich, Abhainn Chosaidh, Allt Coire nan Gael). Assuming that these streams have reached an equilibrium physical condition that is adjusted to the current Loch Cuaich drawdown regime, any significant alteration to loch level variation could upset this state and initiate further adjustment in these channels (e.g. head cut/ incision, with potential implications for upstream channel stability, associated risks to infrastructure, instream habitats and fish passage). However, the operation of the Loch Fearna scheme has been designed to work entirely within the current drawdown regime of Loch Cuaich (Figure 12) meaning that there should be no systematic change to the variation in loch levels that would initiate channel adjustment/ instability. There may be some increased risk related to the increased drawdown rate over a 2.5-3.5 m range within Loch Quaich as a consequence of the Loch Fearna reservoir emptying and filling, with potential implications for physical process in the streams entering the loch. However, further site specific assessments can be undertaken to identify these risks and appropriate mitigation measures applied if identified as necessary.

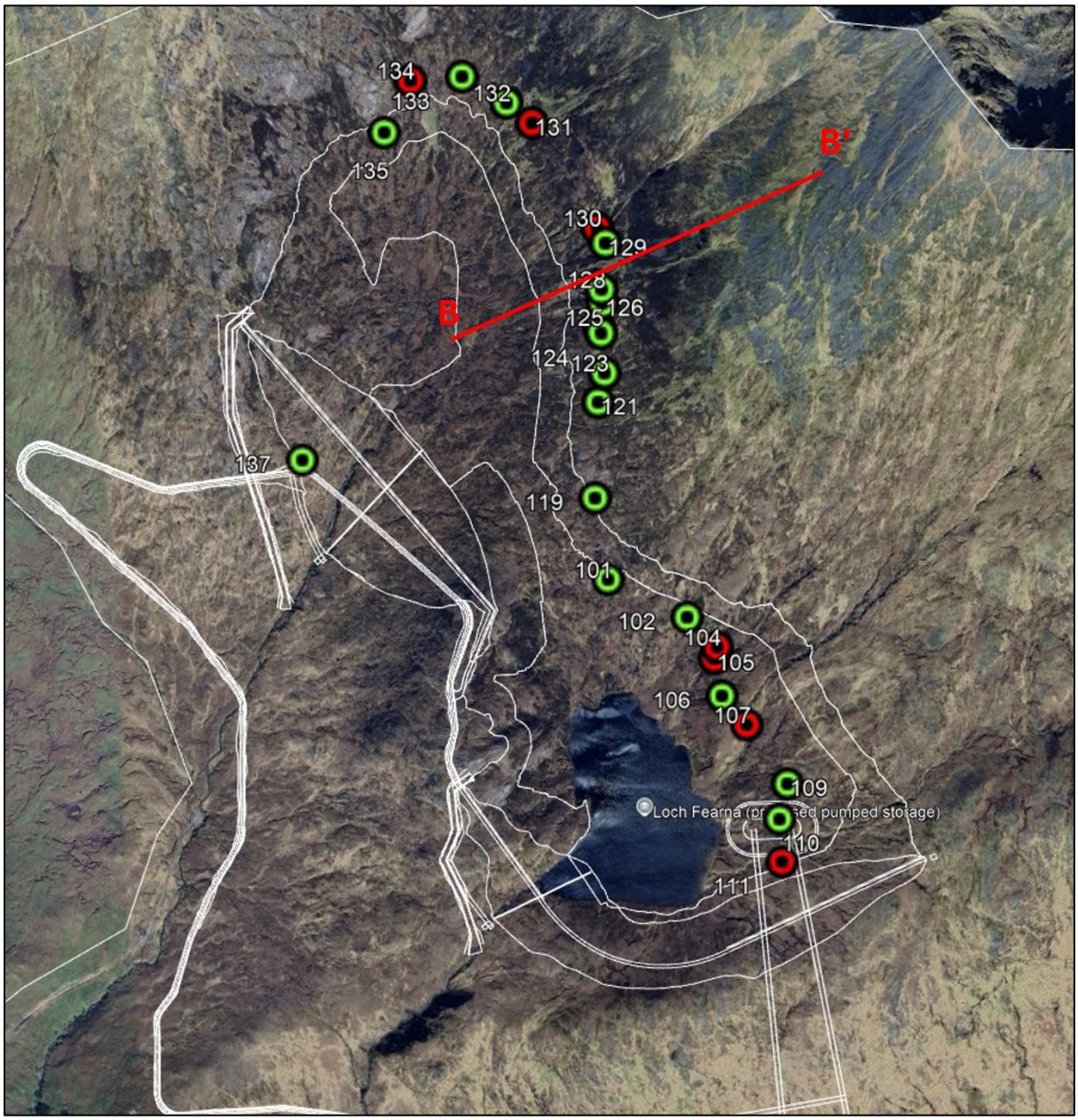


Figure 1. Extents of reservoir shoreline survey, with locations of identified intercepted streams (red = Type A alluvial channels, green = Type B colluvial channels).

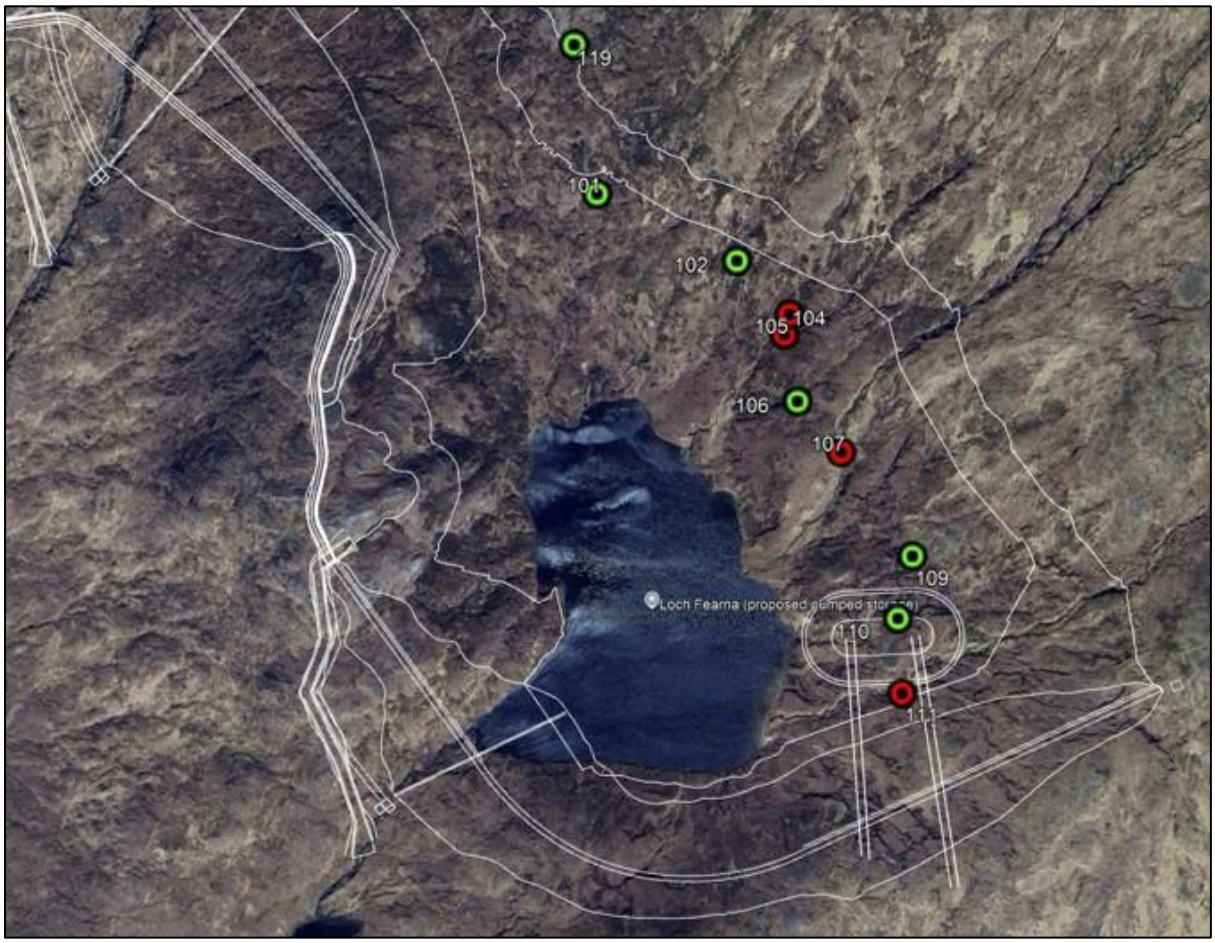


Figure 2. Extents of southern reservoir shoreline survey, with locations of identified intercepted streams (red = Type A alluvial channels, green = Type B colluvial channels).

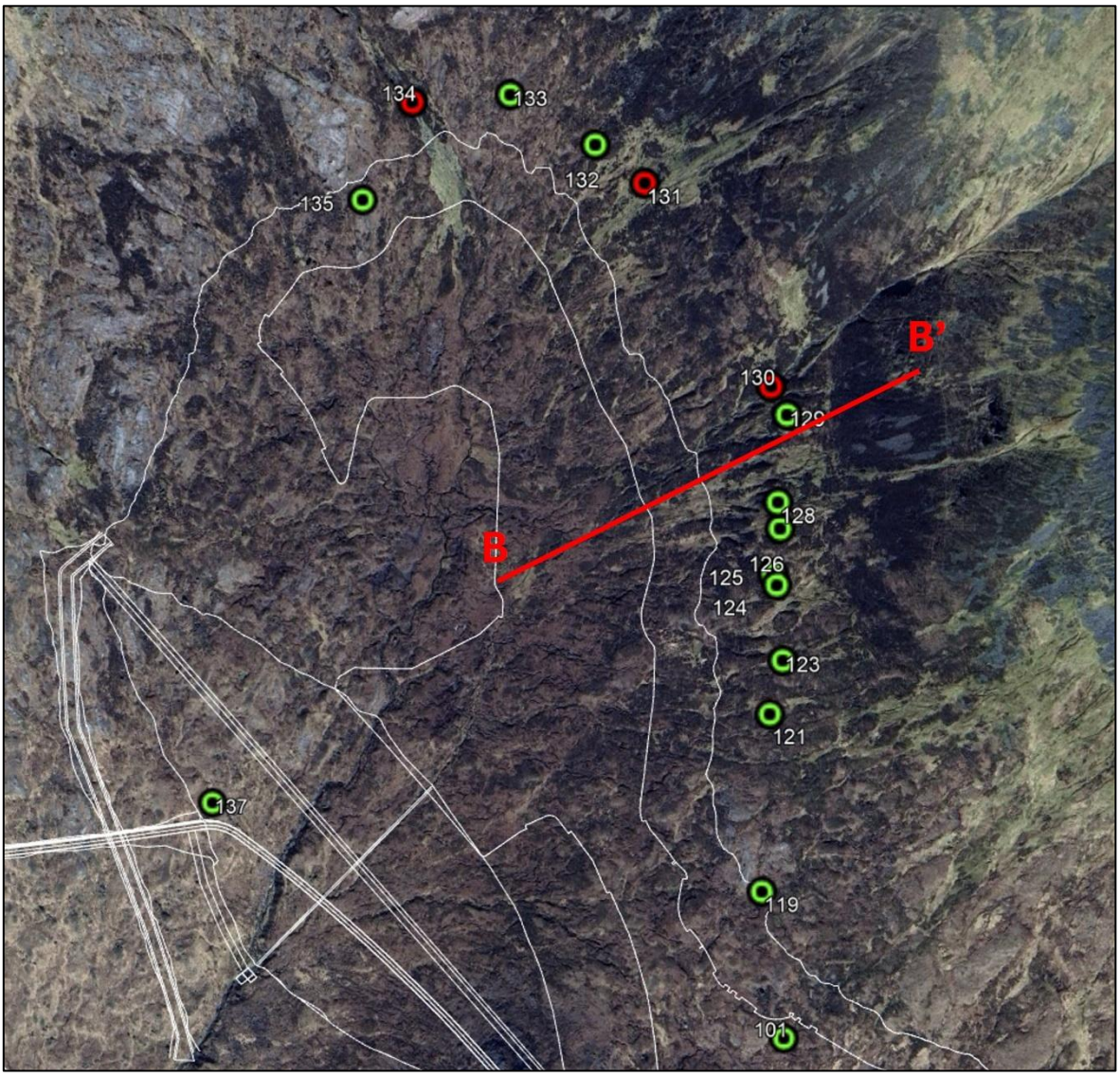


Figure 3. Extents of northern reservoir shoreline survey, with locations of identified intercepted streams (red = Type A alluvial channels, green = Type B colluvial channels)..

Figure 4. Example of a typical surveyed Type A (alluvial) channel. Location 107, Figures 1 and 2.

Figure 5. Example of a typical surveyed Type B (colluvial) channel. Location 129, Figures 1 and 3.

Figure 6. Example of eroding peat in south eastern extents of reservoir. Locations 109 and 110, Figures 1 and 2.

Figure 7. Location 131. Type B (colluvial) channel but exhibiting small recent landslide in headwall area (red circle).

Figure 8. Small downstream sediment deposit (red circle) associated with location 131 headwall landslide (see Figure 7).

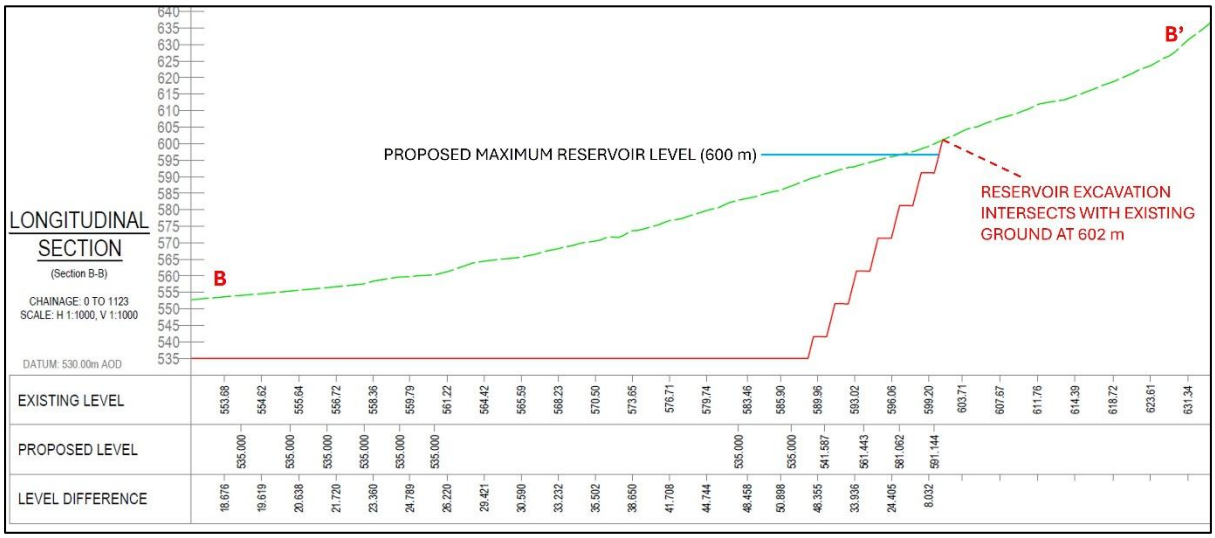


Figure 9. Long section B-B' (see Figures 1 and 3 for location) through the proposed reservoir and upper mountain slope.

Figure 10. Sediment storage in the headwaters of the Allt a Mheil (location 134, Figure 3).

Figure 11. Alluvial sediment deposit located at the small hydropower intake structure on the Allt a Mheil at OS NGR NH 0465 0315.

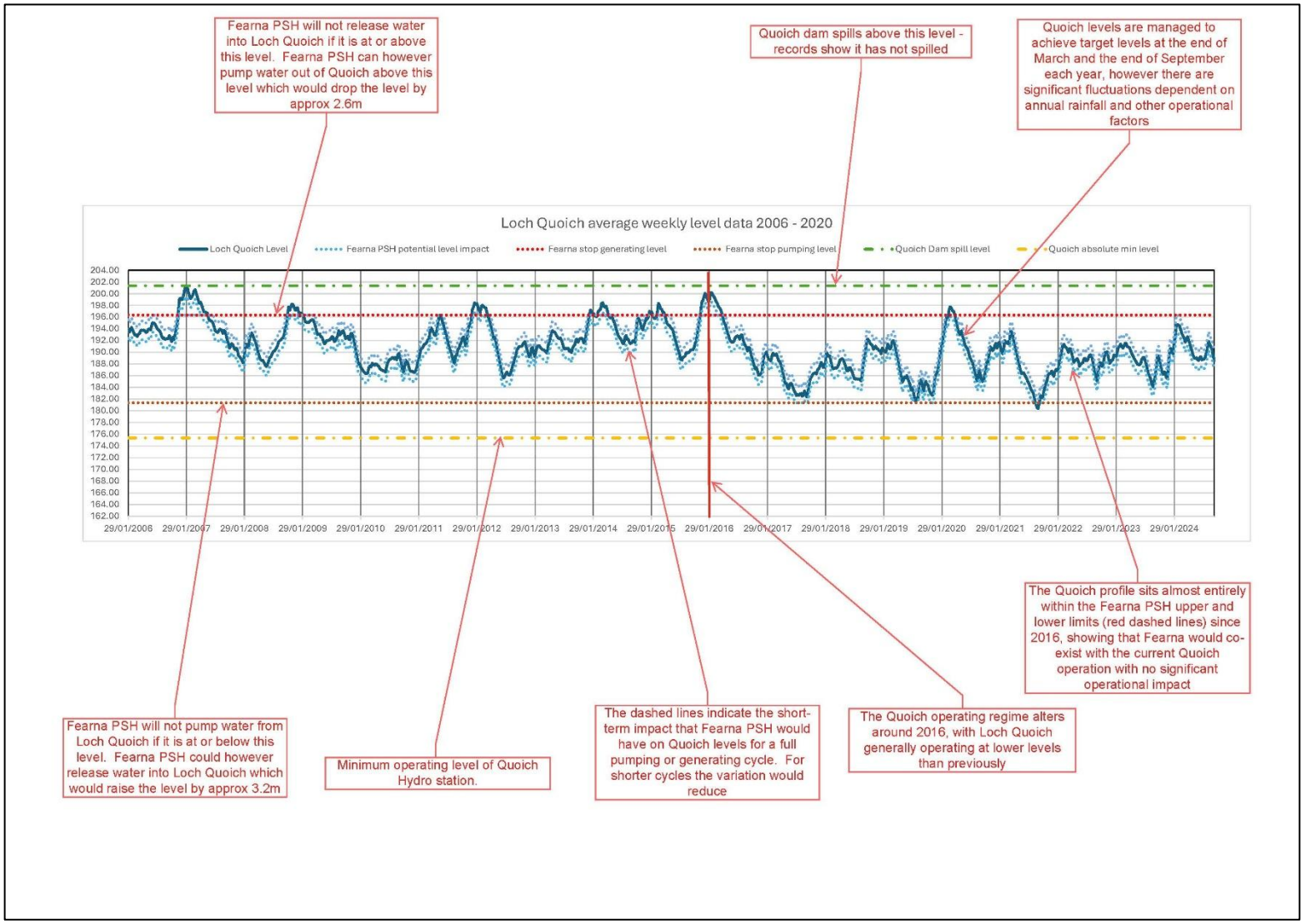


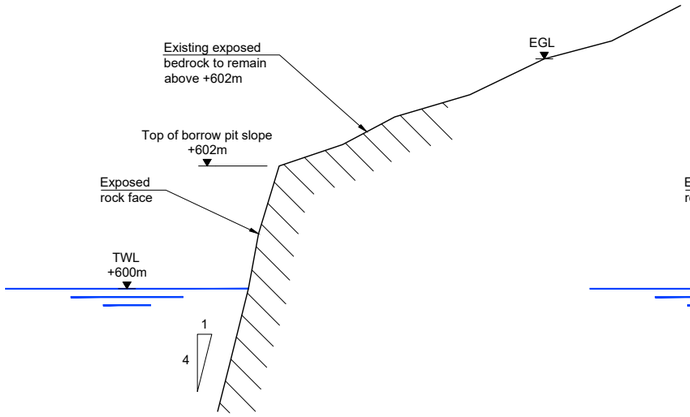
Figure 12. Loch Cuaich water levels 2006 to 2025. Demonstrating that the addition of Loch Fearna operations will not push these outside the drawdown range of the Loch Cuaich since 2016.

[redacted]
CONSULTANT FLUVIAL GEOMORPHOLOGIST

Loch Fearna Pumped Storage Geomorphology Assessment: B. Loch Fearna Reservoir

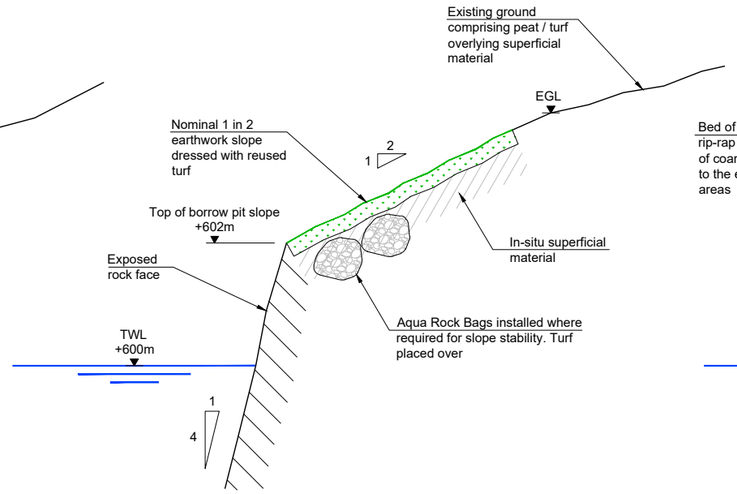
September 2025

APPENDIX A – OUTLINE DESIGN FOR RESERVOIR SHORELINE SLOPE AND STREAM STABILISATION



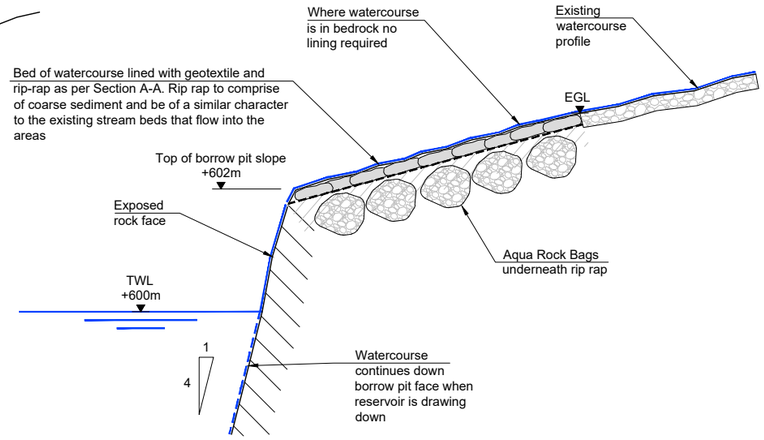
Typical Shoreline Section - Bedrock Areas

1:100 @ A3



Typical Shoreline Section - Superficial Material

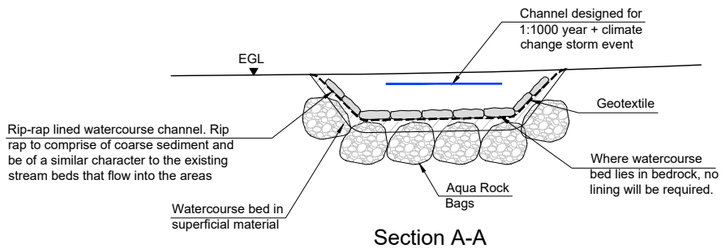
1:100 @ A3



Upper Reservoir Watercourse Transition

1:100 @ A3

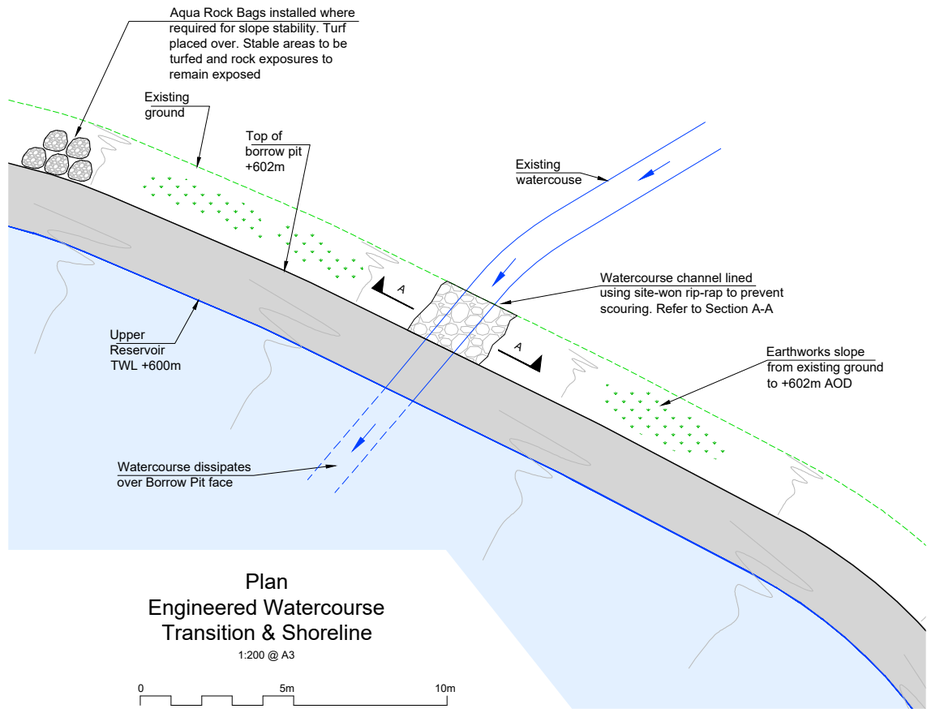
0 2.5m 5m



Section A-A
Reinforced Bed In Superficial Material

1:100 @ A3

0 2.5m 5m



Plan
Engineered Watercourse
Transition & Shoreline

1:200 @ A3

0 5m 10m

IF IN DOUBT - ASK

LEGEND

Rock

REV	DATE	DRAWN	NOTES	CH'K'D	APP'D
T1	16.09.25	MH	FOR TENDER	FRA	FRA

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CLIENT

FEARNA STORAGE

PROJECT

PROPOSED
FEARNA PSH

TITLE

UPPER RESERVOIR
WATERCOURSE DETAILS

SIZE	SCALE AT A3	STATUS
A3	AS SHOWN	TENDER

DRAWING NUMBER: FEA/FC4/252

REVISION: T1