"Achieving Project Execution Results"

Urquhart Bay Wood SAC: Response to NatureScot Further Advice

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Executive Summary

NatureScot's further advice of April 2026 raised two specific matters in respect of Urquhart Bay Wood SAC:

(i) whether the substrate at the lower margin of the SAC is sufficiently free-draining that growing-season waterlogging can be discounted as a pathway to vegetation loss; and

(ii) whether, under the proposed loch level regime, wave attack at the elevations at which the loch surface will most frequently interact with the wooded margin could be sufficient to cause erosional retreat of the vegetated SAC margin.

This response addresses each in turn. The technical conclusions reached in this response are as follows.

Substrate and drainage (Section 4 and Appendix B). Field-based geomorphological assessment finds the lower SAC margin to be a heterogeneous alluvial-deltaic environment, hydraulically connected to Loch Ness through an extensive active and relict coarse-bedded channel network. Local fine-grained deposits are present but are not laterally extensive at a scale that would materially impede drainage across the lower margin. The general near-shoreline area is expected to drain following inundation. The north-eastern sector is the only significant area within the SAC where slower local drainage may be relevant. On a reasonable worst-case substrate assumption for that sector, the ecological assessment set out in the Technical Note in Appendix B concludes that the predicted regime remains compatible with the qualifying alluvial alderwood ecosystem and does not give rise to an adverse effect on site integrity.

Wave-energy distribution and shoreline behaviour (Sections 2, 3 and 5, with Appendix A). The Applicant's analysis concludes that the appropriate test of erosion risk under the proposed regime is the distribution of wave energy across elevation bands and how these energies relate to a site-specific threshold for erosion, not the cumulative time during which the loch surface lies above any particular elevation. Wave-energy-by-elevation analysis (Grey, 2026, Appendix A) shows that the proposed regime redistributes the existing cumulative dissipated wave energy across a broader vertical range than the baseline, with reduced peak concentration. At no elevation band does cumulative dissipated wave energy under the proposed regime exceed the baseline peak. Furthermore, the exposure of higher elevations to increased wave activity remains below the wave-energy level currently delivered in a more focused band to the vegetated margin. This is the most relevant site-specific reference available since the existing shoreline provides the best available empirical evidence for the level of cumulative wave forcing the site safely accommodates without material net retreat. The existing vegetated margin sits at or immediately above the baseline peak band, and the historical and observed shoreline record for the 1870 to 2026 period shows no material net retreat. This provides a no-erosion threshold at or below which there is no erosive risk. Since the redistributed energies for the proposed regime at higher elevations are comfortably below this threshold, and since no net material retreat or evidence of wave erosion damage is observed in the current situation, combined with no assessed adverse effect on the existing vegetation, it can be safely concluded that this redistribution of energy across a wider vertical range including to higher elevations will cause no adverse wave erosion risk to the SAC.

Integrated conclusion (Section 6). The technical evidence does not support a new or materially intensified mechanism for adverse effect on the integrity of Urquhart Bay Wood SAC, by way of growing-season waterlogging or erosional retreat of the vegetated SAC margin under the proposed regime.

The integrity determination remains a matter for the competent authority on the basis of the totality of the HRA evidence.

1. Introduction

1.1 Scope

This report has been prepared in response to the further advice issued by NatureScot in respect of Urquhart Bay Wood Special Area of Conservation (UBW SAC), namely the request of 2 April 2026 concerning substrate porosity and the advice of 13 April 2026 concerning potential erosional retreat of the vegetated SAC margin under the proposed loch level regime.

The report should be read alongside the AECOM March 2026 Summary Note and Technical Annex submitted by the Applicant, Glen Earrach Energy Ltd. The wider Habitats Regulations Appraisal and the ecological compatibility assessment of the proposed regime are set out in those documents. This report does not reopen that wider assessment, but addresses the two specific matters raised by NatureScot:

- whether the substrate at the lower margin of the SAC is sufficiently free-draining, given the dynamic nature of the delta and the possibility of fine-grained lenses of lower permeability, such that growing-season waterlogging can be discounted as a pathway to vegetation loss; and
- whether, under the proposed regime, wave attack at the elevations at which the loch surface will most frequently interact with the wooded margin could be sufficient to cause erosional retreat of the vegetated SAC margin over the operational lifetime of the development, including in the light of the substrate, observed and historical shoreline change, and any relationship between shoreline behaviour and fluvial sediment supply within the catchment.

As relevant site context, Loch Ness was historically raised by approximately 1.2 m around 200 years ago in connection with construction of the Caledonian Canal and associated control structures. The current loch-margin zone has therefore developed under this raised level rather than under the natural pre-Canal shoreline elevation; the implications of this are discussed in Section 4.

1.2 Authorship and contributing input

This report has been prepared as an integrated multidisciplinary response by WestGlen Consult, drawing on specialist geomorphological, wave-energy, ecological and shoreline-process input.

WestGlen Consult has coordinated the preparation of the response and is responsible for the integration of the technical inputs, including the project-specific hydrological, operating-regime and field-evidence context drawn from the wider Glen Earrach Energy project. This integration has been led by Mr R. Martin Lacey CEng and Mr Peter MacDonald CEng. Mr MacDonald is based locally to the SAC and has direct familiarity with the area. Mr. Lacey is a large-scale hydropower specialist with 30 years of large-scale hydropower development experience in a global setting.

Dr Hamish Moir, Consultant Geomorphologist, has prepared the geomorphological assessment of substrate, drainage and historical shoreline behaviour, and has provided specialist input on the geomorphological interpretation of the lower SAC margin. Dr Moir has over 15 years working at a senior role in an environmental consultancy, with extensive professional and academic experience in fluvial geomorphology, river engineering, river management and restoration, hydrodynamic and sediment-transport modelling, and topographic and bathymetric surveying. He holds a PhD from the University of Aberdeen on Atlantic salmon spawning habitat in the River Dee and River Don catchments, Scotland, and is a Visiting Associate Professor at the University of the Highlands and Islands. His prior site-specific work on the geomorphology of Urquhart Bay Wood SAC is summarised in Section 4.3.

The wave-energy-by-elevation analysis at Section 3 is supported by a technical file note prepared by Mr Simon Grey, Director of AWS Ocean Energy Ltd, attached as Appendix A. Mr Grey is a Chartered Engineer with specific expertise in wave energy science and direct local knowledge of Loch Ness and Urquhart Bay.

The ecological assessment of a reasonable worst-case substrate assumption is set out in a supporting Technical Note prepared by AECOM, attached as Appendix B. AECOM ecologists have also reviewed and contributed to the ecological content of this main response where relevant.

The completed response has also been subject to external geomorphological review by Dr Derek McGlashan of Saltire Sustainability Ltd, whose input has informed the treatment of shoreline processes, sediment supply, sediment redistribution and coastal/lakeshore process interpretation. Dr McGlashan holds a PhD in Geomorphology and Law from the University of Dundee, has undertaken coastal and lakeshore geomorphological research and consultancy, and has held teaching and research roles relating to coastal processes, geomorphology and coastal management.

1.3 Structure of the report

The two matters raised by NatureScot are linked: vegetation persistence at the lower edge of the SAC depends in part on substrate drainage behaviour, and the condition of the vegetated margin is in turn one of the factors relevant to the assessment of erosional retreat. The structure of this report reflects that linkage. It begins (Section 2) with a clarification of the time-at-elevation principle applied in SQ1 of the March 2026 Technical Annex, which addresses NatureScot's specific observation regarding loch level exceedance above 16 m AOD. Section 3 presents the wave-energy-by-elevation analysis and provides the quantitative framework for assessing the proposed regime. Section 4 sets out the substrate and drainage evidence, drawing on field-based geomorphological assessment by Dr Moir. The ecological implications of a reasonable worst-case assumption of localised slower drainage are addressed in a supporting Technical Note prepared by AECOM, provided at Appendix B. Section 5 examines the historical and observed shoreline record. Section 6 provides the integrated conclusion. Section 7 provides a summary of the peer review carried out by Dr. McGlashan. Appendix C provides local bathymetry from a recent survey which fed into the peer review by Dr. McGlashan.

2. Clarification of the SQ1 reasoning: time at elevation and wave energy by elevation band

2.1 NatureScot's acceptance points and the residual concern

NatureScot's further advice of 13 April 2026 acknowledges that the March 2026 assessment is helpful and agrees with several of its conclusions in relation to loch-water erosion. Specifically, NatureScot agrees that:

I. the year-round increase in median and mean water level associated with operation of the seasonal variable weir would not on its own increase erosion risk;
II. more frequent water-level cycling would not on its own intensify bank erosion, and would redistribute hydrodynamic loading more broadly across the fluctuating level range;
III. rapid drawdown-induced bank instability appears unlikely given the stage-change rates of the proposed regime, the shallow gradient of the deltaic margin and the low elevation of the woodland fringe.

NatureScot does not, however, consider that those findings by themselves rule out significant new erosion. The residual concern is that, under the proposed higher loch-level regime, wave attack at the elevations at which the loch surface will most frequently interact with the wooded edge could be sufficient to cause erosional retreat of the vegetated SAC margin over the operational lifetime of the development. In support of that concern, NatureScot has noted that under baseline conditions the water level exceeds 16 m AOD around 13% of the time, rising to over 40% of the time under the proposed regime, and has reasoned that on the time-at-elevation principle relied on in SQ1, "all other things being equal", each 0.1 m level band above 16 m AOD would be subject to greater erosion.

2.2 The time-at-elevation principle and the qualification "all other things being equal"

The increase in time during which loch levels exceed 16 m AOD under the proposed regime is acknowledged. However, the inference that this implies greater erosion at each 0.1 m band above 16 m AOD rests on two issues with the application of the time-at-elevation principle.

The first concerns the qualification "all other things being equal". For the inference to hold, wave energy would need to be equal across the elevation range. In reality, the total wave energy available in any given period is fixed, and under the proposed regime it is distributed over a broader range of loch levels than under baseline conditions, meaning that same energy is distributed over a wider range, such that wave energy is not maintained as 'equal' for the purpose of comparison.

The relevant quantity for assessing erosion risk at a given elevation is the cumulative dissipated wave energy within a specific elevation band over time - the time-integrated sum of the wave energy dissipated in that band during each hourly timestep. This quantity is calculated separately for each band; it is not summed across bands. This approach allows direct comparison of the spatial distribution of hydrodynamic forcing against the no-erosion threshold for each band level, rather than relying on residence time alone.

The second is equally important. Exceedance above an elevation is not equivalent to wave attack **at** that elevation. Erosion depends on the magnitude of wave forcing acting at a given contour, not on the duration for which the water surface lies above it. To illustrate, a rise from 13% to 40% exceedance could reflect either a concentration of wave energy just above the elevation in question or a broad spread of levels with no particular concentration at a specific elevation. These scenarios carry very different erosion implications.

This reasoning is consistent with the broad direction set out in the March 2026 Technical Annex, which discussed water-level residence in the context of its effect on wave interaction at the vegetated margin. The present response develops that reasoning quantitatively through Simon Grey's wave-energy-by-elevation analysis.

The appropriate test of erosion risk under the proposed regime is therefore the distribution of wave energy across elevation bands, not the cumulative time during which the loch surface lies above any particular elevation. Analysis of wave energy and how this interacts with the proposed regime is presented in this document at Section 3.

2.3 Consistency with Trenhaile (2000) and the importance of an erosive-force threshold.

The treatment of erosion in Trenhaile (2000), referenced in SQ1, is consistent with the clarification above. Trenhaile's model relates erosion at a contour to the time during which that contour lies within an active wave zone capable of delivering erosively significant forcing, qualified by an erosive-force threshold related to the resistance of the local material. The time-at-elevation factor in Trenhaile's formulation multiplies the surf force available for erosion at that elevation after the threshold has been subtracted; the factor multiplies excess wave forcing above threshold, not wave forcing in absolute terms.

Two implications follow. First, residence at an elevation is a necessary but on its own insufficient condition for erosion at that elevation. Wave forcing must reach the contour in sufficient magnitude to exceed the erosive-force threshold for the local material; where it does not, no erosion occurs at that contour regardless of the duration of residence. Second, the proper application of the time-at-elevation principle requires evaluation of the wave forcing at each elevation, not summation of residence time across elevations. Trenhaile's framework is referenced here for this analytical structure rather than as a direct quantitative model for the vegetated alluvial loch margin at Urquhart Bay Wood.

Therefore, in addition to erosion risk being related to the distribution of wave energy across elevation bands, that wave energy must also be assessed relative to a threshold, where erosion may only occur if this is exceeded. Essentially, the presence of waves is not in itself a precursor of erosion.

2.4 The 0.1 m elevation band scope point

NatureScot has separately observed that the SQ1 analysis in the March 2026 Technical Annex focused on whether wave attack would be concentrated within a single 0.1 m level band, without defining the vertical range of any potential drawdown or active wave interaction zone, and noted that the question originally posed concerned a drawdown zone which could have a vertical range greater than a single 0.1 m band.

The wave-energy-by-elevation analysis presented in Section 3 addresses that point directly with the full methodology provided at Appendix A. The analysis first discretises the shoreline profile into 0.1 m elevation bands to provide a reasonable means for comparison between the modified and baseline conditions. For each hourly time step in the analysis, the specific wave characteristics for that time step are analysed with respect to the shoreline profile, such that the relevant energy dissipation in levels below and above the mean surface level are taken into account, allowing for an appropriate distribution of energies across the band of elevation impacted by that particular wave characteristic. This process is repeated for all of the time steps in the analysis, at which point the energies can be summed for any given elevation to calculate the total energy dissipated by any specific elevation.

The output of this analysis is a series of cumulative wave energy dissipation values for each elevation, which can be directly compared between baseline and the modified operating regime.

2.5 The stability of the existing SAC and the identification of a relevant no-erosion threshold for evaluation of erosive risk

The historical and observed shoreline evidence, set out in Section 5, demonstrates that the existing margin has accommodated the baseline wave-energy distribution without material net retreat. That observed condition provides the empirical reference against which the proposed regime is compared.

Through the analysis of baseline wave energy dissipation, including the distribution of energies across elevations according to wave characteristics, and taking account of the existing stability of the SAC, a no-erosion threshold for the vegetated margin is identified, against which the modified operating regime can be measured.

2.6 The refined technical question

The refined technical question that follows from NatureScot's advice is therefore whether wave-induced forcing at any elevation under the proposed regime, assessed using an appropriate distribution of cumulative energies according to wave characteristics, exceeds the no-erosion threshold identified from the observed stability of the existing shoreline combined with an assessment of the baseline wave energy dissipation characteristic.

3. Wave energy by elevation: incident wave forcing under baseline and proposed regimes

3.1 Approach

The wave-energy-by-elevation analysis at the SAC frontage has been undertaken by Mr Simon Grey, Director of AWS Ocean Energy Ltd. Mr Grey is a Chartered Engineer (MIET, FRSA) with specific expertise in wave energy science and direct local knowledge of Loch Ness and Urquhart Bay. His full file note is provided as Appendix A (Grey, 2026). Appendix A presents the calculation of incident wave power from the wind and fetch record, and the resulting distribution of cumulative dissipated wave energy across shoreline elevation bands at the SAC frontage. The methodology and results are summarised in this section, with attention to the points relevant to the SQ1 clarification set out in Section 2.

The analysis applies first-order methods to estimate incident wave power at the shoreline of Urquhart Bay, and to evaluate the relative distribution of cumulative dissipated wave energy across elevations under baseline and proposed water level regimes. The proposed regime considered in this assessment is the cumulative scenario modelled in the Glen Earrach Energy EIAR, comprising Glen Earrach Energy, Loch na Cathrach and Loch Kemp, with the Seasonal Variable Weir. This is the cumulative scenario relevant to the regulatory question raised by NatureScot. Throughout this document, references to the proposed regime denote that scenario.

3.2 Site setting and directional wave climate

Urquhart Bay is partially sheltered, with limited fetch to the south-west and longer (though still limited) fetch to the north and north-east (Grey, 2026). Wave exposure at the SAC frontage is therefore directionally dependent, with the highest local incident wave energy associated with north-easterly winds aligned with the longer effective fetch directions. The shallow bathymetry within the bay limits incident wave energy through processes such as depth-induced breaking and energy dissipation, such that wave forcing at the shoreline is expected to be lower than at more exposed locations within Loch Ness.

The directional dependence forms part of the analysis. The dominant wind climate over Loch Ness is south-westerly, but the SAC frontage is protected from south-westerly wave energy by sheltering, refraction and attenuation associated with Strone Point and the local bay configuration.[1] Wave forcing at the SAC margin therefore requires the coincidence of an appropriate north-easterly wind direction with sufficient wind speed to generate meaningful waves across the available fetch, and with the relevant loch level.

The shoreline profile at the SAC frontage is not uniform. Grey (2026) identifies a dominant shallowing in the bay approaching the SAC, following which a distinct break in slope is observed between approximately 15.6 m and 15.9 m AOD at the margin of the SAC, both of which features are expected to influence the location and concentration of wave breaking, surf-zone dissipation and swash interaction under varying loch levels. This local geometry is relevant to the distribution of dissipated wave energy across elevation bands, as set out below.

3.3 Water-level probability distribution

The Glen Earrach Energy project hydrological analysis shows that the proposed regime changes the distribution of loch levels by shifting residence time upwards across the relevant elevation range. Figure 1 shows the full-year probability density and exceedance distributions for the baseline and proposed regimes.

[1] Local boat operator Malcolm Stewart (Beastie Boats, Foyers) has extensive daily experience navigating Loch Ness. He confirms that Urquhart Bay Woods is one of the only two genuinely sheltered areas on the loch and is particularly protected from the dominant south-westerly winds. He regularly observes flat-calm conditions in the bay when waves in excess of 1.0 m are present on the main loch. (pers. comm. April 2026 via P. MacDonald, WestGlen Consult).

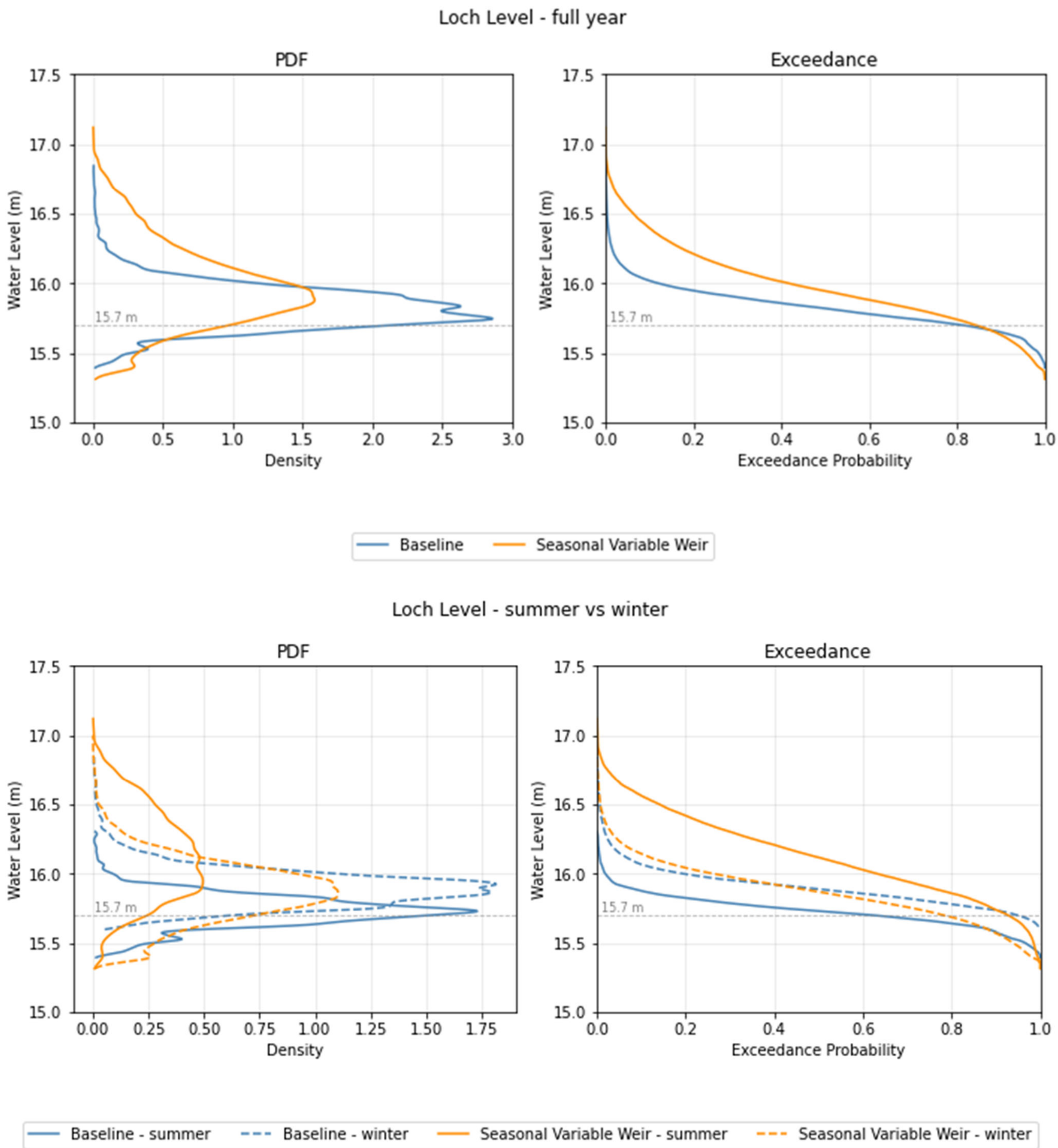

Figure 1 – Top: full-year probability density of loch water level, baseline and proposed regime, with exceedance plot showing the same data, Bottom: the same data presented with a seasonal split (May-Sep and Oct-Apr). Source: GEE project hydrological analysis.

The exceedance plot confirms NatureScot's observation that the proportion of time above 16 m AOD increases under the proposed regime. As set out in Section 2, however, exceedance above an elevation is not equivalent to wave attack at that elevation. The relevant question for erosion is how the total wave energy is distributed across elevation bands, which is addressed by Simon Grey's analysis below. The water-level distribution shown in Figure 1 forms the input to that analysis.

3.4 Methodology

The full method is set out in Appendix A. The principal elements are summarised here.

The analysis uses the same underlying wind record, fetch assumptions and wave-calculation method for both the baseline and proposed regimes. The methodology therefore preserves relative scale accurately between the two cases. The conclusions of the analysis rest on relative comparison: the cumulative dissipated wave energy delivered to a given elevation band under the proposed regime, compared to the same band under the baseline.

Wind data were obtained from the European Centre for Medium-Range Weather Forecasts ERA5 reanalysis dataset for a grid point within Loch Ness, providing a 25-year hourly record (2000 to 2025). The dataset was reviewed against known storm conditions on Loch Ness and a uniform scaling factor applied to align maximum wind speeds with reported Beaufort Force 10 conditions (~25 m/s). The same scaling was applied across all scenarios to preserve relative comparison. Direction-dependent fetch values for a point at the mouth of the River Coiltie were derived from the geography of Urquhart Bay.

Significant wave height (Hs) and peak period (Tp) for each hourly timestep were calculated from the wind speed and fetch using standard deep-water wave theory. Incident wave power was then calculated, and incident wave energy per timestep was derived from incident power multiplied by the timestep duration. This incident wave energy is the input to the contour-by-contour dissipation calculation described below.

To account for near shore wave interaction, for each hourly timestep, the corresponding loch level was combined with the shoreline elevation profile to determine the effective water depth at contours associated with each 0.1 m elevation band. The significant wave height for that hourly timestep was then depth-limited according to the available water depth at that contour, and residual wave power was calculated at successive contours.

The dissipated wave energy within each 0.1 m elevation band for the specific wave characteristics at the timestep was then obtained by analysing the reduction in residual wave energy between adjacent contours affected by the specific wave characteristic being assessed, representing the distribution of wave energy across elevations according to that wave characteristic. This process was repeated for each timestep across the data series, with each time step considering the specific wave characteristic corresponding to that time step. The cumulative dissipated wave energy in each 0.1 m band over the year is then the sum of the per-timestep energy contributions corresponding to that 0.1 m band across the data series period.

The calculation was performed for two cases: a baseline case using observed loch levels in 2023, and the proposed cumulative regime using the modelled loch levels for 2023 from AECOM's hydraulic modelling. The 2023 wind record was confirmed to be representative of the long-term 2000 to 2025 distribution by comparison of wave-power exceedance curves (Grey, 2026, Figure 2). The relative distribution of cumulative dissipated wave energy between the baseline and proposed regimes, which is the quantity of regulatory interest, is therefore considered to be well represented by the 2023 example year.

3.5 Results

The cumulative dissipated wave energy by shoreline elevation band, for the 2023 example year under the baseline and proposed cumulative regimes, is shown in Figure 3 of Grey (2026), reproduced as Figure 2 below. The quantity plotted is the time-cumulative dissipated wave energy within each 0.1 m elevation band over the year, calculated as set out in the Methodology subsection above. Each elevation on the x-axis represents the centre-point of each 0.1 m band.

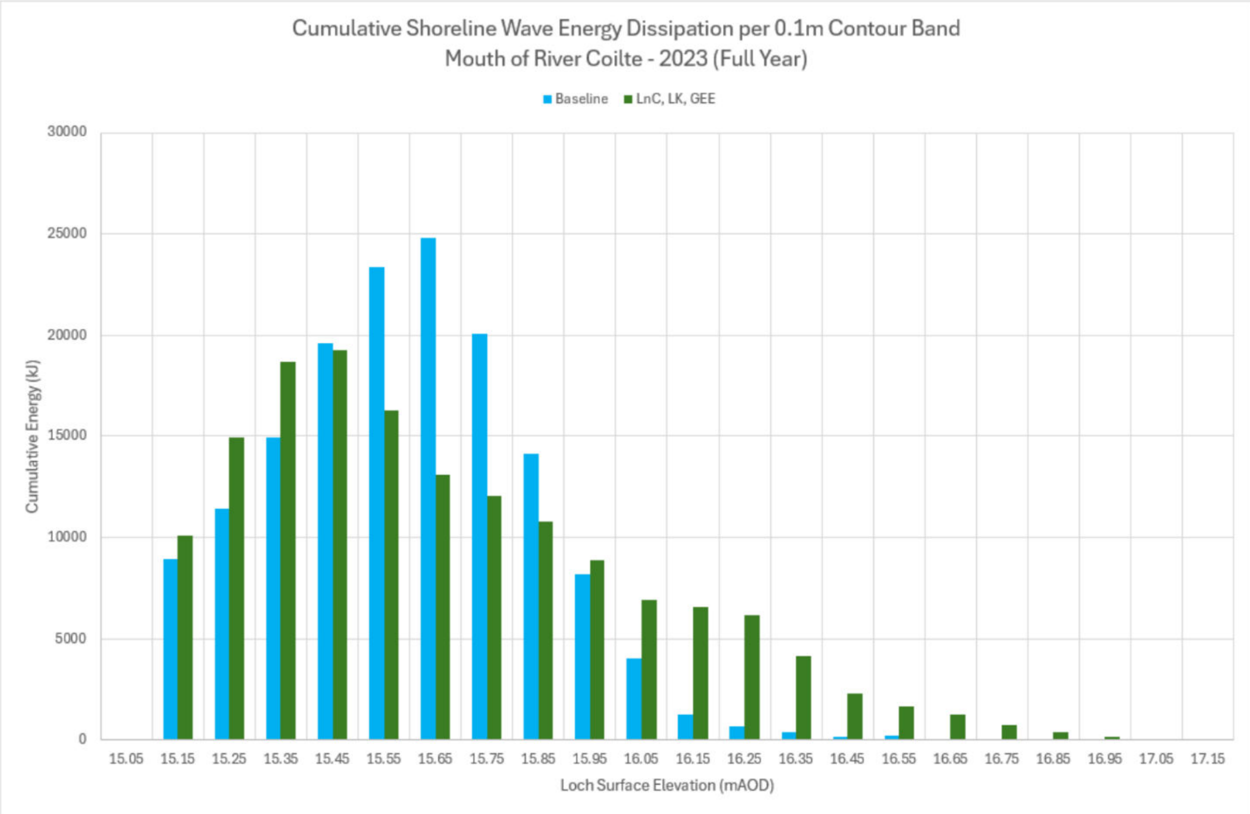

Figure 2 - Cumulative dissipated wave energy by elevation band, 2023, baseline (blue) and proposed regime (green). Reproduced from Grey, 2026, Figure 3

Under the baseline regime, cumulative dissipated wave energy peaks in the 15.6 to 15.7 m AOD band. Energy then declines progressively at higher elevations. This distribution represents the spatial pattern of hydrodynamic forcing acting on the shoreline, which can be interpreted relative to the no-erosion threshold.

Under the proposed regime, cumulative dissipated wave energy is redistributed across a broader range of elevations. The peak wave energy concentration is reduced relative to baseline. At the baseline peak band and at adjacent bands, energies under the proposed regime are reduced relative to baseline. At higher elevations, energies under the proposed regime are increased relative to baseline but remain below the cumulative dissipated energy delivered at both the baseline peak and the proposed-regime peak. The detailed band-by-band distribution is shown in Figure 2.

3.6 Site-specific reference condition: the existing stable vegetated margin

The current vegetated margin sits at approximately 15.7 to 15.8 m AOD, on the basis of the LiDAR data and the field observations recorded during the April 2026 walkovers (Section 4). This is immediately above the baseline peak energy band identified by Grey (2026) at 15.6 to 15.7 m AOD. Field and profile evidence indicate that the lower foreshore includes a shallow bench below the vegetated margin, in the elevation range where baseline cumulative dissipated wave energy is concentrated. The absence of material net retreat above the existing shoreline elevation indicates that hydrodynamic forcing at and above this elevation remains below the effective threshold for erosion, taking account of substrate and vegetation. This provides a site-specific threshold condition against which the energy distribution provided by the proposed regime can be assessed.

Two points follow from the geometry of the SAC. First, the peak of baseline cumulative dissipated wave energy is currently delivered to this lower foreshore bench, which is unvegetated and has been a stable feature of the shoreline over the historical mapping period (Section 5). The substrate beneath the bench can reasonably be assumed to be the same broad alluvial material as beneath the vegetated margin. Second, the vegetated margin sits immediately above the peak band and accommodates near-peak, but not peak, cumulative dissipated wave energy.

The combination of the historical mapping (Section 5) and the field-observable shore profile geometry combined with the baseline cumulative dissipated wave energy profile therefore provides a site-specific wave energy threshold: the present shoreline demonstrably accommodates this baseline cumulative dissipated wave-energy distribution without material net retreat. This is not a modelled or inferred condition; it is observed in the field and supported by mapping evidence over a 150-year period. It is the best reference against which the proposed regime can be tested. Given the elevation of the vegetated margin, the energy concentrations between 15.7 and 15.9 m (15.75 m and 15.85 m on Figure 2) provide the relevant threshold energy levels corresponding to the vegetated margin. The energies at 15.85 m shown in Figure 2 have been adopted on a precautionary basis as a no-erosion threshold against which the proposed regime can be assessed.

3.7 Comparison of the proposed regime against the empirical reference

The relevant comparison to address the refined technical question is whether hydrodynamic forcing under the proposed regime exceeds the threshold conditions currently accommodated by the shoreline. The relevant threshold for the vegetated margin is that associated with the 15.85 m band in Figure 2.

Based on the Simon Grey analysis, the proposed regime does not exceed this threshold in the higher elevations of concern to NatureScot. At and around the existing vegetated shoreline margin, where baseline cumulative dissipated wave energy is concentrated and where the margin shows no clear evidence of material net retreat, cumulative dissipated wave energy under the proposed regime is reduced compared to baseline. At higher elevations, which is the area of concern raised by NatureScot, while the cumulative dissipated wave energies are seen to be higher than baseline, the energies seen are nevertheless consistently lower than the threshold wave energy identified at 15.85 m.

On this basis, the proposed regime does not introduce conditions in which the baseline no-erosion threshold is exceeded at elevations above the existing shoreline and therefore does not introduce a mechanism for increased erosion.

This conclusion depends on two further points. First, that the vegetation in the zone where the proposed regime energies are higher than baseline is of the same characteristic as the vegetation seen at the vegetated margin, such that the identified threshold wave energy remains relevant to those higher elevations. This point is addressed in the next paragraph (section 3.8 below). Second, that there is no adverse effect on the existing vegetation due to other mechanisms, which has been addressed by the Applicant in its EIAR, its March 2026 submission and with further clarification on residual concerns raised by NatureScot provided in sections 4, 5 and Appendix B of this response.

3.8 Spatial extent and receptor character of the increased-exposure band

The elevation band in which cumulative dissipated wave energy is materially increased relative to baseline has been reviewed spatially using the 16.1 m to 17.0 m AOD band overlaid on aerial imagery and the SAC boundary (i.e. the yellow through dark blue zone in Figure 3).

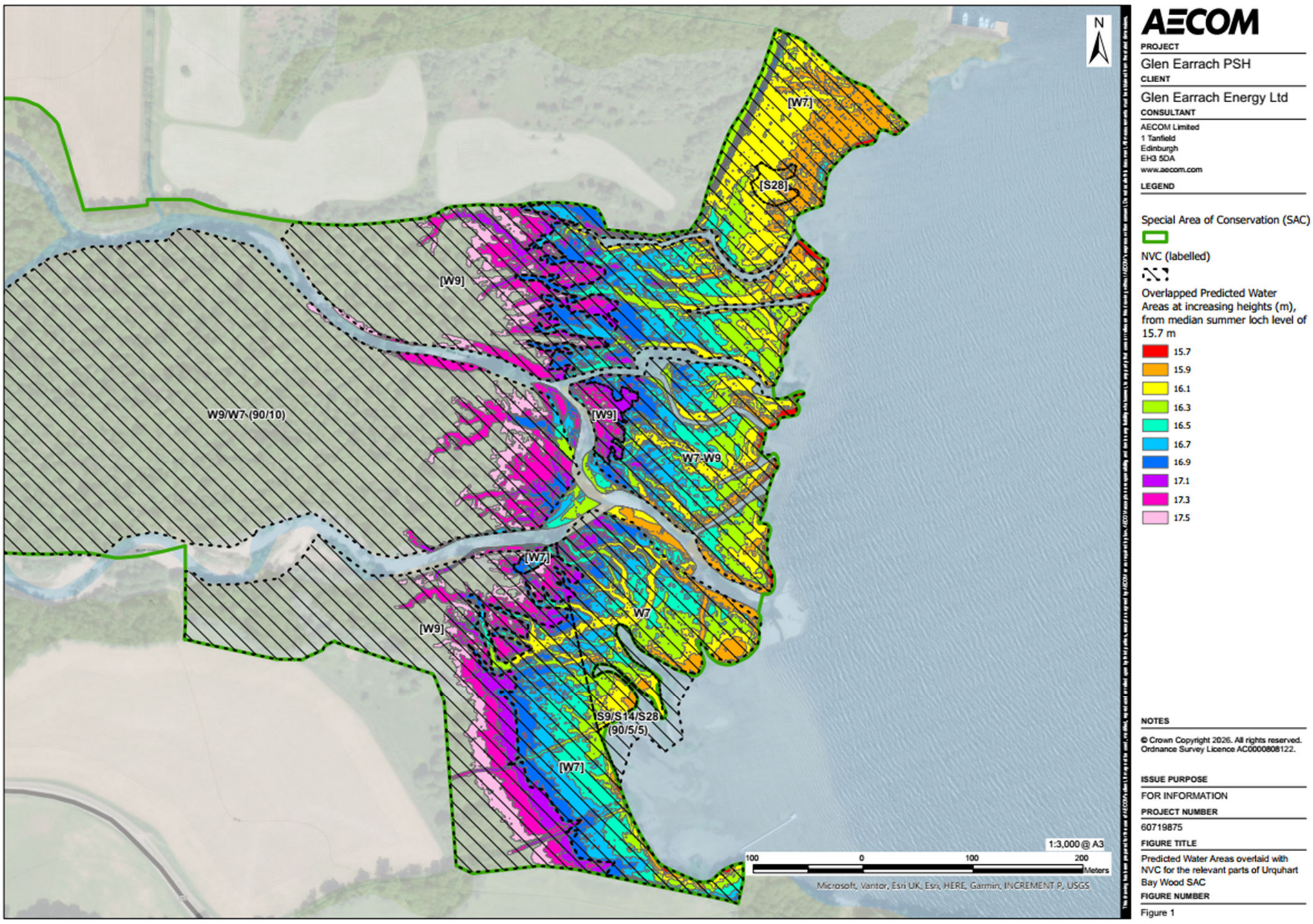

Figure 3 - Location plan showing the lower SAC margin, principal channels, loch-facing margin & NVC markings

The review shows that the increased elevation exposure zone lies within the same broad qualifying woodland types, namely W7 and W9 alluvial alderwood, as the lower-elevation margin which experiences the identified threshold cumulative dissipated wave energy under baseline conditions. The redistributed cumulative dissipated wave energy at those higher elevations remains below this threshold energy currently accommodated by the lower shoreline margin. The increased elevation exposure zone therefore lies within vegetation of comparable broad type to that which currently accommodates higher baseline cumulative dissipated wave energy and does not introduce a materially different or unvegetated receptor.

3.9 Caveats and scope

Two caveats apply to the analysis presented in this section and are noted in Grey (2026). Both are flagged for completeness, and neither undermines the conclusion drawn from the analysis.

First, the calculation is first order. It uses fetch-based wave theory, depth-limited attenuation along the shoreline profile, and a simplified contour-by-contour method to represent the distribution of dissipated wave energy across elevation bands. It does not undertake detailed numerical wave transformation modelling of processes such as refraction, run-up, turbulence, swash interaction, or the full complexity of shoaling and breaking across the nearshore profile. This is appropriate to the regulatory question, since the basis of the response is one of a comparative, rather than absolute, energy analysis. The analysis does not need to predict the absolute erosive force at the site; it needs to compare the wave-energy distribution under the proposed regime against the baseline distribution, which the existing shoreline demonstrably accommodates without material net retreat. The same methodology is applied consistently to both cases, so the relative comparison is preserved and the comparison is therefore valid.

Second, the analysis considers wave-energy comparison alone. It does not assess the continuing stability of the substrate properties, vegetation condition or sediment supply, all of which influence the actual erosional resilience of the shoreline to a given level of wave energy. These aspects are addressed separately in the EIAR, the March 2026 response and Section 4, 5 and Appendix B of this response.

4. Substrate permeability and drainage behaviour

4.1 NatureScot's query of 2 April 2026

NatureScot's advice of 2 April 2026 requested further information to demonstrate that potential growing-season waterlogging would not be an issue at the lower margin of Urquhart Bay Wood SAC. NatureScot noted that, given the highly dynamic nature of the river channels on the site, it could not safely be assumed that the site's sediments are free-draining. Rather, NatureScot considered that there were likely to be lenses of fine-grained material of lower permeability, and that further information was required on how extensive these could be. NatureScot advised that further analysis should be based either on field-based evidence or on transparent and justified reasonable worst-case assumptions about the presence of fine-grained lenses in the substrate.

This section addresses that query. It considers the geomorphological setting of the lower SAC margin, photographic site observations recorded on 4 April 2026 and reviewed by Dr Hamish Moir, field walkovers (with further photographs) undertaken by Dr Moir on 26 and 27 April 2026, the expected sedimentary composition of the lower margin, and the implications for drainage behaviour following inundation.

4.2 Scope and assessment approach

The assessment considers the lower margin of the SAC, broadly corresponding to the elevation bands most relevant to the modelled inundation analysis, with principal focus on the 15.7 m to 16.5 m AOD range identified in the AECOM Additional Information submission, and including the 16.7 m AOD band where relevant. This is the zone that would be periodically inundated and drained under the proposed regime, taking account of the combined operation of existing and proposed pumped storage schemes and the Seasonal Variable Weir.

The assessment is based on geomorphological field observation, review of exposed sedimentary sections, and interpretation of the alluvial fan and delta processes operating at the confluence of the River Enrick and Coiltie Burn with Loch Ness. The purpose was not to demonstrate that the substrate is uniform, but to assess whether fine-grained deposits (i.e. fine sands and smaller) are likely to be sufficiently extensive or continuous to functionally control drainage across the lower-margin band as a whole.

The field assessment focused on naturally exposed materials in actively eroding channel banks of the wider channel network, as these provide the most direct available evidence of substrate composition without intrusive investigation within the SAC. Photographic observations recorded by Peter MacDonald on 4 April 2026 across the channel network were reviewed by Dr Moir as part of the wider evidence base. Dr Moir then undertook a field walkover on 26 April 2026, followed by a joint walkover with Peter MacDonald on 27 April 2026 under more settled conditions, extending observation/ photographic coverage and allowing direct examination of the loch-facing margin and the north-eastern sector.

4.3 Previous site-specific work by Dr Moir

Dr Moir has significant direct prior work experience on the geomorphology and sedimentology of Urquhart Bay Wood SAC (known locally as "The Cover") and the contributing Coiltie and Enrick catchments, independently of his engagement on the Glen Earrach Energy project. The most relevant of this prior work is summarised below.

2012, Geomorphological assessment relating to footbridge reinstatement, The Cover, Drumnadrochit. Commissioned by Glenurquhart Greenspace to support placement of a new footbridge across the Coiltie. The work required a detailed geomorphological assessment of The Cover, including the dynamics of the Coiltie and Enrick channels and their confluence and a historical assessment of channel positions back to 1795. The assessment included channel-position analysis indicating that the Coiltie has periodically switched position by ~200 m within The Cover over the last 100 years.

2017, Drumnadrochit Flood Protection Scheme geomorphological assessment. Carried out in support of the flood protection scheme upstream of Urquhart Bay Wood SAC. Although the flood protection works are upstream of The Cover, the assessment included evaluation of the implications of the scheme for the deltaic area within the SAC. As part of this work, the character of sediment delivery from the Enrick and Coiltie was assessed, with the river found to deliver predominantly coarse alluvium, including cobble, gravel and sand, to the deltaic system. This is consistent with a substrate framework capable of supporting high hydraulic connectivity through the lower margin.

2022, Scottish Water treated wastewater outlet advice on river/ outlet interaction. Undertook work for Scottish Water to assess local geomorphological behaviour of the River Enrick channel system in the vicinity of the wastewater outlet, including the interaction between channel migration and the position of the outfall pipe, relevant to the question of channel mobility within The Cover.

Local knowledge. Dr Moir lives locally to the SAC and visits the area frequently, including recreationally. The area has been of continuing geomorphological interest to him because of the dynamic interaction of two gravel-bed rivers within an alluvial fan and delta setting. His familiarity with the site is therefore not limited to general local knowledge, but is supported by more than a decade of professional assessment, historical channel-position analysis, field observation and continuing personal engagement with the geomorphology of The Cover and the contributing Enrick and Coiltie systems.

This previous work provides important site-specific context for the present assessment. It supports the interpretation of UBW SAC as an active and laterally mobile alluvial-lacustrine system rather than a static loch-margin environment, and underpins the substrate and connectivity reasoning developed in the sections that follow.

4.4 Geomorphological setting

Urquhart Bay Wood SAC occupies a dynamic alluvial and deltaic setting at the confluence of the River Enrick and Coiltie Burn with Loch Ness. The lower SAC margin has been formed by continual sediment transport, channel migration, avulsion and local reworking by loch-margin processes.

The Enrick and Coiltie systems deliver sediment to the bay during flood flows. The coarser sediment fraction is deposited in the active fluvial and deltaic parts of the system, while finer sediment is more likely to accumulate in lower-energy settings closer to the loch margin, in abandoned channels, and in local wetland areas. The resulting substrate is therefore expected to be highly heterogeneous through The Cover area but with a network of coarse-bedded channels (some active, some relict, some now buried) cutting through to the loch shoreline, therefore providing conduits of high hydraulic conductivity.

While the observed sedimentary heterogeneity includes the presence of fine material, the important question for NatureScot's query is whether this size of material occurs as laterally extensive, continuous lenses capable of materially impeding drainage across the lower SAC margin.

4.5 Field observations on substrate composition

Across the wider lower-margin band, away from the immediate shoreline fringe, the field observations show a consistent picture. Channel-bank exposures at locations within the band of interest but set back from the loch consistently revealed predominantly cobble, gravel and sand-sized reworked alluvial material. Although present, there was less evidence of laterally extensive fine-grained deposits further away from the loch shoreline.

Figure 4 - Exposure of coarse sediment (predominantly cobble and gravel) overlaying a deposit of finer material (sand and silt) in an eroding channel bank within the proposed inundation zone but set back from the loch shoreline. This composite sedimentary character of the banks reflects the highly dynamic fluvial environment of the site, with continual changes of dominant geomorphic process (and, therefore, sedimentology at a particular location).

Closer to the loch margin and in lower-energy settings, finer sediment was more common but still not continuous. This is consistent with the expected transition from a dominantly fluvial environment, where coarser material is transported and deposited during flood flows, to a fluvial-lacustrine margin where lower-energy conditions allow finer material to settle locally.

Figure 5 - Exposure of finer sediment (sand and silt) overlaying and adjacent to a deposit of coarser material (cobble and gravel) in an eroding channel bank close to the loch shoreline. Again, this composite sedimentary character of the banks reflects the highly dynamic fluvial environment of the site, with continual changes of dominant geomorphic process (and, therefore, sedimentology at a particular location).

A particularly informative observation in the 26th and 27th April walkover surveys was the identification of a number of channel bank exposures showing a varied sequence of stratigraphy in the deposited sediment: in one specific example (Figure 6), approximately a metre of gravel is sandwiched between finer sediment layers above and below. These observations indicate that, while fine sediment deposits/ lenses do occur, coarse material (likely reflecting previous channel courses) also tends to be present nearby (either vertically or laterally). The evidence suggests that the highly dynamic character of the site provides a complex coarse-bedded channel network, whether current, historical or palaeo, that cuts through any deposits of fine sediment and, thereby, provides porous and permeable conduits. The pattern observed across available exposures was that channel avulsion and reworking have interrupted finer layers and introduced gravel pathways through the sequence.

In Dr Moir's professional geomorphological judgement, this pattern is significant because it is not simply a record of isolated sedimentary deposits. Rather, it is consistent with the expected sedimentary architecture of an active alluvial fan and delta subject to repeated channel migration, avulsion and reworking. On that basis, the observed interbedding of finer and coarser material is interpreted as evidence of a complex fluvial environment that has persisted through the Holocene and indicative of high hydraulic connectivity through the lower margin, rather than as evidence of laterally continuous fine-grained layers capable of controlling drainage across the SAC frontage.

Figure 6 - Sediment exposure on the lower Coiltie (within the inundation zone) exhibiting a sequence of finer-coarser-finer material with depth, demonstrating the complex depositional environment through the site, relating to the highly dynamic interaction of the two rivers and the loch.

The April 2026 walkovers validated the geomorphological interpretation set out in the initial assessment. Fine sediment deposits were observed in a number of locations but these were consistently associated with adjacent or interbedded coarse sections. This supports the interpretation of a heterogeneous alluvial sequence with repeated channel reworking that provides high hydraulic conductivity coarse sediment conduits, rather than a continuous fine-grained barrier across the lower SAC margin.

The field observations therefore support the presence of local fine-grained deposits within the lower margin. They do not, however, support the presence of extensive or continuous fine-grained lenses across the alluvially influenced lower SAC margin at a scale that would be likely to significantly impede drainage. The observed pattern is better interpreted as a heterogeneous alluvial substrate, with local finer deposits occurring within an overall framework of coarser alluvial material reflective of previous channel locations that provide surface and subsurface flow paths.

4.6 Shoreline fining and the wider lower-margin band

The presence of more finer material close to the loch shoreline is expected and does not, in itself, demonstrate a wider impeded-drainage condition. Fining towards the loch margin is a normal feature of this type of fluvial-lacustrine transition. As flow energy reduces towards the loch edge, finer material is more likely to settle in marginal, abandoned or low-energy areas.

Across the broader alluvially influenced zone, the field evidence indicates a mixed substrate dominated by coarser alluvial material in active and formerly active channels, with local finer deposits in lower-energy locations (past and present). The available field evidence does not indicate that the finer shoreline material forms a laterally continuous layer across the lower SAC; rather, it is locally very variable in lateral extent, bisected by coarse sediments reflecting current and past channel locations.

This distinction addresses the core of NatureScot's query. Fine material is present locally, particularly near the loch margin, but there is no field evidence that it is laterally extensive enough to control drainage behaviour across the lower-margin band as a whole.

4.7 Alluvial fan / delta process and hydraulic connectivity

The field interpretation is supported by the geomorphological setting. Urquhart Bay Wood SAC lies within an active alluvial fan and delta system at the confluence of two dynamic river systems. The Enrick and Coiltie have migrated and avulsed across the area throughout the Holocene, producing a complex pattern of active, abandoned channels and palaeo channels. Dr Moir's prior historical mapping analysis identifies dominant channel positions back to 1795, with the most recent c.200 years showing repeated channel reorganisation across the SAC.

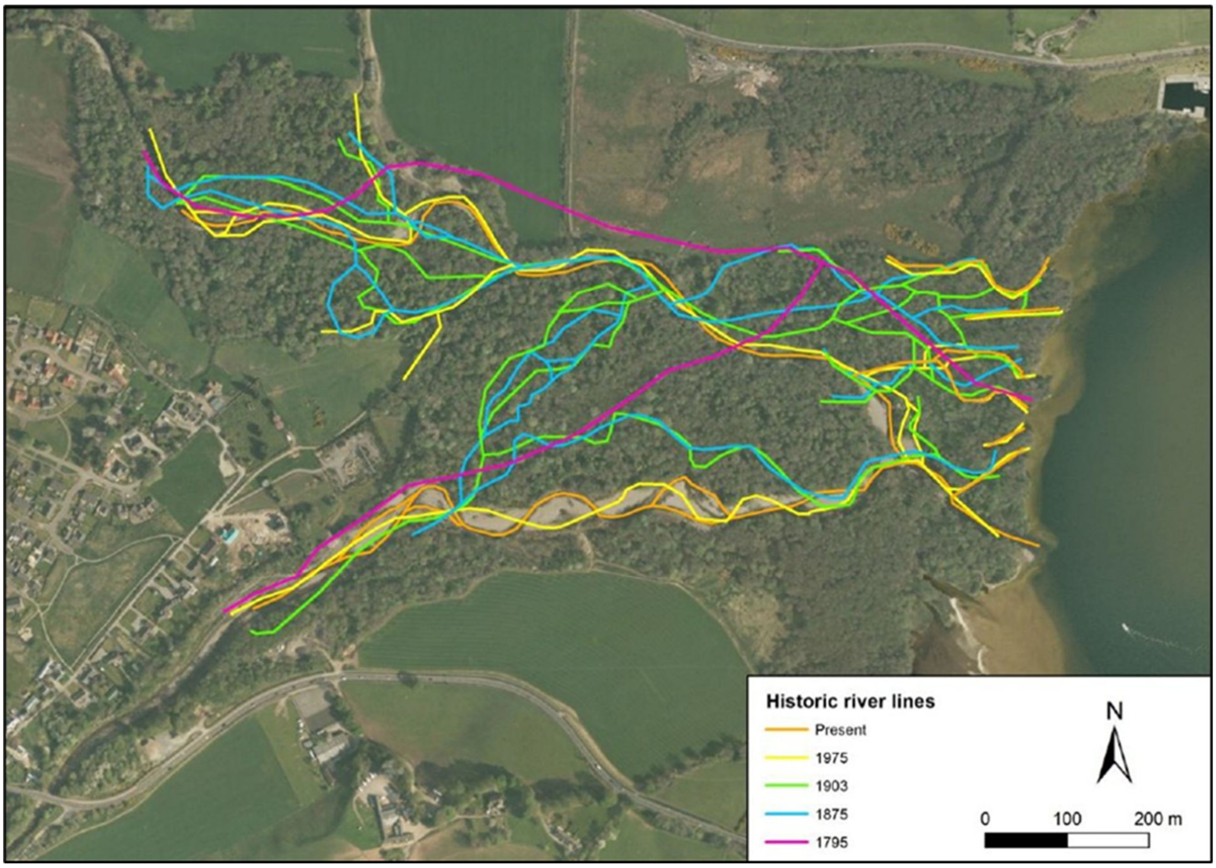

Figure 7 - Historical positions of the River Enrick and Coiltie Burn, showing channel migration and avulsion across Urquhart Bay Wood, drawn from Dr Moir's prior mapping analysis.

These channel features are important for drainage behaviour. In addition to the current active channel network, historical and palaeo-channel features provide hyporheic flow paths through the substrate, increasing hydraulic conductivity and connectivity through to the loch shoreline. The more recent (i.e. last few hundred years or so) flow pathways would be expected to cut through, rework or interrupt any extensive fine-grained deposits that may have formed in lower-energy settings. Older palaeo-channels may subsequently have been infilled by finer sediment nearer the ground surface, but basal coarse material pathways will remain and continue to function as hydraulic conduits. The 27 April walkover observation of gravel layers at depth within otherwise finer-grained sequences, noted in Section 4.5, is a direct illustration of this process. It is worthy of note that, typically, between about 10 to 30% of flow in gravel-bed rivers is hyporheic (Marttila et al., 2019), i.e. below the channel bed/ riparian surface through current and past gravel deposits; it is expected that, given the field-based sedimentary observations, this order of subsurface flow will be present through the UBW site.

In summary, subsurface flow through active and relict channel deposits is an important component of hydraulic connectivity in gravel-bed river/ alluvial fan systems. The observed presence of fine-grained sediments alone does not necessarily imply significant impediment to the drainage potential of the area; the issue is whether low permeability fine-grained deposits are sufficiently laterally continuous to outweigh the hydraulic connectivity related to the active and relict gravel bed channel network. The field observations and geomorphologic process theory evidence do not support that conclusion.

4.8 Potential influence of the historically raised loch level

A further contextual consideration is the artificial raising of the average surface elevation of Loch Ness by approximately 1.2 m in connection with construction of the Caledonian Canal and associated structures, around 200 years ago. The pre-Caledonian Canal loch-margin fine sediment deposits are now at greater depth and are therefore less likely to interact directly with the raised loch levels and inundation events related to the combined pumped storage assessment.

It is not possible, on the present evidence, to define precisely how long would be required for shoreline sedimentology to adjust fully following this historical step-change in loch level. Recovery or re-establishment of shoreline sedimentary structure depends on long-term rates of sediment transport and supply from the Coiltie and Enrick, which have been and continue to be significant in recent years.

The point is therefore treated as supporting context rather than as a primary basis for the conclusion. Even allowing for uncertainty in recovery timescales, the historically raised loch level means that the present loch-margin zone has had much less time to accumulate fine-grained deposits at its current elevation than would have been the case under the natural shoreline over the majority of the Holocene (i.e. last 11,000 years or so). This may limit the depth and continuity of any fine-grained deposits at the current shoreline, a situation that is consistent with the field-based observations discussed above.

4.9 The distinctive north-eastern sector

The north-eastern sector of the SAC has a distinctive local character compared with that of the near-shoreline area to the south and warrants brief separate treatment. This area includes a low-lying wetland area set behind a generally higher, but discontinuous, loch-facing margin, with localised wetland vegetation, including the mapped S28 *Phalaris arundinacea* reed canary-grass swamp. This should not be interpreted as a continuous raised beach, berm or dune feature; rather, the available field observations and LiDAR indicate a locally variable loch margin, with areas of lower, wetter ground set behind parts of the frontage. The main active fluvial channels of the Enrick and Coiltie do not currently directly influence this part of the SAC. Rather, the area is only influenced by drainage from the east and east-north-east via a small burn that discharges into the north-west corner of the area. Dr Moir's prior historical analysis demonstrates that there is unlikely to have been significant flow of the Enrick and/ or Coiltie into this northern area of the SAC since at least 1795 (i.e. before the significant raising of loch levels related to the construction of the Caledonian Canal). However, field evidence and high resolution LiDAR-derived topographic data reveals the presence of palaeo-channels through the area to the immediate west of this northern part of the SAC, identifying that fluvial processes were historically important here.

Field observation also identified bunding and localised bank protection along the roughly west-east and south-north boundary to the SAC, north of the current Enrick channel, intended to keep flood flows and channel migration out of the historically occupied area to the north. This supports the interpretation that the north-eastern area of SAC has been relatively disconnected from active fluvial processes compared with the rest of the SAC, a situation that has likely significantly impacted the physical and ecological condition here.

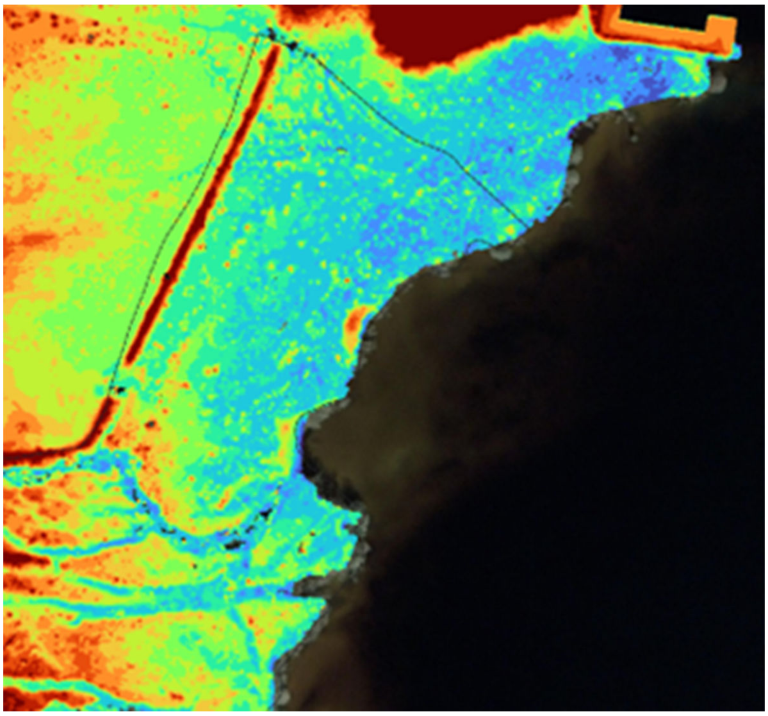

Figure 8 - LiDAR extract showing the north-eastern wetland feature set back behind the loch-facing margin. LiDAR data overlaid on Esri World Imagery (March 2026). Contemporary imagery: Esri World Imagery. Sources: Esri, Maxar, Earthstar Geographics, and the GIS User Community.

This area is demonstrably different in character to the rest of the near-shoreline region of the SAC. It has experienced a longer interval since there has been active fluvial reworking and associated sediment deposition compared to the southern and central parts of the SAC. There is therefore a relative lack of fluvial deposition in this area, which has resulted in a generally lower ground elevation compared to the shoreline areas to the south and an associated greater accumulation of organic material and extent of wetland environment. As such, it would not be appropriate to treat it as representative of the wider SAC frontage.

It is therefore proposed that the less recently active alluvial channel network adjacent to this area is responsible for slower drainage and wetland development, relating to a combination of lower hydraulic conductivity and lower elevation relative to the area of the SAC to the south. This is consistent with the pattern of active and more recently relict channels across the remainder of the SAC, which supports increased hydraulic connectivity and higher elevation through the near-shoreline area.

The north-eastern sector is also relatively sheltered from the principal wave-energy directions affecting Urquhart Bay. As noted in Section 3, Strone Point and the configuration of Urquhart Bay substantially shelter the SAC part of the loch frontage from the predominant south-westerly wave climate. The remaining principal exposure is from north-easterly winds aligned along the Great Glen, but within that exposure case the northern part of the SAC is proportionally less exposed than the more open central and southern parts of the SAC frontage.

Furthermore, the wetland within this area is located behind an intermittent relatively raised zone at the immediate loch shoreline (likely a wave-deposited beach deposit); it is therefore set back from the loch margin and does not form the loch-facing edge of the SAC. The observations made during the April 2026 walkovers identified organic material within the inland wetland area and superficial lacustrine deposits at the loch margin, but did not provide exposed sections from which the underlying substrate in this sector could be directly observed.

The north-eastern sector is therefore best understood as a localised area of distinctive character within the SAC: disconnected from the active fluvial system, resulting in a generally lower elevation that has encouraged wetland development behind a slightly elevated loch margin deposit. It should therefore not be treated as evidence that the wider SAC frontage is characterised by laterally extensive impeded drainage. The interpretation of the relatively high hydraulic conductivity developed for the near-shoreline area of the SAC to the south is therefore not altered by the character of this sector.

A reasonable worst-case ecological consideration of any localised slower drainage in the north-eastern sector, which as noted in the previous paragraphs has not been subject to recent fluvial re-working, is addressed in the AECOM Technical Note provided at Appendix B. Appendix B concludes that any change would remain limited in extent, would involve expansion of wetland communities already present within the SAC's dynamic alluvial ecosystem, and would remain within the range of acceptable within-feature change, without an adverse effect on site integrity.

4.10 Relevance to drainage behaviour following inundation

The lower elevation SAC margin is hydraulically connected to Loch Ness. In the extensive network of coarser alluvial sediment, pore-water levels would be expected to respond to falling loch levels, with efficient drainage occurring as the loch recedes. Drainage behaviour will vary locally according to microtopography, specific sediment composition and proximity to active or relict channels, but the field evidence does not indicate a laterally extensive impeded-drainage condition across the general loch-facing margin.

Although the lower SAC margin should not be considered as uniformly coarse/ free-draining at all locations, it is a highly heterogeneous alluvial environment with a complex sequence of active and relict coarse-bedded channels with local fine-grained deposits. The available field and geomorphological evidence does not support the presence of continuous lower-permeability layers across the wider lower-margin band that would materially impede drainage and result in persistent growing-season waterlogging across the lower SAC margin under the proposed loch level regime.

Because the reasonable worst-case ecological assessment in Appendix B does not predict structural de-vegetation of the loch-facing margin, it does not introduce a drainage-related pathway by which root reinforcement or vegetative energy dissipation at the margin would be removed. The substrate and ecological evidence taken together therefore support the continued operation of the vegetated margin, including its root-reinforcement and wave-energy dissipation functions, under the proposed regime.

4.11 Conclusion on substrate permeability and drainage behaviour

On the basis of geomorphic/ sedimentology theory, the photographic observations recorded on 4 April 2026 and reviewed by Dr Moir, the field walkovers undertaken on 26 and 27 April 2026, and Dr Moir's prior site-specific geomorphological understanding of Urquhart Bay Wood, the following interpretation of the alluvial and deltaic conditions are drawn:

- The lower SAC margin is a heterogeneous, alluvially influenced environment that reflects the interaction of active and former coarse-bedded channels, deltaic deposition, loch-margin processes and local wetland development.
- Coarser alluvial material (i.e. predominantly cobble and gravel) is present within the active and formerly active fluvial parts of the lower margin, with finer sediments tending to be more common (but not continuous) closer to the loch and in lower-energy settings.
- Fine-grained deposits are present locally, particularly near the loch margin and in local wetland and abandoned-channel settings. However, the field evidence does not support the presence of extensive or continuous fine-grained lenses across the general lower SAC margin at a scale that would materially impede drainage between inundation events.
- Fining of sediments towards the shoreline is an expected local depositional process and should not be treated as representative of continuous substrate character across the lower-margin elevation band.
- The extensive active and relict coarse-bedded channel network provides hydraulic connectivity through the lower margin and limits the potential for continuous drainage-impeding fine-grained deposits to persist across the alluvially influenced zone.

- The historically raised loch level, associated with construction of the Caledonian Canal and associated control structures around 200 years ago, provides supporting context, in that the current loch-margin zone has had less time to accumulate fine-grained deposits at its present elevation than would have been the case under a natural shoreline elevation.

- The north-eastern sector is a distinctive local wetland feature, influenced by artificially constrained alluvial processes and a resultant lower ground elevation. It appears to be the principal area within the SAC where local slower drainage and wetland development are materially relevant. However, it should not be regarded as representative of the condition of the general SAC frontage, which does not exhibit laterally extensive impeded-drainage.

- The substrate evidence supports the conclusion that the general near-shoreline area is hydraulically connected with Loch Ness and is expected to drain relatively freely following inundation, with local variation reflecting sediment character and microtopography.

The ecological implications of a reasonable worst-case assumption of localised slower drainage are addressed separately in the AECOM Technical Note at Appendix B.

This addresses NatureScot's 2 April 2026 query on substrate porosity and the potential presence of lower-permeability fine-grained lenses, and does not indicate a credible substrate-based pathway for growing-season waterlogging through drainage lag across the lower SAC margin as a whole.

5. Historical and observed shoreline behaviour

5.1 Purpose of this section

This section addresses NatureScot's request for consideration of whether the loch shore at Urquhart Bay Wood SAC has been retreating, and whether any such retreat could relate to altered loch levels, increased wave height or duration, or changes in fluvial sediment supply within the catchment.

The purpose is not to demonstrate that the SAC margin is static. Urquhart Bay Wood is a highly dynamic alluvial and deltaic system, and local erosion, deposition, channel movement, tree fall, root exposure, large woody material accumulation and local re-establishment are all expected features of such a setting. The relevant question for this assessment is whether the available historical mapping, aerial imagery and site observations indicate sustained and general net retreat of the vegetated SAC margin.

This section therefore tests the observation raised in Section 3, that the existing vegetated margin currently accommodates the baseline alluvial processes and wave-energy distribution without material net retreat.

5.2 Historical map sequence

The historical map sequence has been reviewed using the 1870, 1901 and 1974 surveyed Ordnance Survey mapping, compared against March 2026 satellite imagery. The comparisons are used to identify broad patterns of shoreline behaviour, recognising the limits of historic map accuracy, survey method and shoreline interpretation. They are not used to infer precise metre-scale changes at specific locations.

Figure 9 - 1870 surveyed (1893 published) Ordnance Survey mapping overlaid on March 2026 satellite imagery. Historical Ordnance Survey mapping reproduced with the permission of the National Library of Scotland from digital images supplied under order maps513011: Inverness-shire – Mainland XXIX.12 (Combined), 1893 (georeferenced in QGIS). Overlaid on Esri World Imagery (March 2026). Sources: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Figure contains modified map/image data.

The 1870 mapping shows a materially different river-mouth arrangement from the present day. The Enrick and Coiltie did not discharge through the present combined confluence. The Enrick discharged farther north, near to the location of the historical bund feature described above, while part of the Coiltie discharged separately farther south, with another branch having joined the Enrick upstream. The mapping also shows detached islands or landform features within the bay.

The dominant change since the 1870 survey is substantial deltaic growth/ progradation and reorganisation around the Enrick and Coiltie discharge area. The only location where there has not been advancement of the delta front is in the middle section of the north region of the SAC; this supports the assertion that historical artificial prevention of channel migration into this area has reduced sediment supply to the shore zone, resulting in a generally lower ground elevation and less delta front advancement than elsewhere in the SAC. Across the wider SAC frontage, the 1870 comparison does not indicate broad progressive erosion of the vegetated margin.

Figure 10 - 1901 surveyed Ordnance Survey mapping overlaid on March 2026 satellite imagery. Historical Ordnance Survey mapping reproduced with the permission of the National Library of Scotland from digital images supplied under order maps513011: Inverness-shire – Mainland XXIX.12, 1903 (georeferenced in QGIS). Overlaid on Esri World Imagery (March 2026). Sources: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Figure contains modified map/image data.

The 1901 mapping shows continued morphological adjustment within the bay. At the northern end of Urquhart Bay, the area between the former detached landforms and the mainland is shown as more transitional, with marshy ground rather than clearly open water. Immediately to the south, the 1901 shoreline still very closely matches that of present day, indicating very benign geomorphic processes in this area (i.e. for the reasons described above, referencing the 1870 map).

Across the central and southern parts of the bay, the Enrick and Coiltie still appear as separate or only loosely connected flow systems, with a fragmented delta and distributary channels. The comparison is consistent with deposition/ erosion processes, leading to channel reorganisation. It does not show a coherent pattern of progressive landward retreat of the vegetated SAC margin.

Figure 11 - 1974 surveyed Ordnance Survey mapping overlaid on March 2026 satellite imagery. Historical Ordnance Survey mapping reproduced with the permission of the National Library of Scotland from digital images supplied under order maps513011: NH5229-A, 1:2,500, 1975 (georeferenced in QGIS). Overlaid on Esri World Imagery (March 2026). Sources: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Figure contains modified map/image data.

By 1974, the Enrick and Coiltie had adopted a combined discharge arrangement broadly comparable with the present river-mouth configuration. North of the combined outlet to the loch, the shoreline is generally in a very similar position to present day. The principal difference between the 1974 mapping and the March 2026 imagery is further deltaic progradation around the loch outfall, mainly to the south. Therefore, this comparison does not indicate significant shoreline erosion over the intervening period of more than 50 years.

5.3 Evolution of the north-eastern area

The north-eastern area has a distinct historical development which is relevant to both shoreline behaviour and the local wetland feature discussed in Section 4 and the AECOM Technical Note at Appendix B. However, this area should not be treated as a single uniform shoreline unit. The historical mapping indicates a distinction between the southern part of this north-eastern area, where the shoreline position has remained comparatively stable, and the northern part, where former shore-parallel islands or detached landform features have become simplified and incorporated into a more continuous loch-facing margin.

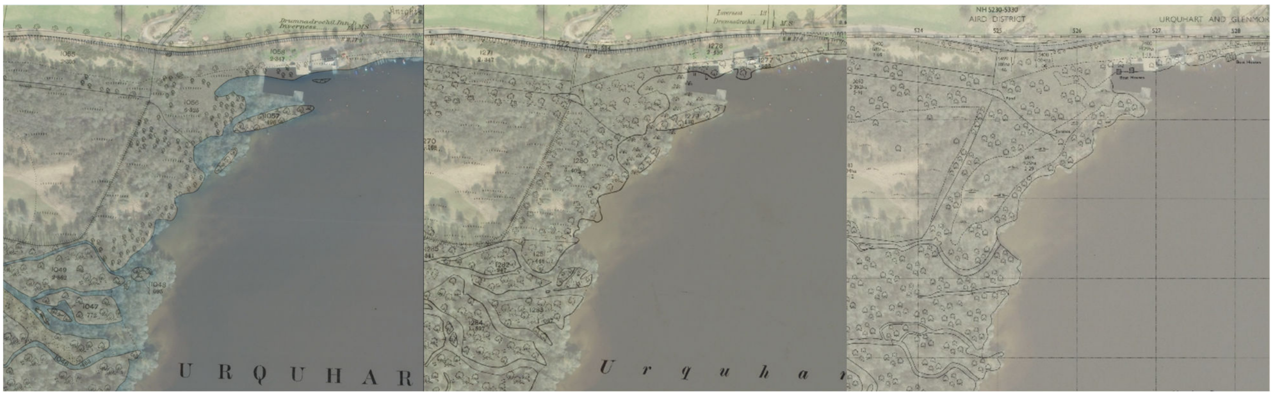

Figure 12 - Progressive map series showing north-eastern sector change between 1870, 1901, 1974 and 2026. Composite of historical Ordnance Survey mapping reproduced with the permission of the National Library of Scotland from digital images supplied under order maps513011: Inverness-shire – Mainland XXIX.12 (Combined), 1893; Inverness-shire – Mainland XXIX.12, 1903; and NH5229-A, 1:2,500, 1975 (all georeferenced in QGIS). Overlaid on Esri World Imagery (March 2026). Sources: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Figure contains modified map/image data.

In the southern part of the north-eastern area, the historical map sequence indicates little evidence of material shoreline movement between the 1870, 1901 and 1974 surveys and the March 2026 imagery. This relative stability is consistent with the interpretation set out above, namely that historical artificial prevention of channel migration into the adjacent upstream area has reduced direct sediment supply to this part of the shoreline, resulting in generally lower ground elevation and limited delta-front advancement compared with the more active central and southern parts of the SAC frontage.

In the northern part of the north-eastern area, the 1870 mapping shows narrow shore-parallel islands or detached landform features, with open or semi-open water between those features and the mainland margin. By the 1901 survey, the area between those features and the mainland is shown as more transitional, with marsh or silted ground. By the 1974 survey, the formerly detached features had become incorporated into a more continuous loch-facing margin, with low-lying wetland behind. This change is likely to reflect a combination of sediment input from the local tributary, loch-derived sediment transport, (i.e. longshore drift), and vegetation colonisation and succession.

The historical sequence therefore does not indicate a coherent pattern of progressive landward retreat in the north-eastern sector. Rather, it indicates relative stability in the southern part of this sector, and local infilling, consolidation and vegetation succession in the northern part. This helps explain the present-day character of the north-eastern sector, where the mapped S28 *Phalaris arundinacea* swamp lies behind the loch-facing woodland margin. That feature is therefore best understood as a localised wetland or infilled area behind the SAC frontage, influenced by human river engineering, local drainage and historical bay-margin development, and representing the area of the bay most sheltered with respect to relevant wave directions. It is not evidence that the wider SAC frontage is subject to laterally extensive impeded drainage or progressive erosional loss.

5.4 Summary of the historical mapping

The historical map sequence shows three consistent patterns.

First, there has generally been active deltaic progradation and reorganisation around the Enrick and Coiltie confluence, with the river-mouth area advancing loch-wards over time.

Secondly, the northern-most sector has experienced local infilling and consolidation, with former detached landforms incorporated into a more continuous loch-facing margin and wetland developing behind.

Thirdly, immediately south of the northern-most section of the SAC, the shoreline has shown no appreciable change in location since 1870. This is likely related to reduced direct sediment supply to this part of the shoreline from immediately adjacent upstream alluvial sources, as a consequence of river engineering preventing channel migration into the area west of this part of the SAC. Notably, this part of the SAC has remained stable over the 150-year period despite the lack of immediately adjacent fluvial input, indicating that the local shoreline does not depend on direct river-mouth sediment input to its own frontage to resist erosion under the existing wave regime, although it would still receive sediment redistributed within the bay from the wider Enrick and Coiltie supply.

In summary, there is no evidence of perceptible systematic landward retreat over the 150 years between 1870 and 2026 in the above mapping comparison. Localised areas of adjustment are present, as would be expected in an active alluvial fan/ delta environment, although these tend to be depositional rather than erosional.

5.5 Present-day edge features identified by NatureScot

NatureScot noted that observed alder trees shown in the March 2026 assessment, standing loch-ward of the continuous turf edge (i.e. surrounded by water) beside the north-eastern sector, with peripheral roots bare of soil and exposed to waves, could indicate erosional shoreline retreat over many decades if these trees initially grew in continuous turf. However, for this to be the case depends on the premise that the trees initially established within a continuous turf edge which has since retreated around them, which the available contemporary and historical evidence does not support.

The mapping comparison in Section 5.4 does not indicate perceptible shoreline retreat at the north-eastern sector, rather an infilling of gaps between former islands shown in the 1870 map, with no other clear change to the overall loch edge.

It is also important to note that the SAC margin is a dynamic alluvial woodland margin. Tree fall, windblow, exposed roots, partial survival of fallen trees, large woody material accumulation, local scour/ deposition and episodic regeneration are normal features of this environment. These processes are visible within the SAC more generally, including along the river channels and within the woodland, not only at the loch-facing edge. Fallen trees and woody debris also form part of the natural physical process regime of the area and are important for the habitat structure of the alluvial woodland.

Alder may establish on locally raised areas such as sediment bars, large wood material, tussock-forming vegetation and other depositional surfaces within a dynamic margin. Some of these surfaces may be temporary and subsequently erode, while others may become stabilised by vegetation and root development. This is consistent with local alluvial and lacustrine adjustment and not, in itself, evidence of sustained net retreat. It does however indicate the considerable tolerance of alder in this SAC to inundation, given that these low-lying alders were observed to be budding (i.e. growing, rather than senescing).

In summary, there is no evidence of perceptible shoreline retreat from the mapping comparison in Section 5.4, including in the vicinity of the observed alders surrounded by water, over a period in excess of 150 years. If these alders have resulted from erosional retreat, it is to a degree that is insignificant over this long period.

5.6 The 2005 to 2023 aerial comparison

NatureScot noted that comparison of 2005 and 2023 aerial imagery appears to show some loss of trees from the edge, but not enough to confidently identify retreat over that period. That characterisation is accepted.

Individual tree loss over an 18-year period is not unexpected in mature alluvial woodland. Tree mortality, windblow, local undercutting, and regeneration can all produce visible change at the local scale. However, such change is not the same as systematic retreat of the vegetated margin.

The longer historical record as set out in Section 5.4 provides the more relevant test of sustained shoreline movement. In particular, the close correspondence between the 1974 mapped shoreline and the March 2026 imagery across much of the SAC frontage[2] does not support a conclusion of sustained landward retreat.

5.7 Fluvial sediment supply

NatureScot raised the possibility that any historical shoreline retreat, if present, could relate to changes in fluvial sediment supply within the catchment, including possible effects from forestry operations.

The mapped and observed morphology is consistent with a shoreline system strongly influenced by sediment availability from the Enrick and Coiltie, and by local redistribution of that sediment within the bay. Where active river input is present, the historical mapping and present shoreline form indicate deltaic progradation and accretion rather than retreat. Wave activity in this setting should therefore not be equated automatically with erosion: where sediment is available, waves may redistribute sediment across the nearshore profile and contribute to local adjustment of the foreshore. Sediment supply from the Enrick and Coiltie remains active, notwithstanding historical local constraints on channel migration. The bay is therefore best understood as a sediment-supplied fluvial-lacustrine margin in which wave forcing operates within a continuing sediment-supply context, rather than as a shoreline whose form is controlled by wave erosion alone.

It is accepted that upstream land use does influence sediment delivery from the Enrick and Coiltie. However, the historical mapping and imagery do not show a pattern of material net retreat of the vegetated SAC margin requiring attribution to reduced sediment supply. Indeed, the current condition of the downstream fluvially-influenced zone of the SAC suggests significant accumulation of sediments, likely reflecting increased supply from upstream areas in recent decades. The observed pattern is one of continuing alluvial and deltaic dynamism, including channel reorganisation, local erosion and deposition and broad persistence of the vegetated SAC frontage.

In the absence of a mapped pattern of sustained retreat, detailed attribution of sediment-supply variation to individual upstream land uses is not necessary for the present assessment. The historical shoreline position record does not suggest an erosional trend that requires explanation by reference to reduced upstream sediment supply. The available morphological evidence is more consistent with continuing sediment delivery from the Enrick and Coiltie supporting the broadly depositional character of the bay. This supports the overall interpretation of Urquhart Bay as a sediment-supplied fluvial-lacustrine margin in which wave action redistributes available sediment locally, rather than driving progressive net retreat of the vegetated SAC frontage.

5.8 Conclusion on historical and observed shoreline behaviour

The historical and observed shoreline evidence does not indicate material net erosional retreat of the vegetated SAC margin under the existing regime. The 1870, 1901 and 1974 map sequence shows substantial alluvial and deltaic reorganisation, particularly around the Enrick and Coiltie confluence, and local infilling and consolidation in the north-eastern sector. Across the wider vegetated SAC frontage, the record shows general progradation rather than systematic landward retreat.

The present-day features identified by NatureScot, including exposed alder roots and individual tree loss, are consistent with local dynamics within an active alluvial woodland. They do not, individually or collectively, demonstrate sustained progressive retreat of the vegetated SAC margin, as no evidence of this can be found from the mapping and air photo imagery.

This supports the conclusion drawn in Section 3: the existing vegetated margin is accommodating the baseline wave-energy distribution without material net retreat and provides a relevant basis for comparison with the modified operating regime with respect to any erosion risk concerns.

[2] Excepting areas of loch shoreline progradation.

6. Integrated conclusion

The integrated conclusion drawing the wave-energy, substrate, ecological and historical-shoreline evidence together is set out below.

Erosion is governed by exceedance of a critical hydrodynamic threshold rather than by residence time at elevation. (Section 2).

The Simon Grey analysis (Section 3, with full methodology at Appendix A) shows that the proposed cumulative hydraulic regime redistributes dissipated wave energy across a broader elevation range, without exceeding, at any elevation band above the vegetated margin, the no-erosion hydrodynamic threshold assessed based on the baseline wave energy in the 15.8 - 15.9 m AOD band.

The existing shoreline provides the site-specific reference associated with this threshold wave energy level, as evidenced by the absence of material net retreat over the historical record. This is supported by the historical shoreline assessment in Section 5. The increased-exposure zone, where the proposed regime results in higher wave energies than baseline, but lower than the identified threshold, lies within the same broad qualifying woodland types as the lower-elevation margin currently exposed to threshold baseline forcing wave energy. On the wave-energy evidence, the proposed regime does not support a conclusion that erosional retreat of the vegetated SAC margin would occur.

On substrate, the field observations and geomorphological evidence (Section 4) do not support continuous lower-permeability deposits across the wider lower SAC margin. The general near-shoreline area is hydraulically connected to Loch Ness through the active and relict channel network and is expected to drain following inundation, with local variation reflecting microtopography and the distinctive character of the north-eastern sector.

The north-eastern sector is the principal area within the SAC where slower local drainage may be relevant. The wetland in this area is set behind the loch-facing margin and should not be treated as representative of the general SAC frontage. The reasonable worst-case ecological implications of localised slower drainage in this sector are addressed in the AECOM Technical Note at Appendix B, which concludes that the predicted regime remains compatible with the qualifying alluvial alderwood ecosystem without an adverse effect on site integrity. The compositional changes predicted in Appendix B would not be expected to remove the vegetation and root-reinforcement functions relevant to erosion resistance at the margin. It is also noted that this part of the SAC is the most sheltered with respect to the wave energies calculated in the wave energy analysis.

The historical and observed shoreline evidence in Section 5 provides a further empirical check, with no material net retreat of the wider vegetated SAC frontage indicated over the 1870 to 2026 period, and the present-day features identified by NatureScot consistent with local dynamics rather than systematic retreat.

The conclusion does not depend on assuming future accretion. However, the historical and morphological evidence indicates that sediment redistribution and local deposition are active components of the bay system, and that wave action in this sediment-supplied alluvial-lacustrine setting should not be equated automatically with net erosional retreat.

It is therefore concluded that the technical evidence does not introduce conditions under which the no-erosion threshold is exceeded at higher elevations and therefore does not support a mechanism for erosional retreat of Urquhart Bay Wood SAC, by way of growing-season waterlogging or wave forcing under the proposed regime.

7. Peer Review by Dr. Derek McGlashan

7.1 Scope of the peer review

This response has been peer reviewed by Dr Derek McGlashan of Saltire Sustainability Ltd. Dr McGlashan holds a PhD in Geomorphology and Law from the University of Dundee and has direct experience in coastal and lakeshore geomorphological research, consultancy and teaching. His review has covered the treatment of shoreline processes, sediment supply, sediment redistribution and coastal/lakeshore process interpretation in this response, drawing on Simon Grey's wave-energy analysis at Appendix A, contemporary aerial and drone observations of the SAC frontage, the published Ordnance Survey map record, and the shore-profile cross-section information provided by the Applicant.

7.2 Concurrence with the central technical reasoning

Dr McGlashan concurs with the central technical logic of the response. The response identifies the existing vegetated margin as sitting at approximately 15.7 to 15.8 m AOD, with the cumulative dissipated wave energy at 15.85 m AOD adopted on a precautionary basis as the relevant threshold-energy comparator. Dr McGlashan confirms that, on this basis, where the cumulative dissipated wave energies under the proposed regime at higher elevations remain below this precautionary threshold, the proposed regime would not introduce wave forcing in excess of that already accommodated by the existing margin without material net retreat over the historical record. The threshold-based comparison set out in Sections 2 and 3 is therefore technically sound.

7.3 Wave activity, sediment availability and shoreline morphology

Dr McGlashan notes that the regulatory framing of NatureScot's further advice has tended to equate wave activity with erosion. In a sediment-supplied fluvial-lacustrine setting such as Urquhart Bay, however, wave activity may also drive sediment transport, redistribution and deposition where sediment is available and the relevant thresholds for the relevant sediment sizes are exceeded. This is consistent with the Hjulström relationship between flow velocity, erosion, transport and deposition.

Drawing on the observed range of sediment sizes within the bay, the active fluvial input from the Enrick and Coiltie systems, the historical mapping record and the observed shoreline morphology, Dr McGlashan considers that the morphology of the SAC frontage is best understood as being strongly controlled by sediment availability and the spatial distribution of that sediment, rather than by wave forcing alone. This is consistent with the interpretation set out in Section 5.7.

7.4 Reduced wave forcing on the existing baseline-peak band

Dr McGlashan has also observed that, although NatureScot's further advice focuses on the potential for additional wave forcing at higher elevations, the proposed regime reduces the cumulative dissipated wave energy delivered to the baseline-peak band at approximately 15.6 to 15.7 m AOD. This is the elevation band currently taking the greatest baseline wave forcing and lies immediately below the vegetated margin.

The proposed regime represents a reduction in wave loading on the part of the existing shoreline currently most exposed to wave activity, and is a favourable aspect of the proposed regime that should be retained within the overall interpretation of erosion risk.

7.5 Foreshore bench formation and sediment redistribution

Dr McGlashan has identified, from the shore-profile cross-sections, the consistent presence of a flatter foreshore bench at approximately 15.3 to 15.5 m AOD. He interprets this as a likely natural morphological response of the shoreline to the present sediment supply and wave climate, with bench development reflecting the interaction between available sediment, wave redistribution and still-water level.

Dr McGlashan further notes that the proposed regime may make a finite additional volume of lower-elevation nearshore sediment available to wave-driven redistribution. This may provide a potentially favourable mechanism by which the foreshore profile could continue to adjust towards a protective bench form. This is not presented as a quantified prediction, and it is not necessary to the conclusion of this response. It does, however, provide further context for interpreting Urquhart Bay as a sediment-supplied system in which sediment redistribution and local deposition are important components of shoreline behaviour.

7.6 Historical resilience and system behaviour

Dr McGlashan's review also notes that the historical and morphological evidence points to a resilient bay system. The mapping evidence does not indicate material net retreat of the vegetated SAC frontage over the OS map sequence reviewed in Section 5. The wider morphological evidence is consistent with a bay that has adjusted over time to changes in sediment supply, river-mouth position, shoreline profile and loch level.

He also observes that, despite the historical raising of Loch Ness associated with the construction of the Caledonian Canal, the system has continued to support a persistent alluvial woodland margin. This supports the conclusion that Urquhart Bay Wood SAC should be understood as a dynamic and resilient fluvial-lacustrine system, rather than as a shoreline undergoing progressive wave-driven retreat.

Furthermore, Dr McGlashan notes and confirms the conclusion that the North East section of the SAC was previously a more active part of the deltaic system of the SAC, with changes made to the routing of the river Enrick prior to the raising of Loch Ness associated with building of the Caledonian Canal.

7.7 Concluding observations

Taken together, Dr McGlashan considers that the analysis presented in this response is a competent technical assessment of the matters raised by NatureScot's further advice. He concurs with the central conclusion that the proposed regime does not introduce conditions giving rise to a credible mechanism for material net erosional retreat of the vegetated SAC margin.

His review supports the interpretation that, under the proposed regime, increased water-level interaction at higher elevations should not be equated with increased erosion risk where the modelled cumulative dissipated wave energies remain below the precautionary threshold comparator, where the existing shoreline shows no material net retreat, and where the wider bay morphology is strongly influenced by continuing sediment supply and redistribution.

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Reproduced with the permission of the National Library of Scotland under CC-BY 4.0. Images georeferenced in QGIS.

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Appendix A: Wave Energy Assessment

File Note prepared by Simon Grey, AWS Ocean Energy Ltd

File Note

Ref:	FN26-002	Prepared: Reviewed: Approved:	S Grey	Date:	1 May 2026
Short title:	**Assessment of Incident Wave Energy at Urquhart Bay, Loch Ness**				

1 General

1.1 Introduction

This file note has been prepared for Glen Earrach Energy Ltd to provide an estimate of incident wave energy at the shoreline of Urquhart Bay, Loch Ness and its distribution across loch-level elevation bands under baseline and proposed water-level regimes. This report does not include interpretation of implications for shoreline stability, substrate response and vegetation condition.

1.2 Site description

Urquhart Bay is partially sheltered, with limited fetch to the south-west and longer fetch to the north and north-east. Wave exposure at the site is therefore directionally dependent, with the highest energy conditions associated with north-easterly winds aligned with the longer fetch directions. In addition, the shallow bathymetry within the bay is expected to limit incident wave energy through processes such as depth-induced breaking and energy dissipation, such that wave forcing at the shoreline is expected to be lower than at more exposed locations within Loch Ness. The shoreline profile is not uniform and includes a distinct break in slope or step feature between approximately 15.6 mAOD and 15.9 mAOD. This geometry is expected to influence the location and concentration of wave breaking, surf-zone dissipation and swash interaction under varying loch levels.

1.3 Methodology background

Wave forcing acts across a vertical zone associated with the still-water level and the prevailing wave conditions. Wave height and period govern incident wave power and the hydrodynamic forcing associated with wave motion. For the purposes of this note, cumulative incident wave energy dissipation is used as a practical comparative measure of the relative wave forcing distributed across elevation bands.

In shallow water, wave energy is progressively dissipated through shoaling, depth-induced breaking, turbulence and swash processes. Consequently, when assessing shoreline interaction, the physically meaningful quantity is not the total energy flux passing successive shoreline contours, as this would repeatedly count the same incident energy, but rather the reduction in wave energy flux between adjacent contours. This reduction represents the energy dissipated within that section of the foreshore.

Accordingly, cumulative wave energy dissipation has been evaluated as a function of elevation band for both the baseline case and the proposed cumulative regime modelled in the GEE EIAR, using 2023 loch-level data from AECOM's hydraulic modelling.

This approach is consistent with established coastal engineering formulations in which wave energy is progressively dissipated across the nearshore through depth-induced breaking and turbulence, and where the spatial gradient of wave energy flux governs the distribution of hydrodynamic forcing (Battjes and Janssen, 1978; Dean and Dalrymple, 2002).

Notwithstanding the limitations of this first-order approach, the methodology provides a consistent basis for comparing the relative distribution of wave forcing across elevation under different water level regimes.

1.4 Summary of results

In summary, the proposed regime redistributes calculated incident wave energy across a broader vertical range of elevation bands. The peak cumulative energy concentration is reduced relative to the baseline case, while cumulative energy at higher elevation bands increases relative to baseline but remains below the baseline peak cumulative energy. These outputs provide the wave-energy input used in the main Urquhart Bay Wood SAC response.

2 Methodology

2.1 Background

At any point in time on the surface of a body of water we will experience a sea-state which is a collection of individual waves with differing amplitude and frequency, all of which combine to create the observed effect. This sea-state is normally described in terms of two parameters, the Significant Wave Height (Hs) and the Peak Period (Tp). Hs corresponds (approximately) to the highest 1/3 of waves in the sea-state, and Tp corresponds to the period of the waves where the peak energy occurs in the spectrum.

Classic wave power theory provides a means of calculating the key parameters for a sea-state in deep water (Dean, 1991) based on the wind speed and fetch (i.e. the distance over the surface of the water along which the wind is blowing). The formula is:

$$H_s = \frac{U^2}{g} \cdot 0.283 \cdot \tanh\left(0.0125\left(\frac{gF}{U^2}\right)^{0.42}\right)$$

$$T_p = \frac{U}{g} \cdot 7.54 \cdot \tanh\left(0.077\left(\frac{gF}{U^2}\right)^{0.25}\right)$$

Where:

- U = wind speed (m/s)
- F = fetch (m)
- $g = 9.81$

Once we have established Hs and Tp, for the deep-water sea-state, we then apply a depth limitation to Hs as described in 2.4 and from this we can calculate the power in the sea-state and by combining this with contemporaneous level data we can calculate the total energy delivered in each elevation band.

From the above, we see that the key parameters we need to establish in order to calculate the sea-state (and hence the incident power) are wind speed and fetch.

2.2 Calculation of fetch

The fetch at a given site is direction-dependent and a function of the site geography. This is illustrated for a point at the mouth of the River Coiltie in Figure 1. Hence, with knowledge of the wind direction at a particular time we can measure the fetch for the conditions at that time. It will be appreciated that a small movement in the point of interest will change the fetch distance for a particular wind direction.

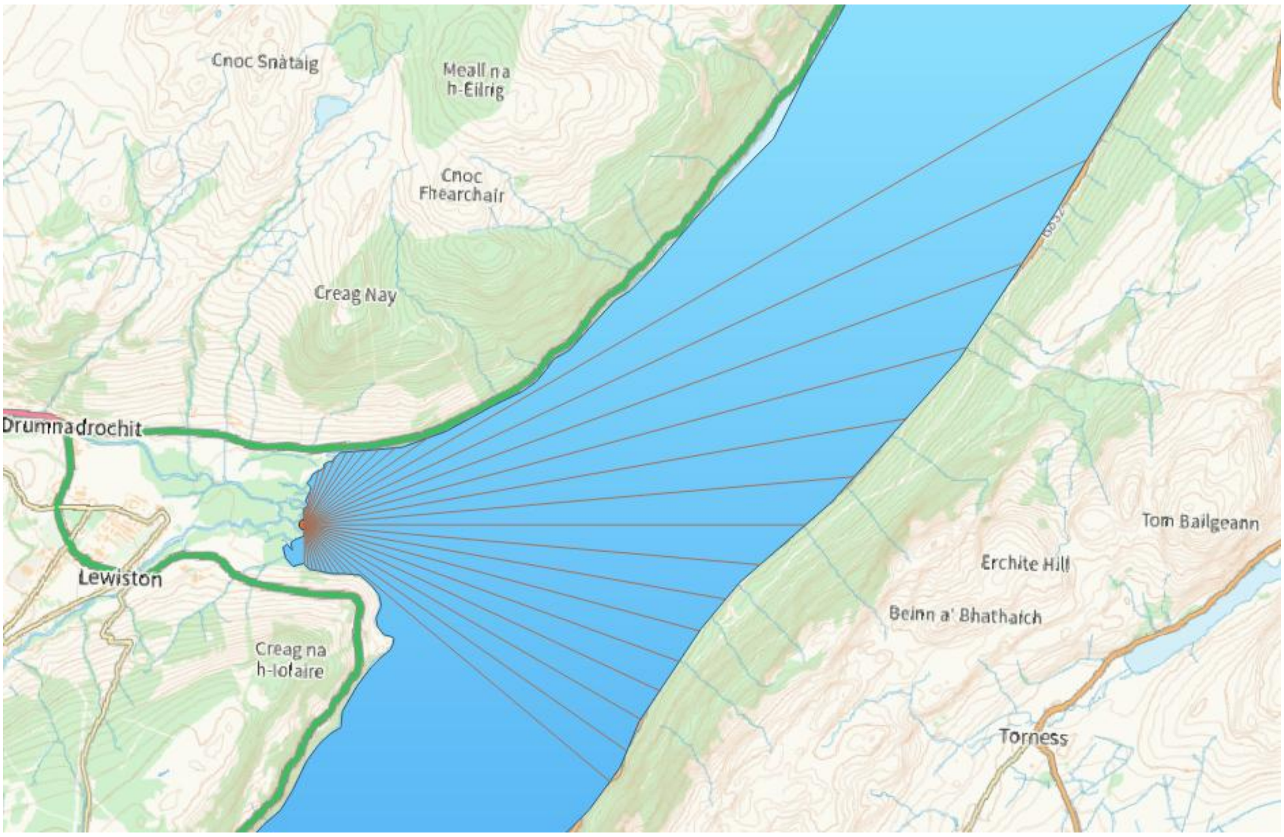

Figure 1: Fetch lines for a point located at the mouth of the River Coiltie

2.3 Wind speed and direction data

Wind speed and direction data were obtained from the European Centre for Medium-Range Weather Forecasts ERA5 reanalysis dataset for a grid point located centrally within Loch Ness at approximately the same latitude as the mouth of the River Coiltie. ERA5 provides a continuous, long-term, hourly meteorological dataset derived from a combination of observations and numerical weather modelling. A 25-year period was extracted in order to provide a representative long-term wind record against which variability between individual years can be considered.

As ERA5 data represents modelled wind fields at a standard reference height (typically 10 m above ground level) and may smooth localised extreme events, the dataset was reviewed to ensure that peak wind speeds were representative of known conditions on the loch. In order to reflect observed storm events, the wind speeds were adjusted by a uniform scaling factor such that the maximum wind speed corresponds to approximately 25 m/s, consistent with reported storm force conditions (Beaufort Force 10) known to have occurred on Loch Ness.

This adjustment affects the absolute magnitude of calculated wave power, but does not affect the relative comparison between scenarios, as the same scaling is applied consistently across all cases. The analysis is therefore presented as a comparative framework between baseline and proposed regimes.

The final step in producing the wind speed and direction dataset was to filter for 2023 only (to correspond with the available loch level data) and to check that the wind speed exceedance curve had a similar profile to the long-term dataset.

2.4 Calculation of depth-limited shoreline wave power and energy per timestep

Wave power for a JONSWAP spectrum defined by Hs and Tp is calculated using the formula

$$P = 441.Hs^2\,.Tp$$

Where:

P = incident wave power in Watt / m of wavefront

Hs, Tp are as defined above.

For the shallow-water case, we first apply the depth-limitation Hs using the elevation contour of interest together with the loch still-water elevation. Incident power is then calculated using the modified Hs value at each contour, and for each water level.

The total energy is simply the power x time in seconds. Wind speed and Direction (and hence Hs and Tp) data are hourly and hence the total energy, ***E*** in kJ is:

$$E = 3.6 * P$$

Note that the energy values calculated are a consistent comparative framework, rather than a definitive and absolute estimate of energy. Directional spreading of wave energy has not been explicitly modelled; however, for this first-order comparative assessment, the use of consistent fetch definitions across all scenarios ensures that relative differences between baseline and proposed conditions remain robust, and the omission does not materially affect the comparative conclusions. Furthermore, a simplified coefficient has been adopted in the wave power calculation, consistent with common engineering approximations of the linear wave power relationship. Again this simplification does not affect the relative assessment of results.

2.5 Calculating energy dissipation across shoreline elevation bands

To quantify shoreline interaction as a function of elevation, the shoreline profile was discretised into 0.1 m elevation bands corresponding to the surveyed or interpreted foreshore profile. This discretised approach represents a finite-difference approximation of the cross-shore gradient in wave energy flux, consistent with surf-zone energy dissipation concepts described by energy loss and set-up due to breaking of random waves.

For each hourly timestep, the contemporaneous loch level was combined with the shoreline elevation profile to determine the effective water depth at each contour.

The incident significant wave height was then limited according to the available water depth using a depth-limited breaking criterion, thereby accounting for attenuation of larger waves in shallow water.

Residual wave power at each contour was subsequently calculated from the attenuated wave parameters. The corresponding wave energy for the timestep was obtained by multiplying wave power by the timestep duration.

Because wave energy propagating shoreward is progressively dissipated through breaking and surf-zone processes, the physically meaningful quantity for shoreline interaction is the reduction in residual wave energy between adjacent contours. Accordingly, the energy dissipated within each elevation band was calculated as the difference in cumulative residual energy between successive shoreline contours.

This approach provides a practical first-order representation of the spatial distribution of wave breaking and surf-zone dissipation across the shoreline profile under varying loch levels.

3 Results and discussion

3.1 Wave power exceedance curves

A wave power exceedance curve is useful to visualise the distribution of wave power, including maximal, typical and minimum conditions. It does not, however, provide information on the coincidence of wave power with loch water level, nor provide an indication of temporal distribution. Both the long-term 2000 – 2025 and the single-year 2023 wave power exceedance curves were computed and are presented in Figure 2.

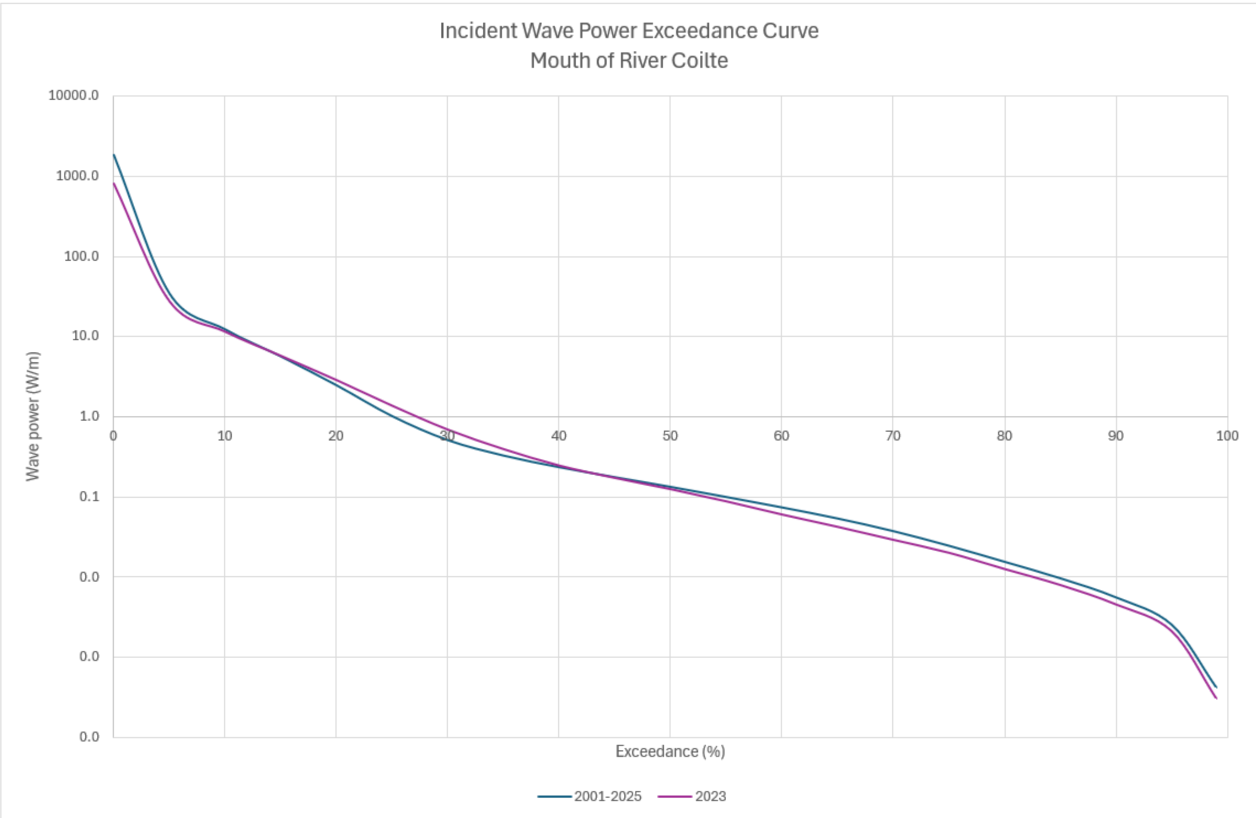

Figure 2: Wave power exceedance curves for mouth of River Coiltie

Figure 2 shows that the 2023 wave-power exceedance curve is closely representative of the long-term 2000 to 2025 distribution. The 2023 dataset is therefore suitable for the comparative baseline/proposed assessment undertaken below.

3.2 Distribution of cumulative energy per elevation band

The distribution of energy dissipation across shoreline level bands was run for two cases: the baseline case and the proposed cumulative regime as modelled in the GEE EIAR, comprising Glen Earrach Energy, Loch na Cathrach and Loch Kemp, with the Seasonal Variable Weir. The results for the representative 2023 year are presented in Figure 3.

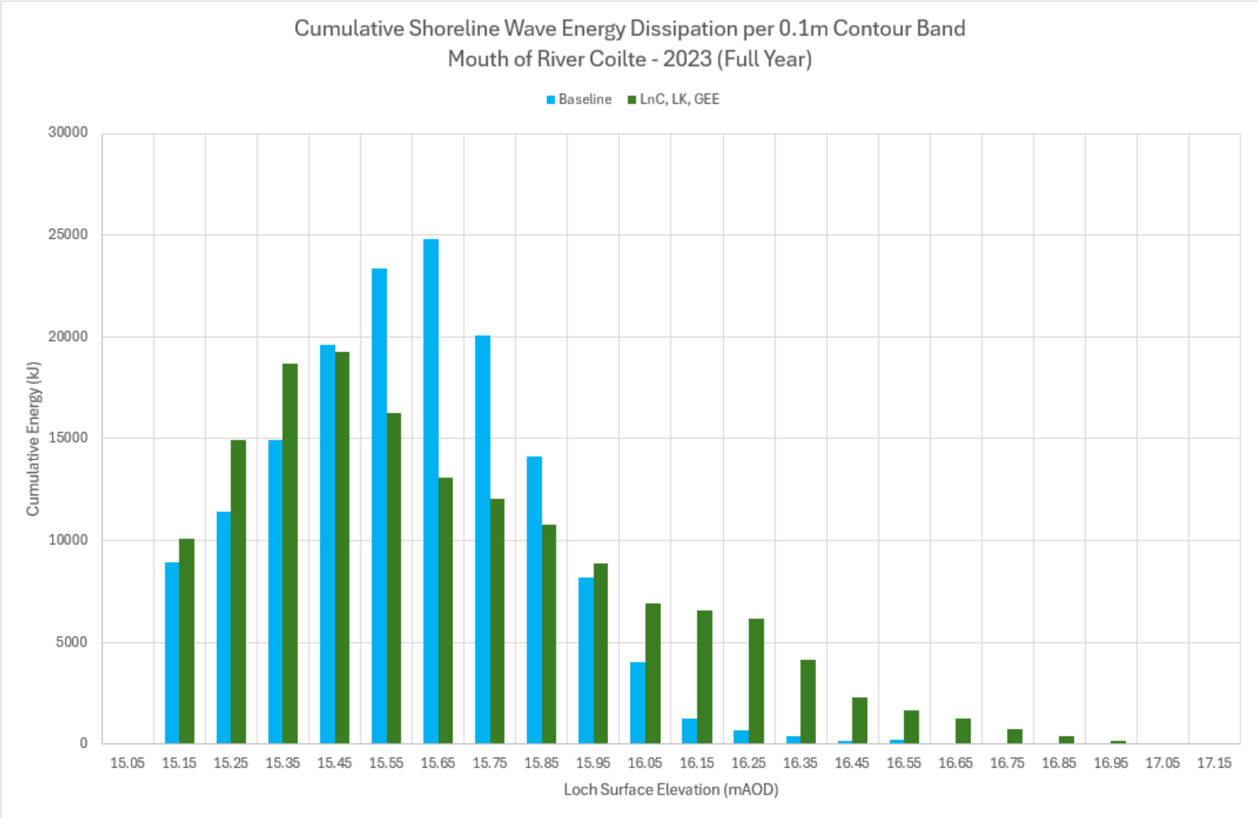

Figure 3: Cumulative dissipated wave energy by shoreline elevation band

Under baseline conditions, cumulative incident wave energy peaks in the 15.6 to 15.7 m AOD band. Under the proposed regime, cumulative incident wave energy is distributed across a broader range of elevation bands, with reduced peak concentration and increased calculated energy at higher elevations. The highest cumulative energy value in any 0.1 m proposed-regime elevation band is lower than the baseline peak shown in Figure 3.

4 Conclusions

This file note has applied a first-order, physically based methodology to estimate incident wave power at the shoreline of Urquhart Bay and to compare the distribution of cumulative incident wave energy by elevation band under baseline and proposed water-level regimes. The approach is therefore considered an appropriate first-order representation of the spatial distribution of wave energy dissipation for comparative assessment purposes, grounded in established coastal process theory.

The analysis uses the same underlying wind record, fetch assumptions and wave-calculation method for both cases. The calculated values are therefore used as a consistent comparative framework rather than as standalone absolute estimates of erosive force or as thresholds for shoreline response.

The 2023 wave-power exceedance curve is closely representative of the long-term 2000 to 2025 distribution and is therefore suitable for the comparative assessment undertaken.

The methodology accounts for depth-limited attenuation of waves across the actual shoreline profile and evaluates the distribution of dissipated wave energy between successive elevation bands. This provides a more physically representative assessment of the location of wave breaking and surf-zone forcing under varying loch levels than a simplified wave-attack-zone approach

The cumulative wave-energy-by-elevation analysis shows that, under baseline conditions, calculated cumulative incident wave energy peaks in the 15.6 to 15.7 m AOD elevation band. Under the proposed regime, calculated cumulative incident wave energy is redistributed across a broader vertical range, with reduced peak concentration and increased energy at higher elevations. The proposed-regime distribution does not exceed the baseline peak cumulative energy.

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End.

S. Grey C.Eng, MIET.
1 May 2026

Appendix B: Reasonable Worst-Case Ecological Assessment

Technical Note prepared by AECOM

Glen Earrach PSH

Response to NatureScot on Urquhart Bay Woods, May 2026

Appendix B: Technical Note – Reasonable Worst-Case Ecological Consideration Regarding Lower-Permeability Substrate

May 2026

Delivering a better world

Quality information

Prepared by	Checked by	Verified by	Approved by
ND MCIEEM Associate Director	JH MCIEEM Principal Ecologist	JR CEnv MCIEEM Technical Director	MC Principal Project Manager

Issue History

Issue	Issue date	Details	Authorized	Name	Position
1	May 2026	First issue			

Table of Contents

1. Introduction

1.1 This technical note has been prepared to address a specific aspect of NatureScot's further advice of 2 April 2026 in relation to Urquhart Bay Wood Special Area of Conservation (SAC). NatureScot requested further information to demonstrate that potential growing-season waterlogging would not be an issue at the lower margins of the SAC, stating that the substrate may not be all freely-draining and that fine-grained lenses of lower-permeability material may occur within the dynamic alluvial substrate, and that their extent was not known. Such fine-grained sediment could impede drainage between inundation events and therefore cause greater vegetational change than with freely-draining sediment. NatureScot advised that the further analysis should be based either on field-based evidence, or on transparent and justified reasonable worst-case assumptions about the presence of fine-grained lenses in the substrate.

1.2 Dr Hamish Moir's geomorphological assessment addresses the field-based substrate question directly and concludes that the lower margin of the SAC is alluvially-influenced and generally hydraulically connected to Loch Ness, with local heterogeneity but no observed evidence of laterally extensive fine-grained deposits capable of materially impeding drainage across the SAC frontage.

1.3 This note addresses the ecological implication of a reasonable worst-case position, i.e. whether reasonable worst-case extents of poorly-draining fine-sediment substrate would alter the conclusions of the March 2026 ecological assessment (regarding floristic changes of a type and scale consistent with the dynamic alluvial ecosystem such that there would not be an adverse effect on the integrity of Urquhart Bay Wood SAC).

1.4 This note is provided as a standalone technical note for cross-reference with the main response to NatureScot's further advice on Urquhart Bay Wood SAC. It should be read alongside the February 2026 AECOM ecological summary note and the March 2026 Technical Annex, particularly Section 3.3, SQ2, which addressed the compatibility of the predicted cyclic inundation regime with retention of alluvial woodland vegetation, together with the substrate and drainage assessment by Dr Hamish Moir accompanying this note.

2. Scope of this note

2.1 The purpose of this note is specifically to address the query from NatureScot regarding the possibility of fine-grained sediment lenses, and whether the presence of such localised lower-permeability substrate and associated effects on growing-season waterlogging, in a reasonable worst-case, would alter the conclusions of the March 2026 assessment, regarding persistence of qualifying alluvial alderwood, floristic changes within acceptability, and that overall there would not be an adverse effect on the integrity of Urquhart Bay Wood SAC.

2.2 The critical question is whether localised slower drainage from possible lower permeability substrate could result in sustained growing-season root-zone saturation through impeded drainage between inundation events, sufficient to cause persistent vegetation loss, or wide-scale tree loss, rather than the likely compositional changes identified in the March 2026 assessment (which included swamp expansion to a degree not considered wide-scale; and an upwards shift in the W7 / W9 transition, noting that both W7 and W9 constitute the qualifying habitat at this SAC and thus the extent of qualifying habitat is not changed by this means).

2.3 The note therefore considers:

- the substrate assumption being tested;
- the north-eastern sector of the SAC as the principal location within which reasonable worst-case changes would occur;
- the modelled cyclic inundation and drying regime;
- flood tolerance and likely floristic changes;
- the status of wetter woodland and swamp communities as part of the qualifying alluvial alderwood ecosystem; and,
- whether the March 2026 conclusion remains valid under this reasonable worst-case assumption.

3. Relevant findings from the March 2026 assessment

3.1 Section 3.3 of the March 2026 Technical Annex addressed the compatibility of the predicted cyclic inundation regime with alluvial woodland, particularly at and below approximately 15.9 m AOD. This concluded that the predicted inundation regime is not equivalent to a sustained, quasi-static summer water level or permanent growing-season saturation. Rather, the modelled regime is characterised by repeated inundation and recession events, with frequent drying intervals between inundations.

3.2 The assessment noted that the dominant inundation durations in the loch-margin area, including the lower elevation bands, are generally short. For example:

- at 16.1 m AOD, growing-season exceedance is 40.3%, with 59.7% of the growing season not inundated and drying distributed across more than 65 modelled drying events;
- at 15.9 m AOD, growing-season exceedance under the modelled in-combination scenario is 63.9%, with 36.1% of the growing season not inundated and drying distributed across more than 80 modelled drying events;
- at 15.7 m AOD, growing-season exceedance is higher, but this band occupies only 0.3% of the SAC and is already subject to substantial inundation under baseline conditions.

3.3 The March 2026 assessment concluded that, on a generally free-draining alluvial substrate, the event-duration and recovery pattern is compatible with general persistence of the qualifying alluvial alderwood and acceptable floristic change within the SAC. It was noted that this floristic change would likely include increased open swamp around the 15.9 m zone and below, of the same types already present, to a degree that would not be wide-scale (NatureScot having previously advised that some change in this regard was acceptable where not wide-scale) and compatible with the dynamic nature of the alluvial alderwood ecosystem, without an adverse effect on site integrity.

4. Reasonable worst-case substrate assumption

4.1 For the purposes of this note, and to examine whether the conclusions of the March 2026 assessment would remain unaltered, a reasonable worst-case assumption is taken that some localised areas within the lower SAC margin may be less freely draining than the general substrate assessment indicates, because of fine-grained lenses or localised wetland deposits. This is not to say that fine-grained lenses are in reality extensive across the wider SAC frontage, which would be contrary to the geomorphological assessment, which finds that the alluvially influenced SAC margin is generally free-draining and hydraulically connected with Loch Ness, with no observed evidence that fine-grained lenses are laterally extensive or continuous.

4.2 Small pockets of finer sediment associated with wetter microsites and localised waterlogging may occur throughout the lower levels of the SAC, as would be expected within a dynamic alluvial and fluvial-lacustrine margin. However, across the wider lower SAC margin, the network of active and relict channels, the predominance of alluvial substrates, and the observed microtopographic variation are consistent with a broadly free-draining and hydraulically connected setting.

4.3 On the available substrate and vegetation evidence, the north-eastern sector is the only significant identified area within the SAC where a less freely draining condition associated with fine-grained sediment might be more prevalent. As noted in the geomorphological assessment, and unlike the majority of the SAC, the north-eastern sector has not been subject to the same recent fluvial reworking by current channels of the Enrick or Coiltie. There is therefore greater potential for fine-sediment deposits here, less likely to have been recently re-worked by active river action, although palaeo-channel features are recorded immediately to the west of this part of the SAC (see Section 4.9 of the main report). It is the part of the SAC where wetter conditions and slower local drainage are most observable at the surface under the existing hydrological regime. The wetter character of this area does not itself imply that the substrate is extensively impermeable – this also reflects the low-lying position of this sector behind the loch-facing margin and inflow from the eastern burn, as set out in the main report.

5. The north-eastern sector as the principal location of reasonable worst-case vegetation change

5.1 The north-eastern sector has a distinctive local character. It includes a low-lying area with localised open vegetation corresponding to the mapped S28 *Phalaris arundinacea* reed canary-grass swamp, and the wider sector includes local occurrences of swamp species such as bottle sedge *Carex rostrata* and water horsetail *Equisetum fluviatile*. This area is also influenced by local drainage from the east and east-north-east, with a burn draining a wider hinterland area into the back of the sector. The loch-facing margin in this part of the SAC is locally variable in elevation and form, rather than comprising a continuous raised barrier. The wetter character of this area reflects its local drainage, depositional history and lack of recent fluvial reworking, rather than necessarily demonstrating an extensive impeded-drainage condition.

5.2 The mapped S28 swamp is a baseline feature of the SAC that exists under the existing hydrological regime and is part of the alluvial ecosystem. It does not extend to the immediate loch-facing SAC margin, which remains bordered by a generally continuous woodland edge. This supports the interpretation of the S28 swamp as a localised internal wetland and drainage-influenced feature within the north-eastern sector, rather than evidence that the general SAC frontage is characterised by laterally extensive, drainage-impeding fine sediment.

5.3 A further wetland area is present in the southern corner of Urquhart Bay, adjacent to existing woodland and behind the spit at the river-mouth area, mainly comprising the swamp NVC type S9 (bottle sedge swamp) with minor amounts of S14 and S28. This area falls outside the designated SAC boundary, lying on depositional material that has accumulated since the SAC was designated. It is therefore not directly relevant to change within the SAC, although it is still part of the alluvial habitat mosaic and important in representing forms of swamp that are characteristic of the present alluvial ecosystem as a whole, and small patches of similar vegetation occur in the north-eastern section near and at the loch edge.

6. Cyclic inundation, drainage and root-zone oxygenation

6.1 The potential ecological concern associated with localised lower-permeability substrate is that drainage following inundation could be slower than in the surrounding coarse alluvial deposits, potentially increasing the duration of root-zone saturation during the growing season.

6.2 However, it is important to note that even on a reasonable worst-case assumption of localised slower drainage, the modelled hydrological regime remains materially different from permanent or sustained growing-season waterlogging. This is because the predicted regime is cyclic, involving repeated inundation and recession events, with frequent intervals during which water levels rise and fall. This process provides both repeated water exchange and repeated opportunity for drainage and re-aeration.

6.3 This regular exchange is relevant to root-zone oxygenation. Flooded soils undergo progressive oxygen depletion and redox change where saturation is sustained and water becomes stagnant. The greatest ecological risk arises where waterlogging is prolonged and continuous, allowing reducing conditions to develop and persist. By contrast, the cyclic regime would repeatedly introduce oxygenated loch water into the margin during rising water levels, followed by recession phases during which exchange between surface water, pore water and atmospheric oxygen can occur. Oxygen availability would therefore be supported both by water exchange during inundation and by re-aeration during intervening recession and drying periods.

6.4 Where inundation is short or intermittent and followed by recession, the redox sequence is interrupted and oxygen availability can be restored before advanced reducing conditions become established. This is materially different from a static or semi-static waterlogged condition in which oxygen is progressively depleted without regular exchange.

6.5 The March 2026 Technical Annex identified that the most frequent inundation events are short in duration (most frequently less than 24 hours), and that drying intervals are distributed throughout the growing season. The presence of localised slower-draining substrate may lengthen effective wetting at particular microsites, which as noted above is most applicable to the north-eastern sector, but it is important to note that it does not convert the predicted regime into sustained, stagnant, growing-season waterlogging across the lower SAC margin.

7. Flood tolerance and vegetation response

7.1 The March 2026 assessment considered the flood tolerance of characteristic species present within the lower alluvial alderwood, and this remains relevant to the reasonable worst-case assumption considered here.

7.2 Alluvial woodland in the north-eastern sector of Urquhart Bay Wood SAC already exhibits a wetter expression of W7, with abundant reed canary-grass, frequent pooled water, and local patches of bottle sedge and water horsetail towards and beside the loch. The March 2026 assessment identified that a number of key species in the low-lying parts of the SAC exhibit considerable tolerance to waterlogging and periodic inundation, including alder *Alnus glutinosa*, the principal canopy species in the W7 woodland, and willows *Salix* spp. Literature was cited indicating tolerance of alder seedlings to over three weeks of submersion (noting that modelled inundation events are most frequently of less than 24 hours duration), the ability of willow species to germinate in extremely wet conditions, some whilst fully submerged, and it was noted that reed canary-grass and bottle sedge (present in and beside the SAC) are capable of growing in very wet conditions including standing water. It was concluded, with regard to the lower levels of the SAC, that there would likely be a reduction in less flood-tolerant herbs and grasses, and that around 15.9 m and below possible replacement of some alder by willow and expansion of existing open swamp that would not be wide-scale. It was not determined that the ecological response to increased wetness would be structural de-vegetation, but rather retention of vegetation subject to these floristic changes.

7.3 This remains the expected ecological response generally across the SAC, given that the geomorphological assessment finds that the alluvially-influenced SAC margin is generally free-draining and hydraulically connected with Loch Ness, with widespread fluvial re-working of the substrate by the rivers (see the geomorphological assessment in the associated Report) and no observed evidence of extensive fine-grained lenses. If the north-east sector (as the location within the SAC where fine-grained material could be more frequent, given absence of recent re-working by the rivers prevalent elsewhere in the SAC) included continuous surface fine-grained sediment over the dominant height bands in that area (16.1 m and below), and if the degree of impeded drainage was sufficient to fully prevent tree regeneration in the existing woodland across that area, then this would equate to a reduction in woodland and expansion of open swamp by approximately 1.49 ha. Taking the total area of alluvial alderwood stated on the Natura 2000 Standard Data Form of 36.18 ha, this would constitute conversion of 4% of the alluvial alderwood to open swamp (or 3.2% of the SAC area as a whole). This degree of change is not considered wide-scale and in keeping with the Conservation Advice Package (see next section) which accepts swamp as part of the dynamic alluvial ecosystem, and with NatureScot's previous advice that some such change would be acceptable. However, it is not likely that the north-east sector is impermeable to this degree, given observations of locally freely-draining superficial material at the loch edge here, and numerous scattered raised patches throughout it (visible on the fine-scale LiDAR map – see Figure 8 of the associated Report). Combined with the tolerances of alder and (even more so) willow to long-term flooding, and the factors set out in Section 6 (and in more detail in the March 2026 Technical Annex), it is not considered likely that the north-east sector would transform to this degree, and that consequently the degree of change in this way would be less.

8. Status of wetter woodland and swamp communities within the qualifying habitat

8.1 The Conservation Advice Package for Urquhart Bay Wood SAC recognises that the qualifying alluvial alderwood is part of an ecosystem that includes variation in woodland community types, and that other wetland types form part of the dynamic alluvial woodland system. It includes the statements that the alluvial alderwood "*comprises woods dominated by alder and willow [...] and low-lying wetlands alongside the channels at the deltas of the River Enrick and Coiltie*", and importantly that "*As this woodland habitat is dynamic in nature the structure and function are best maintained within a larger unit that includes the open communities, mainly fen and swamp, of earlier successional stages.*" Reed canary-grass swamp (as already exists as open habitat within the north-eastern sector), wetter expressions of W7 woodland and occurrences of other swamp species or stands are thus consistent with the dynamic alluvial ecosystem. A proportionally small expansion of open swamp (as indicated above), a potential increase in willow-dominated woodland, and floristic change towards more wetland species concentrated in the north-eastern sector, is therefore considered to remain within the range of acceptable within-feature change and compatible with the structure, functions and processes of the qualifying habitat.

9. Conclusion

9.1 On a reasonable worst-case assumption that some localised lower-permeability substrate occurs within the lower SAC margin, the ecological conclusions of the March 2026 assessment are considered to remain unchanged.

9.2 The predicted hydrological regime is cyclic, with frequent inundation and recession events rather than prolonged static growing-season waterlogging. This regular exchange of aerated water, together with repeated drying opportunity, is relevant to root-zone oxygenation and reduces the likelihood of sustained anoxic conditions developing across the lower margin.

9.3 Where localised slower drainage does occur, the expected response would be compositional change towards wetter species already present, including reed canary-grass, bottle sedge and other wetland-associated species. Such change is consistent with the March 2026 assessment and with the dynamic character of the qualifying alluvial alderwood ecosystem, noted in the Conservation Advice Package for the SAC as best maintained within a larger unit that includes open communities such as swamp. The expected compositional change would not be expected to remove the vegetation and root-reinforcement functions relevant to erosion resistance at the margin, as set out more fully in the March 2026 submission. On the available substrate evidence (see the geomorphological assessment) and vegetation evidence, the north-eastern sector is the only significant identified area within the SAC where a less freely-draining condition associated with fine-grained sediment might be more prevalent. It has not been subject to not been subject to the same recent fluvial reworking as the central and southern parts of the SAC, and is observably wetter under the existing regime. If the dominant height bands in this area (16.1 m and below) contained continuous surface fine-grained sediment that impeded drainage sufficiently to fully prevent tree regeneration, this would constitute conversion of 4% of the alluvial alderwood (3.2% of the SAC as a whole) to open swamp of types that already exist in the alluvial ecosystem. However, this is an extreme upper-bound test rather than the predicted outcome – observations of locally free-draining superficial material at the loch shore, and numerous raised patches across this area, combined with factors such as flooding tolerance of alder and willow and the modelled inundation regime, indicate that the degree of change would be less. This is considered acceptable, noting the previous advice from NatureScot that some such change would be acceptable where not wide-scale, and is in keeping with the dynamic alluvial ecosystem and the above-mentioned Conservation Advice Package.

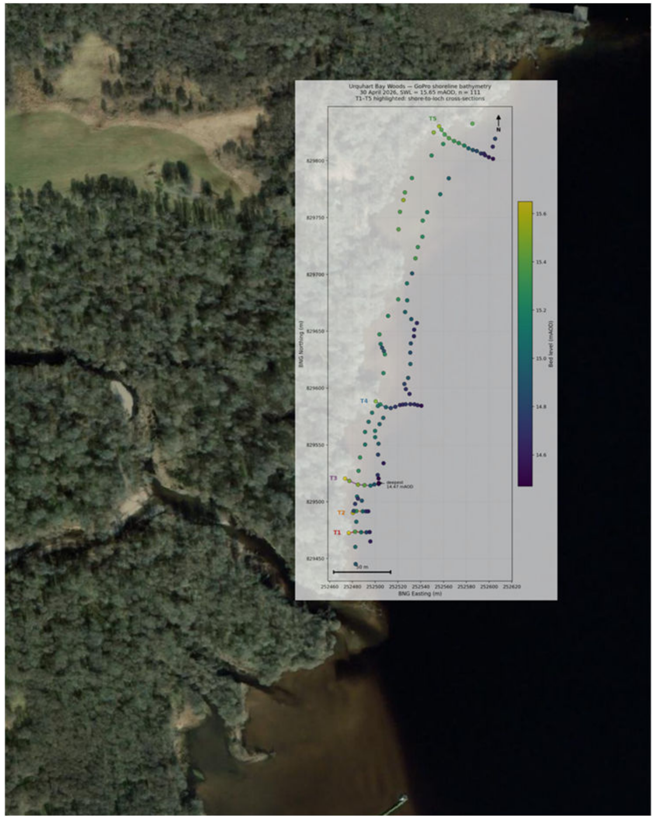
9.4 The conclusion of the February 2026 AECOM ecological summary note and March 2026 Technical Annex therefore remains unchanged: the proposed regime would not result in an adverse effect on the integrity of Urquhart Bay Wood SAC by way of vegetation loss or floristic change arising from growing-season waterlogging.

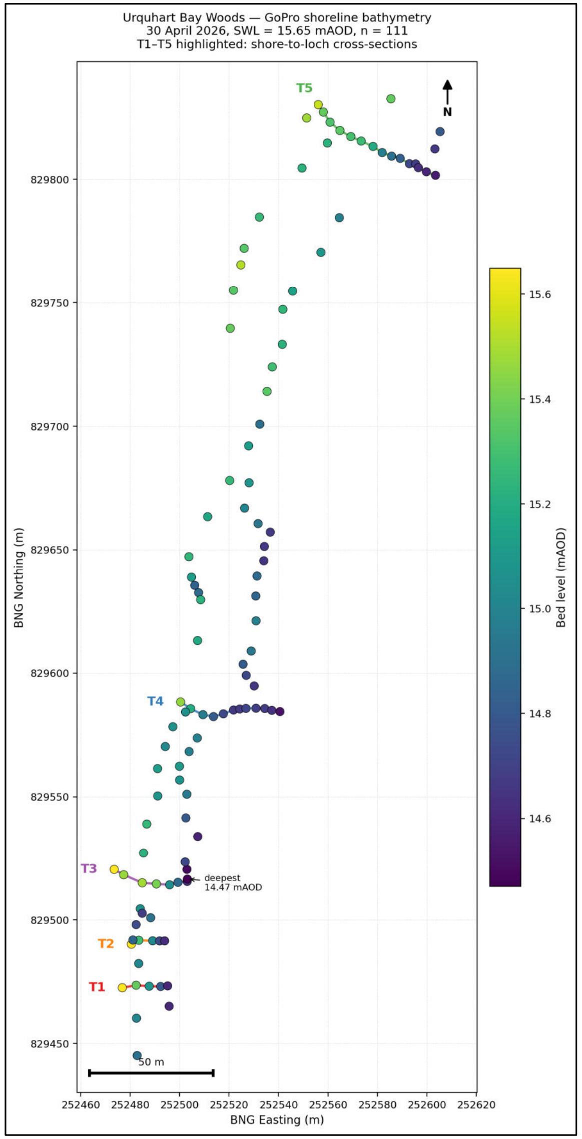
Appendix C: Nearshore Bathymetric Survey

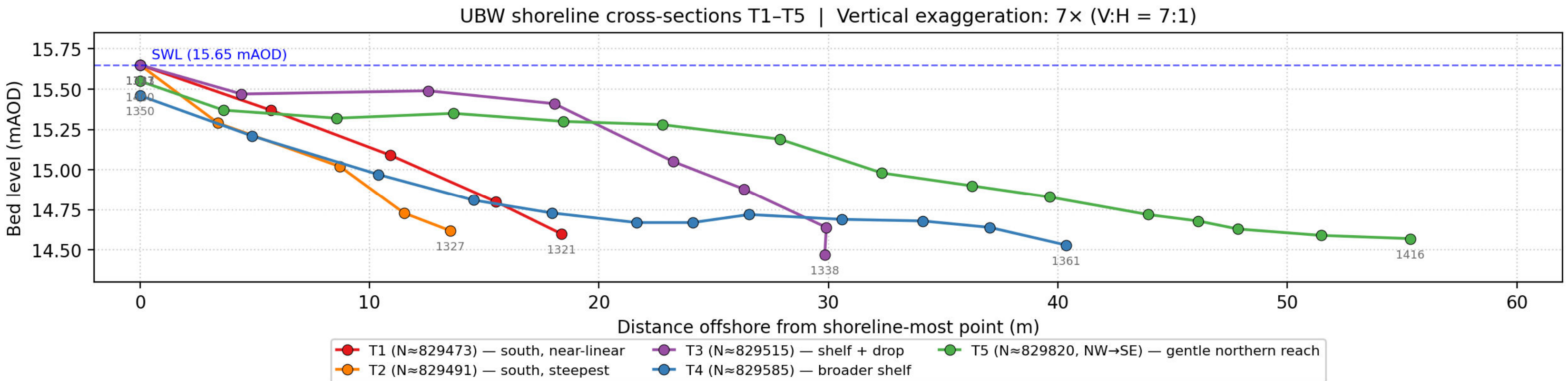
Survey output prepared by Peter MacDonald, WestGlen Consult Ltd

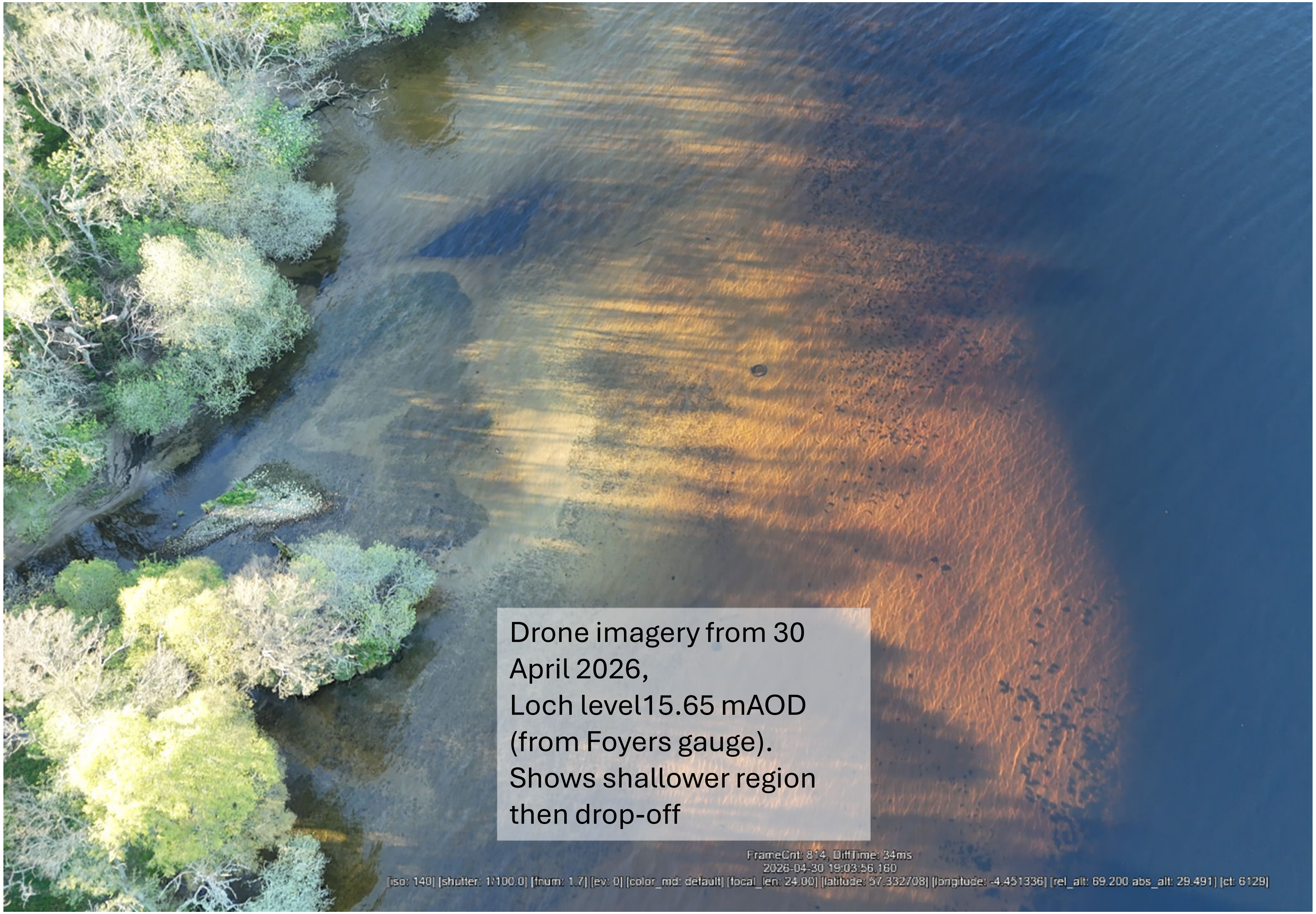
Appendix C - Depth survey of UBW SAC foreshore.

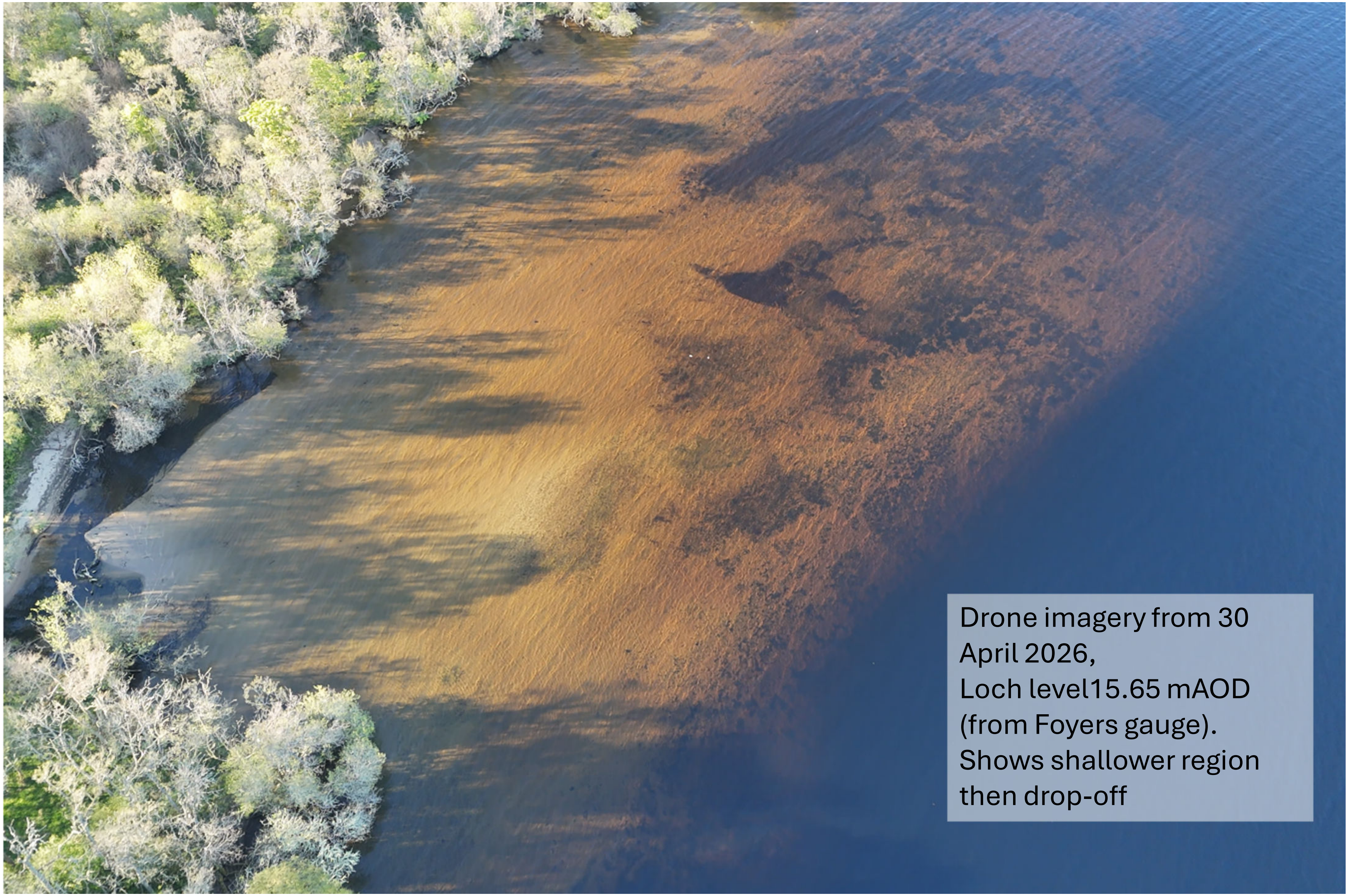
Manual nearshore bathymetric survey undertaken on 30 April 2026 with the loch at SWL 15.65 mAOD. A graduated measuring stick was waded out from the shore at 114 locations along the SAC frontage, with each reading captured as a GPS-tagged photograph on a GoPro Hero 13. 111 photographs returned a successful GPS lock.
EXIF metadata was extracted to give WGS84 coordinates for each point, converted to British National Grid (EPSG:27700), and matched to the manually-read stick depth. Bed level was calculated as SWL minus measured depth. From the resulting point cloud, five shore-to-loch cross-sections (T1–T5) were identified running broadly perpendicular to the local shoreline. GoPro GPS scatter is typically a few metres, so the survey provides a spatially-anchored characterisation of the nearshore profile and shelf-edge geometry rather than a precision survey. Cross-section profiles are shown at 7× vertical exaggeration for legibility.








Drone imagery from 30
April 2026,
Loch level15.65 mAOD
(from Foyers gauge).
Shows shallower region
then drop-off
FrameCnt: 814, DiffTime: 34ms
2026-04-30 19:03:56.160
[iso: 140] [shutter: 1/100.0] [fnum: 1.7] [ev: 0] [color_md: default] [focal_len: 24.00] [latitude: 57.332708] [longitude: -4.451336] [rel_alt: 69.200 abs_alt: 29.491] [ct: 6129]


Drone imagery from 30
April 2026,
Loch level15.65 mAOD
(from Foyers gauge).
Shows shallower region
then drop-off