FEARNA STORAGE

Fearna Pumped Storage Hydro Scheme
CAR Licence Report

Appendix G – Baseline Survey of Temperatures in Loch Quoich and the Gearr Garry

September 2025

Quality Information

Prepared by	Checked by	Approved by
Gavia Environmental and Gilkes Energy Ltd	[redacted]	[redacted]

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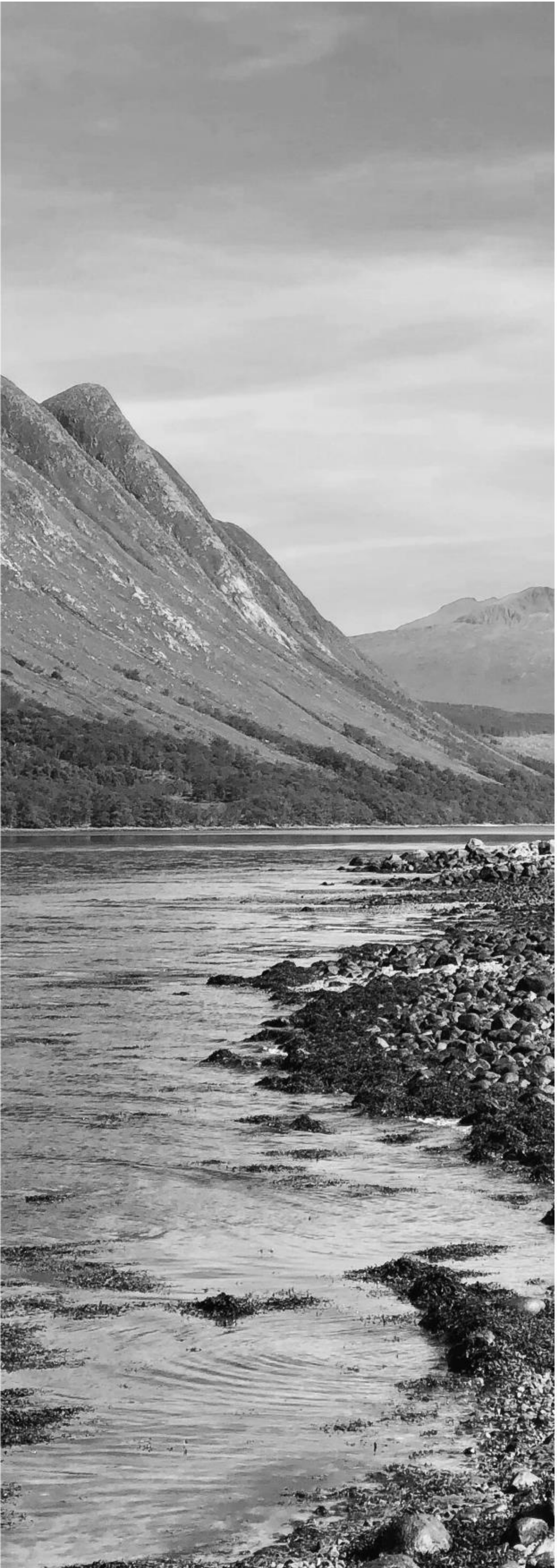
01	September 2025	Issue to SEPA	[redacted]



LOCH QUOICH & GEARR GARRY TEMPERATURE MONITORING INVESTIGATION FOR THE CAR LICENCE REPORT

FEARNA PUMPED STORAGE HYDRO SCHEME

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15/09/2025

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CAR 01	11/09/2025	[redacted]	[redacted]		**Modified for CAR Licence Application**

Quality assurance

This report has been prepared according to Gavia Environmental Quality Management Process. Gavia Environmental employs consultant scientists who are members of appropriate professional institutions and adhere to professional codes of conduct.

Disclaimer

This report is presented to Fearna PSH Ltd. in respect of Loch Quoich & Gearr Garry Temperature monitoring investigation for the CAR Licence Report, and may not be used or relied on by any other person or by the client in relation to other matters not covered specifically by the scope of this report. This report was initially prepared for an EIA submission based on the results of surveys undertaken during 2023. It has been substantially reviewed and revised based on the results of further surveys undertaken during 2024 and 2025 with consideration of the particular requirements of the CAR Licence application process.

Notwithstanding anything to the contrary contained in the report, Gavia Environmental Ltd is obliged to exercise reasonable skill, care, and diligence in the performance of the services required by Fearna PSH Ltd. and shall not be liable except to the extent that it has failed to exercise reasonable skill care and diligence, and this report shall be read and construed accordingly.

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Contents

Executive Summary

A detailed water temperature monitoring investigation has been undertaken within Loch Quoich and the Gearr Garry over a period between August 2024 and July 2025. A total of 11No. temperature sensors were deployed across five discrete locations throughout the investigation area. The investigation was designed to provide insight into the water temperature regime in Loch Quoich and in the Gearr Garry. Additional river temperature data for the Gearr Garry, River Kingie and East Poulary was provided by the Ness District Salmon Fishery Board (NDSFB) and has been used in the investigation.

The monitoring indicates that the water temperature regime in Loch Quoich appears to conform to a warm monomictic lake regime, whereby the lake stratifies into a warm buoyant shallow layer overlying a stable dense colder layer during summer and autumn. This stratification, and the corresponding thermocline collapse, leads to a well-mixed water column which persists and gradually cools during the winter and spring. A single annual mixing event was observed to occur progressively and episodically over a four-week period between late October and mid-November 2024. While not directly observed, the corresponding annual re-stratification is expected to occur between April and June.

Notable diurnal temperature variation is evident in the uppermost surface waters, this variation is strongest in summer becoming more subdued in winter. The overall water temperature regime is observed to range between approximately 4.5 °C and 19 °C. The deeper hypolimnion layer, when present, is observed to be very stable with respect to water temperature, at approximately 7 °C. Prevailing ambient air temperature, coupled with seasonal and meteorological factors are believed to be the dominant driving mechanisms of the water temperature regime observed. A significant secondary driving mechanism is the warm monomictic lake regime which occurs due to the Loch's significant size and depth.

Water temperatures are significantly more variable within the Gearr Garry than in Loch Quoich. Significant diurnal variation was observed at all monitoring locations, with the largest temperature variation range observed in the spring/summer/autumn months, and relatively modest temperature variation observed during the winter months. Prevailing ambient air temperature, coupled with seasonal and meteorological factors have been identified as the dominant driving mechanisms of the water temperature regime observed.

The investigation included monitoring location 5, 200m downstream of the outflow of the existing Quoich hydro scheme, which is conveyed approximately 4km by means of an underground concrete-lined tunnel before being used to drive a turbine-generator at Quoich Power Station. This location is downstream of the confluence of the Gearr Garry and River Kingie, and is thus affected by three incoming flows: the River Kingie, the Gearr Garry and the turbine discharges, as well as by the ambient temperature.

When the Quoich hydro station is not generating, the temperature closely matches that of the River Kingie, which is in turn very strongly influenced by the ambient temperature. There is little moderating effect from the Gearr Garry flows, unless during very dry natural flows in which case it has a small but noticeable moderating effect. There is however a significant moderating effect on water temperature when the Quoich hydro station is generating, with the $18m^3$ flow being sufficient to generate temperatures 6^{o}c warmer in winter and 8^{o}c cooler in spring than the River Kingie flow based on the overlapping period of data currently available.

1 Introduction

This investigation was undertaken to provide a baseline of the current water temperature regime within the Loch Quoich/Gearr Garry system to inform any potential temperature impacts by the Proposed Development on salmonid fisheries within and downstream of Loch Quoich.

This document has been compiled as part of a CAR Licence Report in support of the CAR Licence application.

1.1 Background

The client is proposing to construct a new long-scale long duration 1,800 MW pumped storage hydro scheme and associated infrastructure on Loch Fearna and Loch Quoich located approximately 5km northwest of Kingie Lodge, Invergarry (see **Appendix A, Proposed Development** for Red Line Boundary of development). The Proposed Development would function by transferring water between a lower reservoir, Loch Quoich, and an upper reservoir, Loch Fearna. The maximum water level of the upper loch would be increased by constructing dams to increase its natural water storage capacity.

1.2 Investigation objectives

During stakeholder consultation prior to the compilation of the EIA submission for the proposed development, a potential impact was raised regarding downstream changes in the water temperature of the Gearr Garry and other downstream waterbodies, with resulting impacts on salmonid fisheries.

As limited site-specific information on the water temperature regime in Loch Quoich and the Gearr Garry under their current conditions was available, there was a need for temperature monitoring investigation to provide a detailed understanding of the baseline water temperature regime along with insight into any interactions between the water temperature regime in Loch Quoich and the Gearr Garry, and any potential impacts of the pre-existing hydropower developments within the catchment.

The following detailed objectives for the proposed investigation were defined:

1. To characterise the baseline water temperature regime at different locations within the Loch Quoich/Gearr Garry system.
2. To characterise the baseline water temperature regime at different spatial locations within Loch Quoich relative to each other.
3. To characterise the baseline water temperature regime at different water depths within Loch Quoich relative to each other.
4. To identify any links between the water temperature regime in the loch relative to the regime in the river.

2 Catchment description

2.1 Overview

The upper Glen Garry catchment in which the proposed development is situated includes a number of relevant hydrological features, including infrastructure and modifications associated with the existing Quoich hydro scheme. The following sections summarises the key features of relevance to this temperature monitoring investigation.

A plan of the overall catchment with key locations and features indicated is presented in **Appendix B**.

2.2 Loch Fearna

Loch Fearna is a small upland freshwater loch situated at NGR: NH056031. It is situated at an altitude of 538m AOD, and occupies an area of approximately 10.3ha. The loch is fed by incident rainfall and a number of small tributaries draining from Coire Glas below Spidean Mialach (996m AOD). The loch drains steeply by the Allt Fearna into the northern bank of Loch Quoich approximately 1.1km to the south.

The size and capacity of Loch Fearna is envisaged to be expanded by a series of dams as part of the proposed development.

2.3 Loch Quoich

Loch Quoich is a very large freshwater reservoir situated at NGR: NH012025. It is situated at an altitude of approximately 201m AOD, and occupies an area of approximately 40km^2. The loch is generally oriented from west to east, measuring approximately 14km from end to end. The loch is impounded by dams at both its western and eastern extents. The loch is fed by a very large catchment area featuring many inflowing tributaries. The largest tributaries are the Abhainn Chosaidh, Caolie Water and the River Quoich system on the northern bank, whereas much of the southern bank is typified by short, steeply flowing tributaries flowing down from a west-east trending mountain chain. A number of larger tributaries flow into the southern side of Loch Quoich at its western end, including Allt Coire nan Gall, Allt a Choire Reidh and Allt a Choire Bhuidhe.

The level of Loch Quoich is controlled by the existing Quoich hydro scheme, with water levels varying between 175.38m AOD and the spillway level of Quoich Dam at 201.38m AOD.

2.4 Quoich hydro scheme

The existing Quoich hydro scheme was completed in the late 1950s by the North of Scotland Hydro Electric Board. It comprises the Quoich Dam, two smaller dams at the west end of Loch Quoich, a connecting water transfer tunnel and the Quoich Power station which is located approximately 3.9km downstream of Quoich Dam.

Quoich Dam diverts a generation volume of approximately 18 $m^3 s^{-1}$ via the water transfer tunnel to Quoich power station. A further compensation release of 1 $m^3 s^{-1}$ is provided to the Gearr Garry as a compensation flow under CAR Licence CAR/L/1011471. Additional flows up to a total of approximately 20 $m^3 s^{-1}$ may also be periodically released through the Quoich dam via a dispersal valve.

Quoich Power Station features a single turbine generating a maximum 20MW. The outlet of the power station flows into the river channel which links the Kingie Pool to Loch Poulary.

2.5 Gearr Garry

The Gearr Garry is a stretch of river which starts at Quoich Dam before flowing downstream for approximately in a generally south easterly direction for 3.1km. It ends upon entering the elongate lochs of Kingie Pool and Loch Poulary. The Gearr Garry is primarily fed by a 1 $m^3 s^{-1}$ compensation flow from the base of the Quoich Dam. It is supplemented by a number of inflowing tributaries along its length, with such tributaries being more numerous on the northern side of the valley where the surrounding topography reaches significantly higher altitudes. The Gearr Garry is typically approximately 15m wide and less than 0.5m deep throughout its length, however there are several braided channels and pools along its length. At its largest, the reach is approximately 35m wide. The hydrological regime is heavily modified and regulated due to the existing hydro scheme infrastructure.

2.6 Kingie Pool and Loch Poulary

The Kingie Pool and Loch Poulary are a combined system of relatively shallow elongate lochs which form the outflow of the Gearr Garry. Both lochs are also fed by the River Kingie, which enters the southern shore of Kingie Pool shortly after the inflow of the Gearr Garry. The combined lochs are approximately 3.5km from west to east. At its narrowest point, the combined lochs are approximately 100m wide, increasing to approximately 350m wide at the largest part of Loch Poulary. A large mid-channel island is situated within the Kingie Pool immediately upstream of the existing Quoich Power Station, which is located on the lochs' northern shore. Loch Poulary transitions downstream into the River Garry through a 1km narrow stretch before expanding laterally. A mothballed salmon catch structure spans the entire width of Kingie Pool/Loch Poulary immediately downstream of the power station outflow.

3 Investigation design

3.1 Introduction

A monitoring investigation study was designed to provide the site-specific data required to address the key investigation objectives detailed in Section 1.2 above. The following sections describe key aspects of the investigation design and how it was executed.

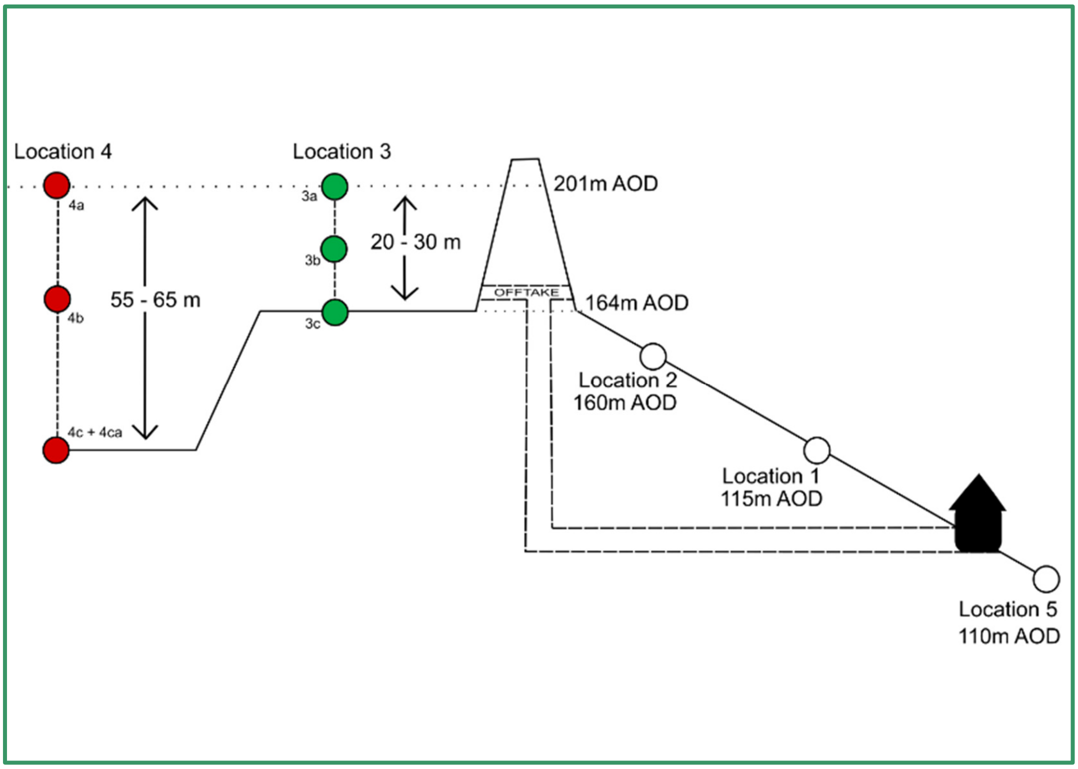
3.2 Monitoring locations

The overall investigation features temperature monitoring sensors deployed at five discrete locations across Loch Quoich, Gearr Garry and the Kingie Pool. A total of 11No. sensors were deployed across the five monitoring locations. The following sections describe the individual monitoring locations and sensor configurations in more detail.

A schematic illustrating showing the general arrangement of monitoring locations used is presented in Figure 1 below. This schematic is not to scale, it represents a vertical profile of approximately 100m and a lateral profile of approximately 10km.

A plan of the investigation area with each monitoring location indicated is presented in **Appendix C**.

Figure 1. Schematic layout of temperature monitoring sensor locations



3.2.1 River monitoring locations

Three monitoring locations are situated within riverine settings within the investigation area. These are locations 1 and 1a, 2 and 5.

Location 1 and 1a

Location 1 is situated at NGR: NH 0956 0113, approximately 2.8km downstream of Quoich Dam, in a water depth of approximately 30cm, approximately 2m into a total river width of 13m at this point. Location 1a, which was installed part way through the monitoring period, is essentially co-located with location 1. It is situated approximately 5m upstream in a similar water depth and flow setting.

Location 1a was added to the investigation to inform whether tree growth (and resulting canopy shading) at the bankside was influencing the water temperature data gathered at location 1.

Location 1 is intended to provide insight into the baseline water temperature regime of the Gearr Garry's main reach a significant distance away from Loch Quoich and Quoich Dam, which is considered likely to provide data which is representative of the Gearr Garry as a whole.

Location 2

Location 2 is situated at NGR: NH 0738 0234, approximately 0.3km downstream of Quoich Dam, in a water depth of approximately 15cm, approximately 2m out into a total river width of 9m at this point.

Location 2 is intended to provide insight into the baseline water temperature regime of the Gearr Garry immediately downstream of the Quoich Dam outflow, which is fed from the base of the dam in a water depth of 20-25m (depending on reservoir level).

Location 5

Location 5 is situated at NGR: NH 1091 0104, approximately 0.2km downstream of the outflow of Quoich Power Station, in a water depth of approximately 0.5m, midstream at a point where the river is approximately 90m wide.

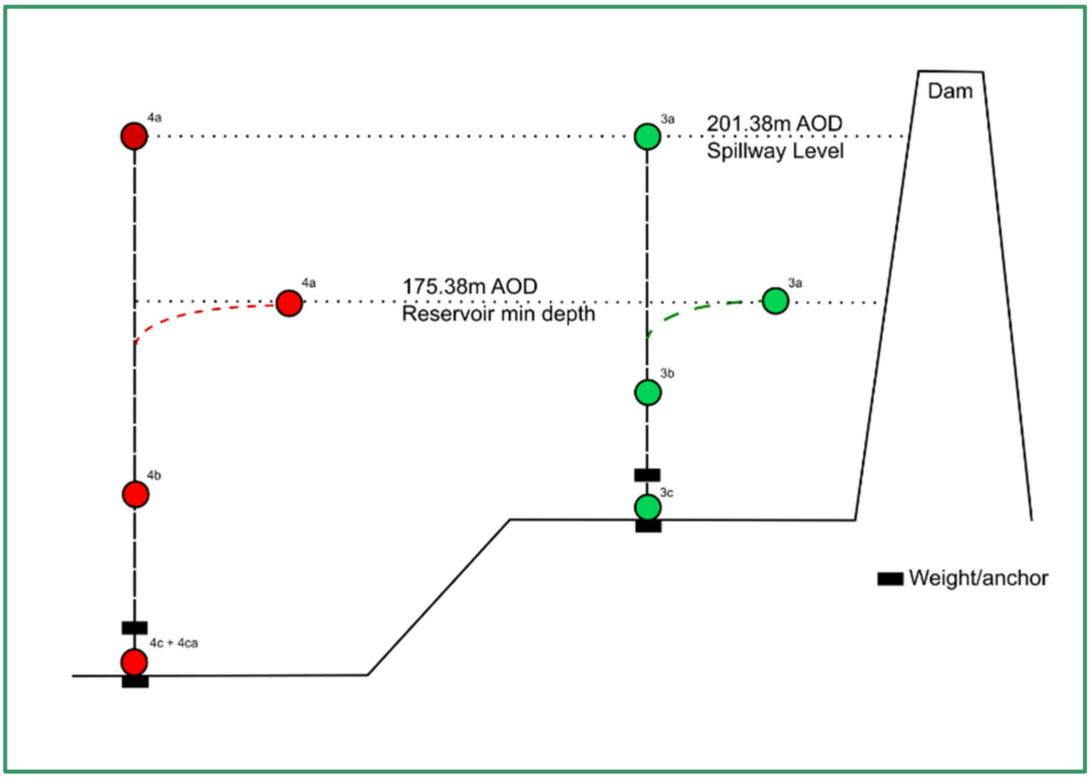
Locations 1 and 2 on the Gearr Garry

3.2.2 Loch monitoring locations

Two monitoring locations are situated within loch (reservoir). These are locations 3 and 4. To provide insight into any depth-dependent temperature variations through the loch's water column, each loch location features three sensors positioned at different depths through the loch's water column.

A schematic illustration of the monitoring configuration used at locations 3 and 4 is presented in Figure 2 below. The position of the 'A' sensor at both location 3 and location 4 is dynamic to allow for changes in reservoir level. The position of the 'B' and 'C' sensors at each location remain essentially unchanged with reference to the reservoir bed throughout, albeit the absolute depth of the 'B' sensor will vary within a range of approximately 5m due to the dynamic nature of the monitoring configuration to allow for changing reservoir water levels.

Figure 2. Schematic layout of vertical temperature sensor arrangement at locations 3 and 4



Location 3

Location 3 is situated at NGR: NH 0604 0158, approximately 1.2km west of Quoich Dam. The water depth at this location varies between approximately 15 – 25m depth depending on prevailing reservoir water level. Three sensors are co-located at location 3, with one each at reservoir surface, reservoir base and at an intermediate depth.

Location 3 was selected for monitoring for two reasons. Firstly, location 3 is situated in an area where the bathymetry of the loch provides a relatively shallow shelf which prevails over large areas of the eastern end of Loch Quoich upstream of Quoich Dam. Secondly, location 3 is situated in an area in close proximity to the planned footprint of the proposed Fearna PSH lower control works infrastructure. As such, it was considered to provide a useful baseline location for undertaking any future monitoring which may be required to assess any future impacts from either the construction or operation of the Fearna PSH scheme.

Location 4

Location 4 is situated at NGR: NH 0604 0158, approximately 4.5km west of Quoich Dam. The water depth at this location varies between approximately 55 – 75m depth depending on prevailing reservoir water level. Four sensors are co-located at location 4, with one each at reservoir surface, reservoir base and at an intermediate depth, plus an additional validation sensor co-located at the reservoir base.

Location 4 was selected for monitoring for as it is in an area where the bathymetry of the loch provides a significantly deeper water depth which is representative of large areas of the central spine of Loch Quoich (reflecting the original topography of the glen prior to its inundation in the 1950s). It should be noted that certain areas of the central part of Loch Quoich are deeper still than those at Location 4.

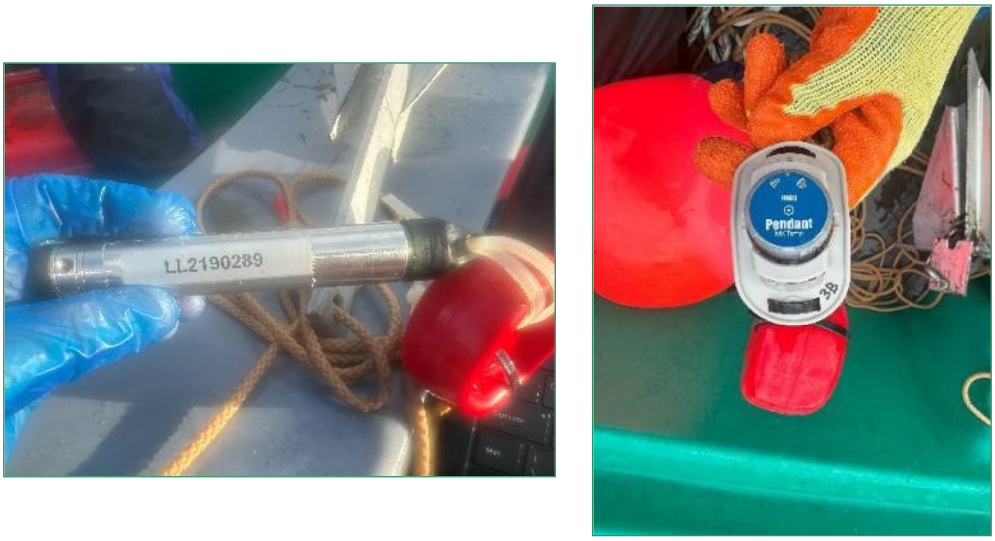
Locations 3 and 4 in Loch Quoich

3.3 Equipment specifications

Two different monitoring instruments have been used during this investigation for temperature monitoring. Primarily, Hobo Pendant instruments from Onset Computer Corporation have been used due to their waterproof and physically robust and reliable sensors. These sensors allow easy Bluetooth data download capabilities, however these sensors do need to be brought to the water's surface to enable the Bluetooth connection to work successfully. Sensors from Onset's Hobo MX2200 range have been utilised.

A second instrument from a different manufacturer was utilised at a single monitoring location (Location 4cA) to provide an independent check upon the data quality from the Onset loggers. This instrument, a Solinst Levelogger, was co-located with Location 4c, as this was judged to be the physically harshest environment (lowest temperatures, highest pressures etc.) within the investigation's scope. This location was selected as the Solinst instrument was considered to offer the most robust sensing platform for such locations and prolonged monitoring period where battery life on other instruments can be a limiting issue.

A specification for the sensors and instruments used is included in **Appendix D**.



Solinst Levellogger and Hobo MX2200 Pendant instruments as deployed (Locations 4cA and 3b respectively)

3.4 Monitoring period

Table 1 below details the instrument details and deployment periods used as part of this investigation.

Table 1. Monitoring locations, equipment details and deployment periods

Location	NGR	Waterbody	Equipment deployed	Serial number	Date deployed
1	NH 0956 0113	Gearr Garry	Hobo MX2201	21690720	29/08/2024
1a	NH 0956 0113	Gearr Garry	Hobo MX2202	21704229	22/11/2024
2	NH 0738 0234	Gearr Garry	Hobo MX2201	21690719	29/08/2024
3a	NH 0604 0158	Loch Quoich	Hobo MX2201	21690724	30/08/2024
3b	NH 0604 0158	Loch Quoich	Hobo MX2201	21690725	30/08/2024
3c	NH 0604 0158	Loch Quoich	Hobo MX2201	21690726	30/08/2024
4a	NH 0359 0219	Loch Quoich	Hobo MX2201	21690721	30/08/2024
4b	NH 0359 0219	Loch Quoich	Hobo MX2201	21690722	30/08/2024
4c	NH 0359 0219	Loch Quoich	Hobo MX2201 Solinst Levelogger	21690723 2190289	30/08/2024
5	NH 1091 0104	Gearr Garry (Kingie Pool)	Hobo MX2202	21704233	22/11/2024

While the equipment for locations 1, 1a, 2 and 5 (the Gearr Garry loggers) remain in-situ and continues to record data, the monitoring period for the purposes of this report ranges from 29/08/2024 to 02/07/2025.

For the loggers at locations 3 and 4 in Loch Quoich, data was last recovered in-situ from these on 13/02/2025. During the summer of 2025, the anchor systems of both of these logger arrays failed, most likely due to fretting of the ropes against the shackles connecting them to their anchors. The loggers at location 4 have not been recovered, but those at location 3 were washed up on the shore in July / August 2025 and data has been recovered from these. The data indicates that the loggers were likely to have been in their designed locations until 22 June 2025, although the battery in logger 3b failed on 16 April 2025 and data only up to this date has been recovered.

3.5 Monitoring frequency

All instruments were configured to record one data point every six hours, at approximately 00:00, 06:00, 12:00 and 18:00 hours each day.

3.6 Additional data sources

A number of additional data sources were availed of in the delivery of this investigation. The following are of particular note.

SSE Generation, via Gilkes Energy Limited, have provided detailed data on the level of Loch Quoich during the investigation period, along with information on the operational regime of the existing hydro scheme. This data includes daily reservoir levels.

Meteorological data from open online sources for locations within the investigation area have been utilised to contextualise the recorded water level and water temperature data collected.

Data from the rainfall gauge at Coillie Mhorgil by Kingie has been obtained from SEPA and this is plotted on the river logger locations as it gives a relative indication of the flows in the Kingie and the flows to the Gearr Garry from the catchment downstream of the Quoich dam.

Following engagement with the Ness District Salmon Fishery Board (NDSFB), the project was granted access to and use of NDSFB's own record of water temperatures in the Gearr Garry and River Kingie.

The contributions of each of the above is gratefully acknowledged.

4 Monitoring results

4.1 Introduction

The following sections provide factual detail and descriptions of the monitoring data gathered and trends observed during the monitoring investigation. Further consideration and interpretation of this data is provided in Section 5 below. It is suggested that Sections 4 and 5 are considered in parallel with the time series graphs included in **Appendix E**.

4.2 Results overview

4.2.1 Factual summary

Summary statistics for all the data collected from each location is presented in Table 2 below.

The data from the logger at location 1 appeared spurious and did not match that from the subsequently installed location 1a, nor was it compatible with the data recovered from Location 2 and the NDSFB's logger in the Gearr Garry. For this reason it is believed to be faulty and its data has been disregarded.

A time series graph showing the complete dataset for each monitoring location is presented in Figure 4. Additional 'month by month' time series graphs which allow greater visual resolution of the temperature results from each location are presented in **Appendix E**.

Table 1. Summary temperature results for all monitoring locations (Aug'24 – July'25)

Location	Ambient air	R1a*	R2	R5*	L3a	L3b	L3c	L4a	L4b	L4c	L4cA
Approximate water depth (m)	N/a	0.3	0.15	0.5	1.0	10	20	1.0	20	55	55
Start Date	29/8/24	22/11/24	29/8/24	22/11/24	30/8/24	30/8/24	30/8/24	30/8/24	30/8/24	30/8/24	30/8/24
End Date	2/7/25	2/7/25	2/7/25	2/7/25	22/6/25	16/4/25	22/6/25	13/2/25	13/2/25	13/2/25	13/2/25
Minimum	-8.6	2.8	2.8	1.4	4.5	4.7	4.7	8.8	8.3	7.3	6.8
Maximum	22.4	18.0	18.8	18.4	18.6	13.0	13.2	15.2	12.9	10.3	9.9
Range	31.0	15.2	16.0	16.9	14.1	8.3	9.5	6.6	4.4	3.0	3.1

4.3 Narrative description

A factual description of the monitoring results from each monitoring location is presented below. Further discussion of the driving mechanisms and interrelationships between different monitoring locations is presented in Section 5 below.

4.3.1 Locations 1 and 1a – Gearr Garry

The temperature data from location 1a illustrates a strong diurnal variation pattern spring to autumn period, with the range of recorded temperatures between daytime maxima and nighttime minima frequently exceeding 2 °C, and occasionally exceeding 5 °C. While still evident, the diurnal pattern of temperature changes is much less stable or sustained during the winter period.

4.3.2 Location 2 – Gearr Garry

The temperature data from location 2 illustrates a modest diurnal variation pattern during the spring to autumn period, with the range of recorded temperatures between daytime maxima and nighttime minima generally being less than 2 °C. During winter period, this diurnal variation pattern appears to break down, with largely stable temperatures persisting for several days at a time punctuated by either one off instances or short periods where a clear day/night contrast reappears.

4.3.3 Location 5 – Gearr Garry, downstream of Quoich Hydro

A time series is provided at Appendix E which charts the temperature at Location 5, the NDSFB River Kingie monitoring location, air temperature, as well as rainfall at the Coillie Mhorgil rain gauge. The data recovered indicates that the water temperature here is influenced by the flow from the Gearr Garry, the flow from the River Kingie, by the flow from the Quoich turbine, by ambient temperature.

4.3.4 Location 3a, 3b and 3c – East end of Loch Quoich

Location 3a, which is set within the uppermost 1m of the water column, records a notable diurnal temperature variation pattern, which is most exaggerated during periods of high ambient air temperatures, during which a day/night temperature range of up to 3 °C is evident. This diurnal pattern remains evident throughout the entire monitoring period, but becomes increasingly subtle during the winter.

Location 3b and 3c both closely mirror the temperatures measured at Location 3a, however, no significant diurnal variation pattern is evident.

4.3.5 Location 4a, 4b and 4c/4cA – 4.5km west of Quoich Dam in Loch Quoich

In general, the temperature data recorded at Location 4 splits into two distinctly different temperature regimes. Location 4a and 4b, which represent surface and shallow waters within the loch begin the monitoring period at approximately 12 °C and gradually and smoothly decrease towards a temperature of approximately 5 °C at the end of the monitoring period (February 2025).

Location 4a records a similar pattern of water temperature results to Location 3a, however, the diurnal variation pattern observed at Location 4a is somewhat subdued relative to that at Location 3a.

By contrast, Location 4c and 4cA, which represent the deeper waters within the Loch begin the monitoring period at approximately 7 °C these conditions persist with very stable deep water temperatures for approximately eight weeks through late Summer/early Autumn with very little temperature variation recorded within the deep water setting. Commencing in late October, a series of short term increased temperature perturbations are recorded, with water temperatures rising by up to 3 °C for 24-48 hours before returning to a lower, but now gradually increasing water temperature trend. At least nine such events are recorded within the water temperature data between October 20th and November 16th 2024. After November 16th, the water temperatures recorded at all Location 4 depths have essentially merged at a temperature of 9 °C which then continues to gradually fall towards a minimum of approximately 5 °C at the end of the monitoring period.

The temperatures recorded at Locations 4c and 4cA (which are co-located sensors of different types) show very strong and consistent agreement across virtually the entire monitoring period, with a consistent variance of approximately 0.5 °C recorded across the monitoring period. This variance provides additional confidence in the data recorded from the deeper water location, and the respective accuracy of the two different sensor types used.

4.4 Additional background data

The Ness District Salmon Fishery Board (NDSFB), whose catchment includes the Loch Quoich/Gearr Garry system is a key stakeholder in relation to any development which may impact on the water environment. The NDSFB has their own network of temperature monitoring loggers located throughout the wider Glen Garry catchment. NDSFB has kindly provided the raw data from their nearby temperature monitoring locations for consideration alongside the results of this investigation. The locations relevant to this study are as follows:

Gearr Garry	Grid Ref. 208142 801949
River Kingie	Grid Ref. 208889 799359
East end of Poulary	Grid Ref. 213109 801214

A time-series graph showing the Gearr Garry and River Kingie water temperatures at the NDSFB monitoring locations is included in the time series charts at Appendix E.

Comparison of the Fearna PSH and NDSFB datasets for the Gearr Garry indicates that they appear broadly consistent with each other, which provides confidence that they are both accurate and representative in detailing the prevailing baseline water temperature regime in the main reach of the Gearr Garry. It should be noted that there are periods in the NDSFB Gearr Garry dataset that indicate that the temperature sensor may have been exposed to the air.

In addition to recorded temperature data, the time series charts of temperatures in the Gearr Garry and downstream also include two additional data plots, the temperature at the outflow of loch Quoich (to either the dam outlet or the headrace tunnel to the Quoich powerhouse) which has been predicted in the Tuflow temperature modelling of Loch Quoich by SLR Consulting (see main Car Licence Report text), and also rainfall data from the Coillie Mhorgil rain gauge near Kingie.

5 Discussion

As described in Section 1.2 above, there were several objectives in undertaking the temperature monitoring investigation on the Loch Quoich/Gearr Garry system. These are restated below to provide structure to the further analysis and interpretation of the temperature monitoring data gathered.

Investigation objectives

1. To characterise the baseline water temperature regime at different locations within the Loch Quoich/Gearr Garry system.
2. To characterise the baseline water temperature regime at different spatial locations within Loch Quoich relative to each other.
3. To characterise the baseline water temperature regime at different water depths within Loch Quoich relative to each other.
4. To identify any links between the water temperature regime in the loch relative to the regime in the river system downstream.

5.1 Objective 1 – Baseline water temperature regime

Continuous water temperature data has been gathered at six-hourly intervals at a range of locations and depths across the Loch Quoich and Gearr Garry system over a period of approximately six months from late August 2024 onwards. Data gathering continues at all locations in the Gearr Garry, but the loggers in Loch Quoich became detached from their moorings in June 2025 and data from Location 3 has been recovered up until this date and for Location 4 until February 2025. Data from Location 1 is incompatible with that from Locations 1a, 2, 5 and the NDSFB Gearr Garry logger. This is likely due to the logger being faulty and the data from this logger has been disregarded.

The data gathered from each of the river locations (Locations 1a, 2) broadly indicate an anticipated water temperature regime, with peak temperatures recorded in late summer before a long and gradual decrease towards a minimum in the winter, followed by a rise into the spring and summer. Several of the locations monitored indicate some form of diurnal temperature variation pattern, as would be expected in 'shallow' water settings where prevailing air temperature and sunshine hours would be expected to be significant drivers of water temperatures. The magnitude of the diurnal variation pattern is greater in summer than winter, which reinforces the hypothesis that seasonal and day/night ambient air temperatures are a key driving mechanism on water temperature in riverine settings (alongside altitude, climate and artificial modifications (such as pre-existing hydro schemes)). Some distinct variations between the different river monitoring locations are evident, in some instances these can lead to temperature variances of up to several degrees centigrade between different river locations. These variances are considered further with regards to later objectives below.

When the combined results of this investigation and NDSFB's own monitoring is considered, it appears that based on the available data that water temperatures in the Gearr Garry oscillate between a late summer maximum of approximately 18 °C and a mid-late winter minimum of between 2-4 °C. It must be recognised that significant in-year and year-to-year variation is possible based on prevailing weather patterns, however, the pattern observed appears credible and consistent with the available validation data.

The data gathered from each of the loch locations indicate a generally stable temperature regime which prevails over at least the upper 20m of the water column within the loch environment.

One aspect of the loch monitoring locations worthy of mention is the distinctly different temperature regime which prevails at Location 4c relative to the other loch monitoring locations. This location, which is set in 55m -60m water depths within a more central portion of the loch, records significantly colder and more stable temperature data throughout the monitoring period. These locations commence the monitoring period at temperatures of approximately 7.0 °C, and remain extremely stable (±0.5 °C) for several weeks before a sudden and marked change in the recorded temperature regime commences in the last week of October. From October onwards, a series of discrete temperature perturbation events occur, with recorded deep water temperatures reaching surface water temperatures for up to 24 hours before dropping back. Several such instances, are recorded. These events appear to be related to a mixing of the water column as part of a progressive convergence between surface water and deep water temperatures (and the distinct water bodies they represent), which occurs over a period of approximately four weeks before concluding in mid-November. Upon completion of this episodic and progressive mixing period, the deep water temperatures appear to achieve equilibrium with the shallower waters' temperatures at approximately 9.0 °C before the now-mixed water body continues its gradual temperature reduction as winter progresses. These events are illustrated in an extract from a time-series graph of Location 4 at Figure 3 below.

It is unfortunate that the loggers at Location 4 came loose from their moorings and no data was recovered after February 2025. This means that the re-establishment of the thermocline during the spring / summer period has not been recorded.

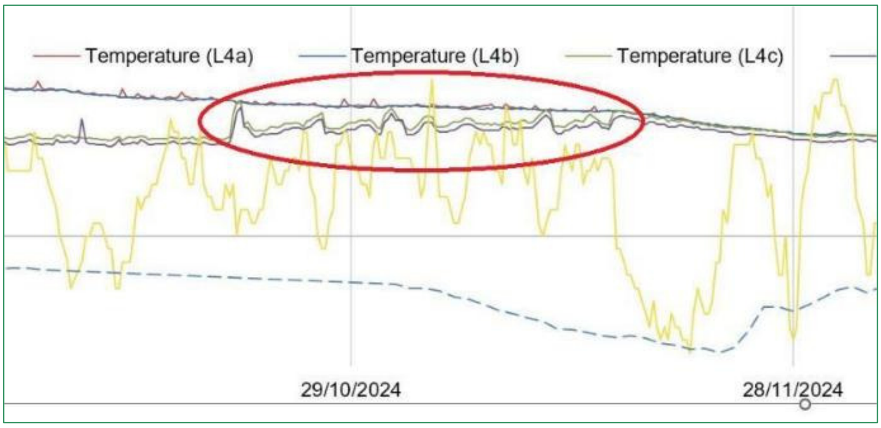


Figure 3. An extract from Location 4 monitoring data illustrating progressive thermocline collapse and water mixing occurring between late-October and mid-November.

5.2 Objective 2 – Spatial variation in Loch Quoich

The design of the monitoring investigation was arranged to allow comparison between the water temperature regime in different locations on Loch Quoich. It must be noted that Loch Quoich is an extremely large body of water, and this study with only two locations can only provide limited insights into spatial variation across the entire loch. Nonetheless, the sensors deployed can be compared in groups of 'equivalent positions' to understand what, if any, spatial variation exists across the loch. Locations 3a and 4a (Group 1), both being surface water sensors, are directly equivalent in positional terms, which is to say the only significant differences between them should be driven by genuine variation across the loch regime. Similarly, Locations 3b, 3c and 4b (Group 2) are also broadly equivalent in positional terms, being deployed at approximately 10m, 20m and 25m water depth respectively.

Broadly speaking, the temperature record at both Location 3a and 4a is very similar, with the recorded temperature at both locations being within 0.5 °C of each other on all bar the hottest weather days (e.g. August 31st, September 1st). Whereas Location 3a generally records slightly warmer temperatures early in the monitoring period, this relationship essentially reverses partway through the monitoring period. The switchover between these two relationships appears to occur between late-October and mid-November.

Within the water column, as represented by locations 3b, 3c and 4a, the overall regime is very consistent between Location 3 and Location 4. With a small number of exceptions, water temperatures at all three locations are very similar (within 0.5 °C) throughout the monitoring period. As noted in Section 5.2 above, there appears to be occasions when colder water from the deeper loch upwell or spread into the shallower shelf setting typified by Location 3. The limited scope of the investigation prevents greater resolution or interpretation of this spatial variation. However, in general terms, it appears that the loch water temperature regime is largely spatially homogeneous.

A time-series graph showing these grouped relationships is presented in **Appendix E**.

5.3 Objective 3 – Depth variation in Loch Quoich

The design of the monitoring investigation was structured to provide insight into any significant depth-driven temperature variation within the loch. As noted in Section 5.1 above, the loch is very large, and includes water depths up to approximately 80m, in excess of the maximum depth location monitored during this investigation, which is approximately 61m. Notwithstanding this limitation, several significant aspects of the depth-driven temperature variation within the loch (and the annual regime which controls it) have been identified.

Location 4c is the only loch monitoring location within this investigation which records a distinctly different pattern of water temperatures. As outlined in Section 5.2 above, the water temperature regime within the deeper loch waters is both significantly colder and more stable than all other monitoring locations. The consistent level of agreement between locations 4c and 4cA provides significant confidence in the accuracy of these results. Overall, the deep water temperature regime evident appears to indicate that a stable, relatively cold stratum of water exists in the deeper parts of the loch during the Summer and Autumn months. From mid-Autumn onwards, the recorded deep water temperature gradually increases until it reaches an equilibrium with the overlying shallower waters. This has been interpreted as representing the breakdown of a distinct thermocline which prevails during the summer and autumn months. As described in Section 5.1, this breakdown is episodic and progressive rather than sudden and short-lived. Once complete, it appears the loch's water temperature regime is homogeneous reflecting a well-mixed overall water body which has been observed to endure throughout winter, and is anticipated to re-stratify during the late-spring/early-summer period, which has not been directly observed due to loss of the loggers at Location 4.

As such, it is considered that Loch Quoich appears to conform to a warm monomictic lake regime, whereby the loch distinctly stratifies in warmer months and becomes thoroughly mixed during colder months. Such lochs never freeze entirely (as distinct from cold monomictic lakes). In such regimes, the water column is clearly stratified for much of the year, with a warm, less-dense epilimnion (shallow, warm buoyant layer) overlying a significantly colder and denser hypolimnion (deep, colder denser layer). While the data recovered for Location 4 ends in February 2025 and as such does not allow confident definition of the start of the stratification process, it would be anticipated to commence between April and June each year. Based on the results gathered, it appears that the Loch Quoich epilimnion is at least 25m deep, whereas the hypolimnion is likely to be deeper according to the bathymetry and prevailing reservoir level during the summer months.

5.4 Objective 4 – Temperature links between Loch Quoich and Gearr Garry

The engineering of the existing hydro scheme at Loch Quoich is such that water from Loch Quoich enters the Gearr Garry via two distinct routes. Firstly, a small compensation flow of 1 $m^3 s^{-1}$ flows into Gearr Garry from the base of Quoich Dam. Secondly, a larger flow of up to 18 $m^3 s^{-1}$ outflows from Quoich Power Station having first flowed through a concrete-lined tunnel of approximately 4km length and a turbine-driven generator mechanism before emerging into Gearr Garry at Kingie Pool.

As described above, the waters of Loch Quoich are expected to act as a buffering source of thermal energy on the outflowing waters. Given the identified Loch Quoich outflows, any impact or link upon water temperature downstream would be expected to be most obvious at Location 2 (downstream of the compensation flow) and Location 5 (downstream of the power station outflow).

There appears to be strong influence exerted by the operation of the existing hydropower scheme on water temperatures in the Gearr Garry. It is important to recognise that this influence manifests itself in at least two distinct ways. Firstly, and least obviously, it is considered likely that the Loch Quoich reservoir (as distinct from the original, natural Loch Quoich) has a significant moderating influence on water temperatures in the Gearr Garry. In the absence of a viable control catchment, it has not been possible as part of this study to quantify this influence. Notwithstanding the above, the current conditions have been in place for many decades, and so any such influences and impacts have long since become 'normal' for this catchment.

The time series provided at **Appendix E** charts the temperature at Locations 1a, 2, the Loch Quoich Location 3c (which can be taken as approximately representative of the discharge flows from Loch Quoich), ambient temperature, as well as rainfall at the Coillie Mhorgil rain gauge. The data recovered indicates that the water temperature at Locations 1a and 2 is partly influenced by the flow discharged through the Quoich dam but predominantly by ambient temperature acting on the residual catchment and the river itself.

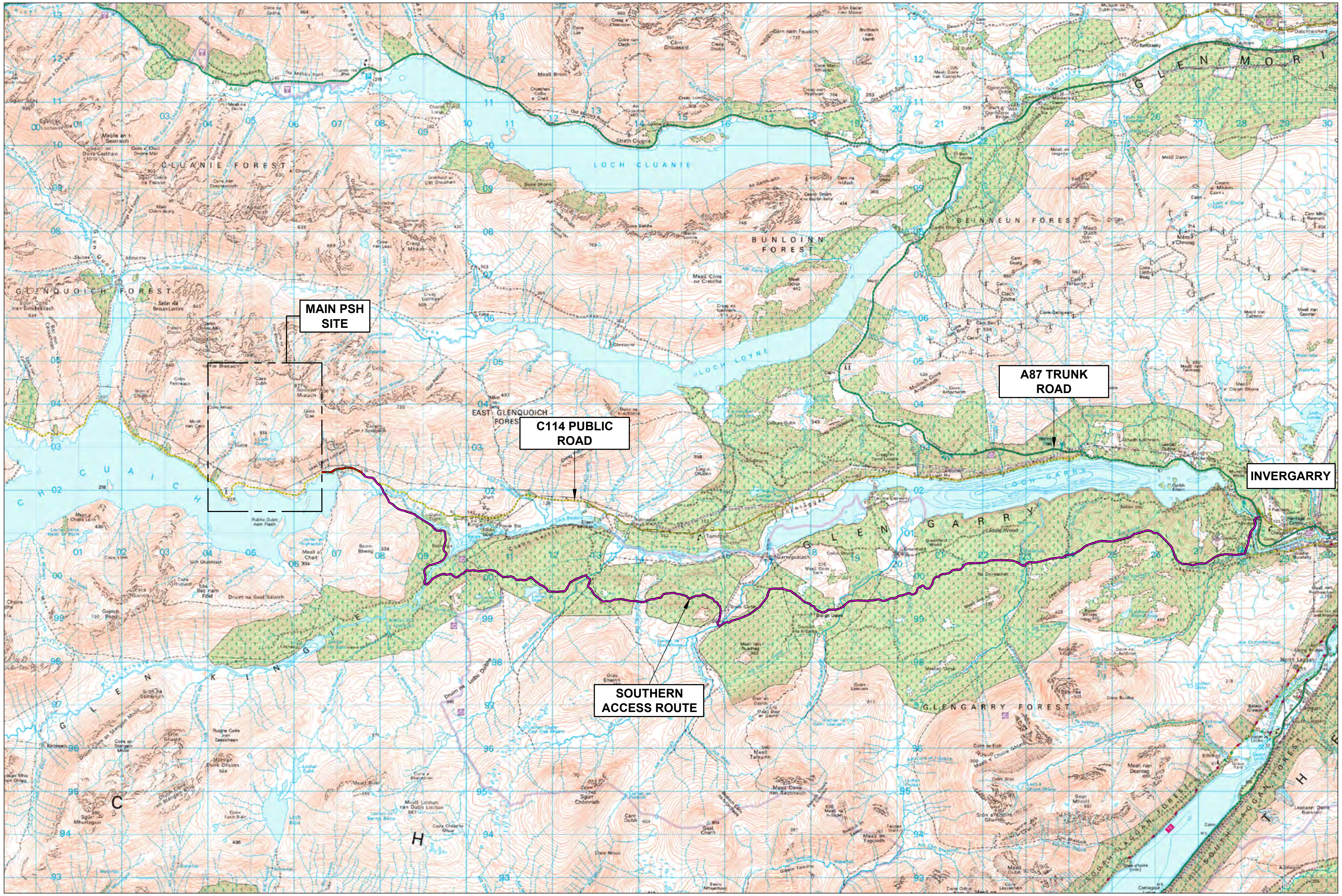
The time series provided at **Appendix E** also charts the temperature at Location 5, the NDSFB River Kingie monitoring location, air temperature, as well as rainfall at the Coillie Mhorgil rain gauge. The data recovered indicates that the water temperature here is influenced by the flow from the Gearr Garry, the flow from the River Kingie, by the flow from the Quoich turbine and by ambient temperature. When the Quoich hydro station is not generating, the temperature closely matches that of the River Kingie, which is in turn very strongly influenced by the ambient temperature. There is little moderating effect from the Gearr Garry flows, unless during very dry natural flows in which case it has a small but noticeable moderating effect.

There is however a significant moderating effect on water temperature when the Quoich hydro station is generating, with the $18m^3$ flow being sufficient to generate temperatures up to 6^oc warmer in winter and 8^oc cooler in spring than the River Kingie flow based on the overlapping period of data currently available for the two monitoring locations, which 22 November 2024 to 28 April 2025. It is possible that the position of Location 5 is in a section of the river downstream of the powerhouse tailrace that is dominated by the hydro generating flow rather than representing a flow that has been thoroughly mixed with the upstream flow from the River Kingie / Gearr Garry, in which case the moderating effect may be exaggerated. This will be possible to check once data is available from the NDSFB East Poulary temperature gauge, which has recently been unsafe to download due to elevated flows in the river.

6 Appendices

Appendix A Proposed development

NORTH



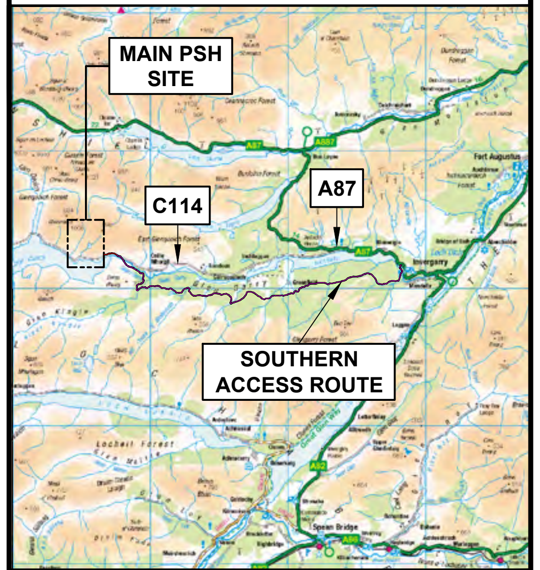
0 2.5km 5km

PLAN

1:50,000 @ A1, 1:100,000 @ A3

IF IN DOUBT - ASK

WIDER LOCATION PLAN



0 5km 10km

REV	DATE	DRAWN	NOTES	CH'K'D	APP'D
P1	22.01.23	MH	PRELIMINARY	FRA	FRA

GILKES energy

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W:www.gilkesenergy.com

CLIENT

FEARNA PSH LTD.

PROJECT

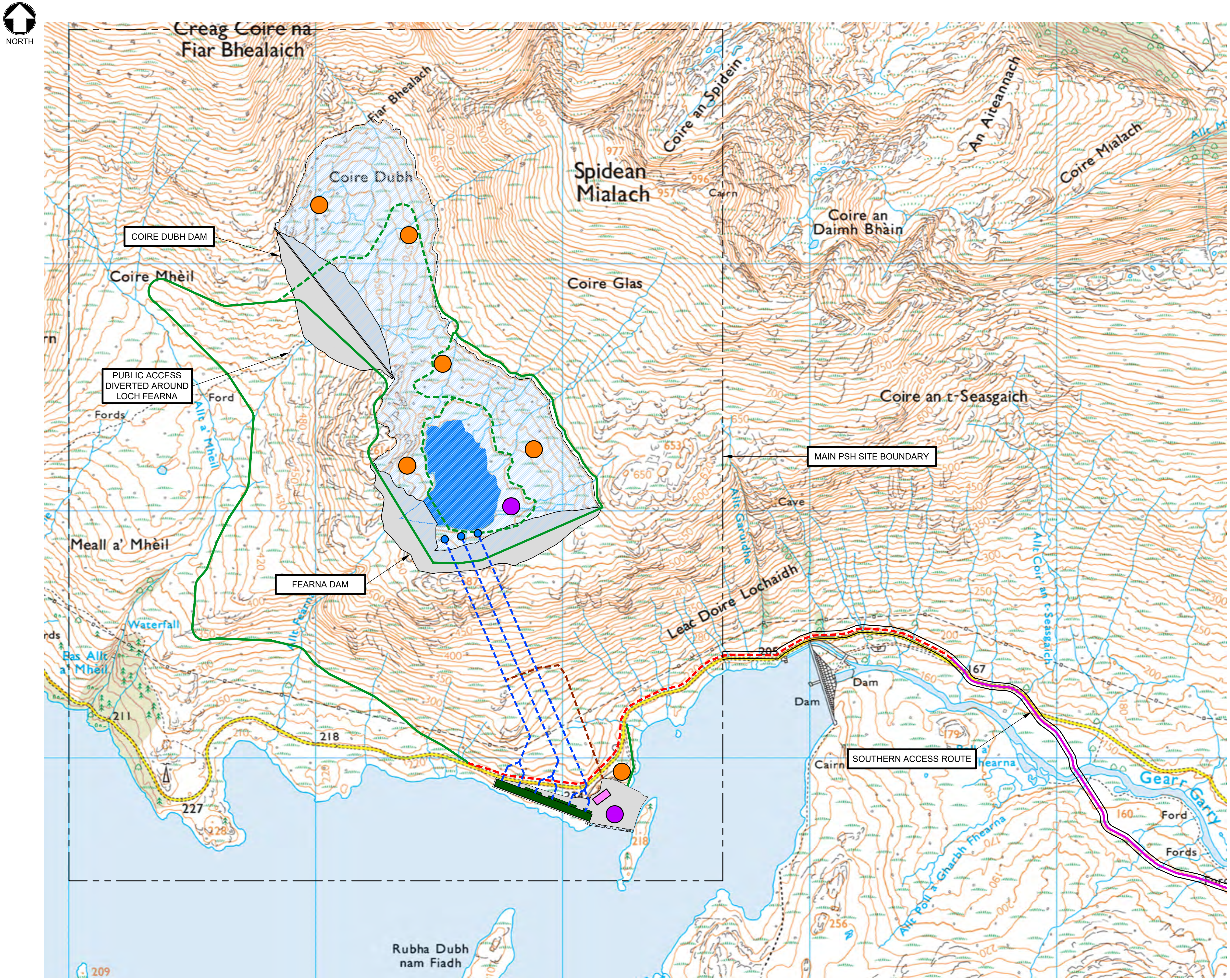
FEARNA PSH

TITLE

LOCATION PLAN

SIZE	SCALE AT A1	SCALE AT A3	STATUS
A1	1:50,000	1:100,000	PRELIMINARY

DRAWING NUMBER	REVISION
FIGURE 3.1	P1



IF IN DOUBT - ASK

NOTES

- EXISTING LOCH FEARNA SURFACE AREA
- PROPOSED INUNDATION
- POWERHOUSE
- DAM FOOTPRINT
- INTAKE
- HIGH PRESSURE TUNNEL
- ACCESS TUNNEL
- POSSIBLE ACCESS TRACK
- SAR TRACK
- TEMPORARY CONSTRUCTION ACCESS (WITHIN INUNDATED AREA)
- PUBLIC ROAD WIDENING
- BORROW PIT
- SITE COMPOUND
- SUBSTATION
- LAYDOWN AREA
- INDICATIVE SITE BOUNDARY

REV	DATE	DRAWN	NOTES	CH'K'D	APP'D
P1	22.01.23	MH	PRELIMINARY	FRA	FRA

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CLIENT

FEARNA PSH LTD.

PROJECT

FEARNA PSH

TITLE

SCHEME ARRANGEMENT

SIZE	SCALE AT A1	SCALE AT A3	STATUS
A1	1:7500	1:15,000	PRELIMINARY

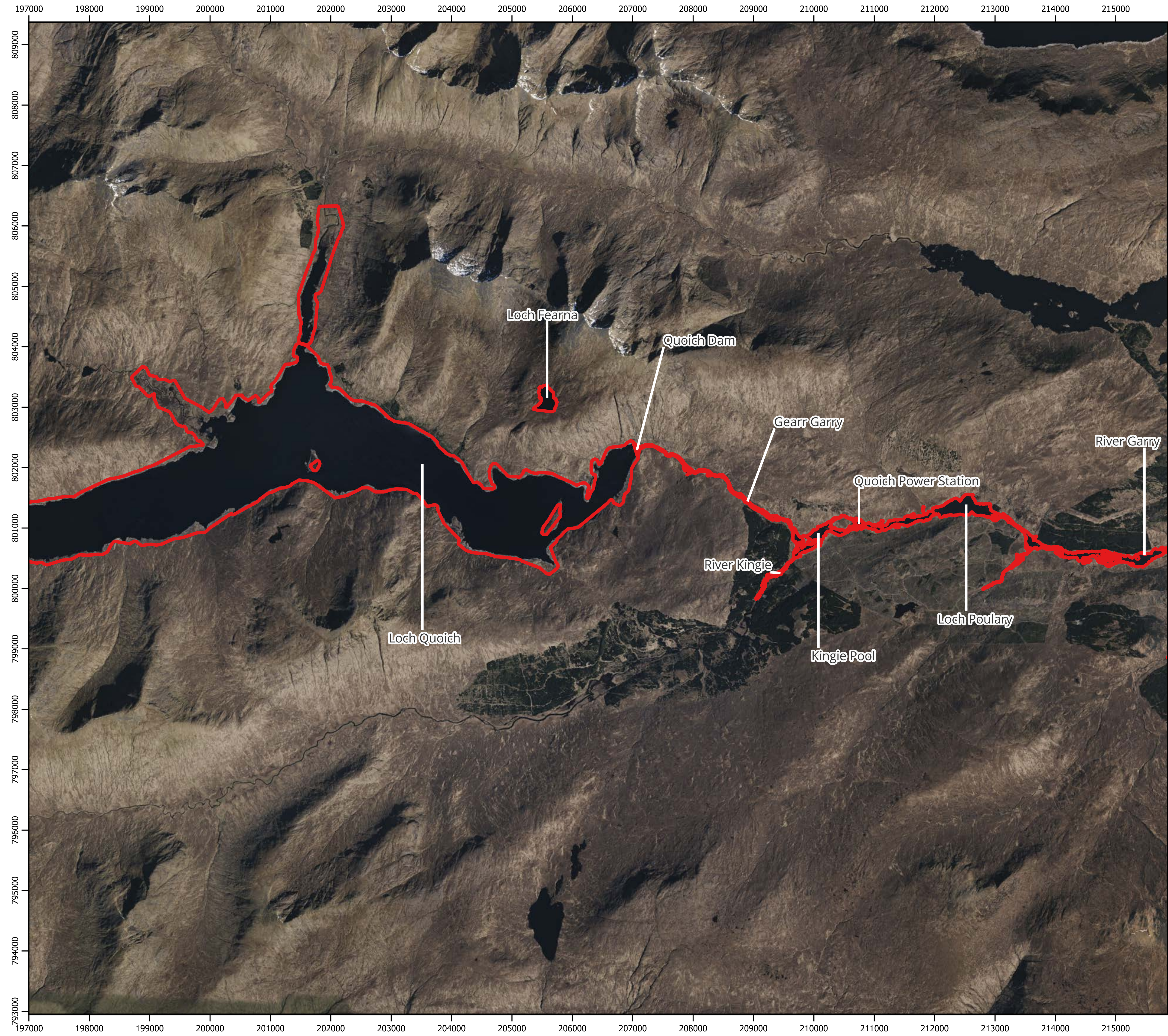
DRAWING NUMBER	REVISION
FIGURE 3.2	P1

PLAN

1:7500 @ A1, 1:15,000 @ A3

0 500m

Appendix B Catchment hydrological features layout



Loch Fearna

Figure 1
Hydrological Features Plan

Key

Features

N

Scale @ A3: 1:58,000

0 1,000 2,000 m

GAVIA environmental

Date: 07-02-2025

Prepared By: AB

Reviewed By: MA

Approved By: MA

Appendix C Monitoring location layout plan

Loch Fearna

Figure 2
Temperature Monitoring Location Plan

Key

Feature Boundaries

Locations

N

Scale @ A3: 1:58,000

0 1,000 2,000 m

GAVIA environmental

Date: 07-02-2025

Prepared By: AB

Reviewed By: MA

Approved By: MA

Appendix D Equipment specifications

Get Quote

Levelogger® 5

Model 3001

The Levelogger 5 records highly accurate groundwater and surface water level and temperature measurements. It combines a pressure sensor, temperature detector, 10-year lithium battery, and datalogger, sealed within a 22 mm x 160 mm (7/8" x 6.3") stainless steel housing with a corrosion-resistant coating baked-on using polymerization technology.

The Levelogger 5 measures absolute pressure using a Hastelloy® pressure sensor, offering high resolution and an accuracy of 0.05% FS. Readings are stable in extreme pressure and temperature conditions. The Hastelloy sensor can withstand 2 times over-pressure without permanent damage. Combined with the durable coating inside and out, the Levelogger 5 has high corrosion and abrasion resistance in harsh environments.

The Levelogger 5 uses a Faraday cage design, which protects against power surges or electrical spikes caused by lightning. Its durable maintenance-free design, high accuracy and stability, make the Levelogger 5 the most reliable instrument for long-term, continuous water level recording.

Fast communication and downloading speeds with a high speed Field Reader 5

Levelogger 5 Features

- Highly stable communication: single-eye optical interface—easier to clean, more scratch resistant
- Large memory: 150,000 sets of data
- Strong, robust design: double o-ring seals for increased leakage protection
- High thermistor sensitivity: accurate platinum RTD
- Superior protection in harsh environments: corrosion and abrasion resistant coating—inside and out
- Intuitive Levelogger Software: Diagnostic Utility for more proactive user “self-tests”

Single-eye optical interface

The Levelogger 5 features a smooth, single-eye optical interface, which allows for easy cleaning and more reliable, faster communication. Using a Solinst USB device, including the Field Reader 5 and Levelogger PC Software, programming and data downloading speeds are 57,600 bps.

Applications

- Aquifer characterization: pumping tests, slug tests, etc.
- Watershed, drainage basin and recharge monitoring
- Stream gauging, lake and reservoir management
- Harbour and tidal fluctuation measurement
- Wetlands and stormwater run-off monitoring
- Water supply and tank level measurement
- Mine water and landfill leachate management
- Long-term water level monitoring in wells, surface water bodies and seawater environments

Flexible Communication

Levelogger Software is streamlined, making it easy to program dataloggers, and view and compensate data in the office or the field. Data compensation is made simple; multiple data files can be barometrically compensated at once.

The Levelogger 5 App Interface on your in-field Leveloggers creates a *Bluetooth*® connection between your dataloggers and the Solinst Levelogger App on your smart device. The Solinst Readout Unit (SRU) connects to your deployed Leveloggers to display and save real-time water level readings that are automatically barometrically compensated. Also an option, the DataGrabber 5 is a field-ready USB data transfer unit.

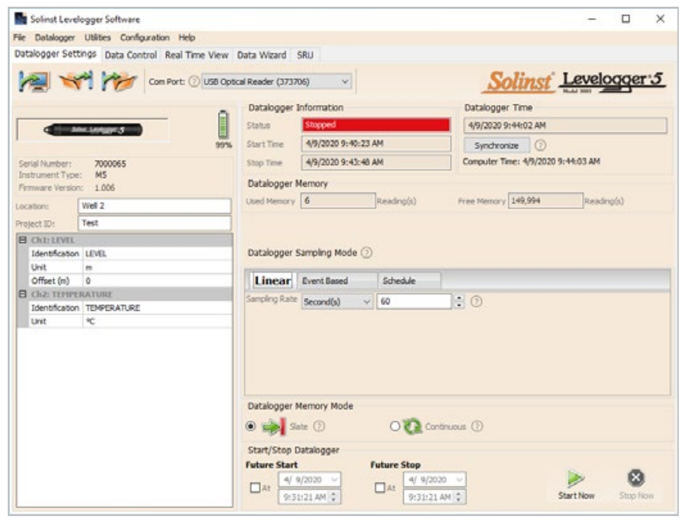
Remote monitoring options include the LevelSender 5, a simple and compact device that fits right in a 2" well, SolSat 5 Satellite Telemetry, STS Telemetry Systems, and the RRL Remote Radio Link. In addition, Levelogger 5 Series dataloggers are SDI-12 compatible.

Levelogger Setup

Programming Leveloggers is extremely intuitive. Simply connect to a PC using an Optical Reader (Desktop Reader 5 or Field Reader 5) or PC Interface Cable. Use a single screen to fill in your project information and sampling regime. Templates of settings can be saved for easy re-use.

The Levelogger time may be synchronized to the computer clock. There are options for immediate start or future start and stop times. The percentage battery life remaining and the amount of free memory are indicated on the settings screen.

Leveloggers can also be programmed with a sampling regime and start/stop times using the Solinst Levelogger App on your smart device.

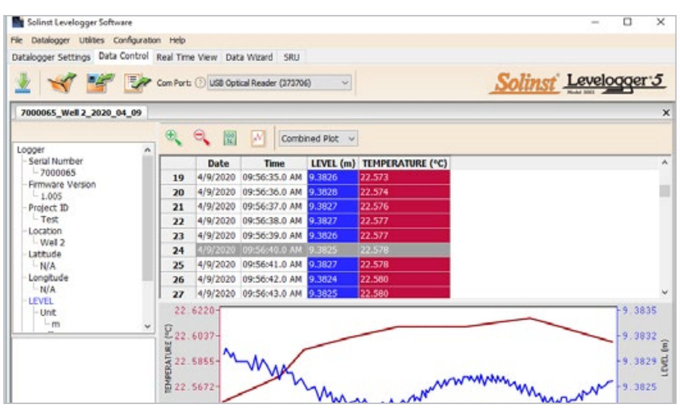


Convenient Sampling Options

Leveloggers can be programmed with linear, event-based, or a user-selectable sampling schedule. Linear sampling can be set from 1/8 second to 99 hours.

Event-based sampling can be set to record when the level changes by a selected threshold. Readings are checked at the selected time interval, but only recorded in memory if the condition has been met. A default reading is taken every 24 hours if no "event" occurs.

The Schedule option allows up to 30 schedule items, each with its own sampling rate and duration. For convenience, there is an option to automatically repeat the schedule.



Data Download, Viewing and Export

Data is downloaded to a PC with the click of a screen icon. There are multiple options for downloading data, including 'Append Data' and 'All Data'. The software also allows immediate viewing of the data in graph or table format using 'Real Time View'.

Level data is automatically compensated for temperature; the temperature data is also downloaded. Barometric compensation of Levelogger data is performed using the Data Wizard, which can also be used to input manual data adjustments, elevation, offsets, density, and adjust for Barometric efficiency. The Levelogger Software allows easy export of the data into a spreadsheet or database for further processing.

The Solinst Levelogger App also allows you to view and save real-time or logged data right on your smart device, or you can view and save the data using an SRU.

Helpful Utilities

The Diagnostic Utility can be used in case of an unexpected problem. It checks the functioning of the program, calibration, backup and logging memories, the pressure transducer, temperature sensor and battery voltage, as well as enabling a complete Memory Dump, if required. A firmware upgrade will be available from time to time, to allow upgrading of the Levelogger 5, as new features are added.

Levelogger 5 App Interface

The Levelogger 5 App Interface uses *Bluetooth®* technology to connect your Levelogger to your smart device. With the Solinst Levelogger App, you can download data, view real-time data, and program your Leveloggers. Data can be e-mailed from your smart device directly to your office (see Model 3001 Levelogger 5 App Interface data sheets).

Download on the App Store

GET IT ON Google play

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Solinst Readout Unit (SRU)

Connect an SRU to an in-field Levelogger via an L5 Direct Read Cable or L5 Threaded or Slip Fit Adaptor to display instant water level readings, Levelogger status, save a real-time logging session, and download data to the SRU memory.

DataGrabber 5

The DataGrabber 5 is a field-ready data transfer device that allows you to copy data from a Levelogger onto a USB flash key (Dual USB & USB-C key provided).The DataGrabber 5 is compact and very easy to transport. It connects to the top end of a Levelogger's Direct Read Cable, or directly to a Levelogger using an adaptor. One push-button is used to download all of the data in a Levelogger's memory to a USB device.

LevelSender 5 Telemetry

The LevelSender 5 is a simple, low cost telemetry system designed to send data from Leveloggers in the field, to your smart device and PC database via cellular communication. There is two-way communication between the LevelSender 5 and Home Station, allowing remote updates. LevelSender 5 stations are compact in design, which allows them to be discreetly installed inside a 2" (50 mm) well (see Model 9500 data sheet).

STS Telemetry

STS Telemetry provides an efficient method to send Levelogger data from the field to your desktop. Cellular communication options give the flexibility to suit any project. STS Systems are designed to save costs by enabling the self-management of data. Alarm notification, remote firmware upgrades and diagnostic reporting make system maintenance simple (see Model 9100 data sheet).

SolSat 5 Satellite Telemetry

The SolSat 5 Satellite Telemetry uses Iridium satellite technology to provide global connectivity for your remote water monitoring projects. The SolSat 5 is simple to set up with Solinst dataloggers using an intuitive and secure Wi-Fi App on your smart device. The SolSat 5 features a built-in barometer, solar panel and a compact weatherproof enclosure for deployment almost anywhere.

RRL Remote Radio Link

The RRL Remote Radio Link is ideal for closed-loop, short range applications up to 30 km (20 miles). The RRL can be linked to an STS telemetry station to change from a closed-loop telemetry system to one which can be accessed from anywhere through internet connectivity. (see Model 9200 data sheet).

®Kevlar is a registered trademark of DuPont Corp.

Standard Cable Deployment

Leveloggers may be suspended on a stainless steel wireline or Kevlar® cord. This is a very inexpensive method of deployment, and if in a well, allows the Levelogger to be easily locked out of sight and inaccessible. Solinst offers wireline and cord assemblies in a variety of lengths.

Solinst 3001 Well Cap Assembly

The 2" Locking Well Caps are designed for both standard and Direct Read Cable deployment options.

The well cap has a convenient eyelet for suspending Leveloggers using wireline or Kevlar cord. The Well Cap insert has two openings to accommodate direct read cables for both a Levelogger and Barologger. Adaptors are available to fit 4" wells.

The cap is vented to equalize atmospheric pressure in the well. It slips over the casing, and can be secured using a lock with a 9.5 mm (3/8") shackle diameter.

Levelogger 2" Locking Well Cap Installations (see Well Caps data sheet for more details)

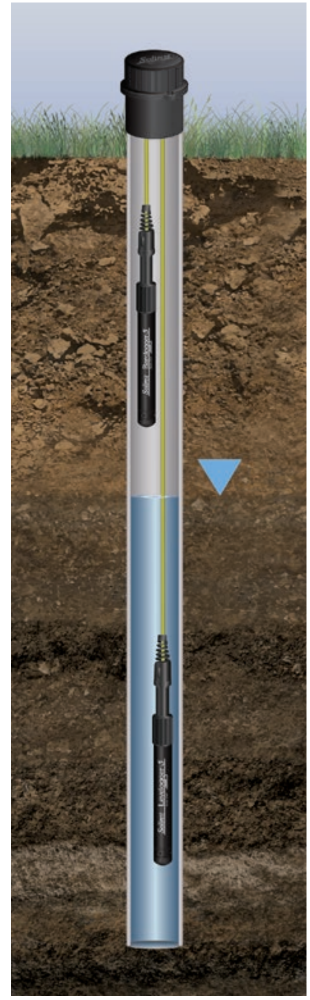
L5 Direct Read Cables

When it is desired to get real-time data and communicate with Leveloggers without removal from the water, they can be deployed using L5 Direct Read Cables. This allows viewing of data, downloading, and programming in the field using a portable PC, or Solinst Levelogger 5 App Interface. You can view and save data to an SRU, or just download data with a DataGrabber 5.

Leveloggers can be connected to an SDI-12 datalogger using the Solinst SDI-12 Interface Cable attached to a L5 Direct Read Cable.

Cable Specifications

L5 Direct Read Cables are available for attachment to any Levelogger in lengths up to 1500 ft. The 3.175 mm dia. (1/8") coaxial cable has an outer polyurethane jacket for strength and durability. The stranded stainless steel conductor gives non-stretch accuracy.



Barologger 5 and Levelogger 5 installed in Well Using L5 Direct Read Cables

Accurate Barometric Compensation

Leveloggers measure absolute pressure (water pressure + atmospheric pressure) expressed in feet, meters, centimeters, psi, kPa, or bar.

The most accurate method of obtaining changes in water level is to compensate for atmospheric pressure fluctuations using a Barologger 5, avoiding time lag in the compensation.

The Barologger 5 is set above high water level in one location on site. One Barologger can be used to compensate all Leveloggers in a 30 km (20 mile) radius and/or with every 300 m (1000 ft.) change in elevation.

The Levelogger Software Data Compensation Wizard automatically produces compensated data files using the synchronized data files from the Barologger and Leveloggers on site.

The Barologger 5 uses pressure algorithms based on air rather than water pressure, giving superior accuracy.

The recorded barometric information can also be very useful to help determine barometric lag and/or barometric efficiency of the monitored aquifer.

The Barologger 5 records atmospheric pressure in psi, kPa, or mbar. When compensating submerged Levelogger 5, Edge, Gold or Junior data, Levelogger Software can recognize the type of Levelogger and compensate using the same units found in the submerged data file (e.g. feet or meters). This makes the Barologger 5 backwards compatible.

Synchronize and Simplify Barometric Compensation Across Entire Site

Levelogger 5 Specifications

Level Sensor:	Piezoresistive Silicon with Hastelloy Sensor
Accuracy:	± 0.05% FS (Barologger 5: ± 0.05 kPa)
Stability of Readings:	Superior, low noise
Resolution:	0.002% FS to 0.0006% FS
Units of Measure:	m, cm, ft., psi, kPa, bar, ºC. ºF (Barologger 5: psi, kPa, mbar, ºC, ºF)
Normalization:	Automatic Temperature Compensation
Temp. Comp. Range:	0º to 50ºC (Barologger 5: -10 to +50ºC)
Temperature Sensor:	Platinum Resistance Temperature Detector (RTD)
Temp. Sensor Accuracy:	± 0.05ºC
Temp. Sensor Resolution:	0.003°C
Battery Life:	10 Years – based on 1 reading/minute
Clock Accuracy (typical):	± 1 minute/year (-20ºC to 80ºC)
Operating Temperature:	-20ºC to 80ºC
Maximum # Readings:	150,000 sets of readings
Memory Mode:	Slate and Continuous
Communication:	Optical high-speed: USB, SDI-12 57,600 bps with USB
Size:	22 mm x 160 mm (7/8" x 6.3")
Weight:	146 grams (5.2 oz)
Corrosion Resistance:	Baked-on coating using polymerization technology (inside and out)
Other Wetted Materials:	Delrin®, Viton®, 316L stainless steel, Hastelloy, PFAS-free PTFE coating
Sampling Modes:	Linear, Event & User-Selectable with Repeat Mode, Future Start, Future Stop, Real-Time View
Measurement Rates:	1/8 sec to 99 hrs
Barometric Compensation:	Software Wizard and one Barologger 5 in local area (approx. 30 km/20 miles radius)

Models	Full Scale (FS)	Accuracy	Resolution
Barologger	Air only	± 0.05 kPa	0.002% FS
M5	5 m (16.4 ft.)	± 0.3 cm (0.010 ft.)	0.001% FS
M10	10 m (32.8 ft.)	± 0.5 cm (0.016 ft.)	0.0006% FS
M20	20 m (65.6 ft.)	± 1 cm (0.032 ft.)	0.0006% FS
M30	30 m (98.4 ft.)	± 1.5 cm (0.064 ft.)	0.0006% FS
M100	100 m (328.1 ft.)	± 5 cm (0.164 ft.)	0.0006% FS
M200	200 m (656.2 ft.)	± 10 cm (0.328 ft.)	0.0006% FS

Low Cost Datalogging: See Levelogger 5 Junior data sheet.
Vented Dataloggers: See LevelVent 5 & AquaVent 5 data sheets.
Conductivity Datalogging: See Levelogger 5 LTC data sheet.

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HOBO
Data Loggers

MX2201

HOBO Pendant MX Water Temperature Data Logger

Bluetooth-enabled logger

A waterproof logger enabled with Bluetooth wireless access to deliver accurate temperature measurements straight to your mobile device or Windows computer using our HOBOconnect app.

Important Information
Requires a compatible mobile device or Windows computer and the HOBOconnect app. System requirements for the app can be found at bottom of the HOBOconnect software page.Want cloud storage and access to the powerful tools of LI-COR Cloud™ IoT software (fka HOBOlink)? Add an MX Data Plan!

Compatible with
HOBOconnect Monitoring App

Supported Measurements

Soil Temperature, Temperature, Water Temperature

Features

- Convenient wireless setup and download via Bluetooth
- Mounting boot included
- Large memory stores 96,000 measurements
- Waterproof to 30 meters (100 feet)
- User-replaceable battery
- Mounting tabs for fast, easy deployment
- LED indicates when temperature exceeds set threshold
- Works with Onset’s free HOBOconnect app
- ±0.5°C (±0.9°F) accuracy

Contact Us

Sales (8am to 5pm ET, Monday through Friday)

- Email sales@onsetcomp.com
- Call 1-508-759-9500
- In U.S. toll free 1-800-564-4377
- Fax 1-508-759-9100

Technical Support (8am to 5pm ET, Monday through Friday)

- Contact Product Support www.onsetcomp.com/support/contact
- Call 1-508-759-9500
- In U.S. toll free 1-877-564-4377

Onset Computer Corporation
470 MacArthur Boulevard
Bourne, MA 02532

HOBO Pendant MX Water Temperature Data Logger (MX2201) Specifications

Temperature Sensor (MX2201 and MX2202)

Range	-20° to 70°C in air (-4° to 158°F in air) -20° to 50°C in water (-4° to 122°F in water)
Accuracy	±0.5°C from -20° to 70°C (±0.9°F from -4° to 158°F)
Resolution	0.04°C (0.072°F)
Drift	<0.1°C per year (<0.18°F per year)
Response Time	17 minutes typical to 90% in air moving 1 m/s, unmounted 7 minutes typical to 90% in stirred water, unmounted

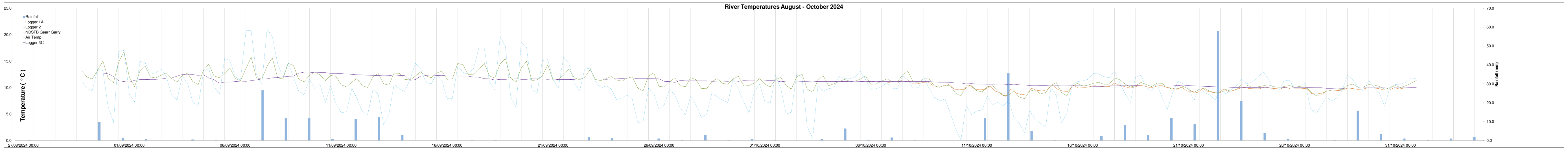
Light Sensor (MX2202)

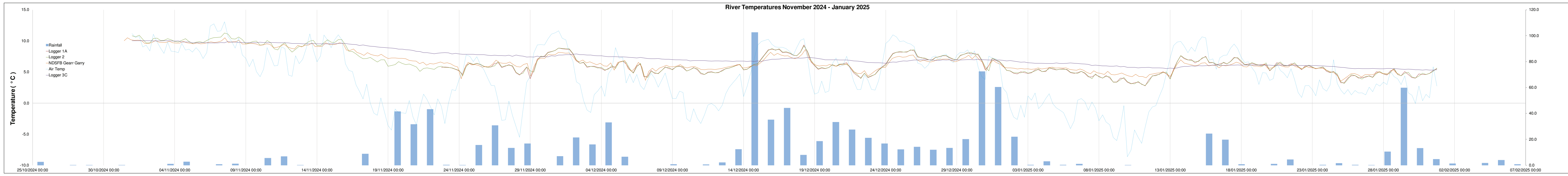
Range	0 to 167,731 lux (0 to 15,582 lum/ft2)
Accuracy	±10% typical for direct sunlight (see Light Measurement on page 2 for more details)

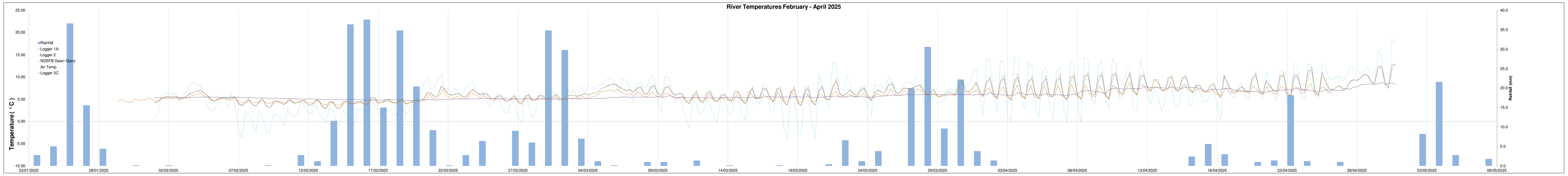
Logger

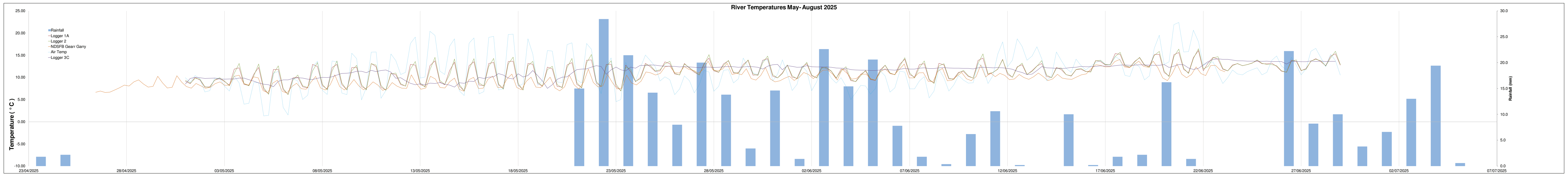
Logger Operating Range	-20° to 70°C in air (-4° to 158°F in air)
Buoyancy (Fresh Water)	2 g positive (0.07 oz positive)
Waterproof	To 30.5 m (To 100 ft)
Radio Power	1 mW (0 dBm)
Transmission Range	Approximately 30.5 m line-of-sight (Approximately 100 ft line-of-sight)
Wireless Data Standard	Bluetooth Low Energy (Bluetooth Smart)
Logging Rate	1 second to 18 hours
Time Accuracy	±1 minute per month at 25°C (±1 minute per month at 77°F)
Battery	CR2032 3V lithium, user replaceable
Battery Life	1 year typical at 25°C (77°F) with logging interval of 1 minute and Bluetooth Always On enabled in software. 2 years typical at 25°C (77°F) with logging interval of 1 minute and Bluetooth Always On disabled in software. Faster logging intervals and statistics sampling intervals, burst logging, remaining connected with the app, excessive downloads, and paging may impact battery life. To ensure proper battery installation, see Battery Information for detailed instructions on replacing the battery.
Memory	96,000 measurements
Full Memory Download Time	Approximately 45 seconds; may take longer the farther the device is from the logger
Wetted Materials	Polypropylene case, EPDM O-ring
Dimensions	3.35 x 5.64 x 1.8 cm (1.32 x 2.22 x 0.69 inches)
Weight	12.75 g (0.45 oz)
Environmental Rating	IP68

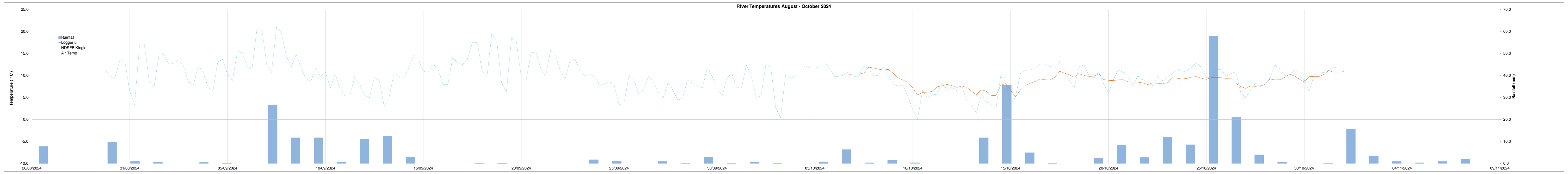
Appendix E Time-series monitoring graphs (Month by month)

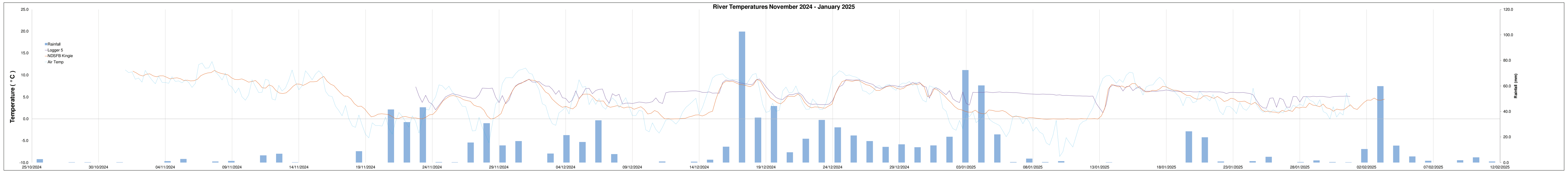

River Temperatures August - October 2024
Rainfall
Logger 1A
Logger 2
NDSFB Gearr Garry
Air Temp
Logger 3C
Temperature (°C)
Rainfall (mm)

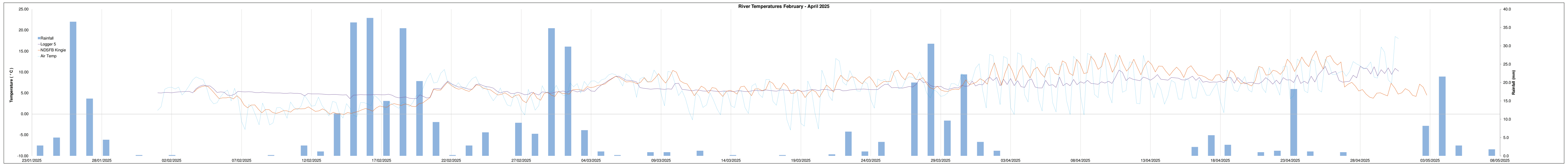

River Temperatures November 2024 - January 2025
Rainfall
Logger 1A
Logger 2
NDSFB Gearr Garry
Air Temp
Logger 3C
Temperature (°C)

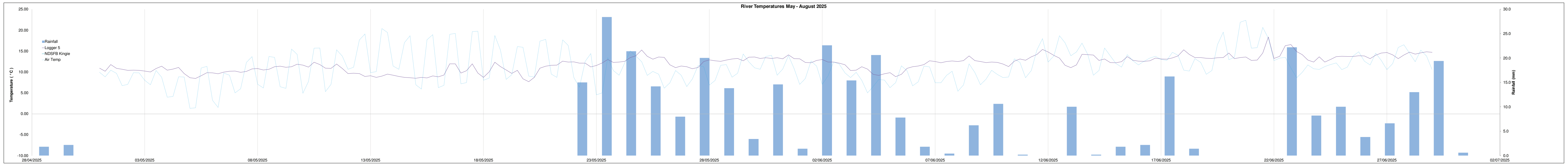

River Temperatures February - April 2025
Rainfall
Logger 1A
Logger 2
NDSFB Gearr Garry
Air Temp
Logger 3C
Temperature (°C)
Rainfall (mm)

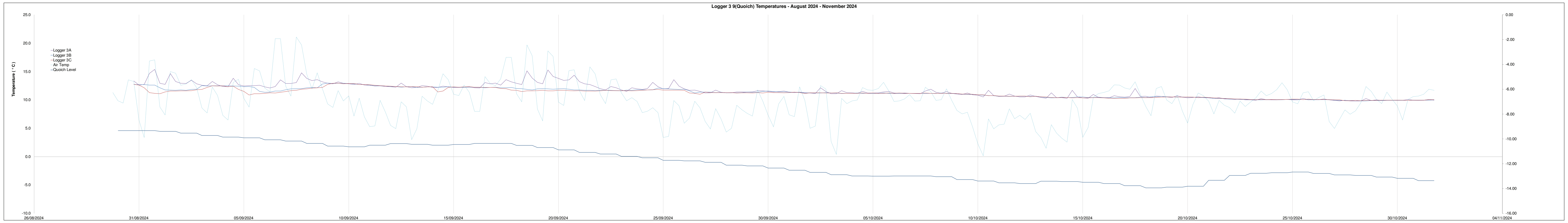

River Temperatures May- August 2025
Rainfall
Logger 1A
Logger 2
NDSFB Gearr Garry
Air Temp
Logger 3C
Temperature (°C)
Rainfall (mm)

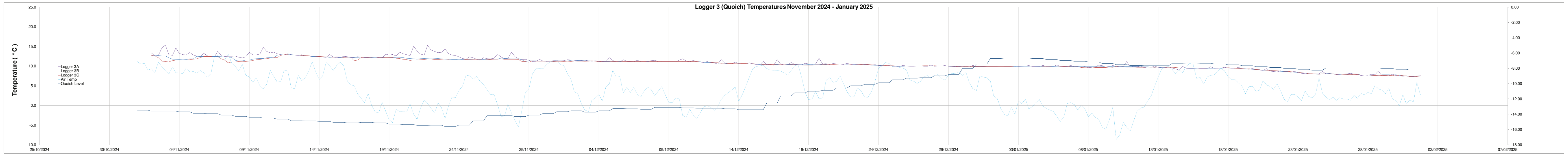

River Temperatures August - October 2024
Rainfall
Logger 5
NDSFB Kingie
Air Temp
Temperature (°C)
Rainfall (mm)

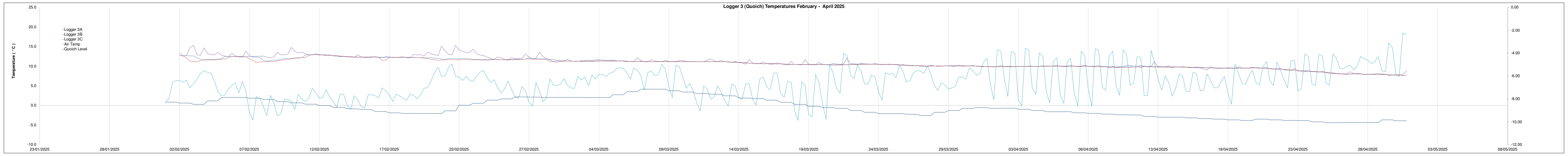

River Temperatures November 2024 - January 2025
Rainfall
Logger 5
NDSFB Kingie
Air Temp
Temperature (°C)
Rainfall (mm)

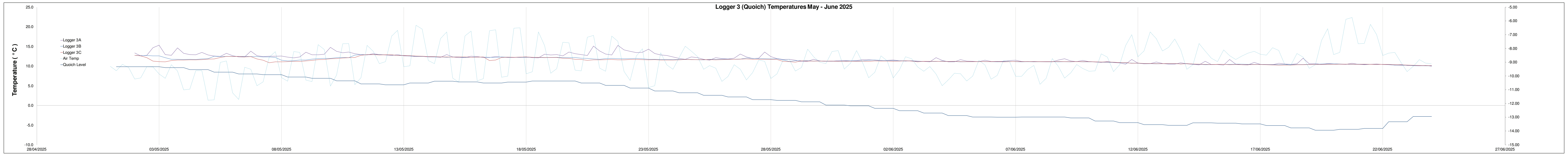

River Temperatures February - April 2025
Rainfall
Logger 5
NDSFB Kingie
Air Temp
Temperature (°C)
Rainfall (mm)

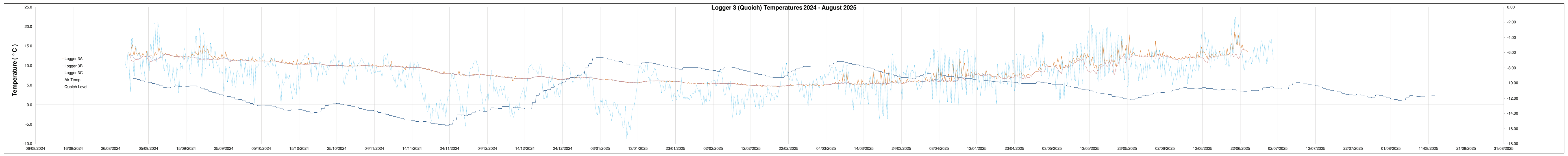

River Temperatures May - August 2025
Rainfall
Logger 5
NDSFB Kingie
Air Temp
Temperature (°C)
Rainfall (mm)

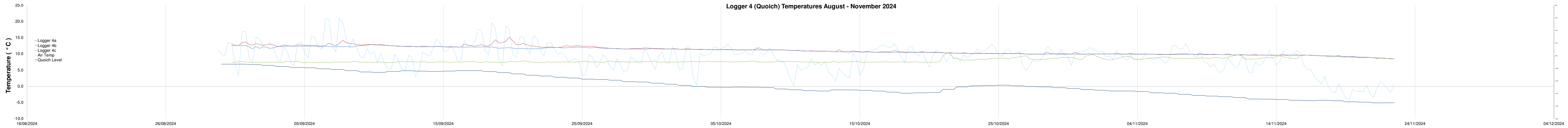

Logger 3 9(Quoich) Temperatures - August 2024 - November 2024
Temperature (°C)
Logger 3A
Logger 3B
Logger 3C
Air Temp
Quoich Level


Logger 3 (Quoich) Temperatures November 2024 - January 2025
Temperature (°C)
Logger 3A
Logger 3B
Logger 3C
Air Temp
Quoich Level


Logger 3 (Quoich) Temperatures February - April 2025
Temperature (°C)
Logger 3A
Logger 3B
Logger 3C
Air Temp
Quoich Level


Logger 3 (Quoich) Temperatures May - June 2025
Temperature (°C)
Logger 3A
Logger 3B
Logger 3C
Air Temp
Quoich Level


Logger 3 (Quoich) Temperatures 2024 - August 2025
Temperature (°C)
Logger 3A
Logger 3B
Logger 3C
Air Temp
Quoich Level


Logger 4 (Quoich) Temperatures August - November 2024
Temperature (° C)
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
Logger 4a
Logger 4b
Logger 4c
Air Temp
Quoich Level
16/08/2024
26/08/2024
05/09/2024
15/09/2024
25/09/2024
05/10/2024
15/10/2024
25/10/2024
04/11/2024
14/11/2024
24/11/2024
04/12/2024