Appendix K

Donich Water Hydro Scheme

Noise Survey and Preliminary Analysis

Report No: P626/Noise Survey r1

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1 Introduction

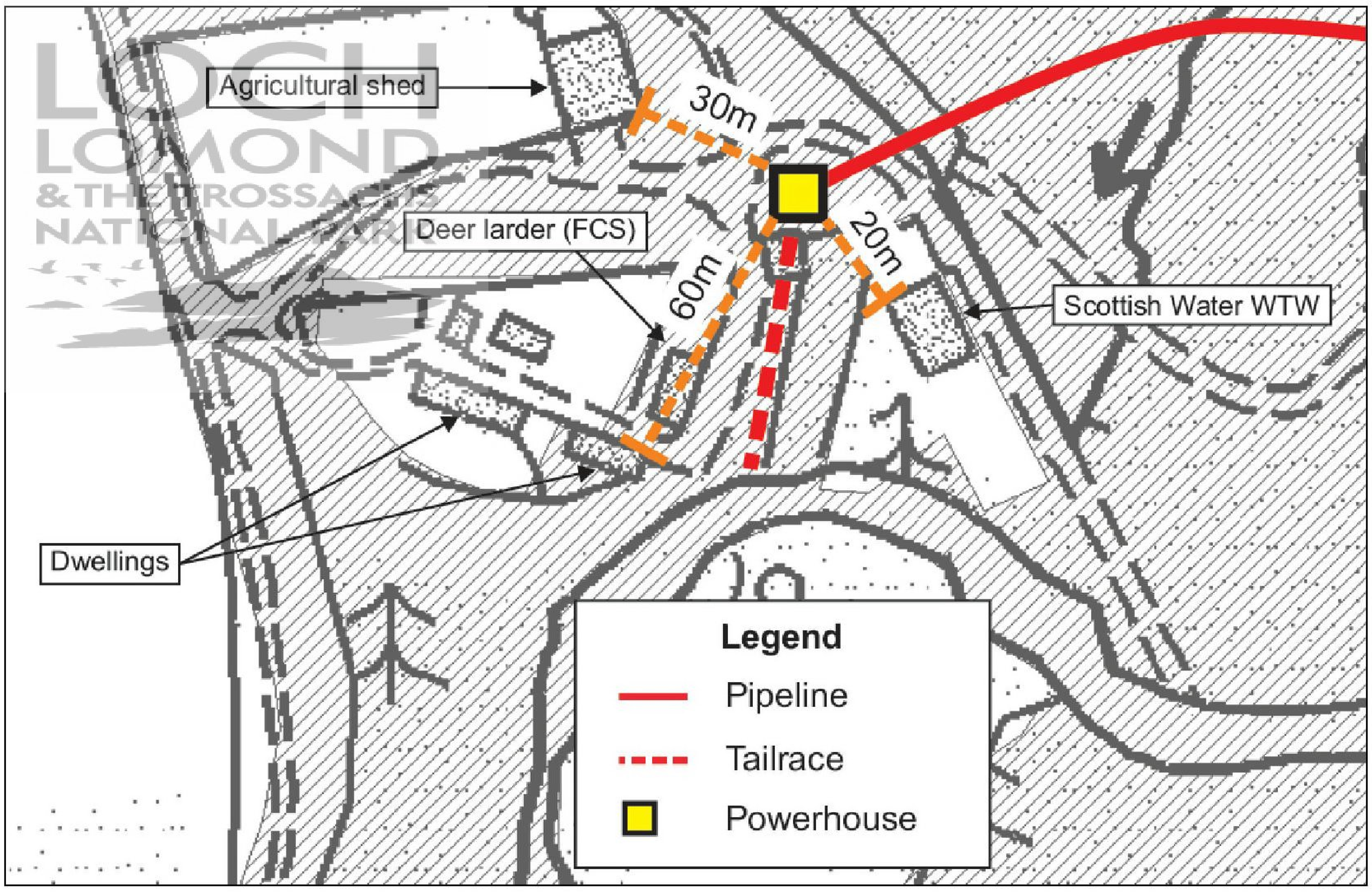
This report sets out the results of a noise survey and analysis carried out for the proposed hydropower plant at Donich, Lochgoilhead.

1.1 Scheme Layout

As part of the proposed scheme, a new powerhouse will be constructed on the right bank of the Donich Water, northeast of Inveronich Farm, which will house a turbine and associated generating equipment.

The nearest building of Inveronich Farm, an agricultural shed, is approximately 30m east of the proposed powerhouse and the nearest dwelling is approximately 60m southwest of the powerhouse. Furthermore there is a building of Scottish Water about 20m southeast of the powerhouse.

Figure 1 – Site layout showing projected powerhouse location and distances to nearby buildings



1.2 Objectives

The purpose of this report is to:

- Provide details of a noise survey undertaken in March 2013;
- Provide indicative sound pressure levels (SPLs) for the turbine and generator;
- Assess the likely effect of these SPLs on the closest residential buildings;
- Consider the construction, layout and orientation of the powerhouse and make suggestions for possible mitigation measures.

2 Survey Set-up and Results

2.1 Timing and Conditions of Survey

The noise survey was carried out between 16:45 GMT and 17:15 GMT on Wednesday, 6th March 2013, when background noise was at a minimum:

- Weather conditions were dry with slight wind;
- There was no work being carried out at or near the site,
- No cars were passing the site at the time of the survey.

It is assumed that in the area of the proposed powerhouse, the main source of background noise is the river, Donich Water. For reference, the flow at the time of the survey was about 0.03 m^3/s at Hydroplan's gauging station further upstream. This is a low flow, equating to the 85^{th} percentile or to the flow that is on average exceeded 85% of the year. Assuming that the flow at the powerhouse location was naturally higher due to the bigger catchment, but still at the same percentile, it can be said that the background noise caused by the river was on a low level at the time of the noise survey. Hence, the recorded noise levels reflect a low ambient background noise level of the river.

2.2 Methodology

The sound level meter used in the survey was the Cirrus CR:800B. To minimize the influence of reflection from nearby objects, the sound level meter was held approximately 1.2m above the ground and at least 3.5m from the nearest reflective surface, where possible. At each location five readings (facing in four directions and upwards) over a 60-seconds time interval were taken.

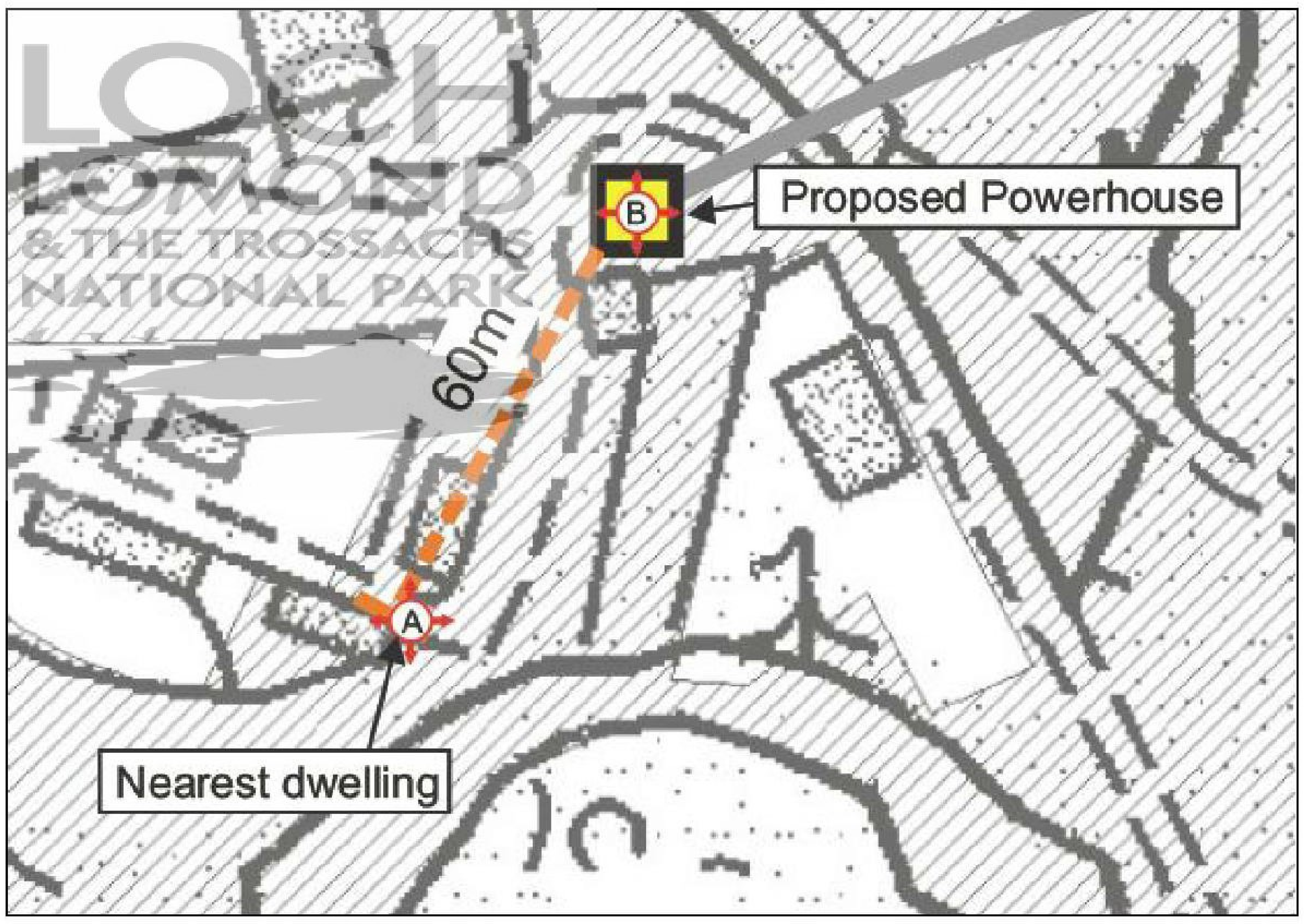
To ensure that the sound level meter responds to frequencies that are likely to be heard by the human ear, an 'A' weighted adjustment was applied to the measurements.

From the values obtained during the 60-seconds measurement intervals the SPL $L_{A90,T}$ was computed. This value is used to represent the 'background noise' and refers to the noise level that is exceeded for 90 per cent during the measurement interval (T). Therefore this value gives a clear indication of the underlying noise level and is hardly affected by single noisy events that may occur during the measurement.

2.3 Location of Sound Pressure Level Readings

Sound pressure readings were taken at west-facing gable of the nearest dwelling (A) and, to obtain a reference value, at the location of the proposed powerhouse (B). The locations and their distance are shown in Figure 2.

Figure 2 – Noise Survey locations



2.4 Survey Results

From the measurements at the two locations the following L_{A90} values were obtained:

Table 1 – LA_{90} values at the two surveyed locations

	Nearest dwelling (A) (dBA)	Powerhouse location (B) (dBA)
North	**51**	42
East	53	40
South	54	**40**
West	52	40
Up	54	40

The lowest L_{A90} SPL found for the dwelling (A) is *51dBA* facing north (away from the river), while the lowest L_{A90} at proposed powerhouse (B) is *40dBA* (in most directions except north). Hence, for the purpose of this report, these two numbers will be assumed as background noise levels for their respective locations.

3 Noise Levels

3.1 Probable noise sources

Hydroplan has undertaken noise surveys at a number of small hydro stations in the past and experience suggests that the highest SPLs are emitted by:

1. Generator cooling fans – especially the higher speed 750 / 1,000 / 1,500 rpm
2. Gearbox / speed increasers
3. Turbine casings, which have minimal support by the concrete foundations.
4. Exposed external pipework resonating with the turbine's mechanical or hydraulic frequencies.

In the case of the Donich scheme (1), and to a lesser extent (3) apply. (4) may apply as the exit of the tailrace, at its preferable location from a technical point of view, will be close to the dwelling (A). The majority of external pipe work will be encased in concrete, thus the noise emitted will be significantly attenuated. Further mitigation measures, as stated Chapter 5.1, can be applied.

3.2 SPLs resulting from operating machinery and their reduction outside the powerhouse

Noise surveys have been taken at operating schemes to determine noise levels caused by different turbine types and to ascertain the effect of the building on noise reduction. The results of some of them are presented below.

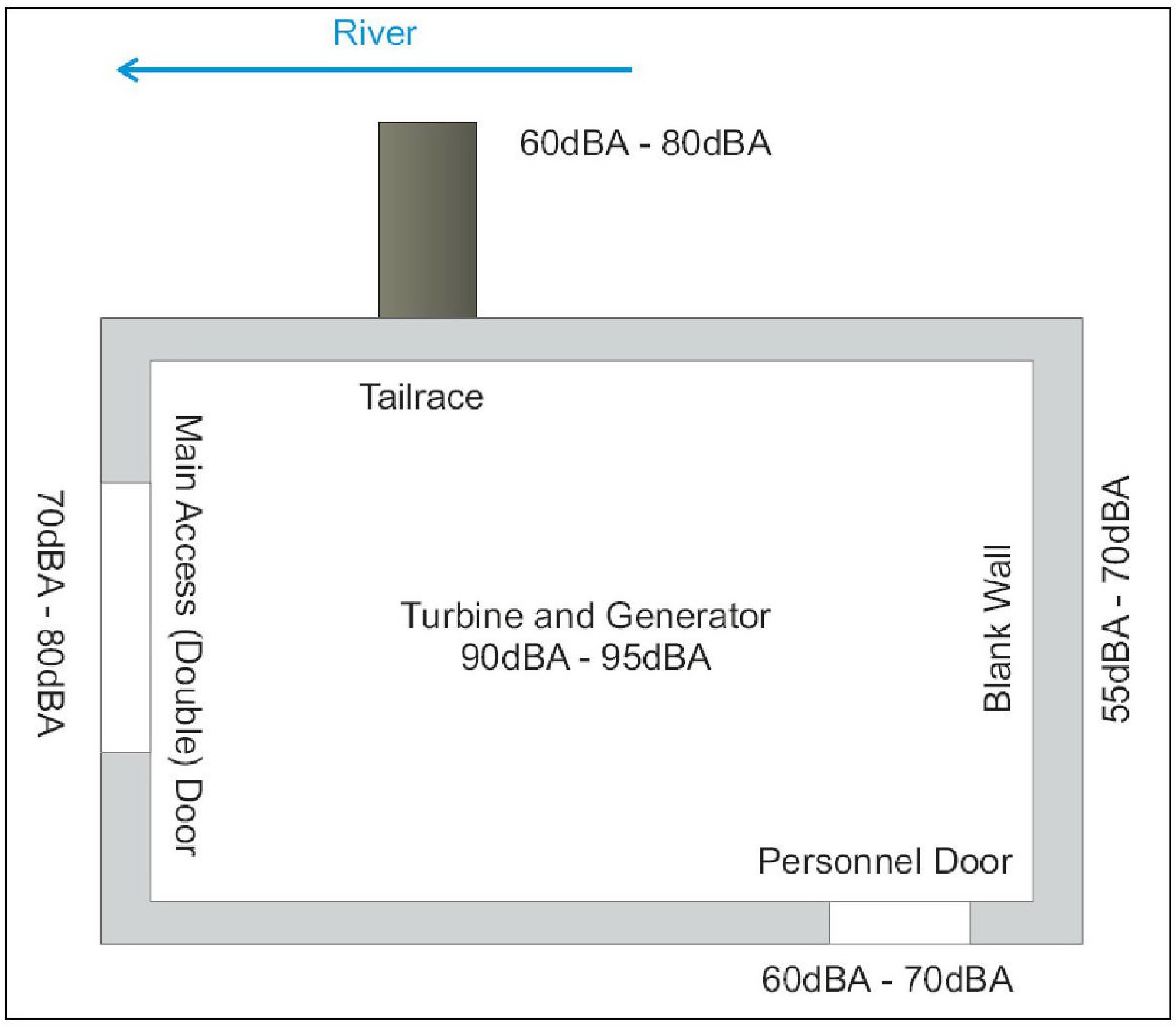
Table 2 – Noise Readings from Operating Schemes

	Pelton 475kW		Pelton 700kW		Francis 680kW	
	Reading (dBA)	Reduction (dBA)	Reading (dBA)	Reduction (dBA)	Reading (dBA)	Reduction (dBA)
Inside Building	96	**0**	93	**0**	91	**0**
Double Doors	77	**20**	73	**21**	68	**23**
River (Tailrace)	71	**25**	79	**14**	60	**31**
Personnel Door	N/A	**N/A**	68	**25**	57	**33**
Blank Wall	52	**44**	66	**27**	54	**36**

It is worth noting that the 475kW Pelton machine was a relatively old installation and that none of the buildings employed any of the mitigation measures listed in Section 5. Also, it can be seen that the capacity of the scheme does not necessarily determine the SPLs from the machinery.

The results show that the fabric of the building has the effect of reducing the noise emanating from inside the building by *14dBA to 44dBA* (approximate values) depending on which face the reading was taken. The double doors tend to 'leak' the most noise whilst a blank wall unsurprisingly provides the most reduction. The illustration below shows a typical powerhouse layout with exemplary SPLs and their reduction.

Figure 3 – Typical Powerhouse Layout and Noise Readings (exemplary figures)



Looking at Figure 3 and assuming the worst case of *95dBA* inside the building and an average reduction of *28dBA,* the noise outside the powerhouse can be reasonably estimated at *67dBA*. This figure will be used as the *maximum source SPL* in the analysis in Section 4.

3.3 Guidelines for Ambient Noise Levels

The World Health Organisation recommends an SPL limit of 30dBA for restorative sleep. However, more practical limits suggested by Local Planning Authorities are 35dBA or even higher in towns.

Moreover BS4142 (1997) suggests predicted noise levels:

- 10dBA above minimum ambient are likely to provoke complaints
- 5dBA above minimum ambient have marginal chance of provoking complaints.
- 10dBA below minimum ambient have very little chance of provoking complaint.

4 Analysis

A simple analysis was undertaken to provide an indication of the likely sound pressure level at the dwelling during operation of the hydro scheme. No allowance for tonal spectra was considered, however no allowance for attenuation due to ground or vegetation was considered either. The simple equation used was for hemi-spherical attenuation i.e. *Attenuation = (20 log R) + k*, where R = distance (m) and k = -8.

Predicted SPL at the nearest dwelling

Maximum source SPL			67dBA
BS4142 (1997) allowance			5dBA
Design SPL			72dBA
Attenuation	= (20 log 60) – 8	=	28dBA
Predicted SPL at the dwelling (B)	= 72 – 28	=	44dBA

This analysis shows that the predicted SPL at the nearest dwelling would be *44dBA*. Compared with the lowest recorded background noise level at the dwelling (A), which was *51dBA* (see section 2.4), the predicted SPL emitted from the powerhouse is about *7dBA* lower than the background noise. This would indicate that the proximity of the scheme would have little chance of provoking complaints from residents.

The noise survey also shows that the background noise at the powerhouse location (B, further away from the river) is *40dBA,* which is notably lower than the one at the dwelling (A). This supports the assumption made at the beginning that the river due its proximity is the main source of background noise at the dwelling.

At flows lower than Q85 (present flow during the survey), and consequently lower background noise levels, the noise emitted from the powerhouse might be noticeable at the nearby dwellings. In this case, mitigation measures to further reduce the noise emissions can be employed (see Section 5.1). However, it should be noted that during the lowest flows the turbine will not be running and hence no noise will be emitted.

5 Noise Attenuation

5.1 Powerhouse Design

The simple analysis in Section 4 indicates that the powerhouse is unlikely to present a problem with noise at the nearest dwelling. However, there are a number of ways of further improving the noise attenuation properties of the powerhouse building. They are as follows:

1. Acoustic baffles on ventilation intake louvres.
2. Outlet louvres and fans orientated to minimise the impact of noise.
3. Close fitting, acoustic grade doors with weather seals on the main equipment access and the personnel entrance.
4. Sealing of potential apertures at the roof eaves with semi-rigid medium density mineral wool.
5. A false ceiling or insulated roof within the depth of the rafters.
6. Cavity wall construction.
7. A louver system that extends to below the water surface to acoustically seal the tailrace.
8. Heavy duty covers on the swab extraction chamber and tailrace chamber to attenuate any noise emanating from the tailrace.

Enough measures will be employed to ensure that the increase in noise at the dwelling as a result of the hydro scheme will be no greater than 5dBA above background noise levels.