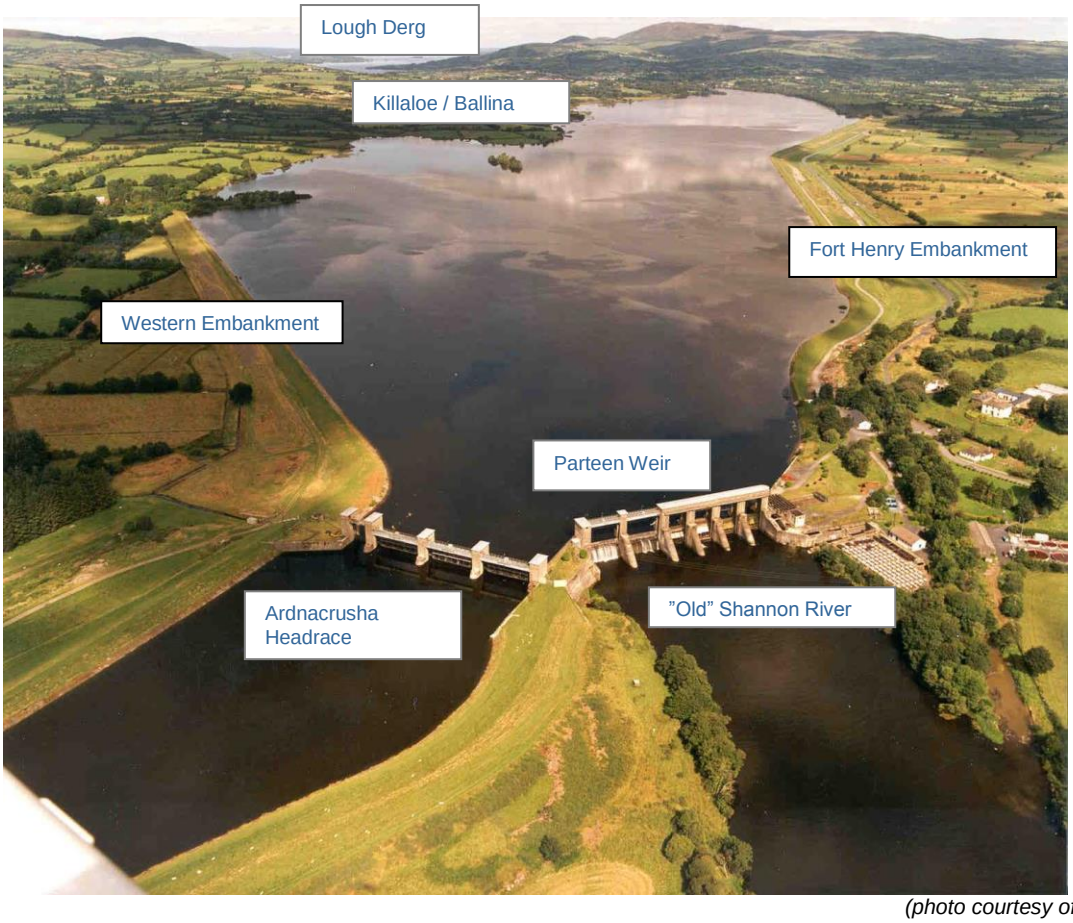
6. Source Abstraction Regime

6.1 Introduction

6.1.1 Parteen Basin

Parteen Basin, also known locally as the “Lower Lake”, was constructed under the Shannon Hydro-Electric Scheme in the late 1920’s. It floods an area through which the Shannon once flowed as a river, and the old channel is still recognisable in depth surveys of the bed of the flooded basin. It is regulated both by the Parteen Weir, and by the flow through Ardnacrusha. Much of its perimeter is formed by high linear engineered embankments, which are inspected daily by ESB staff; visible left and right in Figure 6-1 below.

Parteen Basin allows the Ardnacrusha power station to change its generation rate reasonably quickly; it thereby fulfils a necessary role of maintaining a relatively constant water level within the headrace canal of Ardnacrusha, which is connected to it, and so maintains steady water pressure on the generators in the station, as water is drawn from the Basin at rates which can vary widely. Water drawn from Parteen Basin is replenished from Lough Derg via flows through the Killaloe channel, which links Lough Derg to Parteen Basin, resulting in a wider normal operating band in Parteen Basin, than in Lough Derg upstream.



(photo courtesy of ESB)

Figure 6-1 Parteen Basin (Lower Lake)

The control of water level at Parteen Weir is such that a narrow operating band, 460mm (18 inches approximately) in depth, extends over the surface of the natural Lough Derg. ESB manage water levels very carefully within this normal operating band, across a wide range of flows, as part of their management of the hydro-electric scheme. Water levels in Lough Derg rise above the normal operating band during flood periods.

Accordingly, the normal operating band of water level employed for power generation at Ardnacrusha can be envisaged as a thin 'band of water' on top of, and extending over, the whole area of Lough Derg and Parteen Basin. This is presented schematically, along with the range of historical inflows, in Figure 6-2.

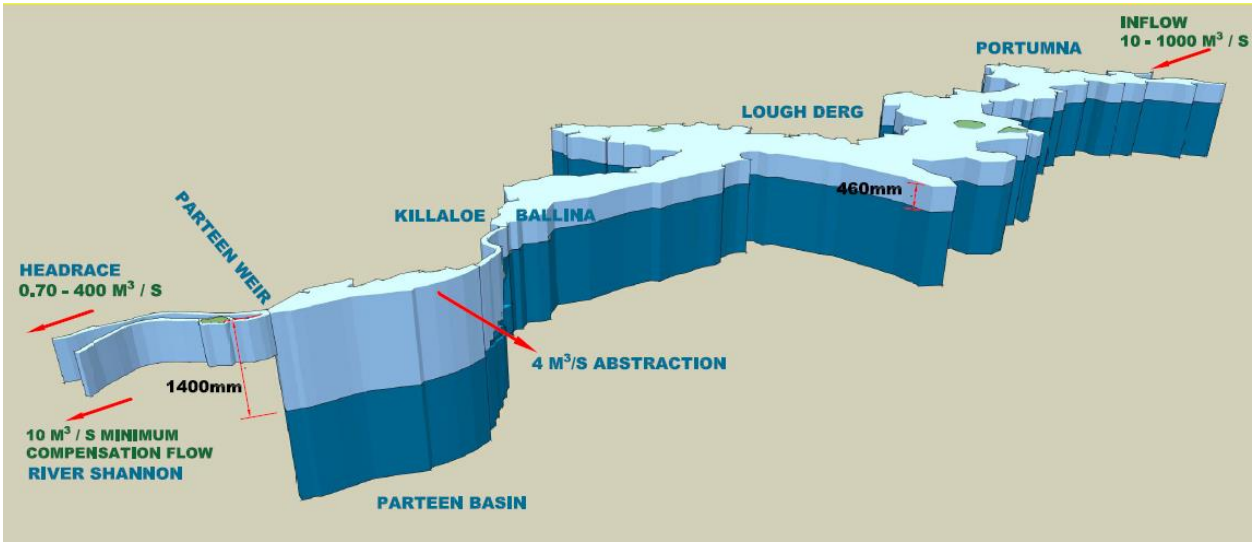


Figure 6-2 Schematic Illustration of the narrow Normal Operating Bands

6.2 Abstraction Regime

The proposed water supply would abstract 330Mld (3.82 m^3/s) as a continuous average at the year 2050. The facility to abstract this 330 Mld of water in 20 hours, rather than 24 hrs, is being sought from ESB, so that avoidance of peak power for pumping and associated higher costs can be considered in detailed design.

There is also a facility being sought, whereby in exceptional circumstances, if supply were interrupted for a period of two days, then the same volume normally abstracted over a 7 day period, could be abstracted in 5 days, to permit refilling of a treated water reservoir in South Dublin, or refilling of sections of pipeline, in the event of an outage. In summary, the flexibilities being sought are summarised in Table 6.1.

Table 6.1 Proposed Abstraction Regime

Description	2050		Flow		Note
Abstraction Requirement (per day)	**330 Mld**		3.82 m^3/s	over 24 hours	average continuous flow rate
			4.58 m^3/s	over 20 hours	normal abstraction
Abstraction volume over 7 days	**2310 Ml**				Volume per week
Recovery abstraction rate		**462 Mld**	5.34 m^3/s	over 24 hours for five days	In exceptional circumstances; the weekly volume is abstracted over 5 days.
Abstraction volume over year	**120,450 Ml**				

The proposed abstraction of water will use a small fraction (approximately 2%) of the annual average flow through Parteen Basin. Abstraction of water from hydro-electric power schemes is commonly employed worldwide to enable environmentally sustainable availability of water for public supply. The proposed abstraction of water is in essence, an abstraction from water normally used in the hydro-power plant, using the

same existing water level controls, and therefore avoiding having to construct a new impoundment. Water levels on Lough Derg & Parteen Basin will be managed within the same water level 'normal operating band' as currently applies. Irish Water, as part of an overall agreement with ESB, will agree the small adjustment in generation water on a continuous year round basis. The statutory compensation water of 10 cubic metres per second (m³/s) spilled from Parteen Weir into the 'Old Shannon River' will remain unchanged and undiminished under this proposal. Navigation and beneficial uses focused on tourism will experience the same operating water level range as normal.

6.3 ESB operations

ESB control water levels on Lough Derg and the movement of water at / through Parteen Basin using both the Shannon Hydroelectric station, and the Parteen Weir. The normal operating band[23] on Lough Derg, referred to below, is managed to achieve this. The overall runoff from the catchment, and the volumes of water passing each way, depend on 'wet' and 'dry' years, and on the profiles of floods and dry weather across any given year. Over 25 years from 1990 to 2015, between 68% and 94% of flow at Parteen Basin, passed through Ardnacrusha, The lower percentage reflects either a dry year overall, or a wet year with substantive flood peaks. In broad scale terms, approximately 90%-95% of the long-term average annual flow in the Shannon at Parteen Weir (approx. 180 m^3/s), is directed through Ardnacrusha, with a minimum statutory compensation water flow of $10m^3/s$ directed to the lower Shannon at Parteen Weir.

It is important to note that the normal operating water level range, while it permits the water supply abstraction and the minimum compensation flow to be provided, it is narrow and quite small in terms of storage for flood attenuation, when flood flows are many orders of magnitude greater than the proposed water abstraction flow.

Ardnacrusha can take a maximum flow of 400 m^3/s on full load to the four generators there, and when inflow to Lough Derg is high, and water level exceeds 30.86 m OD, which is the upper end of the Normal Operating Band, then flow to the old course of the River Shannon is necessarily increased, to safely pass the flood and return water levels to within the Normal Operating Band.

ESB tend to maintain levels at the lower end of the Normal Operating Band in late autumn, in anticipation of the need to operate in higher flow conditions in Autumn/ Winter.

ESB monitor the falling hydrograph in Spring before intervening to retain water towards the upper end of the band. The ESB approach is to manage the water level towards the upper end of the normal operating band in late spring and summer, and to retain it there with due regard to the River Shannon statutory compensation flow obligations, subject to prevailing conditions.

With summertime flood conditions, the need to maintain water levels towards the upper end of the normal operating band is temporarily suspended, generation through Ardnacrusha is increased and Lough Derg is thereby managed by ESB for the safe passage of floods, as normally happens at present. A resumption of the 'low flow regime' takes place once the flood has passed and the falling hydrograph is established and monitored, as before.

Normal Operating Water Levels

At present, water level on Lough Derg and on Parteen Basin is managed to normally lie between the limits set out in Table 6.2:

[23] The 'band' being the normal operating levels between the upper and lower limits.

Table 6.2 Normal Operating Water Levels Lough Derg and Parteen Basin (Metres over Ordnance Datum)

Normal Operating Limits	Lough Derg		Parteen Basin	
	OD Malin Head (m)	OD Poolbeg (m)	OD Malin Head (m)	OD Poolbeg (m)
Upper level	30.86	33.56	30.86	33.56
Lower level	30.40	33.10	30.00	32.70

In this Report, reference to water levels henceforth will be to Ordnance Datum at Malin Head.

As part of the commitment by ESB to management of the available hydropower reserve on the network in exceptional circumstances, a 100mm deep band of water is currently held in a higher category of reserve, so that the Normal Operating Band limits, allowing for this reserve, are as set out in Table 6.3.

Table 6.3 Operating Levels with provision for Reserve Allowance

Operating Limits incorporating Reserve Allowance	Lough Derg		Parteen Basin	
	OD Malin Head (m)	OD Poolbeg (m)	OD Malin Head (m)	OD Poolbeg (m)
Upper level	30.86	33.56	30.86	33.56
Lower level with generation reserve allowance	30.50	33.20	30.00*	32.70*

*Assumed that levels in Parteen are determined by hydraulics of flow range to Ardnacrusha

Other key levels are as shown in Table 6.4 (Malin Head Datum):-

Table 6.4 Key levels on Lough Derg and Parteen Basin (Lower Lake)

Other Key Levels	High Water Level	Low Water Level
Lough Derg		
Maximum Normal Operating Water Level	30.86 m OD	
Minimum Normal Operating Water Level (currently)		30.40 m OD
Minimum Statutory Low Water Level		29.30 m OD
Parteen Basin (Lower Lake)		
Minimum required Water Level Ardnacrusha		28.80 m OD
Dam Crest Level (Embankments Parteen Basin)	32.30 m OD	
Maximum Water Level Parteen Basin	31.30 m OD	
Minimum Water Level Parteen Basin		30.00 m OD

6.4 Calibrated Modelling

There are two linked models employed in analysing the effects of water abstraction.

(a) Hydrodynamic Model of Lough Derg/ Parteen Basin, and
(b) Hydrological Model of the historic record, with and without abstraction.

The hydrodynamic model, developed by the project team, examines the water circulation and water quality within the lake, and is described in Section 7 of this Report.

The hydrological model is linked to the hydrodynamic model; and was also developed by the project team to assess the impact of the proposed abstraction on Lough Derg water levels. The model examines the historical record (supplied by ESB) and compares these recorded levels with simulated levels; as if the proposed water supply abstraction of 3.82m^3/s was in place at that time. The model also modifies the water discharged through Ardnacrusha hydropower station to allow for that abstraction, when such discharges are being made by ESB.

6.5 Environmental Assessment of Source Impact

The environmental impact of the proposed abstraction on the water source will be assessed fully in the Environmental Impact Statement (EIS) and Natura Impact Statement (NIS), and will be informed by the results of the hydrological modelling.

Differential Between Pre-Works and Post-Works Levels

The model analyses daily water levels across the 83 year period from 1932 to 2015. It examines the historic flow position, along with the power generation flows, as if the water supply abstraction had been in place throughout this period. The difference between the pre-works (recorded) and post-works (simulated) levels, across the whole data set, have been examined. It is important to appreciate that this comparison is based on

the historical pattern of hydropower generation. It does not yet take into account the beneficial impact of an adjusted pattern of hydropower generation, which would be subject to agreement with ESB, which is described in Section 6.6 below. In any year where generation would have taken place on a consistent basis throughout the year, the curtailment of flows to generation to match water abstraction, results in no effective difference between water level as recorded historically, and water level which would have occurred if the abstraction had been taking place in those particular years.

A different situation occurs if historic generation in a particular year was ceased by ESB in response to a period of dry weather. In such years, a period would exist after generation had ceased, where the presence of the water abstraction could not be compensated for, since generation would already have ceased, and which therefore would open some differential between historic recorded level (without abstraction) and modelled water level (with abstraction).

It was found that some differential between the water levels with and without abstraction would have been generated in 68 of the 83 years analysed. The degree of differential varies with the severity of the dry weather. Table 6.5 shows the range of maximum deviation in water levels with and without abstraction, assuming the historic pattern of power generation remained unchanged.

Table 6.5 Deviation between Recorded and Simulated Levels in Lough Derg, 1932 – 2015,

Maximum Deviation in Recorded and Simulated Water Levels at Killaloe (mm)	No. of Years in which reduction occurs
0-10mm	42
10-20mm	10
20-30mm	4
30-40mm	3
40-50mm	3
50-60mm	2
60-70mm	4
> 70mm	0

The maximum difference across the 83 years occurs in the drought year of 1995 when the simulated levels with abstraction in place deviate by up to 68mm from the pre-works recorded levels, without abstraction. The results of the simulation for the years 1994 and 1995 are shown in Figure 6-3 below.

The modelled daily water levels are represented by the 'pink line' and the actual recorded daily water levels at Killaloe by the 'blue' line. *Periods where the 'blue' line is not visible are as a result of the 'pink' line being superimposed over the 'blue' line due to there being no difference between recorded and modelled water levels.*

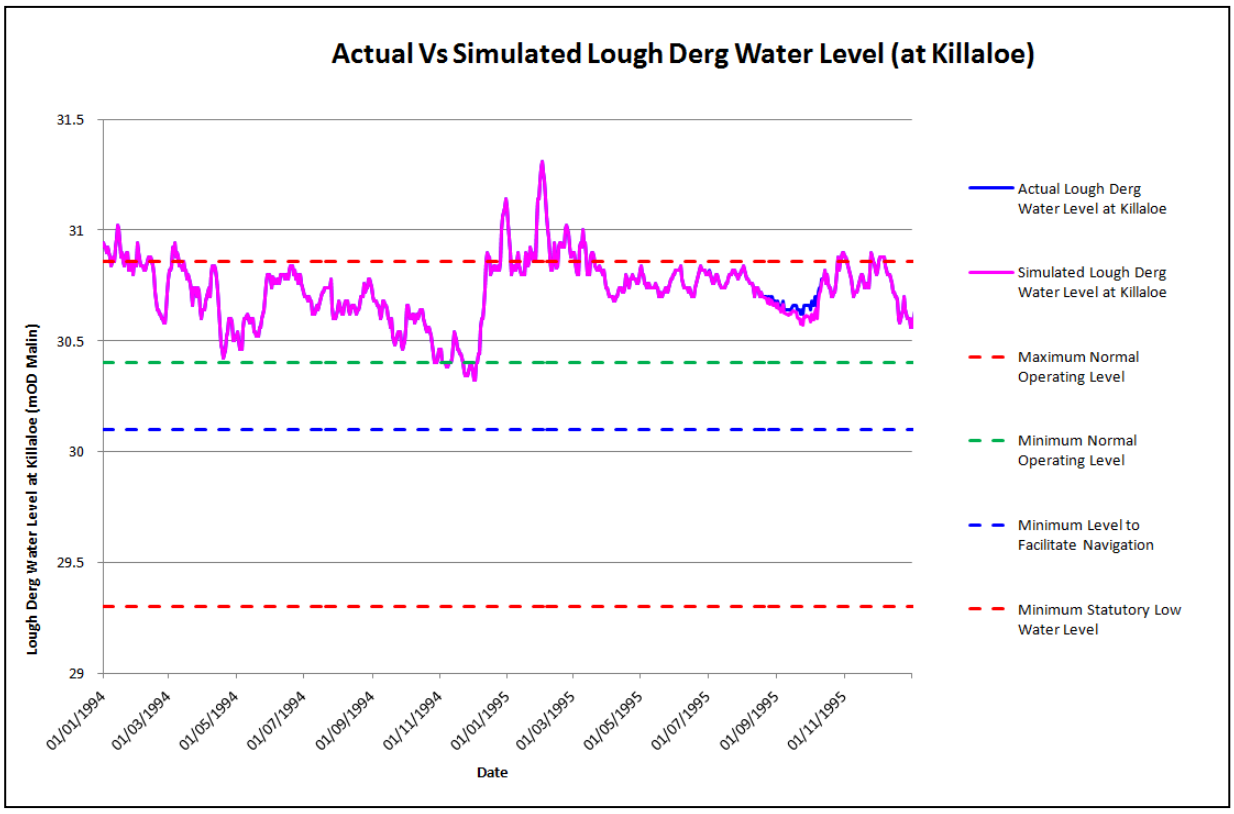


Figure 6-3 Actual Vs Simulated (1994-1995) Lough Derg Water Level for Abstraction = 330Mld (3.82m³/s) plus Fish Pass Flow (0.7 m³/s) and Compensation Flow of 10m³/s

The simulation shows that an abstraction for water supply of 3.82m³/s, together with compensation flow of 10m³/s, and Fish Pass flow of 0.7m³/s, is sustainable within the same normal operating water level band.

For the most part there is no difference between recorded and modelled water levels. This is achievable because the extent of generation during these periods is such that it can be reduced to account for the water abstraction, thus resulting in a net zero effect on lake operations and water level.

In 1995, the simulated and recorded water levels are different, because of the long period (19/08/1995 to 05/10/1995) when there was minimal power generation taking place, and therefore the combined 14.52m³/s outflow, i.e. Old River Shannon compensation flow plus Fish Pass flow of 0.7 m³/s plus Water Supply Project abstraction, would have been provided from storage, compared to the pre-works 10m³/s plus Fish Pass flow of 0.7 m³/s. The water levels would still have been managed within the normal operating water level band, but levels would have been lower during this period by a maximum of 68mm, within that band.

6.6 Control of Water Levels with Water Supply Abstraction

Overall, on an average annual basis, it is expected that approximately 2% of the annual average flow at Parteen Basin will be redirected to water supply. Generation will continue to take place at the same flow rates through the generators, but the duration of generation will be reduced to reflect the proposed water abstraction.

Even in prolonged extreme dry weather, such as was experienced in 1995, it would have been possible to abstract while still maintaining water levels within the normal operating band. Historically, in 1995, recorded flows through Ardnacrusha indicate that power generation was continuing, for at least some hours on most days, right into August of that year.

In 1995, Ardnacrusha continued generating up until August 18th of that year, and for some isolated days after that date. Had abstraction been in place at that time, it would have been met after that date from a combination of storage and inflow. Modelling with the historic pattern of ESB generation, the incremental drawdown due to

the modelled water supply abstraction simulated in that year would have reached the peak of value of (–68mm) on 05/10/1995, but this would have been within the normal operating water level band.

A reduction of generation would not present a technical or generation difficulty, but this is subject to agreement between ESB and Irish Water.

Following the dry weather event, lake levels could be allowed to realign with historic levels/lake management protocols at the onset of autumn / winter wet weather events.

Operation of Lough Derg, post works, will feel and look very similar to the way it currently operates, and there will not be a visible day to day difference. Water being abstracted for water supply will be measured by flow meter, statutory compensation water released to the Old River Shannon will be provided and verified as before, and the water used in generation will be reduced as necessary to keep water levels within the normal operating band.

6.7 Conclusions

The proposed abstraction of water is in essence, an abstraction from water normally used in the hydro-power plant, using the same existing water level controls. Water levels on Lough Derg & Parteen Basin will be managed within the same water level 'Normal Operating Band' as currently applies.

Irish Water will enter into an agreement with ESB, whereby water used in hydropower generation at Ardnacrusha will be reduced to take account of water abstracted for water supply.

Modelling of abstraction under these conditions shows that the abstraction is sustainable within the existing normal operating water level range. Operation of Lough Derg, post works, will feel and look very similar to the way it currently operates, and there will not be a visible day to day difference.

The next stage of the planning process requires the environmental impact assessment and Stage 2 Appropriate Assessment of the proposed abstraction. The proposed scope of the EIS to inform these assessments is set out in the EIS Scoping Report which is offered for public consultation alongside this Final Options Appraisal Report.