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Re: Blessington Wastewater Discharge Licence Application D0063-02

Dear Inspector,

In response to the Regulation 18(3)(b) request for information notice dated 01 April 2025, please see below relevant information;

Provide evidence, including consideration for flows at the primary discharge point, to demonstrate the receiving waterbody is not impacted by the waste water discharge.

Please see appended to this document a Water Quality Impact Assessment Addendum, which concludes that the proposed discharges will not impact on the receiving waterbody (Liffey_040 waterbody), and that the proposed emission limit values are compatible with the achievement of the WFD objectives for the Liffey_040 and the Golden Falls Reservoir lake waterbodies.

Table 3 (Ambient Water Quality Summary 2018-2023) of the water quality impact assessment shows 95%ile BOD at both downstream of Blessington WWTP and Golden Falls Reservoir exceeding the 'good' status EQS. Uisce Éireann state data collected prior to January 2023 is no longer representative of current effluent loading conditions in receiving waters. Demonstrate whether the water quality concentrations meet the relevant EQSs at the current effluent quality and loadings.

The report referenced above includes and analyses updated ambient monitoring data collected between January 2023 to December 2024. As outlined in Section 3.2 and Table 3-2 of the report, the results confirm that the water quality concentrations downstream of the Blessington WwTP primary discharge point meet the relevant EQSs for all assessed parameters (BOD, Ammonia, Orthophosphate & Total Phosphorus).

The report demonstrates that the BOD mean concentrations at both downstream locations meet the river mean EQSs for high indicative quality. Furthermore, BOD 95th percentile concentrations meet the EQS

requirements for good indicative quality downstream of the WwTP and for high indicative quality in the Golden Falls Reservoir.

Yours sincerely,

Peter Keegan

Peter Keegan

UÉ Wastewater Strategy

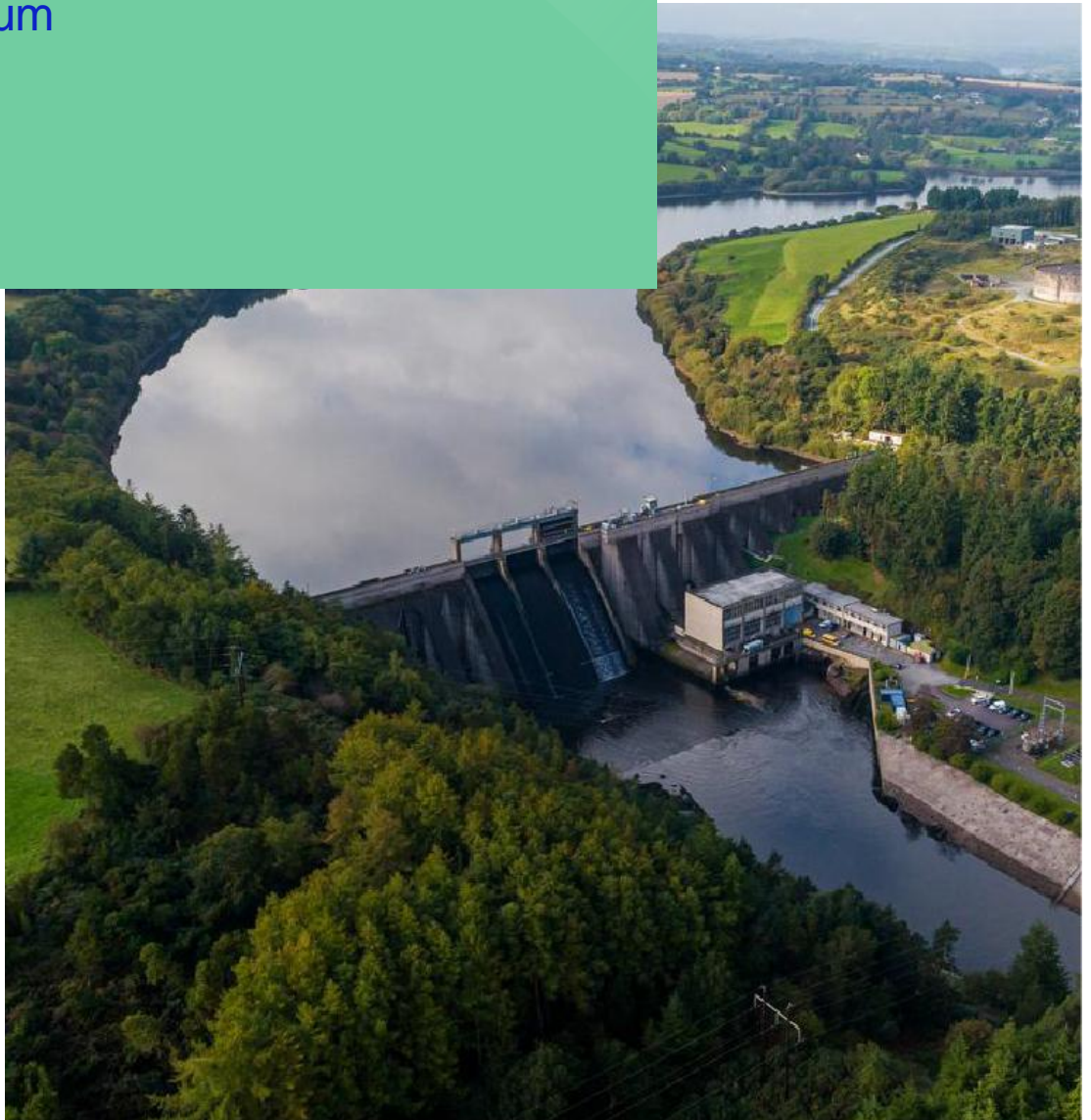
Enclosed: Water Quality Impact Assessment Addendum

Report

Uisce Éireann Water Quality Impact Assessment

Blessington WWTP

Addendum



Delivering Water Services for Ireland

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Quality Assurance

Revision Number	Description of Change	Author(s)	Approved By	Date of Approval
01	First Issue	S Waite	R. Kane	29/08/2025

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1 Background

A Water Quality Impact Assessment report was submitted on 7 September 2023 by Uisce Éireann in support of an application for a Waste Water Discharge Authorisation in connection with the Blessington Wastewater Treatment Plant (WwTP). The discharge from the WWTP outfalls to a short reach of the River Liffey immediately upstream of Golden Falls Reservoir. The report aimed to quantify the impact of the discharges on water quality in Golden Falls Reservoir under the 9,000 Population Equivalent (PE) design capacity of the WwTP. The impact assessment confirmed that the current Emission Limit Values (ELVs) as set in the Wastewater Discharge Licence are appropriate given the expected future increase in WWTP flows.

Following submission of the 2023 report, the Environmental Protection Agency requested further information regarding the flow regime that exists within the relevant sections of the River Liffey and Golden Falls Reservoir. Flows in Golden Falls Reservoir and in the River Liffey upstream are controlled for the purposes of hydropower generation and Uisce Éireann held further discussions with the Electricity Supply Board to understand current operational practices and the associated influence on the hydrological regime. Uisce Éireann also received and analysed further flow monitoring data, obtained an updated set of reservoir and river water quality monitoring data, and have collected further data on effluent flow and quality. The additional river flow data shows that flows through Golden Falls Reservoir are highly complex, and the minimum pass-forward flow of 1.5 m³/s which is required downstream of this structure (and which is calculated as a weekly average) may not be continuously maintained at all times in the River Liffey upstream of the dam.

This Addendum to the 2023 Water Quality Impact Assessment report summarises the additional information collected, and analyses carried out. Section 2 provides a detailed analysis of the reservoir flow data; Section 3 summarises the updated ambient and effluent quality data and Section 4 sets out revised water quality calculations which take account of the complex flow regime. The calculations confirm that the proposed ELVs are sufficient to protect receiving water quality in terms of compliance with EQS, and compatible with achievement of WFD objectives.

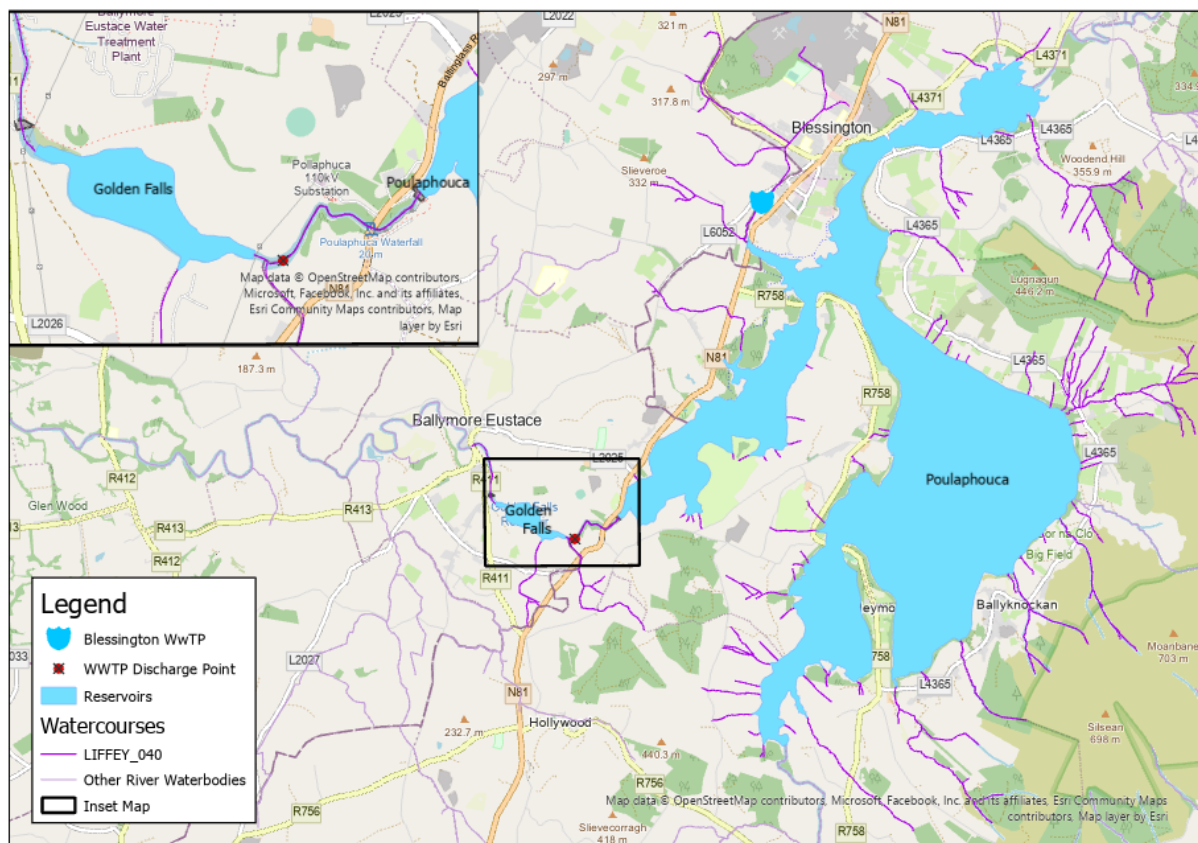
This Addendum also provides calculations of ELVs required to comply with any proposed Mass Emission Limits (MELs, see Section 5). The MEL is set to ensure that any increase in nutrient loading to the Liffey_040 river waterbody and Golden Falls Reservoir lake waterbody is within the assimilative capacity.

2 Site Location and Flow Regime

2.1 Site Location and Flow Controls

Blessington WwTP discharges to a short section of the Liffey_040 river waterbody, ca. 910 m downstream of Poulapouca hydro-electric power station dam, and ca. 1.5 km upstream of Golden Falls hydro-electric power station dam (Figure 2-1). The discharge is located ca.147 m upstream of the inflow of the Liffey_040 to the Golden Falls Reservoir lake waterbody.

Figure 2-1: Blessington WwTP Discharge Point Location.

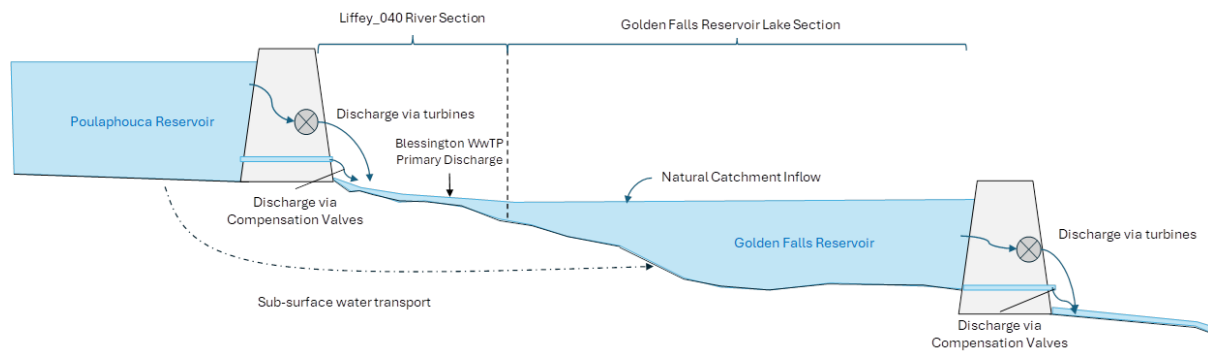


Golden Falls Reservoir is operated by the Electricity Supply Board as a balancing lake¹ for the larger and deeper Poulapouca Reservoir. Flows from Poulapouca Reservoir into Golden Falls Reservoir are variable, with periods of low flow interspersed with periods of much higher flow. By contrast, flows from Golden Falls Reservoir are much more consistent and a minimum pass forward flow equivalent to 1.5 m³/s (measured as a weekly average) is specified downstream of Golden Falls Dam as a condition of operation. Flows are released from both dams via a combination of flow through turbines (used to generate electricity) and compensation valves (used to maintain levels in Golden Falls Reservoir and flow in the River Liffey downstream). A conceptual model of flow through the system is shown in Figure 2-2. In addition to flow from Poulapouca Reservoir, Golden Falls dam receives inflow from a small topographic catchment of 8.0 km². The large impoundment of Poulapouca Reservoir will also locally increase groundwater levels and transport, with emergence within Golden Falls Reservoir downstream

¹ [river-liffey-hydro-electric-stations-pr-pamphlet.pdf](#), Three Rivers Project Report: [Microsoft Word - Chap 2 rr1.doc](#)

likely to further contribute to flow volumes in this reservoir.

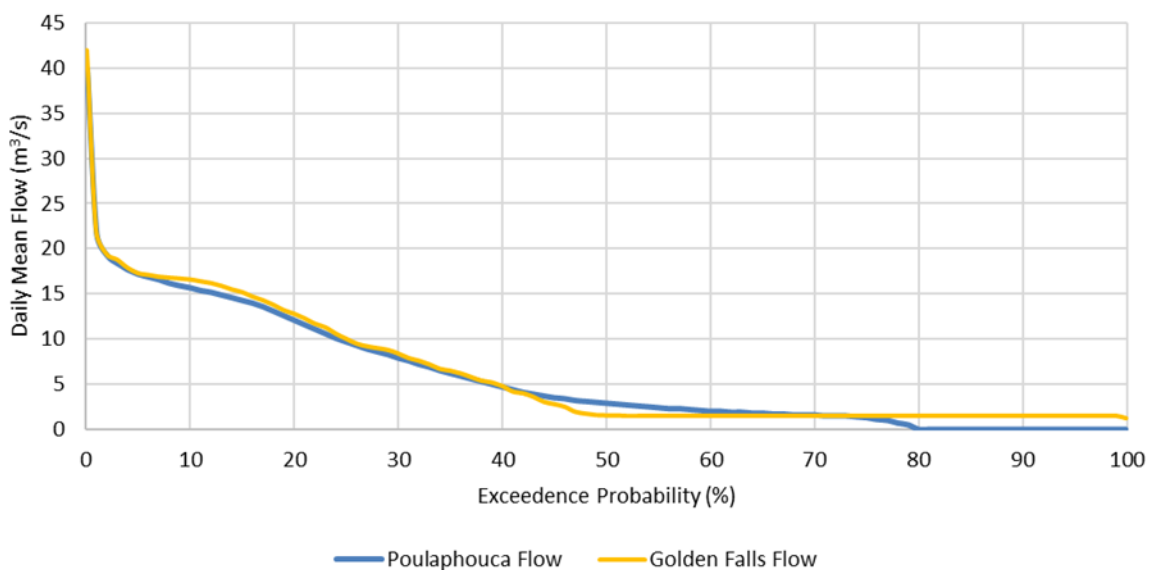
Figure 2-2: Conceptual Model of Flow Through Poulaphouca/Golden Falls Reservoir System.



2.2 Flow Statistic Calculations

Previous analysis of flow at Blessington WwTP discharge point relied on daily mean flow data recorded by the Electricity Supply Board at Poulaphouca Dam and Golden Falls Dam between 1950 and 2013, with flow data from 1985 onwards being representative of current operational conditions. This analysis gave the flow duration curve in Figure 2-3 and showed that a flow of 1.5 m³/s was maintained downstream of Golden Falls Reservoir, while zero flow could occur downstream of Poulaphouca Reservoir for as much as 20% of the time. The analysis also gave average flows of 8.9 m³/s for Poulaphouca Dam and 9.2 m³/s for Golden Falls Dam. The Q₉₅ flow was calculated at 0 m³/s for Poulaphouca Dam and 1.5 m³/s for Golden Falls Dam. The river flow rate and water level at the discharge location is a function of the relative rates of inflow from Poulaphouca Reservoir and outflow through the Golden Falls Dam. The flow regime in the Liffey_040 waterbody at Blessington WwTP primary discharge point is therefore anthropogenically controlled.

Figure 2-3: Daily Mean Flow Duration Curves for Poulaphouca Dam and Golden Falls Dam (1985-2013).



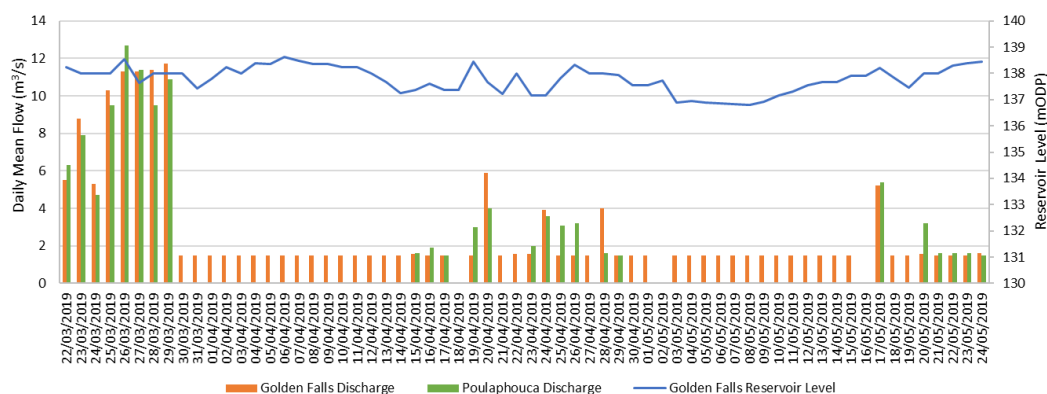
Analysis of the daily mean flow data also indicated that periods of zero flow from Poulaphouca Reservoir

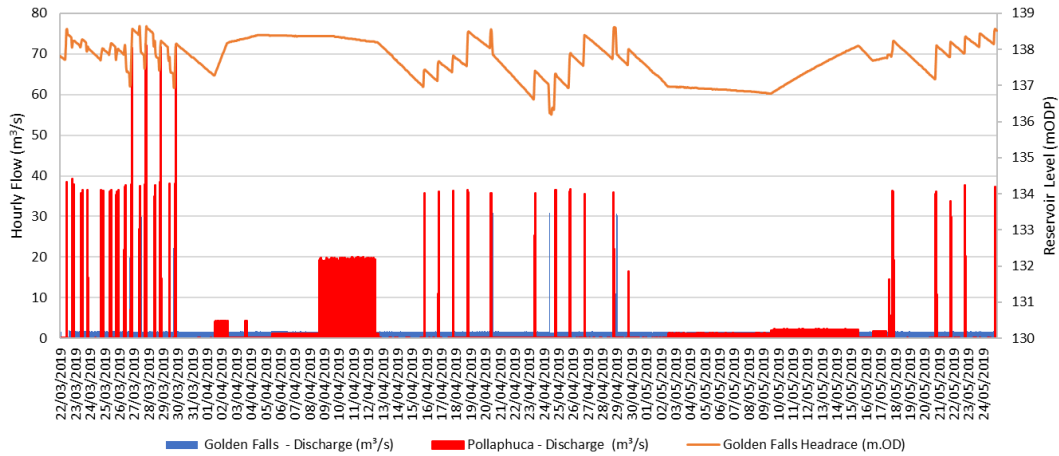
could be prolonged, with zero flow periods of five to seven days being observed frequently since 1992. However, review of the reservoir level data for these periods showed no corresponding reduction in reservoir level in Golden Falls Reservoir. Further discussions with the ESB confirmed that the daily mean flow data is based on records of hydro-electric power generation, and therefore only accounts for the “discharge via turbines” component of flow in Figure 2-2. When appropriate, the flow compensation valves at Poulaphouca Dam are opened to maintain the water level in Golden Falls Reservoir and these flows through the compensation valves are not recorded within the daily mean flow dataset that was previously analysed.

Subsequent to the previous report (2023 report) the ESB provided a number of hydrometric datasets to UÉ. One of these datasets included the flow contributions to Golden Falls Reservoir from the turbine and compensation valve discharges. The data were provided on an hourly timestep and ran from 19 April 2017 to 15 November 2023 for Golden Falls Reservoir and from 19 April 2017 to 25 March 2025 for Poulaphouca Reservoir, a period of more than six calendar years for Golden Falls Reservoir and nearly eight calendar years for Poulaphouca Reservoir. Prior to this, an updated daily mean flow dataset was also provided for the April 2017 to 15 November 2023 period which indicated zero flow periods from Poulaphouca Reservoir of up to 16 and 17 days in April and May 2019, during which levels in Golden Falls Reservoir did not decrease.

The aggregated hourly and daily flow data for this period are compared in Figure 2-4 and the hourly flow data show that a compensation flow occurred from Poulaphouca Reservoir to Golden Falls Reservoir throughout this “zero flow” time period. The hourly flow data also show much higher flow rates from Poulaphouca Reservoir compared to the daily mean flow data, although the higher discharge rates are not sustained throughout the day.

Figure 2-4: Daily Mean Flow Data (Top) and Hourly Flow Data (Bottom) for 22/03/2019 to 24/05/2019.

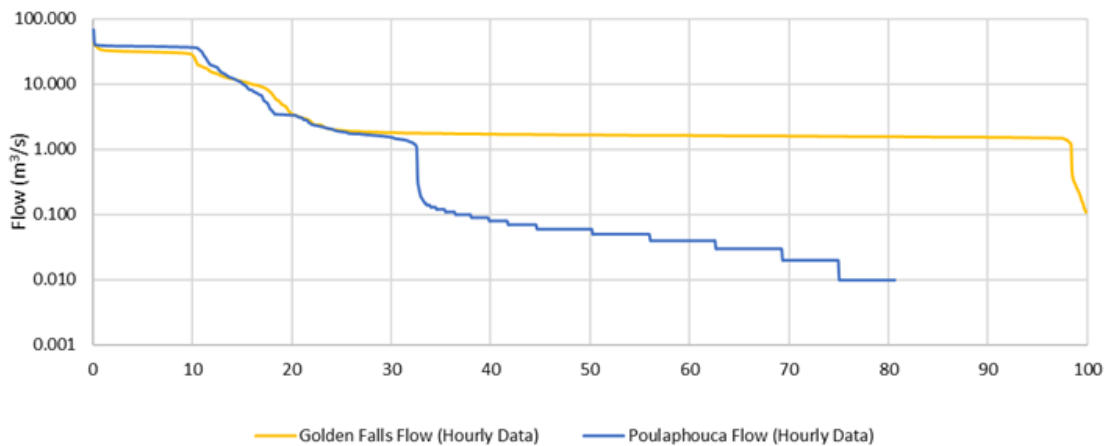




The review of the flow datasets demonstrates that the compensation flows are an important component of flow in the River Liffey at Blessington WwTP discharge point. This was not taken into account in the 2023 report. Revised flow statistics have been re-calculated using the hourly flow dataset in order to include the compensation flow and the flow duration curves are provided in Figure 2-5, which is plotted on a logarithmic axis for improved visibility of compensation flows which generally occur at lower rates. The flow duration curves still show that there is zero flow from Poulaphouca Reservoir for 20% of the time, and that the Q_{95} flow from this Reservoir is therefore 0 m^3/s .

The average flow rate from Poulaphouca Reservoir, including times of zero flow, is given by this dataset as 5.31 m^3/s , increasing to 6.61 m^3/s when considering only the periods when the discharge is actually operational. Flow rates from Golden Falls Reservoir are usually consistent with the required pass-forward flow rate of 1.5 m^3/s , with a Q_{95} of 1.52 m^3/s , and an average flow of 5.74 m^3/s .

Figure 2-5: Flow Duration Curves for Poulaphouca and Golden Falls Reservoir (Hourly Data, 2017 to 2025 to Poulaphouca Reservoir, 2017 to 2023 for Golden Halls Reservoir)



2.3 Reconciling Flow Volumes

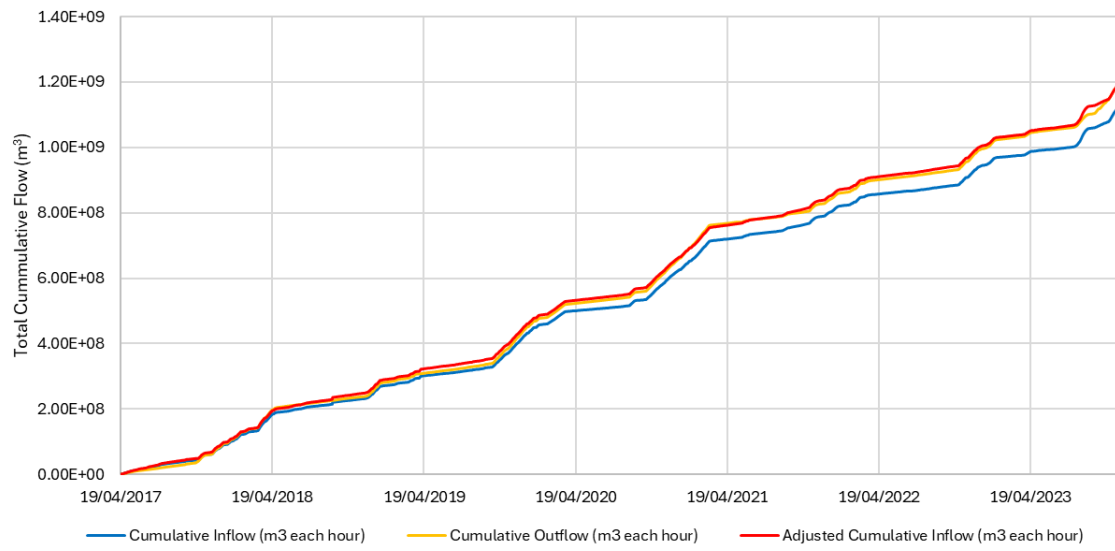
The water quality calculations in Section 4 require assessment of water volumes available for dilution. Calculation of cumulative inflow volume from Poulaphouca Reservoir and cumulative outflow volumes from Golden Falls Reservoir from the hourly flow data supplied by ESB shows a gradual drift between the two datasets, with a 6.24% increase in outflow compared to inflow after the end of the overlapping

data period (Figure 2-6, based on data from April 2017 to November 2023). The available water level data for Golden Falls Reservoir shows that water levels in this reservoir were maintained at a minimum elevation of 135.5mOD Poolbeg. Reconciling of inflows and outflow volumes is required to represent the fact that there is not a long term reduction in reservoir level. The difference between the recorded inflow and outflow volumes can be accounted for through three factors:

- 1) Inflow from the natural catchment of Golden Falls Reservoir downstream of Poulaphouca Reservoir (Figure 2-2). This area occupies an area of 8.0 km² and includes two small watercourses which are part of the Liffey_040 river waterbody (Figure 2-1). Gauged or spot flow data are not available for these watercourses and flow estimates have not been made using the Hydrotool method for flow estimation in ungauged catchments. Using Hydrotool flow estimates from the nearest small adjacent catchment (node 09_190) and scaling for the difference in catchment area gives an annual average flow estimate of 0.17 m³/s for the natural topographic catchment of Golden Falls Reservoir. Applying this flow throughout the flow record period would account for 52% of the discrepancy between inflow and outflow volumes.
- 2) Additional baseflow generated by increased water table elevation and sub-surface transport of water following construction of Poulaphouca and Golden Falls dams. Accounting for the area of Golden Falls Reservoir, assigning the entire remaining extra outflow to emergence of sub-surface flow within the lake would require an emergence rate of 2.1 ml/m²/hr, which is not unrealistic given the setting.
- 3) Small uncertainties in measurement of flow through Poulaphouca or Golden Falls Reservoirs could also account for the difference in flow when integrated over a period of more than six years.

Given the known inflows to Golden Falls Reservoir from the natural catchment, it is considered most appropriate to reconcile the inflow and outflow volumes with the assumption that the outflow volumes are correct. Providing an additional inflow to Golden Falls Reservoir of 0.336 m³/s reconciles the inflow and outflow volumes from the Reservoir to within 0.0001%. The adjusted inflow volumes have been used in the water quality calculations in Sections 4 and 5.

Figure 2-6: Cumulative Inflow and Outflow Volumes, and Adjusted Inflow Volumes, for Golden Falls Reservoir.



3 Ambient and Effluent Quality Data

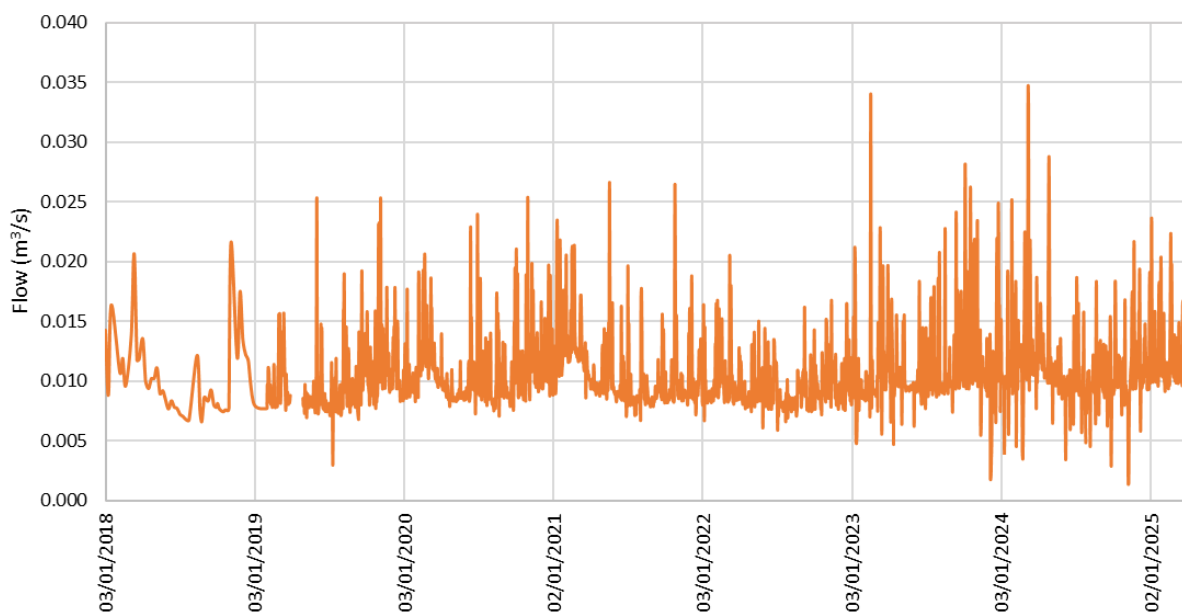
Additional ambient water quality and effluent quality data are now available which were recorded subsequent to submission of the previous 2023 Water Quality Impact Assessment. The updated datasets are discussed in this Section.

3.1 Effluent Flow and Quality Data

The 2023 report used monthly effluent quality data from January 2020 to December 2023 and daily flow data from January 2018 to December 2022. At the time of preparing this addendum, Daily flow data was available until March 2025 and monthly quality data was available until May 2025.

Figure 3-1 shows the updated daily flow timeseries. There has been no significant change in mean effluent flow rates, with a slight increase from 0.010 m³/s used in the 2023 report to 0.011 m³/s from the current dataset. The future mean flow estimate of 0.015 m³/s used in the 2023 analysis is still considered to be valid.

Figure 3-1: Blessington WwTP Effluent Daily Flow Timeseries (2018-2025)



The effluent quality timeseries for BOD (Figure 3-2), orthophosphate (Figure 3-3), total phosphorus (Figure 3-4) and ammonia (Figure 3-5) are shown below. Concentrations of BOD and orthophosphate have been consistently lower since 2023 than in the pre-2023 data, and total phosphorus concentrations have remained stable. Concentrations of ammonia were lower throughout 2023 and to mid-2024, however for a period following October 2024 elevated ammonia concentrations were present in the influent to the WwTP and resulted in elevated ammonia concentrations in the effluent which remained until early 2025. The cause of the ELVs exceedances were due to shock loads to the WwTP, the source of which was investigated but not identified. The short period of elevated effluent ammonia concentrations did not increase long term mean ammonia concentrations above the ELV.

Figure 3-2: Effluent Concentrations of BOD from Blessington WwTP.

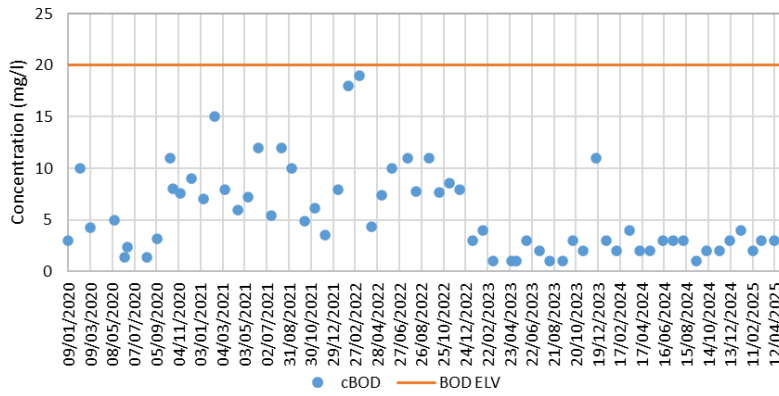


Figure 3-3: Effluent Concentrations of Orthophosphate from Blessington WwTP.

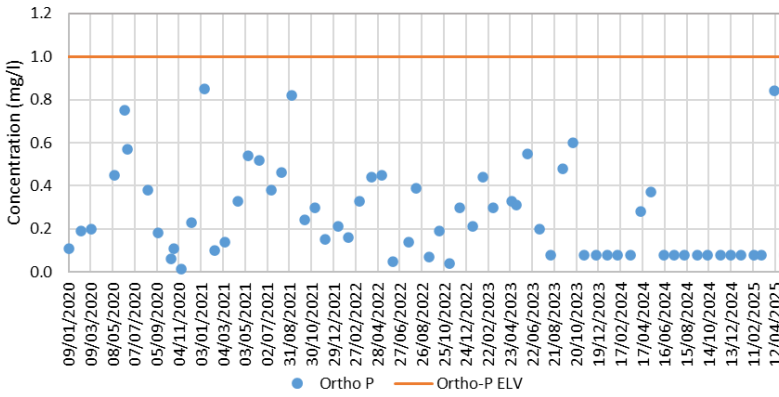


Figure 3-4: Effluent Concentrations of Total Phosphorus from Blessington WwTP.

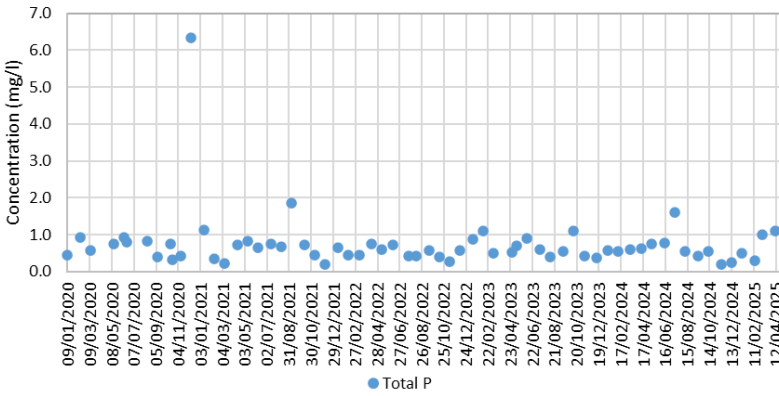


Figure 3-5: Effluent Concentrations of Ammonia from Blessington WwTP.

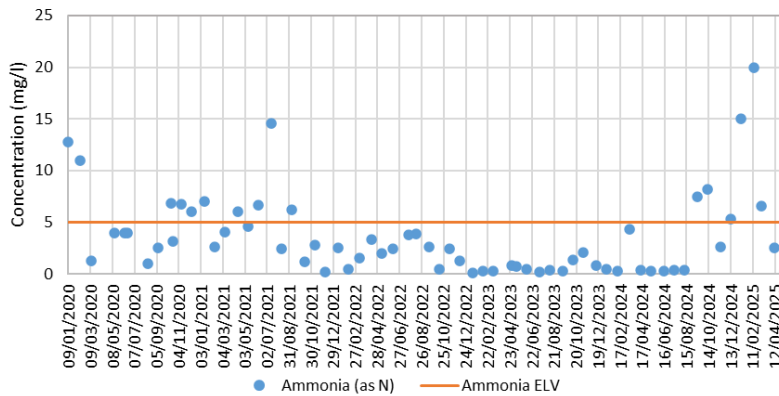


Table 3-1 compares the effluent flow and quality statistics from the data shown in the Figures above with values used in the 2023 Water Quality Impact Assessment report and with ELVs (where applicable). The slight increase in mean effluent flow rate has been accompanied by an improvement in effluent quality in terms of mean ammonia, BOD and orthophosphate, while mean effluent total phosphorus concentrations have remained stable.

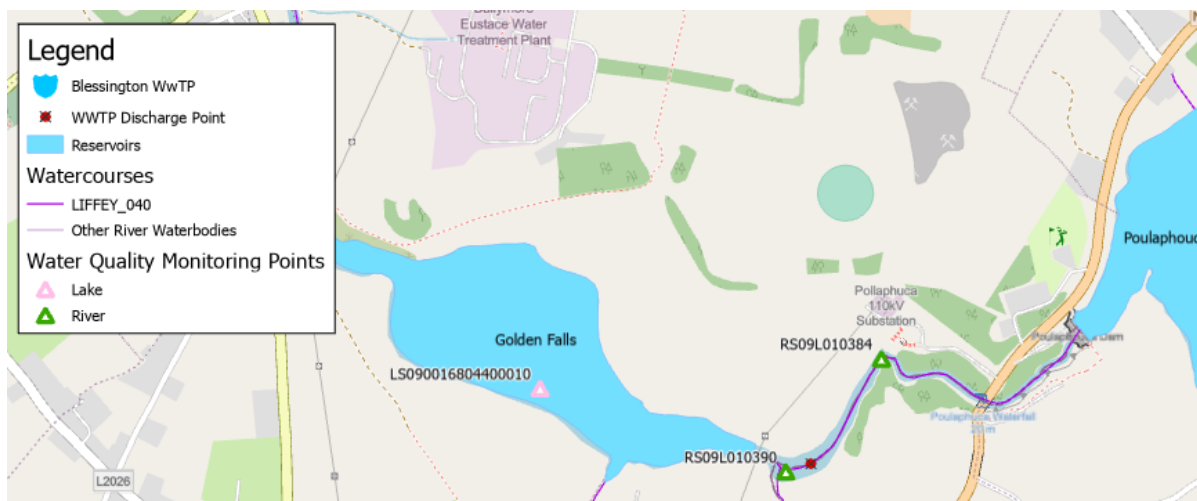
Table 3-1: Effluent Flow and Quality Statistics for Blessington WwTP.

Station Number	ELV	2023 Report Mean		Current Mean	
	mg/l	mg/l	kg/d	mg/l	kg/d
Flow (m³/s)	None	0.010	--	0.011	--
Ammonia	5.0	4.98	4.30	3.55	3.37
BOD	20	9.85	8.51	5.58	5.30
Orthophosphate	1.0	0.40	0.35	0.26	0.25
Total Phosphorus	None	0.73	0.64	0.74	0.70

3.2 Ambient Quality Data

Ambient water quality is monitored at three locations close to the Blessington WwTP discharge point (Figure 3-6). There are two monitoring points in the Liffey_040 river section, upstream and downstream of the primary discharge point for Blessington WwTP discharge point, and a third water quality monitoring point within Golden Falls Reservoir.

Figure 3-6: Water Quality Sampling Points at Blessington WwTP Discharge Point.



Data from RS09L010390 and LS090016804400010 were used to inform the 2023 Water Quality Impact Assessment, however water quality monitoring at RS09L010384 only commenced in January 2023 so data from this location were not available to inform that report. The report used data taken from a point close to the N81 road bridge over the Liffey_040 near Poulaphouca Reservoir as an indicator of upstream water quality, however data from this location are no longer recorded.

Timeseries of ambient water quality data are shown below for ammonia (Figure 3-7), BOD (Figure 3-8), orthophosphate (Figure 3-3) and total phosphorus (Figure 3-4). The timeseries recorded within Golden

Falls Reservoir is the longest and shows elevated ammonia concentrations and very low BOD concentrations in the early part of the record. Orthophosphate concentrations are low at all locations – only 13 out of 130 samples (10%) taken within Golden Falls Reservoir contained detectable concentrations of orthophosphate, compared with 12 out of 60 samples (20%) taken a short distance downstream of Blessington WwTP discharge point and 4 out of 24 (17%) samples taken upstream of the discharge point. Concentrations of total phosphorus are slightly higher, particularly in the later period of the record, with 68 out of 136 samples taken in Golden Falls Reservoir (50%) containing concentrations above the limit of detection. For the two sampling locations either side of Blessington WwTP discharge point, 6 out of 24 samples taken upstream of the discharge contained detectable concentrations of total phosphorus compared with 15 out of 60 samples taken at the downstream location (25% of samples at both sites). Water quality statistics are presented below.

Figure 3-7: Ambient Water Quality Monitoring Data Timeseries for Ammonia (mg/l N).

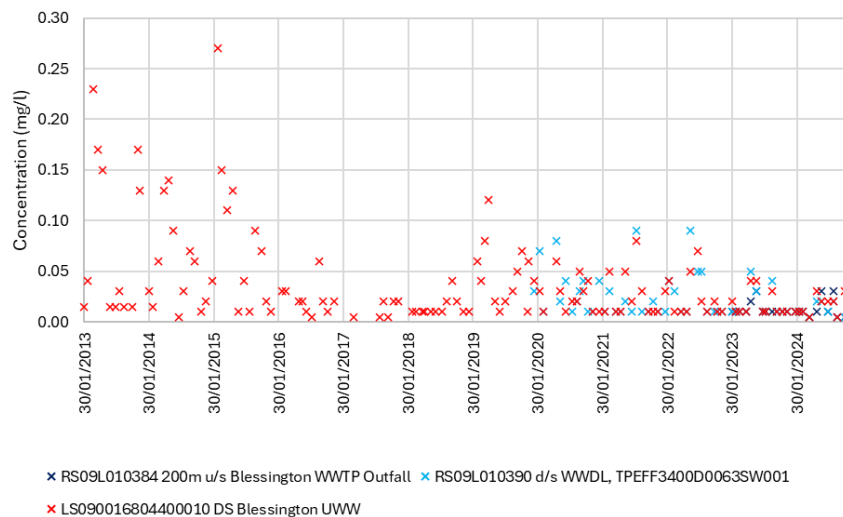


Figure 3-8: Ambient Water Quality Monitoring Timeseries for BOD.

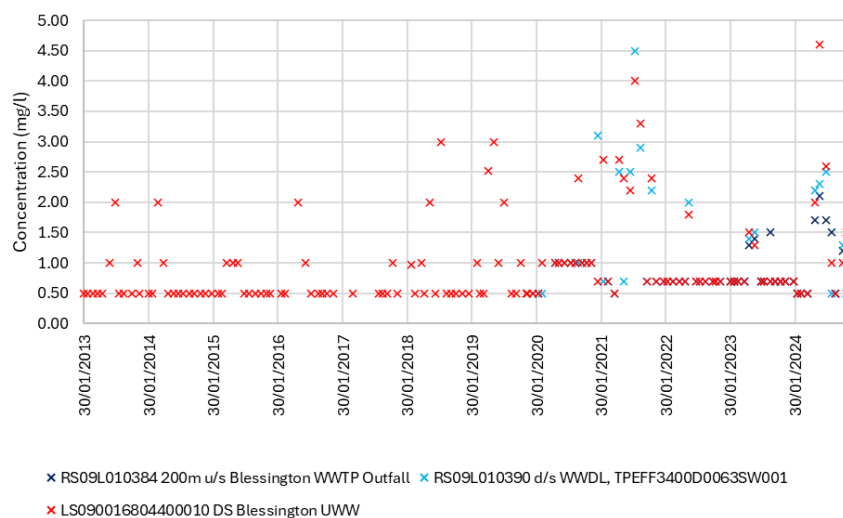


Figure 3-9: Ambient Water Quality Monitoring Timeseries for Orthophosphate.

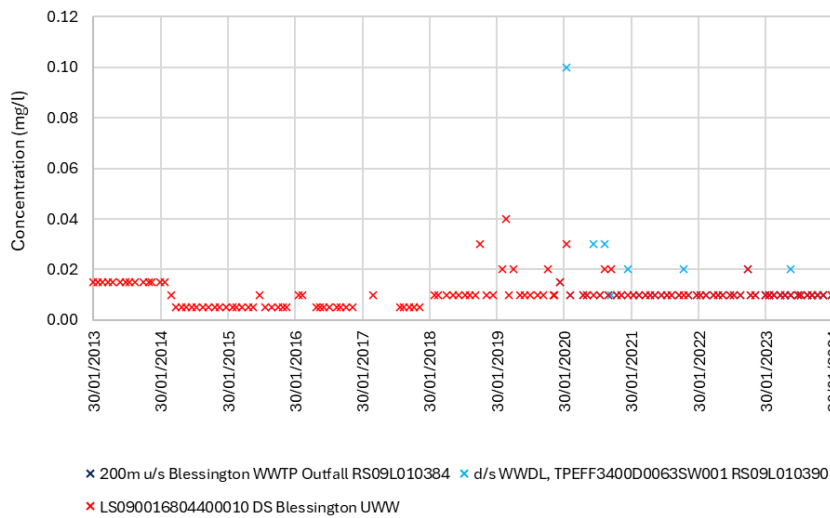
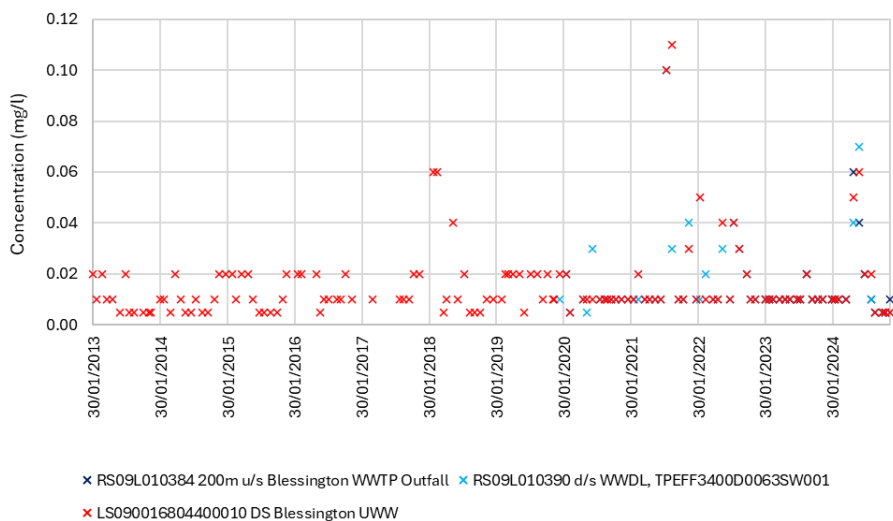


Figure 3-10: Ambient Water Quality Monitoring Timeseries for Total Phosphorus.



The 2023 Water Quality Impact Assessment identified a change in water quality for most parameters which was detectable from 2018 onwards, and this is continued in the current datasets. There was a further improvement in treatment technology used at Blessington WwTP in 2023. Table 3-2 shows the quality statistics for each parameter which is limited by EQS values in either rivers or lakes based on the values reported in 2023 and the data recorded from 2023 onwards. The table is colour coded according to whether the calculated statistic is below the EQS for high indicative quality (blue) or good indicative quality (green). Values which exceed the EQS for good indicative quality are coloured in yellow and grey cells indicated where there is no EQS for a given parameter at a given location.

Table 3-2: Water Quality Monitoring Statistics for Locations Near Blessington WwTP.

Parameter	EQS		RS09L010384 200m u/s Blessington WWTP Outfall		RS09L010390 d/s WWDL, TPEFF3400D0063SW0 01		LS090016804400010 DS Blessington UWW	
	High Status	Good Status	2023 Report	Jan 2023 – Dec 2024	2023 Report	Jan 2023 – Dec 2024	2023 Report	Jan 2023 – Dec 2024
Mean Ammonia (mg/l)	0.040	0.065	0.018	0.012	0.028	0.015	0.027	0.016
95th Percentile Ammonia (mg/l)	0.090	0.140	0.040	0.030	0.083	0.039	0.071	0.039
Mean BOD (mg/l)	1.3	1.5	1.09	0.97	1.16	0.98	1.16	1.12
95th Percentile BOD (mg/l)	2.2	2.6	2.95	1.70	3.00	2.29	2.60	2.51
Mean Orthophosphate (mg/l)	0.025	0.035	0.012	0.009	0.015	0.010	0.012	0.010
95th Percentile Orthophosphate (mg/l)	0.045	0.075	0.030	0.010	0.030	0.019	0.021	0.010
Mean Total Phosphorus (mg/l)	0.010	0.025	0.013	0.014	0.017	0.014	0.019	0.014

Table 3-2 shows that the value of all water quality statistics downstream of the primary discharge point has significantly reduced from the values shown in the 2023 Water Quality Impact Assessment. The reduction in ammonia and orthophosphate concentrations are circa 30-50% and concentrations of these two parameters comply with the requirements for high indicative quality. There has been a reduction in downstream BOD concentrations in the order 15%- 25%, and the mean concentrations meet the mean EQS for high indicative quality and the 95thile concentrations meet the 95thile EQS for good indicative quality. Mean total phosphorus concentrations comply with requirements for good indicative quality in the Golden Falls Reservoir.

The updated water quality statistics are used in the water quality calculations in Sections 4 and 5.

4 Water Quality Impact Assessment Calculations

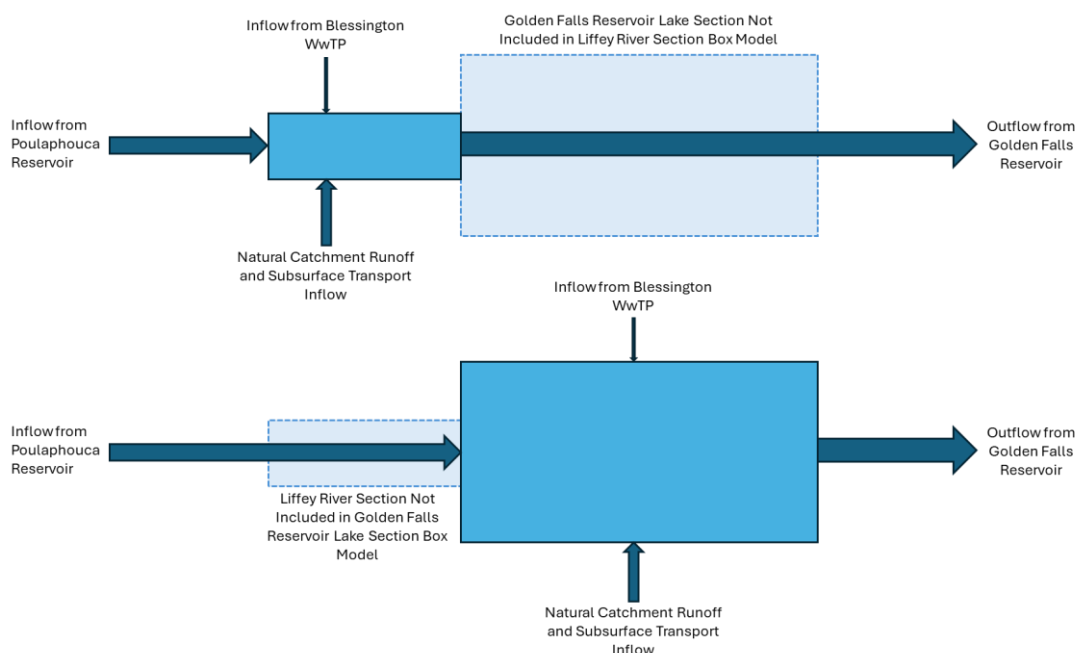
4.1 Methodology

The rate of river flow, BOD and nutrient transport through the Liffey_040 and Golden Falls Reservoir waterbodies will be controlled by a combination of inflow and outflow rates at the Poulaphouca and Golden Falls dams (see Section 2). When flows are discharged from Poulaphouca Reservoir, the ambient flow velocity at Blessington WwTP discharge point are controlled mainly by the driving head from upstream. During times of low or zero flow from Poulaphouca Reservoir, the flow velocity is controlled by draw-down from downstream. Both factors will be important under most operating conditions.

The combined controls on flow in the Liffey_040 river section between Poulaphouca Dam and Golden Falls Reservoir makes the hydrodynamics of mixing in this section highly complex. In practice, very low flow velocities are likely to occur in this reach due to the impoundment at Golden Falls Dam unless there is significant flow from upstream. While this section of watercourse is defined as a river waterbody for the purposes of the Surface Waters Regulations, it behaves as a lake and effectively forms part of the Golden Falls Reservoir in terms of hydrodynamics, controls on water level and effluent dispersion. However, the EQS for river waterbodies will only apply within the designated river section, with the EQS for lake waterbodies applying downstream.

In order to assess compliance with the relevant EQS targets in the different designated sections of the receiving waterbodies, the system has been represented as two separate box models as illustrated in Figure 4-1. The first box model is defined for the river section and allows assessment against EQS values for rivers. The second box model assumes that the discharge is direct to the lake waterbody and therefore evaluates the water quality against the EQS values for lakes.

Figure 4-1: Box Model Setup for Water Quality Impact Assessment for the Liffey_040 Section (Top) and Golden Falls Reservoir Section (bottom).



The models were run using the hourly inflow and outflow data for Poulaphouca and Golden Falls Reservoir for the period April 2017 to November 2023, with the addition of a constant flow of 0.336 m³/s to represent natural catchment inflows and subsurface water transport. A constant average flow rate was also assumed for Blessington WwTP which was set at 0.011 m³/s for the current scenario and 0.015 m³/s for the future scenario. The models were used to simulate mixed concentrations of substances in the river and lake sections over the full period for which flow data are available, 6.5 years.

When modelling the Liffey_040 river section, the inflows and outflows were set to apply to the river section only, and likewise the inflows and outflows were applied to the lake section only when modelling water quality in Golden Falls Reservoir. The inflows and outflows were allowed to alter the volume of water available for dilution at each timestep as follows:

$$\text{Volume Available for Dilution (m}^3\text{)} = \text{Previous Timestep Volume (m}^3\text{)} + \text{Inflow from Poulaphouca (m}^3\text{/s)} \\ + \text{Inflow from Blessington WwTP (m}^3\text{/s)} + \text{Inflow from Natural Catchment (m}^3\text{/s)} - \text{Outflow from Golden Falls Reservoir (m}^3\text{/s)}$$

The mass of each substance to be diluted by the available volume was calculated at each timestep as:

$$\text{Mixed Mass (mg)} = \text{Previous Timestep Mixed Mass (mg)} + \text{Inflow Mass from Poulaphouca (mg)} + \text{Inflow Mass from Blessington WwTP (mg)} + \text{Inflow Mass from Natural Catchment (mg)} - \text{Previous Timestep Outflow Mass from Golden Falls Reservoir (mg)}$$

Where the inflow masses were calculated based on the hourly inflow rate and concentrations assumed as set out in Table 4-1. Concentrations of substances in the inflow from Blessington WwTP were set at full ELV values for ammonia, BOD and orthophosphate. There is currently no ELV for total phosphorus but a value of 2.0mg/l has been used based on a conservative ratio for orthophosphate to total phosphorus in observed effluent data.

Table 4-1: Water Quality Inputs for Inflows to Box Model.

Parameter	Poulaphouca Inflow & Natural Catchment Inflow (mean from u/s Blessington WWTP Outfall)	Blessington WwTP Discharge
Mean Ammonia (mg/l)	0.012	5.0
Mean BOD (mg/l)	0.97	20
Mean Orthophosphate (mg/l)	0.009	1.0
Mean Total Phosphorus (mg/l)	0.014	2.0

The outflow mass from Golden Falls Reservoir was calculated by multiplying the mixed concentration (mixed mass divided by volume available for dilution) by the outflow rate at each timestep, with the outflow mass applied when calculating the mixed mass for the subsequent timestep.

An initial volume and mixed concentration are required for each model. The initial water volumes were set at 47,235 m³ for the river section and 572,113 m³ for the lake section based on the volume of water measured in each section during the bathymetric survey carried out for the 2023 Water Quality Impact Assessment report. The mixed concentrations for each section were defined based on the values given

in Table 4-2

Table 4-2: Water Quality Inputs for Initial Conditions in Box Model.

Parameter	Starting Mixed Concentration
Mean Ammonia (mg/l)	0.015mg/l for River Section model (mean from downstream of Blessington WwTP Discharge) 0.016mg/l for Lake Section model (mean from Golden Falls Reservoir Monitoring Point)
Mean BOD (mg/l)	0.98 for River Section model only (mean from downstream of Blessington WwTP Discharge)
Mean Orthophosphate (mg/l)	0.010 for River Section model only (mean from downstream of Blessington WwTP Discharge)
Mean Total Phosphorus (mg/l)	0.014mg/l for Lake Section model only (mean from Golden Falls Reservoir Monitoring Point)

4.2 Results

The model results did not predict a deterioration in water quality downstream of the Blessington WwTP discharge point in either the river section model or the lake section model. The full modelled timeseries of ammonia in the Liffey_040 river section of the box model is shown in Figure 4-2 and shows that ammonia concentrations are stable between 0.018 mg/l and 0.025 mg/l, with some fluctuations, and do not approach the high indicative quality EQS value for mean ammonia concentration. This is consistent with the current long term mean concentration of 0.022mg/l downstream of Blessington WwTP discharge point (Table 3-2). The increase in ammonia concentration in the river model between 20 April 2019 and 23 October 2019, and the trough in concentration modelled between 1 November 2020 and 1 August 2021, are described in detail below as an illustration of model dynamics. These time periods are highlighted by the red rectangles in Figure 4-2 and detailed timeseries are shown in **Error! Reference source not found.**

Figure 4-2: Timeseries of Modelled Ammonia Concentrations in the Liffey_040 Box Model River Section.

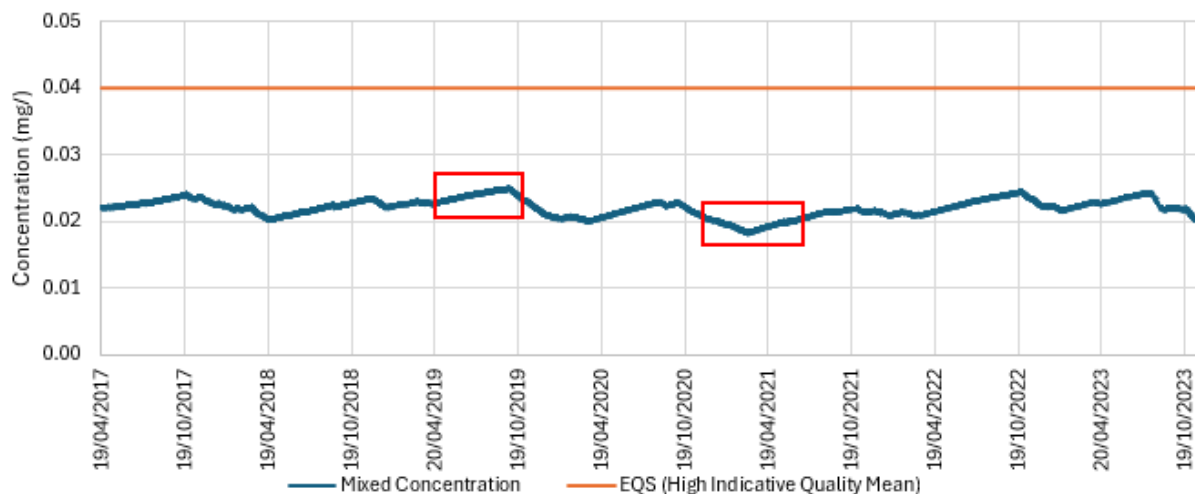


Figure 4-3: Detailed Timeseries of Ammonia Concentration (top), Ammonia Mass and River Section Volume (middle) and River Section Inflow and Outflow (bottom) for the Model Periods 20/04/2019-23/10/2019 and 01/11/2020 to 01/08/2021.

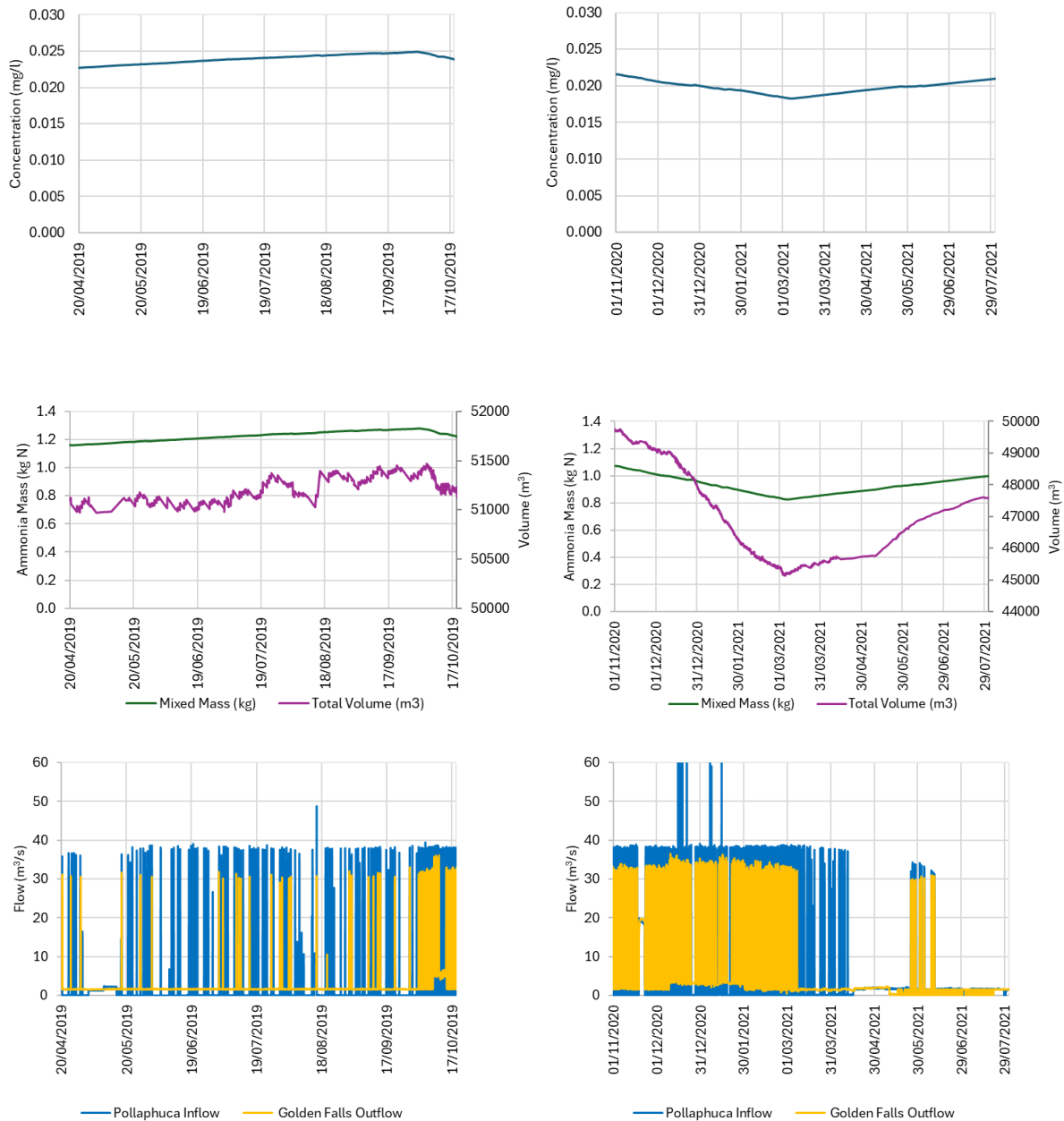


Figure 4-3 shows that the increase in ammonia concentration to a maximum of 0.025 mg/l which occurred on 23 October 2019. This increase in ammonia concentration was accompanied by an increase in total volume available for dilution because there was a reduction in outflow during this period and ammonia accumulated within the modelled section of river. In addition, inflows from Poulaphouca Reservoir were intermittent through this period and discharges from Blessington WwTP, which contain a higher ammonia load, accounted for 0.5% of the total inflow volume. The balance of these factors results in a slight increase in the ammonia concentration simulated in the river section from 0.023 mg/l to 0.025 mg/l.

The reduction in ammonia concentration between 1 November 2020 and 6 March 2021 was associated with a reduction in total volume modelled in the river section because the total outflow (and therefore

ammonia loss) exceeded the total inflow. There was significant flow of reservoir water through the system during this period, which allowed for dilution of effluent with water from Poulaphouca Reservoir which has extremely low mean ammonia concentrations, as well as flushing of ammonia out of the model. This reduced the overall mixed ammonia concentrations from 0.022 mg/l to 0.018 mg/l, a change of 0.004 mg/l.

Minimum modelled ammonia concentrations occur on 6 March 2021, after which ammonia concentrations increase again. This increase is accompanied by a significant reduction in flow through the system, although overall there is a net increase in river section volume due to the rate of inflow exceeding the overall loss of water from Golden Falls Reservoir. This reduction in ammonia loss allows for a slight increase in ammonia concentrations as the extent of effluent contribution to the total inflow rises and less ammonia is lost from the system.

Full timeseries of modelled concentrations are shown below for BOD (Figure 4-4) and orthophosphate (Figure 4-5) in the river section model. Orthophosphate and BOD concentrations both remain stable with minor variation at concentrations just above 0.010 mg/l and at 1.0 mg/l respectively, and do not approach the average EQS concentrations required for high indicative quality.

Figure 4-4: Timeseries of Modelled BOD Concentrations in the Liffey_040 Box Model River Section.

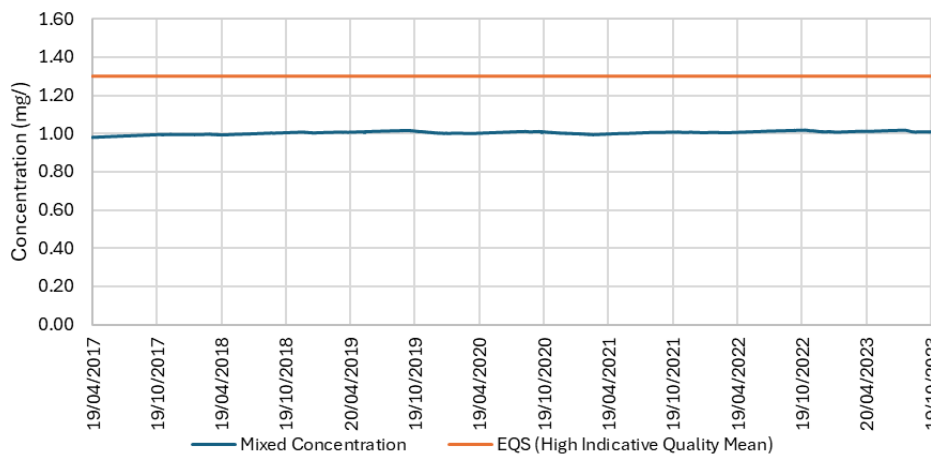
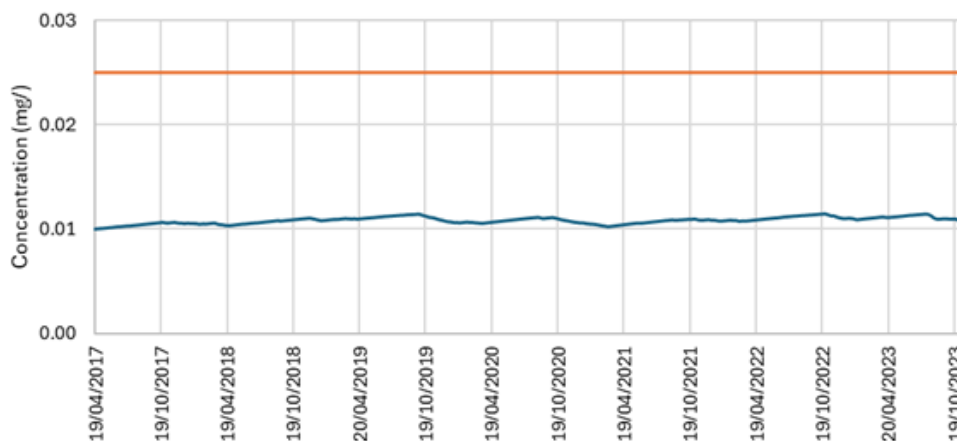


Figure 4-5: Timeseries of Modelled Orthophosphate Concentrations in the Liffey_040 Box Model River Section.



Full model timeseries are shown below for ammonia (Figure 4-6) and total phosphorus (**Error! Reference source not found.**) in the lake box model section. Water quality in this model does not respond to inflow and outflow to the same degree as the river section model due the greater volume of water available for dilution and mixing. Ammonia concentrations a very slight increase from 0.016 mg/l to 0.020 mg/l over the six year model run period, however this degree of increase is extremely small and does not approach the EQS value of 0.04mg/l. It is not expected to occur in reality because effluent concentrations are normally well below the value of 5mg/l assumed in the model. The modelled total phosphorous concentration increases from the starting concentration of 0.014 mg/l to 0.016 mg/l – again, this is a very small increase, does not result in exceedance of the EQS and is not expected to be observed in reality.

Figure 4-6: Timeseries of Modelled Ammonia Concentrations in the Golden Falls Box Model Lake Section.

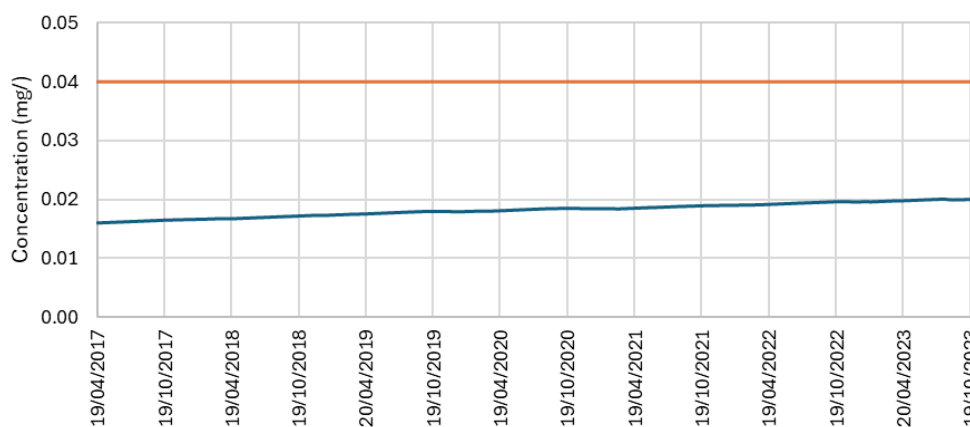
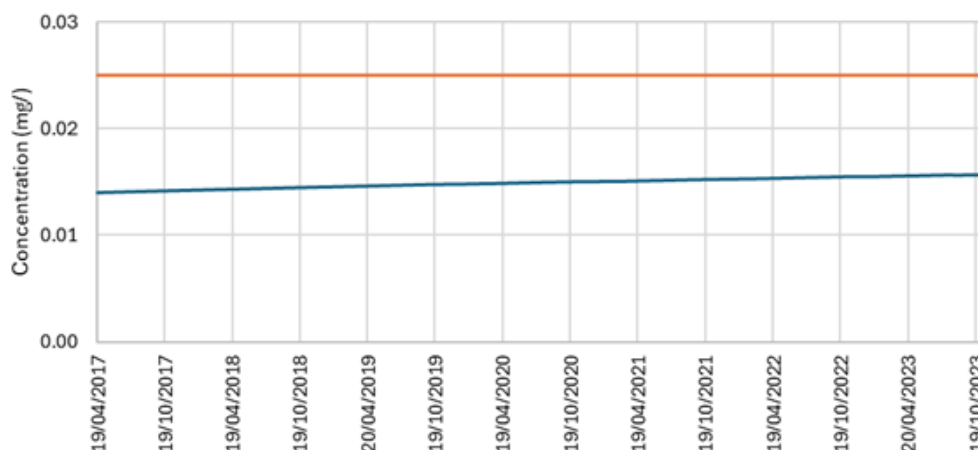


Figure 4-7: Timeseries of Modelled Total Phosphorus Concentrations in the Golden Falls Box Model Lake Section.



The box modelling therefore shows that the current ELVs applied to final treated effluent from Blessington WwTP primary discharge point are sufficient to ensure that mixed concentrations with the Liffey_040 receiving river waterbody and downstream Golden Falls Reservoir lake waterbody both comply with requirements for high indicative quality in terms of ammonia, orthophosphate and BOD, as relevant. The current treatment technology at Blessington WwTP also results in a total phosphorus concentration in the final treated effluent which is compatible with the achievement of good indicative quality in Golden Falls Reservoir in terms of this parameter – mean concentrations of total phosphorus

exceed EQS values for high indicative quality upstream and downstream of Blessington WwTP primary discharge point.

The box models have been further used to simulate the mixed water quality in the Liffey_040 river section and the Golden Falls Reservoir lake waterbody assuming a future increase in effluent discharge rates to 0.015 m³/s. Table 4-3 shows the modelled mean and 95th percentile concentration of each parameter in each relevant box model section for comparison with the applicable EQS values. The model takes account of the discharges from Blessington WwTP only and excludes any other in-catchment inputs.

Table 4-3: Water Quality Outputs from Box Models – Current and Future Effluent Flow Rates.

Parameter	EQS (mg/l)		River Box Model Concentration		Lake Box Model Concentration	
	High Indicative Quality	Good Indicative Quality	Current Effluent Discharge Rate	Future Effluent Discharge Rate	Current Effluent Discharge Rate	Future Effluent Discharge Rate
Mean Ammonia (mg/l)	0.040	0.065	0.021	0.024	0.017	0.018
95th percentile Ammonia (mg/l)	0.090	0.140	0.024	0.028	0.018	0.020
Mean BOD (mg/l)	1.3	1.5	1.00	1.02	n/a	n/a
95th percentile BOD (mg/l)	2.2	2.6	1.02	1.03	n/a	n/a
Mean Orthophosphate (mg/l)	0.025	0.035	0.011	0.011	n/a	n/a
95th Percentile Orthophosphate (mg/l)	0.045	0.075	0.011	0.012	n/a	n/a
Mean Total Phosphorus (mg/l)	0.010	0.025	n/a	n/a	0.015	0.015

The results in Table 4-3 show that the water quality impact of increased effluent flow rates on receiving water quality is slight. The current ELVs at Blessington WwTP are therefore compatible with the objectives of the Surface Waters Regulations, accounting for potential future increases in effluent flow.

5 Mass Emissions

Prior to 2022, wastewater discharge licences granted by the Environmental Protection Agency did not, as standard, set flow parameter limits and compliance was determined in most cases by end of pipe ELVs based on compliance with EQS values in receiving waters only. The EQS values were taken from the Surface Waters Regulations. In order to set limits on total annual environmental loading from a wastewater discharge, the Environmental Protection Agency has recently commenced setting Mass Emission Limits (MELs) on orthophosphate in wastewater discharge licenses. The MELs are used to calculate alternative ELVs based on the need to limit annual environmental loading, and these ELVs have been adopted where they are stricter than the ELV required for compliance with EQS limits for a given parameter.

Uisce Éireann reviewed the requirements and methodology for setting ELVs based on MELs in 2024 and provided a Technical Memorandum for Mass Emission Limits and Reporting to the Environmental Protection Agency in November 2024. The Technical Memorandum included a proposed method for calculating ELVs which would comply with MELs. In this method:

- 1) The assimilative capacity of the receiving watercourse is calculated using Equation 5-1.
- 2) The ELV equivalent to the assimilative capacity is calculated using future average effluent flow rates (Equation 5-2).
- 3) Final ELV values are selected based on the stricter of the two ELVs based on the requirements to comply with the EQS values in the receiving waters, or the requirements to limit the annual mass of substances emitted from the WwTP to the assimilative capacity of the receiving watercourse.

Equation 5-1 and Equation 5-2 are given below:

Equation 5-1: Calculation of River Assimilative Capacity.

$$\begin{aligned} & \text{River Assimilative Capacity (kg. ann}^{-1}\text{)} \\ &= \frac{\left(EQS_{AA}(\text{mg l}^{-1}) - C_{\text{river}}(\text{mg l}^{-1}) \right) \times (\bar{Q}_r(\text{m}^3 \text{s}^{-1}) \times (3600 \times 24 \times 365))}{1000} \end{aligned}$$

Where: EQS_{AA} = EQS for mean orthophosphate concentrations

C_{river} = upstream mean orthophosphate concentrations

\bar{Q}_r = mean river flow

Equation 5-2: Calculation of Annual Mass Emissions Limit.

$$ELV \text{ equivalent to MEL (mg. l}^{-1}\text{)} = \frac{\text{River Assimilative Capacity (kg. ann}^{-1}\text{)}}{\bar{Q}_e(\text{m}^3 \text{s}^{-1}) \times (3600 \times 24 \times 365)} \times 1000$$

Where:

MEL = Mass Emissions Limit

\bar{Q}_e = design average effluent flow rate.

Table 5-1 sets out the values used in for calculating the assimilative capacity of the River Liffey at Blessington WwTP Primary Discharge Point. For consistency of approach and for comparison of calculated ELVs, the upstream orthophosphate concentration has been set based on the ambient water quality used in the box modelling (Table 4-1) and the downstream EQS has been set based on compliance with the EQS for high indicative quality. The average river flow at Blessington WwTP primary discharge has been calculated from the Golden Falls Reservoir outflow hourly timeseries data discussed in Section 2.2 because this represents the total flow passed downstream of the hydro-electric dam and reservoir complex. Using this approach a total assimilative capacity of 2,896kg/yr for orthophosphate was calculated.

Table 5-1: Calculation of River Assimilative Capacity for Setting MEL Values.

Substance	EQS _{AA} (mg/l)	C _{river} (mg/l)	River Flow (m ³ /s)	River Assimilative Capacity (kg/yr)
Orthophosphate	0.025	0.009	5.74	2,896

As per the MEL methodology an appropriate level of assimilative capacity (75%) has been determined based on the environmental sensitivity matrix as set out in Uisce Éireann's Interim Technical Guidance for Water Quality Impact Assessment (Freshwaters) UE-AMT-GL-028. A sensitivity score of 3 was assigned due to proximity of discharge to a Drinking Water River. This yielded a revised MEL capacity of 2,172kg/yr.

Table 5-2 sets out the orthophosphate ELV required at Blessington WwTP to comply with an MEL of 2,172kg/yr.

Table 5-2: ELVs Required at Blessington WwTP to Comply with Mass Emission Limits.

Substance	MEL (kg/yr)	Current Effluent Flow Rate (m ³ /s)	Equivalent ELV (mg/l)	Future Effluent Flow Rate (m ³ /s)	Equivalent ELV (mg/l)
Orthophosphate	2,172	0.011	6.3	0.015	4.6

The ELVs for Blessington WwTP which would be required to comply with MEL of 2,172kg/yr for orthophosphate are less stringent than the existing/proposed ELVs. The proposed ELV of 1.0mg/l for orthophosphate therefore provides adequate protection to water quality in terms of both annual mass emissions and receiving water compliance with EQS values.

6 Conclusion

UÉ prepared this addendum to the 2023 Water Quality Impact Assessment report to support the Blessington Wastewater Discharge Licence Application:

The addendum includes the following;

- A review of updated datasets available on water release rates from Poulaphouca and Golden Falls reservoir and determined appropriate flow statistics based on an improved understanding of the operation of these structures.
- A review of updated available effluent flow, effluent quality and ambient water quality statistics
- A box model assessment of the impacts of the Blessington WwTP discharge on water quality in the Liffey_040 river waterbody and the Golden Falls Reservoir lake waterbody, given current and future effluent discharges rates and assuming continuous discharges at ELV concentrations.

The key findings are as follows:

- Box Modelling demonstrated that the proposed ELVs for ammonia, BOD and Orthophosphate are compatible with the achievement of the WFD objectives for the Liffey_040 and the Golden Falls Reservoir lake waterbodies.
- In addition, a Mass Emissions assessment was carried out in accordance with the methodology proposed by UÉ. This assessment shows that the proposed ELV of 1.0mg/l for orthophosphate will provide more than adequate protection for waterbody compliance with EQS targets and annual mass emission limits.

Therefore, based on the findings of this report, it is concluded that the proposed ELVs for the Blessington WwTP primary discharge are considered to be appropriate. The ELVs are included in Table 6-1 below for reference.

Table 6-1: ELVs Proposed for Blessington WwTP.

Parameter	ELV (mg/l)
Ammonia	5.0
BOD	20
Orthophosphate	1.0
COD	125
Suspended Solids	30