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NENAGH WASTE WATER TREATMENT PLANT

WWDA APPLICATION ATTACHMENT – ATTACHMENT D.2 – 1 – IMPACT ASSESSMENT REPORT

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1. Introduction

This Report provides a summary of the water quality impact assessment and other supporting documentation prepared to determine the impact of the operational discharges from the Nenagh agglomeration on the receiving waterbody, Nenagh River (Name: NENAGH_60, (WFD IE code: IE_SH_25N010700), and also addresses the criteria as outlined in **Section D.2.** of the EPA Guidance Document.

2. Receiving Water Environment

Nenagh is currently served by a combined drainage network conveying flows from the north and south of the town to the inlet works of the WwTP before receiving secondary treatment. Followed by discharge into the Nenagh river. Uisce Éireann proposes to increase the capacity of the WWTP at Nenagh for a 30-year design horizon. The current plant has a design PE of 12,225 and the existing WWDA allows for a PE of 13,000. The upgrade works will have a design PE of 22,000.

The relevant section of the Nenagh River, also known as Nenagh_060 (IE_SH_25N010700) is classified for the period 2016 – 2021 as having “Moderate” WFD status. The EPA has assessed the risk of the Nenagh_60 failing to achieve the requirements as “At Risk”. The objective is to achieve “Good” WFD status of the Nenagh_60.

Table 1: Nenagh_60 WFD Water Body Status.

River Water Body Code	IE_SH_25N010700
WFD (cycle 3 risk status)	At Risk
WFD Ecological Status (2013-2018) Assessment Technique: Monitoring	Moderate
WFD Ecological Status (2016-2021) Assessment Technique: Monitoring	Moderate
Significant Pressures	Agricultural, Urban Run-off and Industrial

Protected Areas

The following table provides an overview of protected areas within the vicinity of the discharges.

Table 2: Protected Areas hydrologically connected to the discharge.

Criteria	Description	Direct discharge or hydrologically connected.	Environmental Risk
Shellfish Waters	None		
Bathing waters	None		
Nutrient Sensitive Areas	The Nenagh River	Direct Discharge	No – See attachments D.2 - 2 – Combined AA Screening and NIS report and D.2 – 5 – Water Quality Impact Assessment Report
Freshwater Mussel Areas	None		
European Sites	Lough Derg (Shannon) SPA (004058) Distance: 7.1km	Hydrologically connected	No – See attachment B.5 – 1 – EIAR.
	Lower River Shannon SAC (002165) Distance: 12km.	Hydrologically connected	No – See attachment B.5 – 1 – EIAR.
Others	The Nenagh_60 is designated for protection of public drinking water supply, but this does not impose any additional requirements for river water quality. See attachments D.2 – 2 – Combined AA Screening and NIS report, Attachment D.2 - 4 - Drinking Water Risk Assessment and D.2 – 5 – Water Quality Impact Assessment Report for more information.		

Table 3: Summary of the upstream and downstream ambient monitoring data used within the tiered assessment (Monitoring period January 2013 – June 2024).

	Upstream Quality		Downstream Quality		Relevant Good Status EQS	
	Mean (mg/L)	Q ₉₅ (mg/L)	Mean (mg/L)	Q ₉₅ (mg/L)	Mean (mg/L)	Q ₉₅ (mg/L)
Ammonia	0.060	0.235	0.080	0.262	0.06	0.14
BOD	1.847	2.840	1.951	3.000	1.5	2.6
Ortho-P	0.029	0.084	0.031	0.088	0.035	0.075

Table 3 displays the mean and Q95ile concentrations of ammonia, BOD and Ortho-P both upstream and downstream of the primary discharge point SW001. Upstream concentrations either exceed the relevant “Good” status EQS values or are within the top 20% band between the “Good” status EQS and “High” status due to the presence of upstream significant pressures such as Agricultural, Urban Run-off and Industrial discharges causing the quality of the Nenagh River to deteriorate. There is no overall change in the “moderate” WFD status for the Nenagh river between the upstream and downstream monitoring points. Looking at specific parameters however, Ammonia does exceed the relevant “Good” status EQS between the upstream and downstream monitoring locations, however this is due to upstream significant pressures causing the upstream Ammonia Concentration to be within the top 20% band between the “Good” and “High” status EQS values.

3. Water Quality Impact Assessment

A tiered assessment approach was used to assess the significance of the wastewater discharge and to determine if the required discharge will have detrimental environmental impacts. The design gives effect to the Combined Approach in that it is designed to meet both the discharge quality standards set out in Urban Wastewater Treatment Regulations (UWWTR), and to identify appropriate emission limit values for the discharge which are compatible with achievement of WFD on Conservation Objectives of receiving waters and relevant Protected Areas.

As part of the tiered assessment approach, mass balance calculations were firstly carried out to determine ELVs for the wastewater discharge into the watercourse. This calculation uses data for water quality, river flow, and effluent flow and concentration to assess the impact of the discharge on the downstream water quality and compliance with the relevant EQS. To assess impacts of wastewater discharges, two sets of calculations are required. The first to assess against environmental compliance with 95%ile EQS targets (carried out using 95%ile river flows) and a second calculation to assess environmental compliance against mean EQS targets (carried out using mean river flows). The assessment is predicated on the assumption that 95%ile concentrations in the river occur at the same time as 95%ile river flows, and that mean concentrations in the river occur at the same time as mean river flows.

The mass balance calculation indicates that an ELV which delivers good status downstream cannot be achieved for BOD, due to the good status EQS already being exceeded in upstream contributing flows. Likewise, ELVs which deliver good status downstream could not be calculated for ammonia and orthophosphate because the good status EQS for 95%ile concentrations are exceeded

upstream, and both mean and 95%ile concentrations must be met to deliver good status for these two parameters under the Surface Water Regulations. Given that feasible ELVs could not be determined using ambient monitoring data, a “notionally clean” approach was then applied.

A notionally clean approach is applied when calculating ELVs for a wastewater discharge where the upstream ambient river quality data show upstream pollution sources have a controlling influence on WFD status at the discharge point. This is in line with the “polluter pays” principle outlined in the WFD. Where upstream river quality data show that the watercourse is already exceeding good status EQS values, or are at risk of exceeding good status EQS values (defined as within the top 25% of the good status band), then the upstream water quality statistics are replaced with statistic values equal to 20% of the high status EQS. This removes the upstream controls on water quality and ensures that ELVs are calculated which can deliver good status downstream of the discharge point in the event that upstream pollution sources are addressed. Uisce Éireann policy is to apply the notionally clean condition on a parameter-by-parameter basis when the mean or 95%ile EQS value for that parameter is exceeded upstream of the WWTP discharge point. With the use of the notionally clean approach for the mass balance calculations ELVs were obtained that were non-sustainable, not attainable with best available techniques. In addition, the simple mass balance approach gives poor predictions of downstream 95%ile water quality and does not take account of the correlation between effluent flow rates and river flow rates.

A Monte-Carlo Analysis was carried out. The Monte-Carlo approach overcomes the limitations of mass balance calculations by utilising multiple different combinations of potential scenarios selected randomly across the probability curves of both datasets. Monte-Carlo analysis uses multiple combinations of watercourse and effluent flows and loads to assess the impact of discharges over a range of potential watercourse flows and quality conditions. This gives a more comprehensive assessment of the impacts of a discharge on the watercourse quality. Refer to attachment D.2 – 5 – Water Quality Impact assessment for the complete breakdown of tiered approach taken to determine the required ELVs for the proposed development

The Monte Carlo approach involved a detailed review of river and effluent flow statistics, upstream and downstream water quality data, effluent quality data, and cross-correlation between river and effluent flows. Probability distribution curves were developed for each variable and incorporated into the Monte Carlo model, with adjustments to reflect the correlation between effluent and river flow rates. A goal-seeking methodology was then applied, the analysis was based on maximum future design effluent flows (255 l/s) and assumed notionally clean upstream river conditions. This method was shown to reliably reproduce observed water quality conditions and produced ELVs

that are more relaxed than those from simple mass balance calculations but still protective of water quality. The ELVs derived from this method are achievable using standard treatment technologies and provide a more cost-effective and proportionate approach to wastewater management, while ensuring compliance with the “Polluter Pays” principle. The Tier 2 assessment confirmed no adverse impact on sensitive receptors, removing the need for further Tier 3 mixing zone analysis.

The MEL for orthophosphate at Nenagh WWTP is calculated in accordance with allowable assimilative capacity based on the Environmental Sensitivity Score of 9, which sets out maximum allowable assimilative capacity of 40% under notionally clean conditions. Taking this in account, the Mass Emission Limit (MEL) was calculated as 1,386kg/year

Table 5 provides a summary of the ELVs as determined according to the tiered approach:

Table 5: Required ELVs at Nenagh WWTP (as determined following a tiered assessment).

Parameter	ELVs (mg/L)	Mass Emission Limit (kg/yr)
Ammonia	0.8	NA
BOD	13	NA
Orthophosphate	0.3	1,386
Total Phosphorus	1	NA

4. Appropriate Assessment

The potential impacts of the proposed development on the Lough Derg (Shannon) SPA, Lower River Shannon SAC and any other European sites not hydraulically connected, were assessed in the Natura Impact Statement – Attachment D.2 – 2 – Combined AA Screening and NIS report.

The NIS provided an assessment of all potential direct or indirect adverse effects on European Sites. Where the potential for an adverse effect on any European Site was identified, it was identified that the pathway by which any such effect may occur had been robustly blocked by avoidance, appropriate design and mitigation measures. The measures ensure that the operation of the proposed development will not adversely affect the integrity of European Sites. The report indicated that the Proposed Development, individually or in combination with other plans or projects, will not adversely affect the integrity of any European Site.

5. Environmental Impact Assessment

An Environmental Impact Assessment Report (EIAR) was prepared in relation to the proposed development (refer to Attachment B.5 – 1 – EIAR).

The EIAR provided an assessment of all significant pressures that could occur during the construction, operation and decommissioning stages of the proposed development on surrounding environment, designated downstream European sites, as well as surface water and groundwater sources within the proximity of the proposed primary discharge and the proposed development. It was concluded that for each possible significant pressure identified, through the use of mitigation strategies as outlined within the EIAR, no significant effects shall occur on the surrounding environment, designated downstream European sites, as well as surface water and groundwater sources within the proximity of the proposed primary discharge and the proposed development.

6. Priority Substance Assessment (PSA) Report

A desk top study, attachment D.2 - 3 Priority Substances Assessment, conducted in accordance with “Guidance on the Screening for Priority Substances for Waste Water Discharge Licences” issued by EPA, has been undertaken to screen for the presence of priority substances in the primary discharge. Benzo[a]pyrene a polycyclic aromatic hydrocarbon (PAH), was identified as potentially exceeding the required EQS based on estimates using the EPA PRTR toolkit. However, since the Nenagh wastewater agglomeration is 98.8% domestic and only 0.2% industrial, the risk of actual exceedance is considered low. Therefore, no further priority substance monitoring is required.

7. Drinking Water Risk Assessment

A Drinking Water Risk Assessment (DWRA) was prepared in relation to the proposed development (refer to attachment D.2 – 4 – Drinking Water Risk Assessment). Based on the Drinking Water Risk Assessment the overall risk from the Nenagh agglomeration operational discharges can be classified as ‘Low Risk’. Drinking water quality is unlikely to be impacted during normal and abnormal operational conditions. Based on the results of this desk top risk assessment, it can be determined that no further Drinking Water Risk Assessment analysis of the discharge is required.

8. River Flow Estimation

To determine the prevailing river flow characteristics present at the discharge location by the Nenagh river, a detailed hydrological analysis was conducted in accordance with Uisce Eireann’s Technical Guidance for Hydrological Estimation (UE-AMT-GL-022). The difference in catchment area between the Tyone gauge and the discharge point on the Nenagh river was found to be 5.2%. The gauged river flow record at Tyone was then used to calculate river flow statistics at Nenagh

WWTP discharge point by scaling the gauge river flow statistics by difference in catchment area (5.2%) to represent flows in the Nenagh River by Nenagh WWTP. Refer to attachment D.2 – 5 – Water Quality Impact assessment for further details on the hydrological analysis undertaken to determine 95%ile flow (0.44m³/s) and mean flow (4.17m³/s) for the Nenagh River at the Nenagh WwTP discharge point.

9. Combined Approach

The Waste Water Discharge Authorisation under the European Union (Waste Water Discharge) Regulations 2007 to 2020, specify that a '*Combined Approach*' in relation to licensing of waste water works must be taken. According to the '*Combined Approach*', emission limits for the discharge are established on the basis of the stricter of either or both, the limits and controls required under the Urban Waste Water Treatment Regulations, 2001, as amended, and the limits determined under statute or Directive for the purpose of achieving the environmental objectives established for surface waters, groundwater or protected areas for the water body into which the discharge is made.

Urban Waste Water Treatment Regulations, 2001: for the 30 year design horizon, the proposed plant has a design population equivalent of 22,000. Article 4 of Directive 91/271/EEC dictates that all urban waste water discharges from agglomerations of >15000 p.e. must be subjected to at least secondary treatment or an equivalent level of treatment before being released into a receiving waterbody. Additionally, Article 7 of the Regulations requires that urban wastewater shall be subject to appropriate treatment before discharge. "Appropriate treatment" is defined as treatment which allows the receiving waters to meet the relevant quality objectives and the relevant provisions of the Directive and of other Community Directives.

Under the Urban Waste Water Treatment Directive Regulations, secondary treatment is required for WWTP with a PE between 2,000 and 10,000 p.e. that discharge to freshwater. For WWTP service a population over 10,000p.e. and discharging into nutrient-sensitive waters, tertiary treatment is required. The proposed Nenagh WWTP will have a design capacity of 22,000 p.e. and will provide tertiary treatment, including phosphorus removal, which is appropriate for its scale.

As determined in attachment D.2 – 5 – Water Quality Impact Assessment Report, the effluent quality of the primary discharge gives effect to the principle of the Combined Approach as defined in Waste Water Discharge (Authorisation) Regulations, 2007 to 2020. The proposed ELVs

accommodate for the more stringent limits of the Urban Waste Water Treatment Directive Regulations and the Surface Water Regulations that apply to the receiving waterbody, and will not compromise the achievement of the environmental objectives for the receiving water). Table 5 page 7 details the proposed ELVs which give rise to the combined approach:

10. Compliance with Relevant National or EU Legislation

Attachment B.6 – 1 – Compliance with EU Directives & National Regulations sets out the relevant EU Directives and national Regulations and provides evidence that the proposed wastewater works will be compliant.

11. Cumulative and In-Combination Effects

Potential cumulative and in-combination effects were examined in the NIS – attachment D.2 – 2 – Combined AA Screening and NIS report. The NIS (section 4.3) found that the proposed development is not likely to result in significant adverse impacts either alone or in combination with existing, planned or likely future projects.

12. Mixing Zone or Transitional Areas of Exceedance (Not Applicable)

Attachment D.2 – 5 – Water Quality Impact Assessment Report, shows that, by following the tiered approach, achievable ELVs can be applied to the discharge by tier 2 of the assessment and sensitive receptors will not be impacted. Additional analysis of the mixing zone at Tier 3 was therefore not required. The number of dilutions available at the proposed discharge location within the Nenagh River was 5.81.

13. Dilutions And Retention Time for Lakes (Not Applicable)

This section is not applicable.

14. Groundwater

Not applicable. No discharge to ground waters.

15. Impacts On Transboundary / Territory of Other States

This report has demonstrated that the achievement of “good” status of the receiving waterbody will not be jeopardised by this discharge and the NIS has indicated that the proposed development, individually or in combination with other plans or projects, will not adversely affect the integrity

of any European Site. Hence by extension, the proposed development has no potential for pollution over long distances or in the territory of other states.

16. For Waste Water Treatment Plants With Coastal Discharges, Provide Evidence That The End Of The Discharge Pipe Is Below The Mean Spring Tide Low Water Line

Not applicable as the proposed development discharges into a river waterbody, there are no coastal discharges present at this site.

Priority Substances Assessment

Agglomeration Name:	Nenagh WWTP
Licence Register No.	D0027-01



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1 Introduction

This report has been prepared for D0027-01, Nenagh, in County Tipperary to inform the wastewater discharge authorisation application.

This desk top study has been undertaken to determine the necessity, if any, for analysis of the discharge of the list of priority substances identified in Appendix 1, in accordance with the “*Guidance on the Screening for Priority Substances for Waste Water Discharge Licences*” issued by the EPA.

Details of the emissions concentration for the primary discharge and impact on the receiving water are included in Appendix 1.

2 Desktop Study

2.1 Assessment of Analysis Required

A. Review of all industrial inputs into WWTP

A list all licensed and any known unlicensed industrial or trade effluent discharges, leachate discharges/imports and other imports is included in Table 2.1 below. State if all trade / industrial discharges are licensed and include any known unlicensed discharges. “Other Imports” includes any non-domestic imports to the WWTP.

Table 2.1 – List of Non-Domestic Discharges to WWTP

Licensee Name / Landfill Name /Other Imports	Type of Industry	Type of Licence (IED / IPPC / Section 16 / Unlicensed)	Potential Source of Dangerous / Priority Substances (Yes / No)	Dangerous / Priority Substances Monitoring Undertaken (Yes / No)
W0240-02	Waste	Waste	Yes	No

Where the answer to “**Potential Source of Dangerous Substances (Yes / No)**” is Yes, **Table 2.2** below has been completed for each industry/landfill/other import source.

Table 2.2 – List of Dangerous or Priority Substances in Non-Domestic Discharges to WWTP

Licensee Name	List Anticipated Dangerous Substances or state if unknown	Monitoring Undertaken (Yes / No)
Waste	Unknow	No

B. Discharge monitoring

The Primary Discharge SW001 was analysed for priority substances (via Desktop Assessment) on 25/11/2024.

Analysis data is included in Appendix 1, with details of the source of the data. Analysis data includes the full list of priority substances listed in the EPA's Guidance on the Screening for Priority Substances for Waste Water Discharge Licences.

C. Downstream monitoring location's participation in relevant monitoring programme

There is no priority substances monitoring data available for downstream of the primary discharge along the Nenagh River.

D. Participation in PRTR reporting

The emissions of specific organic compounds and metals (priority substances) have been estimated for the discharge utilising the EPA's urban WWTP calculation tool for PRTR reporting where monitoring results are not available and are included in Appendix 1.

It is noted from the EPA's report, *An Inventory of Emissions to Waters in Ireland*, that extensive assessment of emission factors was undertaken during 2011 / 2012 that focused on the evaluation of inputs / output concentrations and removal efficiency using a variety of different sized plants and wastewater treatment options. This has led to the significant refinement of the electronic templates toolkit used for WwTP assessment using the PRTR tool. The estimated emission data relevant to the Nenagh agglomeration were estimated by simulating the Nenagh WwTP as a WwTP of 10,000 - 50,000 PE, with no saline intrusion and with Tertiary treatment. All parameters listed in Appendix 1 have emissions data available for the discharge from the PRTR tool.

2.2 Review outcome of Desktop study

Following the desktop study, all parameters in Appendix 1 have been assessed to establish any potential impact on the receiving waters.

Priority substance concentrations in the primary discharge were available for all parameters based on either monitoring results or the EPA PRTR toolkit. This study is considered a full characterisation

3 Assessment of Significance and Recommendations

An assessment of the potential for impacts on receiving waters from priority substances in the primary discharge has been carried out. The assessment considers the primary discharge relevant to Environmental Quality Standards (EQS) for priority substances in surface waters, as set out in the European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended.

One parameter has been identified as potentially being higher than the required EQS, based on the estimated final effluent concentrations calculated using the EPA PRTR toolkit following dilution, as follows:-

- Benzo[a]pyrene

Benzo[a]pyrene is a polycyclic aromatic hydrocarbon (PAH), which is identified at EU level as ubiquitous, and they occur widely in the environment on a global scale.

However, the Nenagh wastewater agglomeration's load is primarily domestic in nature with the domestic load accounting for 98.8% of the total load. The remaining 0.2% of the agglomeration's generated wastewater load is industrial. Based on the very low level of industrial wastewater loading to the Nenagh WWTP it is felt that the likelihood of actual priority substance exceedances is low. There is no further requirement for priority substance monitoring.

The EPA have prepared a report on priority substances, *An Inventory of Emissions to Waters in Ireland*. This document states that Ireland appears to have relatively few problems associated with the presence of Priority / Priority Hazardous substances in its surface waters. It identifies that wastewater discharges are a potential source of metals in receiving waters with lead being the main metal identified as associated with wastewater discharges. However, metals exceedances, in particular those for cadmium, lead, and nickel are primarily associated with areas of historic mining activity. Similarly, PAH's have been identified in stormwater overflows but the most significant source is considered to be rainfall.

Does the assessment use the Desk Top Study Method or Screening Analysis to determine if the discharge contains the parameters in Appendix 1 of the EPA guidance	Desk Top Study
Does the assessment include a review of licensed / authorised inputs to the works?	Yes
Does the assessment include a review of other (unauthorised) inputs to the works?	Yes
Does the report include an assessment of the significance of the results where a listed material is present in the discharge? (e.g. impact on the relevant EQS standard for the receiving water)	Yes
Does the assessment identify that priority substances may be impacting the receiving water?	Yes
Does the Improvement Programme for the agglomeration include the elimination / reduction of all priority substances identified as having an impact on receiving water quality?	No

Appendix 1 – Screening of Parameters for Priority Substances

AA: Annual Average

MAC: Maximum Allowable Concentration

EQS: Environmental Quality Standards

Dilution factor in receiving water: 3.62

No.	Compound	Group of compounds	AA-EQS Inland SW (µg/l)	AA-EQS Other SW (µg/l)	Measured /Estimated Conc. (µg/l) ¹	Data Source [Sample / PRTR / Other (state)]	Sample Date (if applicable)	Effluent Concentration above AA concentration (Yes/No)	Effluent Concentration above AA concentration after dilution (Yes/No)
1	Benzene	VOCs	10	8	0	PRTR	N/A	No	No
2	Carbon tetrachloride	VOCs	12	12	0	PRTR	N/A	No	No
3	1,2-Dichloroethane	VOCs	10	10	0	PRTR	N/A	No	No
4	Dichloromethane	VOCs	20	20	0.05	PRTR	N/A	No	No
5	Tetrachloroethylene	VOCs	10	10	0.06	PRTR	N/A	No	No
6	Trichloroethylene	VOCs	10	10	0	PRTR	N/A	No	No
7	Trichlorobenzenes	VOCs	0.4	0.4	0	PRTR	N/A	No	No
8	Trichloromethane	VOCs	2.5	2.5	0.002	PRTR	N/A	No	No
9	Xylenes (all isomers)	VOCs	10	10	0	PRTR	N/A	No	No
10	Ethyl Benzene	VOCs	n/a	n/a	0.0	PRTR	N/A	N/A	N/A
11	Toluene	VOCs	10	10	0.5	PRTR	N/A	No	No
12	Naphthlene ¹	PAHs	2	2	0.00	PRTR	N/A	No	No
13	Fluoranthene ¹	PAHs	0.0063	0.0063	0.002	PRTR	N/A	No	No

¹ The EQS for these substances shall take effect from 22 December 2015

No.	Compound	Group of compounds	AA-EQS Inland SW (µg/l)	AA-EQS Other SW (µg/l)	Measured /Estimated Conc. (µg/l) ¹	Data Source [Sample / PRTR / Other (state)]	Sample Date (if applicable)	Effluent Concentration above AA concentration (Yes/No)	Effluent Concentration above AA concentration after dilution (Yes/No)
14	Benzo[k]fluoranthene ²	PAHs	MAC of 0.017	MAC of 0.017	0.002	PRTR	N/A	No	No
15	Benzo[ghi]perylene ²	PAHs	MAC of 8.2 x 10 ⁻³	MAC of 8.2 x 10 ⁻⁴	0.00	PRTR	N/A	Yes	No
16	Indeno[1,2,3-c,d]pyrene ²	PAHs			0.00	PRTR	N/A	N/A	N/A
17	Benzo[b]fluoranthene ²	PAHs	MAC of 0.017	MAC of 0.017	0.002	PRTR	N/A	No	No
18	Benzo[a]pyrene	PAHs	1.7 x 10 ⁻⁴	1.7 x 10 ⁻⁴	0.002	PRTR	N/A	Yes	Yes
19	Di(2-ethylhexyl)phthalate (DEHP)	Plasticiser	1.3	1.3	0.92	PRTR	N/A	No	No
20	Isodrin ³	Pesticides	Σ=0.01	Σ=0.005	0	PRTR	N/A	No	No
21	Dieldrin ³	Pesticides			0	PRTR	N/A	No	No
22	Diuron	Pesticides	0.2	0.2	0	PRTR	N/A	No	No
23	Isoproturon	Pesticides	0.3	0.3	0.008	PRTR	N/A	No	No
24	Atrazine	Pesticides	0.6	0.6	0.01	PRTR	N/A	No	No
25	Simazine	Pesticides	1	1	0.014	PRTR	N/A	No	No
26	Glyphosate	Pesticides	60	-	1.53	PRTR	N/A	No	No
27	Mecoprop	Pesticides	n/a	n/a	0.11	PRTR	N/A	No	N/A
28	2,4-D	Pesticides	n/a	n/a	0.051	PRTR	N/A	No	N/A
29	MCPA	Pesticides	n/a	n/a	0.09	PRTR	N/A	No	N/A
30	Linuron	Pesticides	0.7	0.7	0	PRTR	N/A	No	No

² No indicative parameter is provided for this group of substances

³ Σ of Aldrin, Dieldrin, Endrin and Isodrin.

No.	Compound	Group of compounds	AA-EQS Inland SW (µg/l)	AA-EQS Other SW (µg/l)	Measured /Estimated Conc. (µg/l) ¹	Data Source [Sample / PRTR / Other (state)]	Sample Date (if applicable)	Effluent Concentration above AA concentration (Yes/No)	Effluent Concentration above AA concentration after dilution (Yes/No)
31	Dichlobenil	Pesticides	n/a	n/a	0.004	PRTR	N/A	No	N/A
32	2,6-Dichlorobenzamide	Pesticides	n/a	n/a	0.08	PRTR	N/A	No	N/A
33	PCBs	PCBs	n/a	n/a	0	PRTR	N/A	No	N/A
34	Phenols (as Total C)	Phenols	8	8	0.91	PRTR	N/A	No	No
35	Lead	Metals	1.2	1.3	3.04	PRTR	N/A	Yes	No
36	Arsenic	Metals	25	20	0	PRTR	N/A	No	No
37	Copper	Metals	5 or 30 ²	5	3.08	PRTR	N/A	No	No
38	Zinc	Metals	8 or 50 or 100 ³	40	49	PRTR	N/A	No	No
39	Cadmium	Metals	≤ 0.08 (class 1) 0.08 (class 2) or 0.09 (class 3) or 0.15 (class 4) or 0.25 class 5) ⁴	0.2	0.1	PRTR	N/A	No	No
40	Mercury	Metals	MAC of 0.07	MAC of 0.07	0.0	PRTR	N/A	No	No
41	Chromium VI	Metals	3.4	0.6	0.29	PRTR	N/A	No	No
42	Selenium	Metals	n/a	n/a	0	PRTR	N/A	No	N/A
43	Antimony	Metals	n/a	n/a	0.15	PRTR	N/A	No	N/A
44	Molybdenum	Metals	n/a	n/a	0	PRTR	N/A	No	N/A
45	Tin	Metals	n/a	n/a	0.1	PRTR	N/A	No	N/A
46	Barium	Metals	n/a	n/a	18.51	PRTR	N/A	No	N/A
47	Boron	Metals	n/a	n/a	63	PRTR	N/A	No	N/A
48	Cobalt	Metals	n/a	n/a	0	PRTR	N/A	No	N/A
49	Vanadium	Metals	n/a	n/a	2.7	PRTR	N/A	No	N/A
50	Nickel	Metals	4	8.6	4.3	PRTR	N/A	No	No
51	Fluoride	General	500	1,500	242	PRTR	N/A	No	No

No.	Compound	Group of compounds	AA-EQS Inland SW (µg/l)	AA-EQS Other SW (µg/l)	Measured /Estimated Conc. (µg/l) ¹	Data Source [Sample / PRTR / Other (state)]	Sample Date (if applicable)	Effluent Concentration above AA concentration (Yes/No)	Effluent Concentration above AA concentration after dilution (Yes/No)
52	Chloride	General	n/a	n/a	84885	PRTR	N/A	N/A	N/A
53	TOC	General	n/a	n/a	9220	PRTR	N/A	N/A	N/A
54	Cyanide	General	10	10	2.93	PRTR	N/A	No	No
	Conductivity	General	n/a	n/a	N/A	PRTR	N/A	N/A	N/A
	Hardness (mg/l CaCO ₃)	General	n/a	n/a	214909	PRTR	N/A	N/A	N/A
	pH	General	n/a	n/a		PRTR	N/A	N/A	N/A

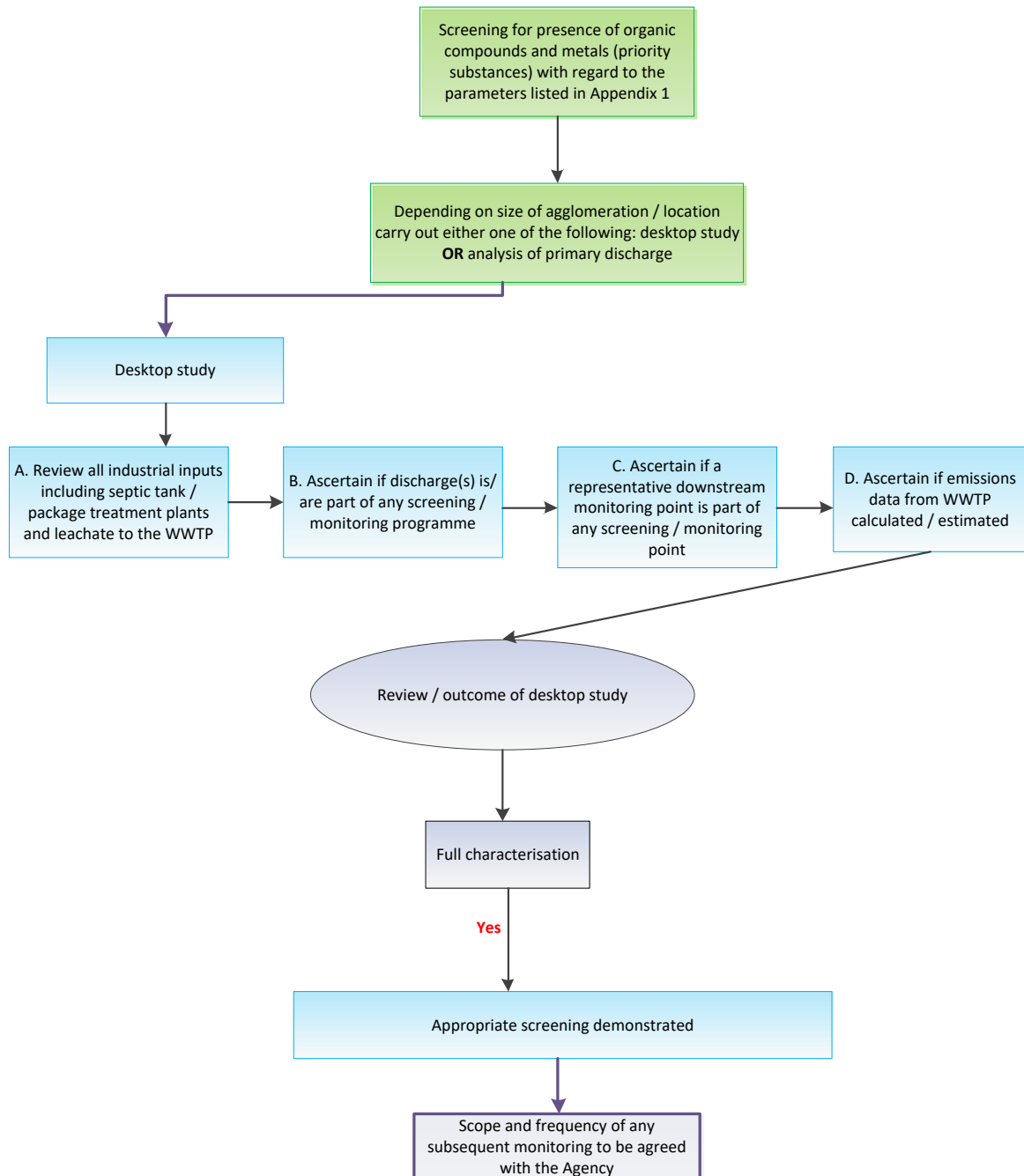
Notes:

1. Where measured values are available these should be used instead of estimated values from PRTR tool.
2. In the case of Copper the value 5 applies where the water hardness measured in mg/l CaCO₃ is less than or equal to 100; the value 30 applies where the water hardness exceeds 100 mg/l CaCO₃. Estimated CaCO₃ value > 100 where no sampling data available (based on PRTR tool)
3. In the case of Zinc, the standard shall be 8 µg/l for water hardness with annual average values less than or equal to 10 mg/l CaCO₃, 50 µg/l for water hardness greater than 10 mg/l CaCO₃ and less than or equal to 100 mg/l CaCO₃ and 100 µg/l elsewhere. Estimated CaCO₃ value > 100 where no sampling data available
4. For Cadmium and its compounds the EQS values vary dependent upon the hardness of the water as specified in five class categories (Class 1: <40 mg CaCO₃/l, Class 2: 40 to <50 mg CaCO₃/l, Class 3: 50 to <100 mg CaCO₃/l, Class 4: 100 to <200 mg CaCO₃/l and Class 5: _200 mg CaCO₃/l)
5. MAC referenced in the case where there is no AA-EQS

Appendix 2 – Priority Substance Screening Flowchart

A flow chart for the screening of the presence of organic compounds and metals (Priority Substances) from WWTP is included below. This flowchart shows that appropriate screening has been demonstrated in line with the assessment undertaken in this report.

Full Characterisation



Drinking Water Risk Assessment

Agglomeration Name:	Nenagh WwTP
Licence Register No.	D0027-01



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1 Introduction

This risk assessment has been produced alongside the wastewater discharge license review application for D0027-01, Nenagh, in County Tipperary. This risk assessment notes and determines the potential impacts on drinking water abstractions within the area of the primary discharge location, the Nenagh River. The Nenagh WwTP occupied an area of approximately 2.4ha and is located bordering the Nenagh River and is access off the Bulfin Road by the Kyleeragh Bridge. Located to the northeast edge of the town, the Nenagh WwTP is surrounded by town land with a Sports Complex to the North.

Pumping stations servicing the Nenagh's Northern catchment, Southern catchment and the Lisbunny Industrial Estate direct flows to the old Nenagh WwTP which discharges through an outfall into the Nenagh River (SW001). There are currently 3 no. pumping stations on the network, of which 2 no. have Dual Function (emergency overflows (EO) and storm water overflow) and 1 No. has emergency overflow associated with them. There is 1 storm water overflow on the network. The first SWO (SW002) is positioned adjacent to the SW001. The Dublin Road PS SWO (SW003) is approximately 600m directly south of the WwTP. The Kenyon Street PS SWO (SW004) is approximately 1.2km southwest of the WwTP beside the Kenyon Street Cemetary. The Kilnasalla PS SWO (SW005) is approximately 2.1km directly west of the WwTP.

The proposed Nenagh WwTP upgrades aim to increase the hydraulic and treatment capacity of the 'new plant' from 12,225 PE to 22,000 for the next 30-year design horizon. The existing 'old plant' is proposed to be decommissioned. The upgrade proposes to maintain the existing primary discharge SW001 and the Nenagh Storm Tank SWO discharge location.

The following four separate categories have been used to evaluate the risk associated with the discharges from the agglomeration, and an overall risk ranking has been assigned on conclusion of this risk assessment:

- Level of treatment and capacity of WwTP.
- Discharge compliance and level of dilution.
- Receiving waters/ abstraction water quality.
- Impact of discharges during normal and abnormal operation.

2 Details of Nenagh Agglomeration and associated drinking water abstraction.

2.1 Nenagh WwTP details

Table 1: Proposed works hydraulic and organic capacity data.

1	Type of treatment (primary, secondary, tertiary)	Tertiary with Phosphate Removal
2	Hydraulic Capacity – Design / As Constructed (dry weather flow) (m ³ /day) Proposed	6,732
3	Hydraulic Capacity – Design / As Constructed (peak flow) (m ³ /day) Proposed	20,200
4	Hydraulic Capacity- Current loading (m ³ /day)	12,960
5	Current average hydraulic loading to the treatment plant (m ³ /day)	6,593
6	Hydraulic Capacity - Remaining (m ³ /day)	Current: 6,367

7	Organic Capacity - Design / As Constructed (PE) - Proposed WWTP	22,000
8	Organic Capacity - Current loading (PE)	12372 -Peak
9	Organic Capacity - Remaining (PE)	Current: 0 PE
10	Will the capacity be exceeded in the next three years? (Yes / No)	No – Upgrade to accommodate load
11	Are ELV's compliant with licence? (Yes / No)	Revised ELV's are subject of current license review
12	If answer to No. 11 above is Yes, list parameters not in compliance	There has been no testing of treated effluent from new discharges conducted thus far with completion date of 31/12/2029.

2.2 Discharges from the agglomeration

Table 2: Discharges from the Agglomeration.

Discharge	Type of Discharge	Receiving waters	Level of Dilution ¹ .	Eastings	Northing	Frequency of discharge (If known)	Compliant Discharge (Yes / No)
SW001	Nenagh WwTP Primary Discharge - to be retained.	Nenagh River	3.62	187285	180081	Constant	Yes
SW003	Dublin Road pumping station SWO & EO.	Nenagh River	3.62	187435	179320	Unknown	Yes
SW004	Kenyon Street SWO.	Nenagh River	3.62	186823	178826	Unknown	Yes
SW005	Kilnasalla pumping station SWO & EO.	Nenagh River	3.62	185069	180171	Unknown	Yes
SW006	Ballygraique pumping station SWO.	Nenagh River	3.62	186817	178069	Unknown	Not applicable
SW007	Decommissioned Nenagh WwTP Inlet Pumping Station SWO.	Nenagh River	3.62	187285	180078	Unknown	No
SW008	Nenagh WwTP Storm Tanks SWO.	Nenagh River	3.62	187285	180081	Unknown	Yes
SW009	Nenagh WWTP Stormwater Tank No.2 overflow (maintenance backup)	Nenagh River	3.62	187285	180081	Unknown	Yes

2.3 Downstream Drinking Water abstractions

Table 3: Downstream Drinking Water Abstraction – NENAGH_60¹

Abstraction Code	Site Location	Abstraction Volume (m ³ /day)	Type	Distance Downstream	Discharge Point
2800PUB1008	Nenagh RWSS	15,050	Reservoir / Lake Draw Off	12.5 km	SW001/SW003-SW009

1. The Nenagh river (NENAGH_60) located within the Shannon IRBD is identified as a River Drinking Water source according to Article 7 Abstraction for Drinking Water of Directive 2000/60/EC of the European Parliament and of the Council. According to the EPA Water Abstraction Register of December 2023 however, there are no drinking water abstractions located within this section of river at present. Therefore, Nenagh_60 of the Nenagh River should be intended as a drinking water abstraction source for future use.

3 Risk Assessment

3.1 Level of Treatment and Capacity of WwTP

The following guidelines provide the basis for ranking the risk associated for Nenagh with respect to this criterion:

- Low risk: Secondary treatment and plant with capacity
- Medium risk: Overloaded secondary treatment (with no untreated overflows)
- High risk: Primary treatment / No treatment / overloaded secondary treatment with significant overflows of untreated wastewater.

Evaluation:

- The level of treatment at the new Nenagh WwTP (i.e., secondary treatment with Phosphorus removal).
- The treatment capacity of the new WwTP (30-year design horizon 22,000 p.e.).
- The primary discharge (SW001) will be compliant with the proposed ELVs
- The discharge distance to the nearest abstraction point downstream of the discharges is greater than 5km;

Conclusion: Risk Classification is Low

3.2 Discharge Compliance and Level of Dilution

- The level of treatment at the new Nenagh WwTP (i.e., secondary treatment with Phosphorus removal).
- The significant dilution factor in receiving water.
- The distances to the nearest abstraction points downstream of the discharges are greater than 5km.
- There have been no reported water quality issues identified at the downstream abstraction points which may be due to the Nenagh WwTW operational discharge

Conclusion: Risk Classification is Low.

3.3 Receiving Waters / Abstracted Water Quality

It is proposed to retain the existing outfall into the Nenagh River (SW001). The primary discharge is situated downstream of the Kyleeragh Bridge. The WFD status of the Nenagh River is currently assigned “Moderate” in the River Waterbody WFD Status 2016-2021 and 2013-2018 due to industrial significant pressures exerted within Lower Nenagh and Clareen. The Nenagh agglomeration is not identified as a significant pressure on the receiving waterbody.

The Monte Carlo assessment undertaken to inform the Nenagh WWDL review highlights the effect of the ambient/background concentration on the assimilative capacity of the receiving water body and confirms that the Nenagh agglomeration is not a significant pressure on this waterbody.

In terms of reported water quality issues/incidents, none have been identified/reported at the downstream abstraction points from either 2800PUB1008 which may be due to the operational discharges from the Nenagh WWTWs.

Conclusion: Risk Classification is Low

3.4 Impact of Discharges During Normal and Abnormal Operations

The new ELV's for the upgraded WwTP are to allow for the receiving waterbody at the Nenagh River to receive no obstruction to the achievement of “good” WFD status for that waterbody nor cause any deterioration of the current status of the Nenagh River. Additionally, the discharge will be monitored to ensure compliance with the proposed ELVs to ensure that the discharges from the upgraded WwTP are compliant.

Normal and abnormal operating conditions, e.g. equipment breakdown, of key equipment have been accounted for within the design of the proposed WwTP within the control philosophy minimising the risk of conditions occurring outside design intention, including undesirable discharges. For instance, Alarms are fit to each key piece of equipment which shall alarm in case prompted to by abnormal conditions occurring such as being triggered by the failure of a flowmeter or water level rising / falling to critical level. Additionally, all equipment will be automatically controlled via PLC. Each site will have its own automation control centre where the plants' operation will be monitored.

Conclusion: Risk Classification is Low.

4 Overall Risk and Recommendations

Based on the Drinking Water Risk Assessment above the overall risk from the Nenagh agglomeration operational discharges can be classified as ‘Low Risk’. Drinking water quality is unlikely to be impacted during normal and abnormal operational conditions.

Based on the results of this desk top risk assessment, it can be determined that no further Drinking Water Risk Assessment analysis of the discharge is required.

Report

Uisce Éireann Water Quality Impact Assessment

Nenagh WWTP



Quality Assurance

Revision Number	Description of Change	Author(s)	Approved By	Date of Approval
01	Issue to EPA	S Waite	R Kane	08/09/2025

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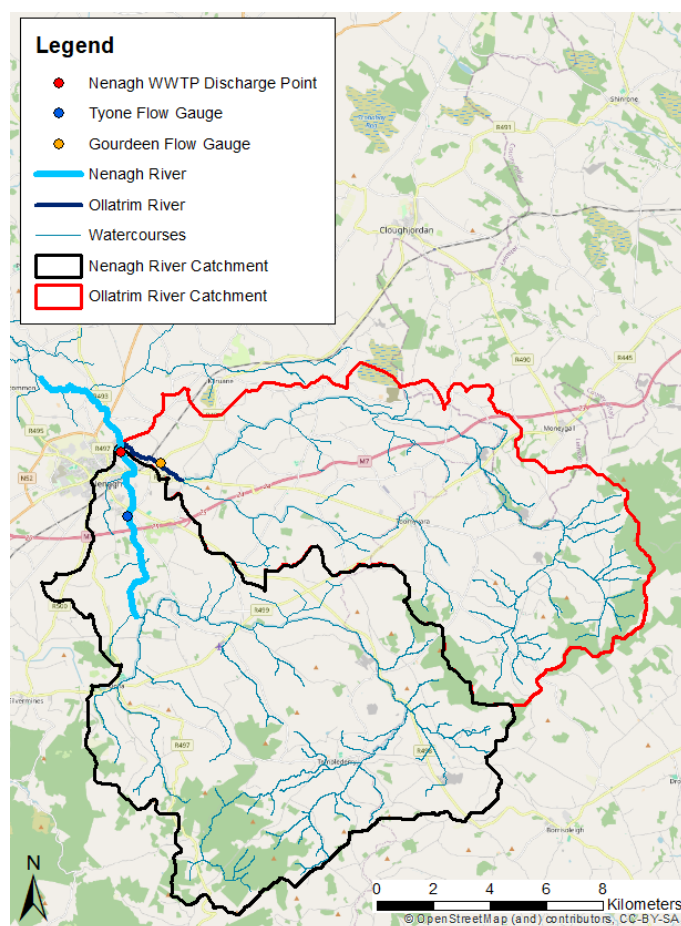
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1 Introduction

Nenagh WWTP discharges treated wastewater to the Nenagh River at Nenagh. A new WWTP is to be constructed to serve an increased population projected over the next thirty years. Design of the new treatment process will require a review of the appropriate target Emission Limit Values (ELVs) to safeguard the quality of water in the Nenagh River. The purpose of this report is to carry out an assessment of the impacts of wastewater discharges from Nenagh WWTP on the receiving water quality, and to determine the appropriate level of treatment to ensure discharges are compatible with the achievement of both Water Framework Directive (WFD) objectives and any relevant Conservation Objectives. This will include an assessment of the existing water quality conditions at the discharge location and calculations to determine appropriate future ELVs for the new WWTP that will ensure compliance with Environmental Quality Standards (EQS) set out in legislation, and provide appropriate protection in the context of annual mass emissions loads to receiving waters.

The existing WWTP discharge point is located at Irish National Grid Reference (INGR) 187285 180081 on the Nenagh River, a short distance upstream of the Ollatrim River inflow (Figure 1). It is proposed that the existing discharge location will be retained by the new WWTP and the impact of the future discharges on water quality in the Nenagh River will be assessed using a Tiered Assessment approach as set out in the Uisce Éireann Interim Technical Guidance on Water Quality Impact Assessment (Freshwaters) (UÉ-AMT-GL-028).

Figure 1: Nenagh WWTP Discharge Point, Key Watercourses, Flow Gauges and Catchment Areas



1.1 Tiered Assessment Framework

An assessment of the impacts of the discharge from Nenagh WWTP has been carried out using the Tiered Assessment Approach, as set out by the European Commission¹ and as adopted by Uisce Éireann's Technical Guidance. The guidelines set out an approach to assessing the impact of discharges, using risk-based methods, where the level of complexity of the assessment is commensurate with the level of risk posed by a discharge.

The UÉ tiered approach for watercourses consists of five Tiers:

- Tier 0: Check to see if the effluent is likely to contain a contaminant of concern. If so, check to see if the contaminant is present at levels above the Environmental Quality Standard (EQS), i.e. the maximum permitted concentration in the receiving waterbody.
- Tier 1: Check to see if discharging the contaminant(s) of concern at levels above the EQS are likely to have a significant impact on the receiving waterbody given existing ambient concentrations.
- Tier 2: An initial assessment of water quality impacts and required ELVs is made based on a simple mass balance approach (Tier 2a). If the mass-balance approach is found to give results that are non-representative of downstream conditions, or if the resulting ELVs cannot be achieved due to technical feasibility, the water quality impact is further simulated using a Monte Carlo analysis (Tier 2b).
- Tier 3: If the Tier 2 assessment methods indicate that EQS targets will not be met, or sensitive receptors are likely to be impacted upon, the mixing zone is to be further assessed based on achievable levels of wastewater treatment using complex models to establish the extent of the mixing zone and duration and frequency of impacts.
- Tier 4: If the Tier 3 analysis suggests that the impacts will be significant, an investigative study is undertaken to examine the concentrations of the contaminant(s) reaching receptors, the characteristics of the receptors, their vulnerability and the ecotoxicity of the contaminants.

At each stage of the Tiered Assessment, the discharge assessment is either completed (if environmental impacts are appropriate and acceptable) or referred for additional assessment at the next stage. In the case of Nenagh WWTP, the level of required analysis did not progress beyond a Tier 2 assessment.

The two methods of Tier 2 calculation are described below.

1.1.1 Simple Mass Balance Method

Simple mass balance calculations can be carried out for any given set of river quality, river flow, effluent quality and effluent flow conditions. For the purposes of assessing impacts of wastewater discharges against targets in legislation (see Section 2) two sets of calculations are typically required, the first to assess against environmental compliance with 95%ile EQS targets (carried out using low Q_{95} river

¹ Technical Guidelines for the Identification of Mixing Zones, pursuant to Art. 4(4) of the Directive 2008/105/EC, European Commission, Brussels, 22 December 2010, C(2010) 9369

flows) and a second calculation to assess environmental compliance against mean EQS targets (carried out using mean river flows). The calculation is shown in Equation 1.

Equation 1: Mass Balance Equation

$$C_{downstream} = \frac{Q_{eff}C_{eff} + Q_{river}C_{river}}{Q_{eff} + Q_{river}}$$

Where: Q_{eff} is the average effluent flow rate (m^3/s) and C_{eff} is the effluent pollutant concentration (mg/l)

Q_{river} is the flow in the watercourse upstream (m^3/s) and C_{river} is the average ambient river pollutant concentration upstream of the outfall (mg/l)

$C_{downstream}$ is the resultant downstream water quality for each pollutant in the watercourse (mg/l)

The simple mass balance approach assumes that 95%ile concentrations in the river occur downstream of a discharge at the same time as Q_{95} river flows due to lack of dilution capacity within the watercourse at times of low flow. This approach also assumes that mean concentrations in the river occur downstream of a discharge at the same time as mean river flows. Because of this method of schematising river quality conditions, simple mass-balance may be considered a conservative approach compared to other methods of modelling which are capable of considering a much wider combination of flow and quality conditions in rivers and effluent.

1.1.2 Monte Carlo Analysis Method

Simple mass-balance calculations do not consider the full range of river and effluent flow conditions or the range of potential quality conditions which may occur in a watercourse upstream or downstream of a discharge. The approach is also not able to easily take account of correlations between inputs, such as correlations between river and effluent flow rates or between effluent flow rate and effluent pollutant concentrations. These factors can be overcome using a Monte Carlo approach whereby complex statistical problems are represented using multiple different combinations of potential scenarios selected randomly from across the probability curves of both datasets. In this context, Monte Carlo analysis uses multiple combinations of watercourse and effluent flows and concentrations in order to simulate downstream conditions, and assess the impact of a discharge over the full range of potential watercourse flow and quality conditions. This gives a more complete analysis of the impacts of a discharge on the watercourse quality and can also be adapted to account for correlations in datasets, however it does require more input data compared to a simple mass-balance approach.

Uisce Éireann have developed methods to facilitate both simple mass balance (UÉ-AMT-FM-007) and Monte Carlo analysis (UÉ-AMT-FM-008) when assessing the impacts of a WWTP discharge on receiving water quality. These methods have both been applied to assess the impacts of the Nenagh WWTP discharges on water quality in the Nenagh River and calculate the ELVs required to deliver the appropriate level of protection to downstream water quality.

1.2 Report Structure

The report sets out the results of a Tiered Assessment of the Nenagh WWTP discharge and calculation of ELVs based on Tier 2 assessment methods. Both Tier 2 calculation methods rely on suitable analysis

of the available environmental data and information on WWTP effluent flows and quality. The report is structured as follows:

- Section 2 provides a brief overview of legislative framework and list of substances for assessment in the tiered analysis.
- Section 3 sets out the hydrological context of the receiving waters and calculates river flow percentiles.
- Section 4 reviews the available water quality data for the receiving watercourses, checks for correlation between river flow and quality and establishes target downstream concentration values and status.
- Section 5 outlines the available effluent flow and quality data and checks for correlation between river flow and effluent flow rates and between effluent flow rate and quality.
- Section 6 provides the results of analysis at Tiers 0, 1 and 2 (simple mass balance approach and Monte Carlo analysis methods). This Section also sets out the requirements for ELVs and MELs.
- The report is summarised in Section 7.

2 Legislative Framework

2.1 Legislation

2.1.1 Urban Wastewater Treatment Directive Regulations (as amended)

The Urban Wastewater Treatment Directive Regulations (UWWTD, 2001)² sets standards to be met in the collection and treatment of wastewater as well as the monitoring requirements for wastewater discharges from urban areas. The Environmental Protection Agency issues licences for WWTP discharges to environmental waters in accordance with the requirements of the UWWTD and the discharge licence for Nenagh WWTP was most recently granted under this legislative instrument in September 2008 (ref. D0027-01), with technical amendments in February 2014, June 2017 and December 2021. The current ELVs applied to effluent from Nenagh WWTP are set out in Table 1 and compared with effluent quality standards required for a wastewater treatment plant of its current capacity under the UWWTD.

Table 1: Current Environmental Limit Values at Nenagh WWTP

Parameter	UWWTD Maximum Permitted Value	Current Nenagh WWTP ELV (WWDA Regs)
Chemical Oxygen Demand (COD) (mg/l)	125	100
Biological Oxygen Demand (BOD) (mg/l)	25	20
Suspended Solids (mg/l)	35	30
pH	--	9
Ammonia (mg/l)	--	1.40
Orthophosphate (mg/l)	--	0.75
Total Phosphorus (mg/l)	1.00	1.00

Under the UWWTD, secondary treatment is required for settlements with a PE of 2,000 to 10,000 and with discharges to freshwaters. Tertiary treatment is required for WWTP which serve more than 10,000 PE and which discharge to nutrient sensitive waters. Nenagh WWTP has a current design capacity of 12,000 PE and provides tertiary treatment with phosphorus removal, which is an appropriate level of treatment for the current capacity. In addition, the UWWTD allows for designation of environmental waters as “nutrient sensitive” and additional application of ELVs for total nitrogen and total phosphorus where this designation is applied. The Nenagh River is designated as nutrient sensitive at Nenagh and a total phosphorus ELV has been applied by the current discharge licence in recognition of this.

2.1.2 European Communities Environmental Objectives (Surface Waters) Regulations 2009

The Water Framework Directive (WFD, Directive 2000/60/EC) defines the ecological status of waterbodies as high, good, moderate, poor or bad. Under WFD, member states are required to prevent pollution of waterbodies and work to improve water quality to a minimum of good status, provided this can be done in a cost effective and proportionate manner. The WFD was enacted into Irish Law through the European Communities Environmental Objectives (Surface Waters) Regulations 2009³ (amended

² Statutory Instruments SI No 254/2001 <https://www.irishstatutebook.ie/eli/2001/si/254/made/en/print> , accessed 12 March 2024

³ Statutory Instruments SI No 77/2019 <http://www.irishstatutebook.ie/eli/2019/si/77/made/en/print>, accessed 26 September 2024

in 2015 and 2019 and referred to throughout this report as “the Surface Water Regulations”).

The Surface Water Regulations set standards which can be used to identify the current status of waterbodies and to determine the impacts of the discharge at Nenagh WWTP on future water quality. The standards are set for ecological community assemblage and for physio-chemical parameters that affect it. Table 2 shows the standards for good and high ecological status in rivers. The discharges may directly impact on concentrations of ammonia, BOD, orthophosphate and pH and this will subsequently have impacts on river ecosystems and dissolved oxygen concentrations. This report will consider only direct impacts on river chemistry and will calculate the appropriate ELVs required to ensure protection of river ecosystems and avoid impacts on dissolved oxygen.

Table 2: Water Quality Standards for River Waters under the Surface Water Regulations

Parameter	Classification System	High-Good boundary	Good-Moderate boundary
Macro Invertebrates	Quality Rating System (Q Value)	0.85	0.75
Fish	Fish Classification Scheme 2 Ireland (FCS2)	0.845	0.540
Phytobenthos	Revised form of Trophic Diatom Index (TDI)	0.93	0.78
Macrophytes	Free Macrophyte Index	0.90	0.68
Ammonia (mg/l)	Mean	0.04	0.065
	95%ile	0.09	0.14
BOD (mg/l)	Mean	1.3	1.5
	95%ile	2.2	2.6
Molybdate Reactive Phosphorus (orthophosphate, mg/l)	Mean	0.025	0.035
	95%ile	0.045	0.075
pH	Mean	Hard Water (CaCO ₃ >100mg/l) = 6-9 Soft Water (CaCO ₃ <100mg/l) = 4.5-9	
Dissolved Oxygen (%)	95%ile value	80-120%	

2.1.3 Wastewater Discharge (Authorisation) Regulations (as amended)

The Environmental Protection Agency issues licences for WWTP discharges under the Wastewater Discharge (Authorisation) Regulations (2007)⁴, referred to in Table 1 as the WWDA Regulations. These regulations aim to ensure that discharge of wastewater do not have adverse impacts on the environment, taking into account the above Directives. This is achieved by taking a “combined approach,” whereby “*the emission limits for the discharge are established on the basis of the stricter of either or both, the limits and controls required under the Urban Waste Water Regulations, and the limits determined under statute or Directive for the purpose of achieving the environmental objectives established for surface waters.*”

Historically, discharge licences granted by the Environmental Protection Agency have not included emission limit values on discharge flow or volume. Heretofore, WWDAs have been authorised based on a proposed agglomeration Population Equivalent and ELVs have been based on effluent

⁴ <http://www.irishstatutebook.ie/eli/2007/si/684/made/en/print>, accessed 19 June 2020

concentrations which are set to ensure compliance with EQS values in receiving waters. In order to set limits on total annual environmental loading from a wastewater discharge, recently the EPA has commenced setting Mass Emission Limits (MELs) on orthophosphate in discharge licences. While not a function of the current licence, a Mass Emission Load assessment has been included in Section 6.

2.1.4 Other Regulations

Additional protection for water quality in rivers can be applied in Ireland under the following legislative instruments:

- The EU Bathing Waters Directive (2006/7/EC, February 2006), transposed into Irish Law as the Bathing Water Quality Regulations⁵ in 2008 with minor amendments in 2011 and 2016.
- The Shellfish Waters Directive (“Directive 2006/113/EC on the Quality Required of Shellfish Waters”) which sets out standards which must be achieved when harvesting shellfish for human consumption and is now incorporated within the Water Framework Directive.
- The 1988 Salmonid Regulations⁶ which have been partly superseded by the Water Framework Directive.

The Nenagh River is not designated as a bathing water, shellfish water or for the protection of salmon. None of the above legislative instruments therefore apply when assessing the impacts of the Nenagh WWTP discharge.

2.2 WFD Waterbodies

Nenagh WWTP discharges to the Nenagh River which is designated under the Surface Waters Directive as river waterbody Nenagh_060 (IE_SH_25N010700) (Figure 2) and the existing discharge location will be utilised by the proposed new WWTP. The Nenagh_060 waterbody includes the Nenagh River upstream and downstream of the Ollatrim River inflow as well as the downstream reach of the Ollatrim River and a further unnamed tributary of the Nenagh River (Figure 2). The Nenagh_060 and upstream Nenagh_050 waterbodies have a “moderate” classification in terms of status under the Surface Water Regulations. The classification of the Nenagh_060 waterbody did not change between the 2010-2015, 2013-2018 and 2016-2021 WFD monitoring periods, while the upstream Nenagh_050 waterbody was classified as at good status for the 2010-2015 monitoring period before being classified as at moderate status thereafter. The current reasons for not achieving good status are given for both waterbodies as sub-optimal invertebrate ecological assemblage and elevated concentrations of nitrate and ammonia. The available water chemistry data for the Nenagh River at Nenagh WWTP is reviewed in Section 4.

2.3 Sensitive Receptors

There are no sensitive designated sites at or within 1km downstream of Nenagh WWTP discharge point. The closest designated site, Lough Derg (Shannon) SPA, is over 10km downstream (over 8km straight-

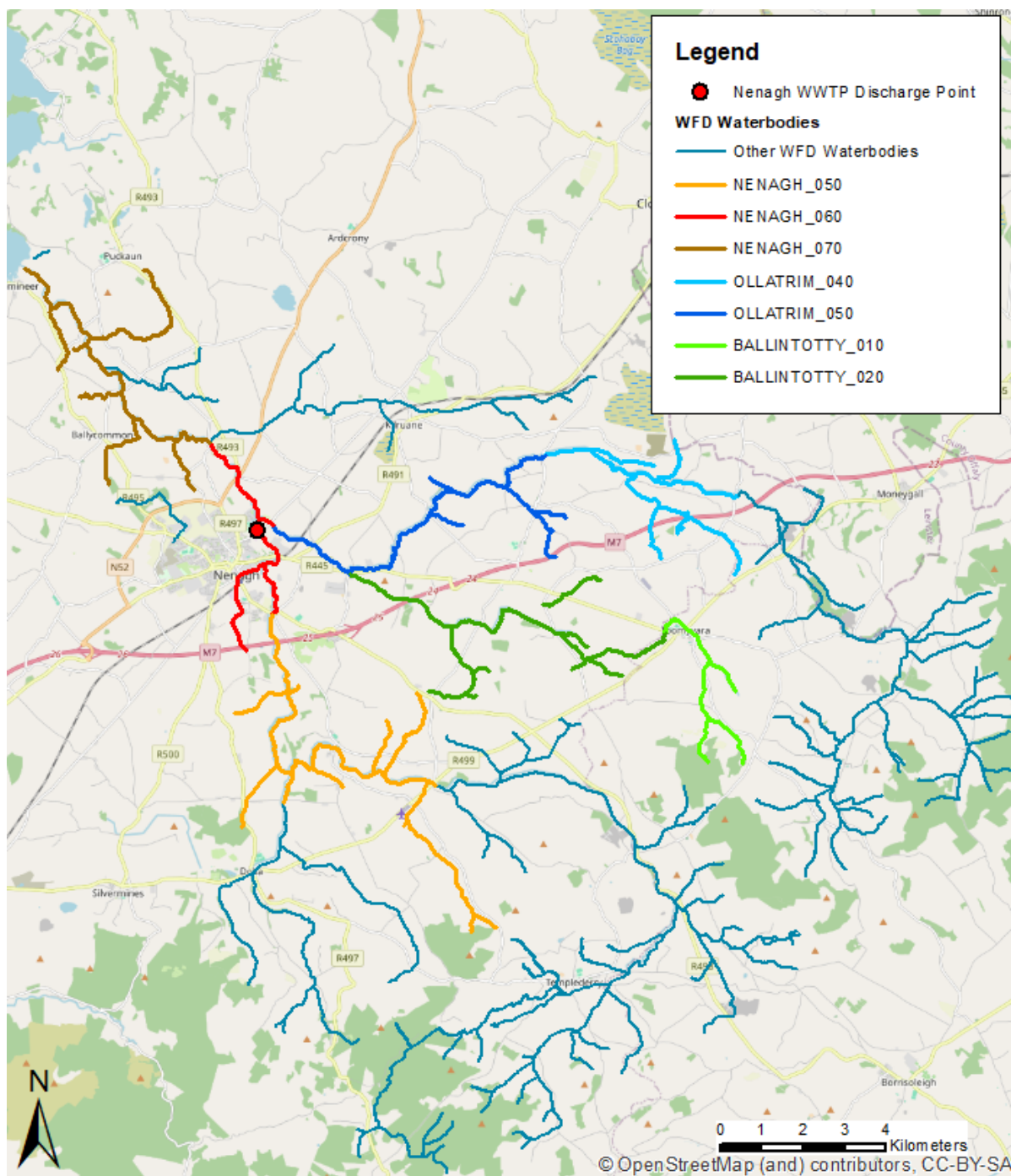
⁵ Statutory Instrument 79/2008, <https://www.irishstatutebook.ie/eli/2008/si/79/made/en/print>, accessed 12 March 2024

⁶ <http://www.irishstatutebook.ie/eli/1988/si/293/made/en/print>, accessed 12 March 2021

line distance) and does not extend along the Nenagh River. As noted in Section 2.1.4, the Nenagh River is not designated for protection of bathing waters, shellfish or salmon and improvements to wastewater treatment are not required at this location for the protection of freshwater pearl mussel. The watercourse is, however, designated as nutrient sensitive and the Nenagh_060 waterbody is also designated for protection of public drinking water supply.

The designation of the Nenagh_060 waterbody for the protection of drinking water supply does not impose additional requirements for river water quality. Recognising this, the discharges from Nenagh WWTP will be subject to limits to protect downstream water quality in line with the requirements of the Surface Waters Regulations and the UWWTD only. The additional protection required under the UWWTD for nutrient sensitive waters is reflected in the application of the total phosphorus ELV and this is applied irrespective of receiving water quality. The substances of concern for a Teir 0 analysis in Section 6 are therefore limited to ammonia, BOD and orthophosphate based on EQS for rivers as set out in the Water Framework Directive.

Figure 2: Designated River Waterbodies within the Nenagh River Catchment

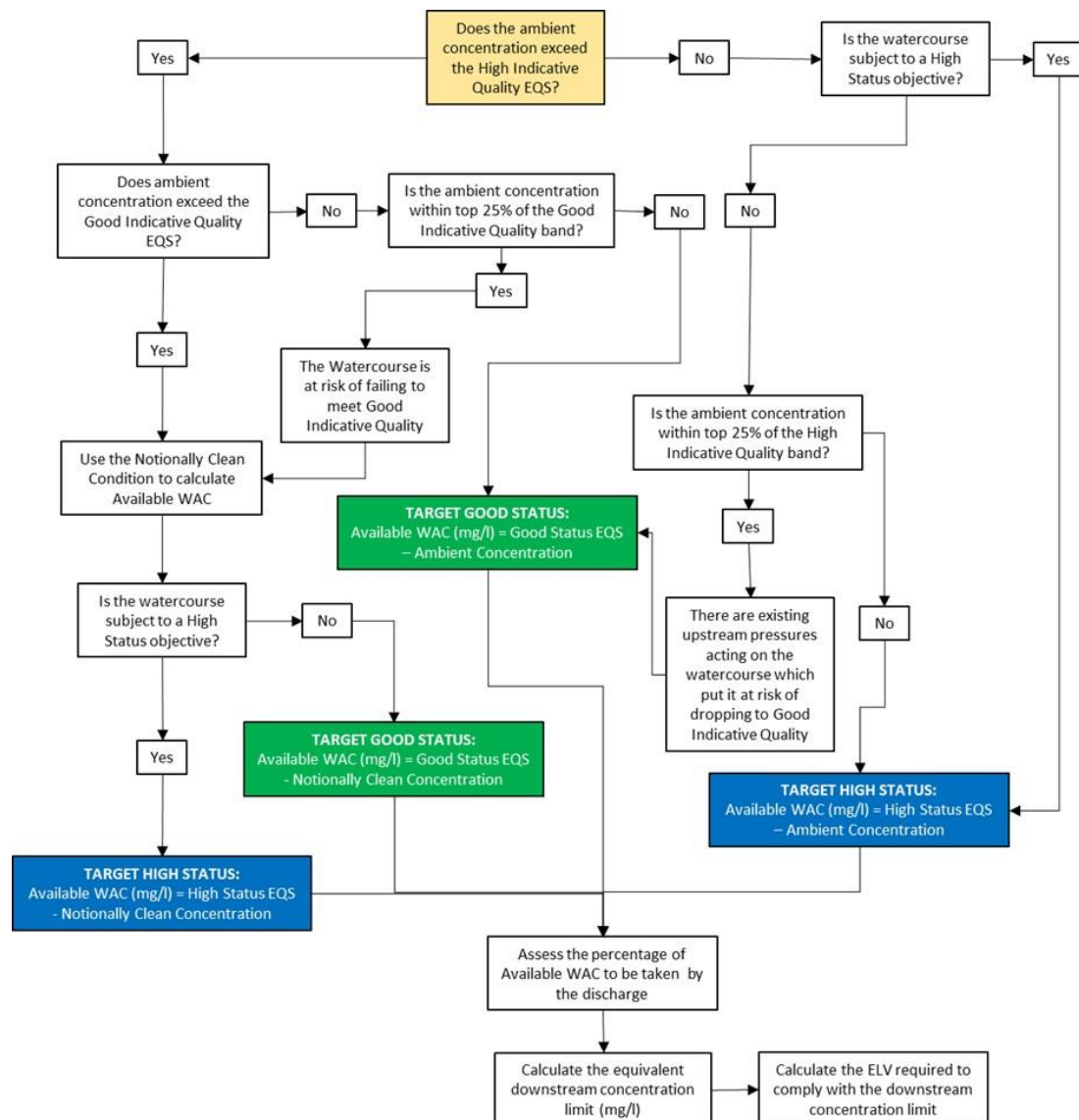


2.4 Assessment Methodology

Uisce Éireann have developed a methodology to ensure a consistent approach is taken to water quality impact analysis and the setting of ELVs for WWTP effluent (Interim Technical Guidance for Water Impact Assessments (Freshwater) Document No. UE-AMT-GL-028). This approach seeks to determine an appropriate downstream target status and percentage of available wastewater assimilative capacity which can be taken by a single wastewater discharge. The available assimilative capacity is defined as the difference between the upstream river nutrient concentration and the target EQS.

Figure 3 provides a flow chart for identifying the target status for a watercourse as either “Good” or “High” status, and if a notionally clean approach should be applied. The flow chart is applied for both mean and 95%ile water quality, with the final target applied for each nutrient based on the worst-case upstream water quality evaluation outcome.

Figure 3: Target Status Flow Chart



The outcome of this process for Nenagh WWTP, based on the upstream river quality data discussed in Section 4 below, is that ELVs should be set for all parameters based on a target status of Good and using notionally clean upstream water quality. The notionally clean approach is applied to allow an assessment of a discharge to receiving watercourses where the concentrations of ammonia, BOD and orthophosphate in the river upstream of the discharge point exceed requirements for good indicative quality due to other upstream pressures. The impact of the upstream pressures is removed to allow for calculation of ELVs which would deliver compliance with the target status under the Surface Water Regulations if the upstream pressures on water quality were addressed. This is simulated by applying water quality statistics at the upstream location which are equal to 20% of the high status EQS value. The use of the notionally clean condition is in line with the “polluter pays” principle in the WFD.

For a given WWTP, ELVs are set such that effluent discharges utilise an appropriate percentage of available WAC based on the sensitivity of the receiving environment. Table 3 provides an environmental sensitivity scoring system, which determines this sensitivity based on the characteristics of the receiving environment. The environmental sensitivity score for the Nenagh River at Nenagh WWTP is 9 and the

score at this location takes account of the significant additional dilution from the Ollatrim River inflow a short distance downstream of the discharge point (see Section 3).

Table 3: Environmental Sensitivity Scoring

Factor	Assessment	Score	Nenagh River at Nenagh WWTP Discharge Point
Current watercourse status	Watercourse not at significant risk of WFD classification change	0	
	Watercourse "at risk" of WFD classification change / currently failing to meet Good	5	5
Discharge Location Score			
Downstream Dilution	Q ₉₅ Flow increases by <20% at next confluence (within WFD Waterbody)	0	
	Q ₉₅ flow increases by 20-50% at next confluence (within WFD Waterbody)	-2	
	Q ₉₅ flow increases by >50% at next confluence (within WFD Waterbody)	-2	
	Q ₉₅ flow increases by >80% at next confluence (within WFD Waterbody)	-4	-4
Environmental Receptors Score			
Environmental Receptors	Discharge to SPA	5	
	Discharge to Special Area of Conservation	5	
	Discharge to Bathing Water	5	
	Discharge to Drinking Water	3	3
	Discharge to Salmonid River	4	
	Discharge to Shellfish Water	2	
	Discharge to Nutrient Sensitive Water	5	5
	Discharge within 1km of SPA	2.5	
	Discharge within 1km of SAC	3	
	Discharge to High Status Objective Waterbody under WFD or the Habitats Directive	10	
	Discharge within 1km of Bathing Water	2.5	
	Discharge within 1km of Drinking Water	1.5	
	Discharge within 1km of Salmonid River	3	
	Discharge within 1km of Nutrient Sensitive Water	3	
Discharge within 1km of Shellfish Water	1		
TOTAL			9

Table 4 provides the upper limits of the available WAC to be used by a WWTP discharge depending on the environmental sensitivity score and the upstream water quality. Based on the scores calculated above, Nenagh WWTP should use up to 40% of the available WAC under notionally clean conditions.

Table 4. Determination of Allowable Assimilative Capacity for Wastewater

Risk Score	Allowable Assimilative Capacity (Using Ambient Data)	Allowable Assimilative Capacity (Using Notionally Clean)
up to 4	Up to 75%	Up to 50%
4 to 9	Up to 50%	Up to 40%
10 to 19	Up to 30%	Up to 30%
19 to 30	Up to 25%	Up to 20%
>30	Up to 10%	Up to 10%

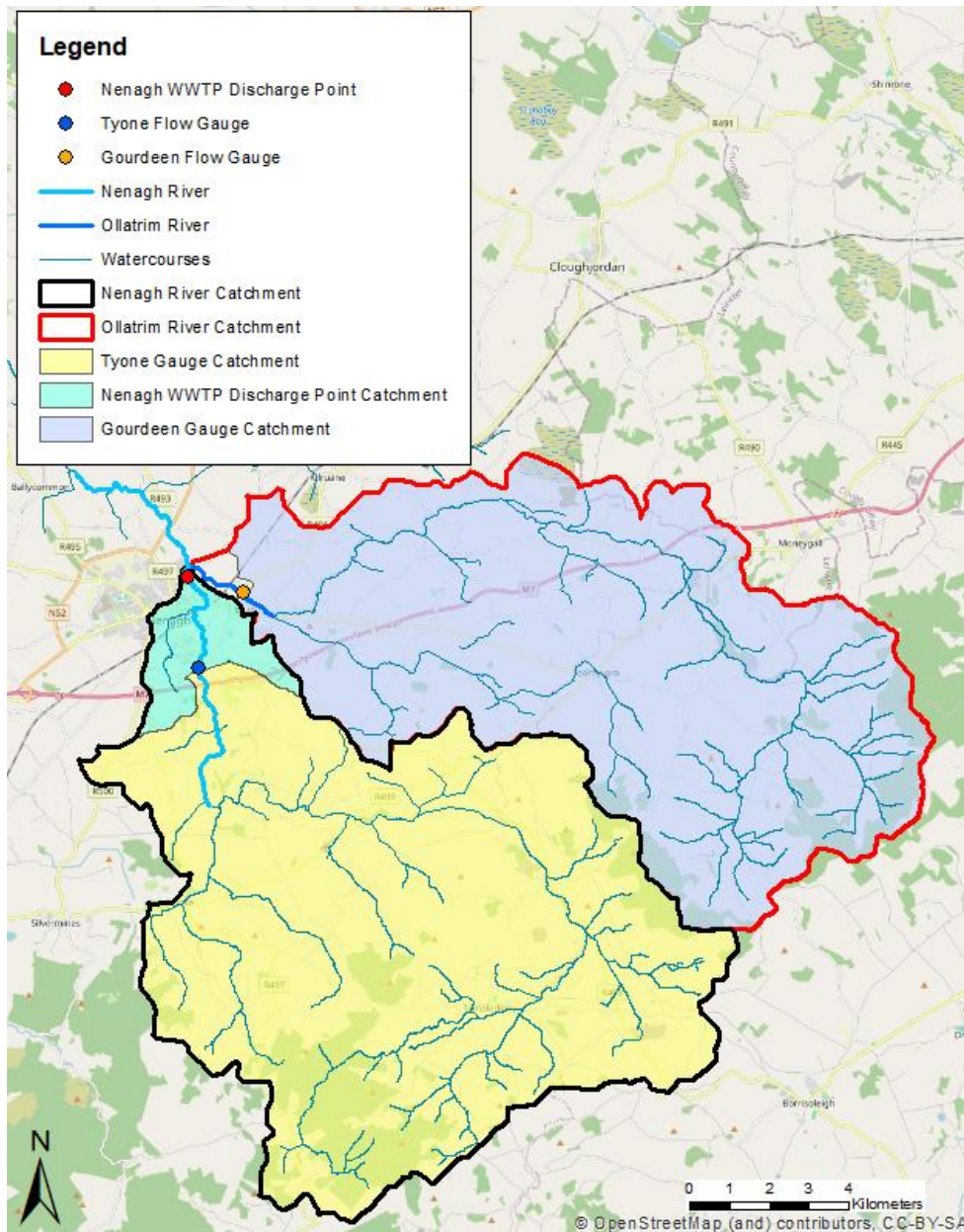
3 Hydrological Analysis

3.1 Nenagh River Catchment and Flow Gauges

The Nenagh River catchment at Nenagh WWTP occupies an area of 143.5km². The Nenagh River is gauged at Tyone, 3.11km upstream of Nenagh WWTP primary discharge point, where the catchment area is 136.1km². The difference in catchment area between the gauge and the discharge point is 5.2%.

The Ollatrim River joins the Nenagh River in a confluence located 0.43km downstream of Nenagh WWTP. The total area of the Ollatrim River catchment is 120km² and the Ollatrim River is gauged at Gourdeen, 1.71km upstream of the Nenagh River confluence. The Ollatrim River catchment area at Gourdeen is 118.9km² and the gauged catchment accounts for 99% of the total catchment area of this watercourse. The key watercourses, catchment areas and gauge locations are shown in Figure 4.

Figure 4: Nenagh WWTP, River Flow Gauges and Contributing Catchment Areas



The gauged river flow record at Tyone will be used to calculate river flow statistics at Nenagh WWTP discharge point. Flow data from the Ollatrim River will be used to calculate the increase in Q_{95} occurring downstream of the Ollatrim River/Nenagh River confluence and this has been used as an input to the Environmental Sensitivity Score in Section 2.4.

3.2 Gauged Flow Data Evaluation

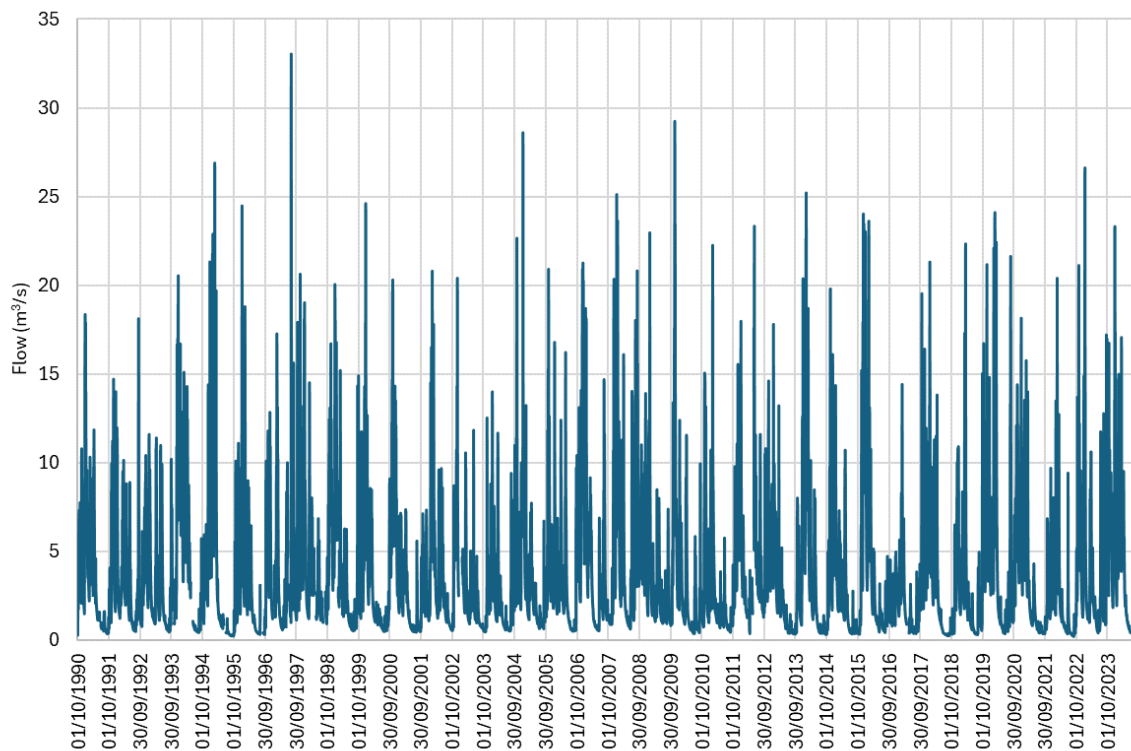
Details of the gauged flow data at Tyone and Gourdeen are provided in Table 5 and the annual flow data and flow percentiles at the two gauges are set out in Appendix A.

Table 5: Location Gauging Station Details

Station Number	25038	25027
Station Name	Tyone	Gourdeen
Waterbody	Nenagh River	Ollatrim River
Site Owner	Environmental Protection Agency	Office of Public Works
Grid Reference	187565 177807	188697 179698
River Basin District	Shannon	Shannon
Catchment Area (km ²)	136.1	118.9
Data Start Date	01/10/1990	01/10/1972
Data End Date	25/09/2024	19/08/2024
Daily Data Percent Complete	97.0	88.8

The Tyone daily flow data timeseries is shown in Figure 5 and the gauge data have been reviewed for quality, non-stationarity and the impact of missing data. This review shows that river flow has been calculated from measured level using three ratings over the period of record. All three ratings give good quality flow data for flows above $0.36\text{m}^3/\text{s}$ ($Q_{97.5}$) with extrapolation at lower flows. The ratings have different limits of good quality flow measurement at high flows – flows exceeding $28.3\text{m}^3/\text{s}$ (exceeding $Q_{0.1}$) were extrapolated between 1990 and 2009 and flows exceeding $22.8\text{m}^3/\text{s}$ ($Q_{0.2}$) were extrapolated between 2009 and 2012. From 2012 to present the upper limit of extrapolation increased to $24.8\text{m}^3/\text{s}$ (exceeding $Q_{0.1}$). The Tyone gauge therefore gives good quality flow measurement over almost the entire range of observed flows, with extrapolation only at the highest and lowest flow conditions.

Figure 5: River Flow Timeseries for the Nenagh River at Tyone (Daily Mean Flows from 1990 to 2024)



The Tyone gauge record is largely complete with no gaps sufficient to skew the flow duration curve. The annual flow statistics in Appendix A show possible non-stationarity in the form of reducing low annual flows, however this non-stationarity is not sufficiently apparent to justify exclusion of older data when calculating whole-record river flow statistics. There are no known anthropogenic influences on gauged river flow at Tyone – the upstream catchment contains no reservoirs, impounded reaches or reaches with known significant abstraction pressures, and there are no WWTP serving more than 500 PE discharging upstream of the gauge.

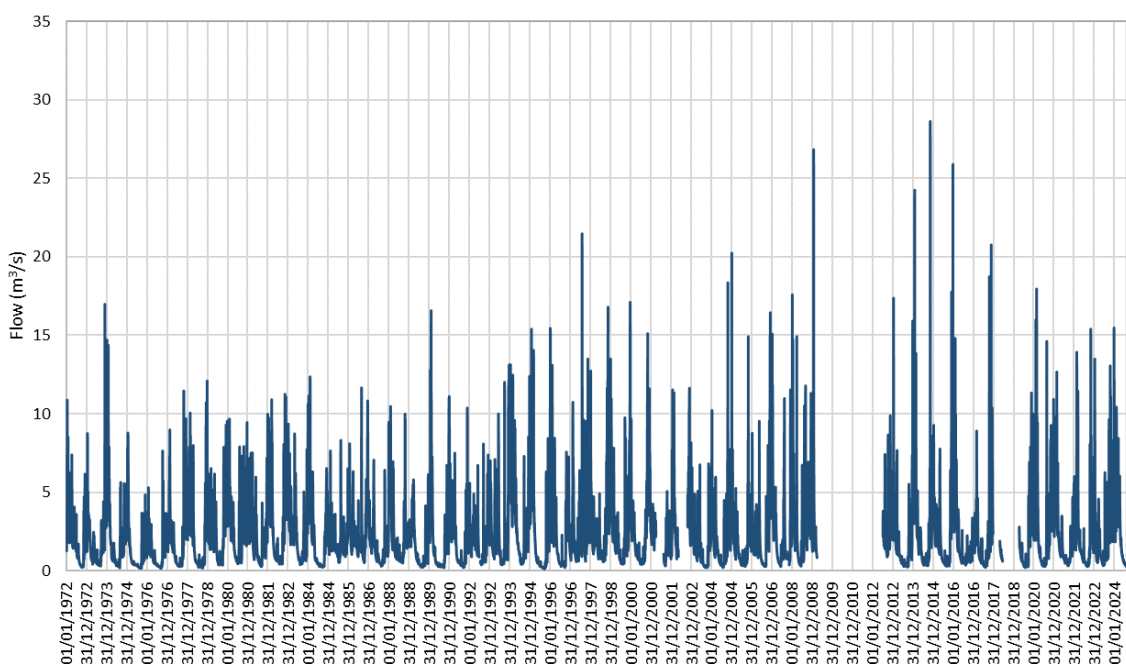
On the basis of these checks, the daily mean flow data from the entire gauge record from the Tyone gauge can be used to produce a flow duration curve and calculate key flow percentiles for the Nenagh River at the gauge. Flows at the gauge can be scaled to represent flows in the Nenagh River at Nenagh WWTP to account for the increase in catchment area between the gauge and the WWTP discharge point. This increase is small and the catchment hydrology will not change significantly between the two locations.

Figure 6 shows the daily mean flow timeseries for the Ollatrim River at Gourdeen flow gauge. Review of the gauge data shows that river flow has been calculated from measured water level using six ratings over the period of record. The thresholds for data quality vary between ratings as follows:

- Rating 1 (1972-1974): poor quality data below $0.5\text{m}^3/\text{s}$ ($Q_{83.3}$), fair quality data between $Q_{83.3}$ and $6.5\text{m}^3/\text{s}$ ($Q_{5.1}$), higher flows calculated with good quality.
- Rating 2 (1974-1981): fair quality data below $3.4\text{m}^3/\text{s}$ ($Q_{19.7}$), good quality data between $Q_{19.7}$ and $21\text{m}^3/\text{s}$ (exceeding Q_1), higher flows are extrapolated.

- Rating 3 (1981-1988): poor quality data below $0.52\text{m}^3/\text{s}$ ($Q_{85.2}$), good quality data between $Q_{85.2}$ and $Q_{5.1}$, fair quality data between $Q_{5.1}$ and $21\text{m}^3/\text{s}$, higher flows extrapolated.
- Rating 4 (1988-2002): poor quality data below $Q_{85.2}$, good quality data between $Q_{85.2}$ and $21\text{m}^3/\text{s}$, higher flows extrapolated.
- Rating 5 (2002-2008): good quality data below $3.3\text{m}^3/\text{s}$ ($Q_{20.6}$), fair quality data from $Q_{20.6}$ to $22\text{m}^3/\text{s}$, higher flows extrapolated.
- Rating 6 (2008 to present): fair quality data up to $22\text{m}^3/\text{s}$, higher flows extrapolated.

Figure 6: River Flow Timeseries for the Ollatrim River at Gourdeen (Daily Mean Flows from 1972 to 2024)



Low flows, including Q_{95} , were only calculated with good or fair quality between 1974 and 1981 and from 2002 onwards. However, review of the annual flow statistics show that the low flow statistics are consistent between years with poor quality low flow data and years with fair or good quality low flow data. The poor quality data in some years therefore does not preclude the use of this data in flow estimation; individual low flow observations may be less precise but the overall statistics calculated from the poor quality periods of record are realistic. Average river flows are measured with good or fair quality throughout the entire record and there is no evidence of non-stationarity at low to average flows at this site.

The gaps in the Gourdeen gauge flow data in Figure 6 arise from the removal of suspect data sections. The gaps affect the entire range of measured flows and should not skew the flow statistics. There are no significant anthropogenic influences on gauged river flow; the catchment contains no large reservoirs or impounded reaches and no watercourse reaches with known significant abstraction pressures. There are no WWTP discharging upstream of the gauge. On the basis of these checks, the daily mean flow data from the entire gauge record from the Gourdeen gauge can be used to produce the flow duration curve and key flow percentiles required for the Ollatrim River.

3.3 Gauged Flow Statistics

Figure 7 shows the flow duration curves for the Nenagh River at Tyone and Nenagh WWTP and for the Ollatrim River at Gourdeen. River flow statistics have been calculated for the Nenagh River at Nenagh WWTP by increasing the gauged flows at Tyone by 5.2% to account for the increase in catchment area between this gauge and the WWTP. Table 6 gives the scaled river flow statistics for the Nenagh River at Nenagh WWTP.

Figure 7: Daily Mean Flow Duration Curves for the Nenagh and Ollatrim Rivers

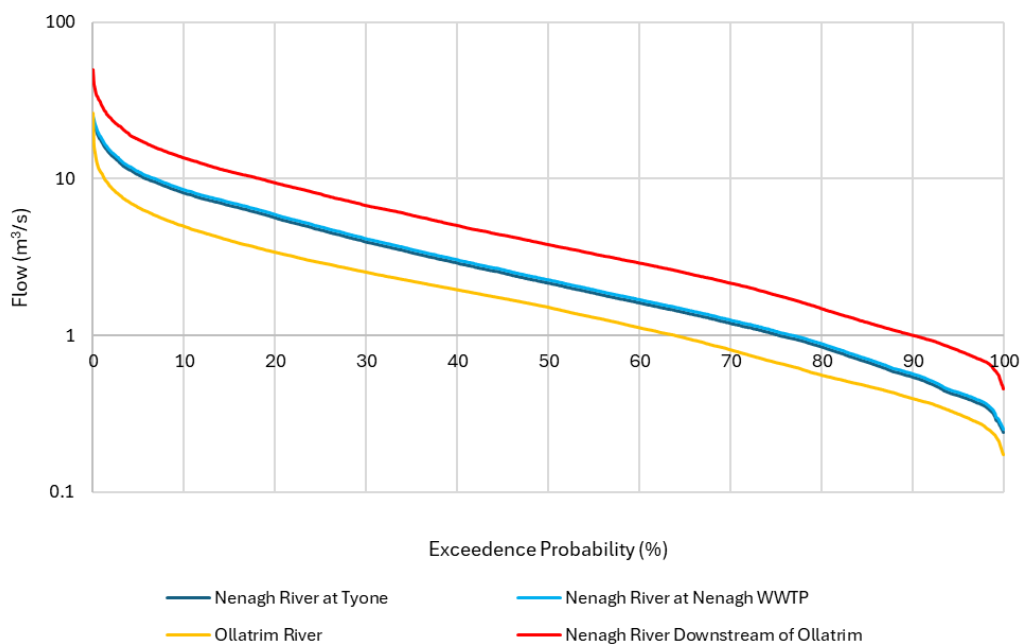


Table 6: Flow Duration Curve Statistics for the Nenagh River at Nenagh WWTP Discharge Point

Flow Exceedence Probability (%)	Flow (m ³ /s)
0.01	25.1
1	18.4
5	11.3
10	8.57
15	7.12
20	5.95
25	4.98
30	4.17
35	3.57
40	3.06
45	2.64
50	2.27
55	1.97
60	1.70
65	1.47
70	1.26
75	1.06
80	0.89
85	0.71
90	0.57
95	0.44
99	0.32
99.9	0.25

The flow statistics for the Nenagh River downstream of the Ollatrim River inflow which form the basis of the red flow duration curve in Figure 7 have been calculated using the following process:

- The daily mean flows for the Nenagh River at Tyone have been scaled by 5.2% to represent the flows from the entire Nenagh River catchment to the Ollatrim River confluence.
- The daily mean flows for the Ollatrim River at Gourdeen have been used to represent the flows from the entire Ollatrim River catchment to the confluence because the increase in catchment area downstream of the Gourdeen gauge is small.
- The two sets of flows have been summed for the entire period for which both records overlap.
- Flow statistics have been calculated downstream of the Ollatrim River/Nenagh River confluence based on the summed flow record.

This method allows for an appropriate calculation of river flow statistics downstream of the Ollatrim River inflow to the Nenagh River, given that the two rivers do not always experience the same flow conditions at the same time. The flow duration curve for the Nenagh River downstream of the Ollatrim River inflow is shown in Figure 7 and the Q_{95} is $0.80\text{m}^3/\text{s}$, 84% greater than at the Nenagh WWTP discharge point. The Environmental Sensitivity Score in Section 2.4 has been set to represent this increase in low river flow and river dilution capacity.

4 River Water Quality Analysis

4.1 Monitoring Locations

River water quality is monitored on the Nenagh River at locations upstream and downstream of Nenagh WWTP discharge point. The upstream monitoring point is RS25M010605 (u/s Nenagh WWTP), on the Bulfin Road Bridge 150m upstream of the primary outfall. The downstream monitoring point is RS25M010620 (d/s Nenagh WWTP), 100m downstream of the outfall. The monitoring locations are shown in Figure 8 and details of the sampling point locations are shown in Table 7.

Figure 8: Nenagh WWTP Discharge Point and River Water Quality Monitoring Locations



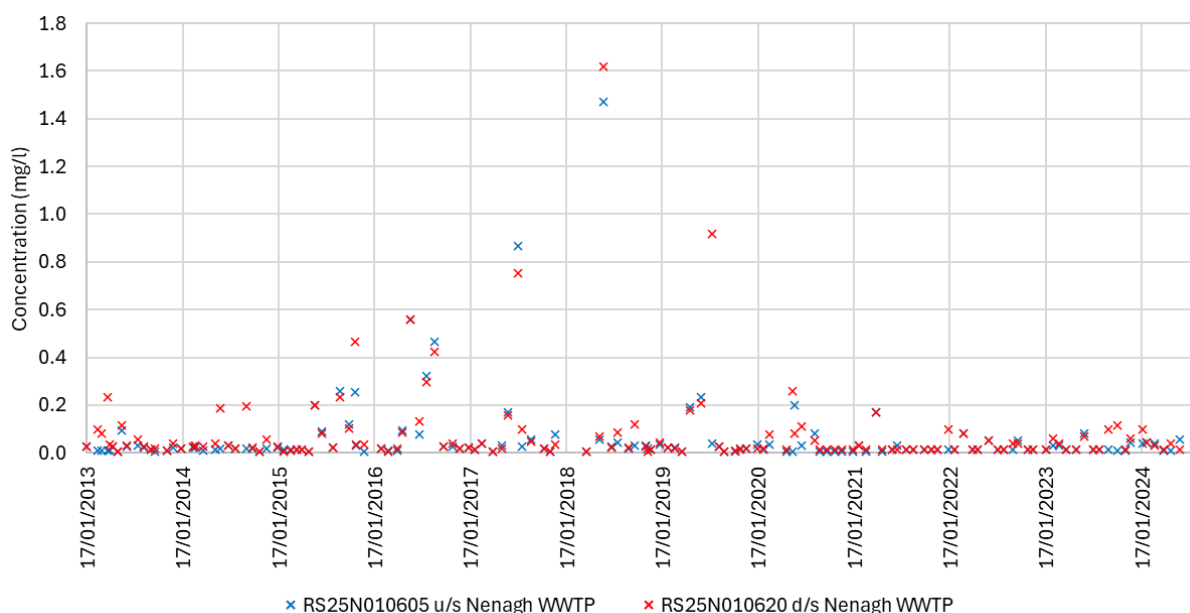
Table 7: Water Quality Sampling Point Details

	Upstream Sampling Point				Downstream Sampling Point			
Station ID	RS25M010605				RS25M010620			
Station Name	u/s Nenagh WWTP				d/s Nenagh WWTP			
Irish Grid Reference	187349 179986				187230 180176			
Substance	pH	Ammonia	BOD	MRP	pH	Ammonia	BOD	MRP
Number of Samples	136	140	140	136	136	133	133	136
Date of First Sample	17/01/2013							
Date of Last Sample	13/06/2024							

4.2 River Quality Timeseries

The timeseries of ammonia sampling data at the two sampling points is shown in Figure 9. The data show a consistent ambient concentration of ammonia with occasional high concentration values, particularly between 2015 and 2020. The high concentrations are observed both upstream and downstream of the WWTP discharge and there is generally limited difference in ammonia concentrations between the two sampling points, with concentrations usually increased slightly at the downstream location. There are no obvious trends in the river quality data which would make data from a specific period of time unrepresentative of current conditions so the entire period of record is suitable for the calculation of water quality statistics in the Nenagh River. Comparing the ammonia concentration at the upstream monitoring point RS25N010605 with the river flow recorded at the Tyone gauge shows no correlation between upstream river flow and quality at Nenagh WWTP ($R^2 = 0.030$).

Figure 9: Ammonia Monitoring Data for the Nenagh River at Nenagh WWTP

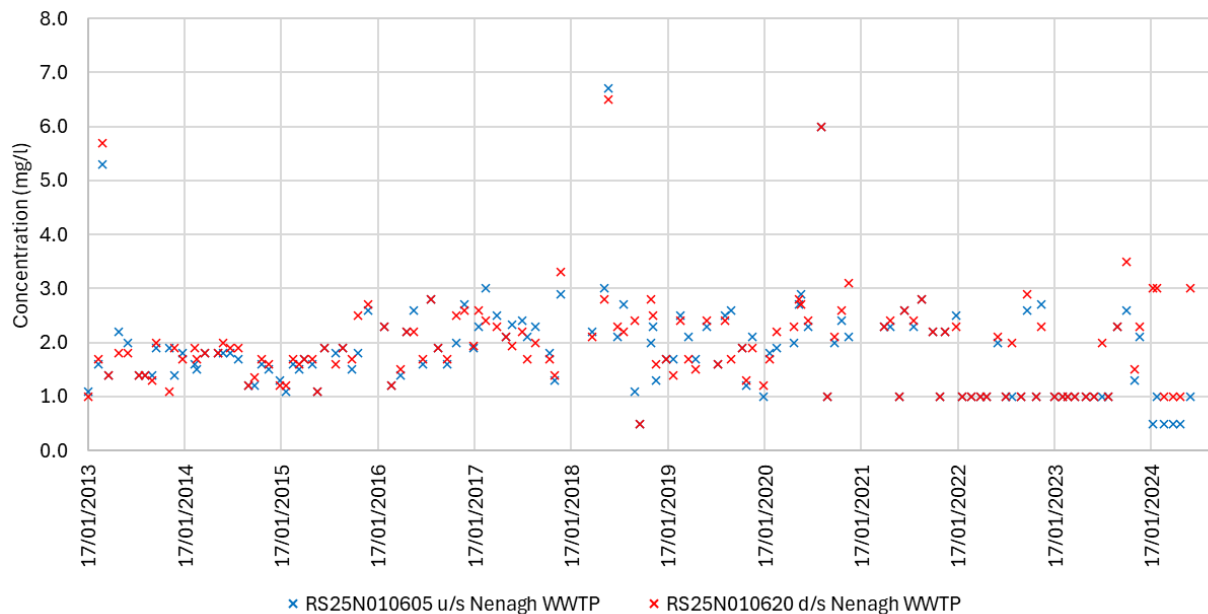


The timeseries of BOD sampling data at the two monitoring points is shown in Figure 10. The data show elevated levels of BOD with occasional very high concentration values, observed both upstream and downstream of the WWTP discharge. There is generally limited difference in BOD concentration between the two sampling points, with concentrations usually increased only slightly at the downstream location. There are no obvious trends in the river quality data which would make data from a specific period of time unrepresentative of current conditions – data from 2016 onwards show more variable concentrations than in previous years but a greater number of samples taken during this period also returned concentrations below the Limit of Detection (LOD). I.e. In line with typical water quality statistical analyses, values at or below LOD levels have been replaced with proxy values of 50% of the LOD (1.0mg/l) when calculating statistical metrics. The limit of detection is higher than the mean EQS for BOD in rivers so mean BOD concentrations may be overestimated at Nenagh relative to the EQS. This is not expected to impact significantly on the 95%ile river concentration.

The lack of clear trends in BOD concentrations in the Nenagh river at Nenagh WWTP means that the

entire period of record is considered to be suitable for the calculation of water quality statistics. Comparing the BOD concentration at the upstream monitoring point RS25N010605 with the river flow recorded at the Tyone gauge shows no correlation between upstream river flow and quality at Nenagh WWTP ($R^2 = 0.000001$).

Figure 10: BOD Monitoring Data for the Nenagh River at Nenagh WWTP



The timeseries of orthophosphate sampling data at the two sampling points is shown in Figure 11. The data show a slight seasonal fluctuation in orthophosphate concentration, with lower concentrations in winter and higher concentrations in summer with occasional high peaks. The peaks occur both upstream and downstream of Nenagh WWTP and concentrations are similar at both locations. There is no trend in the data over time, allowing for use of the entire monitoring record in calculating water quality statistics for the present day. Despite the slight seasonal pattern in river orthophosphate concentrations, there is no correlation between river flow at Tyone and river orthophosphate concentration ($R^2 = 0.012$).

The timeseries of dissolved oxygen saturation at the two sampling points is shown in Figure 12. As with orthophosphate, the data show a slight seasonal fluctuation, with lower dissolved oxygen saturation in winter and higher saturation in summer. The dissolved oxygen saturation is extremely similar at both sites, showing that the Nenagh WWTP discharges do not currently impact on supporting river chemistry sufficiently to change the overall dissolved oxygen profile between the two monitoring locations. The monitored data is almost always between the EQS range of 80-120% (Section 2.1.2) with 95%ile values of 103.0 upstream and 102.3 downstream. showing no environmental impact in terms of this parameter.

Timeseries data for pH are not presented here due to the extremely limited range of values observed at both monitoring points. The mean pH at RS25N010605 is 7.98 and the mean at RS25N010620 is 7.96. This complies with requirements for pH in rivers under the Surface Waters Regulations and shows no significant change either side of Nenagh WWTP discharge point. There is no trend in pH over time.

Figure 11: Orthophosphate Monitoring Data for the Nenagh River at Nenagh WWTP

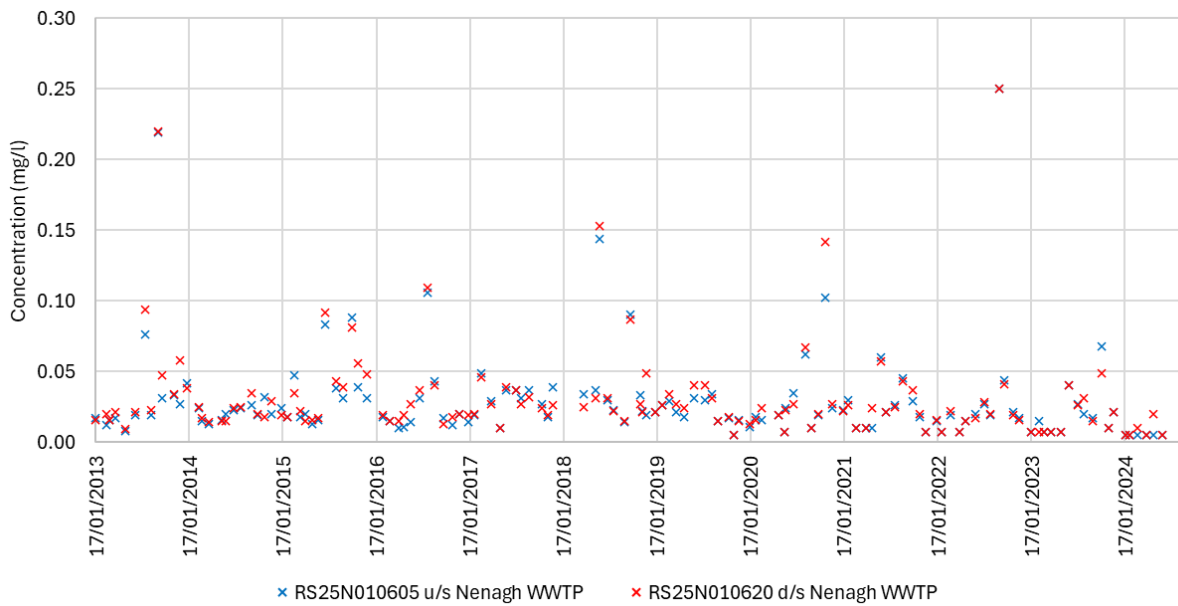
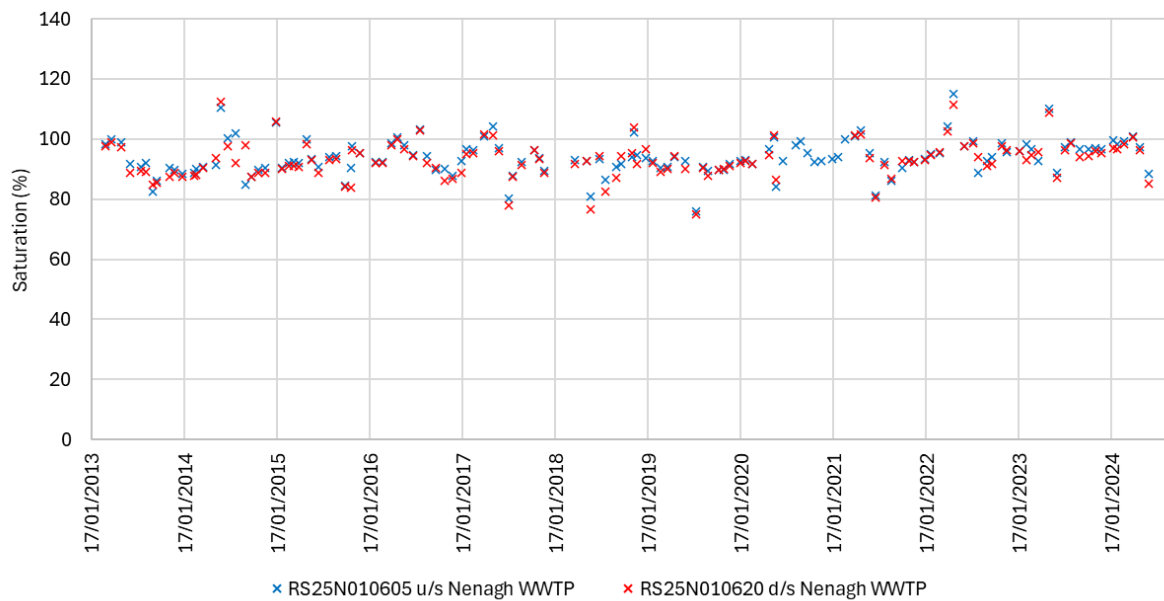


Figure 12: Dissolved Oxygen Monitoring Data for the Nenagh River at Nenagh WWTP



4.3 Ambient Water Quality Data

Table 8 sets out the overall water quality statistics for the Nenagh River upstream and downstream of Nenagh WWTP discharge point. Statistics are provided for mean and 95%ile quality for comparison with EQS under the Surface Water Regulations. Values which comply with requirements for high indicative quality are coloured in blue, values which comply with requirements for good indicative quality are coloured in green and values which exceed the good status EQS are highlighted in orange.

The difference in water quality statistic values between the upstream and downstream monitoring points at Nenagh WWTP is generally small and there is no significant change in pH or dissolved oxygen concentration.

The EQS for good status for BOD is exceeded for both the mean and 95%ile condition at both the upstream and downstream locations. The 95%ile EQS for good indicative quality for orthophosphate is likewise exceeded at both locations, although the mean orthophosphate concentrations meet good indicative quality and both upstream and downstream monitoring points. The 95%ile EQS for ammonia is also exceeded at both points with concentrations failing to meet requirements for good indicative quality. With regards to mean ammonia concentrations, the upstream point complies with requirements for good indicative quality while the mean at the downstream location fails to meet requirements for the good indicative quality.

Table 8: Water Quality Sampling Point Statistics

Substance	RS25M010605		RS25M010620	
	Mean	95%ile	Mean	95%ile
pH	7.98	n/a	7.96	n/a
Ammonia (mg/l)	0.060	0.235	0.080	0.262
BOD (mg/l)	1.847	2.840	1.951	3.000
Orthophosphate (mg/l)	0.029	0.084	0.031	0.088
Dissolved Oxygen (% saturation)	n/a	103.0	n/a	102.3

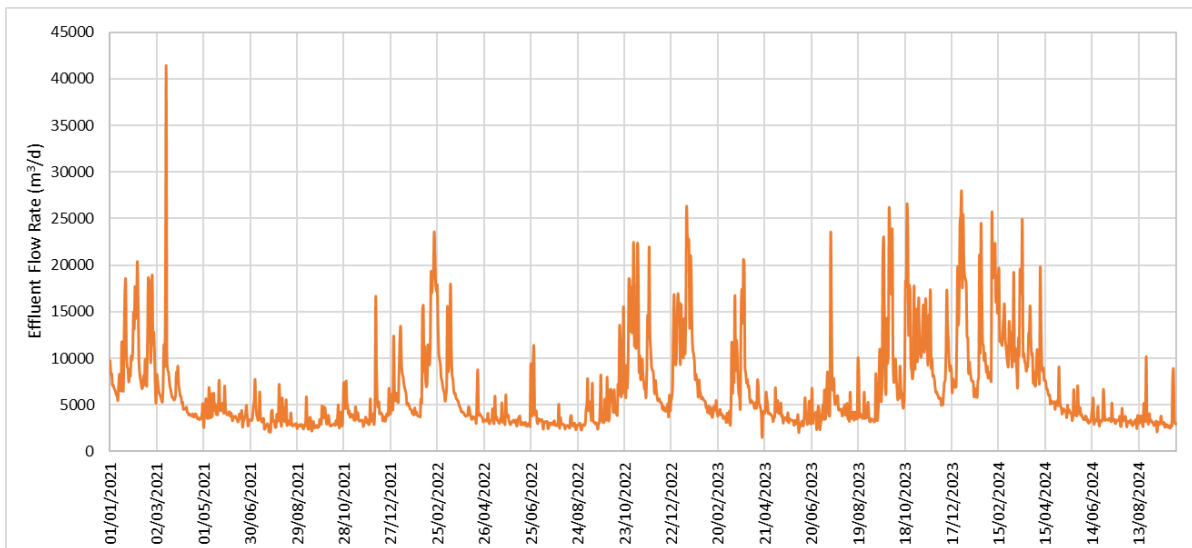
Since the mean and/or the 95%ile EQS concentration for good status is exceeded at the upstream location for all three nutrients, ELVs cannot be set for effluent from the proposed new Nenagh WWTP which would secure compliance with good status at the downstream point. This is due to upstream catchment pressures on water quality. As a result, the proposed ELVs shall be calculated with reference to the notionally clean condition as described in Section 2.4.

5 Nenagh WWTP Effluent Flow and Quality Data

5.1 Effluent Flow Data

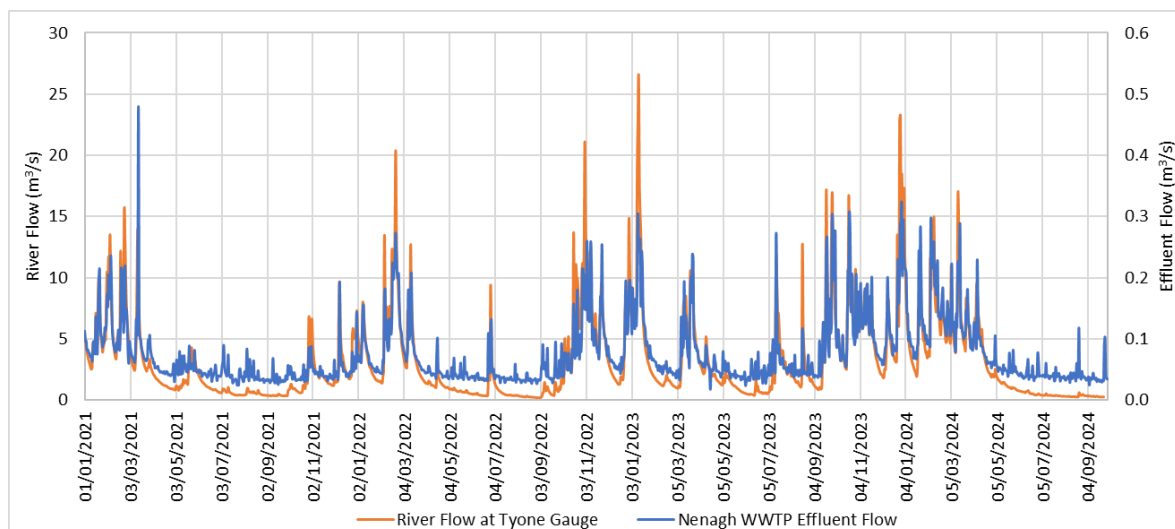
Figure 13 shows the daily flow rate data for Nenagh WWTP from January 2021 to September 2024. The observed mean effluent flow is 6,498m³/d (75.2l/s) with a minimum flow rate of 1,500m³/d and a maximum flow rate of 41,387m³/d.

Figure 13: Nenagh WWTP Effluent Flow Timeseries



Flows in the Nenagh River at Tyone gauge show a strong correlation with the flows monitored at Nenagh WWTP (Figure 14, R² = 0.7626). Note that the effluent flows in Figure 14 are plotted on a separate y-axis and do not exceed river flows. The correlation between river and effluent flow is likely due to rainwater and groundwater ingress into the Nenagh sewerage system during times of wet weather, during which river flows are also increased. This correlation will need to be taken into account in the water quality impact assessment because average to high effluent flow rates will only be seen during times of average to high river flow rates.

Figure 14: Daily Mean River Flow at Tyone Gauge and Nenagh WWTP Effluent Flow Timeseries



The new Nenagh WWTP has been designed to allow for growth in the agglomeration and commensurate an increase in effluent flow rates. The design horizon includes a projected increase in population served by the WWTP from the current population equivalent of 12,000 to a population of 22,000 over the next 30 years. The anticipated increase in future dry weather (Q_{80}) effluent flow is given in Table 9 along with the mean flow anticipated under this scenario; the mean flow has been calculated by applying the dry weather flow scaling factor to the entire observed effluent flow dataset in the Monte Carlo analysis in Section 6.3 and capping the future maximum effluent flow rate. The maximum flow rate will be limited to 20,200m³/d under the future design scenario by the provision of significantly greater pumping station capacity and stormwater storage at the new WWTP.

Table 9: Current and Future Design Effluent Flow Rates

Design Horizon	Current		30-year	
PE Served	12,000		22,000	
Effluent Flow Rates	m ³ /d	l/s	m ³ /d	l/s
Current Observed Dry Weather Flow (Q_{80})	3,265	38		
Predicted Future Dry Weather Flow (Q_{80})			6,732	78
Current Observed Mean Flow	6,500	75		
Predicted Future Mean Flow			11,059	128
Current Observed Maximum Flow	41,387	479		
Predicted Future Maximum Flow			20,200	255

5.2 Effluent Quality

Figures 15, 16 and 17 show the observed effluent quality data in terms of ammonia, BOD and orthophosphate concentration. The data show an increase in ammonia in 2023 but a steady reduction in BOD concentration while effluent orthophosphate concentrations remain stable. There is some uncertainty in the actual concentration of orthophosphate in Nenagh WWTP effluent in 2024 because concentrations were very low compared to typical treated effluent orthophosphate concentrations and all but one sample in 2024 returned concentrations of orthophosphate below a LOD of 0.16mg/l. These samples have been assigned proxy values of 0.08mg/l in Figure 17 and in statistical analysis, but based on data recorded between 2021 and 2023, actual concentrations are likely to have been below this value. Very high ammonia concentrations were recorded twice in 2024 – these do not correspond to extreme effluent flow rates which would reflect a stormwater inflow and may reflect short term pollution events.

Table 10 compares the average effluent concentration of substances limited by ELVs in Section 2.1.1 against observed 2021-2024 averages. Nenagh WWTP complied with all relevant ELVs during this time period. There is no correlation between effluent flow rate and effluent concentrations of ammonia ($R^2=0.020$), BOD ($R^2 = 0.0002$) and orthophosphate concentrations ($R^2=0.002$) showing that Nenagh WWTP functions well under the observed range of effluent flow conditions.

Figure 15: Nenagh WWTP Effluent Ammonia Concentrations

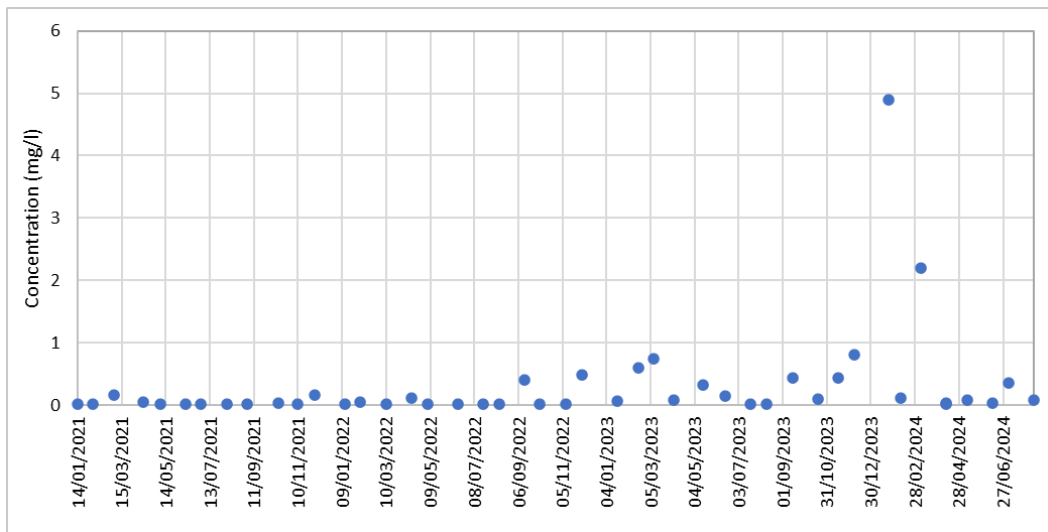


Figure 16: Nenagh WWTP Effluent BOD Concentrations

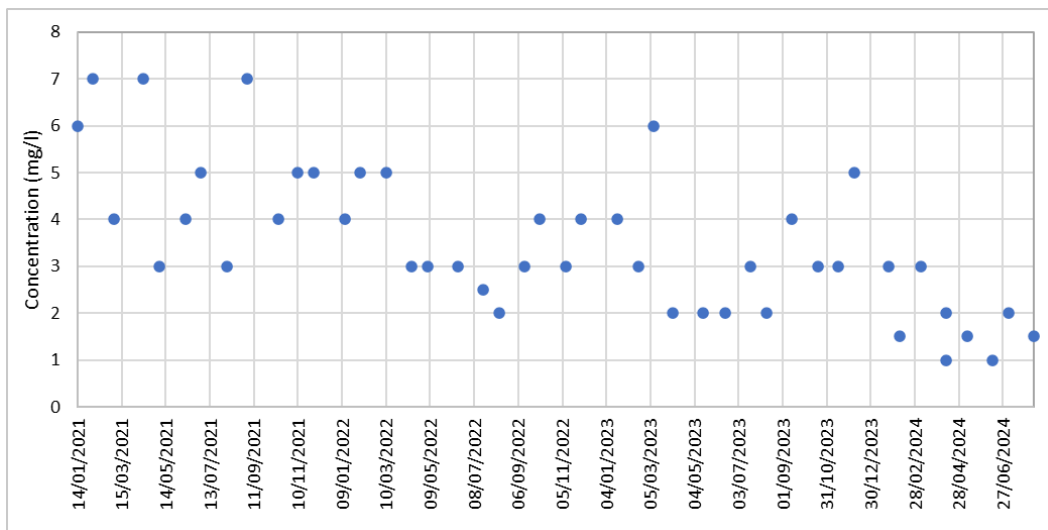


Figure 17: Nenagh WWTP Effluent Orthophosphate Concentrations

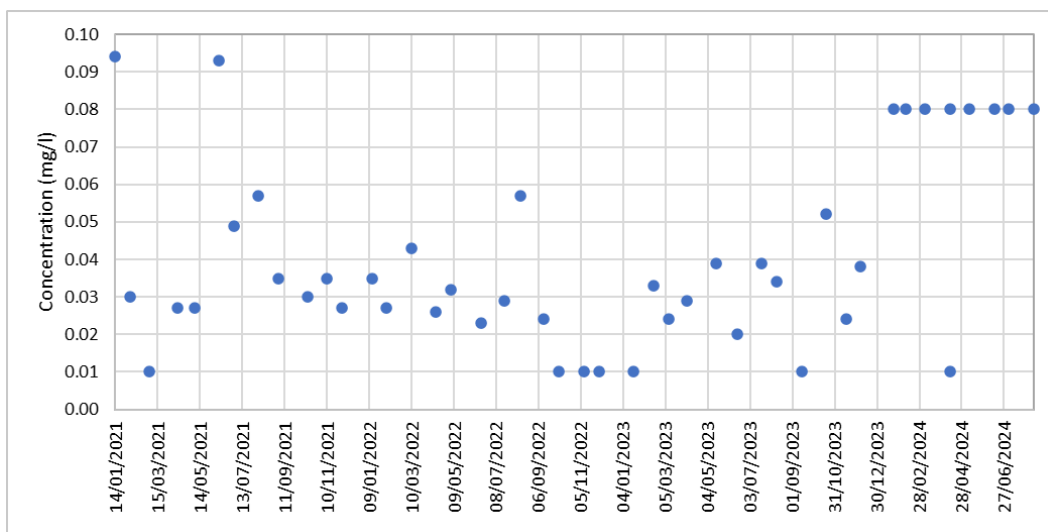


Table 10: Summary of Nenagh WWTP Effluent Quality Data

Parameter	2021-2024 Nenagh WWTP (Mean)
COD (mg/l)	21.38
BOD (mg/l)	3.49
Suspended Solids (mg/l)	13.85
pH	7.55
Ammonia (mg/l)	0.30
Orthophosphate (mg/l)	0.04
Total Phosphorus (mg/l)	0.21

6 Tiered Assessment

The Tiered Assessment approach outlined in Section 1.1 has been applied to the Nenagh WWTP discharge in the Sections below.

6.1 Tier 0 and 1 Assessments

The Tier 0 and 1 Assessments are initial screening checks to identify substances which require impact assessment. The stages are as follows:

- **Tier 0:** check to see if the effluent is likely to contain a contaminant of concern. If so, check to see if the contaminant is present at levels above the EQS.
- **Tier 1:** Check to see if discharging the contaminant(s) of concern at levels above the EQS are likely to have a significant impact on the receiving waterbody given existing ambient concentrations.

Based on review of the legislative framework in Section 2, substances of concern in Nenagh WWTP final treated effluent are ammonia, BOD, orthophosphate and pH. Table 12 compares average effluent, ambient and EQS concentrations of the substances of concern.

Table 11: Effluent, Ambient and EQS Concentrations of Substances of Concern

Parameter	Mean Effluent Concentration	Mean Ambient Concentration (RS25N010605)	Environmental Quality Standard
Ammonia (mg/l)	0.30	0.060	0.065
BOD (mg/l)	3.49	2.840	1.50
Orthophosphate (mg/l)	0.040	0.029	0.035
pH	7.55	7.98	6-9

Table 11 shows that effluent concentrations of ammonia, orthophosphate and BOD exceed both ambient and EQS concentrations at the existing Nenagh WWTP. This is likely to continue at the new WWTP and so these substances will require additional assessment at Tier 2. The pH of the effluent is, and will remain, within the permitted EQS range for rivers and this parameter is therefore screened out at Tier 0.

6.2 Tier 2a Assessment

An initial assessment of the downstream water quality impacts of the Nenagh WWTP discharge has been made using the simple mass balance approach as set out in Section 1.1.1. Following the methodology of the Uisce Éireann Mass Balance Tool UÉ-AMT-FM-007 downstream mean and 95%ile water quality are predicted based on mean upstream river quality, current mean effluent flow rates and current mean effluent concentrations. The difference between the two calculations is the use of Q_{30} average river flows to predict mean downstream water quality and the Q_{95} low river flow to predict 95%ile downstream water quality. The predicted water quality is compared with observed values in Table 12.

Table 12: Downstream Water Quality Statistics Predicted Using Simple Mass Balance Approach

Parameter	Statistic	Upstream Observed	Downstream Predicted	Downstream Observed
Ammonia (mg/l)	Mean	0.060	0.065	0.080
	95%ile	0.235	0.095	0.260
BOD (mg/l)	Mean	1.847	1.880	1.951
	95%ile	2.840	2.270	3.000
Orthophosphate (mg/l)	Mean	0.029	0.029	0.031
	95%ile	0.084	0.031	0.088

The results in Table 12 show that the simple mass balance approach underestimates downstream mean water quality for ammonia and BOD and gives a significant underestimate of downstream 95%ile water quality for all three parameters. This is because this approach has a very simplified representation of upstream river water quality which is the controlling influence on downstream water quality at this site. As discussed in Section 4, the discharges from Nenagh WWTP have limited impact on downstream water quality under the current scenario.

The simple mass balance approach can be used to calculate ELVs which would give a required downstream water quality corresponding to take-up of the intended percentage of the watercourse’s wastewater assimilative capacity (Section 2.4) and taking account of the future increases in flow in Section 5.1. Table 13 gives the ELVs required to deliver good indicative quality downstream of the existing discharge point, based on notionally clean upstream water quality and using 40% of the available WAC.

Table 13: Required ELVs Calculated Using Simple Mass Balance Approach

Parameter	Required ELV (Simple Mass Balance Approach), 30-year Design Horizon
Ammonia (mg/l)	0.27
BOD (mg/l)	4.9
Orthophosphate (mg/l)	0.14

The ELVs calculated using the simple mass balance approach would be difficult to guarantee using current best available treatment technologies. In addition, the simple mass balance approach gives poor predictions of downstream 95%ile water quality (Table 12) and does not take account of the correlation between effluent flow rates and river flow rates (Section 5.1). To ensure that the additional wastewater treatment required for the future development at Nenagh provides cost-effective and proportionate protection of receiving water quality, the water quality impact of the discharge has been further simulated using a Monte Carlo analysis (Tier 2b).

6.3 Tier 2b Assessment

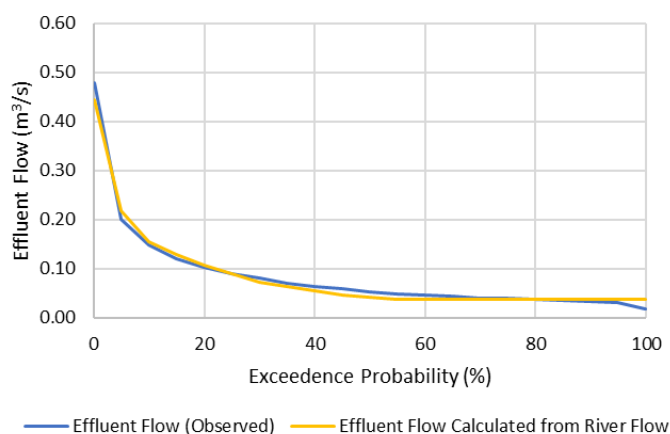
6.3.1 Monte Carlo Simulation of Current Downstream Quality

Additional analysis of the water quality impacts of the Nenagh WWTP discharges were carried out using the methodology of the Uisce Éireann Monte Carlo Tool UÉ-AMT-FM-008. This analysis method provides a more comprehensive representation of the range of upstream water quality, as well as allowing for representation of the correlation between effluent flow rates and river flows rates. This method allows for direct calculation of downstream water quality statistics at RS25N010620 which can then be compared with observed data.

The following data was used for the Monte Carlo analysis:

- River water flow data is taken from the Tyone gauge. A 1.05 multiplication factor was applied to the river flow data when simulating downstream water quality at Nenagh WWTP to account for the additional catchment area between the gauge, the outfall and the downstream sampling point.
- Effluent flow is scaled from river flow using the observed ratio between Q_{30} river and mean effluent flow rates. The effluent flow rates under the existing baseline scenario are restricted to within the observed Q_{80} dry weather flow of 37.8l/s and the observed maximum effluent flow rate of 479l/s, but otherwise vary in line with river flows. This simulates the strong correlation between effluent flow rates and river flows rates at this site and also gives an extremely good fit to the observed probability distribution of effluent flow rates at this site (Figure 18).

Figure 18: Observed Effluent Flow Duration Curve and Effluent Flow Duration Curve Used in Monte Carlo Analysis



- The entire record of observed effluent BOD and orthophosphate data in Section 5.2 have been used to simulate the range of effluent quality produced by the current treatment processes at Nenagh WWTP. The entire record of observed ammonia data has also been used except for the high value of 4.9mg/l seen in January 2024. This is an extreme and short-lived event which is not representative of normal WWTP operation. A downstream river quality sample corresponding to this event is not available and the water quality impacts of this sort of pollution event are not represented in the available ambient record.
- The entire ambient data series presented in Section 4 have been used as observed upstream and downstream river quality data. No edits were required for these datasets.

The upstream observed, downstream observed and simulated downstream water quality are shown in Figures 19 to 21. The combination of model set-up and input data is capable of predicting downstream river water quality to within 10% for both mean and 95%ile statistics for all three parameters (Table 14). This shows that the Monte Carlo analysis method gives a good simulation of water quality in the Nenagh River over the full range of conditions and appropriately represents the impact of the existing Nenagh WWTP discharges. This analysis method can be used to calculate ELVs which will provide the required mean and 95%ile water quality downstream of the new Nenagh WWTP under future design scenarios.

The analysis also shows minimal difference between upstream and downstream river water quality which is consistent with observed data and statistics in Section 4.

Table 14: Comparison Between Predicted and Observed Downstream Water Quality (Monte Carlo Analysis Method)

	Observed Downstream Water Quality		Simulated Downstream Water Quality		% Error from Observations	
	Mean (mg/l)	95%ile (mg/l)	Mean (mg/l)	95%ile (mg/l)	Mean (%)	95%ile (%)
Ammonia	0.080	0.262	0.077	0.258	-3.8	-1.7
BOD	1.951	3.000	1.916	2.918	-1.8	-2.8
Ortho-P	0.031	0.088	0.031	0.089	0.0	0.9

Figure 19: Simulated and Observed Ammonia Concentrations in the Nenagh River at Nenagh WWTP

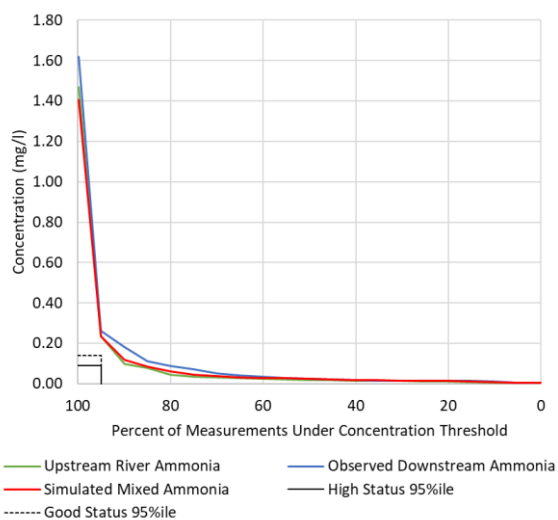


Figure 20: Simulated and Observed BOD Concentrations in the Nenagh River at Nenagh WWTP

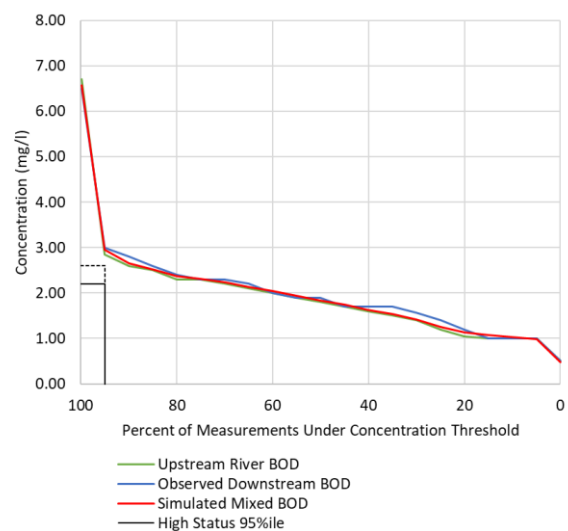
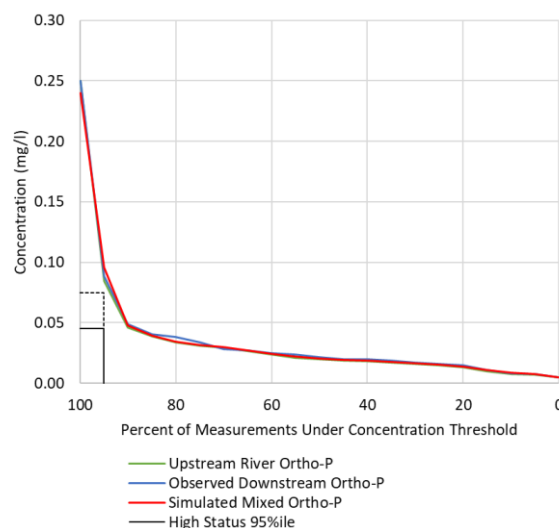


Figure 21: Simulated and Observed Orthophosphate Concentrations in the Nenagh River at Nenagh WWTP



6.3.2 Calculation of ELVs

The Monte Carlo Analysis tool uses a goal seek methodology to adjust the probability distribution for effluent quality up or down until a certain downstream quality statistic is achieved. The calculation is carried out using the future effluent flow rates in Table 9, with maximum future effluent flow rates limited to 255l/s and notionally clean upstream river conditions. The ELVs required at Nenagh WWTP

calculated by this method are set out in Table 15. The ELVs are higher (more relaxed) compared to those calculated using the simple mass balance approach and will be achievable using established treatment technologies. Utilising these ELVs therefore allows a more reliable, cost-effective and proportionate approach to wastewater management while still providing the required protection of receiving water quality, in line with the “Polluter Pays” principle.

Table 15: ELVs Required for Nenagh WWTP from Monte Carlo Analysis Method

Parameter	Required ELV (Monte Carlo Approach, 30-year Design Horizon)
Ammonia	0.8
BOD	13
Ortho-P	0.3

The Tier 2 assessment methods show that achievable ELVs can be applied to the discharge and sensitive receptors are will not be impacted. Additional analysis of the mixing zone at Tier 3 is therefore not required.

6.4 Mass Emissions Loading Assessment

As discussed in Section 2.1.3, in some circumstances the Environmental Protection Agency has commenced setting ELVs based on the annual mass of orthophosphate emitted by a WWTP to a river waterbody.

Mass Emission Limits (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.

The method used by the Environmental Protection Agency to set MELs has varied between sites and settings. In addition, methods used to calculate and report against MELs vary between sites.

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 2.
- 2) The allowable annual assimilative capacity is calculated based on Environmental Sensitivity Score in accordance with Uisce Éireann’s Technical Guidance for Water Quality Impact Assessment (Freshwaters) UE-AMT-GL-028
- 3) The ELV equivalent to the allowable annual assimilative capacity is calculated using future average effluent flow rates (Equation 3).

- 4) Final ELV values are selected based on the stricter of the two ELVs for each parameter 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.

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Equation 2: Calculation of Total River Assimilative Capacity.

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

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

C_{river} = upstream mean orthophosphate concentration

\bar{Q}_r = mean river flow

Equation 3: Calculation of Annual Mass Emissions Limit.

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

Where: MEL = Mass Emissions Limit

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

Table 16 sets out the values used in Equation 2 for calculating the total river assimilative capacity of the Nenagh River at Nenagh WWTP. As with the ELV calculations above, the upstream water quality has been set based on notionally clean water quality statistics and the downstream water quality has been set for each parameter based on compliance with the EQS for good indicative quality. The average river flow at Nenagh WWTP has been calculated from the river flow timeseries data in Figure 5.

Table 16. Calculation of Total River Assimilative Capacity for Setting MEL Values.

Parameter	EQS_{AA} (mg/l)	C_{river} (mg/l)	River Flow (m ³ /s)	River Assimilative Capacity (kg/yr)
Ortho-P	0.035	0.005	3.66	3,464

Based on the values in Table 16, the MEL for orthophosphate at Nenagh WWTP is calculated in accordance with allowable assimilative capacity based on the Environmental Sensitivity Score of 9, which sets out maximum allowable assimilative capacity of 40% under notionally clean conditions. Taking this in account, the Mass Emission Limit (MEL) was calculated as 1,386kg/year.

Table 17 sets out the ELV required at Nenagh WWTP to comply with this MEL (see Equation 3). The values is above the ELV required to deliver compliance with the EQS for good indicative quality downstream of Nenagh WWTP, as calculated in Section 6.3.2.

Table 17. ELVs Required at Nenagh WWTP to Comply with Mass Emission Limits.

Substance	30 year Design Horizon		
	Effluent Flow Rate (m ³ /s)	Equivalent ELV (mg/l)	Annual Mass Emission (kg/yr)
Orthophosphate	0.122	0.36	1,385

7 Summary and Conclusions

Nenagh WWTP discharges treated wastewater to the Nenagh River at Nenagh, a short distance upstream of the confluence with the Ollatrim River. It is proposed to replace the WWTP and the new WWTP will have significantly greater design capacity and additional stormwater management assets.

A water quality impact assessment has been carried out in accordance with Uisce Éireann's Technical Guidance⁷ to determine the current water quality impacts of the discharge and to calculate the required ELVs for the new WWTP which will protect the receiving water quality under the 30-year design horizon future loading scenario, recognising the requirements of the legislative framework. In addition, this assessment has calculated MEL values which limit the annual orthophosphate loading to below the calculated annual allowable assimilative capacity of the receiving watercourse.

The water quality of the Nenagh River upstream of the WWTP currently fails to comply with good status requirements and therefore the “notionally clean” approach has been applied at this site to account for upstream pressures on water quality and to allow an assessment of the impacts of the WWTP discharges in accordance with the ‘Polluter Pays’ principle of the Water Framework Directive.

The Water Quality Impact Assessment utilised a tiered approach with initial screening at Tiers 0 and 1 followed by simple mass balance calculations at Tier 2. The simple mass balance approach produced non-representative estimates of downstream 95%ile water quality and resultant ELVs which could not be guaranteed using best available treatment technologies. Therefore the more comprehensive Monte Carlo methodology was applied to provide more representative assessment of the impact on downstream water quality.

The Monte Carlo methodology required a detailed review of river flow statistics, effluent flow statistics, ambient upstream and downstream river quality data and effluent quality data, along with cross-correlation analysis. Following comprehensive review of the available data, probability distribution curves were calculated for each variable and used in Monte Carlo analysis with adjustments to account for correlation between effluent flow rates and river flow rates. The Monte Carlo method was shown to be capable of closely reproducing both mean and 95%ile observed downstream quality and the model set-up and input data are therefore considered to be robust and suitable for calculation of ELVs. The data review and analysis also confirmed that the existing discharges from Nenagh WWTP have minimal impact on downstream water quality.

⁷ Interim Technical Guidance for Water Impact Assessments (Freshwater) Document No. AMT-GL-028).

The Monte Carlo analysis method was then used to calculate ELVs which take an appropriate percentage of the available assimilative capacity in the river, given upstream water quality and the sensitivity of the receiving environment. The calculation is carried out using effluent flows which have been specified to represent the future design capacity of the WWTP and the proposed ELVs calculated are shown in Table 18. The ELVs from the Monte Carlo analysis method ensure the discharge will be compatible with the achievement of WFD objectives and the achievement of Conservation Objectives for Natura 2000 sites.

Table 18: Required ELVs at Nenagh WWTP (using Monte Carlo and Mass Emission Limit Approaches)

Proposed Nenagh WWTP ELVs (30-year Design Horizon)		
Parameter	ELV (m/g)	Mass Emission Limit (kg/yr)
Ammonia	0.8	n/a
BOD	13	n/a
Orthophosphate	0.3	1,386

8 APPENDIX A – Annual River Flow Statistics

Annual River Flow Statistics for the Nenagh River at Tyone

Year	% missing	Flow (m ³ /s)												
		Max	Min	Q ₅	Q ₁₀	Q ₂₀	Q ₃₀	Q ₄₀	Q ₅₀	Q ₆₀	Q ₇₀	Q ₈₀	Q ₉₀	Q ₉₅
1990	8	18.3	0.28	10.0	7.67	5.95	4.15	3.21	2.41	1.68	0.85	0.61	0.38	
1991	0	18.1	0.49	8.77	6.76	4.57	3.32	2.77	2.34	2.01	1.61	1.23	0.74	0.57
1992	2	11.6	0.45	8.89	7.45	4.64	3.33	2.59	1.84	1.35	1.10	0.91	0.60	0.53
1993	10	20.5	0.43	11.9	9.93	8.14	6.41	4.42	2.83	1.50	0.82	0.56	0.43	
1994	8	26.7	0.24	13.0	9.50	6.40	4.28	2.66	1.43	0.98	0.51	0.33	0.24	
1995	9	24.4	0.25	9.58	6.82	4.56	3.08	2.17	1.61	1.07	0.54	0.40	0.32	
1996	11	33.0	0.58	10.2	8.42	6.14	4.11	2.71	2.10	1.63	1.30	0.87		
1997	15	20.6	0.92	10.7	7.72	5.36	3.56	2.90	2.42	1.72	1.41	1.21		
1998	7	20.0	0.52	11.7	9.27	6.47	4.60	3.21	2.23	1.76	1.29	0.79	0.58	
1999	0.3	24.6	0.49	9.98	7.39	4.99	3.36	2.07	1.66	1.33	1.07	0.86	0.59	0.54
2000	0	20.3	0.45	10.4	7.96	5.98	4.44	3.44	2.34	1.58	0.85	0.60	0.52	0.49
2001	0	20.8	0.55	11.4	8.43	5.19	3.91	2.78	2.19	1.83	1.50	1.27	0.94	0.70
2002	11	20.4	0.55	7.88	5.98	4.17	2.94	2.15	1.70	1.30	0.98	0.77		
2003	0	13.9	0.47	7.68	5.45	3.33	2.41	1.93	1.53	1.14	0.85	0.66	0.54	0.50
2004	0	28.6	0.64	9.22	7.00	5.08	3.50	2.90	2.43	1.96	1.47	1.11	0.87	0.76
2005	0	20.9	0.51	10.3	7.61	5.01	3.68	2.98	2.38	1.97	1.61	0.98	0.58	0.54
2006	0	21.1	0.53	13.3	10.4	7.54	6.12	4.70	3.38	2.44	1.83	1.24	0.76	0.62
2007	1	25.1	0.62	15.0	12.0	8.00	5.51	3.66	2.79	2.07	1.45	1.10	0.93	0.80
2008	2	22.9	0.89	9.00	7.41	5.88	4.35	3.41	2.57	1.93	1.50	1.30	1.09	1.00
2009	0	29.1	0.37	11.3	7.66	4.84	3.19	2.32	1.71	1.26	0.94	0.66	0.54	0.43
2010	0	22.2	0.44	9.00	6.31	3.16	2.06	1.57	1.36	1.21	1.03	0.87	0.71	0.58
2011	11	23.2	0.37	9.90	8.39	6.35	4.71	3.77	3.14	2.59	2.05	1.68		
2012	0	17.7	0.34	7.66	6.46	4.46	3.33	2.58	1.99	1.61	1.07	0.54	0.41	0.37
2013	0	25.2	0.33	13.5	10.1	6.53	4.06	3.07	2.02	1.31	0.84	0.51	0.41	0.38
2014	0	19.6	0.33	8.98	7.20	4.99	3.72	2.60	1.89	1.39	0.81	0.55	0.41	0.39
2015	0	23.9	0.34	13.9	10.9	7.11	4.32	2.96	1.86	1.33	1.06	0.84	0.55	0.41
2016	8	14.4	0.37	5.02	4.07	2.70	2.25	1.71	1.28	1.03	0.80	0.53	0.40	
2017	0	21.3	0.25	10.8	7.73	5.24	3.86	3.07	2.40	1.69	0.73	0.39	0.31	0.27
2018	0	22.2	0.31	8.91	7.16	4.11	2.82	2.07	1.64	1.10	0.74	0.54	0.37	0.35
2019	0	24.1	0.36	13.9	10.7	7.12	5.16	3.82	2.94	1.77	1.16	0.88	0.63	0.43
2020	0	18.1	0.36	10.4	8.24	5.58	4.57	3.49	2.49	1.41	0.95	0.65	0.42	0.39
2021	0	20.4	0.21	7.58	5.82	3.48	2.13	1.64	1.33	0.99	0.72	0.50	0.38	0.28
2023	0	26.5	0.41	11.2	9.03	6.77	4.74	3.16	2.29	1.82	1.50	1.20	0.83	0.58
2023	2	23.3	0.27	10.9	8.29	6.70	5.49	4.14	2.85	1.61	0.68	0.40	0.32	0.29

Annual River Flow Statistics for the Ollatrim River at Gourdeen

Year	% missing	Flow (m³/s)												
		Max	Min	Q ₅	Q ₁₀	Q ₂₀	Q ₃₀	Q ₄₀	Q ₅₀	Q ₆₀	Q ₇₀	Q ₈₀	Q ₉₀	Q ₉₅
1972	0	8.69	0.23	3.97	3.37	2.50	1.64	1.19	0.92	0.62	0.52	0.41	0.32	0.27
1973	0	17.0	0.24	8.03	6.26	3.86	2.74	1.92	1.54	1.08	0.70	0.54	0.38	0.33
1974	0	8.76	0.17	5.02	3.32	2.13	1.67	1.07	0.64	0.47	0.40	0.34	0.20	0.18
1975	0	5.31	0.16	2.56	1.92	1.52	1.25	1.03	0.85	0.58	0.44	0.32	0.26	0.19
1976	0	8.95	0.27	3.71	3.03	2.36	1.96	1.63	1.35	0.89	0.55	0.40	0.33	0.31
1977	0	11.3	0.19	6.37	5.12	3.62	2.92	2.46	2.05	0.98	0.61	0.47	0.30	0.25
1978	0	12.1	0.19	5.33	3.96	2.90	2.30	1.95	1.65	1.19	0.62	0.51	0.43	0.39
1979	0	9.67	0.36	6.70	5.41	4.23	3.36	2.87	2.38	1.84	1.17	0.79	0.62	0.54
1980	0	9.39	0.27	5.86	4.81	3.86	3.15	2.64	2.13	1.67	1.06	0.78	0.46	0.37
1981	0	10.9	0.43	7.06	5.68	4.29	2.81	1.96	1.34	1.04	0.85	0.67	0.48	0.46
1982	0.0	11.2	0.39	7.15	5.87	4.80	3.92	3.11	2.55	2.09	1.59	0.82	0.54	0.47
1983	0	12.3	0.23	7.61	5.96	3.63	2.54	1.89	1.19	0.70	0.52	0.38	0.29	0.28
1984	0	8.30	0.27	4.39	3.51	2.84	2.36	1.98	1.62	1.39	1.24	1.09	0.61	0.54
1985	10	11.6	0.67	5.38	4.21	2.70	2.28	1.97	1.65	1.36	1.17	1.04	0.27	
1986	0	10.7	0.30	5.55	4.14	2.87	2.20	1.72	1.37	0.92	0.72	0.58	0.48	0.37
1987	3	10.5	0.50	6.49	5.11	2.73	1.90	1.47	1.24	1.05	0.92	0.79	0.66	0.53
1988	0	9.95	0.23	4.22	3.44	2.72	2.28	1.98	1.66	1.08	0.64	0.42	0.28	0.26
1989	0	16.6	0.20	7.24	5.12	2.38	1.57	1.01	0.56	0.44	0.39	0.32	0.28	0.26
1990	0	11.0	0.21	5.94	4.60	3.44	2.73	2.09	1.46	0.98	0.63	0.50	0.39	0.28
1991	6	10.4	0.29	4.36	3.52	2.59	2.15	1.82	1.59	1.27	0.93	0.60	0.44	
1992	0.8	11.7	0.38	5.45	4.66	3.33	2.38	1.99	1.60	1.20	1.01	0.63	0.49	0.42
1993	3	13.1	0.42	8.52	7.41	5.72	4.28	2.94	1.82	1.35	1.06	0.75	0.48	0.44
1994	4	15.3	0.11	8.53	6.31	3.68	2.79	1.83	1.00	0.59	0.37	0.28	0.21	0.14
1995	0.3	15.4	0.20	7.19	5.42	3.67	2.50	1.91	1.28	0.70	0.46	0.39	0.32	0.26
1996	0	21.5	0.29	6.23	4.71	3.50	2.67	2.20	1.79	1.52	1.25	0.98	0.74	0.65
1997	9	13.5	0.58	5.68	4.31	2.85	2.14	1.81	1.56	1.24	0.99	0.77	0.61	
1998	3	16.8	0.42	7.80	6.06	3.97	2.90	2.25	1.84	1.43	1.16	0.66	0.49	0.45
1999	4	17.0	0.42	6.30	4.25	2.92	2.14	1.56	1.27	0.97	0.78	0.57	0.49	0.43
2000	39	15.1	0.31	7.17	5.44	3.59	2.87	2.31	1.44	0.34				
2001	39	11.5	0.75	5.93	4.03	2.69	1.75	1.27	1.04	0.82				
2002	8	11.6	0.22	5.38	4.26	2.91	2.16	1.64	1.25	0.91	0.69	0.35	0.24	
2003	0	10.2	0.21	5.23	4.07	2.29	1.78	1.39	1.01	0.67	0.49	0.38	0.26	0.24
2004	0	20.2	0.28	5.29	4.32	2.95	2.14	1.65	1.36	0.98	0.77	0.49	0.39	0.34
2005	0	14.9	0.27	4.89	3.87	2.67	2.05	1.72	1.44	1.12	0.88	0.53	0.37	0.33
2006	0	16.4	0.28	9.06	6.59	4.57	3.58	2.95	2.05	1.40	1.06	0.82	0.53	0.41
2007	10	17.6	0.31	7.66	6.01	3.98	2.62	1.92	1.57	1.02	0.74	0.48	0.15	
2008	50	26.8	0.84	5.76	4.53	3.35	2.34	1.52	0.85					
2009	100													
2010	100													
2011	77	7.42		2.74	2.05	1.08								
2012	0	17.3	0.25	4.72	3.98	2.89	2.13	1.57	1.19	0.97	0.62	0.43	0.32	0.30
2013	3	24.2	0.33	10.8	6.84	4.22	2.55	2.09	1.37	0.94	0.62	0.46	0.39	0.36
2014	0	28.6	0.30	5.06	4.41	3.50	2.71	1.96	1.60	1.18	0.70	0.53	0.41	0.35
2015	0	25.9	0.31	9.78	7.19	4.43	2.93	1.90	1.11	0.84	0.68	0.54	0.46	0.37
2016	0.5	8.91	0.23	3.27	2.47	1.87	1.56	1.15	0.84	0.72	0.64	0.49	0.33	0.27
2017	62	20.7	0.62	3.77	2.37	1.40	0.92							
2018	57	4.26	0.21	1.37	0.86	0.62	0.38	0.26						
2019	0	17.9	0.28	8.78	6.48	4.34	3.14	2.31	1.86	1.25	0.82	0.52	0.37	0.33
2020	0	12.5	0.36	7.53	5.66	4.14	3.35	2.68	2.11	1.27	1.01	0.75	0.51	0.40
2021	0	13.8	0.27	4.95	3.76	2.50	1.70	1.37	1.17	0.93	0.66	0.54	0.38	0.32
2022	2	15.4	0.33	6.31	4.97	3.76	2.68	1.76	1.29	1.03	0.82	0.63	0.48	0.39
2023	11	15.2	0.23	7.53	5.70	4.60	3.76	2.96	2.33	1.42	0.67	0.38		