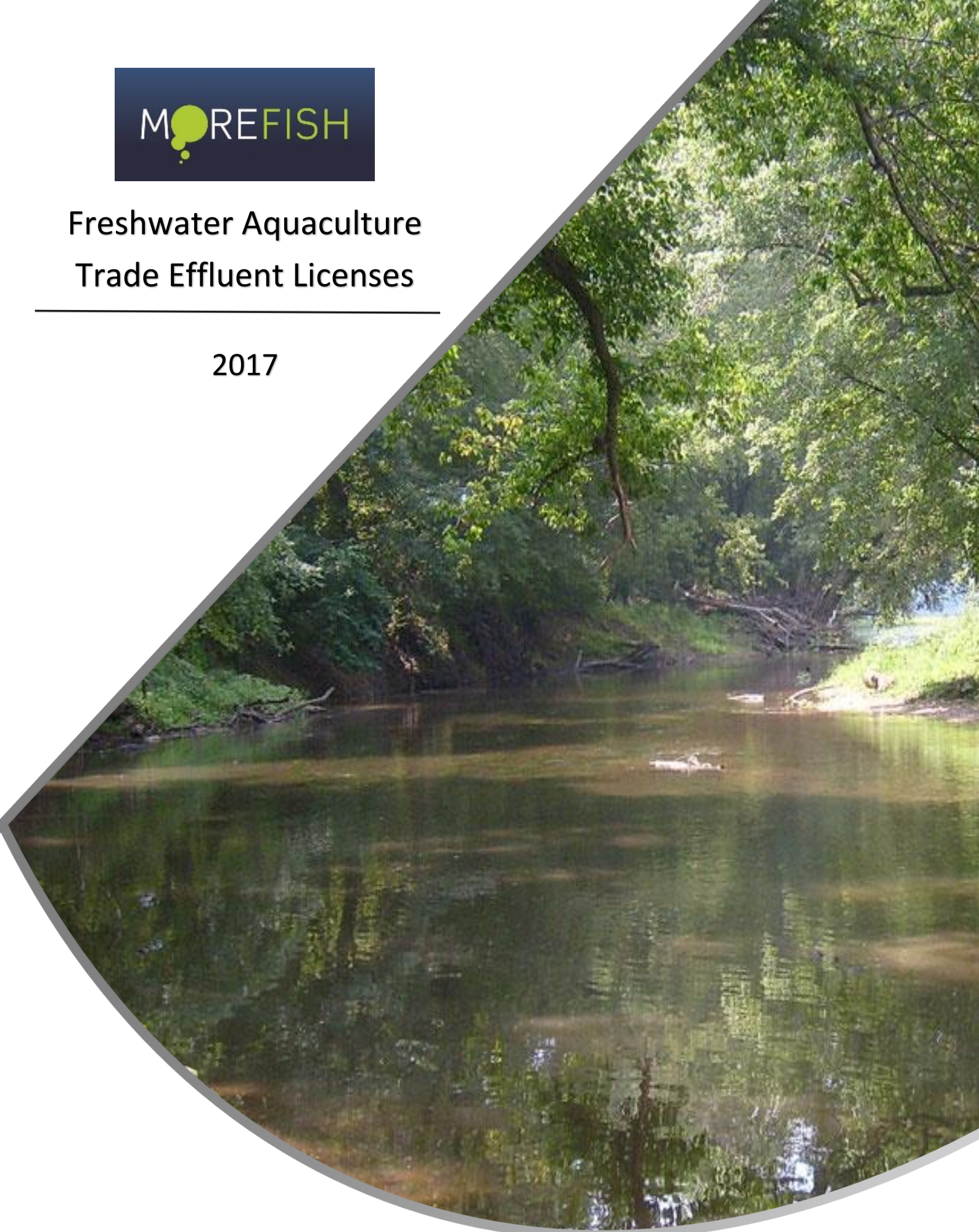




Freshwater Aquaculture Trade Effluent Licenses

2017



NUI Galway
OÉ Gaillimh



Department of
**Agriculture,
Food and the Marine**
An Roinn
**Talmhaíochta,
Bia agus Mara**



A Report on Freshwater Aquaculture Trade Effluent Licenses

MOREFISH

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Table of Contents

<i>List of Tables</i>	<i>i</i>
<i>List of Figures</i>	<i>i</i>
<i>Glossary</i>	<i>ii</i>
<i>Acknowledgements</i>	<i>ii</i>
<i>Executive Summary</i>	<i>iii</i>
1. Project Background	1
1.1. Scope of Review	1
1.2. Overview of Aquaculture in Ireland	3
2. Aquaculture Licencing.....	4
2.1. Discharge Licencing in Ireland	4
2.2. Emission Limit Calculations.....	8
3. Licences by River Basin District.....	8
3.1. Western River Basin District	10
3.2. South Western River Basin District.....	11
3.3. Shannon International River Basin District	11
3.4. North Western International River Basin District.....	12
3.5. Neagh-Bann International River Basin District.....	13
3.6. Eastern River Basin District	13
3.7. South Eastern River Basin District	14
4. Sampling Frequency.....	15
5. Remediation.....	15
6. Conclusions.....	16
References.....	18
Appendix A - Conditions which may be attached to a TEL as per Local Government (Water Pollution) Acts (1977-1990).....	19
Appendix B – S.I. 272 Conditions	21
Appendix C.....	23
Appendix D - Licences by River Basin District	26

List of Tables

Table 1: Outline of Local Authorities contacted as part of this review.	3
Table 2: The range of differential ELVs that are required to be met by RBD for ammonia and the year the licence was issued.	10

Appendix B

Table B 1: Thermal conditions specified in S.I. No. 272 of 2009.	21
Table B 2: Oxygenation conditions specified in S.I. No. 272 of 2009 (psu: The Practical Salinity Unit defines salinity in terms of a conductivity ratio of a sample to that of a solution of 32.4356 g of KCL at 15°C in 1 kg of solution. A sample of seawater at 15°C with a conductivity equal to this KCL solution has a salinity of exactly 35 practical salinity units).	21
Table B 3: Acidification Status specified in S.I. No. 272 of 2009 (Soft water is regarded as ≤ 100 mg/1 CaCO ₃ and hard water is regarded as having a hardness > 100 mg/1 CaCO ₃).	21
Table B 4: The nutrient conditions specified in S.I. No. 272 of 2009 (Total phosphorus (TP) is an important measure of lake trophic status and TP measurements are included as part of the lakes monitoring programme; TP boundary conditions are yet to be established for lakes).	22

Appendix D

Table D 1: The range of parameters for the 4 TELs received for the WRBD. These ELVs are differential concentrations between the influent and effluent waters for the farms with Farm WRBD-A being the only farm to use absolute concentration.	26
Table D 2: The range of parameters used in TELs in the SWRBD. Again, the ELVs are differential except for Farm SERBD-C which is an absolute value.	27
Table D 3: The range of parameters and their ELVs that freshwater aquaculture units must comply with in the SHIRBD. Farm SHIRBD-A is the only site which does not use a differential concentration.	28
Table D 4: The ELVs that were required for the two TELs received for the NWIRBD. The sites these were issued to are no longer in operation and are historic. Neither of these TELs used differential concentrations.	28
Table D 5: The conditions that are required to be met by the licence holders in the ERBD. The copies of the TELs received from the LA were dated from the 1990's and may not be the current licence with subsequent changes in environmental legislation. The ELVs are also based on differential concentration.	29
Table D 6: The conditions which are required by the LAs in the SERBD. The ELVs required by this LA are differential values based on the influent and effluent waters.	29

List of Figures

Figure 1: An overview of the freshwater aquaculture units which have had an aquaculture licence issued by the Department of Agriculture Food and the Marine.	2
Figure 2: A timeline of the origins of Irish aquaculture, the evolution of some of legislation, policy, research and reviews that shaped the conditions and parameters that must be met as part of an aquaculture licence and a trade effluent licence (TEL).	6
Figure 3: The current distribution of all active TELs in the Republic of Ireland. TELs associated with aquaculture are highlighted and account for 1.05% (See Glossary for details of RBD acronyms).	7
Figure 4: The volume of fish produced by freshwater aquaculture units in the Republic of Ireland, represented by River Basin District (BIM, 2016).	9
Figure 5: The locations within the Western River Basin District where aquaculture licences have been issued. .	11
Figure 6: The locations within the South Western River Basin District where aquaculture licences have been issued.	11

Figure 7: The locations within the Shannon International River Basin District where aquaculture licences have been issued.	12
Figure 8: The locations within the North Western International River Basin District where aquaculture licences have been issued.....	13
Figure 9: The locations within the Neagh Bann International River Basin District where aquaculture licences have been issued.....	13
Figure 10: The locations within the Eastern River Basin District where aquaculture licences have been issued.	14
Figure 11: The locations within the South Eastern River Basin District where aquaculture licences have been issued.	15
Figure 12: The sampling frequency with which licence holders must submit environmental monitoring samples to the LA.....	15

Glossary

BIM: Bord Iascaigh Mhara
BOD: Biological Oxygen Demand
DAFM: Department of Agriculture Food and the Marine
ELV: Emission Limit Value
EQS: Environmental Quality Standard
ERBD: Eastern River Basin District
FCL: Fish Culture Licence
LA: Local Authority
LASNTG: Local Authority Services National Training Group
NBIRBD: Neagh-Bann International River Basin District
NWIRBD: North Western International River Basin District
RBD: River Basin District
SERBD: South Eastern River Basin District
SHIRBD: Shannon International River Basin District
SWRBD: South Western River Basin District
TEL: Trade Effluent Licence
WFD: Water Framework Directive
WRBD: Western River Basin District
WSTG: Water Services Training Group
WWTP: Waste Water Treatment Plant

Acknowledgements

The MOREFISH project would like to acknowledge the input and assistance of external industry experts, Local Authority personnel and the EPA for the provision of the RPS abstractions and discharge report. If you would like to learn more about the MOREFISH project please see www.morefish.ie or contact morefish@nuigalway.ie

Executive Summary

MOREFISH is a collaborative project between NUI Galway and Athlone Institute of Technology and is funded by the Department of Agriculture Food and the Marine. The project addresses a number of critical challenges faced by the freshwater aquaculture sector. As part of this project the MOREFISH team undertook a review of Section 4 wastewater discharge licences, commonly referred to as Trade Effluent Licences (TELs).

The main objectives of this review were to:

- Analyse TELs issued for freshwater aquaculture sites.
- Determine the methods used by Local Authorities in producing a TEL for aquaculture units.
- Compare current and historic licences to determine if there has been a major change in the volumes of emissions that aquaculture units are permitted to discharge.

The main datasets consulted as part of this review were (i) land based aquaculture licences issued by the Department of Agriculture Food and the Marine and data regarding current and (ii) historic TELs from Local Authorities where an aquaculture licence was issued within their boundaries. In total, there are 27 freshwater sites in operation in the Republic of Ireland (BIM pers. comm). This review had access to 21 TELs. Of these 21, 13 were for sites currently regarded as in operation.

Based on the analysis of these TELs:

- Freshwater finfish aquaculture licences account for 1.05% of all active TELs.
- There is fragmentation in the updating of licences. There have been significant legislative changes since the issuance of some licences. Older licences typically feature less stringent emission limit values (ELVs) than more recent licences.
- Three LAs explicitly require an Annual Environmental Report be submitted as a condition.
- ELVs are predominantly based on differential concentrations. The most recent licence based on an absolute ELV was issued in 2007.
- There is significant differences in required sampling frequencies between LAs (monthly, bimonthly and quarterly).
- The introduction of S.I. 272 (2009) has reduced the variance in the range of effluent discharge values which farms must comply with, in particular biochemical oxygen demand and ammonia related limits.
- There is a difference in the conditions attached to TELs regarding therapeutics. In some cases ELVs are set for the concentration of therapeutics which may be present in the discharge. Others require a log be kept of substances used, including the volumes utilised and corresponding dates.
- There are variations as to how ionised and unionised ammonia concentrations are specified in licences. A common approach could be considered.
- ELVs should be assessed to ensure concentrations specified in licences can be accurately assessed using laboratory methods applied in certified laboratories.

1. Project Background

MOREFISH is a collaborative project between NUI Galway and Athlone Institute of Technology and is funded by the Department of Agriculture Food and the Marine. MOREFISH comprises a multidisciplinary team drawing from international experts, wastewater treatment specialist, ecotoxicologists, and ichthyologists.

The project addresses a number of critical challenges faced by the freshwater aquaculture sector including the need for more efficient aeration systems, efficient production management and benchmarking, and the deployment of next-generation pulsed light disinfection technologies. These innovations will have key impacts including (i) enhancement of production efficiency and sustainability, (ii) reduction of environmental impacts of aquaculture production and (iii) improvement of fish health and reduction in finfish diseases and mortalities in rearing systems due to improved operating conditions. The project brings together a critical mass of engineering and scientific expertise, industry stakeholders and policy-makers, commercial operators and international experts. MOREFISH has targeted the development of beyond-state-of-the-art approaches that will increase fish biomass yields, productivity and stocking densities, mitigate contamination and cross-infection, and reduce production costs and waste. The project has surveyed a number of key pilot sites (in partnership with industry) to demonstrate key innovations. These pilot sites have been strategically chosen to be representative of the inland aquaculture industry.

1.1. Scope of Review

In June 2016, 21 Local Authorities (LAs) (representing all freshwater aquaculture subject to TELs) were contacted requesting access to TELs for freshwater aquaculture units within their boundaries. Figure 1 shows sites that are currently in operation, sites that are either no longer in operation or sites where it is not known if there are ongoing operations occurring. Some LAs provided complete records including historic licences, others provided current licences, two could not make available the licence and two failed to respond to the request. Bord Iascaigh Mhara (BIM) was also contacted in order to determine the number of aquaculture units that are in operation. Table 1 summarises the number of aquaculture licences issued by DAFM, the sites listed as in operation by Bord Iascaigh Mhara and the number of licences received from the Local Authorities (Licence status – historic/current). 13 TELs were received for sites regarded as in operation.

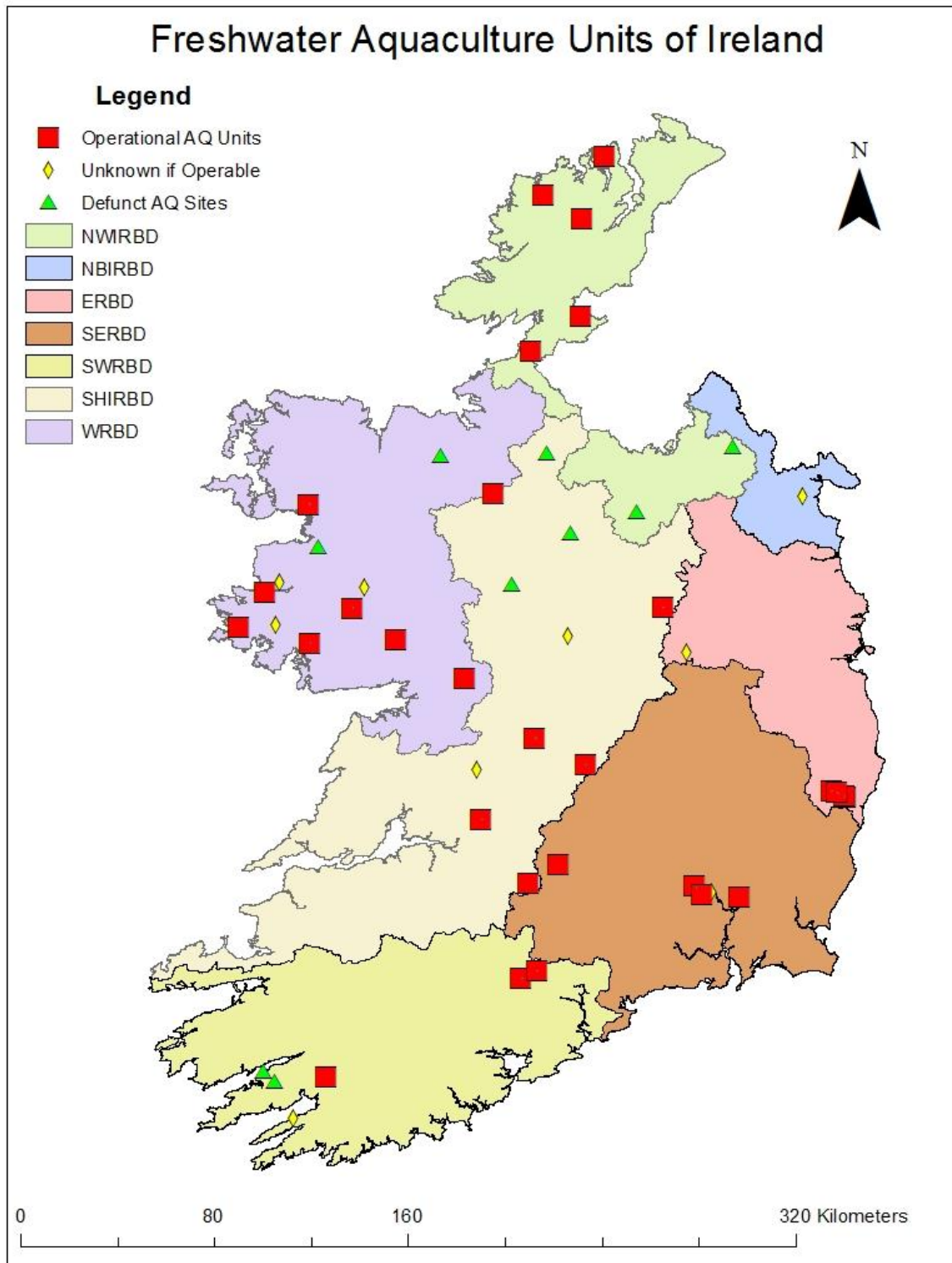


Figure 1: An overview of the freshwater aquaculture units which have had an aquaculture licence issued by the Department of Agriculture Food and the Marine.

Table 1: Outline of Local Authorities contacted as part of this review.

Local Authority	Info Received	Aquaculture Licences Issued (DAFM)	Sites in Operation (BIM)	Number of Section 4's Received	Response
Cavan	Yes.	2	0	1	Licence received.
Clare	Yes.	1	0	0	No Section 4 issued for site.
Cork	Yes.	8	4	4	Other sites no longer in operation.
Donegal	No.	9	4	0	Request declined.
Dublin – South Dublin CoCo, Fingal CoCo & Dun Laoighire Rathdown	No.	1	0	0	Site no longer in operation.
Galway	Yes.	9	6	3	Current licences received.
Kerry	Yes- but not relevant.	3	0	0	1 licence received for a shellfish unit.
Kilkenny	Yes.	6	2	2	Current licences received.
Leitrim	Yes.	1	0	1	Licence received.
Louth	No.	2	0	0	Request declined.
Mayo	No	3	1	0	No response from Local Authority
Monaghan	Yes.	1	0	1	Licence received.
Offaly	No.	1	0	0	Request declined.
Roscommon	Yes.	1	1	1	Licence received.
Sligo	Yes.	2	1	2	1 current and 1 historic licence received.
Tipperary	Yes.	6	4	2	Licences received.
Westmeath	Yes.	2	1	1	Licence received.
Wexford	No.	1	0	0	No response from Local Authority.
Wicklow	Yes.	4	3	3	Licences received.
Total		63	27	21	

1.2. Overview of Aquaculture in Ireland

Aquaculture in Ireland commenced in the mid-19th century in Galway. The rationale behind the activity was to supplement the River Corrib Salmon (*Salmo salar*) fishery (Wilkins, 1989). The Galway Fishery was purchased by the Ashworth Brothers in 1852. At this time the fishery was considered poor for recreational anglers. In December of 1852, Robert Ramsbottom was charged with restocking the Galway Fishery via artificial means. The first salmon hatchery in Ireland was established in Oughterard on the Owenriff River. The hatchery was a success and lead to a period of growth in the supplementing of wild stocks with propagated fish and their introduction to “unproductive” waters for angling and

export purposes. The first attempt at sea culture of salmon occurred in 1854 in Dun Laoighaire within a nearby sea-pond. The attempt was a failure due to the inadequate supply of food and the small number of fish used. Attempts to grow fry would be hampered by the poor quality and limited supply of suitable feed until the mid-20th century (Wilkins, 1989).

In 1957 the Inland Fisheries Trust established a commercial Rainbow Trout (*Oncorhynchus mykiss*) farm in Roscrea, Co. Tipperary to assess the feasibility of trout farming in Ireland. This site is still in operation and is managed by Inland Fisheries Ireland. Following this, a scheme to promote trout farming was commenced by the government. In the subsequent years, freshwater aquaculture saw a mixed pattern of expansion and contraction until 1972, when there was a steady increase in the number of trout farms (ESRI, 1992).

2. Aquaculture Licencing

In total, there have been 63 aquaculture licences granted for freshwater sites; 42 of which were listed as Aquaculture Licences and 19 as Fish Culture Licences (FCLs). Licences granted prior to 1997 were termed FCLs. Currently there are 27 aquaculture sites in operation (BIM pers. comm.).

The licencing of aquaculture for finfish in Ireland started in 1959 and is the responsibility of the Department of Agriculture Food and the Marine. Prior to 1959, aquaculture legislation had been focused on oyster production. Section 15 of the Fisheries (Consolidation) Act 1959, introduced FCLs. The Fisheries Act (1980) allowed for public consultation from “any person aggrieved” in the application of a licence. This was time intensive and slowed the pace in the issuance of licences. Based on the outcomes from the Smerwick Harbour Designation Order, the Minister could resort to issuing licences under Section 15 of the 1959 Act (ESRI 1992, Grist 2002). Since the 1980 Act, there have been 4 other Fisheries (Amendment) Acts, with the 1997 act having the greatest impact on aquaculture licencing with the introduction of the Aquaculture Licences Appeals Board (based on the planning appeals board, An Bord Pleanála (Grist 2002)).

Under the European Communities (Amendment) Regulations (1999), an Environmental Impact Statement (EIS) is required for (i) all fish breeding installations consisting of cage rearing in lakes, (ii) all fish breeding installations upstream of drinking water intakes and (iii) other freshwater fish breeding installations which exceed one million smolts and which utilise less than one cubic metre per second per one million smolts low flow diluting water. An EIS for sites not listed above, may be requested by the Minister (Department of Agriculture Food and the Marine) where it is considered that there is the potential for a significant impact on the environment.

Other legislation of significance to the aquaculture sector includes:

- Local Government (Planning and Development) Acts 1963-2015. Requirement of planning permission.
- Foreshore Acts (1933-2011). Required if building on foreshore or a tidal waterbody.
- Local Government (Water Pollution) Acts 1977-1990. Required if discharging effluent into a watercourse (Section 4 licence/TEL) or a sewer (Section 16).

2.1. Discharge Licencing in Ireland

The legal framework established to govern the potential of eutrophication resulting from freshwater aquaculture is primarily the Local Government (Water Pollution) Act (1977) and the Local Government

(Water Pollution) (Amendment) Act (1990). This allows Local Authorities to monitor the discharge from “trade” premises and to enforce water management plans on these premises. A trade that wishes to discharge to surface waters must apply for a licence from a LA.

The 1977 Local Government (Water Pollution) Act defines trade effluent as:

“effluent from any works, apparatus, plant or drainage pipe used for the disposal to waters or to a sewer of any liquid (whether treated or untreated), either with or without particles of matter in suspension therein, which is discharged from premises used for carrying on any trade or industry (including mining), but does not include domestic sewage or storm water.”

Within the act trade is also defined as:

“Agriculture, aquaculture, horticulture and any scientific research or experiment.”

In order to apply for a trade effluent licence, the appropriate application form must be returned to the relevant local authority by the applicant. This form must be returned with certain documents:

- A copy of a newspaper where the public has been notified about the application to discharge effluent. This must be completed two weeks prior to the submission of the application form to the LA.
- For a first time applicant, it may be required that other information is made available to the LA. In particular, the quality, volume and flow rate of receiving waters and the effects the proposed discharge may have on same.

A decision on an application can be expected within two months of a complete submission. Further information can be requested by the LA. Following the decision by the LA, the outcome is advertised in local newspapers and the public is invited to express concerns or query the nature of the application. At any point, members of the public may object to the proposed licence by contacting the planning appeals board, An Bord Pleanála.

Several conditions can be attached to the licence, which must be met for the licence to remain valid. Licences are also subject to review (Appendix A).

In terms of compliance, the onus to meet the conditions of the licence lies with the licence holder. It is an offence not to comply with the conditions of a licence, and any person found guilty of an offence shall be liable to a fine and/or imprisonment and an additional fine for each day the offence continues. Prosecution for an offence may be brought by a local authority or Irish Water or any persons affected.

Aquaculture activities were not included in the Protection of the Environment Act (2003), which would transfer the responsibility of the regulation of aquaculture discharges to the Environmental Protection Agency. In more recent times, since the implementation of Council Directive 2000/60/EC, the Water Framework Directive (WFD), there have been several statutory instruments transposed into Irish law (Figure 2).

The most significant of these being S.I. 272 of 2009, the European Communities Environmental Objectives (Surface Waters) Regulations, 2009. This statutory instrument laid down the measures and environmental quality standards (EQS) required to achieve the environmental objectives as established for surface waters as per EU Council Directive 2000/60/EC, the WFD. It laid down the criteria for calculating the ecological status and potential of a water body based on biological elements (invertebrate fauna, phytobenthos, macrophytes, phytoplankton and macroalgae) and the underlying

physico-chemical conditions supporting the biological elements i.e. thermal conditions, oxygenation conditions and nutrient conditions (Appendix B).

According to a recent report to the Environmental Protection Agency by RPS Group on the development of a national abstraction and a national discharge database, there are 1,332 active TELs (RPS Group, 2016). The RPS report mentions that only 17 of these licences are current licences for aquaculture units. 3 of the TELs received by RPS were for facilities which utilised saline water and as such are outside the remit of this review. These 14 current TELs for freshwater aquaculture account for 1.05% of all active TELs (Figure 3). The number of active TELs is at odds with the number of freshwater units regarded as operational by BIM and indicates that there are a number of sites which are not licenced. From discussions with LA staff, in certain cases the effluent was regarded as being very dilute and the activity being so brief that a TEL was not necessary e.g. the culturing of unfed fry. It is unclear if some commercial units in operation avail of this derogation.

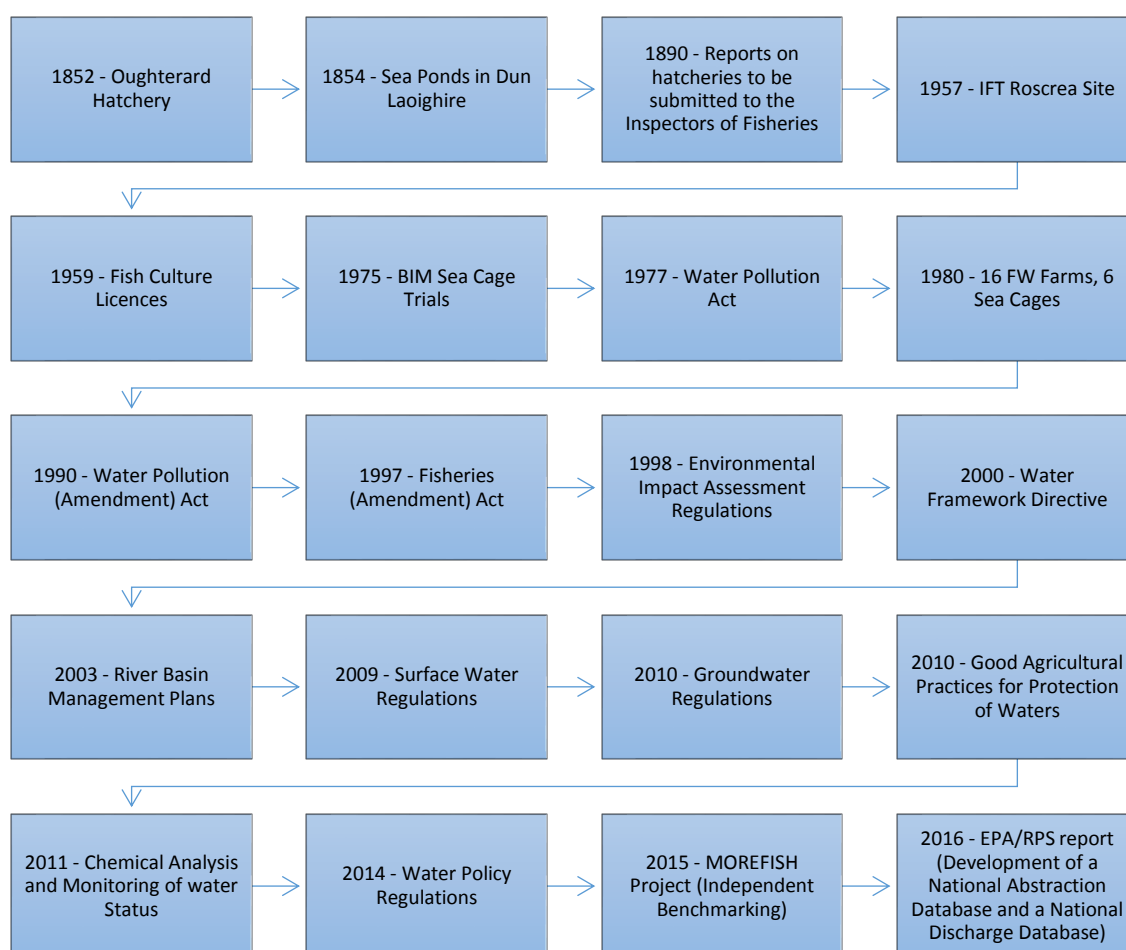


Figure 2: A timeline of the origins of Irish aquaculture, the evolution of some of legislation, policy, research and reviews that shaped the conditions and parameters that must be met as part of an aquaculture licence and a trade effluent licence (TEL).

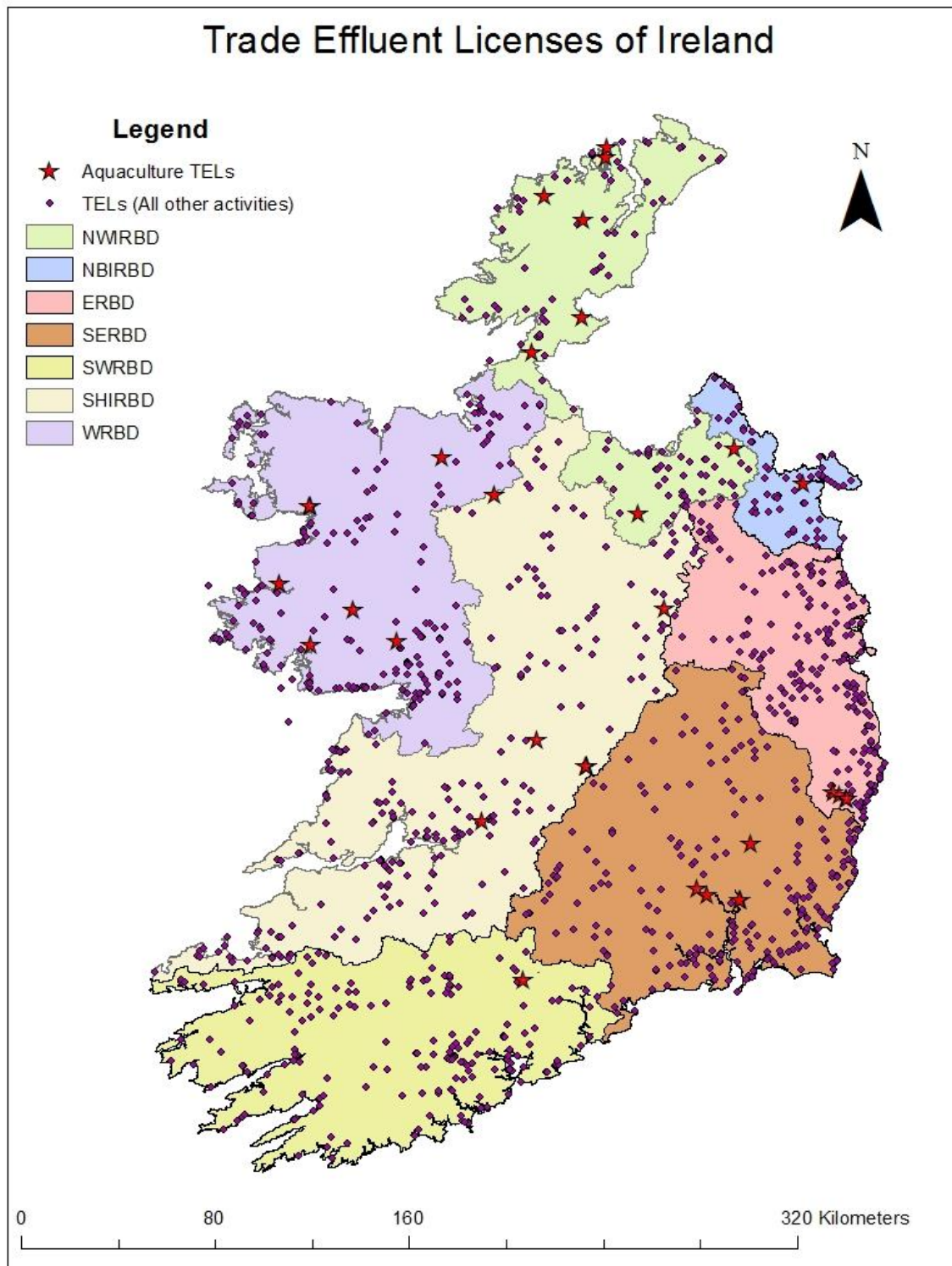


Figure 3: The current distribution of all active TELs in the Republic of Ireland. TELs associated with aquaculture are highlighted and account for 1.05% (See Glossary for details of RBD acronyms)

2.2. Emission Limit Calculations

Since 2011, a set of training documents has been used by the LAs to enable calculation of emission limit values. The training material was procured by the Local Authority Services National Training Group (LASNTG) and comprises two volumes as follows:

Volume 1 – Technical Guidance Manual:

Provides guidance to LAs on the licencing of discharges to surface waters, groundwaters, and to sewers in accordance with the Local Government (Water Pollution) Acts 1977 - 2007.

Volume 2 – Application Forms & Applicant Guidance:

This volume provides various application forms and guidance when applying for discharges to ground or surface waters and sewers. Electronic copies of the Application forms are available to download from <http://www.wsntg.ie/publications/index.asp>

Training in the determination of TELs is currently provided by the LASNTGs Water Services Training Group (WSTG). The approach recommended by the WSTG is to use mass balance methods to estimate the resultant concentration of a discharge in a receiving waterbody. This approach checks whether the resultant concentration is below the 95thile of good status and if the proposed discharge will utilise all the permitted headroom between the existing concentration and the maximum allowable concentration for good status.

One of the main aspects of this methodology is the use of a headroom principle. The headroom principle as defined in the determination of a TEL is the maximum permissible concentration of a substance (to meet good water status) minus the concentration of the substance naturally found in the river. It can be expressed as follows (Eqn. 1):

$$\text{Headroom (mg/l)} = C_{\text{max}} - C \quad (\text{Eqn. 1})$$

C_{max} = maximum permissible (EQS) (mg/l) **C** = background upstream concentration (mg/l)

Once the headroom has been calculated the percentage headroom utilised is calculated. Generally if the utilised headroom is below 25%, it is viewed as not impacting on water quality due to it being below the EQS for that parameter.

Appendix C consists of a case study of how calculations for resulting concentrations downstream of a discharge point are determined Example A is from the WSTG training materials and Example B is a worked example of a hypothetical farm.

3. Licences by River Basin District

The licences received were divided into their appropriate river basin districts (RBDs) as defined under the WFD. The maximum potential biomass (if all sites produce to the maximum permitted by their aquaculture licence) and the value of aquaculture produced in each RBD is presented in each of the following sections.

In 2015, the freshwater aquaculture sector produced 1,638 tonnes of biomass, valued at €9,504,068 (Figure 4). The land area (m²) required to produce this volume of biomass is 191,025.63 m², or 116.6m² per tonne (including necessary supporting infrastructure). Smolts accounted for the highest value species in 2015, with prices averaging €8,193/tonne. Perch were the second highest valued species at

€5,911/tonne. Rainbow Trout were worth €2,782/tonne. The average price across all species produced was €5,802.23/tonne.

In total 21 licences were received. TELs for 13 of the 27 operational aquaculture units were analysed. Historic licences for sites no longer in operation have been included for comparative purposes. A TEL was also received for a site in the Shannon International River Basin District (SHIRBD), which does not have an aquaculture licence on the DAFM website.

A licence was also received for a lake site located in the SHIRBD. This licence was atypical in that there were no specified ELVs placed on the farm but a very comprehensive environmental monitoring programme was in place. The conditions attached to this licence include: weekly samples of – water transparency, dissolved oxygen at various depths and a temperature profile; monthly samples at various depths surrounding the cages, a control site and at the outlet of the waterbody. Samples were then analysed for Total Organic Nitrogen, Total Phosphate, pH, Ammonium, Temperature, Dissolved Oxygen and chlorophyll. Sediment samples were also required annually, which were tested for total phosphorous and total nitrogen. This site is no longer in operation.

The ELVs on the majority of licences received are derived from differential concentrations between the influent and effluent waters.

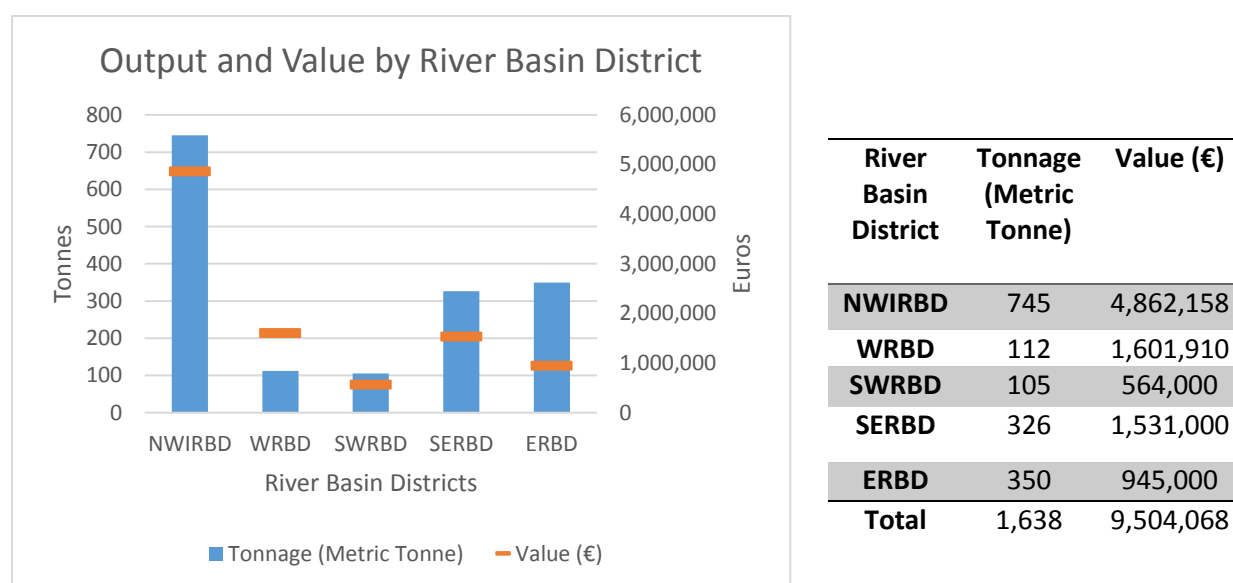


Figure 4: The volume of fish produced by freshwater aquaculture units in the Republic of Ireland, represented by River Basin District (BIM, 2016).

Table 2 summarises the ammonia discharge limits for each of the RBDs. ELVs for ammonia for current licences range from 0.03 to 10 mg N/l. Since the implementation of S.I. 272 (2009), there has been a reduction in the variance associated with ammonia ELVs (0.079 mg N/l) in comparison to pre S.I. 272 values (11.298 mg N/l) for current licences reviewed. The relatively large variance associated with the Pre-S.I. 272 values can, however, be ascribed to the outlier ELV permitted for SHIRBD-A (10 mg N/l).

Table 2: The range of differential ELVs that are required to be met by RBD for ammonia and the year the licence was issued.

Ammonia			
Farm	Year Issued	Value (mg N/L)	Method
ERBD-A	1995	0.4	Differential
ERBD-B	1992	0.4	Differential
ERBD-C	1992	0.4	Differential
SERBD-A	2013	0.03	Differential
SERBD-B	2013	0.05	Differential
SHIRBD-A	2003	10	Concentration
SHIRBD-B	2014	0.15	Differential
SHIRBD-C	2014	0.3	Differential
SWRBD-A	1988	0.5	Concentration
SWRBD-B	2011	0.1	Differential
SWRBD-C	2014	0.1	Differential
WRBD-A	2000	0.5	Differential
WRBD-B	2000	0.5	Differential
WRBD-C	2007	0.8	Concentration

3.1. Western River Basin District

Within the Western River Basin District (WRBD), 13 aquaculture licences have been granted. Currently, there are 7 freshwater units known to be in operation (BIM pers. Comm). The combined biomass for this RBD if all sites produce to their aquaculture licence limit is 165 tonnes. In 2015 the produce of the WRBD was valued at €1,601,190 for 112 tonnes. This only comprised of salmonids species. Of these sites, 4 TELs have been received (with a biomass maximum potential of 130 tonnes based on their aquaculture licences). One of the sites does not appear to have been issued a TEL. For the other sites known to be in operation, no response was received from the LA responsible for the issuance of TELs. Table 2, displays the values which the licensee may not exceed at any time. Within this RBD, there is a difference within the units specified for turbidity (i.e. Jackson Turbidity Unit and Nephelometric Turbidity Unit). WRBD-D is no longer in operation, but has been included to compare historic and current TELs (Figure 5).

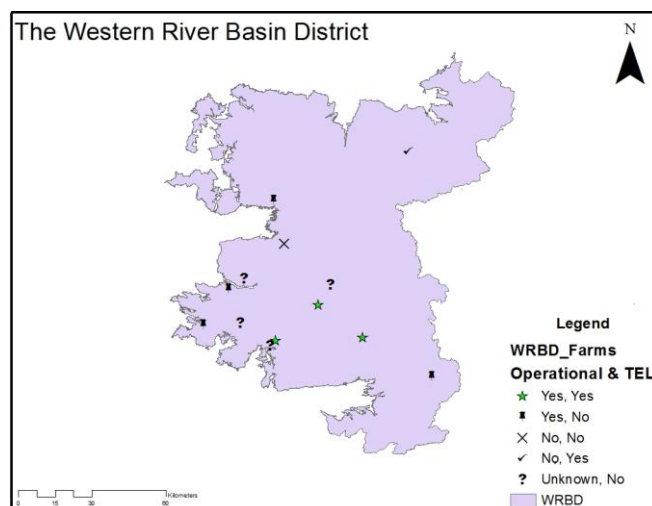


Figure 5: The locations within the Western River Basin District where aquaculture licences have been issued.

3.2. South Western River Basin District

The SWRBD has also had 13 aquaculture licences granted. Three TELs were received for the 4 sites listed as operational by BIM within the SWRBD. The combined output for this RBD from operational units is 69 tonnes from the aquaculture licence. This is almost a third of the potential output if all sites within this RBD were operational (205.75 tonnes). In 2015 the value of produce in the SWRBD was valued at €564,000 for 105 tonnes. The two freshwater species cultivated in this RBD were salmon and rainbow trout. Table 3 displays the range of values that must be met by each licensee.

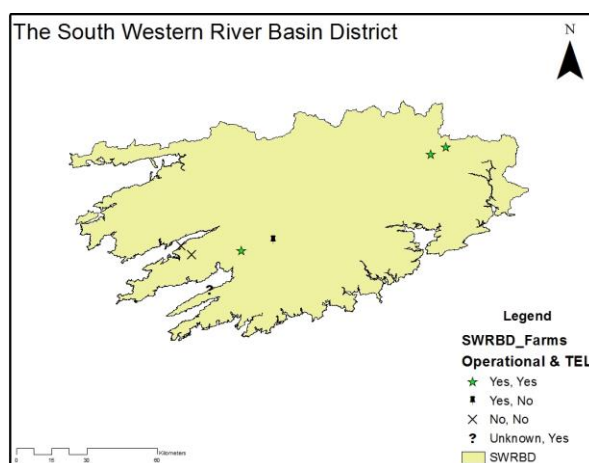


Figure 6: The locations within the South Western River Basin District where aquaculture licences have been issued.

3.3. Shannon International River Basin District

Eleven aquaculture licences have been issued for the Shannon International River Basin District (SHIRBD). Six of these sites are operational and of these sites 4 TELs were received. The biomass potential output for the 6 operational sites is 181.2 tonnes as calculated from aquaculture licences. The output from the sites with TELs is 73.2 tonnes. No figures were available for the amount produced or the value of the produce for 2015. The sites in this RBD are licenced to produce mainly salmonid species, with two units licenced to produce perch (*Perca fluviatilis*) and tench (*Tinca tinca*). One site is

licensed to produce cyprinids such as rudd (*Scardinius erythrophthalmus*), bream (*Abramis brama*) and carp (*Cyprinus carpio*) for stocking purposes. It must be noted that three of the sites are operated by a state corporation and a state agency and as such are not commercial aquaculture units. There is also a hatchery for an angling club within this RBD, which does not appear to have been issued with a TEL. As mentioned, there was a lake site in operation in this RBD until the 2000s. Table 4 displays the range of values that must be met by the licensee.

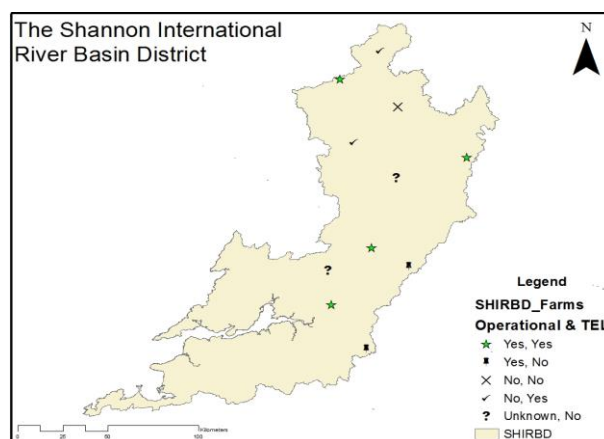


Figure 7: The locations within the Shannon International River Basin District where aquaculture licences have been issued.

3.4. North Western International River Basin District

The North Western International River Basin District (NWIRBD) has 4 operational units, for which no TELs were received. A total of 11 freshwater aquaculture licences were issued within the NWIRBD. Two TELs were received for sites which are no longer active. Farm NWIRBD-A was regarded to be compliant with its licence if 90% of samples were within the specified limits. NWIRBD-B is also unique among the licence received in that the ELVs are also expressed as kilograms emitted per day (kg/day). The conditions for these farms are presented in Table 5 but they are no longer relevant.

It is understood that the sites that are operational have current TELs but the LA was not in a position to share the licences. The 4 operational units have a combined a potential output of 346 tonnes (according to the DAFM aquaculture licence). In 2015 the 4 operational sites output was valued at €4,862,158. According to the BIM Annual Aquaculture Survey 2016, the total tonnage produced for the NWIRBD was 745 tonnes. Table 5 displays the range of historic values that had to be met by the licensee.

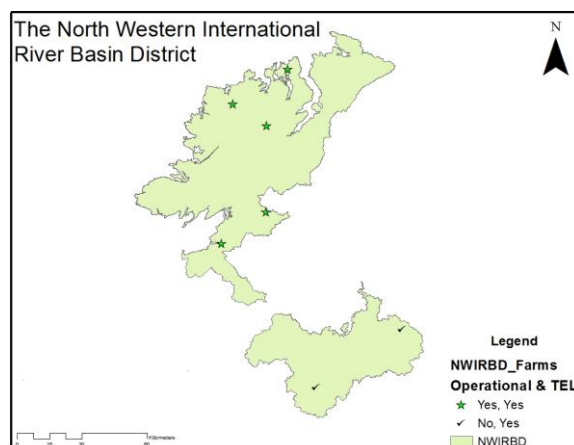


Figure 8: The locations within the North Western International River Basin District where aquaculture licences have been issued.

3.5. Neagh-Bann International River Basin District

There have been two aquaculture licences issued for the Neagh-Bann International River Basin District (NBIRBD) within the Republic of Ireland. Neither site is currently in operation. One does not appear to have been built, but would have had the capacity to grow 700 tonnes of barramundi (*Lates calcarifer*) using a recirculating aquaculture system (RAS). A TEL was issued for this facility but the LA was not in a position to release it. The other freshwater aquaculture site within the NBIRBD was a hatchery for the production of unfed sea trout (*Salmo trutta*) fry for stocking by an angling club and was deemed by the LA not to require a TEL.



Figure 9: The locations within the Neagh Bann International River Basin District where aquaculture licences have been issued.

3.6. Eastern River Basin District

There have been 7 aquaculture licences issued within the Eastern River Basin District (ERBD). One is for a state hatchery which could not be located for display on the map. A site which produced Arctic Char (*Salvelinus alpinus*), has been closed for the past number of years and could not be displayed on

the map. A site which produced ornamental fishes is also no longer in operation. There are currently 4 sites in operation with a permissible combined standing stock of 175 tonnes, with no limit placed on annual production. The TELs were received for all the operational farms, with two of the farms sharing a TEL. The value of the produce from the ERBD for 2015 was €945,000 for 350 tonnes. The licences received for this RBD were very old, having been issued between 1992 and 1995. Table 6 displays the range of values that must be met by the licensee.

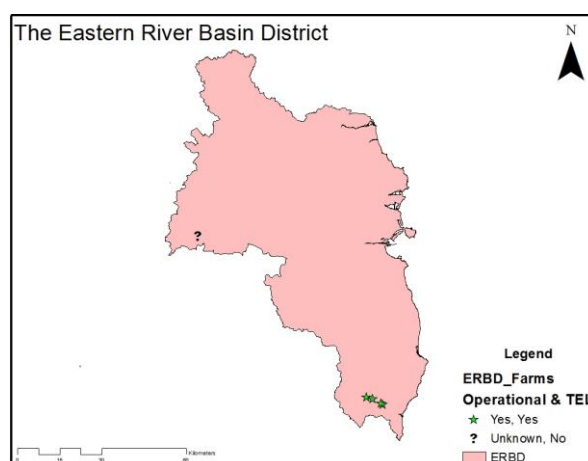


Figure 10: *The locations within the Eastern River Basin District where aquaculture licences have been issued.*

3.7. South Eastern River Basin District

A total of 9 freshwater aquaculture licences have been issued within the South Eastern River Basin District (SERBD). Three sites are operational, of which two TELs were received. These sites focus on the production of rainbow trout and perch. The sites for which TELs were received have a maximum standing biomass of 77.25 tonnes, with no limit on annual production (as calculated from the respective DAFM aquaculture licences). There are two state hatcheries within the SERBD, one of which could not be located. There are also three other units that have been issued with aquaculture licences from DAFM. Two are believed to be no longer in operation and it is unclear if the third is also defunct. In 2015, the produce from the SERBD was valued at €1,531,000 for 326 tonnes of fish. The ammonia levels of 0.03mg N/L are regarded as being quite low and may not be reliably measured. Table 7 displays the range of values that must be met by the licensee.

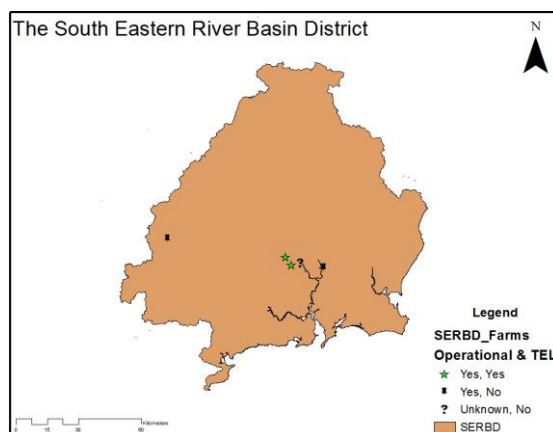


Figure 11: The locations within the South Eastern River Basin District where aquaculture licences have been issued.

4. Sampling Frequency

There are differences in the monitoring frequency in which farms or LAs must submit samples. The majority of LAs require that farms submit monthly records as a condition of their TEL (SERBD-B), others use vague terminology such as bimonthly, without further clarification this could be interpreted as twice a month or once every two months (Figure 12). Quarterly samples are the most common requirement.

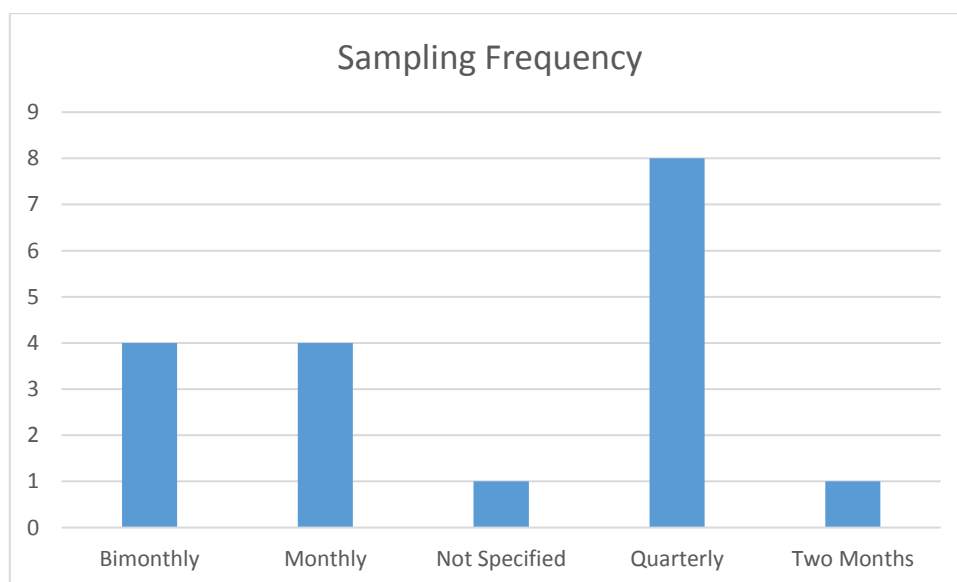


Figure 12: The sampling frequency with which licence holders must submit environmental monitoring samples to the LA.

5. Remediation

Nine of the TELs require that remediation be carried out on effluent prior to discharge to surface waters. Some LAs specify the means of remediation with constructed wetlands being the most

common cited. For the farms where remediation is required but the method has not been stipulated on the TEL, it is likely that the means have been agreed with the owners. In order to meet the more stringent ELVs post S.I. 272 (2009) it is likely that remediation will become a central part of future TELs.

6. Conclusions

MOREFISH is a collaborative project between NUI Galway and Athlone Institute of Technology and is funded by the Department of Agriculture Food and the Marine. The project addresses a number of critical challenges faced by the freshwater aquaculture sector. As part of this project the MOREFISH team undertook a review of Section 4 wastewater discharge licences, commonly referred to as Trade Effluent Licences (TELs).

The objectives of this review were to:

- Analyse TELs issued for freshwater aquaculture sites.
- Determine the methods used by Local Authorities (LAs) in producing a TEL for aquaculture units.
- Compare current and historic licences to determine if there has been a major change in the volumes of emissions that aquaculture units are permitted to discharge.

The main datasets consulted as part of this review were (i) land based aquaculture licences issued by the Department of Agriculture Food and the Marine and data regarding current and (ii) historic TELs from Local Authorities where an aquaculture licence was issued within their boundaries. In total, there are 27 freshwater sites in operation in the Republic of Ireland. This review had access to 21 TELs. Of these 21, 13 were for sites currently regarded as in operation.

The key conclusions of this review include:

- There is fragmentation in the updating of licences. There have been significant legislative changes since the issuance of some licences, with older licences availing of greater effluent limit values (ELVs) than more recent licences.
- The introduction of S.I. 272 (2009) has reduced the variance in the range of values to which aquaculture sites must comply with. It is likely with future renewals that there will be a further reduction in this variance.
- Three LAs explicitly require an Annual Environmental Report from the sites licenced
- ELVs are predominantly based on differential concentrations. The most recent licence based on an absolute ELV was from 2007.
- Some of the ELVs stipulated on both pre and post S.I. 272 (2009) TELs may need evaluation in relation to the ability of laboratories to accurately measure some parameters to low concentrations.
- There is a marked difference in the sampling frequencies required by Local Authorities.
- Freshwater finfish aquaculture licences account for 1.05% of all active TELs.
- There were variations in the conditions attached to TELs in relation to therapeutics and pharmaceuticals. Some LAs require limits set in the volume of therapeutics which may be present in the site discharge. Others require a log be kept of substances used, the volumes and dates.

Of the 18 licences presented in this report, 13 were for current sites. Of these 13, six have been issued since the introduction of S.I. 272 (2009). Some of the TELs analysed have not been updated for almost two decades; though licences are required to be reviewed every three years.

It is hoped this review can be updated and expanded with all current TELs. This review has covered approximately half of the TELs issued to the freshwater aquaculture sites considered operational by BIM. Just under half of the TELs received were issued after the implementation of S.I. 272 (2009).

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Appendix A - Conditions which may be attached to a TEL as per Local Government (Water Pollution) Acts (1977-1990)

- The nature, composition, temperature, rate, volume, periods during which a discharge may or may not be made, the design, construction and location of the discharge outlet and if applicable, the method of treatment and/or the expected effect of the discharge on the receiving water.
- The provision and maintenance of flow meters, gauges, other apparatus, manholes and inspection chambers.
- The taking and analysis of samples, the keeping of records and the furnishing of information to the local authority/Irish Water.
- Measuring the intake of water to a premises for the purpose of assessing waste water discharge volumes.
- Action to be taken in the event of an emergency.
- The prevention of a discharge in the event of a breakdown in plant.
- Require defrayment of or contribution towards the cost incurred by the local authority in monitoring a discharge.
- Specify a date not later than which any conditions shall be complied with.
- Require an annual payment to the local authority which granted the licence.

Granted TELs are subject to reviews (Section 7 of 1977 Act) within the following framework:

- At intervals of not less than three years.
- At any time, with the consent of the person causing the discharge.
- At the official request of the licensee.
- At any time, when a local authority/Irish Water has reasonable grounds for believing the authorised discharge may be a threat to public health or will make the waters unfit for other uses, or that it conflicts, or is likely to conflict, with the sustainable use of water resources, or is inconsistent, or likely to be inconsistent, with requirements of a river basin management plan or programme of measures under the water framework directive (WFD).
- Where a material change has taken place in the nature or volume of the discharge.
- Where a material change has taken place in the conditions of the receiving water or where the capacity of the receiving waste water works has been or is likely to be exceeded.
- Where further information concerning the discharge has become available.
- When new water quality objectives or emission standards for effluents are prescribed under the Water Pollution Acts, 1977 and 1990; and Water Services Act 2007.
- When a drain or service connection, through which trade effluent or other relevant matter is discharged under the terms of the licence is declared to be a sewer under section 69 of the 2007 Act.
- At intervals which may be specified by any Regulations introduced under the 1977 Act.

In this context, the duties of the LA are:

- To review the licence within 3 years.

- To give notice of the intention to review the licence.
- To inform the licence holder of any fees to be paid.
- To seek submissions from the public by advertising in local newspapers.
- Following on from the review by the LA and input from the public, new conditions may be attached to the licence.

Appendix B – S.I. 272 Conditions

Table B 1: Thermal conditions specified in S.I. No. 272 of 2009.

Thermal Conditions (temperature)	River Body	Water	Lake Water Body	Transitional Water Body	Coastal Body	water
	Not greater than 1.5°C rise in ambient temperature outside the mixing zone.					

Table B 2: Oxygenation conditions specified in S.I. No. 272 of 2009 (psu: The Practical Salinity Unit defines salinity in terms of a conductivity ratio of a sample to that of a solution of 32.4356 g of KCL at 15°C in 1 kg of solution. A sample of seawater at 15°C with a conductivity equal to this KCL solution has a salinity of exactly 35 practical salinity units).

Oxygenation Conditions	River Body	Water	Lake Body	Water	Transitional Water Body	Coastal Body	water
Biochemical oxygen demand (BOD) (mg O ₂ /l)	High status ≤1.3 (mean) or ≤2.2 (95%ile)	Demand status ≤1.5 (mean) or ≤2.6 (95%ile)	Good		≤4.0 mg/l (95%ile)		
Dissolved oxygen lower limit	95%ile >80% saturation				(0 psu) 95%ile >70% saturation (35 psu) 95%ile >80% saturation	(35 psu) 95%ile >80% saturation	
Dissolved oxygen upper limit	95%ile <120% saturation				(0 psu) 95%ile <130% saturation (35 psu) 95%ile <120% saturation	(35 psu) 95%ile <120% saturation	

Table B 3: Acidification Status specified in S.I. No. 272 of 2009 (Soft water is regarded as ≤100 mg/1 CaCO₃ and hard water is regarded as having a hardness > 100 mg/1 CaCO₃).

Acidification Status	River Body	Water	Lake Body	Water	Transitional Water Body	Coastal Body	water
pH (Individual values)	Soft Water 4.5 < pH < 9.0 Hard Water 6.0 < pH < 9.0						

Table B 4: The nutrient conditions specified in S.I. No. 272 of 2009 (Total phosphorus (TP) is an important measure of lake trophic status and TP measurements are included as part of the lakes monitoring programme; TP boundary conditions are yet to be established for lakes).

Nutrient Conditions	River Water Body	Lake Water Body	Transitional Water Body	Coastal water Body
Total Ammonia (mg N/l)	High status ≤ 0.040 (mean) or ≤ 0.090 (95%ile) Good status ≤ 0.065 (mean) or ≤ 0.140 (95%ile)			
				Good status (0 psu) ≤ 2.6 mg N/l
Dissolved Inorganic Nitrogen (mg N/l)				(34.5 psu) ≤ 0.25 mg N/l
				High status (34.5 psu) ≤ 0.17 mg N/l
Molybdate Reactive Phosphorus (MRP) (mg P/l)	High status ≤ 0.025 (mean) or ≤ 0.045 (95%ile) Good status ≤ 0.035 (mean) or ≤ 0.075 (95%ile)		(0-17 psu) ≤ 0.060 (median) (35 psu) ≤ 0.040 (median)	

Appendix C

Example A: Adopted from the WSTG Example 1. This example covers the application of a hypothetical waste water treatment plant (WWTP) for a TEL.

(http://www.wstg.ie/wp-content/uploads/2016/07/Worked_Examples_Mass_Balance.pdf).

Example A – calculation of the resulting concentrations downstream from a WTPP for regulated parameters and assessment of the suitability for the WFD good status river quality

For this case study, the method will be applied to an hypothetical WWTP discharging to a hypothetical river with the following characteristics:

Discharge characteristics:

- Maximum discharge volume 9 m³/d,
- Effluent Concentrations: BOD₅ 10 mg O₂/L, ammonia 4 mg N/L, orthophosphate 1.5 mg P/L.

Receiving Water:

- Good Status, 95%ile flow = 0.7 m³/s,
- Background Concentrations: BOD 1.24 mg O₂/L, Ammonia 0.058 mg N/L, Orthophosphate 0.024 mg P/L.
- Max permissible concentrations (Good Status 95%ile Environmental Quality Standards): BOD 2.6 mg O₂/L, ammonia 0.14 mg N/L, orthophosphate 0.075 mg P/L,
- Percentage Headroom permitted - 25%.

The resulting concentration in the river downstream from the fish farm is calculated with the following equation:

$$C_{95} = \frac{Q_{95} \times C_i + Q_e \times C_e}{Q_{95} + Q_e}$$

With C_{95} the resulting concentration for a given parameter, Q_{95} the 95thile flow in river (L/s), Q_e the effluent flow (L/s), C_i the upstream concentration (mg/L) and C_e the effluent concentration Effluent (mg/L)

As an example, the application of the above equation to BOD would give:

$$C_{95,BOD} = \frac{700 \times 1.24 + 0.1 \times 10}{700 + 0.1} = 1.2413 \text{ mg O}_2/\text{L}$$

This calculation was carried out for the other parameters (i.e. ammonia and orthophosphate). The results for this particular site are:

	Background Concentration (C_i) (mg/l)	Resultant Concentration (C_{95}) (mg/l)	Maximum Permissible Concentration (C_e) (mg/l)
BOD	1.24	1.2413	2.6
Ammonia	0.06	0.06	0.14
Orthophosphate	0.021	0.02	0.075

The headroom is calculated by subtracting the resultant concentration from the maximum permissible concentration:

Headroom = BOD C_e – BOD C_{95}

$$\rightarrow \text{BOD Headroom} = 2.6\text{mg/l} - 1.2413\text{mg/l} = 1.358 \text{ mg O}_2/\text{L}$$

$$\text{Percentage Headroom Utilised} = \frac{(C_{95,BOD} - C_i) \times 100}{\text{Headroom}} = \frac{(1.2413 - 1.24) \times 100}{1.358} = 0.1\%$$

This calculation was carried out for the other parameters (i.e. ammonia and orthophosphate). The results for this particular site are:

	Headroom (mg/l)	Headroom permitted	%	Increase (mg/l)	Headroom utilised	%
BOD	1.36	25		0.0013	0.10	
Ammonia	0.082	25		0.00059	0.72	
Orthophosphate	0.051	25		0.0022	0.43	

The resultant increase is within the headroom permitted for all the regulated parameters and would allow the application to be granted, although there may be conditions attached.

Example B: A worked example which covers the application for a TEL from a hypothetical fish farm utilising typical flow and environmental monitoring data (for the purposes of this example it is assumed that the fish farm abstracts 30% of the river flow and returns this 30% flow at the discharge point).

Example B – calculation of the resulting concentrations downstream from a fish farm for regulated parameters and assessment of the suitability for the WFD good status river quality

For this case study, the method will be applied to a hypothetical fish farm abstracting and discharging to a hypothetical river with the following characteristics 95%ile flow above abstraction point = 3.2 m³/s:

Discharge characteristics:

- Maximum discharge volume 0.96 m³/s (30% of river flow),
- Effluent Concentrations: BOD₅ 1.1 mg O₂/L, ammonia 0.085 mg N/L, orthophosphate 0.05 mg P/L.

Receiving Water:

- Good Status, 95%ile flow = 2.24 m³/s,
- Background Concentrations: BOD 0.5 mg O₂/L, Ammonia 0.05 mg N/L, Orthophosphate 0.041 mg P/L.
- Max permissible concentrations (Good Status 95%ile Environmental Quality Standards): BOD 2.6 mg O₂/L, ammonia 0.14 mg N/L, orthophosphate 0.075 mg P/L,
- Percentage Headroom permitted - 25%.

The resulting concentration in the river downstream from the fish farm is calculated with the following equation:

$$C_{95} = \frac{Q_{95} \times C_i + Q_e \times C_e}{Q_{95} + Q_e}$$

With C_{95} the resulting concentration for a given parameter, Q_{95} the 95thile flow in river (L/s), Q_e the effluent flow (L/s), C_i the upstream concentration (mg/L) and C_e the effluent concentration Effluent (mg/L)

As an example, the application of the above equation to BOD would give:

$$C_{95,BOD} = \frac{2240 \times 0.5 + 960 \times 1.1}{2240 + 960} = 0.68 \text{ mg O}_2/\text{L}$$

This calculation was carried out for the other parameters (i.e. ammonia and orthophosphate). The results for this particular site are:

	Background Concentration (C _i) (mg/l)	Resultant Concentration (C ₉₅) (mg/l)	Maximum Permissible Concentration (C _e) (mg/l)
BOD	0.5	0.68	2.6
Ammonia	0.05	0.06	0.14

Orthophosphate	0.041	0.043	0.075
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Headroom:
The headroom is calculated by subtracting the resultant concentration from the maximum permissible concentration:
Headroom = BOD C_e – BOD C_{95}
→ BOD Headroom = 2.6mg/l - 1.2413mg/l = 1.358 mg O₂/L

Percentage Headroom Utilised = $\frac{(C_{95,BOD} - C_i) \times 100}{\text{Headroom}} = \frac{(0.68 - 0.5) \times 100}{1.92} = 9.375\%$

This calculation was carried out for the other parameters (i.e. ammonia and orthophosphate). The results for this particular site are:

	Headroom (mg/l)	Headroom permitted	%	Increase (mg/l)	Headroom utilised	%
BOD	1.92	25		0.18	9.375	
Ammonia	0.02	25		0.07	12.5	
Orthophosphate	0.032	25		0.002	6.25	

The resultant increase is within the headroom permitted for all the regulated parameters and would allow the application to be granted, although there may be conditions attached.

Appendix D - Licences by River Basin District

Table D 1: The range of parameters for the 4 TELs received for the WRBD. These ELVs are differential concentrations between the influent and effluent waters for the farms with Farm WRBD-A being the only farm to use absolute concentration.

Farm	Discharge Volume (m ³ /day)	pH	BOD ₅ (mg O ₂ /L)	DO (min % saturation)	SS (mg/L)	Turbidity	Ammonia (mg N/L)	Total Ammonia * (mg N/L)	Ortho-phosphate (mg P/L)	Total Phosphorus (mg P/L)	Therapeutics (mg/L)
WRBD-A	3456	6.5-8.5	5		10	2 NTU		0.8	0.08		
WRBD-B		+0.2	2		10	2 JTU		0.5		0.1	0.05 ²
WRBD-C ¹	561,600	+0.2	3	60	10			0.5		0.04	0.05 ² 0.05 ³
WRBD-D	720	6.0-9.0	10		15		10			2	

*Total Ammonia refers to the measurement of ammonia by its nitrogen content, TAN (Total Ammonia Nitrogen). ¹Levels of Phenols may not exceed 0.005 mg/L. ²Copper, ³ Malachite Green.

Table D 2: The range of parameters used in TELs in the SWRBD. Again, the ELVs are differential except for Farm SERBD-C which is an absolute value.

Farm	Maximum permitted abstraction of river flow %	Discharge Volume (m ³ /day)	pH	BOD ₅ (mg O ₂ /l)	SS (mg/l)	TSS (mg/l)	Total Nitrogen (mg N/L)	Ammonia (mg N/L)	Ortho-phosphate (mg P/L)	Therapeutics (mg/L)
SWRBD-A		7,200	7.0-8.0	1		1	1	0.1	0.01	0.5 ¹
SWRBD-B	50		7.0-8.0	1		1	1	0.1	0.01	0.5 ¹
SEWBD-C	50	2,300		10	10			0.5	0.3	

¹ Formalin

Table D 3: The range of parameters and their ELVs that freshwater aquaculture units must comply with in the SHIRBD. Farm SHIRBD-A is the only site which does not use a differential concentration.

Farm	Discharge Vol (m ³ /day)	Temperature (°C)	pH	BOD (mg O ₂ /L)	SS (mg/L)	TSS (mg/L)	Nitrate (mg N/L)	Ammonia (mg N/L)	Total Ammonia (mg N/L)	Ortho-phosphate (mg P/L)	Total Phosphorus (mg P/L)	Therapeutics (mg/L)
SHIRBD-A	50	20°C max	6.0-9.0	10	10			10		0.5		
SHIRBD-B	4200	+ 1.5 °C	+ 2	1.5		5	2		0.15	0.05	0.05	0.5 ¹
SHIRBD-C	15000	+ 1.5 °C	+ 2	4		5	2		0.3	0.1	0.2	0.5 ²
SHIRBD-D			9.0-8.0	3			1			0.05	1	1.1 ^{3,4} 0.06 ^{3,4}

¹ Formalin, ² Formaldehyde, ³ Malachite Green, ⁴ Monitoring required annually.

Table D 4: The ELVs that were required for the two TELs received for the NWIRBD. The sites these were issued to are no longer in operation and are historic. Neither of these TELs used differential concentrations.

Farm	Discharge Vol (m ³ /day)	Temperature (°C)	pH	BOD ₅ (mg O ₂ /L)	SS (mg/L)	Ammonia (mg N/L)	Ortho-phosphate (mg P/L)	Total Phosphorus (mg P/L)
NWIRBD-A	100		6.0 – 8.5	5	10		0.05	0.1
NWIRBD-B	30	25°C max	6.0-9.0	5	10	0.2		0.2

Table D 5: The conditions that are required to be met by the licence holders in the ERBD. The copies of the TELs received from the LA were dated from the 1990's and may not be the current licence with subsequent changes in environmental legislation. The ELVs are also based on differential concentration.

Farm	Discharge Vol (m ³ /day)	Temperature (°C)	pH	BOD ₅ (mg O ₂ /l)	DO (min saturation)	% SS (mg/l)	Turbidity (NTU)	Nitrate (mg N/L)	Ammonia (mg N/L)	Ortho-phosphate P/L	Therapeutics (mg/l)
ERBD-A	31968	0	6.0-9.0	15	60	10	5	0.002	0.4	0.2	0.002 ¹
ERBD-B	31968	0	6.0-9.0	15	60	10	5	0.002	0.4	0.2	0.002 ^{1,2}
ERBD-C	31968	0	6.0-9.0	15 ³	60	10	5	0.002	0.4	0.2	0.002 ^{1,2}

¹ Malachite Green (100% active substance), Formalin (100% active substance), Emtryl and Chloramine T or B, ² Twice yearly sampling for therapeutics, ³ Quarterly monitoring for BOD₅.

Table D 6: The conditions which are required by the LAs in the SERBD. The ELVs required by this LA are differential values based on the influent and effluent waters.

Farm	Discharge Vol (m ³ /day)	pH	BOD ₅ (mg O ₂ /L)	SS (mg/L)	Total Ammonia (mg N/L)	Total Phosphorus (mg P/L)
SERBD-A	18316.8	± 0.5 U/S*	2	10	0.03	0.05
SERBD-B	12182.4	± 0.5 U/S*	2	10	0.05	0.05

*Allows an increase of 0.5 with regards to the upstream (U/S) value.