PUBLIC CONSULTATION ON THE PROPOSED METHODOLOGY TO ASSESS THE IMPACT OF ABSTRACTIONS ON WATERBODIES AND IDENTIFY SIGNIFICANT ABSTRACTIONS IN IRELAND

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1 Why are we consulting with you?

On 28 August 2024, the Water Environment (Abstractions and Associated Impoundments) Act 2022 and associated Water Environment (Abstractions and Associated Impoundments) Regulations (S.I. No. 419/2024, S.I. No. 418/2024 - (Licensing Fees)) came into operation with the commencement order S.I. No. 417/2024. The EPA is the competent authority for implementing a licensing regime for water abstractions.

Any abstraction equal to or greater than 2,000 m^3/day will require an abstraction licence. Any abstraction between 25 m^3/day and <2,000 m^3/day will be assessed by the EPA to determine if it is a significant abstraction. If an abstraction is deemed to be significant, an abstraction licence will be required.

The purpose of this consultation is to seek your views on the assessment methodology and hydrological limits that will be implemented by the EPA to assess whether an abstraction is considered to be a significant abstraction.

The consultation period is now open and will close on 28 March 2025. The EPA will review the outcomes of this consultation process and publish the methodology on the EPA website. The published methodology will be reviewed as required and at a minimum, every six years.

Feedback can be guided by the questions below. Please forward any comments you may have to edenabstractionsupport@epa.ie

1) Do you have any comments on the proposed approach and hydrological limits for assessing river waterbodies (Section 3.1)?

2) Do you have any comments on the proposed approach and hydrological limits for assessing lake waterbodies (Section 3.2)?

3) Do you have any comments on the proposed approach and hydrological limits for assessing groundwater bodies, including the impact on surface waterbodies and the supporting conditions of groundwater dependent terrestrial ecosystems (Section 3.3)?

4) What are your views on the proposed significance assessment for associated impoundments (Section 3.4)?

5) What are your views on abstractions not being identified as a significant abstraction where the abstraction volume is less than 1% of the volume of water which can sustainably be abstracted (Section 3)?

2 What is a significant abstraction?

The Water Environment (Abstractions and Associated Impoundments) Act 2022 defines a significant abstraction as an abstraction on its own or together (cumulatively) with other abstractions that:

a) alters, or is likely to alter, the hydrological regime of a body of surface water or a body of groundwater such that the water body fails or is likely to fail to meet its environmental objectives;

b) alters or modifies, or is likely to alter or modify, the flow condition, continuity or morphological condition of a body of surface water as a result of the existence or operation of an associated impoundment, such that the water body fails or is likely to fail to meet its environmental objectives; or

c) causes or is likely to cause a protected area to fail to achieve its environmental objectives.

The principles and hydrologic limits which form the basis of the significant abstraction assessment are set out in Section 18 (4) of the Act, and there is a requirement to have specific regard to the following elements:

In the case of an abstraction from a surface waterbody –

- the hydrological regime of the body of surface water and the impact of an abstraction on river continuity and the morphological condition of that water body;
- the impact or likely impact of an abstraction on the applicable biological quality elements set out in Schedule 5 to the Regulations of 2009, as amended;
- the impact or likely impact of the abstraction on a protected area.

In the case of an abstraction from a groundwater body –

- changes or likely changes to the level of the body of groundwater, taking account of the available groundwater resource and the long-term annual average rate of abstraction;
- the balance between the abstraction and the recharge of water in the body of groundwater;
- the impact or likely impact of the abstraction on the status of surface waters which are hydrologically connected to the body of groundwater;
- the impact or likely impact of the abstraction on a terrestrial ecosystem which depends directly on the body of groundwater;
- any sustained alteration to the flow direction of water which may cause salt water or other intrusion to the body of groundwater;
- the impact or likely impact of the abstraction on a protected area.

3 Principles and Hydrological Limits

This section provides a summary of the proposed methodologies and hydrological limits that will be used by the EPA to initially assess the impact of abstractions on waterbodies and to determine if the abstractions are significant abstractions.

As defined in the Water Environment (Abstractions and Associated Impoundments) Act 2022, significant abstraction assessments will only consider abstractions registered on the national water abstraction register and proposed abstractions that meet or exceed the registration threshold (25 m^3/day).

Wallingford Hydrosolutions developed a water resources model called Qube that has been used by each of the UK environment agencies to evaluate the impact of abstractions on water resources. The Qube model has been modified for Irish conditions, with the EPAs existing HydroTool model used for river flow modelling. This enables the EPA to assess the impact of abstractions on surface water bodies in a comparable manner to Northern Ireland. The EPA will use the Qube model to assess the cumulative impact of abstractions on the water environment, taking account of available information on wastewater discharges and any significant transfers of water e.g. from canals to rivers and vice versa. The EPA will use its existing approach (EPA, 2024) to assess the impact of abstractions on groundwater bodies.

To meet the environmental objectives set out in Section 2 (above), different hydrological limits will apply to water bodies with high status environmental objectives to those with good status environmental objectives. Where a water body's environmental objective is less than good status, an objective of good ecological potential applies. Where water abstraction has been identified as a specified use (activity) for a water body, and is the reason for the lower environmental objective, the abstraction is deemed to be significant and hydrological limits and other conditions will be established under the abstraction licence to ensure the good ecological potential objective is met.

The methodologies and hydrological limits for water bodies, set out in this document, are important factors in the protection of an associated European sites (designated under the Birds and Habitats Directives). Water abstractions will be identified as a significant abstraction where it is assessed that the abstraction will or is likely to compromise the achievement of the standards and objectives established for water dependant protected species and natural habitats of European sites.

The definition of significant abstraction requires that all water abstractions (in a catchment) contributing to a water body failing, or are likely to cause a water body to fail to meet its environmental objectives, are to be identified as a significant abstraction. There may be many registered abstractions located in the catchment area of water bodies failing to meet their environmental objectives, but some of these abstractions may not be causing the waterbody to fail.

The EPA proposes that abstractions between 25 m^3/day and <2,000 m^3/day will not be identified as a significant abstraction where the abstraction volume is less than 1% of the volume of water which can sustainably be abstracted from a river. The remaining abstractions in these catchments will be identified as significant abstractions, subject to the engagement process set out in Section 18 (6 – 11) of the Act.

In accordance with Section 18 (9) of the Act, the EPA will further review this approach, taking account of the monitoring data, risk assessment and environmental condition (status) of the water bodies impacted by abstraction pressures. If water bodies continue to fail to meet their environmental objectives because of abstraction pressures, the EPA may consider issuing licences, with conditions, to some or all of the other abstractions in the catchment.

Where there is evidence that an abstraction between 25 m^3/day and <2,000 m^3/day is dependent upon an impounding structure, the abstraction will be identified as a significant abstraction, subject to the engagement process set out in Section 18 (6 – 11) of the Act. This is because the impact of impounding structures on the morphology, hydrology or continuity of surface waters will require a site-specific assessment, by those carrying out the abstraction, to determine if the impounding structure is impacting on the environmental objectives of the surface water body being achieved.

Where an abstraction is identified as being a significant abstraction, the EPA will communicate the reasons for its decision to the abstractor, using the engagement process set out in Section 18 (6 – 11) of the Act. If there is no material reason provided that would alter the EPA's decision, then the abstractor will be asked to apply to the EPA for an abstraction licence.

3.1 River waterbody assessment

The river waterbody assessment is used to determine whether adequate flow is being maintained in the waterbody and associated protected areas to support and maintain healthy ecology. These flows are defined within the context of the Water Framework Directive (WFD) as the *"hydrological regime consistent with the achievement of the environmental objectives of the WFD in natural surface water bodies as mentioned in Article 4(1)".* Note, European WFD guidance recognizes that the term 'e-flows' are sometimes used to describe ecological and environmental flows. Hereafter in this consultation document, e-flow is taken to mean the environmental flow limit(s) that needs to be met for a water body to meet its WFD environmental objectives.

River flows that are lower than Q95 (the flow that is exceeded 95% of the time) are low flows and during low flows the river ecology is most vulnerable. As the flow increases, the water temperature is more stable, and the river has greater capacity to dilute pollutants and is more navigable for fish and other aquatic species. The ecology in small fast flowing (flashy) upland rivers is more susceptible to reduction in flow, e.g., caused by abstractions, than in larger, lowland rivers, or highly groundwater fed rivers.

The specific allowable abstraction is dependent on river typology. The criteria for categorising river type are based on UK research that looked at the impact of abstractions on river and lake ecology (SNIFFER, 2006) and have been adapted for use in Ireland (Bree, 2018). The river typologies are detailed in ***Table 1*** and are specific to the assessment of abstractions in Ireland. ***Figure 1*** maps the river water body typologies in Ireland.

Table 1 Criteria for identifying river types to which the river flow limits apply

River type	River Type Description
A1	Low rainfall, lowland catchments with moderate groundwater contribution
A2-Downstream	Moderate rainfall, moderate-lowland catchments with moderate-high groundwater contribution
A2-Headwater	Low-moderate rainfall, headwater catchments with moderate-high groundwater contribution
B1	Moderate-high rainfall, moderate-lowland catchments with moderate groundwater contribution
B2	Typology not applicable in Ireland
C1	Typology not applicable in Ireland
C2	High rainfall, moderate-lowland catchments with low-moderate groundwater contribution
D1	Typology not applicable in Ireland
D2	High rainfall, steeply sloping catchments with low-moderate groundwater contribution
Unclassified	Unclassified due to data limitations[1]

[1] Groundwater contribution and/or catchment area e.g. cross border water bodies could not be estimated.

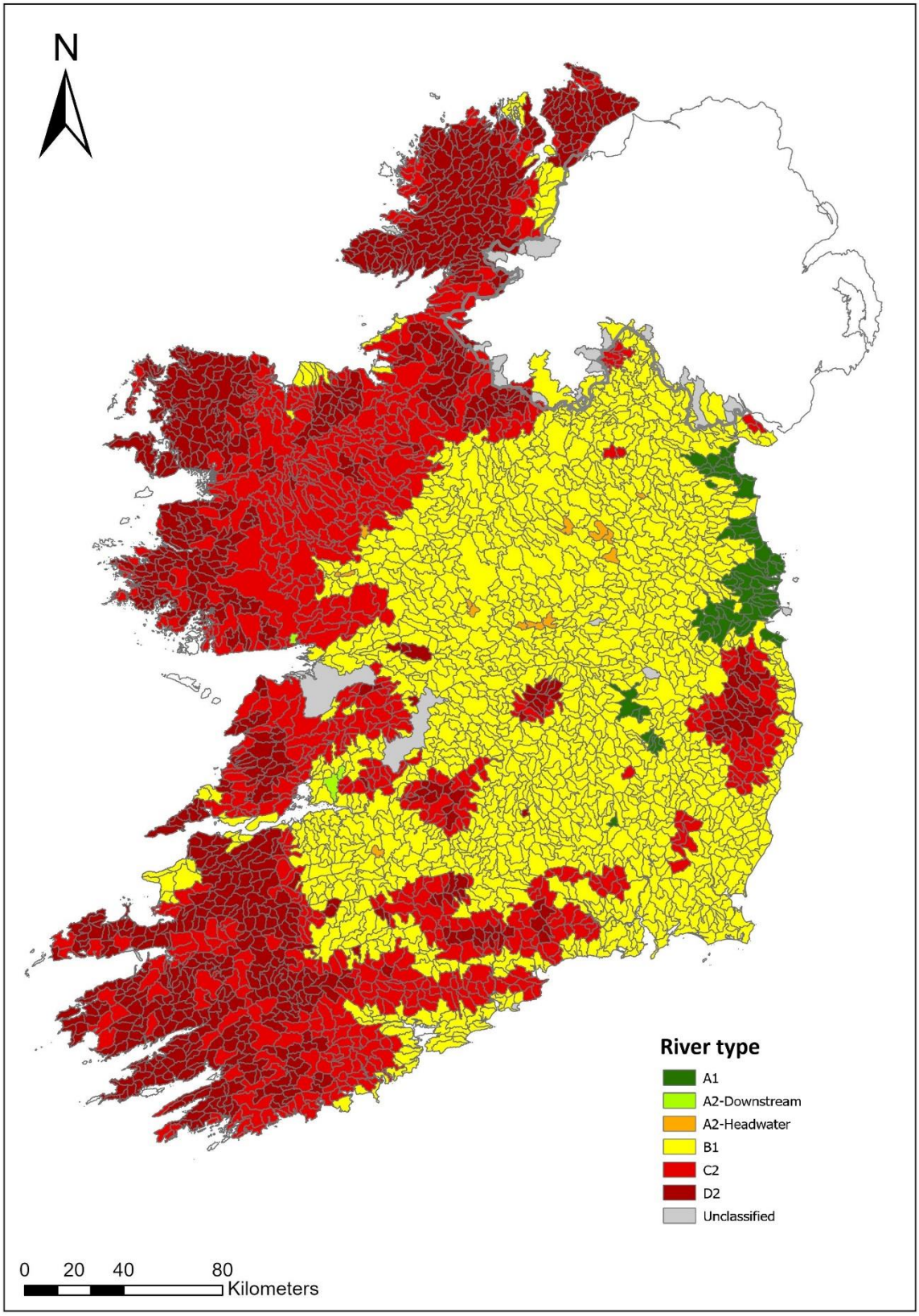

Figure 1 River waterbody typologies in Ireland

The e-flow limits being proposed for use in Ireland, are those that were developed by the UK Technical Advisory Group (UKTAG) and are the limits used in Northern Ireland. The e-flow limits are flow duration curve-based limits which allow for a given percentage of the flow to be abstracted at various naturalized[2] flow percentiles.

To determine whether an abstraction, or the cumulative impact of abstractions, are significant abstractions, the river flow limits detailed in ***Table 2*** are proposed for high status environmental objective river waterbodies and the river flow limits detailed in ***Table 3*** are proposed for good status environmental objective river waterbodies.

Table 2 High status environmental objective river flow limits

Maximum permitted total abstraction per day as a percentage of daily natural flow (Q)		
River Type	Flow > Q95	Flow < Q95
	(% change allowed from the natural flow)	
All	10	5

Table 3 Good status environmental objective river flow limits

Maximum permitted total abstraction per day as a percentage of daily natural flow (Q)				
River Type	Flow > Q60	Flow > Q70	Flow > Q95	Flow < Q95
	(% change allowed from the natural flow)			
A1	35	30	25	20
A2 (downstream), B1	30	25	20	15
A2 (headwaters), C2, D2	25	20	15	10

As an example, for an A1 river type (low rainfall, lowland catchment) with a good environmental objective, when the naturalised flow is at Q95-Q99 (low flow), the allowable percentage that can be abstracted is 20%. Between Q70-Q95, the allowable percentage abstraction increases to 25%, and so on.

Any potential immediate or localized impact from an abstraction, may be negated by returned water e.g., a discharge, or other natural inflow to a water course. Therefore, to address this, we propose to follow the approach taken in Northern Ireland (UKTAG, 2007); where an abstraction results in the e-flow standard being breached, the spatial extent (length) of the river water body where the breach occurs is calculated. For good status objective rivers, where the breach is less than 15% of the total river waterbody length, the contributing abstractions are not deemed to be significant abstractions with regard to the e-flow. Where a river water body has a high status objective, the breach should not be greater than 5% of the total river water body length.

[2] These are the flows that are expected to naturally exist if there are no artificial impacts on a river.

Where the e-flow standard is breached in greater than 15% (for good status objective rivers) or 5% (for high status objective rivers) of the total river waterbody length, the abstractions contributing to the breach are identified as significant abstractions, subject to the engagement process set out in Section 18 (6 – 11) of the Act.

3.2 Lake waterbody assessment

Water abstractions in and/or upstream of a lake waterbody may alter the natural range of water level fluctuations which in turn can impact lake ecosystem dynamics and ecological health. The ecological quality of lakes can be significantly affected by changes to the extent of shallow water through which sunlight can penetrate to the lake bed. Known as the littoral zone, this shallow water habitat is important ecologically, supporting rooted plants (macrophytes) and other biotic species. Lowering the natural water level and thereby increasing the extent of very shallow areas can also exacerbate the erosive effects of wave action which can have an additional effect on biotic species and sediment.

Water clarity (which allows light to penetrate beneath the surface) and lake bathymetry (lake shape and depth) are important when considering the impacts of reduced water levels, e.g., as caused by abstractions.

- Peaty lakes are typically less than clear water lakes, where a “Peat” lake is considered to have (i) a mean water colour greater than 90 hazen units; or (ii) where information on colour is unavailable, more than 75% of the soils of its catchment are comprised of peat.
- In deep, steep-sided lakes, the area of the habitable (littoral) zone may be affected less from water level changes than shallow gently sloping lakes. The latter can be significantly impacted by relatively small changes in water level.

The proposed lake water level limits for lakes with high, good, moderate and poor status environmental objectives are detailed in ***Table 4***.

Table 4 Environmental limits for lake water levels

Reduction in the lake habitable zone area that must not to be exceeded 99% of the days in any year			
High	Good	Moderate	Poor
1%	5%	10%	20%

The habitable zone lake surface is dependent on whether the lake is considered to have the geological sub-type "Peat" or "Non-Peat".

The habitable zone is the area of the lake that enables the growth of rooted plants (macrophytes) or bottom-living algae. It’s extent is dictated by the availability of light, which allows plant growth. It is the extent of the lake surface area from the natural lake shore[3] to a depth 5 metres beneath the depth at which light can penetrate into the lake.

In the absence of field data to the contrary, the depth to light penetration is taken to be 2 metres for lakes with the geological sub-type of “Peat” and 7 metres for “Non-Peat” lakes.

An example of a lake habitable zone area is shown in **Figure *2***.

[3] The natural lake shore is the lake shore that would exist if there were no abstractions, discharges or other artificial influences.

Figure 2 Example of the lakes habitable zone area (illustrative purposes only)

Where a lakes habitable zone area is reduced (due to abstraction) by more than 1% in high status objective lakes, or 5% in good status objective lakes, for more than 1% of the days in any year, the abstraction(s) is identified as a significant abstraction, subject to the engagement process set out in Section 18 (6 – 11) of the Act.

Where there are insufficient data (e.g., insufficient bathymetry or water clarity data) to complete the lake waterbody assessment using the environmental limits in ***Table 4***, the limit proposed in ***Table 5*** may be used as an alternative approach to assess whether a lake is potentially at risk of over-abstraction.

Table 5 Alternative lake risk assessment method

	% allowable change in natural Q50 lake outflow
All lakes	10

Lake waterbodies are assessed by calculating the ratio of the Q50[4] naturalised river outflow to the total net influence of abstractions and discharges (total abstractions minus total discharges) from within and upstream of the lake. Where the ratio is 0.1 (i.e., 10%) or greater, the contributing abstractions may alter the natural range of water level fluctuations which in turn can impact lake water quality.

[4] Q50 refers to the natural flow exceeded for 50 per cent of the time.

Where the ratio is 0.1 or greater the abstractions contributing to the ratio being exceeded are identified as significant abstractions, subject to the engagement process set out in Section 18 (6 – 11) of the Act.

3.3 Groundwater body assessment

Groundwater abstractions, either alone or in combination with other abstractions, can directly impact groundwater resources, leading to an unsustainable lowering of groundwater levels or due to different quality groundwater e.g., saline waters, being introduced. Groundwater abstractions can indirectly impact surface water resources, which may alter the supporting conditions needed to sustain a healthy ecology in surface waters and groundwater dependent wetlands (GWDTE). The approach and hydrological limits used to identify significant groundwater abstractions in Ireland have been in place for several years and are documented in the publication *Methodology for Establishing Groundwater Threshold Values and the Assessment of Chemical and Quantitative Status for Groundwater, including an Assessment of Pollution Trends and Trend Reversal*. This publication was updated in 2024 (EPA, 2024) and is summarized in the following sections.

3.3.1 Groundwater body water balance

Groundwater recharge is water (precipitation) that percolates through the soil and subsoil and replenishes groundwater stored in an aquifer. Where groundwater is being abstracted from a groundwater body via a well or borehole, it is important that the volume of groundwater abstracted over a prolonged period does not exceed the long-term / annual average recharge to the groundwater body. This is to ensure that sufficient groundwater resources remain in the aquifer to support other water uses and the wider environment.

Groundwater levels vary continuously in response to both seasonal fluctuations in recharge and discharge, and in response to groundwater abstractions. However, the presence of a sustained long-term decline in water levels may be a result of over-abstraction. Therefore, long-term water level data are examined in conjunction with the ratio of abstraction volume to recharge to determine whether an abstraction is having a significant impact on groundwater resources.

Subject to the engagement process set out in Section 18 (6 – 11) of the Act, an abstraction is identified as a significant abstraction where the cumulative volume of water abstracted from the groundwater body is greater than 100% of the long-term average groundwater recharge for that groundwater body.

Subject to the engagement process set out in Section 18 (6 – 11) of the Act, an abstraction is identified as a significant abstraction where there is evidence of falling groundwater levels due to the abstraction(s) and the cumulative volume of water abstracted from the groundwater body is greater than:

- 5% of the average groundwater recharge of the groundwater bodies supporting a groundwater dependent wetland (GWDTE)
- 20% of the average groundwater recharge of bedrock groundwater bodies; or
- 30% of the average groundwater recharge of gravel groundwater bodies (EPA, 2024).

3.3.2 Presence of saline (or other) intrusions

Saline (or other) intrusions can occur when the saline-freshwater interface in coastal regions is drawn inland and upwards by an abstraction. Groundwater abstraction can also lead to upward movement

(up coning) of poor quality water, the leakage of saline surface waters to an underlying groundwater body, or drawing in of poorer quality groundwater from an adjacent aquifer.

An assessment for the presence of saline (or other) intrusion is undertaken for groundwater abstractions to determine if the abstraction is causing an exceedance of the groundwater threshold value for these water quality parameters, and has caused sustained upward trends in Electrical Conductivity and Chloride concentrations in groundwater. Exceedance of the relevant Threshold Values and the presence of a statistically significant upward trend in both Chloride and Electrical Conductivity at an abstraction indicates the presence of saline intrusion.

Where this occurs, the abstraction is identified as a significant abstraction, subject to the engagement process set out in Section 18 (6 – 11) of the Act.

3.3.3 Impact on surface waterbodies

Streamflow depletion is the reduction in streamflow that occurs when groundwater baseflow to streams is intercepted by groundwater abstractions. In some cases, where wells are hydrologically connected to streams, groundwater abstractions can draw water from the stream itself.

The potential effects of streamflow depletion are mainly determined by groundwater abstraction rates, distances from streams and the hydrogeological connectivity between the groundwater flow system and the streams. In principle, streamflow depletion will be greater where abstraction rates are higher and groundwater-surface interactions are more significant. Distance is not a primary criterion, as pumping far away can also have significant, if more delayed, effects.

A risk-based approach can be used to determine the impact of groundwater abstractions on rivers and to identify abstractions that may be depleting river flows.

Streamflow depletion modelling (Moe, 2024) indicates that groundwater abstractions will not pose a risk to achieving the environmental objectives of an associated surface water body, where:

- The groundwater abstraction is less than 100 m^3/d (as a daily maximum) and is abstracting from a poorly productive aquifer and the abstraction is situated in either i) a predominantly Low groundwater vulnerability setting, or ii) a Moderate groundwater vulnerability setting where subsoil permeability (as mapped by Geological Survey Ireland) is Low.

- The groundwater abstraction is less than 250 m^3/d (as a daily maximum) and greater than 150 m from streams, irrespective of groundwater vulnerability setting.

- The groundwater abstraction is less than 250 m^3/d and is abstracting from a karst aquifer where the karst features have been extensively mapped[5], provided the abstraction is not within the estimated zone of contribution of a downstream/downgradient spring or stream.

For each of the scenarios above the groundwater abstraction will not be identified as a significant abstraction.

For all remaining groundwater abstractions between 25 and <2,000 m^3/d, the potential streamflow depletion caused by the abstraction should be calculated to determine if those groundwater

[5] By referring to GSI's karst database or conducting first-hand karst mapping, potentially with dye tracer tests. Drilling records can also be useful indicators of karst features.

abstractions pose a risk to achieving the environmental objectives of an associated surface water body. The volume of water depleted from the river will be a proportion of the total volume abstracted, as dictated by the hydrogeology[6] and distance from the river. Once calculated, the streamflow depletion caused by the groundwater abstraction will be considered as part of the cumulative surface water abstractions outlined in sections 3.1 and 3.2.

Any groundwater abstractions contributing to an e-flow breach are identified as significant abstractions, subject to the engagement process set out in Section 18 (6 – 11) of the Act.

3.3.4 Impact on supporting conditions of groundwater dependent terrestrial ecosystems (GWDTEs)

Groundwater dependent terrestrial ecosystems (GWDTEs) are wetlands where the habitats and species are dependent on groundwater levels or flow to maintain the environmental supporting conditions that are required to sustain the habitat and/or species. The GWDTEs included in the National Protected Areas register, which is established under Regulation 8 of S.I. 722 of 2003 (as amended), were identified by the National Parks and Wildlife Service (NPWS). These GWDTE were identified by NPWS because the designated flora, fauna or habitat that depend on groundwater are not in a satisfactory condition. In some instances, this is due to a reduction in groundwater quantity (flow or levels), caused by groundwater abstraction.

Groundwater abstractions can reduce or alter the groundwater levels or flow needed to maintain the habitats and species in the GWDTE. As with stream flow depletion, potential effects on the groundwater levels or flow can be dictated by groundwater abstraction rates, distances from the GWDTE and hydrogeological conditions.

A risk-based approach can be used to determine the impact of groundwater abstractions on GWDTE and to identify abstractions that may be reducing the groundwater flow or levels needed to sustain the flora, fauna or habitat. In general, groundwater abstractions will not alter the groundwater levels or flow needed to maintain the habitats and species in the GWDTE (Moe, 2024) where:

- The groundwater abstraction is less than 100 m^3/d (as a daily maximum) and is abstracting from a poorly productive aquifer and the abstraction is situated in either i) a predominantly Low groundwater vulnerability setting, or ii) a Moderate groundwater vulnerability setting where subsoil permeability (as mapped by Geological Survey Ireland) is Low.
- The groundwater abstraction is less than 100 m^3/d (as a daily maximum) and is greater than 250 m from the boundary of a GWDTE or habitat with a water dependent qualifying interest, irrespective of aquifer type and vulnerability setting.
- The groundwater abstraction is less than 250 m^3/d and is abstracting from a karst aquifer where the karst features have been extensively mapped[7], provided the abstraction is not within the estimated zone of contribution of a downstream/downgradient GWDTE, or habitat with a water dependent qualifying interest.

For each of the scenarios above the groundwater abstraction will not be identified as a significant abstraction, unless there is case specific evidence to the contrary.

[6] Assessments involving karst must be conducted by suitably qualified and experienced hydrogeologists. In any karst-conduit scenario, the use of simplified analytical solutions is not appropriate.

[7] By referring to GSI's karst database or conducting first-hand karst mapping, potentially with dye tracer tests. Drilling records can also be useful indicators of karst features.

For all remaining groundwater abstractions between 25 and <2,000 m^3/d, the potential reduction in groundwater levels or flows to the GWDTE that are caused by the abstraction should be calculated to determine if those groundwater abstractions pose a risk to achieving the supporting conditions needed to sustain the GWDTEs habitat and/or species.

Any groundwater abstractions that have reduced the groundwater level or flow to a GWDTE, such that the groundwater dependent qualifying interests of the wetland have failed their condition assessment under the Habitats Directive[8] will be identified as significant abstractions, subject to the engagement process set out in Section 18 (6 – 11) of the Act.

3.4 Significance Assessment for Associated Impoundments

An "impoundment", as defined in the Act, means the doing of anything whereby the water level or flow in surface waters or the continuity of the morphological condition of a body of surface water is permanently or temporarily changed by means of a structure, including a dam or weir, situated in the water and built or maintained for the purpose of an abstraction or works situated in the water and carried out for that purpose. An "associated impoundment" is an impoundment on which an abstraction depends and cannot exist without.

Impoundments alter the natural distribution and timing of river flows in natural ecosystems. Impoundments may also act as barriers to the movement of sediment and migration of aquatic species. For example, large dams may prevent the free passage of fish, which may impact on the structure and diversity of fish populations and therefore on fish status. The environmental impacts of impoundments can be considered within a hierarchical framework of interrelated effects. Bergkamp et al. (2000) distinguish first, second and third order effects. In general, the complexity of interacting processes increases from first, to third order impacts, as illustrated in **Figure 3**.

[8] The links between water level, flow and ecology are complex and are often wetland specific. Therefore, assessments involving groundwater dependent terrestrial ecosystems should involve consultation with suitably qualified and experienced ecologists.

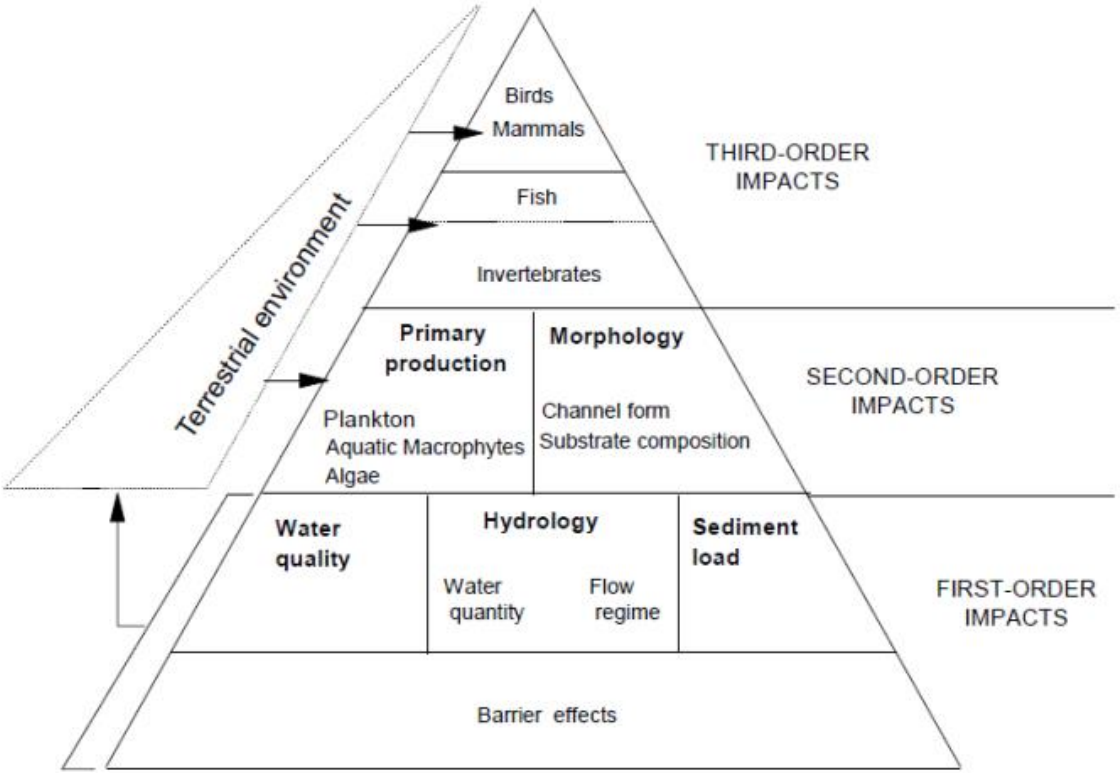

Figure 3 Framework for assessing the impact of barriers on river ecosystems (Bergkamp et al., 2000)

There have been numerous scientific studies across the world that have considered the impact of different barriers (including impoundments) to aquatic species migration (e.g., ONEMA, 2014). The size and nature of an associated impoundment may result in partial or complete environmental impact. The following points outline the key criteria that should be considered in the assessment of associated impoundments.

- the flow velocity,
- the difference in water head (depth) upstream and downstream of the impoundment, which is a factor of the impoundment size (height from the base to the crest of the impoundment), plus the available head (depth) of water above the crest of the impoundment,
- the impoundment design (vertical or sloped), and
- design features (e.g., rock ramps, fish pass) that allow aquatic species to navigate the impoundment, or control features that allow sediment release.

Where there is limited or no information on these criteria, there is no appreciable mechanism to risk assess the impacts of the impoundments on the wider environment.

The environmental impact of an associated impoundment will depend on the impoundment design / function itself and the prevailing flow conditions. During low flows, providing that water is flowing over an impoundment, non-leaping species e.g., lamprey, will not be able to overcome an obstacle greater than 10 cm in height. Fish, that are able to leap, can overcome larger obstacles, e.g., trout and salmon can respectively overcome obstacles greater than 25 cm and 50 cm in height.

Sediment migration downstream depends on the ability of water and sediment to pass over the impoundment. This sediment may pass still naturally during higher flows, or may require manual intervention to remove it from behind some impoundments.

As the velocity and water depth vary in response to weather, flow conditions and the influence of the abstraction itself, a site-specific assessment is required by those carrying out the abstraction, to determine if an associated impoundment is causing environmental issues and to identify any measures that can be carried out to mitigate the issues.

Broadly these measures can be described as solutions to allow upstream and downstream passage of fish and other aquatic species at the impounding structure (e.g., a rock ramp or fish pass); flow related solutions to provide enough water to facilitate migration of aquatic species (e.g., spawning flows); and flows that allow the passage of sediment downstream (e.g., flushing flows). The overall flow regime for an associated impoundment may have many components. This may include ensuring the minimum e-flow is maintained at all times, with additional periodic releases of water, or seasonal releases of water to coincide with the migratory species spawning periods in the freshwater catchment (see **Figure 4**).

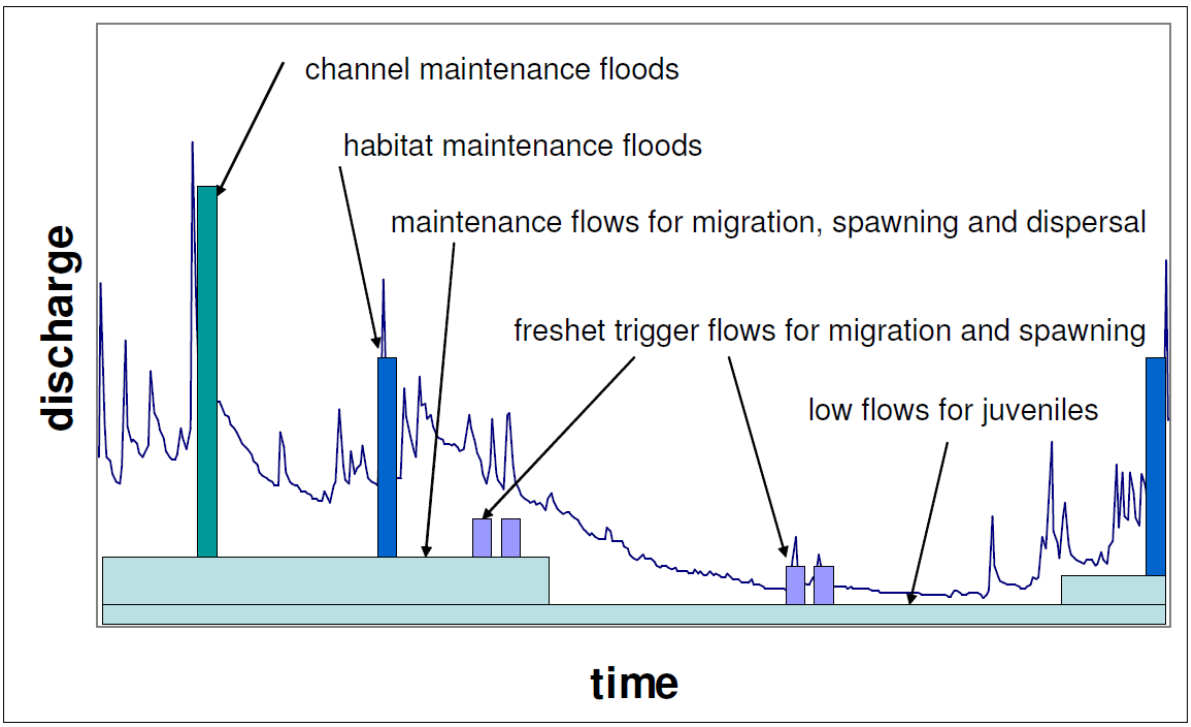

Figure 4 Conceptual "building block" flow components required to deliver the environmental supporting conditions in rivers (SNIFFER, 2007)

Given that bespoke, and often complex, assessments and solutions are required in relation to impoundments, all abstractions between 25 and <2,000 m^3/d that depend on an associated impoundment, will be identified as a significant abstraction, subject to the engagement process set out in Section 18 (6 – 11) of the Act.

4 Supporting Documents

Bergkamp, G., McCartney, M., Dugan, P., McNeely, J., Acreman, M. et al. (2000). *Dams, Ecosystem Functions and Environmental Restoration*. Final Version, prepared for the World Commission on Dams (WCD)

Bree (2018). *Flow Duration Curves for Ungauged Catchments in Ireland. Annual and Monthly Flow Duration Curves and Mean Flows*. Available at:

https://www.epa.ie/publications/monitoring--assessment/freshwater--marine/FDC-and-Meanflow-for-Ungauged-Catchments-TBree-Final-December2018.pdf

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