Classification of good ecological potential in water bodies designated as heavily modified water bodies because of impounding works

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Scope and purpose

1.1 This paper provides a generic checklist to help estimate the ecological potential class of water bodies designated as heavily modified because of impounding works[1]. The checklist is designed to enable the ecological potential class of large numbers of heavily modified water bodies to be estimated prior to the publication of the first river basin management plans in 2009.

1.2 The checklist is not a design manual. It does not identify the precise design of mitigation needed at a site. Where a site is being considered for improvement or where new impounding works are being proposed, the checklist will serve only as a starting point from which appropriate, site-specific mitigation will be identified.

1.3 The checklist will be reviewed and updated for each river basin planning cycle as methods and understanding improve. The reviews will take account of information from environmental monitoring programmes and research projects on the impacts resulting from impounding works and on the effectiveness of, and practicable targets for, different mitigation techniques.

Relevance of measures for classification

1.4 By definition, measures that are not effective at delivering ecological improvements do not constitute mitigation and are therefore not relevant to classification. Such measures will be excluded when using the checklist to classify water bodies and when action is being proposed in relation to particular sites. For some techniques, there may be only low confidence in their ability to deliver more than very minor ecological improvements. Where the level of confidence in the effectiveness of a particular mitigation measure is not reasonably high, that mitigation will also be excluded when making classification decisions and when considering action.

1.5 Mitigation listed on the generic checklist will also be excluded from consideration when classifying a particular water body if the particular circumstances - including the characteristics of the use and of the water body - are such that:

(i) the adverse impact on the water environment that the mitigation is designed to address is not significant;
(ii) the mitigation would have significant adverse impacts on the designated use;

[1] The procedures necessary for applying the checklist are a matter for the individual agencies of UKTAG to determine and may differ between those agencies

(iii) the mitigation would have a significant adverse impact on the wider environment; or
(iv) there is no known practicable technique which could deliver the mitigation[2]

1.6 With respect to point (i) of paragraph 1.5, a 'significant adverse impact on the water environment' means an impact that on its own, or cumulatively with other impacts, would be inconsistent with the achievement of good ecological status in an equivalent but non-heavily modified water body. The UKTAG environmental standards and conditions,[3] together with appropriate consideration of the spatial extent of the impact,[4] will be used to help identify significant impacts on the water environment.

1.7 With respect to point (ii) of paragraph 1.5, adverse impacts on the use may result from mitigation affecting the yield of the reservoir. Mitigation which does not affect the yield is unlikely to impact on the use. The significance of any adverse impacts will depend on a number of factors including, for example, the magnitude of the impact and the degree to which it can be offset (e.g. using supply from other sources).

1.8 With respect to point (iii) of paragraph 1.5, adverse impacts on the wider environment may result, for example, where the mitigation would adversely affect biodiversity or built heritage interests (e.g. listed mills and lades). The significance of these impacts will depend on their magnitude and duration and on the importance of the affected interest.

Application of the checklist in classification

1.9 In the first instance, the checklist is expected to be applied as screening tool to enable a first estimate of whether the ecological potential of water bodies is either good or better, or worse than good. This will be done on the basis of the presence and absence of mitigation.

1.10 Where all the mitigation on the checklist is recorded as present, the hydromorphological alterations caused by the impounding works will be considered to be consistent with the achievement of good ecological potential[5].

1.11 A water body will be estimated to be worse than good ecological potential if mitigation listed on the checklist is either absent or ineffectively designed or operated.

1.12 The results of this screening assessment will be used to prepare the draft river basin management plans in 2008.

[2] Mitigation will not be excluded from the checklist on the grounds that it would be infeasible for technical reasons to implement a mitigation technique within a particular time period. Technical constraints governing the speed with which a mitigation technique can be implemented will be taken into account in the objective setting process.
[3] http://www.wfduk.org/UK_Environmental_Standards/
[4] UKTAG is expected to make recommendations on this later in 2007
[5] There may be other impacts on the water body, such as pollution impacts, which prevent the body achieving good ecological potential overall.

1.13 Where needed to determine if any of the mitigation identified as absent or ineffective should be excluded from consideration in classification on the basis of point (i), (ii), (iii) or (iv) of paragraph 1.5, site specific information will be sought during 2009 for water bodies estimated to be at worse than good ecological potential.

1.14 The site-specific information collected in 2009 will be used to improve confidence in the classifications in time for their publication in the first river basin management plans at the end of 2009.

Relevance of the checklist to proposed new impounding works

1.15 The checklist is intended to serve only as a starting point for identifying mitigation applicable in relation to proposals for new impounding works. The aim should be that water bodies subsequently designated as heavily modified because of the impacts of new impounding works will achieve good ecological potential. However, as noted above, the checklist is not a design manual for identifying precise mitigation requirements.

1.16 Including mitigation in the design of a new impounding works is likely to be easier and cheaper than retrofitting mitigation into existing impounding works. Prospective applicants will be expected to include the latest best practice mitigation measures in their proposals. This will help future proof those proposals in relation to the future classification of the affected water bodies as good ecological potential.

1.17 The notes to Section N6 below identify mitigation additional to that on the checklist which should be considered for new impounding works.

Description of checklist

2.1 The checklist is set out in Table 1.

2.2 Column A of the checklist is divided into the main types of adverse impacts that can result from the presence and operation of impounding works in the absence of effective mitigation. The occurrence and significance of these impacts will depend on the particular design and use of the impounding works and on the characteristics of the part of the water environment in which the impoundment is located.

2.3 Column B is used to indicate whether the corresponding impact referred to in column A is: (i) present or would be present in the absence of existing mitigation [enter "a" for applicable]; or (ii) not present even in the absence of any existing mitigation [enter "n/a" for not applicable][6]. Where a particular impact is not applicable, the corresponding mitigation target in Column C (see paragraph 2.4 below) and the corresponding mitigation in Column D (see paragraph 2.5 below) will not be considered when classifying the water body.

[6] See point (i) of paragraph 1.5

2.4 Column C summarises the targets for mitigation in relation to each significant impact in Column A.

2.5 Column D and the corresponding notes in Section 3 of the paper identify the mitigation needed to achieve the corresponding mitigation target in Column C.

2.6 Column E is used to indicate whether or not the mitigation in Column D is applicable [enter "a"] or not applicable [enter "n/a"] for one or more of the reasons given in points (ii), (iii) or (iv) of paragraph 1.5 above. Where a particular mitigation is not applicable, it will be excluded from consideration when classifying the water body.

2.7 Column F is used to indicate whether the corresponding mitigation in Column D is in place [enter "✓"] or not [enter "x"].

2.8 Water bodies will be screened to estimate their class based on the presence or absence of mitigation, as indicated by Column F. The confidence reported for water bodies identified on this basis as being worse than good ecological potential will depend on whether Column B and Column E have been completed. If the information necessary to complete both these columns is not available, the confidence in class will be reported as low.

Table 1	Checklist for assessing whether the mitigation necessary to achieve good ecological potential is in place				
Column A	**Column B**	**Column C**	**Column D**	**Column E**	**Column F**
IMPACT OF IMPOUNDING WORKS	a n/a	**MITIGATION TARGET**	**POINTS TO CONSIDER**	a n/a	☑ ☒
Significant adverse impact on the movement of one or more species of salmonid fish between habitats important in their lifecycles		**1. The provision for passage of fish upstream and downstream differs only slightly from the best such provision that could be provided given the use**	**1.1** Are structures or other mechanisms in place and managed so as to enable fish to access waters upstream and downstream of the impounding works (e.g. fish pass; bypass channel; etc) (See Note N1.1)?		
			1.2 Are the volume and timing of flow in the downstream river sufficient to enable and, where relevant, trigger fish migration (See Note N1.2)?		
			1.3 Is the risk of fish mortality in turbines, screens and intakes properly managed to enable downstream fish passage (See Note N1.3)?		
			1.4 Are fish able to access relevant feeder-streams draining into the reservoir at appropriate times for spawning and migration (See Note N1.4)?		
Significant impacts on the downstream river flows necessary to maintain river habitats and their associated aquatic plants or animals		**2. The baseline flow regime in downstream rivers differs only slightly from the ecologically best baseline flow regime that could be provided given the use**	**2.1** Is an appropriate baseline flow regime (i.e. flows other than short-duration higher flows) being maintained in the downstream river (See Note N2.1)?		
Significant impacts on the morphological characteristics of the		**3. The sediment/habitat management regime differs only slightly from the ecologically best**	**3.1** Is there an appropriate sediment management regime at any small dams within the scheme (see Note N3.1)?		

downstream river		**sediment/habitat management regime that could be provided given the use**	**3.2** Is the magnitude and frequency of short-duration higher flows sufficient to maintain river habitats (See Note N3.2)?		
Significant impacts on the water quality of the downstream river		**4. The water quality achieved in downstream river is as equivalent to that at good ecological status as all practicable mitigation can make it**	**4.1** Are good status dissolved oxygen levels being achieved downstream of the impounding works (See Note N4.1)?		
			4.2 Is the thermal regime in waters downstream of the impounding works consistent with good status conditions (See Note N4.2)?		
Significant impacts on the level regime necessary to maintain lake/loch habitats and their associated aquatic plants and animals in the impounded water body		**5. The impoundment level regime differs only slightly from the ecological best lake/loch level regime that could be achieved given the use**[1]	**5.1** Is the rate and range of any artificial drawdown appropriately managed to maintain aquatic plant and animal communities in the shore zones of impoundments with gently shelving shore zones (See Note N5.1)?		
			5.2 Is the seasonal pattern of water levels during each year managed so as to enable the establishment and retention of aquatic plant and animal communities in the shore zone of the impoundment (See Note N5.2)?		

[1]Mitigation target **5** is not applicable for impoundments which are managed for the mass storage of water for use in different seasons from that in which it is collected (e.g. mass storage hydropower schemes, or drinking water supply schemes). This includes mass storage schemes which may have other conjunctive uses, such as contributing to flood alleviation schemes. In mass storage schemes, the variation in water levels between seasons tends to be much larger than in natural lakes/lochs. This creates inhospitable conditions for the establishment and retention of the shore zone plant and animal communities that would otherwise be typical of such waters. Consequently, the mitigation indicated against mitigation target **5** is unlikely to be practicable, given the use.

3. Notes on mitigation targets

N1. Satisfactory passage of fish

Comments on scope
This mitigation target covers mitigation to provide for the passage of salmonid fish only. Mitigation to provide passage for other fish species may be necessary to achieve biodiversity conservation objectives (e.g. in Natura Protected Areas) but will not be included in the checklist for classifying good ecological potential. The appropriateness of including such mitigation in classifying ecological potential will be reviewed early in the next river basin planning cycle in the light of knowledge and experience of the techniques necessary to provide for the passage of other fish species, the feasibility of those techniques and their effectiveness. Is this a reasonable position given current knowledge?

In the checklist as currently drafted, mitigation techniques which would be considered consistent with good ecological potential do not include the use of compensatory stocking programmes or the provision of alternative compensatory fish habitat (e.g. by restoring degraded fish habitat elsewhere). They do include the use of fish passes, bypass channels or capture, transfer and release programmes. Is this appropriate?

N1.1 Account will be taken of whether:

(i) there is a fish pass; bypass channel or other suitable mechanism in place to enable fish to access waters upstream and downstream of the impounding works during key periods of the year for migration;
(ii) there is any evidence from relevant environmental monitoring programmes or research programmes that the pass, bypass or other mechanism is inoperative or otherwise ineffective in enabling fish access to waters upstream and downstream of the impounding works; and
(iii) where relevant, good practice standards for the design and operation of fish passes and bypass channels are met (e.g. in the *Notes for Guidance on the provision of fish passes and screens for the safe passage of salmon*[7] published by The Scottish Office to accompany *The Salmon (Fish Passes and Screens) (Scotland) Regulations 1994*) and…[8]

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N1.2 Account will be taken of whether:

(i) flows entering the river below, but close to, the impounding works from unregulated tributaries are likely to be of sufficient magnitude to enable and trigger migration - and therefore mitigation would be unnecessary [if mitigation would be unnecessary, "n/a" should be entered in Column E];
(ii) where point (i) does not apply, flow releases (coordinated with those relevant under N2 and N3) are being made, or spills occurring, during key periods of the year for migration with the intention or effect of providing for fish passage; and

[7] ISBN 07480 3105 Y (July 1995)
[8] [to insert reference to EA guidance on fish passes]

(iii) there is any evidence from relevant environmental monitoring programmes or research programmes that the pattern of flow releases or spills is insufficient to enable or trigger fish migration at the relevant times.

Where there is evidence referred to in point (iii) above, the pattern of flow release will be compared with that known to be sufficient to enable or trigger fish migration past other impounding works and with the flow patterns pertaining during periods of fish migration in similar but un-impounded river systems.

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N1.3 Account will be taken of whether:

(i) unless the risk of fish mortality associated with passage through intakes and turbines is expected to be low, alternate provision is made to provide safe downstream passage and screens are installed and managed in accordance with current good practice guidance (e.g. in the *Notes for Guidance on the provision of fish passes and screens for the safe passage of salmon*[9] published by The Scottish Office to accompany *The Salmon (Fish Passes and Screens) (Scotland) Regulations 1994*) and…[10]); and

(ii) there is any evidence from relevant environmental monitoring programmes or research programmes that downstream fish passage is significantly compromised

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N1.4 Account will be taken of whether:

(i) there is any evidence from relevant environmental monitoring programmes or research programmes that as a result of the design or management of the reservoir, fish cannot gain access to or from feeder streams important for spawning or onward migration.

Fish access to and from rivers and streams draining into reservoirs can be restricted or even prevented as reservoir levels drop lower than they would naturally (e.g. if there is inadequate flow depth for fish movements to and from the residual water in the reservoir and the feeder streams). The establishment and maintenance of clear access channels to feeder streams at all reservoir levels can help ensure fish access to relevant streams from the residual body of water in the reservoir.

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N2. Satisfactory baseline flow regime

N2.1 The baseline flow regime refers to the basic regulated flow regime in rivers downstream of impounding works, excluding any short-duration higher flows

[9] ISBN 07480 3105 Y (July 1995)
[10] [to insert reference to EA guidance on screens]

(whether released deliberately or not) that resemble or simulate flows resulting from storm-events. The baseline regime is sometimes called the compensation flow. Here it includes any water passing the impounding works other than short-duration higher flows. Relevant research was commissioned by UKTAG and published by SNIFFER in 2007 (WFD82)[11] on the ecologically important components of a baseline flow regime. The criteria below are based on this research.

Account will be taken of whether:

(i) drying of the downstream river as a result of the impounding works is avoided;

And whether the following components of the baseline flow regime are present:

(ii) subject to point (1) below, a minimum flow volume at least equivalent to the flow volume standard defined for flows equal to Q_{n95} for good status in the river type concerned; and

(iii) periods of higher volume flows than those referred to in point (ii) above, which:

(a) provide for a range of flow volumes between the minimum flow volume referred to in point (ii) and moderate flow volumes; and

(b) reflect elements of the natural pattern and volumes of flow that would have occurred in the absence of the impounding works between moderate and low flows (e.g. flows between Q_{n60} and Q_{n95}) (see also note N2.1a)

1. Flows may be reduced below the minimum flow volume referred to in point (ii) above provided that: (a) the minimum flow volume does not drop below the volumes defined by the type-specific good status standard for flows less than Q_{n95}; and (b) the period of time during which flows are below the minimum flow volume referred to in point (ii) is less than 18 days in any period of one year.

N2.1a It may not be practicable to provide a baseline flow regime that avoids substantial reductions in the natural depths, widths and continuity of surface flow compared with the depths, widths and continuity that would have been present in the absence of the impounding works and associated abstractions. Where the river has not become adapted to the baseline flow volumes (e.g. by becoming narrower; etc), these reductions may mean that the river has limited ecological potential. In such circumstances, appropriate mitigation would include re-engineering the river (e.g. using flow deflectors) to better fit the available baseline flow regime. Such mitigation would enable the relevant checklist targets to be passed.

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N3. Satisfactory sediment/habitat regime for downstream river

[11] http://www.sniffer.org.uk/results.asp?start=25&keywords=&code=&year=&output=&bool=OR&proposed=1&active=1&complete=1&theme=sniffer_theme_WFD&location=research_areas&refer=res_area_water_1.asp&title=SNIFFER%20Theme%20-%20Water%20Framework%20Directive%20(WFD)&research_area=

This test only applies to the effects on sediments of raised lochs/lakes to the extent that the raising of lochs/lakes has changed the natural sediment regime

N3.1 Account will be taken of whether:

(i) Sediment management at any small dams and weirs within the scheme is undertaken in accordance with the good practice set out in the General Binding Rules in Schedule 3 of the Water Environment (Controlled Activities)(Scotland) Regulations 2005 (as amended).

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N3.2 Account will be taken of:

(i) the occurrence of short-duration higher flows, coordinated with any such flows relevant under N2, and which resemble the magnitude of flows associated with moderate storm events (i.e. flows from deliberate releases - sometimes called freshets - or from spills past the impounding works);
(ii) the extent to which the flows referred to in point (i) approach the regulated flow condition limits for good status identified by UKTAG[12];
(iii) where there are naturally morphologically dynamic river-types downstream, whether the flows referred to in point (i) include periodic flows every 2 to 4 years on average, which, in conjunction with appropriate sediment management, are of sufficient magnitude to enable channel-forming processes in the rivers[13]; and
(iv) any evidence from relevant environmental monitoring programmes or research programmes that the magnitude and frequency of short-duration higher flows is insufficient to provide for the maintenance of habitats in the downstream river; and

Relevant research was commissioned by UKTAG and published by SNIFFER in 2007 (WFD82)[14].

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N4. Satisfactory water quality in downstream river

N4.1 Account will be taken of any evidence that the dissolved oxygen levels in the downstream river do not meet the good status dissolved oxygen standards applicable to the river type concerned.

Low dissolved oxygen may be an issue where water behind large impounding works becomes stratified and the main water releases are taken from depth. Where it is not

[12] http://www.wfduk.org/stakeholder_reviews/stakeholder_review_1-2007/LibraryPublicDocs/UKTAG_Report_Surface_Water_Standards_and_Conditions
[13] Short-duration bank-full flows do most of the dynamic channel-forming work in naturally dynamic gravel rivers.
[14] http://www.sniffer.org.uk/results.asp?start=25&keywords=&code=&year=&output=&bool=OR&proposed=1&active=1&complete=1&theme=sniffer_theme_WFD&location=research_areas&refer=res_area_water_1.asp&title=SNIFFER%20Theme%20-%20Water%20Framework%20Directive%20(WFD)&research_area=

practicable to release water from the surface layers of the reservoir, engineering modifications to the downstream river may sometimes be possible to help improve oxygenation (i.e. by creating an area of turbulent flow immediately downstream of the point of release).

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Where the dominant impact on the temperature regime is from water passing through generating turbines, mitigation will not be relevant for classification, as it would not be reasonably practicable to pass un-stratified water through the turbines

N4.2 Account will be taken of any evidence that alterations to the temperature regime in the downstream river are resulting in significant adverse ecological impacts.

Lower than natural water temperature in summer and higher temperatures in winter may be an issue where the baseline flow regime is provided by release of waters taken from depth behind large impounding works.

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N5. Satisfactory level regime in impoundment

N5.1 Account will be taken of**:**

(i) the presence of a level management regime designed to mitigate the short-term impacts otherwise caused by rapid and large reductions in levels in order to mitigate impacts on shore zone aquatic plants and animals; and
(ii) any evidence that the management regime referred to in point (i) above is ineffective in mitigating adverse impacts on shore zone aquatic plants and animals

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N5.2 Account will be taken of**:**

(i) the existence of a plan for managing the pattern of water level changes through the year with the aim of avoiding patterns of level change which would be hostile to the establishment and retention of shore zone plant and animal communities; and
(ii) any evidence that the management of the pattern of water level changes is failing to enable the establishment and retention of shore zone plant and animal communities

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N6. Additional considerations for new impounding works

N6.1 The ecological impact on the shore zones of reservoirs experiencing significant fluctuations in water levels can be very substantial. In mass storage reservoirs, such as those used in some types of hydropower scheme, the scope to mitigate such impacts is limited. Berms, weirs and excavated pools have been constructed in such reservoirs to help retain water in a proportion of the shallow areas of the reservoir adjacent to the shore. This is expected to protect the shore zone and increase its contribution to the ecological productivity of the reservoir. Unstable banks have also been stabilised using matting.

N6.2 The techniques referred to in Note N6.1 are in the early stages of development. In the first river basin cycle, they will not be included in the checklist. However, where opportunities arise to test and develop these techniques in partnership with operators of impounding works, the agencies will seek to participate in such testing. The agencies will also expect applicants proposing to construct new impoundments to include all reasonably practicable mitigation steps to moderate the impact on the reservoir shore zone of water level fluctuations. This will include consideration of the feasibility of protecting parts of the shore zone using the techniques outlined in paragraph N6.1.

N6.3 For new impounding works in which water in the reservoir is likely to become stratified, mitigation should be included to enable the release of compensation flows from different depths so that temperature and oxygen standards in the downstream river can be achieved.

N6.4 Rapid increases followed by rapid decreases in flow level (sometimes known as hydropeaking) in the river downstream of impounding works used in hydropower schemes can cause significant adverse ecological impacts. For example, fish may become stranded or isolated in pools and backwaters outside the main channel. Such impacts have been observed in a number of studies. They are most noticeable in river stretches whose natural morphological characteristics include extensive zones of shallow water or secondary streams. However, the frequency and severity of occurrence of hydropeaking impacts at hydropower schemes across the UK is not known[15] and mitigation techniques are at a relatively early stage of development and testing. Consequently, such mitigation has not been included in the checklist for the first river basin planning cycle. This position will be reviewed early in the second river basin planning cycle. However, when considering applications for new impounding works associated with hydropower schemes, the agencies will expect all reasonably practicable steps to be taken to moderate the environmental risk posed by such rapid changes in flow levels in the downstream river. This might include ensuring that the rate of rise and fall of water levels is sufficiently slow to allow time for fish and other animals to move to safer areas.

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[15] And may vary substantially depending on the characteristics of the river channel