

Water for life and livelihoods

River Basin Management Plan
Northumbria River Basin District

Annex E: Actions appraisal and
justifying objectives

Contents

	Decision code rapid link	3
E1	Introduction	4
E1.1	The Water Framework Directive's objectives	5
E1.2	Measures and mechanisms - actions to meet our objectives	11
E1.3	Selecting and appraising measures	12
E1.4	Identifying objectives	20
E1.5	Assessments of the river basin management plan	24
E1.6	Detailed information on actions appraisal for individual pressures	26
E2	Assessing biological elements	30
E3	Abstraction and other artificial flow pressures for surface waters and groundwaters	41
E4	Ammonia, dissolved oxygen, acidity, nutrients, temperature, and faecal pollution in surface waters	88
E5	Groundwater quality	149
E6	Biological pressures (biota removal and fish stocking)	174
E7	Invasive non-native (or alien) species pressures	177
E8	Morphology pressure	188
E9	Sediments pressure	215
E10	Priority Substances and Priority Hazardous Substances	247
E11	Surface water drinking water protection planning	265
E12	Identification and appraisal of M4 measures	269

Decision code rapid link – click on code to access supporting table

A1a	C4a	HT1a	N1a
A1b	DO1a	HT3a	N1b
A2a	DO2a	INNS1a	N1c
A2b	DO2b	INNS2a	N1e
A3a	DO3a	M1a	N1o
A3b	DO3b	M1b	P1a
A5a	DO5a	M1c	P1b
A5b	DO5b	M1d	P1c
A5c	DrWPA1a	M1e	P1d
ANC2a	GC1a	M1f	P1e
ANC2b	GC2a	M1g	P1o
B1a	GC2b	M1h	P2a
B2a	GC3a	M1i	P2b
B2b	GC4a	M1j	P3a
B2c	GC4b	M1k	P5a
B2d	GC4c	M2a	P5c
B2e	GC5a	M2b	PH1a
B2f	GC6a	M2c	PH2a
B2g	GC6b	M2d	PH2b
B2h	GQ1a	M2e	PH3a
B2i	GQ1b	M2f	PH3b
B2j	GQ1c	M2g	PH5b
B2k	GQ1d	M2h	S2a
B2l	GQ2a	M2i	S2b
B2m	GQ2b	M2j	S2c
B2n	GQ3a	M3a	S2d
B2o	GQ4a	M3b	S2e
B2p	GQ5a	M3c	S2f
B2q	GQ5b	M3d	S3a
B2r	HL1a	M3e	S3b
B2s	HL2a	M3f	S3c
B3a	HL4a	M3g	S3d
C1a	HR1a	M3h	S3e
C2a	HR2a	M5a	S3f
C3a	HR4a	MS	T1a

E1 Introduction

This annex describes the process we used to identify and appraise measures and to develop water body objectives for the first cycle of river basin management. It also provides details on the justifications for setting any alternative objectives. In carrying out this process we have been guided by the River Basin Planning Guidance published by Defra and Welsh Assembly Government in 2006 and 2008

(<http://www.defra.gov.uk/environment/water/wfd/management.htm>).

We have also taken account of the Common Implementation Strategy (CIS) Guidance Document Number 20, which provides Member States with guidance on the use of exemptions to environmental objectives

(http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/documentn20_mars09pdf/EN_1.0_&a=d)

The guidance document emphasises the point that the Water Framework Directive (WFD) provides the framework and sets the general direction, but that there is scope for differences in understanding and application. Where we have taken a particular approach to the use of exemptions, we have tried to make the decisions as transparent as possible, offering explanations of the reasons behind use of exemptions either for reasons of disproportionate cost, technical feasibility or natural conditions. We have attempted to phase the implementation of measures to spread the costs of implementation while undertaking demonstrable action in the first cycle.

We will also attempt to identify alternative financing mechanisms to fund necessary and cost-effective action in the first cycle, and in cycles two and three. This might include distribution of costs among polluters and users (where the polluter can be identified), use of the public budget, private investment, EU and international funds etc.

We are also following the CIS guidance in our approach, by ensuring that aggregated information is relevant to the individual water body concerned, whilst acknowledging that this does not necessarily imply that the reasons for justifying an exemption must always be located within the water body for which the exemption is sought.

Article 4.8 of the WFD, and reiterated in the CIS document, also requires us, when applying an exemption to a water body to “ensure that the application does not permanently exclude or compromise the achievement of the objectives of this Directive in other bodies of water within the same river basin district and is consistent with the implementation of other Community environmental legislation.” There are various references throughout this annex and plan to ensure this is the case e.g. Birds and Habitats Directives, Nitrates Directive, Bathing Water Directive.

The management of uncertainty will play a large part in the first cycle of river basin management plans as we continue to gather more monitoring data and evidence to establish the cause of water quality failures, or in order to develop the most cost-effective solution. We have taken uncertainty into account in setting objectives and deciding on the appropriate action to take for water bodies. This action is based largely on undertaking further investigations and making most use of new monitoring data to reduce the uncertainties in the future. The types of uncertainty considered in the CIS guidance, include:

- whether, and to what extent, a water body is adversely impacted and what and/or who causes the impact;
- the impact of policies already in place or planned and various trends and developments, including innovation and technical change;

- the effectiveness of measures in addressing an adverse impact on a water body (note that this will have an effect on the certainty of the benefits as well);
- the assessment of the achievement of good status;
- the costs associated with measures;
- the benefits resulting from improvements to the status of water bodies, particularly the calculation of the non-marketable benefits.

These uncertainties may lead to an extended deadline for the reason of technical infeasibility (for example where we do not know the source of a problem) or disproportionate cost (for example where we are not sure a water body isn't already at good status) because of the impact on cost and benefit estimates.

The river basin management plan is subject to economic and environmental assessment. An impact assessment has been produced (<http://www.environment-agency.gov.uk/research/planning/33106.aspx>) which reviews the costs and benefits of implementing the plan. The plan has also been the subject of a Strategic Environmental Assessment, and an environmental report has been produced which looks at the broader impacts that the plan may have on the environment, including the effects the plan may have on climate change. (Annex H sets out how climate change may itself impact on measures that we are able to put forward in the plan). The potential for the plan to have any significant negative effects on Natura 2000 sites has also been assessed by us, in consultation with Natural England and the Countryside Council for Wales.

E1.1 The Water Framework Directive's objectives

The Directive sets out in Article 4 the default environmental objectives that we should aim to meet. In summary, they are:

In relation to surface waters

- prevent deterioration in the status of water bodies;
- by 2015 achieve good ecological and chemical status¹ in all water bodies other than those which are artificial or heavily modified;
- by 2015 achieve good ecological potential and surface water chemical status for artificial and heavily modified water bodies;
- by 2015, achieve the objectives and comply with the standards for protected areas;
- reduce pollution from priority substances and cease discharges, emissions and losses of priority hazardous substances.

In relation to groundwaters

- prevent deterioration in status;
- take all measures necessary to prevent the input of hazardous substances into groundwater and to limit the input of other pollutants to groundwater;
- by 2015 achieve good quantitative and chemical status²;
- reverse any significant and sustained upward trend in the concentration of pollutants resulting from human activities;
- by 2015, comply with objectives and standards for protected areas.

¹ Also known as 'good surface water status': Article 2(18)

² Also known as 'good groundwater status': Article 2(20)

In relation to protected areas

The objectives for protected areas are mostly governed by the other European Community legislation under which they are designated, for example the Habitats Directive. For drinking water protected areas, the objectives are set out in the Water Framework Directive (WFD) itself. The protected areas objectives apply in addition to the requirement to achieve the environmental objectives of the WFD. It is not always possible to link the water body objectives with the protected area objectives as they are not always directly comparable, and in a number of cases, the size and scale of water bodies is not the same as waters identified as protected areas and so are not comparable. Where water body boundaries overlap with protected areas, and the objectives align, the most stringent objective applies. More details on protected areas and their objectives are set out in Annex D.

Alternative objectives

In certain circumstances (set out in Article 4.4 and 4.5 of the WFD) Member States may deviate from achieving the default objectives (e.g. good status by 2015). Objectives which are different from the default objectives are referred to here as alternative objectives.

Use of the alternative objectives is the mechanism which the WFD provides for:

- considering, amongst other things, other environmental, social and economic priorities alongside water management priorities; and
- prioritising action over successive river basin management planning cycles.

The alternative objectives and their conditions are the only relevant considerations when justifying the prioritisation of action under the WFD.

The types of alternative objective are:

- an extended deadline, e.g. achieving good ecological status by 2027;
- a less stringent objective, e.g. achieving moderate ecological status by 2015;
- different objectives for heavily modified or artificial water bodies, e.g. good ecological potential.

Alternative objectives are determined through a process of measures appraisal and objective setting. This process is at the heart of river basin management planning, and includes technical assessments (including consideration of technical infeasibility), economic assessment (to consider issues of disproportionate expense) and public consultation.

We have produced a list of simplified reasons for setting alternative objectives (extended deadlines and/or less stringent objectives). These are shown in Table 1.

Table 1: Reasons for not achieving good status

Reason	Sub-reason	Guidance notes
Technically infeasible	No known technical solution is available	Applies where there is no practical technique for making the necessary improvement. Does not include financial considerations. Techniques which may be under development but which are not yet known to be effective in practice will fall into this category.
	Cause of adverse impact unknown	Applies where a water body is classed as worse than good but the reason (the pressure or the specific source of the pressure) for this failure has not yet been determined. Consequently, a solution cannot feasibly be identified.
	Practical constraints of a technical nature prevent implementation of the measure by an earlier deadline	Includes administrative constraints in terms of commissioning, gaining permission for, and undertaking the necessary works. Does not include constraints due to a lack of legislative mechanisms or of funding.
	Problem cannot be addressed because of lack of action by other countries	<p>Application expected to be very limited in the UK. May possibly be applicable:</p> <ul style="list-style-type: none"> (a) in the international river basin districts shared between Northern Ireland and the Republic of Ireland if the problem cannot be resolved through the established partnership working arrangements for those basins. (b) where problems are caused by aerial deposition of transboundary pollutants and (a) local mitigation cannot solve the problem; and (b) discussions with the other countries have not led to effective action. <p>Where this reason is applied, the Commission must be informed about the issue under Article 12.</p>
Disproportionately expensive	Unfavourable balance of costs and benefits	Attaining the default objective is not worthwhile because the costs of the measure are out of proportion to the benefits, taking into account qualitative as well as quantitative information.

Reason	Sub-reason	Guidance notes
	Significant risk of unfavourable balance of costs and benefits	Applies where there is a sufficiently low confidence that a water body is adversely impacted. In these circumstances, there is a significant risk that putting in place additional measures to attain the objective is not worthwhile (because the default objective may already be achieved), producing no benefits and wasted investments. Potential measures can still be implemented where there is general agreement to proceed even where we have low confidence that a particular water body is adversely affected.
	Disproportionate burdens	Applies where the measure would be: (a) unaffordable to implement within a particular timetable without creating disproportionate burdens for particular sectors or parts of society; or (b) the only solution would be significantly at odds with the polluter pays principle.
Natural conditions	Ecological recovery time	Applies where there is expected to be a delay before the biological quality of the water body recovers. The delay may be due to the time taken for the plants and animals to re-colonise and become established after the hydromorphological, chemical and physicochemical conditions have been restored to 'good'; or the time taken for the habitat conditions to 'stabilise' after improvement works. For example, this may apply to lakes affected by eutrophication.
	Groundwater status recovery time	Applies where the climatic or geological characteristics dictate the rate at which groundwater levels recover or saline (or other) intrusions reverse once over-abstraction has been addressed.

Of these reasons only “Technically infeasible - No known technical solution is available” or “Disproportionately expensive - Unfavourable balance of costs and benefits” could lead to setting a less stringent objective. However, in most cases they could also lead to setting an extended deadline. All other reasons lead to setting an extended deadline.

The CIS guidance document on the use of exemptions states that “disproportionality” is a political judgement, informed by economic information, and an analysis of the costs and benefits of measures necessary to make a decision on exemptions. We have used the principles on the approach to disproportionate cost set out in the CIS document to guide us in our use of exemptions in the plans. These principles include:

- disproportionality should not begin at the point where measured costs simply exceed quantifiable benefits;
- the assessment of costs and benefits will have to include qualitative costs and benefits as well as quantitative;
- the margin by which costs exceed benefits should be appreciable and have a high level of confidence;
- in the context of disproportionality the decision-maker may also want to take into consideration the ability to pay of those affected by the measures and some information on this may be required.

The costs of measures required under other existing Community water legislation (e.g. Nitrates Directive) already agreed when the WFD was adopted cannot be considered when deciding on disproportionate cost.

We will also make a concerted effort to overcome practical issues of a technical nature, so that there is a greater likelihood of finding further technically feasible improvements.

Detailed justification³ for setting alternative objectives for specific water bodies is given in section E2 to E11.

Temporary deterioration in status

In certain circumstances (set out in Article 4.6 of the WFD) a temporary deterioration in status of a water body, caused by exceptional or unforeseen events such as extreme floods, prolonged droughts or accidents, is allowed. The exception does not apply to those effects of extreme floods and prolonged droughts which could reasonably have been planned for and prevented, nor does it apply in the case of accidents which could reasonably have been foreseen.

Droughts

In England and Wales, the main bodies responsible for managing water resources are the Environment Agency, water companies and the Government. All of these bodies have a role in drought management.⁴

Defining and then monitoring indicators helps the Environment Agency and water companies decide when a drought is happening and what actions they need to take. These indicators are often called drought triggers and a range of different triggers are used to identify whether drought actions need to be taken. Triggers can be based on:

- hydrological thresholds: rainfall, rivers levels and flows, reservoir storage, groundwater levels;
- environmental indicators: water quality, ecology;
- levels of customer demand;
- management actions.

As a trigger is approached or crossed, a water company or the Environment Agency will consider whether to implement a pre-determined action or move to the next stage of drought management. The decision to take action will be based on a range of factors, including present and forecast weather conditions and how effective the action would be.

The Environment Agency and water companies prepare for droughts by producing Drought Plans detailing the actions that will be taken if a drought occurs. These actions aim to

³ As required by Article 4.4 or 4.5 of the WFD

⁴ For more details see Environment Agency report "Managing drought in England and Wales"; <http://publications.environment-agency.gov.uk/pdf/GEHO0308BNTR-E-E.pdf>

manage water resources effectively, both for the environment and for public water supply, when they come under pressure by drought.

Droughts usually take a long time to develop and different actions are needed as a drought progresses. The sequence of actions will not always be the same as droughts are all different and need to be managed on an individual basis.

Floods

The Environment Agency is responsible for providing flood forecasting and warnings to the public in England and Wales. This involves monitoring rainfall, river levels and sea conditions. Combined with weather data and tidal reports the Environment Agency provides local area forecasts on the possibility of flooding and its likely severity.

There are four levels of flood warning: three of the codes indicate the severity of the warning (Flood Watch, Flood Warning, Severe Flood Warning) and a fourth is an 'All Clear', meaning the threat has passed.

Severe floods may impact on water body status through effects such as the loss of habitat (e.g. scouring of sediments and instream vegetation), the physical displacement of species or increased inputs of pollutants including sediment. These impacts may be localised and of insufficient magnitude to affect the status of an entire water body.

Water bodies are classified on an annual basis and therefore any deterioration in status due to a severe flood may not be detected until up to a year after the event.

Accidents

The Environmental Damage (Prevention and Remediation) (England) Regulations 2009 and the Environmental Damage (Prevention and Remediation) (Wales) Regulations 2009 bring the Environmental Liability Directive into effect in England and Wales. Under the Regulations, environmental damage of either surface water or groundwater is defined as damage causing a change of water body status,

This means:

- either a deterioration of water status overall, for example the water body as a whole would now be classified as 'poor' rather than 'good'.
- or a deterioration of any of the individual elements or parameters such that the value of that element or parameter is now consistent with a lower status than before. This applies even if the water body is not reclassified as being of lower status. For example, suppose a water body would be good status but for a dam preventing fish migration. Because of the dam, the status is currently poor even though water quality is good. An accident causes pollution of this water body. Water quality is now moderate status. The pollution is, therefore, significant enough on its own to cause a change of status even though the overall poor status – as dictated by the impact of the dam – has not changed. This is environmental damage.

Water bodies are classified on an annual basis and therefore environmental damage is only likely to be determined if the effects of the accident last for up to a year. Adverse effects that are short-term or limited in their geographical extent are unlikely to amount to environmental damage.

When environmental damage is confirmed, the Regulations include a remediation objective of achieving the same level of natural resources or services that would have existed if the damage had not occurred.

E1.2 Measures and mechanisms - actions to meet our objectives

The term 'measures' in the Water Framework Directive encompasses both on the ground actions and the policy and legislative instruments to achieve these actions. In this plan separate terms are used as follows:

- **Measure** - any action which will be taken on the ground to help achieve Water Framework Directive objectives.
- **Mechanism** - the policy, legislation, financial tools and other relevant means which are used to bring about those actions. Mechanisms include, for example: licensing systems; legislation; economic instruments; codes of good practice; negotiated agreements; promotion of water efficiency; educational projects; research, development and demonstration projects.

Annex F describes the mechanisms that are available for implementing measures. We have a long history of protecting and improving the water environment and there are many existing measures in place that are continuing to help improve the water environment. There are also many measures that are planned for reasons other than the Water Framework Directive. These measures fall under the 'umbrella' of the Water Framework Directive. As part of the measures appraisal process we need to understand how they can help meet the Directive's default objectives.

We have categorised measures in four broad groups to help simplify the river basin management planning process (see table 2 below). This ensures there is a common way of distinguishing between those measures that already exist (not driven by the Water Framework Directive), and those additional measures that we are proposing in order to meet Water Framework Directive objectives. The categories relate mainly to the nature of the driver and not necessarily the measure. As a result, a particular type of measure may appear in more than one category depending on the reason for using it.

Table 2: **Categories of measures**

M1	Measures already happening (not driven by WFD): Actions already agreed and funded, which may help to meet the objectives of the Water Framework Directive. This group includes the National Environment Programme for Periodic Review 2004 (PR04), the Coal Authority mine water restoration programme, ongoing local initiatives and partnerships measures.
M2	New measures that will happen (not driven by WFD): Actions that will happen irrespective of the Water Framework Directive (usually under other Directives) but which may help to meet the objectives of the Water Framework Directive. This group mainly covers new action for Directives on Freshwater Fish, Urban Waste Water Treatment, Habitats, Nitrates, current and revised Bathing Waters and Shellfish Waters. In some cases, there may be choices over the standards or objective to be achieved, or the date by which the objective is to be met and where further work is needed on the benefits (for example for Guideline Standards in Directives, or for diffuse pollution measures for Natura 2000 sites). In these cases, the measures will be treated, for management purposes, as M3b or M4 ⁵ .

⁵ This is because the process is similar and the benefits affect the attractiveness of other M3b and M4 schemes (and vice versa) but it is important to retain the point that the initial driver is M2.

M3	(a) New measures that will happen – national (driven by WFD): Measures for the Water Framework Directive that only require national decisions. For example, controls on chemicals, fertilisers and the formulation of other products (such as detergents), as well as national general binding rules and codes of practice that apply to specific activities.
	(b) New measures that will happen – national, river basin district (RBD) targeted (driven by WFD): Measures led nationally that require targeting at the water body or catchment scale. For example, bespoke calculations of permit conditions, targeted use of uniform emission limits, targeted use of diffuse pollution measures (for example England Catchment Sensitive Farming Delivery Initiative new catchments, catchment scale water protection zones).
M4	New measures that will happen – local, RBD agreed (driven by WFD): New measures specifically for objectives of the Water Framework Directive that require no national decisions. For example, a local partnership to create a new wetland, new rivers trusts initiatives or a local awareness/education campaign.

Toolkit of measures

We have compiled a comprehensive list of measures that may be used to deal with particular environmental problems and may be applied locally or across a much wider area, including nationally. They have been referenced to the pressures that give rise to the problems, and the sectors and their activities that are associated with these. We have carried out further work to consider more specifically measures to manage hydromorphological problems.

We used this 'measures toolkit' to help identify or confirm:

- which sectors may be contributing to particular environmental problems and pressures;
- what measures we could use to tackle these;
- what mechanisms exist to bring about this action;
- which existing processes may help to implement these mechanisms;
- what to consider in selecting mechanisms - in some cases the same measure could be implemented via more than one mechanism;
- how to assess and compare the effectiveness of measures.

We were also able to use this to help identify where new or amended delivery mechanisms might be needed.

E1.3 Selecting and appraising measures

Overall process

The measures appraisal process is central to the objective setting process. The process is used to consider whether;

- it is technically feasible to implement measures to achieve a desired objective,
- doing so would be disproportionately expensive (by comparing the costs of the measures with the benefits and other impacts implementing the measure will deliver), and
- whether natural conditions affect the ability or the timing of the achievement of an objective.

The process in principle can be summarised in a number of steps, shown below and diagrammatically in figure 1:

Step one – Identify current (M1) or planned measures (M2) and assess how far these go to meeting default objectives.

Step two – If default objectives are not achieved after step 1, identify potential additional M3 measures.

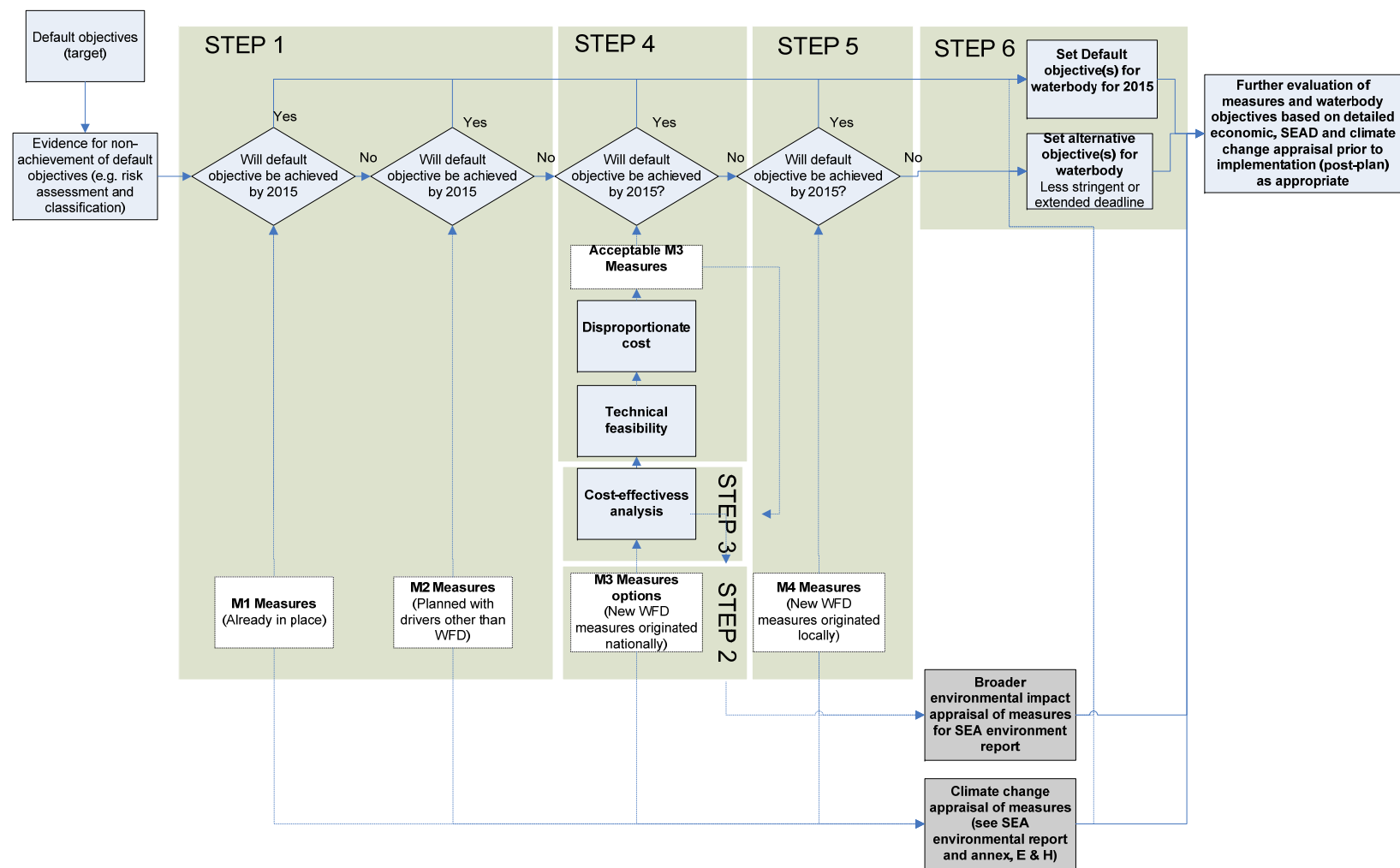
Step three - Identify cost-effective options for M3 measures.

Step four - Appraise cost-effective option(s) for M3 measures to see whether they are currently technically feasible and not disproportionately costly (by comparing the costs of the measures with the benefits and other impacts implementing the measure will deliver) and identify how much further these take us to meeting default objectives.

Step five - If default objectives are not achieved after steps 2-4, identify and appraise M4 measures and evaluate how much further these take us to meeting default objectives.

Step six - Identify and report final water body objectives (default or alternative objectives) and any justifications for alternative objectives. The choice of which alternative objective is set (extended deadline or a less stringent objective) will depend on whether the particular conditions in Article 4.4 and/or 4.5 of the WFD are met. Where the conditions of both Article 4.4 and Article 4.5 are met, we have, in most cases, set an objective of reaching good status by an extended deadline.

Figure 1: **Summary of measures appraisal and objectives setting process**



In practice the measures appraisal process operated at three different, but overlapping levels:

1. national strategic level led by Defra and Welsh Assembly Government
2. national/river basin district led by the Environment Agency
3. river basin district led by the Environment Agency and the liaison panels

The national strategic level consisted of the Defra and/or Welsh Assembly Government consultations on new or amended powers (delivery mechanisms) to control diffuse pollution and morphology and the preliminary cost effectiveness analysis. These are discussed further below.

The national/river basin district level consisted of the application of a range of existing approaches (e.g. application of routine water quality planning methods to determine new discharge consent limits for sewage treatment works) and the development and application of new methods such as those for the identification and designation of heavily modified water bodies and associated morphological mitigation measures (see Annex I). These approaches are described in sections E2 to E11 of this annex, which gives detailed information on action appraisal for individual pressures.

We also worked with liaison panels⁶ and other stakeholders to identify a range of locally applied measures. This is described in section E12 on the identification and appraisal of M4 measures.

The appraisal process was designed to avoid incurring unnecessary costs in situations where it is not clear that there is a problem, that the cause of the problem is not certain, or that the most cost-effective action to deal with the problem can not yet be determined.

Confidence about status assessments

Surface waters

Our assessments of water body status are accompanied by a description of how certain we can be that the water body is below good status. These assessments can be found in Annex B for each quality element in each water body, and for the overall water body status.

The Environment Agency has used three expressions to describe how certain we are that a water body does not achieve the objective of good status. Although the terms confidence and certainty can be interchangeable, the Environment Agency has taken the decision to use an expression of certainty to describe all surface water classifications.

How certain we are that the water body is less than good status	Threshold
Very certain	≥95% certain that the water body does not meet the objective of good status
Quite certain	≥75to ≤95% certain that the water body does not meet the objective of good status
Uncertain	>50% to <75% certain that the water body does not meet the objective of good status

⁶ For information on liaison panels see annex L

This description of certainty takes account of the precision of our results. Precision is influenced by natural variation in the data over time, as well as errors in the assessment process. The Environment Agency can assess how the probability of misclassification changes in relation to the amount of sampling for each biological element. This allows us to estimate the most likely levels of certainty we can achieve with a given sampling effort. For example, a diatom sample from spring and autumn will allow no more than a 70% certainty of being at a particular status, but often gives high certainty (>95%) of being somewhere below good status.

In some situations our expression of certainty is based on weight of evidence or expert opinion. There are three examples of this:

- The way different water bodies respond to nutrient enrichment can be complicated. Sometimes we find that the water body does not meet the required standard for phosphorus but the biological community shows no sign of damage. In such situations it would be misleading to say we are very certain that the water body is at less than good status. In other situations, the water body does not meet the required standard for phosphorus, and the biological community – the diatoms and macrophytes – also show signs of damage: The result for each element on its own may be uncertain. But the fact that all elements suggest the same thing – weight of evidence that there is an impact – means that we become more certain that there is a problem. So we modify the overall certainty according to the statistical certainty of each test.
- As our monitoring programme for estuarine and coastal water bodies is new, certainty in our draft classifications for these water bodies is partly based on the amount of data available for each of the classification tools. We say we are uncertain where our data sets are limited. Our marine monitoring programme will continue to provide more data, so the certainty of our assessments in estuarine and coastal waters should steadily improve over time.
- Where expert judgement has been used to provide a classification we can only ever be uncertain in our assessment.

Groundwater status

For groundwater, confidence is reported as a qualitative statement and is used as an indicator for prioritising action. All poor status classifications for groundwater, irrespective of confidence, will require some form of action. This is because the classification criteria for both chemical and quantitative status comprise a rigorous weight of evidence approach.

Confidence in poor status will be reported as either “high” or “low”, depending on the test. These terms are defined as follows:

- “High” confidence will usually mean that competent authorities can proceed immediately to considering restorative action, or, for example, improvement to existing measures, according to procedures in the Directive. In some cases there may be “high” confidence in the poor status, but uncertainty over the measures that should be implemented, and an options appraisal of measures/objectives will be required
- “Low” confidence will usually mean that further investigation should be carried out as a priority to improve confidence and measures taken in the first river basin management planning cycle where appropriate.

It is stressed that the assessment of confidence in status should not be used as the only driver for instigating measures. Good status groundwater bodies may require higher priority attention if they are predicted to fail either the trend objective in the long term or some other measure of the risk of future deterioration in status.

Confidence in good status will be reported as either “high” or “low”, depending on the test. These terms are defined as follows:

- “High” confidence will usually mean that the only requirement is to assess potential future deterioration using surveillance monitoring.
- “Low” confidence is associated with a more limited evidence base, often in groundwater bodies that are at risk. Further operational monitoring will be required to improve the level of confidence.

Further details of how confidence in groundwater status is determined are given in Annex A.

New Water Framework Directive measures & mechanisms

Several Defra/Welsh Assembly Government consultations⁷ have explored the case for new and amended powers and controls that will enable Water Framework Directive objectives to be met⁸. Whilst the cases for some of these additional powers and measures were being finalised in 2009 (including those on diffuse pollution), we were guided in mid 2008 by Defra/Welsh Assembly Government via the River Basin Planning guidance Volume 2 on what assumptions to make regarding their use and availability for the first RBMP. In addition, with the launch of the Defra Water Strategy for England in February 2008 (<http://www.defra.gov.uk/Environment/quality/water/strategy/index.htm>) and in Wales the Environment Strategy for Wales (<http://wales.gov.uk/topics/environmentcountryside/epg/envstratforwales/?lang=en>) further measures were signalled (not necessarily driven by the Water Framework Directive) by the Government, which will help meet Water Framework Directive objectives within the first cycle of river basin management planning.

Measures or mechanisms that have been confirmed following recent consultations have been included in Annex C (Actions to deliver objectives). For example, the use of Water Protection Zones.

However, there are further measures or mechanisms which may also be taken forward during the first planning cycle, and which will consequently improve the ambition of the plan. For example:

- a statutory code of practice to provide guidance on the use and management of septic tanks;
- a possible ban on phosphorus in detergents;
- measures to reduce the impacts from sewer misconnections;
- possible General Binding Rules, based on best practice, which will cover the abuse of the drainage system, commercial washing activities, surface water control plans on construction sites and site management for industrial, institutional and commercial sites;
- using the proposed Floods and Water Bill to reduce risk of diffuse pollution through improved management of surface water drainage.
- potential review of the Oil Storage Regulations

Preliminary Cost Effectiveness Analysis

A national preliminary cost effectiveness analysis (pCEA) exercise was completed in 2007. This considered the scope and scale of measures on a national basis, and their costs and effectiveness for the first round of river basin management plans. The findings of the pCEA meant that very little additional work on cost effectiveness was needed at a more local level.

⁷ Listed in Annex L – Consultation record

⁸ Listed in Annex C – Actions to deliver objectives

Preliminary cost effectiveness analysis

The work was coordinated by Defra, and involved participation from the Welsh Assembly Government, Department of Trade and Industry (as was), the Environment Agency, Ofwat, British Waterways the Department for Communities and Local Government (DCLG), and working groups representing key interested groups.

The assessment considered:

- what should be done in the first planning cycle using consistent national measures, and what happens if we take longer to meet objectives;
- the types and costs of measures to be decided at national or river basin district level, reducing the need for further detailed analysis;
- the overall costs and what is affordable;
- the role of industry and other organisations in implementing measures;
- what measures could be ruled in or out of the first cycle from a national assessment.

The working groups were based on key industry and business sectors, with final reports based on cross-cutting pressures. The groups were tasked with agreeing combinations of measures for addressing pressures on water bodies attributable to the sectors concerned, and providing high level analysis on the cost and effectiveness of these measures. They took into account existing obligations and costs, but also considered what could be achieved with new national measures. It showed that, given the uncertainties associated with classification, source apportionment and the effectiveness of measures, a longer term adaptive approach to river basin management planning will ultimately be more effective and cost-effective than an unphased approach, given current state of knowledge.

www.wfdcrp.co.uk See table of Non Related CRP Outputs - Results of Preliminary Cost Effectiveness Analysis of the Water Framework Directive Revised After Stakeholder Review December 2007.

National Benefits Survey

The UK Collaborative Research Programme into the Water Framework Directive use survey methods to estimate, in monetary terms, the value placed by households on improvements to the water environment brought about by the WFD. In July 2007, 1487 interviews were undertaken in 50 locations throughout England and Wales. From the survey results a range of willingness to pay benefit estimates were produced. These results have been used in the national impact assessment for the WFD

(<http://www.defra.gov.uk/environment/quality/water/wfd/documents/RIA-river-basin-v2.pdf>), the river basin district impact assessment that accompanies this plan, and as part of the assessment of costs, benefits and other impacts when assessing disproportionate costs issues at water body level.

Further information on the national benefits survey can be found at www.wfdcrp.co.uk.

Where an alternative objective has been set, the benefits of achieving good status will not be realised. The level of these foregone benefits depends on the current status of the water body. These benefits (in monetary terms) of improving a water body to good status in this river basin district are given in table 3.

Table 3: Monetary benefits of improving a water body to good status in the Northumbria River Basin District

Current status	Benefits (£ per water body per year)
Bad	230,445
Poor	168,634
Moderate	127,427

Ministerial Guidance

The pCEA, national impact assessment and formal public consultation were used by Defra and Welsh Assembly Government to provide guidance to the Environment Agency (<http://www.defra.gov.uk/environment/quality/water/wfd/management.htm>). This guidance included advice to:

- phase implementation to ensure an adaptive, cost-effective and proportionate long term approach meeting all WFD requirements by 2027 or as soon as possible thereafter given feasibility, proportionality and natural conditions and the progressive reduction/cessation of priority substances and priority hazardous substances;
- ensure overall costs (i.e. negative consequences) of action to achieve WFD objectives do not exceed the overall benefits (positive consequences);
- favour the most cost-effective measures;
- make use of alternative objectives, and
- when the conditions of both Article 4.4 and 4.5 are met set objectives with an extended deadline rather than a less stringent objective.

Identification and appraisal of M4 measures

We have identified the gap between the improvements resulting from M1-M3b measures and the achievement of Water Framework Directive default objectives in each water body. Local (M4) measures have been developed to help to close this gap, many of which were developed with liaison panels. A common set of appraisal criteria was developed with liaison panels and a national measures workshop was held in October 2007 to discuss and agree the criteria. This means that each M4 measure was developed, evaluated and recorded in the same way across England and Wales. More information on the identification of M4 measures in this river basin district is given in section E12.

Inclusion of carbon in disproportionate cost assessment in measures appraisal

We have taken initial steps to include the cost of carbon in our disproportionate cost assessments. We have focused on PR09 water quality measures since this is where the most significant additional carbon emissions will occur (as a result of requirements for additional treatment, construction of new works or upgrades to existing works). The majority of other actions are likely to have low impact as they are investigations, partnerships or encouraging best practice management. The potential impact of these can be assessed as the work is progressed. Methodologies and policies are being developed to ensure carbon costs are included in further appraisal work prior to the implementation of measures.

Specific scheme information on the carbon dioxide emissions associated with both building within schemes (embedded carbon) and operation of schemes was obtained from water company final business plans. The figures for embedded and operational carbon were then used to calculate a cost of carbon in the assessment based on Defra guidance. Our findings highlight that the additional carbon emissions are currently too small to make a significant

difference to the disproportionate cost assessment. In future, the shadow price of carbon may be revised upwards and start to have more impact on investment choices in future cycles of river basin management planning.

Consulting on measures

Measures were included for consultation as part of the draft river basin management plan. They were presented in three planning scenarios:

Scenario A included all the known and funded measures that already operate, or are likely to operate. This scenario comprised all M1 and M2 measures that would occur in the absence of the Water Framework Directive (but which are now a core part of the Water Framework Directive and help to achieve the Directive's objectives) and new M3a measures that had been determined through national decisions and processes.

Scenario B represented the estimate of the measures that would be included in the first river basin management plans to deliver the environmental outcomes and support the proposed water body objectives.

Scenario C included all measures in scenario B plus measures that may be worthwhile but where the case had not been confirmed yet. To enable these measures to be implemented, additional information was needed to reduce uncertainty and justify further funding, where appropriate.

Annex L (Consultation and Engagement) lists the many approaches taken for engagement on developing the river basin management plan. These included the active involvement of stakeholders in the pCEA, development of new and amended mechanisms by Defra and Welsh Assembly Government, liaison panels discussing and influencing the planning scenarios and, together with local stakeholders, the development of M4 measures. In addition, the consultation on the draft plan was a key process to gather further information to improve the certainty of the effectiveness and benefits of the measures identified in scenario C and enable some of them to be included in this first plan.

E1.4 Identifying objectives

The measures appraisal process has enabled us to identify the expected outcomes for each of the elements that together define the status of a water body, based on implementing a challenging but realistic set of measures (see Annex C). We have used these expected outcomes to propose default or alternative objectives for each water body (see Annex B).

In carrying out these processes, we have reviewed the programme of measures and:

- for each water body predicted (using modelling and/or expert judgement) the status that each non-biological element will achieve (and by when) when the measures are implemented;
- checked that the measures proposed for different pressures are compatible in terms of timing and benefits - they should not work against each other and ideally should complement each other;
- predicted the status for the biological elements that we would expect to be achieved. These predictions were made by a panel of Environment Agency officers with local, expert knowledge supported by decision rules and a variety of data sets.
- the predicted outcomes have been translated to a set of overall objectives for each water body using the same 'one out all out rules' used in classification. Where any of the

predicted outcomes for the elements of status are not 'good status by 2015' we have set alternative objectives. The status objectives⁹ for each water body are shown in Annex B.

For water bodies adversely affected by multiple pressures (e.g. physical modifications to the bed and banks; over abstraction; etc), we have separately assessed the timescale needed to tackle each impact preventing the achievement of good status. We have then combined these assessments to identify the earliest date by which all the conditions needed for good status can be achieved in the water bodies (e.g. for surface waters, the right water quality; flows and levels; structure and condition of the bed, banks, shores; etc). We can then decide if good status can be achieved by 2015.

Improvements in some of the characteristics of these water bodies can be made, and are proportionate to make, earlier than others. This means that water bodies whose overall objective is good status by 2021 or 2027, may nevertheless be subject to significant improvements in the interim.

In identifying objectives, we have used the best information currently available to us. Our initial focus has been on gathering information on water bodies that can be improved by 2015.

There is significant uncertainty about how pressures and technology will change after 2015. Climate change will bring wetter, warmer winters; hotter, drier summers; and more frequent extreme events, including sea level rise, storms, summer droughts, and floods. It is not known how the biology in waters will respond to this. The population in the river basin district is likely to increase, with further urbanisation. Agriculture will respond to the changed climate (both here and abroad), market conditions, financial incentives and regulatory pressures. Technology and other solutions to address the pressures will improve, but the future economic climate (nationally or for particular sectors or groups of society) which will govern the rate at which some new solutions can be introduced is unknown.

Where we have set an objective using an extended deadline, we have generally set an objective of good status by 2027. However, many water bodies will achieve good status by 2021, but given the above uncertainty we are currently unable to say which water bodies these will be.

Investigations will take place to help improve the understanding of the changing pressures on the water environment and the current and future impact they will have on the achievement of good status (and other WFD objectives).

Investigations will also be undertaken to:

- confirm the current status, where this is uncertain;
- gather corroborative evidence of biological problems to justify expenditure where there is low confidence of failure of chemical standards;
- identify the cause of the problem, including its location, the specific activity causing it and/or the pathway by which a pollutant is entering a water body;
- assess whether existing and currently planned actions will resolve the problem;
- identify cost effective solutions;
- find new technical solution or improve the cost effectiveness of current ones;
- assess whether the costs, benefits and other impacts of potential solutions are disproportionate; and
- seek alternative financing mechanism, where current methods of funding solutions could impose a disproportionate burden on a particular sector or part of society.

⁹ Note that all Protected Area objectives are presented in Annex D

In developing the river basin management plans approximately 8,500 investigations have been identified for England and Wales, including further monitoring. The vast majority of these will be undertaken by the Environment Agency and all of these will be completed by the end of 2012. The investigations will focus on resolving what is causing the problem and what the best method to tackle it is. As a result of the evidence they will provide, we will be able to take further action in the first cycle where practicable.

By using the decision codes to cross reference the individual water body tables in Annex B ('Water body status objectives'), with the tables in section E2 to E11 of this annex, the types of investigation that will be carried out for each water body can be identified. The specific timing of each investigation is not yet known. This will be identified when the plan is implemented at the catchment level. More information on specific investigations, including their timing (where known) is given in Annex C ('Actions to deliver objectives').

When investigations are completed the results may lead to:

- the implementation of more of the measures we are already using
- modifications or improvements to the measures we are already using
- the implementation of new measures
- the justification of less stringent objectives

We are confident that a proportion of investigations will lead to improvement action that can be put in place within the first cycle. This will mean that more water bodies than those currently identified will achieve good status by 2015.

Alternative objectives in the Northumbria River Basin District

In this river basin district the majority of alternative objectives we have set are those with extended deadlines. However we have set less stringent objectives in two groundwater bodies where we are reasonably confident that we will be unable to achieve good status by 2027. These groundwater bodies are: Tyne Carboniferous Limestone and Coal Measures (GB40302G701500) and Wear Carboniferous Limestone and Coal Measures (GB40302G701600). These groundwater bodies are important sources of public and private water supply and support surface water flows in the Tyne and Wear catchments respectively.

In both groundwater bodies the reason for not achieving good status is because the groundwater has become polluted as a result of the extensive long-term non-coal mining activity in the area. Because the source of pollution is widespread and below ground, there is currently no technical solution that can be applied to return the groundwater body to good status before 2027. This does not mean that we will be doing nothing. Our objective for these bodies, in relation to this problem, is to return them to good status as soon as is practically and technically possible. In the meantime we will be implementing a range of actions to reduce the impact of the pollution. This includes treatment of minewater discharges.

Table 4 below shows how many times alternative objectives have been set for the different standard reasons within the Northumbria River Basin District (please note that the numbers in the table cannot be summed to give total numbers of water bodies since more than one reason may apply to any particular water body).

Table 4: **Alternative objectives for the Northumbria River Basin District**

Alternative objective reason	Sub-reason	No. of water bodies in RBD
Technically infeasible	No known technical solution is available	51
	Cause of adverse impact unknown	230
	Practical constraints of a technical nature	0
	Number of water bodies in RBD where technically infeasible has been used	255
Disproportionately expensive	Unfavourable balance of costs and benefits	17
	Significant risk of unfavourable balance of costs and benefits	180
	Disproportionate burdens	14
	Number of water bodies in RBD where disproportionately expensive has been used	196
Natural conditions	Ecological recovery time	1
	Groundwater status recovery time	0
	Number of water bodies in RBD where natural conditions has been used	1
Total number of water bodies in RBD with an alternative objective (extended deadline and/or less stringent status objective)		247

We have not made use of the WFD article 4.7 exemption for new modifications or new sustainable human development activity in this river basin district.

Use of expert judgement

Our monitoring programmes do not give us assessments for all water bodies. This is because we target our monitoring at water bodies at risk of degradation and because we have a roving monitoring programme that moves from one location to the next on an annual basis. By 2010 our roving monitoring programme will complete its first phase and most water bodies will have been monitored. The remainder are typically small water bodies. Where we lack data we have used expert judgements to provide an initial assessment of the water body (see Annex A). Expert judgement of status was based on risk assessments (see Annex G), information from Natural England and the Countryside Council for Wales on the condition of Sites of Special Scientific Interest (SSSIs), national expert opinion and information from local Environment Agency staff. In addition for lakes, modelled total phosphorus concentration was compared with the relevant environmental standard for the lake type, then a risk matrix was constructed to determine which lakes were likely to be at good status and which were moderate status (see table 5). Clearly, such status assessments are uncertain.

Classification results based on expert judgement are clearly marked in Annex B.

Table 5: Expert judgement risk matrix for lakes without monitoring data

	Risk Assessment	At Risk	Probably at Risk	Probably not at Risk	Not at Risk	Not Risk assessed
Conservation Condition (SSSI)		7	6	5	4	1
No data or not SSSI	0	Moderate	Moderate	Good	Good	Moderate
Favourable	1	Moderate	Moderate	Good	Good	Good
Unfavourable recovering	2	Moderate	Moderate	Good	Good	Moderate
Unfavourable no change	3	Moderate	Moderate	Moderate	Moderate	Moderate
Unfavourable declining	4	Moderate	Moderate	Moderate	Moderate	Moderate

Objectives for these water bodies are also based on expert judgement. Following a review of the effect of available measures, if the predicted status was still less than good, and given the uncertainty about the current status, we have set an alternative objective of an extended deadline. This is for reasons of 'Technically infeasible; cause of adverse impact unknown' - there has been insufficient time to investigate the causes of the failures (if indeed they do fail) and 'Disproportionately expensive; significant risk of unfavourable balance of costs and benefits' - because although we have used all information available at the time of the assessment, we do not have high confidence that the water bodies are at less than good status.

E1.5 Assessments of the river basin management plan

Impact assessment

The river basin management plan is subject to an impact assessment (IA) which looks at the costs of the reference case and the costs and benefits of implementing the main policy option (<http://www.environment-agency.gov.uk/research/planning/33106.aspx>). In accordance with IA guidance the reference case relates to the baseline of existing policy actions, while the main policy relates to the expected impacts of additional policy actions on both private and public sectors.

Strategic environmental assessment

River basin management plans fall within the scope of the Strategic Environmental Assessment Directive (SEAD). In accordance with this, we have undertaken a strategic environmental assessment and produced an Environmental Report published together with the draft plan. When finalising the plan we have taken the results of the consultation on the draft plans and the SEAD Environmental Reports into account. The Post Adoption Statement and accompanying Statement of Environmental Particulars published with this river basin management plan, explains how the issues raised during consultation have been addressed and includes an assessment of the changes between the draft plans and the first plans.

Habitats Regulations assessments

Any plan that may have a significant effect on a Natura 2000 site (Special Area of Conservation (SAC) or Special Protection Area (SPA))¹⁰ must be subject to an appropriate assessment of its implications for Natura 2000 sites, in view of the site's conservation objectives.

An assessment of the effects of the draft river basin management plan on Natura 2000 sites, and consultation with Natural England and the Countryside Council for Wales, has informed development of this plan.

The Habitats Regulations Assessment, which considers if this plan may have a significant effect on any Natura 2000 site, has also been undertaken by the Environment Agency. The assessment, conclusions and implications are discussed in Annex C.

A copy of the Habitats Regulations Assessment of this plan is available at <http://www.environment-agency.gov.uk/research/planning/33106.aspx>.

Objectives for Natura 2000 Protected Areas (water dependent SACs and SPAs)

There is no specific date in the EC Habitats and Birds Directives for meeting the objectives for Natura 2000 sites. The Water Framework Directive introduces the 2015 deadline; this applies to the Natura 2000 Protected Areas (water dependent SACs and SPAs).

Where a Natura 2000 Protected Area is also a water body, or forms part of a 'water body' it will also have water body status objectives in Annex B. Alternative objectives may have been applied to the water body status objectives in Annex B. Where a water body is also a Natura 2000 Protected Area, alternative water body status objectives do not mean that the objective of Favourable Conservation Status by 2015 should not be met. The tables in Annex B indicate any water bodies that coincide with Natura 2000 Protected Areas.

The deadline for favourable conservation status may be extended if the Natura 2000 Protected Area is also a 'water body', or forms part of a 'water body'. The objectives for Natura 2000 Protected Areas are detailed in Annex D, and that annex indicates any sites where the objective of favourable conservation status has been extended and provides the reasons and justifications for the extended deadlines. Natural England and the Countryside Council for Wales provided advice on whether the deadlines for favourable conservation status should be extended.

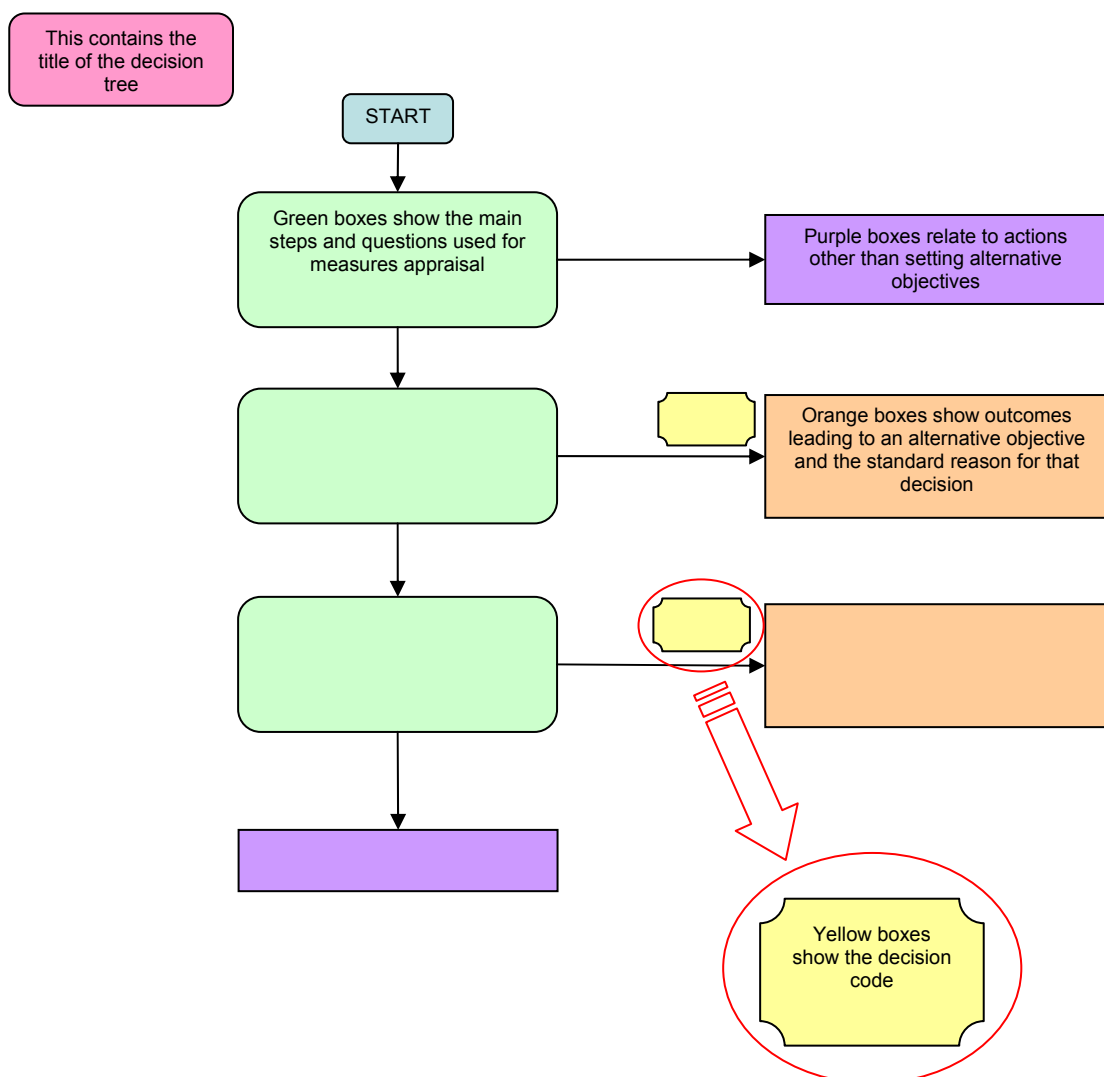
¹⁰ The Regulations also apply to candidate SACs and Sites of Community Importance (SCI)). As a matter of policy, the Environment Agency is also applying this approach to potential SPAs and designated Ramsar sites. The Habitats Regulations do not apply as a matter of law or government policy to proposed SACs or proposed Ramsar sites".

E1.6 Detailed information on actions appraisal for individual pressures and justification of alternative objectives

The following sections (E2 to E11) set out detailed information on actions appraisal for individual pressures and include more information on the justification for setting alternative objectives.

Each of these sections includes one or more decision trees. These decision trees show the main steps taken in appraising the measures needed to address a pressure and achieve good status. The trees also set out where decisions can lead to the setting of an alternative objective. A generalised decision tree is shown in Figure 2 below.

Figure 2. **A generalised decision tree**



Each branch of a tree leading to an alternative objective has a 'decision code'. These codes are unique to a particular decision tree (e.g. S1 is from the sediments tree, P1 from the phosphorus tree).

For any branch on the decision tree, the information supporting the decision to set an alternative objective may vary. For example, if the source of the pressure varies then the other supporting information (such as possible future measures to address the pressure) may vary too. Therefore the decision code for a particular branch in the tree may have sub-divisions e.g. S1a, S1b.

Each decision code therefore records the current progress in appraising measures to tackle a pressure. The tree sets out the steps that remain in the appraisal process once the uncertainty relating to the current step is resolved. The uncertainty will be resolved by carrying out investigations or additional monitoring.

More detailed information about the decisions to set alternative objectives is presented in tables in each of the pressure sections. There is a separate table relating to each decision code. Each table describes the type of investigation required to reduce the uncertainty and allow the appraisal process to progress to the next step in the decision tree. The table also describes the types of measures that may be implemented once the appraisal process is completed. A summary of the information contained in these tables is provided in table 6.

The decision codes also appear in the Annex B water body tables against the relevant classification element (within the justifications column). This provides a cross-reference from the Annex B tables to the supporting information presented in this annex. This cross-referencing between the information in Annexes B and E is shown in Figure 3 below.

Some of the information in the tables in the pressure sections is repeated in different tables several times. This is to allow people who are navigating the plan from Annex B to access a complete set of information in just one pressure table.

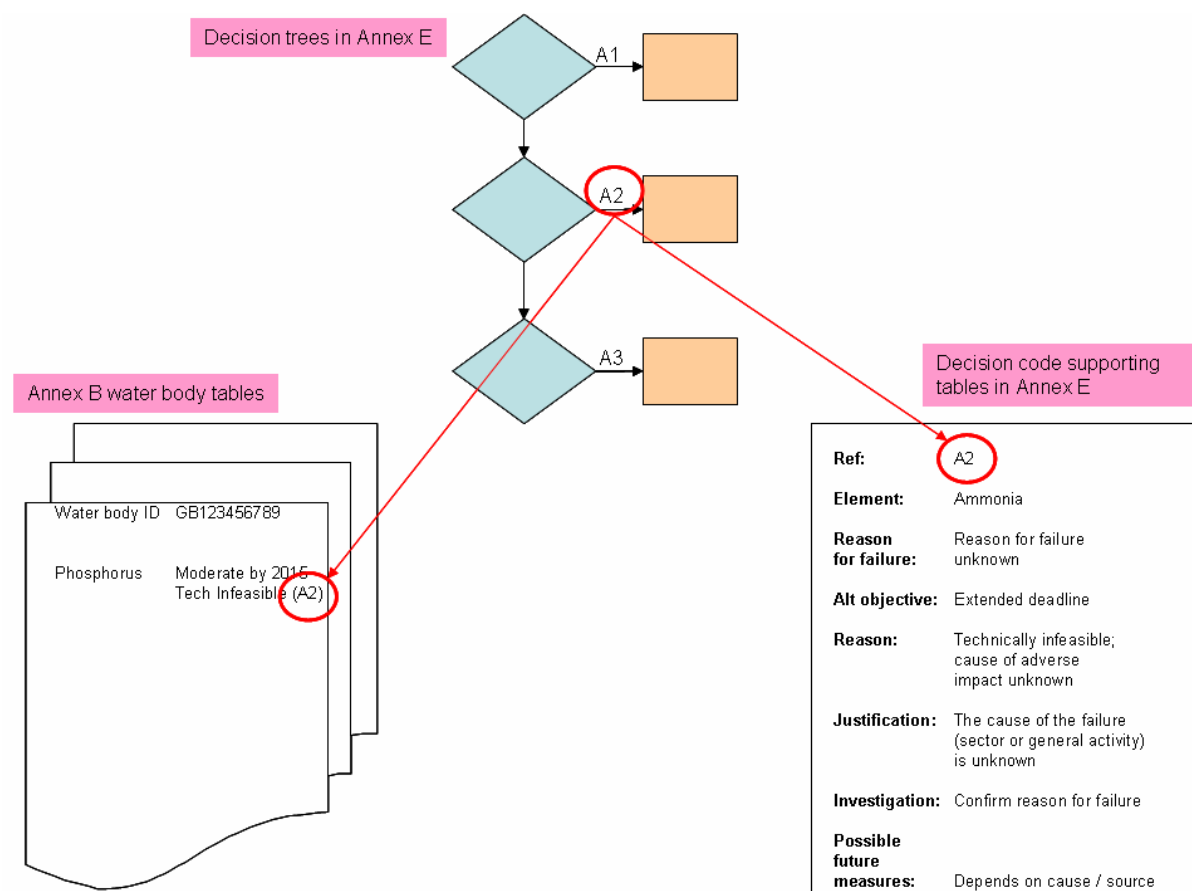
The aim of setting out the information in this way is to make the key decision making processes used in the preparation of this plan as transparent as possible.

Please note that further detailed information for surface water Drinking Water Protected Areas (DrWPAs), including compliance information and objectives, appears in Annex D.

Table 6: Explanation of supporting tables

Reference	<i>The decision code(s) e.g. S1a.</i>
Element predicted not to achieve good by 2015	<i>The relevant classification element(s) to which the code applies.</i>
Reason for failure	<i>The reason(s) for failure.</i>
Alternative objective	<i>The type of alternative objective i.e. extended deadline or less stringent objective.</i>
Reason for alternative objective	<i>The reason and sub-reason (as described in table 1) for setting the alternative objective.</i>
Justification for alternative objective	
<p><i>A one line summary of the justification is given here</i></p> <p><i>A more detailed explanation of why an alternative objective has been set and the nature of the uncertainty that led to the decision. If relevant, any information on costs and benefits is included here.</i></p>	
Investigation type	
<i>The general type of investigation required to resolve the uncertainty and allow the actions appraisal process to proceed to the next step in the decision tree.</i>	
Example of investigation	
<i>A more detailed description of the type of investigation(s) that might be carried out. Where possible, these investigations will take place before 2013 so that the results are known in time for the formal review of this plan by 2015.</i>	
Possible future measures	
<i>The types of measures that may be implemented once the actions appraisal process has been completed. Depending on progress, some of these measures may be implemented during the first cycle (i.e. by December 2012).</i>	
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive	
<i>The types of measures that might be required in order to address the pressure and achieve good status in all water bodies, although these measures are currently thought to be likely to be technically infeasible or disproportionately expensive.</i>	

Figure 3 Schematic showing how decision codes provide cross reference between Annex B and Annex E



E2 Assessing biological elements

Biological elements at less than good status

If a biological element in a water body is classified as being at less than good status then the presumption is that this is due to one or more pressures acting on the biology and causing an impact. It is therefore necessary to identify the pressure(s) and then appropriate (feasible and proportionate) measures to reduce or remove the pressure, allowing the biology to recover to good status.

The processes for determining measures to tackle specific pressures are outlined in the subsequent sections in this annex.

However, the first steps in appraising a biological element are generic and these are set out in the decision tree below. These steps include assessing the level of certainty that the biological element really is at less than good status and whether the pressure causing the failure, and the source of that pressure, have been identified with a reasonable level of confidence.

In some cases the pressure that has caused the biology to be at less than good status may already have been tackled but the biology has yet to recover and achieve good status. An assessment must therefore be made on whether additional measures are required or whether, if sufficient time is allowed, the biology will recover to good status without any further action being taken.

Once these steps have all been considered then the need for additional measures to address specific pressures can be assessed using the processes set out in the rest of this annex.

Biological elements in Artificial and Heavily Modified Water Bodies

Some biological elements are sensitive to hydromorphological pressures, with the specific elements varying depending on the water body type.

Lake, transitional and coastal water bodies

In lake, transitional and coastal water bodies designated as Artificial or Heavily Modified, these morphology-sensitive biological elements have not been used to produce ecological potential classifications and are not used in setting the objectives for these water bodies. So even though these elements may be at less than good status, they do not lead to the setting of alternative objectives in these water bodies. Therefore no justification for these elements being at less than good status in 2015 is required in terms of technical feasibility or disproportionate cost.

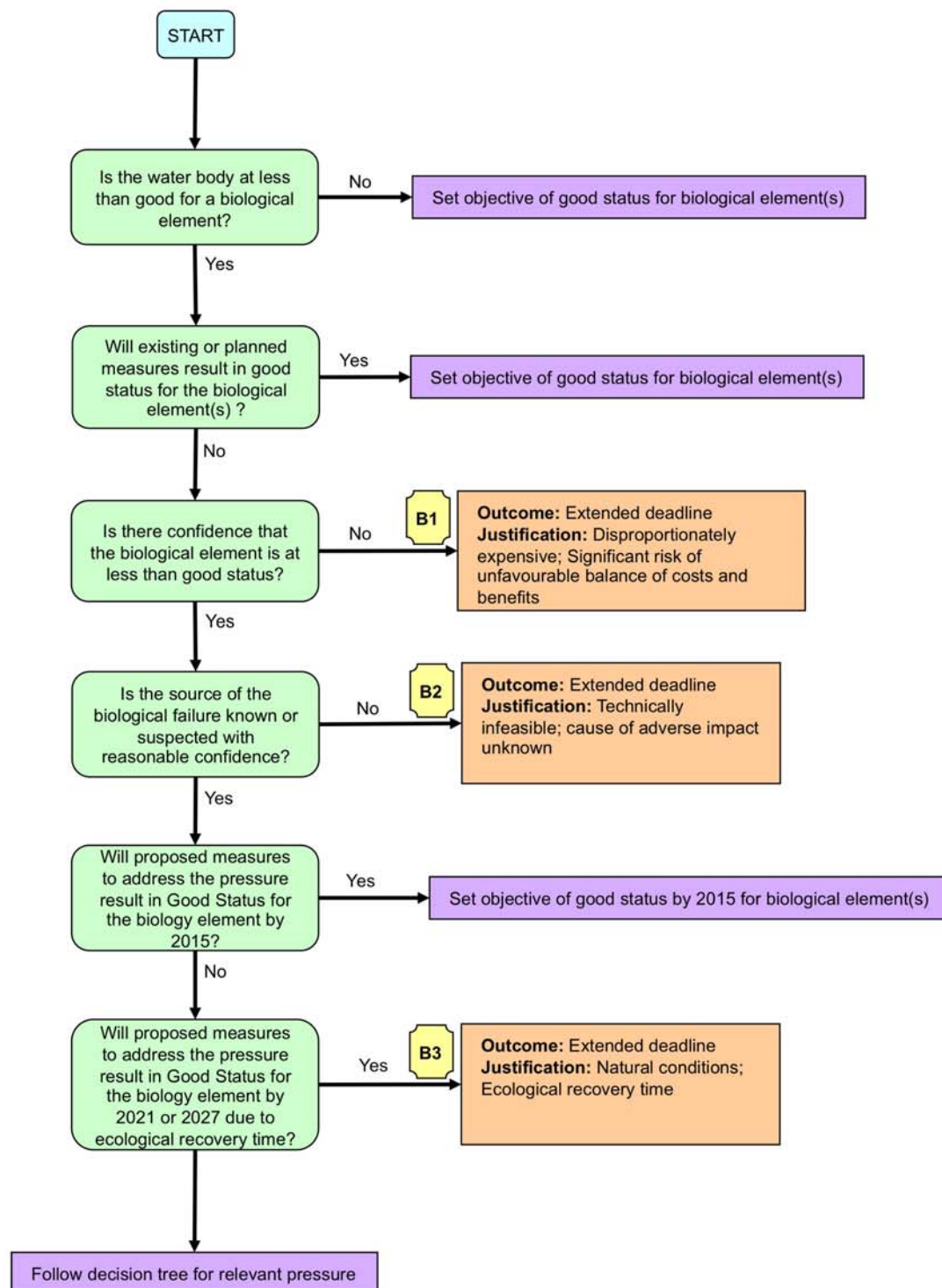
Where these elements are predicted to be at less than good status in 2015 in an Artificial or Heavily Modified Water Body the justification column in the Annex B water body tables will contain “Not required (MS)”. The MS decision code refers to ‘morphology-sensitive’.

River water bodies

In Artificial or Heavily Modified river water bodies where flow as a supporting condition supports good then, as described above for the other categories of water body, the morphology-sensitive biological elements are not used in classification or objective setting. Where these morphology-sensitive biological elements are predicted to be at less than good status in 2015, the justification column in the Annex B water body tables will contain “Not required (MS)”.

However, in Artificial or Heavily Modified river water bodies where the modification is not flow-related and flow as a supporting condition currently does not support good status, then all biological elements available are used in the classification and objective setting for the water body. If the flow in these water bodies is predicted to not support good in 2015 then the justification for any morphology-sensitive biology elements not achieving good status in 2015 will be the same as that assigned to flow as a supporting condition.

Decision tree for
Biological elements



Reference	B1a
Element predicted not to achieve good by 2015	Biological elements
Reason for failure	Unknown – uncertain there is a failure/impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive - significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>There is not high confidence that the biology elements have failed</p> <p>In these cases the biological elements do not achieve the good status boundary values but with low confidence of failure. Without confidence in a biological failure we cannot reliably consider the pressures and measures. To do so would mean a significant risk of wasted investment on additional measures in already compliant water bodies. It is therefore disproportionately expensive to achieve good status by 2015.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm any failure with certainty, identify the pressures causing the failure and appraise additional measures. Where possible additional measures will be implemented within the first cycle.</p>	
Investigation type	
Investigate to confirm failure and/or impact	
Example of investigation	
Additional monitoring or specifically tailored investigations to improve certainty that there is an impact on the biological elements. Supplementary data could also be used to build sufficient weight of evidence to show that biological populations are impacted.	
Possible future measures	
<p>If the biological populations are impacted then possible future measures will depend on the significance and/or extent of the failure, the identification of the pressure(s) causing the failure and the source of the pressure(s).</p> <p>Possible measures are described in the tables of supporting information for individual</p>	

pressures.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
Not possible to identify these at this stage

Reference	B2a
Element predicted not to achieve good by 2015	Biological elements
Reason for failure	Unknown – reasons for failure unknown
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The pressure causing the failure is unknown</p> <p>Although the biological element is known to be at less than good status, the pressure causing the impact is not known. It is therefore technically infeasible to identify and appraise appropriate measures, and achieve good status by 2015.</p> <p>Where the failure of good status for a biological element is not also supported by a failure of a standard for a physico-chemical element or priority hazardous substance, it is often not easy to identify the pressure causing the biological failure. In the time available we have not been able to identify the specific pressure(s) causing the impact on biology.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to identify the pressure(s) causing the failure and appraise additional measures. Where possible additional measures will be implemented within the first cycle</p>	
Investigation type	
Investigate cause of failure	
Example of investigation	
Additional monitoring or specifically tailored investigations to identify the pressure(s) causing the impact and the source(s) of the pressure(s). Supplementary data could also be used to build sufficient weight of evidence to identify the pressure and/or source or more detailed analysis of the biological data may help to indicate the likely pressure. For example, by more detailed analysis of the invertebrate data or looking at the diagnostic data associated with the fish classification outputs.	
Possible future measures	
Possible future measures will depend on the identification of the pressure(s) causing the failure and the source of the pressure(s). Possible measures are described in the tables of supporting information for individual pressures.	

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
Not possible to identify these at this stage

Reference	B2b to B2s
Element predicted not to achieve good by 2015	Biological elements
Reason for failure	<p>Various pressures and reasons:</p> <p>B2b = suspected fish stocking B2c = suspected copper B2d = suspected cypermethrin B2e = suspected diazinon B2f = suspected iron B2g = suspected mecoprop B2h = suspected toxic chemicals / pollutants B2i = suspected zinc B2j = suspected hydrology (flows) B2k = suspected temperature B2l = suspected ammonia B2m = suspected dissolved oxygen B2n = suspected organic pollution B2o = suspected pH / acidification B2p = suspected morphology B2q = suspected nitrate (DIN) B2r = suspected phosphate B2s = suspected sediments</p>
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The pressure causing the failure is not known with certainty</p> <p>Although a pressure responsible for the impact on the biological element has been suggested, there is low confidence that the pressure has been correctly identified. For example, the pressure may also be an element of classification (such as ammonia) which is currently classified at good status. Further work is therefore needed to confirm that the correct pressure has been identified before work can begin to identify and appraise appropriate measures. It is therefore technically infeasible to achieve good status by 2015.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm the pressure(s) causing the failure and appraise additional measures. Where possible additional measures will be implemented within the first cycle.</p>	
Investigation type	
Investigate cause of failure	

Example of investigation
Additional monitoring or specifically tailored investigations to identify the pressure(s) causing the impact and the source(s) of the pressure(s). Supplementary data could also be used to build sufficient weight of evidence to identify the pressure and/or source or more detailed analysis of the biological data may help to indicate the likely pressure.
Possible future measures
Possible future measures will depend on the identification of the pressure(s) causing the failure and the source of the pressure(s). Possible measures are described in the tables of supporting information for individual pressures.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
Not possible to identify these at this stage

Reference	B3a
Element predicted not to achieve good by 2015	Biological elements
Reason for failure	Various pressures and sources
Alternative objective	Extended deadline
Reason for alternative objective	Natural conditions - ecological recovery time
Justification for alternative objective	
<p>The biology will not recover to good status until after 2015</p> <p>All necessary measures have or will be put in place to mitigate the pressure causing the biological failure. However, there is expected to be a delay before the biology returns to good status. This may be due to the biological populations taking time to re-colonise or re-establish once the hydromorphological, chemical or physicochemical conditions have been restored to good or the time taken for the habitat conditions to stabilise after improvement works. For example, once a barrier to fish migration has been removed it will take time for fish to migrate into the now accessible area and re-establish populations and therefore good status is not expected to be achieved by 2015.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time for the biology to recover.</p>	
Investigation type	
Monitoring of ecological recovery	
Example of investigation	
Monitoring of biological elements to confirm that populations recover to good status	
Possible future measures	
Not applicable at this stage	
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive	
None	

Reference	MS (Morphology Sensitive)
Element predicted not to achieve good by 2015	Biological elements
Reason for failure	Various pressures and sources
Alternative objective	Not applicable
Reason for alternative objective	Not required
Why a justification for alternative objective is not required	
<p>Biological element not included in classification</p> <p>Some biological elements are identified as being sensitive to morphological pressures. The specific elements vary depending on the water body type:</p> <ul style="list-style-type: none"> • rivers = fish, macroinvertebrates and macrophytes • lakes = macrophytes • Trac waters = seagrass, fish and benthic invertebrates <p>As these elements are sensitive to morphological pressures, it is difficult to determine whether these biological elements in Artificial and Heavily Modified Water Bodies are at less than good status due to the effects of morphological changes alone or also the impacts from other pressures.</p> <p>Where indicated by the use of this decision code, these elements have therefore not been included in the classification or objective setting processes for the Artificial and Heavily Modified Water Bodies concerned. In these instances, the status of the morphology-sensitive biological element can not lead to an alternative objective being set.</p>	
Investigation type	
Not applicable	
Example of investigation	
Not applicable	
Possible future measures	
If these morphology-sensitive biological elements are at less than good status in an Artificial or Heavily Modified water body, other drivers may well require action to be taken to improve their status. For example if the water body has a protected area designation.	
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive	
Not applicable	

E3 Abstraction and other artificial flow pressures for surface waters and groundwaters

Introduction

The demands for water from public water supply, industry and agriculture all impact upon the natural flows and water level of most of the surface water and groundwater bodies within England & Wales. As a result, the natural flows of most surface water bodies are affected by upstream abstraction, discharges distribution and in some cases reservoirs and river basin transfers. Most abstractions and discharges have permits, though there are some activities that will be brought into regulation when parts of the Water Act 2003 are implemented. Such water resource systems have evolved over the last 150 years to form one of the most important parts of the infrastructure underpinning our economic development.

The degree that flows have been altered is reflected in the abstraction and flow regulation pressure maps reported in Annex G for surface water bodies within each river basin district.

Water Framework Directive requirements for flow and water levels

The Water Framework Directive (WFD) regards flows and water levels as an important element in supporting the biological classification of surface water bodies and that flows or water levels should be sufficient to support the biological quality elements. However, it gives no direct guidance on flow or water level requirements. The only exception is for those surface water bodies considered to be at high ecological status. For these, flows and levels should reflect totally or nearly totally undisturbed conditions.

For groundwater bodies, the WFD recognises the importance of groundwater in maintaining flows and water levels in springs, rivers and wetlands. This forms an important part of the quantitative classification of groundwater bodies. But again, no direct guidance is given on the management of groundwater required to maintain the flows or water levels in surface water bodies.

Environmental flow indicators to support WFD environmental objectives

To help guide the management of the impacts of abstraction on surface and groundwater bodies we have derived environmental flow indicators. Environmental flow indicators (EFIs) provide the proportion of the flow regime of a water body that can be allowed for abstraction without causing unacceptable impacts on the water environment. They will be applied in England and Wales, enabling us to continue to manage abstraction in an even-handed way.

Our environmental flow indicators are based on UK Technical Advisory Group (UKTAG) flow standards which were derived using expert opinion and also informed by early results from the Environment Agency Catchment Abstraction Management Strategies (CAMS). UKTAG consulted on flow condition limits as part of its technical review of proposals for WFD standards in 2007 and published final standards in 2008 (UK Environmental Standards & Conditions Phase 1 Final Report April 2008). The environmental flow indicators have been applied to the surface water bodies in England & Wales in the light of the experience and information gained from the first Catchment Abstraction Management Strategies (CAMS) completed between 2001 and 2008.

The environmental flow indicators provide an initial base for identifying those impacts of abstraction on surface flows that could limit good ecological status. However, the links between changes to flows or water levels and the ecological responses are poorly

understood. The site-specific variability in the relationships between hydrological parameters (flow rate, velocity, depth, cross-section) and biological conditions mean it is difficult to model these relationships in a generic way that can readily be applied with confidence across England and Wales. As a result there are uncertainties in both the derivation and the application of the environmental flow indicators. These limitations should be borne in mind, and the indicators on their own should not be used to inform decisions on measures to manage abstraction where there are risks that the measure may be disproportionately costly for the uncertain ecological benefits. We plan to review both the derivation and application of the environmental flow indicators to reduce uncertainty and inform revisions in time for second river basin management plans.

Assessing the impact of abstraction on surface water flows and the groundwater quantitative classification

Environmental flow indicators (EFIs) have been applied to surface and groundwater bodies to identify where flows and water levels may not be supporting good ecological status. The results of this exercise are reported in Annex B both as the 'quantity and dynamics of flow' supporting element result for surface water bodies (rivers, lakes and estuaries), and the quantitative classification 'dependent surface water' element for groundwater bodies.

For the screening of abstraction impacts on each of the surface water bodies, the current flow is derived from an estimated natural flow by adjusting for abstractions and discharges. The current flow estimate is then compared with the environmental flow indicator derived for the same water body. Where the current flow is estimated to be greater than the environmental flow indicator, it is likely to support good ecological status. Where the current flow is less than the environmental flow indicator, there is a risk that the flow will be insufficient to support good ecological status. The amount that the flow is estimated to be below or in deficit of the environmental flow indicator can provide an important clue to the scale and ecological significance of the impact. Thus, where the flow deficits are estimated to be greater than 50% of the natural flow, we have a higher confidence that the impact of abstraction on flows may be limiting ecological status.

The process we have used to arrive at outcomes for each water body is presented in the form of decision trees which are included at the end of this section. For example the decision trees show the different outcomes for high or low confidence that abstraction is affecting ecological status. The decision trees for rivers and lakes include consideration of whether the water body is heavily modified and if that modification is for water resource purposes.

The quantitative classification of groundwater bodies includes consideration of the available groundwater resources, together with the impacts of abstraction on river flows and water levels in groundwater fed wetlands, and the stability of saline intrusions. The assessment of the impacts of groundwater abstraction on wetlands and the stability of saline intrusions is based on local site specific knowledge and monitoring results. For these groundwater bodies, and where the assessment of the impacts of abstraction indicates poor status, we can have a relatively high confidence in the classification of poor status. By contrast, the assessment of available groundwater resources includes estimates of the groundwater flow to surface water bodies. Assessments of groundwater abstraction impacts on surface water flows are relative to the environmental flow indicators described above. Because of the uncertainties in this assessment we have low confidence in most results where the available groundwater resources indicate poor status. However in exceptional cases, where the evidence of impact on surface waters is clear, we have assigned high confidence to the poor status assessments for the groundwater balance and the surface water impact. The decision tree for groundwater bodies at poor quantitative status shows the process we have used to arrive at outcomes and actions for each groundwater body.

Before specific measures can be applied, investigations are needed to resolve these uncertainties, both in the assessment and to establish the best solution. The confidence levels expressed for the surface water flow deficits and groundwater classification provide a guide to the need for investigations into where, and the extent that, abstraction may be reducing the flows and levels; the significance of this reduction in either limiting or supporting good ecological status; and the need for measures to manage abstraction. The outcomes on the decision trees will guide what the focus of investigation should be, for example whether the uncertainty is in the hydrological assessment, or in the economic justification of measures. These outcomes are described further in the section 'Additional Measures' below.

Programmes of measures to support WFD environmental objectives

Water resource measures fall into two groups:

- Revision of existing mechanisms and obligations to support WFD objectives.
- Additional measures to be completed in the first and subsequent river basin management plans (RBMPs).

Environmental impacts of abstractions are controlled through the grant and change of abstraction licences. Not all abstraction licences are time limited, and the mechanism of change and the funding of the change for those that are not time limited may be complex.

Existing mechanisms and obligations

Measures to regulate new proposals for abstractions and Water Resource impoundments to prevent deterioration (M1)

The results of the surface water flow screening and groundwater quantitative classification assessments will be used to guide our abstraction licensing system (under the Water Resources Act 1991 and Water Act 2003 - see Annex F for details). These results will be translated into maps to indicate where water is available for additional abstraction (unless there is good local evidence to the contrary). These maps will be published in our future Catchment Abstraction Management Strategies (CAMS) to provide the framework to guide the determination and trading of permits.

Working with Government, we will continue with plans to extend the abstraction licensing systems to all sectors and parts of England & Wales (Water Act 2003). To this end, regulations under the Water Act 2003 will bring exempt abstractions above 20m³ per day within the system of abstraction licensing control. The revised system of abstraction licensing control will be used to ensure that any new abstraction, water resources impoundment or flow regulation proposals do not result in deterioration of ecological status, unless the proposal can be justified as an allowable new modification under Article 4(7) of the WFD.

Most abstractors do not abstract the full amount authorised. We have made assessments against the current abstraction (impacts on the environment now), against predicted abstraction in 2015 (the end of first river basin management plans) and against the full licensed quantity. Predicted increase in actual abstraction is generally small, but the future use of full licensed amounts requires further investigation to assess the potential no-deterioration impacts.

Measures to promote efficient and sustainable water use (M1)

We have included measures to promote efficient and sustainable water use in order to alleviate abstraction pressures on existing resources and the water environment.

Wise and efficient use of water involves us all, as water users and customers of the water companies. For water companies, the requirement and justification of such measures has been included within the draft Water Company Water Resources Management plans required under the Water Industry Act 1991 as amended by the Water Act 2003. Ofwat has set water companies water efficiency targets as part of their ongoing activities which companies will be expected to meet from 2010 onwards. Some water companies have proposed additional water efficiency activities; however, the funding and implementation of these is dependent on final decisions by Ofwat under the water company price review. For this reason some water company actions have not been included in Annex C tables at this stage.

In April 2009 the Environment Agency published its strategy “Water for people and the environment” setting out how we believe water resources should be managed throughout England and Wales to 2050 and beyond. This complements aspects of river basin management plans (RBMPs), but also covers longer term considerations of water demand and supply. Some of the actions on efficient water use set out in the strategy are also listed in Annex C of RBMPs.

For many industries, water efficiency measures are required under Environmental Permitting Regulations (2000). Where justified, permits under these regulations include measures to conserve water use and reduce leakage.

For river basin districts where agricultural water use has a significant impact on water resources we have included measures to promote efficient water use largely by education campaigns, e.g. the NFU “Water Matters” campaign. These are additional to the requirements to demonstrate reasonable need for water and use water efficiently as part of the abstraction licensing process.

The above measures will ensure that the RBMP meets the obligation to promote an efficient and sustainable water use in order to avoid compromising the achievement of the WFD environmental objectives (Article 11 3(c)).

Habitats Directive: Measures to restore existing abstraction to sustainable levels (M2)

Annexes C and D contain water resources measures to achieve our contribution to favourable conservation status of Natura 2000 sites by 2015. The monitoring and site specific investigations at these sites to justify the need for any changes to existing abstraction licences, required as a result of the Habitats Directive, are being completed as part of our current Restoring Sustainable Abstraction programme. Where changes to existing abstraction licences have been identified and justified, the relevant sites have been listed within Annex C as measures for completion by 2015 (although they are regarded as work that would have taken place without WFD).

Many of the abstraction licences identified are held by Water Companies and any reduction in abstraction rates may have to be matched by either the development of alternative supplies or more efficient water use. Most schemes for the delivery of alternative supplies and changes in licences have now been included within the PR09 Water Company plans and, where agreed with by Ofwat, will be funded by Water Companies. Once a scheme has been included within the final plan, and funding has been allocated by Ofwat, we consider that the mechanism has been secured for the delivery of this measure. The successful implementation of the scheme will be followed by a voluntary licence change by the Water Company. It is expected that all such schemes will have the mechanism in place for delivery by 2012.

For all other (mainly non-water industry) abstraction licences, delivery of actions requiring modification of abstraction licences are likely to require the payment of compensation by the Environment Agency. The rate at which these schemes can be progressed will directly relate to our ability to increase abstraction charges to pay compensation. We are aiming to have the process for most licence changes for Habitats Directive sites started by 2012, but plans may require revision once the full costs of licence changes have been assessed against our ability to raise charges via our regional based charging scheme.

Sites of Special Scientific Interest (SSSIs) Investigation of abstraction impacts (M1)

The existing Restoring Sustainable Abstraction programme includes commitments to investigate the impact of existing abstraction that are perceived to be limiting the conservation objectives of Sites of Special Scientific Interest, sites identified in the Biodiversity Action Plan and other locally important conservation sites. This programme of investigations predates, but complements, the requirements of the WFD, and will provide information on what changes in abstraction will need to be made as a part of the programme of measures for future cycles of river basin management plans. Measures currently in Annex C identify when we expect the process to be started.

Additional measures

[Note: codes in square brackets refer to outcomes in the decision trees]

Measures to reduce uncertainty: investigations to determine the ecological significance of reduced flows (M3b)

The 'quantity and dynamics of flow' supporting element results (reported in Annex B), identify those surface water bodies where the net impact of both abstraction and discharges is estimated to have reduced flow below the environmental flow indicators and where there is a risk that flow may be insufficient to support good ecological status. However, the uncertainties in the assessments and the environmental flow indicators make them unreliable in both defining the magnitude and ecological significance of reduced flows without further investigation. Any measures to reduce abstraction impacts based solely on a comparison with the environmental flow indicators may not result in any biological improvement and therefore are likely to be disproportionately expensive. The cost of the modification or cancellation of abstraction licences has been estimated to be between £1.5m to £7m per MI/day reduction in the reliable output. The preliminary cost effectiveness analysis undertaken by Defra estimated the cost of achieving EFIs by 2015 as between £3,600 million and £25,000 million for England and £70 million to £2,100 million for Wales.

In view of the above costs and uncertainties, the following actions will be undertaken, to:

- review both the derivation and application of the environmental flow indicators for all water bodies in England and Wales, with the aim of improving them to inform the revisions to the river basin management plans in 2015.
- undertake site specific investigations to determine both the size and biological benefits of increased flows and to refine the assessment of costs, benefits and other impacts of measures to reduce the impacts of abstraction.

Without these investigations, measures to reduce abstraction could be premature and represent a high risk of being disproportionately expensive.

Site specific investigations will be included within the Restoring Sustainable Abstraction programme with the WFD as a driver. Priority will be given to completing investigations in the first RBMP cycle at those water bodies where we have a high confidence that flow may be limiting good ecological status [Rivers outcome HR3 & HR4]. The results of these will then provide the case for any measures to reduce abstraction to be included in the second cycle

of RBMPs (ending 2021). For the remaining water bodies where current flows are estimated to be below the environmental flow indicator [Rivers outcome HR2], the ecological significance of the impact of abstraction on flow will either be reviewed in the light of further monitoring or be investigated specifically in the second RBMP cycle. This phased, risk based approach was one of the recommendations of the preliminary Cost Effectiveness Analysis completed with Defra in 2007 (Water Resources pCEA 2007).

Measures to reduce uncertainty: investigations on heavily modified water bodies to determine the ecological significance of managed flows (M3b)

The designation of heavily modified water bodies (HMWB) for water supply purposes encompasses valuable and important parts of our water supply infrastructure including:

- Inter-basin water transfers, for example the Ely-Ouse scheme
- Reservoir releases for downstream abstraction, for example the river Dee
- Groundwater pumping to augment flows for downstream abstraction, for example the Shropshire groundwater scheme
- Reservoirs with direct catchment areas, for example Ladybower
- Reservoirs for pumped storage, for example Grafham water
- Semi-natural lakes with dammed outlets, for example Ennerdale

The ecological classification of these groups of HMWBs requires detailed knowledge of how the operation of such schemes may both impact on flows and limit good ecological potential. Some schemes have been constructed and are already operated to mitigate biological impacts. Consequently we have assessed the current status of the HMWB on the presence or absence of feasible mitigation measures (in line with the agreed method used for all ecological potential assessments in the UK). For HMWBs designated for water supply purposes and judged to be below good ecological potential, we have set the alternative objective of an extended deadline. This is on the basis that there is low certainty there is a problem to solve, and the ecological outcome of mitigation measures requires further investigation. The premature implementation of measures could therefore be disproportionately expensive [Rivers outcome HR1 and Lakes outcome HL1].

A programme of work will be undertaken to

- review the benefits and costs of possible mitigation measures and improve the hydrological assessment of HMWBs designated for water supply purposes, with the aim of informing a programme of measures for second cycle river basin management plans (2015)
- undertake site specific investigations to determine both the size and biological benefits of mitigation measures and changing flows to justify the need for measures to achieve good ecological potential

As most of the HMWBs are water company assets, the potential for impact on use must also be considered and this programme of work will be undertaken in partnership with the water companies. Until the above work has been completed a timetable for delivery of the measures cannot be confirmed.

Measures to Reduce Uncertainty: Poor Groundwater Quantitative Status (M3b)

In England there are 17 groundwater bodies at poor quantitative status where we have high confidence in the assessment because there are reported impacts related to groundwater abstraction. Of these, three of the groundwater bodies are in poor status resulting from a long standing saline intrusion, where the benefits of further investigation and restoring the aquifer would be limited. Less stringent objectives are set on the basis that any measures to reduce abstraction would be disproportionately expensive, because of the extreme length of

time for measures to have any effect [Groundwater outcome GQ4]. The remaining 14 groundwater bodies require further investigations to confirm that groundwater abstraction is causing poor status and determine whether or not remedial measures will produce tangible environmental benefits. For these groundwater bodies, we have set alternative objectives with extended deadlines (2027) to allow time for investigations to be completed and appropriate measures implemented [Groundwater outcome GQ3 and GQ5].

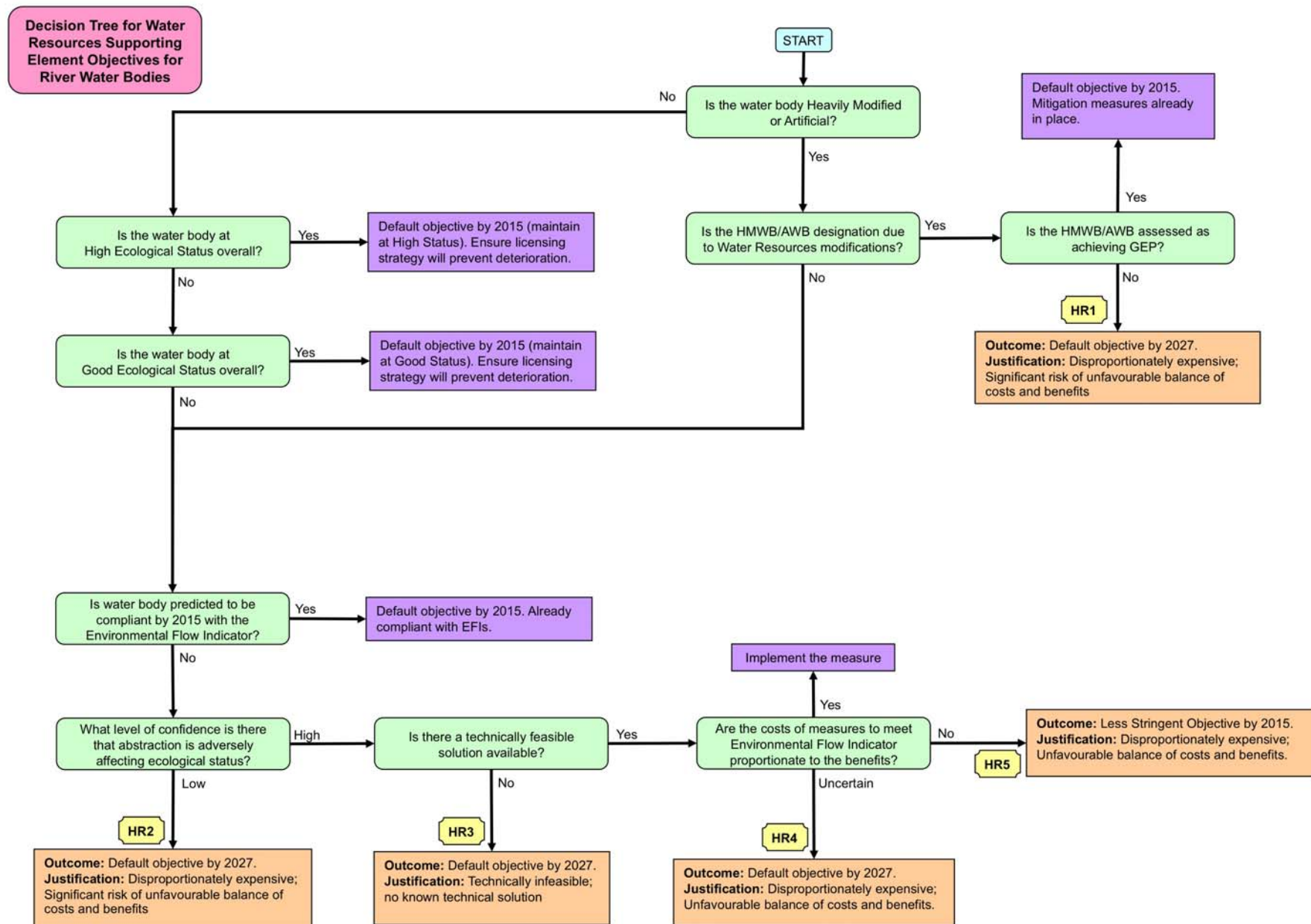
For the remaining 89 groundwater bodies in England and Wales assessed at poor status we have relatively low confidence in their assessment [Groundwater outcome GQ2]. For these groundwater bodies we have set alternative objectives of an extended deadline to 2027 to allow time to determine the impact and biological significance of groundwater abstraction on surface water flows and where necessary to justify the need for any changes to the abstraction licences involved. Without this information any measures to reduce groundwater abstraction would be disproportionately expensive because of the uncertainty of biological outcomes. To start this determination we intend to carry out at least a basic level of investigation (desk study) for each of these groundwater bodies.

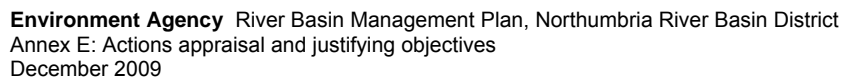
Measures to Prevent Deterioration: Good Groundwater Quantitative Status (M3b)

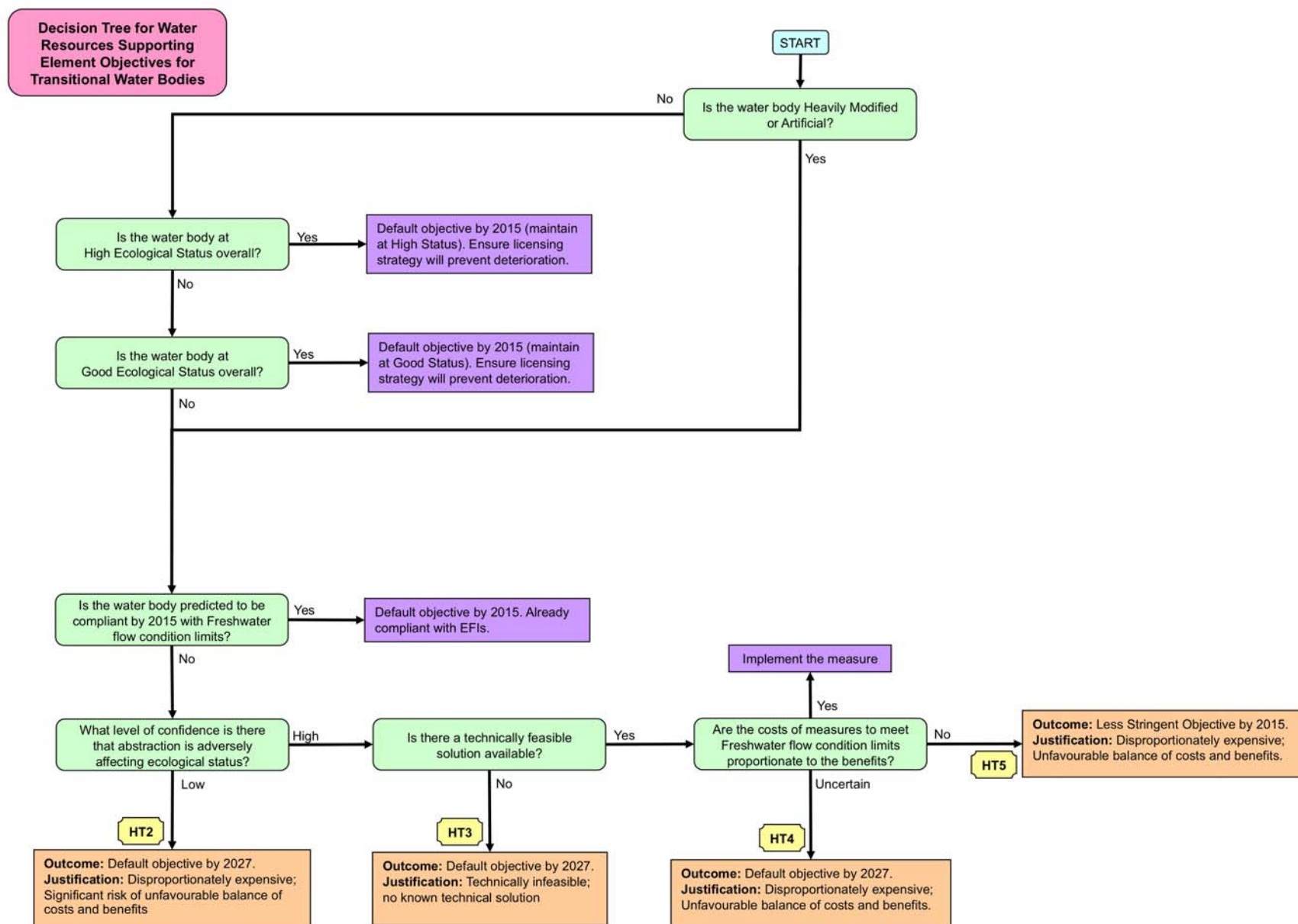
In England and Wales there are 30 groundwater bodies at good quantitative status that we have assessed as being at risk of deterioration of one or more quantitative element due to abstraction quantities that have been licensed but not currently used. Some of these are already under investigation. We intend to carry out a basic level of investigation (desk study) for each of these groundwater bodies and where needed consider options for preventing deterioration in status of the quantitative elements.

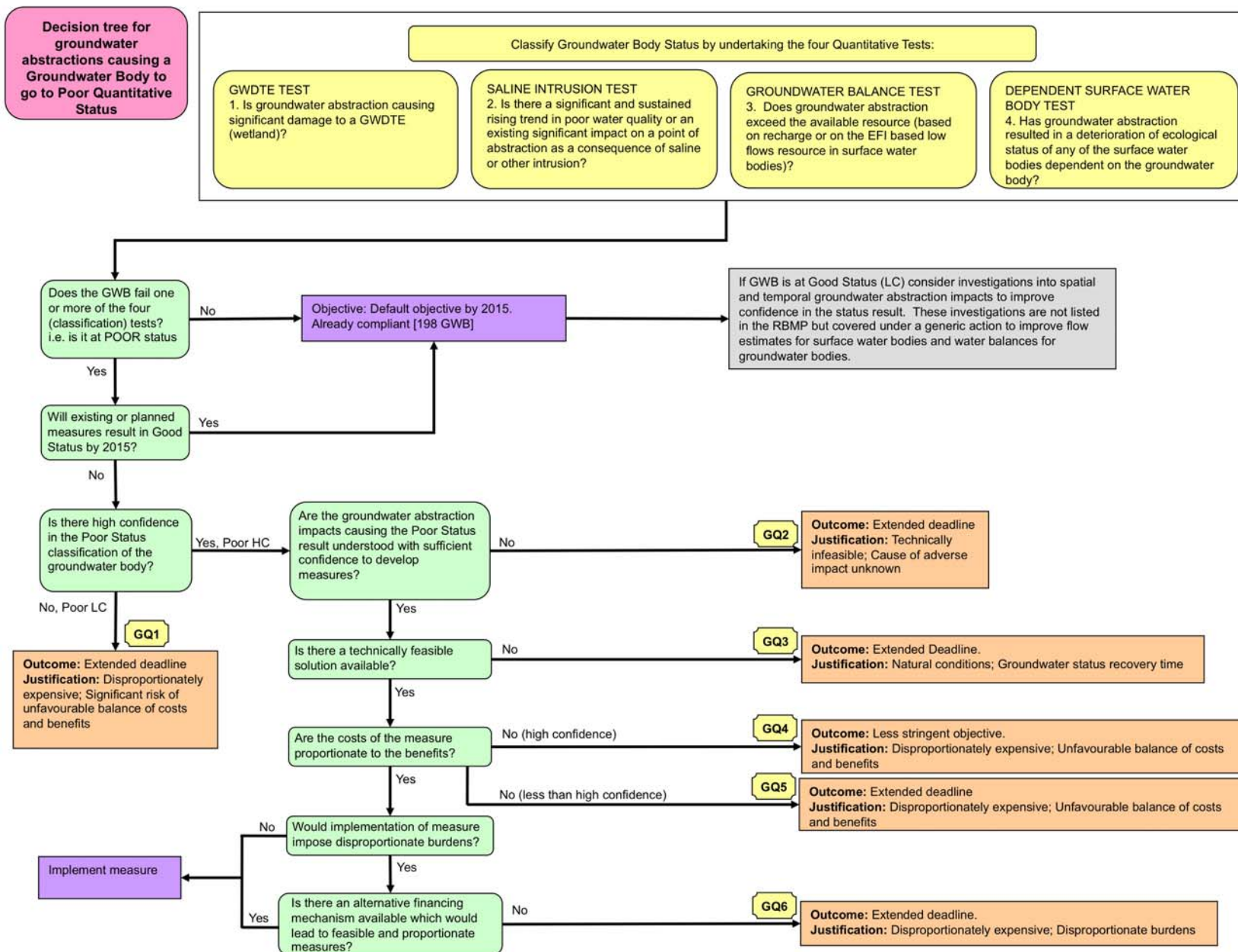
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- Water Resources pCEA 2007 “Preliminary Cost Effectiveness of WFD measures: chapter 4.2 Water Resources” Defra Economics, Collaborative Research Programme (available on: www.wfdcrp.co.uk)









Reference	HR1a
Element predicted not to achieve good by 2015	Hydrology
Reason for failure	Suspected - Flow Alteration due to Water Regulation
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that flow regulation is adversely affecting ecological potential</p> <p>It is disproportionately expensive to require changes to the flow regime at this time because the assessment of Good Ecological Potential has considered the presence or absence of potential mitigation measures and we have not established the relationship between mitigation measures and river ecology, therefore do not have the information to assess the ecological benefits of these mitigation measures.</p> <p>Until this link is sufficiently established for a water body, there is a significant risk that there will be either no or low benefits from implementing mitigation measures.</p> <p>Changes in flow regime can be costly as they may reduce resources available for drinking water which needs to be replaced from other sources. For the majority of water bodies in this category, there is a significant risk that there will be either no or low benefits from implementing mitigation measures. However there are a few water bodies in this category where need for change in flow regime has been established following specific investigations to meet Habitats Directive requirements. In these cases only, solutions will be implemented within the timescale of the first RBMP.</p>	
Investigation type	
investigate source of failure	
Example of investigation	
<p>Investigations in HMWBs or AWBs designated due to Water Resources modifications that are not currently achieving Good Ecological Potential will initially focus on the potential mitigation measures that may be appropriate in individual cases and the benefits that will be delivered by additional mitigation. Investigations will also consider the impact of potential mitigation on the primary economic use for which the water body was designated.</p>	

Possible future measures
After investigations, potential mitigation options will be implemented subject to the consideration of the costs and potential benefits of the measures. Mitigation measures are likely to be specific to each water body, however could include changes in management of the flow regime to benefit river ecology.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
Fundamental changes in flow regime such as restoring to natural flow regime are likely to be disproportionately expensive because of the high cost of replacement sources of drinking water in the order of £1.5m - £7m per Ml/d.

Reference	HR2a
Element predicted not to achieve good by 2015	Hydrology
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that abstraction is adversely affecting ecological status</p> <p>It is disproportionately expensive to require changes to the current abstraction regime at this time because our risk assessment (Environmental Flow Indicator threshold compliance) shows that there is only low confidence that abstraction pressure is adversely affecting ecological status.</p> <p>The flow regime is a supporting element in classification. Environmental Flow Indicators have been developed as a screening tool to indicate the level of flow below which Good Ecological Status may not be supported. Where we have low confidence that abstraction pressure is adversely affecting ecology, further studies are required to understand the relationship between flow and ecological status before we can attribute the failure in ecological status to abstraction pressures. Until this link is sufficiently established for a water body, there is a significant risk that there will be either no or low benefits from taking remedial action to improve flows.</p> <p>In such cases these low expected benefits contrast to potential very high costs of remedial measures. Water is abstracted from the environment to provide drinking water supplies and for use by industry. Where abstractions need to be reduced to improve the flow regime in the environment, alternative abstraction sources need to be developed. Developing new abstractions is very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day.</p> <p>The only practicable lower-cost actions to reduce the impact of abstraction are those that promote efficient and sustainable water use. In catchments subject to significant abstraction pressures, these are either already in place or will be put in place under this RBMP.</p>	
Investigation type	
investigate to confirm failure and/or impacts	
Example of investigation	
Monitoring and modelling to assess the impacts of abstraction pressures on ecological status. This work will include investigation of the hydrological impacts of	

abstraction and review of the flow requirements to support Good Ecological Status.

Possible future measures

Possible future measures include reduction in abstraction licence quantities, restrictions on abstraction during particular months, and the imposition of conditions on licences, such as Hands-Off flow constraints. The costs and benefits of measures will however need to be considered, and other measures such as river restoration schemes may prove to be a more cost beneficial way of achieving ecological status improvements.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

It is likely that reduction or ending of abstractions to meet Environmental Flow Indicator thresholds in all water bodies will be disproportionately expensive, due to the potential impacts on public water supply and other water users.

The preliminary cost effectiveness analysis undertaken by Defra estimated the cost of achieving EFIs by 2027 as between £3,200 million and £20,000 million for England and £65 million to £980 million for Wales. In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies.

Reference	HR4a
Element predicted not to achieve good by 2015	Hydrology
Reason for failure	Confirmed - Abstraction
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Likely unfavourable balance of costs and benefits of achieving good ecological status</p> <p>An extended deadline is required for all water bodies that are failing to achieve Good Ecological Status, do not meet Environmental Flow Indicator thresholds and where there is a high confidence that abstraction pressure is adversely affecting ecological status. In these water bodies, flows are unlikely to support Good Ecological Status and the costs and benefits of possible remedial measures must be considered</p> <p>At this stage, direct measures to reduce abstraction sufficiently to support Good Ecological Status are considered likely to be disproportionately expensive. Costs to reduce or relocate abstractions are typically high, ranging from £1.5m to £7m per MI/d of abstraction. This leads to considerable uncertainty in the costs of measures in the light of uncertainty in the scale of flow improvement required to support Good Ecological Status. On the benefits side there is also considerable uncertainty. Low flow is rarely the only cause of failure of ecological status and the benefits of improving flow will depend on whether actions to reduce other pressures are taken.</p> <p>Further investigation is required to identify proportionately costly solutions.</p>	
Investigation type	
investigate feasible measures	
Example of investigation	
<p>Monitoring and modelling to assess the water body specific impacts of abstraction pressures on ecological status. Investigation will be focussed on assessing the costs and potential benefits of measures in order to identify proportionately costly solutions. Part of this will also involve hydroecological investigation to establish the conditions required to support good ecological status and the scale of measures required in order to achieve this.</p>	

Possible future measures

Possible future measures include reduction in abstraction licence quantities, restrictions on abstraction during particular months, and the imposition of conditions on licences, such as Hands-Off flow constraints. The costs and benefits will however need to be considered, and other measures such as river restoration schemes may prove to be a more cost beneficial way of achieving ecological status improvements.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

It is likely that reduction or ending of abstractions to meet Environmental Flow Indicator thresholds in all water bodies will be disproportionately expensive, due to the potential impacts on public water supply and other water users.

The preliminary cost effectiveness analysis identified that costs to reduce or relocate abstraction may be in the order of £1.5m - £7m per Ml/d of abstraction. The same analysis estimated the cost of achieving EFIs by 2027 as between £3,200 million and £20,000 million for England and £65 million to £980 million for Wales. In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies.

Reference	HL1a
Element predicted not to achieve good by 2015	Hydrology
Reason for failure	Suspected - Flow Alteration due to Water Regulation
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that flow regulation is adversely affecting ecological potential</p> <p>It is disproportionately expensive to require changes to the flow regime at this time because the assessment of Good Ecological Potential has considered the presence or absence of potential mitigation measures and we have not established the relationship between mitigation measures and ecology, therefore do not have the information to assess the ecological benefits of these mitigation measures.</p> <p>Until this link is sufficiently established for a water body, there is a significant risk that there will be either no or low benefits from implementing mitigation measures.</p> <p>Changes in flow regime can be costly as they may reduce resources available for drinking water which needs to be replaced from other sources. For the majority of water bodies in this category, there is a significant risk that there will be either no or low benefits from implementing mitigation measures. However there are a few water bodies in this category where need for change in flow regime has been established following specific investigations to meet Habitats Directive requirements. In these cases only, solutions will be implemented within the timescale of the first RBMP.</p>	
Investigation type	
investigate source of failure	
Example of investigation	
<p>Investigations in HMWBs or AWBs designated due to Water Resources modifications that are not currently achieving Good Ecological Potential will initially focus on the potential mitigation measures that may be appropriate in individual cases and the benefits that will be delivered by additional mitigation. Investigations will also consider the impact of potential mitigation on the primary economic use of the water body for which it was designated. This will be particularly important for reservoirs designated for public water supply abstraction.</p>	

Possible future measures
After investigations, potential mitigation options will be implemented subject to the consideration of the costs and potential benefits of the measures. Mitigation measures are likely to be specific to each water body, however these could include changes in the rate and range of artificial drawdown to maintain aquatic plant and animal life or minor structural changes such as some types of fish passes.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
Measures that involve major changes to the structure of the impoundment are likely to be technically infeasible or disproportionately expensive due to the disruption of public drinking water supplies.

Reference	HL2a
Element predicted not to achieve good by 2015	Hydrology
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that abstraction is adversely affecting ecological status</p> <p>It is disproportionately expensive to require changes to the current abstraction regime at this time because our risk assessment (Environmental Flow Indicator threshold compliance) shows that there is only low confidence that abstraction pressure is adversely affecting ecological status.</p> <p>The flow regime is a supporting element in classification. Environmental Flow Indicators have been developed as a threshold to indicate the level of lake outflows below which Good Ecological Status may not be supported. Where we have low confidence that abstraction pressure is adversely affecting ecology, further studies are required to understand the relationship between flow and ecological status before we can attribute the failure in ecological status to abstraction pressures. Until this link is sufficiently established for a water body, there is a significant risk that there will be either no or low benefits from taking remedial action to improve flows.</p> <p>In such cases these low expected benefits contrast to potential very high costs of remedial measures. Water is abstracted from the environment to provide drinking water supplies and for use by industry. Where abstractions need to be reduced to improve the flow regime in the environment, alternative abstraction sources need to be developed. Developing new abstractions is very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day.</p> <p>The only practicable lower-cost actions to reduce the impact of abstraction are those that reduce water demand and promote efficient use. In catchments subject to significant abstraction pressures, these are either already in place or will be put in place under this RBMP.</p>	
Investigation type	
investigate to confirm failure and/or impacts	

Example of investigation
Monitoring and modelling to assess the impacts of abstraction pressures on ecological status. This work will include investigation of the hydrological impacts of abstraction and review of the flow requirements to support Good Ecological Status.
Possible future measures
Possible future measures include reduction in abstraction licence quantities, restrictions on abstraction during particular months, and the imposition of conditions on licences, such as Hands-Off flow constraints. The costs and benefits will however need to be considered, and other measures such as habitat restoration schemes may prove to be a more cost beneficial way of achieving ecological status improvements.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>It is likely that reduction in abstraction to meet Environmental Flow Indicator thresholds in the outflowing river of lake water bodies, or to remove other hydrological impacts on the lake level will be disproportionately expensive due to the potential impacts on public water supply and other water users. The preliminary cost effectiveness analysis identified that costs to reduce or relocate abstraction may be in the order of £1.5m - £7m per MI/d of abstraction.</p> <p>In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies.</p>

Reference	HL4a
Element predicted not to achieve good by 2015	Hydrology
Reason for failure	Confirmed - Abstraction
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Likely unfavourable balance of costs and benefits of achieving good ecological status</p> <p>An extended deadline is required for one lake water body in England (Hardley Flood) that is failing to achieve Good Ecological Status, does not the meet Environmental Flow Indicator thresholds for lake outflows and where there is a high confidence that abstraction pressure is adversely affecting ecological status. In this water body, flows are unlikely to support Good Ecological Status and the costs and benefits of possible remedial measures must be considered</p> <p>At this stage, direct measures to reduce abstraction sufficiently to support Good Ecological Status are considered likely to be disproportionately expensive. Costs to reduce or relocate abstractions are typically high, ranging from £1.5m to £7m per MI/d of abstraction. This leads to considerable uncertainty in the costs of measures in the light of uncertainty in the scale of flow improvement required to support Good Ecological Status. On the benefits side there is also uncertainty. Alien species are known to be a primary cause of failure of ecological status (for which no measures are readily available) and the benefits of improving flow in this case will be low .</p>	
Investigation type	
investigate feasible measures	
Example of investigation	
<p>Monitoring and modelling to assess the water body specific impacts of abstraction pressures on ecological status. Investigation will be focussed on assessing the costs and potential benefits of measures in order to identify proportionately costly solutions. Part of this will also involve hydroecological investigation to establish the conditions required to support good ecological status (lake outflows and water level regime) and the scale of measures required in order to achieve this.</p>	

Possible future measures

Possible future measures include reduction in abstraction licence quantities, restrictions on abstraction during particular months, and the imposition of conditions on licences, such as Hands-Off flow constraints. The costs and benefits will however need to be considered, and other measures such as river restoration schemes may prove to be a more cost beneficial way of achieving ecological status improvements.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

It is likely that reduction in abstraction to meet Environmental Flow Indicator thresholds will be disproportionately expensive, due to the potential impacts on public water supply and other water users. The preliminary cost effectiveness analysis identified that costs to reduce or relocate abstraction may be in the order of £1.5m - £7m per MI/d of abstraction.

In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies.

Reference	HT1a
Element predicted not to achieve good by 2015	Hydrology
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that abstraction is adversely affecting ecological status</p> <p>It is disproportionately expensive to require changes to the current abstraction regime at this time because our risk assessment (Environmental Flow Indicator threshold compliance) shows that there is only low confidence that abstraction pressure is adversely affecting ecological status.</p> <p>The freshwater flow regime is a supporting element in classification. Freshwater flow condition limits have been developed as a screening tool to indicate the level of freshwater inflow below which Good Ecological Status may not be supported. Where we have low confidence that abstraction pressure is adversely affecting ecology, further studies are required to understand the relationship between flow and ecological status before we can attribute the failure in ecological status to abstraction pressures. Until this link is sufficiently established for a water body, there is a significant risk that there will be either no or low benefits from taking remedial action to improve flows.</p> <p>In such cases these low expected benefits contrast to potential very high costs of remedial measures. Water is abstracted from the environment to provide drinking water supplies and for use by industry. Where abstractions need to be reduced to improve the flow regime in the environment, alternative abstraction sources need to be developed. Developing new abstractions is very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day.</p> <p>The only practicable lower-cost actions to reduce the impact of abstraction are those that reduce water demand and promote efficient use. In catchments subject to significant abstraction pressures, these are either already in place or will be put in place under this RBMP.</p>	
Investigation type	
investigate to confirm failure and/or impacts	

Example of investigation
Desk studies to review the hydrological condition. Where required, monitoring and modelling to assess the water body specific impacts of abstraction pressures on ecological status. This work will include investigation of the hydrological impacts of abstraction, the flow requirements to support Good Ecological Status and the feasibility of measures to deliver these flow requirements.
Possible future measures
Possible future measures include reduction in abstraction licence quantities, restrictions on abstraction during particular months, and the imposition of conditions on licences, such as Hands-Off flow constraints. The costs and benefits of measures will, however, need to be considered.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>It is likely that reduction in abstraction to meet flow condition limits in all inflowing water bodies will be disproportionately expensive, due to the potential impacts on public water supply and other water users. The preliminary cost effectiveness analysis identified that costs to reduce or relocate abstraction may be in the order of £1.5m - £7m per Ml/d of abstraction.</p> <p>In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies.</p>

Reference	HT3a
Element predicted not to achieve good by 2015	Hydrology
Reason for failure	Suspected - Abstraction
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Likely unfavourable balance of costs and benefits of achieving good ecological status</p> <p>An extended deadline is required for three transitional water bodies in England that are failing to achieve Good Ecological Status, do not meet flow condition limits for freshwater inflows and where there is a high confidence that abstraction pressure is adversely affecting ecological status. In these water bodies, flows are unlikely to support Good Ecological Status and the costs and benefits of possible remedial measures must be considered</p> <p>At this stage, direct measures to reduce abstraction sufficiently to support Good Ecological Status are considered likely to be disproportionately expensive. Costs to reduce or relocate abstractions are typically high, ranging from £1.5m to £7m per MI/d of abstraction. This leads to considerable uncertainty in the costs of measures in the light of uncertainty in the scale of flow improvement required to support Good Ecological Status. On the benefits side there is also considerable uncertainty. Low flow is not the only cause of failure of ecological status in these water bodies and the benefits of improving flow will depend on whether actions to reduce other pressures are taken.</p> <p>Further investigation is required to identify proportionately costly solutions.</p>	
Investigation type	
investigate source of failure	
Example of investigation	
Monitoring and modelling to assess the water body specific impacts of abstraction pressures on ecological status. Investigation will be focussed on assessing the costs and potential benefits of measures to reduce abstraction on freshwater inflows in order to identify proportionately costly solutions. Part of this will also involve hydroecological investigation to establish the conditions required to support good ecological status and the scale of measures required in order to achieve this.	

Possible future measures

Possible future measures include reduction in abstraction licence quantities, restrictions on abstraction during particular months, and the imposition of conditions on licences, such as Hands-Off flow constraints.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

It is likely that reduction in abstraction to meet flow condition limits in all inflowing water bodies will be disproportionately expensive, due to the potential impacts on public water supply and other water users. The Preliminary Cost Effectiveness Analysis identified that costs to reduce or relocate abstraction may be in the order of £1.5m - £7m per Ml/d of abstraction.

In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies.

Reference	GQ1a
Element predicted not to achieve good by 2015	Saline Intrusion
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that there is a failure in this element of groundwater status</p> <p>It is disproportionately expensive to require changes to the current abstraction regime at this time because there is only low confidence that there is a failure of the saline intrusion element of groundwater status as a result of abstraction pressure.</p> <p>There are a few groundwater bodies where high rates of groundwater abstraction have been associated with the intrusion of poorer quality groundwater - typically close to the coast or estuaries. However the influence of abstraction patterns, climate and sea level variables on continued groundwater quality trends has not yet been characterised with sufficient certainty to define alternative abstraction management interventions.</p> <p>Until the relationship between abstraction and saline intrusion is sufficiently established for a groundwater body, there is a significant risk that there will be either no or low benefits from taking remedial action to improve flows.</p> <p>In such cases these low expected benefits contrast to potential very high costs of remedial measures. Water is abstracted from the environment to provide drinking water supplies and for use by industry. Where abstractions need to be reduced to reduce saline intrusion, alternative abstraction sources need to be developed. Developing new abstractions is very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day.</p> <p>The only practicable lower-cost actions to reduce the impact of abstraction are those that promote efficient and sustainable water use. In catchments subject to significant abstraction pressures, these are either already in place or will be put in place under this RBMP.</p>	
Investigation type	
investigate to confirm failure and/or impacts	

Example of investigation
Investigate the spatial and temporal impacts of groundwater abstraction management regimes, e.g. through groundwater modelling studies or monitoring, possibly associated with signal tests. Also consider the effectiveness of potential abstraction control measures and their associated costs and benefits.
Possible future measures
Change in groundwater abstraction regime – adjust the duration and rate of pumping so as to reduce the impact of saline intrusion.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>The restoration of groundwater quality in aquifers following saline intrusion associated with natural recharge and hydraulic gradients may take 10s, 100s or 1000s of years to achieve. It should be possible in the long term to halt ongoing intrusion through abstraction control measures. However, developing new abstractions is very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day. In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies.</p> <p>Rising sea levels also pose a significant threat to GW quality around the coast which is not specifically related to abstraction and may frustrate attempts to protect a sustainable fresh groundwater resource.</p>

Reference	GQ1b
Element predicted not to achieve good by 2015	Impact On Surface Water Ecological Status
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that there is a failure in this element of groundwater status</p> <p>It is disproportionately expensive to require changes to the current abstraction regime at this time because there is only low confidence that there is a failure of the surface water ecological status as a result of groundwater abstraction pressure.</p> <p>For many principal aquifer groundwater bodies (and a few secondary aquifers), high rates of groundwater abstraction are locally or more generally associated with predicted impacts on dependent surface water body flows which are estimated to fall below the Environmental Flow Indicators considered to support Good Ecological Status. However, the spatial and temporal distribution of these flow impacts and their severity are not yet understood with confidence and more work is thereafter required to evaluate the benefits on river ecology of any abstraction reduction.</p> <p>Until these factors are understood sufficiently for a water body, there is a significant risk that there will be either no or low benefits from taking action to reduce groundwater abstractions.</p> <p>In such cases these low expected benefits contrast to potential very high costs of remedial measures. Water is abstracted from the environment to provide drinking water supplies and for use by industry. Where groundwater abstractions need to be reduced to improve the flow regime in dependent rivers, alternative abstraction sources need to be developed. Developing new abstractions is very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day.</p> <p>The only practicable lower-cost actions to reduce the impact of abstraction are those that promote efficient and sustainable water use. In catchments subject to significant abstraction pressures, these are either already in place or will be put in place under this RBMP.</p>	
Investigation type	
investigate to confirm failure and/or impacts	

Example of investigation
<p>In view of the number of groundwater bodies in this category the investigations are likely to be tiered with at least basic level of investigation in the first cycle. Investigations will improve the spatial and temporal characterisation of groundwater abstraction impacts; refine understanding of the likely costs and benefits of abstraction rate reductions in helping to restore flows and thereby achieve ecological status targets; may be integrated alongside consideration of other pollution and habitat pressures to determine the optimum way forward.</p>
Possible future measures
<p>Any future measures need to be based on a better characterised balance between costs and benefits carried out for each water body incorporating all the pressures. Measures may include reductions in abstraction licences, but other measures such as river restoration schemes may prove to be a more cost beneficial way of achieving ecological status improvements.</p>
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>Large reduction or relocation of groundwater abstractions may be disproportionately expensive because replacement abstractions are very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day. . Even if progressed, some of the higher storage sandstone aquifers respond slowly to changes in abstraction and recovery may not be realised by the desired deadline. In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies</p>

Reference	GQ1c
Element predicted not to achieve good by 2015	Water Balance
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that there is a failure in this element of groundwater status</p> <p>It is disproportionately expensive to require changes to the current abstraction regime at this time because there is only low confidence that there is a failure of the water balance element of groundwater status as a result of groundwater abstraction pressure.</p> <p>For many principal aquifer groundwater bodies (and a few secondary aquifers), high rates of groundwater abstraction is estimated to reduce the natural outflow from the groundwater body as a whole by more than the aggregated available low flow resource. This resource is estimated from the Environmental Flow Indicators considered to support Good Ecological Status in all the surface water bodies draining each groundwater body. However, an adequate characterisation of the flow impacts has not yet been achieved and more work is thereafter required to evaluate the benefits on river ecology of any abstraction reduction.</p> <p>Until these factors are understood sufficiently for a water body, there is a significant risk that there will be either no or low benefits from taking action to reduce groundwater abstractions</p> <p>In such cases these low expected benefits contrast to potential very high costs of remedial measures. Water is abstracted from the environment to provide drinking water supplies and for use by industry. Where groundwater abstractions need to be reduced to improve the flow regime in dependent rivers, alternative abstraction sources need to be developed. Developing new abstractions is very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day.</p> <p>The only practicable lower-cost actions to reduce the impact of abstraction are those that promote efficient and sustainable water use. In catchments subject to significant abstraction pressures, these are either already in place or will be put in place under this RBMP.</p>	
Investigation type	
investigate to confirm failure and/or impacts	

Example of investigation

In view of the number of groundwater bodies in this category the investigations are likely to be tiered with at least basic level of investigation in the first cycle. Investigations will improve the spatial and temporal characterisation of groundwater abstraction impacts; refine understanding of the likely costs and benefits of abstraction rate reductions in helping to restore flows and thereby achieve ecological status targets; may be integrated alongside consideration of other pollution and habitat pressures to determine the optimum way forward. Any future measures need to be based on a better characterised balance between costs and benefits carried out for each water body incorporating all the pressures.

Possible future measures

Measures may include reductions in groundwater abstraction licences.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Large reductions or relocation of groundwater abstraction may be disproportionately expensive because replacement abstractions are very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day. Even if progressed, some of the higher storage sandstone aquifers respond slowly to changes in abstraction and recovery may not be realised by the desired deadline. In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies

Reference	GQ1d
Element predicted not to achieve good by 2015	Groundwater Dependent Terrestrial Ecosystems (Quantitative)
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that there is a failure in this element of groundwater status</p> <p>It is disproportionately expensive to require changes to the current abstraction regime at this time because there is only low confidence that there is a failure of the dependant terrestrial ecosystem element of groundwater status as a result of groundwater abstraction pressure.</p> <p>There are three groundwater bodies supporting groundwater dependent terrestrial ecosystems (e.g. wetlands) which may be suffering some damage associated with groundwater abstraction, but where the temporal and spatial distribution of groundwater level and flow impacts is not yet well understood. Monitoring and groundwater modelling studies are ongoing or are still being evaluated to improve the confidence in groundwater abstraction impact prediction. Further work is needed to determine the ecological benefits of reducing groundwater abstraction.</p> <p>Until these factors are understood sufficiently, there is a significant risk that there will be either no or low benefits from taking action to reduce groundwater abstractions.</p> <p>In such cases these low expected benefits contrast to potential very high costs of remedial measures. Water is abstracted from the environment to provide drinking water supplies and for use by industry. Where groundwater abstractions need to be reduced to improve the condition of dependant wetlands, alternative abstraction sources need to be developed. Developing new abstractions is very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day.</p> <p>The only practicable lower-cost actions to reduce the impact of abstraction are those that promote efficient and sustainable water use. In catchments subject to significant abstraction pressures, these are either already in place or will be put in place under this RBMP.</p>	
Investigation type	
investigate to confirm failure and/or impacts	

Example of investigation
Use groundwater modelling plus monitoring to confirm estimates of groundwater abstraction impacts on shallow water table dependent wetland ecological assemblages. Thereafter consider the combinations of abstractions and site management/drainage which could be damaging the wetland, and consider technical feasibility and benefits of potential abstraction control or other measures and their associated costs. Also need to consider the specific wetland ecologies to weigh the costs of the possible measures up against their potential benefits.
Possible future measures
Measures may include reductions in abstraction licences, and/or water level management plan solutions associated with site management interventions,
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>Large reductions in abstraction could be disproportionately expensive and possible also ineffective in improving the shallow water level regime which may be more directly influenced by drainage and site management. In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies</p> <p>The condition of the wetlands may be improved by water level management plan measures but not totally restored.</p>

Reference	GQ2a
Element predicted not to achieve good by 2015	Saline Intrusion
Reason for failure	Suspected - Saline Intrusion
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>Insufficient understanding of the impact to enable development of measures to achieve the objective by 2015</p> <p>It is technically infeasible to apply changes to the flow regime at this time because the adverse impact is not understood with sufficient confidence to allow development of remedial actions.</p> <p>There are two GW Bodies in England for which this justification applies with respect to the Saline & Other Poor Water Quality Intrusions test: Tame Anker Mease - PT Sandstone Burton and Kent Romney Marsh.</p> <p>In the Burton Sandstone, poorer quality (high chloride) groundwater exists in the lower parts of the deep confined Permo-Triassic Sandstone aquifer, and almost certainly in the underlying Coal Measures. There is concern that abstraction is resulting in the upwelling of deep saline waters from the deep aquifer. The cause of the salinity problem has been investigated using the groundwater model. Based on the modelling undertaken to date the link between rates of abstraction and associated intrusion has not been adequately established so a definitive solution to mitigating the abstraction pressure has not been identified. An extended deadline is required to consider if a solution is technically feasible by 2027.</p> <p>Saline intrusion from the sea at Romney Marsh associated with abstraction from the Dungeness shingle aquifer remains a problem, even though some restrictions to the abstraction regime have been made. The cause of these ongoing problems is uncertain & further investigations are required to determine whether a technically feasible solution is possible by 2027.</p>	
Investigation type	
investigate source of failure	
Example of investigation	
Investigate the technical feasibility of potential abstraction control measures and their associated costs and benefits	

Possible future measures
Change in groundwater abstraction regime
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>The restoration of groundwater quality in sandstone aquifers (eg PT Sandstone Burton) following saline intrusion associated with natural recharge and hydraulic gradients may take 10s, 100s or 1000s of years to achieve. It should be possible in the long term to halt ongoing intrusion through abstraction control measures. However, replacement abstractions are very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day. In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies</p> <p>Rising sea levels also pose a significant threat to GW quality around the coast which is not specifically related to abstraction (e.g. at Romney Marsh) and which may frustrate attempts to protect a sustainable fresh groundwater resource.</p>

Reference	GQ2b
Element predicted not to achieve good by 2015	Groundwater Dependent Terrestrial Ecosystems (Quantitative)
Reason for failure	Suspected - Abstraction groundwater
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>Insufficient understanding of the impact to enable development of measures to achieve the objective by 2015</p> <p>It is technically infeasible to apply changes to the flow regime at this time because the adverse impact is not understood with sufficient confidence to allow development of remedial actions.</p> <p>There are two GW Bodies in England for which this justification applies with respect to the "Significant Damage to Wetlands" test: The Worcestershire Middle Severn Sandstone, and the Reigate Lower Greensand. In both cases investigations into groundwater abstraction pressures on SSSI sites are still being undertaken. These are considering the combined impacts of many licence holders such that the technical feasibility of any proposed abstraction reduction related solution is not yet understood with confidence.</p> <p>Abstraction control related measures cannot be planned with confidence and although water level and site management improvements are also being considered, these cannot be confidently predicted to restore the sites from their 'significantly damaged' condition before the extended 2027 deadline.</p>	
Investigation type	
investigate source of failure	
Example of investigation	
<p>Use groundwater modelling plus monitoring to investigate the combinations of abstractions and site management/drainage which could be causing the wetland significant damage, and also to consider technical feasibility of potential abstraction control or other measures and their associated costs and benefits. Also need to consider the water needs of the specific wetland habitats to evaluate the benefits of reducing abstraction and/or changing water levels.</p>	

Possible future measures

Measures may include reductions in abstraction licences, and/or water level management plan solutions associated with site management interventions e.g. Hurcott Pool

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Large reductions in public water supply abstraction across the groundwater body at a broader scale may be required to realise water table recovery to improve these wetland sites, rather than more localised fixes. However, developing replacement abstractions is very expensive; costing from £1.5m to £7m to provide a single mega-litre of water each day, and such reductions may be disproportionately expensive.

The condition of the wetlands may be improved by water level management plan measures but not totally restored.

Reference	GQ3a
Element predicted not to achieve good by 2015	Groundwater Dependent Terrestrial Ecosystems (Quantitative)
Reason for failure	Confirmed - Abstraction groundwater
Alternative objective	Extended deadline
Reason for alternative objective	Natural conditions - ecological recovery time
Justification for alternative objective	
<p>Delayed recovery of the ecology in the dependent terrestrial ecosystem (wetland) means that the objective will not be achieved by 2015</p> <p>It is technically infeasible for this element of groundwater quantitative status to improve to good by 2015 because the plants and animals in the groundwater dependent wetland are unlikely to recover, given the conditions at the site.</p> <p>There is only one groundwater body in England for which an extended deadline is justified by ecological recovery time, even though the groundwater abstraction cause of the problem has been confirmed. This is the failure of the Groundwater Dependent Terrestrial Ecosystems (wetlands) element at the Kent Romney Marsh groundwater body (Dungeness SAC). Investigations under the Habitats Directive have resulted in the application of restrictive conditions to a public water supply licence when groundwater levels are below a certain threshold. However, the ecology of the wetland will take time to adjust to the new regime and the benefits of the scheme may be difficult to demonstrate because of a paucity of baseline monitoring data, and other unrelated pressures on the wetland from climate change and rising sea levels.</p>	
Investigation type	
monitor the effectiveness of measures in place	
Example of investigation	
Monitoring to investigate the link between abstraction pressure and the wetland, including the rate of discernable ecological recovery.	
Possible future measures	
Measures will be implemented in 1st cycle but it will take time for the benefit to be seen. Other measures may be necessary in the future, subject to review of the monitored effectiveness of those already put into action.	

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

It is possible that efforts to restore the wetland through modified abstraction controls may be frustrated by saline intrusion associated with sea level rise and will prove to be technically infeasible in the long term.

Reference	GQ4a
Element predicted not to achieve good by 2015	Saline Intrusion
Reason for failure	Confirmed - Saline Intrusion
Alternative objective	Less stringent status objective
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The costs of achieving good status for this element are disproportionate to the benefits</p> <p>In three Permo-Triassic Sandstone groundwater bodies (all in the North West RBD), groundwater abstraction is known to be causing saline intrusion and the impacts are understood with confidence. These groundwater bodies support critical groundwater sources which are essential to the Merseyside economy e.g. for major industry and public water supply.</p> <p>Costs for locating alternative water sources for such supplies would be in the range of £1.5 to 7 million per megalitre per day and the value of the associated recovery of freshwater aquifer would be both limited (i.e. there would be no ecological benefit) and difficult to realise (because it may take 100s or 1000s of years to flush out the saline water under natural gradients).</p> <p>Management to prevent further deterioration is being implemented through the Catchment Abstraction Management Strategy. Sustainability Appraisal has been undertaken and the target status of groundwater resources is not an improvement on the current status.</p> <p>A less stringent objective is therefore justified due to the social and economic cost of reducing abstraction sufficiently to achieve good status, and the limited environmental benefit.</p>	
Investigation type	
Monitoring to prevent further deterioration	
Example of investigation	
Ongoing monitoring of groundwater levels and salinity is essential to avoid further deterioration. Groundwater modelling investigation has also been undertaken to test abstraction scenarios to plan more targeted restrictions on abstraction and guidance on approach to new abstraction licences.	

Possible future measures
Seek to reduce licence quantities as and when they are no longer needed.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
Recovery of saline parts of sandstone groundwater body will not occur within desired timescales. All known measures sufficient to achieve good groundwater status for this element are likely to be technically infeasible or disproportionately expensive

Reference	GQ5a
Element predicted not to achieve good by 2015	Water Balance
Reason for failure	Confirmed - Abstraction groundwater
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>There is likely to be an unfavourable balance of costs and benefits of achieving good status of the water balance element</p> <p>This alternative objective has been assigned to a number of Chalk and Sandstone groundwater bodies in England where high rates of public water supply groundwater abstraction reduces the natural outflow from the groundwater body as a whole by more than the aggregated available low flow resource. This resource is estimated from the Environmental Flow Indicators considered to support Good Ecological Status in all the surface water bodies draining each groundwater body. These flow impacts are understood with confidence (e.g. in many cases groundwater modelling studies have been undertaken to characterise and confirm them) and a technically feasible solution for restoring flows is available (i.e. reduce abstraction). However, the cost of such measures is known to be high (in the range of £1.5m to £7m per megalitre per day) and their ecological benefits in terms of restoring baseflow within the dependent surface water bodies are undetermined.</p> <p>Understanding of the most cost beneficial actions to realise ecological improvements needs to be developed further before such action can be planned, so an extended deadline is justified on the basis that achieving good status of this element by 2015 is very likely to be disproportionately expensive.</p>	
Investigation type	
investigate to confirm abstraction impacts and to refine the balance of costs and benefits	
Example of investigation	
<p>Investigations to refine understanding of the likely costs and benefits of abstraction rate reductions in helping to restore flows and thereby achieve ecological status targets will be integrated alongside consideration of other pollution and habitat pressures to determine the optimum way forward. Any future measures need to be based on a better characterised balance between costs and benefits carried out for each water body incorporating all the pressures.</p>	

Possible future measures
Measures may include reductions in groundwater abstraction licences.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>Large reduction or relocation of public water supply abstraction are likely to be disproportionately expensive because replacement abstractions can cost between £1.5m to £7m to provide a single mega-litre of water each day. Even if progressed, some of the higher storage sandstone aquifers respond slowly to changes in abstraction and recovery may not be realised by the desired deadline. In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies.</p>

Reference	GQ5b
Element predicted not to achieve good by 2015	Impact On Surface Water Ecological Status
Reason for failure	Confirmed - Abstraction groundwater
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>There is likely to be an unfavourable balance of costs and benefits of achieving good ecological status of the dependent surface waters</p> <p>This alternative objective has been assigned to a number of Chalk and Sandstone groundwater bodies in England where high rates of groundwater abstraction for public water supply are locally or more generally associated with impacts on dependent surface water body flows causing these flows to fall well below the Environmental Flow Indicators considered to support Good Ecological Status. These flow impacts are understood with confidence (e.g. in many cases groundwater modelling studies have been undertaken to characterise and confirm them) and a technically feasible solution for restoring flows is available (i.e. reduce abstraction). However, the cost of such measures is known to be high (i.e. in the range of £1.5 to 7 million per megalitre per day) and their benefits in terms of improving ecological status are undetermined.</p> <p>Understanding of the most cost beneficial actions to realise ecological improvements needs to be developed further before such action can be planned, so an extended deadline is justified on the basis that achieving good status of this element by 2015 is very likely to be disproportionately expensive.</p>	
Investigation type	
investigate to confirm abstraction impacts and to refine the balance of costs and benefits	
Example of investigation	
Investigations to refine understanding of the likely costs and benefits of abstraction rate reductions in helping to restore flows and thereby achieve ecological status targets will be integrated alongside consideration of other pollution and habitat pressures to determine the optimum way forward. Any future measures need to be based on a better characterised balance between costs and benefits carried out for each water body incorporating all the pressures.	

Possible future measures

Measures may include reductions in abstraction licences, but other measures such as river restoration schemes may prove to be a more cost beneficial way of achieving ecological status improvements.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Large reduction or relocation of groundwater abstractions are likely to be disproportionately expensive because replacement abstractions can cost between £1.5m to £7m to provide a single mega-litre of water each day. Even if progressed, some of the higher storage sandstone aquifers respond slowly to changes in abstraction and recovery of dependent surface water flows may not be realised by the desired deadline. In regions where demand for water is high relative to resources, it may not be feasible to locate alternative sources for drinking water without causing deterioration in other water bodies

E4 Ammonia, dissolved oxygen, acidity, nutrients, temperature and faecal pollution in surface waters

We explain in this section how we have assessed what can be achieved in the first cycle of river basin management for the general water quality conditions necessary to support good ecological status. We explain where, for the phased achievement of objectives, deadlines have been extended. These are generally applied where we need to confirm the outcomes of planned actions; or where we need to improve our understanding of current status or causes and effects of pressures to enable us to target appropriate actions.

This section covers nutrients, dissolved oxygen, acidity, temperature and ammonia in surface waters. We explain how we have assessed what can be achieved for other chemical pollutants, sediment and groundwater quality in separate sections.

Development and use of the standards

The water quality conditions necessary to support high and good ecological status, as well as the conditions associated with moderate, poor and bad status, are described by water quality standards. New standards for the Water Framework Directive are developed by the United Kingdom's Technical Advisory Group (UKTAG). The UKTAG is a working group of experts drawn from environment agencies and conservation agencies. The general water quality standards proposed to support healthy communities of aquatic plants and animals are detailed in the phase 1 and phase 2 UKTAG reports¹¹.

The new physico-chemical standards replace or extend established regimes of standards and the policies by which they are used to take action. Existing standards stem from other European directives, or from national initiatives such as the River Quality Objectives¹². Table 7 summarises the general elements for which new standards have been developed to meet the needs of the Water Framework Directive. Other directives and requirements will continue to be important in delivering improvements for these elements. Many of the "designations" under the older directives become Protected Areas under the Water Framework Directive (see Annex D).

Standards are used to assess and control the impact of industry and land use, both urban and rural to protect and improve the environment. They are used to assess where action might be needed and the extent of action required. We use mathematical models to calculate what regulatory action is required to protect water quality, for example permit conditions for discharges. We monitor our waters to check the status being achieved. Complying with these water quality standards should ensure the associated biological status is met.

Where possible, the standards have been developed from extensive data on water chemistry and biology, checking where measured changes in biology are linked to measured changes in water chemistry. They have been developed by technical experts based on current scientific understanding of biological response to water quality building on knowledge from pre-existing standards.

For some elements, particularly nutrients, the biological response is less predictably linked to compliance with the chemical standard than, say, for ammonia or dissolved oxygen. This means there is less confidence that failure of the nutrient standard alone is sufficient to judge

¹¹ The UKTAG Phase 1 and Phase 2 reports on the UK Environmental Standards and Conditions are available from the UKTAG website http://www.wfduk.org/UK_Environmental_Standards/

¹² River Quality Objectives apply to all rivers in England and Wales

the risk to the biology. In such cases confidence about the need to improve status would come from supporting evidence that the biology is at risk from eutrophication. We call this an 'indirect' approach to using standards. As well as confirming whether action is needed, the gathering of further biological data will also help in the development of better standards.

Table 7. General chemical and physicochemical quality elements for surface waters

Water category	Quality elements	Indicators for standards proposed by UKTAG	Typology specific
Rivers	1. Thermal conditions	1. Temperature	yes
	2. Oxygenation conditions	2. Dissolved oxygen	yes
	3. Salinity	3. -	
	4. Acidification status	4. pH	no
	5. Nutrient conditions	5. Reactive phosphorus	yes
Lakes	1. Transparency	1. -	
	2. Thermal conditions	2. -	
	3. Oxygenation conditions	3. Dissolved oxygen	yes
	4. Salinity	4. Conductivity	no
	5. Acidification status	5. Acid neutralising capacity	No
	6. Nutrient conditions	6. Total phosphorus	yes (type or site specific)
Estuaries and Coastal Waters	1. Transparency	1. -	
	2. Thermal conditions	2. -	
	3. Oxygenation conditions	3. Dissolved oxygen	yes (salinity dependent)
	4. Nutrient conditions	4. Dissolved inorganic nitrogen	Yes
Fresh waters (Rivers & Lakes)	Ammonia (specific pollutant)	Ammonia	Yes
Saline waters (Estuaries & Coastal)	Unionised Ammonia (specific pollutant)	Unionised Ammonia	No

General approach to directing improvement action

The Water Framework Directive requires us to take action to prevent deterioration of status and where necessary and proportionate, restore waters to good status. Where different options are available the actions taken forward should be those judged to be most cost-effective. The approach is based on risk and on taking action in proportion to what it can achieve (the benefits) and what it will cost. The Water Framework Directive allows "alternative objectives" if the action required is technically infeasible or if achieving good is disproportionately expensive¹³.

To justify actions under the Water Framework Directive we assess:

- whether it is technically feasible to achieve good status;
- what the most cost-effective way of doing this is (based on the range of pressure sources needing to be reduced and the technically feasible options available to address these);
- whether the costs of the proposed actions will be in proportion to the benefits,
- whether the costs would impose a disproportionate burdens for particular sectors or parts of society; and if so
- whether there are alternative funding mechanisms available.

¹³ And all the other requirements of Article 4.4 or Article 4.5 are met

In assessing this we must consider uncertainty and how confident we are about:

- Current status: whether or not we are actually in good status because of failure to meet the water quality standards
- Future status: what status we expect to achieve after current and agreed future actions are completed
- Reasons for failure: why waters fail to meet good status, in particular, for action to meet water quality standards, the relative importance of different sectors and sources of pollution
- Improvement options: how much the sources of pollution can be reduced, through measures that are judged to be technically feasible and not disproportionately expensive.

Status assessment

We have followed the recommendations and proposals from UKTAG¹⁴ on how waters should be classified and how the information provided through classification should be used in the river basin management planning process. This includes how to manage the risk of misclassifying the status of water bodies and how confidence in status classifications should be taken into account in deciding where action to protect and improve the status of water bodies is targeted. The key points are summarised here.

We use monitoring data to assess current status and compliance with water quality standards. Current failure to meet the required standards and status indicates that action might be required to improve status. But we must also consider how confident we are in this assessment. Our status estimates will always be subject to error because monitoring is not done everywhere and all the time, and because our monitoring techniques will never be perfect. The WFD allows for a risk-based approach to monitoring. We therefore risk making an incorrect judgement about the true status. It is important to understand and manage this risk so that we limit the potential to either fail to act because a water body is wrongly reported as better than it is, or to waste resources improving water bodies that are wrongly classed as worse than they are.

For nutrients, the confidence of being less than good status due to risk of eutrophication is assessed not just by failure of the nutrient standard but also using evidence from biological elements which are sensitive to nutrient pressures. The overall confidence is judged on a weight of evidence basis. This takes account of the extent of relevant biological evidence available and the confidence that these elements are less than good. This is in accordance with recommendations from UKTAG and Ministerial Guidance on River Basin Planning.

For lakes, transitional and coastal waters, the confidence of being less than good status based on weight of evidence across nutrients and the relevant impact indicators is assessed using expert judgement. For rivers, the Environment Agency approach is described in the boxed section below. Further information on the UK approach to assessing eutrophication under EU water policies will be available in 2010 through a proposed UKTAG consultation report. This is being produced by a task group of UKTAG and UK Eutrophication Steering Group members to follow the recent publication of EU guidance¹⁵.

Whilst high confidence of eutrophication is needed for consideration of site specific regulatory measures, this does not preclude lower confidence failures leading to the

¹⁴ UKTAG Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive, <http://www.wfduk.org/UKCLASSPUB/>

¹⁵ Common Implementation Strategy for the Water Framework Directive: Guidance Document (No. 23) on Eutrophication Assessment in the context of European water policies http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/guidance_document_1/ EN_1.0 &a=d

consideration of other types of measures such as national measures or lower cost 'no regrets' measures.

Where we are confident of phosphate failure and this is indicative of some biological impact, (e.g. in alkaline lowland rivers) we will take action to reduce phosphates by such means as providing education or training, routing people to sources of funding or invoking the England Catchment Sensitive Farming Initiative, without waiting for the full information on diatoms and macrophytes that would be necessary to justify targeted regulatory action to control eutrophication such as the designation of a sensitive area under the Urban Waste Water Treatment Directive or of a Water Protection Zone.

Weight of Evidence rules for combining macrophyte, diatom and phosphate in river classification

A. Weight of Evidence (WoE) – macrophyte and phytobenthos quality element

1. The WoE confidence of being worse than good for the combined macrophyte and phytobenthos quality element is the statistical certainty of the worst of macrophytes and diatoms but subject to the modification that this cannot be greater than the certainty shown in Tables 1 and 2 below. These tables summarise the rules for the maximum overall certainty of being less than good, that have been assigned to the overall quality element.

Table 1 **Certainty of being less than good in low alkalinity upland river systems**
($< 50\text{mgCaCO}_3/\text{l}$ or $\geq 80\text{m}$ altitude)

		Macrophyte Class					
		No data	High	Good	Moderate	Poor	Bad
Diatom Class	No data	U	U	U	Q	V	V
	High	U	U	U	Q	V	V
	Good	U	U	U	Q	V	V
	Moderate	Q	Q	Q	V	V	V
	Poor	V	Q	Q	V	V	V
	Bad	V	Q	Q	V	V	V

Table 2 **Certainty of being less than good in high alkalinity lowland river systems**
($\geq 50\text{mgCaCO}_3/\text{l}$ and $< 80\text{m}$ altitude)

		Macrophyte Class					
		No data	High	Good	Moderate	Poor	Bad
Diatom Class	No data	U	U	U	Q	V	V
	High	U	U	U	Q	V	V
	Good	U	U	U	Q	V	V
	Moderate	U	U	U	V	V	V
	Poor	Q	Q	Q	V	V	V
	Bad	Q	Q	Q	V	V	V

B. Weight of Evidence – combined certainty for biology and phosphate

2. The overall certainty to assign to the combination of biology classification with phosphate is given in Table 3.

Table 3: Combined certainty for biological and phosphate classification in rivers

Phosphate	Combined Macrophyte- Phytobenthos QE			
	Cert not Good	V	Q	U
	V	V	Q	U
	Q	V	Q	U
	U	Q	U	U

U – Uncertain, Q – Quite Certain, V – Very Certain

- At present we do not have sufficient understanding of the relative sensitivity of the diatom and macrophyte classification tools to determine whether macrophyte status for particular water bodies could be inferred from the status of phosphate and diatoms alone in lowland river systems. We will review the position as the technical knowledge base develops in the run-up to the UKTAG review of nutrient standards in 2012.

Despite site specific uncertainties in monitoring results, regional summaries like "30 per cent of the water bodies in a particular country or river basin district are worse than good status" can be very accurate. This is because the individual risks of misclassifying several hundred water bodies average out. On the other hand a list of named water bodies that are classed as worse than good status will include some water bodies which are, in truth, at good status or better.

Certain types of national measures can be justified to address levels of failure expressed on a national scale in which case we do not need high confidence of failure at specific sites. The costs and benefits would similarly be assessed at a national rather than local scale. Benefits might be, for example, that we expect 3 per cent of waters to move into good status nationally, though we are unlikely to be able to specify which waters these would be. These measures cover, for example, product bans, uniform emission standards on discharges, farmers adopting certain management approaches, and general binding rules. These might aim to improve status, provide a step in the right direction, or help prevent deterioration in status. Measures applied in this way do not require site specific confidence of cause and effect and between action and outcome.

As well as uncertainty in current status we will also have uncertainty about future status. Our approaches to estimating the outcomes of the actions are approximate and the prediction of still being less than good may be pessimistic. We would be particularly uncertain of future status where we anticipate improvements within water bodies where we have low confidence that even the current status is less than good. Estimated outcomes could be from measures within or upstream of the water body. Our ability to estimate the relative importance of pollution sources following improvement actions to all or some of them also gives considerable uncertainty about where future measures might need to be targeted.

Where there is uncertainty about predicted status following improvements we would not tend to justify further action. In these cases we have set alternative objectives with an extended deadline on the grounds that imposing further measures could be wasteful due to uncertainty in whether they are needed and the benefits that could be realised. We will review the success of the planned actions before we look to implement any further high cost actions.

For example, we have not looked for further improvements to those sewage treatment works improved in AMP4 to meet the requirements of the Freshwater Fish Directive. £650 million

will be spent in AMP4 to reduce ammonia discharged from these works. We will review the need for further action at these works if future status assessments confirm that we are failing good status.

Sources of status impacts and measures

Where we are certain that the future status will still fall short of that required, we will assess whether we know enough about the pollution sources contributing to the failure and whether there are technically feasible measures that can be targeted to those sources.

The physico-chemical supporting elements will be affected by natural conditions as well as impacts from human activities. We use information from a number of sources to try and understand why the waters are failing. This includes monitoring, modelling, expert judgement and local knowledge. The most important sources influencing the physico-chemical elements are sewage discharges, industrial discharges, urban drainage and runoff from agricultural land use. These can reach the water environment as point or diffuse sources. Their relative importance varies depending on the element and the location. The physical features and flow conditions, including the impact of abstractions can also be important influencing factors, particularly for dissolved oxygen.

In some cases we do not know what is causing the failure (indeed in thousands of assessments there will always be hundreds of spurious failures caused by statistical uncertainties in monitoring¹⁶).

In some cases we will know the source of the pollution in broad terms but will not yet know enough about the specific sources within this and/or the pathways by which the pollution reaches the water environment to be able to assess detailed actions to address the pollution. This can be the case where pollution is from diffuse sources, such as urban areas or from the agricultural sector, comprising many individually small contributory pollution sources. Their variability spatially and through time also makes them difficult to quantify. This leaves considerable uncertainty about the significance of the various sources and hence the effectiveness of actions to address these. For instance, there can be many sources and pathways for agricultural nutrients to reach water courses to which different options (and feasibility and expense) for reducing nutrient loss could be applied depending on their relative importance.

Where we cannot identify sources, pathways and responsible parties with sufficient confidence we need to undertake further investigations. These will include local investigations as well as national projects, such as those on source apportionment. These ongoing investigations will enable us to assess how best to reduce the sources and quantify the costs and benefits. We have set alternative objectives with an extended deadline on the grounds that it is technically infeasible to apply site specific improvement measures unless we have sufficient knowledge about the sources that need addressing. Applying measures with only weak certainty that they are appropriately targeted would risk wasted investment.

This may apply to all or just some of the sources. Where we have sufficient certainty about some of the sources we will have justified actions to address these even if there is insufficient certainty to address the other sources of pollution. For instance we may have strong enough evidence of site specific impacts from larger sewage works discharges, have calculated what applying nutrient removal technology would deliver and justified that action being taken to reduce the sewage source contribution. If that action is driven purely by the Water Framework Directive the actions and outcomes would have been subject to a disproportionate cost assessment. In some cases the benefits that can be achieved by

¹⁶ And an associated risk of taking action on sites that do not need it.

addressing the known sources are insufficient to justify the costs. In these cases we will use an extended deadline to allow us to improve our understanding of the other sources of pollution to establish whether an improved package of measures to address all sources will be cost-beneficial.

As before national measures (e.g. product bans, uniform emission standards on discharges, farmers adopting certain management approaches) can be justified based on a national scale understanding of the relative importance of different sources without needing detailed location specific knowledge of sources.

The work for the preliminary cost-effectiveness assessment¹⁷, summarised the approaches that are currently feasible and their relative cost-effectiveness.

Actions on Diffuse Pollution

Diffuse pollution has been identified as an issue across England and Wales. It arises from a number of sectors and sources and impacts a variety of water uses including drinking water, bathing, recreation, economically significant species (e.g. shellfish and salmon) and biodiversity, as well as ecological status for the Water Framework Directive.

As discussed above for many of the diffuse sources our knowledge of the detail of sources and pathways is too uncertain to know what measures would be feasible and effective, particularly at a detailed site specific level. For this reason, the measures included in this plan tend to focus on actions planned for other drivers, national measures, and locally targeted actions to control pollution. These measures are also important to help prevent deterioration¹⁸ of the status of water bodies.

Actions include pollution prevention through local education campaigns; voluntary initiatives and the adoption of best practice methodologies; enforcement action and use of anti-pollution works notices; policies on development planning; cross-compliance with Nitrates and Sludge Directives (Nitrate vulnerable zones now cover some 70 per cent of England and 3.6 per cent of Wales); the Silage, Slurry and Agricultural Fuel Oil Regulations; the Groundwater Directive; Existing and enhanced Agri-environment schemes; Codes of Good Agricultural Practice; rectifying misconnections of foul sewer to surface water drains (in some cases delivered through collaborative projects, for example water industry funded initiatives).

Control on the use of phosphates in laundry detergents is a potential future measure that could be implemented in England and Wales. This would contribute to reductions in phosphorus discharged to waters within catchments served by small sewage works (where it is less cost effective to install phosphorus stripping), in catchments that lack mains sewerage, and in catchments with larger works which do not currently have phosphorus removal. By reducing the phosphate reaching sewage works it would also reduce the costs of meeting discharge standards where phosphorus removal is required under the Urban Waste Water Treatment Directive or the Habitats Directive.

In England the Catchment Sensitive Farming Delivery Initiative (ECSFDI) has been an important mechanism to reduce a range of environmental impacts from agriculture. In Phase 2 of the initiative (2008-11) the priority catchments have been expanded from 40 to 50 and have extending the coverage within 7 existing catchments. The ECSFDI will also support 16

¹⁷ Defra and the Welsh Assembly Government carried out this analysis of countrywide measures in England and Wales. It produced an overview of the costs and effectiveness of measures, and the sectors that could be involved in delivering them, ruling out or limiting certain measures as clearly not cost effective at least in the first cycle of river basin management and so focussing effort on the key options. Results are available at <http://www.wfdcrp.co.uk/> including a summary of measures included in the pCEA <http://www.wfdcrp.co.uk/pdf/WFD%20Ministerial%20Guidance%20MeasuresToolkit.xls>

¹⁸ They act as insurance policies against the threat of damage to vital national resources

strategic partnerships outside the priority catchments. The initiative is also undertaking intensive monitoring and evaluation which is accumulating a good knowledge base on the anticipated effectiveness of actions. For example, modelling suggests that phosphorus losses can be reduced by around 5%. This is an average estimate and at a local scale and within sensitive sub-catchments reductions of up to 20% could be achieved.

Revised Water Protection Zones are a mechanism to control agricultural and non-agricultural diffuse pollution in high risk areas. These would enable more stringent pollution control measures to be targeted to all relevant pollution sources. Work is ongoing to trial a methodology for how these zones would be justified and implemented including what types of measures might be applied within them. If similar outcomes can be anticipated through other mechanisms (e.g. voluntary initiatives, pollution prevention, enforcement) escalation of action to Water Protection Zones would only be proposed if status did not improve sufficiently.

Actions by the water industry

Actions requiring investment by the water industry are managed in cycles of planning and investment called Asset Management Plans and are considered as part of the periodic Price Review.

The majority of actions delivered by the water industry are primarily driven by established obligations for water quality, nearly all under other current Directives (M1 and M2 measures). Many of the improvements will also help us achieve Water Framework Directive obligations and are included in the overall outcome estimates to 2015. However, the specific costs and benefits are not subject to further WFD analysis because they are not driven by the Water Framework Directive.

Water industry measures cover actions currently underway in the 4th Asset Management Plan (AMP4) and also those planned for the next investment period from 2010-15. This is the periodic review for 2009 (or PR09¹⁹). The final list of schemes for new requirements under the Water Framework Directive (M3b measures) will be subject to sign off by Ministers in December 2009 as part of the first river basin management plans.

The schemes driven by the Water Framework Directive which have been recommended for funding are those assessed to be cost-beneficial. This assessment was made using scheme specific capital and operating costs from the water company final business plans, including the cost of carbon. Environmental outcomes were expressed as river lengths improving by a particular status change. Schemes were considered in combination where this was relevant to achieving the environmental outcome. The benefits were calculated using information from the national benefits survey undertaken by the UK Collaborative Research Programme²⁰, disaggregated for each river basin district. The assessment and recommendations took account of uncertainties in the ability to estimate outcomes and assign monetary benefits.

There are limits on the effluent quality that it is currently technically feasible to achieve (termed BAT or Best Achievable Technology)²¹. This is the accepted minimum level that we could set as a permit limit. Assessment of the need and ability to go beyond BAT would be based on a site specific assessment to judge technical feasibility and, if feasible, whether it could be justified on the grounds of costs, benefits and other impacts. Based on what is typical in terms of dilution of effluent discharges, BAT is generally not a constraint to

¹⁹ Also referred to as AMP5

²⁰ Final Report to Defra for CRP Project 4b/c The Benefits of Water Framework Directive Programmes of Measures in England and Wales <http://www.wfdcrp.co.uk/pdf%5CCRPSG%204bcd%20Final.pdf>

²¹ This follows the preliminary Cost Effectiveness Analysis. The upper limits are generally 95-percentile standards of 1 mg N/l for ammonia and 5 mg/l for the Biochemical Oxygen Demand and an annual average of 1 mg/l for total phosphorus.

achieving in river standards for ammonia and Biochemical Oxygen Demand but can be for phosphorus. Investigations will continue into technological improvements that would help reduce the sewage contribution to failure of good status standards. Implementation of these could be feasible in future cycles subject to an assessment of the costs, benefits and other impacts.

Schemes driven by the Water Framework Directive to address nutrients were identified where there was sufficient biological evidence to confirm the need for action and where the sewage works was confirmed as a contributory source.

Actions and outcomes

The measures presented in the first river basin management plans are those that we can currently justify. We use models and expert judgement to estimate the outcomes in terms of the future status that we expect these measures to deliver. The predicted outcomes are included in Annex B of this plan. Where we do not think status will reach good by 2015 but we cannot justify any further measures we have set alternative objectives for those elements. We have assigned decision tree codes to explain the reasons as summarised in the decision trees and tables below. These are based on the considerations and sources of uncertainty explained in the previous sections.

The main justifications for setting alternative objectives are:

- Insufficient confidence in the current status or future status to justify the need for improvement action (1a, 1b, 1c, 1d, 1e);
- Confidence of not being good but insufficient confidence in the current or future sources of failure to be able to identify appropriate measures (2a, 2b, 3a, 3b);
- Confidence of not being good, source(s) confirmed, technically feasible measures to address the source(s) but the costs of the measures are not proportionate to the benefits and other impacts (5a, 5b, 5c);

Alternative objectives can be a less stringent objective than good status or an extended deadline in which to seek to achieve good status. Where we have certainty over status and the sources of failure, and justified improvement actions are planned, we may still estimate that status will not reach good. We may also have cases where improvement actions cannot currently be justified on the grounds of disproportionate cost. In these cases we would currently set an extended deadline for achieving good on the grounds that:

- there is uncertainty in our estimates of what can be achieved so an extended deadline allows time to review measured progress and re-evaluate what more might be possible
- methods for assessing effectiveness of measures, outcomes, costs and benefits will continue to improve which will change current judgements about cost-effectiveness and proportionality
- developments in ways of reducing pollution could enable us to achieve more in the future and could also change the balance of costs and benefits

Further work

We have tried to predict the status of water bodies up to 2015 as a result of actions planned and in hand in the first cycle. The planning of further improvements will continue through the first cycle of river basin management.

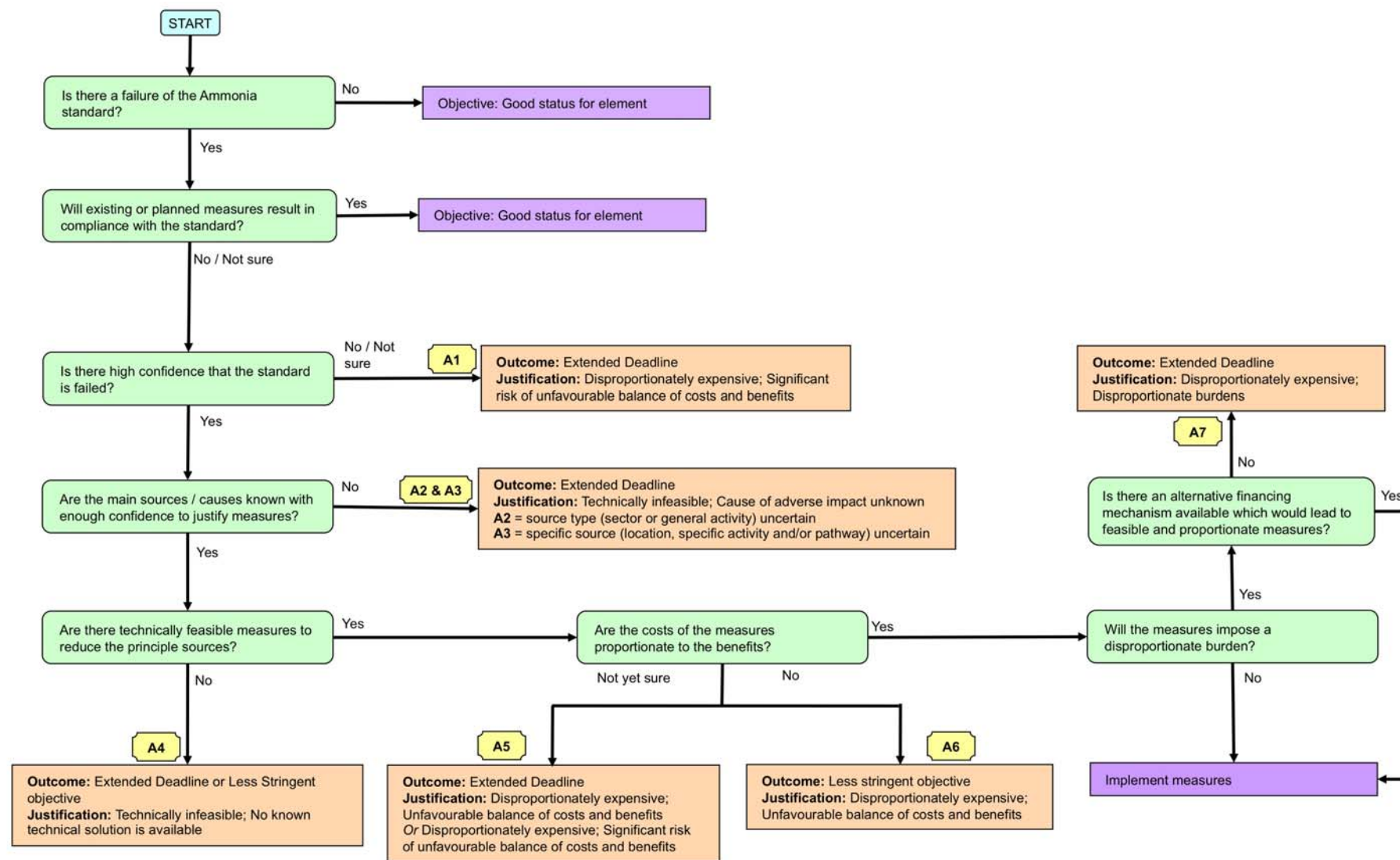
To enable us to identify and justify what further action is needed and quantify the costs and benefits we will be doing work locally and nationally to reduce the uncertainty that remains about:

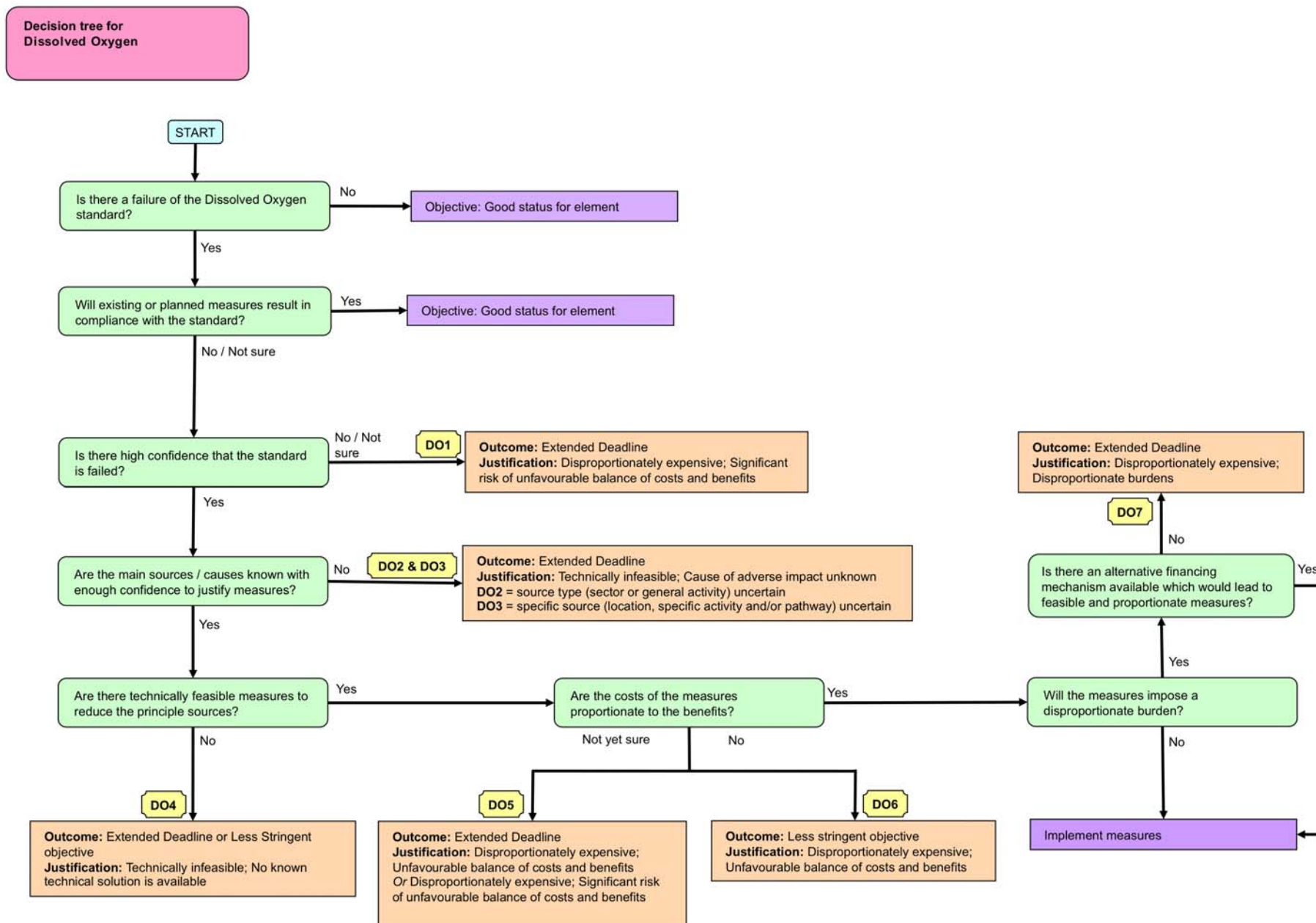
- Status assessments using new classification tools

- Whether water bodies are adversely impacted, including adequate biological evidence for sites failing nutrient standards, and the outcome of actions to address Protected Area requirements. This includes monitoring started in 2008 to gather additional biological evidence downstream of sewage treatment works where additional treatment to remove phosphorus would be justified if we were confident there is a risk of damage.
- The reasons waters fail to meet good status, in particular, the relative importance of different sources of pollution
- How much technology and ways of taking action can develop to improve technical capability and cost effectiveness and deliver greater environmental improvement
- Costs and / or benefits and whether improvements to the methodology change the balance of proportionality when appraising measures
- The long-term impacts of climate change
- Whether good status can be achieved with extended deadlines or whether less stringent objectives are required, particularly for nutrients. Currently uncertainty about status due to insufficient biological evidence is the main reason for setting extended deadlines for nutrients. From the monitoring undertaken for this plan it is now clear that there is a link between high levels of phosphate in surface waters and biological failures in the main river type (lowland alkaline rivers). We are already collecting additional biological data in locations where the phosphate standard is exceeded. As a consequence the percentage of water bodies at good or better biological status is likely to reduce from 51 to 46 per cent. We know that it will be very expensive and technically challenging to reduce nutrient levels sufficiently to comply with the nutrient standards. For example, we used our SIMCAT models to estimate the length of river that might improve to good status if phosphate removal to the limit of what is currently judged cost-effective were applied to every sewage works in England and Wales discharging to failing waters. This suggested that compliance might only increase by around 6 per cent. A rough estimate of the cost is £6 billion (based on unit costs provided by the water industry) in total for the 1,800 sewage works (though in practice not all these works would require phosphate removal as certain works would make relatively insignificant contributions to the overall load). By comparison, approximate benefits are estimated to be around £2 billion based on a disaggregated national benefits number, valuing good status at say £30,000 per kilometre per year and assuming no other pressures or elements would place the water in worse than good status.

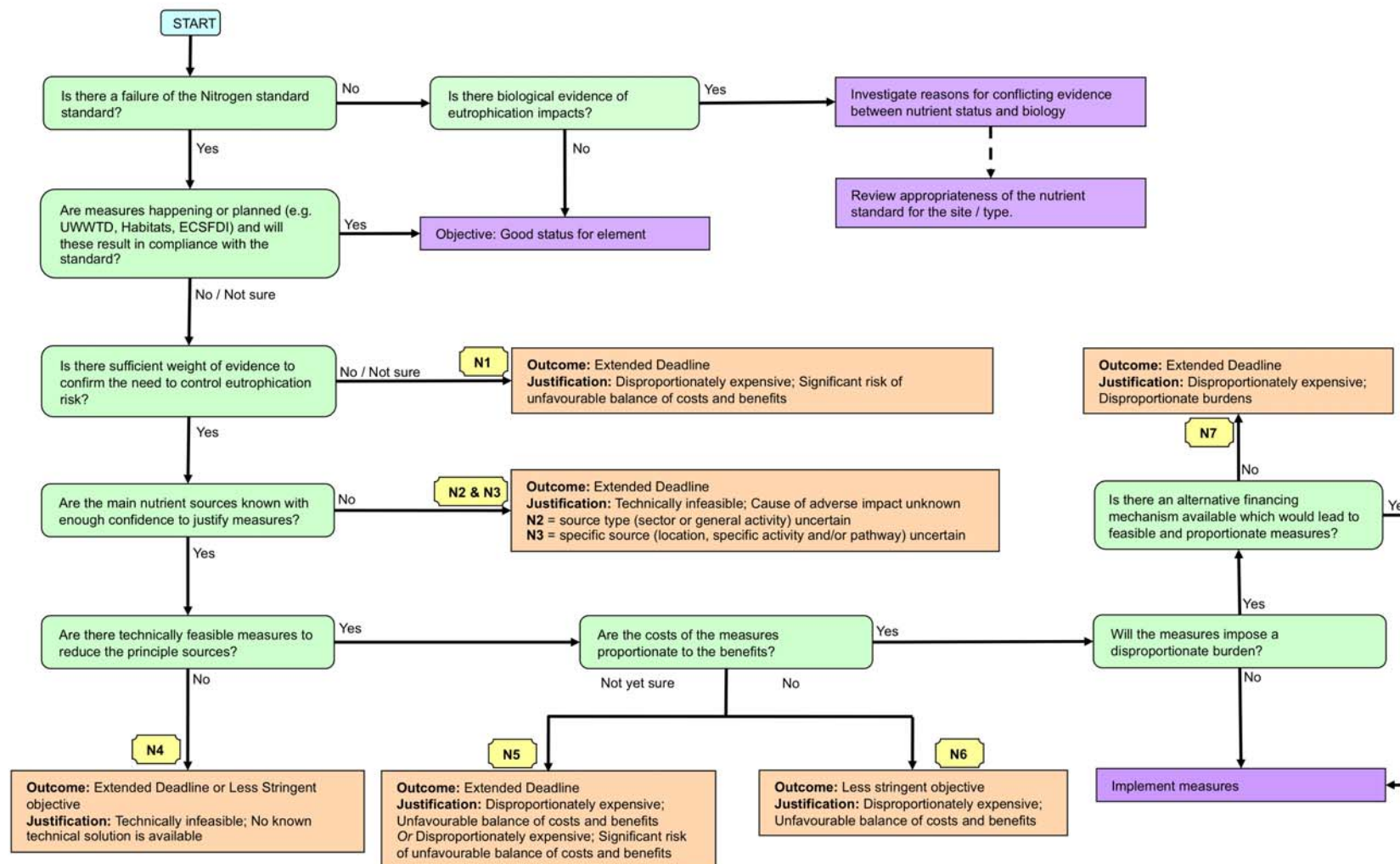
The further work will be completed in parallel so the future measures can be justified as soon as we have sufficient certainty.

Decision tree for Ammonia



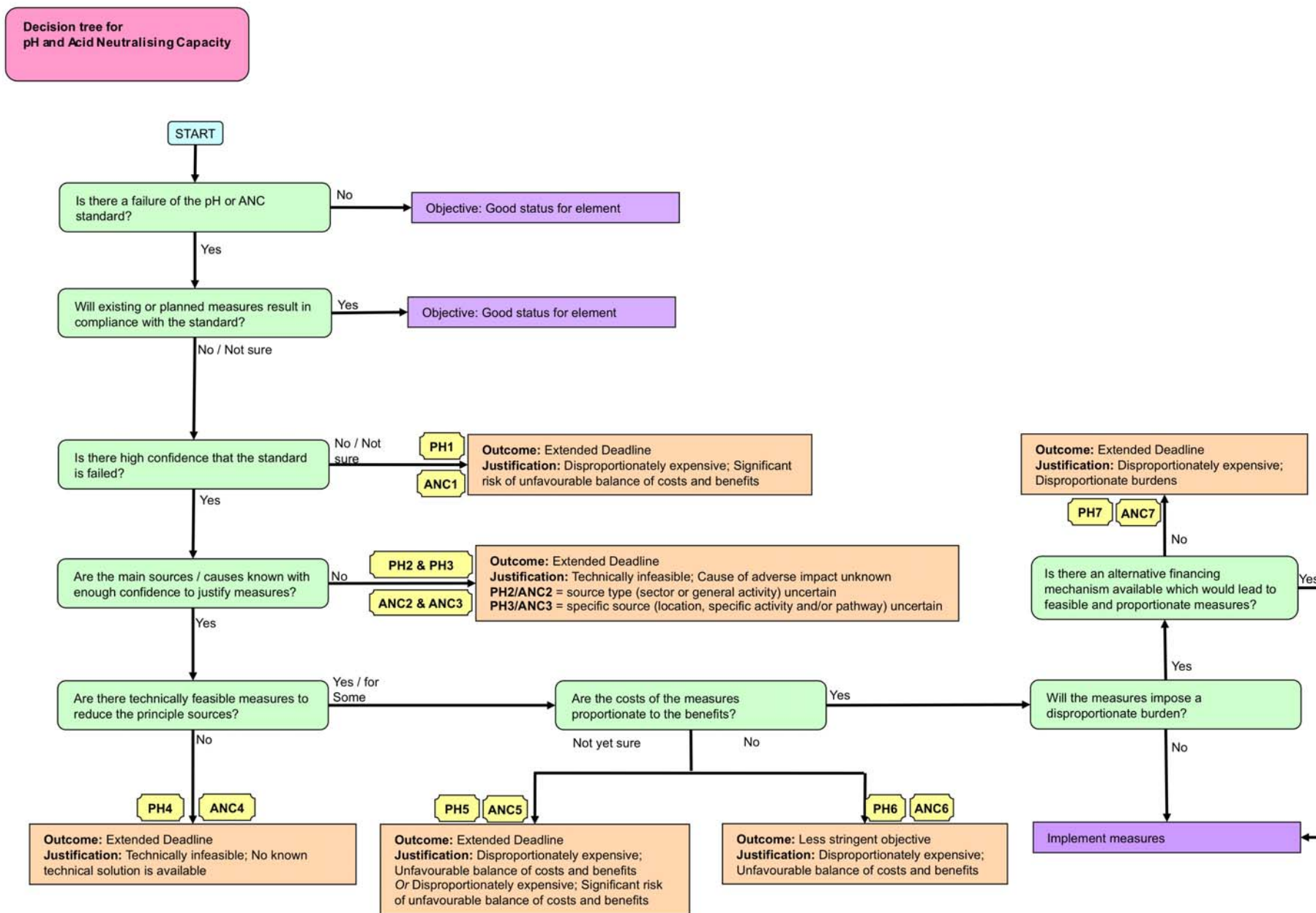


Decision tree for Dissolved Inorganic Nitrogen (ecological status objectives) in Transitional and Coastal Waters¹²

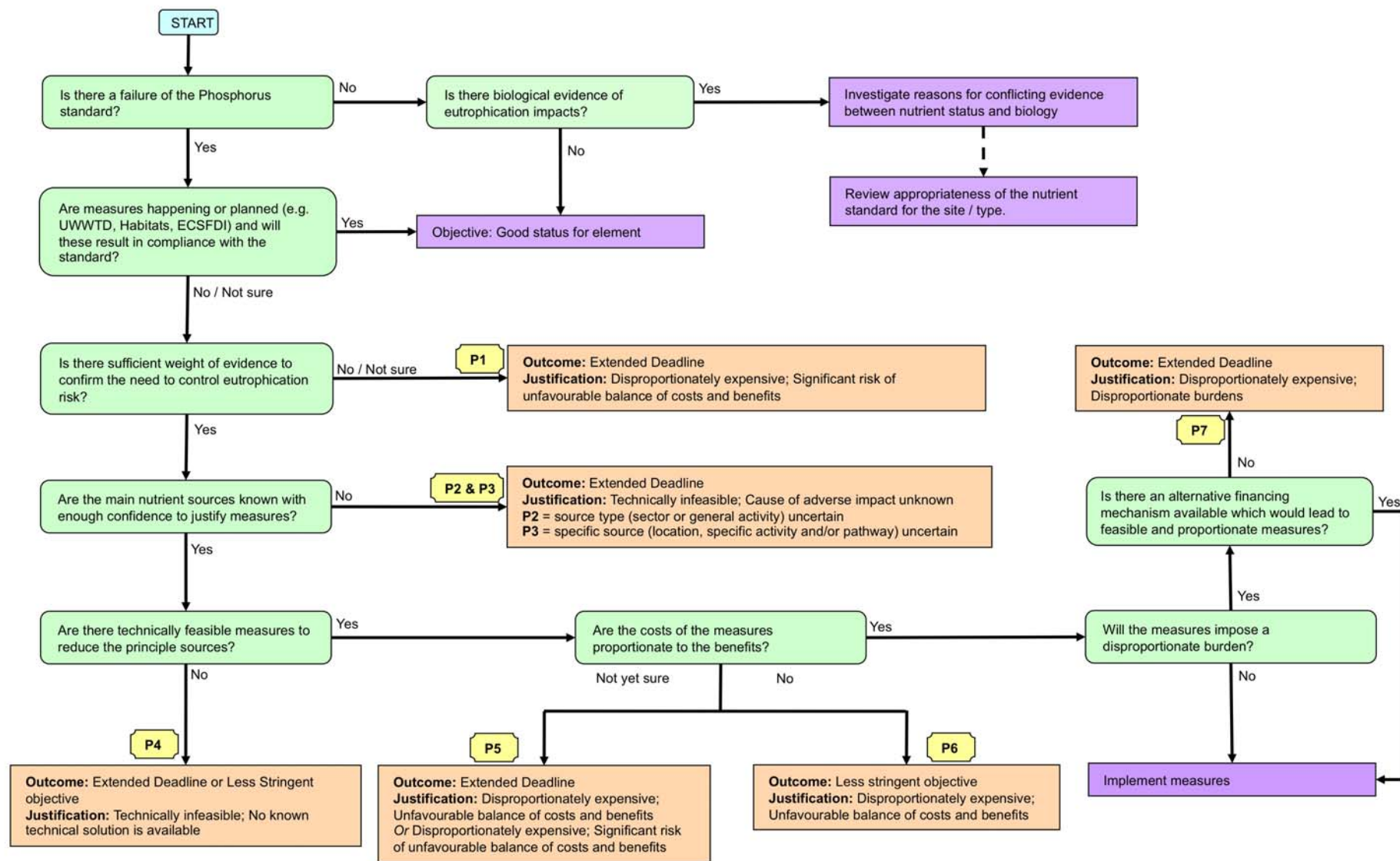


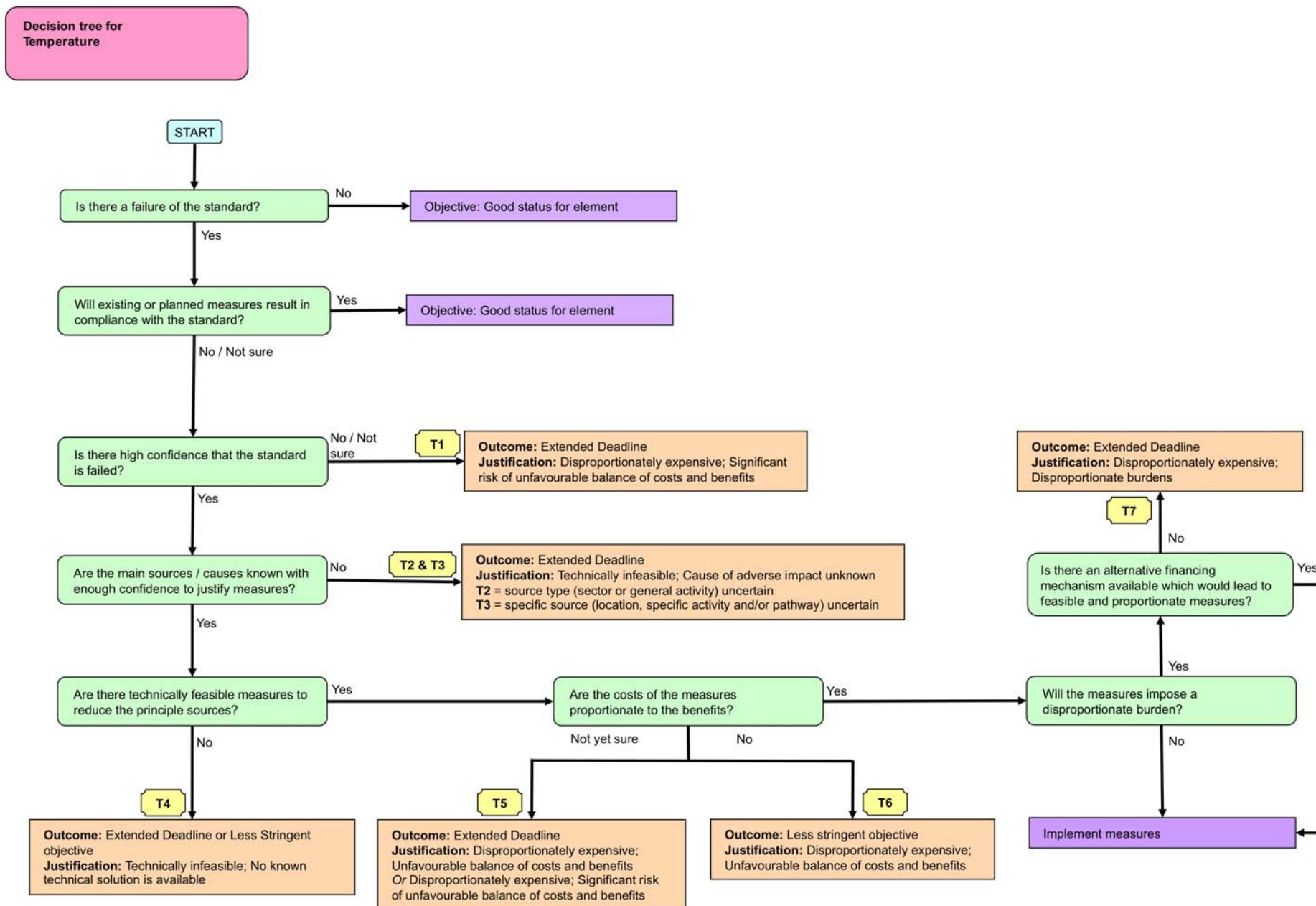
¹ A Water Framework Directive standard for nitrate in rivers and lakes has yet to be established

² Measures to address nitrate will also be carried out in certain Protected Areas (Nutrient Sensitive Areas designated under the Nitrates and Urban Waste Water Treatment Directives and Natura 2000 sites designated under the Habitats and Birds Directives)



**Decision tree for
Phosphorus (ecological status
objectives)**





Reference	A1a, DO1a, PH1a, T1a
Element predicted not to achieve good by 2015	A1a = Ammonia DO1a = Dissolved Oxygen PH1a = pH T1a = Temperature
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>There is not high confidence that the standard is failed</p> <p>For these water bodies we do not have the statistical confidence that the standard is failed; the water body may be compliant. Without confidence in a failure we cannot reliably consider sources and measures. To do so would mean a significant risk of wasted investment on measures in already compliant water bodies. In the first cycle we will carry out further investigations to confirm any failure with certainty, identify sources and appraise additional measures. Where possible additional measures will be implemented.</p> <p>It is disproportionately expensive to implement further measures at this time. An extended deadline for achieving good ecological status is therefore required. One of the main sources of ammonia is discharges from municipal sewage treatment works. These works can also discharge significant loads of organic material that can result in a reduction in dissolved oxygen levels in receiving water bodies. Removing ammonia and organic material from sewage is expensive requiring structural changes to the works and ongoing operational costs for energy, maintenance and the disposal of sludge. The preliminary cost effectiveness analysis estimated that to put additional treatment capacity on all sewage treatment works for water bodies at risk of not achieving WFD standards would cost £304 to £848 million/year depending on how much ammonia was removed. Even where the need to control ammonia is confirmed, there is still a significant risk that removing ammonia from sewage treatment works is disproportionately expensive because of the balance of costs and benefits (see tables reference A5c). Of the 34 cases assessed, 21 were assessed as being not justified because of the unfavourable balance of costs, benefits and other impacts. Actions are in most instances expensive and need to be justified in terms of addressing real failures.</p> <p>As part of the recent review of water prices for the water industry (PR09), we looked for cases where, irrespective of compliance with established environmental standards, further improvements to the quality of discharges would deliver local benefits sufficient to justify the costs of improvement. One case was found. This is in the Thames RBD where 5 sewage works will be improved for the benefit of the</p>	

Thames Estuary.
There are no ongoing actions in or upstream of the water body that are estimated to bring improvements in the status in this water body.
Investigation type
Investigate to confirm failure and/or impact
Example of investigation
<p>Additional monitoring to confirm status and the need to take additional action.</p> <p>Monitoring and modelling work to identify the relative sources of ammonia, dissolved oxygen, pH or temperature in the catchment.</p> <p>If the need for additional action is confirmed, identification of the most cost effective combination of measures necessary to achieve good ecological status.</p>
Possible future measures
<p>Possible future measures will depend on confirmation of being at less than good status and the identification of sources that contribute to this status. If the need to take additional action and the sources are confirmed, further measures (subject to further assessment of cost, benefits and other impacts) will be implemented. These measures may include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as England Catchment Sensitive Farming Delivery Initiative, better targeting of agri-environment schemes, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions).</p>
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>It will be disproportionately expensive to install ammonia removal technology on all municipal sewage treatment works in England and Wales.</p> <p>It is likely that installing additional ammonia removal technology on many works will be disproportionately expensive. To reduce ammonia to 1 mg/l at all works where this may be necessary would cost £848 million/year across England and Wales.</p>

Reference	A1b
Element predicted not to achieve good by 2015	Ammonia
Reason for failure	<p>Suspected - point source water industry sewage works</p> <p>Suspected - point source water industry storm discharge (incl. CSO)</p>
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Improvement work to sewage discharges is happening or is planned in the water body but the extent of the improvement is uncertain</p> <p>For these water bodies we currently have the statistical confidence that the standard is currently failed. However, we know there is current or planned work to improve sewage treatment works or storm sewage discharges in the water body. These committed improvements will take place before 2015. We are uncertain of the extent of the improvement and the associated confidence of meeting good status. Further action will not be pursued until the outcome is established through future monitoring. This is because we have low confidence that future quality would fail the standard. Without confidence in a failure we cannot reliably consider further measures. To do so would mean a significant risk of wasted investment on measures in already compliant water bodies. In the first cycle we will carry out further investigations to confirm any failure with certainty, identify sources and appraise additional measures. Where possible additional measures will be implemented.</p> <p>It is disproportionately expensive to implement further measures at this time. An extended deadline for achieving good ecological status is therefore required. Removing ammonia from sewage is expensive requiring structural changes to the works and ongoing operational costs for energy, maintenance and the disposal of sludge. The preliminary cost effectiveness analysis estimated that to put additional treatment capacity on all sewage treatment works for water bodies at risk of not achieving WFD standards would cost £304 to £848 million/year depending on how much ammonia was removed. Even where the need to control ammonia is confirmed, there is still a significant risk that removing ammonia from sewage treatment works is disproportionately expensive because of the balance of costs and benefits (see tables reference A5c). Of the 34 cases assessed, 21 were assessed as being not justified because of the unfavourable balance of costs, benefits and other impacts. Actions are in most instances expensive and need to be justified in terms of addressing real failures.</p>	

Investigation type
Investigate to confirm failure and/or impact
Example of investigation
<p>Additional monitoring to confirm status following the implementation of planned measures and to confirm the need to take additional action.</p> <p>If necessary, monitoring and modelling work to identify the relative sources of ammonia.</p> <p>If the need for additional action is confirmed, identification of the most cost effective combination of measures necessary to achieve good ecological status.</p>
Possible future measures
<p>Possible future measures will depend on the outcome of planned measures and confirmation of being at less than good status and the identification of sources that contribute to this status. If the need to take additional action and the sources are confirmed, further measures (subject to further assessment of cost, benefits and other impacts) will be implemented. These measures may include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as England Catchment Sensitive Farming Delivery Initiative, better targeting of agri-environment schemes, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions).</p>
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>It will be disproportionately expensive to install ammonia removal technology on all municipal sewage treatment works in England and Wales.</p> <p>It is likely that installing additional ammonia removal technology on many works will be disproportionately expensive. To reduce ammonia to 1 mg/l at works where this may be necessary would cost £848 million/year across England and Wales.</p>

Reference	A2a, DO2a, PH2a, ANC2a
Element predicted not to achieve good by 2015	A2a = Ammonia DO2a = Dissolved Oxygen PH2a = pH ANC2a = Acid Neutralising Capacity
Reason for failure	Unknown - reasons for failure unknown
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The cause of the failure (sector or general activity) is unknown</p> <p>Ammonia, substances affecting dissolved oxygen, pH and acid neutralising capacity (ANC) are released into the environment from a wide range of sources including urban and agricultural land use, industry and domestic release to sewers. For water bodies where the sources of the pollution is not known, or not known in sufficient detail to be able to identify and appraise measures (including identification of the person who is responsible for causing the pollution), it is technically infeasible to identify and implement additional measures, and achieve the objective by 2015. An extended deadline for achieving good ecological status is therefore required.</p> <p>For over 20 years we have routinely (usually annually) assessed compliance with water quality standards (such those for the freshwater fisheries directive and river quality objectives) and tried to identify the activities releasing the substances and causing the failure of the standards. We use a number of different approaches to do this including routine and investigative monitoring, modelling, and site inspections. Despite this, the sources of some of these old failures remains unknown.</p> <p>In 2008 and 2009 (as part of the classification work for the draft and first river basin management plans) we assessed compliance with the new standards for ammonia, dissolved oxygen, pH and ANC. Where these substances did not have standards under the old compliance schemes, or where the standards for the water framework directive are tighter than before, we have identified new failures. In the time available, we have not been able to identify the sources and their relative contributions for each of the new failures.</p>	
Investigation type	
Investigate reason for failure.	

Example of investigation

The significance of locally relevant sources will be assessed through additional monitoring, site visits, desktop studies and modelling (e.g. using SIMCAT models) to identify and apportion causes of failure. The most cost effective combination of measures necessary to achieve good ecological status will be identified. Investigations will include local studies as well as using information and understanding from national source apportionment projects and ongoing work to improve our understanding of the effectiveness of measures. Modelling will also be used to assess the likely outcome from the actions in order to appraise the costs, benefits and other impacts. This will allow appropriate measures to be identified for implementation in this or subsequent river basin management planning cycles.

Possible future measures

Possible future measures will depend on the sources that contribute to the failure. Measures may include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as England Catchment Sensitive Farming Delivery Initiative, better targeting of agri-environment schemes, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions).

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Uncertain until the sectors or general activities causing the failure is known.

Reference	A2b, DO2b, PH2b, ANC2b
Element predicted not to achieve good by 2015	A2b = Ammonia DO2b = Dissolved Oxygen PH2b = pH ANC2b = Acid Neutralising Capacity
Reason for failure	Suspected - point and/or diffuse source
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The cause of the failure (sector or general activity) is not known with certainty</p> <p>Ammonia, substances affecting dissolved oxygen, pH and acid neutralising capacity (ANC) are released into the environment from a wide range of sources including urban and agricultural land use, industry and domestic release to sewers. For water bodies where the source of pollution causing the failure is suspected, but we do not have strong enough evidence to confirm it, it is technically infeasible to identify and implement additional measures, and achieve the objective by 2015. An extended deadline for achieving good ecological status is therefore required.</p> <p>For over 20 years we have routinely (usually annually) assessed compliance with water quality standards (such those for the freshwater fisheries directive and river quality objectives) and tried to identify the activities releasing the substances and causing the failure of the standards. We use a number of different approaches to do this including routine and investigative monitoring, modelling, and site inspections. Despite this, the sources of some of these old failures remain suspected and not confirmed by evidence.</p> <p>In 2008 and 2009 (as part of the classification work for the draft and first river basin management plans) we assessed compliance with the new standards for ammonia, dissolved oxygen, pH and ANC. Where these substances did not have standards under the old compliance schemes, or where the standards for the water framework directive are tighter than before, we have identified new failures. In the time available, we have not been able to confirm the sources and their relative contributions for each of the new failures.</p>	
Investigation type	
Investigate source of failure.	

Example of investigation

The significance of locally relevant sources will be assessed through additional monitoring, site visits, desktop studies and modelling (e.g. using SIMCAT models) to identify and apportion causes of failure. The most cost effective combination of measures necessary to achieve good ecological status will be identified. Investigations will include local studies as well as using information and understanding from national source apportionment projects and ongoing work to improve our understanding of the effectiveness of measures. Modelling will also be used to assess the likely outcome from the actions in order to appraise the costs, benefits and other impacts. This will allow appropriate measures to be identified for implementation in this or subsequent river basin management planning cycles.

Possible future measures

Possible future measures will depend on the sources that contribute to the failure. Measures may include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as England Catchment Sensitive Farming Delivery Initiative, better targeting of agri-environment schemes, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions).

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Uncertain until the sectors or general activities causing the failure is confirmed.

Reference	A3a, DO3a, PH3a
Element predicted not to achieve good by 2015	A3a = Ammonia DO3a = Dissolved Oxygen PH3a = pH
Reason for failure	Confirmed - diffuse source agricultural
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The specific agricultural source (location, specific activity and/or pathway) of the failure is unknown</p> <p>Although agriculture is known to be causing the problem, until the specific source(s) is known in sufficient detail to be able to identify and appraise measures (including identification of the person who is responsible for causing the pollution), it is technically infeasible to identify and implement additional measures, and achieve the objective by 2015. An extended deadline for achieving good ecological status is therefore required.</p> <p>For over 20 years we have routinely (usually annually) assessed compliance with water quality standards (such those for the freshwater fisheries directive and river quality objectives) and tried to identify the activities releasing the substances and causing the failure of the standards. We use a number of different approaches to do this including routine and investigative monitoring, modelling, and site inspections. Because of this work we know agriculture is causing the problem but the specific source is yet to be identified.</p> <p>In 2008 and 2009 (as part of the classification work for the draft and first river basin management plans) we assessed compliance with the new standards for ammonia, dissolved oxygen, pH and ANC. Where these substances did not have standards under the old compliance schemes, or where the standards for the water framework directive are tighter than before, we have identified new failures. In the time available, we have been able to identify agriculture as the source but have yet to identify the specific source.</p>	
Investigation type	
Investigate source of failure.	

Example of investigation

The significance of locally relevant agricultural diffuse sources will be assessed through additional monitoring, site visits (including tracing studies), desktop studies and modelling to identify and apportion the sources of failure. The most cost effective combination of measures necessary to achieve good ecological status will be identified. Investigations will include local studies as well as using information and understanding from national source apportionment projects and ongoing work to improve our understanding of the effectiveness of agricultural measures. There are a number of national projects being planned to do further testing and evaluation (including field trials) of feasible and cost effective means of reducing agricultural pollution, including ongoing work within the Catchment Sensitive Farming catchments in England and Demonstration Catchment work in Wales. Modelling will also be used to assess the likely outcome from the actions in order to appraise the costs, benefits and other impacts. This will allow appropriately targeted measures to be identified for implementation in this or subsequent river basin management planning cycles.

Possible future measures

Possible future measures will depend on the more detailed identification of source contributions and investigations into the feasibility and relative effectiveness of measures.

Measures might include for example:

- More local partnership projects to support farmers to change practice
- Increased roll-out (in terms of duration and geographic extent) of Catchment Sensitive Farming advisory initiatives in England, and in Wales expansion of the Environment Agency's Catchment Co-ordinator Initiative
- Widen the measures and activities included in agri-environment initiatives (e.g. rural sustainable drainage systems)
- Widen the measures and activities that are included in the Common Agricultural Policy funded initiatives (e.g. increase soil resource protection measures in current approach to cross-compliance, or whatever may follow in future)
- Establish and or extend existing national partnerships that provide advice and support to land managers to improve practice
- Increased Environment Agency-led pollution enforcement campaigns (including use of anti-pollution works notices)
- where appropriate designation of Water Protection Zones

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

- Wide scale reversion of arable land to low intensity pasture over large parts of England and Wales
- Wide scale reversion of agricultural land to woodland over large parts of England and Wales
- Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales

Reference	A3b, DO3b, PH3b
Element predicted not to achieve good by 2015	A3b = Ammonia DO3b – Dissolved Oxygen PH3b = pH
Reason for failure	Confirmed - non-agricultural diffuse source
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The general activity causing the failure is known but the specific source (location, specific activity and/or pathway) is unknown</p> <p>Although the sector or general activity (for example, contaminated land, urban run-off, industrial estate, housing) causing the problem is known, until the specific source(s) is known in sufficient detail to be able to identify and appraise measures (including identification of the person who is responsible for causing the pollution), it is technically infeasible to identify and implement additional measures, and achieve the objective by 2015. An extended deadline for achieving good ecological status is therefore required.</p> <p>For over 20 years we have routinely (usually annually) assessed compliance with water quality standards (such those for the freshwater fisheries directive and river quality objectives) and tried to identify the activities releasing the substances and causing the failure of the standards. We use a number of different approaches to do this including routine and investigative monitoring, modelling, and site inspections. Because of this work we know the general activity causing the problem but the specific source is yet to be identified.</p> <p>In 2008 and 2009 (as part of the classification work for the draft and first river basin management plans) we assessed compliance with the new standards for ammonia, dissolved oxygen, pH and ANC. Where these substances did not have standards under the old compliance schemes, or where the standards for the water framework directive are tighter than before, we have identified new failures. In the time available, we have been able to identify the general activity as the source but have yet to identify the specific source.</p>	
Investigation type	
Investigate source of failure	

Example of investigation

The significance of locally relevant non-agricultural diffuse sources will be assessed through additional monitoring, site visits (including tracing studies), desktop studies and modelling to identify and apportion the sources of failure. The most cost effective combination of measures necessary to achieve good ecological status will be identified. Investigations will include local studies as well as using information and understanding from national source apportionment projects and ongoing work to improve our understanding of the effectiveness of measures. Modelling will also be used to assess the likely outcome from the actions in order to appraise the costs, benefits and other impacts. This will allow appropriately targeted measures to be identified for implementation in this or subsequent river basin management planning cycles.

There may also be techniques that are under development but have not been proved effective in practice. Further investigations to progress this work (e.g. through controlled laboratory experiments, field trials or pilot plants) may result in feasible measures being identified for implementation in this or subsequent river basin management planning cycles.

Possible future measures

Possible future measures will depend on the more detailed identification of source contributions and investigations into the feasibility and relative effectiveness of measures.

Measures might include for example:

- More local partnership projects with key partners e.g. Highways Agency, local authorities, Business Groups to change practice and reduce the risk of non-agricultural diffuse pollution.
- Establish Urban Catchment Officers in England and Wales to give advice to SMEs, local authorities and those responsible for managing roads to help prevent non-agricultural diffuse pollution (similar to England Catchment Sensitive Farming Delivery Initiative)
- Increased pollution enforcement campaigns (including use of anti-pollution works notices).
- Increased roll-out of Water Protection Zones
- Development of General Binding Rules for particular high risk activities and sectors (e.g. construction sector)
- Establish and or extend existing national partnerships that provide advice and support to improve practice (e.g. Amenity Forum pesticide initiative)
- Prohibitions on the use of amenity fertilisers
- Extend the geographic scale and pace of roll-out of work to correct misconnections of foul sewers to surface water drains
- Targeted retro-fitting of Sustainable Urban Drainage systems in all new developments and all re-developments
- Targeted land use change e.g. prohibition of development in priority areas

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

- Wide scale land use change e.g. prohibition of development in large parts of England and Wales that are particularly sensitive to non-Agricultural diffuse water pollution
- Wide scale remediation of sites contaminated from historic uses

Reference	A5a, DO5a
Element predicted not to achieve good by 2015	A5a = Ammonia DO5a = Dissolved Oxygen
Reason for failure	Confirmed - point source water industry
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The discharge(s) contributing to the failure is known but it is uncertain if the costs of the measure(s) are proportionate to the benefits</p> <p>Although the sewage treatment works or storm sewage discharges contributing to the failure are known, until further site specific appraisal is done, it is uncertain if the cost of implementing the improvement measure(s) is proportionate. It is therefore disproportionately expensive to implement further measures at this time and an extended deadline for achieving good ecological status is required.</p> <p>Removing ammonia and organic material from sewage is expensive requiring structural changes to the works and ongoing operational costs for energy, maintenance and the disposal of sludge. The preliminary cost effectiveness analysis estimated that to put additional treatment capacity on all sewage treatment works for water bodies at risk of not achieving WFD standards would cost £304 to £848 million/year depending on how much ammonia was removed. Even where the need to control ammonia is confirmed, there is still a significant risk that removing ammonia from sewage treatment works is disproportionately expensive because of the balance of costs and benefits (see tables reference A5c). Of the 34 cases assessed, 21 were assessed as being not justified because of the unfavourable balance of costs, benefits and other impacts. Actions are in most instances expensive and need to be justified in terms of addressing real failures.</p> <p>For some water bodies the need for schemes had not been identified within the timescales for PR09 planning. At some sites the earlier classifications did not show the standards were failed with high confidence and so improvement schemes were not identified. The final classifications now show such failures. In the time available, we have been able to identify the sewage discharge(s) contributing to the failure. However, it has not been possible to identify the costs of the required measures and identify potential benefits and other impacts that improving the discharges will deliver.</p> <p>If this further appraisal confirms that it is disproportionately expensive to achieve good ecological status by 2015, these water bodies will be re-categorised with reference 5c. If measures are shown to be proportionate we will look to progress measures as soon as practicable. These future measures may need to be phased, particularly if they depend on action to address other sources.</p>	

Investigation type
Investigate proportionate measures
Example of investigation
Investigations will establish whether it is cost-beneficial to implement measures at the water industry sources. These investigations would also need to confirm the significance of other sources to ensure we identify the most cost-effective combination of measures and that this combination is not disproportionately expensive. This will be assessed mainly through modelling but may require some additional monitoring.
Possible future measures
Possible future measures could include enhanced treatment of sewage discharges, improvements to intermittent discharges, and action to address other sources, depending on their relative significance. Development of new techniques and practices could also provide more effective measures which achieve a better balance of costs, benefits and other impacts..
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>Measures that are likely to be technically infeasible or disproportionately expensive will depend on the substance in question and the source of the substance. The preliminary cost effectiveness analysis (pCEA) evaluated the technical feasibility and costs associated with available and potential measures.</p> <p>For example, it is technically feasible to install additional ammonia removal technology on all municipal sewage treatment works in England and Wales. However, it is likely that installing ammonia removal technology on many works will be disproportionately expensive. To reduce ammonia to 1 mg/l at works where this may be necessary would cost £848 million/year across England and Wales.</p>

Reference	A5b, DO5b, PH5b
Element predicted not to achieve good by 2015	A5b = Ammonia DO5b = Dissolved Oxygen PH5b = pH
Reason for failure	Confirmed - point source, non-water industry
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The discharge contributing to the failure is known but it is uncertain if the cost of the measure is proportionate to the benefit</p> <p>Although the discharge contributing to the failure is known, until further site specific appraisal is done, it is uncertain if the cost of implementing the improvement measure is proportionate. It is therefore disproportionately expensive to implement further measures at this time and an extended deadline for achieving good ecological status is required.</p> <p>For some water bodies the earlier classifications did not show the standards were failed with high confidence and so improvement schemes were not identified. The final classifications now show such failures. In the time available, we have been able to identify the sewage discharge(s) contributing to the failure. However, it has not been possible to identify the costs of the required measures and identify potential benefits and other impacts that improving the discharges will deliver.</p>	
Investigation type	
Investigate proportionate measures	
Example of investigation	
<p>Investigations will establish whether it is cost-beneficial to implement measures at the sources. These investigations would also need to confirm the significance of other sources to ensure we identify the most cost-effective combination of measures and that this combination is not disproportionately expensive. This will be assessed mainly through modelling but may require some additional monitoring.</p> <p>If this further appraisal confirms that it is disproportionately expensive these water bodies would be re-categorised (similar to reference 5c). If measures are shown to be proportionate we will look to progress measures as soon as practicable. These future measures may need to be phased, particularly if they depend on action to address other sources.</p>	

Possible future measures
Possible future measures could include enhanced treatment of discharges, remediation of contaminated land, and action to address other sources, depending on their relative significance. Development of new techniques and practices could also provide more effective measures which achieve a better balance of costs, benefits and other impacts.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
Wide scale, precautionary tightening of discharge consents for ammonia and/or BOD for most point sources through England & Wales

Reference	A5c
Element predicted not to achieve good by 2015	Ammonia
Reason for failure	Confirmed - point source water industry sewage works
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The discharge causing the ammonia failure is known and a site specific appraisal has shown the improvement measure available to be currently disproportionately expensive</p> <p>Through our PR09 planning work we identified the sewage treatment works causing the ammonia failure. We identified the costs of the required measure and identified potential benefits and other impacts that improving the discharges will deliver. This showed the measure to be currently disproportionately expensive.</p> <p>These appraisals used:</p> <ul style="list-style-type: none"> - site specific costs provided by Ofwat following submission of water company final business plans; - site specific information on embedded carbon and operating carbon emissions to calculate carbon costs; - environmental outcomes recorded as length of river improved to meet WFD objectives; - benefits based on the NERA National Benefits Survey (Collaborative Research Project 4b/c); - additional local benefits identified after consultation with RBD liaison panels. <p>Our PR09 appraisal of the costs and benefits of ammonia removal schemes, assessed 34 cases, 21 were assessed as being not justified because of the unfavourable balance of costs, benefits and other impacts. The 13 schemes that were assessed as having a favourable balance of costs, benefits and other impacts will improve 12 water bodies and 128 kilometres of river.</p> <p>Technological improvements may make the improvement needed less costly and / or the estimated benefits may change significantly with better information. An extended deadline for achieving good ecological status is therefore required.</p>	
Investigation type	
Investigate proportionate measures	

Example of investigation

At these sites the assessments will be reviewed as further information becomes available that might change the balance of costs, benefits and other impacts. This might come from: an improved understanding of the relative importance of other sources such that combined action becomes cost-beneficial; benefits may be valued more highly; benefits may increase if outcomes become more certain; advancements in treatment technology may reduce the cost of the measures and/or improve the outcome that can be realised.

If measures are shown to be proportionate we will look to progress measures as soon as practicable. These future measures may need to be phased, particularly if they depend on action to address other sources.

Possible future measures

Possible future measures could include improvement treatment for sewage discharges as well as action on other source contributions, depend on the relative significance of these (and other) sources. Development of new or novel techniques to reduce pollution for both any or all of the significant sources could also provide more effective measures which achieve a better balance of costs, benefits and other impacts.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Measures that are likely to be technically infeasible or disproportionately expensive will depend on the source of ammonia. The preliminary cost effectiveness analysis (pCEA) evaluated the technical feasibility and costs associated with available and potential measures.

For example, it is technically feasible to install ammonia removal technology on all municipal sewage treatment works in England and Wales. However, it is likely that installing ammonia removal technology on many works will be disproportionately expensive. To remove ammonia to 1 mg/l at works where this may be necessary would cost £848 million/year across England and Wales.

Reference	P1a, N1a
Element predicted not to achieve good by 2015	P1a = Phosphate or Total Phosphorus N1a = Dissolved Inorganic Nitrogen
Reason for failure	Unknown and/or uncertain there is a failure/ impact and source not confirmed
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>There is currently insufficient weight of evidence to confirm the need to control eutrophication risk using site specific and potentially expensive regulatory action</p> <p>Guidance on river basin management planning issued by Defra and Welsh Assembly Government requires that, for failures of nutrient standards, evidence of whether the biology is truly impacted should be taken into account when considering the case for improvement actions. However where we are confident of phosphate failure and this is indicative of some biological impact (e.g. in alkaline lowland rivers) we will take action to reduce phosphates by such means as providing education or training, routing people to sources of funding or invoking the England Catchment Sensitive Farming Initiative, without waiting for the full information on diatoms and macrophytes that would be necessary to justify targeted regulatory action to control eutrophication such as the designation of a sensitive area under the Urban Waste Water Treatment Directive or of a Water Protection Zone.</p> <p>The Environment Agency has established a programme of gathering additional biological data in locations where the phosphate standard is exceeded including the monitoring of macrophytes and phytobenthos. This includes monitoring to gather additional biological evidence downstream of sewage treatment works where additional treatment to remove phosphorus would be justified if we were confident there is a risk of damage.</p> <p>For these water bodies the sources of nutrient are not yet confirmed.</p> <p>It is disproportionately expensive to implement further measures at this time. An extended deadline for achieving good ecological status is therefore required. The major source of phosphorus is discharges from municipal sewage treatment works. Removing phosphorus from sewage is expensive (8 to 7408 £/kg of P removed depending on the size of the works and the treatment technology used) requiring structural changes to the works and ongoing operational costs for chemicals, energy and sludge disposal. Even where the need to control the risk of eutrophication is confirmed, there is still a significant risk that removing phosphorus from sewage treatment works is disproportionately expensive because of the balance of costs and benefits (see table reference P5c). Of the 51 cases assessed, 15 were assessed as</p>	

being not justified because of the unfavourable balance of costs, benefits and other impacts.

As part of the recent review of water prices for the water industry (PR09), we looked for cases where, irrespective of compliance with established environmental standards, further improvements to the quality of discharges would deliver local benefits sufficient to justify the costs of improvement. None were found.

There are no ongoing actions in or upstream of the water body that are estimated to bring improvements in the status in this water body. In 2010 we will report to River Basin Liaison Panels on those water bodies where new knowledge of the links between phosphate and biology has resulted in a change to our assessment and hence the detail of the actions we are taking to improve their status.

Investigation type

Investigate to confirm failure and/or impact

Example of investigation

Additional biological monitoring (in particular for macrophytes in rivers and lakes) to understand cause and impact and, where necessary, to confirm status. This has already started. For example, we have already started monitoring downstream of some sewage treatment works to gather additional biological evidence to potentially justify additional treatment to remove phosphorus.

Where required, from 2010 investigative monitoring will be implemented to confirm the significance of all marginal phosphate failures and, where necessary, gather further biological evidence.

Monitoring and modelling work will also be undertaken to identify the relative sources of nutrients in the catchment.

Where the need for additional action is confirmed by, for example, the indication of impacts on macrophyte and phytobenthos (diatoms) in rivers and lakes we will move quickly to the identification of the most cost effective combination of measures necessary to achieve good ecological status.

Through the UK Technical Advisory Group on the WFD, the Environment Agency is working to improve the understanding of the links between phosphate, diatoms and macrophytes in rivers and lakes to inform the future review of nutrient standards, monitoring plans and the level of evidence needed to justify the use of different control mechanisms.

Possible future measures

Restrictions on phosphorus in detergents.

The major sources of nutrients are discharges from sewage treatment works and agricultural activities. If the need to take additional action and the sources of the nutrient are confirmed, further measures (subject to further assessment of cost, benefits and other impacts) will be implemented.

Examples of such measures include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as the England Catchment Sensitive Farming Delivery Initiative, better targeting of agri-environment schemes, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions), and action to address misconnections.

The Environment Agency is now working with the main farming groups to understand better the main ways in which phosphate from land enters and is transported in water bodies. We will also look at what the advice and incentives available through agri-environment schemes and the England Catchment Sensitive Farming Delivery Initiative can do to reduce phosphate pollution of water and wetlands alongside the industry led campaign for the Farmed Environment.

In parallel with this approach, the Environment Agency will continue to develop work on regulatory measures, such as designating Water Protection Zones (WPZs) if voluntary approaches are shown not to work in a particular area, or where higher environmental standards are needed in for example protected areas, so that we are ready and able to ensure progress is made before 2015. The work to identify the ways in which phosphate enters water bodies and the means of reducing this will inform the measures that might be applied in WPZs which can only be effective if the means of control have been clearly identified.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Sewage treatment works discharges:

It will be disproportionately expensive to install phosphorus removal technology on all municipal sewage treatment works in England and Wales. To do so would cost up to £6billion and result in benefits of approximately £2billion. Removing phosphorus requires more energy and so has a carbon impact. Depending on the size of the works and the treatment technology used it is estimated that between 16-1426 tonnes of additional carbon are produced per tonne of phosphorus removed.

It is likely that installing phosphorus removal technology on many of the works serving less than 250 people will be disproportionately expensive. It will cost between 157-7408 £/kg to remove phosphorus from these smaller works.

Agricultural activities:

- Wide scale reversion of arable land to low intensity pasture over large parts of England and Wales
- Wide scale reversion of agricultural land to woodland over large parts of England and Wales
- Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales

Reference	P1b, N1b
Element predicted not to achieve good by 2015	P1b = Phosphate or Total Phosphorus N1b = Dissolved Inorganic Nitrogen
Reason for failure	Unknown - uncertain there is a failure/ impact and source not confirmed
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>There is currently insufficient weight of evidence to confirm the need to control eutrophication risk using site specific and potentially expensive regulatory action</p> <p>Guidance on river basin management planning issued by Defra and Welsh Assembly Government requires that, for failures of nutrient standards, evidence of whether the biology is truly impacted should be taken into account when considering the case for improvement actions. However where we are confident of phosphate failure and this is indicative of some biological impact (e.g. in alkaline lowland rivers) we will take action to reduce phosphates by such means as providing education or training, routing people to sources of funding or invoking the England Catchment Sensitive Farming Initiative, without waiting for the full information on diatoms and macrophytes that would be necessary to justify targeted regulatory action to control eutrophication such as the designation of a sensitive area under the Urban Waste Water Treatment Directive or of a Water Protection Zone.</p> <p>The Environment Agency has established a programme of gathering additional biological data in locations where the phosphate standard is exceeded including the monitoring of macrophytes and phytobenthos. This includes monitoring to gather additional biological evidence downstream of sewage treatment works where additional treatment to remove phosphorus would be justified if we were confident there is a risk of damage.</p> <p>For these water bodies all or some of the nutrient sources are known.</p> <p>It is disproportionately expensive to implement further measures at this time. An extended deadline for achieving good ecological status is therefore required. The major source of phosphorus is discharges from municipal sewage treatment works. Removing phosphorus from sewage is expensive (8 to 7408 £/kg of P removed depending on the size of the works and the treatment technology used) requiring structural changes to the works and ongoing operational costs for chemicals, energy and sludge disposal. Even where the need to control the risk of eutrophication is confirmed, there is still a significant risk that removing phosphorus from sewage treatment works is disproportionately expensive because of the balance of costs and benefits (see table reference P5c). Of the 51 cases assessed, 15 were assessed as being not justified because of the unfavourable balance of costs, benefits and other</p>	

<p>impacts.</p> <p>As part of the recent review of water prices for the water industry (PR09), we looked for cases where, irrespective of compliance with established environmental standards, further improvements to the quality of discharges would deliver local benefits sufficient to justify the costs of improvement. None were found.</p> <p>There are no ongoing actions in or upstream of the water body that are estimated to bring improvements in the status in this water body. In 2010 we will report to River Basin Liaison Panels on those water bodies where new knowledge of the links between phosphate and biology has resulted in a change to our assessment and hence the detail of the actions we are taking to improve their status.</p>
Investigation type
Investigate to confirm failure and/or impact
Example of investigation
<p>Additional biological monitoring (jn particular for macrophytes in rivers and lakes) to understand cause and impact and, where necessary, to confirm status. This has already started. For example, we have already started monitoring downstream of some sewage treatment works to gather additional biological evidence to potentially justify additional treatment to remove phosphorus.</p> <p>Where required, from 2010 investigative monitoring will be implemented to confirm the significance of all marginal phosphate failures and, where necessary, gather further biological evidence.</p> <p>Monitoring and modelling work will also be undertaken to identify the relative sources of nutrients in the catchment.</p> <p>Where the need for additional action is confirmed by, for example, the indication of impacts on macrophyte and phytobenthos (diatoms) in rivers and lakes we will move quickly to the identification of the most cost effective combination of measures necessary to achieve good ecological status.</p> <p>Through the UK Technical Advisory Group on the WFD, the Environment Agency is working to improve the understanding of the links between phosphate, diatoms and macrophytes in rivers and lakes to inform the future review of nutrient standards, monitoring plans and the level of evidence needed to justify the use of different control mechanisms.</p>
Possible future measures
<p>Restrictions on phosphorus in detergents.</p> <p>The major sources of nutrients are discharges from sewage treatment works and agricultural activities. If the need to take additional action and the sources of the nutrient are confirmed, further measures (subject to further assessment of cost, benefits and other impacts) will be implemented.</p>

Examples of such measures include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as the England Catchment Sensitive Farming Delivery Initiative, better targeting of agri-environment schemes, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions), and action to address misconnections.

The Environment Agency is now working with the main farming groups to understand better the main ways in which phosphate from land enters and is transported in water bodies. We will also look at what the advice and incentives available through agri-environment schemes and the England Catchment Sensitive Farming Delivery Initiative can do to reduce phosphate pollution of water and wetlands alongside the industry led campaign for the Farmed Environment.

In parallel with this approach, the Environment Agency will continue to develop work on regulatory measures, such as designating Water Protection Zones (WPZs) if voluntary approaches are shown not to work in a particular area, or where higher environmental standards are needed in for example protected areas, so that we are ready and able to ensure progress is made before 2015. The work to identify the ways in which phosphate enters water bodies and the means of reducing this will inform the measures that might be applied in WPZs which can only be effective if the means of control have been clearly identified.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Sewage treatment works discharges:

It will be disproportionately expensive to install phosphorus removal technology on all municipal sewage treatment works in England and Wales. To do so would cost up to £6billion and result in benefits of approximately £2billion. Removing phosphorus requires more energy and so has a carbon impact. Depending on the size of the works and the treatment technology used it is estimated that between 16-1426 tonnes of additional carbon are produced per tonne of phosphorus removed.

It is likely that installing phosphorus removal technology on many of the works serving less than 250 people will be disproportionately expensive. It will cost between 157-7408 £/kg to remove phosphorus from these smaller works.

Agricultural activities:

- Wide scale reversion of arable land to low intensity pasture over large parts of England and Wales
- Wide scale reversion of agricultural land to woodland over large parts of England and Wales
- Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales

Reference	P1c, N1c
Element predicted not to achieve good by 2015	P1c = Phosphate or Total Phosphorus N1c = Dissolved Inorganic Nitrogen
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>There is not sufficient weight of evidence to confirm the need to control eutrophication risk and there are ongoing or planned improvement actions</p> <p>Guidance on river basin management planning issued by Defra and Welsh Assembly Government requires that for failures of nutrient standards that the biology is truly impacted when considering the case for improvement actions. For these water bodies there is no or insufficient biological data or other evidence to justify taking additional measures to control the risk of eutrophication. From the monitoring undertaken for this plan it is now clear that there is a link between high levels of phosphate in surface waters and biological failures in the main river type (lowland alkaline rivers). We are already collecting additional biological data in locations where the phosphate standard is exceeded. This includes monitoring started in 2008 to gather additional biological evidence downstream of sewage treatment works where additional treatment to remove phosphorus would be justified if we were confident there is a risk of damage.</p> <p>There are ongoing actions within or upstream of the water body (either at sewage treatment works and / or through actions on agriculture in the catchment). Some of these actions are driven by eutrophic designations under the Urban Waste Water Treatment Directive and / or the Nitrates Directive. The ongoing actions will reduce nutrient levels and lead to some improvement in status. We are uncertain of the extent of the improvement and further action would not be pursued until the outcome was established through future monitoring. This is because we have low confidence that future quality would fail the standard. Without confidence in a failure we cannot reliably consider further measures. To do so would mean a significant risk of wasted investment on measures in already compliant water bodies. Our priority in the first cycle will be to carry out further investigation to confirm any failure with certainty, identify sources and additional potential measures. This will also need to consider biological response times.</p> <p>It is disproportionately expensive to implement further measures at this time. An extended deadline for achieving good ecological status is therefore required. The major source of phosphorus is discharges from municipal sewage treatment works. Removing phosphorus from sewage is expensive (8 to 7408 £/kg of P removed depending on the size of the works and the treatment technology used) requiring</p>	

structural changes to the works and ongoing operational costs for chemicals, energy and sludge disposal. Even where the need to control the risk of eutrophication is confirmed, there is still a significant risk that removing phosphorus from sewage treatment works is disproportionately expensive because of the balance of costs and benefits (see tables reference P5c). Of the 51 cases assessed, 15 were assessed as being not justified because of the unfavourable balance of costs, benefits and other impacts.

As part of the recent review of water prices for the water industry (PR09), we looked for cases where, irrespective of compliance with established environmental standards, further improvements to the quality of discharges would deliver local benefits sufficient to justify the costs of improvement. None were found.

Investigation type

Investigate to confirm failure and/or impact

Example of investigation

Additional biological monitoring to confirm status. This has already started. For example, in 2008 we started monitoring downstream of some sewage treatment works to gather additional biological evidence to potentially justify additional treatment to remove phosphorus.

Monitoring and modelling work to review the relative sources of nutrients in the catchment.

If the need for additional action is confirmed, identification of the most cost effective combination of measures necessary to achieve good ecological status.

Possible future measures

Ban on phosphorus in detergents.

The major sources of nutrients are discharges from sewage treatment works and agricultural activities. If the need to take additional action and the sources of the nutrient are confirmed, further measures (subject to further assessment of cost, benefits and other impacts) will be implemented.

Examples of such measures include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as England Catchment Sensitive Farming Delivery Initiative, better targeting of agri-environment schemes, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions).

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Sewage treatment works discharges:

It will be disproportionately expensive to install phosphorus removal technology on all municipal sewage treatment works in England and Wales. To do so would cost up to £6billion and result in benefits of approximately £2billion. Removing phosphorus requires more energy and so has a carbon impact. Depending on the size of the

works and the treatment technology used it is estimated that 16-1426 tonnes of additional carbon are produced per tonne of phosphorus removed.

It is likely that installing phosphorus removal technology on many of the works serving less than 250 people will be disproportionately expensive. It cost between 157-7408 £/kg to remove phosphorus from these size works.

Agricultural activities:

- Wide scale reversion of arable land to low intensity pasture over large parts of England and Wales
- Wide scale reversion of agricultural land to woodland over large parts of England and Wales
- Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales

Reference	P1d
Element predicted not to achieve good by 2015	Phosphate or Total Phosphorus
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Improvement work is happening or is planned in the water body but the extent of the improvement is uncertain</p> <p>Guidance on river basin management planning issued by Defra and Welsh Assembly Government requires that for failures of nutrient standards that the biology is truly impacted when considering the case for improvement actions.</p> <p>For these water bodies there is currently sufficient weight of evidence (including biology classification) to confirm the need to control eutrophication risk. However, we know there is current or planned work within or upstream of the water body at sewage treatment works and /or on agriculture in the catchment. These actions will reduce nutrient levels and lead to some improvement in status. We are uncertain of the extent of the improvement and further action would not be pursued until the outcome was established through future monitoring. This is because we have low confidence that future quality would fail the standard. Without confidence in a failure we cannot reliably consider further measures. To do so would mean a significant risk of wasted investment on measures in already compliant water bodies. Our priority in the first cycle will be to carry out further investigation to confirm any failure with certainty, identify sources and additional potential measures. This will also need to consider biological response times.</p> <p>It is disproportionately expensive to implement further measures at this time. An extended deadline for achieving good ecological status is therefore required. The major source of phosphorus is discharges from municipal sewage treatment works. Removing phosphorus from sewage is expensive (8 to 7408 £/kg of P removed depending on the size of the works and the treatment technology used) requiring structural changes to the works and ongoing operational costs for chemicals, energy and sludge disposal. Even where the need to control the risk of eutrophication is confirmed, there is still a significant risk that removing phosphorus from sewage treatment works is disproportionately expensive because of the balance of costs and benefits (see tables reference P5c). Of the 51 cases assessed, 15 were assessed as being not justified because of the unfavourable balance of costs, benefits and other impacts.</p>	

Investigation type
Investigate to confirm failure and/or impact
Example of investigation
<p>Additional biological monitoring to confirm. This has already started. For example, in 2008 we started monitoring downstream of some sewage treatment works to gather additional biological evidence to potentially justify additional treatment to remove phosphorus.</p> <p>Monitoring and modelling work to review the relative sources of nutrients in the catchment.</p> <p>If the need for additional action is confirmed, identification of the most cost effective combination of measures necessary to achieve good ecological status.</p>
Possible future measures
<p>Ban on phosphorus in detergents.</p> <p>The major sources of nutrients are discharges from sewage treatment works and agricultural activities. If the need to take additional action and the sources of the nutrient are confirmed, further measures (subject to further assessment of cost, benefits and other impacts) will be implemented.</p> <p>Examples of such measures include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as England Catchment Sensitive Farming Delivery Initiative, better targeting of agri-environment schemes, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions).</p>
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>Sewage treatment works discharges:</p> <p>It will be disproportionately expensive to install phosphorus removal technology on all municipal sewage treatment works in England and Wales. To do so would cost up to £6billion and result in benefits of approximately £2billion. Removing phosphorus requires more energy and so has a carbon impact. Depending on the size of the works and the treatment technology used it is estimated that 16-1426 tonnes of additional carbon are produced per tonne of phosphorus removed.</p> <p>It is likely that installing phosphorus removal technology on many of the works serving less than 250 people will be disproportionately expensive. It cost between 157-7408 £/kg to remove phosphorus from these size works.</p> <p>Agricultural activities:</p> <ul style="list-style-type: none"> • Wide scale reversion of arable land to low intensity pasture over large parts of England and Wales • Wide scale reversion of agricultural land to woodland over large parts of England

and Wales

- Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales

Reference	P1e, N1e
Element predicted not to achieve good by 2015	P1e = Phosphate or Total Phosphorus N1e = Dissolved Inorganic Nitrogen
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The water body is within a site currently being investigated as a candidate for designation as a sensitive area eutrophic (and / or in Transitional / Coastal waters a polluted water eutrophic)</p> <p>That review will confirm whether the site is at risk of eutrophication, not at risk, or needs further investigation. If it is at risk basic measures under UWWTD &/or Nitrates Directive would then be applied.</p>	
Investigation type	
Investigate to confirm failure and/or impact	
Example of investigation	
Conclusion of the review as a candidate sensitive area / polluted water, which could require further investigation if evidence is inconclusive. Investigations would also look at whether other measures in combination with the basic measures under UWWTD / Nitrates Directive could be justified in terms of costs, benefits and other impacts. The investigative work would be through a combination of modelling and potentially further monitoring.	
Possible future measures	
Conclusion of the review as a candidate sensitive area / polluted water will confirm if the water body is at risk from eutrophication. If so basic measures required by those designations would then be applied. Progressing measures to address other sources, for example agricultural phosphorus, would depend on their relative contribution and whether these were justified in terms of costs, benefits and other impacts. Into the future developments in technology and our understanding of the effectiveness of measures could provide enhanced measures.	

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Sewage treatment works discharges:

It will be disproportionately expensive to install phosphorus removal technology on all municipal sewage treatment works in England and Wales. To do so would cost up to £6billion and result in benefits of approximately £2billion. Removing phosphorus requires more energy and so has a carbon impact. Depending on the size of the works and the treatment technology used it is estimated that 16-1426 tonnes of additional carbon are produced per tonne of phosphorus removed.

It is likely that installing phosphorus removal technology on many of the works serving less than 250 people will be disproportionately expensive. It cost between 157-7408 £/kg to remove phosphorus from these size works.

Agricultural activities:

- Wide scale reversion of arable land to low intensity pasture over large parts of England and Wales
- Wide scale reversion of agricultural land to woodland over large parts of England and Wales
- Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales

Reference	P1o, N1o
Element predicted not to achieve good by 2015	P1o = Phosphate or Total Phosphorus N1o = Dissolved Inorganic Nitrogen
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>There is not sufficient weight of evidence to confirm the need to control eutrophication risk</p> <p>Guidance on river basin management planning issued by Defra and Welsh Assembly Government requires that for failures of nutrient standards that the biology is truly impacted when considering the case for improvement actions. For these water bodies biological data for nutrient sensitive elements is suggesting good or better status so there is low certainty that there is a risk of eutrophication even though nutrients are exceeding the standard. Where we are not confident of failing good status we would not use regulatory powers to pursue costly site specific measures on the grounds that we would only anticipate low or uncertain benefits which would not be proportionate to the costs.</p> <p>It is disproportionately expensive to implement further measures at this time. An extended deadline for achieving good ecological status is therefore required. The major source of phosphorus is discharges from municipal sewage treatment works. Removing phosphorus from sewage is expensive (8 to 7408 £/kg of P removed depending on the size of the works and the treatment technology used) requiring structural changes to the works and ongoing operational costs for chemicals, energy and sludge disposal. Even where the need to control the risk of eutrophication is confirmed, there is still a significant risk that removing phosphorus from sewage treatment works is disproportionately expensive because of the balance of costs and benefits (see tables reference P5c). Of the 51 cases assessed, 15 were assessed as being not justified because of the unfavourable balance of costs, benefits and other impacts.</p>	
Investigation type	
Investigate to confirm failure and/or impact	
Example of investigation	
Investigate reasons for conflicting evidence between nutrient status and biology. This could lead to a review of the appropriateness of the nutrient standard for the site	

/ type. Site would also be kept under review against risk of deterioration.

Possible future measures

Ban on phosphorus in detergents.

The major sources of nutrients are discharges from sewage treatment works and agricultural activities. If the need to take additional action and the sources of the nutrient are confirmed, further measures (subject to further assessment of cost, benefits and other impacts) will be implemented.

Examples of such measures include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as England Catchment Sensitive Farming Delivery Initiative, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions).

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Sewage treatment works discharges:

It will be disproportionately expensive to install phosphorus removal technology on all municipal sewage treatment works in England and Wales. To do so would cost up to £6billion and result in benefits of approximately £2billion. Removing phosphorus requires more energy and so has a carbon impact. Depending on the size of the works and the treatment technology used it is estimated that 16-1426 tonnes of additional carbon are produced per tonne of phosphorus removed.

It is likely that installing phosphorus removal technology on many of the works serving less than 250 people will be disproportionately expensive. It cost between 157-7408 £/kg to remove phosphorus from these size works.

Agricultural activities:

- Wide scale reversion of arable land to low intensity pasture over large parts of England and Wales
- Wide scale reversion of agricultural land to woodland over large parts of England and Wales
- Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales

Reference	P2a
Element predicted not to achieve good by 2015	Phosphate or Total Phosphorus
Reason for failure	Unknown - reasons for failure unknown
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The cause of the failure (sector or general activity) is unknown</p> <p>Phosphorus is released into the environment from a range of sources including municipal sewage treatment works and agricultural land use. For water bodies where the sources of the nutrients are not known, or not known in sufficient detail to be able to identify and appraise measures (including identification of the person who is responsible for causing the pollution), it is technically infeasible to identify and implement additional measures, and achieve the objective by 2015. An extended deadline for achieving good ecological status is therefore required.</p> <p>For over 15 years we have routinely (usually every four years) reviewed water bodies to control eutrophication or the risk of eutrophication where the predominant release of nutrients has been from municipal sewage treatment works. We use a number of different approaches to do this including routine and investigative monitoring, modelling, and site inspections.</p> <p>In 2008 and 2009 (as part of the classification work for the draft and first river basin management plans) we assessed compliance with the new standards for phosphorus. We have identified new failures. In the time available, we have not been able to identify the sources and their relative contributions for each of the new failures.</p> <p>The water body is not predicted to improve as a result of any planned actions upstream.</p>	
Investigation type	
Investigate reason for failure	
Example of investigation	
<p>The significance of locally relevant potential point and diffuse sources will be assessed through additional monitoring, site visits, desktop studies and modelling to identify and apportion causes of failure (sources and pathways) and develop a cost-effective combination of measures. These will include local investigations as well as using information and understanding from national source apportionment projects</p>	

and ongoing work to improve our understanding of the effectiveness of measures, particularly for agricultural sources. Modelling will also be used to assess the likely outcome from the actions in order to appraise the costs, benefits and other impacts. This will allow appropriate measures to be identified for implementation in this or subsequent river basin management planning cycles.

Possible future measures

Possible future measures will depend on the identification of nutrient source contributions. In general the principle sources are sewage and agriculture so measures could include additional regulatory controls on these sources within the limits of what is currently technically possible, or which becomes possible through developments in technology and our understanding of the effectiveness of measures.

Examples of such measures include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as England Catchment Sensitive Farming Delivery Initiative, better targeting of agri-environment schemes, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions).

For any future designations under the Urban Waste Water Treatment Directive and/or the Nitrates Directive basic measures as required by those Directives would then be applied. Similarly for any requirements identified to meet Habitats Directive objectives.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Uncertain until the sectors or general activities causing the failure is confirmed.

Reference	P2b
Element predicted not to achieve good by 2015	Phosphate or Total Phosphorus
Reason for failure	Suspected – point and/or diffuse source
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The cause of the failure (sector or general activity) is not known with certainty</p> <p>Phosphorus is released into the environment from a range of sources including municipal sewage treatment works and agricultural land use. For water bodies where the sources of the nutrients are suspected, but we do not have strong enough evidence to confirm it, it is technically infeasible to identify and implement additional measures, and achieve the objective by 2015. An extended deadline for achieving good ecological status is therefore required.</p> <p>For over 15 years we have routinely (usually every four years) reviewed water bodies to control eutrophication or the risk of eutrophication where the predominant release of nutrients has been from municipal sewage treatment works. We use a number of different approaches to do this including routine and investigative monitoring, modelling, and site inspections.</p> <p>In 2008 and 2009 (as part of the classification work for the draft and first river basin management plans) we assessed compliance with the new standards for phosphorus. We have identified new failures. In the time available, we have not been able to identify the sources and their relative contributions for each of the new failures.</p> <p>For a few water bodies the code P5a has also been applied with P2b. This indicates that actions have been completed following designation as a sensitive area eutrophic under the Urban Waste Water Treatment Directive but no further actions are ongoing. Relative sources are now given as suspected, these need to be confirmed to establish whether there are further feasible and cost-beneficial actions that can be taken on the remaining source from sewage discharges and/or that from other sources.</p>	
Investigation type	
Investigate source of failure	

Example of investigation

The significance of locally relevant potential point and diffuse sources will be assessed through additional monitoring, site visits, desktop studies and modelling to identify and apportion causes of failure (sources and pathways) and develop cost-effective combinations of measures. Investigations will include local studies as well as using information and understanding from national source apportionment projects and ongoing work to improve our understanding of the effectiveness of measures, particularly for agricultural sources. Modelling will also be used to assess the likely outcome from the actions in order to appraise the costs, benefits and other impacts. This will allow appropriate measures to be identified for implementation in this or subsequent river basin management planning cycles.

Possible future measures

Possible future measures will depend on the identification of nutrient source contributions. In general the principle sources are sewage and agriculture so measures could include additional regulatory controls on these sources within the limits of what is currently technically possible, or which becomes possible through developments in technology and our understanding of the effectiveness of measures.

Examples of such measures include additional regulatory controls on point sources, including sewage treatment works and storm sewage discharges; actions to address diffuse sources, e.g. extension of schemes such as England Catchment Sensitive Farming Delivery Initiative, better targeting of agri-environment schemes, pollution prevention (through the adoption of best practice methodologies, local education campaigns and voluntary initiatives); control at source (e.g. through additional use restrictions).

For any future designations under the Urban Waste Water Treatment Directive and/or the Nitrates Directive basic measures as required by those Directives would then be applied. Similarly for any requirements identified to meet Habitats Directive objectives.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Uncertain until the sectors or general activities causing the failure is confirmed.

Reference	P3a
Element predicted not to achieve good by 2015	Phosphate or Total Phosphorus
Reason for failure	Confirmed - diffuse source agricultural
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The specific agricultural source (location, specific activity and/or pathway) of the failure is unknown</p> <p>Although agriculture is known to be causing the problem, until the specific source(s) is known in sufficient detail to be able to identify and appraise measures (including identification of the person who is responsible for causing the pollution), it is technically infeasible to identify and implement additional measures, and achieve the objective by 2015. An extended deadline for achieving good ecological status is therefore required.</p> <p>For over 15 years we have routinely (usually every four years) reviewed water bodies to control eutrophication or the risk of eutrophication where the predominant release of nutrients has been from municipal sewage treatment works. We use a number of different approaches to do this including routine and investigative monitoring, modelling, and site inspections.</p> <p>In 2008 and 2009 (as part of the classification work for the draft and first river basin management plans) we assessed compliance with the new standards for phosphorus. We have identified new failures. In the time available, we have not been able to identify the sources and their relative contributions for each of the new failures.</p> <p>WFD biology classification indicates certainty of being less than good from the weight of evidence across nutrient sensitive elements. Nutrient sources include confirmed diffuse agricultural as a broad source. However, further investigation is required to establish the specific agricultural sources and the pathways by which they reach the water environment to establish whether there are feasible measures that can be applied and if these are cost-beneficial. This would enable appropriate targeting of measures alone or in combinations. General measures on agriculture are not expected to deliver much improvement in status. Applying site specific measures without a good understanding of whether these are actually being targeted at the most significant sources risks wasted investment. Lack of knowledge limits our ability to develop the most cost-effective combination of measures, and to ensure costs are proportionate to benefits and other impacts.</p>	

Investigation type
Investigate feasible measures
Example of investigation
<p>The significance of locally relevant agricultural diffuse sources will be assessed through additional monitoring, site visits (including tracing studies), desktop studies and modelling to identify and apportion the sources of failure. The most cost effective combination of measures necessary to achieve good ecological status will be identified. Investigations will include local studies as well as using information and understanding from national source apportionment projects and ongoing work to improve our understanding of the effectiveness of agricultural measures. There are a number of national projects being planned to do further testing and evaluation (including field trials) of the most effective means of reducing agricultural nutrient pollution, including ongoing work within the Catchment Sensitive Farming catchments in England and Demonstration Catchment work in Wales. Modelling will also be used to assess the likely outcome from the actions in order to appraise the costs, benefits and other impacts. This will allow appropriately targeted measures to be identified for implementation in this or subsequent river basin management planning cycles.</p>
Possible future measures
<p>Possible future measures will depend on the more detailed identification of source contributions and investigations into the feasibility and relative effectiveness of measures.</p> <p>Measures might include for example:</p> <ul style="list-style-type: none"> • More local partnership projects to support farmers to change practice • Increased roll-out (in terms of duration and geographic extent) of Catchment Sensitive Farming advisory initiatives in England, and in Wales expansion of the Environment Agency's Catchment Co-ordinator Initiative • Widen the measures and activities included in agri-environment initiatives (e.g. rural sustainable drainage systems) • Widen the measures and activities that are included in the Common Agricultural Policy funded initiatives (e.g. increase soil resource protection measures in current approach to cross-compliance, or whatever may follow in future) • Establish and or extend existing national partnerships that provide advice and support to land managers to improve practice • Increased Environment Agency-led pollution enforcement campaigns (including use of anti-pollution works notices) • where appropriate designation of Water Protection Zones
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<ul style="list-style-type: none"> • Wide scale reversion of arable land to low intensity pasture over large parts of England and Wales • Wide scale reversion of agricultural land to woodland over large parts of England and Wales • Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales

Reference	P5a
Element predicted not to achieve good by 2015	Phosphate or Total Phosphorus
Reason for failure	Confirmed - point source water industry
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The discharge(s) contributing to the failure is known but it is uncertain if the costs of the measure(s) are proportionate to the benefits</p> <p>Although the sewage treatment works or storm sewage discharges contributing to the failure are known, until further site specific appraisal is done, it is uncertain if the cost of implementing the improvement measure(s) is proportionate. It is therefore disproportionately expensive to implement further measures at this time and an extended deadline for achieving good ecological status is required.</p> <p>Removing phosphorus from sewage is expensive (8 to 7408 £/kg of P removed depending on the size of the works and the treatment technology used) requiring structural changes to the works and ongoing operational costs for chemicals, energy and sludge disposal. Even where the need to control the risk of eutrophication is confirmed, there is still a significant risk that removing phosphorus from sewage treatment works is disproportionately expensive because of the balance of costs and benefits (see tables reference P5c). Of the 51 cases assessed, 15 were assessed as being not justified because of the unfavourable balance of costs, benefits and other impacts. Actions are in most instances expensive and need to be justified in terms of addressing real failures.</p> <p>For some water bodies the need for schemes had not been identified within the timescales for PR09 planning. At some sites the earlier classifications did not show the standards were failed with high confidence and so improvement schemes were not identified. The final classifications now show such failures. In the time available, we have been able to identify the sewage discharge(s) contributing to the failure. However, it has not been possible to identify the costs of the required measures and identify potential benefits and other impacts that improving the discharges will deliver.</p> <p>If this further appraisal confirms that it is disproportionately expensive to achieve good ecological status by 2015, these water bodies will be re-categorised with reference 5c. If measures are shown to be proportionate we will look to progress measures as soon as practicable. These future measures may need to be phased, particularly if they depend on action to address other sources.</p>	

Investigation type
Investigate proportionate measures
Example of investigation
Investigations will establish whether it is cost-beneficial to implement measures at the water industry sources to justify inclusion into water industry investment programmes. These investigations would also need to confirm the significance of other sources of phosphorus to establish whether it is feasible to address these and deliver combined action that is cost-beneficial. This will be assessed mainly through modelling but may require some additional monitoring .
Possible future measures
Possible future measures could include further phosphorus removal for sewage discharges as well as action on agricultural sources, depending on the relative significance of these (and other) sources. Development of new techniques and practices for both of these sources could also provide more effective measures which achieve a better balance of costs, benefits and other impacts.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>It will be disproportionately expensive to install phosphorus removal technology on all municipal sewage treatment works in England and Wales. To do so would cost up to £6billion and result in benefits of approximately £2billion. Removing phosphorus requires more energy and so has a carbon impact. Depending on the size of the works and the treatment technology used it is estimated that 16-1426 tonnes of additional carbon are produced per tonne of phosphorus removed.</p> <p>It is likely that installing phosphorus removal technology on many of the works serving less than 250 people will be disproportionately expensive. It cost between 157-7408 £/kg to remove phosphorus from these size works.</p>

Reference	P5c
Element predicted not to achieve good by 2015	Phosphate or Total Phosphorus
Reason for failure	Confirmed - point source water industry sewage works
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The discharge causing the phosphorus failure is known and a site specific appraisal has shown the improvement measure available to be currently disproportionately expensive</p> <p>Through our PR09 planning work we identified the sewage treatment works causing the phosphorus failure. We identified the costs of the required measure and identified potential benefits and other impacts that improving the discharges will deliver. This showed the measure to be currently disproportionately expensive.</p> <p>These appraisals used:</p> <ul style="list-style-type: none"> - site specific costs provided by Ofwat following submission of water company final business plans; - site specific information on embedded carbon and operating carbon emissions to calculate carbon costs; - environmental outcomes recorded as length of river improved to meet WFD objectives; - benefits based on the NERA National Benefits Survey (Collaborative Research Project 4b/c); - additional local benefits identified after consultation with RBD liaison panels. <p>Our PR09 appraisal of the costs and benefits of phosphorus removal schemes assessed 51 cases, of which 15 were assessed as being not justified because of the unfavourable balance of costs, benefits and other impacts. The 36 schemes that were assessed as having a favourable balance of costs, benefits and other impacts will improve 25 water bodies and 268 kilometres of river.</p> <p>Technological improvements may make the improvement needed less costly and / or the estimated benefits may change significantly with better information. An extended deadline for achieving good ecological status is therefore required.</p>	
Investigation type	
Investigate proportionate measures	

Example of investigation

At these sites the assessments will be reviewed as further information becomes available that might change the balance of costs, benefits and other impacts. This might come from: an improved understanding of the relative importance of other sources such that combined action becomes cost-beneficial; benefits may be valued more highly; benefits may increase if outcomes become more certain; advancements in treatment technology may reduce the cost of the measures and/or improve the outcome that can be realised.

If measures are shown to be proportionate we will look to progress measures as soon as practicable. These future measures may need to be phased, particularly if they depend on action to address other sources.

Possible future measures

Possible future measures could include further phosphorus removal for sewage discharges as well as action on agricultural sources, depending on the relative significance of these (and other) sources. Development of new techniques and practices for both of these sources could also provide more effective measures which achieve a better balance of costs, benefits and other impacts.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

It will be disproportionately expensive to install phosphorus removal technology on all municipal sewage treatment works in England and Wales. To do so would cost up to £6billion and result in benefits of approximately £2billion. Removing phosphorus requires more energy and so has a carbon impact. Depending on the size of the works and the treatment technology used it is estimated that 16-1426 tonnes of additional carbon are produced per tonne of phosphorus removed.

It is likely that installing phosphorus removal technology on many of the works serving less than 250 people will be disproportionately expensive. It cost between 157-7408 £/kg to remove phosphorus from these size works.

E5 Groundwater quality

Pressures affecting groundwater quality

The main pressures affecting groundwater quality are significant point sources of pollution (from a wide range of chemicals) and diffuse pollution from nutrients, mines and minewaters, pesticides, and urban sources. There are also abstraction pressures which can cause saline intrusion.

The most important and overarching groundwater quality objective is pollution prevention (the prevent or limit objective - see below). In this case, measures are not driven solely by failures, but also by pressures. Because of the large size of most groundwater bodies and the scale of status assessment it is possible to have pockets of polluted groundwater within a good status body. The prevent or limit objective aims to avoid such local pollution and prevent deterioration. Thus an important target for measures is good quality groundwater that is subject to significant risks (i.e. pressures) even though it may not yet be at poor status.

Environmental objectives for groundwater quality

The WFD contains the following environmental objectives for groundwater quality:

Prevent or limit objective

This applies to all groundwater, not just groundwater bodies, and applies at the point of discharge to groundwater. Comprehensive measures to meet the prevent or limit objective (PoL) will in time result in achievement of all other environmental objectives for groundwater. Note: the old Groundwater Directive (80/68/EEC) adopted a similar approach to groundwater protection but its scope was limited in terms of dealing with diffuse sources of pollution. The WFD and the new Groundwater Directive (2006/118/EC) seek to remedy this situation. For deliberate discharges of pollutants to groundwater, we meet the PoL objective through the use of regulatory regimes. Pollution prevention measures for non-deliberate inputs of pollutants to groundwater are wider ranging, including both direct and indirect regulation, and the provision of advice to operators. Our approach to implementing all these measures is described in Groundwater Protection: Policy and Practice (GP3) (<http://www.environment-agency.gov.uk/research/library/publications/40741.aspx>).

No deterioration in status

This will be achieved through effective implementation of PoL measures. Upward trends in pollutant concentrations could lead to deterioration in status. We will identify these trends where they are significant, and implement measures to reverse them. Good status groundwater bodies, where there is a significant deterioration in quality that could eventually lead to poor status, are a high priority for action (see below).

If PoL measures are effective, then good status will be maintained. However, in many aquifers there will be a significant time lag between a change in activities on the land surface and a corresponding change in groundwater quality, due to the time taken for water to percolate to the water table. For this reason, it is possible that groundwater status could deteriorate temporarily before any improvement measures become fully effective.

Achieve good chemical status

Where a groundwater body is at poor chemical status, effective PoL measures should eventually restore the body to good chemical status. However, where historical (often unregulated) activities have resulted in land contamination and have affected groundwater, it may not be possible to meet this objective by the 2015 deadline and therefore alternative

objectives will be set. Where PoL measures are not being effective our action would be to review the measures, and tighten existing controls as necessary and where feasible. Unless historic land contamination is widespread or affects a particularly important receptor it is unlikely to affect status. Where it does, it may be feasible to remediate contaminated land and groundwater using a combination of the existing planning and land contamination regulatory regimes. However, in many cases complete remediation may not be technically feasible or cost effective and we may have to rely on natural processes of degradation to take their course over many years and, where necessary, set alternative objectives for groundwater bodies in the medium term.

Trends

A significant and sustained upward trend in pollutant concentrations is one which is statistically and environmentally significant. For a trend to be environmentally significant it must be one that, if not reversed, could lead to a failure of one or more environmental objectives within 12 years (two river basin management planning cycles). There is no fixed period for achieving trend reversal as this will depend on local environmental conditions. The trend objective is failed when measures are not put in place to achieve trend reversal. We will use PoL measures to achieve reversal of trends, but this reversal may not be immediate due to the delayed response in groundwater. Wherever possible, measures must be implemented in time to avoid any future failure of environmental objectives.

Protected Areas

There are two Protected Areas of particular concern for groundwater quality:

1. Drinking Water Protected Areas (DrWPA) – the measures needed to deliver this objective are subject to specific assessment for the plan, described below.
2. Nitrate Vulnerable Zones (NVZs) – the action plans that apply are basic measures for this plan, and have therefore not been subject to any specific further assessment.

Achieving the objectives for DrWPAs is also a requirement for meeting good chemical status for groundwater bodies. Another is that there shall be no significant damage to Groundwater Dependent Terrestrial Ecosystems (GWDTE). Some, but not all GWDTEs are Protected Areas designated under other community legislation.

Priority of objectives

There is an inherent priority in the groundwater quality objectives based on the timescales for implementation, spatial scale of application and the ability to use alternate objectives/exemptions. This determines their significance for protecting groundwater quality, and therefore our priorities for meeting them. A prioritised list of our groundwater quality objectives is set out in Table 9, with our highest priority objective first.

Table 9. Prioritised list of groundwater quality objectives

Groundwater Objectives	Alternatives available	Time scale for achieving	Spatial scale for action
1. Prevent or limit	None, but some exemptions	Short	Local (all groundwater)
2. Protected Area Objectives	Possible time extensions where not set by other Directives	Other directives - Short DWPA – Medium	Medium - the protected area
3. No deterioration in status	None	Medium	Large (groundwater bodies)
4. Trend reversal	None – Measures must be implemented and working by 2015	Long	Medium
5. Achieve good status by 2015	Time extensions, Less stringent objectives	Medium	Large (groundwater bodies)

Current compliance with the status objective

We assessed the status of the 304 groundwater bodies in England and Wales using the five chemical status tests. The methodology for assessing chemical status can be found on the UKTAG website²². Each test addresses one of the quality elements that defines good groundwater chemical status. The results below show the number of groundwater bodies that are at poor status for each of the tests:

- Saline Intrusion = 11
- Surface Water Ecological Status = 54
- General Chemical Assessment = 48
- Drinking Water Protected Area = 53
- Groundwater Dependent Terrestrial Ecosystem = 2

After combining these results on a 'one out all out' basis, 124 groundwater bodies (41%) are at poor chemical status. Because of the way chemical status is assessed under the Directives, it is not feasible to give an overall statistical confidence in the status assessments.

We also found that 81 groundwater bodies (27%) had a statistically (at the 90% confidence level) and environmentally significant upward trend in pollutant concentrations.

Development of measures

As described above, the current (pre implementation of WFD and new Groundwater Directive) approaches to protection and improvement of groundwater quality have been laid out in our Groundwater Protection Policy (GP3). For deliberate discharges we use all existing permitting and other relevant regimes that are applicable to groundwater. The main examples are Water Resources Act consents, Environmental Permitting Regulations permits and Groundwater Regulations authorisations.

For non-deliberate inputs of pollutants to groundwater the controls are both regulatory and advisory, the main measures being Groundwater Regulations notices, Anti-pollution Works notices, Nitrate Vulnerable Zones, Local Authority land use planning, codes of practice, guidance notes, memoranda of understanding/operating agreements, Voluntary Initiative (for pesticides), England Catchment Sensitive Farming Delivery Initiative and day to day site specific advice. These are all targeted using a risk-based approach that will be supported by groundwater quality monitoring. This monitoring will assess the effectiveness of measures.

In this section we do not go into further detail regarding the development of specific measures, apart from those that particularly apply to groundwater quality (i.e. Drinking Water Protected Areas, Source Protection Zones, Safeguard Zones, and Water Protection Zones).

Measures appraisal process

As a general guide, the measures that are prioritised should address the objectives and priorities noted in the objectives table above. Whilst measures should be considered to address poor status, it is equally a priority to consider measures in groundwater bodies that are currently good but which are deteriorating in quality. Such deterioration will compromise both the no deterioration in status and trend reversal objectives and may be an indication

²² See Paper 11b(i) from the *UK Technical Advisory Group on the Water Framework Directive* titled 'Groundwater Chemical Classification for the purposes of the Water Framework Directive and the Groundwater Daughter Directive' 2007
http://www.wfduk.org/stakeholder_reviews/stakeholder_review_1-2007/stakeholder_reviews/stakeholder_review_1-2007/sr1-2007-gwreports/

that existing prevent or limit measures are ineffective and need to be tightened up. We will therefore develop measures to address deterioration in groundwater quality. Groundwater occurs under all of the land surface and groundwater bodies have been designated for around 90% of the land surface in England & Wales (85% in England and 99% in Wales). Many measures designed to deal with surface water issues will also have an impact on groundwater. Many of the “new” measures required to meet the groundwater objectives of the WFD involve more widespread or more intensive application of existing measures (for example, pollution prevention inspections and remedial action).

As noted above, prevent or limit measures are effectively the first and most important line of defence in protecting groundwater quality but they will also make a substantial contribution to meeting some surface water objectives. We already implement PoL measures but these are often less effective for diffuse sources of pollution. New WFD measures for groundwater quality therefore will tend to focus on diffuse sources.

The first step in our measures appraisal process was to centrally collate a list of existing and planned national measures. Local hydrogeologists then considered the effectiveness of these national measures as part of the appraisal process. They then considered what additional local measures could be put in place to meet the environmental objectives in each groundwater body. This was done using an expert judgement approach. Any measures that were considered to be disproportionately expensive were not included in the plan. All measures were then reviewed nationally to ensure consistency across river basin districts.

Development of predicted outcomes

We have identified predicted outcomes for the first three cycles of river basin management planning for each groundwater body. This was done by local expert hydrogeologists following the process set out in the Groundwater Quality Decision Tree (included at the end of this groundwater section). As part of this process they took into account the effectiveness of existing and planned local and national measures, and the recovery time of each groundwater body.

Status in future river basin management planning cycles

We anticipate that of the 124 groundwater bodies (112 in England and 12 in Wales) at poor chemical status nationally, 2 will recover to good status by 2015, a further 4 will recover to good status by 2021 and a further 113 (including all those in Wales) will recover to good by 2027. Because groundwater generally has a long residency time (the time water spends underground) groundwater bodies take a long time to respond to measures and return to good status.

There are 5 groundwater bodies that we anticipate will take longer than 2027 to recover. This is because there is currently no known technical solution to deal with the problem. Wherever we are unsure how long recovery will take we have initially assumed that the body will be good by 2027. In the second RBMP we will be able to provide a more robust assessment of likely recovery time as we will have more monitoring data and more knowledge on the effectiveness of our measures. It is possible therefore that in the next river basin management plan we will predict that more groundwater bodies will take longer than 2027 to recover to good status.

Justification of alternative objectives

Our assessment predicted that it was disproportionately expensive to get many poor status groundwater bodies to good status by 2015. The justification we used was ‘disproportionately expensive – unfavourable balance of costs and benefits’. This justification was used to justify time extensions to 2021 or 2027 on groundwater bodies that had been impacted by a wide range of pressures, including high nitrate concentrations. A key driver

behind this assessment is that, as noted earlier, groundwater quality responds very slowly to most measures in most groundwater bodies, particularly with respect to diffuse pollutant sources. Although technically feasible, measures to directly remediate groundwater quality are normally disproportionately expensive or have other undesirable environmental outcomes. By extending the deadline to 2021 or 2027, less costly measures can be used that utilise land use change in place of direct groundwater remediation schemes (e.g. pump and treat schemes). Therefore over a longer time period the cost of meeting good status is much lower, and therefore the benefits are likely to outweigh the costs in many groundwater bodies. Specific examples of where this justification was used can be found in supporting tables for GC4a, GC4c and GC4d, at the end of this section.

There were also a significant number of groundwater bodies where it was technically infeasible to get to good status by 2015. This was particularly the case for groundwater bodies where further investigations were needed. In these cases we used the justification technically infeasible - cause of adverse impact unknown. For example, we used this justification where elevated phosphate concentrations had caused a groundwater body to go to poor status, but we need further investigation to improve our understanding of the Source-Pathway-Receptor conceptual model. Specific examples of where this justification has been used can be found in the supporting table for GC1a.

We also used the technically infeasible - no known technical solution is available justification on a small number groundwater bodies that had gone to poor status. Specific examples of where this justification has been used can be found in the tables for GC2a, GC2b, and GC3a.

The natural conditions - groundwater status recovery time justification was used on a small number of groundwater bodies that could not get to good by 2015. Specific examples of where this justification has been used can be found in tables GC6a and GC6b.

Finally the 'disproportionately expensive – disproportionate burdens' justification was used on a small number of groundwater bodies that could not get to good by 2015. This justification was only used where a phased Coal Authority scheme was being implemented. An example of where this justification has been used can be found in table GC5a.

Drinking Water Protected Areas (DrWPA)

All groundwater bodies in England & Wales meet the criteria for DrWPAs and have been so designated.

We propose a tiered risk-based approach to the protection of drinking water abstractions and for compliance with Article 7 of the Water Framework Directive (see table 10 below).

At Tier 1 we would continue to apply to the existing protection measures under our Groundwater Protection Policy.

At Tier 2A we would seek to use additional voluntary measures in non-statutory Safeguard Zones.

At Tier 2B we propose to use Water Protection Zones (WPZs).

If all existing voluntary measures have been tried and exhausted, or we can show they will not work, a WPZ would be proposed. Voluntary measures include CSF, VI and agri-environment schemes.

A WPZ is a legislative mechanism to deliver statutory measures to control water pollution over and above existing statutory powers. The use of WPZs is enabled under section 93 of Water Resources Act, 1991. Defra is undertaking amendments to the Act to improve the order-making process to make it more transparent, and these changes are planned to come into force by December 2009. A Water Protection Zone Order defines both the area and the specific measures designed to deal with identified water quality problems within it. We will put forward a proposed WPZ designation which will be subject to consultation (including an Impact Assessment), with a decision being taken by Defra's Secretary of State before the Order, if approved, is laid before parliament.

WPZs can be applied as areas within the catchments of abstraction sources for drinking water to deal with specific point or diffuse source problems. In this instance they would be based on existing groundwater Source Protection Zones.

In all cases the assessment of which tier of protection is appropriate will be preceded by a review of Environment Agency and water company data, including monitoring data, data used for characterisation under the Water Framework Directive, and the results of the water company risk assessments under the amended Water Quality (Water Supply) Regulations – "Water Safety Plans".

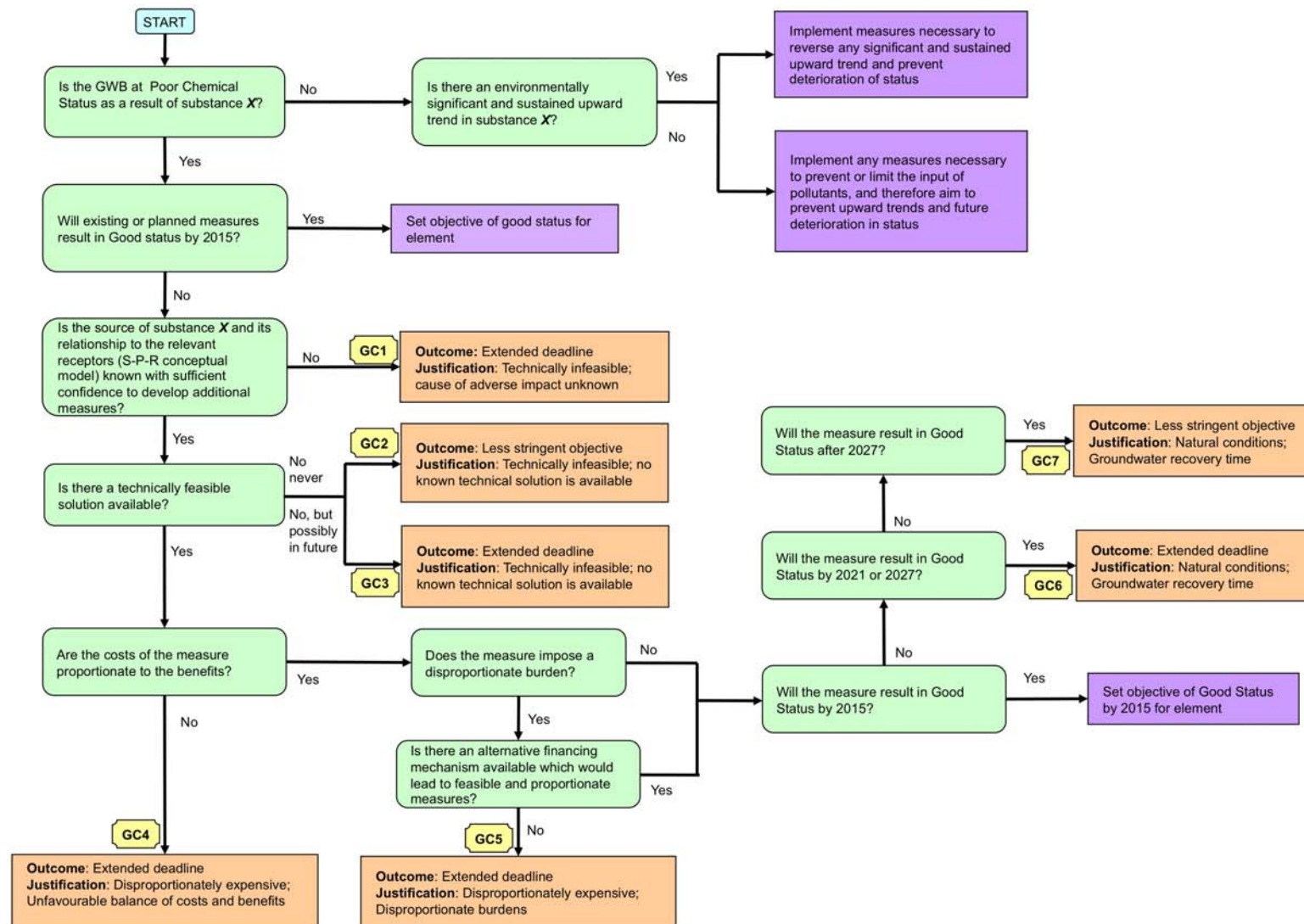
Table 10. Tiered risk-based approach to the protection of drinking water abstractions and for compliance with Article 7 of the Water Framework Directive

Tier	Description	Controls
1	General protection of the DrWPA (i.e. the whole groundwater body)	We will continue to apply the policies in accordance with our Groundwater Protection Policy (GP3). Existing groundwater Source Protection Zones ²³ would remain as a non-legislative tool to influence external stakeholders and focus our policies.
2A	Specific non-statutory protection (Safeguard Zones)	Our assessments indicate that certain abstractions are likely to require additional measures to avoid failing the Article 7.3 objective, but that there may be low confidence in the assessment, or we consider that non-statutory measures are sufficient. This may include targeted enforcement action to reinforce the GP3, voluntary agreements or campaigns. Non-statutory Safeguard Zones would be based upon existing groundwater Source Protection Zones, modified locally as necessary.
2B	Water Protection Zone designation	Would be considered where an abstraction is failing to meet Article 7.3 [or likely to if current trends continue] with a high degree of confidence and all existing voluntary measures have been tried and exhausted, or we can show they will not work. In such cases we may seek a Water Protection Zone Order if we can show that applying additional statutory measures is likely to work and will provide a cost effective solution. In this case, a separate application will be made and a public consultation carried out for each one. A more detailed investigation will be made of the causes of failure within the catchment and the remedial options.

²³ We define SPZs for each groundwater abstraction for human consumption. Zone 1 (SPZ1) is the area closest to the abstraction, representing the highest risk to the source. Zones 2 and 3 are progressively larger. Risk-based Policies to prevent pollution are applied within these zones.

Decision tree for
all substances causing a
Groundwater Body to go to Poor
Chemical Status

Note: Saline Intrusion is covered
by the decision tree for
groundwater abstractions



Reference	GC1a
Element predicted not to achieve good by 2015	Drinking Water Protected Area General Chemical Assessment Impacts on wetlands Impacts on surface water
Reason for failure	Suspected - point and diffuse sources from agriculture, land contamination and disused mines The failures are caused by various substances including phosphate, pesticides, chlorinated solvents, metals, ammonia, nitrate and bromate
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The source of the substance and its relationship to the relevant receptors is understood with insufficient confidence to develop measures to meet good chemical status by 2015</p> <p>Suspected sources (sectors and general activities) causing the failure of good chemical status have been identified. However, until the sources have been confirmed and the relationship to the relevant receptors (using a conceptual source-pathway-receptor model) better understood, the identification and application of measures (including who needs to implement them) to reduce the pollution is not possible. It is therefore not technically feasible to achieve good status by 2015. An extended deadline for achieving good chemical status is therefore required.</p> <p>A phased investigation programme will be implemented which will enable us to develop a robust Source-Pathway-Receptor conceptual model. This will help to indicate whether measures can be implemented to enable the groundwater body to get to good status.</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Develop a robust Source-Pathway-Receptor conceptual model, which includes a detailed assessment of the source of the pollution. Assess possible future measures to get the body to good status. Undertake an options appraisal on these measures, including an assessment of disproportionate cost. Develop a pollution action plan at the latest by 2012.	

Possible future measures
It is not yet clear what future measures are needed.
Measures required to achieve 100% Good Chemical Status by 2027 that are likely to be technically infeasible or disproportionately expensive
It is not yet clear what future measures would be required to achieve 100% good chemical status by 2027.

Reference	GC2a
Element predicted not to achieve good by 2015	General Chemical Assessment
Reason for failure	Confirmed - diffuse source contaminated land The failures are caused by chlorinated solvents
Alternative objective	Less stringent status objective
Reason for alternative objective	Technically infeasible: no known technical solution
Justification for alternative objective	
<p>No known technically feasible solution is available</p> <p>The failure is caused by chlorinated solvents (TCE and DCE) resulting from the long history of industrial activity affecting a number of locations in the groundwater body. Because of the extensive nature of the pollution and the fact that it has penetrated to great depths there is currently no technical solution that can be applied to effectively clean up the groundwater and return the groundwater body to good status before 2027.</p> <p>Future entry of these pollutants will be prevented or limited so that no further deterioration will take place. This will be achieved through a range of measures including pollution prevention campaigns, environmental permitting and application of industry codes of practice (for solvents). The measures will ensure that there will be the least possible deviation from good status in the future and any adverse trends in pollutant concentrations reversed.</p>	
Investigation type	
No further investigations are planned.	
Example of investigation	
No further investigations are planned.	
Possible future measures	
All necessary measures are in place. However, additional measures will be explored if our monitoring shows that the groundwater body is not recovering as expected.	

Measures required to achieve 100% Good Chemical Status by 2027 that are likely to be technically infeasible or disproportionately expensive
No technically feasible measures are available.

Reference	GC2b
Element predicted not to achieve good by 2015	Impacts on surface water General Chemical Assessment
Reason for failure	Confirmed - Disused mines point and/or diffuse source The failure is caused by metals (e.g. Iron, Zinc, Lead, Cadmium, Copper)
/Alternative objective	Less stringent status objective
Reason for alternative objective	Technically infeasible: no known technical solution
Justification for alternative objective	
<p>No known technically feasible solution is available</p> <p>In these groundwater bodies the reason for not achieving good status is because the groundwater has become polluted as a result of the extensive long-term coal and/or metal mining activity in the area. Because the source of pollution is widespread and below ground, there is currently no technical solution that can be applied to return the groundwater body to good status before 2027.</p> <p>Measures are being put in place to treat the polluted mine water discharges at the point of entry to the failing surface water bodies. This will reduce the pollution, and risk of failure, of associated surface water bodies. It will ensure that there will be the least possible deviation from good groundwater status in the future and any adverse trends in pollutant concentrations reversed.</p>	
Investigation type	
Investigate technically feasible solutions.	
Example of investigation	
Further investigations will take place into these discharges from abandoned metal and coal mines. The objective will be to determine the most cost-effective remedial options.	
Possible future measures	
Minewater remediation schemes on discharges that have been identified as being a high priority. These will prevent or limit further inputs of pollutants to the water body or impacts on receptors. The measures will ensure that there will be the least	

possible deviation from good status and adverse trends in pollutant concentrations will be reversed.
Measures required to achieve 100% Good Chemical Status by 2027 that are likely to be technically infeasible or disproportionately expensive
Implementation of minewater remediation schemes for all discharges.

Reference	GC3a
Element predicted not to achieve good by 2015	Drinking Water Protected Area
Reason for failure	Confirmed - agricultural source The failure is caused by the pesticide bentazone
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: no known technical solution
Justification for alternative objective	
<p>No known technically feasible solution is available</p> <p>Extensive investigations into the pesticide (bentazone) pollution have been carried out over many years. Monitoring has shown that the concentrations of bentazone in the groundwater are decreasing. Even though all surface inputs have stopped, the rate of decline is not sufficient to achieve good status by 2015. A detailed review of all possible remedial options was carried out in 2008/9. This study has shown that it is not possible to remediate the bentazone pollution. This is mainly because a clearly defined source of the bentazone pollution could not be found, even though extensive investigations have been carried out. In situ remediation of bentazone pollution that is distributed throughout the aquifer is not technically feasible. There is therefore no known technical solution to meet good status by 2015. Groundwater monitoring will be carried out to ensure that the groundwater body meets good status by 2027.</p> <p>The abstracted drinking water is currently treated to remove bentazone to ensure that drinking water standards are achieved</p>	
Investigation type	
Monitoring	
Example of investigation	
Groundwater monitoring to confirm falling trend in bentazone concentrations and improve the conceptual understanding of the source-pathway-receptor linkages.	
Possible future measures	
We propose continual monitoring of the abstraction to confirm a falling trend in bentazone, combined with pollution prevention measures in the catchment.	

Measures required to achieve 100% Good Chemical Status by 2027 that are likely to be technically infeasible or disproportionately expensive

We anticipate that good status will be reached by 2027. No new measures beyond those listed above are required.

Reference	GC4a
Element predicted not to achieve good by 2015	Drinking Water Protected Area General Chemical Assessment Impacts on wetlands
Reason for failure	Confirmed - diffuse source agricultural Failures are caused by nitrate and/or ammonia
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The costs of the measures required to achieve good status are not proportionate to the benefits</p> <p>In order to meet the objective of good status by 2015 groundwater remediation schemes would probably be required. Although technically feasible, measures to directly remediate groundwater quality are normally disproportionately expensive as they are likely to cost hundreds of millions of pounds per groundwater body. They may also have other undesirable environmental outcomes, such as exacerbating climate change. The main benefit of such remediation would be the reduction in the nitrate removal treatment costs for water abstracted for drinking water supplies.</p> <p>The typical installation costs for nitrate treatment are £4m (plus significant on-going operational cost). Even where there are several individual abstractions requiring treatment the benefits of a remediation scheme for the whole groundwater body cannot be justified on the basis of the significant (orders of magnitude) difference between benefits and costs. It is therefore disproportionately expensive to meet good status by 2015.</p> <p>Measures are in place (e.g. Nitrate Vulnerable Zone action programme, agri-environment measures, cross-compliance e.g. soil protection reviews, Code of Good Agricultural Practice or England Catchment Sensitive Farming Delivery Initiative) that will reduce nitrate levels. However, at a catchment scale the level of reduction in relation to the objective is uncertain and additional measures may prove necessary in some catchments. Because of the variable and often long recovery time associated with these aquifers (from several years to many decades) the full benefit of measures may not be seen for some time.</p> <p>As the deadline is extended to 2027, less costly measures can be used to achieve good status. These include Nitrate Vulnerable Zone action programmes, England Catchment Sensitive Farming Delivery Initiative, water company lead catchment management schemes, Safeguard Zones, Water Protection Zones, targeted set-aside and targeted measures with agri-environment schemes. The benefits of these</p>	

schemes are likely will outweigh the costs over a longer time horizon.
Investigation type
Investigate feasible measures and monitor impacts of existing measures
Example of investigation
Review the impact of recent land management changes using the latest groundwater monitoring data and potentially specialist models where appropriate. Undertake further research into potential future measures.
Possible future measures
Preparation of pollution action plan to guide further pollution prevention activities, Nitrate Vulnerable Zone action plans, England Catchment Sensitive Farming Delivery Initiative, water company lead catchment management schemes, Safeguard Zones, Water Protection Zones, targeted set-aside, targeted measures with agri-environment schemes.
Measures required to achieve 100% Good Chemical Status by 2027 that are likely to be technically infeasible or disproportionately expensive
Widespread move to a low nitrogen input land management system (e.g. forestry or low N input grassland). In certain aquifers with a slow response it is likely that groundwater remediation would also be needed.

Reference	GC4b
Element predicted not to achieve good by 2015	Impacts on surface water General Chemical Assessment
Reason for failure	Confirmed - Disused mines point and/or diffuse source The failures were mainly caused by metals (e.g. Lead, Copper, Zinc, Cadmium)
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The costs of the measures required to achieve good status are not proportionate to the benefits</p> <p>Remediation of all non-coal mines in this groundwater body by 2015 would rely on established technologies such as those employed at Wheal Jane in Cornwall. These technologies, whilst proven, consist of chemical dosing which is costly, energy intensive and unsustainable in the long-term. The treatment system at Wheal Jane cost over £5m to construct (almost double this in options appraisal, feasibility and design) and about £1m per year to operate. Many such schemes may be needed in each groundwater body. It is therefore likely to be disproportionately expensive to employ this treatment technology on the scale needed to meet good status by 2015. However, recent trials of innovative technologies have indicated that passive treatment may be viable and the benefits are likely to outweigh the costs. We are planning to carry out further studies to pilot these technologies in the first planning cycle.</p> <p>To meet good status by 2015 established technologies would have to be used. Therefore it is currently disproportionately expensive to meet this objective.</p>	
Investigation type	
Investigate feasible measures	
Example of investigation	
Investigate the use of innovative passive treatment technologies and their suitability for application at different sites (technology transfer)	

Possible future measures
Possible use of innovative passive treatment technologies. Recent trials of these technologies have indicated that passive treatment may be viable and cost effective. We will carry out studies to pilot these technologies in the first river basin management cycle.
Measures required to achieve 100% Good Chemical Status by 2027 that are likely to be technically infeasible or disproportionately expensive
Implementation of minewater remediation schemes for all discharges.

Reference	GC4c
Element predicted not to achieve good by 2015	Impacts on surface water
Reason for failure	Confirmed - point source land contamination The failures were due to chlorinated solvents
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The costs of the measures required to achieve good status are not proportionate to the benefits</p> <p>Although the clean-up of the pollution sources is expected to be completed by 2015, natural flushing of the groundwater pathway to the affected watercourse is expected to take several more years. In order to meet good status by 2015 extensive groundwater remediation would be needed. This could be done for example through installing pump and treat systems. Such systems are likely to cost over £1m to install and operate. These systems will also increase CO₂ emissions through additional energy consumption. In this case the additional benefits of such systems are low as the additional benefits would only accrue for a few years. It will not be disproportionately expensive to meet good status by 2021 as this can be done using lower cost conventional technologies, without resorting to a pump and treat groundwater remediation scheme.</p> <p>Therefore there an extended deadline for achieving good status of 2021 is required.</p>	
Investigation type	
Monitoring	
Example of investigation	
Groundwater monitoring to confirm that the measures are working.	
Possible future measures	
Clean-up of the source. This is expected to be complete by 2013.	

Measures required to achieve 100% Good Chemical Status by 2027 that are likely to be technically infeasible or disproportionately expensive
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None

Reference	GC5a
Element predicted not to achieve good by 2015	Surface water test General quality test
Reason for failure	Confirmed - Disused mines point and/or diffuse source The failures were mainly caused by metals (e.g. Iron)
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: disproportionate burdens
Justification for alternative objective	
<p>The costs of the measures are proportionate to the benefits but would impose a disproportionate burden if implemented by 2015</p> <p>A phased Coal Authority scheme is being implemented in this groundwater body to restore the body to good status. Treasury has agreed that the funding for these schemes will be phased over three river basin management planning cycles to 2027 due to affordability issues. To bring forward the implementation date of all these minewater remediation schemes would also cause considerable practical difficulties, for example gaining permission for, and undertaking the necessary works. This phased approach will allow time to investigate and implement the most cost effective solution in each case, and it will also allow learning to take place. Our PCEA study has shown that a phased approach is likely to significantly reduce the overall cost of the whole programme. It would therefore impose a disproportionately burden to meet good status by 2015. Achieving good status by 2027, with the highest priority sites tackled by 2015, is a proportionate and cost effective response to the problem.</p> <p>Affordability is one area where there is limited guidance available at a European level and hence additional care must be taken in justifying exemptions to ensure that they follow the spirit of the Directive and its objectives. Although the adoption of the WFD entails obligations for member states to make available the necessary means for implementation, this needs to be moderated by the option available to member states to phase the implementation (through extended deadlines) of measures to spread the costs of implementation (while taking clear and demonstrable action in the first cycle).</p> <p>To apply a time extension on grounds of affordability consideration should be given to the availability of alternative financing mechanisms, the consequences of non-action and steps taken to resolve affordability in the future. We have considered all of these factors as part of justifying this alternative objective.</p>	

Investigation type
Further investigate feasible measures and their applicability at individual sites
Example of investigation
Investigation and prioritisation of minewater remediation schemes to achieve maximum environmental benefit.
Possible future measures
Minewater remediation schemes
Measures required to achieve 100% Good Chemical Status by 2027 that are likely to be technically infeasible or disproportionately expensive
Immediate implementation of minewater remediation schemes for all discharges.

Reference	GC6a
Element predicted not to achieve good by 2015	Drinking Water Protected Area General Chemical Assessment
Reason for failure	Suspected - point and diffuse sources from agriculture and amenity use The failure was caused by the pesticides atrazine and simazine
Alternative objective	Extended deadline
Reason for alternative objective	Natural conditions - groundwater status recovery time
Justification for alternative objective	
The measures will not result in good status by 2015 but will by 2027 The pesticides causing these failures (atrazine and simazine) are now banned. These pesticides have historically been extensively used for both agriculture and amenity use. Despite the ban the groundwater body will still take a number of years to recover because of the long residence time of water within these aquifers.	
Investigation type	
Monitoring	
Example of investigation	
Groundwater monitoring to confirm that the measures are working.	
Possible future measures	
Continued monitoring. No additional measures are required.	
Measures required to achieve 100% Good Chemical Status by 2027 that are likely to be technically infeasible or disproportionately expensive	
None.	

Reference	GC6b
Element predicted not to achieve good by 2015	General Chemical Assessment
Reason for failure	Groundwater status recovery time The failure has been caused by ammonia and sulphate
Alternative objective	Extended deadline
Reason for alternative objective	Natural conditions - groundwater status recovery time
Justification for alternative objective	
The measures will not result in good status by 2015 but will by 2027 These failures have been mainly caused through over abstraction. This over abstraction has pulled deep connate water containing ammonia and sulphate into the aquifer. As several large abstractions have now ceased, we anticipate that this groundwater body will recover naturally by 2027.	
Investigation type	
Monitoring	
Example of investigation	
Groundwater monitoring to confirm that the measures are working.	
Possible future measures	
None, other than monitoring.	
Measures required to achieve 100% Good Chemical Status by 2027 that are likely to be technically infeasible or disproportionately expensive	
None.	

E6 Biological pressures (biota removal and fish stocking)

Fish removal and stocking

Fish removal for recreational, personal consumption or commercial purposes may have the potential to affect fish stocks' achieving 'Good Ecological status' (GES). Equally, sustainable cropping may be entirely compatible with GES, or an alternative objective may be appropriate where a high economic benefit is being sustained by the fish removal activities.

In most recreational fisheries it has become popular to either practice catch and release or to re-stock to maintain the fish population. Byelaws and orders can be introduced to enable the Environment Agency, or Sea Fisheries Committees, to limit fish removal and our policies are being set to ensure the Water Framework Directive (WFD) objectives are supported by this means. Many fish species have a great capacity to reproduce and support significant cropping as a sustainable catch. This capacity may often be reduced as increasing environmental pressures come to bear and thereby reduce population resilience.

Our prime commercial freshwater fisheries where fish are removed, are for salmon, sea trout and for eels and these are subject to detailed Species Action and Management Plans to sustain the stocks. 'No deterioration' can be achieved by not exceeding sustainable cropping levels. Our Salmon Action Plans and Eel Management Plans are based on these accepted principles and are designed to deliver the WFD standards.

Defra and Welsh Assembly Government have recently reviewed who should take the lead role for managing fisheries in estuarine and coastal water bodies and other marine waters. In Wales, Welsh Assembly Government will be responsible for managing sea fisheries but is likely that the Environment Agency will be asked to manage estuarine waters. In England, new inshore fisheries and conservation authorities will be set up. The Environment Agency will sit on these committees.

Sustainable fishing practices and application of controls by the Sea Fisheries Committees could ensure sustainable cropping is not exceeded, helping to achieve 'Good ecological status'. However, the near-shore waters and estuaries have been found to be important juvenile production areas for many species and their sensitivity in this context is only now becoming clearer as new science emerges.

Weed removal

Weed cutting on rivers is practised primarily for flood risk management, recreational fishery or navigation reasons. It is a common feature of chalk streams where macrophyte growth is usually very strong. Loss of channel capacity and the associated rise in water levels can pose a significant flood risk if not managed. The chalk based regions of the South and East of England are mainly where this takes place. Sustainable cropping regimes are mostly instituted to ensure the overall ecology is not harmed in what are often Protected Areas. When applied correctly the practice can enhance the resilience of the plants to flood flows and other environmental pressures. Where this is the case, alternative objectives would not be expected.

Weed removal is also widely practised in the slow flowing, often nutrient rich drainage channels common across many of our low-lying wetlands and drained areas. Their characteristics can often lead to prolific macrophyte growth, threatening both their prime purpose of drainage or wetland, but also their recreational and amenity value for fishing and navigation. In most cases drainage channels are designated as artificial water bodies, with their principal use being the drainage of water. Where macrophyte growth is affecting this

principal use, weed removal may continue within the context of achieving Good Ecological Potential; where not, then alternative objectives will be required to allow it to continue to prevent economic loss from flooding.

Weed removal is partially regulated by Water Quality regulations. Consents will be set to ensure WFD standards are achieved. Consultation with Natural England will be sought due to the SSSI and SAC designations often applying to such waters.

Weed removal in still waters is not currently regulated other than where herbicide application is consented or an impact would affect another owner or site downstream.

Determining outcomes

The impacts of biota removal and fish stocking are most likely to be noticed as changes in those elements of the biological classification that are directly affected i.e. macrophytes and fish. Excessive stocking of some species of cyprinids in lakes, might lead to a characteristic switching in community type from a clear water, macrophyte dominated community to a “muddy” water, phytoplankton dominated community. We therefore need to diagnose the effect of these pressures through symptomatic changes in biology. .

We have collated information on the ‘Reasons for Failure’ linked to the observed impacts in biological populations, as seen through the WFD classification tools. From this analysis there is little evidence that biota removal or fish stocking have a significant adverse effect. However, there is evidence of an impact of fish stocking at a few N2K sites where action will be taken.

Where we do not know why a fish or macrophyte classification is less than good, we will undertake investigative monitoring to determine the cause of the impact. If in time, we find that biota removal and fish stocking are affecting the achievement of good status we will undertake an appraisal of the costs, benefits and other impacts of the fishery or weed removal activity to determine whether an alternative objective for that water body is justified, or whether additional measures are required to achieve good status.

Priorities for Action

Statutory Measures which will happen irrespective of WFD (M2)

Fish removal:

- Salmon Action Planning (SAPs)
- ILFA (Import of Live Fish Act) consents and controls
- NLO's (net limitation orders) on commercial salmonid nets
- National ‘season’ and methods Byelaws
- European Eel Fishery Regulations

Weed removal:

- Discharge Consents on weed cutting and herbicides
- National Alien Species Strategy
- Natural England consents for most relevant waters due to SSSI designations

Other measures likely to be required (M3a, M3b and M4)

Fish removal:

- Implement SAPs stock management actions – M3a
- Consent Enforcement and NLO applications – M3a

- National Byelaw on Coarse fish removal – M3a
- Resource to implement European Eel Fishery Regulations – M3b
- National Spring Salmon Byelaws – M3a
- Signal Crayfish management Plan – M3b
- Regional Exploitation control Byelaws where required – M3b
- Marine Bill for NLO procedure improvement, privileged fixed engine regulation, emergency byelaw powers, Byelaw consents for fish removal - M3a

Weed removal:

- Resources to implement Alien Species Strategy and prompt species eradication programmes – M3b
- Weed cutting standards to be a required element of consents – M4

E7 Invasive non-native (or alien) species pressures

Introduction

Invasive non-native (or “alien”) species are not specifically mentioned in the Water Framework Directive. However, the directive requires us to assess other “significant anthropogenic impacts on the status of surface waters”. The presence of most invasive species is the result of human activity and it is widely recognised that their presence may affect ecological status. There are on-going discussions at the EU level on how best to deal with invasive non-native species within the Water Framework Directive (WFD).

In this section we explain how we have assessed what can be achieved for surface waters under the first cycle of river basin management; we also explain what can't be achieved and why.

Invasive non-native species are one of the biggest threats to the ecology of our water bodies and, even if action is taken, they may prevent us from meeting the objectives of no deterioration and good ecological status in many water bodies.

The impact from non-native species will increase over coming years as established species continue to spread. Increased trade and travel has already led to a dramatic increase in the arrival of new species into Europe, and we can expect some of these to arrive in England and Wales. Climate change may favour the spread and increase the impact of non-native species. For example, if average temperatures rise, invasive non-native species may migrate northwards from Europe. At the same time, species that are already here but presently benign, may become invasive. If native species are put under increasing pressure by climate change, then the relative impact of invasive non-native species on them might increase.

Highly invasive species are likely to become established and cause problems in any habitat in which they appear. Their propensity to spread rapidly means that prevention is generally the only effective way of dealing with problems, as once they are established, control is likely to be prohibitively expensive or technically infeasible and unsuccessful. Managing non-native plants, particularly in the early stages of establishment is more likely to be effective, but only if legislation continues to permit herbicide use in or near water. Identifying those “environmentally liable” is almost impossible. In some cases, action to control invasive non-native species through chemical, biological or physical means could cause environmental damage itself.

As an example of the invasive non-native species problem, the North American signal crayfish, *Pacifastacus leniusculus*, is established in many water bodies in England and Wales and has caused the widespread extinction of native crayfish populations. In some parts of the Thames, these crayfish have almost eliminated many larger invertebrate species and thereby have had a direct impact on ecological status. There is currently little prospect of eliminating this species. The key measure is to prevent its spread into new areas. Alternative objectives may be required for some water bodies where serious infestations already exist on the basis of both technical feasibility (no known technical solution is available) and disproportionate cost (unfavourable balance of costs and benefits).

Apart from the cost in biodiversity terms, invasive non-native species can also create a huge economic cost to a wide range of sectors, probably of the order of several billion pounds annually in Britain. For example, it is expected to cost £70 million to deal with invasive weeds such as Japanese knotweed on land destined to host the infrastructure of the 2012 London Olympics. Invasive non-native species pose a particular threat to flood risk management; invasive non-native plants may block channels and the Chinese mitten crab burrows into

flood and coastal defence works causing extensive damage. Many organisations (e.g. Highways Agency, rail authorities, local authorities, agencies, British Waterways, Rivers Trusts and others) spend millions of pounds per year attempting to control a few key species. The Environment Agency alone spends around £2 m per annum. The general public is engaged through their concern for the impacts on their fisheries and conservation interests, through its wide coverage in the media and, to a lesser extent, by becoming involved in control measures through voluntary organisations (e.g. BTCV and Wildlife Trusts).

Given that invasive non-native species have such a broad economic impact, it is particularly important that we assess the wider economic benefits that would be achieved by any invasive non-native species measures considered for river basin management plans.

The importance of this issue is reflected by the development of the “Invasive Non-Native Species Framework Strategy for Great Britain” (May 2008) by the Government (www.nonnativespecies.org). While we will ensure that this strategy will deliver WFD objectives, its scope is much broader; it covers terrestrial ecosystems and deals with the economic, conservation and health impacts of invasive non-native species.

The risk of invasive non-native species to WFD objectives

There is no environmental standard for invasive non-native species. While the presence of certain invasive non-native species is known to have an impact on ecology, their impact on ecological status as we measure it is generally unknown and unclear.

However, for a few species we do know, or can deduce, that they have an impact on ecological status and we know that the further spread of those species is likely to adversely affect ecological status. A formal assessment of the ecological impact of each invasive non-native species of concern and an assessment of the cost-effective measures for their control is a key measure that has started as part of the action plan for the “Invasive non-native species framework strategy for Great Britain”.

A summary of the WFD Article 5 risk assessment for alien species is given in Table 11 and is based on the best available data on the distribution of the ten species of particular concern. The risk assessment is a significant under-estimate of the pressure because the list of species of concern is now greater (see below) and the available data on the distribution of those species is poor.

Table 11. Summary of the Risk Assessment for Alien (Invasive Non-Native) Species

Number of water bodies at risk from alien (invasive non-native) species				
Risk Category	Lakes	Rivers	Transitional	Coastal
Number of water bodies	763	6114	135	93
At Risk	0	0	0	0
Probably at Risk	39	1205	50	43
Probably Not at Risk	380	4509	73	48
Not at Risk	0	0	0	0
Not assessed	344	400	12	2

To deal with the different levels of uncertainty identified above UK WFD Technical Advisory Group (UKTAG) have put relevant species into three groups:

- **high impact** (invasive non-native species known to be invasive and documented as causing harm);

- **low impact** (a low probability of becoming invasive and field observations over many years have indicated low impact)
- **unknown impact** (probability of becoming invasive is unknown and a full risk assessment is required).

A summary of the outcome of this process is given in table 12.

Table 12. **Summary of UKTAG high, low and unknown impact taxa.**

Impact group	Number of plant species	Number of animal species	Total
High	14	14	28
Low	9	15	24
Unknown	22	48	70
Total	45	77	122

("Revised classification of alien species according to their level of impact", UKTAG, June 2009).

This system of grouping invasive non-native species according to their risk is used to influence the classification of water bodies as follows:

"A water body will be classed as worse than high status if there is evidence that one or more species of high impact has become established over a significant spatial extent of the water body.

A water body will be classed as worse than good status if there is evidence that an alien species on the high impact list is causing the biological quality elements to deviate more than slightly from their reference conditions. The evidence used to assess whether the impacts of listed alien species are incompatible with good status will be obtained from biological quality element monitoring results where suitable data are available. Where those data are unavailable (e.g. because of the limitations of the biological classification tools), the evidence may be derived from risk analyses. In the latter case, if the risk analyses indicate that status is worse than good, the status assigned on the basis of the alien species assessment will be moderate."

We have applied this assessment using available information on the distribution of invasive non-native species. However, the result will underestimate the impact of invasive non-native species as the available data is poor in the extent of its coverage and does not consider projected risks resulting from new invasive species and changing patterns of current invasive species (e.g. further spreading etc). The availability of reliable information on the current and changing distribution of invasive non-native species would improve our confidence when we determine the reasons for failure in ecological status at a particular water body. Developing a central data repository for invasive non-native species is therefore a key measure that we have begun.

What can be achieved in the first cycle?

Early action to prevent invasive non-native species becoming established is much more cost-effective and sustainable than the long-term control of a well-established species because eradication is generally technically infeasible and/or disproportionately expensive.

By the end of the first cycle of river basin management (2015) our aim is that through concerted actions there has been no deterioration in the ecological status of water bodies due to pressure from invasive non-native species.

Therefore our planning assumptions are:

- A default objective of no deterioration.
- For Natura 2000 sites an objective of favourable conservation status by 2015 (Further details of invasive non-native species measure appraisal for these sites is located at Annex D).
- For all sites at risk of not achieving good status due to invasive non-native species we are generally setting alternative objectives (lower objectives) on the basis of technical feasibility (no known technical solution is available) or disproportionate cost (measure not worthwhile).
- Ongoing work may identify that it is possible to act on some species to improve status in some water bodies. Therefore alternative objectives (lower objectives) will be reviewed such that good status or extended deadlines are set in future cycles of river basin management.
- The main concerted effort to tackle this pressure will come through the 'Invasive Non-Native Species Framework Strategy and Action Plan for Great Britain' (May 2008). Our activity will be within the scope of this framework.
- We commit to the concerted actions under the Invasive Non-native Species Framework action plan that we are certain will benefit the ecology of aquatic ecosystems.

Outline measures

Given the nature of the invasive non-native species, actions taken in isolation at a water body scale are unlikely to work (due to re-invasion from elsewhere) unless they are part of a concerted national effort. So all of the measures for invasive non-native species in river basin management plans (including M4 measures) sit within the Invasive non-native species action plan for Great Britain and many of the measures below will be delivered by that action plan.

Measures

- The GB Programme Board will commission standard risk assessments to identify the highest impact species (published at <http://www.nonnativespecies.org/>) and identify priority invasive species for mitigation and control action at GB and/or national levels
- Through the use of working groups or lead bodies draw up Individual Species Action Plans for species identified as presenting particular risk levels, to minimise the risks associated with them
- Make appropriate use of existing legislative powers, for example, to prohibit the sale of species which present the highest risk. (other examples: Salmon and freshwater fish act (S30); Import of live fish act; Environment Agency Fisheries byelaws; Convention on biological diversity; NERC Act; Habitats Directive; IMO convention on ballast water)
- Establish a central repository for holding data on invasive non-native species distribution and ensure that data flows on to it.
- Draw together a database of projects to facilitate better information sharing and to make the best of opportunities for partnership working and other resource synergies
- Contribute to the development of any EU level initiatives to improve legislation and controls relating to the threat posed by invasive non-native species
- Set up and maintain a website on invasive non-native species issues which links to agencies, NGOs and others working on invasive non-native species. This will form a key source of information on governmental action and progress, and on other programmes and initiatives taking place within GB
- Increase awareness of the importance of the 'preventative approach' in addressing the threats posed by invasive non-native species
- Continue to raise awareness with the public of the risk of transferring non-native species accidentally

- Establish National Invasive Non-Native Species Forums to plan, prioritise and coordinate action.
- Develop a national early warning system with contingencies for rapid response control measures to eradicate new invasions
- Integrate invasive non-native species control measures across all policy areas
- Provide advice and training on identification, control and disposal of invasive non-native species to all relevant groups
- Develop and implement codes of practice to reduce the spread of invasive non-native species caused incidentally by the practice of all relevant sectors (e.g. Code of practice for the management of Japanese Knotweed on development sites)
- Reduction of extent of invasive non-native species by operations (e.g. FRM maintenance programme; other direct works either alone or in partnership with others; reduction in N and P by water quality programme; PSA targets; UKBAP)
- Seek sustainable and cost-effective methods for managing established invasions, such as biological control.
- Support established local fora by providing advice and guidance

Additional measures for 2009

Additional measures have been funded for the period June 2009 to March 2010 as follows:

- Research into novel control methods
- Eradication and control at selected SSSIs and Natura 2000 sites
- Control and eradication of topmouth gudgeon (*Pseudorasbora parva*), the African clawed-toad (*Xenopus laevis*), fathead minnow (*Pimephales promelas*) and water primrose (*Ludwigia grandiflora*) at selected sites
- Local trials to control floating pennywort (*Hydrocotyle ranunculoides*)
- Work to raise awareness of the issue amongst the public and target groups
- Control actions by selected local fora

Measures excluded.

Once established, it is not technically feasible or it is disproportionately expensive to control some invasive non-native species in the wider environment (although intensive and expensive measures may be considered to be feasible and not disproportionately expensive at protected areas where the benefits are greater).

For example, using existing methods it is technically infeasible (no known technical solution is available) to control signal crayfish at sites where they are established.

Research has estimated that in Wales alone, it will cost £76 million for an eradication programme for Japanese knotweed using existing methods. There is a high risk that the programme would have been unsuccessful and the benefits in terms of delivering good ecological status are unclear. So this is considered disproportionately expensive (unfavourable balance of costs and benefits).

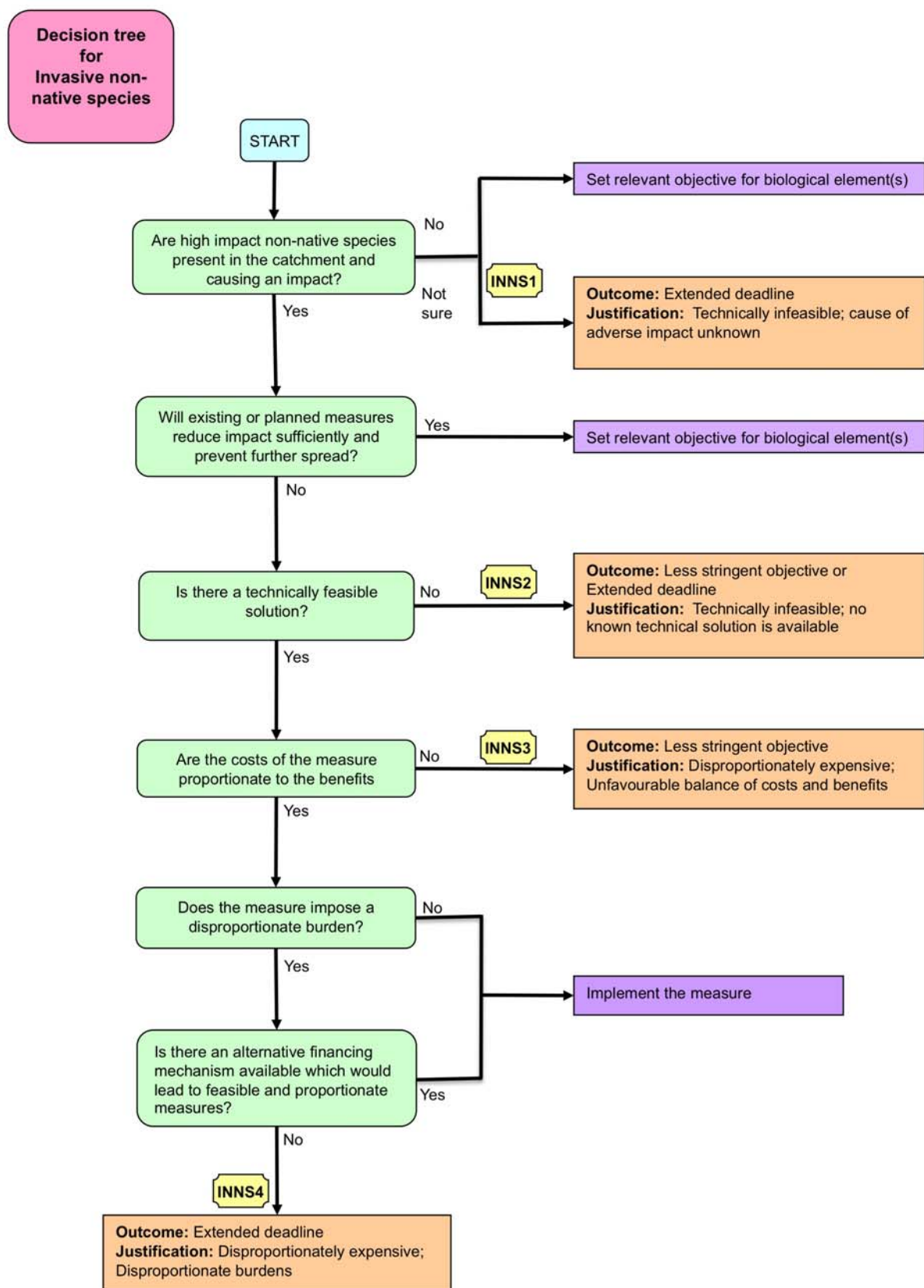
However, we will seek opportunities to encourage, or support, collaborative research into novel control methods (such as biological control agents).

Setting objectives for individual water bodies

The measures outlined above are, with few exceptions, strategic actions at the national or regional scale as this is the only efficient and effective way to deal with this pressure. However, objectives have to be set at the water body scale.

The decision tree below outlines how we will make decisions on what objective to set for individual water bodies, where we have information on invasive non-native species.

The starting point is an initial assessment of the species present and the impact they are causing on ecological status. Currently, we have this information available for very few water bodies. This is because, until we had undertaken the risk assessment and other work in preparation for the WFD, we had not appreciated the nature of the pressure and its likely impact on ecological status. Therefore, it will be a priority to improve the information base over the first cycle of the river basin management plan; improved information on the distribution of species will come from our own monitoring and data collected by the GB Strategy data repository; improved information on the impact will come from an analysis of our own biological data and that has begun.



Reference	INNS1a
Element predicted not to achieve good by 2015	Biological elements
Reason for failure	Suspected – Alien Species
Alternative objective	Extended Deadline
Reason for alternative objective	Technically infeasible – cause of adverse impact unknown
Justification for alternative objective	
<p>Low confidence that the high impact invasive non-native species present in the catchment are causing an impact</p> <p>High impact invasive non-native species are present in the catchment, but it is not known whether or to what degree they are having an impact and causing the biological element(s) to be at less than good status.</p> <p>Until the impact of the invasive non-native species can be confirmed, the identification and application of additional measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>The biological tools to assess good ecological status have only just been developed. Our understanding of how and to what degree the presence of invasive non-native species in a catchment impact on the biological elements of ecological status is not yet well developed. We have already started R&D work to improve our understanding and diagnosis techniques (see below).</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm that established invasive non-native species are causing the observed impact and to identify and implement measures.</p>	
Investigation type	
Investigate to confirm the cause of the impact	
Example of investigation	
Initially, we will undertake R&D to develop a method of using data from existing monitoring programmes to characterise the impacts of high-risk invasive non-native species; if successful this will allow better diagnosis of the problem at a local level. We have demonstrated the impact of the Signal Crayfish on the River Kennet taking this approach.	

If this approach is unsuccessful, we will undertake scientific monitoring designed specifically to detect the impact of particular species; this may include field experiments involving manipulation of the densities of invasive non-native species or their exclusion.

Possible future measures

There are only a few technically feasible methods for removing established populations of most of the invasive non-native species. These include application of biocides, mechanical removal and biological control agents. Many of these techniques have limited effectiveness, and in some cases will not be cost beneficial because of the negative impact they have on other species, or their use is not acceptable to interested stakeholders.

Research is being undertaken into more cost effective control techniques including the identification and testing of biological control agents (e.g. for Himalayan balsam and giant hogweed) and trials of the mechanical removal of floating pennywort.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Uncertain until we understand the cause of the adverse impact.

Reference	INNS2a
Element predicted not to achieve good by 2015	Biological elements
Reason for failure	Confirmed – Alien Species
Alternative objective	Extended Deadline
Reason for alternative objective	Technically infeasible – no known technical solution is available
Justification for alternative objective	
<p>There is no effective method of control or eradication available for some established non-native species.</p> <p>Established invasive non-native species are likely to be causing the biological element(s) to be at less than good status but no known technical solution is available. Because no technical solution is available it is not technically feasible to achieve good status by 2015.</p> <p>As an example, Signal crayfish <i>Pacifastacus leniusculus</i>, is established in many water bodies in England and Wales and has been shown to drastically reduce the abundance of many larger invertebrate species and thereby has had a direct impact on ecological status. Intensive trapping of Signal crayfish in rivers has been shown to be ineffective or even harmful; biocide may be effective in eradicating new populations locally to limit their spread but its application is restricted due to site-specific issues such as drinking water supplies and livestock watering; R&D indicates that the use of crayfish pheromones does not make trapping a more effective control method.</p>	
Investigation type	
Investigate technically feasible solutions	
Example of investigation	
<p>R&D to seek sustainable and cost-effective methods for managing established invasions. This type of research generally has a high to moderate risk of failure. Recent research has identified a host-specific biocontrol agent for (the bug <i>Aphalara itadori</i>) Japanese knotweed (<i>Fallopia japonica</i>) that, subject to Government approval for its release, could reduce the impact of Japanese knotweed.</p> <p>Research is being undertaken to identify and test further biological control agents (e.g. for Himalayan balsam (<i>Impatiens glandulifera</i>) and giant hogweed (<i>Heracleum mantegazzianum</i>)) and to trial the mechanical removal of floating pennywort (<i>Hydrocotyle ranunculoides</i>).</p>	

Possible future measures
Sustainable and cost-effective methods for managing established invasions.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
No known solution is currently available.

E8 Morphology pressure

Introduction

Hydromorphology is a term used in the Directive to describe, in combination, the hydrologic and geomorphological processes and attributes of rivers, lakes, estuaries and coastal waters. For rivers, hydromorphology considers not only the form and function of the channel but also its connectivity, which defines its ability to allow upstream and downstream migration of aquatic organisms and maintain natural continuity of sediment transport through the fluvial system. The Directive requires surface waters to be managed in such a way as to safeguard their hydrology and geomorphology so that ecology is protected. In doing so, the Directive recognises the key role water resources and habitats play in supporting healthy aquatic ecosystems.

This section deals with the morphology and continuity (or connectivity) aspects of hydromorphology. Details of the methods and standards used to risk assess morphological pressures and to designate and classify water bodies as artificial or heavily modified can be found in Annexes G, I and A are also available on the UKTAG website (<http://www.wfduk.org/>)

The purpose of the section is to detail the approach we have taken to the identification and planning of morphological improvement measures and subsequent objective setting process for surface water bodies.

Current data quality and availability

Water bodies have been risk assessed for pressures on morphology and subsequently designated as artificial and heavily modified using nationally available datasets. These datasets provide information on both direct modifications to water bodies (i.e. presence of modifications for flood protection purposes using the Environment Agency's national flood and coastal defence database, NFCDD) and on wider catchment scale pressures (i.e. areas of intense urbanisation derived from wider land use datasets).

The designation process, detailed in Annex I, looks at all modifications that affect the water body. Considering the scale and number of water bodies and available data it is not at present possible to provide detail of individual modifications to each water body.

For the river basin management plans, all designations and classifications have been reviewed by local Environment Agency staff who are familiar with each water body. Where possible, they have been discussed with other bodies for example, Internal Drainage Boards, the Ports and Inland Navigation Sector and Water Companies.

Currently, data on hydromorphological quality and associated pressures and impacts can be found in a number of Environment Agency national and regional datasets. A common attribute of most of these databases is that the data is not arranged in a manner that is sympathetic to WFD requirements. This makes assessing the status of a water body difficult particularly from the hydromorphological perspective.

There is also a range of data that is held outside of the Environment Agency. For example a number of operators such as local authorities, Internal Drainage Boards, British Waterways and Water Companies hold data on engineering assets managed for flood risk management, navigation or water supply/storage purposes. The coverage and availability of such data varies across from organisation to organisation and where possible we utilised such data when undertaking water body assessments.

We have already initiated a project to develop a centralised and fully supported database for all morphological data for delivery within the first cycle of river basin management.

Evidence base for morphology

The Environment Agency has reviewed the scientific evidence for linking specific hydromorphological pressures to ecological impacts for rivers, lakes and transitional and coastal waters

These reviews reveal some difficulties in attributing ecological impacts to particular hydromorphological changes. The impacts of a change are often complex and depend not just on the nature of the modification but also on the aquatic environment – so the same modification in different sites is likely to result in different ecological impacts. In addition, impacts might be felt a considerable distance from the site of the modification, and/or some time after the modification takes place, and the cumulative effects of different impacts are not always clear and are unlikely to be simply additive.

The risk assessment and designation process are based on the spatial extent of modification within a water body or adjacent land, and assumes a direct link between pressure and risk of failure. However there is uncertainty, resulting from limited scientific evidence, about the specific impacts that morphological pressures have on biology. This results in uncertainty in the extent to which these pressures (and associated measures) are relevant in terms of achieving Water Framework Directive objectives.

The Environment Agency has already started to work with stakeholders to improve the evidence base in the first river basin management cycle and are developing a number of catchment trials and pilots to:

- trial the effectiveness of restoration and mitigation measures
- collect additional data to determine cause and effect relationships between pressures and impacts on biology
- develop mechanisms to plan and deliver measures through catchment based partnerships.
- investigate the benefits and other impacts of mitigation measures

These investigations, details of which are provided under the programmes of measures in Annex C, will enable us to focus those measures where we have high confidence that they will deliver improvements to ecological status or potential.

Whilst this is a long term activity it is expected that significant progress will have been made in time to support morphological assessments and programmes of measures for the second cycle of river basin management planning.

Designation of artificial & heavily modified waters

In some cases where the hydromorphology of a water body has been physically altered it may be difficult for the water body to meet good ecological status. If, in order to achieve good status, it would require changes to a water body's hydromorphology that would have significant adverse effects on the water body 'use' i.e. the social or economic activity responsible for those modifications, then it can be designated as artificial or heavily modified (UKTAG, 2008). The WFD also requires that the current 'use' cannot be provided by a significantly better environmental option.

Relevant 'uses' and human activities are defined as navigation (including port facilities, or recreation), activities for the purposes of which water is stored (such as drinking-water supply, power generation or irrigation), water regulation, urbanisation, flood protection, land

drainage, the wider environment (e.g. sites designated for conservation), and other important sustainable human development activities.

In England and Wales a two-stage approach has developed to apply the Article 4(3) tests to those water bodies provisionally identified as artificial water body or heavily modified. The two stage process followed the principles outlined in the Common Implementation Strategy guidance document no.4 (European Commission, 2003). The process comprised of a rapid designation of 'obvious' artificial and heavily modified water bodies and a further detailed assessment of those water bodies that could not be designated in the rapid designation stage. Full details of the methods used to designate water bodies as artificial or heavily modified can be found in Annex I.

A core part of the designation process involved assessing if restoration to good ecological status would impact on water body use and whether water body modifications associated with the use represent the best environmental option. Such assessments were undertaken within the constraints of the available data and evidence. Given these data and evidence limitations a number of principles were adopted:

- 1) Designation has been based where possible on existing asset data. For example, for flood risk management activities, the Environment Agency's National Flood and Coastal Defence Database has been used. The assumption is that all assets contained within this dataset provide a current 'use' i.e. they contribute to flood protection.
- 2) During the designation process, where modifications were extensive and deemed significant then it was assumed that restoring the water body to GES would have a significant adverse impact on the use and benefits provided by these modifications. In many cases the exact ecological benefit/s of whole scale removal or alteration of modifications are uncertain and the costs of undertaking such activities are likely to be disproportionately costly.
- 3) Assets built in more recent times which were subject to requirements to assess environmental implications generally provide the 'best environmental option'. For example all flood and coastal risk management (FCRM) schemes are subject to assessment under the Environmental Impact Assessment (EIA) Regulations therefore ensuring that the best environmental option is promoted. Work is being undertaken to update EIA regulations and FCRM project appraisal guidance to take account of new WFD requirements to ensure all future activities take full account of water body status and objectives identified in the river basin management plans.
- 4) Through a programme of trials and data collection the hydromorphological evidence base is being developed. As results emerge, action will be taken to implement measures which are shown to have ecological benefits and which are not disproportionately costly. This investigation work will further ensure that limitations are addressed in time for the review of artificial and heavily modified water body designations required for the second cycle of river basin management.

Identification of good ecological potential for artificial & heavily modified waters

To determine the ecological potential of artificial and heavily modified water bodies the Environment Agency has applied the methodology²⁴ recommended by UKTAG²⁵.

²⁴ http://www.wfduk.org/tag_guidance/Article%2011/POMEnvStds/gep_guidance_final

²⁵ The UK Technical Advisory Group on the Water Framework Directive established by the UK government administrations and comprising representatives from SEPA, the Environment Agency, the Northern Ireland Environment Agency, SNH, Natural England, Countryside Council for Wales and the Department for the Environment & Local Government in the Republic of Ireland.

The methodology is based on an approach known as the 'alternative approach' by UKTAG²⁶. This approach was agreed between Member States and the European Commission under the Common Implementation Strategy for the Water Framework Directive²⁷. More details on the method can be found in Annex A and the supporting document at <http://www.wfduk.org/UKCLASSPUB/>.

It has not been possible to differentiate between water bodies whose hydromorphological characteristics are consistent with good ecological potential and those whose characteristics are consistent with maximum ecological potential. Consequently, the hydromorphological characteristics of such bodies are identified as being consistent with 'good or maximum' ecological potential collectively. The Directive does not require these classes to be differentiated for reporting purposes.

This 'alternative approach' will be reviewed and updated for each river basin management planning cycle as methods and understanding improve. The reviews will take account of experience of applying the guidance, information from environmental monitoring programmes, research projects on the impacts resulting from physical modifications, and information on the effectiveness and practicability of different mitigation measures.

The decision on where measures are applied within water bodies is not part of the classification process; this is addressed as part of the programme of measures and the wider river basin management planning process.

Identification and development of measures

A review has been undertaken of the range of restoration and mitigation measures to address hydromorphological pressures. This includes both catchment and water body or sub-water body scale measures. Relevant measures have been incorporated into a morphology measures toolkit containing information on the range of measures options available and details of estimated scale of effect, ecological benefits, & cost- effectiveness. This toolkit has assisted with the prioritisation of measures for promotion in the first river basin management cycle (up to 2015) and will be employed in future river basin management.

The toolkit has three components:

- Pressures: This contains a list of hydromorphological pressures, and the measures that are likely to help mitigate the impacts of these pressures.
- Measures: This worksheet contains a list of specific measures, each of which is accompanied by a brief description. Measures are grouped into 11 broad categories, see table below.
- Evaluation tool: This worksheet contains a detailed description of each measure and an assessment of their effectiveness in delivering hydromorphological improvements.

Details of broad measures categories and specific measures and potential measure categories (M1 – M4) are provided in table 13.

²⁶ This is an alternative to that identified in CIS guidance. The alternative approach is considered less uncertain and more pragmatic than the more theoretical CIS approach

²⁷ http://circa.europa.eu/Members/irc/env/wfd/library?!=/framework_directive/thematic_documents/hydromorphology/technical_reportpdf/EN_1.0_&a=d (please note you will be asked to create an account when you first access this site)

Table 13: **Broad measures categories and specific measures for addressing hydromorphological pressures (from Environment Agency Morphology measures toolkit)**

Measure type	Specific measure	Description [inc. measure category, M1, M2, M3, M4]
Working with Physical Form and Function	Removal of hard engineering structures (e.g. naturalisation)	Remove existing hard structures (e.g. concrete bank protection, concrete beds, sea walls) to allow natural processes to re-establish [M3a, M4]
	Managed Realignment of flood defences	Breach, remove or set back existing flood defences and allow previously defended areas to become inundated, recreating coastal and estuarine flood zones and/or restoring connectivity with floodplain [M3a]
	Managed Retreat	Allow the coastline to erode naturally (applies to defended and undefended coastline) [M3b]
	Recreate a sinuous river channel (re-meandering)	Recreate a sinuous channel in artificially straightened river reaches to provide an approximation of a natural planform [M3b]
	Narrow over-wide channels	Instigate narrowing of over-wide channels using structures and/or vegetation to encourage sedimentation along channel margins [M3b]
	Create low flow (2-stage) channels in over-widened/over-deepened channels (increase morphological diversity)	Create low-flow channel in over widened channel (could be meandering, through use of deflectors) [M3b]
	Reconnect and restore historic aquatic habitats	Reconnect cut off meanders and abandoned secondary channels to increase water conveyance and habitat quality, and restore backwater habitats by removing encroaching vegetation [M3b]
	Recreation of gravel bars and riffles using permanent and/or temporary bed structures (increase morphological diversity)	Install structures to encourage sediment accretion and localised diversity in channel bedforms [M3b]
	Bank reprofiling (rehabilitation)	Reduce bank slopes to reduce erosion, encourage stabilisation and improve marginal habitat [M3a, M3b, M4]
	Cliff reprofiling	Reduce angle of cliff slope to reduce erosion, encourage stabilisation and improve marginal habitat [M3b]
	Beach reprofiling	Modify profile of beach [M3b]
	River bed raising or lowering (regrading)	Regrade bed to raise levels in over-deepened channels or lower levels in over-widened channels [M3b]
	Beach Recharge	Introduce sediment (e.g. from dredging) to areas where erosion is a problem [M3b]
	Replenishment of mobile sediments	Introduce sediment from the mobile load (fine sediments, gravel), e.g. to recreate bars and riffles [M3b]
	Adopt strategic options and policies promoting natural recovery	Apply policies to encourage natural recovery of water bodies (e.g. promote removal of unnecessary structures) [M3a]

Measure type	Specific measure	Description [inc. measure category, M1, M2, M3, M4]
	Use of engineering techniques to assist natural recovery	Assist natural recovery of water body with use of sympathetic engineering techniques (e.g. replacement of hard defences) [M3a, M3b]
Structural Modification	Replace existing structures with new structural designs to minimise impact hydromorphological impact (avoid like for like)	Use improved design when replacing structures (e.g. use clear-span bridges instead of piered structures) [M3a]
	Replace hard defence with soft engineering	Replace existing hard structures with soft / bioengineered solutions [M3a, M3b, M4]
	Modify existing structures	Modify existing structures to reduce pressure (e.g. add culvert, reverse sluice, lower defence, alter dimensions, change orientation or profile) and/or to allow free passage of wildlife [M3b, M4]
	Construct breach or spillways	Install structures that allow controlled release of water through existing defences [M3b]
	Implement Tidal Exchange Systems	Insertion of pipes in sea defences to allow controlled exchange of tidal water with the purpose of increasing elevation of land behind defences [M3b]
	Reinstate natural outfall level	Allow release from impounding structures once water reaches natural level of outfall [M3b]
	Install fish pass	Install fish pass to allow free passage around structure [M3b]
	Use soft engineering techniques	Use soft engineering techniques instead of hard engineering (e.g. timber piling, coir matting, willow mattresses, fibre rolls, grassed composites, fabric cell revetments with pockets for vegetation establishment, and open cell lattice revetments with gaps for planting) [M3b]
Operations and Maintenance	Cessation of maintenance	Cease maintenance of structures to allow natural conditions to develop [M3b]
	Develop/review appropriate dredging strategy (timing, selective dredging, phasing, extent, technique)	Develop dredging strategy that minimises hydromorphological damage [M3a]
	Develop/review appropriate vegetation management plans	Develop vegetation management strategy that minimises hydromorphological damage [M3a]
	Change technique to manage and minimise disturbance to morphology (access and operation)	Minimise damage by adopting controlled management procedures for all works on water body (e.g. limited access points, working from one bank only, use of floating pontoons whilst recharging sediment, use of silt curtains and low turbidity suction dredgers whilst dredging, and use low-impact vegetation management techniques such as hand picking, selective cutting, boat-mounted apparatus, and long-reach excavators) [M3a]
	Retain marginal vegetation	Retain habitats in marginal zones to reduce erosion and maintain bank stability [M3b, M4]

Measure type	Specific measure	Description [inc. measure category, M1, M2, M3, M4]
	Control or eradicate invasive species causing hydromorphological impact	Remove non-native invasive species that can cause hydromorphological as well as ecological damage (e.g. signal crayfish and Japanese knotweed cause structural damage; Himalayan balsam and giant hogweed enhance winter erosion). Allow natural recovery, or assist natural recovery, e.g. by spraying seed mix on cleared areas [M3a]
	Install silt, sand or gravel traps	Remove excess sediments through use of suitable sediment traps [M3a, M3b, M4]
	Strategic placement of dredged material (e.g. creation of shallow water zones or gravel bars)	Use dredged materials to improve hydromorphological quality (e.g. creation of shallow water zones or gravel bars) [M3b, M4]
	Phased dewatering of navigation channels whilst maintenance takes place	Drain non-adjacent sections prior to undertaking maintenance works to minimise morphological and ecological impacts (phased dewatering) [M3b]
	Change operational regime of weirs and locks	Restore more natural discharge regime (natural variations to rainfall rather than controlled variations), e.g. by opening locks and weirs [M4]
Land management	Removal of stock	Remove livestock from areas of concern - use of a carefully chosen 'sacrifice field' where damage will have the least impact [M3b, M4]
	Reduce stocking densities	Reduce numbers of livestock in areas of concern or during wet conditions to limit damage to soil structure and reduce sediment yield [M3a]
	Reduce grazing time (daily and/or over the season)	Limit grazing time in areas where erosion or soil compaction may be a problem [M4]
	Introduction of stock-proof fencing (reduce bank side erosion)	Reduce bank erosion by restricting livestock access [M3b]
	Improve river crossings for livestock and farm access	Reduce damage to water body by installing bridges for livestock and farm machinery [M4]
	Establish/relocate feed and water troughs to reduce erosion	Create drinking ponds to provide livestock with water and reduce trampling of river and lake banks [M4]
	Cultivate land for crop establishment in spring rather than autumn	Cultivate land early to minimise erosion and establish ground cover in winter [M3a]
	Adopt minimal cultivation systems	Establish crops which require minimal cultivation, to minimise soil erosion, runoff generation and compaction by farm machinery [M3b]
	Cultivate and drill across slope	Cultivate in line with contours to reduce channelling of runoff [M4]
	Leave autumn seedbeds rough	Leave rough vegetation to protect seedbeds which are vulnerable to erosion [M4]
	Avoid tramlines over winter	Avoid use of tramlines in arable fields to minimise erosion during the winter, e.g. by cultivating winter cereals without the use of tramlines or by establishing paths for spraying once the crops have become established [M4]
	Loosen compacted soil layers	Break up compacted soil to increase infiltration and reduce surface runoff and sediment yield [M4]

Measure type	Specific measure	Description [inc. measure category, M1, M2, M3, M4]
	Establish in-field sediment buffer strips	Leave uncropped areas (grass or natural vegetation) as a barrier to surface water and sediment runoff [M3b]
	Cease maintenance of field drainage systems	Allow sediment and vegetation to build up in field drainage systems to reduce conveyance to water bodies [M3a]
	Re-site gateways away from high-risk areas	Move gateways away from areas where soils erosion, compaction and runoff are problems [M4]
	Re-route informal vehicle and livestock access ways across slope	Move pathways across slope to minimise erosion through creation of downslope flow pathways [M4]
Water Management	Introduce minimum flow limits	Prevent flows falling below a specified level (below which hydromorphological quality may be impaired) [M4]
	Introduce compensatory flows (not just at low flow levels)	Maintain flow levels by introducing flow from other water bodies [M3a]
	Regulate abstraction and discharge	Regulate abstraction and discharge to maintain flow regimes and avoid unnecessary high or low flows [M3a]
	Reduce abstraction	Encourage use of efficient sustainable irrigation systems and raw water storage areas [M1]
	Implementation of SUDS	Implement Sustainable Urban Drainage Systems - permeable rather than impermeable surfaces, buffer strips to manage runoff, etc. [M3a, M3b, M4]
	Establish and maintain artificial (constructed) wetlands for use as sediment traps	Create areas of wetland vegetation in suitable areas to help retain sediment and associated contaminants (grants available for farmers) [M3a]
	Water efficiency planning (domestic, business, industry, agriculture)	Improve efficiency of water usage - limit abstraction and maintain river flows [M3a]
Habitat Creation	Introduce riparian vegetation/green corridors	Introduce riparian vegetation to reduce water and sediment in wash, provide shade, introduce organic material and provide habitat [M3b]
	Introduce lakeside vegetation	Introduce lakeside vegetation to reduce water and sediment inwash, provide shade, introduce organic material and provide habitat [M3b]
	Encourage saltmarsh recovery	Encourage recovery of saltmarsh vegetation to protect coast from erosion [M3b]
	Create reed fringes	Create reed fringes around water body to dissipate wave energy and reduce erosion [M4]
	Create compensation habitats	Create habitats to replace those that are lost or damaged, e.g. aquatic, riparian, offline pond (with no direct connections to other water bodies) [M3b]
	Create shallow margin in front of hard defence	Create shallow margin habitats in front of existing defences using soft engineering techniques/double row piling to encourage vegetation in slow flow areas [M3b]

Measure type	Specific measure	Description [inc. measure category, M1, M2, M3, M4]
Development Control and Planning	Update policy and process guidance to take account of morphology	Ensure that existing guidance and instructions are updated in order to avoid or minimise hydromorphological impacts [M3a]
	Limit further development of the bank and/or near-shore zone	Limit new development in areas adjacent to a water body, to minimise hydromorphological pressures and impacts [M3b]
	Avoid or limit development in the floodplain	Prevent unnecessary floodplain development to minimise hydromorphological pressures and impacts [M1]
	Regulation of in-channel structures	Regulate construction, maintenance and operation of in-channel structures, to minimise hydromorphological pressures and impacts [M1]
	Regulation of development in the marine environment	Regulate development in the coastal and marine environment to minimise hydromorphological pressures and impacts [M1]
	Develop and apply a set of General Binding Rules for riparian/lakeside landowners	Develop and apply General Binding Rules, covering best practices for all riparian agricultural activities (livestock and agriculture) [M3a]
Navigation	Encourage reduction of boat wash impacts through traffic management in sensitive areas	Restrict access in sensitive areas or at sensitive times, e.g. by setting annual movement limits
	Limit number of mooring permits available	Employ limits to reduce no of vessels mooring to reduce pressure
	Restrict speed	Introduce speed limits to reduce morphological damage, e.g. from boat wash. Should be 3mph in most constricted and sensitive areas
	Lateral zoning to concentrate boats within a central channel	Confine boats to centre of channel to reduce boat wash effects on banks, e.g. through use of marker posts or buoys
	Avoid or prevent mooring in sensitive areas	Careful planning of mooring facilities to avoid and/or prevent sensitive sites [M4]
	Design moorings for ecological benefit	Employ design to promote ecological benefit and reduce impacts of scour [M3b]
	Encourage use of environmentally friendly vessel design	Introduce shallow draft vessels with shrouded props, modified hulls and speedometers to reduce the hydromorphological impacts of boat movement [M4]
Science	Improve understanding of responses to hydromorphological pressures	Undertake research into the hydromorphological responses resulting from land management pressures [M3a]
	Trial existing mitigation measures	Undertake trials and pilot studies of suitable mitigation measures and monitor effectiveness [M3a, M4]
	Develop and trial new mitigation measures	Use research to inform the development of mitigation measures [M3a, M4]
Monitoring and Appraisal	Hydrological Monitoring	Monitor flow characteristics in rivers, lakes, estuaries and coasts, to identify trends and improve modelling capabilities [M3a, M4]
	Morphological Monitoring	Monitor water levels in rivers, lakes, estuaries and coasts, to identify trends and improve modelling capabilities [M3a, M4]
	Hydrological Appraisal	Monitor changes in shoreline patterns [M3a, M4]
	Morphological Appraisal	Monitor sediment composition - particle size distribution, sources, etc. [M3a, M4]

Measure type	Specific measure	Description [inc. measure category, M1, M2, M3, M4]
Education	Education on use of guidance	Training for regulators and developers on correct use of guidance notes [M3a, M4]
	Education on identifying opportunities for delivering mitigation measures	Training for regulators on identification of opportunities for hydromorphological improvement within new developments [M3a, M4]
	Educate landowners on sensitive management practices	Educate landowners on hydromorphologically-sensitive management practices, possibly with reference to existing guidance (Environment Agency 2003 <i>Best Farming Practices: Profiting from a good environment</i> Defra 2005 <i>Controlling soil erosion</i>) [M3a]
	Education and awareness raising of impacts of navigation	Information to raise awareness of impacts of bankside, shoreline, offshore activities to water body users [M3b]

Planning and delivery of measures

The Environment Agency and other organisations already undertake a range of activities that contribute to the delivery hydromorphological improvement measures. Examples include current flood risk and coastal management activities, water resources management and involvement in a wide range of catchment and local habitat restoration activities.

Mitigation measures that would contribute to delivery of good ecological status or potential have been identified and prioritised in current Environment Agency capital programmes.

The Environment Agency's Medium Term Plan (MTP) identifies actual and projected spending on Flooding and Coastal erosion Risk Management (FCRM) projects over a rolling five-year period. The MTP provides a means of identifying funded projects that will incorporate mitigation measures into the project design and final construction phase. Information about the schemes identified in the MTP was used to identify where water bodies may benefit from these mitigation measures and where ecological classification may be improved.

This 'mitigation measures' alignment exercise focuses on:

- River, coastal, estuarine and lakes water bodies that were designated as either heavily modified or artificial and were failing good ecological potential due to mitigation measures not being in place.
- MTP (schemes with funding allocation for years 2009 to 2012).
- MTP schemes that will provide the mitigation measures identified in the classification process as currently 'not in place'.
- Schemes involving the replacement or enhancement of existing assets, rather than new schemes.

This process has identified over 400 mitigation measures, within 67 water bodies that will be in place as a direct result of FCRM funded schemes over the next three or so years. These schemes will help improve the ecological quality of water bodies currently classified as Moderate Ecological Potential (ModEP) or poorer and progress the objective of achieving Good Ecological Potential (GEP).

It is the intention that these planning mechanisms will be fully aligned with the river basin management planning process from cycle 2 onwards.

The Environment Agency has also worked with other organisations, for example the Association of Rivers Trusts (ART) to identify relevant improvement measures that are being undertaken by others to ensure these contribute to the delivery of water body improvements. We will continue to work with partners to identify and align these measures during the first cycle of river basin management.

It is not always possible to identify who should take action to achieve the objective of good ecological status or potential. For example, where we have historic structures or activity where it is no longer clear who was involved and/or who was legally responsible. This is especially difficult where the structures were put there legally under a different legal and regulatory regime, perhaps even required by Government; and/or where the ownership or use of the structure has changed over time. As many past damaging activities were delivered and funded through legally compliant schemes, and as it is difficult to identify responsible parties, it is unlikely that reliance on the 'polluter pays' principle will deliver the extent of restoration works necessary to comply with the requirements of the Directive.

The Environment Agency is currently working with Defra & Welsh Assembly Government to address any “gaps” in existing legislation which were identified during the Defra & Welsh Assembly Government consultation ‘Mechanisms to deliver Water Framework Directive requirements on hydromorphology’, (December 2007). These include proposals for a power to restore the morphology condition of surface water bodies.

Objective setting

The following assumptions have been made when setting objectives for morphology:

1. Where a water body is currently classified at good ecological status or potential then it will have a predicted outcome of good ecological status or potential by 2015.
2. Where a water body is currently classified at moderate ecological status/potential or below and measures have been identified from the above activities and programmes that are planned and funded and assessed as taking the water body to good ecological status/potential, then these have been given objectives of good ecological status or potential by 2015.
3. Where a water body is currently classified at moderate ecological status/potential or below and no measures have been identified from the above activities OR those that have been assessed as not enough to achieve good ecological status/potential by 2015, then these have been given an objective of good status/potential by 2027, the justification for this extended deadline is outlined below.

The decision tree below provides details of the decisions made for determining water body objectives for morphology. It explains how the extended deadlines to reach good ecological status or potential have been assigned to water bodies and the justification behind these decisions. This applies to all water bodies including those that are artificial or heavily modified. The decisions are based on identified reasons for failure; these reasons are related to the pressures which are preventing the water body from reaching good. As hydromorphology is often controlled by a complex set of interrelating pressures some water bodies have more than one reason for failure.

In some cases it will not be possible to achieve good ecological status or potential even if all morphological improvement measures and/or mitigation measures identified are in place. For example other pressures such as diffuse pollution may be preventing achievement of the required ecological status. And without action to address these other pressures, good ecological status/potential will not be achieved. Actions will be taken to tackle the other pressures such as diffuse pollution.

The evidence base for hydromorphology needs to be improved and therefore uncertainty plays a key role in justification of measures, examples can include uncertainty over:

- the exact ecological impact of the particular pressure
- the source of the morphological pressure
- the effectiveness of the measure

In these cases further investigation will be required to reduce this uncertainty so that we can improve our confidence in some measures in time for the second cycle of river basin management.

Setting objectives on the basis of an extended deadline allows improvements to be prioritised over successive planning cycles whilst not imposing disproportionate burdens on those who have to pay for them. Further investigation during the first cycle of river basin management will provide more information on the cost and benefit of measures. Improving the evidence base will also give us greater confidence in the applicability and effectiveness (technical feasibility) of improvement measures.

The implementation of morphological measures will be based on the consideration of:

1. the confidence of the classification
2. the spatial extent of adverse impacts
3. the scale of improvements and mitigation required and hence the costs and the extent of technical planning and preparation required
4. planned asset refurbishment or replacement schedules
5. consideration of other pressures acting on the water body

Measures that are less likely to be disproportionately expensive are:

- Measures to reduce uncertainty – these include measures to improve understanding of the pressure and the relationship between pressure and impact.
- Measures delivering significant improvements - at no or low cost e.g. making barriers to migration passable to migratory species, and reducing maintenance where this allows a degree of natural recovery and does not jeopardise the use.
- Win-wins - such as measures which have economic as well as environmental benefits (for example, beneficial use of dredged material).
- Measures which will deliver improvements for other pressures - as well as for morphology for example, some of the measures for morphology based on agricultural land will also help tackle water resources, sediment and nutrients pressures.

Table 14 below provides examples of measures likely to be considered not disproportionately costly and those likely to be considered disproportionately costly in the first cycle of river basin management planning.

Table 14. Hydromorphological measures and disproportionate cost

Hydromorphological improvement measures considered	
Likely not to be disproportionately costly	Likely to be disproportionately costly
Measures to reduce uncertainty – improving pressure data, science on pressure/impact relationship and testing/piloting measures.	Wholesale restoration or removal of flood and coastal defences, and other engineered or reinforced channels.
Making barriers to migration passable.	Removal of major infrastructure, bridges and culverts under buildings.
Reducing maintenance to allow natural recovery.	Some sediment management for the ports and navigation sector.
Protection of the riparian zone e.g. anti-livestock fencing to allow natural recovery from overgrazing.	Hull design or other modifications to vessels.
Developing or amending dredging / disposal strategies for maritime navigation.	
Blocking grips and drains to restore upland wetland source areas	

Further investigation during the first cycle of river basin management will provide more information on the cost and benefit of measures. Where a water body is currently classified at moderate ecological status/potential or below and all the measures identified are disproportionately costly when compared to the benefits realised, then a revised less stringent objective may be set for that water body for the second cycle of river basin

management onwards. The option to set a less stringent objective will only be used where a reasonable alternative cannot be found (as illustrated in decision tree below).

The effectiveness of morphological improvement measures is dependent on the existence of other pressures. It is rare that a water body will be subject only to morphological pressures – typically other pressures such as diffuse pollution from agriculture or towns, or point source pollution will also be acting to limit ecological status or potential. In cases where morphology is not the only limiting pressure, measures for morphological improvement would not necessarily see a corresponding improvement to the overall water body quality until further measures are implemented to improve the other pressures. Phasing morphological measures to reflect the implementation of measures to deal with other pressures will allow the maximum environmental improvement and a more efficient use of resources.

Managing future modifications

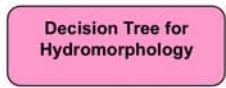
The Water Framework Directive requires an assessment of all new physical modifications to ensure they do not cause deterioration in the status or potential of a water body or prevent a water body from meeting its ecological objective.

Article 4.7 of the Directive sets out the circumstances under which a deterioration in water body status or failure to meet ecological objectives as a result of a new physical modification is permitted. Deterioration in status or failure to meet ecological objectives as a result of a new physical modification will only be permitted where the following conditions are met:

- a) all practicable steps are taken to mitigate the adverse impact on the status of the body of water;
- b) the reasons for those modifications or alterations are specifically set out and explained in the river basin management plan required under Article 13 and the objectives are reviewed every six years;
- c) the reasons for those modifications or alterations are of overriding public interest and/or the benefits to the environment and to society of achieving the water body
- d) ecological objectives are outweighed by the benefits of the new modifications or alterations to human health, to the maintenance of human safety or to sustainable development, and
- e) the beneficial objectives served by those modifications or alterations of the water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option.

All new physical modifications will be assessed in terms of their impact on the overall status of a water body and ability of that water body to meet its ecological objective. The baseline status of each water body against which deterioration will be assessed is set out as the classified status in this river basin management plan (see Annex B).

Article 4.7 assessment has been a requirement since December 2006. All new physical modifications occurring in water bodies between December 2006 and March 2009 that were likely to have caused a deterioration in status or prevented a water body from meeting its water body objectives are reported in Annex B of this plan.



Reference	M1a to M1k
Element predicted not to achieve good by 2015	Morphology
Reason for failure	<p>M1a = Suspected - physical modification flood protection</p> <p>M1b = Suspected - physical modification land drainage</p> <p>M1c = Suspected - physical modification urbanisation</p> <p>M1d = Suspected - physical modification barriers to fish migration</p> <p>M1e = Suspected - physical modification flood and coastal erosion protection</p> <p>M1f = Suspected - physical modification water storage and supply (including for power generation)</p> <p>M1g = Suspected - physical modification wider environment</p> <p>M1h = Suspected - physical modification inland navigation</p> <p>M1i = Suspected - physical modification recreation</p> <p>M1j = Suspected - physical modification other sustainable human use</p> <p>M1k = Unknown - reasons for failure unknown</p>
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The cause of the morphological pressure is unknown</p> <p>We suspect that the reason for failure is caused by one or more morphological pressures but we lack enough evidence to confirm this is true.</p> <p>Morphological pressures may derive from a complex combination of multiple physical modifications and/or management activities each of which may have a different impact on water body biology. It is not always immediately possible to identify the specific source of the pressure and so the cause of the adverse impact on biology remains unknown. It is not technically feasible to implement appropriate morphological improvement measures until the cause of the adverse impact has been determined.</p> <p>Where the source of the morphological pressure remains unknown, further investigation is required to confirm the nature and extent of the pressure. Work is underway in the Environment Agency to develop a comprehensive, up to date database on morphological pressures to help identify sources of impact.</p>	

Once the source of the pressure is identified, we will need to assess whether designation as an artificial or heavily modified water body is required.

An extended deadline for achieving water body objectives is therefore required to allow time to undertake investigations to confirm the source of the morphological pressure and to enable identification and implementation of appropriate measures.

Investigation type

Investigate source of failure

Example of investigation

Where the source of the morphological pressure remains unknown, further investigation is required to confirm the nature and extent of the pressure. Desk based studies will gather further information on the water body, morphological modification and management activities. The Environment Agency is developing a comprehensive database on morphological pressures to help this process. Appraisal of this information will determine what the morphological pressures are. Where there is low confidence that the pressures have been correctly identified or a lack of adequate data, further detailed field study is required.

Field studies to characterise the morphological pressures could include, amongst others:

- River Habitat Survey/Habitat mapping
- Catchment sediment dynamics survey
- Biological surveys
- Hydrological/hydraulic modelling
- Cross sectional surveys
- Depth, Velocity, Substrate surveys

Possible future measures

Once we are able to identify the specific source of the pressure within the water body, we will then be able to choose an appropriate morphological improvement measure. The following list provides examples of possible improvement measures that could be employed once investigations have confirmed the pressure source:

- Remove barriers to fish passage
- Enhancement/Restoration schemes
- Restoration of natural flows through habitat management & removal of impediments to flow
- Revised sediment management strategies
- More widespread use of Sustainable Urban Drainage Systems
- Codes of Practice / General Binding Rules for operational activities/boat traffic
- Management of the physical impacts of commercial inshore fisheries
- Increased habitat enhancement via flood risk and coastal management capital and maintenance activities

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

- Wholesale restoration or removal of flood and coastal defences, and other engineered or reinforced channels.
- Removal of major infrastructure, bridges and culverts under buildings.
- Hull design or other modifications to vessels.
- Removal of all barriers to migration

Reference	M2a and M2b
Element predicted not to achieve good by 2015	Morphology
Reason for failure	M2a = Suspected - physical modification commercial fin fisheries M2b = Suspected - physical modification commercial shell fisheries
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that morphological pressures are adversely affecting biology</p> <p>There is significant risk that it is disproportionately expensive to implement measures to improve hydromorphological conditions at this time because we have an incomplete understanding of the relationship between morphology pressures and biological impacts.</p> <p>Within transitional and coastal waters in particular the ecological impacts that can be directly attributed to commercial fisheries operations are not well understood. In some cases we know the source of the morphological pressure but are not able to quantify the exact nature and extent of the impact on biology. Morphological pressures are rarely if ever the sole pressure exerted on the water environment. As different pressures can act in combination to cause failure to achieve good status or potential it is difficult to relate individual modifications or management actions to identified ecological impacts.</p> <p>Where we have low confidence that commercial fin or shell fisheries pressure is adversely affecting biology (and to what extent), further studies are required to understand the relationship between the pressure and biology before we can attribute the failure in ecological status to morphological pressures. Until this link is sufficiently established for a water body, there is a significant risk that there will be either no or low benefits from taking remedial action to reduce the morphological pressure.</p> <p>In these cases we will improve our understanding of these pressure-impact relationships. By doing so we will improve our understanding of which specific measures will deliver greatest benefit to the specific biological elements that are most impacted.</p>	
Investigation type	
Investigate source of failure & relationship with ecological impact	

Example of investigation
<p>A study is being undertaken to develop a methodology to assess the level of morphological risk that commercial fisheries activities could pose. This will be done by integrating information on fisheries activity with information on habitat sensitivities. It will include quantification of the pressure, evaluation of impacts across habitat types and the spatial distribution of the effects. Its purpose is to determine the levels or types of fishing activity that could compromise good ecological status or potential.</p> <p>This information will then be used to determine what (if any) are the most appropriate measures to reduce or mitigate the impacts of ongoing commercial fisheries activities, or else the most appropriate measures to improve hydromorphological and biological quality.</p>
Possible future measures
<p>This will depend upon the outcome of the study, but may include the development and uptake of best practice guidance.</p>
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<p>Not possible to identify measures at this stage</p>

Reference	M2c to M2j
Element predicted not to achieve good by 2015	Morphology
Reason for failure	M2c = Confirmed - physical modification wider environment M2d = Confirmed - physical modification other sustainable human use M2e = Confirmed - physical modification flood protection M2f = Confirmed - physical modification urbanisation M2g = Confirmed - physical modification land drainage M2h = Confirmed - physical modification water storage and supply (including for power generation) M2i = Confirmed - physical modification recreation M2j = Confirmed - physical modification inland navigation
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>Low confidence that morphological pressures are adversely affecting biology</p> <p>Where we know that morphological pressures are adversely affecting biology but we have low confidence in the nature or extent of impacts, further studies are required to understand the relationship between the pressure and biology. Until this link is sufficiently established for a water body there is a significant risk that there will be either no or low benefits to the biology from taking remedial action to reduce the morphological pressure.</p> <p>Within some water bodies our assessments have confirmed the presence and cause of morphological pressures, which have been identified as the reason for failure. However, the exact nature and extent of impacts on the biological quality elements as a consequence of these known morphological pressures is not always clear. In these cases we need to improve our understanding of these pressure-impact relationships. By doing so we will improve our understanding of which specific measures will deliver greatest benefit to the specific biological elements that are most impacted.</p> <p>In addition, in many cases morphological pressures are not the only pressures on the water environment and these can act in combination to exert a negative impact on ecological status. In these cases it is important to understand if there is a key limiting pressure that should be the focus of early action as this will deliver greatest benefit to</p>	

the biology. Where morphology is not the limiting pressure there is likely to be very limited benefit to the biology relative to the cost of taking action.
Investigation type
Investigate nature and extent of ecological impact
Example of investigation
<p>Where there is a lack of adequate data or low confidence in our understanding of the ecological impacts of known morphological pressures more detailed study is required. These more detailed site or water body scale studies will provide better understanding of the morphological and biological condition, using a range of different survey, monitoring and modelling techniques.</p> <p>Where required, analysis of morphological pressures and other relevant information to determine the significance of morphology in relation to other pressures on the water environment, for example water quality issues, relative to ecological status.</p> <p>The improvement of our evidence base will enable successful delivery of hydromorphological measures that address the ecological impacts in a way that is more targeted and not disproportionately expensive.</p>
Possible future measures
<p>There are a wide range of measures that could be delivered in future to address known hydromorphological pressures, including:</p> <ul style="list-style-type: none"> • Modification of existing structures • Development and implementation appropriate sediment or vegetation management strategies • Cessation of maintenance or changing maintenance operations • Modification or removal of barriers to fish passage • Restoration or enhancement of morphological conditions and habitat <p>The justification for their future use will depend on analysis of the technical feasibility of delivery in consideration of local conditions within each specific water body and analysis of the costs and benefits of that action.</p>
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<ul style="list-style-type: none"> • Wholesale restoration or removal of flood and coastal defences, and other engineered or reinforced channels. • Removal of major infrastructure, bridges and culverts under buildings. • Hull design or other modifications to vessels. • Measures which are not proven to be technically successful or applicable at the scale or under the conditions of particular water bodies . • Removal of all barriers to migration

Reference	M3a to M3h
Element predicted not to achieve good by 2015	Morphology
Reason for failure	<p>M3a = Confirmed - physical modification flood protection</p> <p>M3b = Confirmed - physical modification urbanisation</p> <p>M3c = Confirmed - physical modification land drainage</p> <p>M3d = Confirmed - physical modification water storage and supply (including for power generation)</p> <p>M3e = Confirmed - physical modification ports and harbours</p> <p>M3f = Confirmed - physical modification flood and coastal erosion protection</p> <p>M3g = Confirmed - physical modification inland navigation</p> <p>M3h = Confirmed - physical modification recreation</p>
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: no known technical solution
Justification for alternative objective	
<p>Technical solutions to address the ecological impact caused by the physical modification are under development and their effectiveness is not yet known</p> <p>There is a known morphological pressure (a physical modification) and an observed biological impact but uncertainty surrounds the effectiveness of the measure(s) available to reduce that impact.</p> <p>There are a range of morphological improvement measures available to mitigate and reduce biological impacts from physical modification. However, we do not always have a high level of confidence in the outcome and effectiveness of these improvement measures in relation to the specific biological quality elements. Many of the morphological improvement measures are yet to be proven in terms of their effect on biology at the water body scale. Similarly, the effectiveness of morphological improvement measures across differing environmental conditions, for example, different river types, remains unknown.</p> <p>A programme of research is underway to improve our confidence in the applicability, feasibility and success of a range of morphological improvement measures. Extending the deadline for achieving objectives will allow time to complete these investigations to confirm the effectiveness of morphological improvement measures.</p> <p>For artificial and heavily modified water bodies, mitigation measures have been identified as necessary in order to achieve GEP. The feasibility of these measures</p>	

requires further examination. Mitigation measures defined from the ecological potential classification process are derived from a generic list that deals with pressures and impacts on a broad scale. To ensure that the measures are technically feasible in each individual water body, local conditions and requirements must be considered. Mitigation measures must also be looked at in combination to identify their effect where there are multiple pressures and impacts present in the water body.

Investigation type

Investigate feasibility of measures

Example of investigation

Where we have low confidence in how effective the morphological improvement measures are in bringing biological improvements, further investigations are underway. Investigations are taking the form of catchment trials, testing of measures and monitoring the success of measures in bringing biological improvements.

The biological improvement brought about by morphological improvement measures in some water bodies may be different where different physical conditions prevail. Certain measures may be effective in some water bodies and not others. The above trials and investigations will help determine situations in which specific measures are likely to be applicable and suitable.

Possible future measures

Once investigations have established the effect of morphological improvement measures this will inform the choice of measure to be implemented in order to meet WFD objectives. Some possible measures are listed below:

- Removal of barriers to fish passage.
- River enhancement/restoration schemes
- Restoration of natural flows through habitat management & removal of impediments to flow.
- Revised sediment management strategies
- More widespread use of Sustainable Drainage Systems.
- Codes of Practice / General Binding Rules for operational activities/boat traffic.
- Opportunistic habitat enhancements on the back of capital and maintenance works

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

- Wholesale restoration or removal of flood and coastal defences, and other engineered or reinforced channels.
- Removal of major infrastructure, bridges and culverts under buildings.
- Hull design or other modifications to vessels.
- Measures which are not proven to be technically successful or applicable at the scale or under the conditions of particular water bodies
- Removal of all barriers to migration

Reference	M5a
Element predicted not to achieve good by 2015	Fish
Reason for failure	Confirmed - physical modification barriers to fish migration
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive - Disproportionate burdens
Justification for alternative objective	
<p>If implemented before 2015, the required measure would impose a disproportionate burden. We are considering possible relevant alternative financing mechanisms.</p> <p>We are confident that the fish classification is at less than good status and that barriers to fish migration are the only or contributory factor in the observed impact. A technically feasible solution is available. The results of the national impact assessment have shown that there is a favourable cost/benefit ratio associated with remedies to deal with barriers to fish migration. This will be supported by the introduction of the fish passage regulations, expected in 2011. Further investigation of alternative financing mechanisms will take place in order to introduce these measures, or identification of the "polluter" if this is possible. We will follow the Common Implementation Strategy Guidance Document No. 20, where it states that when affordability arguments are used to extend the deadline, the possibility to use relevant alternative financing mechanisms should be fully considered, which could include distribution of costs along polluters and users, use of the public budget (at different levels), private investment, EU and international funds etc. Environment Agency, Defra and other EU partners are currently preparing an EU Life bid, for example, on developing expertise and sharing best practice on catchment restoration funds.</p> <p>Affordability is one area where there is limited guidance available at a European level and hence additional care must be taken in justifying exemptions to ensure that they follow the spirit of the Directive and its objectives. Additional care has been taken in explaining why these exemptions are being used and in making this transparent.</p> <p>Although the adoption of the WFD entails obligations for member state to make available the necessary means for implementation, this needs to be moderated by the option available to member state to phase the implementation (through extended deadlines) of measures to spread the costs of implementation (while taking clear and demonstrable action in the first cycle).</p> <p>To apply a time extension on grounds of affordability consideration should be given to the availability of alternative financing mechanisms, the consequences of non-action and steps taken to resolve affordability in the future.</p>	

Government is generally involved in financing fish passes because of the nature of the problem. There are no “polluters” in the normal sense of the word and the benefits are typically to the general public rather than identifiable individuals or organisation. Where fish passes can be financed by other means this is generally done. In particular to reduce costs care is taken to make sure that fish passes are installed where other changes to the water body (e.g. for flood defence) are taking place. This means that a large number of necessary fish passes are installed at low or no cost, but this is not sufficient to cover all cases where there is a positive benefits to cost ration.

The polluter pays principle is the central tenet of the Directive and where benefits are produced of similar importance is the beneficiary pays principle. Only when action is not financeable through these principles should resort be made to public budgets.

In the main the fish passes have no identifiable “polluter” and the beneficiaries are impossible to target because these are generally non use benefits (i.e. not individual or organisation like fisheries). If “polluters” or beneficiaries could be uniquely identified they would be chased for a contribution to the cost which may make them affordable depending upon the scale of the cost.

In terms of the consequences of the time extension for fish passes these are mainly the delayed benefits of achieving good ecological status in the relevant water bodies.

Defra is actively engaged in identifying alternative sources of financing for fish passes and in securing available funds through the process of allocating government funds. Defra sought an additional £10 million as part of business planning (25% to be spent on fish passes) and is currently establishing a business case for further expenditure as part of the Comprehensive Spending Review. Both the processes consider the costs and the benefits of the action in a similar way to that required by the Directive, to ensure that public budgets are spent on the most value for money interventions. As a consequence additional expenditure over and above that identified in the spending review process would not be considered value for money, in the sense that using the money to finance a greater number of fish passes would produce a net cost because the benefits of the passes are less than the benefits of alternative ways of spending the governments budget. This process of setting public budgets is kept under constant review as is the question of alternative sources of finance including taxes and changes and should changes arise in the future these will be reflected in later plans.

Investigation type

Investigate feasible measures

Example of investigation

Investigate cheaper measures and alternative financing mechanisms.

Possible future measures

The introduction of the new fish passage regulations will give additional powers to help address this pressure. Where the Environment Agency owns the barriers it will be our responsibility to address fish passage issues. For those owned by third parties, the responsibility will lie with them. Encourage local groups e.g. Rivers Trusts, angling associations, to install fish passes, which can often be more cost

effective.
Explore Axis 4 Leader options in funding action at local catchment level.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
Removal of all barriers to fish migration. In most cases we will have to introduce fish passes rather than removing the obstruction.

E9 Sediments pressure

Scope of the sediment pressure

For the purpose of this Plan sediment is taken to mean:

- organic and inorganic solids which may be on, or near the bed of a water body, or suspended within the water column.
- the direct polluting effects of sediment (including direct physical damage to biota, shading effects and smothering habitat). It includes managing delivery of excessive quantities of sediment from land based activities (urban and rural) and managing the redistribution of sediment from within water body activities (e.g. weed cutting etc).

We have assumed that sediment pressure does not include:

- Lack of sediment in a habitat due to anthropogenic activities modifying sediment dynamics (e.g. due to dredging and bank/foreshore development). Such aspects are a result of hydromorphological alterations and should be assessed through abstraction and/or morphological pressures.
- Impacts due to contaminants associated with sediment (e.g. nutrients and chemicals). Such aspects are a result of polluting activities that should be assessed under the relevant pressure.

Sediment pressure is relevant to rivers, lakes, transitional (estuarine) and coastal (TraC) waters. It is assumed that it has limited significance to groundwater.

Sediment pressure can have an impact on a variety of objectives relevant to WFD including:

- Surface water 'status' objectives
- Habitat Directive protected areas
- Economically significant species protected areas (Freshwater Fish Directive)
- Drinking water protected areas (including colour problems) (Surface Water Abstraction Directive)

The scale of the problem

The relationship between the amount of sediment in a river and any environmental impact is not simple. In some river catchments there is relatively little sediment but because the river is particularly sensitive then the impact can be large. At the other end of the scale, some rivers can have a high sediment load but this may actually support a particular habitat or not be considered to have a significant impact.

All river basin districts identified sediment as a Significant Water Management Issue, with many citing it among the 'top five' issues within their river basin district (RBD). We are developing a weight of evidence approach to identify the scale and source of the problem. Risk assessment information forms part of this weight of evidence.

Sediment risk assessment information is given in Annex G. Note that the large water bodies that were split into smaller bodies at the end of 2008 have not yet had a new sediment risk assessment, and so have been reported as 'Not Assessed'. However, the assessment made on the original smaller water body has been taken into account as part of our wider weight of evidence to appraise and determine appropriate measures.

Another key piece of information for weight of evidence is sediment monitoring information. However, we do not routinely measure sediment quantity, type, or quality. Sediment is difficult to monitor routinely because levels of sediment are largely related to rainfall events that are unpredictable and sediment does not remain in the water column making normal

water quality sampling unreliable. The current evidence base is focussed on detailed studies at specific sites, with limited national collation.

Understanding precisely how ecology responds to different levels and types of sediment is complex, and often unclear. Given this diversity and uncertainty, it is extremely challenging to define appropriate targets and standards to support particular WFD objectives for different types of a water body.

There are currently no UKTAG water quality standards for sediment. Similarly there are no mandatory water quality standards for sediment in existing Directives. It is assumed that where sediment compromises delivery of WFD objectives (e.g. Good Ecological Status) then this will be picked up through ecological monitoring. However, WFD Classification and associated ecological monitoring are new tools. It is therefore unlikely we will have sufficient information or knowledge from them in the short term to develop new, widespread national measures for sediment pressure in the first round of river basin management planning. Our weight of evidence will incorporate this information when it becomes available but currently it is assumed that:

- planning of local measures to tackle sediment problems will be based on local knowledge and expert judgement of Environment Agency national, regional and area staff in close co-operation with other relevant co-deliverers (e.g. Natural England, Countryside Council for Wales)
- if there is no evidence that sediment is harming WFD objectives, we will assume sediment conditions are adequate for Good Ecological Status.

Source of the problem

The variation in sediment behaviour (derivation, transport, and deposition) coupled with limited monitoring can make it difficult to specifically apportion the sediment pressure to particular sources, sectors and activities. For example, it is difficult to determine the relative contributions of sediment to a rural watercourse from arable cultivation, the livestock sector and bank side erosion.

The complexity of apportioning the sediment pressure makes it difficult to precisely identify sources and sectors. It is also difficult to have confidence in the impact of specific measures and the timescale for improvements, particularly at a local level.

In the first round of river basin management planning we will be very reliant upon building a weight of evidence to justify and identify appropriate action at the river basin district scale, and in particular fishery, biology and investigative monitoring at the local scale.

Appraisal of measures and objectives

The approach to assessing available measures to tackle sediments and determining appropriate objectives is set out in the decision tree below.

National measures (M1, M2 and M3a)

Although we do not have enough information at a national level to justify new wide-scale national action on sediment, many existing national measures will help reduce the risk of problems from sediment. These measures will be particularly important to prevent further deterioration. They include:

- Legislation to minimise impacts from sediment and suspended solids in consented discharges.

- Pollution prevention legislation (such as anti-pollution Works Notices) to prevent illegal discharges or high risk activities that may give rise to sediment problems.
- Agricultural cross-compliance and associated measures (e.g. those stemming from Nitrates Directive, Sludge Directive, waste management and storage of materials such as slurry) to reduce the risks of sediment laden run-off from farming activities.
- Agri-environment Entry Level Scheme (ELS) in England and Tir Cynnal in Wales, as well as woodland management schemes in Rural Development Programmes.
- Pollution Reduction Plans for Priority Hazardous Substances (e.g. TBT) consider sediment as a source and sink of pollution and propose appropriate mitigation strategies.
- Existing pollution prevention guidance and policy to encourage:
 - better management of run-off from construction sites;
 - new developments to be better designed to avoid (or at least minimise) adverse impacts on sediment transport and deposition;
 - increased use of sustainable drainage systems (SUDS) to draining developed areas.

Many of these existing measures are primarily aimed at other pressures (e.g. phosphorus), but we must maximise their benefit for sediment management. Proposals for using these measures to tackle sediment are given in Annex C of this plan. Those measures that have not been included are summarised in Table 15 below.

It is assumed that the economic justification for using these national measures has been established through national processes such as public consultation on new and revised regulations and their associated impact assessments (e.g. recent Government consultations on revised powers to tackle diffuse pollution) and other appraisal (e.g. Defra/Welsh Assembly Government's preliminary Cost-Effectiveness Analysis for Water Framework Directive).

Regional measures (M3b and M4)

Despite the application of these national measures, there will be some water bodies where sediment remains a problem. Where there is sufficient evidence, we aim to ensure that measures are developed and implemented at a RBD, or more local, level to address these problems.

Local biology and fish class information has only very recently become available to help identify specific water bodies where sediment may be compromising WFD Objectives. Regional and Area Environment Agency staff have reviewed biological and fish class data and identified 'reasons for failure', including those water bodies believed to be impacted by sediment. They have also used expert judgement to estimate whether biological objectives are likely to be achieved given existing or proposed national and regional measures including:

1. Nationally funded but river basin district targeted (M3b) measures:

- The England Catchment Sensitive Farming Delivery Initiative (ECSFDI) which RBD liaison panels have already contributed to through the recent extension and refresh programme.
- Environment Agency Wales funded catchment initiatives.
- Agri-environment Higher Level Scheme (HLS), Tir Cynnal and Tir Gofal.
- Existing or proposed Grant in Aid funded pollution prevention campaigns (including use of anti-pollution works notices).

2. River basin district lead (M4) measures:

- Partnerships with local authorities, water companies, local communities and developers to help control sediment from urban areas by putting in place Sustainable Urban Drainage Systems (SUDS).

- Partnerships with the farming community to help control sediment from agricultural diffuse pollution.
- Partnerships and Codes of Practice to help improve land drainage, dredging/de-silting and weed-cutting operations.
- Partnerships to minimise impacts from boat traffic wash.
- Bank/shore habitat restoration and stabilisation projects such as the work carried out by the various Rivers Trusts.

This process has led to the development of the programme of measures outlined in Annex C of this river basin management plan.

It is likely that most new action to resolve sediment problems in the first round of river basin management will be carried out through existing or proposed voluntary initiatives and partnerships (M4 measures). The economic appraisal of these will be developed as part of the river basin district measures appraisal process.

Measures which were considered but have not been included in Annex C are summarised in Table 15 below.

Table 15. Sediment measures that have been considered but not included in scenarios A or B

Proposed option:	Type of measure:	Reason for not including it in scenario A or B
Modify agricultural cross-compliance so it is more effective at supporting WFD objectives in respect of sediment.	M2 – national	Technically Infeasible – practical constraints of a technical nature prevent implementation of the measure by an earlier date. Review and development of cross-compliance is linked to EU Common Agricultural Policy and undertaken at an EU level
Modify agri-environment schemes so they are more effective at supporting WFD objectives in respect of sediment.	M2 – national	Technically Infeasible – practical constraints of a technical nature prevent implementation of the measure by an earlier date. Review and development of agri-environment is linked to EU Common Agricultural Policy and undertaken at an EU level. There are also practical constraints to modifying individual farm agreements which have not yet completed their original lifespan. A review of some parts of agri-environment is due in 2010 and we intend identify a range of resource protection/sediment management measures that need to be included as options in future schemes
General Binding Rules (GBRs) to control sediment releases from particularly high risk activities (e.g. construction, or some forestry operations)	M3a - national	However, inclusion in this list of GBRs could change in the future depending on current discussions with Defra who have been considering GBRs as part of their work on non-Agricultural diffuse pollution.
Require all new developments to have Sustainable Urban Drainage Systems in catchments where sediment laden run-off is contributing to failure of good status.	M3b - nationally funded, locally targeted	However, inclusion in this list could change in the future depending on current discussions with Defra.

Proposed option:	Type of measure:	Reason for not including it in scenario A or B
Markedly increase Environment Agency resources allocated to agricultural and urban pollution prevention and enforcement activity.	M4 – RBD led	<p>Likely to be disproportionately expensive - Implementation of the measure by an earlier deadline would impose disproportionate burdens</p> <p>We intend taking a phased approach, targeting Grant in Aid funded pollution prevention and enforcement work at the highest priority sites where we have most certainty about the activities giving rise to sediment problems.</p>

Objectives and extended deadlines

Many of the national measures detailed above were originally intended for other pressures (e.g. nutrients). As such, there is significant uncertainty regarding how effective they will be in mitigating sediment pressures. It is highly probable that these measures alone will not be sufficient to ensure wide scale attainment of WFD objectives, where sediment is the principle cause of failure. However, we believe that if used robustly they may be sufficient to minimise further deterioration due to sediment, and are therefore worthwhile. There is also considerable uncertainty with regard to many sediment measures targeted by RBDs, particularly in relation to the efficacy of new diffuse pollution measures (e.g. Water Protection Zones) or the willingness of some stakeholders to participate in partnerships.

Furthermore there are often uncertainties on the causes of failure where sediment is a pressure. It is often difficult to demonstrate whether the primary cause of a biological failure is due to sediment or some other pressure (e.g. hydromorphology). Even when sediment is identified as the primary cause it is not always clear what the relative contributions of sediment are from different sources in a particular water body (e.g. agriculture sector and/or aquaculture sector).

Given these uncertainties it is highly likely that in many cases where sediment is implicated as a cause of failure, we will need to undertake further investigation to determine an appropriate course of action.

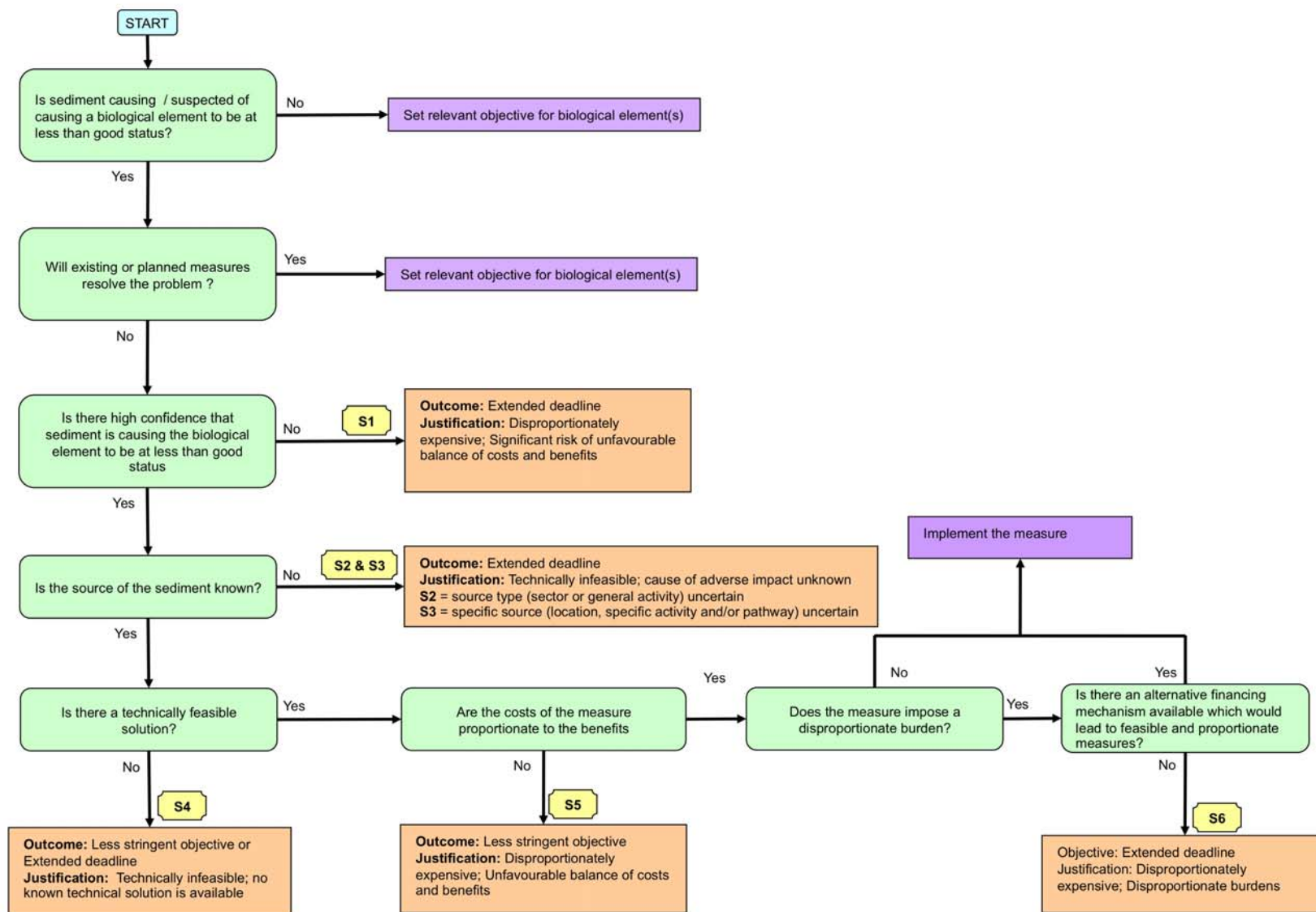
Actions required to improve the evidence base for future rounds

To improve our ability to deal with sediment appropriately in future, the following actions will be undertaken:

- Ensure the implementation of appropriate monitoring (routine and targeted) for suspended solids and bed sediments including sediment tracking studies.
- Collation and review of a national evidence base.
- Review of existing science and commissioning of new science in a strategic way to better understand:
 - the link between ecology and sediment,
 - the sources and fate of sediments in catchments,
 - appropriate standards/thresholds to help manage various types of sediment issue (including biological indicators),
 - the effectiveness of measures to tackle sediment problems.
- Development of guidance to support information gathering for weight of evidence approach, targeting monitoring and appraisal of measures.

Anticipated costs for this are likely to be a minimum of £20m over the first river basin management cycle (see Defra's preliminary Cost Effectiveness Analysis report for further detail).

Decision tree for sediment



Reference	S2a
Element predicted not to achieve good by 2015	Biological element
Reason for failure	Suspected – sediment from unknown diffuse sources
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The source (sector or general activity) of the sediment impacting on biology is not yet confirmed</p> <p>The sediment causing the failure of biological elements to achieve good status is suspected to come from diffuse sources. Until the specific sources and pathways are known with reasonable confidence, the identification and application of measures (including who needs to implement them) to reduce the sediment inputs is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm the source and pathways of sediment causing failure and to identify and implement appropriate measures.</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Investigations to confirm the source of sediment and the pathways by which the sediments are entering water bodies (e.g. agricultural, urban or abandoned mines etc). The investigation may include site visits, monitoring, and desk study modelling.	
Possible future measures	
<p>Depending on outcome of investigation, potential measures include:</p> <ul style="list-style-type: none"> • More local partnership projects to support farmers to change practice, or stabilise bank-side habitat • Increased roll-out (in terms of duration and geographic extent) of Catchment Sensitive Farming type advisory initiatives in England and Wales • Increased Environment Agency-led pollution enforcement campaigns (including 	

use of anti-pollution works notices)

- Where appropriate designation of Water Protection Zones
- Widen the measures and activities included in agri-environment initiatives (e.g. rural sustainable drainage systems) as well as securing more effective targeting and enhanced funding
- Widen the measures and activities that are incorporated in to Common Agricultural Policy funded initiatives (e.g. increase soil resource protection measures in current approach to cross-compliance, or whatever may follow in future)
- Establish and or extend existing national partnerships that provide advice and support to land managers to improve practices (e.g. continued roll out of Think: Soils training)
- Targeted land use change (e.g. afforestation or reversion of arable land to low intensity pasture) in priority areas
- More local partnership projects with Forestry Commission and other forestry operators to implement Forestry Guidelines
- Develop current Forestry Guidelines into mandatory requirements or General Binding Rules for use in high risk situations
- Designation of Water Protection Zones that apply to sites specifically impacted by Forestry operations
- More local partnership projects with key partners e.g. Highways Agency, local authorities and Business Groups to change practice and reduce the risk of non-agricultural diffuse pollution
- Establish Urban Catchment Officers in England and Wales to give advice to businesses, local authorities and those responsible for managing roads to help prevent diffuse pollution (similar to England Catchment Sensitive Farming Delivery Initiative)
- Development of General Binding Rules for particular high risk activities and sectors (e.g. construction sector)
- Establish and or extend existing national partnerships that provide advice and support to improve practice
- Targeted retro-fitting of Sustainable Urban Drainage systems in priority areas
- Targeted land use change e.g. prohibition of development in priority areas
- Code of Practice on dredging and disposal of in-channel sediment
- Continue roll-out of national Coal Mine programme and Metal Mines Strategy in Wales
- Develop non-coal mine programme to target treatment solutions at priority sites
- Tighten discharge consents for some trade activities in high risk areas (i.e. will result in changes to operational practices and/or installation of treatment processes to remove sediment from waste water prior to discharge)

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

- Wide scale reversion of arable land to low intensity pasture over large parts of England and Wales
- Wide scale reversion of agricultural land to woodland over large parts of England and Wales
- Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales
- Wide scale prohibition of high risk forestry activities in large parts of England and Wales
- Wide scale land use change e.g. prohibition of development in large parts of England and Wales that are particularly sensitive to non-Agricultural diffuse water

pollution

- Wide scale, precautionary tightening of discharge consents for suspended solids for most point sources through England & Wales

Reference	S2b
Element predicted not to achieve good by 2015	Biological element
Reason for failure	Suspected – sediment from diffuse source agricultural
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The source (sector or general activity) of the sediment impacting on biology is not yet confirmed</p> <p>Agriculture is the suspected source of the sediment. However, until this is confirmed with reasonable confidence, the identification and application of measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure and inform the identification of appropriate measures.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm that agricultural sources are causing the failure and to identify and implement appropriate measures.</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Investigations to confirm the source of sediment and the pathways by which the sediments are entering water bodies (e.g. field run-off, field drains, road/track drains, bank-side erosion and livestock poaching etc.). The investigation may include site visits, monitoring, and desk study modelling.	
Possible future measures	
<p>If agriculture is confirmed as the source of the problem:</p> <ul style="list-style-type: none"> • More local partnership projects to support farmers to change practice, or stabilise bank-side habitat • Increased roll-out (in terms of duration and geographic extent) of Catchment Sensitive Farming type advisory initiatives in England and Wales • Increased Environment Agency-led pollution enforcement campaigns (including 	

<p>use of anti-pollution works notices)</p> <ul style="list-style-type: none"> • Where appropriate designation of Water Protection Zones • Widen the measures and activities included in agri-environment initiatives (e.g. rural sustainable drainage systems) as well as securing more effective targeting and enhanced funding • Widen the measures and activities that are incorporated in to Common Agricultural Policy funded initiatives (e.g. increase soil resource protection measures in current approach to cross-compliance, or whatever may follow in future) • Establish and or extend existing national partnerships that provide advice and support to land managers to improve practice • Targeted land use change (e.g. afforestation or reversion of arable land to low intensity pasture) in priority areas
<p>Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive</p>
<ul style="list-style-type: none"> • Wide scale reversion of arable land to low intensity pasture over large parts of England and key areas in Wales • Wide scale reversion of agricultural land to woodland over large parts of England and Wales • Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales

Reference	S2c
Element predicted not to achieve good by 2015	Biological element
Reason for failure	Suspected – sediment from diffuse source forestry
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The source (sector or general activity) of the sediment impacting on biology is not yet confirmed</p> <p>Forestry is the suspected source of the sediment. However, until this is confirmed with reasonable confidence, the identification and application of measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help investigate and identify the sources and pathways of sediment that are contributing to biological failure and inform the identification of appropriate measures to reduce sediment.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm that forestry is the source causing the failure and to identify and implement appropriate measures.</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Investigations to confirm the source of sediment and the pathways by which the sediments are entering water bodies (e.g. forestry tracks, clear felling etc). The investigation may include site visits, monitoring, and desk study modelling.	
Possible future measures	
<p>If forestry is confirmed as the source of the problem:</p> <ul style="list-style-type: none"> • More local partnership projects with Forestry Commission and other forestry operators to implement Forestry Guidelines • Develop current Forestry Guidelines into mandatory requirements or General 	

<p>Binding Rules for use in high risk situations</p> <ul style="list-style-type: none"> • Where appropriate, designation of Water Protection Zones that apply to sites specifically impacted by Forestry operations
<p>Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive</p>
<ul style="list-style-type: none"> • Wide scale prohibition of high risk forestry activities in large parts of England and Wales

Reference	S2d
Element predicted not to achieve good by 2015	Biological element
Reason for failure	<p>Suspected – sediment from diffuse source road run-off</p> <p>Suspected - sediment from diffuse source mixed urban run-off</p> <p>Suspected - sediment from diffuse source housing</p> <p>Suspected - sediment from diffuse source trading/industrial estates</p> <p>Suspected - sediment from diffuse source contaminated land</p> <p>Suspected - sediment from diffuse source contaminated sediments</p>
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The source (sector or general activity) of the sediment impacting on biology is not yet confirmed</p> <p>Urban sources (including roads) are suspected source of the sediment. However, until this is confirmed with reasonable confidence, the identification and application of measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure and inform the identification of appropriate measures to reduce sediment.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm that urban sources of sediment are causing the failure and to identify and implement appropriate measures.</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
<p>Investigations to confirm the source of sediment and the pathways by which the sediments are entering water bodies (e.g. housing estates, industrial/trading estates, contaminated land, waste management sites, misconnected foul sewers or road run-off etc). The investigation may include site visits, monitoring, and desk study</p>	

modelling.
Possible future measures
<p>If urban sources are confirmed as being the source of the problem:-</p> <ul style="list-style-type: none"> • More local partnership projects with key partners e.g. Highways Agency, local authorities and Business Groups to change practice and reduce the risk of non-agricultural diffuse pollution • Establish Urban Catchment Officers in England and Wales to give advice to businesses, local authorities and those responsible for managing roads to help prevent diffuse pollution (similar to England Catchment Sensitive Farming Delivery Initiative) • Increased Environment Agency pollution enforcement campaigns (including use of anti-pollution works notices) • Where appropriate, designation of Water Protection Zones • Development of General Binding Rules for particular high risk activities and sectors (e.g. construction sector) • Establish and or extend existing national partnerships that provide advice and support to improve practice • Extend the geographic scale and pace of roll-out of work to correct misconnections of foul sewers to surface water drains • Targeted retro-fitting of Sustainable Urban Drainage systems in priority areas • Targeted land use change e.g. prohibition of development in priority areas • Code of Practice on dredging and disposal of in-channel sediment
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<ul style="list-style-type: none"> • Wide scale land use change e.g. prohibition of development in large parts of England and Wales that are particularly sensitive to urban diffuse water pollution

Reference	S2e
Element predicted not to achieve good by 2015	Biological element
Reason for failure	Suspected - sediment from disused mines - point and/or diffuse
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The source (sector or general activity) of the sediment impacting on biology is not yet confirmed</p> <p>Disused mines are a suspected source of the sediment. However, until this is confirmed with reasonable confidence, the identification and application of measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure and inform the identification of appropriate measures to reduce sediment.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm that disused mines are the source of the sediment causing failure and to identify and implement appropriate measures.</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Investigations to confirm the source of sediment and the pathways by which the sediments are entering water bodies (e.g. old flooded adits, run-off from waste spoil heaps etc). The investigation may include site visits, monitoring, and desk study modelling.	
Possible future measures	
<p>If disused mines are confirmed as the source of the problem:</p> <ul style="list-style-type: none"> Continue roll-out of national Coal Mine programme and Metal Mines Strategy in 	

Wales

- Develop non-coal mine programme to target treatment solutions at priority sites.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

- Wide scale rehabilitation at all disused coal and non-coal mines sites across the whole of England and Wales

Reference	S2f
Element predicted not to achieve good by 2015	Biological element
Reason for failure	Suspected - sediment from point source (water industry, domestic and trade premises)
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The source (sector or general activity) of the sediment impacting on biology is not yet confirmed</p> <p>Point source discharges are the suspected source of the sediment. However, until this is confirmed with reasonable confidence, the identification and application of measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure and inform the identification of appropriate measures to reduce sediment.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm that point source discharges are the source of the sediment causing failure and to identify and implement appropriate measures.</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Investigations to confirm the source of sediment and the pathways by which the sediments are entering water bodies (e.g. sewage works, water treatment works, sewer overflows, fish farms etc). The investigation may include site visits, monitoring, and desk study modelling.	
Possible future measures	
<p>If point source discharges are confirmed as the source of the problem:</p> <ul style="list-style-type: none"> • Tighten discharge consents for some trade activities in high risk areas (i.e. will 	

result in changes to operational practices and/or installation of treatment processes to remove sediment from waste water prior to discharge)
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
None

Reference	S3a
Element predicted not to achieve good by 2015	Biological element
Reason for failure	<p>Confirmed – sediment from agricultural diffuse Source</p> <p>Confirmed - sediment from diffuse source forestry</p> <p>Confirmed - sediment from road run-off</p> <p>Confirmed – sediment from mixed urban run-off</p> <p>Confirmed - sediment from housing diffuse source</p> <p>Confirmed – sediment from trading/industrial estates diffuse source</p> <p>Confirmed – sediment from contaminated land</p> <p>Confirmed - sediment from contaminated sediments</p> <p>Confirmed - sediment from disused mines point and/or diffuse</p>
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The specific source (location, specific activity and/or pathway) of the sediment that is impacting on the biology is not known</p> <p>Until the specific source(s) of the sediment is known with reasonable confidence, the identification and application of additional measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure and inform the identification of appropriate measures</p> <p>Projects have also been initiated that will review the effectiveness of measures to control diffuse pollution, including sediment, that will improve the identification of appropriate cost effective solutions.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm the source and pathways of sediment causing the failure and to identify and develop appropriate measures (e.g. source protection measures to stop diffuse pollution occurring in the first place or mitigation measures to stop sediment getting into water bodies).</p>	

Investigation type
Investigate source of failure
Example of investigation
Investigations to identify the relative importance of the specific activities and locations giving rise to unacceptable quantities of sediment in a river system. This may include site visits, monitoring, desk study modelling and stakeholder (e.g. farmer) liaison.
Possible future measures
<p>Depending on outcome of Investigation, potential measures include:</p> <ul style="list-style-type: none"> • More local partnership projects to support farmers to change practice, or stabilise bank-side habitat • Increased roll-out (in terms of duration and geographic extent) of Catchment Sensitive Farming type advisory initiatives in England and Wales • Increased Environment Agency-led pollution enforcement campaigns (including use of anti-pollution works notices) • Where appropriate designation of Water Protection Zones • Widen the measures and activities included in agri-environment initiatives (e.g. rural sustainable drainage systems) as well as securing more effective targeting and enhanced funding • Widen the measures and activities that are incorporated in to Common Agricultural Policy funded initiatives (e.g. increase soil resource protection measures in current approach to cross-compliance, or whatever may follow in future) • Establish and or extend existing national partnerships that provide advice and support to land managers to improve practices (e.g. continued roll out of Think: Soils training) • Targeted land use change (e.g. afforestation or reversion of arable land to low intensity pasture) in priority areas • More local partnership projects with Forestry Commission and other forestry operators to implement Forestry Guidelines • Develop current Forestry Guidelines into mandatory requirements or General Binding Rules for use in high risk situations • Designation of Water Protection Zones that apply to sites specifically impacted by Forestry operations • More local partnership projects with key partners e.g. Highways Agency, local authorities and Business Groups to change practice and reduce the risk of non-agricultural diffuse pollution • Establish Urban Catchment Officers in England and Wales to give advice to businesses, local authorities and those responsible for managing roads to help prevent diffuse pollution (similar to England Catchment Sensitive Farming Delivery Initiative) • Development of General Binding Rules for particular high risk activities and sectors (e.g. construction sector) • Establish and or extend existing national partnerships that provide advice and support to improve practice • Targeted retro-fitting of Sustainable Urban Drainage systems in priority areas • Targeted land use change e.g. prohibition of development in priority areas

- Code of Practice on dredging and disposal of in-channel sediment
- Continue roll-out of national Coal Mine programme and Metal Mines Strategy in Wales
- Develop non-coal mine programme to target treatment solutions at priority sites
- Tighten discharge consents for some trade activities in high risk areas (i.e. will result in changes to operational practices and/or installation of treatment processes to remove sediment from waste water prior to discharge)

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

- Wide scale reversion of arable land to low intensity pasture over large parts of England and Wales
- Wide scale reversion of agricultural land to woodland over large parts of England and Wales
- Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales
- Wide scale prohibition of high risk forestry activities in large parts of England and Wales
- Wide scale land use change e.g. prohibition of development in large parts of England and Wales that are particularly sensitive to non-Agricultural diffuse water pollution
- Wide scale, precautionary tightening of discharge consents for suspended solids for most point sources through England & Wales

Reference	S3b
Element predicted not to achieve good by 2015	Biological element
Reason for failure	Confirmed – sediment from agricultural diffuse source
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The specific agricultural source (location, specific activity and/or pathway) of the sediment that is impacting on the biology is not known</p> <p>Until the specific source(s) of the sediment is known with reasonable confidence, the identification and application of additional measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure and inform the identification of appropriate measures</p> <p>Projects have also been initiated that will review the effectiveness of measures to control diffuse pollution, including sediment, that will improve the identification of appropriate cost effective solutions to reduce sources of agricultural sediment.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm the agricultural source and pathways of sediment causing the failure and to identify and develop appropriate measures (e.g. source protection measures to stop diffuse pollution occurring in the first place or mitigation measures to stop sediment getting into water bodies).</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Investigations to identify the relative importance of the specific activities and locations giving rise to unacceptable quantities of sediment in a river system. This may include site visits, monitoring, desk study modelling and stakeholder (e.g. farmer) liaison.	

Possible future measures

When specific source identified:

- More local partnership projects to support farmers to change practice, or stabilise bank-side habitat
- Increased roll-out (in terms of duration and geographic extent) of Catchment Sensitive Farming type advisory initiatives in England and Wales
- Increased Environment Agency-led pollution enforcement campaigns (including use of anti-pollution works notices)
- Where appropriate designation of Water Protection Zones
- Widen the measures and activities included in agri-environment initiatives (e.g. rural sustainable drainage systems) as well as securing more effective targeting and enhanced funding
- Widen the measures and activities that are incorporated in to Common Agricultural Policy funded initiatives (e.g. increase soil resource protection measures in current approach to cross-compliance, or whatever may follow in future)
- Establish and or extend existing national partnerships that provide advice and support to land managers to improve practice
- Targeted land use change (e.g. afforestation or reversion of arable land to low intensity pasture) in priority areas

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

- Wide scale reversion of arable land to low intensity pasture over large parts of England and key areas in Wales
- Wide scale reversion of agricultural land to woodland over large parts of England and Wales
- Wide scale reduction in livestock densities (cattle, sheep and pigs) over large parts of England and Wales

Reference	S3c
Element predicted not to achieve good by 2015	Biological element
Reason for failure	Confirmed - sediment from diffuse source forestry
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The specific forestry source (location, specific activity and/or pathway) of the sediment that is impacting on the biology is not known</p> <p>Until the specific source(s) of the sediment is known with reasonable confidence, the identification and application of additional measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure and inform the identification of appropriate measures</p> <p>Projects have been initiated that will review the effectiveness of measures and guidance to control diffuse pollution (e.g. review of the Forest and Water guidelines), including sediment, that will improve the identification of appropriate cost effective solutions to reduce sources of sediment.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm the agricultural source and pathways of sediment causing the failure and to identify and develop appropriate measures (e.g. source protection measures to stop diffuse pollution occurring in the first place or mitigation measures to stop sediment getting into water bodies).</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Investigations to identify the relative importance of the specific activities (e.g. Clear felling) and locations giving rise to unacceptable quantities of sediment in a river system. This may include site visits, monitoring, desk study, modelling and stakeholder liaison.	

Possible future measures
<ul style="list-style-type: none"> • More local partnership projects with Forestry Commission and other forestry operators to implement Forestry Guidelines • Develop current Forestry Guidelines into mandatory requirements or General Binding Rules for use in high risk situations • Where appropriate, designation of Water Protection Zones that apply to sites specifically impacted by Forestry operations
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<ul style="list-style-type: none"> • Wide scale prohibition of high risk forestry activities in large parts of England and Wales

Reference	S3d
Element predicted not to achieve good by 2015	Biological element
Reason for failure	Confirmed - sediment from road run-off Confirmed – sediment from mixed urban run-off Confirmed - sediment from housing diffuse source Confirmed – sediment from trading/industrial estates diffuse source Confirmed – sediment from contaminated land Confirmed - sediment from contaminated sediments
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The specific source (location, specific activity and/or pathway) of the sediment that is impacting on the biology is not known</p> <p>Until the specific Urban sources (including roads) of the sediment is known with reasonable confidence, the identification and application of additional measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure and inform the identification of appropriate measures</p> <p>Projects have also been initiated that will review the effectiveness of measures to control diffuse pollution, including sediment, that will improve the identification of appropriate cost effective solutions to reduce sources of sediment.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm the urban source and pathways of sediment causing the failure and to identify and develop appropriate measures (e.g. source protection measures to stop diffuse pollution occurring in the first place or mitigation measures to stop sediment getting in to water bodies e.g. SUDS)</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Investigations to identify the relative importance of the specific activities and locations giving rise to unacceptable quantities of sediment in a river system. This may include	

site visits, monitoring, desk study modelling and stakeholder liaison (e.g. SME sector groups, local authorities and Highways Agency, the public).

Possible future measures

- More local partnership projects with key partners e.g. Highways Agency, local authorities and Business Groups to change practice and reduce the risk of non-agricultural diffuse pollution
- Establish Urban Catchment Officers in England and Wales to give advice to businesses, local authorities and those responsible for managing roads to help prevent diffuse pollution (similar to England Catchment Sensitive Farming Delivery Initiative)
- Increased Environment Agency pollution enforcement campaigns (including use of anti-pollution works notices)
- Where appropriate, designation of Water Protection Zones
- Development of General Binding Rules for particular high risk activities and sectors (e.g. construction sector)
- Establish and or extend existing national partnerships that provide advice and support to improve practice
- Extend the geographic scale and pace of roll-out of work to correct misconnections of foul sewers to surface water drains
- Targeted retro-fitting of Sustainable Urban Drainage systems in priority areas
- Targeted land use change e.g. prohibition of development in priority areas
- Code of Practice on dredging and disposal of in-channel sediment

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

- Wide scale land use change e.g. prohibition of development in large parts of England and Wales that are particularly sensitive to non-Agricultural diffuse water pollution

Reference	S3e
Element predicted not to achieve good by 2015	Biological element
Reason for failure	Confirmed - sediment from disused mines point and/or diffuse
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The specific source (location, specific activity and/or pathway) of the sediment that is impacting on the biology is not known</p> <p>Until the specific point or diffuse source(s) of the sediment from disused mines is known with reasonable confidence, the identification and application of additional measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure and inform the identification of appropriate measures</p> <p>Projects have also been initiated that will review the effectiveness of measures to control diffuse pollution, including sediment, that will improve the identification of appropriate cost effective solutions to reduce sources of sediment.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm the source and pathways of sediment causing the failure and to identify and develop appropriate measures (e.g. reducing the risk of run-off from waste spoil heaps or tackling flooded adits).</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Investigations to identify the relative importance of the specific activities and locations giving rise to unacceptable quantities of sediment in a river system. This may include site visits, monitoring, desk study modelling and stakeholder liaison (e.g. land owners and Coal Authority).	

Possible future measures
<p>When Specific source is identified:</p> <ul style="list-style-type: none"> • Continue roll-out of national Coal Mine programme and Metal Mines Strategy in Wales • Develop non-coal mine programme to target treatment solutions at priority sites.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
<ul style="list-style-type: none"> • Wide scale rehabilitation at all disused coal and non-coal mines sites across the whole of England and Wales

Reference	S3f
Element predicted not to achieve good by 2015	Biological element
Reason for failure	Confirmed - sediment from point source (water industry, private and trade)
Alternative objective	Extended deadline
Reason for alternative objective	Technically Infeasible - cause of adverse impact unknown
Justification for alternative objective	
<p>The specific point source (location, specific activity and/or pathway) of the sediment that is impacting on the biology is not known</p> <p>Until the specific point source of the sediment is known with reasonable confidence, the identification and application of additional measures (including who needs to implement them) tailored to local circumstances is not possible. It is therefore not technically feasible to achieve good status by 2015.</p> <p>Projects have been initiated that will develop methodologies for reviewing and gathering evidence to help identify the sources and pathways of sediment that is contributing to biological failure and inform the identification of appropriate measures</p> <p>Projects have also been initiated that will review the effectiveness of measures to control diffuse pollution, including sediment, that will improve the identification of appropriate cost effective solutions to reduce sources of sediment.</p> <p>An extended deadline for achieving good ecological status is therefore required. This will allow time to undertake investigations to confirm the source and pathways of sediment causing the failure and to identify and develop appropriate measures (e.g. put in place additional treatment, and/or changes in operational practices to reduce sediment in discharge).</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Investigations to identify the relative importance of the specific activities and locations giving rise to unacceptable quantities of sediment in a river system. This may include site visits, monitoring, desk study modelling and stakeholder liaison (e.g. fish farms).	

Possible future measures
<p>When point source is identified:</p> <ul style="list-style-type: none"> • Tighten discharge consents for some trade activities in high risk areas (i.e. will result in changes to operational practices and/or installation of treatment processes to remove sediment from waste water prior to discharge)
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
None

E10 Priority Substances, Priority Hazardous Substances and Specific Pollutants

Water Framework Directive requirements and standards

Priority Substances and Priority Hazardous Substances

The Water Framework Directive provides for the identification of priority substances, for which the objectives are a progressive reduction of discharges, emissions and losses and, for a subset of priority hazardous substances, a cessation or phasing out of discharges, emissions and losses within 20 years. It also requires that environmental quality standards (EQS) are established at EU level, which must be met for 'good chemical status' to be achieved.

A list of 33 priority substances, including 13 priority hazardous substances, was agreed by co-decision in 2001 (Decision 2455/2001/EC). EQS for these substances were published in December 2008 in Directive 2008/105/EC on Environmental Quality Standards in the Field of Water Policy (the "EQS Directive"). This effectively replaces the Dangerous Substances Directive (76/464/EEC). The EQS Directive also includes the requirement that concentrations of certain priority substances do not increase in sediment and/or biota, in addition to the requirement for Member States to establish an inventory of emissions, discharges and losses of priority substances and priority hazardous substances in each river basin district.

The EQS Directive reiterates that the objectives and provisions of WFD Article 4 apply, therefore the objective to achieve 'good chemical status' and for a progressive reduction of priority substances and cessation of priority hazardous substances are subject to disproportionate cost and technical infeasibility considerations.

Specific Pollutants

Member States must also identify "specific pollutants" - substances of national concern which are discharged in significant quantities – and develop appropriate EQS using a common methodology. Standards for specific pollutants must be met for good ecological status to be achieved

In the first instance, the UK WFD Technical Advisory Group (UKTAG) prioritised 19 potential specific pollutants. EQS were developed for 10 substances and these were reviewed by stakeholders in 2007. For the remaining 9 substances, UKTAG has recommended that existing standards should be used in the first planning cycle, because in the absence of high quality field and toxicity data, a large safety factor would have to be incorporated into the EQS. This approach tightens the EQS, potentially resulting in an over-precautionary standard that is inconsistent with environmental conditions and which confers no additional environmental benefit. The intention is that UKTAG will continue to collect suitable data with which to review standards in time for the second river basin management planning cycle. To this end, UKTAG has established links with other Member States (including Germany, France, the Netherlands, Belgium and the Republic of Ireland) with a view to sharing best practice and where possible developing common solutions.

Current compliance

We have assessed compliance with standards for priority substances and specific pollutants in order to identify those water bodies at risk of not achieving WFD objectives and consequently, where measures are required. Based on monitoring data from 2006-08, about 9% of water bodies in England and Wales will fail to achieve standards for priority

substances, priority hazardous substances and specific pollutants. Over half of these water bodies fail with high (at least 95%) confidence.

Pollution Reduction Plans and development of measures

Chemicals are released into the environment from a wide range of sources including urban and agricultural land use, industry, domestic release to sewers, mines, ports and harbours. The relative importance of these sources varies depending on the chemical, hence the feasibility and effectiveness of various actions to reduce environmental concentrations will vary between substances. For this reason, programmes of measures must be developed for each substance.

Our approach has been to develop national pollution reduction plans (PRPs) for all priority and priority hazardous substances and 6 specific pollutants. The full list is included in Annex F. PRPs review current data on production, uses, sources, environmental monitoring and release, and include an evaluation of available regulatory restrictions and potential control measures. This assesses each available and potential measure for technical feasibility and cost effectiveness, using a range of supporting information, e.g. the preliminary cost effectiveness analysis (pCEA).

Details of the available and potential measures for each substance were collated for each failing water body. Local Environment Agency staff used this information to select those measures that could be usefully applied at the water body scale within their RBD. They also identified any local (M4) measures that could help deliver WFD obligations. These include investigations, targeted pollution prevention advice and campaigns and voluntary agreements based on best practice. All relevant measures have been included in Annex C of this river basin management plan²⁸.

The PRPs were sent to industry sectors, trade associations, conservation organisations, regulators and liaison panels for their comments, during early 2009. This targeted consultation was supported by several sector-specific workshops. The PRPs were then updated to take account of comments received via the consultation and workshops, but are intended to be “living documents” and will be updated, for example to reflect changes in compliance, uses/sources and measures as more information becomes available, and as progress is made through the first river basin management planning cycle.

The rationale used to identify measures for the first river basin management planning cycle is summarised below. More detailed information on measures, including those measures that apply at the national scale and which will be used for generally bearing down on emissions of priority hazardous substances, is provided in the PRPs.

Measures tend to fall into three categories:

i) Control at source

There are a number of initiatives, particularly at the European level, to restrict chemicals at source. These include the REACH (Registration, Evaluation and Authorisation of Chemicals) Regulations and substance-specific marketing and use restrictions. These initiatives will reduce emissions of chemicals to water and for some substances, for example isoproturon,

²⁸ NB: Water body compliance is based on median data from all sampling points within that water body. This may mean that a water body reported as “compliant” may have some localised areas of non-compliance. Where the source of non-compliance is known, additional M4 measures will be identified to address the problem, where it is cost effective and technically feasible to do so.

pentachlorophenol and trichlorobenzenes, we believe the reduction will be sufficient to achieve WFD objectives.

The Environment Agency is an enforcing body for REACH and as such, undertakes risk-based campaigns to address compliance with chemical restrictions and coordinates associated enforcement action. Where possible, we will include priority substances and priority hazardous substances in our enforcement campaigns.

ii) Actions to address point sources of pollution

Sewage treatment works

While standards of sewage treatment have greatly improved in recent years, sewage treatment works (STW) are often a source of chemicals including metals, pesticides, PAHs and TBT. These can arise from discharges of trade effluent to sewer, domestic use and road runoff.

For some substances, the effectiveness of planned source control measures and additional end-of-pipe treatment options is unknown. In these cases, investment in improved sewage treatment (in addition to that required to comply with other EC Directives) might be ineffective and disproportionately costly. The updated WFD Impact Assessment estimated the annual cost to the water industry of end-of-pipe removal of chemicals at around £329m if implemented in the first planning cycle, or £131m if implemented over three cycles.

Therefore we have proposed that under PR09, the water industry will carry out a programme of investigation to identify those STW that are at risk of causing non-compliance with WFD objectives for chemicals. Where a STW is identified as causing a problem, companies will assess the effectiveness and costs of options for removing the risk, including end-of-pipe treatment, control at source and catchment-based solutions, for example tightening trade discharges to sewer. Investigations will be completed by 2012 to allow removal options to be appraised in time for the second round of river basin management planning.

Industrial discharges

Industrial sites, including those regulated under the Environmental Permitting Regulations (EPR, formally the Pollution Prevention and Control Regulations) may be a source of chemicals. There is some uncertainty in relation to the impact of specific sites or activities on the achievement of WFD objectives, particularly in relation to downstream EQS failures or emissions of priority hazardous substances. Therefore in the first planning cycle, we want to work with a range of sectors to address these information gaps. This may involve:

- Investigations to confirm the loading from sites listed on the Pollution Inventory and determine the contribution of that loading to downstream EQS failures
- Investigations to confirm whether priority hazardous substances are being discharged at specific sites
- An assessment of the available measures which could help achieve WFD objectives, for example, use of alternative chemicals, better pollution prevention measures or improved end-of-pipe treatment - and the cost of these measures.

Investigations may be prioritised at certain sites, depending on releases reported on the Pollution Inventory, downstream EQS failures or known uses of particular substances. Investigations should be completed by 2012 and where risks to the achievement of WFD objectives are confirmed, an appraisal of the available measures should also be carried out. Potential measures would be subject to a disproportionate cost assessment on a site by site basis. This will ensure that cost-effective, sustainable, long-term solutions can be identified and implemented within the second cycle of river basin management planning.

We will also provide advice to small and medium sized businesses on obligations in relation to priority substances, priority hazardous substances and specific pollutants through the NetRegs website (www.netregs.gov.uk).

Discharges from abandoned mines

Many of the largest discharges of metals to surface and ground waters arise from mining e.g. minewaters and discharges from mine spoil heaps. At least 164 river catchments in England and Wales are known to be impacted by abandoned mines and are failing to achieve good status.

Abandoned coal mines are a significant source of metals including iron. The Coal Authority is continuing to implement a phased remediation plan up to 2027 for the priority sites which are contributing to the failure of 54 water bodies to meet good status.

The majority of EQS failures for other metals, particularly lead and cadmium, are in metal mining areas, particularly in the South West, Western Wales, Dee, Northumbrian and North West RBDs. There are also some problems in the Humber, Solway-Tweed and Severn RBDs. 110 water bodies are failing to achieve good status because of non-coal (primarily metal) mines. The Defra/Welsh Assembly Government/Environment Agency non-coal mines prioritisation project included a comprehensive analysis of impact and identified 221 water bodies impacted by non-coal mines with a further 236 probably impacted.

Remediation of all non-coal mines by 2015 would rely on established technologies such as those employed at Wheal Jane in Cornwall. These technologies, whilst proven, consist of chemical dosing which is costly, energy intensive and unsustainable in the long-term. It would be disproportionately expensive to employ this treatment technology on a large scale. However recent trials of innovative technologies have indicated that passive treatment may be viable and cost effective. We are hoping to carry out studies to pilot these technologies in the first planning cycle.

To progress a suitable strategy we need to carry out detailed catchment investigations to confirm the relative importance of sources and to optimise treatment solutions. Phasing of subsequent remediation measures would allow costs to be spread and for treatment technologies to be developed at a significant saving. The non-coal mines project has estimated that a programme to deal with the water-related environmental problems in all of the impacted water bodies would cost £370 million over an initial ten year period, with additional subsequent operating costs.

It would also be beneficial if responsibility for managing non-coal minewaters could be given to a government funded body (analogous to the Coal Authority's role for coal mine waters). This change should take place before 2012 to allow measures to be implemented in the second planning cycle.

iii) Actions to address diffuse pollution

Diffuse pollution arises from a range of sectors. It is often difficult to quantify as it can vary spatially and over time, therefore the significance of various sources – and hence the effectiveness of any associated restrictions – can be uncertain. For this reason, the measures included in this plan tend to focus on pollution prevention through local education campaigns, voluntary initiatives and the adoption of best practice methodologies and improved source apportionment through investigations. Measures are driven by cross-compliance with Nitrates and Sludge Directives, the Silage, Slurry and Agricultural Fuel Oil Regulations, the Groundwater Directive, anti-pollution works notices and policies on development planning, as well as restrictions on the use of certain substances.

Most of the existing and proposed national measures to control diffuse water pollution focus on preventing deterioration in the status of water bodies. For example, there are few instances of non-compliance with standards for pesticides, but some are increasing in concentration in drinking water protected areas and this trend must be reversed to meet obligations under WFD Article 7 (specific measures to meet the requirements of Article 7 are listed in Annexes C and D). Our PRPs have identified a range of measures that could be deployed voluntarily or through regulatory mechanisms. For example while the pesticide cypermethrin has been temporarily suspended for use in sheep dip, we will continue to promote further use restrictions in the agricultural, forestry and wood preservation sectors through the use of voluntary mechanisms. These could include catchment sensitive farming, rectifying misconnections of foul sewer to surface water drains, and national pesticides initiatives, for example the Voluntary Initiative, the Amenity Forum and the National Pesticides Strategy. We will be aiming to achieve compliance with the EQS by 2015, and will complement voluntary and partnership working with targeting pollution enforcement activity, e.g. anti-pollution works notices. This will ensure actions taken by our co-deliverers are not undermined by the inappropriate activities of others.

For pesticides generally, we will promote the use of voluntary mechanisms during the first cycle unless there is a clear case for immediate introduction of measures via regulatory mechanisms. Early in the first planning cycle, we will be exploring the scope for use of water protection zones (a regulatory mechanism) for a limited number of sites where implementation of measures via voluntary approaches has already proved to be unsuccessful. For other catchments if voluntary take up is not successful in the first cycle we will be seeking more extensive regulatory mechanisms in subsequent cycles.

The situation is somewhat different for the marine antifoulant TBT. Just over 60 water bodies fail the EQS for TBT, despite its use being heavily restricted already. Although further measures to restrict tin-based substances as plastic additives are being considered at European level, (and we have included measures to increase enforcement of existing restrictions) it may be that the major remaining sources arise from historical contamination of sediments and land, the re-suspension by boat movements and dredging as well as inputs from the sewerage system.

Measure for TBT therefore include investigations by the navigation sector into the impact of dredging and dredging disposal activities where these may cause or contribute to EQS failures or deterioration in a water body. We have also included measures to require a national guidance framework for dredging and dredgings disposal to be developed by December 2009 and to be applied by December 2012. The development of the framework will be overseen by Defra and Welsh Assembly Government in conjunction with the Port and Harbour Authorities, the Marine and Fisheries Agency (and future Marine Management Organisation) and the Environment Agency. Where ports and harbours are confirmed as a significant source of TBT to a water body, for example as a result of dredging activities that re-suspend contaminated sediments into the water column, the framework will drive local measures for individual ports and harbours to be applied at a local level by December 2012 where not disproportionately expensive or technically infeasible. This work will be informed by the Defra "Contaminated Marine Sediment" Project and the Cefas Project which is assessing the environmental impact of navigational dredging in estuaries and coastal waters.

Measures will also be applied to other contributing sectors, as appropriate, to deal with their contributions. We cannot predict the extent the national guidance framework will achieve compliance with the EQS, so generally we have predicted less than good status by 2015.

Approach in the first planning cycle

There are a number of initiatives, particularly at EU level, to restrict chemicals at source. These should reduce emissions to water, and where we believe the reduction is sufficient to achieve WFD objectives e.g. where there are few or no EQS failures, we have not proposed additional measures for the first river basin management planning cycle. We will carry out appropriate monitoring to ensure that WFD obligations for such substances continue to be achieved.

Where we have less certainty that such restrictions will achieve WFD objectives, for example where other sources of a substance remain, we have proposed investigations to evaluate the significance of those sources and options to address their impact where a risk to WFD objectives is confirmed. We have included additional measures where we are able to quantify their impact with confidence and we will continue to carry out targeted pollution prevention measures and enforcement of existing marketing and use restrictions.

Development of predicted outcomes

We have identified predicted outcomes for the first planning cycle for each water body, for each relevant substance. These predicted outcomes are included in Annex B of this plan and take into account the effectiveness of the measures described above.

Where the available measures will maintain or achieve compliance with the EQS by 2015, we have assigned a predicted outcome of good chemical status for priority substances and at least good ecological status for specific pollutants. Where the available measures will not achieve compliance by 2015, we have set alternative objectives for those substances. The rationale for this decision is presented in the chemicals decision tree below. There are 5 main justifications for setting alternative objectives:

- the water body is currently non-compliant with the EQS with low confidence of failure;
- the water body is currently non-compliant with the EQS with high confidence of failure, but the source of the substance is not known, or not known in sufficient detail to be able to identify appropriate measures;
- the water body is currently non-compliant with the EQS, with high confidence of failure, the source of the substance is known but there is no technically feasible solution;
- the water body is currently non-compliant with the EQS, with high confidence of failure, the source of the substance is known, but while there are technically feasible measures, the costs of the measures are not proportionate to the benefits;
- the water body is currently non-compliant with the EQS, with high confidence of failure, the source of the substance is known, there is a technically feasible solution and the cost of a measure is in proportion to the benefit, but it imposes a disproportionate burden and an alternative financing mechanism is not available.

More information on alternative objectives is included in the decision code tables at the end of this section, together with details of the investigations that will be carried out to confirm failures and identify sources, potential measures for the second planning cycle and measures which are considered to be technically infeasible or disproportionately costly.

Use of Biotic Ligand Models

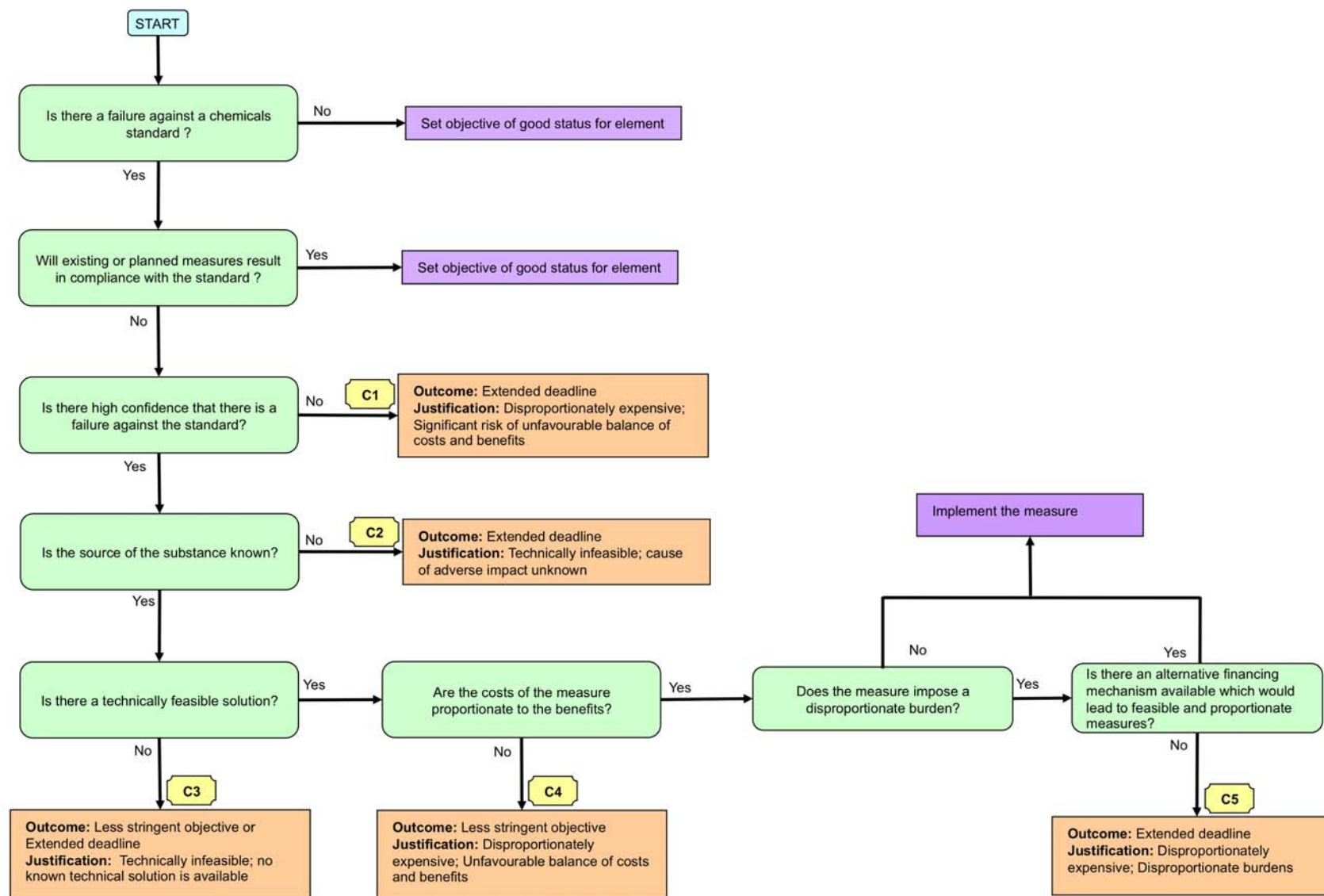
The WFD allows for the consideration of bioavailability when assessing monitored metal concentrations against EQS. We have developed biotic ligand models (BLMs) for copper and zinc, which are able to estimate the fraction of dissolved metal concentrations in freshwater that is biologically relevant, i.e. able to exert toxic effects, based on physico-chemical parameters. We have assessed our monitoring data for copper and zinc using the BLMs and as a result have 3 classes of compliance for these substances:

- Compliant with the EQS based on face value monitoring data, in which case we have assigned a predicted outcome of “good” by 2015;
- Compliant with the EQS based on bioavailable fraction, in which case we have assigned a predicted outcome of “good” by 2015 on the basis that prevailing physiochemical conditions protect against risk to biology.
- Non-compliant with EQS based on bioavailable fraction (and hence, face-value data), in which case we have extended the deadline for achieving “good” to 2027. In the interim period, investigations into sources will be undertaken in order to identify appropriate measures for implementation in subsequent planning cycles.

Future river basin management planning cycles

Work carried out in during the first river basin management planning cycle should deliver some improvement in chemical status. It should also identify cost effective, proportionate and sustainable measures for implementation in the second planning cycle, or provide robust evidence to support less stringent objectives on the grounds of technical feasibility or disproportionate cost.

Decision tree for
PHS, PS and SP



Reference	C1a
Element predicted not to achieve good by 2015	Priority substances, priority hazardous substances and specific pollutants
Reason for failure	Unknown - uncertain there is a failure / impact
Alternative objective	Extended Deadline
Reason for alternative objective	Disproportionately expensive: significant risk of unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The water body is currently non-compliant with the EQS, but with low confidence of failure</p> <p>For over 20 years we have routinely monitored surface waters for chemical parameters listed in a range of national and European legislation (including for example, those chemicals specified in the Dangerous Substances and Freshwater Fish Directives). The Environmental Quality Standards Directive (2008/105/EC) introduces new or more stringent standards for many substances. In some cases where a new standard has been introduced, we have not previously monitored surface waters for these substances – our monitoring programme is targeted where risk is considered to be highest. Similarly where a more stringent standard has been introduced our analysis may have been at a higher limit of detection than would now be required to assess compliance with the increasingly stringent standards. While we have adapted our monitoring programme to take account of the new standards, there is sometimes insufficient monitoring data to assess compliance with high confidence. This will be addressed as additional monitoring data becomes available.</p> <p>For water bodies which are currently non-compliant with low confidence of failure, our priority in the first cycle will be to carry out further investigation to confirm the situation and identify sources and additional potential measures. To identify measures until the failure is confirmed would mean that there is a significant risk of wasted investment. This is considered disproportionately costly given the high possibility that such measures would not confer any additional environmental benefit.</p>	
Investigation type	
Investigate to confirm failure and/or impact	
Example of investigation	
Additional monitoring or modelling (e.g. using SIMCAT models) to confirm failure against the standard with high confidence. Where an EQS failure is confirmed with high confidence, the significance of various sources can then be assessed in order to identify and apportion causes of failure. This will allow appropriate measures to be targeted for implementation in this or subsequent river basin management planning cycles.	

Possible future measures

Possible future measures will depend on the substance in question, confirmation of failure against the standard and identification of sources that contribute to the failure. Measures which could be appropriate for individual substances are set out in national pollution reduction plans (PRPs) for all the priority and priority hazardous substances and 6 specific pollutants. Measures may include control at source (e.g. through additional marketing and use restrictions); additional regulatory controls on point sources, including sewage treatment works, industrial emissions and action to address discharges from abandoned mines; actions to address diffuse sources, e.g. pollution prevention (through local education campaigns, voluntary initiatives and the adoption of best practice methodologies), extension of schemes such as England Catchment Sensitive Farming Delivery Initiative and the Voluntary Initiative for pesticides, and additional controls on dredging to reduce releases of TBT from contaminated sediments.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Measures that are likely to be technically infeasible or disproportionately expensive will depend on the substance in question and the source of that substance. The PRPs include an evaluation of the technical feasibility and costs associated with available and potential measures, which is based a range of supporting information, e.g. the preliminary cost effectiveness analysis (pCEA).

This illustrates that some measures will be more useful in the first river basin management planning cycle than others. For example, it is feasible and relatively cost effective to investigate the concentration of lead in leachate from landfill sites and remediate where necessary (estimated at £5 million per tonne lead removed); it is neither feasible nor cost effective to replace all domestic lead pipes to prevent leaching into the sewerage system (£54 – 136 million per tonne lead removed). It should also be noted that some substances, e.g. cadmium are naturally occurring and complete elimination from all surface waters will not be possible. Furthermore, in some exceptional circumstances where water bodies are severely impacted by a legacy of metal mining, it may be technically infeasible or disproportionately expensive to restore metal concentrations to a level that approaches the standard due to the nature of the metal sources.

Reference	C2a
Element predicted not to achieve good by 2015	Priority substances, priority hazardous substances and specific pollutants
Reason for failure	Unknown - reasons for failure unknown
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The source of the substance causing the failure is unknown</p> <p>Chemicals are released into the environment from a wide range of sources including urban and agricultural land use, industry, domestic release to sewers, mines, ports and harbours. For water bodies where the sources of the pollution is not known, or not known in sufficient detail to be able to identify and appraise measures (including identification of the site or activity who is responsible for causing the pollution), it is technically infeasible to identify and implement additional measures, and achieve the objective by 2015.</p> <p>For over 20 years we have routinely (usually annually) assessed compliance with water quality standards (such as those for the Dangerous Substances and Freshwater Fish Directives) and tried to identify the activities releasing the substances and causing the failure of the standards. We use a number of different approaches to do this including routine and investigative monitoring, modelling, and site inspections. Despite this, the sources of some of these old failures remains unknown.</p> <p>In 2008 and 2009 we assessed compliance with the new standards for priority substances, priority hazardous substances and specific pollutants. Where these substances did not have standards under the old directives, or where the standards for the water framework directive are tighter than before, we have identified many new failures.</p> <p>We have produced and consulted on (in conjunction with the draft river basin management plans) national pollution reduction plans for all the priority and priority hazardous substances and 6 specific pollutants. These identify potential point, diffuse and historical sources of these substances but their significance varies locally and in the time available, we have not been able to identify specific sources and their relative contributions for each of the new failures. An extended deadline for achieving good ecological and/or chemical status is therefore required.</p>	
Investigation type	
Investigate cause of failure	

Example of investigation

Potential point, diffuse and historical sources are set out in national pollution reduction plans (PRPs) for all the priority and priority hazardous substances and 6 specific pollutants. The significance of these and any locally relevant sources will be assessed through additional monitoring or modelling (e.g. using SIMCAT models) to identify and apportion causes of failure. This will allow appropriate measures to be targeted for implementation in this or subsequent river basin management planning cycles.

Possible future measures

Possible future measures will depend on the substance in question and the sources that contribute to the failure. Measures which could be appropriate for individual substances are set out in the PRPs. Measures may include control at source (e.g. through additional marketing and use restrictions); additional regulatory controls on point sources, including sewage treatment works, industrial emissions and action to address discharges from abandoned mines; actions to address diffuse sources, e.g. pollution prevention (through local education campaigns, voluntary initiatives and the adoption of best practice methodologies), extension of schemes such as England Catchment Sensitive Farming Delivery Initiative and the Voluntary Initiative for pesticides, and additional controls on dredging to reduce releases of TBT from contaminated sediments.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

"Measures that are likely to be technically infeasible or disproportionately expensive will depend on the substance in question and the source of that substance. The PRPs include an evaluation of the technical feasibility and costs associated with available and potential measures, which is based a range of supporting information, e.g. the preliminary cost effectiveness analysis (pCEA).

This illustrates that some measures will be more useful in the first river basin management planning cycle than others. For example, it is feasible and relatively cost effective to investigate the concentration of lead in leachate from landfill sites and remediate where necessary (estimated at £5 million per tonne lead removed); it is neither feasible nor cost effective to replace all domestic lead pipes to prevent leaching into the sewerage system (£54 – 136 million per tonne lead removed). It should also be noted that some substances, e.g. cadmium are naturally occurring and complete elimination from all surface waters will not be possible. Furthermore, in some exceptional circumstances where water bodies are severely impacted by a legacy of metal mining, it may be technically infeasible or disproportionately expensive to restore metal concentrations to a level that approaches the standard due to the nature of the metal sources.

Reference	C3a
Element predicted not to achieve good by 2015	Priority substances, priority hazardous substances and specific pollutants
Reason for failure	<p>Confirmed - point source - trade/industry EPR (non-water industry)</p> <p>Confirmed - natural mineralisation</p> <p>Confirmed - disused mines point and/or diffuse source</p> <p>Confirmed - diffuse source - contaminated land (incl. landfill)</p> <p>Confirmed - point/diffuse source - disused mines</p>
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: no known technical solution
Justification for alternative objective	
<p>The water body is non-compliant with the EQS, but there is no technically feasible solution</p> <p>This applies where a water body is non-compliant with the EQS, with high confidence of failure, the source of the substance is known, but there is currently no known technical solution available to mitigate the source of pollution.</p> <p>For example, in one case of non-compliance with the EQS for iron, the reason for failure has been identified as natural mineralisation on the basis that there is a naturally high concentration of iron in the groundwater source discharging to the surface water body. There are no technically feasible means of removing the iron. It may be that it will never be possible to achieve the EQS in this water body, in which case when we review this plan in 2015 we will set a less stringent objective. Alternative objectives have also been set on this basis where landfill sites or trade discharges have been identified as the cause of EQS failures, but where appropriate treatment solutions must be developed. In these cases, our priority in the first cycle is to work with the relevant sectors to identify and develop cost-effective, sustainable, long-term solutions which can be implemented within the second cycle of river basin management planning. We have initiated this process through the consultation on our pollution reduction plans (PRPs).</p> <p>In most cases, alternative objectives have been set on the basis of this justification where discharges from abandoned mines have been confirmed as the cause of EQS failures for metals. At least 164 river catchments in England and Wales are known to be impacted by abandoned mines and are failing to achieve good status.</p>	

Although remediation of such discharges has been possible, for example at Wheal Jane in Cornwall, the treatment system consists of chemical dosing which is costly, energy intensive and unsustainable in the long-term. Furthermore, although this technology is effective for treating most point source discharges of minewaters, disused mines cause a range of environmental impacts. Site-specific solutions must be developed for both diffuse and point sources, and it takes several years to design and obtain permissions before they can be implemented. Sustainable treatment methods for non-coal minewaters are less well established than for coal minewaters.

Recent trials of innovative technologies have indicated that passive treatment may be viable and cost effective. However, it is not known whether this type of technology will be capable of delivering compliance with EQSs in all cases. Therefore our approach in the first planning cycle is to undertake additional investigations and research, in order to identify and pilot these technologies. This means that standards for metals in water bodies affected by mine water discharges may not be achieved by 2015. However this work will allow us to develop sustainable and long-term solutions which can be implemented within subsequent cycles of river basin management planning. Solutions will be developed to address a range of mine water impacts, leading to maximum environmental benefit when implemented. Furthermore the Impact Assessment of the EQS Directive (Defra, 2009) indicates that this phased approach will significantly reduce the costs of meeting standards for metals in these water bodies, from an estimated £585 million to an estimated £374 million (present value).

Investigation type

Investigate feasible measures

Example of investigation

Initiatives such as the Welsh Metal Mines Strategy are piloting novel treatment technologies for discharges from abandoned mines. Where other sites or activities have been identified as a source of metals or other substances, our priority in the first cycle is to work with the relevant sectors to identify and develop cost-effective, sustainable, long-term solutions which can be implemented within the second cycle of river basin management planning. We have initiated this process through the consultation on our pollution reduction plans (PRPs).

Possible future measures

The outputs from the investigations outlined above will help identify technically feasible measures for implementation in subsequent river basin management planning cycles. Measures which could be appropriate for individual substances are set out in the PRPs but could include control at source, additional controls on point sources (particularly discharges from abandoned mines), and actions to address diffuse sources.

Possible future measures will be implemented where the risk from a given sector, site or activity is confirmed. For many water bodies, this will involve action on sewage discharges and other point sources and management of dredging practices. For this reason, the water industry will be carrying out a programme of investigation which will include an appraisal of the relative merits of a range of control measures and it may be for example, that control at source (i.e. marketing and use restrictions) will be

more appropriate for some substances. Similarly the ports and harbours authorities are developing a national guidance framework on dredging and the disposal of dredgings, which will help identify technically feasible measures for implementation in subsequent river basin management planning cycles. It should be noted that new solutions identified or developed as a result of any programme of investigation will be subject to considerations of disproportionate cost.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Measures that are likely to be technically infeasible or disproportionately expensive will depend on the substance in question and the source of that substance. The PRPs include an evaluation of the technical feasibility and costs associated with available and potential measures, which is based on a range of supporting information, e.g. the preliminary cost effectiveness analysis (pCEA, Defra 2007).

This illustrates that some measures will be more useful in the first river basin management planning cycle than others. For example, it is feasible and relatively cost effective to investigate the concentration of lead in leachate from landfill sites and remediate where necessary (estimated at £5 million per tonne lead removed); it is neither feasible nor cost effective to replace all domestic lead pipes to prevent leaching into the sewerage system (£54 – 136 million per tonne lead removed).

It should be noted that some substances, e.g. cadmium are naturally occurring and complete elimination from all surface waters will not be possible. Where this is confirmed, we may decide to set less stringent objectives. We have received qualitative evidence from industry that some priority substances are present in the raw materials used in industrial processes, for example mercury is often present in caustic soda. It may not be possible to use alternative materials in some manufacturing processes, therefore any future measures would have to focus on end of pipe treatment – if technically feasible and not disproportionately costly. Similarly, cadmium is sometimes present in high concentrations in coal, but security of energy sources is of national importance therefore it may not be technically feasible to reject coal from cadmium-rich ore.

In some exceptional circumstances, water bodies may be so severely impacted (e.g. for some rivers polluted through a legacy of metal mining) that it may be technically infeasible or disproportionately expensive to restore metal concentrations to a level that approaches the standard due to the nature of the metal sources.

Reference	C4a
Element predicted not to achieve good by 2015	Priority substances, priority hazardous substances and specific pollutants
Reason for failure	<p>Confirmed - diffuse source - mixed urban run-off</p> <p>Confirmed - point source - water industry sewage works</p> <p>Suspected - point source - water industry sewage works</p> <p>Suspected - diffuse source - contaminated sediments</p>
Alternative objective	Extended deadline
Reason for alternative objective	Disproportionately expensive: unfavourable balance of costs and benefits
Justification for alternative objective	
<p>The water body is non-compliant with the EQS, but the costs of the measures are not proportionate to the benefits</p> <p>In a very limited number of cases where a water body fails to achieve the EQS for TBT, technically feasible measures are available but an alternative objective has been set because the costs of the measures are currently considered to be disproportionate to the benefits.</p> <p>Although most uses of TBT are banned in the EU, non-compliance with the EQS remains due to historic contamination in sediments. TBT may be present in imported textiles and treated timber and is present as an impurity in organotin compounds e.g. those present in PVC. There are numerous potential sources of TBT to the environment, many of which subsequently emerge at sewage treatment works.</p> <p>The measures that would address these sources in the first planning cycle include a ban on the marketing and use of TBT-treated timber, requirements for special storage arrangements for TBT treated wood, a restriction on the use of dibutyltin stabilisers in PVC or a change to building regulation to ban the use of articles containing TBT above trace levels in new buildings where the TBT may be released to water. Without an accurate assessment of the significance of these sources and the environmental benefit that would arise from addressing them, it would be disproportionately costly to proceed with these measures.</p> <p>An alternative option would require improved end-of-pipe treatment at sewage treatment works. The water industry has continued to improve effluent treatment in order to meet the requirements of the Dangerous Substances Directive and many discharges have consented limits for TBT and other substances. However, the new EQS for TBT is 100 times more stringent than the previous EQS and it is likely that in</p>	

some cases, effluent treatment will have to be upgraded further. In the absence of evidence on the removal efficacy of various treatment technologies, tertiary treatment with sand filters and granular activated carbon is considered the most effective treatment. However the preliminary cost effectiveness analysis (pCEA, Defra, 2007) considered that the immediate requirement of sand filters and GAC at all STW would be disproportionately costly on the basis of very large costs and unknown or limited benefits. Furthermore, it would be premature to require improved treatment given:

- the impact that other regulatory drivers will have on the sources of chemicals to the sewerage network from domestic, industrial and diffuse sources in the forthcoming years
- uncertainties over which sewage treatment works may need improvement given the controls currently in place or to be introduced and, hence, the technologies (secondary treatment, tertiary treatment or some other action) that may be required, and
- the large number of sewage treatment works that have to be assessed in relation to the above.

The pCEA recommended that the impact of current and planned measures should be allowed to take effect before additional measures are considered. Therefore under PR09, the water industry will carry out a programme of investigation to identify those STW that are at risk of causing non-compliance with WFD objectives for chemicals. They will also investigate the efficacy of various treatment technologies and carry out selected catchment investigations. This will allow a full range of options to be appraised where a risk is confirmed.

As a general point, if it is considered necessary and feasible to upgrade effluent treatment at a specific STW, the appropriate scheme may be proposed through the AMP process. The cost would be considered as part of this process and cost-effective schemes would proceed. There have been no instances where a local or site-specific case could be made for proceeding with schemes to achieve the requirements of the EQS Directive through PR09, due to the uncertainties outlined above.

In terms of addressing the risk from contaminated sediments: the Impact Assessment for the EQS Directive (Defra, 2009) estimated that to achieve the EQS for TBT by 2015, measures relating to capital and maintenance dredging would result in annual costs of £185 million (based on current practices). By phasing implementation through the setting of alternative objectives, further work could be carried out to assess the cost-benefit of alternative solutions. This would result in annual costs of £35 million.

Investigation type

Cost / benefit assessment where the case for progressing a measure has yet to be confirmed

Example of investigation

Under PR09, the water industry will carry out a programme of investigation to identify those STW that are at risk of causing non-compliance with WFD objectives for chemicals. They will also investigate the efficacy of various treatment technologies and carry out selected catchment investigations. This will allow a full range of options

to be appraised where a risk is confirmed. We are hoping to carry out similar programmes of investigation with other sectors. Cost / benefit assessments will be based on site-specific considerations.

Possible future measures

Possible future measures will depend on the outputs of any cost / benefit assessments carried out. Measures which could be appropriate for individual substances are set out in the PRPs but could include control at source, additional controls on point sources and actions to address diffuse sources. For TBT, this may mean a ban on the marketing and use of TBT-treated timber, requirements for special storage arrangements for timber treated wood, a restriction on the use of dibutyltin stabilisers in PVC (this option is currently being explored at the EU level), a change to building regulation to ban the use of articles containing TBT above trace levels or additional effluent treatment at STW. It may be that measures which are currently considered disproportionately costly in relation to environmental benefit may become more viable options if technology developments or market forces result in a more favourable balance of costs and benefits.

Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive

Measures that are likely to be technically infeasible or disproportionately expensive will depend on the substance in question and the source of that substance. The PRPs include an evaluation of the technical feasibility and costs associated with available and potential measures, which is based a range of supporting information, e.g. the preliminary cost effectiveness analysis (pCEA).

This illustrates that some measures will be more useful in the first river basin management planning cycle than others. For example, it is feasible and relatively cost effective to investigate the concentration of lead in leachate from landfill sites and remediate where necessary (estimated at £5 million per tonne lead removed); it is neither feasible nor cost effective to replace all domestic lead pipes to prevent leaching into the sewerage system (£54 – 136 million per tonne lead removed). It should also be noted that some substances, e.g. cadmium are naturally occurring and complete elimination from all surface waters will not be possible. Furthermore, in some exceptional circumstances where water bodies are severely impacted by a legacy of metal mining, metal concentrations are so high that it is unlikely that any treatment will restore concentrations to a level that approaches the standard.

E11 Surface water drinking water protection planning

Water bodies from which drinking water is abstracted have been designated as Drinking Water Protected Areas (DrWPAs). The objectives for such areas are recorded in Annex D.

Pressures affecting surface water DrWPAs

The main pressures affecting surface water DrWPAs are pesticides, nutrients and organic matter from agriculture, although risks also exist from mining, transport, industry and the urban amenity sector. These pollutants most commonly enter watercourses through 'diffuse' pathways, such as runoff from fields or hard surfaces after application or rainfall; or in the case of organic matter, through degradation of drainage channels in peat.

Compliance status

There are currently 145 DrWPAs at risk in England and Wales. For full details see Annex D.

Development of measures

For **point source discharges** we use all existing permitting and other relevant regimes that are applicable. The main examples are Water Resources Act consents and Environmental Permitting Regulations permits.

For **non-deliberate, or diffuse inputs** of pollutants the controls are both regulatory and advisory and are delivered by the Environment Agency or through partnerships. The main measures are anti-pollution works notices, Nitrate Vulnerable Zone action plans, codes of good practice, local agreements and partnerships, the pesticides Voluntary Initiative, England Catchment Sensitive Farming Delivery Initiative and ad-hoc delivery of pollution prevention advice.

Consideration of DrWPAs will be made when planning and delivering these activities.

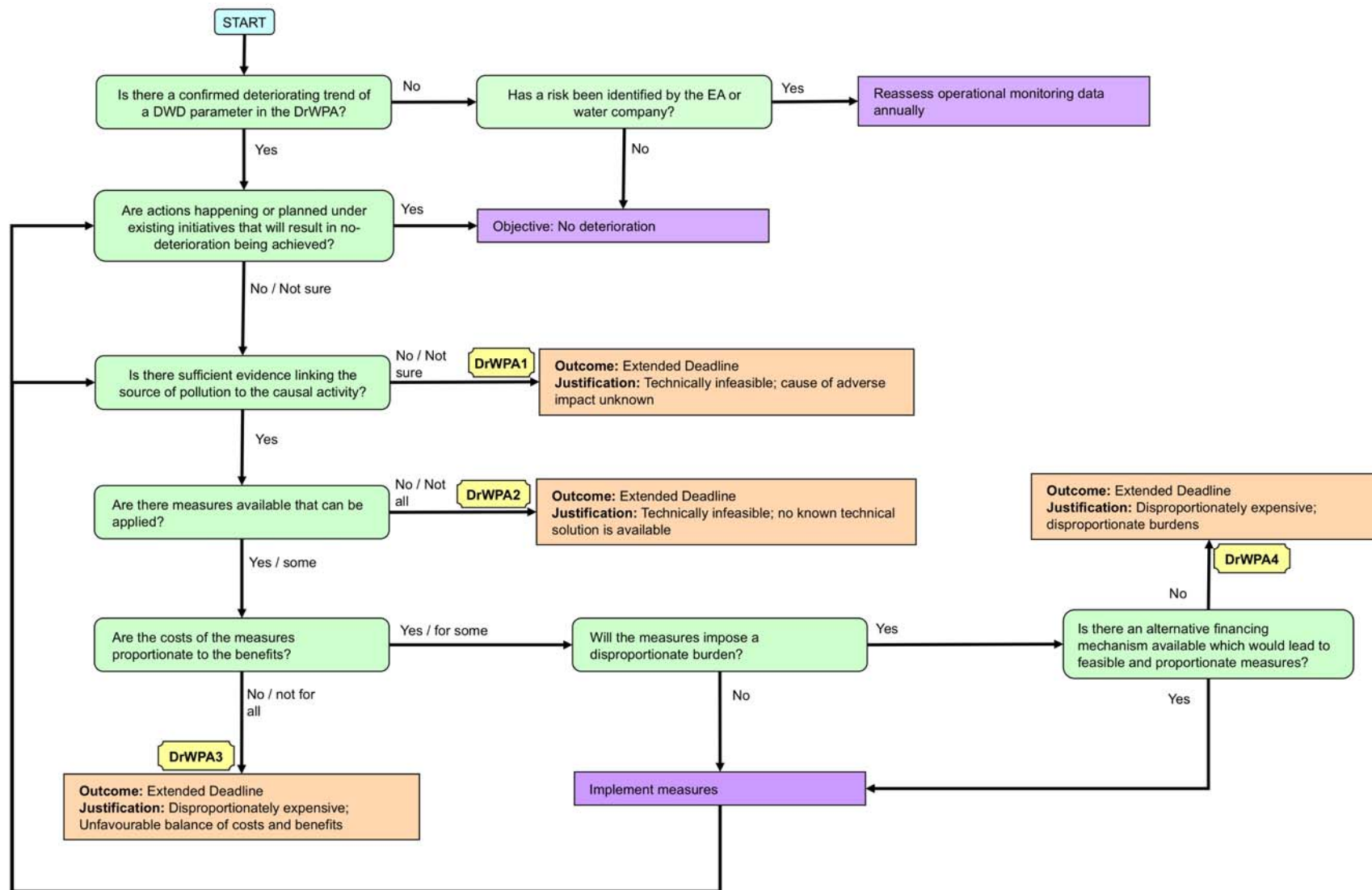
Where deterioration of DrWPAs can be confirmed with high confidence and existing measures are judged to be insufficient, Safeguard Zones may be established to target measures and gather information on the sources of pollution. Detailed Catchment Action Plans will be drawn up in Safeguard Zones to establish the necessary course of action.

The Environment Agency will seek to ensure the necessary environmental monitoring is undertaken to inform the designation of such areas and the programmes of measures needed.

Justification of extended deadlines

In some cases, although deterioration of water quality in a DrWPA can be confirmed, no measure can yet be applied because of the lack of understanding about the source or pathway of the pollutant. Extended deadlines for implementing measures have therefore been applied to 15 DrWPAs on the basis that measures are currently technically infeasible as the cause of the adverse impact is unknown. This decision process is outlined in the surface water DrWPA decision tree below and more detailed justification and supporting information is provided in the accompanying table.

**Decision tree for surface water
Drinking Water Protected Areas
(DrWPAs)**



Reference	DrWPA1a
Element predicted not to achieve good by 2015	Drinking Water Protected Areas
Reason for failure	Suspected - diffuse source agricultural
Alternative objective	Extended deadline
Reason for alternative objective	Technically infeasible: cause of adverse impact unknown
Justification for alternative objective	
<p>The specific source (location, specific activity and/or pathway) of the pollution is not known</p> <p>Metaldehyde, Colour and Ammonia are predicted to cause failure of Article 7 objectives with high confidence. Although safeguard zones have been proposed for Metaldehyde and Colour issues elsewhere, in these instances it is not possible without further investigations. The types of measures used for addressing these parameters are likely to be predominantly advice-based and will therefore require some level of targeting in order to be effective. While effective targeting of measures may not require individual contributors to be identified, it does require a degree of understanding of land use patterns within the catchment of the abstraction, and the interrelationships between the various source(s) and their transport media.</p> <p>Once investigations have yielded the necessary information, the Environment Agency will delineate Safeguard Zones and develop Catchment Action Plans within the first cycle.</p>	
Investigation type	
Investigate source of failure	
Example of investigation	
Where the source of the issue cannot be sufficiently precisely identified as described above, there will be a number of ways in which to provide the necessary information. The most likely way forward will be to undertake both a desk-based exercise, using GIS mapping techniques and/or source apportionment modelling, in tandem with a bespoke investigative environmental monitoring programme.	
Possible future measures	
Farm visits, local seminars and workshops, text messaging and leaflet distribution are all communication media that can be utilised to disseminate best practice material and information on the relevant regulatory requirements. There are a variety of mechanisms available for such activity. Where such voluntary measures are ineffective, works notices may be served if appropriate, or Water Protection Zone (WPZ) orders may be sought to introduce additional statutory measures such as, for example, localised substance restrictions or mandatory limits on stocking densities or	

fertiliser application.
Measures required to achieve 100% GES/GEP by 2027 that are likely to be technically infeasible or disproportionately expensive
Not relevant

E12 Identification and appraisal of M4 measures

Our staff identified the gap between the improvements resulting from M1-M3b measures and the achievement of Water Framework Directive default objectives in each water body. Local (M4) measures have been developed to help to close this gap, many of which were developed with liaison panels. A common set of appraisal criteria was developed with liaison panels and a national measures workshop was held in October 2007 to discuss and agree the criteria. This means that each M4 measure is developed, evaluated and recorded in the same way across England and Wales.

For the appraisal of our local (M4) measures we followed the nationally developed guidance. This essentially sets out a three stage process which is:

- Stage 1 – Identify solution / mechanism
- Stage 2 – Prioritisation and geographic targeting
- Stage 3 – Measures development.

A group of technical specialists assessed each of the measures against the agreed guidance and determined which should be included in the draft river basin management plan. As part of the draft plan, the measures were open to comment during the consultation. We received comments on the proposed measures and some respondents proposed new local measures.

Following the consultation the measures were reviewed. For each measures we considered:

- Will the measure address the issue?
- Is there an identified lead and co-deliverer(s)?
- Is there a high level of confidence in the effectiveness of the measure?
- Will it address more than one issue?
- Are there any constraints?
- Has funding been secured?

The measures are designed to be generic and were developed to capture the hundreds of measures that were suggested during development. We are trying to avoid very specific measures at this stage, due to space constraints and because in some cases we are uncertain which water body should be targeted within a catchment. Where we do have specific information we have provided some examples in the 'Where it will happen' column in Annex C. Further work will continue to target our local measures given that we now have classification information available to us.