Appendix A: The General Quality Assessment Scheme – Methodologies for the Classification of River and Estuary Quality

The Environment Agency's method for classifying the water quality of rivers and canals is known as the General Quality Assessment scheme (GQA). It is designed to provide an accurate and consistent assessment of the state of water quality and changes in this state over time.

The scheme consists of separate windows on water quality:

- **Chemical quality** – dissolved oxygen, biochemical oxygen demand and ammonia.

An indicator of organic pollution in general, chemical monitoring assesses the quality of rivers in terms of the measurements which detect the most common types of pollution – discharges of organic wastes from sewage treatment works, from agriculture and from industry.

- **Biological quality** – using macro-invertebrates.

An indicator or overall "health" of rivers, biological monitoring can provide information about types of pollution that would be missed by chemical monitoring.

- **Nutrient status** – phosphate and nitrate.

Levels of these nutrients are most likely to be directly influenced by human activities.

- **Aesthetic quality** – litter, foam, odour and colour.

Assessing river quality in terms of sight and smell, usually our first perception of the quality of a river.

Estuary quality – biological, chemical and aesthetic quality.

All data and results are made available to the public and may be obtained (for Anglian Region data) by contacting the Public Register team on 01733 464311.

What this document contains

Section 1. Offers brief background notes on the various parts of the GQA assessment scheme. These notes include tables showing "Grades at a glance" for each of the above windows. These "at a glance" tables will assist with the interpretation of any GQA printouts which may have been supplied.

Section 2. Reference is made during Section 1 to tables 1 to 9. These tables offer more detailed information on how grades are assigned and comprise the second part of this document.

Section 3. Offers information on River Quality Objectives, particularly the River Ecosystem scheme.

For further information

Please visit our website at www.environment-agency.gov.uk. From our home page follow the links to Science and Research, then What Science Is Happening Now, then Environmental Monitoring, then GQA Methodologies.

SECTION 1 – NOTES ON THE GQA

General Quality Assessment of Rivers – Chemistry

The chemical GQA describes quality in terms of chemical measurements which detect the most common types of pollution. It allocates one of six grades (A to F) to each stretch of river, using the same, strictly defined procedures, throughout England and Wales. The process is set out below.

To each sampling site, we assign a stretch of river that the site will characterise. In the main these sites, and the monitoring, are the same as those used to take decisions on developments that will affect water quality – discharges, abstractions and changes in land use.

We use only results from the routine pre-planned sampling programmes with samples analysed by accredited laboratories. To avoid bias we ignore all extra data collected for special surveys or in response to incidents or accidents. The routine programme involves monthly sampling at some 7,000 monitoring points on over 40,000 kilometres of rivers and canals in England and Wales.

Sites are sampled a minimum of 12 times a year. We use the data collected over three years because this produces 36 samples per site, giving the required precision in making judgements about particular rivers, bearing in mind the cost of monitoring. All the results collected over the three years are included. No extreme data values are excluded.

Chemistry grades at a glance

Grade	*Quality*
A	Very good
B	Good
C	Fairly good
D	Fair
E	Poor
F	Bad

A grade is defined in Table A.1 by standards for the determinands biochemical oxygen demand (BOD), ammonia and dissolved oxygen. A grade is assigned to each river length according to the worst determinand. These determinands are indicators of pollution that apply to all rivers, first because of the widespread risk of pollution from sewage or farms, and second because of the toxicity of ammonia and the requirement for dissolved oxygen for aquatic life, including fish.

Table A.2 describes the general characteristics of each grade.

General Quality Assessment of Rivers – Biology

Each biological sampling site corresponds to a stretch of river also characterised by a chemical site (but not all stretches have a biological sampling point). Although biological and chemical sites are not always coincident they are subject to the same water quality, and as far as possible are not separated by tributaries, discharges, weirs or other potential influences on water quality.

The biological scheme is based on the macro-invertebrate communities of rivers and canals, and include insects such as mayflies and caddis flies, together with snails, shrimps, worms and many others. Macro-invertebrates can be affected by pollutants that occur infrequently or in very low concentrations and which may be missed by chemical sampling.

For biological assessment, macro-invertebrates are grouped into 83 taxa. As different taxa respond differently to pollution, they are given scores of between 1 (pollution-tolerant taxa) and 10 (pollution-sensitive taxa). The presence of taxa sensitive to pollution suggests better water quality than for sites where only pollution-tolerant taxa are found.

By comparing taxa found in the sample with those expected if the river were unpolluted, rivers can be classified into one of six grades (Table A.3). There will be some rivers where water quality might permit a higher grade were it not for limits imposed by poor habitat, the nature of the river channel or the pattern of river flows.

The divisions between grades are based on the need to detect and report changes in biological quality so that any deterioration may be acted upon before it goes too far. The extremes (grades a and f) are set to reflect very good and bad quality, with intermediate grades set pragmatically between these extremes. Although the biology of these intermediate grades will differ from site to site in terms of the actual taxa that are present, the grades will reflect the relative position of the sites on a common scale between the best and worse possible quality.

The grading of waters through sampling is not precise. There is, on average, a risk of 22% that rivers will be graded incorrectly. It is unusual for this error to extend beyond the adjacent grade. There is a tendency for a pessimistic grade to be calculated as taxa are more likely to be missed than added when samples are analysed.

Biology grades at a glance

Grade	*Quality*
a	Very good
b	Good
c	Fairly good
d	Fair
e	Poor
f	Bad

General Quality Assessment of Rivers – Nutrients

Samples are analysed for their concentrations of two nutrients, nitrate and phosphate. Data collected over three years are used to determine average nutrient concentrations. All the results collected over three years are included. No extreme data values are excluded.

A grade from 1 to 6 is allocated for both phosphate and nitrate. These are not combined into a single nutrients grade, because they reflect different aspects of water quality. Table A.4 shows the limits for each phosphate grade. Table A.5 shows the limits for each nitrate grade.

There are no 'good' or 'bad' concentrations for nutrients in rivers in the way that we describe chemical and biological quality. Rivers in different parts of the country have different concentrations of nutrients. 'Very low' nutrient concentrations, for example, are not necessarily good or bad; the classification merely states that concentration in this river are very low relative to other rivers.

Phosphate grades

The descriptors used relate to the Phosphate concentrations in the grades. 'High' descriptions refer to grades where the average concentration is more than $0.1mgl^{-1}$. This is the concentration which is considered indicative of possible existing or future problems of eutrophication (the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing accelerated growth of algae and higher plant forms which can disturb the balance of organisms present in the water and the quality of the water concerned.)

High concentrations of phosphate do not necessarily mean that the river is eutrophic. Other factors have to be taken into account such as the amount and type of algae present, flow rates and dissolved oxygen concentration.

Nitrate grades

The descriptors used relate to the Nitrate concentrations in the grades. 'High' descriptions refer to grades where the average concentration is more than $30mgl^{-1}$. This limit very roughly corresponds to the 95 percentile limit of $50mgl^{-1}$ which is used in the European Community (EC) Drinking Water Directive and the EC Nitrate Directive. There is, however, no direct comparison because the methods used to calculate the 95 percentile for the purposes of these Directives are strictly laid down and cannot be estimated from average concentrations over three years.

Phosphate and Nitrate grades at a glance

Grade	*Description – Phosphate*	*Description – Nitrate*
1	Very low	Very low
2	Low	Low
3	Moderate	Moderately low
4	High	Moderate
5	Very high	High
6	Excessively high	Very high

General Quality Assessment of Rivers – Aesthetics

The aesthetic quality of rivers and canals is based on:

- litter (gross litter, general litter, sewage litter, dog faeces);
- oil, surface scum, foam, sewage fungus, ochre;
- colour and odour.

Litter items are counted in the water and on banks where there is public access. Oil, surface scum, foam, sewage fungus and ochre are assessed as percentage cover of the water surface or river bed. Colour is assessed in the field, odour is qualitatively assessed from the bankside.

The general rule is that a standard site comprises both riverbanks and the water. This is referred to as a 'two-bank site'. There will be sites where only one bank has public access or the river is so wide that each bank should be treated as separate sites. These are referred to as a 'one-bank site'.

Aesthetic grades at a glance

Grade	*Quality*
Grade 1	Good
Grade 2	Fair
Grade 3	Poor
Grade 4	Bad

Each parameter is assigned a class in the following way:

- Litter – the total number of items counted for each parameter;
- Oil, scum, foam, sewage fungus and ochre – the percentage cover of the water;
- Colour – hue and intensity;
- Odour – type and intensity.

Table A.6 shows this process in more detail.

Tables A.7 and A.8 show how a class is assigned for each parameter surveyed, for a two-bank site and a one-bank site.

The overall grade for a site is derived from the 'score' allocated to each parameter. The number of 'points' for each parameter is based on the relative importance given to each parameter from a public perception study. The final total score is simply the sum of the number of points for all parameters (Table A.9).

The scheme is designed so that a site can be classified as 'bad' by a high score for one parameter, if that parameter carries a high perception of poor water quality. Conversely a site will not be classified as 'poor' or 'bad' if only one parameter is present, and that parameter carries a low perception of poor water quality. A site might also be classified as 'poor' or 'bad' if a combination of parameters are present.

In November and December 2000 the Agency tested this method for monitoring the aesthetic quality of rivers across England and Wales. As a result, some changes to the method have been recommended. We are now working with the National Aquatic Litter Group to establish a new protocol that can be used by any organisation to monitor the aesthetic quality of rivers.

Estuarine Classification Scheme

The Environment Agency reports estuarine water quality in England and Wales every five years. This is based on an assessment and classification scheme prepared by the Classification of Estuaries Working Party (CEWP) in the 1970s.

Estuaries are classed as Good, Fair, Poor or Bad, based on:

- **biological quality** – presence of certain fish species
- **aesthetic quality** – evidence of aesthetic pollution, e.g., sewage-derived litter
- **chemical quality** – in terms of dissolved oxygen concentrations.

A score is calculated for each of these categories according to set criteria (Table A.10). These scores are added to determine the overall class (Table A.11).

Estuary classes at a glance

Class	*Quality*
A	Good
B	Fair
C	Poor
D	Bad

This scheme is due to be improved in the near future. Estuary quality will be reported to meet the requirements of the new European Community Water Framework Directive. This will classify the ecological status of estuaries using information on water quality, hydrology, plants, fish populations and benthic fauna.

SECTION 2 - TABLES

Table A.1: Standards for the chemical GQA			
GQA Grade	*Dissolved oxygen (% saturation) 10-percentile*	*Biochemical oxygen demand (mgl^{-1}) 90-percentile*	*Ammonia ($mgNl^{-1}$) 90-percentile*
A	80	2.5	0.25
B	70	4	0.6
C	60	6	1.3
D	50	8	2.5
E	20	15	9.0
F	<20	-	-

NOTES:
90-percentile compliance – the river should contain less than the specified levels for at least 90% of the time.
10-percentile compliance – levels should not fall below the standard for more than 10% of the time.
mgl^{-1} – milligrammes per litre
$mgNl^{-1}$ – milligrammes per litre of Nitrogen

Table A.2: Grades of river quality for the chemical GQA		
Chemical grade		*Likely uses and characteristics**
A	Very good	All abstractions Very good salmonid fisheries Cyprinid fisheries Natural ecosystems
B	Good	All abstractions Salmonid fisheries Cyprinid fisheries Ecosystems at or close to natural
C	Fairly good	Potable supply after advanced treatment Other abstractions Good cyprinid fisheries Natural ecosystems, or those corresponding to good cyprinid fisheries
D	Fair	Potable supply after advanced treatment Other abstractions Fair cyprinid fisheries Impacted ecosystems
E	Poor	Low grade abstraction for industry Fish absent or sporadically present, vulnerable to pollution** Impoverished ecosystems**
F	Bad	Very polluted rivers which may cause nuisance Severely restricted ecosystems

* Provided other standards are met
** Where the grade is caused by discharges of organic pollution

Table A.3: Grades of river quality for the biological GQA	
Grade	*Biological criteria*
a	The biology is similar to (or better than) that expected for an average, unpolluted river of this type, size and location. There is a high diversity of families, usually with several species in each. It is rare to find a dominance of any one family.
b	The biology shows minor differences from grade 'a' and falls a little short of that expected for an unpolluted river of this size, type and location. There may be a small reduction in the number of families that are sensitive to pollution, and a moderate increase in the number of individuals in the families that tolerate pollution (such as worms and midges). This may indicate the first signs of organic pollution.
c	The biology is worse than that expected for an unpolluted river of this size, type and location. Many of the sensitive families are absent or the number of individuals is reduced, and in many cases there is a marked rise in the numbers of individuals in the families that tolerate pollution.
d	The biology shows considerable differences from that expected for an unpolluted river of this size, type and location. Sensitive families are scarce and contain only small numbers of individuals. There may be a range of those families that tolerate pollution and some of these may have a high number of individuals.
e	The biology is restricted to animals that tolerate pollution with some families dominant in terms of the numbers of individuals. Sensitive families will be rare or absent.
f	The biology is limited to a small number of very tolerant families, often only worms, midge larvae, leeches and the water hog-louse. These may be present in very high numbers, but even these may be missing if the pollution is toxic. In the very worse cases there may be no life present in the river.

Table A.4: Phosphate classification		
Grade	*Grade limit ($mgPl^{-1}$) Average*	*Description*
1	<0.02	Very low
2	>0.02 to 0.06	Low
3	>0.06 to 0.1	Moderate
4	>0.1 to 0.2	High
5	>0.2 to 1.0	Very high
6	>1	Excessively high

NOTES:
$MgPl^{-1}$ – milligrammes per litre of Phosphate

Table A.5: Nitrate classification		
Grade	*Grade limit ($mgNO_3l^{-1}$) Average*	*Description*
1	<5	Very low
2	>5 to 10	Low
3	>10 to 20	Moderately low
4	>20 to 30	Moderate
5	>30 to 40	High
6	>40	Very high

NOTES:
$MgNO_3l^{-1}$ – milligrammes per litre of Nitrate

Table A.6: GQA aesthetics – classification scheme				
	Class 1 score	*Class 2 score*	*Class 3 score*	*Class 4 score*
Sewage litter	0	4	8	13
Odour	0	4	8	12
Oil	0	2	4	8
Foam	0	2	4	8
Colour	0	2	4	8
Sewage fungus	0	2	4	8
Faeces	0	2	4	6
Scum	0	1	3	5
Gross litter	0	1	2	3
General litter	0	1	2	3
Ochre	0	0	0	1

Table A.7: GQA aesthetics – class tables (two-bank site)				
Litter (number of items)				
Type	*Class 1*	*Class 2*	*Class 3*	*Class 4*
Gross	0	1-2	3-9	10+
General	0-5	6-49	50-99	100+
Sewage	0	1-5	6-24	25+
Faeces	0	1-5	6-24	25+
Other aesthetic parameters (percentage cover of oil, scum, foam, sewage fungus, ochre)				
	Class 1	*Class 2*	*Class 3*	*Class 4*
	0	>0-5%	>5-25%	>25%
Colour				
	Blue/Green	*Red/Orange*	*Brown/Yellow/Straw*	
Colourless	Class 1	Class 1	Class 1	
Very pale	Class 1	Class 2	Class 1	
Pale	Class 3	Class 3	Class 2	
Dark	Class 4	Class 4	Class 3	
Odour				
	Group 1	*Group 2*	*Group 3*	
No smell	Class 1	Class 1	Class 1	
Faint smell	Class 1	Class 2	Class 3	
Obvious smell	Class 2	Class 3	Class 4	
Strong smell	Class 3	Class 4	Class 4	

NOTES
Group 1 – tolerated and less indicative of poor water quality (musty, earthy, woody)
Group 2 – rated as indicators of poor water quality (farmy, disinfectant, gas, chlorine)

Group 3 – rates as indicators of very poor water quality (sewage, polishing/cleaning fluid, ammonia, oily smell, bad egg [sulphide])

Table A.8: GQA aesthetics – class tables (one-bank site)				
Litter (number of items)				
Type	*Class 1*	*Class 2*	*Class 3*	*Class 4*
Gross	0	1-2	3-6	7+
General	0-5	6-39	40-74	75+
Sewage	0	1-5	6-19	20+
Faeces	0	1-3	4-12	13+
All other parameters are the same as for a two-bank site				

Table A.9: GQA aesthetics – Total Score		
Grade	*Aesthetic quality*	*Total score*
1	Good	1, 2, 3
2	Fair	4, 5, 6, 7, 8
3	Poor	9, 10, 11, 12
4	Bad	>=13

Table A.10: Scores for biological, aesthetic and chemical quality of estuaries	
Description	*Points*
Biological quality (scores are totalled)	
(a) Allows the passage of fish to and from fresh water of all relevant species of migratory fish, when this is not prevented by physical barriers. Relevant species include salmonids, eels, flounders, cucumber smelts etc..	2
(b) Supports a residential fish population which is broadly consistent with the physical and hydrographical conditions.	2
(c) Supports a benthic community which is broadly consistent with the physical and hydrographical conditions.	2
(d) Absence of substantially elevated levels in the biota of persistent toxic or tainting substances from whatever source.	4
Maximum number of points	*10*
Aesthetic quality (one score allocated)	
(a) Estuaries or zones of estuaries that either do not receive a significant polluting input or which receive inputs that do not cause significant aesthetic pollution.	10
(b) Estuaries or zones of estuaries which receive inputs which cause a certain amount of aesthetic pollution but do not seriously interfere with estuary usage.	6
(c) Estuaries or zones of estuaries which receive inputs which result in aesthetic pollution sufficiently serious to affect estuary usage.	3
(d) Estuaries or zones of estuaries which receive inputs which cause widespread public nuisance.	0
Water quality (one score allocated)	
Dissolved oxygen exceeds the following saturation values:	
60%	10
40%	6
30%	5
20%	4
10%	3
below 10%	0

Table A.11: Estuary classes		
Class	*Quality*	*Number of points*
A	Good	24 to 30
B	Fair	16 to 23
C	Poor	9 to 15
D	Bad	0 to 8

SECTION 3 – RIVER QUALITY OBJECTIVES

Whereas the GQA is an *assessment of water quality at the time of sampling*, River Quality Objectives (RQOs) are *planned targets for water quality*.

The Environment Agency uses RQOs to plan improvements to river quality. RQOs ensure that river quality is checked against all the standards needed to support Uses.

Each river stretch has a group of Uses, and the amalgamation of the standards for all these Uses gives a set of water quality standards for that part of the river. These quality standards may be statutory (as laid down by various European Community Directives) or non-statutory.

The Environment Agency uses Local Environment Agency Plans (LEAPs) to consult on RQOs and to prepare plans for meeting the RQOs. If directed to do so by the Secretary of State, the Agency will also use these plans to prepare proposals to transform the RQOs into Statutory Objectives.

RQOs in Anglian Region currently cover the following Uses:

- River Ecosystem
- Abstraction for Public Water Supply
- Abstraction for Industrial Water Supply
- Spray Irrigation of Field Crops
- Livestock Watering

Abbreviations used for river stretch Uses are as follows:

PD Potable Water Supply (direct to treatment)
PI Potable Water Supply (via impoundment)
SI Spray Irrigation
LW Livestock Watering

Only River Ecosystem (RE) is a national system. For other Uses, plans will continue to be based on our Regional objectives for the present. The Agency refers to the River Ecosystem Classification, and other systems, when setting River Quality Objectives.

The River Ecosystem (RE) Classification

River Ecosystem is a use-orientated scheme of environmental objectives. Depending on the particular use of a river it will require a particular level of environmental protection and need to be of a certain standard of water quality.

RE targets specify the uses for which a particular river should be able to provide. For example, River A should be clean enough to support fish, while River B should be clean enough to allow abstraction for drinking water.

Having decided on the uses of a river, a decision must be made on what chemical standards will be required to ensure that this river is suitable for these uses, and hence to ensure that the RE target is met.

The River Ecosystem (RE) Classification comprises five hierarchical classes in order of decreasing quality. The five classes and how they relate to uses are illustrated in Table A.12, below.

Table A.12: River Ecosystem Classifications

Classification	*Use*
RE1	Water of very good quality and suitable for all fish species
RE2	Water of good quality and suitable for all fish species
RE3	Water of fair quality and suitable for high class coarse fish populations
RE4	Water of fair quality and suitable for coarse fish populations
RE5	Water of poor quality which is likely to limit coarse fish populations

Unclassified rivers will be:

- Rivers of bad quality in which fish species are unlikely to be present,

or

- Rivers for which there are insufficient data to enable the river to be classified,

or

- Some rivers with limited flow.

The chemical standards appropriate to these classes are detailed in Table A.13.

Table A.13: RE Classifications, Chemical Criteria								
Class	*Dissolved Oxygen (% saturation) 10-percentile*	*BOD (ATU) (mgl^{-1}) 90-percentile*	*Total Ammonia ($mgNl^{-1}$) 90-percentile*	*Un-ionised Ammonia ($mgNl^{-1}$) 90-percentile*	*pH Lower limit as 5-percentile Upper limit as 95-percentile*	*Hardness (mgl^{-1} $CaCO_3$)*	*Dissolved Copper (μgl^{-1}) 95-percentile*	*Total Zinc (μgl^{-1}) 95-percentile*
RE1	80	2.5	0.25	0.021	6 – 9	<=10 >10 – 50 >50 – 100 >100	5 22 40 112	30 200 300 500
RE2	70	4	0.6	0.021	6 – 9	<=10 >10 – 50 >50 – 100 >100	5 22 40 112	30 200 300 500
RE3	60	6	1.3	0.021	6 – 9	<=10 >10 – 50 >50 – 100 >100	5 22 40 112	300 700 1000 2000
RE4	50	8	2.5	-	6 – 9	<=10 >10 – 50 >50 – 100 >100	5 22 40 112	300 700 1000 2000
RE5	20	15	9	-	-	-	-	-

NOTES:
BOD (ATU) refers to the Biochemical Oxygen Demand measured when the sample is suppressed by adding allyl thio-urea
90- and 95-percentile compliance – this means that the river should contain less than the specified levels for at least 90 or 95% of the time, respectively
10- and 5-percentile compliance – this means that levels should not fall below the standard for more than 10 or 5% of the time, respectively
mgl^{-1} – milligrammes per litre
μgl^{-1} – microgrammes per litre
The standards of copper and zinc vary according to the hardness of the water. Hardness is measured as Calcium Carbonate ($CaCO_3$) in mgl^{-1}