Draft Final R&D Note R&D Project 237

Assessment of Low Flow Conditions Phase 2 Evaluation of Methodology

> Scott Wilson Kirkpatrick December 1991 R&D 237/2/T





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INTRODUCTION

This R&D Note summarizes the results of R&D Project B2.2, "Assessment of Low Flow Conditions" which has as its objective the development of a standard method for the as essment of low flow conditions, generally arising from over-abstraction.

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The method developed is based on the use of four Indicators and two Adjustment Factors as follows:

The Indicators are:

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Hydrological Ecological Landscape/Amenity Public Perception

Each Indicator is evaluated by combining scores assigned to a number of weighted Parameters which contribute to the Indicator. The Indicators can then be combined in a number of ways to determine for any site:

- * the severity of the condition
- * the reliability of the assessment
- * whether the problem is "real" or "perceived"

In order to assess the priority which each site should receive for alleviation, two Adjustment Factors are introduced to take account of:

- the Size of the affected site, i.e. the length and size of watercourse affected, and
 - the Cost, or more correctly the benefit/cost ratio, of alleviation

The "scores" and "weights" proposed are based upon experience and upon the results of field testing carried out in the late summer of 1991.

The full scope, history and background to the study are set out in the Final Project Report, dated December 1991, which is available from cach Regional R&D Coordinator, but this is not necessary for the application of the method.

However, a number of points should be understood before applying the method:

Not all Indicators or Parameters need to be used and indeed there are restrictions placed in some cases on the number of Parameters that can be used within an Indicator. This is because there is a degree of overlap or redundancy in the parameters, so that the user can select from a "menu" of Parameters those for which data are available and/or are most relevant to the particular site

ii) The amount and quality of data used in the assessment is reflected in the Reliability Index of the assessment.

iii) The method will not distinguish between low flows caused by drought and those caused by long-term abstraction. The assessment must therefore be reviewed in the

context of the degree of drought occurring in the years over which the data on which the assessment is made were collected.

iv) The method was developed during 1990 under the normal constraints of time and budget and was concluded before the results of some other very relevant and important research work became available, notably the evaluation by the Institute of Hydrology (IH) of the program "PHABSIM" which offers the prospect of a reasonably reproducible method of assessing minimum ecologically acceptable flows.

The method is explained in more detail in the following chapters, which are extracted from the full report and retain the numbering from that report.

The calculation of each Indicator is set out on sample calculation sheets and a spreadsheetbased macro, developed in Lotus 1-2-3, is also available to facilitate these calculations. INTRODUCTION TO ASSESSMENT METHOD

The Assessment Method is based on obtaining adequate evidence from four Indicators and two Adjustment Factors, namely:-

Hydrological Indicator Ecological Indicator Landscape/Amenity Indicator Public Perception Indicator Size Adjustment Cost of Alleviation Adjustment

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The steps involved in the assessment are shown on Table 6.1.

Scores are assigned to each Indicator and they can be combined in a number of ways (as set out in Section 12) to determine for any site:-

- the severity of artificially-induced low flows (The Severity Index)
- * the reliability of the assessment (*The Reliability Index*)
- * the degree to which the problem is real or perceived only O
- the priority which the site should receive, Regionally or Nationally for alleviation

The Indicators can be used at two levels:-

- Preliminary Screening, which requires minimum data and staff resource
- * Full Assessment, which requires a large data base and input from staff working in a number of disciplines.

For the Preliminary Screening, scores may be assigned directly to the Indicators by the assessor (see Section 12). However, this level of assessment will result in a low Reliability Index, as it relies on very limited data.

For the Full Assessment the score for each Indicator is calculated by combining scores assigned to a number of weighted parameters related to each Indicator (see Sections 7 to 10). The Full Assessment is comprehensive and time consuming and it is expected that it will only be applied to those sites for which some form of Preliminary Screening has suggested that the stream is suffering the effects of low flows.

In either case, it is not necessary to use every one of the Parameters or Indicators, but only those for which data is available, or those for which data can be collected at minimum cost.

Prior to evaluation of the Indicators, the assessor must first decide whether the length of watercourse affected should be treated as one site or as a whole series of separate sites. This is of particular significance where a length of several kilometres of river is affected. The decision rests with the assessor, but if treated as several sites, it is recommended that the sites should be selected either

- to reflect natural breaks, e.g. hydraulic controls, locks, different land uses or
- by dividing the river into (arbitrary) lengths of 1km

If divided, each length of (say) 1km can be assessed separately for Severity Index (SI) and Reliability Index (RI), with the option of taking the mean of them to produce the SI and RI for the whole of the affected length.

If the whole length is assessed as one, the assessor will, in effect, have to "average" the data for each parameter, over the whole length. Either approach should be valid.

Table 6.1 : THE SEQUENCE OF THE ASSESSMENT

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STEPS	Assessment required at each step
1	Define whether Preliminary Screening or Full Assessment required
2	Select Main Indicators of low flows (at least one for Preliminary, all for Full) Hydrological Indicator Ecological Indicator Landscape/Amenity Indicator Public Perception Indicator
3	Assign scores for the appropriate parameters of every Indicator used
4	Calculate Severity Index and Reliability Index for each of the indicators selected
5	Combine the Indicator Indices to obtain Overall Severity Index, and Overall Reliability Index
6	Adjust Overall Severity Index to take account of: Size, and Cost
7	Decide on the further action for the stream system.
8	Repeat steps 2 to 7 if more data is available

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7. THE HYDROLOGICAL INDICATOR

The Consultants propose that the Hydrological Indicator should be assessed on the basis of six parameters. Each of these parameters and the system of their scoring is discussed in the following sections. Table 7.1 shows a summary of all the parameters proposed.

7.1 Groundwater Balance Parameter (H1)

This parameter, applicable to streams mainly supported by groundwater flow would be calculated for the groundwater catchment considered to be suffering low flows. It is the sum of all annual groundwater abstraction licences (ALA) divided by the calculated annual recharge (AR), for the catchment upstream of an assessment point.

HI-ALA

Licensed surface water abstractions (SWALA in table 7.2) and effluent returns (ER in table 7.2) would be included only if

- a) parameter H2 is not used, and
- b) abstraction is primarily supported by spring flow. Otherwise they would be ignored.

Scoring would be as follows: _ _ _

ALA AR 10yrDrought+	Score
>1	4
0.7 - 1.0	3
0.4 - 0.7	2
0.2 - 0.4	1
< 0.2	0

* see (iii) below.

The weighting assigned is 50%.

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SUMM	IARY OF HYDROLOGICAL INDICATOR
Groundwater Balance parameter H1 -	Annual Licensed Abstraction (ALA/AR) Annual Recharge (1 in 10 yr. drought)
	Groundwater catchment. May need to add 'licence-exempt' abstractions, surface water abstractions and effluent returns. Weighting = 50%.
Riverflow Balance parameter H2 -	Daily Maximum Licensed Abstraction or Q95 "Natural" Q95 "Natural" Reservoir Compensation Flow
	Surface water catchment: Non-reservoired or Reservoired May need to add 'licence-exempt' abstractions, groundwater abstractions, effluent returns and downstream channel abstractions Weighting = 50%.
Groundwater Level parameter H3 –	Mean annual decline in minimum groundwater levels Mean Seasonal Range Welghting = 10%.
Stream Morphology parameter H4 –	Channel Size (% of Channel) Percentage of 'normal low flow channel' occupied by low flows at end of Augu Ratio of XSA(current) : XSA(normal). Weighting = 10%.
Row and Ecology relationship parameter H5 -	Residual Flow Minimum Ecologically Acceptable Flow
÷	Residual flow = (Q95 "Natural" - DMLA) for Non-reservoired catchments Residual flow = Compensation Flow (+ additions) for Reservoired catchments
	Weighting = 90%.
Movement of Springhead parameter H6 -	Change in Stream Type
	Length of stream reaches with changed classification (perennial – intermittent intermittent – ephemeral).
	Weighting = 10%.

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Table 7.1 : Summary of parameters related to the Hydrological Indicator

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Three points should be made concerning the application of this parameter

- i) As many affected sites are in the headwaters, it is likely in some (or many) cases that abstraction in adjacent catchments may affect low flows. Some judgement will be required to decide what is the appropriate catchment to be considered, or whether groups of catchments should be considered together.
- Some Regions stressed the occasional importance of unlicensed abstractions such as trickle irrigation, private domestic and stock watering usage. It is therefore proposed that where the assessor adjudges currently licence-exempt activities (x) to represent a significant proportion of the total annual abstraction within the catchment, an estimate is made and cumulatively accounted for in the form

$H_1 = \frac{ALA + (x)}{AR}$

iii) It had initially been assumed that this parameter would be calculated on the basis of the average annual recharge on the grounds that the marking system can be adjusted to allow for drought years. However, there is a strong argument for using the calculated annual recharge in the *I* - *in* -10 year drought (return period as defined by the Met Office, based upon the cumulative departure of monthly rainfall from the long-term mean indices) in order to more directly take into account drought conditions used by the Regions when setting abstraction licences

7.2 <u>Riverflow Balance Parameter (H2)</u>

This parameter, applicable to streams supported mainly by surface runoff, would be calculated for the surface water catchment. It is calculated differently for reservoired and non-reservoired catchments. For non-reservoired catchments, it consists of the sum of the daily maximum licensed abstraction (DMLA) divided by the naturalised 95 percentile flow (Q_{95}) assessed by the Institute of Hydrology (IH) Low Flow Study methods. Significant unlicensed abstractions and effluent returns would be added algebraically to the DMLA. In the event that parameter H1 is not used, licensed groundwater abstractions deemed to have a direct impact on low flows (e.g. within 250m of the river) would be similarly added.

Non-reservoired catchments:

$$H_2 = \frac{DMLA}{Q_{95}natural}$$

For reservoired catchments, storage usually permits the yield (i.e. reservoir abstraction) to greatly exceed Q_{95} . DMLA is not relevant, therefore, and a different approach to the calculation of the riverflow balance parameter is required. In this case, it consists of the Q_{95} natural divided by the reservoir compensation flow (COMP). Licensed abstractions from the channel downstream of the reservoir (DMLCA), significant unlicensed abstractions and effluent returns would be added algebraically to COMP. Licensed groundwater abstractions with a direct impact on low flows would again be added.

Reservoired catchments:

$$H_2 = \frac{Q_{95}natural}{COMP}$$

Scoring would be as follows:

$H2 - \frac{DMLA}{Q_{95}} H2 - \frac{Q_{95}}{COMP}$	Score	
÷ .		
>1	4	
0.7 - 1.0	3	
0.4 - 0.7	2	
0.2 - 0.4	1	
<0.2	0	

The weighting assigned is 50%.

In collecting the data to assign a score to this parameter the following points should be noted:

i) There has been some discussion on the relative merits of Q_{95} , the 95 percentile flow based on the flow duration curve and MAM the Mean Annual Minimum flow based on the flow frequency curves. Both of these measures are derived from the same basic data set and may not be truly representative of the 'natural' or 'historic' conditions since this data may include some flow data affected by long term abstraction.

It is understood that neither measure is 'better' than the other but consultation with the Regions indicated that Q_{ss} is more commonly used in this context.

ii) The Consultants have also considered whether the 1-day, 7-day or 10-day Q_{95} should be used. Provided that the same measure is consistently used, we do not believe it is critical which is selected. However, since current and future IH low flows work is standardising on 7-days, we would propose that the 7-day Q_{95} is used where such data is readily available.

iii)

- We recommend that licensed abstractions should be used in preference to actual abstractions. Where this is the case, licensed effluent returns should also be added to the balance. If, however, actual abstraction figures are used, actual effluent returns must be added, and not licensed quantities.
- iv) Although the parameter is calculated quite differently for reservoired and nonreservoired catchments it is not as simple as it may appear to distinguish between the two; -particularly -where a regulating- reservoir is some-wayupstream of, and therefore regulates a relatively small part of the catchment to, the site to be assessed. In this case the non-reservoired catchment parameter should be used, the compensation releases should be added algebraically to DMLA and any licences upstream of the reservoir should be ignored.

The reservoired catchment parameter is only applicable where the majority of the catchment is reservoired and there is a high degree of regulation.

The interpretation of "high degree of regulation", "some way upstream" and "regulates a relatively small part of the catchment" is left to the judgement of the user, but in borderline cases both reservoired and non-reservoired parameters can be assessed and the most appropriate one used.

7.3 Groundwater Level Parameter (H3)

Originally conceived within Phase 1 as an Aquifer Gradient Parameter, this effectively proved unworkable during evaluation by the Regions due to the sparsity of historic gradient data and the subjectivity of old contour maps.

During consultation with Regions it was consistently stated that a measure based on groundwater levels should be included, as level decline, if demonstrated, would be a clearer indication of lowering of aquifer levels.

This parameter would be calculated from the longer-term records of annual maximum and minimum groundwater levels, typically collected and tabulated as part of Regional monitoring networks, many originally instigated by the 1963 Water Resources Act.

If available, a borehole within the critical catchment under evaluation should obviously be chosen for the computation of H3. However, it is recognised that many 'upper' catchment zones and associated interfluve areas suffer from a dearth of monitoring boreholes. In such cases it is suggested that Regional hydrogeological staff utilise discretion to decide whether an alternative borehole record can be substituted. Although such a borehole may be in an adjacent catchment or downstream of the area under evaluation, it may be that similar aquifer characteristics and a comparative (radial) distance from the suspect groundwater abstraction zone may allow its utilisation.

This parameter simply aims to identify a gradual fall in aquifer storage, manifested by a decline in the annual minimum groundwater level. The annual low point (minima) of the groundwater hydrograph is noted for a sequence of at least five years. The mean annual decline (MAD) in the minima is then calculated over the chosen period of years.

In order to account for the natural seasonal variability in groundwater levels and allow for the significant differences in storage characteristics between the UK's major aquifers, it is suggested that the MAD is expressed as a ratio of the mean seasonal range (MSR) exhibited by the groundwater hydrograph over the same time period.

Hence

$H3 - \frac{MAD}{MSR}$

It is recommended that at least 10 years of continuous records be used, to help 'average-out' individual, or an occasional sequence of climatic extremes, such as dry (low recharge) winters and summer droughts.

Scoring will be as follows:

MAD MSR	Score
< 0.1	0
0.1 - 0.3	1
0.3 - 0.5	2
> 0.5	3
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Where local hydrogeological knowledge is of sufficient confidence to directly interrelate absolute (datum) levels of the affected river stretch with groundwater - for example a fissure zone originally contributing base flow but now allowing bed leakage due to reversed groundwater gradients - a discretionary higher score of 4 may be awarded.

The weighting assigned to the parameter is 10%.

7.4 Stream Morphology Parameter (H4)

This parameter reflects the proportion of the "normal low flow channel" occupied by low flows at the end of August. It would be calculated as the mean of the ratios of current cross-sectional area of flow (XSA current) to 'normal' cross-sectional area of flow (XSA normal) at not less than 5 representative cross sections.

A suggested definition of 'normal low flow channel' is the channel occupied by the base flow at the end of the month in which a Soil Moisture Deficit first occurs.

This is based on the premise that the impact of abstraction on low flows is far greater at the end of the dry season (when storage is drawn down) than at the beginning of the dry season, when storage should be more or less full. The Consultants have considered using wetted perimeter or hydraulic radius but have concluded that cross-sectional area is most appropriate. Since this parameter is based on relative rather than absolute areas, we believe it is acceptable to calculate area as surface width x maximum depth. However, this parameter must be used with caution,

- a) because following a dry winter in which full recharge does not occur, the 'normal low flow' may be abnormally low
- b) it is also a measure of the 'flashiness' of the river which is dependent on other factors such as geology and land use

It must not be used where the flow is significantly influenced by backwater effects from a control i.e. it should only be used where cross-section area is approximately proportional to flow.

H4-	XSA(Current)
	XSA(Normal)

Scoring would be:

% of Channel	Score
< 10%	4
10 - 30%	3
30 - 50%	2
50 -70%	1
>70%	0

The weighting assigned is 10%.

7.5 Flow and Ecology Relationship Parameter (H5)

The development of techniques to establish minimum ecologically acceptable flows (MEAF) is the subject of another NRA research project, reference B2.1 discussed in Chapter 2 of this report.

In using the MEAF it should be noted that the ecologically acceptable flow will not be a single value for a given river but will vary with season. As the methodology has not yet been defined in application in low flow assessment is, to an extent, premature. However, when such techniques are available, the relationship between low flow occurring and MEAF will be the most important single parameter in describing the severity of the problem and in monitoring and managing low flows. The following parameter is therefore proposed.

As a measure of low flow problems in surface water areas, the proposed parameter would be calculated differently for reservoired and non-reservoired catchments.

and

c)

For non-reservoired catchments:

 $H5 - \frac{Q_{95} - DMLA}{MFAF}$

where $Q_{95} = 95$ percentile flow for 'natural' catchment calculated from IH Low Flows Study. In this case MAM₇ may be a better measure than Q_{95} since it is based on a consecutive run of low flows).

DMLA = as defined in H2 above

MEAF = minimum ecologically acceptable flow in the critical month (September)

For reservoired catchments, DMLA is often much greater than Q_{33} and therefore the parameter as given above is invalid as a low flow indicator. The residual flow in reservoired situations is equivalent to the compensation flow (COMP) and therefore the parameter should be:

 $H_{a} = \frac{COMP}{MEAF}$

-~~ H5

Licensed abstractions from the channel downstream of the reservoir (DMLCA), significant unlicensed abstractions, effluent returns and tributary inflows (the sum of the Q_{55} for each tributary) would be added algebraically to COMP.

A possible problem is that the ecologically acceptable flow may be achieved in the month which is critical in terms of minimum flow but the (higher) ecologically acceptable flow required at some other time of year may not be achieved, is the critical time in terms of low flows may not coincide with the critical time in terms of ecologically acceptable flows.

The compensation flow for reservoired catchments should be determined at the same time of year as the MEAF. Generally, COMP will be the minimum compensation flow and MEAF will be the "minimum ecologically acceptable flow" in the year. However, the timing of these may not always coincide.

This parameter is more difficult to quantify where the abstraction is primarily from groundwater and in such a case the measured residual flow may have to be used.



The scoring would be as follows:

Parameter Value $H5 - \frac{Q_{95} - DMLA}{MEAF} H5 - \frac{COMP}{MEAF}$	Score
<60%	4
60 - 80%	3
80 - 100%	2
100 - 120%	1
> 120%	0

The weighting assigned is 90%

7.6 Movement of Springhead (H6)

Stream reaches can be classified into 3 main types: perennial, intermittent and ephemeral. These are defined, for this project, as follows:

Perennial reaches flow throughout the year.

Intermittent reaches flow for most of the year but are dry for at least 2 weeks (in the summer).

Ephemeral reaches only flow during and immediately after rainfall or snow melt.

The change in classification of a stream reach from either perennial to intermittent or intermittent to ephemeral is assumed to indicate a low flow problem. Such a change during a 1 in 10 year drought, however, is an exception to this and is not included. The "change" in stream parameter is defined as:

The total length of reaches of a stream, upstream of the assessment point, that have changed their classification from either perennial to intermittent, or intermittent to ephemeral.

H6 = Total Length of River with Changed Classification

Scoring would be as follows:

Length of river (Km)	Score
>8	4
4 - 8	3
2 - 4	2
0 - 2	
0	0

Equal importance is assumed for a change from perennial to intermittent, as a change from intermittent to ephemeral. Changes from perennial to ephemeral are unlikely but can be scored in exactly the same way.

The weighting assigned is 10%.

7.7 <u>Accretion/Depletion Profiles (H7)</u>

If available, such profiles are very descriptive of the problem but not easy to convert to a simple parameter. They measure the quality of the problem rather than its quantity. For the present it is not therefore proposed to include this in the list of assessment parameters.

7.8 Sample Calculation of Hydrological Indicator

Once all the parameters related to the Hydrological Indicator have been decided, based on data availability and suitability of the parameters for the catchment area, scores are calculated by the assessor. The score of four is the maximum that any parameter may be given. The degree of significance of each parameter is determined by a parameter weight, which is multiplied by the given score to arrive at a weighted score. The weighted scores are added together and divided by four times the sum of weights of parameters actually used, which will give the value of the Hydrology Severity Index (HSI).

Hydrology Reliability Index (HRI) is the sum of Weight of Parameters used.

Parameter	Parameter weight (a)	Weight of parameters used	Score (out of 4) (b)	Wrighted score (a) * (b)
H1	0.5	0.5	4	2.0
H2	0.5	-	-	-
НЗ	0.1	0.1	3	0.3
H4	0.1	-	-	-
H5	0.9	-	-	-
H6	0.1	_	_	-
Totals		0.6 (Y)		2.3 (Z)

Example Calculation of the Hydrological Indicator

From the above example the following calculations may be made:

Hydrology Severity Index (HSI)

TotWeightedScore HSI-TotWeightofParms+4 Z **Y**+4 2.3 0.6+4 -0.96

Hydrology Reliability Index (HRI)

HRI-TotWeightofParmsUsed -0.6

A complete sample calculation for a sample stream is shown on Table 7.2. Biank sheets for use of assessors when the assessment is undertaken by the Regional NRAs are given in Annex I. The calculation has been set up on a LOTUS spreadsheet for ease of calculation.

As a result of the evaluation (Phase 2) the parameter weights have been amended and the amended weights are shown in Table 7.2.

Two other amendments have also been made in the form of restrictions on the use of parameters, namely:

- i) The total weight of parameters used must not exceed 1.0, i.e. not all of the parameters may be used.
- ii) H1, H2, H5 are PRIMARY parameters.
- iii) H3, H4, H6 are SECONDARY parameters.
- iv) If any PRIMARY parameter is used, not more than one SECONDARY parameter may be used with it.
- v) If H1 and H2 are used together, the weight of each should be reduced from 0.5 to 0.4, to reflect the overlap of these two parameters.

The purpose of these amendments (which may appear rather complicated) is to prevent the same data being used in several parameters to produce a high score.

	T.	ABLE 7.2 : SAME		4	
		YDROLOGIC	AL INDICATOR		
			Rhor Evamola	DATE- 19/8/02	
	(see Haport Chapter	8 7.1 (0 7.8 for tull (ppianation of the met	nodołogy)	
H1 GROUND	WATER BALANCE PA	RAMETER -	ANNUAL LICENSEL	ABSTRACTION RGE	
	A A .	1000			
Calculated AR (ier ALA = 1 in 10 vr drought) =	1200	Im3/a (GWALA) Im3/a (AR)		
Total Annual 'Li	cence-exempt' Abst	- 1100	m3/a (X) -	ONLY enter if sign	ificant
Total Surface W	ater ALA =]m3/a (SWALA) /	ONLY enter if H2 n	ot used and
Ucensed Efficer	nt Returns (annual) =]m3/a (ER) <i>}</i>	ALA is supported b	y spring flow
	LA+X+SWALA-ERVAL	8 . 1.53	7		
			7		
ALA/AR	Score				
210					
0.7-1.0	3				
0.4-0.7	2	4.0			
0.2-0.4	1		Assign score: H1 =	4	PRIMARY
<0.2	0		•		
				1	
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Total Groundwat Licensed Effluen Non-reservoired cato DMLA/Q95 or Q95/COI >1.0 0.7-1.0 0.7-1.0 0.4-0.7 0.2-0.4 <0.2 H3 GROUNDM Mean Annual De Mean Seasonal F MAD/MSR = MAD/MSR - >0.5	ter DMLA (with direct in the Returns (daily) = catchments: Total DM thments: Q95/COMP = MP 4 3 2 1 0 VATER LEVEL PARAM cline in minimum grou Range = Score 4 3	mpact) = ILA/Q95 = (SWDML QNF/(COMP-DML	MISA (GWEMEA) MSA (ERTWO) A+X2+GWDMLA-ER CA-X2-GWDMLA+EI Assign score: H2 = mm m	J ONLY enter II I TWO/JONF = TWO) = 1.0 (MAD) (MSR) see Report Chapter	7.3 to assign acore
Total Groundwat Licensed Effluen Non-reservoired cato DMLA/Q95 or Q95/COI >1.0 0.7-1.0 0.4-0.7 0.2-0.4 <0.2 H3 GROUNDM Mean Annual De Mean Seasonal F MAD/MSR = MAD/MSR = 0.5 0.3-0.5	ter DMLA (with direct in it Returns (daily) = catchments: Total DM thments: Q95/COMP = MP 4 3 2 1 0 VATER LEVEL PARAM cline in minimum grou Range = Score 4 3 2	mpact) = ILA/Q95 = (SWDML QNF/(COMP-DML HETER ndwater levels =	MISA (GWEMEA) MISA (ERTWO) A+X2+GWDMLA-ER CA-X2-GWDMLA+EI Assign score: H2 = m m		7.3 to assign acore
Total Groundwat Licensed Effluen Non-reservoired cato Reservoired cato >1.0 0.7-1.0 0.4-0.7 0.2-0.4 <0.2 H3 GROUNDM Mean Annual De Mean Seasonal F MAD/MSR = MAD/MSR = MAD/MSR 1 ->0.5 0.3-0.5 0.1-0.3	ter DMLA (with direct in it Returns (daily) = it catchments: Total DM thments: Q95/COMP = MP 4 3 2 1 0 VATER LEVEL PARAM cline in minimum grou Range = Score 4 3 2 1	mpact) = ILA/Q95 = (SWDML QNF/(COMP-DML	m3/d (GWLMLA) m3/d (ERTWO) A+X2+GWDMLA-ER CA-X2-GWDMLA+EI Assign score: H2 = mm * If MAD/MSR > 0.5,	CMLY enter II I TWO/JONF = TWO) = 1.0 (MAD) (MSR) see Report Chapter	7.3 to assign acore

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		TABLE 7.2 : SAM	PLE CALCULATION (con't.)	
		HYDROLOGIC	AL INDICATOR	page 2 of 2
NRA REGION:	A region	NAME OF STREAM:	River Example DATE: 12/8/	92
	(see Report Ch	eoters 7.1 to 7.8 for full	emianation of the methodology)	
		ARAMETER		
Green	Current VSA	Normal YSA	Current	
Section	of flow (m2)	of flow (m2)	Normal	
1		35	2396	
2	9	44	20%	
3	15	49	31%	
4	22	<u>63</u>	35%	
5		Mean	2634	
96 of Char	nal Score			
<10%	4	4		
10-30%		3		
50-50%	•	2		+
>70%	. (D	Assign score: H4 = 3	SECONDARY
H5 FLOW AN	D ECOLOGY REL	ATIONSHIP PARAMET	ER - RESIDUAL FLOW	Y
				ACCEPTABLE FLOW
Q95(7) =	- 1100		m3/d (QNF) <i>) ONLY enter</i>	for non-res. catchments
Reservoir Comr	y nay = sensation Flow (m)	aan daily) =	m3/d (COMP) }	
Total downstrea	m channel abstra	ction (daily) -	m3/d (DMLCA)	
Total 'Licence-	exempt' abstractio	in (daily) =	m3/d (X2) CNLY enter for	reservoired catchments
Licensed Efflue	nt Returns (daily) -	•	m3/d (ERTWO) }	
Tributary Inflow	s (sum of Q95s) =		m3/d (TRIB) }	le redec de classe act as a
MEAP (CRUCE) R	10mm) =			is under development as p Project B2.1 and is as vet
(Q95-DML	AYMEAF Score	3	undefined)	
or COMP/	WEAF		المربوب مراجا الحالف	التوسيع ممانية المراجح
<60%		Non-res.	catchments: (Q95-DMLA)/MEAF = hmente: (COMP-DMI CA-X2+ERTWO	
80-100%		2		
100120%	, 100 1	Ĩ		
>120%	(<u>)</u>	Assign score: H5 =	PRIMARY
H6 MOVEME	IT OF SPRINGHE	AD paramete	r	
Total length of r	eaches changed fi	rom perennial to interm	ittent - km	
Total length of r	eaches changed fi	rom intermittent to epho	imeral =km	
Cum of row	abe: (km) Caar	51	Sum =km	- C.
Sum Of rea	LUBO (KIII) SCORE			
>6 4-8		3		
2-4	1	2		
0-2		1		
0	0	<u> </u>	(Assign acote: H6 =	SECONDARY
	CALC	ULATION OF HYDE	IOLOGICAL INDICATOR	
_ .	Param. weight	4	Weight of params. used Score	Weight x Score
Parameter	0.5)#H1 (& H2 are BOTH used,	0.4	1.6
Parameter H1	0.5 set b	oth weights to 0.4	0.4	1.6
Parameter H1 H2				0
Parameter H1 H2 H3	0.1			- I • • I
Parameter H1 H2 H3 H4 H5	0.1 0.1		0.1	0.3
Parameter H1 H2 H3 H4 H5 H6	0.1 0.1 0.9 0.1		0.1	0.3
Parameter H1 H2 H3 H4 H5 H6	0.1 0.1 0.9 0.1	SUM1 -	0.1 	0.3 0 0 SUM2 - 3.5
Parameter H1 H2 H3 H4 H5 H6	0.1 0.1 0.9 0.1	SUM1 -	0.1 0.9 (max. 1)	0.3 0 0 SUM2 - 3.5

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8. THE ECOLOGICAL INDICATOR

8.1 <u>Introduction</u>

8.1.1 Introduction - the 2.2 Low Flows Study TOR

The brief for the B2.2 Low Flows study was to develop a rapid low flows assessment methodology to be used nationally in ranking sites already flagged by the NRA as possible low flow problems. This would enable the finite funds available to the NRA for dealing with low flows to be distributed to Regions with the most serious problems.

To fulfil the TOR, it was necessary to consider the following points when developing the methodology

- 1) There was to be a minimum requirement for data collection, so the system should be based on established methods and incorporate historical data.
- 2) The methodology should be able to incorporate a wide range of data, collected by the various Regions in a non-uniform way, and usually for purposes other than low flows assessment
- 3) The methodology should be simple and non-time-consuming and should be understandable by non-specialists.
- 4) The methodology should extract as much information as possible from the data, which were likely to be scarce.
- 5) The methodology should be applicable to watercourses and river types in different geographical regions.

These constraints were particularly important when considering the ecological factors involved in low flows assessment, as biological data have been traditionally collected in an unstandardised way by the water industry for water quality monitoring rather than habitat assessment and conservation purposes.

8.1.2 Philosophy behind the ecological indicator

The assessment methodology provides a framework around which hydrological, ecological, landscape, cost and public perception information can be assembled and evaluated. The values or scores generated can then be used to rank sites which are competing for the NRA's limited low flows alleviation resources.

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The ecological indicator generates scores which reflect the extent to which low flows are jeopardising the channel and riparian communities which depend on groundwater or a surface watercourse. To generate valid scores, the ecological indicator must first define the function of flowing water to the channel and riparian communities, and secondly, assess the extent to which this function is being fulfilled. The function of running water for aquatic communities is to generate and maintain the habitat features the constituent populations require and to provide physico-chemical conditions within the range they can tolerate. There is therefore a complex inter-relationship between water chemistry, habitat structure and instream plant, fish and benthic macro-invertebrate community structure, which is central to the design of the ecological indicator.

Where food resources are adequate, habitat is sufficiently diverse and physico-chemical conditions lie within a particular range, a stable, diverse and well-balanced stream community will develop. This may include macro-invertebrates, submerged aquatic vascular plants and game or coarse fish. Changes in habitat or water chemistry caused by low flows, effluents, channel engineering or any other stresses will displace the delicate balance between the channel environment and colonising communities. This invariably causes a restricted species assemblage to adopt the habitat.

For example, cold, good quality, flowing water is important in generating the eroding habitats and physico-chemical conditions required by game fish and certain macro-invertebrate species. If these conditions change, the community will alter, as species adapted to exploit the newly established environment gain prominence. This change in community structure may occur as a direct response to changes in water chemistry and habitat structure, or may be the indirect effect of water quality on habitat structure.

Low flows affect both habitat generation and water quality, so the problem when developing the assessment methodology was to separate low-flow-induced effects from those caused by other factors affecting water chemistry and habitat, such as enrichment with sewage effluent and channel maintenance.

Flow decreases may derogate habitat by increasing sediment deposition and temperature, which in turn encourages the establishment of surface dwelling and emergent plants.

Decreases in water quality may debilitate sensitive species directly or may cause sediment or colonial algae/bacteria to accumulate at the channel surface thus altering the substrate available for colonisation.

Engineering activities may remove habitat features, alter flow regime/sedimentation and alter water chemistry.

By studying community structure, the condition of the stream ecosystem can be assessed. The aim of the community structure aspects of the macro-invertebrate, fisheries and plant parameters was to establish target communities, which, provided flows have been adequate, should have been achieved. If these targets are not met, then the shortfall is likely to be the result of low flows, which may be reducing water quality or affecting habitat or both. The method must be able to take account of the effects non-low-flow-related changes in water quality, channel engineering and river type have had on community structure up to the time of sampling. This is much the same as the 'tare' function on a laboratory balance which accounts for the weight of the beaker in order to display the weight of its contents. NRA Project B2.2 : Low Flow Conditions

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	SI	JMMARY OF ECOLOGICAL INDIC.	ATOR
E1	Invertebrate Community Parameter	Based on Average Score Per Taxon (ASPT). Ra	tio of measured ASPT : potential ASPT.
	(potential : measured ASPT)		Weighting = 40%.
E2	Fishery parameter (Non-tidal, Tidal, Access to	Decline in fish community from Game species to in tidal fisheries and access to migratory fish, al Also loss of fishing in short-term.	nrough to Coarse species; also declines I primarily due to low flows
	migratory fish)	• •	Weighting = 20%.
E\$	Fish Stocks parameter	Ratio of present fish stock : 'potential' fish stock	L.
	(present/potential fish stock x 100%)		Weighting = 30%.
64	Plant parameter	Seasonal change in terrestial plants in channel	and long-term change in bankside flor Welghting = 10%.
35	Conservation parameter	Assessed on basis of formally designated sites a sites.	and conservation value of non-designation
	·		Weighting = 30%.
5	tt Wilson Kirknetrick 1991		
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-			ترمية بية <u>و ـــــــــــــــــــــــــــــــــ</u>
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-	Table 8.1 : S	ummary of parameters related to the Eco	logical Indicator
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8.1.3 Overview of parameters comprising the ecological index

Five ecological parameters are proposed (Table 8.1), of which the first four will measure the impact of existing flow conditions and the fifth, conservation, will be used only if there is other evidence (hydrological or ecological) that low flows are occurring. The reasons for this are explained below. Data on invertebrates and fisheries will be used as measures of low flow conditions because they respond to sustained periods of low flows. These invertebrate and fish parameters may appear to be complicated, but this is essential so that the effects of low flows can be differentiated from effects of water quality and engineering. Bankside plants may contribute some limited information about the lowering of the water table.

Macro-invertebrate community parameter - It was decided to use average score per taxon (ASPT) as an index of macro-invertebrate community structure, and to down-weight the index to take account of non low-flow-induced factors such as water quality and engineering influences. The suitability of ASPT for this purpose is discussed further in section 8.1/2

Angling and Fishery parameter - There was no convenient summary fish-community index, so the method had first, to specify the changes in community structure which might be caused by water quality and habitat changes, and secondly to suggest the extent to which community change resulted from low flows. To attach factors to down-weight the effects of effluents, channel engineering and geographical location to the classification would have made it complex and cumbersome. For this reason, the implementation of the fishery parameter requires a fishery scientist to judge the extent to which low flows are responsible for changes in the fishery.

A further aim of this parameter was to incorporate information on 'fishing interests' as well as 'the fishery', which are not necessarily congruous. For example, trout spawn in gravel redds up tributaries and in headwaters, so if these habitats are lost due to low flows, the stream's 'fishing' could be made up by ensuring adequate water depth, and restocking with mature fish. This, however, would derogate 'the fishery'. So, satisfying the immediate needs of the angler does not necessarily ensure a successful fishery. However, it was felt that the parameter should take account of fishing interest, and respond to short- term effects such as the loss of fishing due to acute low flow incidents, as well as responding to long-term changes in community structure.

Fish stocks parameter - Low base flows affect community structure by reducing water quality and altering the eroding nature of the habitat. Low flows caused by river abstraction in contrast, are likely to reduce fish production and displace the age structure of the community in favour of young fish. In other words, although spawning may still occur, fewer fish will survive to develop the older year classes. Non-low-flow-related changes in water chemistry and habitat destruction may also affect fish stocks, so, as with other parameters, it is necessary to separate the influence of channel modifications and sewage effluents on fish stocks from that caused by flows. This will be done by introducing a scoring procedure similar to that suggested for the macro-invertebrates community. Alternatively, the fishery scientist may assess the extent to which low flows are contributing to the decline and allocate a score. The aim was to develop a methodology which was adaptable enough to incorporate whatever data was considered by the fishery scientists in the Regions to reflect their low flows problem. For this reason, the framework of the methodology has been kept simple and flexible.

Plant parameter - There is a dearth of data concerning plant distribution in the Regions but a plant parameter was included in the method to ensure that data which was available, could contribute to the low flows assessment. Again an informed judgement must be made by biologists in the Regions as to the extent to which low flows were responsible for the changes.

Conservation parameter - The final section of the ecological indicator, scores a catchment according to the presence of nationally or locally important conservation features. However, because the presence of conservation and landscape features provides no direct indication of the severity of low flows in the catchment, the conservation parameter should be used only when there is direct evidence that low flows are a problem. This is to avoid the accumulation of high scores on the basis of strong public perception of a problem in an area of outstanding conservation value with high water quality, but for which there is no direct evidence that low flows are causing the problem. In other words, the fact that a stream is of high water quality or supports a valuable wetland habitat or contains rare plant, fish or animal species is relevant only when there is hydrological or ecological evidence that low flows are threatening the catchment.

8.1.4 Long-term NRA-funded research to develop methods of determining Minimum Ecologically Acceptable Low Flow - MEAF

Research in North America and New Zealand during the late 1970's and early 1980's aimed to quantify the flow needs of the various stream communities. To protect the welfare of these fisheries that the Co-operative Instream Services Group of the US Fish and Wildlife Service developed the 'Incremental Flow Method' (IFM) in 1976. This system enables the amount of physical habitat available for various lifestages of fish to be estimated at different flows. Suitable habitat features must include the presence of sufficient water depth for the fish populations and the presence of eroding riffles (redds) in which eggs can be laid.

Similar habitat management methodology (Physical HABitat SIMulation - PHABSIM, NRA K&D topic 2.1) is presently being funded by the NRA and will eventually enable MEAF's to be determined for UK rivers. When this research is complete the MEAF will provide a benchmark against which to low flow derogation can be measured. This will eliminate the need for the more a methodology to assess the extent of habitat and community derogation by low flows.

8.2 Invertebrate community parameter (E1)

8.2.1 Development of the macro-invertebrate community parameter

There are various tools available to the NRA for analysing macro-invertebrate community structure. Most however have been developed for water quality monitoring purposes and must be specifically adapted for use in low flows assessment. The aim of the ecological assessment is to generate a target community; the community which would have existed at the site before the present low flows had influenced the habitat. If the present community fails to meet this target, then derogation will be indicated, for which low flow is likely to be the cause.

It is cumbersome to adapt a system such as **RIVPACS**^{*} for this purpose, as it predicts community structure from the physico- chemical conditions associated with the low-flow derogated habitat rather than that at the site under 'natural' conditions. The former is adequate when considering water quality because although the predicted fauna may be restricted, it can be concluded that water quality is not limiting when this fauna has been achieved. However, the latter is needed when considering low flows, as it is necessary to show that the community is below potential, is unbalanced and that the site probably supports smaller populations of fish than would otherwise be the case.

Unless historic physico-chemical data is available, adapting RIVPACS for low flows assessment would involve estimating the conditions (substrate size, alkalinity, depth, width, distance from source, gradient) which existed at the site before low flows became a problem. RIVPACS could then use these to predict the 'natural' assemblage for the site, which could then be compared with the present assemblage to give a measure of habitat derogation.

However, for the present assessment methodology, it was decided to adopt a simpler approach and to modify biological quality indices to generate macro-invertebrate community targets.

(*RIVPACS - River invertebrate prediction and classification system - was developed from research carried out by IFE - Institute of Freshwater Ecology - in the 1980's. Macro-invertebrate communities associated with a range of unpolluted streams throughout the UK were investigated in co-operation with the water industry. Species lists were manipulated with the multivariate statistics packages 'TWINSPAN' - TWo-way INdicator SPecies ANalysis - and 'DECORANA' - DEtrended COrrespondence ANAlysis - to cluster sites with similar community structure. These site clusters were then correlated with physico-chemical variables by Multiple Discriminant Analysis. When this information had been assembled it was possible to develop a package (RIVPACS) to operate in the reverse direction - in other words to predict the assemblages which might be expected at sites displaying a given set of physico-chemical characteristics.)

8.2.2 The ASPT-based macro-invertebrate community parameter

The indices of macro-invertebrate community structure which are most widely used for water quality purposes are the Biological Monitoring Working Party score (BMWP) and the related Average Score Per Taxon (ASPT). Unlike diversity indices, they do not rely on equating individuals per species with total number of species per site and are not greatly influenced by temporal changes. BMWP score and ASPT reflect biological quality by scoring the presence or absence of particular invertebrate types at a site. Both indices may vary in different geographical regions, scores at lowland sites being generally lower than those at upland sites. ASPT differs consistently between sites in upland and lowland areas and this effect is removed in the methodology by applying a factor of 0.8. The factor was developed from the IFE's analyses of the performance of BMWP score and ASPT at 268 sites in 41 catchments in the early 1980's (Armitage et al., 1983). Unpolluted upland site had maximum ASPT's of around 6.8, whereas lowland sites could have ASPT's as low as 5.4.

The following points were considered when developing the low flows assessment methodology around ASPT rather than BMWP.

a) BMWP score increases with sampling effort and is not a particularly useful index when comparing data between Regions, as the data will have been collected in different ways. ASPT suffers less in this respect.

b) BMWP will be greater at a habitat-diverse site (where there are many types of invertebrate, each adapted to exploit a particular habitat niche) than at a site with a relatively homogeneous habitat. Differences in ASPT between sites with diverse and homogeneous habitats is less extreme.

c) Both BMWP score and ASPT decline as habitat structure at a site changes from predominantly eroding to more depositing (beetles, bugs and species adapted to quiescent conditions score lower than lotic species). This decline in habitat may be caused by low flows or by increases in effluent discharge or by a combination of the two.

d) Both BMWP score and ASPT decline as the organic component (from sewage effluent, run-off etc) of the channel flow increases. This may be caused by low flows or by increases in effluent discharge or by a combination of the two.

It has been argued that at sites with relatively homogeneous habitat structure comprising habitat niches containing high scoring invertebrates (such as small mountain streams in Cumbria), the loss of some of these niches due to low flows will not alter ASPT but would alter species diversity. However, on a national scale, flows which reduce the number of habitat niches in a channel but do not destroy the eroding nature of the channel are far less severe than those which severely alter the nature of the habitat. The ASPT-based method would rightly score streams displaying habitat loss higher than those that do not.

If the high current velocities in mountain streams declined sufficiently to severely disadvantage the stoneflies, mayflies and caddisflies that compete effectively under such conditions, then other less-high-scoring species would increase in dominance. This would then reflect in ASPT.

The maximum achievable ASPT might therefore be a useful starting point from which to adapt water quality data for low flows application. The Consultants proposal is to successively down rate the index to take account of stresses due to water quality, channel engineering, and location (ie whether the source is in an upland or a lowland, and whether the site is in a headstream, mid-reach or lower reach). The product would be a coarse estimate of the ASPT potential of a stretch of river. If the ASPT measured for the stretch failed to reach this value, then it would indicate derogation, for which flow is likely to be the cause. The procedure would start with the question:



1) Is macro-invertebrate data available?

If the answer is 'NO' then the algorithm ends but if the answer is 'YES' then proceed to 2

2) Generate potential ASPT, as shown on flow chart in Figure 8.1.

This would score the invertebrate communities in fast flowing eroding headwaters with various proportions of sewage effluent differently from those in slower flowing more depositing reaches with similar sewage effluent components. In the same way, ponded depositing or 'heavily-managed' lower river reaches could be scored.

3) Relate the measured ASPT to the potential ASPT, and generate a score for the river stretch from the table below:

Measured	Potential ASPT								
ASPT	<4.5	4.5-5.0	5.1-5.5	5.6-6.0	6.1 -6.5	>6.5			
<4.5	0	1	2	3	4	4			
4.5-5.0		0	1	2	3	4			
5.1-5.5			0	1	2	3			
5.6-6.0	-4.			0	1	2			
6.1-6.5					0	1			
>6.5						0			



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Figure 8.1. Flow Chart to Generate Potential ASPT

Thus, the maximum score of 4 would be allocated where potential ASPT was high, and the ratio of measured to potential ASPT was low.

The weighting for this invertebrate community parameter, (E1) is 40%

8.3 Fishery parameter (E2)

The fishery parameter is based on the fact that a river can be divided into the following zones on the basis of fish community structure:

- 1) Trout-salmon zone
- 2) Grayling zone
- 3) Barbel-chub-dace zone
- 4) Bream-roach-tench zone

A change from one zone to another reflects changes in habitat and water chemistry and our assumption is that low flows affect fisheries primarily by altering these variables.

Data on species composition, population density and biomass is variously collected in the NRA regions, so the aim of the fishery parameter is to use this available data to score any changes in community structure and/or fishing potential which result from low flows. As with the invertebrate parameter, the main task is to separate low-flow-induced changes in water quality and habitat from those produced by effluents and channel modifications.

As there is no convenient summary index of fish community structure, the method must first, specify the changes in community structure which might be caused by water quality and habitat changes, and secondly, suggest the extent to which community change results from low flows. To incorporate a system to down-weight the effects of effluents, channel engineering and geographical location would have made the classification system complex and cumbersome, so the implementation of the fishery parameter requires the fishery scientists in the method to judge the extent to which low flows are responsible for changes in their fisheries.

A further aim of this parameter is to incorporate information on 'fishing interests' as well as 'the fishery', which, as mentioned in the overview of the ecological indicator, are not necessarily congruous. By responding to fishing interests, the method is able to make use of data on the short-term loss of fishing due to acute low flow incidents, as well as data on longer-term changes in community structure.

If there is evidence that a decline in fish community is due to low flows, then scores will be assigned from the table below. Decline might occur in, headstream, non tidal or tidal reaches. In non-tidal reaches the decline may involve deterioration in the quality of a game fishery, a coarse fishery or a conversion from a game to a coarse fishery. There might also be a loss of access for migratory species. Alternatively, the short-term impact of low flows on angling can be assessed by awarding scores of 0 to 4 where there is a decline in fishing in a river reach as a result of low flows:

Score	Description
0	No evidence of short-term impact of low flows on angling.
1	
2	
3	
4	No fishing was possible during a season due to low flows.

It is suggested that the maximum score from either the above source or the following table is carried forward for use in calculating the ecology indicator

Table of scores to be allocated where low flows produce changes in fish community structure:

Non Tidal	Fish community under	Decline due to low flows							
Fisheries	'normal' flow conditions	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Game	HEADSTREAM:								
	(a)Trout, salmon	2	3	4	-	-		-	•
	(b) Small trout only (+ loss of older year classes)	•	2	3	-	-	-	-	-
	(c)Minor species only (loss of spawning habitat)	-	-	2	-	-	-	-	
	(d)Complete loss lower reaches	-	-	•	-	•	-	•	-
	LOWER REACHES:					-		_	_
	(e)Trout	2	3	4	<u> </u>	1	2	3	4
Coarse	(f)Barbel, chub, dace, perch, pike	-	3	4	-	•	1	2	3
	(g)Small populations of species (f) (+ loss of older year classes)	+	2	3			1	1	2
	(h)Bream, perch, roach, tench	-	3	4	-	-	-	-	1
	(i)Small populations of species (h) (+ loss of older year classes)	•	2	3		-		140	

Tidal Fisheries	Access to migratory Fish						
Decline d	Decline due to low flows						
	2	b	c		a	b	c
(a)No reduction in Game or Coarse	-	2	4	(a) No reduction	-	2	4
(b)Seasonal decline to euryhaline spp	-	-	2	(b) 20% reduction	-	•	2
(c)Permanent decline to euryhaline spp	-	-	-	(c) 50% reduction	-	-	-

The weighting of the fishery parameter (E2) is 20%.

Værficationof holde needed. Put detalled barde ist, followed by suijde venso on p62.
8.4 Fish Stocks Parameter (E3)

Low base flows affect community structure by reducing water quality and altering the eroding nature of the habitat. This may cause a succession from a game to a coarse fishery, or result in the survival of only ubiquitous bottom-feeding species. In contrast, low flows caused by river abstraction are likely to reduce fish production and displace the age structure of the community in favour of younger fish. In other words, although spawning may still occur, fewer fish will survive to develop the older year classes.

The loss of older year classes is incorporated in the community structure table in the above section but the methodology should also be able to detect low-flow-related declines in production. This is the function of the fish stocks parameter.

As with other parameters, non-low-flow-related declines in water chemistry and habitat destruction may affect fish stocks, so, it is necessary to separate the influence of channel modifications and sewage effluents from that caused by low flows. This will be done by introducing a scoring procedure similar to that suggested for the macro-invertebrate community. Alternatively, the fishery scientist may assess the extent to which low flows are contributing to the decline and allocate a score accordingly.

The fish stocks parameter is based on a comparison of present fish stocks and the 'potential' fish stock. Potential fish stock would be derived by down-weighting fish stock measured before the low flow were a problem, to take account of subsequent adverse impacts of sewage effluents and channel modifications. An algorithm similar to that used for macro-invertebrates for this purpose is shown below.

This parameter (E3) may be calculated where present and archive data on fish stocks are available, or where the fishery scientist can reasonably predict the potential fish stock of a stretch of river. This system is flexible in that data in various forms can be used. These might include population density, biomass or which ever variable is measured in the individual Regions.

The procedure on the flow chart below would start with the question:

1) Is data on fish stock available for the period before low flows were perceived as a problem (or can a reasonable estimate of such fish stocks be made)?

If the answer is 'No', then the algorithm ends, but if the answer is 'Yes' then use the flow chart below to generate potential fish stocks.

	Channel modifications	Effluent component (NWC Class)	Potential fish stock value (NP)
	Low (x1)	Decrease (x1)	
Past stock	Moderate (x0.9)	No change (x1)	
	High (x0.8)	Increase (x0.8)	

2) Compare the measured present fish stock (NM) with the potential fish stock (NP) as the ratio:

<u>NM</u> NP

and then convert to a percentage (multiply by 100).

A value of less than 100% indicates that a decline in fish stocks has occurred and may result from low flows. The greater the stock depletion, the more serious the effects of low flows. A value greater than 100% indicates that there is probably no decline in fish stocks due to low flows.

Score	Value to which fish stock has decline	Severity of low flow related decline in fish stock		
4	<40%	Serious decline		
3	40 - 59%	Large decline		
2	60 - 79%	Moderate decline		
1	80 - 99%	Slight decline		
0	>100%	None		

3) A scoring system for this parameter is suggested below.

The weighting of this Fish Stock (E3) parameter is 30%

8.5 Plant Parameter (E4)

In upland reaches, high flows and current velocities erode and scour the channel, and encourage the colonisation of submerged, well attached algae and thin-leaved vascular plants.

Thin leaves reduce the risk of dislocation during spates but at the same time protect against burial during periods of sediment deposition. In contrast, low flows may increase sediment deposition and temperature and cause surface dwelling, strap-leaved and emergent plants to establish. The establishment of this community may then encourage further sediment deposition, leading eventually to the establishment of riparian species within the channel.

Algal and aquatic vascular plant data is not widely available in the Regions. However, abnormal short-term invasion of the channel by riparian species during summer months, and the longer- term changes in herbs, shrubs and trees on the river banks should be scored. As in the fishery parameter, an informed judgement must be made by biologists in the Regions as to the extent to which low flows are responsible for the changes.

Score	Description
0	No change, other than normal seasonal variation in channel or bankside flora.
2	Abnormal invasion of the river channel in summer by marginal terrestrial plants.
4	Bankside flora has changed or is changing due to a lower water table.

The plant parameter (E4) weighting is 10%.

8.6 <u>Conservation parameter (E5)</u>

This parameter (E5) assesses the value of river corridors in conserving natural habitats and wildlife. The assessment is based on two sources of information. First, it takes account of the formal designation of conservation areas which rely on groundwater or surface water to maintain their character. Secondly, this parameter incorporates the duty of the NRA to conserve the whole river system, including groundwater levels and springs.

The NRA's code of practice (Water Act 1989, section 9) states that priority should be given to the conservation of SSSI's and sites of national importance. SSSI's based on fisheries assets have not been widely designated but English Nature is undertaking that task at present. Assessments for this parameter should be made by Conservation Officers in the Regions who will have access to English Nature's list of designated sites and the data from river corridor surveys commissioned by the NRA.

After liaison with the NRA it has been decided to include the water quality standard of a river stretch in this parameter. However, the presence of good quality water and conservation/landscape features provides no direct measure of the severity of low flows in the catchment, so the conservation parameter should be used only when there is direct evidence that low flows are a problem. The conservation parameter will then assist in prioritising sites for support. This is to avoid the accumulation of high scores based on strong

public perception of a problem in an area of high conservation value with high water quality, but for which there is no direct evidence that low flows are causing a problem.

The scores apply to ponds and open water as well as flood plain meadows, marshlands, swamps, fens, carrs, mires, flushes and river banks and islands. Formally designated sites should be awarded scores as outlined in the upper section of the table below. Sites within the river system should be awarded scores as indicated in the lower table and the two scores added together. Cumulative scores should be divided by 2 to calculate this ecological parameter. A maximum score of 4 can be generated.

Score	Channel, riparian or other habitats depending on surface or groundwater for their character
5	RAMSAR Sites, National Nature Reserves (NNR's) Marine Nature Reserves (MNRs') Special Protection Areas (SPA's). Sites of Special Scientific Interest (SSSI's) Habitat of species protected by EC Directive or Wildlife and Countryside Act
4	Conservation sites of regional or county importance (eg Naturalist Trust Reserve, RSPB reserve).
3	Local nature reserve
0	No formal designation

The conservation parameter (E5) should be given a weighting of 30%.

'Local nature reserves' is an umbrella term for features referred to variously as Heritage sites, c-sites, local nature reserves and sites of historic interest.

Score	Instream and riparian habitat
3	High conservation value, eg a diverse, natural and typical habitat of a viable size and containing species sensitive to disturbance. NWC class 1 stretch
2	Moderate conservation value, eg a smaller or less diverse site; or a site with natural or typical habitat but no particularly threatened species. NWC class 2 stretch
1	Site of minor conservation value NWC class 3 stretch
0	Site of no conservation value. NWC class 4 stretch

8.7 <u>Sample Calculation of Ecological Indicator</u>

A full sample calculation for the Ecological Indicator is shown in Table 8.2. Blank calculation sheets to use in NRA Regions are attached in Annex I.

As a result of the evaluation (Phase 2) the parameter weights have been amended and the amended weights are shown on Table 8.2.

In addition further restrictions have been placed on the use of parameters as follows:

- i) The total weight of parameters used must not exceed 1.0, i.e. not all of the parameters may be used.
- ii) Parameter E5 should not be used unless there is other firm evidence of low flows, from at least two of parameters H1, H2, H5, E1, E2, E3.

TABLE 8.2 : SAMPLE CALCULATION

.

	EC	COLOG		NDIC/	TOR	_	_	_		page	1 of
IRA REGION:	A region NA	ME OF ST	REAM: R	iver Exa	mple	0	ATE:	12/8/92			
	(see Report Chapters (9.1 to 8.7 f	or full exp	vanation	n of meth	odology)					
1 INVERTEB	TATE COMMUNITY PARAMET	TER									
enerate potenti	al ASPT:										
elect multipliers	-										
SOURCE -	- 	URCE: Up	land = 1:	Lowland	d = 0.8						
REACH -	0.95 RE/	ACH: Head	dstream =	1; Mid	= 0.95; L	.ower = 0.	9	-			
	IS. = 0.95 CH	ANNEL MI	ODIFICAT	TONS.:		= 1; Mode class 1)	rate = 0. 1 · Mode	95; Ede maa (MM	NSIV9 = MC clas	= 0.9 H= 21	
EFF.COMP.				Hig	th (NWC	class 3) =	0.9			10 £j =	v.a
stential ASPT -	6.14										
easured ASPT	- 4.80										
				007							
Score	-4.5	۳ ۸5-50 5	-0(0m12)/ :1_5 5 5	6-60 A	81_85	~6.5					
		J.U J	. 1-J.J J.	0-0.0 0	A 1-0.5	-0.0					
	<4.3 U 4.5-5.6	1	2	3	4					÷	
Measured	5.1-5.5	U	ċ	1	2	3					
ASPT	5.6-6.0		_	0	1	2					
	6.1-6.5				0	1			_		
	>6.6					0	Ŀ	Assign a	core:	E1 = 🛛	3
	ARAMETER					<u> </u>					_
Non-Tidai F	isheries:										
Score	Fish community under					Decline du	e to low	flows			
	'normal' flow conditions		F .	-1	•	-	•		6 1		
Gamo	Handetzaam		0)	C)	a)	8)	ŋ	φ.	ny	9	
Gaune			-2	3			.+. <u>-</u> 2*	1	•••••••••••••••••••••••••••••••••••••••		
	b) Small trout only (+ loss	ofolder	120	2	3	_	_	-	-	_	
	year classes)				•						
	c) Minor species only (los	is of	•	-	2	-	-	-	-	-	
	spawning habitat)										
1	Lower reaches									- 1	
	e) Trout		2	3	4	-	1	2	3	4	
COL	f) Barbel, chub, dace, per	rch, pike		3	4	-	-	1	2	3	
	g) Small populations of sp	oecies f)	•	2	3	-	-5 4 6	-	1	2	
1	(+ loss of older year cla	isses)									
	n) Bream, perch, roach, to			3	4		-	•	-	1	
	I) Small populations of spo	ecies n)	-	2	3	-	-	-	-	-	
L		19969)		_				·			
Tidal Fisher	86 .					Access to	migrator	y Fish:			
	Dec	line due to	low flow	8]	Г			Decline (lue to l	ow flo	ws
		a	Ь	c					b	C	
a) No reduct	ion in Game or Coarse		2	4	la la	a) No redu	ction	-	2	4	
b) Seasonal	decline to euryhaline spp		•	2	l t	o) 2096 rec	luction	-	. •	2	
	it decline to euryhaline sp	-	-			:) 50% red	uction	-		-	
c) Permaner			<u>_</u> .	<u></u>							
C) Permaner			ç	Core							
C) Permaner	Short-term impact para	lmeter	•	~~~							
C) Permaner R: No fishing w	Short-term impact para as possible during a season du	ue to low fi	ows	4							

TABLE 8.2 : SAMPLE CALCULATION (cont'd)

			ECOLOGICA	L INDICATOR		pag	e 2 of 2
NRA REGI	ON: A re	glon	NAME OF STREAM	I: River Example	DATE	12/8/92	
	(see Report Chap	ters 8.1 to 8.7 for ful	explanation of metho	dology)		
E3 FISH:	STOCKS PAR	AMETER					<u> </u>
Generate p	otential fish st	ock: Past fish	stock (N) -				
Select mult	tipliers: (E	Chan.Mods.= Eff.Comp. =	CHAN EFFL	INEL MODIFICATIONS	S: Low = 1; Mode Decrease = 1; No	rate = 0.9; High = () Change = 1; Incre	0.8)ase = 0.(
Potential fit Present/Po	sk stock (NP) - tential Fish Sto	N x multipliers - ck (FSR%) +		Measured present fi	ish stock (NiM) =		
Prese	nt/Potentiai	Decline r	related to low flows	Score			
Í	<40%		Serious decline	4			
	40-59%		Large decline Moderate decline	3			
	80-99%		Slight decline	ī			
	>100%	<u></u>	None	0	l.	Assign acone and	
E4 PLAN	T PARAMETE	R					
Descr	iption of chang	Jes			Score		
Banks	side flora has c	hanged or is cha	nging due to a lower	water table	4		
Abnor	mal Invasion o	f the river channe	el in summer by mar	ginal terrestrial plants	2		
No ch	ange, other th	an normal seasor	nal variation in chann	el or bankside flora	07	lssion acorec E4 =	2
·							
5 CONS	SERVATION P/	NRAMETER					
Only use th	is parameter il	there is direct en	vidence that low flow	s are a problem (i.e. fr	om 2 of paramete	ws H1,H2,H5,E1,E 2	2, <i>E3</i>)
Forma	ally designated	sites:		(+)			
Chann	nel, ripartan or	other habitats de	pending on surface	or groundwater for the	Ir character		
RAMS	AR Sites, Nati	onal Nature Resi	erves (NNRs), Marine	Nature Reserves (MN	IRs), Special Pro	tection Areas	5
(SPAs Count	i), Sites of Spe ryside Act	cial Scientific Inte	arest (SSSIs), Habita	t of species protected	by EC Directive (r Wildlife and	
Conse	irvation sites o	f regional or cour	nty importance (eg N	aturalist Trust Reserve	, RSPB Reserve	•	4
Local	nature reserve	(including Herita	ige sites, C-sites, an	d Sites of historic inter	rest)		3
No for	mal designatio	n					0
Sites v	within the river	system:					
Instrea	am and riparia	n habitat				S	core
High c	conservation va	lue, eg a diverse	, natural and typical	habitat of a viable size	and		3
contai	ning species s	ensitive to disturt	bance. NWC class 1	stretch			2.1
Moder	ate conservati	on value, eg a sm	haller or less diverse	site; or a site with nat,	Iral or		2
typical	l habitat but no	particularly threa	atened species. NW	C class 2 stretch			
Site of	l minor consen	vation value. NW	C class 3 stretch			1	1
Site of	no conservati	on value. NWC c	lass 4 stretch			- N. K. S. S.	0
vdid acores	from both tabl	es and divide by :	2 to give final E5 sco	re.	[A	ssign score: E5 =	2
		CALCUI	LATION OF ECOL	OGICAL INDICAT	DR		
Parameter	Para	m.weight	Weight of params, u	used Score	Weight x S	icore	
Eı	0	4					
E2	0.	2		1	0.0		
E3	0.	3		┥ ┝────┥	0.0		
E4	0.	1	0.1	2	0.2		
es 🛛	0.	3	0.3	2	0.6		
			SUM1 - 0.8	(max.1) SUM2 -	2.0		
	ovority Indox						
		$\rightarrow \text{COM2}(\text{OUR})$	n 1 Anj 2				
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9. THE LANDSCAPE AND AMENITY INDICATOR

This indicator incorporates parameters describing the overall importance of the river in the landscape and also the impact of low flows on the visual outlook and on the recreational and amenity use of the river. A summary of the parameters included in this Indicator is given in Table 9.1. This indicator provides an assessment of the value of the river and river corridor, as perceived by people. The wider implications of the landscape must be established first, in order that the seriousness of any problems associated with low flows can be assessed. Secondly, this indicator assesses the extent to which the amenity of the river/river corridor is affected by low flows during the summer months.

Data collected in a consistent manner and recorded in a standard form, will produce consistent and comparable results. The assessment is 'built up' by applying the method to each 1000m length of river. Where the length of river to be assessed is in excess of this length, the total score for the full length is divided by the number of sections (of 1000m) surveyed. The component parts of the landscape, such as trees, landforms and artifacts, will be recorded and their importance to the landscape as a whole will be assessed. All landscape assessments should take place at a specified time of year. This could possibly correspond with the timing of the first sampling of river invertebrates in spring/early summer. This assessment could be carried out by the same ecological/conservation survey team, after an introduction to the specialist techniques required. Alternatively, personnel trained in landscape assessment techniques could be employed.

9.1 Landscape Designation and Rarity Parameter (L1)

This parameter L1, assesses the *importance* of the landscape through which the river flows. It will be important in prioritising competing projects for low flow alleviation, but since it is not a measure of low flows as such, it should be only used if there is other evidence that low flows occur. The parameter L1 is derived from two components, the landscape designation and landscape rarity.

Landscape Designation

The value of the landscape to people has already been established by the designation of tracts of landscape into categories such as National or Country Parks. These categories indicate the importance of a piece of landscape in the national and local context and have been allocated scores accordingly:

Score	Description
2	Important in a national context, ie National Parks and Areas of Outstanding Natural Beauty.
1	Important in a local context ie Areas defined as Country Parks/Special Value etc within local or structure plan context.
0	Landscape has no official designation.

An additional score may be awarded as follows:

+1 Areas which are undergoing environmental improvements (either national or local) and where finance exists to support such improvements ie landscapes within Development Corporation Areas, Local Initiative Areas.

Landscape Rarity

The importance of a river or river corridor within its wider landscape is assessed by this score for rarity. A higher score is awarded to a river or river corridor which is rare in a *national* context - as opposed to a *local* context - as this reflects the greater sensitivity with which these landscapes have to be treated.

Score	Description
2 Where river/river corridor landscape is "the best examples of" in the national control	Where river/river corridor landscape is "the only" or "one of the best examples of" in the national context.
1	Where river/river corridor landscape is "the only" or "one of the best examples of" in the local context.
0	The river has no rarity value.

The score for Parameter L1 is the sum of the scores assigned under Landscape Designation and Landscape Rarity, with a range of 0 to 4 ie a score of 5, which is possible , would be counted as 4..

Landscape designation and rarity parameter (L1) weighting is 20%.

9.2 The Importance of the River as a Landscape Feature and its Impact on Adjacent Land (L2)

This parameter (L2) is also derived from two components:

	SUMMARY OF LANDSCAPE AND AMENITY INDICATOR				
L1	Landscape Designation and Rarity parameter	Designation: Nat.Parks & Areas of Outstanding Na Rarity: 'National' and 'Local' Rarity.	itural Beauty/Country Parks/no desig		
	(Designation + Rarity Score)		Weighting = 20%.		
12	Importance of the river as a landscape feature and its impact on adjacent land parameter	Importance: Visual Importance of river. Impact: Be land use.	neficial or degraded adjacent		
	8	(Importance + Impact)	Weighting = 30%.		
LS	Recreation parameter	Number of water-contact activities unable to take ((Not Fishing or Angling - see E2).	place in certain time periods.		
		·	Weighting = 30%.		
14	Amenity parameter	Based on Odour at channel, Visual problems in charler bank/adjacent land.	annel, and Visual problems on		
			Weighting = 10%.		
15	Historical and Cultural Associations	Importance of historical and archaeological interes	t sites.		
	parameter		Weighting = 10%.		

Table 9.1 : Summary of parameters related to Landscape and Amenity limicator

The Importance of the river as a landscape feature

This component establishes how visually important the river is within the landscape, regardless of any planning designation. The assessment should be made from places which are accessible to the public, such as footpaths, roads and local vantage points within the river corridor. Where several access points exist, the dominant overall impression should be recorded.

Score	Description
3	High importance - dominant landscape feature, due associated artifacts such as weirs, bridges etc.
2	Medium importance - only stretches of the river are visible, or the course is only noticeable because of bankside vegetation being visible.
1	Low importance - the river is barely noticeable.

Impact of River on Adjacent Land

In many areas the river has had a considerable impact on the adjacent landscape. Many towns grew because the adjacent river was navigable or was used as an energy source for mills etc. In addition the 'management' of the river either allowed the adjacent land to be drained or to flood so changing its agricultural use. It is important within this parameter that only the present day use is recorded, as the historical element is allowed for in L5.

The scoring is based on the principle that the greater the score assigned to each parameter, the greater the 'problem'. However within this parameter there are both positive and negative impacts in relation to the river and its effect on adjacent land. Consequently the score for 'importance' above is reduced by a negative mark where the overall impact is attractive in order to reduce the overall score and vice versa. For example, a score of 3 for 'importance' would be followed by -1 for impact if the drainage of the adjacent land had resulted in better agricultural land or reduced flooding.

Score	Description
-1	Where a beneficial adjacent land-use (within 500m) is primarily as a result of man's impact on or management of the river
+1	Where a degraded or unsightly adjacent land use is primarily as a result of man's impact on or management of the river which could be remedied if remedial action were taken to the river

The two scores are added to produce a score with a range of 0 to 4. The weighting of this parameter (L2) is 30%.

9.3 <u>Recreation Parameter (L3)</u>

The parameter L3, assesses the impact of low flows on water-based recreational activities. As the impact of low flows on fishing is assessed in parameter E2, fishing and angling are excluded from the following assessment of water-contact recreational activities.

Recreational use may be passive or active. In general active use is associated with sports which require direct contact with water, such as: canoeing; sailing; rowing; boating; swimming; diving; water-skiing and wind surfing. These sports should have a higher score than passive recreational use, as any reduction in water quantity or quality as a result of low flows, can seriously affect participation in the sport. The scores should be awarded if the activity has been affected by a reduced volume or flow of water or a change in water quality due to low flows has occurred within the specified time period.

Score	Description
4	When three or more water contact recreational activities were unable to take place sometime in each year during a 5 year period.
3	Three or more water-contact recreational activities were unable to take place at any time in any one twelve month period.
2	One or two water-contact recreational activities were unable to take place at any time in any twelve month period.
1	Any water-contact recreational activity was affected by low flows within the last five years. This also includes a reduction in enjoyment of a sport, resulting from low river flows.
0	No change has been noted.

Fishing and angling are not included in the score of recreational activities in the above table.

The above score takes into account the present (and potential) use of the river for recreation. However, if historical evidence exists, which can be authenticated, that an active watercontact activity was possible on the river in the past (say 25 yrs) and there is a demand for that sport nationally or locally an additional score of +1 may be awarded as follows, up to a maximum total of 4 for this parameter.

Score	Description
+1	The river was able to support a water-contact recreational activity within the past 25 years, but this activity is no longer possible due to lower river flows.

The weighting of the recreation parameter (L3) is 30%.

9.4 <u>Amenity Parameter (LA)</u>

This parameter L4 assesses the impact of low flows on the general amenity of the river by reference to bank-side recreational pursuits and access to the river. Although low flows do not prevent walking, birdwatching, sightseeing and picnicking from taking place, the enjoyment of these recreational pursuits may be affected. Odour and visual impact are based on pollution and nuisance, as measured in some NRA regions. These will need to be recorded during the summer months at specified times, which it is suggested should be in the first week of August.

The parameter score is derived from the sum of scores, up to a total of 4, based on the following three components of the parameter.

Odour

Score	Description
2	Strong odour at channel edge eg sludge, sewage, chemical or farmyard wastes and noticeable at a distance of more than 10 metres from the channel.
1	Noticeable odour at the channel edge.
0	No noticeable odour.

Visual River Channel

This includes unnatural water colour, farm wastes, foam, sewage, fungus, crude sewage, visible solids, rotting vegetation and also where refuse and litter are exposed or if no water is present.

Score	Description
3	Three or more of the above elements which persist over a period of several months, as a result of low flows or three or more of the above elements which occur intermittently.
2	One to three of the above elements which persist over a period of several months, as a result of low flows.
1	Two of the above elements which occur intermittently, as a result of low flows.
0	No visual problem.

Visual - River Bank and Adjacent Land

An additional score of 1 can be awarded where the general public are encouraged to have access to the river as part of a wider planning designation such as: a public open space; or the provision of a long distance footpath or nature trail.

Score	Description
+1	Where planning designation encourages public use.

The weighting of the amenity parameter (L4) is 10%

9.5 <u>Historical and Cultural Associations (L5)</u>

This parameter allows the evaluation of impact on the river within a wider context, eg does the name of a building or a town derive from the name of the river or is the landscape character particularly influenced by water mills, designed parkland or particular bankside vegetation. If so, such associations reinforce the requirement to maintain appropriate water levels.

Score	Description
4	Sites of national historical/archaeological interest ie. National Monuments, National Trust sites.
3	Sites of regional historical/archaeological interest generally within 500m.
2	Sites which have national cultural associations such as paintings and literature, or local archaeological sites.
1	Sites of local historical archaeological, cultural or literary interest, such as place names
0	No historical or cultural associations.

The weighting of this historical and cultural parameter (L5) is 10%.

9.6 Sample Calculation of Landscape and Amenity Indicator

A full sample calculation for the Landscape/Amenity Indicator is shown on Table 9.2. Blank calculation sheets for use by NRA Regions are attached in Annex I to this report.

It is repeated here for emphasis that parameters L1, L2, L4, L5, are not direct evidence of low flows and should not be used unless there is other firm evidence of low flows from at least two of parameters H1, H2, H5, E1, E2, E3.

As a result of the evaluation (Phase 2) the parameter weights have been amended and the amended weights are shown on Table 9.2.

	TABL	E 9.2 : SAMPLE CALCULATION		
	LAND	SCAPE AND AMENITY INDICATO	R	0200 1 of
NRA REGION:	A reciper A	NAME OF STREAM: River Example	DATE: 12/8/92	
	(see Benort Chanti	ers 9.1 to 9.6 for full emission of methodology)		
Note: Do not use l		hare is other firm addence of low flows from at las	act 2 of normators H1 H2 L	15 E1 E2 E5
L1 LANDSCAPE	DESIGNATION AND	RARITY PARAMETER		R,E1,C2,C2
For Landscape De	signation:			
Description				Score
Important in	a national context, ie N	lational Parks and Areas of Outstanding Natural B	Beauty	2
Important In	a local context, le Area	s defined as Country Parks/Special Value etc. wit	thin local or structure plan	1
Landscape h	as no official designatio	on		0
An additiona	ecore may be awarded	1 se fallowe		
Areas which finance exist Initiative Area	are undergoing environ to suport such improv as	mental improvements (either national or local) an vements, is landscapes within Development Corpo	nd where oration Areas, Local	+1
For Landscape Ra	rity:			
Description				Score
Where river/r in the nation:	iver corridor landscape Il context	is "the only" or "one of the best examples of"		. 2
Where river/r in the local c	iver corridor landscape ontext	is "the only" or "one of the best examples of"		1
The river has	no rarity value			0
Add acores to a ma	pointum of 4.		Assion acore: L1 -	3
L2 IMPORTANC For Importance: Description High Importa	E OF THE RIVER AS A	A LANDSCAPE FEATURE AND ITS IMPACT ON A	NOJACENT LAND PARAME	TER Score
L2 IMPORTANC For Importance: Description High Importa bridges etc. Medium Impo	E OF THE RIVER AS A nce - dominant landsci rtance - only stretches	ape feature, due to associated artifacts such as w	NOJACENT LAND PARAME reirs, ceable	TER Score 3
L2 IMPORTANC For Importance: Description High Importa bridges etc. Medium Impo because of b	E OF THE RIVER AS A nce - dominant landsci rtance - only stretches ankside vegetation beir	ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ng visible	NDJACENT LAND PARAME reirs, ceable	Score 3 2
L2 IMPORTANC For Importance: Description High Importa bridges etc. Medium Impo because of b Low Importar	E OF THE RIVER AS A nce - dominant landsci rtance - only stretches ankside vegetation beir ce - the river is barely	ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ng visible noticeable	NOJACENT LAND PARAME reirs, ceable	Score 3 2
L2 IMPORTANCE For Importance: Description High Importa bridges etc. Medium Importa because of be Low Importar	E OF THE RIVER AS A nce - dominant landsci rtance - only stretches ankside vegetation beir ce - the river is barely	A LANDSCAPE FEATURE AND ITS IMPACT ON A ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ng visible noticeable	NDJACENT LAND PARAME reirs, ceable	Score 3 2 1
L2 IMPORTANC For Importance: Description High Importa bridges etc. Medium Impo because of b Low Importar For Impact: Description	E OF THE RIVER AS A nce - dominant landsci rtance - only stretches ankside vegetation beir ce - the river is barely	ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ng visible noticeable	NDJACENT LAND PARAME reirs, ceable	Score 3 2 1 Score
L2 IMPORTANC For Importance: Description High Importa bridges etc. Medium Impo because of b Low Importar For Impact: Description Where a bene Impact on, or	E OF THE RIVER AS A nce - dominant landsci rtance - only stretches ankside vegetation beir ce - the river is barely ficial adjacent land usi management of, the riv	ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ng visible noticeable e (within 500m) is primarily as a result of man's ver	NDJACENT LAND PARAME Neirs, Seable	Score 3 2 1 Score -1
L2 IMPORTANC For Importance: Description High Importance bridges etc. Medium Importan because of ba Low Importan For Impact: Description Where a bene Impact on, or Where a degree on, or manag	E OF THE RIVER AS A nce - dominant landsci rtance - only stretches ankside vegetation bein ce - the river is barely ficial adjacent land usi management of, the riv raded or unsightly adjacement of, the river, whi	ape feature, due to associated artifacts such as w a of the river are visible, or the course is only notic ng visible noticeable e (within 500m) is primarily as a result of man's ver cent land use is primarily as a result of man's imp ich could be remedied if remedial action were take	act an	Score 3 2 1 Score -1 +1
L2 IMPORTANC For Importance: Description High Importa bridges etc. Medium Importa because of be Low Importar For Impact: Description Where a bene impact on, or Where a dege on, or manag to the river	E OF THE RIVER AS A nce - dominant landsci rtance - only stretches ankside vegetation beir ce - the river is barely rficial adjacent land usi management of, the riv aded or unsightly adjac ement of, the river, whi	ape feature, due to associated artifacts such as w a of the river are visible, or the course is only notic ing visible noticeable e (within 500m) is primarily as a result of man's ver cent land use is primarily as a result of man's imp ich could be remedied if remedial action were take	ADJACENT LAND PARAME reirs, ceable	Score 3 2 1 Score -1 +1
L2 IMPORTANC For Importance: Description High Importa bridges etc. Medium Importa because of bi Low Importar For Impact: Description Where a bend Impact on, or Where a degli on, or manag to the river	E OF THE RIVER AS A nce - dominant landsci intance - only stretches ankside vegetation bein ce - the river is barely ficial adjacent land usi management of, the river raded or unsightly adjac ement of, the river, whi age of 0-4	ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ng visible noticeable e (within 500m) is primarily as a result of man's ver cent land use is primarily as a result of man's imp ich could be remedied if remedial action were take	ADJACENT LAND PARAME reirs, seable act an Assion score:: 12 =	Score 3 2 1 Score -1 +1
L2 IMPORTANC For Importance: Description High Importan bridges etc. Medium Importan because of be Low Importan For Impact: Description Where a benefit impact on, or Where a deget on, or managet to the river Add scores to a rate Description	E OF THE RIVER AS A nce - dominant landsci rtance - only stretches ankside vegetation beir ce - the river is barely sticial adjacent land usi management of, the riv aded or unsightly adjac ement of, the river, whi nge of 0-4 t PARAMETER	A LANDSCAPE FEATURE AND ITS IMPACT ON A ape feature, due to associated artifacts such as w a of the river are visible, or the course is only notic ing visible noticeable e (within 500m) is primarily as a result of man's ver cont land use is primarily as a result of man's imp ich could be remedied if remedial action were take	ADJACENT LAND PARAME reirs, seable act an Assion score: 12 =	Score 3 2 1 Score -1 +1 3
L2 IMPORTANC For Importance: Description High Importa bridges etc. Medium Importa because of bi Low Importar For Impact: Description Where a bene Impact on, or Where a degi on, or manag to the river Add scores to a ray L3 RECREATION When 3 or me during a 5 yes	E OF THE RIVER AS A nce - dominant landsci intance - only stretches ankside vegetation bein ce - the river is barely sticial adjacent land usi management of, the river management of, the river, whi aded or unsightly adjac ement of, the river, whi age of 0-4 I PARAMETER (do not include fishing the water-contact recreat a period	A LANDSCAPE FEATURE AND ITS IMPACT ON A ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ng visible noticeable e (within 500m) is primarily as a result of man's ver cent land use is primarily as a result of man's implic inclosed if remedial action were take	ADJACENT LAND PARAME reirs, ceable Assion score: 12 =	Score 3 2 1 Score -1 +1 3 Score 4
L2 IMPORTANC For Importance: Description High Importa bridges etc. Medium Importa because of be Low Importar For Impact: Description Where a bene impact on, or Where a dege on, or manag to the river Add scores to a rai L3 RECREATION When 3 or moduring a 5 yes 3 or more wat one 12 month	E OF THE RIVER AS A nce - dominant landsci entance - only stretches ankside vegetation bein ce - the river is barely sticial adjacent land usi management of, the riv raded or unsightly adjac ement of, the river, whi raded or unsightly adjac ement of, the river, whi	A LANDSCAPE FEATURE AND ITS IMPACT ON A ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ing visible noticeable e (within 500m) is primarily as a result of man's ver cent land use is primarily as a result of man's implic incloud be remedied if remedial action were take ing/angling) vational activities were unable to take place somet I activities were unable to take place at any time in	ADJACENT LAND PARAME reirs, ceable Assion score: 12 =	Score 3 2 1 Score -1 +1 3 Score 4 3
L2 IMPORTANCE For Importance: Description High Importan bridges etc. Medium Importan because of be Low Importan For Impact: Description Where a bene impact on, or Where a bene impact on, or a range to the river Add scores to a range 3 or more wat one 12 month 1 or 2 water- 12 month per	E OF THE RIVER AS A nce - dominant landsci rtance - only stretches ankside vegetation beir ce - the river is barely relicial adjacent land usi management of, the river aded or unsightly adjacement of, the river, whi aded or unsightly adjacement of, the river, whi add or unsightly adjacement of, the river, whi add or unsightly adjacement of, the river, whi add or unsightly adjacement of, the river, whi adjacement of, the river, whi adjacement of, the river, whi adjacement of, the river, adjacement of, the river, whi adjacement of, the river, adjacement of, the river, whi adjacement of, the river, whi adjacement of, the river, adjacement of, the river, whi adjacement of, the river, adjacement of	A LANDSCAPE FEATURE AND ITS IMPACT ON A ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ing visible noticeable e (within 500m) is primarily as a result of man's ver cent land use is primarily as a result of man's imp ich could be remedied if remedial action were take ing/angling) vational activities were unable to take place somet I activities were unable to take place at any time in itvities were unable to take place at any time in an	ADJACENT LAND PARAME reirs, ceable act an <u>Assion score: L2 =</u> time in each year n any	TER Score 3 2 1 Score -1 +1 3 Score 4 3 2
L2 IMPORTANC For Importance: Description High Importa bridges etc. Medium Importa because of be Low Importar For Impact: Description Where a bene Impact on, or Where a dege on, or manag to the river Add scores to a rai Construction When 3 or moduling a 5 yes 3 or more wate one 12 month 1 or 2 water-co This also inclu	E OF THE RIVER AS A nce - dominant landsci entance - only stretches ankside vegetation bein nce - the river is barely sticial adjacent land use management of, the river aded or unsightly adjacement of, the river, whi raded or unsight	A LANDSCAPE FEATURE AND ITS IMPACT ON A ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ing visible noticeable e (within 500m) is primarily as a result of man's ver cent land use is primarily as a result of man's implic ich could be remedied if remedial action were take ing/angling) vational activities were unable to take place somet I activities were unable to take place at any time in ity was affected by low flows within the last 5 year oyment of a sport, resulting from low river flows	ADJACENT LAND PARAME reirs, ceable act an Assion score: L2 = ime in each year n any y s.	TER Score 3 2 1 Score -1 +1 3 Score 4 3 2 1
 L2 IMPORTANCE For Importance: Description High Importation bridges etc. Medium Importation because of bit Low Important For Impact: Description Where a benefit impact on, or Where a benefit impact on, or Where a degree on, or manage to the river Add scores to a rank L3 RECREATION When 3 or moduring a 5 yes 3 or more wall one 12 monthing a 5 yes 3 or more wall one 12 monthing a 10 year - co 1 or 2 water - co 1 This also incluing the second secon	E OF THE RIVER AS A nce - dominant landsci stance - only stretches ankside vegetation beir ce - the river is barely sticial adjacent land usi management of, the riv aded or unsightly adjac ement of, the river, whi aded or unsightly adjac ement of, the river, whi add or unsightly adjac ement of, the river, whi adjac ement of, the river, whi a	A LANDSCAPE FEATURE AND ITS IMPACT ON A ape feature, due to associated artifacts such as w s of the river are visible, or the course is only notic ing visible noticeable e (within 500m) is primarily as a result of man's ver cent land use is primarily as a result of man's implic ch could be remedied if remedial action were take ing/angling) vational activities were unable to take place somet I activities were unable to take place at any time in itvities were unable to take place at any time in itvities were unable to take place at any time in an ity was affected by low flows within the last 5 year oyment of a sport, resulting from low river flows	ADJACENT LAND PARAME reirs, ceable act en <u>Assion ecore: 12 =</u> time in each year n any Y 8.	TER Score 3 2 1 Score -1 +1 3 Score 4 3 2 1 0
 L2 IMPORTANCE For Importance: Description High Importance bridges etc. Medium Importance because of because of because	E OF THE RIVER AS A nce - dominant landsci entance - only stretches ankside vegetation bein ce - the river is barely eficial adjacent land use management of, the river aded or unsightly adjacement of, the river, whi aded or unsightly adjacement of, the river, whi aded or unsightly adjacement of, the river, whi add or unsightly adjacement of, the river, whi added or unsightly adjacement of, the river, whi added or unsightly adjacement of the recreational activity addes a reduction in enjo	A LANDSCAPE FEATURE AND ITS IMPACT ON A ape feature, due to associated artifacts such as w a of the river are visible, or the course is only notic ing visible noticeable e (within 500m) is primarily as a result of man's ver cent land use is primarily as a result of man's implich could be remedied if remedial action were take ing/angling) vational activities were unable to take place somet i activities were unable to take place at any time in ity was affected by low flows within the last 5 year oyment of a sport, resulting from low river flows	ADJACENT LAND PARAME reirs, ceable act an Assion score: L2 = ime in each year n any y s. ears,	TER Score 3 2 1 Score -1 +1 3 Score 4 3 2 1 0 +1

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			-1.4	
	NRA Pr	oject B2.2 : Low Flow Cond	litions	
	TABLE 9	2: SAMPLE CALCULATION (cont'd)	
	LANDS	CAPE AND AMENITY INC	DICATOR	page 2 of
NRA REGION:	A region	NAME OF STREAM: River Example	DAT	TE: 12/8/92
	(see Report Chapters	9.1 to 9.6 for full explanation of met	hodolo gy)	
Note: Do not us	e L1,L2,L4 or L5 unless them	e is other firm evidence of low flows	from at least 2 of pai	ramaters H1,H2,H5,E1,E2,E5
A AMENITY	PARAMETER			
For Odour:				
Description	n			Score
Strong odd a distance	or at channel edge, eg slud of > 10m from the channel	ge, sewage,chemical or farmyard wa	istes and noticeable	at 2
Noticeable	odour at the channel edge			1
No noticea	ble odour			0
For Visual Impai	irment at the river channel:			
	n			Score
3 or more (low flows,	of the above elements which or 3 or more of the above ele	persist over a period of several mon ments which occur intermittently	ans, as result of	3 :
1 to 3 of th	e above elements which per	sist over a period of several months,	as result of low flows	s 2
2 of the ele	ments which occur intermitt	ently, as a result of low flows		1
No visual p	xoblem			0
For Visual Impai	irment on the river bank and	adjacent land:		
Description			······································	Score
Where play	nning designation encourage	is public use	1.	+1
vdd acores to a	maximum of 4.		Age	ge ecore: L4 =
5 HISTORIC	AL AND CULTURAL ASSOC	ATIONS PARAMETER		
Description	1		· · · ·	Score
Sites of nat	tional historical/archaeologic	al interest, le National Monuments, l	National Trust sites	4
Sites of rec	jional historical/archaeologic	al interest, generally within 500m		3
Sites which	1 have national cultural associated at the store	ciations such as paintings and literal	ture, or local	2
Sites of loc	ai historical/archaeological.	cultural or literary interest, such as r	lace names	1
No historic	al or cultural associations			, o
<u> </u>			ASS	
	CALCUL	ATION OF LANDSCAPE AND A	MENITY INDICA	TOR
	– • • • •	Weight of params.used	Score	Weight x Score
arameter	Param.weight			
¹ arameter L1	Param.weight 0.2	0.2	3	0.6
'arameter L1 L2 L3	Param.weight 0.2 0.3 0.3	0.2 0.3 0.3	3	0.6
'arameter L1 L2 L3 L4	Param.weight 0.2 0.3 0.3 0.1	0.2 0.3 0.3 0.1	3 3 2 3	0.6 0.9 0.6 0.3
Parameter L1 L2 L3 L4 L5	Param.weight 0.2 0.3 0.3 0.1 0.1	0.2 0.3 0.3 0.1 0.1 SUM1 - 1	3 3 2 3 3	0.6 0.9 0.6 0.3 0.3 SUM2 - 2.7
Parameter L1 L2 L3 L4 L5 Andscape an	Param.weight 0.2 0.3 0.3 0.1 0.1 0.1	0.2 0.3 0.3 0.1 0.1 0.1 0.1 (= SUM2/(SUM1x4) =	3 3 2 3 3 3	0.6 0.9 0.6 0.3 0.3 SUM2 - 2.7
Parameter L1 L2 L3 L4 L5 Andscape an andscape an	Param.weight 0.2 0.3 0.3 0.1 0.1 d Amenity Severity Index d Amenity Reliability Index	0.2 0.3 0.3 0.1 0.1 0.1 SUM1 = 1 (= SUM2/(SUM1x4) = Bx = SUM1 =	3 3 2 3 3 3 3	0.6 0.9 0.6 0.3 0.3 SUM2 - 2.7

10. THE PUBLIC PERCEPTION INDICATOR

The Public Perception Indicator is based on two parameters, the *proximity* of the river to urban areas and the extent of *complaints* received by the NRA. The parameters are summarised in Table 12.

10.1 Proximity of River to Centres of Population Parameter (P1)

This parameter assesses the number of people within reasonable proximity of the river who might be affected by low flows in the river and who might be disadvantaged if alleviation work is not undertaken. Recreation and amenity are assessed by parameters L3 and L4 and parameter P2 assesses complaints from the public.

Score	Description
4	River flows through a large centre of population ie. a town.
3	River flows through a small centre of population ie. a village.
2	River flows within 1km of a town.
1	River flows within 1km of a village.

The distinction between a town and a village is usually evident in a given Region but where this is not the case a suitable guideline might be to classify a town as any conurbation with more than 10,000 population.

The weighting of the proximity of river to centres of population parameter (P1) is 30%.

10.2 <u>Complaints Received from the Public Parameter (P2)</u>

Public pressure is an important factor in highlighting perceived 'problems' of low river flows, whether the problems are real or not. It is therefore important to allow for this factor within the framework, although it is recognised that not all complaints are factually correct. Scores will be awarded where complaints about low river flows have been received over a number of years, and not in relation to a single incident of a particularly severe drought.

	SUMMARY	OF PUBLIC PERCEPTION INDIC	ATOR
P1	Proximity of River to Centres of Population	Based on size of pop. and proximity.	Weighting = 30%.
P2	Complaints received from the Public	Number and source of complaints.	Weighting = 70%.

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Table 10.1 : Summary of parameters related to Public Perception Indicator

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Score	Description
4	Written complaints received from national organisations (e.g. English Nature, CLA, CPRE, Salmon and Trout Association, etc) in support of local pressure groups formed specifically to deal with problems affecting the river and its environment.
3	Press coverage or written complaints received from national organisations or local clubs or pressure groups.
2	A moderate number (over 5 per annum on average) of written complaints received from individuals about problems related to low river flows over a period of years.
1	Up to 5 written complaints received on average per annum from individuals about problems related to low river flows over a period of years.
0	No complaints received about problems related to low river flows.

The weighting of the Complaints Received from the Public parameter (P2) is 70%.

10.3 Sample Calculation of Public Perception Indicator

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A full sample calculation of the public perception indicators is shown in Table 10.2. Blank calculation sheets are included in Annex I for use by the NRA Regions.

	74.01			
		E 10.2 : SAMPLE CALCULATION		
	PUBI	LIC PERCEPTION INDICATOR		page 1 of
NRA REGIO	N: A region	NAME OF STREAM: River Example	DATE: 12/8/92	
	(see Report Chapt	ers 10.1 to 10.3 for full explanation of methodology)	· ·	
P1 PROXI	AITY OF RIVER TO CENTRI	ES OF POPULATION parameter		
Descrip	tion	Scol	re	
River flo	ows through a large centre of	of population, ie a town	4	
River flo	ows through a small centre o	of population, le a village	3	- 61
River fle	ows within 1km of a town		2	
River flo	ws within 1km of a village		1	
(It unsure of a	own/village distinction; use:	: Town = > 10,000 pap.)	Assign acore: IP1	
P2 COMPL	AINTS RECEIVED FROM T	HE PUBLIC parameter		
Descrip	lion		······	Score
Written etc.) in a	complaints received from na support of local pressure gro	ational organisations (e.g. English Nature, CLA, CPR oups formed specifically to deal with problems affecti	IE, Salmon & Trout Asso ing the river and It's	c. 4
environ				
	TION			
Press c	ment overage or written complain	ts received from national organisations or local clubs	or pressure groups	3
Press c A mode problem	ment overage or written complaint rate number (> 5/annum on is related to low river flows o	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years	or pressure groups	3 2
Press c A mode problem Up to 5/ low rive	ment overage or written complaint rate number (> 5/annum on is related to low river flows o annum on average written c r flows over a period of years	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s	or pressure groups uais about related to	3 2 1
Press c A mode problem Up to 5/ low rive	ment overage or written complaint rate number (> 5/annum on is related to low river flows o annum on average written c r flows over a period of years plaints received about probl	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s	or pressure groups uals about related to	3 2 1
Press c A mode problem Up to 5/ low rive	ment overage or written complaint rate number (> 5/annum on is related to low river flows o annum on average written c r flows over a period of years plaints received about probl	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s lems related to low river flows-	or pressure groups uals about related to Assign acore: P2 =	3 2 1
Press c A mode problem Up to 5/ low rive	ment overage or written complaint rate number (> 5/annum on is related to low river flows of annum on average written c r flows over a period of years plaints received about probl CALCULATION	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s lems related to low river flows	or pressure groups uais about related to Assign acore: P2 =	3 2 1
Press c A mode problem Up to 5/ low rive - No com	ment overage or written complaint rate number (> 5/annum on is related to low river flows of annum on average written c r flows over a period of years plaints received about probl CALCULATION Param.weight	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s lems related to low river flows	related to Assign acore: P2 =	3 2 1 0
Press c A mode problem Up to 5/ low rive - No com Parameter P1	ment overage or written complaint rate number (> 5/annum on is related to low river flows of annum on average written c r flows over a period of years plaints received about proble CALCULATION Param.weight 0.3	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s ems related to low river flows	e Weight x Sco 4 1 1.2	3 2 1 0
Press c A mode problem Up to 5/ low rive No com Parameter P1 P2	ment overage or written complaint rate number (> 5/annum on is related to low river flows o annum on average written c r flows over a period of years plaints received about probl CALCULATION Param.weight 0.3 0.7	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s lems related to low river flows OF PUBLIC PERCEPTION INDICATOR Weight of params.used Scor	e Weight x Sco	3 2 1 0
Press c A mode problem Up to 5/ low rive - No com Parameter P1 P2	ment overage or written complaint rate number (> 5/annum on is related to low river flows of annum on average written c r flows over a period of years plaints received about probl CALCULATION Param.weight 0.3 0.7	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s lems related to low river flows- OF PUBLIC PERCEPTION INDICATOR Weight of params.used Scor 0.3 SUM1 = 0.3	related to related to Assign score: P2 = re Weight x Sco 4 5UM2 = 11	3 2 1 0
Press c A mode problem Up to 5/ low rive - No com Parameter P1 P2	ment overage or written complaint rate number (> 5/annum on is related to low river flows of annum on average written c r flows over a period of years plaints received about probl CALCULATION Param.weight 0.3 0.7	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s dems related to low river flows	related to related to Assign acore: P2 = *e Weight x Sco 4 1.2 SUM2 = 1.2	3 2 1 0
Press c A mode problem Up to 5/ low rive - No com Parameter P1 P2 Public Perc Public Perc	eption Severity Index = explain Severity Index = eption Reliability Index =	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s lems related to low river flows- OF PUBLIC PERCEPTION INDICATOR Weight of params.used Scor 0.3 SUM1 = 0.3 SUM1 = 0.3	e Weight x Sco SUM2 = 12	3 2 1 0
Press c A mode problem Up to 5/ low rive - No com Parameter P1 P2 Public Perc Public Perc Scott Willson	eption Severity Index = <i>Kirkpetrick 1991</i>	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems s lems related to low river flows- OF PUBLIC PERCEPTION INDICATOR Weight of params.used Scor 0.3 SUM1 = 0.3 SUM1 = 0.3	related to 4 1.2 5 SUM2 = 12	3 2 1 0
Press c A mode problem Up to 5/ low rive - No com Parameter P1 P2 Public Perc Public Perc Public Perc Scott Willson	eption Severity Index = <i>Kirkpetrick 1991</i>	ts received from national organisations or local clubs average) of written complaints received from individu over a period of years complaints received from individuals about problems a ems related to low river flows	e Weight x Sco SUM2 = 12	3 2 1 0

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11. COMBINING THE INDICATORS

Having established 'scores' in the form of *Severity Index* and *Reliability Index* for each Indicator, they can be combined in a number of ways. Table 11. I shows this for the sample calculations used in previous chapters.

11.1 Overall Severity Index

The Severity Index (SI) calculated as the sum of the (weighted) SI's for each of the Indicators as follows:-

	Indicator SI (a)	Weight % (b)	Weighted SI (a) * (b)
Hydrology HSI		40%	
Ecology ESI		30%	
Landscape/Amenity LSI		20%	
Public Perception PSI		10%	

TotalSI- $\sum (a * b)$

It should be noted that the weights are fixed but all other spaces are filled in by the assessor. A further discussion of-weights is given in Chapter 13 of this report.

11.2 Overall Reliability Index

The Overall Reliability Index is calculated in a similar way as the Overall Severity Index, but the Public Perception Indicator does not contribute to the Reliability Index and the weights used are amended to:

Hydrology HRI	40%
Ecology ERI	35%
Landscape/Amenity LSI	25%

During the evaluation, a number of Regions "scored" parameters on the basis of informed judgements by experienced staff, rather than hard data, whereas others would only assign a score on the basis of hard data.

Such "judgemental" scoring carried out by suitably experienced staff can make a valuable contribution to the assessment but should be reflected in the assessment of Reliability Index.

It is proposed therefore that in assessing the Reliability Index, the assessor should use a proportion only of the indicator weight to reflect the degree of confidence which he or she has in the assessment.

11.3 Suggested Action

Having assessed the Severity Index and the Reliability Index the action arising from this assessment might be categorised as shown in Table 11.7.1

Table 11.2 : SUGGESTED ACTION RESULTING FROM ASSESSMENT OF LOW FLOWS

Severity Index	Reliability Index	Action Required
High	High	Put in NRA Capital Works programme for alleviation
High	Low	Further study and data collection required
Low	High	No action unless strong public pressure in which case mount a public relations campaign to explain that there is no problem.
Low	Low	No action unless strong public pressure-in-which case initiate minimum cost studies and mount public relations campaign

Detailed action by the NRA following the assessment is beyond the scope of this project and therefore it has not been considered further. However, during the formulation and evaluation of the methodology, various points of discussion emerged which might aid or influence the NRA in allocating priority for action between high-scoring sites. These Factors, and the way in which they might be applied, are discussed below.

11.4 <u>Real or Perceived Problem</u>

The assessment of whether there is a real problem or a problem only in the public's perception is based upon a *qualitative comparison* of the Hydrological and Ecological Indicators with the Public Perception Indicator.

In the case where the Public Perception Severity Index is high but the other Indicators show a low Severity Index with a medium to high Reliability Index then the problem can be categorised as a perceived, problem only.

In all other cases, the Public Perception Indicator is most unlikely to change the conclusion drawn from the other indicators but may influence the likely order of priority.

11.5 Size Adjustment

Up to this stage in the assessment procedure, a short length of headwater stream could score the same as perhaps tens of kilometres of the middle course of a large river. The importance of the two low flow conditions could be expected to be quite different, however.

A Size Adjustment factor is therefore required, to reflect the length and size of watercourse affected. This, like the Cost adjustment factor discussed below, would be applied as an adjustment to the SI (but not RI) assessed from the four basic Indicators.

However, unlike cost, the Size Adjustment should influence the ranking by severity of problem and not only the rehabilitation/alleviation priorities. It should therefore be applied, in all cases, before the application of the cost/benefit adjustment.

It is proposed that an adjusted Severity Index (SIa) should be calculated from the initial Severity Index (SIi) from the following formula:

$$SIa = SIi \times L^{1/3} \times CA^{1/3}$$

where L is the length of watercourse affected (km)

-CA is the catchment area to the mid-point of the length affected (km²).

The indices of "1/3" have been selected (rather than "1/2") on the basis that the greater length of affected channel usually (but not always) means a greater catchment area.

11.6 Cost Adjustment

The cost, or more correctly the Benefit/Cost Ratio of an alleviation scheme, does not affect the severity of the problem but should have some influence on the order of priority Proposal Number for related her Project. (Terry Sherry 's) assigned to schemes.

The Cost Adjustment is based on the following:-

- The cost of 'buying out' an existing licence has been quoted in i) a number of Regions as approximately £1 million per Ml/day.
- ii) Any alleviation scheme will have an effect equivalent to a reduction in licensed abstraction. For example, if a recirculation scheme or groundwater support scheme produces an increase in low flow of 0.5 Ml/day without affecting the available abstraction, this can be considered as having the

same value as buying out abstraction licences of this magnitude, i.e. a Value or Benefit of £500,000.

iii) The cost of the alleviation scheme can be expressed as a commuted sum (Net Present Value of Costs). It is suggested that should this be calculated at a discount rate of 5% over 30 years.

Thus the Cost Adjustment, summarised in Table 11.3 could be expressed as the Benefit/Cost ratio with the Benefit calculated as in ii) above and the Cost calculated as in iii) above.

This is only an approximate adjustment as the Consultants have not investigated the accuracy of the quoted cost of buying out licences, and the relationship between the increase in low flow achieved by alleviation measures and the corresponding availability of licensed abstraction is, in some cases complex. However it does give some guide to the viability of alleviation options.

In principle, no alleviation scheme should proceed if its Benefit/Cost Ratio is less than 1 since this means that it would be more cost-effective to 'buy-out' licences.

In practice, however, alternative sources may not be available or may only be available at higher cost. Since the cost of buying out licences should be based on the cost of alternative sources, this would signal that the quoted cost of buying out is inaccurate. In reality, the cost of alternative sources and hence of buying out licences will vary but the figure quoted above may be taken as a starting point.

If, in order to mitigate the effects of 1MI/d abstraction, an alleviation scheme in one area costs 10 times as much as an equivalent scheme in- another-area, - the latter should be moved up the list of priorities. That is not to say that the schemes should be ranked solely on the basis of benefit/cost ratio. Following the rules:-

- i) increasing Benefit/Cost ratio should increase priority and
- ii) increasing *Leverity* Index should increase priority.

One obvious way of taking account of the Benefit/Cost (B/C) ratio is to multiply the Adjusted Severity Index as calculated under 11.5 above by the B/C ratio.

Intuitively, however, this is likely to give too much significance to the B/C ratio and a suggested multiplier would be

$$(1+0.5(\frac{B}{C}-1))$$

It may be that in testing this method, the 'reduction factor' of 0.5 in the above expression will be shown to be still too high and will need to be reduced.

A full sample calculation of the cost adjustment is shown in Table 11.4. Blank calculation sheets are included in Annex I for use by the NRA Regions.

TABLE 11.1 : SAMPLE CALCULATION OF THE OVERALL INDICES

		LCULATION OF O	VEHALL INDI	CATORS		page 1 of 1
A REGION:	A region	NAME OF STREAM	: River Example	DATE	12/8/92	
ERALL SEVE	ATY INDEX (SI)					
Si type Hydrologica Ecological S Landscape (Public Perci	i SI il and Amenity SI aption SI	54 0.57 0.63 0.68 1.00	Weight 40.0% 30.0% 20.0% 10.0% Total SI (SII) =	0.39 0.19 0.14 0.10		
	BILITY INDEX (B)					
FI type		Ri (orig.)	Weight	Weighted FI	1	
Hydrologica Ecological R Landscape a	l RI U and Amenity RI	0.90 0.80 1.00	40.0% * 35.0% * 25.0% *	0.36 0.28 0.25		
* Use only a Report Ch	proportion of indica apter 11.2)	tor weight if "judgemental	Total Ri = scoring* has been	carried out (see		
SSIBLE ACTIC				5%		
SI	RI	Action				
	High	Put in Conital Proces		_		
ingn	1 1 1 1 1 1 1 1	Fut in Capital Progra	amme for Alleviatio	n		
High	Low	Further studies requ	amme for Alleviatio irect	n		
High Low	Low High	Further studies requ No action unless structure case mount public re	amme for Alleviatio ilred ong public pressure elations campaign	n a, in which		* 8
High Low	Low High	Further studies required in Capital Progra Further studies required in the state of	amme for Alleviatio ired ong public pressure elations campaign ong public pressure or studles and mou	n e, in which e, in which case Initia nt public relations ca	ite mpalgn	
Trigh High Low Low	Low High Low	Further studies required in Capital Progra Further studies required in the state of	amme for Alleviatio ired ong public pressure elations campaign ong public pressure ir studles and mou	n e, in which e, in which case Initia nt public relations ca	tte mpalgn	
E ADJUSTME	Low High Low NT NT Itercourse affected (i izea to mid-point of i	Further studies required in Capital Progra Further studies required in the state of	amme for Alleviatio ired ong public pressure elations campaign ong public pressure ir studies and mou	n e, in which a, in which case Initia nt public relations ca 5 km 12 km2	ite mpalgn	
THIGH Low Low TE ADJUSTME Length of wa Catchment a Adjusted Ser	Low High Low NT NT NT Nercourse affected (i Isea to mid-point of i verity Index (Sia) = S	Further studies required in Capital Progra Further studies required in the state of	amme for Alleviatio ired ong public pressure elations campaign ong public pressure or studies and mout	n e, in which nt public relations car 5 km 12 km2	te mpalgn	
TE ADJUSTME Low Low E ADJUSTME Length of wa Catchment a Adjusted Ser	Low High Low NT NT NT NT NT NT NT NT NT NT NT NT NT	Further studies requ No action unless stra case mount public ro No action unless stra minimum cost further L) = ength affected (CA) = Sli x L ¹³ x CA ¹² =	amme for Alleviatio ired ong public pressure elations campaign ong public pressure or studies and mous	n e, in which nt public relations ca 5 km 12 km2	te mpaign	
Trigh High Low Low E ADJUSTME Length of wa Catchment a Adjusted Ser ST ADJUSTMI Benefit:	Low High Low NT NT NT NT NT NT NT NT NT NT NT NT NT	Further studies requ No action unless stra case mount public re No action unless stra minimum cost furthe	amme for Alleviatio ired ong public pressure elations campaign ong public pressure ir studies and mout	n e, in which nt public relations car 5 km 12 km2	te mpalgn	
Trigh High Low Low E ADJUSTME Length of wa Catchment a Adjusted Ser ST ADJUSTMI Benefit: Increase in k Benefit (or V	Low High Low NT NT NT NT NT NT NT NT NT NT NT NT NT	Further studies required in Capital Progra Further studies required in the state of	amme for Alleviatio ired ong public pressure elations campaign ong public pressure ir studies and mout	n e, in which e, in which case Initia nt public relations ca 5 km 12 km2 3.18 3.18 0.5 Mi/day £0.50 million	te mpalgn	
Trigh High Low Low TE ADJUSTME Length of wa Catchment a Adjusted Ser ST ADJUSTMA Benefit: Increase in k Benefit (or V Cost: Net Present (discount rat	Low High Low NT NT NT NT NT NT NT NT NT Northy Index (Sia) = S ENT ENT Now flow resulting from alue) = (approx.) Value of costs of alle e = 5% over 30 years	Further studies required in Capital Progra Further studies required in the state of the state o	amme for Alleviatio ired ong public pressure elations campaign ong public pressure ir studies and mout	n e, in which a, in which case Initia nt public relations cau 5 km 12 km2 12 km2 12 km2 20.50 Mi/day £0.50 million £0.45 million	ite mpalgn	
Trigin High Low Low TE ADJUSTME Length of wa Catchment a Adjusted Ser ST ADJUSTMI Benefit: Increase in k Benefit (or V Cost: Net Present (<i>discount rat</i> Benefit/Cost	Low High Low NT NT NT tercourse affected (i trea to mid-point of i verity index (Sia) = S ENT Dow flow resulting from alue) = (approx.) Value of costs of alle e = 5% over 30 years ratio =	Further studies required in Capital Progra Further studies required in the state of the state in the state of the state o	amme for Alleviatio ired ong public pressure elations campaign ong public pressure or studies and mous	n e, in which a, in which case Initia nt public relations cau 5 km 12 km2 18 0.5 Mi/day 20.50 million 20.45 million	ite mpaign	
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ANNEX I

4.1

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BLANK CALCULATION SHEETS FOR ASSESSMENT OF LOW FLOWS



	ATL.	Invlugical I		page 1 of 2
NRA REGION:	NAME	E OF STREAM:	DATE	
(isee Report Chapters 7.	1 to 7.8 for full explan	ation of the methodology)	
H1 GROUNDWA	TER BALANCE PARA	AETER - ANN	IUAL LICENSED ABSTRACTION	
			NNUAL RECHARGE	
Total Groundwater	ALA =	m3/	B (GWALA)	
Calculated AR (1 Ir	n 10 yr drought) =	m3/i	a (AFI)	
Total Annual 'Licer	nce-exempt' Abst. =	m3/	a (X) <i>– ONLY enter II s</i> i	gnificant
Total Surface Wate	er ALA =	m3/	a (SWALA) / ONLY enter if H	2 not used and
Licensed Effluent I	Returns (annual) =	m3/	a (ER) } ALA is supporte	d by spring flow
ALAVAR = (GWALA	+X+SWALA-ERYAR =			
ALAVAR	Score			÷
>1.0	4			
0.7-1.0	3			
0.4-0.7	2			•
0.2-0.4	1	Ass	gn score: H1 -	PRIMARY
<0.2	o	100.000		
12 RIVERFLOW	BALANCE PARAMETE	R - DAILY MAXIMU	M LICENSED ABSTRACTION	or Q95 "NATURAL"
		Q95	"NATURAL"	RES.COMP.FLOW
fotal Surface Wate	r DMLA =	m3/	I (SWDMLA) - ONLY enter	for non-res. catchments
Reservoir Compen	sation Flow (mean daily) =m3/	(COMP) - ONLY enter	for reservoired catchment
lotal downstream (channel abstraction (da	lly) m3/e	1 (DMLCA) - ONLY enter	for reservoired catchment
	mot' electrontion (daily)	- 34	1 CC20 - CONLY enter	' if significant
I OLEL . LICOUCO-OXO	where and an array of a county)	-		
10tal "Licence-exe 295(7) =		m3/	1 (QNF)	
lotal "Licence-exe 295(7) = lotal Groundwater	DMLA (with direct impi	act) =m3/0	(QNF) (GWDMLA) }	
iotal "Licence-exe 295(7) = lotal Groundwater Licensed Effluent F	DMLA (with direct impa Returns (daily) =	act) =	(QNF) (GWDMLA) } (ERTWO) } ONLY enter	'If H1' not used
lotal "Licence-exe 295(7) = Fotal Groundwater Joansed Effluent F	DMLA (with direct impa Returns (daily) =	(COS = (StAUS) (1 A) (2)	(QNF) (GWDMLA) } (ERTWO) / ONLY enter	If H1 not used
local "Licence-exe 295(7) = Fotal Groundwater Joansed Effluent F Non-reservoired ci Reservoired catchr	DMLA (with direct impa Returns (daily) = atchments: Total DMLA ments: Q95/COMP = Q	Act) - m3/4 m3/4 m3/4 m3/4 m3/4 m3/4 m3/4 m3/4	(QNF) (GWDMLA) } (ERTWO) / OWLY enter (ERTWO) / OWLY enter (2-GWDMLA-ERTWO)/QNF =	If H1 not used
I otal "Licence-exe 295(7) = Fotal Groundwater Joansed Effluent F ion-reservoired catchr Reservoired catchr	DMLA (with direct impa Beturns (daily) = atchments: Total DMLA ments: Q95/COMP = QI	act) =	(QNF) (GWDMLA) } (ERTWO) } ONLY enter (2-GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) =	If H1 not used
Otal "Licence-exe 295(7) = Fotal Groundwater Joansed Effluent F tion-reservoired ci Reservoired catchr DMLA/Q95	DMLA (with direct impa Returns (daily) = atchments: Total DMLA ments: Q95/COMP = QI	Act) =	(QNF) (GWDMLA) } (ERTWO) } ONLY enter (2-GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) =	If H1 not used
otal "Licence-exe 295(7) = fotal Groundwater Joansed Effluent f ion-reservoired ca teservoired catchr DMLA/Q95 or Q95/COMF	DMLA (with direct impa Returns (daily) = atchments: Total DMLA ments: Q95/COMP = QI	Act) =	(QNF) (GWDMLA) } (ERTWO) } OWLY enter (ERTWO) } OWLY enter (2-GWDMLA+ERTWO) =	If H1 not used
Idial "Licence-exe 295(7) = Fotal Groundwater Joansed Effluent F ion-reservoired ca Reservoired catchr DMLA/Q95 or Q95/COMF	DMLA (with direct impa Beturns (daily) = atchments: Total DMLA ments: Q95/COMP = Qi	act) =	(QNF) (GWDMLA) } (ERTWO) } OWLY enter GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) =	If H1 not used
Ideal "Licence-exe 295(7) = Fotal Groundwater Joansed Effluent F Non-reservoired catchr Reservoired catchr DMLA/Q95 or Q95/COMF >1.0	DMLA (with direct impa Beturns (daily) = atchments: Total DMLA nents: Q95/COMP = QI	act) =	(QNF) (GWDMLA) } (ERTWO) } OWLY enter GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) =	If H1 not used
Iotal "Licence-exe 295(7) = Fotal Groundwater Joensed Effluent F Non-reservoired catchr Reservoired catchr DMLA/Q95 or Q95/COMF >1.0 0.7-1.0	DMLA (with direct impa Beturns (daily) = atchments: Total DMLA nents: Q95/COMP = QI Score 4 3	act) =	(QNF) (GWDMLA) } (ERTWO) } ONLY enter (2-GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) =	If H1 not used
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Ideal "Licence-exe 295(7) = Fotal Groundwater Joansed Effluent F Non-reservoired catchr DMLA/Q95 or Q95/COMF >1.0 0.7-1.0 0.4-0.7 0.2-0.4 <0.2	DMLA (with direct impa Returns (daily) = atchments: Total DMLA nents: Q95/COMP = Qi Score 4 3 2 1 0	Assi	(QNF) (GWDMLA) } (ERTWO) } OWLY enter c2-GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) =	If H1 not used
Idai "Licence-exe 295(7) = Fotal Groundwater Joansed Effluent F ion-reservoired ca Reservoired catchr DMLA/Q95 or Q95/COMF >1.0 0.7-1.0 0.4-0.7 0.2-0.4 <0.2	DMLA (with direct import Returns (daily) = atchments: Total DMLA ments: Q95/COMP = QI Score 4 3 2 1 0	Assi	(QNF) (GWDMLA) } (ERTWO) } OWLY enter c2-GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) =	If H1 not used
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Iotal "Licence-exe 295(7) = Fotal Groundwater Joensed Effluent F Non-reservoired catchr DMLA/Q95 or Q95/COMF >1.0 0.7-1.0 0.4-0.7 0.2-0.4 <0.2 13 GROUNDWA Mean Annual Decli Mean Seasonal Ra	DMLA (with direct impo Returns (daily) = atchments: Total DMLA ments: Q95/COMP = Qi Score 4 3 2 1 0 TER LEVEL PARAMET ine in minimum groundwinge =	Assi	(QNF) (GWDMLA) } (ERTWO) } ONLY enter (2-GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) = (2-GWDMLA+ERTWO) =	If H1 not used
Iotal Licence-exe 295(7) = Fotal Groundwater Joensed Effluent F Non-reservoired catchr DMLA/295 or 295/COMF >1.0 0.7-1.0 0.4-0.7 0.2-0.4 <0.2 43 GROUNDWA Mean Annual Decli Mean Seasonal Ra	DMLA (with direct import Returns (daily) = atchments: Total DMLA ments: Q95/COMP = Qi Score 4 3 2 1 0 TER LEVEL PARAMET ine in minimum groundwinge =	Assi	QNF) (GWDMLA) } (ERTWO) / ONLY enter C+GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) =	If H1 not used
Iotal Licence-exe 295(7) = Total Groundwater Licensed Effluent F Non-reservoired catchr DMLA/Q95 or Q95/COMF >1.0 0.7-1.0 0.4-0.7 0.2-0.4 <0.2 13 GROUNDWA Mean Annual Deck Mean Seasonal Ra MAD/MSR =	DMLA (with direct importants) Peturns (daily) = atchments: Total DMLA ments: Q95/COMP = Qi Score 4 3 2 1 0 TER LEVEL PARAMET ine in minimum groundwinge = Score	Assi	QNF) (GWDMLA) } (ERTWO) / ONLY enter 2+GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) =	If H1 not used
Iotal "Licence-exe Description of the second secon	DMLA (with direct impo Returns (daily) = atchments: Total DMLA ments: Q95/COMP = QI Score 4 3 2 1 0 TER LEVEL PARAMET me in minimum groundwinge =	Assi	(QNF) (GWDMLA) } (ERTWO) / OWLY enter 2+GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) = (2-GWDMLA+ERTWO) = (2-GWDMLA+ERTWO) =	If H1 not used
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I otal "Licence-exe Q95(7) = Total Groundwater Licensed Effluent F Non-reservoired catchr DMLA/Q95 or Q95/COMF >1.0 0.7-1.0 0.7-1.0 0.4-0.7 0.2-0.4 <0.2 H3 GROUNDWA Wean Annual Decli Wean Seasonal Ra MAD/MSR = MAD/MSR - >0.5	DMLA (with direct importance impo	Act) = m3/4 m3/4 m3/4 m3/4 m3/4 m3/4 m3/4 m3/4	(QNF) (GWDMLA) } (ERTWO) / ONLY enter 2+GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) = (2-GWDMLA+ERTWO) = (MAD) m (MAD) m (MAD) m (MSR)	If H1 not used PRIMARY pression score
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Iotal "Licence-exe Description of the second secon	DMLA (with direct import Returns (daily) = atchments: Total DMLA ments: Q95/COMP = QI Score 4 3 2 1 0 TER LEVEL PARAMET me in minimum groundwinge = Score 4 3 2 1	Act) - m3/4 m3/4 m3/4 m3/4 m3/4 m3/4 m3/4 m3/4	QNF) (GWDMLA) } (ERTWO) / ONLY enter C+GWDMLA-ERTWO)/QNF = (2-GWDMLA+ERTWO) =	If H1 not used

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	<u></u>	HYDROLOGIC		CATOR	D200 2 of 2
		NAME OF STREAM		DATE-	
	(see Report Ch	apters 7.1 to 7.8 for full	emienati	on of the methodolom/)	
HA STREAM	MORPHOLOGY F	ARAMETER			
Cross	Criment XSA	Normal XSA	Current	2	
Section	of flow (m2)	of flow (m2)	Normal		
1				7	
2				-	
3				1	
4					
5				=	
·		- Mean -	' L		
% of Cha	unnel Score				
<10%		4			
10-30%		3			
30-5096		2			
>70%		0	Assign	score: H4 -	SECONDARY
H5 FLOW A	ND ECOLOGY REL	ATIONSHIP PARAMET	BR -	RESIDUAL FLO	<u>w</u>
				MINIMUM ECOLOGICALL	Y ACCEPTABLE FLOW
Q95(7) =			m3/d	(QNF) J ONLY ente	r for non-res. catchments
Total DMLA (s	98 H2) =			(DMLA))	
Heservoir Com	pensation Flow (m	ean daily) =		(COMP) }	
Total Oownaire Total 'Liceoce.	am channel aosta -avemnt' ebstractiv	coori (caliy) =		(OMEGA) = (OMEGA) = O(2)	r roconninad catchmonia
icansed Efflu	ant Returns (daily)		m3/d	(ERTWO) }	
Tributary Inflo	ws (sum of Q95s) =		m3/d	(TRIB) }	
MEAF (critical	month) =		m3/d	(MEAF) (Note: MEAL	F is under development as pl
·		_	_	of NRA R&L	Project B2.1 and is as yet
(Q95-DM	ILA)MEAF Scor	0		undefined)	
or COMP	MEAF				and a surger
<60%		4 Non-res. 3 Res. cato	catchmer hmenter (118: (Q95-OMLA)/MEAF = COMP_DAILOA_Y2+EPTM(
80-100%		2	undute (
100-120	, M	1			
>120%	1	0	Assign	scarez HS =	PRIMARY
	NT OF SPRINCH				
Total length of	reaches changed i	rom perennial to intermi	ittoot -		
Total length of	reaches changed (rom intermittent to ephe	meral -	(Km	
	-	·	Sum =	km	
Sum of re	aches (km) Score	9			
8<		•			
4-8	:	3			
2-4	:	2			
0-2		1			
		<u> </u>	Assign	scors: H6 =	SECONDARY
	CALC	ULATION OF HYDE	IOLOGK	CAL INDICATOR	
Parameter	Patton, weight		Weight	of params. used Scor	e Weight x Score
H1	0.5) If H1	& H2 are BOTH used,			
H2	0.5) set b	oth weights to 0.4			
H3	0.1				
-+4	0.1				
45	0.9				
-16	0.1				
	• 1	SUM1 =	X.	(max.1)	SUM2 -
lydrology Se	averity Index = 9	UM2/(SUM1+4) =			
Judician D	aliohilitu Indou - G				
	511200X 🖛	JUMI =	1000000		

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		ECOL	OGI	CAL II	IDICA	TOR					page 1 (
NRV	A REGION:	NAME	OF STR	REAM:			۵	ATE:			
		(see Report Chapters 8.1 to	08.7 fc	r full exp	lanation	of met	hodology)				
1	INVERTEBRAT	E COMMUNITY PARAMETER									
len	erate potential A	SPT:									
iek	ct multipliers:										
	SOURCE -	SOURC	ie: Upl	and = 1;	Lowland	1 - 0.8		_			
÷	REACH =		: Head	stream =	1; Mid :	= 0.95; I Imited	Lower = 0.1	9 rate — O 9	5. Exte	nska -	
	EFF.COMP. =	EFFLUE	ENT C	OMPONE	ENT: Los	W (NWC	ciass 1) =	1; Moder	ate (NM	/C clas	8 2) = 0.
					Hig	h (NWC	C class 3) =	0.9			
ote	ential ASPT =										
le:	sured ASPT =										
	Score		P	otential /	SPT	-					
		<4.5 4.5-	5.0 5.	.1 -5.5 5 .	6-6 .0 €	1-6.5	>6.5	-4			
		<4.5 0	1	2	3	4	4				
	Management	4.5-5.0	0	1	2	3	4			1.1	
	ASPT	5.6-6.0		v	0	<u>د</u> 1	2				
		6.1-6.5			•	Ó	ī				
		>6.6					0		asign a	corec	1-
	Score	Fish community under					Decline du	e to low	flows		
	Score	Fish community under 'normal' flow conditions		b)	0		Decline du	e to low	flows	b)	
	Game	Fish community under 'normal' flow conditions Headstream		b)	c)	d)	Decline du e)	ie to low i Ŋ	flows g)	h)	ŋ
	Game	Fish community under 'normal' flow conditions Headstream a) Trout, salmon		b) 2	c) ₋3	d) _4	Decline du e)	ie to low 1 1) -	flows g) _	h) -	D -
	Game	Fish community under 'normal' flow conditions Headstream a) Trout, salmon b) Small trout only (+ loss of o year classes)	older	b) 2 -	c) _3 2	d) -4 -3	Decline du e) - -	e to low 1 D - -	flows g) - -	h) -	i) - -
	Game	Fish community under 'normal' flow conditions Headstream a) Trout, salmon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of	Nder	b) 2 -	c) _3 2	d) 4 3 2	Decline du e) - -	e to low 1 0 - - -	flows GD - -	h) - -) - - -
	Game	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss	Xder	b) 2 -	c) _3 2	d) -4 -3 -2	Decline du e) - -	e to low 1 1) - - -	flows g) - -	h) - -) - - -
	Game	Fish community under 'normal' flow conditions Headstream a) Trout, salmon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches	Nder	b) 2 - -	c) _3 _2 	d) 4 3 2 -	Decline du e) - - -	e to low 1 0 - - - -	flows 2) - - -	h) 	0)
	Game	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout	older	b) 2 - - 2	c) -3 - - - 3	d) 4 3 2 - 4	Decline du e) - - - -	e to low 1 1) - - - 1	flows 9) - - - 2	h) 3	0 - - - 4
	Game Coarse	Fish community under 'normal' flow conditions Headstream a) Trout, salmon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, (o) Small populations of species	pike 25 0	b) 2 - - 2 -	c) 3 2 - 3 3 2	d) 4 3 2 - 4 4 4	Decline du e) - - - - -	e to low 1 1) - - - 1	flows g) - - - 2 1	h) - - 3 2	0) 4 3)
	Game Coarse	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, (g) Small populations of species (+ loss of older year classes	pike ss () s)	b) 2 - - 2 - 2	c) _3 _2 	d) 4 3 2 - 4 3	Decline du e) - - - - - -	e to low 1 0 - - - 1 - 1	flows (1) - - - 2 1 -	h) - - 3 2 1	i) - - - 4 3 2
	Game Coarse	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, (g) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench	pike es () s) n	b) 2 - - 2 -	c) -3 - - - 3 2 3 2 3	d) -4 -3 - - - 4 - - 4 - - - 4 - - - - - -	Decline du e) - - - - - - - -	e to low 1 1) - - - 1 - 1	flows g) - - - 2 1 - -	h) - - 3 2 1	0 - - - 4 3 2 1
	Game Coarse	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, j g) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species	pike ps: () s) n s h)	b) 2 - - - 2 - - -	c) 3 2 - 3 3 2 3 2 3 2	d) 4 3 2 - 4 3 4 3	Decline du e) - - - - - - - - - - - - -	e to low 1 0 - - - 1 - - - - -	flows g) - - - 2 1 - - - - - - - - -	h) - - 3 2 1	0 - - 4 3 2 1 -
	Game Coarse	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of oryear classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, (g) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes (+ loss of older year classes	pike es () s) n s) s) s)	b) 2 - - 2 - - -	c) -3 - - - 3 2 3 2 3 2	d) 4 3 2 - 4 3 4 3	Decline du e) - - - - - - - - - - - -	e to low 1) - - - 1 - - - - - - - - - - - - -	flows g) - - - 2 1 - - - - - - -	h) - - 3 2 1	i) - - 4 3 2 1 -
	Game Coarse Tidal Fisheries	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, (g) Small populations of species (+ loss of older year classes (+ loss of older year classes (+ loss of older year classes (+ loss of older year classes	pike es () s) n s h) s)	b) 2 - - 2 - - -	c) 3 2 - 3 3 2 3 2 3 2	d) 4 3 2 - 4 3 4 3	Decline du e) - - - - - - - - - -	e to low 1) - - 1 - - - - - - - - - - - - -	flows g) - - - 2 1 - - - - - - - - - - - - - - -	h) - - 3 2 1 -	0) 4 3 2 1
	Game Game Coarse Tidal Fisheries	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, j g) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes (+ loss of older year classes (+ loss of older year classes	pike ps: () s: () s: h) s: h) s: h) s: h)	b) 2 - - 2 - - -	c) 3 2 - 3 2 3 2 3 2	d) 4 3 2 - 4 3 4 3	Decline du e) - - - - - - - - - - - -	e to low 1) - - - 1 - - - - - - - - - - - - -	flows g) - - - 2 1 - - - - 2 (Fish: vecline c	h) - - 3 2 1 -	i) - - 4 3 2 1 -
	Game Game Coarse Tidal Fisheries	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, (g) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes (+ loss of older year classes	pike pike s () s) s h) s) due to a	b) 2 - - 2 - - - - - - - - - - - - - - -	c) 3 2 - 3 2 3 2 3 2 8 c	d) 4 3 2 - 4 3 4 3	Decline du e)	e to low 1) - - 1 - - - - - - - - - - - - -	flows g) - - - 2 1 - - - - - - - - - - - - - - -	h) - - 3 2 1 - -	i) - - 4 3 2 1 -
	Game Game Coarse Tidal Fisheries a) No reduction b) Seasonal de	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, (g) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes (+ loss of older year classes)	kider pike es () s) s) s) due to a	b) 2 - - 2 - - - - - - - - - - - - - - -	c) -3 2 - - 3 2 3 2 3 2 8 c 4 2	d) 4 3 2 - 4 3 4 3	Decline du e) - - - - - - - - - - - - -	e to low 1) - - - 1 - - - - - - - - - - - - -	flows g) - - - 2 1 - - 2 1 - - - 2 1 - - - 2 (Fish: ecline (8 - - -	h) - - 3 2 1 - - - - - - - - - - - - - - - - - -	i) - - 4 3 2 1 - - - 4 2 0 w flows
	Game Game Coarse Tidal Fisheries a) No reduction b) Seasonal de c) Permanent d	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, (g) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes (+ loss of older year classes (+ loss of older year classes (+ loss of older year classes) Decline	pike es () s) s h) s) due to a -	b) 2 - - 2 - - - - - - - - - - - - - - -	c) _3 2 - _ 3 2 3 2 3 2 8 c 4 2 _	d) 4 3 2 - 4 3 4 3	Decline du e) - - - - - - - - - - - - - - - - - -	e to low 1) - - - 1 - - - migratory D ction luction	flows g) - - - 2 1 - - - - - - - - - - - - - - -	h) - - 3 2 1 - - - - - - - - - - - - - - - - - -	i) - - - 4 3 2 1 - - - 4 2 - - - - - - 4 2 - - - - - - -
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×r.	Game Game Coarse Tidal Fisheries a) No reduction b) Seasonal de c) Permanent d	Fish community under 'normal' flow conditions Headstream a) Trout, saimon b) Small trout only (+ loss of oryear classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, (g) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes (+ loss of older year classes) (+ loss of older year classes (+ loss of older year	pike pike es () s) s) clue to a - -	b) 2 - - 2 - - - - - - - - - - - - - - -	c) _3 2 - - 3 2 3 2 3 2 3 2 3 2 3 2 3 2 3 2	d) 4 3 2 - 4 3 4 3	Decline du e) - - - - - - - - - - - - -	e to low 1) - - 1 - migratory D ction luction	flows g) - - - - - - - - - - - - - - - - - -	h) - - 3 2 1 1 - - - - - - - - - - - - - - - - -	i) - - - 4 3 2 1 - - - 4 2 - - - - 4 2 - - -
Æ	Game Game Coarse Tidal Fisheries a) No reduction b) Seasonal de c) Permanent d	Fish community under 'normal' flow conditions Headstream a) Trout, salmon b) Small trout only (+ loss of o year classes) c) Minor species only (loss of spawning habitat) d) Complete loss Lower reaches e) Trout f) Barbel, chub, dace, perch, j g) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes h) Bream, perch, roach, tench i) Small populations of species (+ loss of older year classes (+ loss of older year classes ii) Decline Decline Short-term impact parameter possible during a season due to	pike es f) s) due to a ter o low fi	b) 2 - - 2 - - - - - - - - - - - - - - -	c) _3 2 - 3 2 3 3 2 3 3 2 3 3 2 3 3 2 3 3 2 3 3 2 3 3 2 3 3 2 3 3 2 3 3 2 3 3 3 2 3 3 3 2 3 3 3 3 3 3 3 3 3 3 3 3 3	d) 4 3 2 - 4 3 4 3	Decline du e) - - - - - - - - - - - - -	e to low 1) - - - 1 - - - - - - - - - - - - -	flows g) - - - - - - - - - - - - - - - - - -	h) - - 3 2 1 - -	i) - - 4 3 2 1 - - 4 3 2 1 - - 4 3 2 1 - - - 4 - - - 4 - - - - - - - - - - - - -

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			ECOLOGI	CAL INDI	ATOR			page 2 of .
NR/	REGION:		NAME OF ST	REAM		DATE:		
		(see Report Cl	hapters 8.1 to 8.7 fc	x full explanal	ion of method	ology)	· · · ·	
ES	FISH STOCKS P	NRAMETER						
Gen	erate potential fish	stock: Past f	fish stock (N) =]			
Sele	ct multipliers:	CHAN.MODS.	C	HANNEL MO	SFICATIONS:	Low = 1; Mo	derate = 0.9; Hig	h = 0.8
		EFF.COMP. =	E	FFLUENT CO	MPONENT: D	ecrease = 1;	No Change = 1; I	ncrezse =
Pote	ntial fisk stock (Ni	7) = N x multiplie	(T = C)	Maasu	ed present fis	h stock (NM)	.	1
Pres	ent/Potential Fish	Stock (FSR%) =			•			
	Present/Potential	Declir	ne related to low flo	WS :	Score			
	<40%		Serious declin	ie	4			
	40-59%		Large decline	llaa	3			
	80-99%		Slight decline		1			
	>100%		None		0		Assign score:	3
E4	PLANT PARAME	TEA			·····	1		
	Description of cha	2006				Score	ה	
	Banksida flora ha	s changed or is (changing due to a k	ower water tat	le			
	Abnormal invesio	n of the river cha	onel in summer by	marginal terro	estrial olants	2		
	No change other		annoi in danima by	hangel or han	keide flora	-	Anelon conversi	- 1
•	nuo change, ocher	Their normer sea	SOME VEHICLE OF HE	And THE UP Date			Papergr active.	
5	CONSERVATION	PARAMETER	·					
ንոհ	use this parameter	r II there is direr	t widence that inw	i flowe are a or	ohlom /i e fra	m 2 of naram	alam H1 H2 H5 P	:1 E2 E3
y	Formally designed							. , <u>, , , , , , , , , , , , , , , , , ,</u>
	Pormany designal	es att as hat the						
	Chaimei, npanan		cepencing on sun	lace or ground		Character		
	HAMSAR Sites, N	ational Nature H	leserves (NNRs), M	iarine Nature F	leserves (MNI	Rs), Special F	Protection Areas	5
• •	(SPAS), SILES OF S	pecial Scientific	Interest (SSSIS), PL	abitat of speck	as protected p	y EC Directiv	e or wiidline and	
		n of regional or o	outhi importance (on Naturalist 7	Curet Bocones	DCDD Daga	· · · · · · · · · · · · · · · · · · ·	-
		s of regional of c		and Shee e	i ust rieseive,		***)	
	No formal design:	we (including rig	niiaya silas, C-sila	s, and sues of		95()		3
	Riton within the d			·				
	Sites wurm the m	dan babitat						- Cooro
								Scure
	containing spacie	i value, eg a dive	wse, natural and ty	pical nabitat of	a viable size	and		3
				ASS I SURFACTI				
	MODERATE CONSERV	ation value, eg a	Smaller or less div	erse site; or a	site with natu	ral or		2
		no particolariy ti			stretch			
		Anvation value.	NWC Class 3 Stretc	n				T
	Site of no conserv	ation value. NW	C class 4 stretch					0
dd	scores from both t	ibles and divide	by 2 to give final E	5 acore.			Assign score: E	5
		CALC	CULATION OF E	COLOGICA	L INDICATO	R		
ara	meter P	aram.weight	Weight of para	ms. used	Score	Weight	x Score	
E1		0.4					•	
E2		0.2]	
E3		0.3						
E4		0.1	Ē				1	
5		0.3					1	
			SUM1 - 🔤	(max. 1)	SUM2 -			
Col	ogy Severity Inc	iex = SUM2/(S	UM1x4) =					
	ory Roliability I	Nev - SIIM1						
	- 87		_		3			

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	LANDSCAPE AND AMENITY INDICATOR	page 1 of
NRA RI	EGION: NAME OF STREAM: DATE:	
	(see Report Chapters 9.1 to 9.6 for full explanation of methodology)	
Note: D	to not use L1,L2,L4 or L5 unless there is other firm evidence of low flows from at least 2 of parameters H1,H2,H	45,E1,E2,E5
L1 /	INDSCAPE DESIGNATION AND RA. JTY PARAMETER	
For Lan	discape Designation:	
	escription	Score
	iportant in a factional context, se National Parks and Areas of Outstanding Natural Beauty	2
co	iportant in a local context, le vieas defined as country Parks/Special Value e.c. within local of subjectine plan Intext	·
	indiscape has no official designation	0
Ar	n additional acore may be awarded as follows:	
in In	eas which are undergoing environmental improvements (either national or local) and where hance exists to suport such improvements, ie landscapes within Development Corporation Areas, Local itiative Areas	+1
For Lan	dscape Rarity:	
De	secription	Score
WI in	here river/river corridor landscape is "the only" or "one of the best examples of" the national context	2
W	here river/river corridor landscape is "the only" or "one of the best examples of "	1
10		
11	ie river has no rarry value	0
Ndd aco	Assign acore: L1-	
2 M	PORTANCE OF THE RIVER AS A LANDSCAPE FEATURE AND ITS IMPACT ON ADJACENT LAND PARAME	तम
For Imp	orlance:	
De	Historia de la computer de la	Coord
		Score
nd =	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc.	3
hti hdi Mi bei	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc	3
i i i bri Mi be Lo	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adium importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable	3
For Impa	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adium importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act:	3 2 1
For Impa De De De	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adium importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act:	3 2 1 Score
For Impi Int Int Int Int	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adjum importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: scription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river	3 2 1 Score -1
F# bri bri be Lo Lo For Imp. For Imp. Vi Wi Wi So.	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adjum importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: scription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river, which could be remedied if remedial action were taken	3 2 1 Score -1 +1
Far Impa be Lo For Impa for Impa Son Imp Ma Imp Son to I	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adium importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: iscription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river, which could be remedied if remedial action were taken the river	3 2 1 Score -1 +1
ior Impi ior Impi ior Impi im Wi in Wi in to I dd sco	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adjum importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: iscription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river, which could be remedied if remedial action were taken the river mes to a range of 0-4 Assign score: 12:=	3 2 1 Score -1 +1
Fit bri bri Lo For Imp Tot Imp Mi Mi Mi Mi Mi Mi Mi Mi Mi Mi Mi Mi Mi	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adium importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: iscription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river, which could be remedied if remedial action were taken the river res to a range of 0–4 <u>Assign score:::12:</u>	3 2 1 Score -1 +1
Fill Lo bri Lo For Impi For Impi Vi Wi Un to I Vi Vi Vi Vi Vi Vi Vi Vi Vi Vi Vi Vi Vi	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adium importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: scription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river, which could be remedied if remedial action were taken the river res to a range of 0–4 <u>Assign score::12 +</u> CREATION PARAMETER scription (do not include fishing/angling)	3 2 1 Score -1 +1 Score
Tor Imp for Im	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adium importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: scription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river res to a range of 0–4 <u>Assign score: 1.2.*</u> CREATION PARAMETER scription (do not include fishing/angling) here 3 or more water-contact recreational activities were unable to take place sometime in each year ring a 5 year period	3 2 1 Score -1 +1 \$ Score 4
Fill Lo bri Lo for imp for imp	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adium importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: scription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river, which could be remedied if remedial action were taken the river res to a range of 0-4 CCREATION PARAMETER scription (do not include fishing/angling) here 3 or more water-contact recreational activities were unable to take place sometime in each year ring a 5 year period or more water-contact recreational activities were unable to take place at any time in any e 12 month period	3 2 1 Score -1 +1 \$ Score 4 3
The second secon	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adium importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: scription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river, which could be remedied if remedial action were taken the river res to a range of 0–4 CREATION PARAMETER scription (do not include fishing/angling) here 3 or more water-contact recreational activities were unable to take place sometime in each year ring a 5 year period or more water-contact recreational activities were unable to take place at any time in any e 12 month period	3 2 1 Score -1 +1 +1 Score 4 3 2
The second secon	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adium importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: scription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river here a degraded or unsightly adjacent land use is primarily as a result of man's impact o, or management of, the river, which could be remedied if remedial action were taken the river res to a range of 0-4 CREATION PARAMETER scription (do not include fishing/angling) here 3 or more water-contact recreational activities were unable to take place sometime in each year ring a 5 year period or more vater-contact recreational activities were unable to take place at any time in any e 12 month period y water-contact recreational activities were unable to take place at any time in any month period y water-contact recreational activities were unable to take place at any time in any month period y water-contact recreational activities were unable to take place at any time in any state-contact recreational activities were unable to take place at any time in any month period y water-contact recreational activities were unable to take place at any time in any is also includes a reduction in enjoyment of a sport, resulting from low river flows	3 2 1 Score -1 +1 +1 Score 4 3 2 1
The second secon	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adlum importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: scription here a beneficial adjacent land use (within 500m) is primarily as a result of man's pact on, or management of, the river nere a degraded or unsightly adjacent land use is primarily as a result of man's impact , or management of, the river, which could be remedial action were taken the river res to a range of 0–4 CREATION PARAMETER scription to on include fishing/angling) hen 3 or more water-contact recreational activities were unable to take place sometime in each year ring a 5 year period w more water-contact recreational activities were unable to take place at any time in any e 12 month period w atter-contact recreational activities were unable to take place at any time in any e 12 month period w atter-contact recreational activities were unable to take place at any time in any e 12 month period w atter-contact recreational activities were unable to take place at any time in any e 12 month period w atter-contact recreational activities were unable to take place at any time in any e 12 month period w atter-contact recreational activities were unable to take place at any time in any e 13 month period	3 2 1 Score -1 +1 +1 Score 4 3 2 1 0
The second secon	gh Importance - dominant landscape feature, due to associated artifacts such as weirs, idges etc. adjum importance - only stretches of the river are visible, or the course is only noticeable cause of bankside vegetation being visible w importance - the river is barely noticeable act: scription here a beneficial adjacent land use (within 500m) is primarity as a result of man's pact on, or management of, the river here a degraded or unsightly adjacent land use is primarity as a result of man's impact , or management of, the river here a degraded or unsightly adjacent land use is primarity as a result of man's impact , or management of, the river here a degraded or unsightly adjacent land use is primarity as a result of man's impact , or management of, the river here a degraded or unsightly adjacent land use is primarity as a result of man's impact , or management of, the river here a degraded or unsightly adjacent land use is primarity as a result of man's impact , or management of, the river res to a range of 0-4 <u>CREATION PARAMETER</u> scription (do not include fishing/angling) here 3 or more water-contact recreational activities were unable to take place sometime in each year ring a 5 year period or more water-contact recreational activities were unable to take place at any time in any e 12 month period w avater-contact recreational activity was affected by low flows within the last 5 years. is also includes a reduction in enjoyment of a sport, resulting from low river flows change has been noted bistorical evidence exists, an additional score may be awarded where: e river was able to support a water-contact recreational activity within the past 25 years, this activity is no lower accelline due to flower flows the support a water-contact recreational activity within the past 25 years, this activity is no lower accelline due to flower flower.	3 3 2 1 3 2 1 +1 5 5 5 5 5 6 4 3 2 1 0 1 0 +1

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		SCAPE AND AMENITY	INDICATOR	page 2 o
IRA REGION:		NAME OF STREAM:	DATE:	
	(see Report Chapter	rs 9.1 to 9.6 for full explanation of	methodology)	
lote: Do not use	L1,L2,L4 or L5 unless th	ere is other firm evidence of low fi	ows from at least 2 of param	rters H1,H2,H5,E1,E2,E
A AMENITY P	PARAMETER			
for Odour:				
Description				Score
a distance of	ur at channel edge, eg slu of > 10m from the channe	idge, sewage,cnemica) or tarmyaj i	o wastes and noticeable at	2
Noticeable	odour at the channel edge	9		1
No noticeat	ble odour			0
ior Visual Impair	ment at the river channel	•	3	
Elements includ Ind also where n	le unnatural water colour, refuse and litter are exposi	farm wastes, foam, sewage, fung ed or if no water is present)	us, crude sewage, visible so	lids, rotting vegetation,
Description			· · ·	Score
3 or more o low flows, o	f the above elements which or 3 or more of the above e	ch persist over a period of several elements which occur intermittent	months, as result of Y	3
1 to 3 of the	above elements which p	ersist over a period of several mor	iths, as result of low flows	2
2 of the elec	ments which occur Interm	ittently, as a result of low flows		1
No visual p	roblem			0
or Visual Impair	ment on the river bank an	nd adjacent land:		
·		-		
Description				Score
Description Where plan	ning declaration encoura	nes nublic use		Score
Description Where plan dd acores to a r	ning designation encoura naximum of 4.	ges public use	Asian	+1 +1
Description Where plan dd acores to a r 5HISTORICA	ning designation encoura nædmum of 4. NL AND CULTURAL ASSO	ges public use	Assign (Score +1 score: L4 =
Description Where plan dd acores to a r 5 HISTORICA	ning designation encoura maximum of 4. N. AND CULTURAL ASSO	ges public use	Asign	Score +1 Icore: 1.4 =
Description Where plan dd acores to a r 5 HISTORICA Description Sites of pati	ning designation encoura naximum of 4. NL AND CULTURAL ASSO	ges public use		Score +1 score: L4 = Score
Description Where plan dd acores to a r 5 HISTORICA Description Sites of nati	ning designation encoura maximum of 4. N. AND CULTURAL ASSO ional historical/archaeolog	ges public use DCIATIONS PARAMETER gical interest, le National Monume	Assign nts, National Trust sites	score: L4 = Score: L4 = Score 4
Description Where plan dd scores to a r 5 HISTORICA Description Sites of nati Sites of regi Sites which	ning designation encoura naximum of 4. NL AND CULTURAL ASSO ional historical/archaeolog ional historical/archaeolog have national cultural ass	ges public use OCIATIONS PARAMETER gical interest, le National Monume gical interest, generally within 500 sociations such as paintings and i	Assign Assign nts, National Trust sites m terature, or local	Score: 14 - Score: 14 - Score: 4 3 2
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Description Where plan dd acores to a r 5 HISTORICA Description Sites of nati Sites of regi Sites which archaeologi Sites of loca	ning designation encoura naximum of 4. NL AND CULTURAL ASSO ional historical/archaeolog ional historical/archaeolog have national cultural ass ical sites al historical/archaeologica	ges public use OCIATIONS PARAMETER gical interest, le National Monume gical interest, generally within 500 sociations such as paintings and il	Assign nts, National Trust sites m terature, or local as place names	Score: 14 - score: 14 - Score 4 3 2
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Description Where plan dd acores to a r 5 HISTORICA Description Sites of nati Sites of regi Sites of regi Sites of loca No historica	ning designation encoura maximum of 4. NL AND CULTURAL ASSO ional historical/archaeolog ional historical/archaeolog have national cultural ass ical sites al historical/archaeologica ti or cultural associations	ges public use DCIATIONS PARAMETER gical interest, le National Monume gical Interest, generally within 500 sociations such as paintings and il	Assign nts, National Trust sites m terature, or local as place names Assign s	Score +1 score: L4 = Score 4 3 2 1 1 0 score: L5 =
Description Where plan dd acores to a m 5 HISTORICA Description Sites of nati Sites of regi Sites of loca No historica	ning designation encoura naximum of 4. IL AND CULTURAL ASSO ional historical/archaeolog ional historical/archaeolog have national cultural ass ical sites al historical/archaeologica al or cultural associations CALCU	ges public use OCIATIONS PARAMETER gical interest, le National Monume gical Interest, generally within 500 sociations such as paintings and it it, cultural or literary interest, such	Assign Ints, National Trust sites m terature, or local as place names Assign a ASSign a	Score +1 score: L4 = Score 4 3 2 1 0 score: L5 = R
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		PUE	LIC PERCEPTIO		R		page 1 d
NRA	REGION:		NAME OF STREAM	t		DATE	
		see Report Chap	ters 10.1 to 10.3 for full	explanation of me	thodology)		
P1	PUDXIMITY OF F	EVER TO CENT	HES OF POPULATION	parameter			
	Description				Score]	
	River flows throug	gh a large centre	of population, ie a town		4		
	River flows throug	ph a small centre	of population, ie a villag	9	3		
	River flows within	1km of a town			2		
	River flows within	1km of a village			÷ 1		
11 ur	sure of town/villag	e distinction, us	r Town = > 10.000 pop.)		Assian score: P1 =	
2	COMPLAINTS RE	CEIVED FROM	THE PUBLIC parameter	ſ			
-							8001
	L'ascription					•	
	Written complaint etc.) in support of	s received from r local pressure g	national organisations (e. roups formed specifically	.g. English Nature y to deal with prob	e, CLA, CPRE, plems affecting	Salmon & Trout Asso the river and it's	c. 4
	Written complaint etc.) in support of environment Press coverage o	s received from r local pressure g r written complaie	national organisations (e. roups formed specifically nts received from nation:	.g. English Nature y to deal with prob al organisations o	a, CLA, CPRE, plems affecting r local clubs or	Salmon & Trout Asso the river and it's pressure groups	c. 4
	Written complaint etc.) in support of environment Press coverage of A moderate numb problems related	s received from r local pressure g r written complain ver (> 5/annum of to low river flows	national organisations (e. roups formed specifically nts received from nation: n average) of written con over a period of years	.g. English Nature y to deal with prob al organisations o pplaints received t	e, CLA, CPRE, olems affecting r local clubs or from individual	Salmon & Trout Asso the river and it's pressure groups s about	c. 4
	Written complaint etc.) in support of environment Press coverage of A moderate numb problems related Up to 5/annum on low river flows ove	s received from r local pressure g r written complain ter (> 5/annum or to low river flows a average written or a period of yea	national organisations (e. roups formed specifically nts received from nation: n average) of written con over a period of years complaints received from rs	.g. English Nature y to deal with prob al organisations of nplaints received t m individuals abou	e, CLA, CPRE, plems affecting r local clubs or from individual ut problems rel	Salmon & Trout Asso the river and it's pressure groups 8 about ated to	c. 4
	Written complaint etc.) in support of environment Press coverage of A moderate numb problems related Up to 5/annum on low river flows ove No complaints red	s received from r local pressure g r written complain er (> 5/annum of to low river flows a everage written er a period of yea ceived about prob	national organisations (e. roups formed specifically nts received from nationa n average) of written com over a period of years complaints received from rs	.g. English Nature y to deal with prob al organisations of nplaints received f n Individuals about flows	a, CLA, CPRE, plems affecting r local clubs or from individual ut problems rel	Salmon & Trout Asso the river and it's pressure groups 8 about ated to	c. 4
	Written complaint etc.) in support of environment Press coverage of A moderate numb problems related Up to 5/annum on low river flows ove No complaints rec	s received from r local pressure g r written complain ter (> 5/annum of to low river flows a average written ir a period of yea seived about prot	national organisations (e. roups formed specifically nts received from nationa n average) of written com over a period of years complaints received from rs blems related to low river	.g. English Nature y to deal with prob al organisations of nplaints received t n Individuals about flows	e, CLA, CPRE, plems affecting r local clubs or from individual ut problems rel	Salmon & Trout Asso the river and it's pressure groups s about ated to Assign score: P2 =	c. 4
	Written complaint etc.) in support of environment Press coverage of A moderate numb problems related Up to 5/annum on low river flows ow No complaints red	s received from r local pressure g r written complain to low river flows a average written or a period of yea ceived about prot	national organisations (e. roups formed specifically nts received from nationa n average) of written con over a period of years complaints received from rs blems related to low river	g. English Nature y to deal with prob al organisations of nplaints received t n Individuals abou flows	a, CLA, CPRE, plems affecting r local clubs or from individual ut problems rel	Salmon & Trout Asso the river and it's pressure groups about ated to Assign score: P2 =	c. 4
² 818	Written complaint etc.) in support of environment Press coverage of A moderate numb problems related Up to 5/annum on low river flows ove No complaints rec (meter F	s received from r local pressure g r written complain to low river flows a average written or a period of yea ceived about prot CALCULATION	national organisations (e. roups formed specifically ints received from national in average) of written com- over a period of years complaints received from rs blems related to low river blems related to low river	.g. English Nature y to deal with prob al organisations of nplaints received t n Individuals about flows EPTION INDICA params.used	a, CLA, CPRE, plems affecting r local clubs or from individual ut problems rel to roblems rel to roblems rel	Salmon & Trout Asso the river and it's pressure groups s about ated to Assign score: P2 = Weight x Sco	c. 4
⁵ ara	Written complaint etc.) in support of environment Press coverage of A moderate numb problems related Up to 5/annum on low river flows ove No complaints red	s received from r local pressure g r written complain to low river flows a average written or a period of yea ceived about prot calculation calculation Param.weight 0.3	national organisations (e. roups formed specifically ints received from national in average) of written com- over a period of years complaints received from rs elems related to low river l OF PUBLIC PERCE Weight of	.g. English Nature y to deal with prob al organisations of aplaints received to mindividuals about flows	a, CLA, CPRE, olems affecting r local clubs or from individual ut problems rel 	Salmon & Trout Asso the river and it's pressure groups 8 about ated to Assign score: P2= Weight x Sco	c. 4
Para P1 P2	Written complaint etc.) in support of environment Press coverage of A moderate numb problems related Up to 5/annum on low river flows ove No complaints rec (meter F	s received from r local pressure g r written complain to low river flows a average written or a period of yea ceived about prot calculation Param.weight 0.3 0.7	national organisations (e. roups formed specifically ints received from national in average) of written com- over a period of years complaints received from rs elems related to low river l OF PUBLIC PERCE Weight of	g. English Nature y to deal with prob al organisations of nplaints received to in Individuals about flows	a, CLA, CPRE, olems affecting r local clubs or from individual ut problems rel 	Salmon & Trout Asso the river and it's pressure groups about ated to Assign score: P2= Weight x Sco	c. 4
Para P1 P2	Written complaint etc.) in support of environment Press coverage of A moderate numb problems related Up to 5/annum on low river flows ove No complaints red Complaints red	s received from r local pressure g r written complain to low river flows a average written or a period of yea ceived about prot CALCULATION Param.weight 0.3 0.7	national organisations (e. roups formed specifically ints received from national in average) of written com- over a period of years complaints received from rs blems related to low river l OF PUBLIC PERCE Weight of SUM1 –	g. English Nature y to deal with prob al organisations of nplaints received to n Individuals about flows	A, CLA, CPRE, blems affecting r local clubs or from individual ut problems rel TOR Score	Salmon & Trout Asso the river and it's pressure groups about ated to Weight x Sco SUM2 =	c. 4
Para P1 P2	Written complaint etc.) in support of environment Press coverage of A moderate numb problems related Up to 5/annum on low river flows ow No complaints rec (C meter F	s received from r local pressure g r written complain to low river flows a average written or a period of yea ceived about prot CALCULATION Param.weight 0.3 0.7	national organisations (e. roups formed specifically ints received from national in average) of written com- over a period of years complaints received from rs elems related to low river l OF PUBLIC PERCE Weight of SUM1 –	.g. English Nature y to deal with prob al organisations of aplaints received f in individuals abou flows EPTION INDICA params.used	a, CLA, CPRE, olems affecting r local clubs or from individual ut problems rel TOR Score	Salmon & Trout Asso the river and it's pressure groups about ated to Assign score: P2 = Weight x Sco	c. 4

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NRA Project B2.2 : Low Flow Conditions

				ICATOHS	page 1 or
RA REGION:		NAME OF STREAM:	:	DATE:	
VERALL SEVE	RITY INDEX (SI)				
Si type		SI		Weighted Si	
Hydrologica	al Si		40.0%		
Ecological S	SI and Amenity SI		30.0%		
Public Perc	eption SI		10.0%		
			Total SI (Sii) =		
VERALL RELL	ABILITY INDEX (RI)				
Fil type		Ri (orig.)	Weight	Weighted Ri	
Hydrologica	el Ri		40.0%		
Ecological	RI		35.0% *		
Landscape	and Amenity PJ		25.0% *		
			Total RI -	-	
· Use only	a proportion of Indica	tor weight if "judgemental	scoring" has been	n carried out (see	
Report Cl	hapter 11.2)	······································			
		Action			
l High	High	Put In Capital Progra	imme for Alleviatio	on	
	•		• •		
High	Low	Further studies requi	ired		
High Low	Low High	Further studies requined in the studies requined in the studies strong case mount public restricts and studies required in the	ired ong public pressur slations campaign	re, in which	-
High Low	Low High Low	Further studies requi No action unless stro case mount public re No action unless stro	ired ong public pressur slations campaign ong public pressur	re, in which re, in which case initiate	-
High Low	Low High Low	Further studies requi No action unless stro case mount public re No action unless stro minimum cost furthe	ired ong public pressur slations campaign ong public pressur r studies and mou	re, in which re, in which case initiate Int public relations campaig	- n
High Low Low	Low High Low	Further studies requi No action unless stro case mount public re No action unless stro minimum cost furthe	ired ong public pressur slations campaign ong public pressur r studies and mou	re, in which re, in which case initiate Int public relations campaig	- n
High Low Low	Low High Low	Further studies requi No action unless stro case mount public re No action unless stro minimum cost furthe	ired ong public pressur slations campaign ong public pressur r studies and mou	re, in which re, in which case initiate int public relations campaig	- n
High Low Low ZE ADJUSTME	Low High Low ENT	Further studies requi No action unless stro case mount public re No action unless stro minimum cost furthe	ired ong public pressur slations campaign ong public pressur r studies and mou	re, in which re, in which case initiate int public relations campaign	n
High Low ZE ADJUSTME Length of w Catchment	Low High Low ENT ratercourse affected (area to mid-point of	Further studies requi No action unless stro case mount public re No action unless stro minimum cost furthe	ired ong public pressur slations campaign ong public pressur r studies and mou	re, in which re, in which case initiate int public relations campaig	- n
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Scott Wilson Kirkpstrick 1991

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