River Hydromorphology Assessment Technique (RHAT)

Training guide (2009)

Northern Ireland Environment Agency
www.ni-environment.gov.uk

Contact details:-

NIEA – Northern Ireland

Mary Toland - Mary.Toland@doeni.gov.uk

Laura Parkhill - Laura.Parkhill@doeni.gov.uk

EPA - Ireland

Catherine Bradley - C.Bradley@epa.ie

John Lucey - J.Lucey@epa.ie

Martin McGarrigle - M.Mcgarrigle@epa.ie

Patricia McCreesh – P.McCreesh@epa.ie

Cover image: Annalong Upper River, Co. Down

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ABBREVIATIONS

CEN	European Committee for Standardisation
CV	Culverts
D/S	Downstream
E	Extensive
EA	Environment Agency
EM	Embankment
EPA	Environmental Protection Agency
FD	Ford
GIS	Geographical Information System
GPS	Global Positioning System
HEP	Hydro-Electric Power
IG	Improved grassland
IGR	Irish Grid Reference
L	Left
LB	Left Bank
ND	Narrowed
NIEA	Northern Ireland Environment Agency
NSSHARE	North South Shared Aquatic REsources
NV	Not Visible
OD	Over-deepened
OSNI	Ordnance Survey of Northern Ireland
OW	Over-widened
PC	Poaching
PDA	Personal Digital Assistant
PPE	Personal Protective Equipment
P-R-G	Pool-Riffle-Glide
R	Right
RB	Right Bank
RHS	River Habitat Survey
RI	Reinforced
RS	Re-sectioned
RHAT	River Hydromorphology Assessment Technique
RP	Rough Pasture
SB	Set back embankment
U/S	Upstream
WB	Water body
WD	Woody debris
WFD	Water Framework Directive

INTRODUCTION

The European Water Framework Directive 2000/60/EC requires Member States to classify rivers in terms of hydromorphology to support high ecological status (of fish, macrophytes, invertebrates and diatoms) and to put into place mitigation measures necessary to achieve at least "good" status and prevent further deterioration of the water body status.

The Environmental Protection Agency (EPA) in the Republic of Ireland and Northern Ireland Environment Agency (NIEA), through the North South Shared Aquatic REsources (NS SHARE) project agreed a field assessment technique, for WFD classification, called the Rapid Assessment Technique (RAT). The initial developers were Professor Keith Richards and Dr. Rachel Horn in 2005, who based the technique on the US Environmental Protection Agency Rapid Bio-Assessment Protocols and the River Habitat Survey (RHS) of the Environment Agency (EA). However, the RAT guide and form have been largely modified from the initial draft by NIEA using expert knowledge, guidance from the European Committee for Standardisation (CEN), practical application and has been renamed the River Hydromorphology Assessment Technique (RHAT).

RHAT classifies river hydromorphology based on a departure from naturalness, and assigns a morphological classification directly related to that of the WFD: high, good, moderate, poor and bad, based on semi-qualitative and quantitative criteria. The eight criteria that are scored are:

1. Channel morphology and flow types
2. Channel vegetation
3. Substrate diversity and condition
4. Barriers to continuity
5. Bank structure and stability
6. Bank and bank top vegetation
7. Riparian land cover
8. Floodplain interaction

It is designed to be a rapid visual assessment based on information from desktop studies, using GIS data, aerial photography, historical data and data obtained from previous field surveys.

For WFD Classification, hydromorphology can be used to contribute to the status classification of waterbodies at high ecological status only. However, RHAT plays a vital role in identifying why a waterbody might be failing to achieve good ecological status, deciding what indirect and direct efforts are needed to improve status and in helping to prevent further deterioration.

It is recommended that anyone carrying out the RHAT has received training from NIEA/EPA specifically to use the RHAT. Accredited surveyors in RHAT will be issued with a surveyor code that must be referenced in any documentation.

WEATHER CONDITIONS

Surveys are best carried out from May to September. During the summer months the channel vegetation is at its most apparent, and rivers tend to be at lower flows, allowing in-channel features to be assessed. However surveys can be done outside this period by removing the score(s) for features not visible.

EQUIPMENT

Field forms including Health and Safety Sheet
RHAT description sheets
RHAT full survey sheets
RHAT spot-check sheets
Photo detail sheets
Personal protective equipment (PPE)
Pencils and rubber
Digital camera
Rangefinder
Global positioning system (GPS)
Weather writer x2
Spare batteries
Throw rope
First Aid kit
Mobile Phone
Spray kit
"Tick-kit"
Optional plastic tube to cover barbed wire
Optional hiking pole
Optional personal digital assistant (PDA)

HEALTH AND SAFETY

It is imperative that **all** Health and Safety policies required by **your** organisation are followed strictly. We recommend leaving site safety sheets at your base, use of PPE and phone-in procedures. If your safety is compromised at all by animals, people, access difficulties, etc, abandon the survey or find another survey stretch. Complete dynamic risk assessments as appropriate. A copy of NIEA's dynamic risk assessment for hydromorphology Sheet 1 is included (page 5).

CHECKLIST

- Check that the batteries are fully charged.
- Have the desk-study notes of your form completed and map route planned
- PPE
- For NI take Water Order warrant cards or local equivalent.
- Where you are not warranted to enter private land seek access permission from the landowner (never enter a locked yard by climbing fences or gates).

SHEET 1 - (RHAT) AN EXAMPLE OF A DYNAMIC RISK ASSESSMENT

Field Health and Safety sheet

River Name_____ Site Code_____ Date_____

1 = Low risk 5 = High risk

Please circle applicable number

PARKING	1	2	3	4	5
FENCES/BARRIERS	1	2	3	4	5
GROUND STABILITY	1	2	3	4	5
DENSE VEGETATION	1	2	3	4	5
BANK STEEPNESS OR STABILITY	1	2	3	4	5
RISK FROM ANIMALS	1	2	3	4	5
PHONE COVERAGE	1	2	3	4	5

Previous RHS/RAT/RHAT surveys - year and code _____

Details of access _____

1.1 SITE IDENTIFICATION (page 7)

Surveillance monitoring programmes have been allocated for both the EPA and NIEA with further sites to be assessed for operational and investigative monitoring. Full RHAT surveys should preferably start at or within 1km of the biology sites and at least 100m away from any bridges. Spot-check RHAT surveys (**Section 1.9**) are usually taken from a bridge or similar vantage point. Bridges and their associated features, such as widening of the channel and reinforcement may cause bias when considered on a waterbody scale. **The River name** is provided along with the **WFD site code** (biology site). A **hydromorphology site code** should be allocated with a 5 digit site code. The first 3 digits are letters based on the river name and the last 2 digits are numbers. Each site should have a different number e.g. Roogagh River could have the site code ROO01 (with further sites on the river given different numbers like ROO02, ROO03 etc).

1.2 DESKTOP STUDY NOTES (page 7)

Desktop studies should be carried out before going into the field using the GIS ArcMap Program to help identify the river type by looking at the expected geology, altitude, etc and recorded onto Sheet 2 (page 7). In addition, ArcMap provides information about the pressures at a local and catchment scale and about the sinuosity of the channel.

LAYERS	PURPOSE
Sluices	Identify pressure
Impoundments	Identify pressure
Fords	Identify pressure
Permanent weirs	Identify pressure
RW_CATCLIP_base (CATCLIP)	Waterbody, ID, altitude, geology
Rivers Agency layer NI	Show designations
CORINE	Help identify main land cover
LCM2000	Help identify intensive land cover
OSNI base mapping layer	Maps
Orthophotography	Aerial photos
Natural heritage layer	Identify if designated habitats etc.
Typology prediction tool	Uses sinuosity etc. to predict typology

From the GIS consider the planform of the river. The typology prediction tool layer will show the **expected river type** (except bedrock channels as they are usually smaller stretches). River types include bedrock, step-pool/cascade, pool-riffle-glide and lowland meandering (page 22-37). Corroborate this by looking at the CATCLIP layer and look at the altitude.

By using the layers above, a picture of the waterbody may be built up. Print off a copy with the pressures added at the waterbody level (Map 1) and at a closer level particularly around the WFD surveillance site (Map 2).

SHEET 2: RHAT (VERSION 2)

TRIBUTARY / MAIN CHANNEL*

Site Identification

River Name _____ Site Code _____

Nearest WFD site FF10 _____

Water Body ID _____ Start U / S or D / S*

First IGR _____ Last IGR _____

Bank surveyed from L / R / Both / In-Channel*

Desk-study notes		Field Notes
ACTION TO TAKE PRIOR TO FIELDWORK General overall shape of river Check weirs, impoundments etc. on catchment Floodplain connectivity and land use		**River type** Date Time Surveyors Weather conditions now Estimated river **width** (m) (average 3 readings) Estimated survey **length** (m) (40 X wetted width) Estimated river **depth** (m) Channel characteristics (e.g. different stream types on the reach) Pressures
Expected river type Rain last week Estimated river width Estimated survey length Riparian land cover(s) River Agency designated? Other comments including dominant geology - limestone / siliceous / peat*		
RESULTS		
Hydromorph score WFD class		*Circle as appropriate

Photograph details include IGR or approximate location

_____

_____

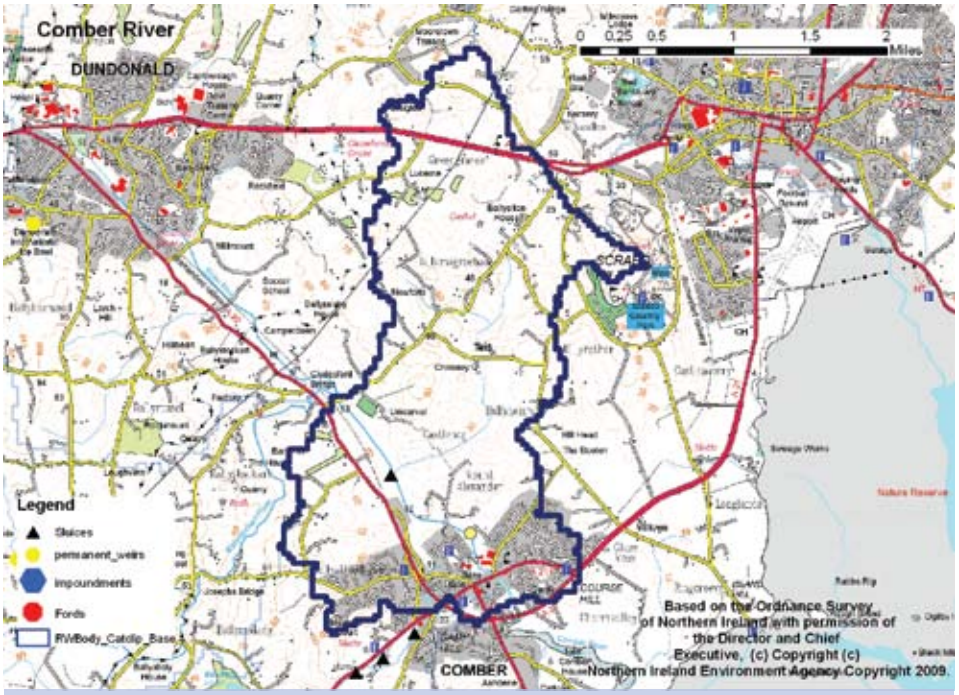
_____

_____

N.B. The survey length should be 40x the wetted width with a minimal stretch of 160m but not exceeding 1km.

Additional river typologies may be added depending on regional variations in topography.

Example Map 1 shows the Comber River. As can be seen from the overview, large sections of the river appear to be very straight, suggesting that re-sectioning has been carried out in the past. By using the information button within the waterbody the ID, geology and altitude can be determined. From the overview a weir is visible on the stretch.



Map 1. Comber River. Waterbody ID: GBNI1NE050504020

Figure 1a and 1b verify the re-sectioning of the Comber River channel. Figure 1a shows that the right bank is reinforced along the whole stretch by sheet piling. It is apparent from the photo that very little vegetation exists on either bank. Figure 1b further upstream shows a permanent composite weir which is one of the pressures identified from the Permanent weir layers on GIS. These pressures and features will help the surveyor in their evaluation of the survey reach.

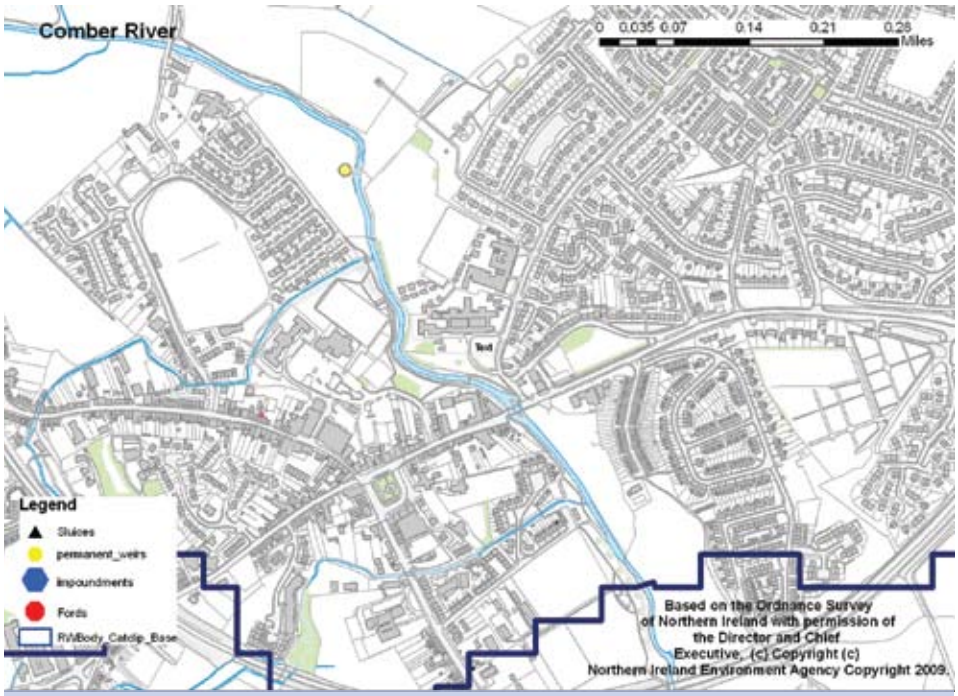
Figure 1a Comber River

Figure 1b Comber River

The CORINE layer (including CORINE LAND COVER % of upstream catchment), LCM2000 layer and the CATCLIP layer will give an overview of the **main riparian land cover(s)**. **Rivers Agency** layer or Office of Public Works, OPW will show whether the river is designated, and further information can be obtained from the Rivers Agency or OPW if necessary.

Hide all layers except the OSNI large scale vector layer. At a scale of 1:4999 or lower use the measuring tool to find the **estimated river width** (Map 2). This in turn gives the **estimated survey length** (width x 40) and will allow you to estimate how much of the vector layer you need to print. Survey length will be between 160 metres minimum and 1km maximum.

Historical layers can allow changes to the channel to be measured such as comparison of straightening against a previous river courses.



Map 2. Vector layer (<1:4999). Use the measuring tool on ArcGIS to obtain 3 estimated river widths

Orthophotographs (as seen in Map 3) provide an aerial overview that can help determine access to a site, identify pressures, potential land cover(s) and bank and bank-top vegetation. These should be taken to the survey site along with a map.

COMPASS Informatics has developed a predictive typology tool that is still to be trialled but may help determine provisional typology.

Map 3. Orthophotography layer

1.3 ON SITE (page 7)

Determine which bank (left or right) you are on by facing downstream and whether you are starting at the Upstream (U/S) or Downstream (D/S) end of the survey stretch. If you swap banks during the survey circle "Both" in the form. If the survey is conducted in-channel, please follow all safety procedures as dictated by **your** organisation and wear appropriate safety gear. In-channel surveys are not recommended and should only be conducted only at very low flows.

At the start point take a Global Positioning System (GPS) reading and note the **First Site IGR**. Walk along the river bank taking necessary photos (see 1.5 photograph details) and record any notes on the field form. At the end point note the **Last site IGR** using GPS.

1.4 FIELD NOTES FOR THE FULL RHAT SURVEY (page 7)

Make a note of the date, time, weather conditions and observed river type on the front page of the RHAT form. The surveyors name(s) should also be recorded.

Confirm the desk-top assessment for river width by estimating on site the observed width in metres (preferably using a rangefinder) in three places and take the average, rounding up or down to the nearest metre. Multiply the width by 40 to give the **estimated survey length**. Before the season starts it may be worth checking how many steps (at a normal walking pace) you take in 40m.

During the survey, stop every 40m and make notes on the last page of the RHAT form (Appendix i) of any features observed over that distance that may help in the assessment of the river once the survey length (160m minimum – 1km maximum survey length) has been walked. For example, what length of the bank is reinforced (RI), or embanked (EM), what is the extent of alien species present? Sheet 3 (page 12) is formatted for the surveyor to tick or circle features that are ecologically important or that help with the final score.

1.5 PHOTOGRAPH DETAILS

A modern compact camera (no camera phones) will ensure that features are recorded satisfactorily. Take a photo noting if the photo is an overview or of a particular feature. In addition, if there are any artificial features or points of interest photograph them and record the IGR if necessary. Take a photo of your photo detail sheet that you have labelled (Figure 2a) or the front of the RHAT field form (Sheet 2). Then take a photo (see Figure 2b) looking in the direction of the survey stretch. Take at least two clear photos of the stretch. If there are any features you are not sure about, take a photo and seek advice from colleagues. A photo detail sheet is included in Appendix ii.

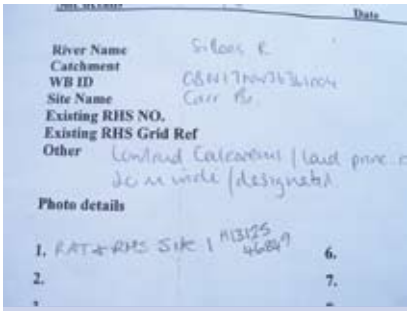

Date
River Name Sillees R.
Catchment
WB ID
Site Name
Existing RHS NO.
Existing RHS Grid Ref
Other
Photo details
1. RAT+RHS Site 1
2.
6.
7.

Figure 2a Photo detail sheet

Figure 2b General photo from start point Sillees River, Lowland meandering

Photo summary:

- At least two overviews
- Any artificial features
- Overview of the land cover, waterbody or valley form if appropriate

NB - For photographs that will be used for intercalibration (discussed in 2.0 Quality Control), make sure to take photographs of each of the 8 attributes marked and of any artificial features.

1.6 ARTIFICIAL FEATURES (page 12)

Figure 3 A re-sectioned river Lissenderry Feeder Stream

On Sheet 3 of the RHAT form the anthropogenic impacts are noted. This section is based on the RHS survey method. The top half of the form is concerned with the physical changes made to the channel and banks. The boxes next to re-sectioning, reinforcement and embankments can be marked with a tick √ or, if more than 30% of the survey stretch is affected, mark with an **E** (for extensive) the same format as in RHS.

Re-sectioning (Figure 3) can be recorded if at least 3 of the following are observed:

1. Uniform bank profile
2. Straightened planform
3. Bank width to height ratio <4:1
4. Usually one flow type
5. Intensive or urban land use
6. No trees/uniformly aged trees
7. Trapezoidal channel shape

If known, circle on Sheet 3 where there is any evidence of culverts, over-deepening, over-widening, or, conversely narrowing of the river.

For culverts (CV), fords (FD), bridges, weirs and fish passes, tally the number visible on the stretch and for bridges and weirs assess whether they are major, intermediate or minor. Note: an intermediate weir includes permanent weirs that are now in disrepair and allow water to flow through, but this must extend across the whole channel. Where this is not the case and the feature extends over a third of the channel, it is classed as a deflector.

For poaching (PC) assess the cumulative impact of each bank at the end of the survey.

SHEET 3: NS RHAT

Anthropogenic Impacts

River Name _____ Site Code _____ Date _____

Feature		Tick if present, record as E if > 30%		
Resectioned		None ☐	Left bank ☐	Right bank ☐
Reinforcement		None ☐	Left bank ☐	Right bank ☐
Embankments	NO*	LB ☐ RB ☐	Set back LB ☐	SB RB ☐
Culverts**		Y / N / Unknown*		
Over deepened		Y / N / Unknown*		
Over widened		Y / N / Unknown*		
Narrowing		Y / N / Unknown*		
Fords**		Y / N*		
Poaching		None ☐ Left bank ☐ ___(m)	Right bank ☐ ___(m)	
		Major /	Intermediate /	Minor
Bridges**	NO*			
Weirs**	NO*			
Fish Pass**		Y / N*	**Location:** Side / Middle / Other	

Physical features or resource use if applicable. *

Deflectors / Jetties / Arterial drainage / Side channels / Mid channel (MC) bar / MC island/ Field Drains / Mill Race / Tributary

Navigation / Fishing / Recreation / Forestry C* or D* or mixed* / Urban / Industry / HEP / Agriculture

Trashline present (height __ m) above water / Buffer zone (LB __ m / RB__ m back from water edge)

Other observations - Invasives - Trees - Birds - Pollution indicators - Invertebrates*

Rhododendron / Himalayan Balsam / Japanese Knotweed / Giant hogweed / Snowberry / Cherry-Laurel/ Gunnera / NONE

Sycamore / Beech / Conifers / Oak / Ash / Alder / Willow / Birch / Hazel / Hawthorn / Blackthorn / Holly / NONE

Heron / Sand martin / Grey wagtail / Dippers / Kingfishers / NONE

Sewage fungus / Diatomaceous algae / Oil / Cladophora / Vaucheria / Dumping / Silt on Substrate / NONE

Other comments including features not listed:

** **Circle** as appropriate* ***E** - extensive.* *** **Tally** as appropriate.* ***LB** - left bank / **RB** - right bank*

	MAJOR	INTERMEDIATE	MINOR
BRIDGE	⩾25m of bank-length. Or if any in-channel supports regardless of width.	⩾10-25m of bank-length. No in-channel supports.	⩽10m of bank-length. No in-channel supports.
WEIR	Permanent, water tight, fixed. Extends whole channel width.	Semi-permanent extends whole width but allows some water through.	Small, temporary features that will be dislodged in high flow.

Weirs are built for a number of reasons. Historically they were built for managing water levels for navigation and for abstraction purposes such as mills. Weirs can frequently be seen next to gauging stations where they are used to measure discharge. For fishery enhancement weirs are often used to maintain a certain depth for the migration of fish and to aerate the channel.

Weirs should be assessed in terms of the barrier they pose not only to fish but sediment, nutrients and other biota. The migration of fish must be assessed in their ability to migrate past a weir and this includes the migration of lamprey. The greatest obstacle of a weir to the lamprey is the height, especially straight-drop weirs (Figure 4).

Figure 4 A straight-drop weir, Glensawisk Burn

1.7 PHYSICAL AND OF ECOLOGICAL INTEREST (page 12)

This section involves identifying physical or biological features. Note arterial drainage involves deepening and widening of channels. It may also include artificially dug drains usually associated with agricultural areas while a side channel is a natural phenomenon. Field drains are often visible as plastic pipes discharging into the river from the bank. Any artificial feature extending at least 30% of the way across the channel should be noted and scored appropriately. Any additional information can be added to the "other comments" section. A set of photographs of alien species of vegetation and native bird species is included to assist with identification.

For physical features, if a trash-line is present, note how high it is above the water level. A trashline can be indicated by a line of debris that the river has deposited along its banks or floodplain after it has been in spate. This can help to determine whether there are any barriers to floodplain connectivity. In addition, if a buffer zone of fencing or trees is present on either bank, note the distance back from the water's edge. This can help with restoration of rivers in the future because fenced off areas are useful at a local scale in preventing an increase in sediment load due to poaching.

Deflectors on Black River

Arterial drainage being dug on Fury

Mid channel island on Skerry River

Inlet pipe into Blackwater, Mallusk

INVASIVE AND NUISANCE PLANT SPECIES


Rhododendron


Himalayan Balsam


Japanese knotweed


Giant hogweed


Cherry laurel


Snowberry


Gunnera spp.
(Image - NIEA Hydromorphology Team)

Grey heron - *Ardea cinerea*
Image - Laurie Campbell

Grey wagtail - *Motacilla cinerea*
Image - Laurie Campbell

Kingfisher
Image - Stephen Foster

Dipper

A photograph of a sand martin was not available at the time of publication.

1.8 SCORING SCHEME

The eight criteria for RHAT are described in the accompanying Guidance sheets for use in the field. Each criterion contains a brief description of what the surveyor should be evaluating, a mark scheme based on departure from naturalness (but also takes into account a channel's recovery despite earlier modification), and a more typology specific guide to the typical pressures that may impact on the river.

Allocate a score (Sheet 4) to each attribute observed using the RHAT marking scheme. The boxes shaded in grey for Bedrock and Cascade / Step-pool are to remind the surveyor that the riparian land cover for these 2 typologies may be scored in terms of land cover within the floodplain and not only from 1m back from the bank-top to 20metres as the other typologies observe. This is due to the fact that a bedrock or cascade/step-pool channel banks may be confined by natural valley gradients. The dominant land cover closest to the channel therefore becomes more important. However, discretion may be used. For example the presence of a road at the top of a steep bank may still influence the channel in terms of reinforcement or by increasing flow amounts by the increase in surface run-off then this should be considered in the scoring of this attribute.

SHEET 4: RHAT RIVER HYDROMORPHOLOGY ASSESSMENT TECHNIQUE

Field Assessment of Morphological Condition

River Name _____ Site Code _____ Date _____

If river is in spate 2 and 3 may be marked as NV or note if any attribute is not scored for any other reason. For the greyed area of the riparian land cover can be defined as land cover within the flood-plain.

	Bedrock	Cascade / Step-pool	Pool-riffle-glide	Lowland Meandering
1. Channel form and flow types	4	4	4	4
2. Channel vegetation	4	4	4	4
3. Substrate condition	4	4	4	4
4. Barriers to continuity	4	4	4	4
5. Bank structure & stability L+R	4	4	4	4
6. Bank vegetation L+R	4	4	4	4
7. Riparian land cover L+R	4	4	4	4
8. Floodplain connectivity L+R	4	4	4	4
TOTAL	32	32	32	32
Hydromorph Score *				
WFD class **				

* Hydromorph score = $\frac{\Sigma \text{ Assessment score}}{\text{Total}}$

** WFD Class
> 0.8 = high
>0.6 – 0.8 = good
>0.4 – 0.6 = moderate
>0.2 - 0.4 = poor
< 0.2 = bad.

Alternatively, if an attribute that is usually scored is not assessed, cross out the box, deduct marks from the total and make a note of why the attribute was omitted e.g. if the river is in spate. If previous knowledge of the river or further investigation provides information, this attribute may be scored. All areas included in the field forms should be assessed (Appendix iii).

The score at this stage is attributed to the river reach. If the survey stretch contains other typologies, they must be assessed in separate RHAT forms. This is necessary in order to help classify the waterbody as a whole.

1.9 SPOT-CHECK SURVEYS

Spot-check surveys (Appendix iv) are carried out where there is no significant change to the land cover or river when the river is viewed from a bridge or a strategic vantage point, or if the land cover poses limitations on the survey team (e.g. marsh land). Spot-checks score all the attributes included on the full RHAT surveys and are seen as a useful addition in assessing the water body. These should only be assessed by staff trained in using the full RHAT.

1.10 CLASSIFICATION OF THE WATERBODY AS A WHOLE

A classification procedure at the water body scale is currently being developed. It involves up scaling from individual surveys using the full and spot-check RHAT surveys.

2.0 FURTHER INFORMATION

Hydromorphology scores from MImAS, RAT (A previous version of RHAT) and expert opinion were compared for river sites in Ecoregion 17. The outcome report showed 60% agreement in class between RAT and MImAS and 60% agreement between the original RAT and expert opinion. Differences were taken into account with revisions being made to the RAT where applicable.

A comparison study was carried out with the draft CEN standard on River Hydromorphology. Results from CEN and RAT assessments matched in 50% of cases and were within one class for a further 40% of sites. The RHAT has been further developed in line with CEN.

2.1 QUALITY CONTROL AND INTERCALIBRATION

At present one site per surveyor per survey season is to be used for intercalibration purposes. For EPA and NIEA this has been agreed following an initial training exercise and was carried out for the 2008 survey season. For 2009 please send the following for your chosen quality site: field sheets, scores, photographs, and any additional information that may prove useful, to Laura.Parkhill@doeni.gov.uk. Once all the surveyor sites have been collated they will be distributed to the group for scoring and the results posted back to the email address above or to the address on the back cover. Site details can be sent in at any time during the survey season. The results will help identify further training needs.

DESCRIPTION OF ATTRIBUTES AND PHOTO AIDS

1. CHANNEL MORPHOLOGY AND FLOW TYPES (OVERVIEW)

This attribute evaluates the form of the stream and its **deviation from natural** (including the planform, cross-section and natural bedforms and obstructions). Using an overview from desk-top studies, historical data and field observations, assess whether the channel form is as expected. This will include a general assessment of the physical features on site such as width and depth variations, the gradient and the amount of artificial features along the stretch. Drained channels should be assessed in terms of their recovery and impact on flow types. **DO NOT SCORE** major dams/weirs upstream of survey stretch here. These are scored in **4. Barriers to continuity**. Velocity/depths include slow-shallow, slow-deep (depth >0.5m), fast-shallow and fast-deep (depth >0.5m). (Note most re-sectioning where the channel appears very straight was completed in NI in 1940s.) Percentages represent how natural the stream appears.

Condition category				
High **>95-100% natural**	**Good** **>85-95% natural**	**Moderate** **>65-85% natural**	**Poor** **>25-65% natural**	**Bad** **<25% natural**
Channel form appears natural. Natural obstructions such as boulders, bedrock outcrops, WD (woody debris), riffles, pools, bars, meanders occur and contribute to heterogeneity of channel form. Wide variety of velocity/ depth (see above), or pool size/depth combinations are present where expected. The river follows a course of least resistance and this has not been altered by man.	Evidence of earlier alterations to small part of the stretch (> 20yrs ago), but no recent disturbance, and good recovery. Good recovery may be indicated by vegetation colonising the area. Spacing of natural obstructions not optimal, but heterogeneity of channel form remains good. A wide variety of velocity/depth combinations are present where expected.	Evidence of disturbance to channel form or evidence of the removal of natural obstructions up to a third of the reach. Variety of velocity / depth combinations present is less than expected. Evidence of recent disturbance on small part of stretch. As an indication of recovery from interference vegetation colonisation may not be optimal.	Clear evidence of alteration to course e.g. straightening of channel and / or channel cross section or significant removal of natural obstructions up to three quarters of reach. Recovery may be evident but overall alterations are too extensive. Minimal variation in flow depths and velocities.	Extensive interference, e.g. river re-sectioning, straightening, dredging, realignment along entire reach. Survey area has fairly uniform width, depth and velocity where not expected.
4	3	2	1	0

Description of undisturbed stream types	Typical pressures	Departure from high status
Bedrock: Channel forms may include waterfalls and plunge pools, as well as flat sheets of bedrock, fissures and boulders. The flow types present range from turbulent to tranquil, depending on the gradient and channel features. The river will cut downwards rather than meander.	Removal of natural obstacles, Impounding, abstraction and flow regulation Re-sectioning Modified sediment regime	Evidence that disturbance results in changes to form, flow depths and velocities.
Cascade and step-pool: Cobble and boulder streams with possible bedrock outcrops. A series of "steps", separated by intervening pools. In step-pool system distance between pools is approx. 1-4 times width of the stream. The steps and pools create zones of turbulent flow interspersed by more tranquil flows.	As for bedrock	As above for bedrock
Pool-Riffle-Glide: Sand, gravel / pebble or cobble, dependent on gradient and sediment type upstream. Frequent gravel bars, riffles and pools. Usually associated with mid-altitude regions. There will be more flow sinuosity and a wide variety of flow types. They can be found above bedrock and cascade streams at higher altitudes.	Channelisation / straightening / deepening / Bank and bed reinforcement Impounding, abstraction and flow regulation	Artificial features. Featureless, uniform velocity, width & depth
Meandering: Silt, sand and gravel / pebble streams. These are associated with lowland regions. The sinuosity of the stream increases the stream length to 3-4 times the valley length. Bars and pools occur in association with the bends and crossing of the meander pattern. Bed forms are associated with a range of flow depths, velocities and pool sizes. The flow regime is generally laminar; turbulent flow is uncommon.	As for pool-riffle-glide and constraints to development of natural meander progression	Increase in meander wavelength – i.e. straightening Alterations to cross-section including evidence of widening, deepening or removal of bed forms. Drainage schemes.
CHECKLIST – how natural does it look visually? Are there a variety of depths and speeds in water? Absence of artificial features on stretch surveyed.		

CHANNEL MORPHOLOGY

BEDROCK CHANNEL

Roogagh, Co. Fermanagh
CLASS - HIGH

- River will cut down rather than laterally
- Flow type as expected
- Mosses present as expected
- Substrate as expected
- Weir upstream
- Woodland 20m back on right
- Woodland extends to 10m on left then

CASCADE AND STEP POOL

Roogagh, Co. Fermanagh
CLASS - HIGH

- Channel form appears natural
- Cobble and boulder based
- Turbulent and tranquil flows
- Expect to see only mosses
- No barrier to longitudinal flow
- Trees and vegetation semi-continuous entire stretch

POOL-RIFFLE-GLIDE

Carey River, Co. Antrim
CLASS - GOOD

- P-R-G at higher altitude
- No valley constraints. Some embankment. Meandering
- Channel veg and substrate as expected
- U/S a mill race exists diverting some flow
- Fencing on both sides reduces poaching
- Sparse trees
- Agricultural land cover extending close to channel

MEANDERING

Colebrooke, Co. Fermanagh
CLASS - POOR

- Flow laminar and meanders but constrained by modifications
- Resectioned and reinforced
- Major bridge on stretch
- Himalayan Balsam extensive
- Limited chance to connect to floodplain
- Deflectors and gauging station on reach
- Land cover is rough pasture with no tree along one bank

2. CHANNEL VEGETATION - HABITAT AND ORGANIC DEBRIS

This attribute relates to **the presence, diversity and habitat potential of any vegetation**, including woody debris (WD), occurring within the channel. The stream type and riparian land cover affect the type and quantity of vegetation present, for example in terms of the amount of leaf litter provided as a source of food, the amount of shading which can help control temperature and the number of refuges such as underwater and bank side roots for habitat. The score will indicate the extent to which vegetation is as expected, the diversity of species and succession, and will take into account the amount that has been removed from the channel. Note that in NI, it is Rivers Agency policy to leave root stumps in channel to create habitat. **Percentages represent how natural the stream appears.**

Condition category				
High **>95-100% natural**	**Good** **>85-95% natural**	**Moderate** **>65-85% natural**	**Poor** **>25-65% natural**	**Bad** **<25% natural**
Types and quantity of aquatic and marginal vegetation and organic debris within the stream are diverse or correspond to that expected for the stream type, and for the riparian conditions. **AND/OR** Organic debris (leaf litter etc.) present. **AND/OR** In wooded catchments WD is present: some WD dams are well established and enhance habitat and stream heterogeneity.	Evidence of vegetation management is minimal, or confined to small stretches of the reach and range of vegetation types present corresponds to that expected for the stream type and riparian conditions.	Evidence of some vegetation management: cutting and removal of vegetation, or vegetation sparse and poor quality – limited range of types, **AND/OR** excessive amounts of vegetation present.	Clear evidence of vegetation management: significant removal of vegetation; **AND/OR** vegetation not supported or out competed by algae or poor quality; **AND/OR** Excessive amounts of vegetation present. WD present in urban areas increases risk of floods.	Extensive vegetation management throughout length of reach: **AND/OR** vegetation growth not supported or out competed by algae **AND/OR** Significant amounts of vegetation present where not expected throughout length of reach.
4	3	2	1	0

Description of undisturbed stream types	Typical pressures	Departure from high status
Bedrock: Stable bedrock streams abundant mosses, lichens and attached algae. If present these can contribute to habitat structure. Unstable areas will have less vegetation. In wooded areas much of the organic matter in mountain rivers is detritus and WD from the riparian zone. In non-wooded areas organic debris from shrubby and herbaceous riparian vegetation may accumulate within the stream during the growing season.	Impounding, abstraction and flow regulation Modified sediment regime	Floating or rooted higher plants are not suited to high velocity conditions. The presence of significant amounts of aquatic vegetation may indicate reduced discharge and velocities. However these may be natural in shaded streams or downstream of bogs due to flow stability.
Cascade and step-pool: As for bedrock.		
Pool-Riffle-Glide: During the growing season, rooted aquatic vegetation (macrophytes) may be present at channel margins, especially in lower-gradient examples of riffle-pool streams. Pioneer species vegetation may be present on in-stream bars and islands, and at channel margins. The diversity of type and species and maturity of such vegetation indicates the balance between succession and regeneration of the system (i.e. between stability and disturbance). Mid-channel islands and vegetated bars will be present. Note Pebble gravel substrates will naturally have little or no vegetation.	Vegetation management Agriculture Modified sediment regime Bed reinforcement Impounding, abstraction and flow regulation Dredging, deepening	Excessive growth of aquatic vegetation Mature vegetation on in-stream bars and islands Evidence of vegetation management or inability to support vegetation - lack of vegetation and organic debris.
Meandering: Rooted aquatic vegetation may be common at channel margins during the growing season. Mid-channel island present and fringing reed beds may be present but not to excess.	As for pool-riffle-glide	As for pool-riffle-glide
CHECKLIST – Vegetation in channel as expected – WD, organic debris or stumps are present.		

CHANNEL VEGETATION

BEDROCK CHANNEL

Glenariff River

- Mid-altitude, Glens of Antrim
- Mosses and lichens as expected
- Woody debris in channel from bank vegetation providing food and refuge.
- No known pressures U/S
- No vegetation management in channel

CASCADE AND STEP POOL

Glendun River
CLASS - HIGH

- Channel vegetation as expected
- No shading will allow the mosses to grow abundantly
- Mid-altitude site, so the substrate would not lend itself to free floating species that prefer more unconsolidated substrates
- Channel form appears natural

P-R-G/MEANDERING

Ballinamallard Trib

- Vegetation not as expected
- Excessive growth due to silty substrate and no vegetation cover

MEANDERING

Finn River

Finn River

- Fringing reeds and floating rooted plants – as expected

3. SUBSTRATE DIVERSITY AND CONDITION (EMBEDDEDNESS)

This attribute evaluates the type, quantity and diversity of substrate present in the stream. The dominant substrate depends on the stream type. The score will reflect the heterogeneity of the substrate present, the degree to which coarse particles are embedded by fines particularly in the upstream and central portions of riffles, the quality and cleanliness of the substrate, and the extent to which any anthropogenic influence has directly altered the substrate (e.g. abstraction or artificial bed protection e.g. FORD). The substrate may be unconsolidated (loose), embedded or hard. An unconsolidated substrate will displace easily when stepped on or kicked. Embedded substrates will only dislodge with force. Hard substrate includes exposed bedrock or artificial surfaces. Tributaries/ arterial drainage along the river may increase the sediment load to the river. Assess whether any tributaries/ arterial drainage cause significant changes to the sediment composition of the channel being surveyed. **Is river in spate? If yes, and features are not visible delete 4 marks from total and move on to 4.) Barriers to continuity.**

Condition category				
High **>95-100% natural**	**Good** **>85-95% natural**	**Moderate** **>65-85% natural**	**Poor** **>25-65% natural**	**Bad** **<25% natural**
The diversity of substrate types corresponds to that expected for the stream type. **AND/OR** Coarse sediments are not embedded by fines. **AND/OR** Pool substrates are firm. **AND/OR** Pool substrates are firm. **AND/OR** Substrates are clean and free from deposits and oils unless chalky/ limestone stream –then a white layer will be apparent. **AND/OR** Substrate has not been altered or removed. **AND/OR** 0-1% of the substrate is artificial	Good diversity of substrate types, but with more fine sediment than optimal. **AND/OR** Pool substrates are fairly firm **AND/OR** Sediments are clean and free from deposits. **AND/OR** >1-5% of the substrate is artificial	Fine sediment more dominant than expected for stream type. **AND/OR** >5-15% of the substrate is artificial	Some evidence of interference, e.g. bed protection present on reach, sediment input or abstraction **AND/OR** High percentage of fine sediments with boulders cobbles and gravel particles surrounded by fines. **AND/OR** >15-30% of the substrate is artificial	Extensive interference, e.g. bed protection or excessive sediment input, or abstraction. **AND/OR** Runs and pools filled with sediment. Homogeneous channel. **AND/OR** Substrate is highly embedded therefore reducing the surface area on the bed for colonisation of plants. **AND/OR** High percentage of fine sediments with coarse sediments>75% embedded. **AND/OR** Oils and other deposits like sewage fungus etc cover sediments. **AND/OR** >30% of the substrate is artificial
4	3	2	1	0

Description of undisturbed stream types	Typical pressures	Departure from high status
Bedrock: A range of substrate types may be found in bedrock streams, with small accumulations of finer sediments in fissures, pools and backwaters created by obstructions such as large boulders. Dominated by bedrock and hard substrates.	Impounding, abstraction and flow regulation Modified sediment regime Structures Riparian land cover. In-channel structures producing localised scouring or deposition	Increasing quantities of fine sediment present around coarse or hard particles
Cascade and step-pool: Dominated by cobbles and boulders streams with possible bedrock outcrops. However, finer sediment accumulates within pools and the interstices between and beneath coarse particles. Dominated by hard substrates		
Pool-Riffle-Glide: The beds of Pool-Riffle-Glide channels are predominantly gravel, with occasional patches of cobbles and sand with coarse particles occurring in riffles and finer particles in pools. The sediments exhibit a variety of sorting and packing. In the upper and central portions of riffles a coarse surface layer is exposed above a finer subsurface such that movement of surface grains releases fine sediment trapped by the larger grains. Most large floods will produce some bed load movement on an annual basis, thus reducing the stability of the channel. Dominated by embedded or unconsolidated material.	Bed reinforcement Impounding, abstraction and flow regulation Riparian land cover Construction / structures Channelisation / straightening / widening / realignment / deepening Sediment manipulation/ In-channel structures producing localised souring or deposition.	Excessive deposition: coarse particles in riffles become embedded by fines thus removing bed habitat by reducing exposed surface area. Lack of system regeneration i.e. flushing out fines from gravel / pebble interstices. Pools have soft sediments and do not support aquatic plants due to scouring.
Meandering: These streams are dominated by silt, sand and fine gravel, with coarser particles accumulating in bars on the inside of meander bends. These fine particles accumulations are mobile even in relatively small flood events. Dominated by unconsolidated material.	As for pool-riffle-glide	Pools have soft sediments and ability to support aquatic plants is reduced Coarse particles on bars embedded by fine particles
CHECKLIST – is substrate as expected and free from human influence and is it free from deposits?		

SUBSTRATE

BEDROCK CHANNEL

Glenariff River
SUBSTRATE SCORE - HIGH

- Dominated by bedrock and consolidated material
- Pools are often found containing finer sediment
- Substrate is natural and as expected

CASCADE AND STEP POOL

Kilkeel River
CLASS - MODERATE

- Expect typology to be cascade/step-pool due to altitude and cutting down rather than laterally
- More fines than expected because D/S of Silent Valley Dam but in good condition
- Prevents migration of fish, nutrients and
- Sediment. Will score a "0" for Channel Flow as major impoundment U/S
- Land cover is agricultural and urban

Score reduced by Channel flow and riparian land cover

POOL-RIFFLE-GLIDE

Ballymully River

- Expect P-R-G
- Excessive fines more than expected for stream type. Substrate score: BAD
- This photo D/S of culverted bridge
- RI, RS and EM banks
- Land cover is urban as residential
- Home and recycling plant present
- No physical barrier but low flow may
- prevent fish migration
- Little chance of floodplain interaction

MEANDERING

Blackwater River at Bond's Bridge

- An instance where substrate was not marked in field and a note of NV was made and the points deducted from the total
- However, using knowledge of the area, this river is used for navigation and has been dredged at one stage. While it would be expected that the substrate would be unconsolidated, this still means there would be a "departure from naturalness," and more fines than optimal would be observed. This may be scored as a result

4. BARRIERS TO CONTINUITY

This attribute relates to the discharge within the stream, which affects both the variation in velocity across the channel and the longitudinal continuity of the flow. The score will indicate the extent to which the continuous flow for downstream transport of water, nutrients and migration of fish (as identified by WFD are salmon, trout, eels, shad and lamprey) is affected by abstraction, impoundments, weirs, dams or other flow controls. It is advisable to look at the desk-top study to identify the locality of weirs, impoundments etc at a catchment level. If there is a major artificial feature upstream that impacts on the entire stretch such as a dam then the score will be BAD. These categories are amendable subject to expert knowledge of the river. Note: Any dams created by WD are marked in 2. CHANNEL VEGETATION.

If there are any other features not listed or an individual expert believes that a lower/higher score should be appropriated then document and photograph feature. **Is river in spate? If yes, and features are not visible delete 4 marks from total and move on to 5.) Bank structure and stability.**

Condition category				
High **>95-100% natural**	**Good** **>85-95% natural**	**Moderate** **>65-85% natural**	**Poor** **>25-65% natural**	**Bad** **<25% natural**
There are no weirs or dams to impede flow and no other structures or management practices that cause insufficient water flow to transport fish.	Presence of minor artificial structures, such as deflectors, groynes, bridge abutments and jetties on **wider** channels.	Channel flow is impeded by features that are artificial and extend across the entire channel, but water flows through. This may include intermediate weirs. **OR** The presence of minor artificial structures, such as deflectors, groynes, bridge abutments and jetties on **narrow** channels. **OR** Channel flow is impeded by a small permanent weir but a fish pass is present and the species that use the channel would not be hindered.	Channel flow is impeded by a significant permanent weir (a fish pass may be present but sediment and energy used by fish to pass this would not be feasible). **OR** By the presence of a major feature such as culverts, or sluices that channel the flow through them. **OR** A composite weir with functioning fish pass.	Channel flow is impeded the entire length of the survey stretch or upstream by the presence of a dam or abstraction. **OR** A **number** of permanent weirs and/or major features. **OR** A composite weir if no fish pass. **OR** The major feature is having a significant impact on the channel continuity.
4	3	2	1	0

Description of undisturbed stream types	Typical pressures	Departure from high status
Bedrock: Boulders and cobbles often exposed, but few isolated pools Over bank flows uncommon.	Impounding, abstraction and flow regulation WD or obstacle acting as permanent barrier	Physical barriers to flow
Cascade and step-pool: At low flows, many of the largest particles (boulders, cobbles) may be exposed, but there should be continuous flow with few isolated pools	As for bedrock	As for bedrock
Pool-Riffle-Glide: Gravel bars may be exposed in low water conditions, but gravels and cobbles in riffles as well as logs and snags are mainly submerged.	Dams upstream of survey site. Impounding, abstraction, diversion (mill race or canal) and flow regulation Weirs Artificial in-channel features	Reduced longitudinal continuity of flow Presence of artificial structures
Meandering: In low flow conditions some bars or islands may be exposed, but water fills the most of the channel.		
CHECKLIST – is river in spate? If not – are there any barriers to the longitudinal flow of water, nutrients, sediment and fish? Are there any barriers to the lateral flow of the water within the channel?		

BARRIERS TO CONTINUITY

POOL-RIFFLE-GLIDE

Glenarm River
SCORE - INTERMEDIATE

- An intermediate weir and 2 structures acting as groynes
- This has a slight impoundment effect and will cause smaller sediment to deposit behind the weir
- Water and Fish are not prevented from migration but a change in the deposition and the channel will occur

POOL-RIFFLE-GLIDE

Glenarm River (further upstream)
SCORE - INTERMEDIATE

- A log that has been permanently placed by man across the channel (not WD)
- This is an intermediate weir as it extends across the whole channel and is fixed but allows water to flow under
- This presents a barrier to larger sediment and flow is impacted

POOL-RIFFLE-GLIDE

Glensawisk Burn

- Before modifications this would have been a high altitude pool-riffle-glide
- Channel flow would be BAD as there are a series of permanent weirs at a height preventing fish and sediment migration
- The channel is quite wide still and normal flow is now of minimal depth
- Land cover appears to be dwarf trees and semi-natural

CASCADE AND STEP POOL

Crumlin River

- Waterfall and fish pass observed
- Although some fish species will be able to migrate, sediment and nutrients will be prevented
- D/S channel becomes more P-R-G. But the size of the boulders would suggest a more turbulent stream type

5. BANK STRUCTURE AND STABILITY

This attribute looks at the shape and stability of the banks of the stream. The expected bank structure depends on the stream type. The score will relate to both the degree of bank engineering, e.g. steepening, and the effect of riparian or channel use on the stability of the banks, e.g. poaching by cattle. Note that in their natural state, some banks are irregular, under cut and eroding due to the nature of the material – earth, sand, peat or clay. Such bank irregularities provide habitat and refuge for channel biota, and as such are not necessarily indicative of poor quality. **Each bank should be evaluated separately**. Note stability is important because of the impact a river in spate will have on the erodibility of the bank and therefore the sediment load in channel. **Percentages are how natural the banks are.**

Condition category					
	High >95-100% natural	**Good >85-95% natural**	**Moderate >65-85% natural**	**Poor >25-65% natural**	**Bad <25% natural**
	Banks are in their natural condition, which may include unstable, eroding, undercut, irregular and stable banks depending on the stream type and the position within the reach.	Evidence of bank alterations or protection is minimal. **AND/OR** Banks are natural but unstable and may be slumped, or have minor poaching or terracing but good recovery.	Evidence of bank alterations on up to a third of the bank length. **AND/OR** Some evidence of instability, up to a third of the reach such that habitat potential of channel margins is reduced. This may be due to non-natural causes e.g. poaching by cattle, erosion by boats. Evidence may include fence posts eroding away.	Clear evidence of alteration to bank structure up to three quarters of the bank length. **AND/OR** Evidence of instability up to three quarters of the reach or significant bank instability due to non-natural causes e.g. poaching by cattle, erosion by boats.	Extensive interference, e.g. bank protection or steepening over entire length of reach, or bank stability degraded as a result of realignment or outside influence over entire reach.
L	2	1.5	1	0.5	0
R	2	1.5	1	0.5	0

Description of undisturbed stream types	Typical pressures	Departure from high status
Bedrock: The banks are of bedrock or large boulders and are therefore generally stable, and erosion resistant		
Cascade and step-pool: The banks are of bedrock or large boulders and are therefore generally stable, erosion resistant in all but the highest discharges.		
Pool-Riffle-Glide: The bank stability depends on the erodibility of the bank material and the position within the pool-riffle sequence. Pool-riffle streams can be formed in sediments with both high and low threshold to movement and the presence of riparian vegetation may enhance the bank stability. On the outside of bends adjacent to pools banks are more likely to be eroding or undercut, whilst deposition in riffles and bars protects banks and leads to shallower profiles. A variety of bank types and irregular form provide a variety of habitats for in-stream biota.	Bank strengthening Bank steepening Channelisation / realignment / deepening Flow manipulation Construction / structures –scour Bed reinforcement Impounding, abstraction and flow regulation Vegetation removal Riparian land cover	Excessive erosion, crumbling banks Re-profiled banks Reduced heterogeneity of bank structure and irregularity Banks degraded by erosion due to cattle, boats, etc. Reduced vegetation cover leads to erosion
Meandering: The bank stability depends on the erodibility of the bank material and the position within the meander sequence. Meandering streams can be formed in sediments with both high and low threshold to movement and the presence of riparian vegetation may enhance the bank stability. On the outside of bends adjacent to pools, banks are more likely to be eroding or undercut, whilst deposition in bars protects banks and leads to shallower bank profiles. A variety of bank types and irregular form provide a variety of habitats for in-stream biota.	As for pool-riffle-glide	As for pool-riffle-glide and Constrained from development of natural meander progression
CHECKLIST – Assess each bank individually. Does the bank appear stable? Is this stability natural? Assess the extent of external influences, including cattle and man, on the stability of the bank. Do not include vegetation here.		

BANK STRUCTURE AND STABILITY

POOL-RIFFLE-GLIDE

Glenelly River

- Picture shows resectioning on entire bank and new fencing
- The exposed soil will be prone to erosion particularly during spate
- The fencing does act as a buffer but replanting or maintaining bank vegetation would have been more effective
- Likelihood is that unless the bank colonises rapidly the bank it will continue to erode

POOL-RIFFLE-GLIDE

Roe River
CLASS - HIGH (both banks)

- Earth banks
- Undercutting and eroding as expected
- No barrier to flooding
- Substrate as expected from an upper P-R-G

MEANDERING

Comber River

- RI bank entire length. Therefore for this bank the score would be BAD
- There is no bank and banktop vegetation scoring BAD
- There will be no chance of flooding because the ability to flood is reduced. The height and nature of the RI will cause the flow to be move faster through the stretch
- The land cover is urban and will score BAD for this bank

MEANDERING

Newry at Jerrettspass
CLASS - POOR

- Channel form does not appear natural
- Appears resectioned entire length on both banks – trapezoidal shape
- Appears steepened impacting on bank structure score
- No vegetation on one bank
- Substrate scored MODERATE
- Channel has little chance of connecting with floodplain as it appears overdeepened

6. BANK AND BANK-TOP VEGETATION - HABITAT AND ORGANIC DEBRIS

This attribute assesses the types, continuity and stratification (the canopy layers) of the bank vegetation. Bank top should be taken as the first obvious break in slope and 1m back. The stream type, altitude, geology and riparian land use may affect the type and extent of bank vegetation present. Bank vegetation contributes to stream habitat and bank stability and the score will reflect the amount of vegetation cover, the variety of vegetation class present (**woody, shrubby, macrophyte**), the degree of shading of the channel, whether the vegetation is alien, and the degree of human activity in managing the bank vegetation. Alien species that impact on the bank stability are perennials such as Himalayan balsam, Japanese knotweed, Giant hogweed, Rhododendron and Snowberry. These out-compete the native species and reduce the quality of organic debris. Note that, although sycamore and beech are non-native, if there are a range of canopy layers their impact may be assumed minimal. The exception is coniferous trees as there is no under storey and the acidity they produce will have more significant impacts. **Each bank should be evaluated separately. Percentages are of natural vegetation.**

Condition category					
	High >95-100% natural	**Good >85-95% natural**	**Moderate >65-85% natural**	**Poor >25-65% natural**	**Bad <25% natural**
	The banks are covered in a good variety of canopy layers and native trees of a variety of ages. The distribution and continuity is maintained the length of the river. The type and quantity correspond to that expected for the stream type. Minimal disturbance of vegetation occurs through grazing, mowing or other management.	Disruption / vegetation management minimal: more than 85% of survey length or bank is covered by native vegetation or a range of canopy layers. **AND/OR** One class of plants is not well represented or alien species present in a small amount or along a small stretch.	65-85% of the survey length or bank is covered by native vegetation or a range of canopy layers, but where one layer of plants is not well represented. **AND/OR** Disruption / vegetation management is evident, but removal does not affect plant re-growth potential. **AND/OR** A bank has little or no vegetation but the reach from overhanging branches from the opposite bank is sufficient to supply food and shading.	25-65% of the survey is covered by native vegetation; disruption obvious; **AND/OR** Large patches of bare soil or closely cropped vegetation common or nettles present **AND/OR** Alien species present over large stretch of survey area. **AND/OR** Management of vegetation evident e.g. mowing or felling of trees. **AND/OR** Dense vegetation in >100m continuous stretch providing excessively deep shade of the channel. **AND/OR** Conifer forest present.	Significant disruption to the vegetation on the bank along the survey stretch where only one class of vegetation is represented and has been removed to stubble height 5cm or less. **AND/OR** Where there are non-native species such as Himalayan balsam, etc, along the extent of the survey stretch. **AND/OR** Coniferous plantation present on banks and/or bank top.
L	2	1.5	1	0.5	0
R	2	1.5	1	0.5	0

Description of undisturbed stream types	Typical pressures	Departure from high status
Bedrock: These streams may be in confined valleys, with little or no floodplain. The natural vegetation cover will depend on the location of the stream. Bedrock banks support little vegetation.	Reduction in native species of vegetation affects habitats for native invertebrates. Reduced channel shading Alien species reduce stability of bank and bank top and reduce quality of organic debris to channel. Vegetation management Forestry Agriculture Grazing Urban development	Alien vegetation Reduced diversity of vegetation types and maturity Vegetation removed / cover reduced Reduced refuge from trailing roots and vegetation. Bank instability.
Cascade and step-pool: The natural vegetation cover will depend on the location of the stream.		
Pool-Riffle-Glide: The vegetation cover will depend on the location of the stream; however, these stream types interact regularly with their floodplains.		
Meandering: The vegetation cover will depend on the location of the stream; however, these stream types interact regularly with their floodplains. Areas of moorland, wetland and wet grassland may characterise the riparian zones, although mature wet woodland may also be present at the lower gradient end of the system.		
CHECKLIST – is the vegetation continuous, non-alien, and with many canopy layers?		

BANK AND BANK-TOP VEGETATION

POOL-RIFFLE-GLIDE

Fury River at Knockroe
CLASS - GOOD

- This photo shows a good example of a pool-riffle-glide
- The substrate is as expected with cobbles, boulders and pebbles
- Good colonisation by moss
- Good shading of the channel on both sides maintaining temperature, food and detritus for the ecology in the river
- However D/S of this photo arterial drainage is increasing the amount of siltation into the channel and therefore the substrate attribute will be marked down accordingly

Aghavea River, Co. Fermanagh

- Although there is no vegetation on the right bank looking at this photograph, the overhanging branches from the left bank provide shade and food
- This would score MODERATE for the right bank and HIGH for the left bank if this continued along the whole reach
- The steep banks and lack of vegetation on the right bank suggests this bank has been resectioned at some stage

POOL-RIFFLE-GLIDE

Golan Water

- Coniferous forest
- Shallow roots and therefore unstable leads to more erosion
- This would score BAD for both attributes

Ballinderry River

- Giant hogweed
- Outcompetes native vegetation and spreads quickly
- Tends to increase instability of the bank as the root system is not as stabilising as trees
- Assess the extent of alien species as a percentage of the river stretch

7. RIPARIAN LAND COVER

This attribute relates to the land cover within the floodplain or the zone adjacent to the stream 20m back from the bank top assessed on site. The stream type and location will affect the floodplain extent and land cover. The score will reflect the amount and type of vegetation (i.e. whether or not native) within this zone, or the intrusion of human activities. Weight should be given to proximity to the river channel, the nature of the activity and to the importance of the floodplain area to the river ecosystem (i.e. more important for lowland rivers that interact regularly with the floodplain zone). Land covers with a lower impact are broad-leaved forest, ferns, moors and heath land and bog. Note although bog or heath may be managed they release water at a slower rate. Land covers that have a higher impact on the channel include grazing, rough pasture (RP), agriculture, improved grassland (IG), coniferous forests and urban development. If there is more than one land cover consider what land cover is having a greater impact. This may not necessarily be the most dominant land cover. Take into account if the land cover has been left to ecological succession. **Each bank should be evaluated separately**. CORINE and LCM2000 on GIS can assist in the evaluation of this attribute. **Percentages relate to the natural land cover in the riparian zone.**

	Condition category				
	High >95-100% natural	**Good >85-95% natural**	**Moderate >65-85% natural**	**Poor >25-65% natural**	**Bad <25% natural**
	Vegetation cover within the riparian zone is > 95% natural. This may include wood, wetland, moor, heath, etc. and this dominates the area closest to the channel.	Vegetation cover within the riparian zone is > 85% natural and this dominates the areas closest to the channel. Some minor impacts may include footpaths or trails.	Vegetation cover within the riparian zone is > 65 % natural. Some areas close to the channel may be affected by human activities, but remain covered in vegetation e.g. **RP**; agriculture or grazing	Vegetation cover is more than 25% natural, but significant areas close to the channel are affected by human activities e.g. **IG**.	There is little or no riparian buffer zone, human activities extend close to the channel over the length of the reach. Included here are urban development and coniferous forests.
L	**2**	**1.5**	**1**	**0.5**	**0**
R	**2**	**1.5**	**1**	**0.5**	**0**

Description of undisturbed stream types	Typical pressures	Departure from high status
Bedrock: These rivers are often confined and do not interact regularly with the floodplain. Land use within the floodplain depends on location and should be determined in the desk study or on site	Coniferous Forestry Quarrying	Reduced cover of native vegetation Presence of exotic species Forestry, pasture, crops Roads, railways and urban areas
Cascade and step-pool: These rivers are often confined and do not interact regularly with the floodplain. Land use within the floodplain depends on location and should be determined in the desk study or on site.	Coniferous Forestry Quarrying	Reduced cover of native vegetation Presence of exotic species Forestry, pasture, crops Roads, railways and urban areas
Pool-Riffle-Glide: The vegetation cover will depend on the location of the stream; however, these stream types interact regularly with their floodplains. Areas of moorland, wetland and wet grassland may characterise the riparian zones, although mature wet woodland may also be present at the lower gradient end of the system.	Vegetation management Forestry Agriculture Grazing Urban development Construction	Reduced cover of native vegetation Presence of exotic species Forestry, pasture, crops Roads, railways and urban areas
Meandering: The vegetation cover will depend on the location of the stream; however, these stream types interact regularly with their floodplains. Areas of moorland, wetland and wet grassland may characterise the riparian zones, although mature wet woodland may also be present at the lower gradient end of the system.		
CHECKLIST – how non-natural is the land cover back 20m from the bank top? **Assess the likely impact of the land cover on the stream.**		

RIPARIAN LAND COVER

Plasket's Burn

- Improved grassland on one bank. From the photo, this will score 0.5 on the right bank. The other bank is scored separately
- However the extent of IG as a percent of the survey stretch as a whole must be assessed.
- There is no buffer to the channel and no bank top vegetation
- The stretch seems very straight and could imply straightening or resectioning

Ballinderry River

- Looking at the picture the river is extremely straight suggesting complete resectioning
- The left bank riparian cover is rough pasture. This is illustrated by the presence of Juncus
- Cattle may still be grazing on this left area but the land looks as as if it is allowed to flood and is not managed as intensively as grassland

CASCADE AND STEP-POOL

Beagh's Burn, Glen's of Antrim

- Riparian land cover is ferns and small dwarf trees
- The exposed nature of the area would only suit these vegetation types
- This would score a GOOD for riparian land cover. Although the ferns are natural, it would be expected that more dwarf trees would be present. They have probably been outcompeted

MEANDERING

Kesh River, Co. Fermanagh
CLASS - MODERATE

- RI toe
- No bankside vegetation
- Human activities extend close to the channel; no buffer zone on far bank
- No connection with floodplain
- However, flow is typical for channel type
- River has been altered by man by confining lateral connectivity and increasing the velocity of flow by reinforcing the bank

8. FLOODPLAIN INTERACTIONS – CHANNEL LATERAL CONNECTIVITY

This attribute concerns the degree of lateral connectivity between the channel and floodplain. The natural connectivity depends on the stream type, but for the stream types that would naturally flood (assess valley confinement) over bank at high discharges, the score will reflect the degree to which channel and bank work have altered flow regimes. Factors that will affect connectivity include overdeepening, overwidening, bank reinforcement such as sheet piling and gabions, bank protection schemes including embankments (including set-back) and flood walls, etc. Assess the impact of abstraction practices for HEP, fish farms, mill races and canals. A trashline or the flattening of vegetation may act as a measure of the extent of interaction. Note any cut-off meanders, remnant channels etc. Historical maps, the valley form, the presence of wetland woods or marshes and River Agency information may be available to identify the floodplain. **Each bank should be evaluated separately. Percentages relate to the natural ability of the stretch to flood.**

Condition category					
	High >95-100% natural	**Good >85-95% natural**	**Moderate >65-85% natural**	**Poor >25-65% natural**	**Bad <25% natural**
	Natural bank form – no barrier to over bank flooding. Valley form allows flooding. **AND/OR** No flow regulation therefore high discharge conditions are sufficient for over bank flows for lower gradient stream types.	Natural bank form over most of reach, but small section affected by embankment works, etc. **AND/OR** Any regulation or abstraction has minor impact. High discharge conditions are usually sufficient for over bank flows for lower gradient stream types.	Up to a third of the stretch is preventing the water from reaching the floodplain. **AND/OR** Regulation or abstraction affects high discharge conditions such that over bank flows occur at approximately 50% of frequency expected for natural conditions for lower gradient stream types.	Significant embankment works, etc. that prevent floodplain interaction up to 75% of the channel. **AND/OR** Regulation or abstraction affects high discharge conditions such that over bank flows occur at <25% of frequency expected for natural conditions for lower gradient stream types.	More than 75% of reach is affected by flood alleviation works, embankments or reinforcement, etc. **AND/OR** Significant impact from flow regulation, etc: flows rarely sufficient for bankfull flow in lower gradient stream types.
L	2	1.5	1	0.5	0
R	2	1.5	1	0.5	0

Description of undisturbed stream types	Typical pressures	Departure from high status
Bedrock: These rivers are often confined and do not interact regularly with the floodplain.		
Cascade and step-pool: These rivers are often confined and do not interact regularly with the floodplain.		
Pool-Riffle-Glide: At high discharge there is over-bank flooding.	Channelisation, deepening, widening Bank reinforcement Embankments Construction / structures Impounding, abstraction and flow regulation Construction / structures	Reduced frequency of connection with riparian area – no evidence of regular floods (debris and sediment deposits) Desk study data shows flow regulation or manipulation upstream Steepened banks, raised banks. HEP; Fish farms; Mill races. Influence of man on the flow
Meandering: At high discharge there is over-bank flooding.		
CHECKLIST – Is the river subject to any barriers preventing flooding? Are there any flow regulation installations or any abstractions of water from the river?		

FLOODPLAIN INTERACTIONS

POOL-RIFFLE-GLIDE

Doagh River. Doagh

- Channelised and culverted through an urban area
- Reinforced and resectioned.
- Nuisance species of Butterbur seen to right of photo
- Substrate, channel flow and floodplain connectivity will be impacted
- Downstream of urban areas likely to have an area of erosion as the volume of water is no longer constrained

POOL-RIFFLE-GLIDE

Clough River, Main

- Embanked and set-back embanked extensive – no connectivity to floodplain
- No bankside vegetation
- If embanked material then river probably dredged changing substrate
- U/S fishery enhancement in form of sidebars
- However, the embankment still remains and little bankside vegetation for shelter, food, etc

POOL-RIFFLE-GLIDE

Roe River
CLASS - GOOD

- Mid altitude P-R-G
- Able to meander but confined naturally by valley sides
- Land cover consists of grassland vegetation and more trees would be expected
- Collapsed fencing allowing poaching
- No barrier to flooding

MEANDERING

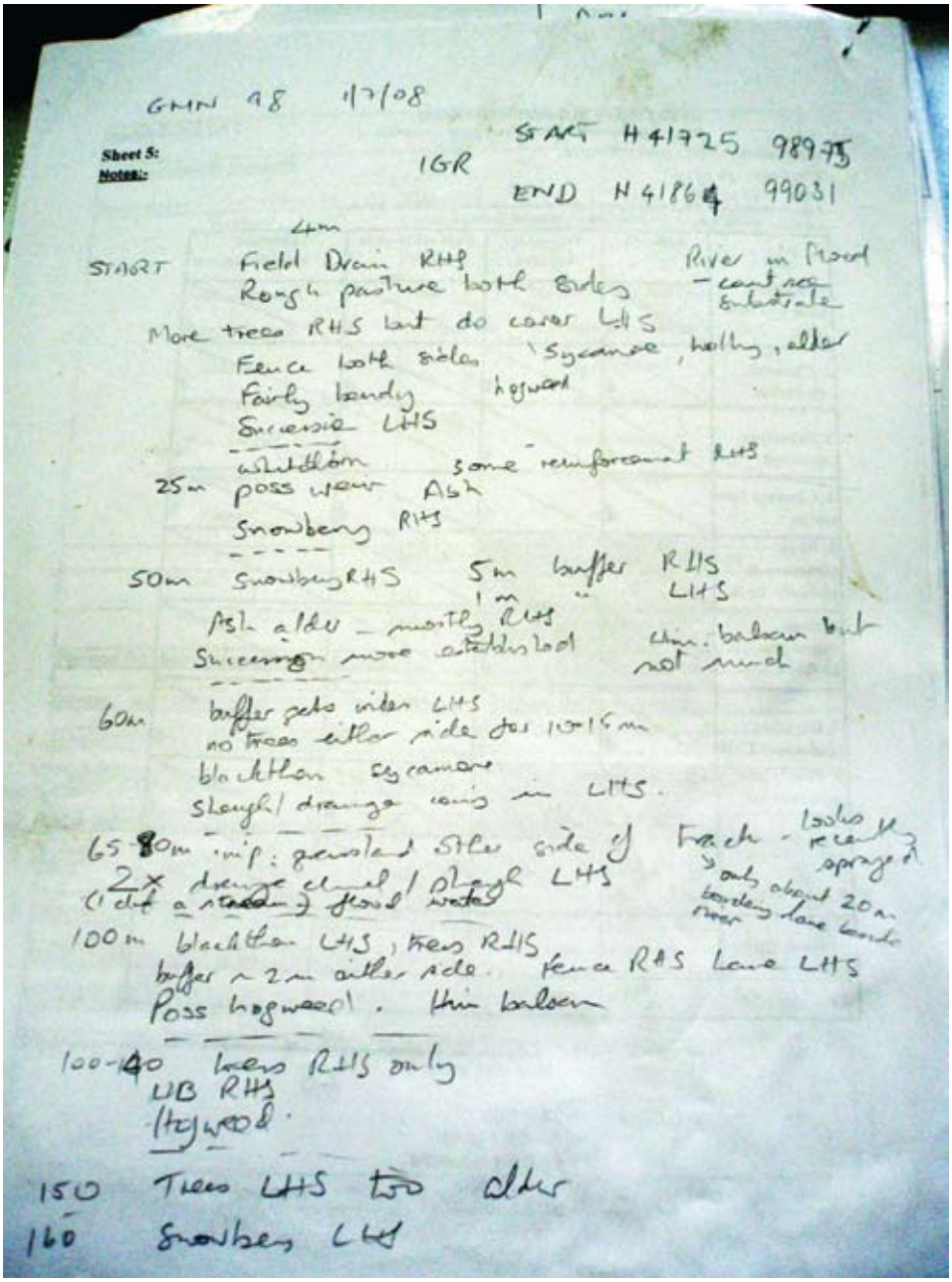
Ballymortimer River
CLASS - BAD

- Lowland meandering that appears to be narrowed or have its ability to meander reduced by the RI present on the entire stretch
- The substrate has been modified
- The channel vegetation is not as expected
- Channel form is not natural
- Excessive channel vegetation present where not expected
- Series of small weirs – probably more aesthetic based

APPENDICES

APPENDIX i

FIELD NOTES



APPENDIX ii

PHOTO DETAIL SHEET

Photo detail sheet Date:

Site name & river name:

Site code: WB name:

WB number:

Other additional information:

Photo details

1.	9.
2.	10.
3.	11.
4.	12.
5.	13.
6.	14.
7.	15.
8.	16.

Photo detail sheet Date:

Site name & river name:

Site code: WB name:

WB number:

Other additional information:

Photo details

1.	9.
2.	10.
3.	11.
4.	12.
5.	13.
6.	14.
7.	15.
8.	16.

APPENDIX iii

FULL RHAT FORM (VERSIONS AVAILABLE ON EXCEL FORMAT - CONTACT DETAILS ON INSIDE FRONT COVER)

Field Health and Safety sheet

River Name_____ Site Code_____ Date_____

1 = Low risk 5 = High risk

Please circle applicable number

PARKING	1	2	3	4	5
FENCES/BARRIERS	1	2	3	4	5
GROUND STABILITY	1	2	3	4	5
DENSE VEGETATION	1	2	3	4	5
BANK STEEPNESS OR STABILITY	1	2	3	4	5
RISK FROM ANIMALS	1	2	3	4	5
PHONE COVERAGE	1	2	3	4	5

Previous RHS/RAT/RHAT surveys - year and code _____

Details of access _____

RHAT (VERSION 2)

TRIBUTARY / MAIN CHANNEL*

Site Identification

River Name _____ Site Code _____

Nearest WFD site FF10 _____

Water Body ID _____ Start U / S or D / S*

First IGR _____ Last IGR _____

Bank surveyed from L / R / Both / In-Channel*

Desk-study notes		**Field Notes**
ACTION TO TAKE PRIOR TO FIELDWORK General overall shape of river Check weirs, impoundments etc. on catchment Floodplain connectivity and land use		**River type** Date Time Surveyors Weather conditions now Estimated river **width** (m) (average 3 readings) Estimated survey **length** (m) (40 X wetted width) Estimated river **depth** (m) Channel characteristics (e.g. different stream types on the reach) Pressures *Circle as appropriate
Expected river type Rain last week Estimated river width Estimated survey length Riparian land cover(s) River Agency designated? Other comments including dominant geology - limestone / siliceous / peat*		
RESULTS		
Hydromorph score WFD class		

Photograph details include IGR or approximate location

_____

_____

_____

_____

N.B. The survey length should be 40x the wetted width with a minimal stretch of 160m but not exceeding 1km.

NS RHAT

Anthropogenic Impacts

River Name _____ Site Code _____ Date _____

Feature		Tick if present, record as E if > 30%		
Resectioned		None ☐	Left bank ☐	Right bank ☐
Reinforcement		None ☐	Left bank ☐	Right bank ☐
Embankments	NO*	LB ☐ RB ☐	Set back LB ☐	SB RB ☐
Culverts**		Y / N / Unknown*		
Over deepened		Y / N / Unknown*		
Over widened		Y / N / Unknown*		
Narrowing		Y / N / Unknown*		
Fords**		Y / N*		
Poaching		None ☐ Left bank ☐ ___(m)	Right bank ☐ ___(m)	
		Major /	Intermediate /	Minor
Bridges**	NO*			
Weirs**	NO*			
Fish Pass**	Other	Y / N*	**Location:** Side / Middle / Other	

Physical features or resource use if applicable. *

Deflectors / Jetties / Arterial drainage / Side channels / Mid channel (MC) bar / MC island/ Field Drains / Mill Race / Tributary

Navigation / Fishing / Recreation / Forestry C* or D* or mixed* / Urban / Industry / HEP / Agriculture

Trashline present (height __ m) above water / Buffer zone (LB __ m / RB__ m back from water edge)

Other observations - Invasives - Trees - Birds - Pollution indicators - Invertebrates*

Rhododendron / Himalayan Balsam / Japanese Knotweed / Giant hogweed / Snowberry / Cherry-Laurel/ Gunnera / NONE

Sycamore / Beech / Conifers / Oak / Ash / Alder / Willow / Birch / Hazel / Hawthorn / Blackthorn / Holly / NONE

Heron / Sand martin / Grey wagtail / Dippers / Kingfishers / NONE

Sewage fungus / Diatomaceous algae / Oil / Cladophora / Vaucheria / Dumping / Silt on Substrate / NONE

Other comments including features not listed:

** **Circle** as appropriate* ***E** - extensive.* *** **Tally** as appropriate.* ***LB** - left bank / **RB** - right bank*

RHAT RIVER HYDROMORPHOLOGY ASSESSMENT TECHNIQUE

Field Assessment of Morphological Condition

River Name _____ Site Code _____ Date _____

If river is in spate 2 and 3 may be marked as NV or note if any attribute is not scored for any other reason. For the greyed area of the riparian land cover can be defined as land cover within the flood-plain.

	Bedrock	Cascade / Step-pool	Pool-riffle-glide	Lowland Meandering
1. Channel form and flow types	4	4	4	4
2. Channel vegetation	4	4	4	4
3. Substrate condition	4	4	4	4
4. Barriers to continuity	4	4	4	4
5. Bank structure & stability L+R	4	4	4	4
6. Bank vegetation L+R	4	4	4	4
7. Riparian land cover L+R	4	4	4	4
8. Floodplain connectivity L+R	4	4	4	4
TOTAL	32	32	32	32
Hydromorph Score *				
WFD class **				

* Hydromorph score = $\frac{\Sigma \text{ Assessment score}}{\text{Total}}$

** WFD Class
> 0.8 = high
>0.6 – 0.8 = good
>0.4 – 0.6 = moderate
>0.2 - 0.4 = poor
< 0.2 = bad.

SHEET 5

NOTES

APPENDIX iv

SPOT-CHECK RHAT FORM (ELECTRONIC VERSIONS AVAILABLE).

Spot-check RHAT form Page 1 of 2

N.B. Only complete if check can be done safely. TRIB / MAIN CHANNEL**

1. SURVEY SITE DETAILS			
River name		Site code	
Nearest WFD site F10			
Vantage point		Bridge name (if applicable)	
Water Body I.D		IGR	
Date		Surveyor	
Channel type U/S		Channel type D/S	
Bank veg. U/S L		Bank veg. D/S L	
Bank veg. U/S R		Bank veg. D/S R	
Land cover U/S L		Land cover D/S L	
Land cover U/S R		Land cover D/S R	

2. ARTIFICAL FEATURES	* Tick for present, E for extensive, X for N/A.					
Upstream*	RS ☐	RI ☐	EM LB ☐	EM RB ☐	SB LB ☐	SB RB ☐
	OD ☐	OW ☐	ND ☐	FD ☐	PC ☐	NONE ☐
Down-stream*	RS ☐	RI ☐	EM LB ☐	EM RB ☐	SB LB ☐	SB RB ☐
	OD ☐	OW ☐	ND ☐	FD ☐	PC ☐	NONE ☐

Comments/Additional information including in-channel pressures (weirs etc):

Spot-check RHAT form (continued) Page 2 of 2

3. MARK SCHEME		
Attribute	Upstream	Downstream
1.Channel form and flow types		
2. Channel vegetation		
3. Substrate condition		
4. Barriers to Continuity		
5. Bank structure & stability L+R	R	R
6. Bank vegetation L+R	R	R
7. Riparian land cover L+R	R	R
8. Floodplain connectivity L+R	R	R
Total		

Overall summation:

4. SPOT-CHECK CLASS:**				** Please circle appropriate
HIGH (>0.8)	GOOD (>0.6-0.8)	MODERATE (>0.4-0.6)	POOR (>0.2-0.4)	BAD (>0.0-0.2)

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Catherine Bradley (EPA)
John Lucey (EPA)
Martin McGarrigle (EPA)

Peter Hale (NIEA)
Tony Waterman (NIEA)
Gregor Watson (NIEA)

Nigel Holmes

Paul Raven (EA) for RHS definitions

Laurie Campbell
Stephen Foster

COMPASS

Original authors of RAT – Dr Keith Richards and Dr Rachel Horn
NS SHARE project

Eamon Hagan, Jake Gibson, Rosetta Mullan and Patrick Murphy (NIEA) for proof-reading

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EPA accredited RHAT surveyors: (from L to R)
Patricia McCreesh; Catherine Bradley; John Lucey and Martin McGarrigle.

NIEA accredited RHAT surveyors: (from L to R)
Rosetta Mullan; Mary Toland; Laura Parkhill and Patrick Murphy.

Northern Ireland Environment Agency
Water Management Unit
17 Antrim Road
Lisburn
BT28 3AL

www.ni-environment.gov.uk

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