South West Region: River Yarty, Sir Arthur's Pill

Annex of R&D Note 456

Silsoe College, Cranfield University

R&D Project Record 317/21/ST

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South West Region: River Yarty, Sir Arthur's Pill

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J A L Dunderdale, J Morris

Research Contractor:
Silsoe College, Cranfield University

National Rivers Authority
Rivers House
Waterside Drive
Aztec West
Bristol
BS12 4UD

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Aztec West
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Statement of Use
This document describes methods, results and conclusions of a study to evaluate the impacts of alternative river maintenance strategies on the River Yarty and Sir Arthur's Pill in the South Western Region. Its main purposes are to provide supporting information for R&D Note 456 'River Maintenance Evaluation' and to provide data which support routines for the prioritisation and programming of river maintenance.

Research Contractor
This document was produced under R&D Project No. 317 by:

Silsoe College
Cranfield University
Silsoe
Bedford
MK45 4DT.

Tel: 01525 863 000 Fax: 01525 863 001

NRA Project Leader
The NRA's Project Leader for R&D Project 317 was:

Stewart Powers - NRA Severn Trent Region

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RIVER YARTY

R&D 317/21/ST

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SOUTH WEST RIVER YARTY

1. BACKGROUND

1.1 Physical Background

The River Yarty rises at Staple Hill in the highland area of Black Down Hills, 6.75 km south of Taunton in Devon. The river is 21 km in length from source to the confluence with the River Axe, 0.75 km south of Kilmington. The catchment area of the River Yarty is 21 km^2 and predominantly rural in character.

1.2 Study Reach

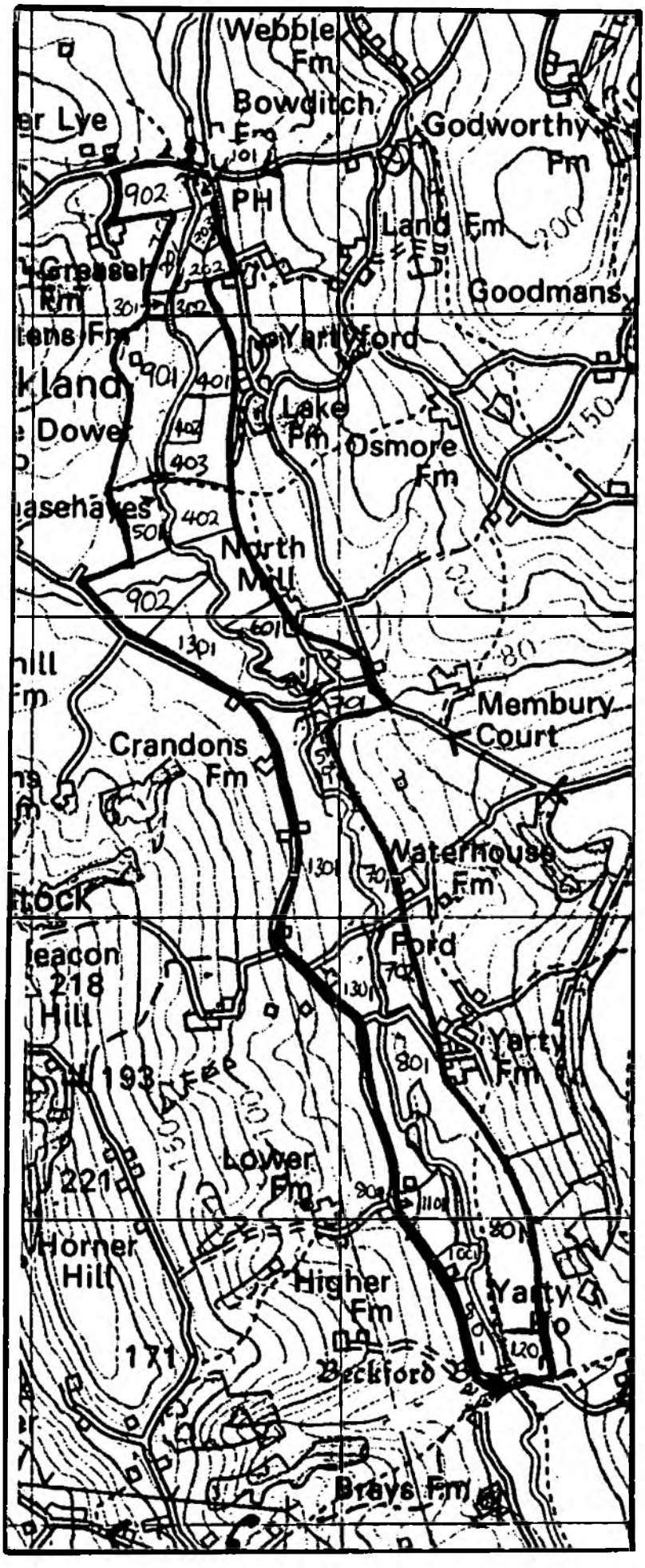
The reach of river selected for study (Figure 1) runs for 5 km from Long Bridge (GR. 256 055) to Beckford Bridge (GR. 266 014). This site was selected for inclusion within the River Maintenance Evaluation study as it is characteristic of main rivers in the region on which maintenance is performed. The area of land deriving benefit from the river maintenance work in terms of its effect on flooding and land drainage is estimated to be 85 ha (Figure 1).

1.3 River Characteristics

The River Yarty is typical of many main rivers in Devon. The river banks are heavily lined with trees, especially alder and willow, along much of the study reach and deciduous broadleaved woodland is common in the lower area of the study reach. The river meanders over a narrow floodplain, constrained by steep valley sides. The meander belt is 450 m wide, containing both large sweeping and tight meanders.

The channel width ranges from 3 to 12 m. Freeboard varies dramatically from 0.25 m with slumped grass banks to 3 m high solid earth cliffs. Bank heights and angles are variable in dimension and change every few metres. Earth cliffs are a common bank feature, especially on the outer bend of meanders.

The River Yarty is a fast flowing river with an average gradient of 1 in 74. Riffles and pools are interspersed with rapids, runs and areas of slack water. Cobbles and pebbles are the dominant bed substrates with areas of gravel and the occasional boulder.



Legend :

Benefit area

201 Land use blocks

Scale 1 : 21 250

Figure 1 Location of the River Yarty site, benefit area and land use blocks

1.4 Land Drainage

The majority of the benefit area is naturally drained. Figure 2 shows the areas of the benefit area which are drained by pipes. Further information is provided in Section 2.4. Twenty four ditches discharge water into the River Yarty within the study reach.

An old weir upstream of the ford at Waterhouse Farm (GR. 261 031) serves to split the channel in two, reducing flow in the main channel which is crossed by a ford. The secondary channel is crossed over a very low concrete slab bridge approximately 18 inches above the river bed. In times of higher flow, this bridge is frequently submerged.

1.5 Geology, Soils and Land Capability

The geology of the area is characterised by the soft red sandstones of Permo-Triassic age. The Permo-Triassic period was an extended episode of continental erosion and deposition under an arid climate.

The Fladbury Soil Association is characteristic of the River Yarty floodplain. The Fladbury series is the dominant soil with the subsidiary Wyre series found on the slightly higher floodplain areas. Both series are deep clayey alluvial soils. The Fladbury soil is a pelo-alluvial gley soil which is characteristically mottled throughout the subsoil. The Wyre series is described as a pelogleyic brown calcareous alluvial soil which lacks mottling above 40 cm in depth.

Soil profiles taken within the reach are shown in Figure 3. The wetter sandy clay soil is characterised by mottling and has a gleyed subsoil. Both the Fladbury and Wyre soils are permeable, albeit slowly. The soil is waterlogged within 70 to 40 cm of the surface for more than 180 days in a year. The primary source of waterlogging is groundwater, the levels of which fluctuate seasonally. The Soil Survey of England and Wales (SSEW) classify soils with this wetness regime as Wetness Class IV (Findlay et al, 1984). Locally, prolonged waterlogging results in a Wetness Class of V during the winter in which soil is waterlogged within 40 cm for 180 to 335 days in the year. According to records from the nearest meteorological station to the site (Twist), the average annual rainfall is approximately 972 mm.

The land is classed as Grade 4 under the Agricultural Land Classification System of MAFF, with the dominant land use being permanent grassland or long leys. The risk of poaching (surface damage by livestock) is high and the incidence of flooding restricts grazing seasons.

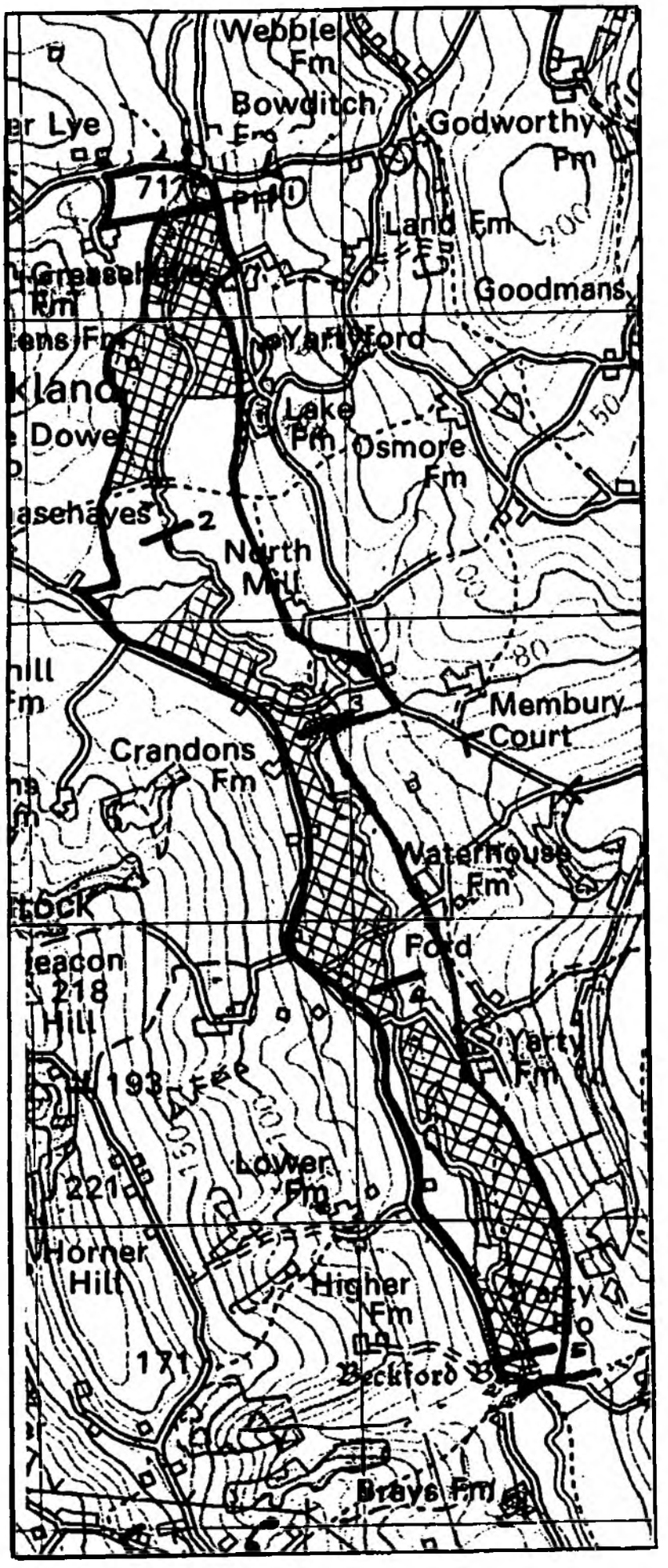
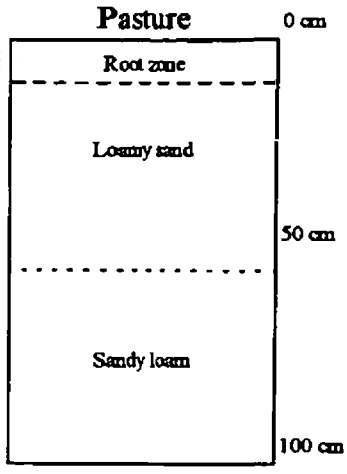
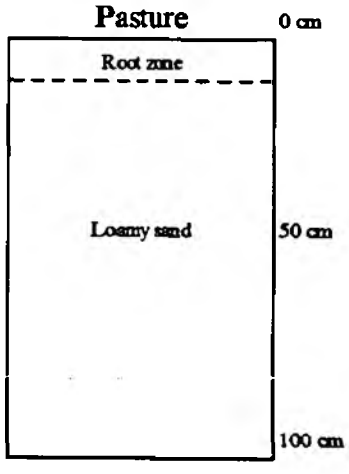


Figure 2 Land drainage and location of cross-sections

Grid Reference	255 044
Soil Core Number	1
Soil Colour	Dark reddish brown
Comments	Uniform profile



Grid Reference	259 037
Soil Core Number	2
Soil Colour	Dark reddish brown
Comments	Uniform profile



Grid Reference	262 027
Soil Core Number	3
Soil Colour	Dark brown
Comments	Mottling of subsoil

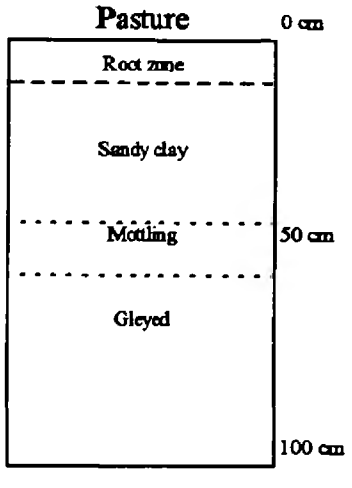


Figure 3 Soil profiles

1.6 Capital Works

Capital works were performed on the River Yarty in 1968 following the East Devon floods which were the result of summer storms. These works involved a pioneer timber and bank management scheme when tree clearance and bank maintenance took place. Between 1980 and 1987 a block stone bank revetment scheme was carried out. Bed check weirs were created although these works are just downstream of the study reach.

1.7 River Maintenance

The aim of river maintenance work is to provide a clear watercourse in times of high water and to prevent the flooding and damage of the transport network and numerous low bridges which cross the river. Maintenance is carried out as a preventative measure to minimise the probability of fallen timber accumulating against bridges or as debris dams.

The first tree and bush river maintenance work since the capital scheme was performed during the winters of 1992 and 1993. The return period for future maintenance work is to be five or ten years. Chain-saws and tractors fitted with a winch are the predominant methods used in the tree maintenance. Unstable limbs and low, overhanging branches are removed if they pose a restriction to flow. Willows are pollarded in order to generate regrowth.

Fallen trees and other debris are removed from the channel as required. Since 1968, five gang days per year have been spent clearing debris from the channel.

The level of maintenance on the River Yarty is set following an inspection of the river by the NRA. Availability of equipment and labour also determine the timing of maintenance. In practice, tree and bush maintenance on this section is performed on a 'stop gap' basis. When work gangs have no other maintenance to perform, they are transferred to the River Yarty.

Standards of service (SoS) for the level of maintenance performed are set following an engineers' survey. Watercourse condition and availability of skills and machinery determine the method of tree and bush maintenance performed.

Prior to maintenance, conservation, fisheries and pollution bodies within the NRA and external groups are invited to attend a meeting to discuss the work programme in detail. If necessary, the work programme may be modified following this meeting. Landowners, tenants and

fisheries owners are informed via a telephone call and visit. If public utilities may be affected, relevant bodies are notified via a telephone call which is followed by a letter and map detailing the areas of work.

1.7.1 Farmers views on maintenance

During interviews with farmers, opinions expressed on the maintenance regime were divided. Five farmers expressed their satisfaction with the maintenance regime, stating that it was both beneficial and necessary in order to protect the bridges from flooding and to prevent blockages. However, others stated that it was both a waste of time and pointless as it had no impact on channel capacity. One expressed the opinion that maintenance was carried out at the wrong time and another thought that maintenance worsened the situation as the channel was deepened which resulted in faster flow and increased erosion.

1.7.2 Alternative maintenance strategies

Various alternative maintenance strategies were suggested by farmers during discussions. The dominant suggestion was that some action should be taken to reduce erosion. It was thought that this could be done through planting trees on the river banks and through the use of stone block revetments. Straightening of the bends was suggested as a method of reducing erosion as it would allow a direct route for flow thus reducing the risk of bank erosion. If maintenance were performed in the summer (June onwards) rather than during winter, this is thought by farmers to reduce the incidence of soil compaction as during summer, the load bearing strength of the land is higher than in winter. Stone revetment work has since been carried out in the vicinity of Crandons Farm Bridge (GR. 259 038).

1.8 Climate

The impact of river maintenance on watertable depth and river levels depends on the particular weather conditions, especially rainfall, which vary from season to season and year to year. The seasonal and yearly totals for the period of study (Twist met. station, GR. 290 037) are presented in Table 1.1. The probability of wet, average and dry seasons and years occurring has been determined through analysis of monthly rainfall figures which span a 13 year period. The classification system of the Food and Agricultural Organisation (FAO) was used to determine the wet, average and dry rainfall bands. Wet and dry seasons and years are classed

as those which receive greater than 125 % and less than 75 % of the average rainfall values respectively. Further information on this classification system is presented in the R&D Note 456 Section 3.5.4.

Table 1.1 Rainfall totals

Period	Season	Actual Rainfall (mm)	Average * Rainfall (mm)	% Average Rainfall
1992	Spring	168.4	202.0	83.4
	Summer	220.8	180.1	122.6
	Autumn	331.8	282.4	117.5
1993	Spring	218.8	202.0	108.3
	Summer	173.2	180.1	96.2
	Autumn	398.6	282.4	141.1
1994	Spring	259.0	202.0	128.2
	Summer	119.9	180.1	66.6
	Autumn	392.1	282.4	138.8
1995	Spring	187.0	202.0	92.6
Total	1992	913.3	970.05	94.1
	1993	1134.3	970.05	116.9
	1994	1199.6	970.05	123.7

* Based on 13 Year record from 1980 to 1993, Twist met. station

The summer and autumn of 1992, autumn of 1993 and spring and autumn of 1994 were wetter than average when compared to the long term average rainfall. This fact is confirmed by farmers who reported some flooding and wet condition underfoot.

The probability of a wet, average and dry season and year occurring is shown in Table 1.2. Rainfall probabilities are based on a 13 year record of monthly rainfall data from the Twist meteorological station (station reference 352 634, GR. 290 037).

Table 1.2 Probability of climatic condition

Season	Dry *	Average *	Wet *
Spring	0.07	0.715	0.215
Summer	0.21	0.43	0.36
Autumn	0.21	0.57	0.22
Year	0.64	0.22	0.14

* Based on records since 1980

The process by which financial benefits of maintenance are calculated according to the probability of each type of season and year occurring is explained in the R&D Note 456, Section 3.5.4.

2. FARM SURVEY

2.1 Introduction

Through site survey, structured interviews and informal discussions with farmers the area deriving benefit from river maintenance in terms of its impact on flooding and land drainage is estimated to be 85 ha. This area is classed as the benefit area (BA). The benefit area has been divided into different blocks (Figure 1) according to land management and land use, drainage conditions and flooding.

2.2 Farm Type, Size and Tenure

Five of the 13 farms within the benefit area are classed as dairy farms according to the European Union (EU) classification system. Three are lowland and livestock farms and one a mixed enterprise. The remaining four are classed as other enterprises. These include small holdings (2 and 5 ha) one of which is grazed by a horse.

Farm sizes range from 2 ha to 202 ha. The average farm size is 65 ha. The Standard Man Day (SMD) or Man-Work-Unit requirement ranges from five to 804, the average is 290. This SMD requirement may be used to assess the labour requirement of the agricultural enterprise. Generally, the higher the SMD value, the greater the amount of labour required.

Ten of the farms are under sole proprietorship. The remaining three are run in partnerships. All the farmers have one holding, although one farmer has two farms. These two farms are run as one unit under the same holding number. The majority of land within the benefit area is owner occupied. Only two farmers have rented land within this area. This comprises 1 ha which is held under a 364 day tenancy agreement and 6 ha held under a summer grazing agreement.

2.3 Livestock Enterprises

The general farming pattern of the Yarty valley is one of mainly beef and sheep enterprises with small areas which are cut for hay and silage.

Six farms have beef herds of various sizes and ages. All the cattle are under two years of age, with four herds following an 18 month grass / cereal system. One is under a system of

fattening with beasts sold on when they reach 400 - 700 kg in weight. The remaining herd consists of store cattle which are fattened off grass and silage and sold on.

Four farms have sheep enterprises. The lambing rate for these Horn Cross ewes under the fat lamb system is above average at 1.6 lambs/ewe tupped. One farm has 300 store lambs under the grass fattening system. These are bought in April and sold in the following February and March after being fattened.

The size of dairy herds on five farms range from one to 80 Freisan cows. Three farms have dairy followers aged between six months and two years. Milk yields range from 5350 litres/cow/year (average yield) to 6000 litres/cow/year (high yield).

One farm has a large pig enterprise under which 300 hogs are kept under a fattening system.

2.4 Arable Enterprises

Two farms have some arable enterprises, although only 0.5 ha lies within the benefit area. Winter cereals, commonly winter barley, turnips and sugar beet are grown under an arable / root crop rotation.

2.5 Land Use In The Benefit Area

Table 2.1 and Figure 4 provide a breakdown of land use within the benefit area. The majority of land is under extensive grassland (76 %). The remaining area is predominantly under intensive grassland with 0.5 ha under cereal and root production.

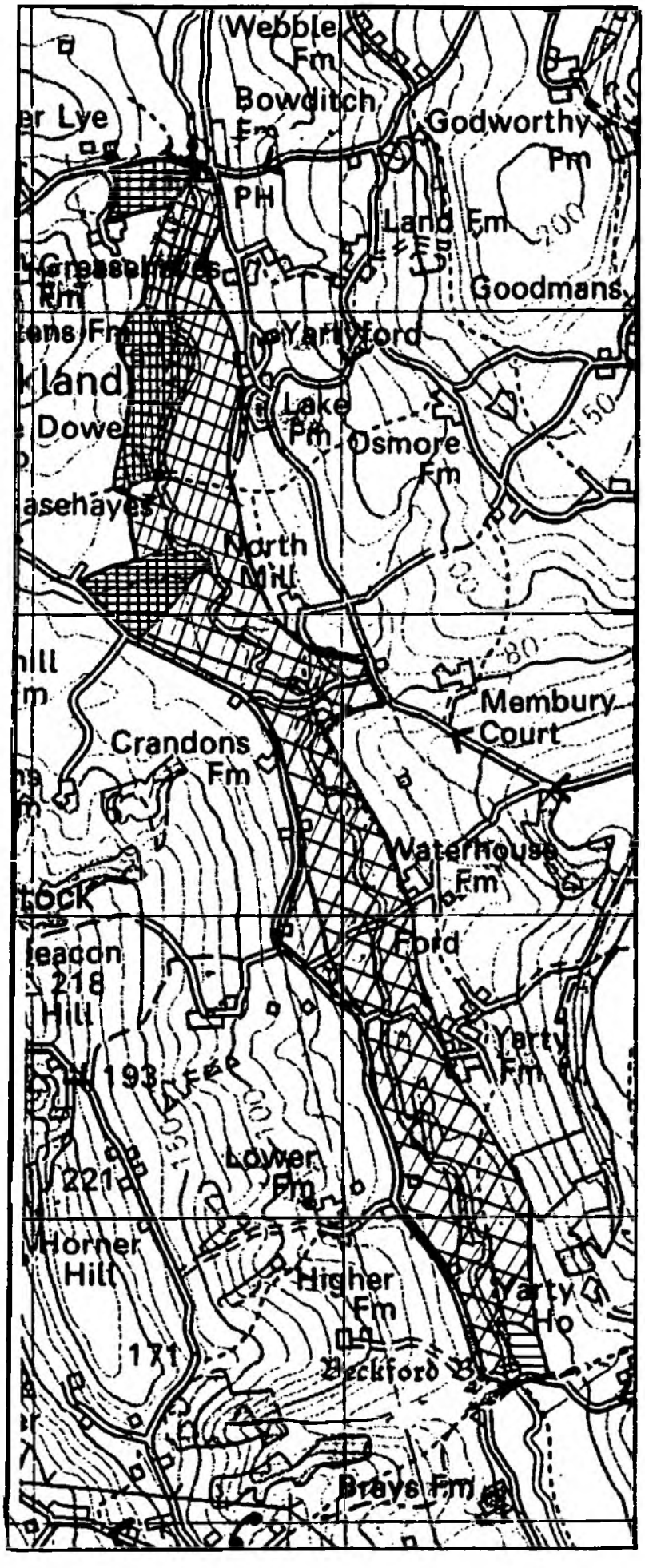
Table 2.1 Land use in the benefit area

Land Use	Area (ha)	% of Benefit Area	% Land With Field Drains
Extensive grass	64.9	76.3	43.9
Intensive grass	19.6	23.1	43.9
Cereal / root	0.5	0.6	0.0

Extensive grassland is classified as that which receives little or no nitrogen input and is subject to little or no grass conservation. If grass conservation takes place, hay rather than silage is usually cut. Beef and sheep commonly graze extensive grassland over a short grazing season.

In comparison, grassland under an intensive system is usually grazed over long grazing seasons by dairy cattle. Multiple cuts of silage are taken and inputs of nitrogen are relatively high (> 50 kgN/ha).

Approximately 44 % of land under intensive and extensive grassland systems is artificially drained by pipes. The remaining areas are naturally drained by gravity. Land under the arable / root crop rotation is not drained by pipes (Table 2.1).



Legend :

Intensive grass

Extensive grass

Cereal / root crop

Scale 1 : 21 250

Figure 4 Land use in the benefit area

2.6 Turnout and Yarding Dates

Dates for the turnout and yarding of livestock vary within the benefit area as Tables 2.2 and 2.3 indicate. The majority of grassland within the benefit area is grazed from April to October. Drier areas have longer grazing seasons although no livestock are overwintered out to grass within the benefit area - livestock are moved from the valley floor to graze higher areas. Eight percent of the benefit area is not grazed by livestock. A small area is grazed by horses and the remainder is left as meadow.

Table 2.2 Turnout dates

Turnout Date	% Grassland Area	% of Benefit Area
Mid / late March	12.9	12.8
Early / mid April	10.7	10.6
Mid / late April	59.4	59.0
After first silage cut	8.5	8.4
Not grazed	8.5	8.4

Table 2.3 Yarding dates

Yarding Date	% Grassland Area	% of Benefit Area
Mid / late October	45.9	45.6
Early / mid November	15.0	14.9
Mid / late November	20.6	19.9
Mid / late December	10.0	9.9
Not grazed	8.5	8.4

2.7 Grass Conservation

The majority of grassland is grazed only and is not cut for silage. One cut of silage is taken off 12 % (10.1 ha) of the grassland. Silage is cut in early to mid June. No hay is cut within the benefit area.

2.8 Nitrogen Application

Levels of nitrogen applied to grassland within the benefit area range from zero to 74 kg/ha. Table 2.4 shows actual levels applied. Fifty eight percent of the grassland area receives no

application of nitrogen. Over the remaining area, the compound NPK fertiliser in the proportions 20:10:10 and 29:5:5 are commonly applied.

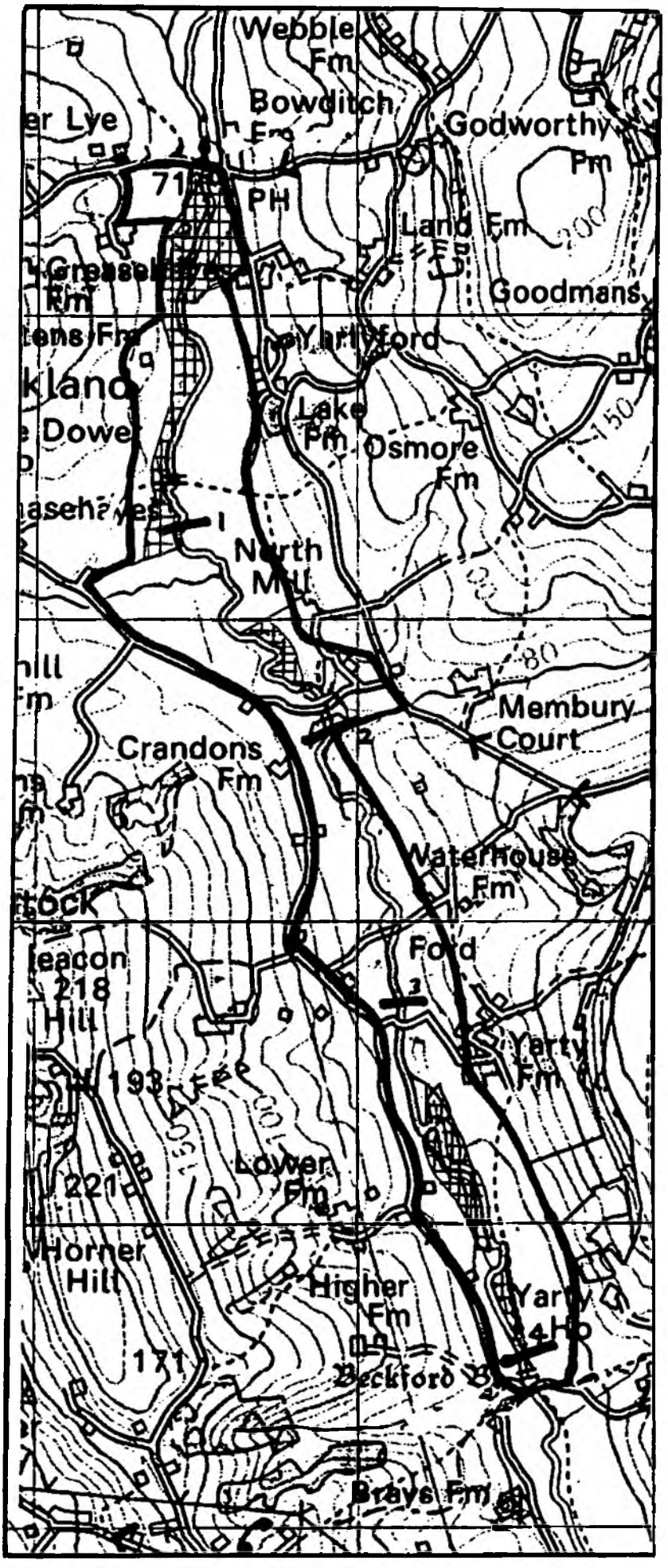
Table 2.4 Nitrogen application rates

Rate (kg N/ha)	Grassland Area (ha)	% Grassland Area
0	49.0	58.0
1 - 15	5.7	6.8
16 - 30	28.5	33.7
50 - 74	1.3	1.5

2.9 Flooding

Six farmers within the benefit area reported flooding on their land. In all cases, high river water levels due to excessive rainfall were thought to be the main factor responsible for the flood conditions. On average, 21 % of the benefit area floods (Figure 5) on an annual basis during the autumn and winter months. However, 6 % of the benefit may be subject to flashy summer floods if rainfall is high and the channel blocked by debris.

The duration of flood events is short. All farmers report the flood duration to be of one or two days. Litter and debris on pasture are cited as the main consequences of flooding by many of the farmers. Such debris has to be cleared by hand. Erosion of the river banks is also reported to be a consequence of some significance.



Legend :

Flooded areas

Debris dams

Scale 1 : 21 250

Figure 5 Areas prone to flooding and location of simulated debris dams

2.10 Waterlogging

Throughout the spring and summer the wetness condition of the land within the benefit area is reported to be relatively dry. During the summer, as Table 2.5 shows, the majority of land is rarely wet with only 12 % being occasionally wet.

In the spring and autumn, a greater proportion of the land is wet. In the autumn, 29 % of the benefit area is reported as being often wet and four percent of the land is permanently wet. These wetter conditions have been attributed to the low lying nature of the land and the weather conditions.

Table 2.5 Farmer assessment of wetness condition

Season	Wetness Condition	Area (ha)	% Benefit Area
Spring	Rarely wet	30.8	36.2
	Occasionally wet	54.2	63.8
	Often wet	0.0	0.0
	Permanently wet	0.0	0.0
Summer	Rarely wet	74.5	87.6
	Occasionally wet	10.5	12.4
	Often wet	0.0	0.0
	Permanently wet	0.0	0.0
Autumn	Rarely wet	11.6	13.6
	Occasionally wet	44.7	52.6
	Often wet	25.0	29.4
	Permanently wet	3.7	4.4

2.11 Statistical Analysis

It is apparent that land use, farming practice, drainage and flooding are interrelated. Statistical methods were used to determine whether these relationships occurred more frequently than might be expected by pure chance. Full details of this analysis in which the 12 sites were grouped according to NRA Region, are presented in the Interim Report R&D 317/13/ST, presented to the NRA in December 1994.

The following observations can be made from the statistical analysis of fields in the benefit area of the River Yarty maintenance programme:

- Land management within the benefit area and land use are a function of the farming system followed. The dominant farming system influences land use within the benefit area.

Typically it is an area of pasture, devoted to dairy, sheep and beef and therefore even if the land is liable to flood and prone to wet conditions, land use reflects the dominant farming system; in this case dairy and lowland and livestock.

- A relationship exists between flooding and land use. The cereal / root crop production areas are not prone to flooding. Extensive grassland areas are prone to flooding. Flood duration is longer on extensive grassland (2 days) than on intensive grassland (1 day). (Statistically, there is a 40 % chance of correctly predicting the incidence of flooding on the basis of land use).

- A relationship exists between turnout dates for livestock and field wetness conditions in the spring. Land which is rarely wet in spring is grazed from late March or early April. The wetter land (occasionally wet) is grazed from mid to late April. (Statistically, there is an 85 % chance of correctly predicting livestock turnout dates on the basis of field wetness conditions in the spring).

3 HYDRAULIC AND HYDROLOGICAL INFORMATION

3.1 Introduction

Information on channel hydraulics and hydrological data has been used to determine the impact of maintenance on channel capacity and flood return periods.

3.2 Cross-section Surveys

Cross-sectional surveys of the River Yarty channel were taken at five points along the study reach at an average interval of 1.2 km (Figure 2). Channel capacity and freeboard were determined from these cross-sections. The channel cross-section remained unchanged following the tree and bush clearance programme and so a post-maintenance cross-sectional survey was not necessary.

Prior to maintenance, channel roughness was expressed in the form of Manning's n coefficient, in accordance with the methodology developed by Cowan (1956). This coefficient is composed of six elements which include the degree of irregularity of the channel bed, level of vegetation growth and relative effect of obstructions such as tree roots and fallen branches. Further details of this methodology are contained within the R&D Note 456 Appendix IV. The same procedure was followed post-maintenance in order to determine friction values for the 'with' and 'without' maintenance situation.

Stage/discharge curves for the 'with' and 'without' maintenance situation were constructed for each cross-section using the different values of Manning's 'n'. Channel cross-section information, stage/discharge curves and channel information are presented in Figure 6. The bankfull channel capacities and associated return periods for the 'with' and 'without' maintenance scenario are presented in Table 3.1.

The bankfull capacity figures obtained from the cross-sections indicate an average increase in capacity attributable to maintenance of 16 % and an average increase in the interval between flood events of 35 %.

Table 3.1 Bankfull capacity and return periods

Cross-Section No.	Without Maintenance Bankfull Capacity (m^3/s)	Without Maintenance Return Period (years)	With Maintenance Bankfull Capacity (m^3/s)	With Maintenance Return Period (years)
1	16.7	3.0	20.8	8.0
2	5.6	0.3	7.1	0.4
3	10.3	0.9	11.5	1.1
4	10.1	0.8	11.5	1.0
5	14.5	2.0	17.2	3.8

(Source: modelled estimates)

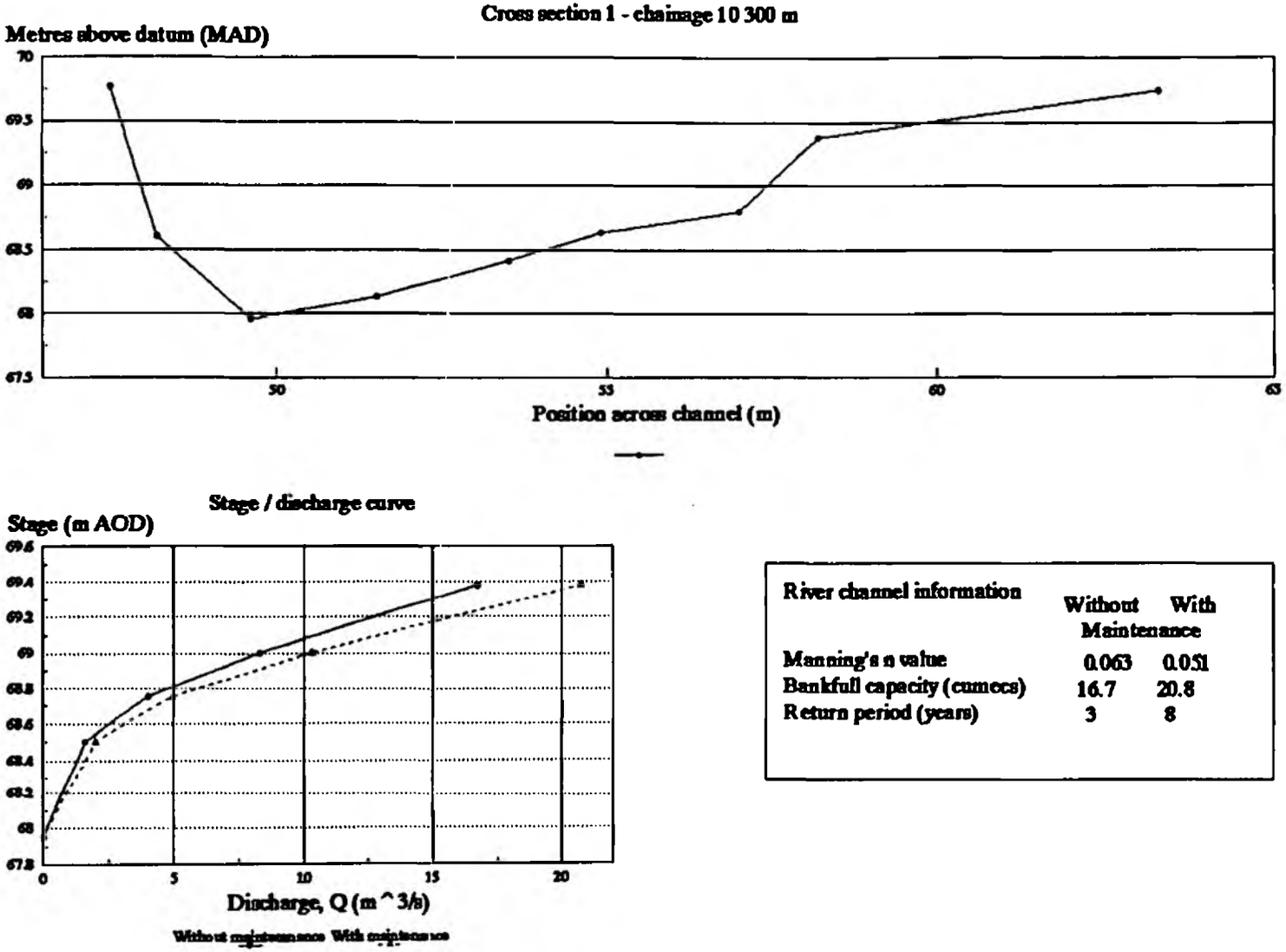
3.3 Flood Return Period

Throughout the period of study (1992 to 1995) river water level information was collected on a regular basis through the reading of three gauge boards which were installed in the reach at Longbridge, Case Bridge and Beckford Bridge. Information regarding frequency, duration and magnitude of flood flows were collected from interviews with local farmers and NRA staff. A flood return period curve has been compiled from this information, using the methodology contained within the Flood Studies Report (NERC, 1975). The frequency of floods of different magnitudes can be estimated from the flood return period curve (Figure 7).

The flood return period for each block which floods and associated flooded areas are shown in Table 3.2. The 'without' maintenance return period is estimated by the farmer, the 'with' maintenance value is a modelled estimate using the cross-section information and Manning's n coefficient. It is assumed that the flooded area remains unchanged following maintenance.

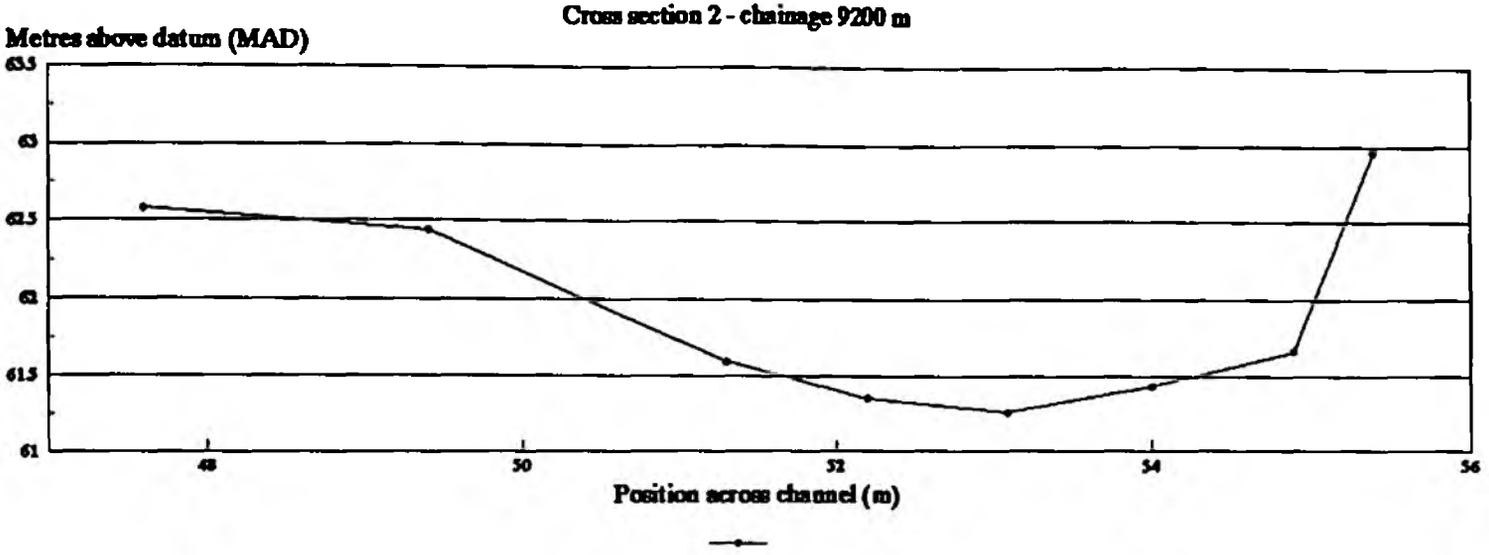
Table 3.2 Flood return periods and flooded areas

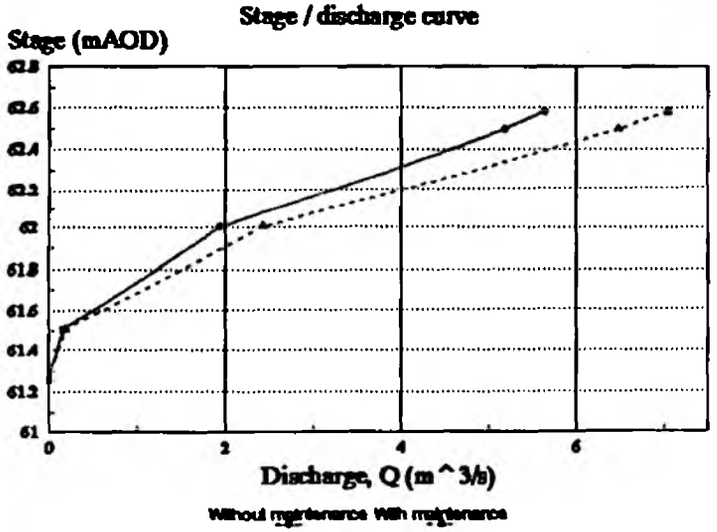
Block No. (Size, ha)	Flooded Area (ha)	Flood Return Period (Years) Without Maintenance	With Maintenance	Block No. (Size, ha)	Flooded Area (ha)	Flood Return Period (Years) Without Maintenance	With Maintenance
101 (1.1)	0.88	0.3	3.0	801 (15.2)	1.90	0.3	3.5
201 (2.0)	1.60	1.0	3.0	901 (8.6)	2.00	0.3	3.0
202 (1.3)	0.33	1.0	3.0	1001 (1.90	0.23	0.5	2.0
203 (1.3)	1.00	0.5	3.0	1201 (0.5)	0.10	0.5	2.0
301 (0.5)	0.50	1.0	3.0	1301 (17.8)	3.56	0.5	1.0
501 (2.6)	2.08	0.5	1.0				
601 (3.3)	0.33	0.5	1.0				



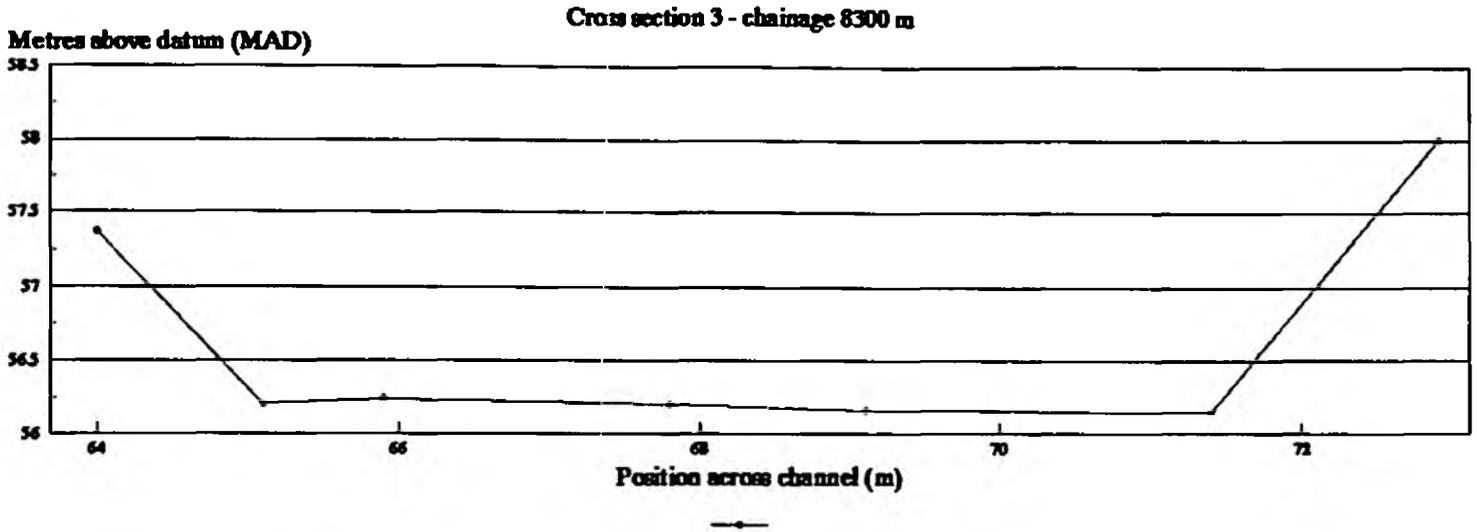
River channel information	Without Maintenance	With
Manning's n value	0.063	0.051
Bankfull capacity (cumecs)	16.7	20.8
Return period (years)	3	8

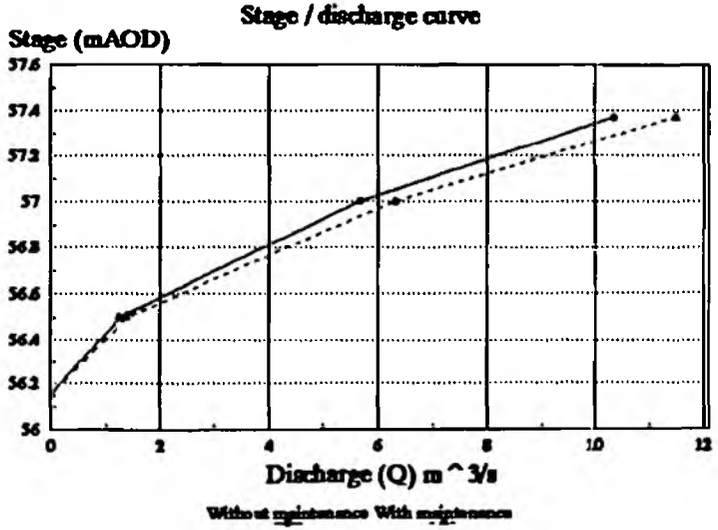
Figure 6 River Yarty channel information



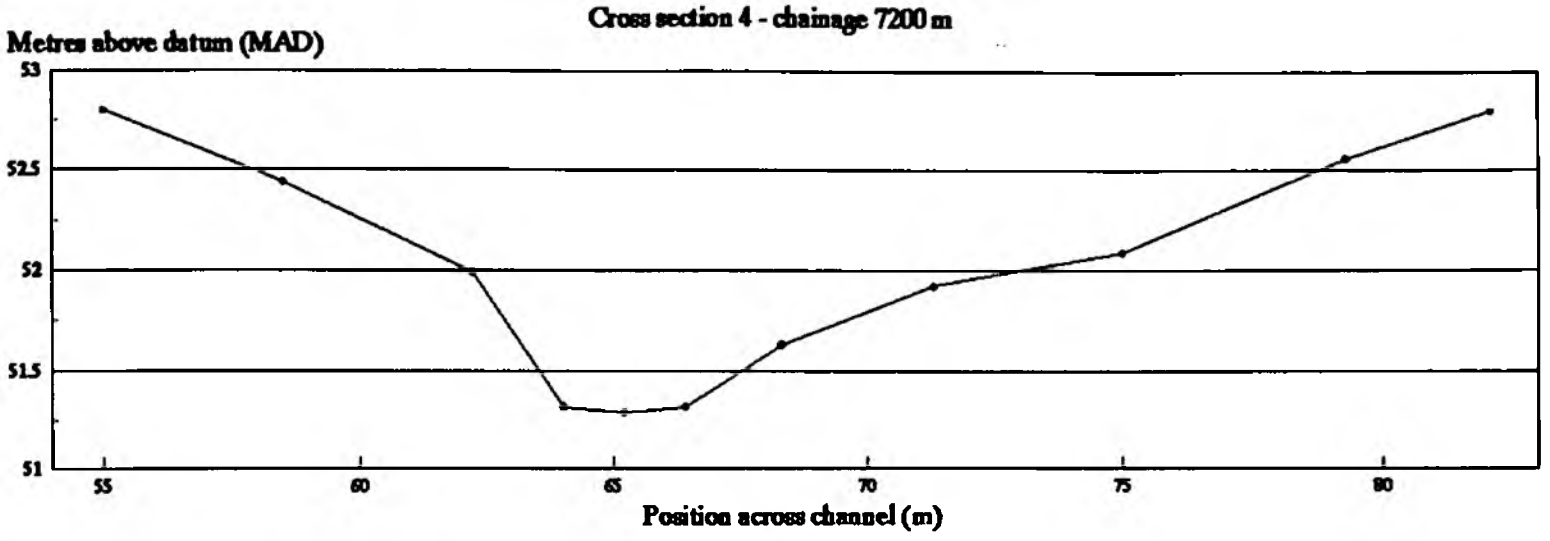


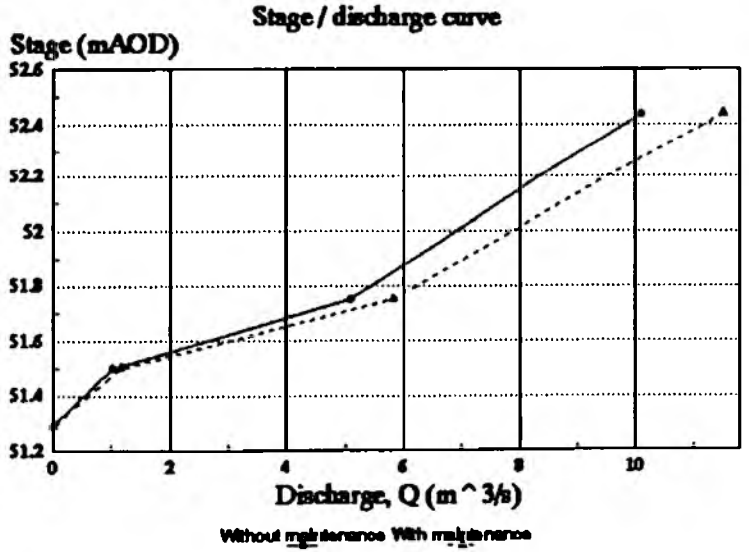
River channel information	Without Maintenance	With
Manning's n value	0.05	0.04
Bankfull capacity (cumecs)	5.6	7.1
Return period (years)	0.3	0.4



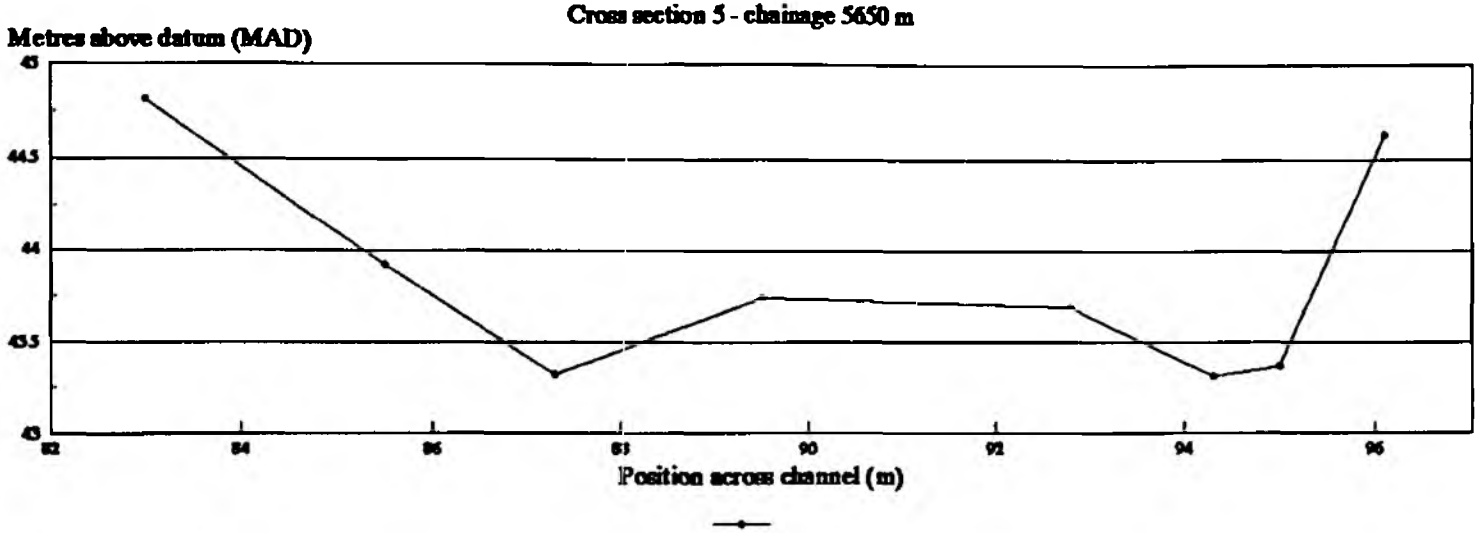


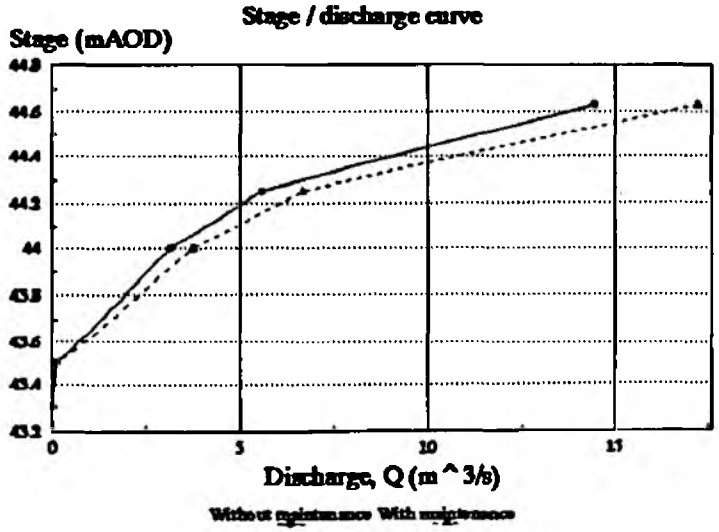
River channel information	Without maintenance	With
Manning's n value	0.05	0.045
Bankfull capacity (cumecs)	10.3	11.5
Return period (years)	0.85	1.1





River channel information	Without Maintenance	With
Manning's n value	0.049	0.043
Bankfull capacity (cumecs)	10.1	11.5
Return period (years)	0.8	1.0





River channel information	Without Maintenance	With
Manning's n value	0.062	0.052
Bankfull capacity (cumecs)	14.5	17.2
Return period (years)	2.0	3.8

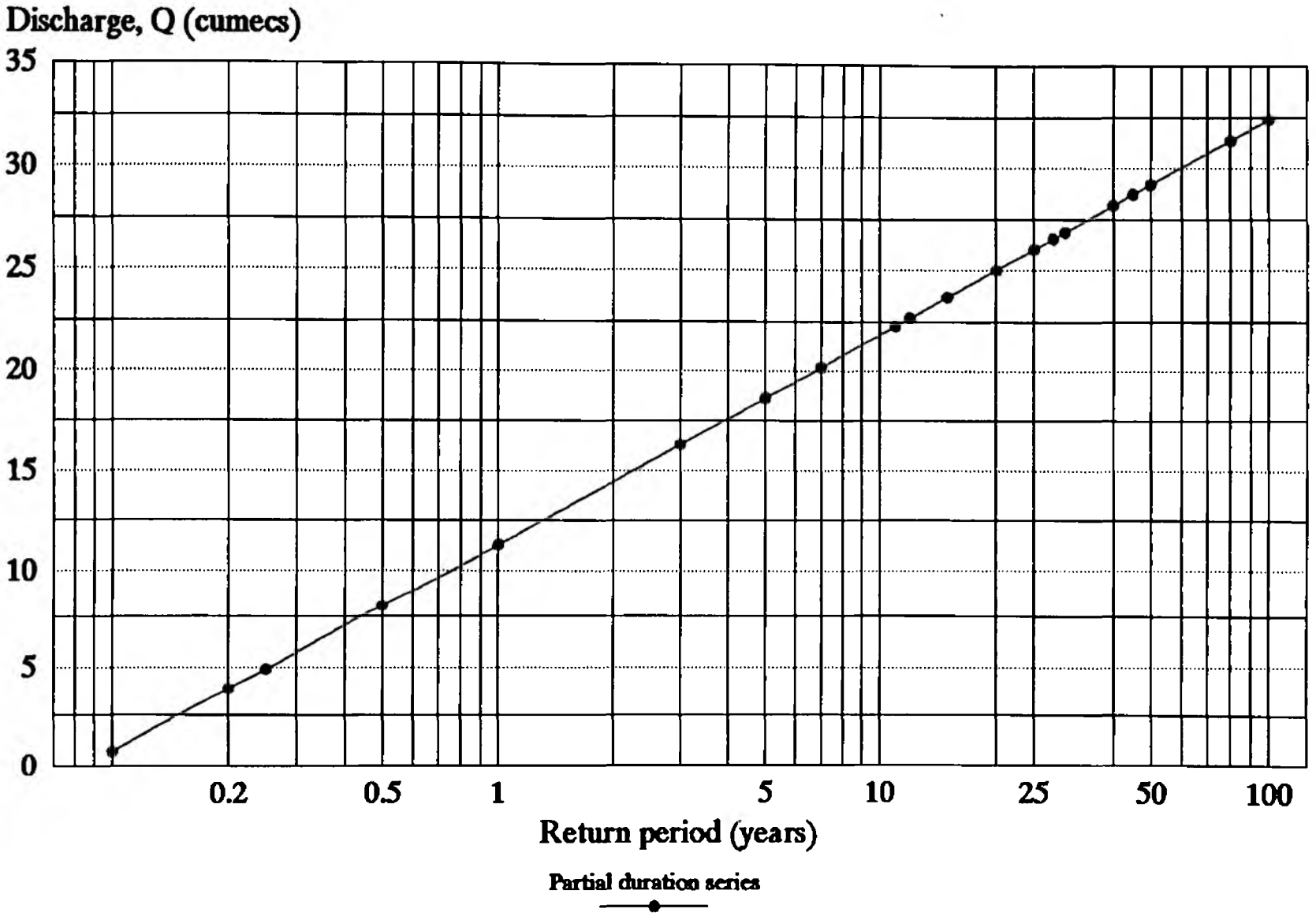


Figure 7 Flood return period curve

4. LAND DRAINAGE

4.1 Field Drainage Status

Through an extensive literature review and farmer survey, the drainage status of agricultural land has been classified into three standards according to watertable depth. Three watertable bands have been identified:- > 0.5 m from the surface, between 0.3 to 0.5 m of the surface and < 0.3 m from the surface. According to the time the watertable lies within these bands, the drainage status is classed as good (G, no limitations to agriculture), bad (B, some restrictions on agriculture) or very bad (VB, severe limitations to agricultural productivity). Further details are presented in the R&D Note 456, Section 3.5.2.

The drainage status of the different land blocks within the benefit area of the River Yarty has been determined on a seasonal basis using a non-steady state watertable model which relates infield watertable levels (and hence drainage conditions) to observed water levels in the river and ditch system (see R&D Note 456, Section 3.5.2 for further details). The model has been run with river water levels for the 'with' and 'without' maintenance situation using the same climatic data to enable the isolation of the impact of maintenance on drainage status. An example of the input and output of the model is shown in Appendix I. An example of the classification of the weeks of each season which are under conditions of good, bad and very bad drainage status are shown in Appendix I.

In some cases, there may be a change in the number of weeks that the watertable lies within the good, bad or very bad drainage bands following maintenance. However, these changes may not be of sufficient magnitude to change the drainage status classification. Where a change in drainage status has occurred due to maintenance, the changes appear in bold print in Table 4.1.

The results of the model and the assessment of drainage status made by farmers are shown in Table 4.1. The results from the watertable model are consistent with the farmer assessment of drainage condition under dry and average rainfall conditions. In a wet season, the majority of farmers perceive the field drainage condition to be drier than predicted by the watertable model. In a wet season, there is 50 % agreement between farmer and modelled assessment of drainage conditions. During wet seasons, farmers attribute much of the drainage problem to surface runoff, antecedent rainfall, flooding from the river and the clay soil type. One farmer

reported that submerged outfalls for field drainage pipes contributed to the waterlogged conditions.

These assessments of watertable position in various seasons confirm that with maintenance, drainage status in the benefit area is generally bad in wet climatic conditions and good in average and dry seasons. If maintenance were not performed, the drainage status would generally remain unchanged. Without maintenance, under average weather conditions, farmers estimate that drainage conditions would deteriorate from good to bad over 5 % and from bad to very bad over 29 % of the benefit area.

Table 4.1 Drainage status for wet, average and dry seasons, without/with maintenance

Block No		Wet Season *		Average Season *		Dry Season *		Farmer Assessment With Maintenance			Without
		Without	With	Without	With	Without	With	Wet	Average	Dry	
101	Y	G	G	G	G	G	G	*B*	G	G	G
201	Y	B	B	G	G	G	G	*G*	G	G	G
202	Y	G	G	G	G	G	G	G	G	G	G
203	Y	G	G	G	G	G	G	G	G	G	G
301	N	B	B	G	G	G	G	B	G	G	G
302	Y	G	G	G	G	G	G	G	G	G	G
401	Y	VB	VB	B	B	G	G	*B*	*G*	G	B
402	N	B	B	G	G	G	G	B	G	G	G
403	N	B	B	G	G	G	G	*G*	G	G	G
501	N	B	B	G	G	G	G	*VB*	G	G	G
601	N	G	G	G	G	G	G	G	G	G	G
701	N	VB	VB	B	B	**B**	**G**	*B*	B	G	VB
702	N	VB	VB	B	B	G	G	*B*	B	G	B
801	Y	VB	VB	G	G	G	G	*B*	G	G	B
901	Y	B	B	G	G	G	G	B	G	G	G
902	N	**VB**	**B**	B	B	G	G	B	B	G	VB
1001	N	**VB**	**B**	G	G	G	G	B	G	G	B
1101	N	VB	VB	G	G	G	G	*G*	G	G	G
1201	N	**VB**	**B**	G	G	G	G	B	G	G	G
1301	N	B	B	G	G	G	G	*G*	G	G	G

NB : *Modelled results
Y or N refers to the presence or absence of field drainage
Bold type indicates a change in drainage status as a result of maintenance
Italics indicate a difference in drainage status predicted by the model and farmer assessment

Current levels of maintenance activity prevent the deterioration of drainage status on 4 blocks of land. The percentage change of area by drainage status as a result of maintenance is estimated to be :

- in a wet season, maintenance prevents a deterioration in drainage status from B to VB on 9.9 ha (12 % of BA)
- in a dry season, maintenance prevents a deterioration from G to B on 2.2 ha (3 % of BA).

4.2 Debris Dams

The impact of maintenance on land drainage within the floodplain is negligible. This is expected as the trimming of trees and bushes which overhang the river will have minimal impact on channel friction and capacity unless debris dams form. Maintenance is carried out as a preventative measure to minimise the probability of fallen timber accumulating against bridges and thus causing localised flooding, increased water levels upstream of the debris dam, waterlogging, structural damage and risk to the general public using the road network.

4.2.1 Nature of debris dams

Debris dams are accumulations of organic matter within the river channel. Such dams form when a piece of woody material such as a tree limb falls into the channel and lodges against boulders or protrusions from the bed or bank(s). Smaller pieces of debris are caught against the original piece of debris. These provide the framework in which leaves and other debris accumulate.

4.2.2 Impact of debris dams

Unless removed, the accumulation of debris will form a dam and a barrier to flow causing the water upstream of the dam to 'back-up'. Ultimately, debris dams exert a resistance to flow and alter the roughness of the channel. Under low flows, when the water is shallow, irregularities in the dam are exposed and their effects more pronounced. The frictional drag exerted on the water is it crosses the dam reduces the flow slows water over the blockage. Water levels are thus raised upstream of the debris dam due to this 'back-up' effect. This may result in a localised increase in flooding and waterlogging as the watertable locally rises.

Under higher flows, the frictional drag of the debris dam is drowned out and the dam exerts less influence over river flow,

In addition to their impact on watertables, debris dams which partially or completely block the channel may exert control over local channel morphology. In meandering streams such as the River Yarty, the formation of debris dams may result in local erosion and scour of the bed and banks around the dam. This may serve to widen the channel thus diverting flow around the blockage. Mid-channel bars may develop immediately downstream of the blockage due to reduced flow levels and flow velocity in the lee of the dam. Stream ecology may be influenced by the dam through the creation of temporary habitats for such wildlife as otters.

4.3 Simulation of Debris Dams in the Channel

The impact of debris dams on land drainage has been determined through simulation modelling using FLUCOMP; a computational river model package produced by HR Wallingford. This model was used to predict the impact of debris dams on water level and discharge values along the study reach.

Debris dams were simulated via the imposition of fixed weirs along the channel section. Weirs are the closet approximation to debris dams available in the package. The height and breadth of the weir crest was altered to simulate varying degrees of channel restriction. The two sizes of dam simulated were 50 % and 75 % blockages of the cross-sectional area. The 50 % blockage of the cross-sectional area is deemed to be the lower limit for 'justifiable' debris removal (Bowles, 1992).

4.3.1 Physical effect of in-channel blockages

The location of the simulated debris dams are shown in Figure 5. The debris dams were located so as to be out of spatial influence of each other. The simulations showed that debris dams on the River Yarty affected river levels for a distance of approximately 300 m upstream of the dam irrespective of the season. The 50 % blockage is estimated to result in the change in drainage status over 28 ha (33 % of BA) whilst the 75 % blockages result in a change over 43 ha (51 % of the BA). The impact of debris dams on drainage status is shown in Tables 4.2 and 4.3.

Table 4.2 Impact of 50 % debris dam blockage on drainage status

Dam Location	Season	Current Drainage Status	Drainage Status with debris dam	Area affected (ha)	Land Use
1	Spring	G	B	2.8	Extensive grass
1	Summer	G	B	0.9	" "
1	Autumn	G	B	0.94	" "
2	Spring	VB	VB	0	" "
2	Summer	VB	VB	0	" "
2	Autumn	VB	VB	0	" "
3	Spring	G	B	4.5	" "
3	Summer	G	B	2.7	" "
3	Autumn	G	B	3.6	" "
4	Spring	G	B	5.4	" "
4	Summer	G	B	2.7	" "
4	Autumn	G	B	4.41	" "

Table 4.3 Impact of 75 % debris dam blockage on drainage status

Dam Location	Season	Current Drainage Status	Drainage Status with debris dam	Area affected (ha)	Land Use
1	Spring	G	B	5.85	Extensive grass
1	Summer	G	B	2.16	" "
1	Autumn	G	B	4.5	" "
2	Spring	VB	VB	0	" "
2	Summer	VB	VB	0	" "
2	Autumn	VB	VB	0	" "
3	Spring	G	B	5.4	" "
3	Summer	G	B	2.79	" "
3	Autumn	G	B	5.13	" "
4	Spring	G	B	6.3	" "
4	Summer	G	B	5.4	" "
4	Autumn	G	B	5.85	" "

5 SCHEME APPRAISAL

5.1 Benefits of Tree and Bush Maintenance

The benefits of river maintenance on the Yarty comprises two elements. Firstly, the control of tree and bush growth has a direct influence, albeit small, on the hydraulic performance of the channel. Secondly, tree and bush work reduces the probability of debris falling into the channel and creating a debris dam. When dams do arise, it is customary to remove them to limit the potential damage to the channel, adjacent land and structures downstream. The following benefit assessment examines these two elements.

5.2 Maintenance Benefits

For each block of land, agricultural production scenarios were created which reflect different levels of field management under conditions of good, bad and very bad drainage (see R&D Note 456 Section 3.5.4). These scenarios are based on discussions with farmers in the benefit area over the period 1992-1994.

Changes in field drainage status as a result of maintenance under dry, average and wet climatic conditions have been identified. Changes in flood risk due to maintenance have also been determined. Estimates have been derived of the monetary value of changes in field management and productivity associated with changes in the standards of drainage service.

Two perspectives have been used to value agricultural performance. The first perspective is that of financial analysis which uses the prices paid and received by farmers to estimate the added-value associated with drainage. Financial analysis shows the benefits of maintenance to farmers in the benefit area.

The second perspective is that of economic analysis which modifies the financial analysis to make allowance for the direct and indirect subsidies paid to farmers by Government. In accordance with the MAFF Project Appraisal Guidance Notes on Flood Defence (PAGN, 1993), these modifications involve reductions in the financial value of output (including subsidies) by 10 % in the case of cereals, oil seeds and grain legumes, 35 % for beef and 25 % for sheep. Commodities subject to quota such as potatoes, sugar beet and milk are treated as

winter wheat. The set aside areas are also treated as wheat. The reasons for these adjustments are discussed in the R&D Note 456 Section 2.7.2.

Table 5.1 shows the financial net returns (1995/96 prices) for each block of land within the benefit area under conditions of good, bad and very bad drainage. Changes in net returns relating to a change in drainage status are also shown. Table 5.2 presents similar data using economic prices. Table 5.3 shows the flood costs for each block of land assuming 'with' and 'without' maintenance and specified field drainage conditions. It is assumed that there is no difference between financial and economic values in the case of flood damage to standing crops.

Table 5.4 combines data on changes in drainage status, flood risk and financial performance to determine the financial benefits and change in financial net returns due to maintenance for wet, average and dry weather conditions for each block of land in the benefit area. These benefits are the avoidance of losses which would occur in the absence of maintenance. Benefits weighted by field size for wet, average and dry seasons are multiplied by the relative probability of the occurrence of the season to give an average expected annual benefit. These are summed for the benefit area as a whole.

Table 5.4 estimates a total expected annual benefit of £ 382 in 1995 financial prices, equivalent to about £ 4.5/ha per year. These are very modest benefits which reflect the small direct impact of tree and bush work on drainage conditions in the flood plain. Table 5.5 shows the benefits attributable to maintenance using economic prices based on the current MAFF Project Appraisal Guidance Notes. Total average expected annual benefits are about £ 334 in economic prices for the benefit area, equivalent to £ 3.9/ha. On this basis, the benefit to the national economy is 87 % of the benefits which accrue to farmers. This difference reflects the adjustments required by MAFF to remove government subsidy from the assessment of benefits. These estimates require cautious interpretation as explained in the R&D Note 456 Section 2.7.2.

Table 5.1 Financial net returns

Block	Area (ha)	Net Return (£/ha) G	B	VB	Change in Net Return (£/ha) G - B	G - VB	B - VB
101	1.10	389	341	291	49	98	49
201	2.00	511	410	339	101	172	71
202	1.30	511	410	339	101	172	71
203	1.30	515	413	346	102	169	67
301	0.50	375	334	292	41	84	43
302	2.80	375	334	292	41	84	43
401	2.40	207	170	135	37	72	35
402	5.70	177	152	108	25	69	44
403	3.50	406	353	308	54	98	45
501	2.60	401	305	265	96	136	40
601	3.30	165	134	112	31	53	22
701	2.20	446	334	292	112	155	43
702	0.90	462	399	282	63	181	118
801	15.20	208	159	115	49	93	44
901	8.60	503	415	349	88	154	66
902	7.50	503	415	349	88	154	66
1001	1.90	182	149	118	33	64	31
1101	3.90	253	208	168	46	85	39
1201	0.50	607	316	101	291	506	216
1301	17.80	151	125	99	26	52	26

Table 5.2 Economic net returns

Block	Area (ha)	Net Return (£/ha) G	B	VB	Change in Net Return (£/ha) G - B	G - VB	B - VB
101	1.10	107	84	68	23	39	16
201	2.00	126	89	68	37	58	21
202	1.30	126	89	68	37	58	21
203	1.30	130	92	74	38	56	18
301	0.50	93	77	62	16	30	15
302	2.80	93	77	62	16	30	15
401	2.40	97	70	46	27	51	24
402	5.70	45	32	17	13	28	15
403	3.50	378	305	194	73	184	111
501	2.60	79	54	42	25	37	12
601	3.30	58	37	25	22	33	11
701	2.20	110	77	62	33	48	15
702	0.90	64	47	25	17	39	22
801	15.20	75	45	18	29	57	27
901	8.60	503	415	349	88	154	66
902	7.50	503	415	349	88	154	66
1001	1.90	76	52	32	23	44	20
1101	3.90	120	94	71	26	49	22
1201	0.50	378	305	194	73	184	111
1301	17.80	62	43	26	19	36	17

Table 5.3 Flood costs

			GOOD DRAINAGE		BAD DRAINAGE		VERY BAD DRAINAGE		CHANGE IN FLOOD COSTS					
Block Number	Without maintenance FRP	With maintenance FRP	Without maintenance flood cost	With maintenance flood cost	Without maintenance flood cost	With maintenance flood cost	Without maintenance flood cost	With maintenance flood cost	GOOD Without -with	BAD Without -with	VERY BAD Without -with	GOOD TO BAD Without -with	BAD TO VERY BAD Without -with	GOOD TO VERY BAD Without -with
101	0.30	3.00	15.43	1.54	14.22	1.42	12.91	1.29	13.89	12.80	11.62	12.68	11.49	11.37
201	1.00	3.00	6.08	2.03	5.17	1.72	4.47	1.49	4.05	3.45	2.98	3.14	2.75	2.44
202	1.00	3.00	1.90	0.63	1.62	0.54	1.40	0.47	1.27	1.08	0.93	0.99	0.86	0.77
203	0.50	3.00	11.71	1.95	9.95	1.66	8.60	1.43	9.76	8.29	7.17	8.00	6.94	6.65
301	1.00	3.00	5.79	1.93	5.34	1.78	4.83	1.61	3.86	3.56	3.22	3.41	3.05	2.90
501	0.50	1.00	10.60	5.30	8.53	4.27	7.75	3.88	5.30	4.27	3.88	3.23	3.49	2.45
601	0.50	1.00	1.04	0.52	0.95	0.48	0.85	0.43	0.52	0.48	0.43	0.43	0.38	0.33
801	0.30	3.50	2.70	0.23	2.70	0.23	1.99	0.17	2.47	2.47	1.82	2.47	1.76	1.76
901	0.30	3.00	6.25	0.63	5.55	0.56	4.93	0.49	5.63	5.00	4.44	4.93	4.38	4.31
1001	0.50	2.00	1.25	0.31	1.14	0.29	1.02	0.26	0.94	0.86	0.77	0.83	0.74	0.71
1201	0.50	2.00	41.88	10.47	33.16	8.29	23.40	5.85	31.41	24.87	17.55	22.69	15.11	12.93
1301	0.50	1.00	1.76	0.88	1.62	0.81	1.46	0.73	0.88	0.81	0.73	0.74	0.65	0.58

Table 5.4 Changes in net returns due to maintenance and climate, 1995/96 financial prices

Block	Area (ha)	Wet Season			Average Season			Dry Season			Total Change (£/yr)
		Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	
101	1.10	0	14	14	0	14	14	0	14	14	15
201	2.00	0	3	3	0	4	4	0	4	4	8
202	1.30	0	1	1	0	1	1	0	1	1	2
203	1.30	0	10	10	0	10	10	0	10	10	13
301	0.50	0	4	4	0	4	4	0	4	4	2
302	2.80	0	0	0	0	0	0	0	0	0	0
401	2.40	0	0	0	0	0	0	0	0	0	0
402	5.7	0	0	0	0	0	0	0	0	0	0
403	3.50	0	0	0	0	0	0	0	0	0	0
501	2.6	0	4.27	4	0	5.3	5	0	5.3	5	13
601	3.3	0	0.52	1	0	0.52	1	0	0.52	1	2
701	2.2	0	0	0	0	0	0	111.99	0	112	40
702	0.9	0	0	0	0	0	0	0	0	0	0
801	15.2	0	1.82	2	0	2.47	2	0	2.47	2	35
901	8.6	0	5	5	0	5.63	6	0	5.63	6	47
902	7.5	65.91	0	66	0	0	0	0	0	0	131
1001	1.9	30.91	0.74	32	0	0.94	1	0	0.94	1	17
1101	3.9	0	0	0	0	0	0	0	0	0	0
1201	0.5	215.65	15.11	231	0	31.41	31	0	31.41	31	42
1301	17.8	0	0.81	1	0	0.88	1	0	0.88	1	15
Total	85										382

Probability of :-			Benefit (£/ha)
	Wet season	0.265	
	Average season	0.572	
	Dry season	0.163	

Table 5.5 Changes in net returns due to maintenance and climate, 1995/96 economic prices

Block	Area (ha)	Wet Season			Average Season			Dry Season			Total Change (£/yr)
		Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	
101	1.10	0	14	14	0	14	14	0	14	14	15
201	2.00	0	3	3	0	4	4	0	4	4	8
202	1.30	0	1	1	0	1	1	0	1	1	2
203	1.30	0	10	10	0	10	10	0	10	10	13
301	0.50	0	4	4	0	4	4	0	4	4	2
302	2.80	0	0	0	0	0	0	0	0	0	0
401	2.40	0	0	0	0	0	0	0	0	0	0
402	5.7	0	0	0	0	0	0	0	0	0	0
403	3.50	0	0	0	0	0	0	0	0	0	0
501	2.6	0	4.27	4	0	5.3	5	0	5.3	5	13
601	3.3	0	0.52	1	0	0.52	1	0	0.52	1	2
701	2.2	0	0	0	0	0	0	32.86	0	33	12
702	0.9	0	0	0	0	0	0	0	0	0	0
801	15.2	0	1.82	2	0	2.47	2	0	2.47	2	35
901	8.6	0	5	5	0	5.63	6	0	5.63	6	47
902	7.5	65.91	0	66	0	0	0	0	0	0	131
1001	1.9	20.46	0.74	21	0	0.94	1	0	0.94	1	12
1101	3.9	0	0	0	0	0	0	0	0	0	0
1201	0.5	111.1	15.11	126	0	31.41	31	0	31.41	31	28
1301	17.8	0	0.81	1	0	0.88	1	0	0.88	1	15
Total	85										334
Probability of :-		Wet season		0.265						Benefit (£/ha)	**3.93**
		Average season		0.572							
		Dry season		0.163							

As an alternative estimate to that based on watertable modelling, Table 5.6 estimates the benefits due to maintenance which were perceived by farmers (earlier reported in Table 4.1) where they identified a change in drainage conditions between the 'with' and 'without' maintenance situations in an average, representative season. These estimates include the flood damage costs identified in Table 5.3 which were based on a combination of farmer and modelled data.

Farmer assessment gave an average annual financial benefit of £ 1631 (£ 19/ha) and an economic benefit of £ 1252 (£ 15/ha).

Table 5.6 Farmer asessment of maintenance benefits

Block	Area (ha)	Average Season Financial Prices			Average Season Economic Prices		
		Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance
101	1.10	0	14	15	0	14	15
201	2.00	0	3	7	0	4	8
202	1.30	0	1	2	0	1	2
203	1.30	0	10	13	0	10	13
301	0.50	0	4	2	0	4	2
302	2.80	0	0	0	0	0	0
401	2.40	37	0	89	27	0	65
402	5.7	0	0	0	0	0	0
403	3.50	0	0	0	0	0	0
501	2.6	0	4.27	11	0	5.3	14
601	3.3	0	0.52	2	0	0.52	2
701	2.2	43	0	95	15	0	33
702	0.9	0	0	0	0	0	0
801	15.2	49	1.82	772	29	2.47	478
901	8.6	0	5	43	0	5.63	48
902	7.5	66	0	495	66	0	495
1001	1.9	33	0.74	64	23	0.94	45
1101	3.9	0	0	0	0	0	0
1201	0.5	0	15.11	8	0	31.41	16
1301	17.8	0	0.81	14	0	0.88	16
Total	85	Total financial benefit (£)		1631	Total economic benefit (£)		1252
		Benefit (£/ha)		19	Benefit (£/ha)		15

5.3 Debris Dams

Tree and bush work is partly justified as a means of avoiding the accumulation of debris in the channel with consequences for retained water levels and increased flood risk. The work is accompanied by debris removal as and when required. The influence of debris dams on land drainage was determined by simulation as previously described. The analysis showed that debris dams have greatest influence on land drainage conditions during spring. For this reason

spring has been used to assess the likely impacts of debris dams which form and are not removed.

Table 5.7 shows the reductions in financial and economic returns due to a reduction in field drainage conditions associated with debris dams. It is assumed that dams are formed at equi-distant points along the reach, such that all the channel is affected in some way, but the dams are independent in their effect. The annual financial cost of a single dam at location 3 for instance is £ 401 in the case of a 50 % blockage and £ 481 for a 75 % blockage. If the whole channel was affected in some way by debris the annual financial costs would range between about £ 2576 and £ 3331 depending on the degree of blockage. Economic prices gives annual costs of £ 821 and £ 1060. The dams are also likely to result in an increase in flood incidence on land already subject to flooding, rather than significant increases in the aerial extent of flooding. Very high flows tend to move over, around, or sweep away debris material. Preliminary assessment suggests that flood costs will double from those identified in Table 5.3 above, equivalent to an additional £ 170/year. On this very rough assessment, a channel blocked with (75 %) debris dams would result in financial losses of about £ 3300 + £ 170 per year, about £ 41/ha, and economic losses of about £ 1060 + £ 170 per year (£14/ha).

These estimates indicate the order of benefits which could be attributable to a combined tree and bush and debris removal programme. The estimate excludes the benefits of avoiding damage to structures such as bridges and to the channel itself due to debris accumulating in or travelling down the channel.

5.3.1 Financial and economic impact of debris dams

Through simulation, the influence of debris dams on land drainage has been determined. Table 5.8 shows the change in financial net returns associated with the change in drainage status resulting from 50 % and 75 % blockage of the channel cross-sectional area.

Table 5.7 Net return with 50 % and 75 % blockage

Dam Site	Area Affected (ha) 50 % Blockage	75 % Blockage	Drainage Status	Current Net Return (£/ha) F	E	Drainage Status With Dam	Net Return With Dam (£/ha) F	E	Total Change (£/yr) 50 % Blockage F	E	Total Change (£/yr) 75 % Blockage F	E
1	2.80	5.85	G	578	124	B	457	86	339	106	708	222
2	0	0	No Change									
3	4.50	5.40	G	613	125	B	524	90	401	159	481	189
4	5.40	6.30	G	815	453	B	475	350	1836	556	2142	649
								Total	**2576**	**821**	**3331**	**1060**

NB: F = financial prices, E = economic prices
Areas of influence based on spring conditions
Dams are assumed to be beyond the influence of each other, but collectively influencing levels throughout the reach

5.4 Maintenance Costs

Maintenance activities on the River Yarty involve the clearance and removal of overhanging trees and bushes, together with those which are at risk of falling into the channel. This work is carried out on a rolling programme with a return period of about 8 years. According to NRA records the cost for the 2 km reach was £ 1590 in 1995 prices. This is equivalent to an annual cost of £ 297 per year when spread over 8 years at 6 % rate of interest. In addition, the removal of debris dam material is carried out when deemed appropriate. Records of actual expenditure on debris removal are not available for the study reach, although average regional costs (based on the Severn Trent Region) are about £ 1500/km/year, equivalent to £ 3000 /year for the 2 km reach.

5.5 Scheme Appraisal

The estimated annual benefits attributable to maintenance can be compared with estimated equivalent annual costs spread over the relevant maintenance interval to determine the justification for expenditure. Table 5.8 shows that the tree and bush work carried out on an 8 year cycle is viable in both financial and economic terms. Benefits exceed costs. Table 5.8 also shows that it is worth spending up to £ 3600 along the reach per year on all tree and bush related activities, including the removal of debris from the channel. This assumes that blockages would become a permanent feature of the channel if no works were carried out. The possible damage to structures is excluded from the assessment.

Table 5.8 Maintenance scheme appraisal: River Yarty

Average Annual Benefit (£)	Average Annual Benefits (£)	Average Annual Costs (£)	Benefit: Cost Ratio
Modelled Estimates			
Tree and Bush Work Only			
Financial Prices	384	297	1.29
Economic Prices	334	297	1.12
Tree and Bush and Debris Removal (75% blockages)			
Financial Prices	3330	3000	1.10
Economic Prices	1000	3000	0.33
Farmer Estimates (Tree and Bush Work Only)			
Financial Prices	1631	297	5.49
Economic Prices	1252	297	4.22

The farmer based estimate shows that, based on benefits in an average weather year, the maintenance scheme is viable. The scheme generates an annual benefit : cost ratio of 5.49 and 4.22 in financial and economic terms respectively.

This analysis requires cautious interpretation. There is little evidence to confidently explain the link between tree and bush work and the probability of debris dams forming in the channel. Furthermore the behaviour and impact of dams change according to flows. A major justification for dam removal is to avoid the risk of flood borne debris causing damage or serious blockage at sensitive points elsewhere in the drainage system. The maintenance scheme is marginal in financial and economic terms. This implies that it is not justified. The maintenance is actually performed on an 'ad hoc' basis, providing work if there is spare capacity amongst the labour gangs.

This conclusion must be interpreted cautiously as discussed in the R&D Note 456 Section 2.7.2.

6 ENVIRONMENT

6.1 Introduction

The environmental quality of the River Yarty is outlined in this chapter. Reference is made to river corridor surveys, public consultation and farmer assessment.

6.2 River Corridor Survey

Prior to the river maintenance works in 1992, a river corridor survey was completed (Appendix II) for the selected reach following the survey methodology developed by the Nature Conservancy Council (NCC, now English Nature, EN). Sketch maps and record cards have been produced for each 500 m section. The survey concentrated on the river corridor and adjacent land. Details concerning such features as channel dimensions, bed substrate, presence of structures, field drainage and bank vegetation were collected.

As river maintenance did not alter the channel characteristics, a complete post-maintenance corridor survey was not necessary. The post-maintenance survey took the form of a vegetational survey which concentrated on the banks and the areas on which tree and bush maintenance has been carried out (Appendix II). To date, two kilometres of the study reach have been subject to tree and bush maintenance.

6.3 Public Consultation

In the spring of each year a 'Conservation liaison Meeting' is held by the NRA to discuss the work programme for river maintenance in the following year. Representatives from various organisations such as the Countryside Commission (CC) and English Nature (EN) are invited to attend. Objections to the proposed work can be raised and if necessary modifications to the work programme made.

6.4 Farmer Assessment

Farmers interviewed within the benefit area were asked to identify any environmental features along the reach which they thought were likely to be disturbed or destroyed by the maintenance work.

All the farmers were aware of wildlife within the river corridor and mentioned kingfishers, herons as being particularly noticeable. The river is good for fishing - trout (brown and sea) and salmon frequent the river and spawn in shallow areas. The majority of those interviewed thought that the maintenance had a beneficial impact on the environment and encouraged tree regeneration.

6.5 Channel and Bank Quality

The environmental quality of the River Yarty has been determined by following the procedure outlined in the 'Guidelines for the Justification of River Maintenance' (R&D Note 511) produced within the framework of the NRA R&D Note 456 (River Maintenance Evaluation).

The quality of the river channel is classed as medium. There is a well developed pool and riffle sequence within the study reach and numerous minor habitats are created by tree roots and overhanging branches. The overall channel structure has developed and altered naturally over time and has been modified in only a few isolated areas by man.

The banks are of simple structure, consisting of predominantly three vegetation types including trees and bushes. Bank width is typically in the region of 5 - 10 m. The bank quality is classed as high. At times of low flow there is a well developed transitional zone between the river and channel edge and sediments are exposed. The structure of the bank vegetation is varied consisting of trees, bushes, scrub areas and grassland; some of which is grazed sheep and or cattle. Tree roots stabilise some banks and provide bank and underwater habitats. Earth cliffs provide ideal habitats for sand martins and kingfishers.

7 CONCLUSIONS

7.1 Scheme Appraisal

The existing maintenance scheme of tree and bush clearance every 8 to 10 years is viable in financial and economic terms. The average annual economic benefit of maintenance in terms of its prevention in a deterioration in drainage status and increase in flooding is £ 334. Average annual maintenance costs are £ 297. The benefit : cost ratio is therefore 1.12.

Debris removal is justifiable in financial terms but not in economic prices. The benefit : cost ratios are 1.10 and 0.33 respectively.

7.2 Maintenance Best Practice

The 'best practice' vegetation maintenance methods for the River Yarty were determined using the procedures outlined in the Guidelines (R&D Note 511), produced as a result of the Environmental Impact Assessment Study.

Channel

Best practice maintenance operations for emergent weed are identified as :

- Biennial cutting;
- Cutting on a 3 to 5 year rotation; and,
- Desilting / raking at an interval of 2 to 7 years.

Best practice maintenance operations for floating and submerged weed are identified as :

- Annual cutting in the autumn;
- Biennial cutting; and,
- Cutting on a 3 to 5 year rotation.

All these maintenance operations should be selective, concentrating on those areas which are particularly choked by vegetation or areas in which the weed is liable to cause an obstruction, hazard or restriction to flow.

Since the beginning of this study, tree and bush maintenance and construction of bank revetments are the only maintenance operations to have been performed on the River Yarty

within the study reach. To date, the tree and bush work has been confined to the first two kilometres of the study reach. Little aquatic vegetation grows within the channel due to the mobile nature of the gravel substrate restricting root development and due to shading of the channel. Selective desilting of gravel shoals every seven years may be sufficient to enable the channel to provide the required standard of service. The maintenance regimes recommended as best practice in environmental terms for vegetation management are thus not applicable to this channel whilst the incidence of weed growth remains low.

Bank

Best practice maintenance operations for bank vegetation are identified as :

- Single bank mowing / flailing in spring / summer leaving a 1 m wide toe strip;
- Single bank mowing / flailing in autumn / winter leaving a toe strip > 0.25 m wide;
- Mowing / flailing every 3 - 5 years leaving a toe strip over 1 m wide or selective cutting (< 20 %); and,
- Light grazing.

Since the start of the study, the only bank maintenance performed has been some revetment work to protect an eroding bank near a bridge. The majority of the banks are grazed lightly by sheep and or beef and are not mown.

This is in accordance with the bank maintenance regime recommended as best practice in environmental terms.

7.3 Recommendations

It is recommended that further research examines in detail:-

- the impact of debris dams on flooding within the benefit area.

7.4 Epilogue

This report has assessed the impacts of the current maintenance regime on the study reach. It has been used along with other study sites to formulate guidelines on the appraisal of maintenance works and best environmental practice. These draft guidelines are summarised in Chapter 5 of the R&D Note 456 and presented in full under separate covers.

8. REFERENCES

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Map: Ordnance Survey Landranger 193. Taunton and Lyme Regis. 1: 50 000. Ordnance Survey, Southampton.

Map: Agricultural Land Classification, Sheet 177 (1974). MAFF.

APPENDIX I

Example of input and output data for the watertable model

River Yarty
Block Number 1001
Cross-section 5

	Input Data	Output Data
	River height (m AOD)	Watertable height (m AOD)
Week 1993		
1	43.40	44.43
2	43.40	44.63
3	43.40	44.60
4	43.40	44.53
5	43.40	44.44
6	43.40	44.35
7	43.40	44.25
8	43.40	44.22
9	43.39	44.14
10	43.39	44.05
11	43.40	43.98
12	43.40	43.94
13	43.86	44.15
14	43.86	44.46
15	43.41	44.47
16	43.41	44.38
17	43.38	44.27
18	43.38	44.07
19	43.36	44.01
20	43.36	44.07
21	43.76	44.14
22	43.76	44.23
23	43.42	44.12
24	43.42	44.26
25	43.40	44.05
26	43.40	43.85
27	43.40	43.69
28	43.40	43.88
29	43.51	43.82

Example of drainage status classification, River Yarty

With maintenance

Block 1001		No. of weeks		No. of
	Watertable depth (m)	1993	Spring 1993	weeks
>0.5	44.13	38	44.13	13
0.3><0.5m	44.33	6	44.33	0
<0.3m	44.63	8	44.63	0

Drainage status classification, according to time watertable is within the G, B, VB drainage bands — Good

Without maintenance

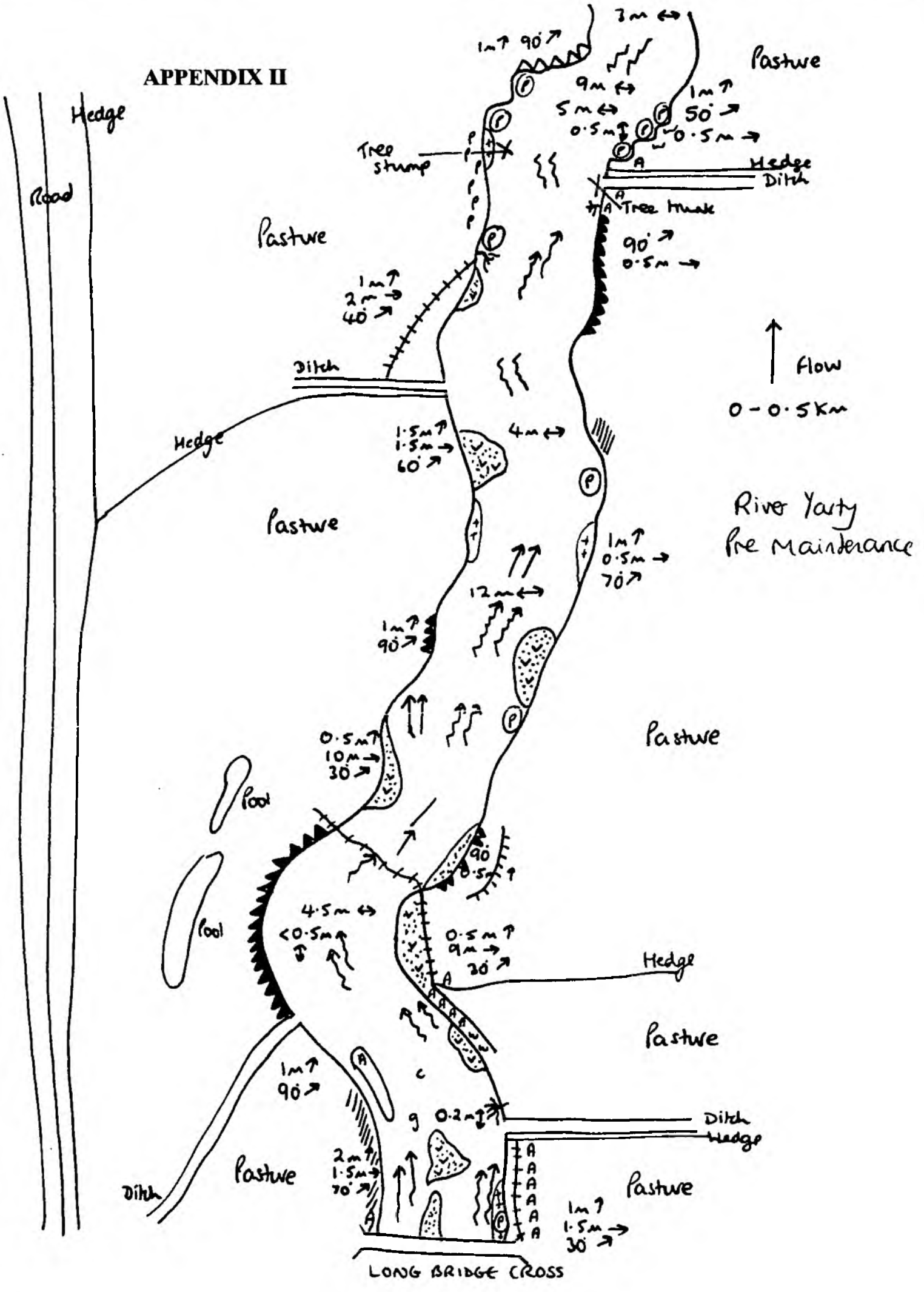
		No. of weeks		No. of
	Watertable depth (m)	1993	Spring 1993	weeks
>0.5	44.13	21	44.13	6
0.3><0.5m	44.33	9	44.33	4
<0.3m	44.63	22	44.63	3

Drainage status classification, according to time watertable is within the G, B, VB drainage bands — Bad

Summer 1993	No. of weeks	Autumn 1993	No. of weeks
44.13	13	44.13	7
44.33	0	44.33	3
44.63	0	44.63	3
	Good		Bad

Summer 1993	No. of weeks	Autumn 1993	No. of weeks
44.13	11	44.13	4
44.33	2	44.33	1
44.63	0	44.63	8
	Good		Very Bad

APPENDIX II


Hedge
Road
Tree stump
Pasture
Ditch
Hedge
Pasture
Pool
Pool
Pasture
Hedge
Pasture
Ditch
Pasture
Ditch
Hedge
Pasture
LONG BRIDGE CROSS
Hedge
Ditch
Tree trunk
Pasture
Flow
0 - 0·5 Km
River Yarty
Pre Maintenance

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER RIVER YARTY

Km No. 0 - 0.5 km

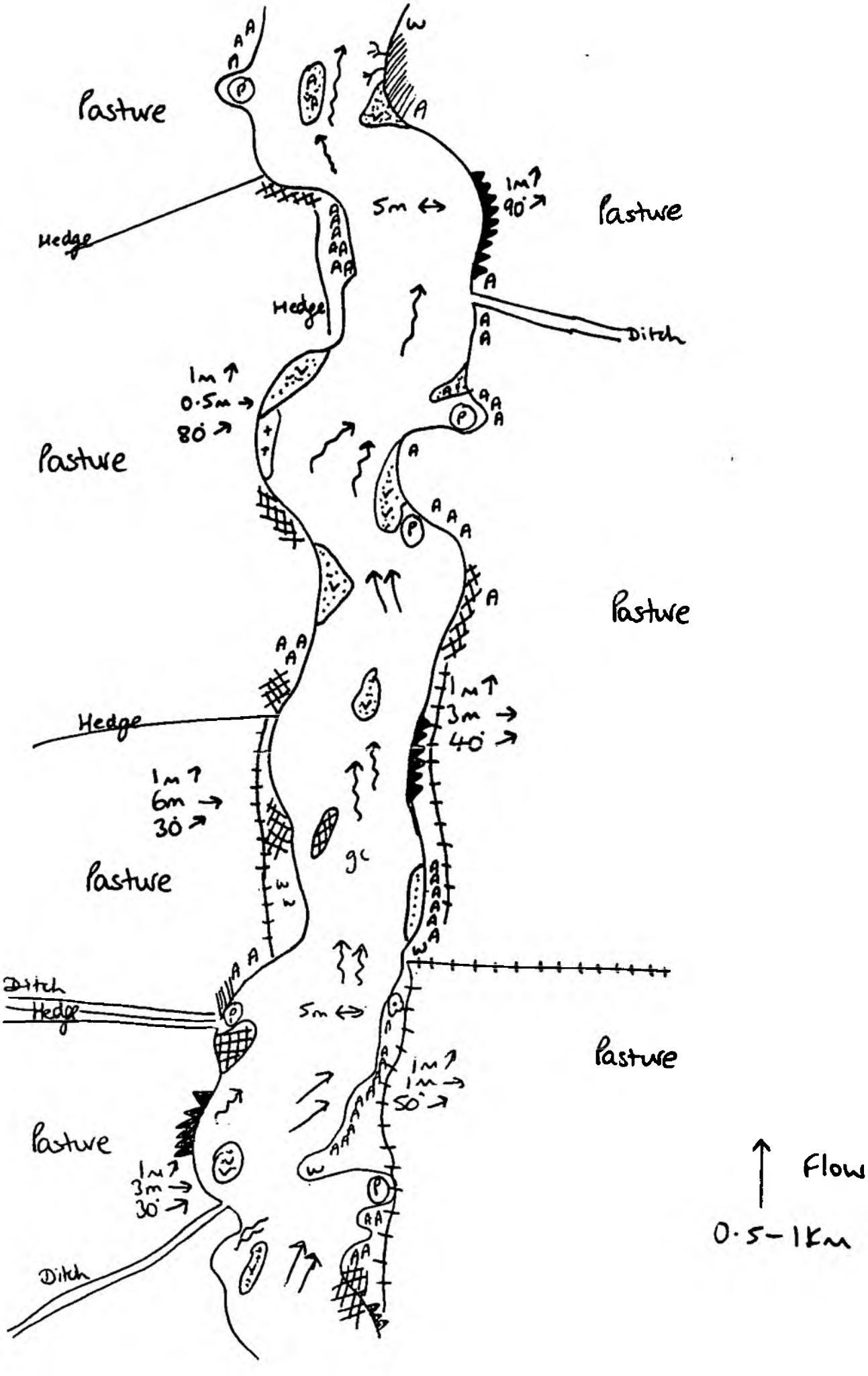
Date 9/4/92

Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj. land in each stretch)		
canal =	2	2
ditch		
dyke		
pond, pool, cut-off %	3	
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	3
hedge =		
fence on bank		
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road	10	
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑	8	7
soft earth cliff >80°	4	
rock cliff		
artificial		
FB flood bank ach		
FB flood bank set back		
levee		
Height <1m	10	20
1-<2m	90	80
>2m		
Width <1m		
1-<2.5m	90	70
2.5-<5m		10
>5m	10	10
Slope <30°		
30-<60°	60	80
60-<90°	40	50
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard	6	
W Willow old, not pollard		4
S Standard willows		
Alder	1	14
Other trees		
Young trees		
Thick Scrub/shrubs %	8	2
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots	1	2
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg	2	
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	15
.25-<.5		85
0.5-<1.0		
>1.0m		
Width <1		
1-<5		80
5-<10		15
10-<20		5
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		50
p pebbles		50
g gravel		
s sand		
si silt/mud		
cl clay		
peat		
Habitats and Flow		
pool		1
slack		64
riffle		10
rapids		5
run		20
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		10
mud		3
sss sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget. area		0-5
B bryophytes		
E emergents		
A submerged	100	
P floating algae % of stretch		total to 100%


Pasture
Hedge
Hedge
Pasture
Hedge
Pasture
Ditch
Hedge
Pasture
Ditch
5m ↔
1m ↑
90° ↗
Pasture
1m ↑
0.5m →
80° ↗
1m ↑
3m →
40° ↗
1m ↑
6m →
30° ↗
gc
5m ↔
1m ↑
1m →
50° ↗
1m ↑
3m →
30° ↗
Flow
0.5–1km

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

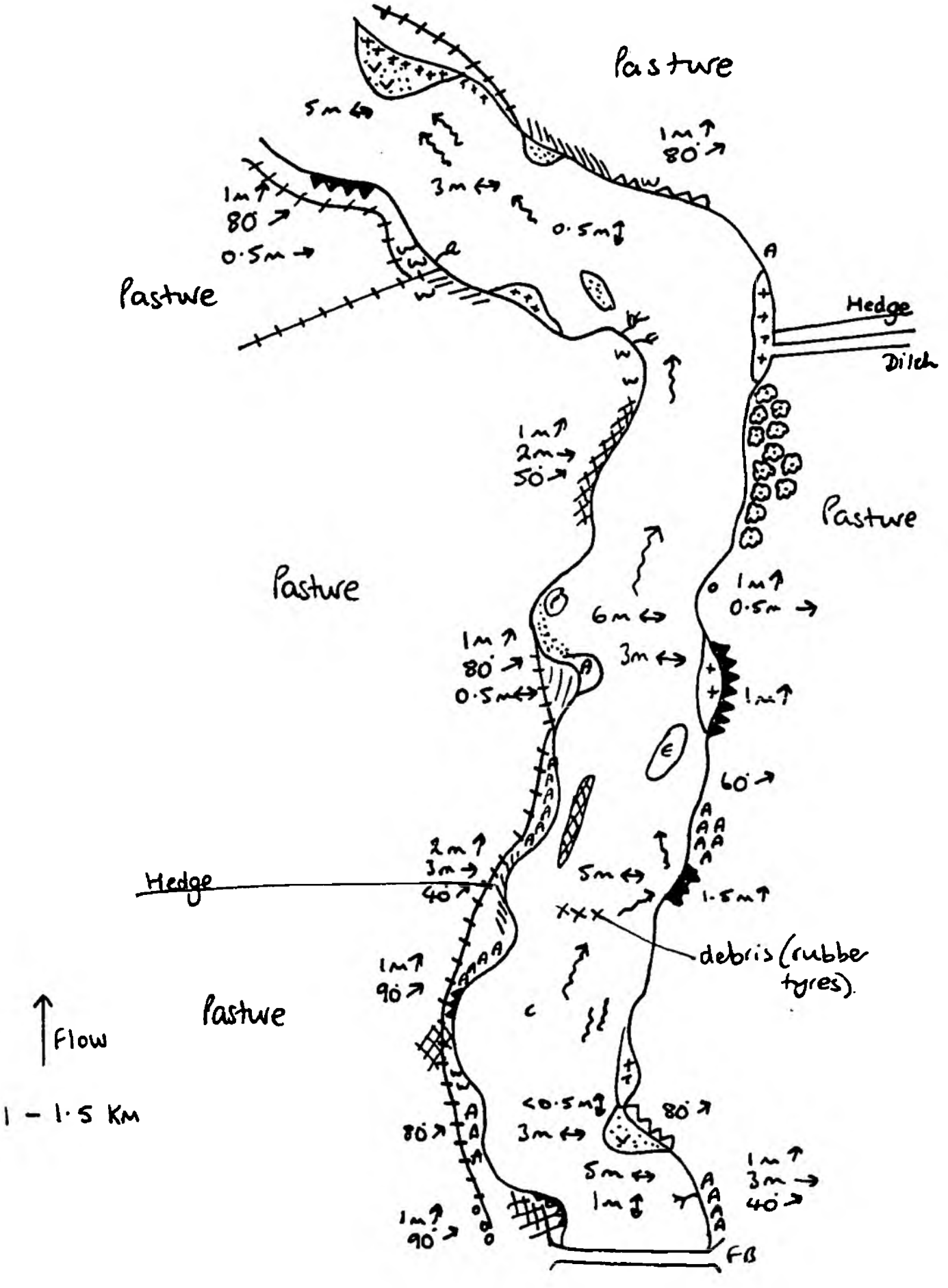
River RIVER YARTY
Km No. 0·5 – 1 KM
Date 9/4/92
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj land in each stretch)		
canal =		
ditch	2	1
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1·5m		
5·10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	3	
hedge =		
fence on bank	11	40
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑	2	8
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1·<2m	100	100
>2m		
Width <1m	50	10
1·<2.5m		20
2.5·<5m	40	30
>5m	10	
Slope <30°		
30·<60°	50	70
60·<90°	50	30
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		1
P Willow recent pollard		
W Willow old, not pollard	2	3
S Standard willows		
A Alder	15	31
Other trees		
Young trees		
Thick Scrub/shrubs %	2	8
Sparse Scrub/shrubs %		
Reed/Sedge %	8	8
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		2
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg	3	
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	
.25·<.5		100
0·5·<1.0		
>1.0m		
Width <1		
1·<5		100
5·<10		
10·<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		50
p pebbles		50
g gravel		
s sand		
si silt/mud		
cl clay		
peat		
Habitats and Flow		
pool		2
slack		38
ripple		
rapids		10
run		50
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		100
emergent 1·2m wide		
emergent >2m wide		
total veget. area		2
B bryophytes		
E emergents	100	
A submerged		
F floating		
algae % of stretch		

total = 100%


Pasture
5m
1m
80°
3m
0.5m
1m
80°
0.5m
Pasture
Hedge
Ditch
1m
2m
50°
Pasture
Pasture
6m
3m
1m
80°
0.5m
1m
0.5m
1m
60°
2m
3m
40°
Hedge
5m
1.5m
debris (rubber tyres)
1m
90°
Pasture
Flow
1 - 1.5 Km
<0.5m
3m
80°
80°
5m
1m
1m
3m
40°
1m
90°
FB

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

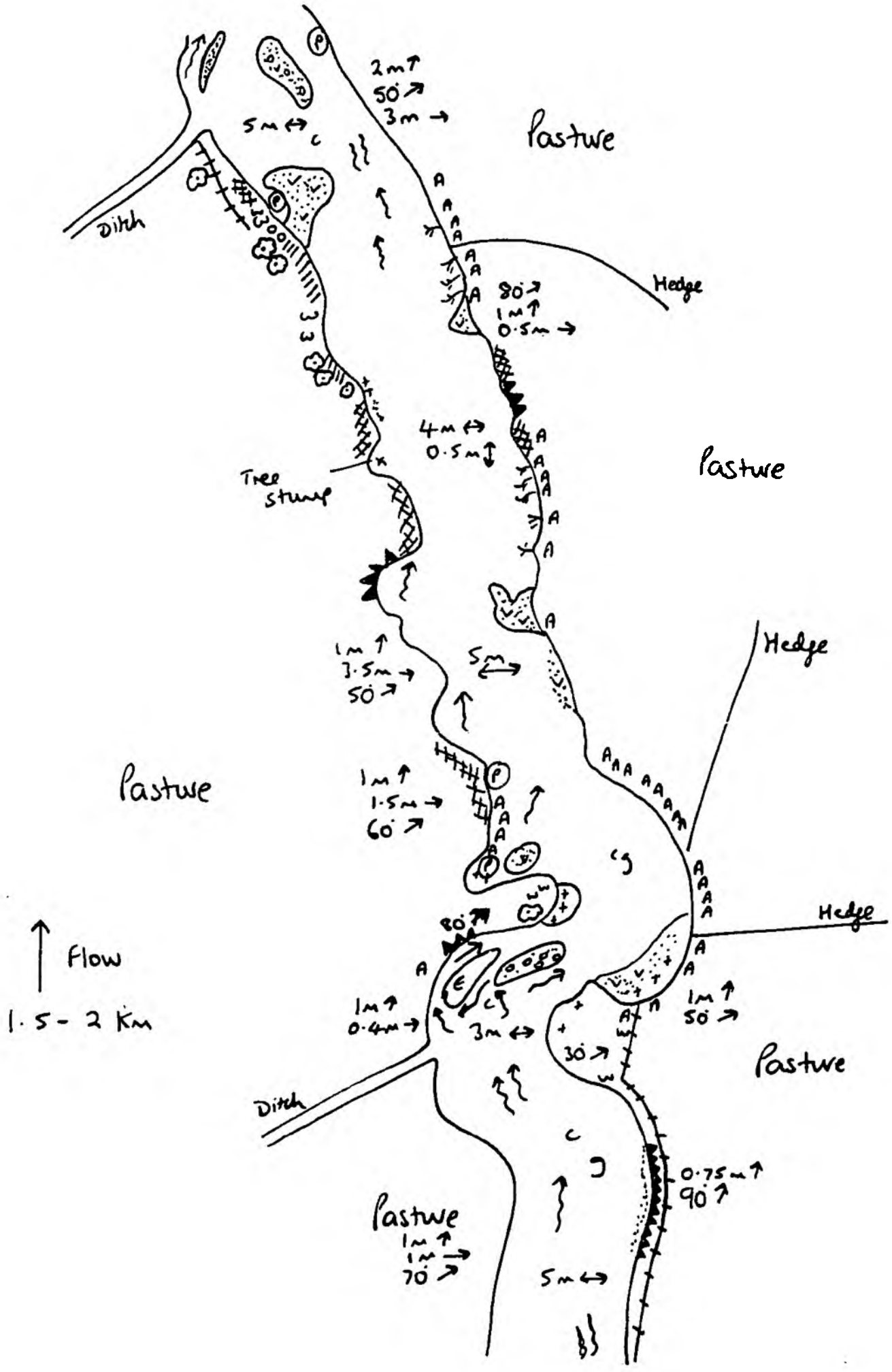
River RIVER YARTY
Km No. 1-1.5 km
Date 9/4/92
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing – canal + % of adj. land in each stretch		
canal =		1
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	1
hedge =		
fence on bank	65	6
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑	6	99
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m	80	70
1-<2.5m	20	30
2.5-<5m		
>5m		
Slope: <30°	20	50
30-<60°	80	50
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		12
P Willow recent pollard	7	
W Willow old, not pollard		1
S Standard willows		
A Alder	13	11
Other trees		
Young trees	3	1
Thick Scrub/shrubs %.		5
Sparse Scrub/shrubs %.	8	
Reed/Sedge %.	12	
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots	3	1
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		
locks/500m	1	
inlet/500m		
Depth <.25m %		
.25-<.5		60
0.5-<1.0		40
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		50
p pebbles		50
g gravel		
s sand		
si silt/mud		
clay		
peat		
Habitats and Flow		
pool		1
slack		29
riffle		10
rapids		
run		60
waterfall		
protruding rocks		
Margins		
shingle ± bare		3
shingle, vegetated		6
mud		2
sand		
FLORA %		
emergent veg < 1m wide		100
emergent 1-2m wide		
emergent >2m wide		
total veget. area		1
B bryophytes		
E emergents	90	
A submerged	10	
F floating		
algae % of stretch		

total to 100%


Pasture
Hedge
Ditch
Tree stump
Pasture
Hedge
Pasture
Hedge
Pasture
Ditch
Pasture
Flow
1.5 - 2 Km

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat.		
plantation		
Coniferous semi-nat.		
plantation		
Mixed semi-natural		
plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

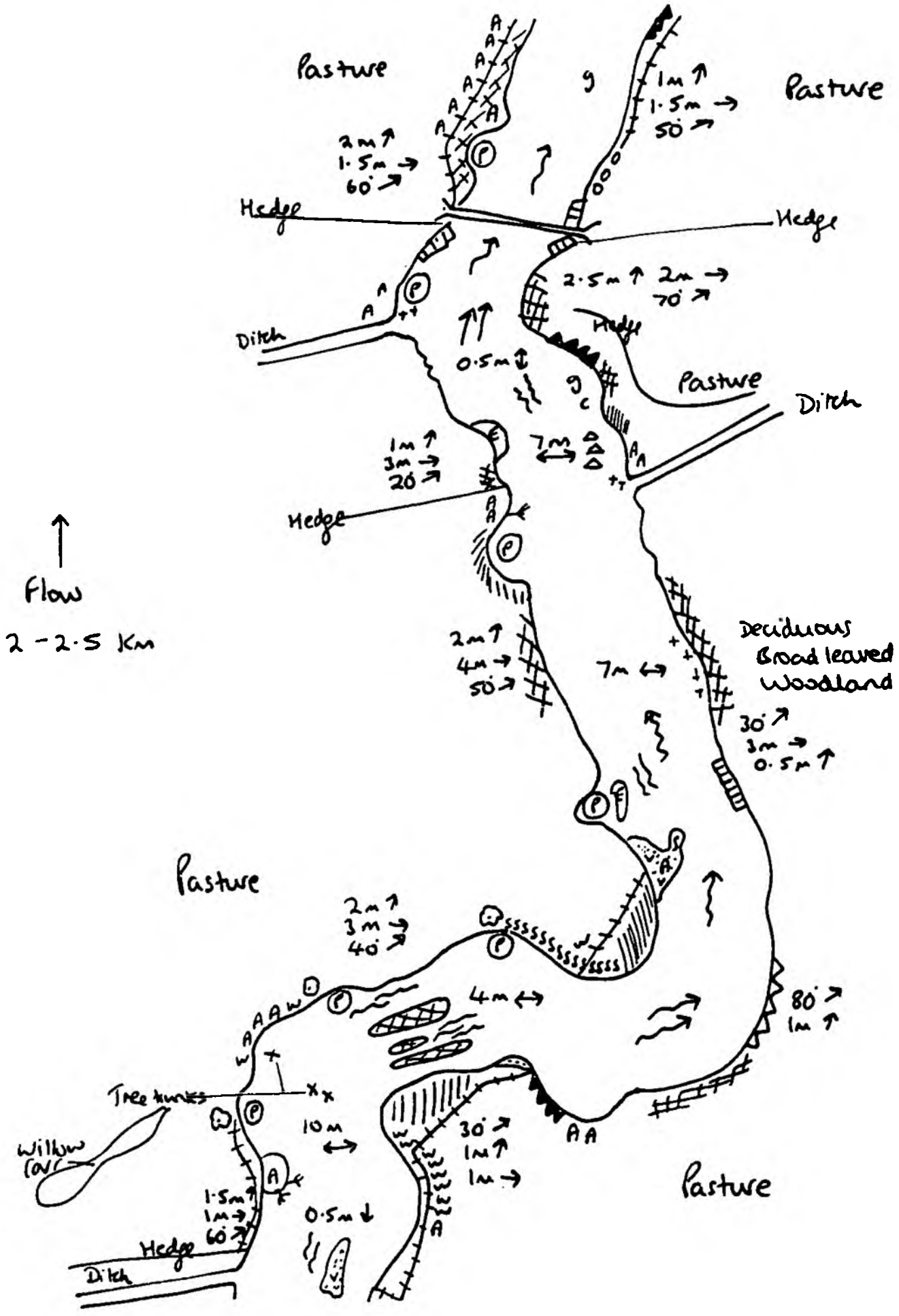
RIVER RIVER YARTY
Km No. 1·5–2 km
Date 9/4/92
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing – canal + % of adj. land in each stretch		
canal =	2	
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1–5m		
5–10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		3
hedge =		
fence on bank	5	
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1M↑	5	8
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1–<2m	100	100
>2m		
Width <1m	20	90
1–<2.5m	30	
2.5–<5m	50	10
>5m		
Slope <30°	80	70
30–<60°	20	30
60–<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore	6	
Willow recent pollard		
Willow old, not pollard	6	2
Standard willows		
Alder	5	30
Other trees	1	
Young trees	2	
Thick Scrub/shrubs %.	6	
Sparse Scrub/shrubs %.		
Reed/Sedge %.	15	4
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots	9	
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		90
.25–<.5		10
0.5–<1.0		
>1.0m		
Width <1		100
1–<5		
5–<10		
10–<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		50
g gravel		50
s sand		
si silt/mud		
cl clay		
peat		
Habitats and Flow		
pool		1
slack		13
riffle		15
rapids		1–20
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		3
mud		1
sss sand		
FLORA %		
emergent veg < 1m wide		100
emergent 1–2m wide		
emergent >2m wide		
total veget. area		0–5
B bryophytes		
E emergents	100	
A submerged		
F floating		
algae % of stretch		

total to 100%


Pasture
Pasture
Hedge
Hedge
Ditch
Pasture
Ditch
Hedge
Flow
2 - 2.5 km
Deciduous Broad leaved Woodland
Pasture
Pasture
Tree trunks
Willow (W)
Hedge
Ditch

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		35
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder	10	
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	90	65
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich vegel.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER RIVER YARTY

Km No. 2 - 2·5 KM

Date 10/4/92

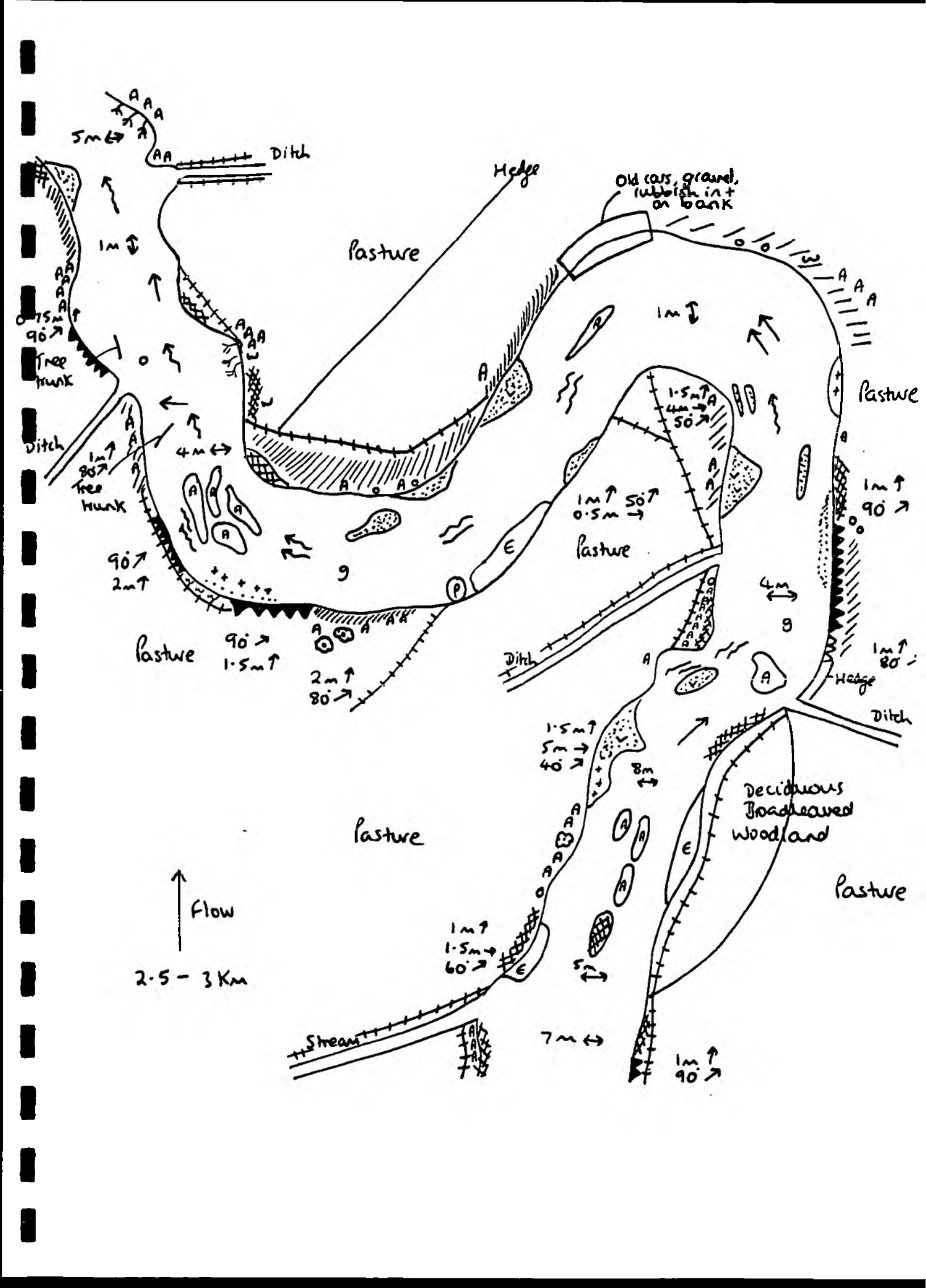
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		
canal =		
ditch	2	1
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream <1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	3	2
hedge =		
fence on bank	15	20
fence set back		
wall		
banking		
caravans		
feld farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		8
solid earth cliff 1m↑		4
soft earth cliff >80°		
rock cliff		
artificial	1	1
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		30
1 <2m	100	60
>2m		10
Width <1m		
1-<2.5m	40	90
2.5-<5m	60	10
>5m		
Slope: <30°	20	
30 <60°	80	75
60 <90°		25
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore	3	
P Willow recent pollard		8
W Willow old, not pollard	3	
S Standard willows	15	
Alder	6	5
Other trees		
Young trees		3
Thick Scrub/shrubs %	10	6
Sparse Scrub/shrubs %		1
Reed/Sedge %	10	25
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots	3	
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		
.25-<.5		100
0.5-<1.0		
>1.0m		
Width <1		
1-<5		10
5-<10		90
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		50
g gravel		50
s sand		
si silt/mud		
cl clay		
peat		
Habitats and Flow		
pool		2
slack		57
rillle		3
rapids		2
run		35
waterfall		
protruding rocks		1
Margins		
shingle ± bare		
shingle, vegetated		
mud		1
sand		
FLORA %		
emergent veg <1m wide		100
emergent 1-2m wide		
emergent >2m wide		
total veget area		2
B bryophytes		
E emergents	90	
A submerged	10	
F floating		
algae % of stretch		

(total to 100%)


Ditch
Hedge
Old cars, gravel, rubbish in + on bank
Pasture
Pasture
Pasture
Pasture
Pasture
Pasture
Ditch
Ditch
Ditch
Hedge
Deciduous Broadleaved Woodland
Stream
Flow
2·5 – 3 Km
5m
1m
0·75m 90°
Tree trunk
4m
1m 80°
Tree trunk
90° 2m
90° 1·5m
2m 80°
1m 50°
0·5m
1·5m 4m 50°
4m
1m 90°
1m 80°
1·5m 5m 40°
8m
1m 1·5m 60°
5
7m
1m 90°

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		10
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	90
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marshy/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER RIVER YARTY

Km No. 2·5 - 3 KM

Date 10/4/92

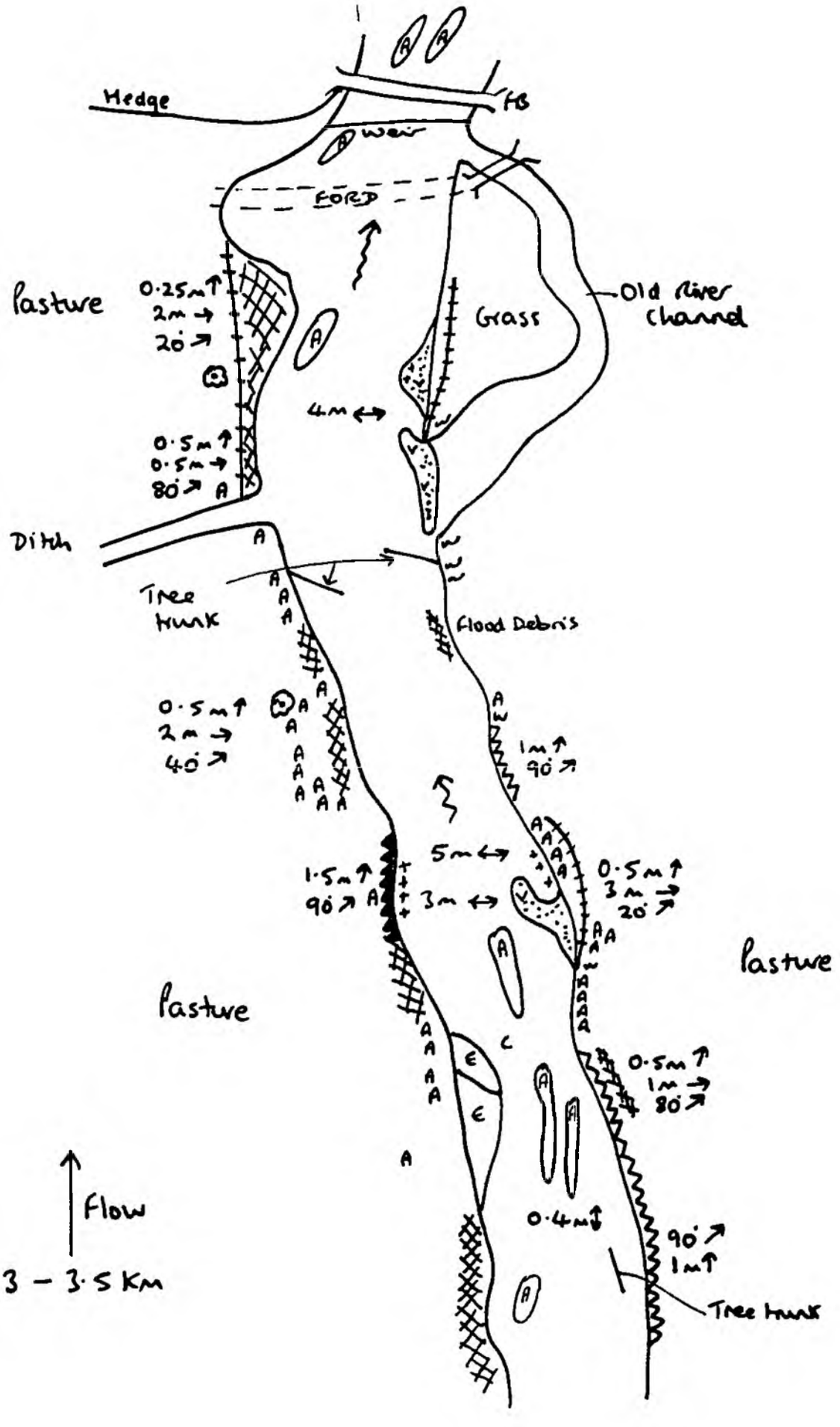
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		
canal =		
ditch	3	1
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m	1	
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		2
hedge =		
fence on bank	30	30
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		3

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑	10	6
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m	40	
1-<2m	60	100
>2m		
Width <1m	70	100
1-<2.5m	10	
2.5-<5m	20	
>5m		
Slope <30°		
30-<60°	60	
60-<90°	40	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard	3	3
S Standard willows		
A Alder	29	16
Other trees	3	
Young trees	3	6
Thick Scrub/shrubs %	10	25
Sparse Scrub/shrubs %	3	15
Reed/Sedge %	15	10
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		6
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		
.25-<.5		100
0.5-<1.0		
>1.0m		
Width <1		90
1-<5		10
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		50
p pebbles		50
g gravel		
s sand		
si silt/mud		
cl clay		
peat		
Habitats and Flow		
pool		1
slack		10
riffle		5
rapids		4
run		20
waterfall		
protruding rocks		
Margins		
shingle ± bare		20
shingle, vegetated		10
mud		3
sand		
FLORA %		
emergent veg < 1m wide		100
emergent 1-2m wide		
emergent >2m wide		
total veget. area		3
B bryophytes		
E emergents	50	
A submerged	50	
F floating		
algae % of stretch		

(total to 100%)


Hedge
FB
Weir
FORD
Pasture
0·25m ↑
2m →
20° ↗
Grass
Old River Channel
4m ↔
0·5m ↑
0·5m →
80° ↗ A
Ditch
Tree trunk
Flood Debris
0·5m ↑
2m →
40° ↗
1m ↑
90° ↗
5m ↔
1·5m ↑
90° ↗ A
3m ↔
0·5m ↑
3m →
20° ↗
Pasture
Pasture
0·5m ↑
1m →
80° ↗
Flow
3 – 3·5 Km
0·4m ↕
90° ↗
1m ↑
Tree trunk

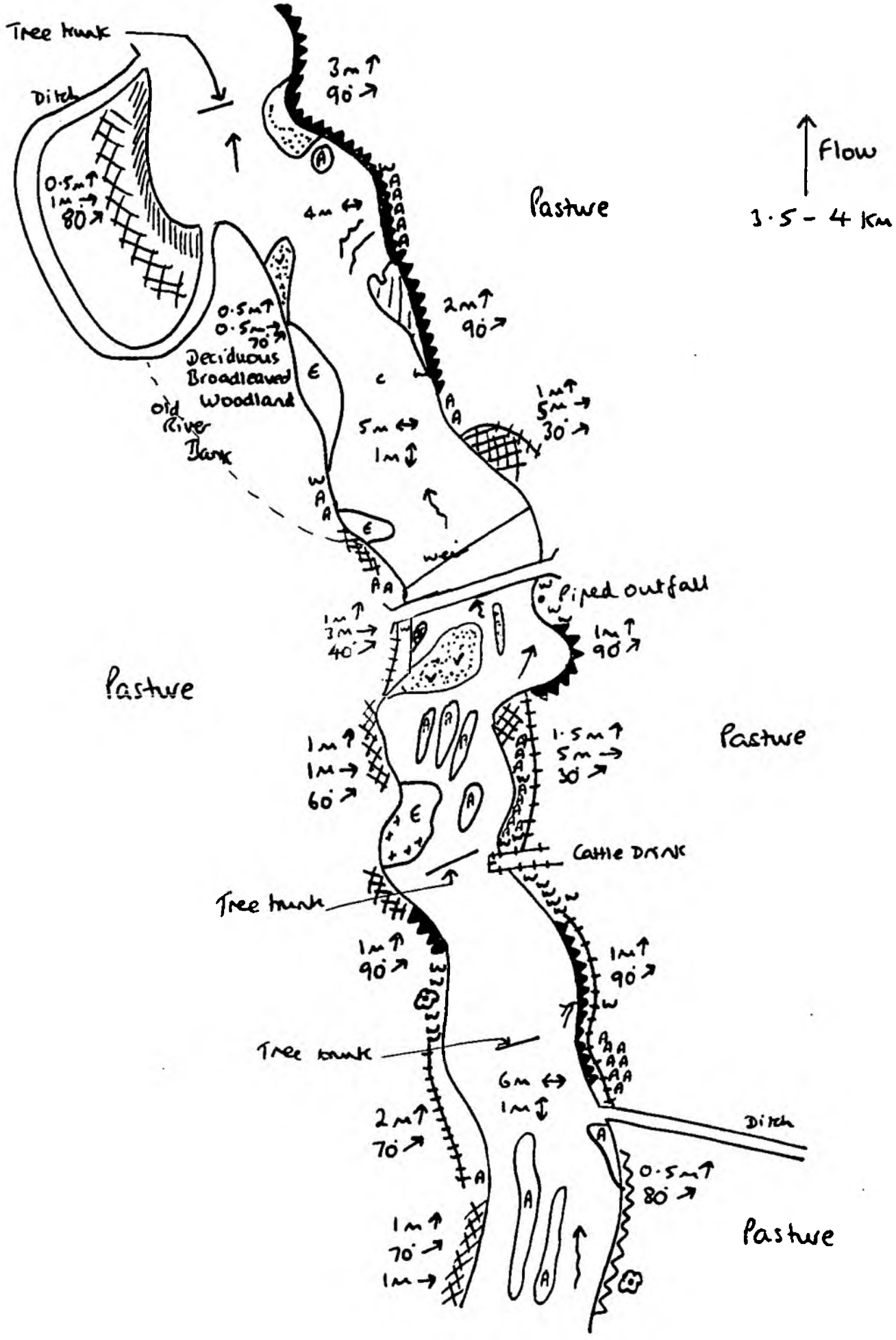
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/resseded		
5. Marshy/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich vegel.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

River: RIVER YARTY
Km No.: 3 - 3.5 Km
Date: 10/4/92
Surveyor: JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj land in each stretch	
canal =		
ditch	1	
dyke		
pond, pool, cut-off %		2
lake %		
gravel pit %		
reservoir %		
marina %		
2. flowing		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	
hedge =		
fence on bank	15	10
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑	5	
soft earth cliff >80°		20
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m	55	70
1-<2m	45	30
>2m		
Width <1m	80	60
1-<2.5m	20	30
2.5-<5m		10
>5m		
Slope <30°	20	20
30-<60°		
60-<90°	80	80
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore	2	
P Willow recept pollard		
W Willow old, not pollard		6
S Standard willows		
A Alder	20	12
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %	30	5
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		2
weirs/500m		1
locks/500m		
inlet/500m	1	
Depth <.25m	%	
.25-<.5		100
0.5-<1.0		
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
bld bed rock		
b boulders		10
c cobbles		80
p pebbles		90
g gravel		
s sand		
si silt/mud		
cl clay		
peat		
Habitats and Flow		
pool		
slack		80
ripple		
rapids		
run		20
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		10
mud		5
sand		
FLORA %		
emergent veg < 1m wide		100
emergent 1-2m wide		
emergent >2m wide		
total vegel area		3
B Bryophytes		
E emergents	50	
A submerged	50	total to 100%
F floating		
algae % of stretch		


Tree trunk
Ditch
0·5m↑
1m→
80↗
3m↑
90↗
Flow
3·5 - 4 km
Pasture
4m↔
2m↑
90↗
0·5m↑
0·5m→
70↗
Deciduous Broadleaved Woodland
old River Bank
5m↔
1m↕
1m↑
5m→
30↗
weir
Piped outfall
1m↑
3m→
40↗
1m↑
90↗
Pasture
1m↑
1m→
60↗
1·5m↑
5m→
30↗
Pasture
Cattle Drink
Tree trunk
1m↑
90↗
1m↑
90↗
Tree trunk
6m↔
1m↕
2m↑
70↗
Ditch
0·5m↑
80↗
1m↑
70↗
1m→
Pasture

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation	15	
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	85	100
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER RIVER YARTY

Km No. 3.5 – 4 Km

Date 11/4/92

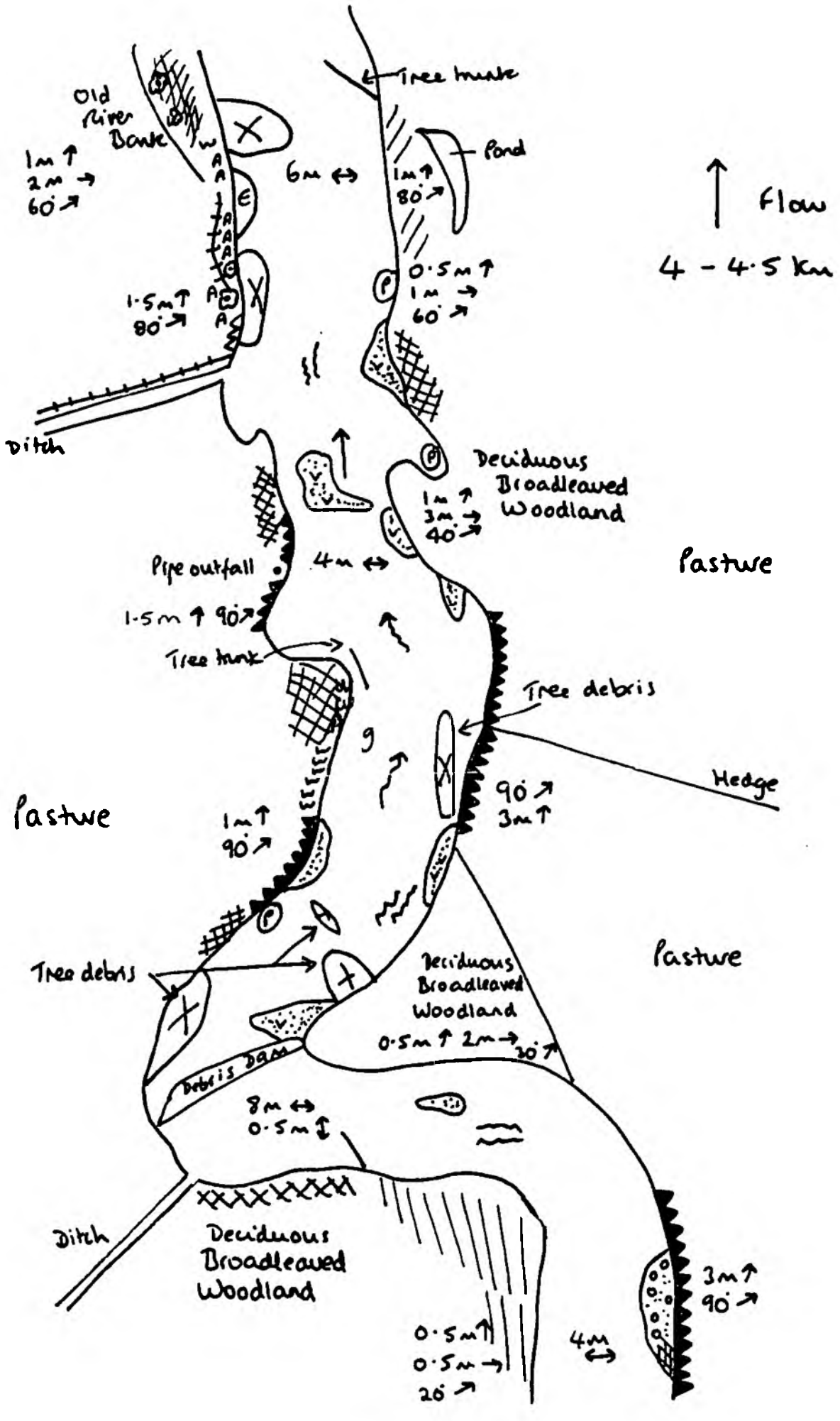
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal } % of adj. bank in each stretch	2	1
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	10	25
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
sheet %		
solid earth cliff 1M↑ }	3	50
soft earth cliff >80 }		10
rock cliff		
artificial		
flood bank adj		
flood bank set back		
levee		
Height <1m	20	50
1-<2m	90	40
>2m		10
Width <1m	100	70
1-<2.5m		30
2.5-<5m		
>5m		
Slope <30°		30
30-<60°		
60-<90°	100	70
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore	1	1
Willow recent pollard		
Willow old, not pollard	7	13
Standard willows	5	24
Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %	10	
Sparse Scrub/shrubs %		
Reed/Sedge %	20	
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		1
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		1
locks/500m		
inlet/500m		
Depth <.25m %		
.25-<.5		
0.5-<1.0		100
>1.0m		
Width <1		
1-<5		60
5-<10		40
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		100
p pebbles		
g gravel		
s sand		
+ silt/mud		
clay		
peat		
Habitats and Flow		
pool		
slack		66
ripple		2
rapids		2
run		30
waterfall		
protruding rocks		
Margins		
shingle ± bare		5
shingle, vegetated		10
mud		
sand		
FLORA %		
emergent veg < 1m wide		100
emergent 1-2m wide		
emergent >2m wide		
total veget. area		4
B bryophytes		
E emergents	20	
A submerged	80	
P floating		
algae % of stretch		

total to 100%


Old River Bank
1m ↑
2m →
60° ↗
6m ↔
Tree trunk
Pond
1m ↑
80° ↗
0·5m ↑
1m →
60° ↗
Flow
4 - 4·5 km
1·5m ↑
80° ↗
Ditch
Deciduous Broadleaved Woodland
1m ↑
3m →
40° ↗
Pasture
Pipe outfall
4m ↔
1·5m ↑ 90° ↗
Tree trunk
Tree debris
Hedge
90° ↗
3m ↑
Pasture
1m ↑
90° ↗
Tree debris
Deciduous Broadleaved Woodland
0·5m ↑ 2m → 30° ↗
Pasture
Debris dam
8m ↔
0·5m ↕
Ditch
Deciduous Broadleaved Woodland
3m ↑
90° ↗
0·5m ↑
0·5m →
20° ↗
4m ↔

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation	20	55
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	45
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER RIVER YARTY

Km No. 4-4-5

Date 11/4/92

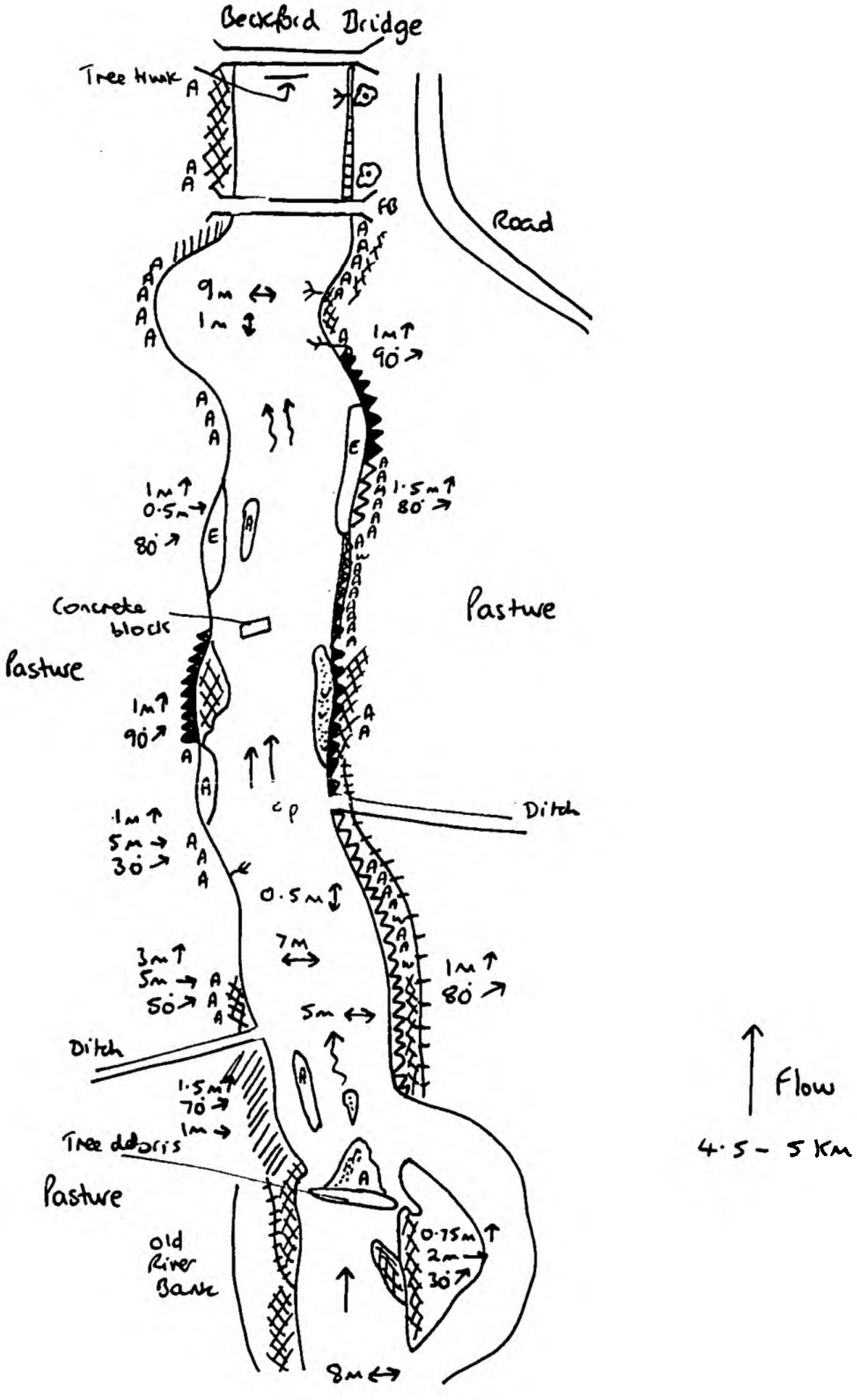
Surveyor JALD

	LB	RB
C. OPEN WATER		
1. Standing - canal +	% of adj land in each stretch	
canal =		
ditch	2	
dyke		
pond, pool, cut-off %		2
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		1
hedge =		
fence on bank	8	
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑	10	20
soft earth cliff >80°	1	
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m	15	80
1-<2m	85	
>2m	20	
Width <1m	5	40
1-<2.5m	35	60
2.5-<5m		
>5m		
Slope: <30°	20	60
30-<60°	80	40
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore	4	
P Willow recent pollard		
W Willow old, not pollard	9	
S Standard willows		
A Alder	8	
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %	15	5
Reed/Sedge %	15	5
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		40
.25-<.5		100
0.5-<1.0		
>1.0m		
Width <1		
1-<5		50
5-<10		50
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		100
s sand		
si silt/mud		
clay		
peat		
Habitats and Flow		
pool		1
slack		75
riffle		5
rapids		5
run		15
waterfall		
protruding rocks		
Margins		
shingle ± bare		5
shingle, vegetated		15
mud		
sand		
FLORA %		
emergent veg < 1m wide		100
emergent 1-2m wide		
emergent >2m wide		
total veget. area		0.5
B bryophytes		
E emergents	100	
A submerged		
F floating		
algae % of stretch		

(total to 100%)


Beckford Bridge
Tree trunk
FB
Road
9m ↔
1m ↕
1m ↑
90°
1m ↑
0·5m →
80°
1·5m ↑
80°
Concrete block
Pasture
Pasture
1m ↑
90°
cp
Ditch
1m ↑
5m →
30°
0·5m ↕
7m ↔
3m ↑
5m →
50°
1m ↑
80°
5m ↔
Ditch
1·5m ↑
70°
1m →
Tree debris
Pasture
Old River Bank
0·75m ↑
2m →
30°
8m ↔
Flow
4·5 - 5 km

	LG	RG
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	100
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER RIVER YARTY

Km No. 4·5 – 5 Km

Date 11/4/92

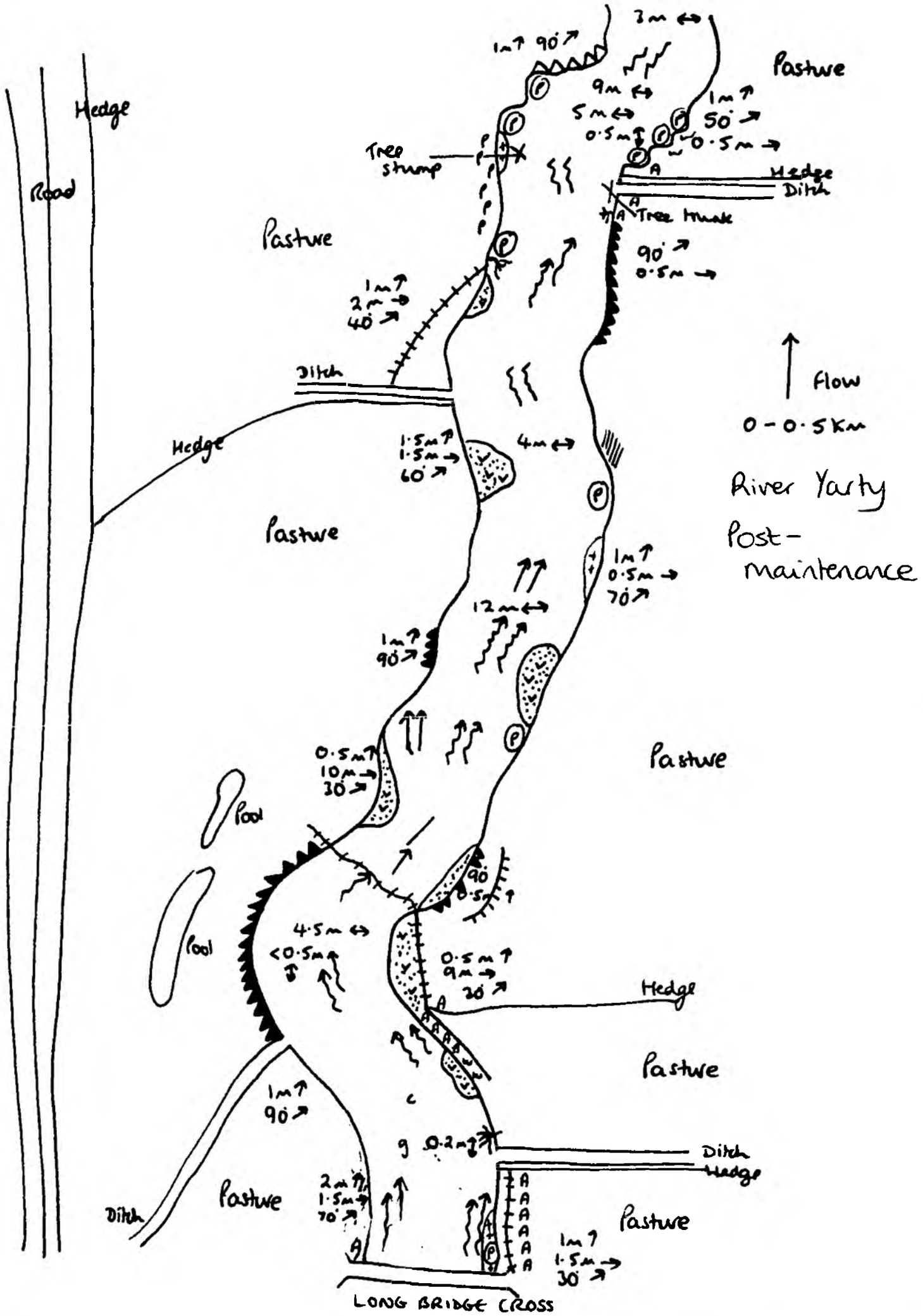
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj land in each stretch	
canal =		
ditch	1	1
dyke		
pond, pool, cut-off %		
lake %		1
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank		21
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		2
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑	5	22
soft earth cliff >80°		20
rock cliff		
artificial		5
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		10
1-<2m	80	90
>2m	20	
Width <1m	40	90
1-<2.5m	40	10
2.5-<5m	20	
>5m		
Slope: <30°		15
30-<60°	20	
60-<90°	80	85
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		2
P Willow recent pollard		
W Willow old, not pollard		3
S Standard willows		
A Alder	18	28
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %	11	
Reed/Sedge %		
Dense open %	20	18
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS	1	
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		2
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		
.25-<.5		40
0.5-<1.0		60
>1.0m		
Width <1		
1-<5		30
5-<10		70
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		50
p pebbles		50
g gravel		
s sand		
si silt/mud		
clay		
peat		
Habitats and Flow		
pool		
slack		65
riffle		
rapids		15
run		20
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		5
mud		
sand		
FLORA %		
emergent veg < 1m wide		100
emergent 1-2m wide		
emergent >2m wide		
total veget. area		5
B bryophytes		
E emergents	40	
A submerged	60	
F floating		
algae % of stretch		

total to 100%


Hedge
Road
Tree stump
Pasture
Ditch
Hedge
Pasture
Pool
Pool
Pasture
Hedge
Pasture
Ditch
Pasture
Ditch
Hedge
Pasture
LONG BRIDGE CROSS
Hedge
Ditch
Tree trunk
Flow
0 - 0·5 km
River Yarty
Post-maintenance

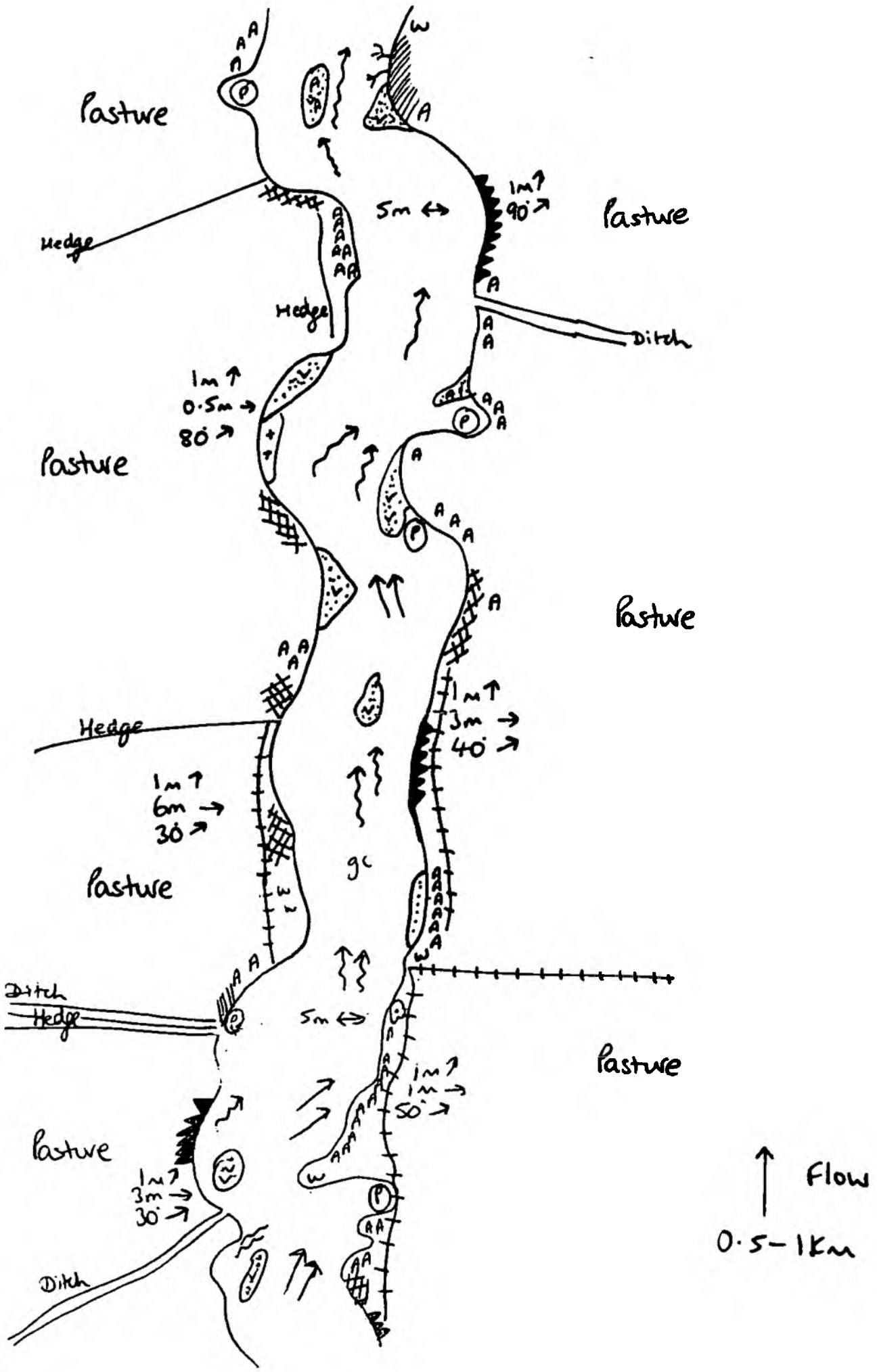
River RIVER YARTY
Km No. 0 - 0·5 km
Date 4/93
Surveyor JALD

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

	LB	RB
C. OPEN WATER		
1. Standing - canal +	% of adj land in each stretch	
canal =	2	2
ditch		
dyke		
pond, pool, cut-off %	3	
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	3
hedge =		
fence on bank		
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
slack pile		
flood debris		
road	10	
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑	8	7
soft earth cliff >80°	4	
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m	10	20
1-<2m	90	80
>2m		
Width <1m		
1-<2.5m	90	70
2.5-<5m		10
>5m	10	10
Slope <30°		
30-<60°	60	80
60-<90°	40	50
>90°		
road		
sand		
bare shingle		
vegetated shingle		
earth		
natural cobbles	100	100
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard	6	
W Willow old, not pollard		4
S Standard willows		
A Alder	1	14
Other trees		
Young trees		
Thick Scrub/shrubs %	8	2
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots	1	2
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg	2	
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		
locks/500m		
Inlet/500m		
Depth <.25m	%	15
.25-<.5		85
0.5-<1.0		
>1.0m		
Width <1		
1-<5		80
5-<10		15
10-<20		5
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		50
p pebbles		50
g gravel		
s sand		
si silt/mud		
cl clay		
peat		
Habitats and Flow		
P pool		1
slack		
ss riffle		64
↑↑ rapids		10
↑↑ run		5
waterfall		20
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		5
mud		3
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget area		
B bryophytes		total to 100%
E emergents		
A submerged		
F floating		
algae % of stretch		


Pasture
Hedge
Hedge
5m ↔
1m ↑
90° ↗
Pasture
Ditch
1m ↑
0.5m →
80° ↗
Pasture
Pasture
Hedge
1m ↑
6m →
30° ↗
Pasture
gc
1m ↑
3m →
40° ↗
Ditch
Hedge
5m ↔
Pasture
1m ↑
1m →
50° ↗
Pasture
1m ↑
3m →
30° ↗
Ditch
Flow
0.5–1km

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/resseded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich vegetl.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER RIVER YARTY

Km No. 0·5 – 1 KM

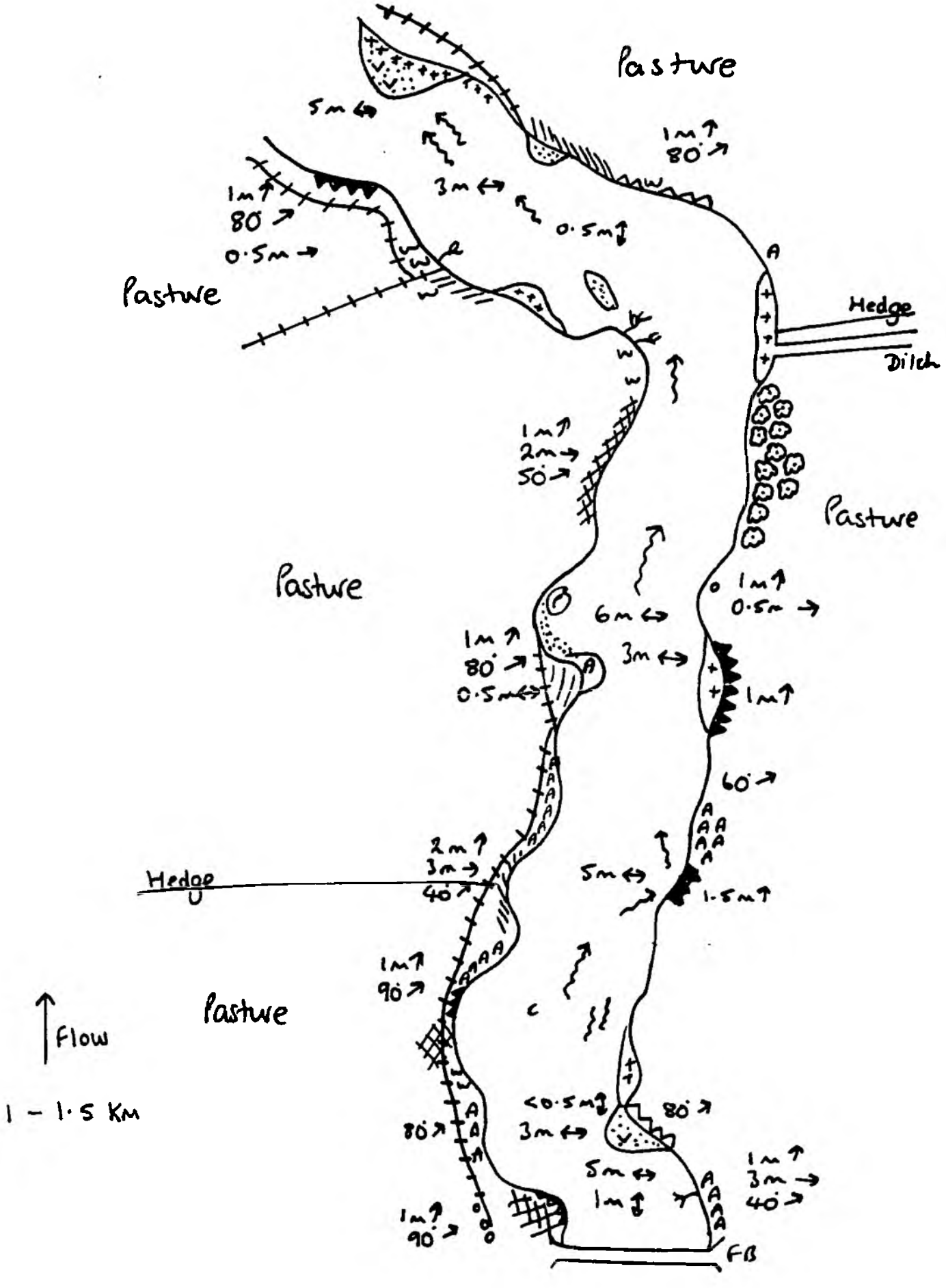
Date 4/93

Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj.	
canal =	land in	
ditch	each stretch 2	1
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	3	
hedge =		
fence on bank	11	40
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
slight %		
solid earth cliff 1m↑	2	8
soft earth cliff > 80°		
rock cliff		
artificial		
FB flood bank adj		
FU flood bank set back		
levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m	50	10
1-<2.5m		70
2.5-<5m	50	20
>5m	10	
Slope <30°		
30-<60°	50	70
60-<90°	50	30
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		1
P Willow - recent pollard		
W Willow old, not pollard	2	3
S Standard willows		
A Alder	15	31
Other trees		
Young trees		
Thick Scrub/shrubs %.	2	8
Sparse Scrub/shrubs %.		
Reed/Sedge %.	8	8
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		2
ISLANDS		
Rocky, vegetated		
with etc too rocky, + bare		
shingle and rock		
shingle, rock + veg	3	
new earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m	1	
Depth <.25m	%	
.25-<.5		100
0.5-<1.0		
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		50
p pebbles		50
g gravel		
s sand		
si silt/mud		
cl clay		
peat		
Habitats and Flow		
pool		2
slack		38
riffle		10
rapids		50
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget. area		
B Bryophytes		total to 100%
E emergents		
A submerged		
F floating		
algae % of stretch		


Pasture
5m
1m
80°
3m
0.5m
1m
80°
0.5m
Pasture
Hedge
Ditch
1m
2m
50°
Pasture
Pasture
6m
3m
1m
80°
0.5m
1m
0.5m
1m
60°
2m
3m
40°
Hedge
5m
1.5m
1m
90°
Pasture
C
Flow
1 - 1.5 Km
<0.5m
80°
3m
80°
5m
1m
1m
3m
40°
1m
90°
FB

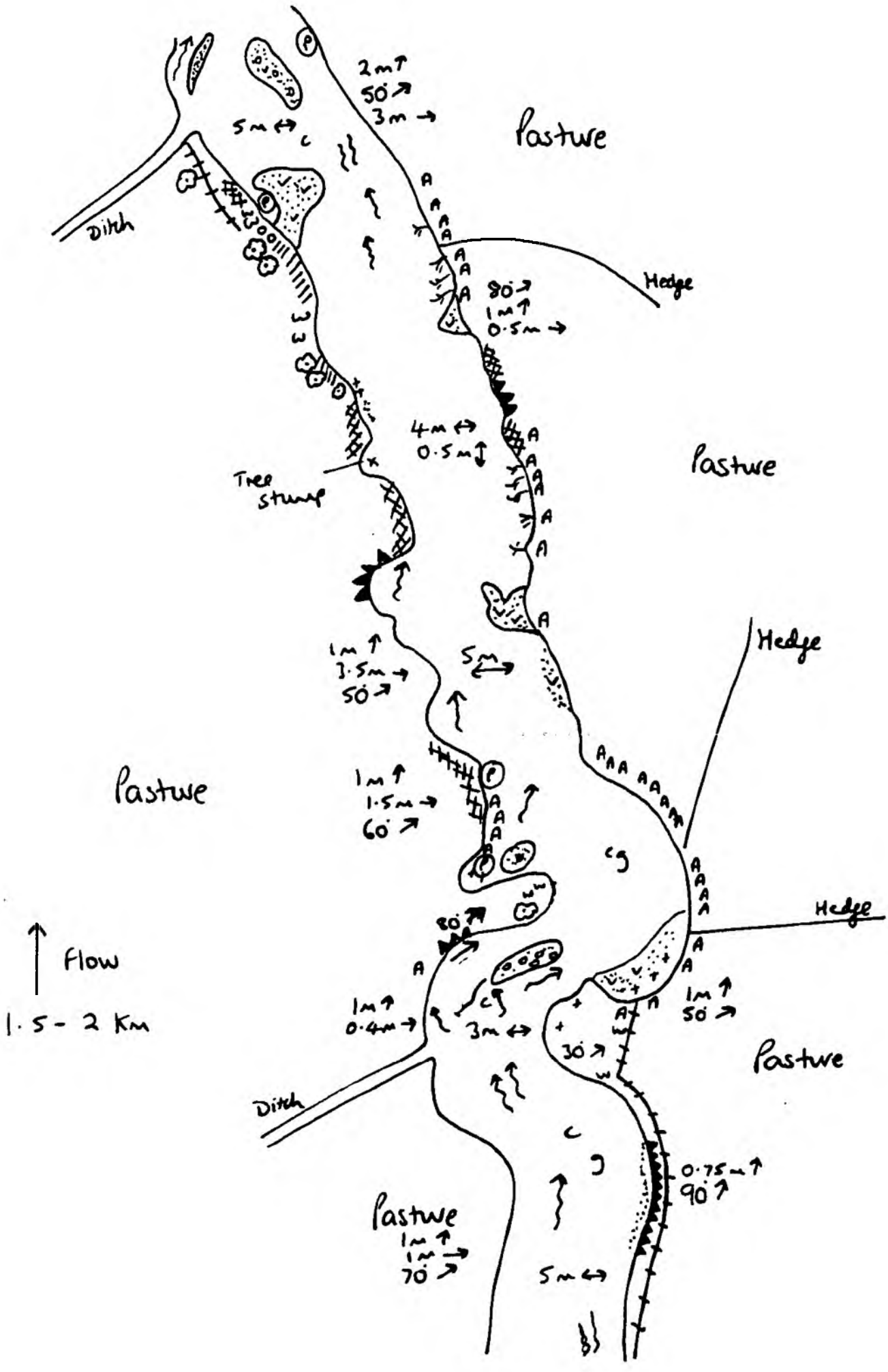
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich vegetn.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

River RIVER YARTY
Km No. 1-1-5 km
Date 4/93
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		1
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	1
hedge =		
fence on bank	65	6
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1m↑	6	8
soft earth cliff >80°		9
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m	80	70
1-<2.5m	20	30
2.5-<5m		
>5m		
Slope <30°	20	50
30-<60°	80	50
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		12
P Willow - recent pollard	7	
W Willow old, not pollard		1
S Standard willows		
A Alder	13	11
Other trees		
Young trees	3	1
Thick Scrub/shrubs %		5
Sparse Scrub/shrubs %	8	
Reed/Sedge %	12	
Dense open %		
Sparse open %		
Resseeded or mown %		
Exposed tree roots	3	1
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		
locks/500m		
inlet/500m	1	
Depth <.25m	%	
.25-<.5		60
0.5-<1.0		40
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		50
p pebbles		50
g gravel		
s sand		
si/mud		
cl clay		
peat		
Habitats and Flow		
pool		1
slack		29
riffle		10
rapids		
run		60
waterfall		
protruding rocks		
Margins		
shingle ± bare		3
shingle, vegetated		6
mud		2
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		total to 100%
E emergents		
A submerged		
F floating		
algae % of stretch		


Pasture
Hedge
Ditch
Tree stump
Pasture
Hedge
Pasture
Hedge
Pasture
Ditch
Pasture
Flow
1.5 - 2 Km

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat.		
plantation		
Coniferous semi-nat.		
plantation		
Mixed semi-natural		
plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved	100	100
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich vegtl.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER RIVER YARTY

Km No. 1·5–2 km

Date 4/93

Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj land in each stretch	
canal =		
ditch	2	
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1·5m		
5·10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		3
hedge =		
fence on bank	5	
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff (1m ↑	5	8
soft earth cliff > 80°		
rock cliff		
artificial		
flood bank ach		
flood bank set back		
levee		
Height <1m		
1·<2m	100	100
>2m		
Width <1m	20	90
1·<2.5m	30	
2.5·<5m	50	10
>5m		
Slope <30°	80	70
30·<60°	20	30
60·<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore	6	
Willow recent pollard		
Willow old, not pollard	6	2
Standard willows		
Alder	5	30
Other trees	1	
Young trees	2	
Thick Scrub/shrubs %	6	
Sparse Scrub/shrubs %		
Reed/Sedge %	15	4
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		9
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m	1	
Depth <.25m %		90
.25·<.5		10
0.5·<1.0		
>1.0m		
Width <1		
1·<5		100
5·<10		
10·<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		50
g gravel		50
s sand		
si/mud		
cl clay		
peat		
Habitats and Flow		
pool		1
slack		73
riffle		5
rapids		1
run		20
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		3
mud		1
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1·2m wide		
emergent >2m wide		
total veget area		
B bryophytes		
E emergents	100	
A submerged		total 10 100%
F floating		
algae % of stretch		

SIR ARTHUR'S PILL

R&D 317/21/ST

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SIR ARTHUR'S PILL

LIST OF FIGURES

LIST OF TABLES

SOUTH WEST SIR ARTHUR'S PILL

1. BACKGROUND

1.1 Introduction

Sir Arthur's Pill rises at Saunton, north west of Braunton village in North Devon. From source to mouth it is 6 km in length, draining a catchment of 11 square kilometres. The area is bounded to the north by the highland area of Saunton Down. The Taw-Torridge Estuary and the River Caen form the southern and eastern boundaries. The western boundary is formed by the sand dunes of Braunton Burrows which stretch for 5.75 km from the estuary to Saunton. The catchment area of Sir Arthur's Pill is small; approximately 15 km ^{2}.

Sir Arthur's Pill flows through two distinctly different areas: an area of high grade arable land and an extensive area of permanent pasture (Braunton Marsh).

1.2 Study Reach

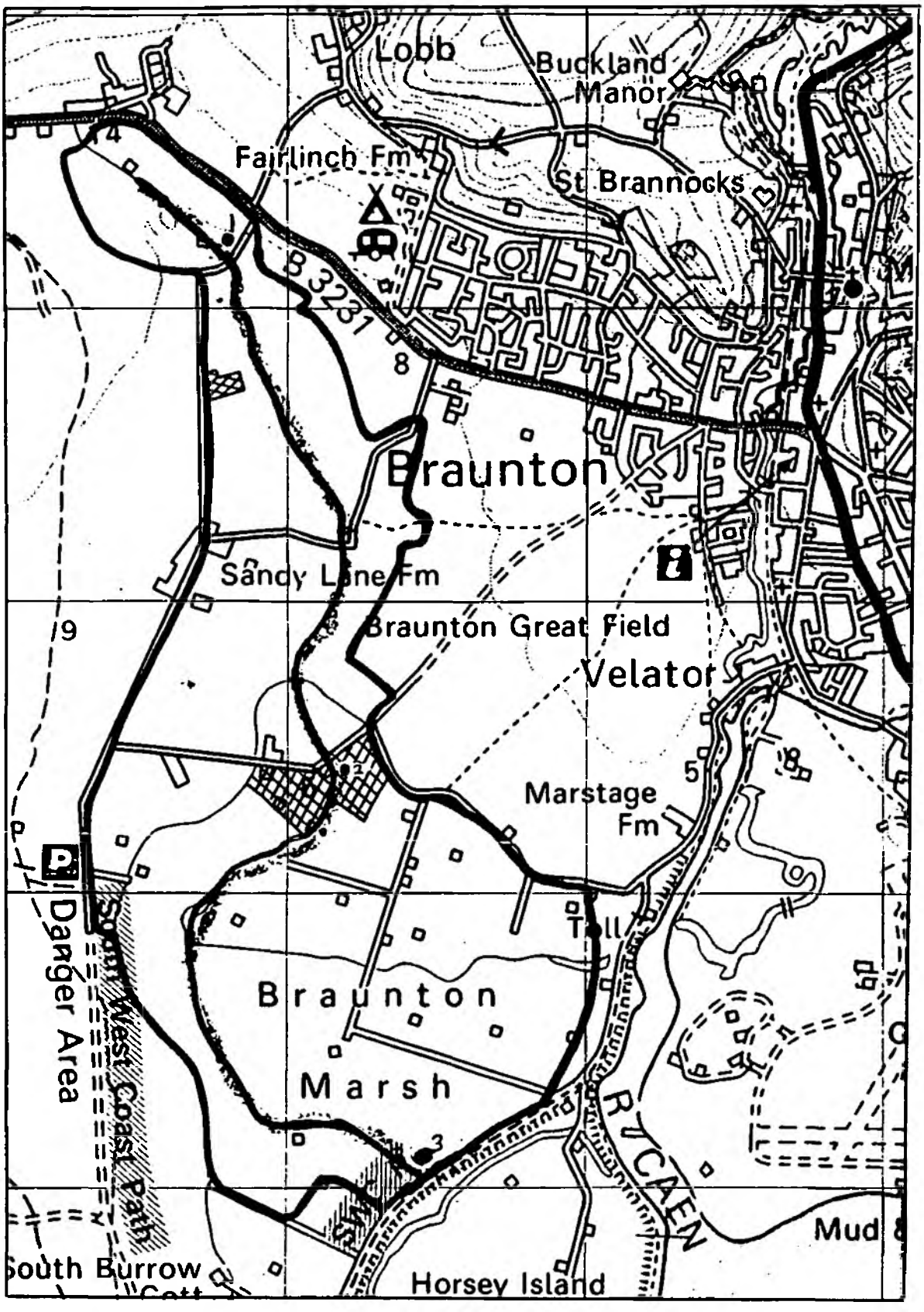
The section of river selected for study (Figure 1) runs for 5 km between Saunton (GR. 465 374) and the Great Sluice (GR. 474 341). Sir Arthur's Pill is a main river characteristic of those in the area on which weed clearance is regularly performed. The land area which derives a benefit from river maintenance in terms of reduced flooding and improved land drainage is 242 ha.

1.3 Braunton Marsh

Sir Arthur's Pill flows through two distinct areas in terms of land use. From the head of main river to 2.25 km downstream, it flows over an area of mainly arable land skirting the edge of the Great Field - a relic of the open-field strip farming cultivation, before flowing over Braunton Marsh.

Braunton Marsh is an extensive area of reclaimed salt marsh which was cut off from the sea by the creation of a large bank between 1811 and 1815 following an 1811 Act of Parliament which permitted the enclosure. The scheme was designed by James Green, a British Engineer

and the Great Sea Bank was constructed by local labour and workers from Cornwall, Ireland and Holland. Some arable crops were traditionally grown on the marsh but now the area is used entirely for grazing.



Legend

Scale 1 : 6250

- Benefit Area
- Agricultural Land Classification Class 4
- Agricultural Land Classification Class 3
- Location of Soil Cores

Figure 1 Location of Sir Arthur's Pill and background information

1.4 River Characteristics

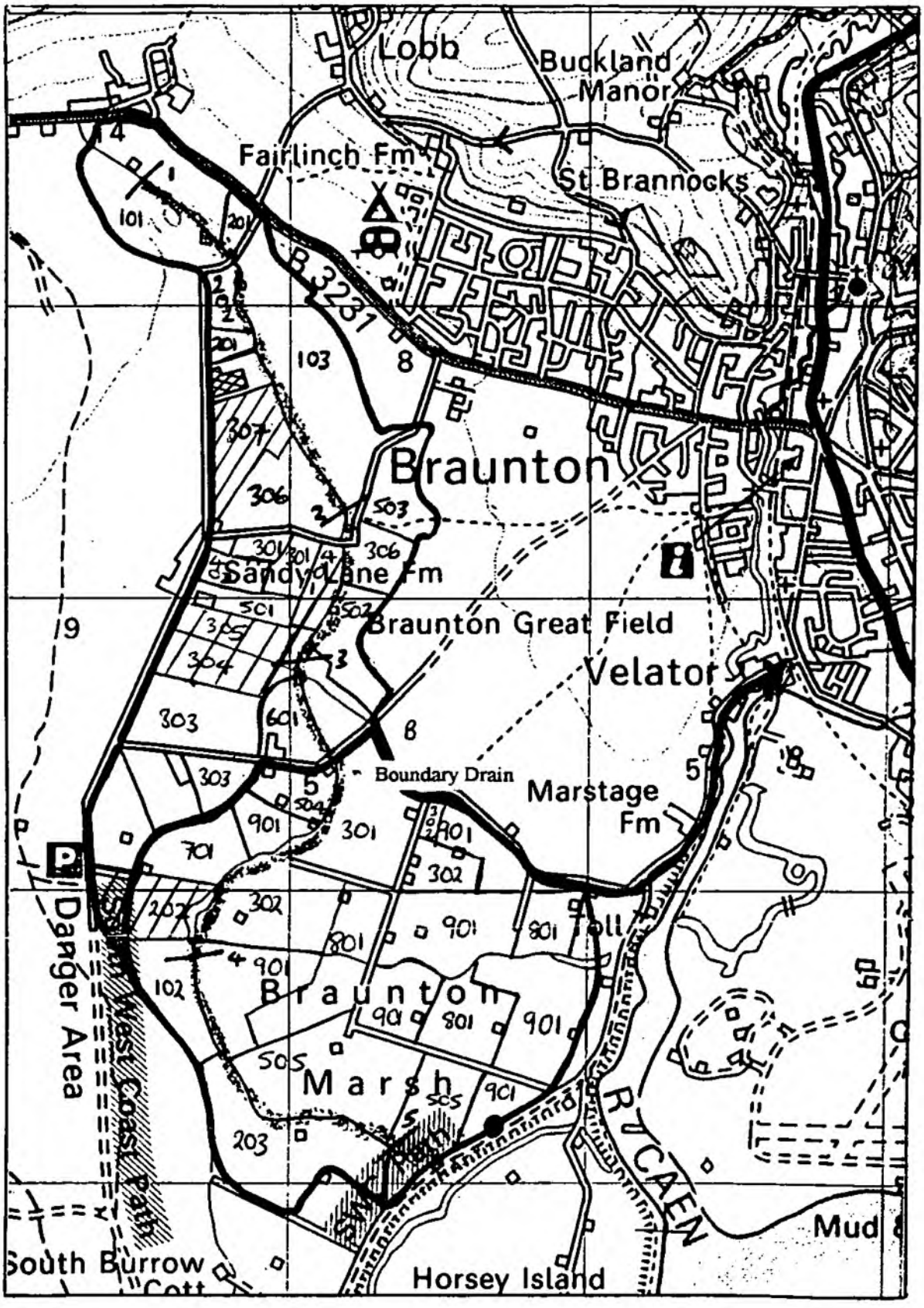
Sir Arthur's Pill is a straight drain, only meandering slightly over a wide floodplain when it reaches Braunton Marsh. The channel is trapezoidal in shape with its depth varying between 1 m at the head of main river to 2.5 m to the landward side of the Great Sluice. Channel width varies between 0.75 m at the head of main river to 2.5 m at the sluice. Freeboard averages 0.75 m north of the marsh but over the marsh itself this is reduced to 0.2 m and at particular points in the autumn and winter there is no freeboard and the water floods out of the drain and onto the marsh. The bed substrate is dominated by silt and sand - characteristic of the old salt marsh over which it flows.

1.5 Land Drainage

When the marsh was reclaimed, the routes of the main tidal creeks over the marsh were replaced by a series of artificial delphs (ditches). These drain the marsh and remove water flowing down from the highland area between Saunton and Lobb. Water is discharged out to sea through the Great Sluice in the sea embankment.

A comprehensive system of ditches traverse the marsh, marking field boundaries and creating barriers to stock. These are maintained (weed cut) by the Internal Drainage Board (IDB) every three years. Water levels in the ditches are controlled via a series of sluices which keep levels high in summer and lower in winter. One such sluice is located at Velator Bridge (GR. 485 358). From this structure, in times of low flow in Sir Arthur's Pill, water from the River Caen is diverted into it via the Boundary Drain. The Boundary Drain in turn feeds minor ditches within the marsh area, keeping their water levels high. The sluices are controlled and operated by the IDB.

Figure 2 indicates the areas of land in the benefit area which have field drainage pipes installed. Of the land surveyed, 36 % is underdrained with pipes. The remainder is naturally draining. Areas of horticulture are associated with the most intensively drained land. Further information is provided in Section 2.5.



Legend

Scale 1 : 6250

Piped drainage

Natural drainage

Cross-section location

Great sluice

Land use blocks

Figure 2 Land drainage and location of cross-sections

1.6 Geology, Soils and Land Capability

Sir Arthur's Pill flows over sand and silt deposits of marine and estuarine origin. The shaley silt stone with sandstone and limestone's to the north and shale and silt stones of Lower Carboniferous age in the south, form the boundaries to this alluvium which was laid down in recent and Pleistocene times.

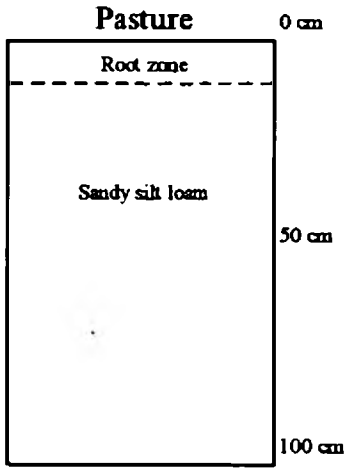
The soil type is characterised by the Isleham Association containing both the Isleham and Crowdy series. The soils have developed over a permeable sandy drift which is typically waterlogged over long periods due to a high watertable. Humic sandy gleys are the typical soil type.

Soil profiles taken at three points within the benefit area are shown in Figure 3. Soil colour is a uniform dark brown. Sandy silt loams characterise the soil profile beneath the root zone. Some mottling and gleying is evident on the poorly drained soils.

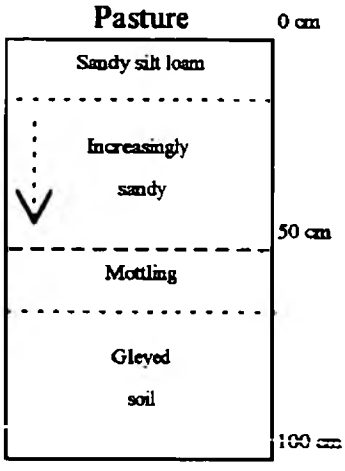
The Crowdy series is perennially waterlogged and the risk of poaching (surface damage by livestock) is high. The soil profile is typically waterlogged within 0.4 m of the surface for over 50 % of the year and waterlogged within 0.7 m of the surface for over 90 % of the year. The Soil Survey of England and Wales (SSEW) classify such soils as having a Wetness Class of VI. Due to a high watertable the Wetness Class of the Isleham series is V. The soil is commonly waterlogged for 95 % of the year within 0.4 m of the surface (Findlay et al, 1984). According to precipitation records from the nearest meteorological station to Sir Arthur's Pill (Chivenor Met. Office), the average annual rainfall is high, averaging approximately 868 mm. This contributes to the high watertables in the area.

The Agricultural Land Classification of the Ministry of Agriculture Fisheries and Food (MAFF) characterises the area adjacent to Sir Arthur's Pill and Braunton Marsh as Grade 3 (Figure 1). The Great Field is classed as Grade 2 agricultural land. A small area on the northern boundary of the marsh area is classed as Grade 4.

Grid Reference	468 373
Soil Core Number	1
Soil Colour	Dark brown
Comments	Well drained, uniform profile



Grid Reference	472 345
Soil Core Number	2
Soil Colour	Dark brown
Comments	Increased gleying with depth



Grid Reference	475 341
Soil Core Number	3
Soil Colour	Dark brown
Comments	Well drained, uniform profile

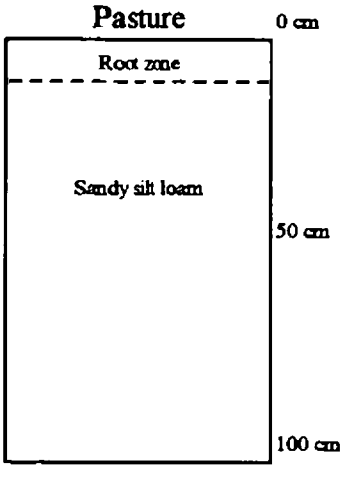


Figure 3 Soil profiles

1.7 Capital Works

In 1979 the channel was dredged to a design standard and re-graded. Local re-sectioning took place at the same time and the tidal flaps were replaced. Two water level control structures were refurbished in 1992/93. These consist of weirs which are used to control levels in Sir Arthur's Pill at various times in the year.

1.8 River Maintenance

Desilting and weed clearance along the entire length of Sir Arthur's Pill takes place approximately every 18 months for the benefit of land drainage. All the channel vegetation (100 %) is removed using a 360 degree excavator. The river banks are left untouched and are not flail mown. Debris from the channel is spread on the surrounding land. Repairs to structures such as the weirs and Great Sluice are carried out as required.

The main reason for carrying out regular weed clearance is that it is scheduled into a regular programme of maintenance due to site inspections highlighting the need for vegetation control. The availability of equipment/labour and customer demand also influence the scheduling of maintenance works. Custom and practice is the main reason for determining the standard of service maintained by weed clearance. Proven suitability and the cost of maintenance are the main factors in determining the maintenance method selected. Prior to maintenance, landowners/tenants are visited by a representative from the NRA. Pollution bodies are informed of imminent work via the telephone.

1.8.1 Farmers views on maintenance

During interviews with farmers in the benefit area, the majority of the farmers expressed satisfaction with both the timing and frequency of maintenance on Sir Arthur's Pill. However, one farmer expressed concern that a layer of clay was removed from the channel bed along with the weed. This deepened the channel which rendered the banks more unstable and prone to slippage and undercutting.

1.8.2 Alternative maintenance strategies

The only alternative method of maintenance suggested by the farmers was to flail mow the banks either annually or twice per year. This would aid access to the channel for grazing livestock.

1.9 Climate

The impact of river maintenance on watertable depth and river levels depends on the particular weather conditions, especially rainfall, which vary from season to season and year to year. The seasonal and yearly rainfall totals for the period of study in the area of Sir Arthur's Pill are shown in Table 1.1.

Table 1.1 Rainfall totals

Period		Actual Rainfall (mm)	Average Rainfall (mm) *	% of Average Rainfall
1992	Spring	146	170	86
	Summer	244	199	123
	Autumn	307	308	100
1993	Spring	130	170	76
	Summer	343	199	173
	Autumn	272	308	88
1994	Spring	214	170	126
	Summer	166	199	84
	Autumn	412	308	134
1995	Spring	186	170	110
Total	1992	863	889	97
	1993	1042	889	117
	1994	1172	889	132

(Source : Chivenor Met. Station GR. 494 347)

This confirms the farmers comments that the summers of 1992 and 1993 and autumn of 1994 were wetter than normal. The summer of 1993 is classed as very wet. The rainfall data were collected from the meteorological stations at Chivenor (station number 395 162, GR. 494 347) and Lower Slade W.T.W (station number 395 607, GR. 5095 4588).

Monthly rainfall records covering a period of 14 years were used to determine the probability of wet, average and dry seasons and years occurring (Table 1.2) in the immediate area round Sir Arthur's Pill. The classification of seasons and years is based on that of the Food and Agricultural Organisation (FAO). Dry and wet seasons and years are classed as those with < 75 % of the mean and > 125 % of the mean respectively. Further details are contained in the R&D Note 456, Section 3.5.4.

Table 1.2 Probability of climatic conditions

Season	Dry *	Average *	Wet *
Spring	0.22	0.62	0.16
Summer	0.46	0.39	0.15
Autumn	0.21	0.65	0.14
Year	0.54	0.38	0.08

* (Based on records since 1980)

The Main Report (R&D Note 456, Section 3.5.4) describes the process by which financial benefits of maintenance are calculated according to the probability of each type of season occurring.

1.10 Aquatic Vegetation

Aquatic vegetation within the channel was identified prior to maintenance (Section 1.10.1 to 1.10.4). This vegetation has both hydraulic and environmental implications for the channel.

1.10.1 Floating plants

Lemna (Duckweed) and *Azolla* (Water fern) are common although the latter is predominately found in the Boundary Drain and not in Sir Arthur's Pill. Both are small and free-floating with rootlets on the underside of each leaf pad and often form dense mats.

Lemna and *Azolla* spread through vegetative reproduction by budding from pouches on the side of the leaves. Rapid growth often results in a dense cover over the water surface. Regrowth following removal through maintenance is thus rapid, especially as it is impossible for complete removal of the plant through mechanical methods alone. Chemical control may need to be considered if the growth reaches excessive rates. However, as *Lemna* and *Azolla* are purely floating plants, they poses little resistance to flow and do not restrict channel capacity. However, water quality may be affected as a dense mat may restrict the penetration of light into the water thus restricting activity of fish and invertebrates. As plant growth will also be restricted beneath the mat, its presence may actually reduce flow resistance through inhibiting plant growth.

1.10.2 Emergent plants

The emergent weeds include the narrow leafed *Phragmites australis* (Common reed), *Typha* (Reedmace or bull rush) and *Phalaris* (Reed Canary-Grass). Emergent plants pose a greater resistance to flow than floating species. If vegetation stands are dense, their stems and leaves provide a barrier to flow, causing the hydraulic resistance of the channel to increase and water levels to rise. If the stems are flexible, they will bend in the direction of flow and during high flows will exert minimal resistance to flow as their effect is drowned out.

1.10.3 Submerged plants

The submerged weed *Elodea* (Canadian pondweed) is abundant within Sir Arthur's Pill and the Boundary Drain. *Juncus* (Rush) is a submerged plant with fine hair-like leaves which can reach 300 cm in length. It is a streamlined plant and moves in the direction of flow. The greater the flow, the lower the resistance this plant poses to movement of water. At high flows, the hydraulic impact of *Juncus* is drowned out.

1.10.4 Algae

Filamentous algae is also found within Sir Arthur's Pill. It spreads rapidly through cell division (simple fission) and is difficult to completely remove. It grows up from the hydrosoil and often invades areas in which other aquatic plants have been removed.

2. FARM SURVEY

2.1 Introduction

Site survey, informal discussions and structured interviews with farmers indicate a benefit area of 242 ha (Figure 1). Detailed discussions have been held with nine farmers within this area. The benefit area is described as that which will derive a benefit from river maintenance in terms of improved drainage and reduced incidence of flooding. The benefit area is divided into different blocks (Figure 2) according to land use type (LUT) land management and drainage condition.

2.2 Farm Type, Size and Tenure

Seven farms within the benefit area are classed as lowland and livestock enterprises according to the European Union (EU) system of classification. One is a general horticultural enterprise and the remaining holding is classified as a specialist cereal farm. Farm sizes range from 4 ha to 324 ha, averaging 86 ha. The number of Standard Man Days (SMD) required for each farm ranges from five to 1630. The latter is for the largest farm; a lowland and livestock enterprise. The SMD (Man - Work Units) is a standard, approximate method for assessing the labour requirements for regular staff. It is assumed that 300 SMD are provided annually per man.

The largest farm within the benefit area is a managed farm. Two others are run as a partnership and the remainder are under sole proprietorship. The majority of land within the benefit area is owner occupied. One farmer has rented land within this area, comprising one 4 ha field held under a full tenancy agreement.

2.3 Livestock Enterprises

The system of livestock farming on Braunton Marsh follows a similar pattern over the whole marsh. Friesian beef kept under the 24 month system are most commonly found on the marsh. Beasts are bought at 125 kg and sold between 550-700 kg live weight. Five farms have beef herds of various sizes. Four of these have spring calving suckler herds, the herd size ranging from 32 to 140 beasts.

Five of the farms within the benefit area have flocks of sheep under the fat lamb system. Flock sizes range from 150 to 2400 ewes and are of mule and mixed breeds. The lambing rate ranges from 1 to 1.8 lambs/ewe tupped (average 1.5).

A small number of dairy followers are also grazed on the marsh as are some race horses. The stocking rate over the whole marsh is in the region of 10 beasts/ha.

2.4 Arable Enterprises

Four farms within the benefit area have some arable enterprises. Two grow winter cereals, potatoes (both early and main crop) and field vegetables under varying rotations. The general horticultural farm follows a fixed rotation of early potatoes and field vegetable crops which includes brassicas and leeks.

A fixed cropping rotation is practised by the specialist cereal enterprise under which field vegetables are followed by winter or spring barley, winter or spring wheat and early potatoes. Ten hectares are double cropped with field vegetables.

2.5 Land Use In The Benefit Area

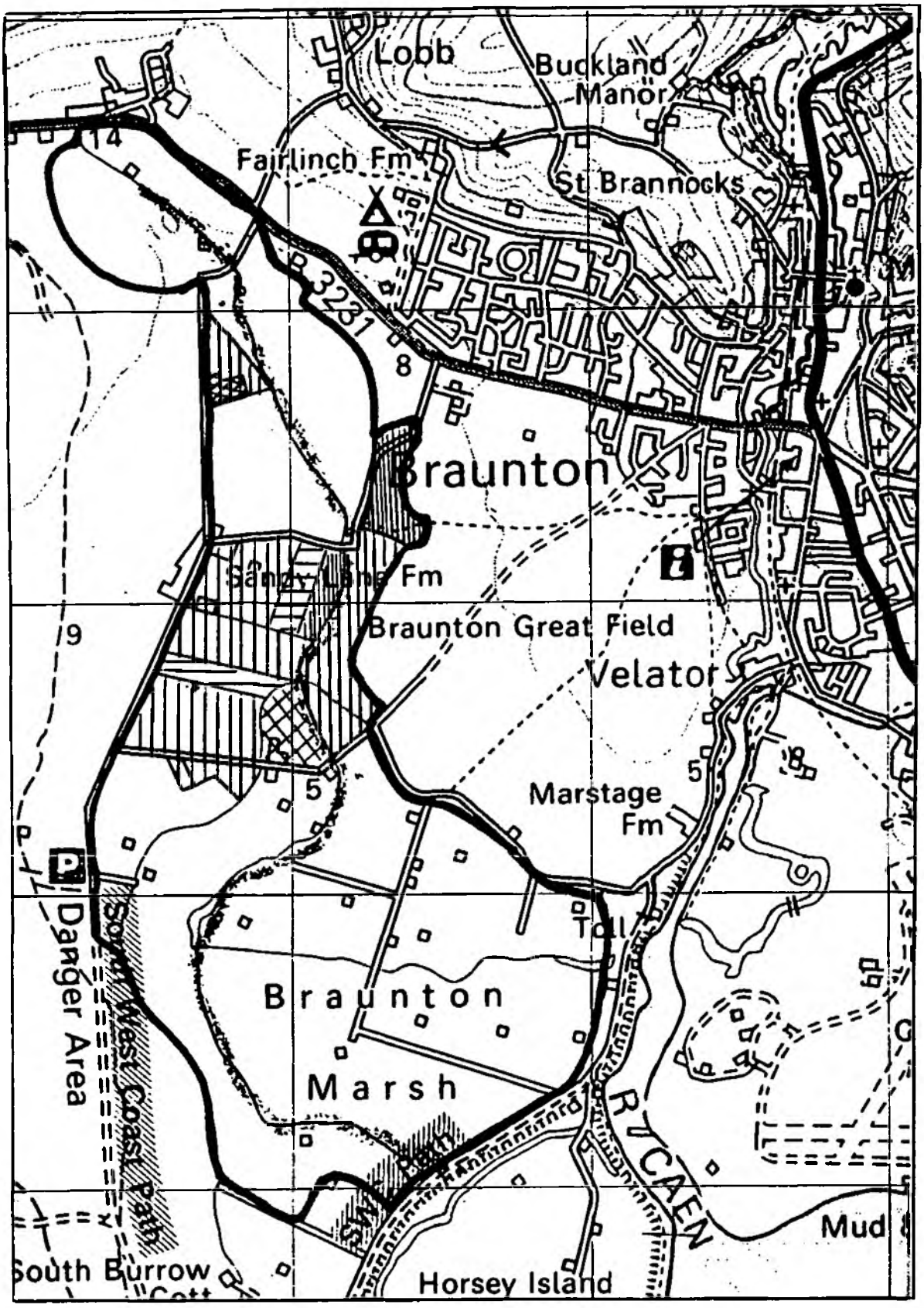
As Figure 4 illustrates, the majority of land surveyed within the benefit area (67 %) is under extensive grassland. Arable enterprises in the form of cereal/root crops account for 16 % of the benefit area. Holiday homes cover 4.5 ha of the benefit area (2 %). Table 2.1 provides detailed information regarding the percentage of land within the benefit area under the different land uses.

Table 2.1 Land use in the benefit area

Land Use	Area (ha)	% Benefit Area	% Land Drained
Extensive grass	162.0	67	10
Intensive grass	18.0	7	26
Cereal/roots	38.0	16	11
Horticulture	19.0	8	58
Other	4.5	2	0
Total	242.0	100	36

Extensive grassland is classified as that which receives low levels of nitrogen (typically < 50 kg/ha) and on which little or no grass conservation takes place. If conserved, one cut of hay is usually taken. The grass is grazed by beef and sheep, not dairy cattle. Grassland under the intensive system is high quality grazing land. It is usually well drained and receives moderate to high inputs of nitrogen. Multiple cuts of silage and/or hay are typically made.

Table 2.1 also shows the percentage of each land use which is drained by pipes. In total, 36 % of the benefit area is underdrainaed.



Legend

Scale 1 : 6250

Extensive grass

Cereal / root crop rotation

Other

Intensive grass

Horticulture

Figure 4 Land use in the benefit area

2.6 Turnout and Yarding Dates

Dates for the turnout and yarding of stock within the benefit area vary as Tables 2.2 and 2.3 illustrate. Stock is turned out to graze over the majority of the benefit area (42 %) in April. Over 5 % of the benefit area, livestock is turned out to graze after the grass has been cut for hay or silage. Twenty eight percent of the benefit area is grazed all year.

Table 2.2 Turnout dates

Turnout Date	Grassland Area (ha)	% Benefit Area
Early/mid April	12	5
Mid/late April	89	37
After hay cut	6	2.5
After silage cut	5	2
Grazed all year	68	28

Table 2.3 Yarding dates in Autumn

Yarding Date	Grassland Area (ha)	% Benefit Area
Mid / late October	61	25
Mid / late November	46	19
Mid/late December	5	2
Grazed all year	68	28

The majority of the stock which are yarded, are taken off the land in October. The land which is grazed all year is typically grazed by beef during the period April to October and by sheep over the winter months.

2.7 Grass Conservation

Table 2.4 shows the area of grassland which is cut for hay and silage. The majority of the grassland is grazed only (87 %). Silage is cut over 10 % of the grassland area and hay is cut over 3 %. The dates for the hay and silage cuts are early June and mid May respectively.

Table 2.4 Grass conservation

Conservation System	Grassland Area (ha)	% Grassland Area
Grazed only	156	87
1 cut silage	18	10
1 cut hay	6	3

2.8 Nitrogen Application

Nitrogen is applied to all the grassland surveyed within the benefit area; mostly in the form of compound fertilisers, especially 20 N:10 P:10 K. Application rates range from 20 to 50 kg/ha. Further details are presented in Table 2.5.

The higher rates of nitrogen application correspond to the areas which are grazed by dairy cattle and followers (intensive grassland).

Table 2.5 Nitrogen application rates

Rate (kg/ha)	Grassland Area (ha)	% Grassland Area
0	0	0
1 - 20	85	47
21 - 35	63	35
36 - 50	32	18

2.9 Flooding

Land within the benefit area does not flood on a regular basis. No flooding has been experienced on the land during the time of this study. Water levels in Sir Arthur's Pill, the Boundary Drain and minor ditches are controlled by boards in the weirs which are lowered as required to minimise the incidence of flooding. The land adjacent to the river is expected to flood at times during the winter months when water levels are high. Farmers accept this threat as to be expected when working marsh land adjacent to a river.

2.10 Waterlogging

Throughout the benefit area the wetness condition follows a similar pattern throughout the year. Table 2.6 shows the area experiencing different levels of waterlogging during the spring, summer and autumn.

During the spring, 60 % and 38 % of land surveyed is rarely and occasionally wet. Only 2 % of the land is often wet and none permanently wet. Throughout the summer the marsh area dries and only 11 % experiences occasional wet conditions. During the winter, 47 % of the benefit area is permanently wet.

Table 2.6 Wetness condition of agricultural land

Season	Condition	Area (ha)	% Benefit Area
Spring	Rarely wet	145	60
	Occasionally wet	93	38
	Often wet	4	2
	Permanently wet	0	0
Summer	Rarely wet	215	89
	Occasionally wet	27	11
	Often wet	0	0
	Permanently wet	0	0
Autumn	Rarely wet	29	12
	Occasionally wet	53	22
	Often wet	46	19
	Permanently wet	114	47

The main factors responsible for these wet conditions are the limited freeboard in Sir Arthur's Pill and the low lying nature of the land. The area is marshland and so by nature it is characteristically wet throughout the winter months.

2.11 Statistical Analysis

It is apparent that land use, farming practice and drainage are interrelated. Statistical methods were used to determine whether these relationships occurred more frequently than might be expected by pure chance. Full details of this analysis in which the 12 sites were grouped

according to NRA Region, are presented in the Interim Report R&D 317/13/ST, presented to the NRA in December 1994.

The following observations can be made from the statistical analysis of fields in the benefit area of the Sir Arthur's Pill maintenance programme:

- The dominant farming system influences land use within the benefit area. In this case, the dominant farm type is lowland and livestock which is characterised by beef and sheep enterprises. This farm type determines the land use, which is unlikely to change from grass to arable even if drainage were to improve as a result of maintenance.

- A strong relationship exists between land use and installation of field drainage. Areas with field drainage are predominantly given over to horticulture whilst land under an extensive grass system is not drained by pipes. (Statistically, there is an 83 % chance of correctly predicting the incidence of field drainage on the basis of land use).

- Grazing seasons are a function of spring and autumn field wetness conditions and not soil type. This wetness condition is in itself a function of the presence of field drainage. Those fields which are drained by pipes are subject to longer grazing seasons than those which are naturally draining. Livestock are overwintered on the land which is classed as rarely wet. (Statistically, there is a 66 % and 91 % chance of correctly predicting turnout and yarding dates for livestock on the basis of field wetness conditions in the spring and autumn respectively).

3 HYDRAULIC AND HYDROLOGICAL DATA

3.1 Introduction

Information on channel hydraulics and hydrological data has been used to determine the impact of maintenance on channel capacity and flood return periods.

3.2 Cross-section Surveys

Cross-sectional surveys of the channel were completed at five points within the selected section (Figure 2). Channel capacity has been determined from these cross-sections. Because the channel dimensions were not altered during the weed clearance process, a post-maintenance cross-sectional survey of the channel was not necessary.

Before maintenance was carried out, channel roughness was expressed in the form of the Manning's n coefficient, using the methodology developed by Cowan (1956). This coefficient consists of six parameters which include the predominant bed material, degree of meandering and the level of vegetation growth. Further details of the methodology used are presented in the R&D Note 456, Appendix IV. The same procedure was followed after maintenance in order to determine values of channel friction in a 'with' (post)and 'without' (pre) maintenance situation.

Stage/discharge curves have been created for the 'with' and 'without' maintenance situation using these different values of Manning's n. The channel cross-section information including Manning's n values and stage/discharge curves are presented in Figure 5 and Table 3.1.

Table 3.1 Bankfull capacity

Cross-Section	With Maintenance Bankfull Capacity (cumecs)	Without Maintenance Bankfull Capacity (cumecs)
1	8.6	4.4
2	1.6	0.8
3	2.0	1.0
4	7.5	4.5
5	2.1	1.0

(Source: modelled estimates)

The bankfull capacity figures obtained from the cross-sections indicate an average increase in capacity attributable to maintenance of 52 % (from 2.3 to 4.4 m^3/s).

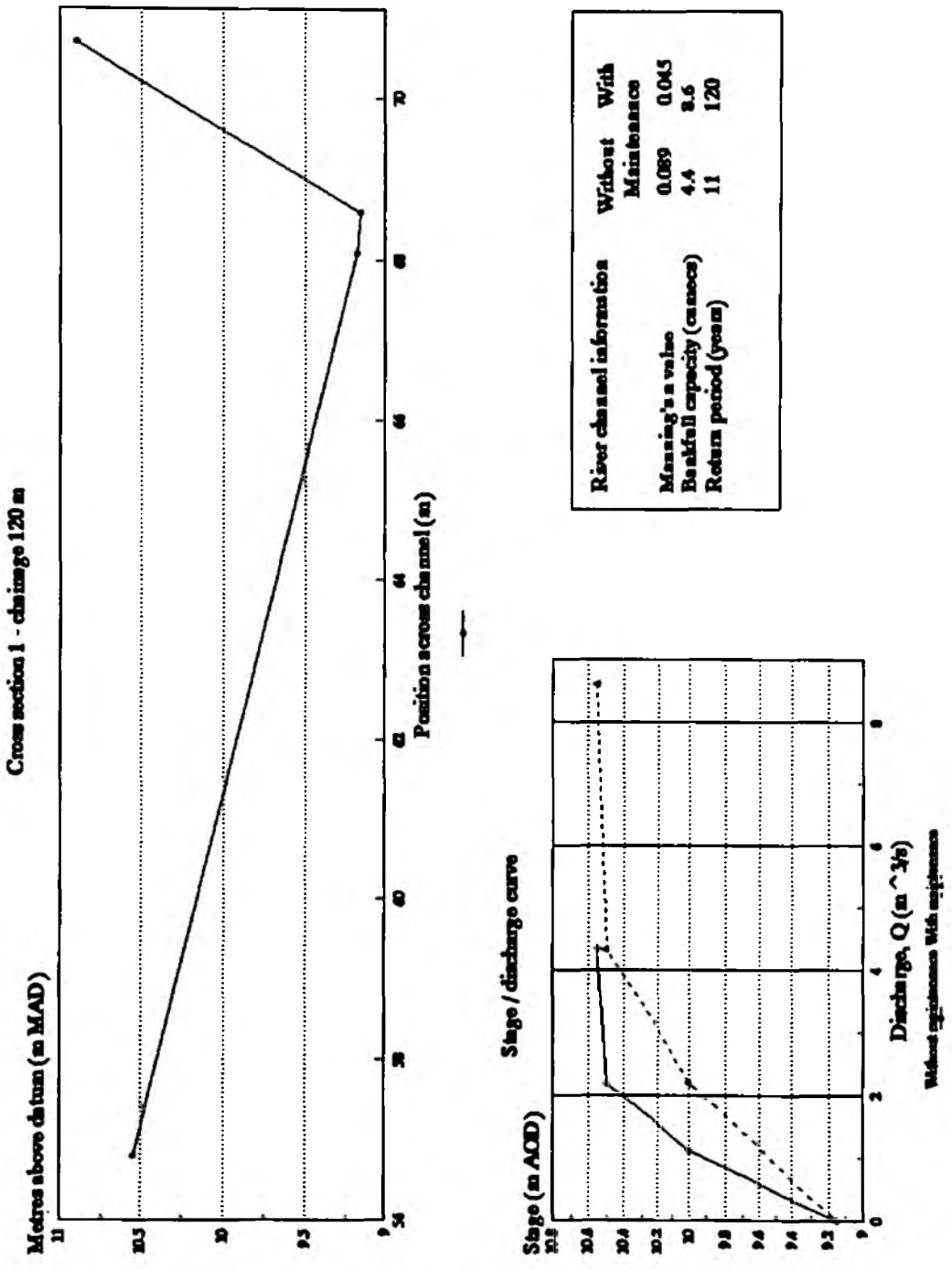
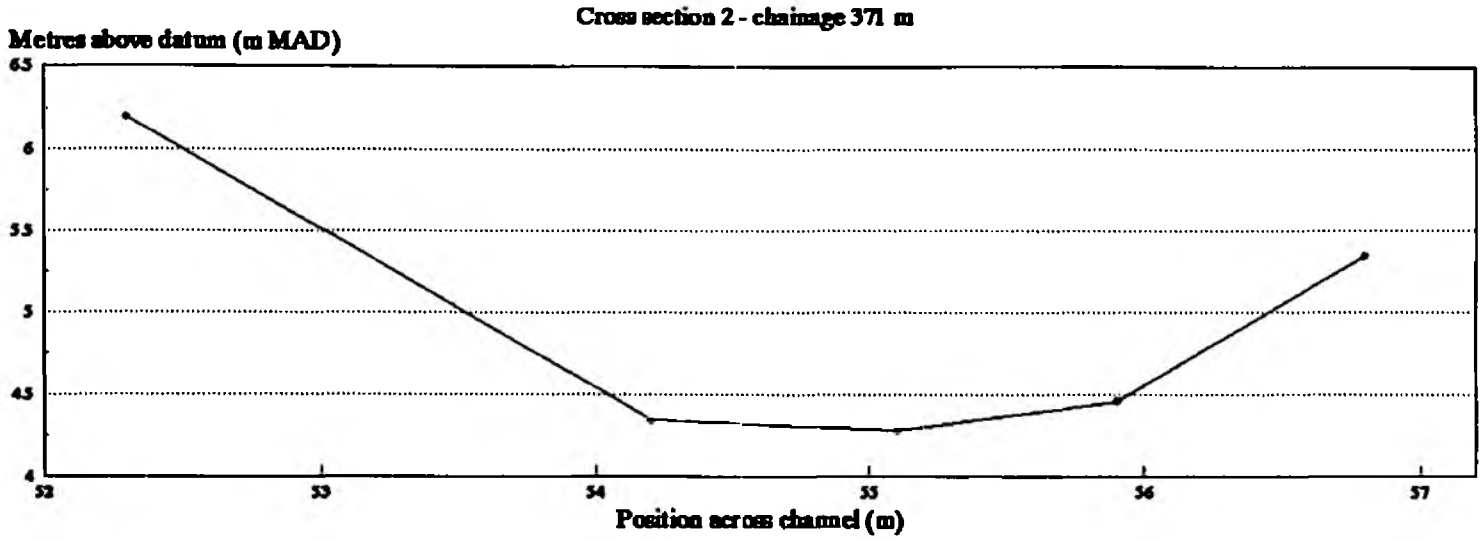
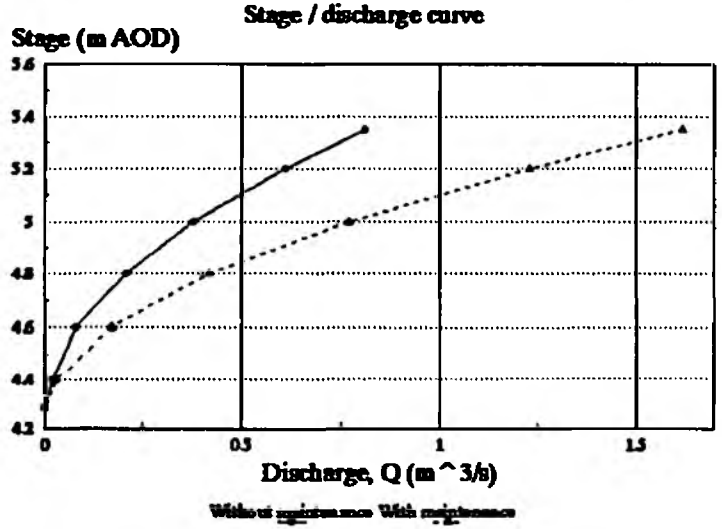
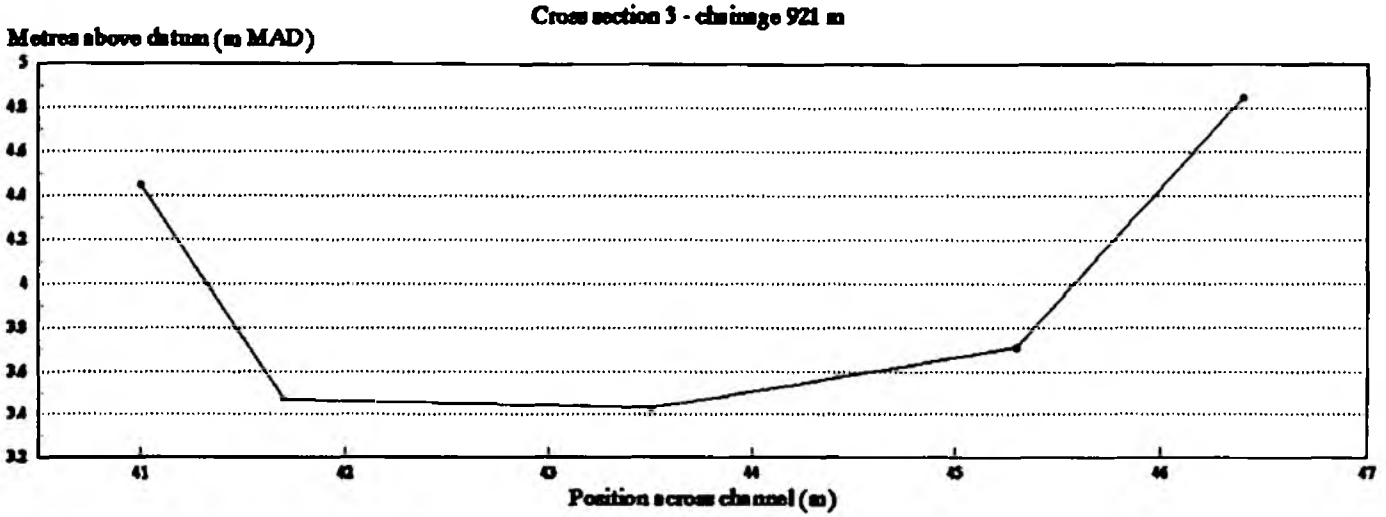


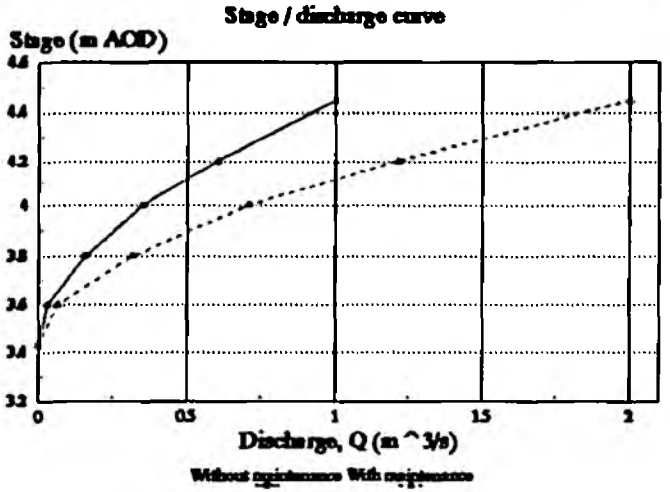
Figure 5 Sir Arthur's Pill channel information



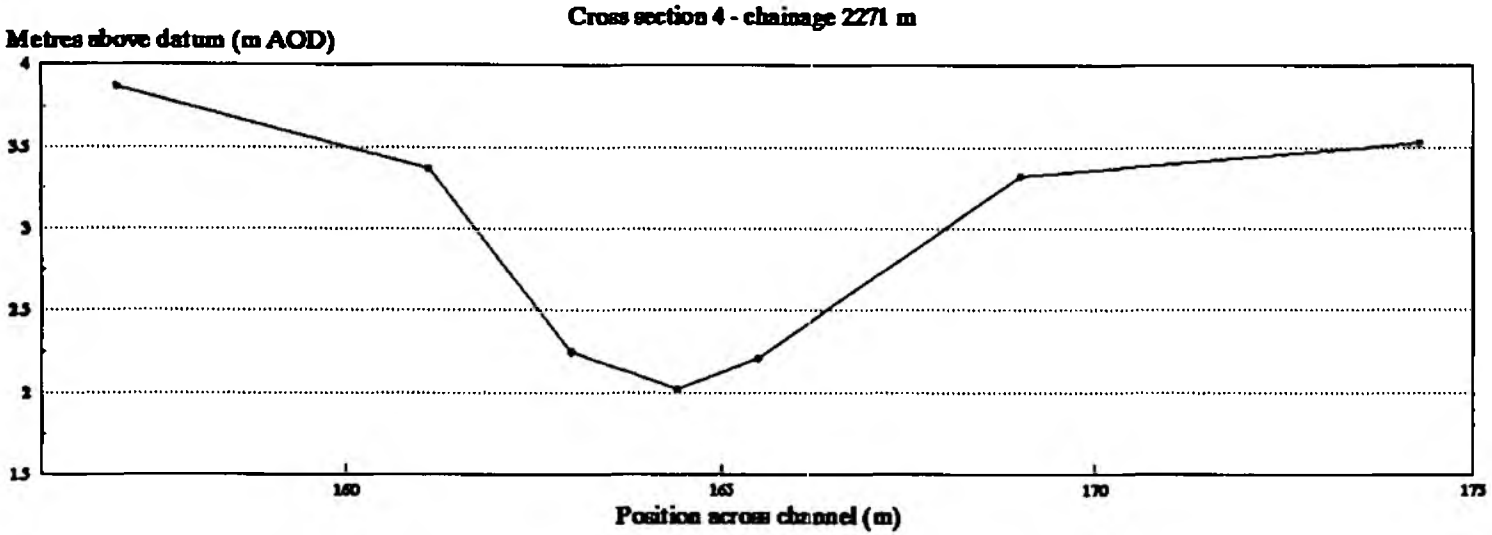


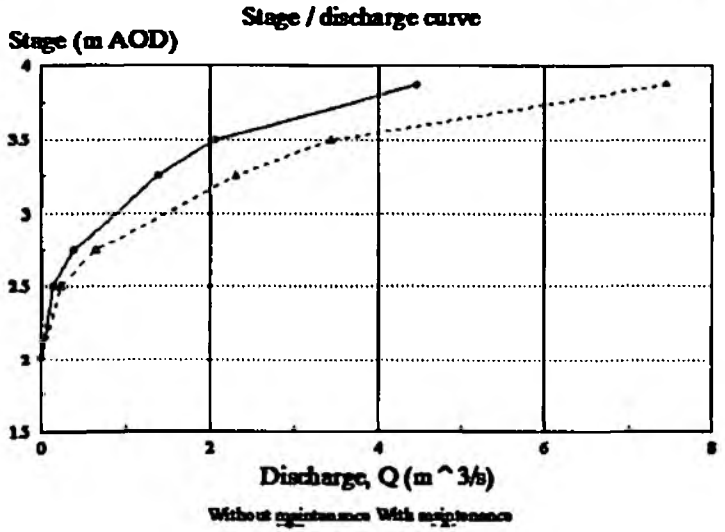
River channel information	Without Maintenance	With
Manning's n value	0.08	0.04
Bankfull capacity (cumecs)	0.8	1.6
Return period (years)	0.15	0.7



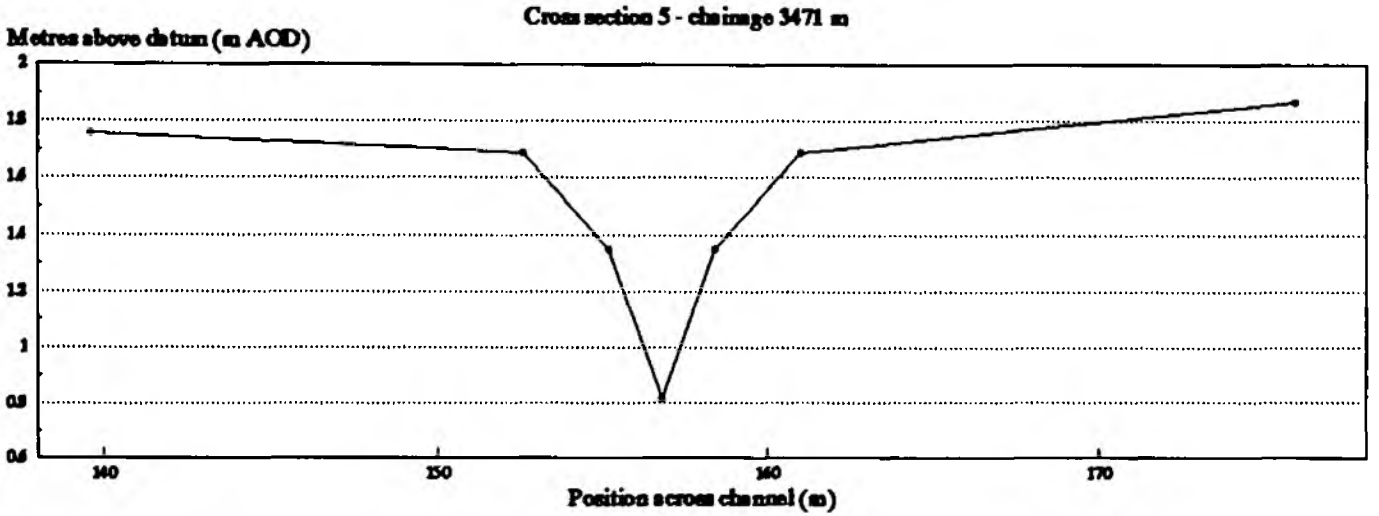


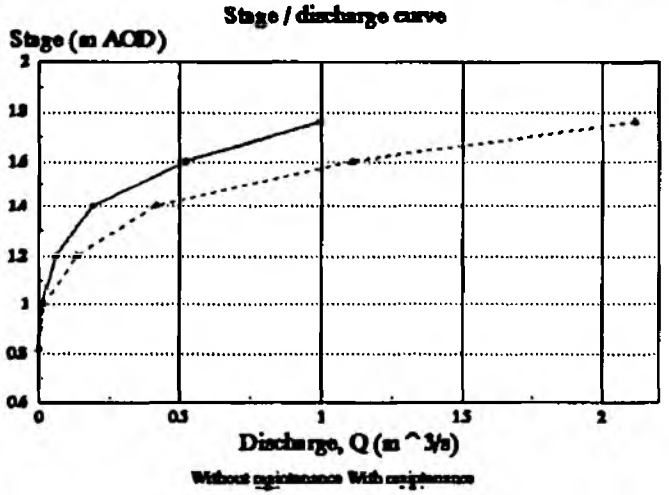
River channel information	Without Maintenance	With
Manning's n value	0.08	0.04
Bankfull capacity (cumecs)	1.0	2.0
Return period (years)	0.2	1.0





River channel information	Without Maintenance	With Maintenance
Manning's n value	0.09	0.054
Bankfull capacity (cumecs)	4.5	7.5
Return period (years)	12	90





River channel information	Without Maintenance	With
Manning's n value	0.085	0.04
Bankfull capacity (cumecs)	1.0	2.1
Return period (years)	0.2	1.1

3.3 Flood Return Period

Throughout the period of the study (1993 - 1995), river water level information was collected on a fortnightly basis by reading off channel water levels from three gauge boards which were installed within the reach. General information regarding flood flows, frequency and duration were collected from farmers and NRA staff. This information was used to compile a flood return period curve for Sir Arthur's Pill using the methodology detailed within the Flood Studies Report (NERC, 1975).

Land within the benefit area is reported not to flood as levels in the channel and Boundary Drain are controlled by a series of sluice boards which are raised or lowered as required to regulate water levels in the channel. If the sluice boards were not operated and land were allowed to flood, the frequency of flooding could be ascertained from the flood return period curve in Figure 6.

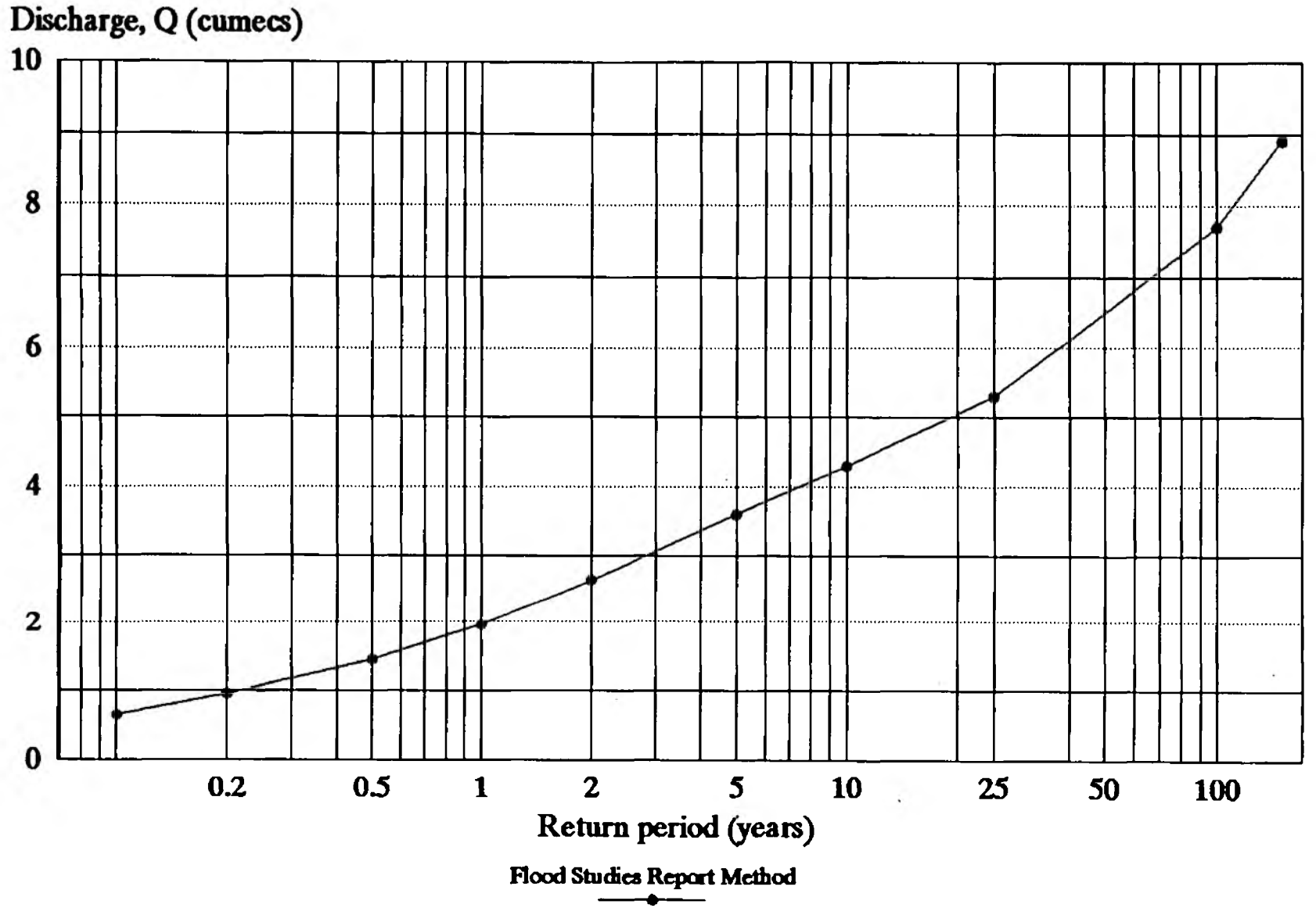


Figure 6 Flood return period curve

4. LAND DRAINAGE

4.1 Field Drainage Status

Through an extensive literature and farmer survey, drainage status of the land has been classified into three standards according to watertable depth. Three watertable bands have been identified as > 0.5 m from the surface, between 0.3 to 0.5 m of the surface and < 0.3 m from the surface. According to the time the watertable lies within these bands, the drainage standard is classed as good (G, no restrictions on land use), bad (B, some restrictions on agriculture) or very bad (VB, severe limitations to agriculture). Further details are presented in the R&D Note 456, Section 3.5.2.

The drainage status of fields within the benefit area has been determined on a seasonal basis using a non-steady state watertable model which relates infield watertable levels (and hence drainage conditions) to observed water levels in the river and ditch system (see R&D Note 456, Section 3.5.2 for further details). The model has been run using river water levels for the 'with' and 'without' maintenance scenario using the same climatic data in order to isolate the impact of maintenance on drainage status. An example of the input and output data of the model is shown in Appendix I.

The results of the watertable model and the assessment of drainage status made by farmers are shown in Table 4.1. In some cases, there may be a change in the number of weeks that the watertable lies within the good, bad and very bad drainage bands following maintenance. However, these changes may not be of sufficient magnitude to change the drainage status classification. Where a sufficient change in drainage status has occurred due to maintenance, resulting in a change in drainage status, the changes appear in bold print in Table 4.1.

Generally, the output from the watertable model is consistent with the farmers' assessment of drainage status under wet, dry and average climatic conditions for the 'with' maintenance situation. The differences appear to be in the distinction between the bad and very bad drainage condition. The farmers tend to class all the land broadly as bad and are unable to determine if the land is under very bad drainage conditions. Under average conditions, there is 88 % agreement between farmer and modelled assessment of drainage conditions with

maintenance. In wet and dry seasons, there is 79 % and 83 % agreement between farmer and modelled assessment of drainage condition for the with maintenance situation respectively.

The assessments confirm that the drainage status in the benefit area 'with' maintenance is generally good under wet, average and dry climatic conditions. If no maintenance were performed, drainage conditions would deteriorate towards bad in wet and average seasons. In a dry season land would remain under a good classification.

Examples of the classification of the weeks of each season which are under conditions of good, bad and very bad drainage status are shown in Appendix II.

Table 4.1 Drainage status for wet, average and dry seasons, without/with maintenance

Block No		Wet Season *		Average Season *		Dry Season *		Farmer Assessment With Maintenance			Without
		Without	With	Without	With	Without	With	Wet	Average	Dry	
101	N	G	G	G	G	G	G	G	G	G	B
102	Y	**B**	**B**	**B**	**B**	G	G	B	*G*	G	B
103	N	**B**	**B**	**B**	**G**	G	G	*G*	G	G	G
201	N	G	G	G	G	G	G	G	G	G	B
202	N	**B**	**B**	**B**	**G**	G	G	B	G	G	B
203	Y	**VB**	**B**	**VB**	**B**	G	G	B	B	G	B
301	N	G	G	G	G	G	G	*B*	*B*	*B*	B
302	N	VB	VB	B	B	G	G	*B*	B	*B*	B
303	N	**VB**	**G**	**B**	**G**	G	G	G	G	G	B
304	Y	G	G	G	G	G	G	G	G	G	B
305	Y	G	G	G	G	G	G	G	G	G	B
306	N	**B**	**G**	**B**	**G**	G	G	G	G	G	B
307	Y	**B**	**G**	**B**	**G**	G	G	G	G	G	B
401	Y	**B**	**G**	**B**	**G**	G	G	G	G	G	G
402	N	G	G	G	G	G	G	G	G	G	G
501	Y	G	G	G	G	G	G	G	G	G	B
502	N	G	G	G	G	G	G	G	G	G	B
503	N	G	G	G	G	G	G	G	G	G	B
504	N	G	G	G	G	G	G	G	G	G	B
505	N	VB	VB	**VB**	**B**	B	B	*B*	B	*G*	B
601	N	**B**	**G**	**B**	**G**	G	G	*B*	G	G	B
701	N	**B**	**G**	G	G	G	G	G	G	G	B
801	N	B	B	B	B	G	G	B	*G*	G	B
901	N	**VB**	**B**	**VB**	**B**	B	B	B	B	*G*	VB

NB : * Modelled results, Y or N refers to the presence or absence of field drainage, bold type highlights changes in drainage status due to maintenance, italics show differences between modelled and farmer assessment of drainage with maintenance.

River maintenance results in the prevention of a deterioration in drainage status on 8 blocks of land in a wet season and on 10 blocks in an average season. The percentage change in drainage status by area as a result of maintenance activities is estimated below :

- In a wet season maintenance prevents deterioration from :

  B to VB over 29 ha (12 % of BA)

  G to B over 28 ha (11 % of BA)

  G to VB over 7 ha (3 % of BA).

- In an average season maintenance prevents deterioration from :

  B to VB over 52 ha (21 % of BA)

  G to B over 50 ha (21 % of BA).

The maintenance on Sir Arthur's Pill is preventing a deterioration of drainage standards on 42 % of the area in an average season and 26 % in wet seasons. Farmers assess that in the absence of maintenance, drainage status would deteriorate on 77 % of the area in an average season.

5 SCHEME APPRAISAL

5.1 Maintenance Benefits

For each block of land, agricultural production scenarios were created which reflect different levels of field management under conditions of good, bad and very bad drainage (see R&D Note 456 Section 3.5.4). These scenarios are based on discussions with farmers in the benefit area over the period 1992-1994.

Changes in field drainage status as a result of maintenance under dry, average and wet climatic conditions have been identified. Changes in flood risk due to maintenance have also been determined. Estimates have been derived of the monetary value of changes in field management and productivity associated with changes in the standards of drainage service.

Two perspectives have been used to value agricultural performance. The first perspective is that of financial analysis which uses the prices paid and received by farmers to estimate the added-value associated with drainage. Financial analysis shows the benefits of maintenance to farmers in the benefit area.

The second perspective is that of economic analysis which modifies the financial analysis to make allowance for the direct and indirect subsidies paid to farmers by Government. In accordance with the MAFF Project Appraisal Guidance Notes on Flood Defence (PAGN, 1993), these modifications involve reductions in the financial value of output (including subsidies) by 10 % in the case of cereals, oil seeds and grain legumes, 35 % for beef and 25 % for sheep. Commodities subject to quota such as potatoes, sugar beet and milk are treated as winter wheat. The set aside areas are also treated as wheat. The reasons for these adjustments are discussed in the R&D Note 456 Section 2.7.2.

Using the results of watertable modelling, Table 5.1 shows the financial net returns (1995/96 prices) for each block of land within the benefit area under conditions of good, bad and very bad drainage. Changes in net returns relating to a change in drainage status are also shown. Table 5.2 presents similar data using economic prices.

Table 5.1 Financial net returns

Block	Net Return (£/ha)			Change in net Return (£/ha)		
	Good	Bad	Very Bad	Good to Bad	Bad to Very Bad	Good to Very Bad
101	135	93	69	43	24	66
102	206	146	95	60	52	112
103	190	137	94	53	43	95
201	518	311	230	207	82	288
202	207	156	152	51	4	55
203	185	151	123	34	28	62
301	146	116	73	29	43	73
302	206	167	126	39	41	80
303	554	303	233	252	70	321
304	554	303	233	252	70	321
305	137	108	64	28	45	73
306	536	338	255	197	84	281
307	108	84	63	24	20	44
401	1247	543	151	705	392	1096
402	1247	543	151	705	392	1096
501	1037	514	174	523	339	863
502	1037	514	174	523	339	863
503	1038	515	175	524	339	863
504	1046	524	175	522	348	871
505	418	332	234	86	98	184
601	Holiday homes					
701	351	292	244	59	48	110
801	354	289	218	65	71	213
901	431	285	262	146	23	-262

Table 5.2 Economic net returns

Block	Net Return (£/ha)			Change in net Return (£/ha)		
	Good	Bad	Very Bad	Good to Bad	Bad to Very Bad	Good to Very Bad
101	1	-17	-20	18	3	21
102	28	5	-12	23	17	40
103	29	7	-12	22	19	41
201	365	301	165	63	137	200
202	66	44	35	22	8	30
203	61	46	33	16	13	28
301	-8	-14	-19	7	5	12
302	66	48	33	18	15	33
303	372	301	168	70	134	204
304	372	301	168	70	134	204
305	-9	-15	-24	7	8	15
306	382	320	189	62	131	193
307	-14	-20	-25	6	4	10
401	1126	603	177	523	426	949
402	1126	603	177	523	426	949
501	743	897	177	-154	721	566
502	743	897	177	-154	721	566
503	933	898	177	35	721	756
504	933	898	177	35	721	756
505	375	309	177	67	132	198
601	Holiday homes					
701	149	121	97	29	24	52
801	130	96	63	33	33	66
901	135	109	82	27	26	53

Table 5.3 combines data on changes in drainage status and financial performance to determine the financial benefits and change in financial net returns due to maintenance for wet, average and dry weather conditions for each block of land in the benefit area. These benefits are the avoidance of losses which would occur in the absence of maintenance. Benefits, weighted by field size for wet, average and dry seasons are multiplied by the relative probability of the occurrence of the season to give an average expected annual benefit. These are summed for the benefit area as a whole.

Table 5.3 estimates a total expected annual benefit of about £ 7700 in 1995 financial prices, equivalent to about £ 32/ha per year. The benefits relate to watertable control. Table 5.4 shows the benefits attributable to maintenance using economic prices based on the current MAFF Project Appraisal Guidance Notes. Total average expected annual benefits are approximately £ 5000 in economic prices for the benefit area, equivalent to £ 21/ha. On this basis, the benefit to the national economy is 65 % of the benefits which accrue to farmers. This difference reflects the adjustments required by MAFF to remove government subsidy from the assessment of benefits.

As an alternative estimate to that based on watertable modelling, Table 5.5 estimates the benefits due to maintenance which were perceived by farmers (earlier reported in Table 4.1) where they identified a change in drainage conditions between the 'with' and 'without' maintenance situations in an average, representative season. Farmer assessment gave an average annual financial benefit of £ 23571 (£ 97/ha) and an economic benefit of £ 2483 (£ 10/ha).

According to the criteria used, these financial and economic benefit estimates show the limits which farmers and the nation respectively could justifiably spend on maintenance. These estimates require cautious interpretation as explained in the R&D Note 456 Section 2.7.2.

Table 5.3 Changes in net returns due to maintenance and climate, 1995/96 financial prices

Block	Area (ha)	Wet Season			Average Season			Dry Season			Total Change (£/yr)
		Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	
101	14.60	0	0	0	0	0	0	0	0	0	0
102	5.80	0	0	0	0	0	0	0	0	0	0
103	11.60	0	0	0	53	0	53	0	0	0	349
201	4.70	0	0	0	0	0	0	0	0	0	0
202	6.80	0	0	0	51	0	51	0	0	0	198
203	9.00	27	0	27	27	0	27	0	0	0	206
301	13.70	0	0	0	0	0	0	0	0	0	0
302	16.2	0	0	0	0	0	0	0	0	0	0
303	6.80	321	0	321	252	0	252	0	0	0	1558
304	4.2	0	0	0	0	0	0	0	0	0	0
305	4.7	0	0	0	0	0	0	0	0	0	0
306	11.2	197	0	197	197	0	197	0	0	0	1848
307	6.3	24	0	24	24	0	24	0	0	0	127
401	2.8	705	0	705	705	0	705	0	0	0	1652
402	3.1	0	0	0	0	0	0	0	0	0	0
501	8	0	0	0	0	0	0	0	0	0	0
502	7.2	0	0	0	0	0	0	0	0	0	0
503	4.2	0	0	0	0	0	0	0	0	0	0
504	4.2	0	0	0	0	0	0	0	0	0	0
505	22.9	0	0	0	98	0	98	0	0	0	1281
601	4.4	Holiday Homes									
701	3.6	59	0	59	0	0	0	0	0	0	56
801	46.00	0	0	0	0	0	0	0	0	0	0
901	20.4	23	0	23	23	0	23	0	0	0	393
Total	242.40										7666
Probability of :-		Wet season		0.265						Benefit (£/ha)	32
		Average season		0.572							
		Dry season		0.163							

Table 5.4 Changes in net returns due to maintenance and climate, 1995/96 economic prices

Block	Area (ha)	Wet Season			Average Season			Dry Season			Total Change (£/yr)
		Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	Benefit due to drainage (£/ha/yr)	Benefits of flood alleviation (£/ha)	Change in net return due to maintenance	
101	14.60	0	0	0	0	0	0	0	0	0	0
102	5.80	0	0	0	0	0	0	0	0	0	0
103	11.60	0	0	0	22	0	22	0	0	0	146
201	4.70	0	0	0	0	0	0	0	0	0	0
202	6.80	0	0	0	22	0	22	0	0	0	86
203	9.00	13	0	13	13	0	13	0	0	0	98
301	13.70	0	0	0	0	0	0	0	0	0	0
302	16.2	0	0	0	0	0	0	0	0	0	0
303	6.80	204	0	204	70	0	70	0	0	0	640
304	4.2	0	0	0	0	0	0	0	0	0	0
305	4.7	0	0	0	0	0	0	0	0	0	0
306	11.2	62	0	62	62	0	62	0	0	0	581
307	6.3	6	0	6	6	0	6	0	0	0	32
401	2.8	523	0	523	523	0	523	0	0	0	1226
402	3.1	0	0	0	0	0	0	0	0	0	0
501	8	0	0	0	0	0	0	0	0	0	0
502	7.2	0	0	0	0	0	0	0	0	0	0
503	4.2	0	0	0	0	0	0	0	0	0	0
504	4.2	0	0	0	0	0	0	0	0	0	0
505	22.9	0	0	0	132	0	132	0	0	0	1729
601	4.4	Holiday Homes									
701	3.6	29	0	29	0	0	0	0	0	0	28
801	46.00	0	0	0	0	0	0	0	0	0	0
901	20.4	26	0	26	26	0	26	0	0	0	444
Total	242.40										5009
Probability of :-		Wet season		0.265						Benefit (£/ha)	**21**
		Average season		0.572							
		Dry season		0.163							

Table 5.5 Farmer assessment of maintenance benefits

Block	Area (ha)	Average Season Financial Prices: Benefit due to drainage (£/ha/yr)	Average Season Financial Prices: Benefits of flood alleviation (£/ha)	Average Season Financial Prices: Change in net return due to maintenance	Average Season Economic Prices: Benefit due to drainage (£/ha/yr)	Average Season Economic Prices: Benefits of flood alleviation (£/ha)	Average Season Economic Prices: Change in net return due to maintenance
101	14.60	43	0	628	18	0	263
102	5.80	60	0	348	23	0	133
103	11.60	0	0	0	0	0	0
201	4.70	207	0	973	63	0	296
202	6.80	51	0	347	22	0	150
203	9.00	0	0	0	0	0	0
301	13.70	0	0	0	0	0	0
302	16.2	0	0	0	0	0	0
303	6.80	252	0	1714	70	0	476
304	4.2	252	0	1058	70	0	294
305	4.7	28	0	132	7	0	33
306	11.2	197	0	2206	62	0	694
307	6.3	24	0	151	6	0	38
401	2.8	0	0	0	0	0	0
402	3.1	0	0	0	0	0	0
501	8	523	0	4184	-154	0	-1232
502	7.2	523	0	3766	-154	0	-1109
503	4.2	524	0	2201	35	0	147
504	4.2	522	0	2192	35	0	147
505	22.9	0	0	0	0	0	0
601	4.4	Holiday Homes					
701	3.6	59	0	212	29	0	104
801	46.00	65	0	2990	33	0	1518
901	20.4	23	0	469	26	0	530
Total	242	Total financial benefit (£)		23571	Total economic benefit (£)		2483
		Benefit (£/ha)		97	Benefit (£/ha)		10

5.2 Maintenance Costs

Maintenance activities on the Sir Arthur's Pill involve desilting and weed clearance carried out on an 18 month cycle. According to NRA sources, the 1992/93 cycle cost £ 7700, equivalent to an annual average cost of £ 5430 in 1995 prices, about £ 23/ha of benefit.

5.3 Scheme Appraisal

The estimated benefits attributable to maintenance can be compared with estimated costs to determine the justification for expenditure. Maintenance costs have been amortised to derive annual costs in order for the appraisal to involve a simple comparison of annual benefits and costs.

Table 5.6 shows that according to the modelled results, the existing maintenance scheme is viable in financial terms and almost breaks even in economic terms:

Table 5.6 Maintenance scheme appraisal: Sir Arthur's Pill

Average Annual Benefit (£)	Average Annual Benefits (£)	Average Annual Costs (£)	Benefit : Cost Ratio
Modelled Estimates			
Financial Prices	7700	5430	1.42
Economic Prices	5000	5430	0.92
Farmer Estimates			
Financial Prices	23571	5430	4.34
Economic Prices	2483	5430	0.46

Farmer assessment gave an average annual financial benefit of £ 23571 (£ 97/ha) and an economic benefit of £ 2483 (£ 10/ha) under average seasons. The scheme generates an annual benefit : cost ratio of 4.34 and 0.46 in financial and economic terms respectively.

These conclusions must be interpreted cautiously as discussed in the R&D Note 456 Section 2.7.2.

6 ENVIRONMENT

6.1 Introduction

The environmental quality of the Sir Arthur's Pill is outlined in this chapter. Reference is made to river corridor surveys, public consultation and farmer assessment.

6.2 Sites of Specific Scientific Interest

Three sites within the benefit area were bought by English Nature in April 1991. These sites are designated as the Braunton Swampool Site of Specific Scientific Interest (SSSI) part owned by the Devon Wildlife Trust, and the Greenaways and Freshmarsh SSSI sites (Figure 7). The Braunton Swampool site is one of only three remaining herb rich grazing meadows in Devon. The SSSI is flat and low lying with a high watertable. The soil is derived from marine alluvium with peaty horizons.

All three sites support a rich and diverse flora including local rarities such as the Marsh Arrowgrass (*Triglochin palustris*) and Tasteless Water-Pepper (*Polygonum mite*). The flora is thought to be typical of a traditional grazing marsh of which less than 24 000 ha remain in Great Britain.

In the past, management of the land resulted in the development of two different vegetation communities; MG11 and MG10 under the National Vegetation Classification (NVC). Land management deteriorated and fen vegetation developed (NVC M27/28). The aim of English Nature and the Devon Wildlife Trust is to resume traditional management of the land to encourage the development of the traditional vegetation community. At present, the land is not grazed but simulated hay cutting is practised in the summer.

6.3 River Corridor Survey

Prior to the river maintenance works in 1992, a river corridor survey was completed (Appendix II) for the selected reach following the survey methodology developed by the Nature Conservancy Council (NCC, now English Nature, EN). Sketch maps and record cards have been produced for each 500 m section. The survey concentrated on the river corridor

and adjacent land. Details concerning such features as channel dimensions, bed substrate, presence of structures, field drainage and bank and in channel vegetation were recorded.

As river maintenance did not alter the channel characteristics, especially as the banks were not flail mown, a complete post-maintenance corridor survey was not necessary. The post-maintenance survey took the form of a vegetational survey which concentrated on the location and percentage cover of channel vegetation (Appendix II).

6.4 Public Consultation

In the spring of each year a 'Conservation liaison Meeting' is held by the NRA to discuss the work programme for river maintenance in the following year. Representatives from various organisations such as EN, Countryside Commission (CC), English Heritage (EH), the Internal Drainage Board (IDB) and Royal Society for the Protection of Birds (RSPB) are invited to attend. Objections to the proposed work can be raised and if necessary modifications to the work programme made.

6.5 Farmer Assessment

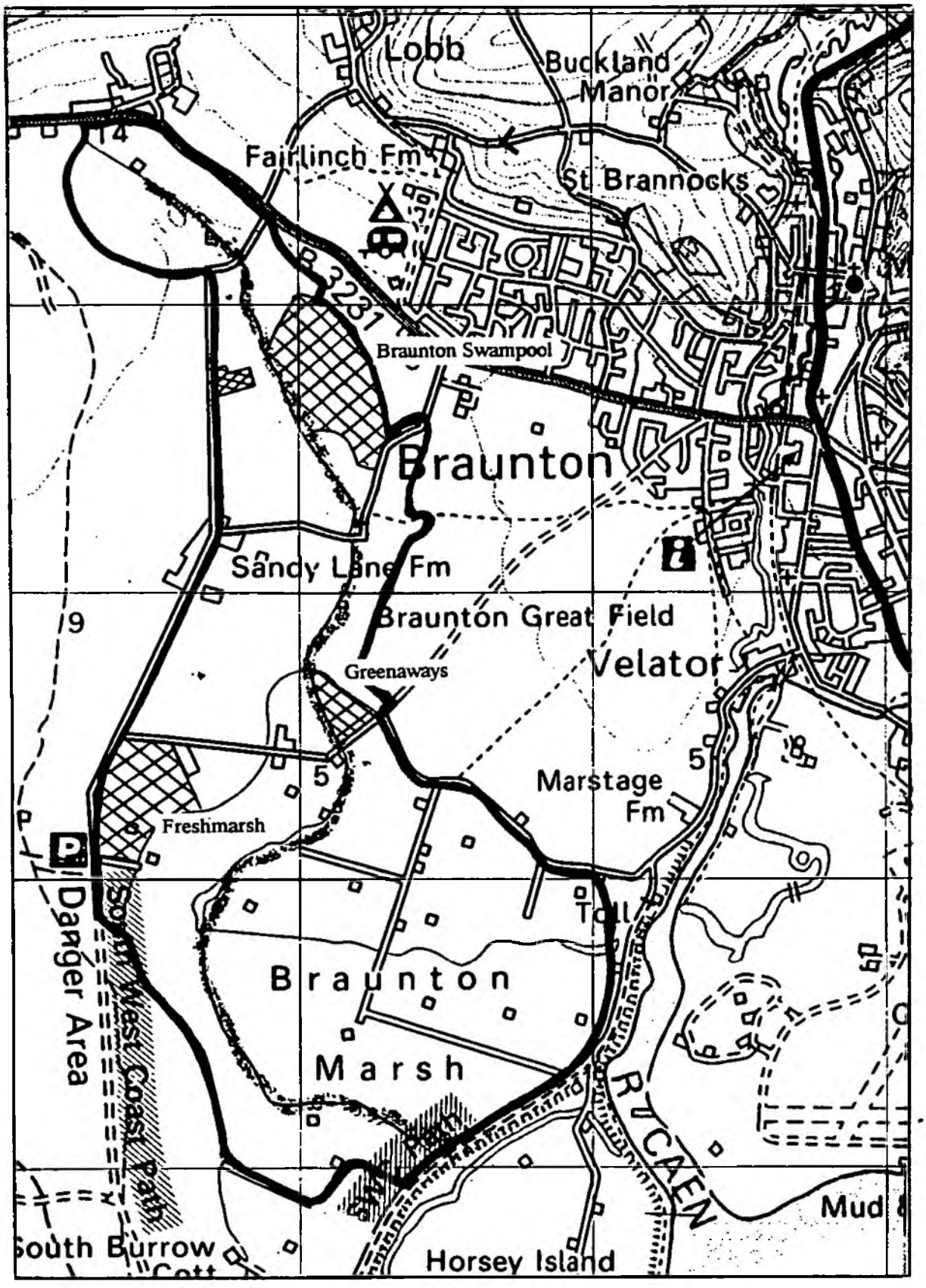
Farmers interviewed within the benefit area were asked to identify any environmental features along the reach which they thought were likely to be disturbed or destroyed by the maintenance work. Only one thought that river maintenance would have a detrimental impact on the environment. The young trees growing on the river banks were thought to be destroyed or damaged by machinery.

6.6 Channel and Bank Quality

The environmental quality of the Sir Arthur's Pill has been determined by following the procedure outlined in the 'Guidelines for the Justification of River Maintenance' (R&D Note 511) produced within the framework of the NRA R&D Note 456 (River Maintenance Evaluation).

The quality of both the channel and bank is classed as low. There is no transitional zone between the channel edge and the river at times of low flow, the sediment is uniform, no riffles and pools are present and the channel is of a uniform habitat.

The banks are of uniform structure, consisting of predominantly one vegetation type and no trees or scrub. Bank width is typically less than 2 m. The banks over the marsh area consist of uniform grass cover which is grazed by sheep and cattle. The bank structure is not varied and there are no dense stands of single species or flowering herbs. Channel banks of the upper section of the Sir Arthur's Pill which flows through the arable area are also uniform in structure and cleared of vegetation during the maintenance programme.



Scale 1 : 6250

Figure 7 Sites of Specific Scientific Interest

7 CONCLUSIONS

7.1 Scheme Appraisal

The existing maintenance scheme of weed clearance and desilting is viable in financial terms. The average annual benefit of maintenance in terms of its prevention in a deterioration in drainage status is £ 7700. Average annual maintenance costs are approximately £ 5430. The benefit : cost ratio is therefore 1.42. In economic prices, the benefit : cost ratio is 0.92; the scheme almost breaks even.

7.2 Guidelines for River Maintenance

The 'Guidelines for the Justification of River Maintenance' (R&D Note 511), produced as a result of this River Maintenance Evaluation Study were used to provide an alternative method for justification of river maintenance on Sir Arthur's Pill.

According to this method, the economic benefit : cost ratio is 2.1. This value is more than that derived from the detailed analysis; the results of which are summarised in Section 7.1. The differences in result may be due to the fact that average channel dimensions were taken for the whole study reach. If the study reach is divided up into sub-reaches, the benefit : cost ratio produced using the Guidelines is more comparable to that produced under detailed analysis.

7.3 Impact of Maintenance on Channel Vegetation

The types of vegetation found within Sir Arthur's Pill are discussed in Section 1.10. The impact of the submerged and emergent vegetation on channel capacity is also discussed. Different vegetation types respond to maintenance in different ways.

The floating vegetation *Lemna* and *Azolla* reproduce vegetatively and unless every fragment of this vegetation is removed from the channel, vegetative reproduction will occur and the weed will rapidly regrow. Chemical control is the most effective method of control in this case. However, *Lemna* and *Azolla* do not affect channel capacity as they are free-floating plants and offer no resistance to flow. They can however, reduce water quality.

The Canadian pondweed (*Elodea*) reproduces through a system of rhizomes (underground stems). The current method of maintenance - regular cutting, actually stimulates regrowth of

this vegetation. Desilting of the channel every few years is necessary in order to remove the rhizomes in the channel sediments.

The current maintenance regime is appropriate in controlling much of the channel vegetation. The vegetation is cut and removed from the channel and the channel is desilted every 18 months. Desilting reduces the rhizome and seed bank in the channel sediments. Regular cutting of the reeds and Canary grass stimulates regrowth. Through cutting every 18 months, vegetation regrowth is likely to occur at a slower rate than if cutting was on an annual basis.

7.4 Maintenance Best Practice

The 'best practice' vegetation maintenance methods for Sir Arthur's Pill were determined using procedures outlined in the Guidelines for the Justification of River Maintenance' (R&D Note 511), produced as a result of the Environmental Impact Assessment Study.

Channel

Best practice maintenance operations for emergent weed are identified as :

- Annual autumn cutting;
- Biennial cutting; and,
- Cutting on a 3 to 5 year rotation.

Best practice maintenance operations for floating and submerged weed are identified as :

- Biennial cutting;
- Cutting on a 3 to 5 year rotation; and,
- Desilting / raking on a 2 to 7 year rotation.

All these maintenance operations should be selective, concentrating on those areas which are particularly choked by vegetation or areas in which the weed is liable to cause an obstruction, hazard or restriction to flow.

Since the beginning of this study, weed maintenance has been performed at an interval of approximately 18 months during the autumn or winter. All the channel vegetation is removed. Generally, in terms of timing, the maintenance regimes recommended as best practice in environmental terms for vegetation management are currently being applied to this reach of the

Sir Arthur's Pill. However, if some vegetation were left un-cut along the channel margins this would improve the environmental quality of the channel.

Bank

Best practice maintenance operations for bank vegetation are identified as :

- Light grazing.

The majority of the banks in the grassland areas are grazed by sheep, cattle or horses and are not flail mown. In arable areas, the banks are not flail mown. Grazing regimes are relatively intensive and if the bank is un-fenced, the bank vegetation remains short and uniform in structure.

If the bank maintenance regime recommended as best practice in environmental terms were implemented, the grazing intensity of the banks should be reduced. This may entail the fencing of banks adjacent to the watercourse.

7.5 Recommendations

It is recommended that further research examines :-

- the impact of a reduced maintenance frequency (cutting every 2 years) on land drainage within the benefit area; and,
- the impact of reduced channel maintenance on channel environmental quality.

7.6 Epilogue

This report has assessed the impacts of the current maintenance regime on the study reach. It has been used along with other study sites to formulate guidelines on the appraisal of maintenance works and best environmental practice. These draft guidelines are summarised in Chapter 5 of the R&D Note 456 and presented in full under separate covers.

8. REFERENCES

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Map: Agricultural Land Classification. Sheet 163 (1974). MAFF.

Map: Ordnance Survey Landranger 180. Barnstaple and Ilfracombe Area. 1:50 000. Ordnance Survey, Southampton.

APPENDIX I

Example of input and output data for the watertable model

Sir Arthur's Pill
Block Number 901
Cross-section 5

	Input Data	Output Data
	River height (m AOD)	Watertable height (m AOD)
Week 1993		
1	1.44	1.49
2	1.44	1.69
3	1.37	1.66
4	1.44	1.61
5	1.44	1.51
6	1.37	1.44
7	1.37	1.39
8	1.37	1.38
9	1.43	1.37
10	1.43	1.35
11	1.40	1.32
12	1.40	1.37
13	1.40	1.34
14	1.40	1.46
15	1.40	1.40
16	1.40	1.35
17	1.37	1.22
18	1.37	1.18
19	1.28	1.24
20	1.28	1.37
21	1.40	1.30
22	1.40	1.69
23	1.40	1.69
24	1.40	1.40
25	1.60	1.28
26	1.60	1.35
27	1.60	1.69
28	1.60	1.62
29	1.51	1.67

Example of drainage status classification, Sir Arthur's Pill

With maintenance

Block 901		No. of weeks	
	Watertable depth (m)	1993	Spring 1993
>0.5	1.22	19	1.22
0.3><0.5m	1.42	11	1.42
<0.3m	1.72	22	1.72

Drainage status classification, according to time watertable is within the G, B, VB drainage bands

Without maintenance

		No. of weeks	
	Watertable depth (m)	1993	Spring 1993
>0.5	1.22	2	1.22
0.3><0.5m	1.42	18	1.42
<0.3m	1.72	32	1.72

Drainage status classification, according to time watertable is within the G, B, VB drainage bands

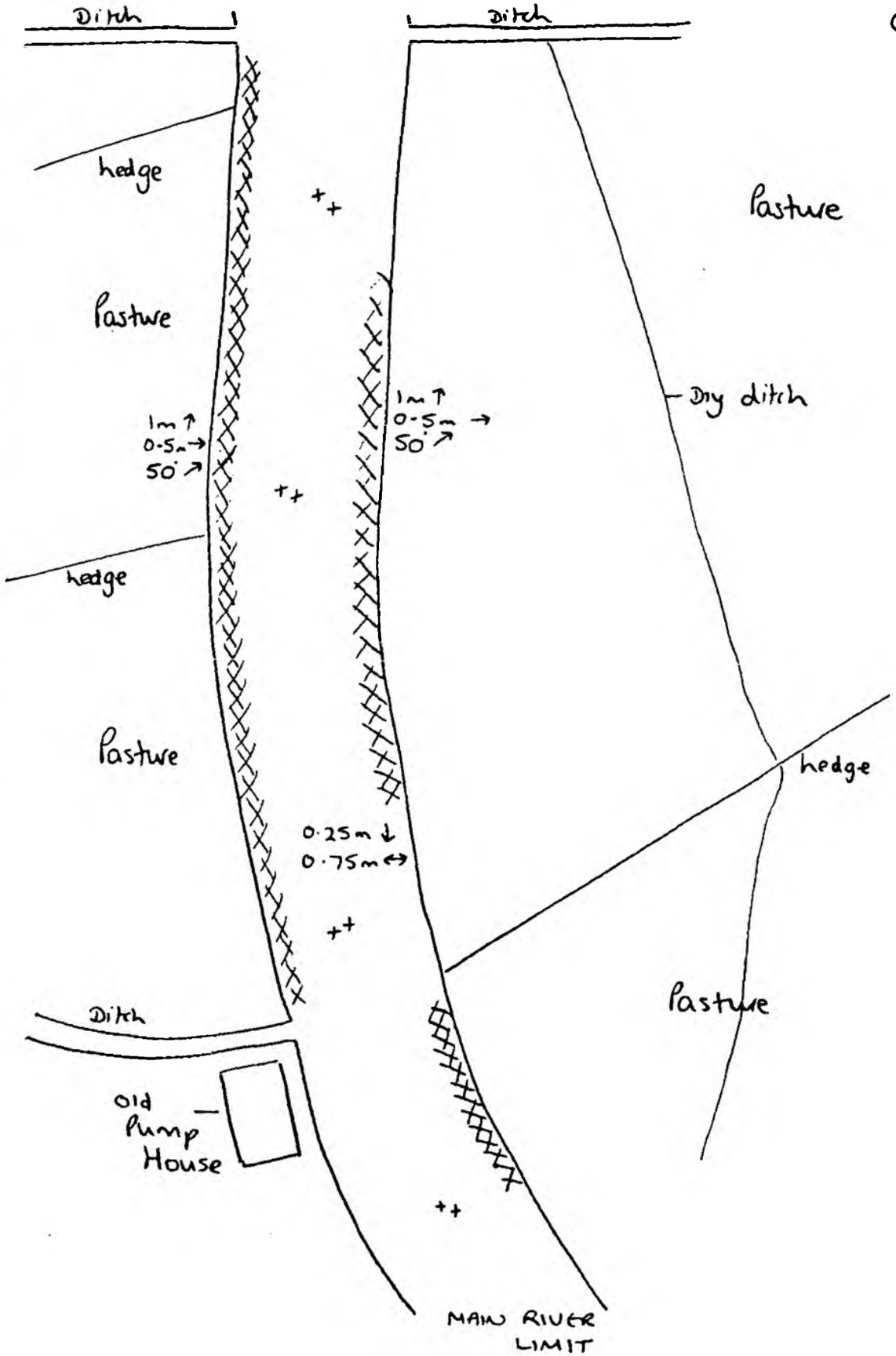
No. of weeks	Summer 1993	No. of weeks	Autumn 1993	No. of weeks
12	1.22	4	1.22	1
1	1.42	4	1.42	3
0	1.72	5	1.72	9
Good		Bad		Very Bad

No. of weeks	Summer 1993	No. of weeks	Autumn 1993	No. of weeks
2	1.22	0	1.22	0
10	1.42	5	1.42	1
0	1.72	8	1.72	12
Bad		Very Bad		Very Bad

APPENDIX II

Sir Arthur's Pill
Pre Maintenance

Flow
0 - 0·5 Km.



	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	100
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER BRAUNTON MARSH

Km No. 0 – 0·5 KM

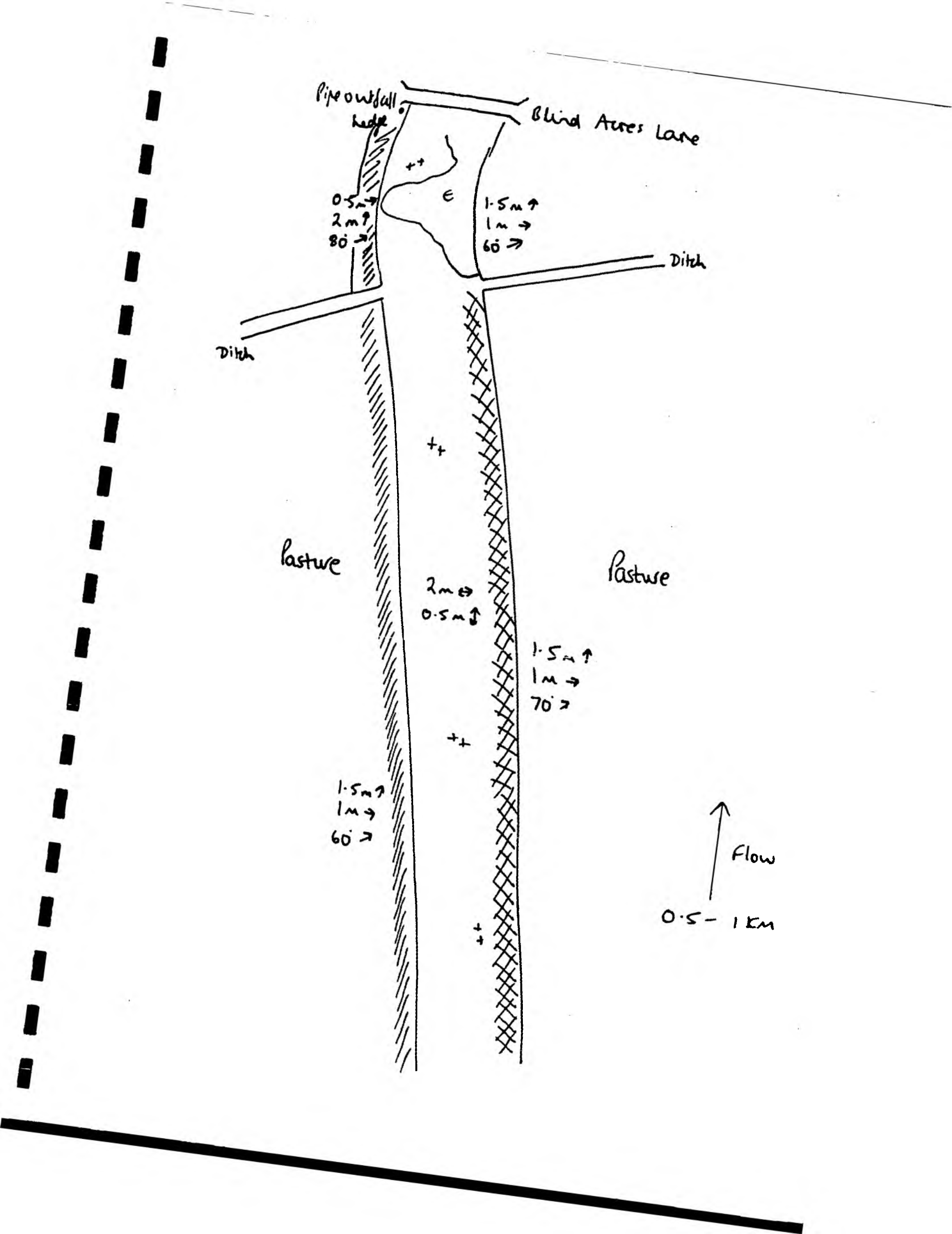
Date 6/4/92

Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj. land in each stretch	
canal =	2	8
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide –		
1·5m		
5·10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =	1	1
fence on bank		
fence set back		
wall		
building	2	
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

	LB	RB
BANK FEATURES %		
shell %		
solid earth cliff (1m↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
flood bank adj.		
flood bank set back		
levee		
Height <1m	100	100
1·<2m		
>2m		
Width <1m	100	100
1·<2.5m		
2.5·<5m		
>5m		
Slope <30°	100	100
30·<60°		
60·<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %	80	80
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	1
Depth <.25m %	100
.25·<.5	
0.5·<1.0	
>1.0m	
Width <1	100
1·<5	
5·<10	
10·<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
+ silt/mud	100
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	100
emergent 1·2m wide	
emergent >2m wide	
total veget. area	20
B bryophytes	
E emergents 100	
A submerged	
F floating	total ≤ 100%
algae % of stretch	


Pipe outfall
Hedge
Blind Acres Lane
0·5m →
2m ↑
80° →
1·5m ↑
1m →
60° ↗
Ditch
Ditch
Pasture
Pasture
2m ↔
0·5m ↕
1·5m ↑
1m →
70° ↗
1·5m ↑
1m →
60° ↗
Flow
0·5 - 1 km

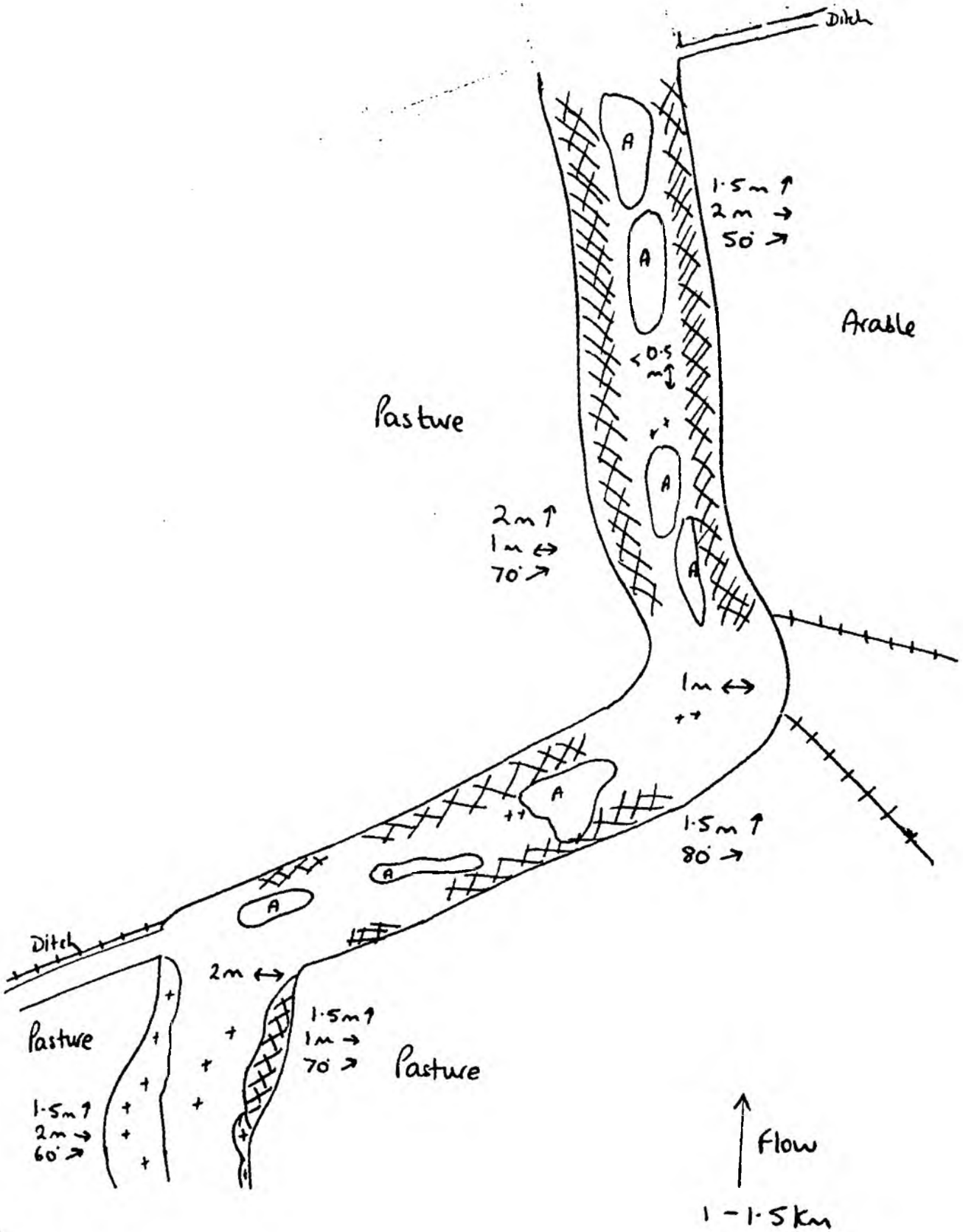
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	100
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/resseded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER Braunton Marsh
Km No. 0·5 – 1 Km
Date 6/4/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)		
canal =	1	1
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1·5m		
5·10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =	2	
fence on bank		
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1m ↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1·<2m	100	
>2m		
Width <1m	20	
1·<2.5m	80	
2.5·<5m		
>5m		
Slope <30°		
30·<60°	80	
60·<90°	20	
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %	100	
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25·<.5	100
0.5·<1.0	
>1.0m	
Width <1	
1·<5	100
5·<10	
10·<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	37
emergent 1·2m wide	3
emergent >2m wide	
total veget. area	30
B bryophytes	
E emergents 100	
A submerged	
F floating	
algae % of stretch	(total to 100%)


Ditch
A
A
A
A
A
A
A
1·5m ↑
2m →
50° ↗
Arable
< 0·5 m
Pastwe
2m ↑
1m ↔
70° ↗
1m ↔
1·5m ↑
80° ↗
Ditch
2m ↔
1·5m ↑
1m →
70° ↗
Pasture
Pastwe
1·5m ↑
2m →
60° ↗
Flow
1 - 1·5km

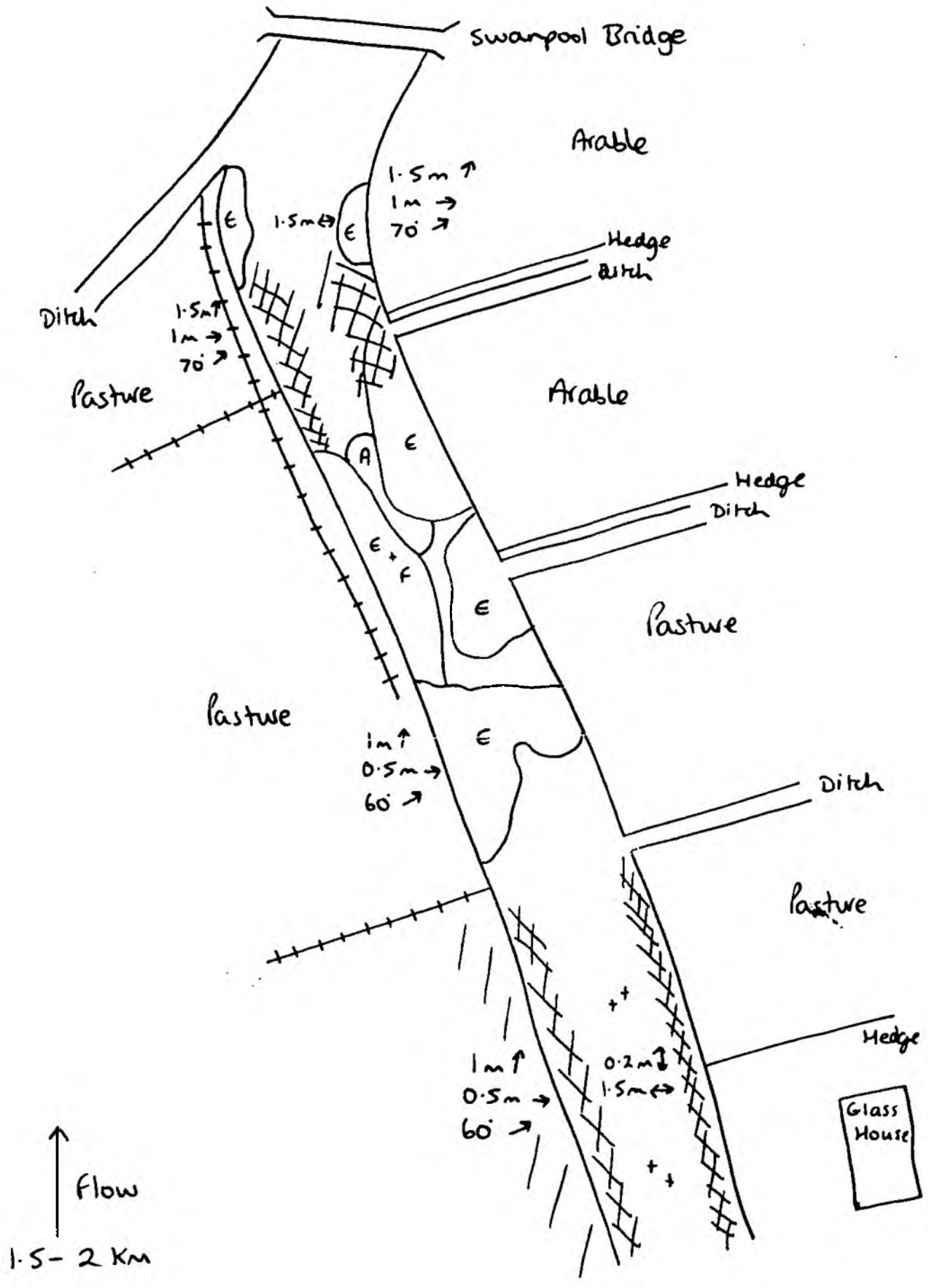
River Braunton Marsh
Km No. 1 - 1·5 km
Date 6/4/92
Surveyor JALD.

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	60
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj. land in each stretch)		
canal =		
ditch	1	1
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		40
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	1	1
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1m↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m		
1-<2.5m	100	100
2.5-<5m		
>5m		
Slope <30°		
30-<60°	20	40
60-<90°	80	60
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	100
.25-<.5	
0.5-<1.0	
>1.0m	
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si/mud	100
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	20
sand	
FLORA %	
emergent veg < 1m wide	100
emergent 1-2m wide	
emergent >2m wide	
total veget area	45
B bryophytes	
E emergents 70	
A submerged 30	total ≤ 100%
F floating	
algae % of stretch	


Swanpool Bridge
Arable
1.5m ↑
1m →
70° ↗
Hedge
Ditch
Ditch
1.5m ↑
1m →
70° ↗
Pasture
Arable
A
E
Hedge
Ditch
E + F
E
Pasture
Pasture
1m ↑
0.5m →
60° ↗
E
Ditch
Pasture
Hedge
1m ↑
0.5m →
60° ↗
0.2m ↕
1.5m ↔
Glass House
Flow
1.5 - 2 Km

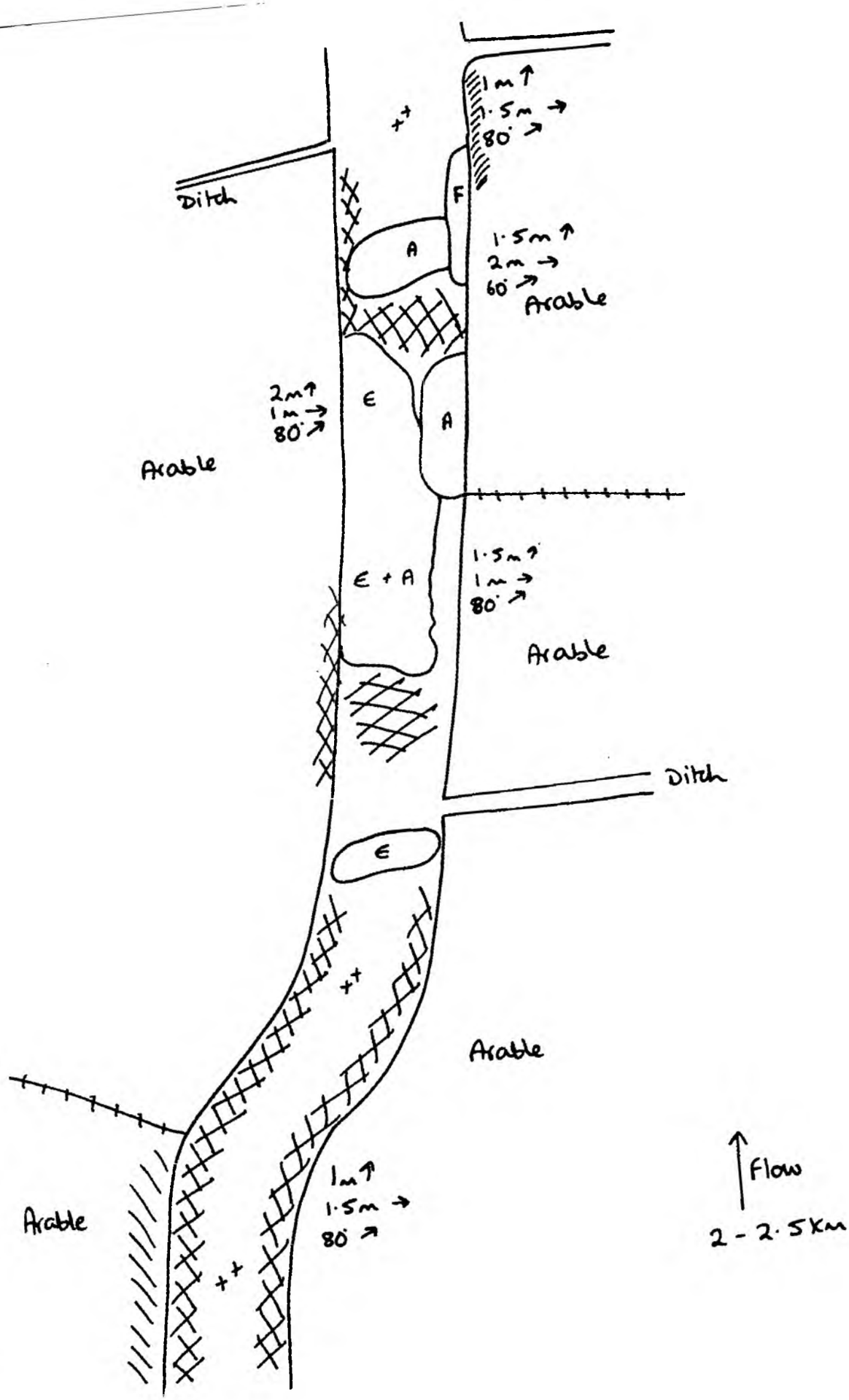
	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	40
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/resseded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER Braunton Marsh
Km No. 1·5 – 2 KM
Date 6/4/92
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)	1	3
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		3
hedge =		
fence on bank	45	60
fence set back		
wall		
building		2
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff (1m ↑)		
soft earth cliff (> 80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height < 1m		
1 - <2m	100	100
>2m		
Width < 1m	75	
1 - <2.5m	25	100
2.5 - <5m		
>5m		
Slope: <30°		
30 - <60°		
60 - <90°	100	100
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.	35	
Reed/Sedge %.		
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	1
Depth < .25m %	100
.25-<.5	
0.5-<1.0	
>1.0m	
Width <1	100
1-<5	
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si/mud	100
clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	90
emergent 1-2m wide	100
emergent >2m wide	
total veget. area	60
B bryophytes	
E emergents	80
A submerged	100
F floating	10
algae % of stretch	(total to 100%)


1m ↑
1·5m →
80° ↗
++
Ditch
F
A
1·5m ↑
2m →
60° ↗
Arable
2m ↑
1m →
80° ↗
∈
A
Arable
1·5m ↑
1m →
80° ↗
∈ + A
Arable
Ditch
∈
++
Arable
Arable
1m ↑
1·5m →
80° ↗
++
Flow
2 - 2·5km

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/resseded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

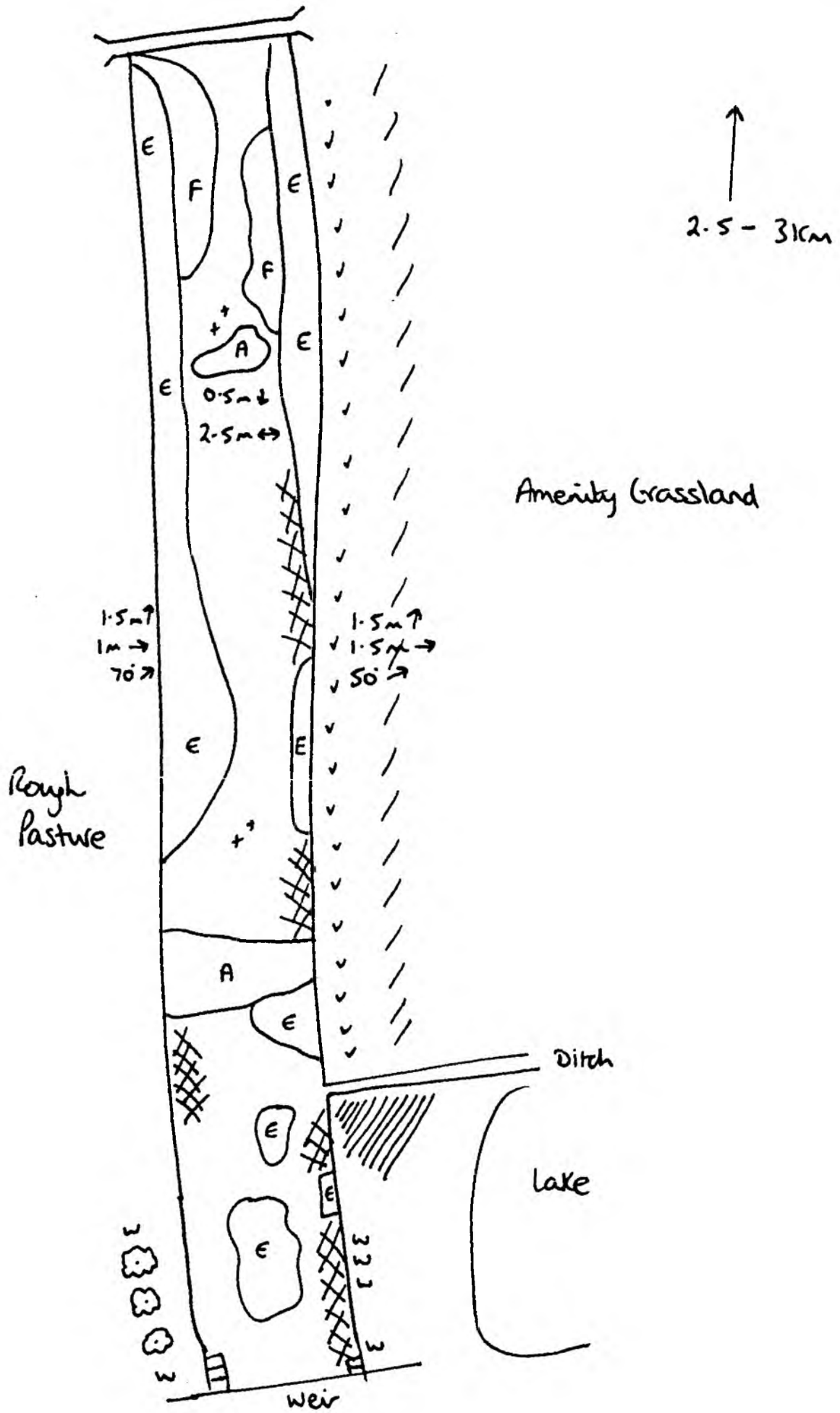
RIVER Braunton Marsh
Ref No. 2 - 2.5 km
Date 6/4/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj land in each stretch)		
canal =	1	2
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	100	100
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	1	1
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1M↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m		
1-<2.5m	100	100
2.5-<5m		
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
O Young trees		
Thick Scrub/shrubs %		8
Sparse Scrub/shrubs %	20	
Reed/Sedge %	18	
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	100
.25-<.5	
0.5-<1.0	
>1.0m	
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si/mud	100
cl clay	
peat	
Habitats and Flow	
P pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg <1m wide	100
emergent 1-2m wide	
emergent >2m wide	
total veget. area	60
B bryophytes	
E emergents	80
A submerged	100
P floating	
algae % of stretch	

(Total to 100%)


2.5 - 3Icm
Amenity Grassland
Rough Pasture
Ditch
Lake
Weir
0.5m
2.5m
1.5m
1m
70
1.5m
1.5m
50
E
F
A
W

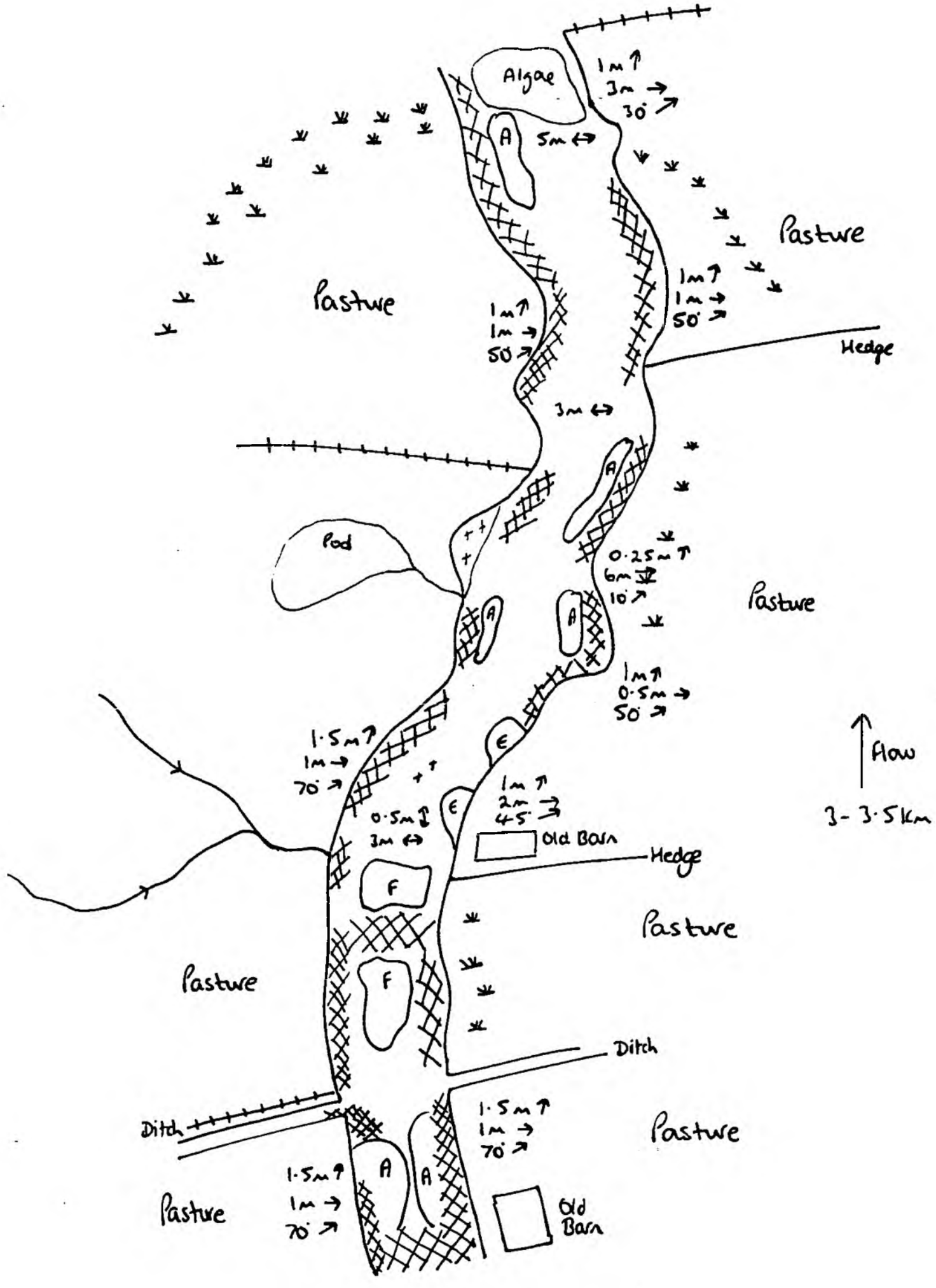
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER Braunton Marsh
Rm No. 2·5 – 3 Km
Date 7/4/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing – canal +	% of adj. land in each stretch	
canal =		1
ditch		
dyke		
pond, pool, cut-off %		
lake %		10
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1·5m		
5·10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		90
ephemeral/short herb		
hedge +		
hedge =		
fence on bank		
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑		
soft earth cliff >80		
rock cliff		
artificial	1	1
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1·<2m	100	100
>2m		
Width <1m		
1·<2.5m	100	100
2.5·<5m		
>5m		
Slope <30°		
30·<60°		100
60·<90°	100	
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard	2	4
S Standard willows		
A Alder		
Other trees	3	
Young trees		
Thick Scrub/shrubs %		5
Sparse Scrub/shrubs %		80
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		80
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		1
locks/500m		
inlet/500m		
Depth <.25m	%	
.25·<.5		100
0.5·<1.0		
>1.0m		
Width <1		
1·<5		100
5·<10		
10·<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si silt/mud		100
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		80
emergent 1·2m wide		20
emergent >2m wide		
total veget. area		50
B bryophytes		
E emergents	80	
A submerged		(total)
F floating	50	= 100%
algae % of stretch		


Algae
A
5m ↔
1m ↑
3m →
30°
Pasture
Pasture
1m ↑
1m →
50°
Hedge
3m ↔
A
Pod
0·25m ↑
6m ↔
10°
Pasture
A
A
1m ↑
0·5m →
50°
Flow
3 - 3·5km
1·5m ↑
1m →
70°
E
1m ↑
2m →
45°
E
0·5m ↕
3m ↔
Old Barn
Hedge
F
Pasture
Pasture
F
Ditch
Ditch
1·5m ↑
1m →
70°
Pasture
1·5m ↑
1m →
70°
A
A
Pasture
Old Barn

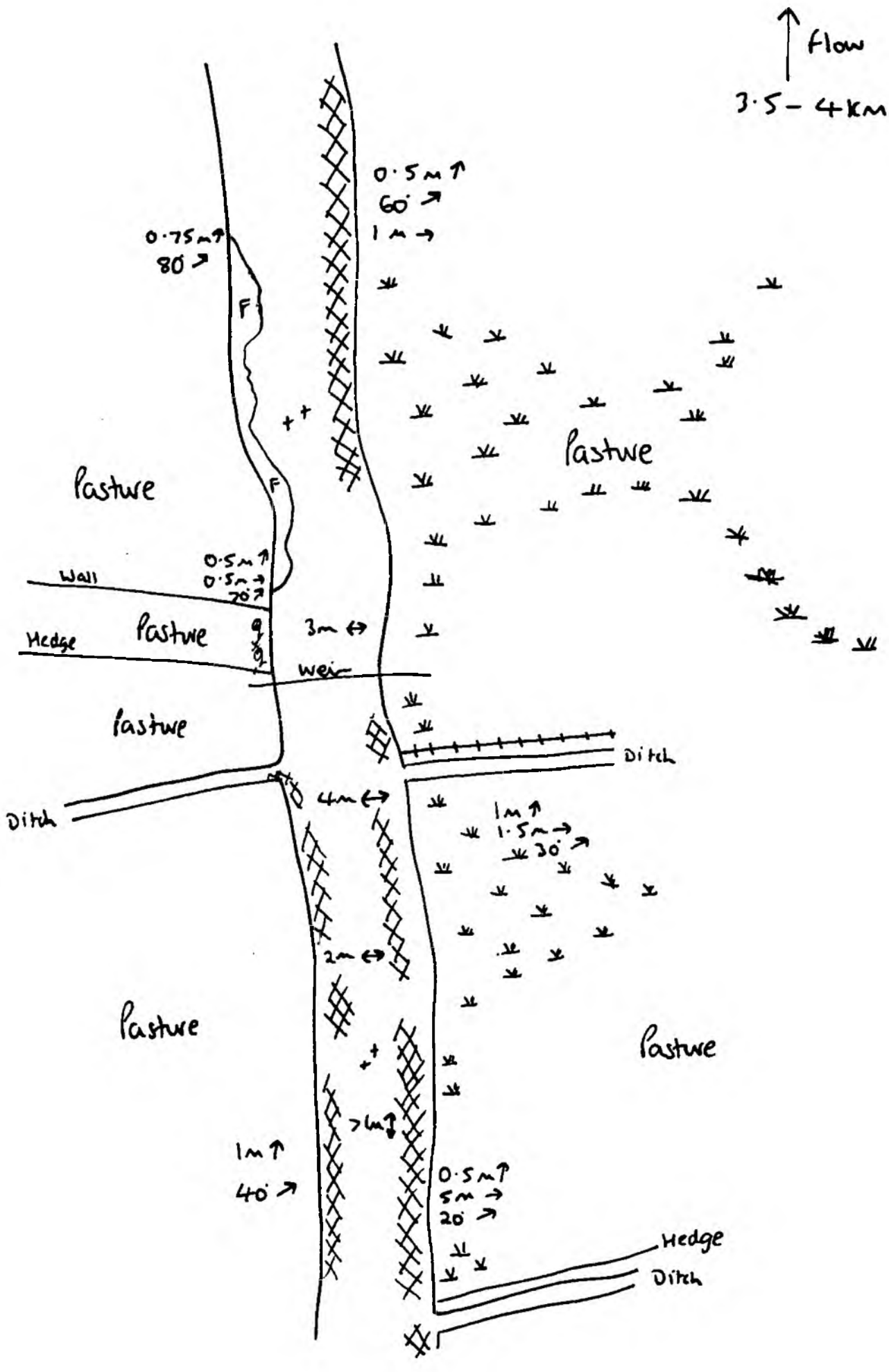
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	10	
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland	90	100
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER Braunton Marsh
Km No. 3 - 3.5km
Date 7/4/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of ad; laid in each stretch)		
canal =	1	1
ditch		
dyke		
pond, pool, cut-off %	10	
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		2
hedge =		
fence on bank	2	1
fence set back		
wall		
building		3
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
sheet %		
solid earth cliff		
soft earth cliff		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		10
1-<2m	100	90
>2m		
Width <1m		
1-<2.5m	100	80
2.5-<5m		20
>5m		
Slope: <30°		20
30-<60°	50	80
60-<90°	50	20
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m	1	
Depth <.25m	%	
.25-<.5		
0.5-<1.0		100
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si silt/mud		100
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
rills		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		8
sand		
FLORA %		
emergent veg < 1m wide		95
emergent 1-2m wide		5
emergent >2m wide		
total veget area		60
B bryophytes		
E emergents	80	
A submerged	15	
F floating	5	(total = 100%)
algae % of stretch	3	


Flow
3·5 – 4km
0·5m ↑
60° ↗
1m →
0·75m ↑
80 ↗
F
F
Pasture
Pasture
Wall
0·5m ↑
0·5m →
20° ↗
Hedge
Pasture
3m ↔
Weir
Pasture
Ditch
Ditch
4m ↔
1m ↑
1·5m →
30° ↗
2m ↔
Pasture
Pasture
>1m
1m ↑
40° ↗
0·5m ↑
5m →
20° ↗
Hedge
Ditch

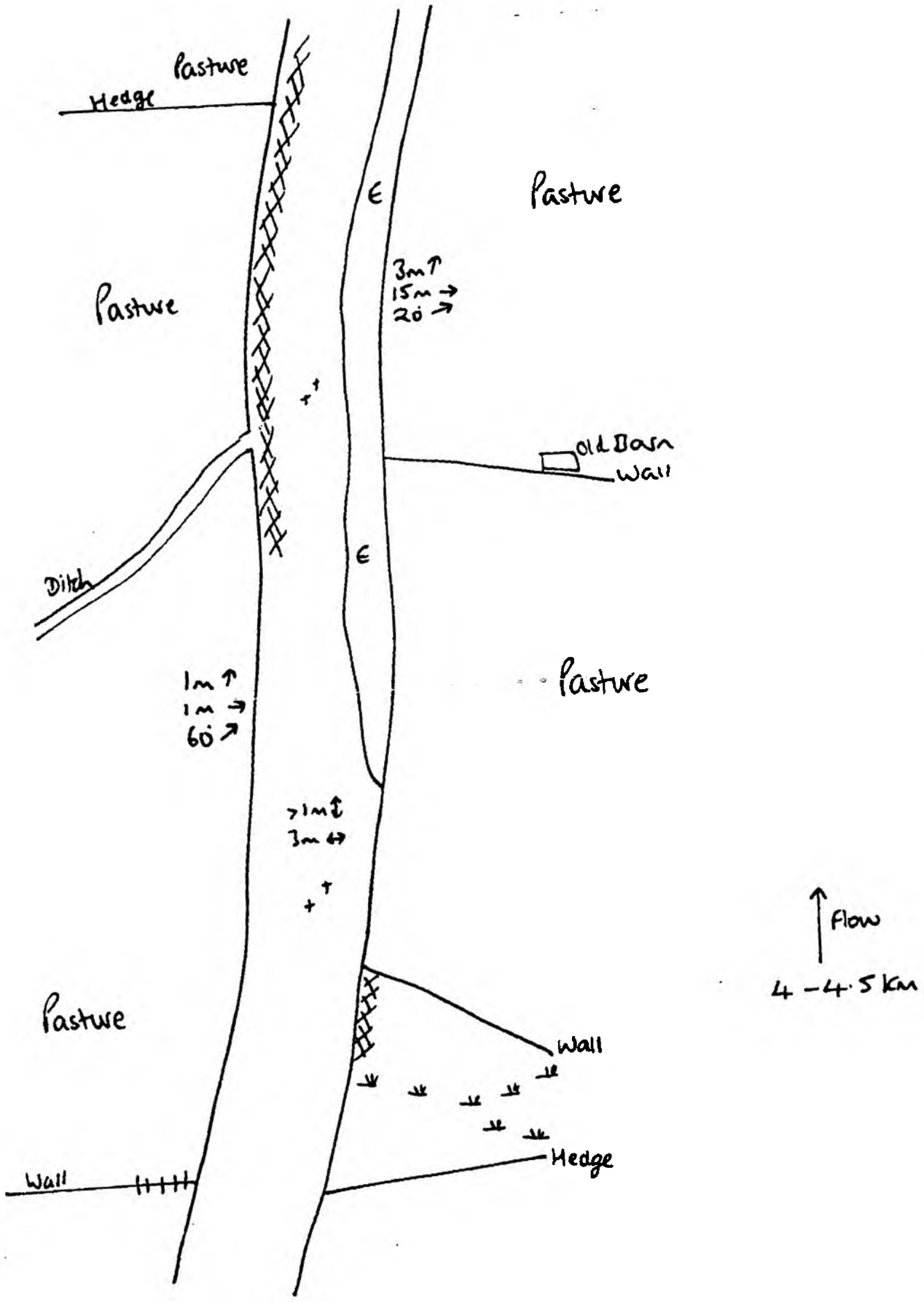
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		100
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER Brauton Marsh
Km No. 3.5 – 4 Km
Date 7/4/92
Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj. land in each stretch)		
canal =	1	2
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	2	1
hedge =		
fence on bank		1
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m	100	40
1-<2m		60
>2m		
Width <1m	100	
1-<2.5m		80
2.5-<5m		20
>5m		
Slope: <30°		
30-<60°	40	100
60-<90°	60	
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth		
natural cobbles	100	100
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %	2	
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
with eye rocky, + bare		
shingle and rock		
shingle, rock + veg		
new earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	1
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	100
>1.0m	
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	100
si silt/mud	
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	100
emergent 1-2m wide	
emergent >2m wide	
total veget. area	25
B bryophytes	
E emergents 80	
A submerged	
F floating 20	(total = 100%)
algae % of stretch	


Pasture
Hedge
Pasture
Pasture
3m ↑
15m →
20 ↗
Old Barn
Wall
Ditch
Pasture
1m ↑
1m →
60 ↗
>1m ↕
3m ↔
Flow
4 - 4.5 km
Pasture
Wall
Hedge
Wall

River Braunton Marsh
Rm No. 4-4.5 km
Date 7/4/92
Surveyor JALD.

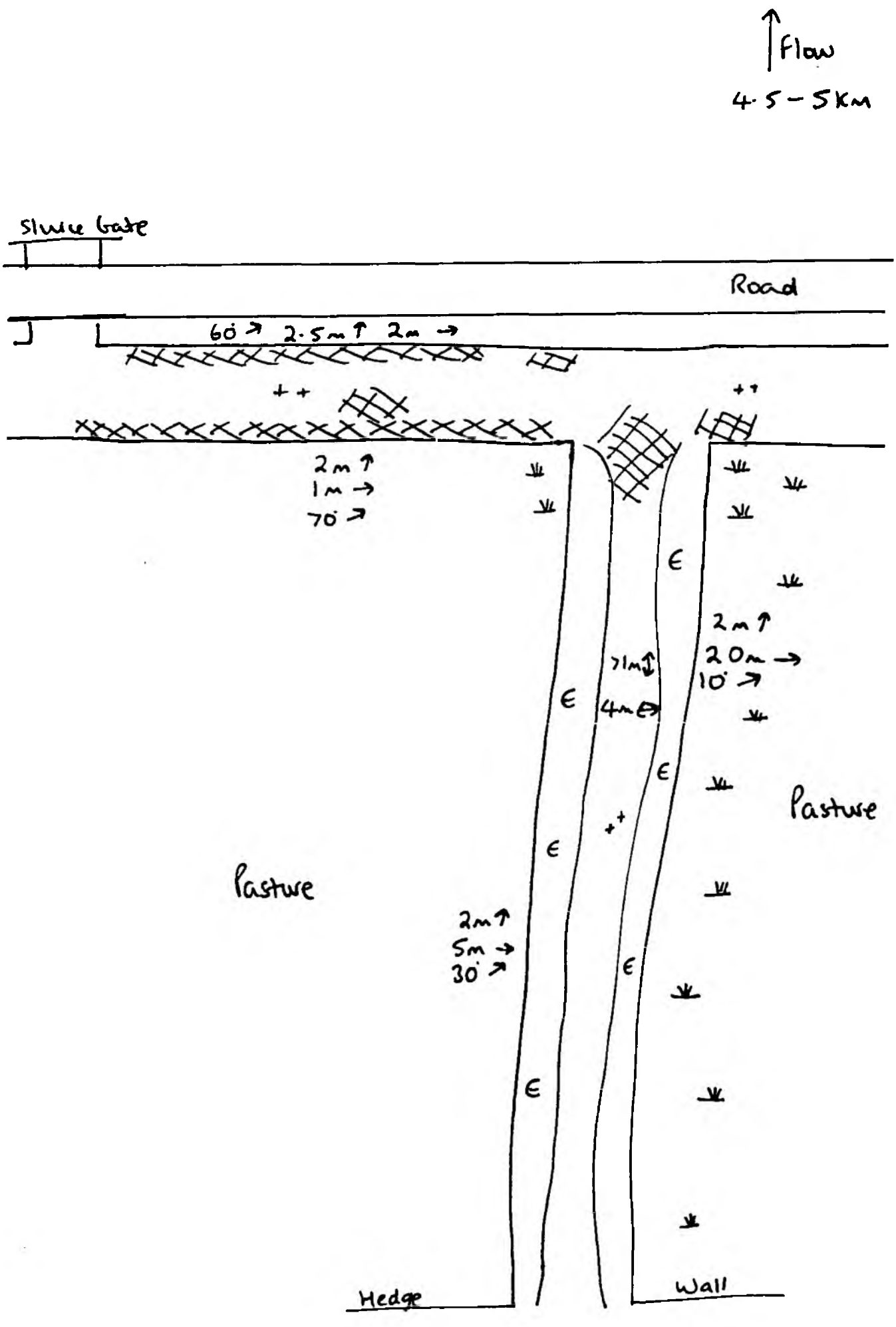
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	90
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		10
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp rich vegel.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarfscrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj. land in each stretch)		
canal =		1
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	1
hedge =		
fence on bank		
fence set back		
wall	1	2
building		2
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (1m↑)		
soft earth cliff (>80°)		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m	100	
>2m		100
Width <1m		
1-<2.5m	100	
2.5-<5m		
>5m		100
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		5
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	
.25-<.5		
0.5-<1.0		
>1.0m		100
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si/mud		100
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg <1m wide		100
emergent 1-2m wide		
emergent >2m wide		
total veget. area		15
B bryophytes		
E emergents	100	
A submerged		
F floating		
algae % of stretch		

(total = 100%)


Flow
4·5 – 5km
Sluice Gate
Road
60 → 2·5m ↑ 2m →
2m ↑
1m →
70 →
2m ↑
20m →
10 →
Pasture
Pasture
2m ↑
5m →
30 →
Hedge
Wall

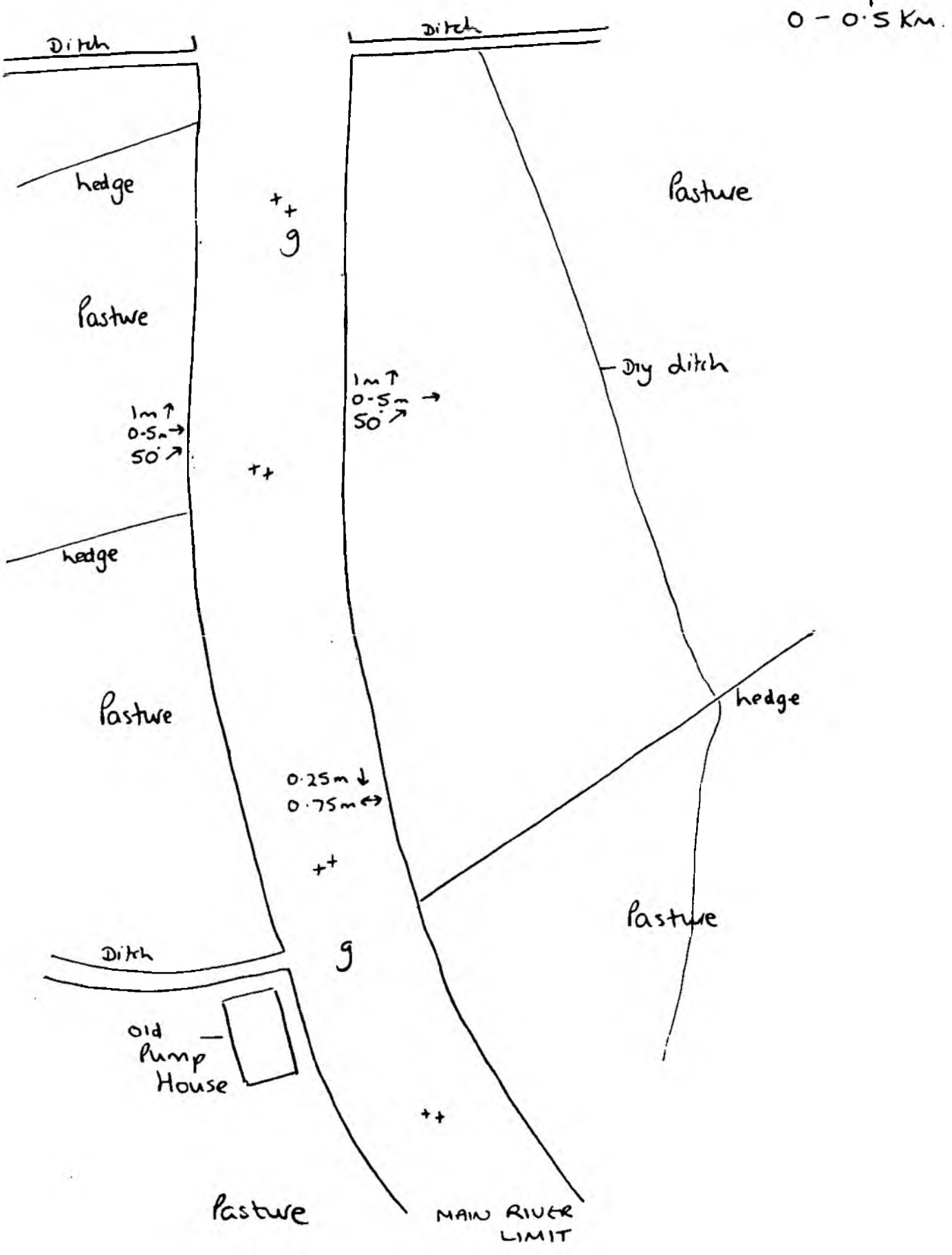
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		60
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER Braunton Marsh
Rm No. 4·5 - 5 km
Date 8/4/92
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj. land in each stretch	
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %.		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	
hedge =		
fence on bank		
fence set back		
wall		1
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		40
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
-levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m		
1-<2.5m	40	100
2.5-<5m	60	
>5m		
Slope <30°		60
30-<60°	60	
60-<90°	40	40
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %.		
Sparse Scrub/shrubs %.		
Reed/Sedge %.		
Dense open %.		
Sparse open %.		
Reseeded or mown %.		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

	RIVER
RIVER HABITATS	
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	
s sand	
si silt/mud	100
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	40
emergent 1-2m wide	80
emergent >2m wide	
total veget. area	60
B bryophytes	
E emergents	100
A submerged	
F floating	(total ≤ 100%)
algae % of stretch	


Braunton Marsh
Post Maintenance.
Flow ↑
0 - 0.5 Km.
Ditch
Ditch
hedge
Pasture
Pasture
Dry ditch
1m ↑
0.5m →
50 ↗
1m ↑
0.5m →
50 ↗
hedge
Pasture
hedge
0.25m ↓
0.75m ↔
Pasture
Ditch
Old Pump House
Pasture
MAIN RIVER LIMIT

River BRAUNTON MARSH

Km No. 0-0.5 KM

Date 29/3/93

Surveyor JALD

	LG	RB		LB	RB
A. WOODLAND & SCRUB %			**G. OPEN WATER**		
1. Broad-leaved semi-nat. plantation			1. Standing - canal + % of adj land in each stretch		
Coniferous semi-nat. plantation			canal =		
Mixed semi-natural plantation			ditch	2	1
2. Scrub - dense			dyke		
scattered			pond, pool, cut-off %		
Carr - alder			lake %		
willow			gravel pit %		
3. Parkland			reservoir %		
4. Recently felled wood			marina %		
B. GRASSLAND & MARSH %			2. Running		
1. Acidic unimproved			stream < 1m wide		
semi-improved			1-5m		
Neutral unimproved	100	100	5-10m		
semi-improved			>10		
Calcareous unimproved			**I. ROCK**		
semi-improved			1. cliff		
4. Improved/reseeded			scree		
5. Marsh/marshy grassland			limestone pavement		
C. TALL HERB & FERN %			cave		
1. Bracken			other		
2. Upland spp. rich veget.			2. artificial/waste		
3. Other - tall ruderal			**J. MISCELLANEOUS**		
non ruderal			arable		
D. HEATHLAND %			amenity grassland		
1. Dwarf scrub - dry			ephemeral/short herb		
wet			hedge +		
3. Lichen/bryophyte			hedge =	1	1
4. Montane			fence on bank		
5. Heath/grassland - dry			fence set back		
6. wet			wall		
E. MIRE, FLUSH AND SPRING %			building	2	
1. Mires - bog			caravans		
Fen - reed			fish farm		
sedge			silage clamp		
sweet-grass			sewage works		
mixed			garden		
2. Bog flushes			slick pile		
F. SWAMP/INUNDATION %			flood debris		
1. Swamp - single sp. dom.			road		
Tall mixed assemblage			railway disused		
			used		
			other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m	100	100
1-<2.5m		
2.5-<5m		
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		

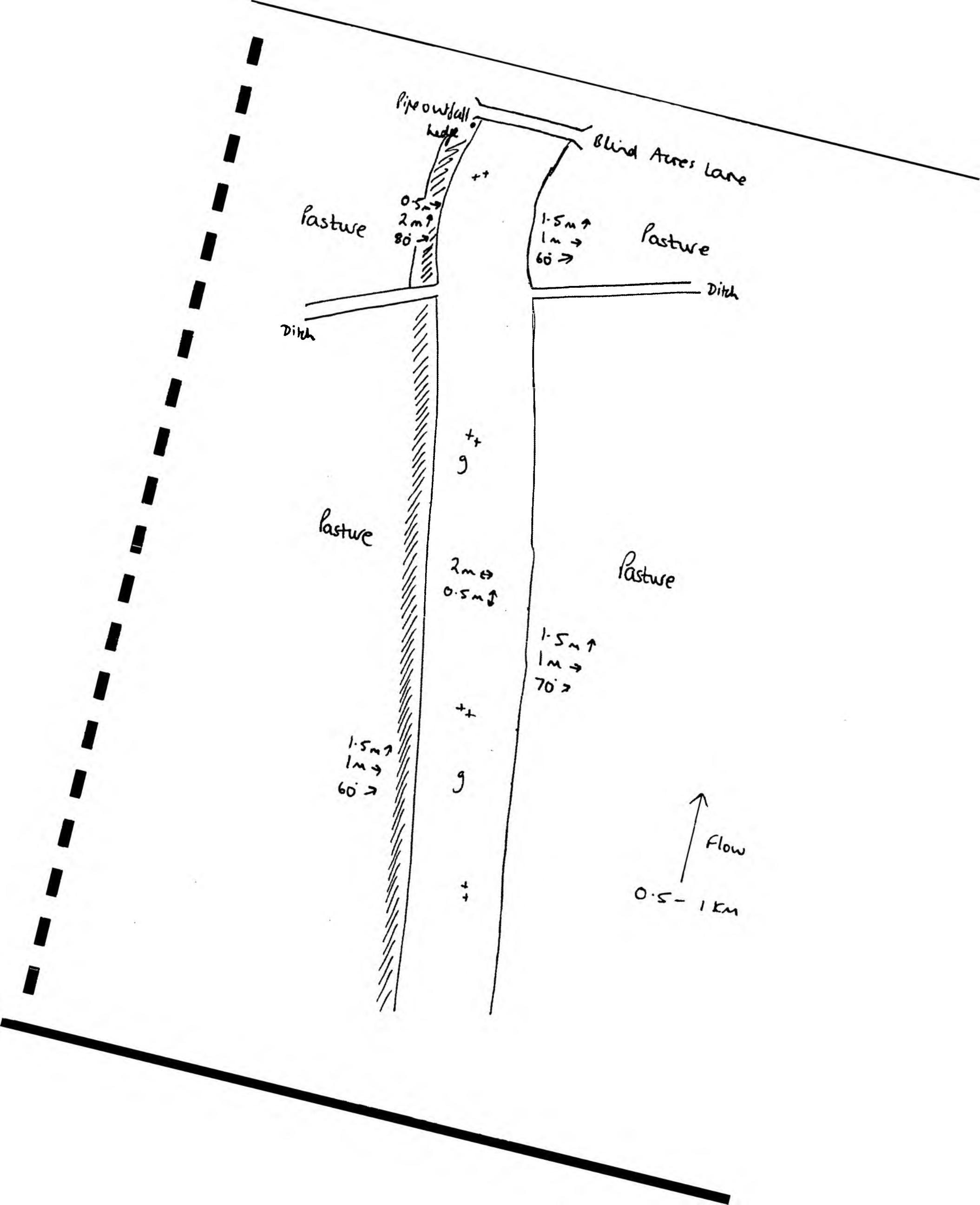
BANK VEGETATION

- Conifer
- Oak, Ash, Sycamore
- P Willow recept pollard
- W Willow old, not pollard
- S Standard willows
- A Alder
- Other trees
- Young trees
- Thick Scrub/shrubs %
- Sparse Scrub/shrubs %
- Reed/Sedge %
- Dense open %
- Sparse open %
- Reseeded or mown %
- Exposed tree roots

ISLANDS

- Rocky, vegetated
- rocky, + bare
- shingle and rock
- shingle, rock + veg
- earth - maturing
- earth - with trees
- developed

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	100
.25-<.5		
0.5-<1.0		
>1.0m		
Width <1		100
1-<5		
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		20
s sand		
+ silt/mud		80
clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		
E emergents		
A submerged		total to 100%
F floating		
algae % of stretch		


Pipe outfall
Hedge
Blind Acres Lane
Pasture
0.5m →
2m ↑
80° →
1.5m ↑
1m →
60° →
Pasture
Ditch
Ditch
Pasture
2m ↔
0.5m ↕
Pasture
1.5m ↑
1m →
70° →
1.5m ↑
1m →
60° →
Flow
0.5 - 1 km

River BRAUNTON MARSH

Km No. 0·5 – 1 KM

Date 29/3/93

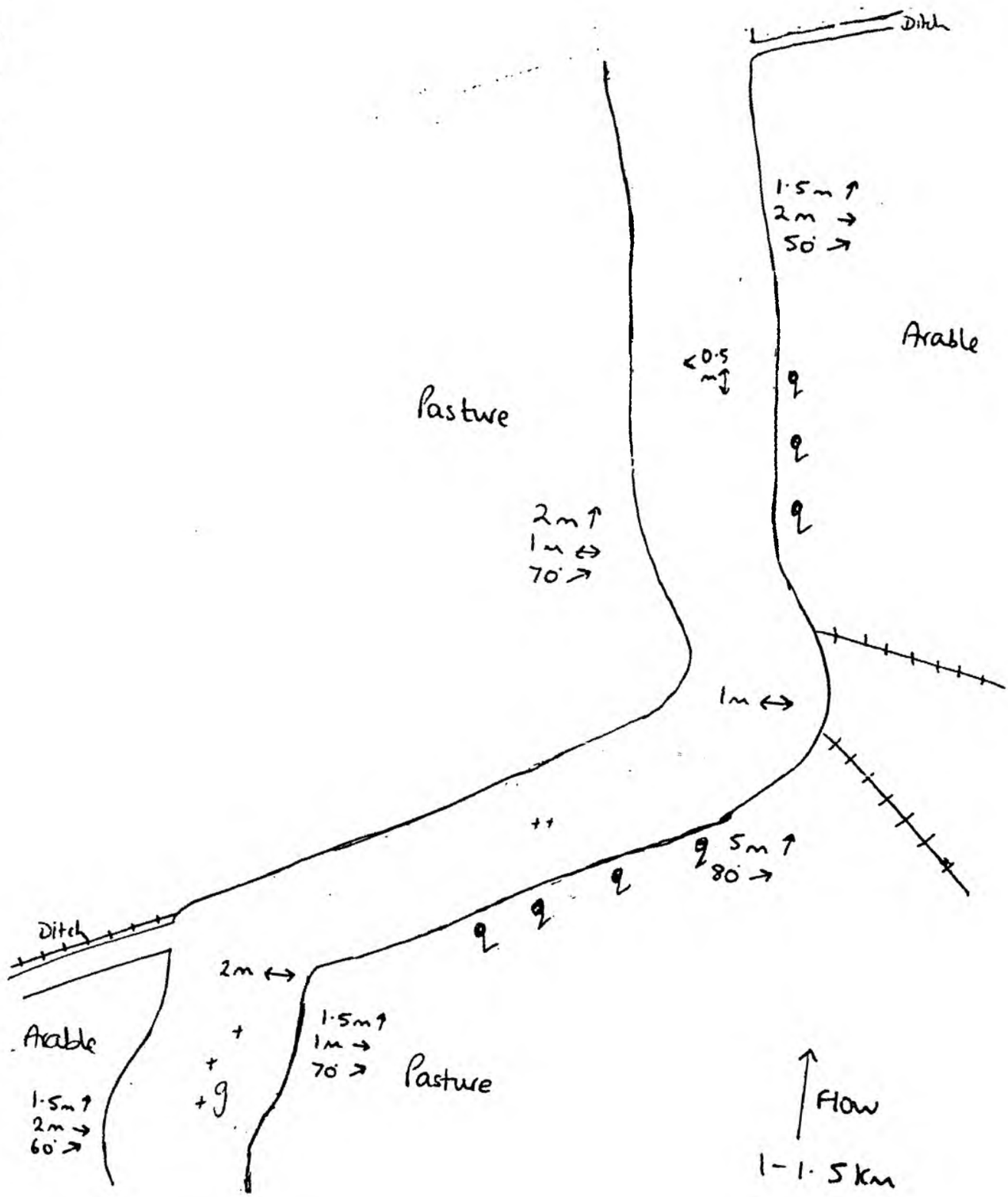
Surveyor JALD

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	100
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing – canal + (% of adj. land in each stretch)	1	1
canal =		
ditch		
dyke		
pond, pool, cut off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1–5m		
5–10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	2	
hedge =		
fence on bank		
fence set back		
wall		
bankings		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1M↑		
soft earth cliff >80		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m	100	
1–<2m		
>2m		
Width <1m	20	
1–<2.5m	80	
2.5–<5m		
>5m		
Slope <30°	80	
30–<60°	20	
60–<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recept pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
O Young trees		
Thick Scrub/shrubs %	100	
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	100
.25–<.5		
.5–<1.0		
>1.0m		
Width <1		100
1–<5		
5–<10		
10–<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		10
s sand		
si/mud		90
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle + bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1–2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		total = 100%
E emergents		
A submerged		
F floating		
algae % of stretch		


Ditch
1·5m ↑
2m →
50° ↗
Arable
<0·5 m ↕
Pastwe
2m ↑
1m ↔
70° ↗
1m ↔
5m ↑
80° →
Ditch
2m ↔
1·5m ↑
1m →
70° ↗
Pasture
Arable
1·5m ↑
2m →
60° ↗
Flow
1-1·5km

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	60
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich vegel.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

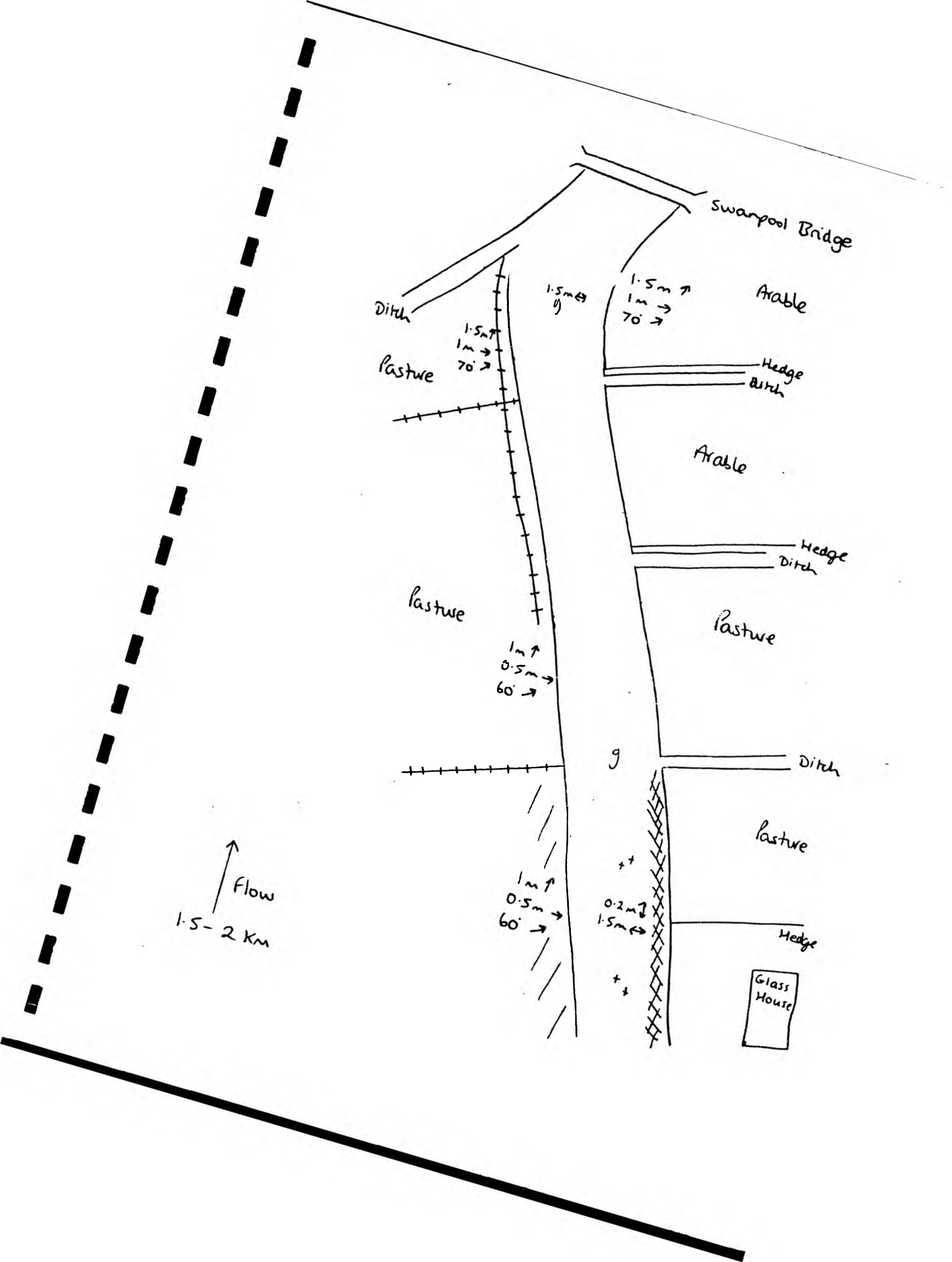
RIVER BRAUNTON MARSH
Km No. 1 - 1·5 KM
Date 29/3/93
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj land in each stretch	
canal =	1	1
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. flowing		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	40	
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	1	1
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff 1M↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m		
1-<2.5m	100	100
2.5-<5m		
>5m		
Slope <30°		
30-<60°	20	40
60-<90°	80	60
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		20
Sparse open %		
Resown or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	100
0.5-<1.0	
>1.0m	
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	5
s sand	
si/mud	95
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	
E emergents	
A submerged	
F floating	
algae % of stretch	

total to 100%


Swanpool Bridge
Ditch
1.5m ↔
g
1.5m ↗
1m →
70° →
Arable
1.5m ↑
1m →
70° →
Pasture
Hedge
Ditch
Arable
Hedge
Ditch
Pasture
Pasture
1m ↑
0.5m →
60° →
g
Ditch
Pasture
1m ↑
0.5m →
60° →
0.2m ↕
1.5m ↔
Hedge
Glass House
Flow
1.5 - 2 Km

River BRAUNTON MARSH
Km No. 1·5 - 2 km
Date 30/3/93
Surveyor JALD

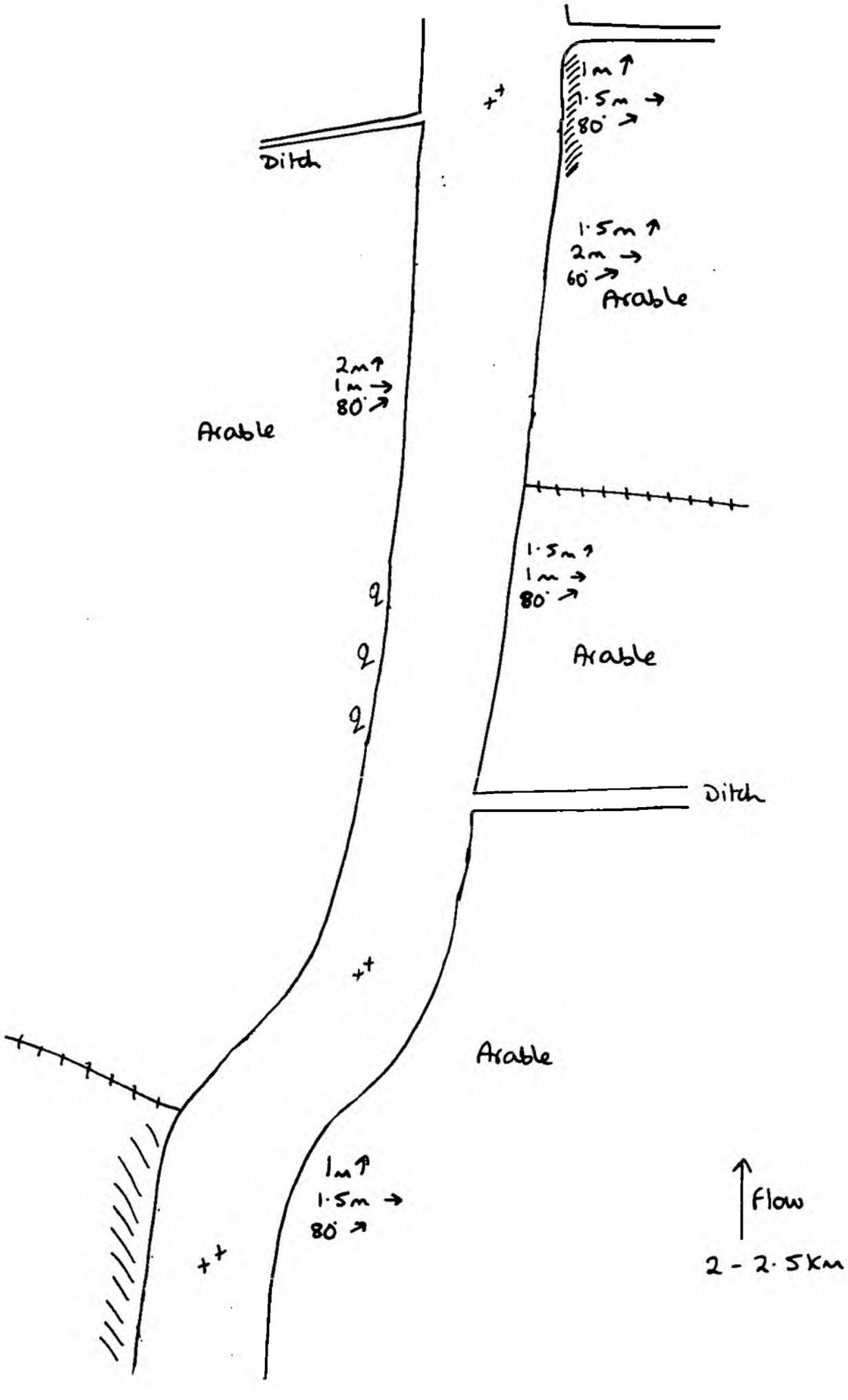
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	40
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj. land in each stretch)		
canal =		
ditch	1	3
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		3
hedge =	45	60
fence on bank		
fence set back		
wall		
building		2
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stock pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
soiled earth cliff 1m↑		
salt earth cliff >80		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m	75	
1-<2.5m	25	100
2.5-<5m		
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %	35	
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, 1 bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	100
.25-<.5		
0.5-<1.0		
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		20
s sand		
si silt/mud		80
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		35
emergent 1-2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		
E emergents		
A submerged		
F floating		
algae % of stretch		

(total ≤ 100%)


Ditch
1m ↑
1·5m →
80° ↗
1·5m ↑
2m →
60° ↗
Arable
2m ↑
1m →
80° ↗
Arable
1·5m ↑
1m →
80° ↗
Arable
Ditch
Arable
1m ↑
1·5m →
80° ↗
Flow
2 - 2·5km

River BRAUNTON MARSH

Km No. 2-2-5 km

Date 30/3/93

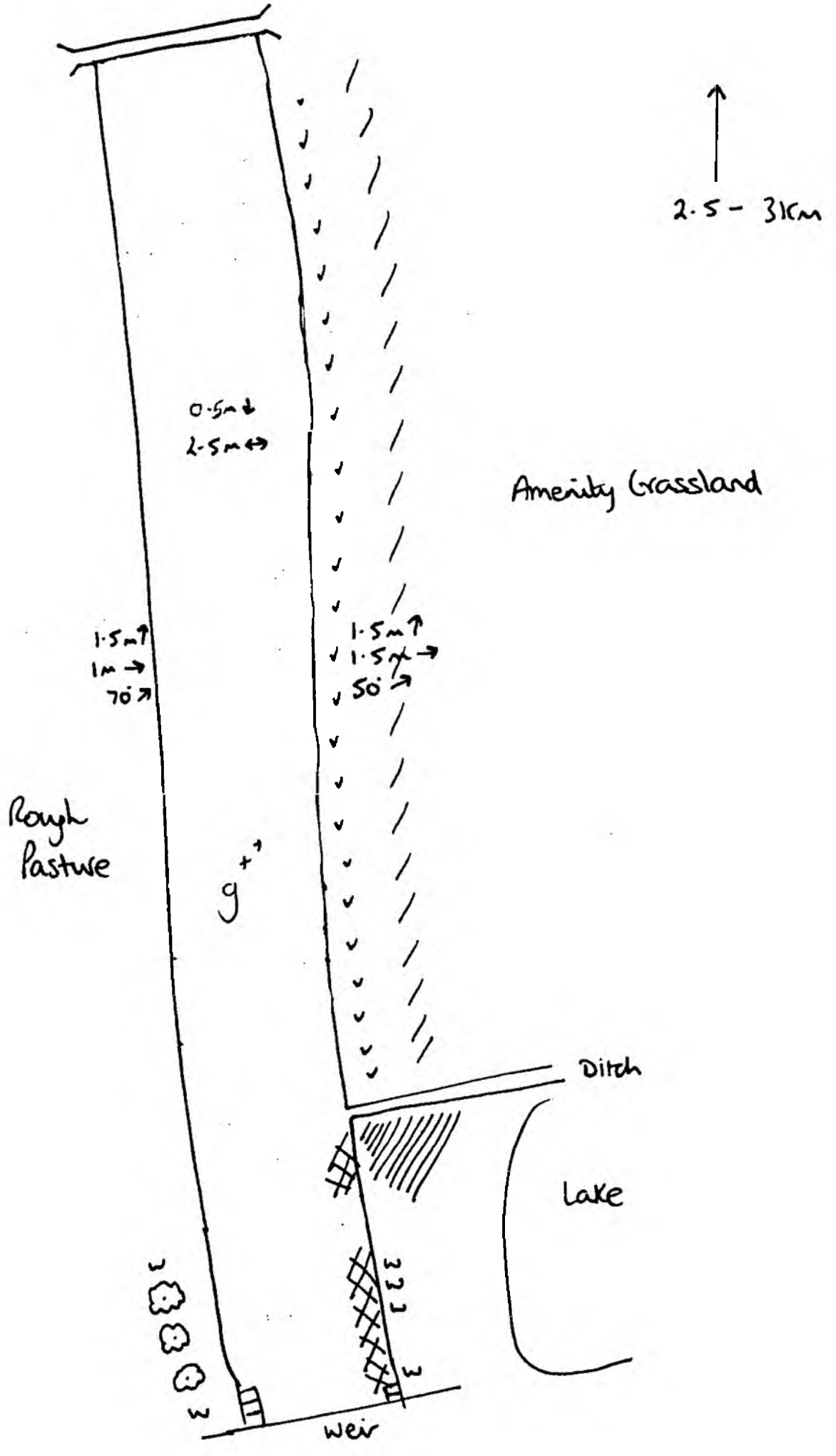
Surveyor JALD

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved		
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/resseded		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich vegel.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj land in each stretch)	1	2
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable	100	100
amenity grassland		
ephemeral/short herb		
hedge +		
hedge =		
fence on bank	1	1
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway - disused		
used		
other		

BANK FEATURES %	LB	RB
sheet %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m		
1-<2.5m	100	100
2.5-<5m		
>5m		
Slope <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow - recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		8
Sparse Scrub/shrubs %	20	
Reed/Sedge %		
Dense open %		
Sparse open %	10	
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		100
.25-<.5		
0.5-<1.0		
>1.0m		
Width <1		100
1-<5		
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si/mud		100
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		total 10 100%
E emergents		
A submerged		
F floating		
algae % of stretch		


2.5 - 3km
0.5m
2.5m
Amenity Grassland
1.5m
1m
70
1.5m
1.5m
50
Rough Pasture
Ditch
Lake
Weir

River BRAUNTON MARSH

Km No. 2·5 – 3 km

Date 30/3/93

Surveyor JALD

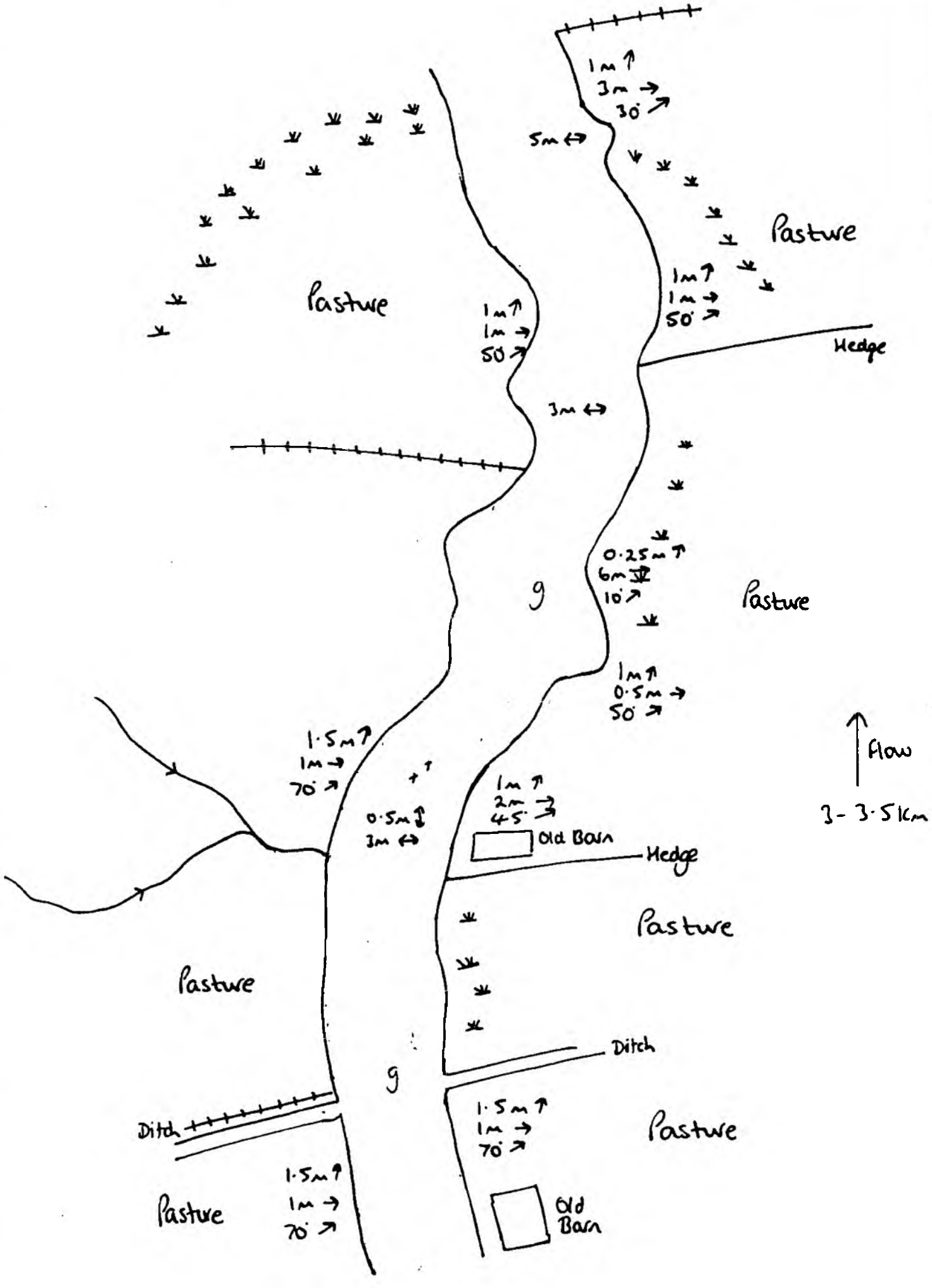
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/resown		
5. Marsh/marshy grassland		
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

	LB	RB
G. OPEN WATER		
1. Standing – canal) % of pdj land in each stretch		
canal =		
ditch		1
dyke		
pond, pool, cut-off %		
lake %		10
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1–5m		
5–10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		90
ephemeral/short herb		
hedge ↑		
hedge =		
fence on bank		
fence set back		
wall		
building		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
slick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m ↑	1	1
soft earth cliff > 80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height < 1m		
1 – <2m	100	100
>2m		
Width < 1m		
1 – <2.5m	100	100
2.5 – <5m		
>5m		
Slope <30°		100
30 – <60°	100	
60 – <90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard	2	4
S Standard willows		
A Alder		
Other trees	3	
Young trees		
Thick Scrub/shrubs %	5	
Sparse Scrub/shrubs %	80	
Reed/Sedge %		
Dense open %		
Sparse open %		
Resected or mown %	80	
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth – maturing		
earth – with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		1
locks/500m		
inlet/500m		
Depth <.25m %		100
.25–<.5		
0.5–<1.0		
>1.0m		
Width <1		100
1–<5		
5–<10		
10–<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		20
s sand		
si/mud		80
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1–2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		
E emergents		
A submerged		
F floating		
algae % of stretch		

total = 100%


1m ↑
3m →
30°
5m ↔
Pasture
Pasture
1m ↑
1m →
50° ↗
Hedge
1m ↑
1m →
50° ↗
3m ↔
0.25m ↑
6m ↔
10° ↗
Pasture
1m ↑
0.5m →
50° ↗
1.5m ↑
1m →
70° ↗
0.5m ↕
3m ↔
1m ↑
2m →
45° ↗
Old Barn
Hedge
Flow
3 - 3.5 kn
Pasture
Pasture
Ditch
Ditch
1.5m ↑
1m →
70° ↗
Pasture
1.5m ↑
1m →
70° ↗
Old Barn

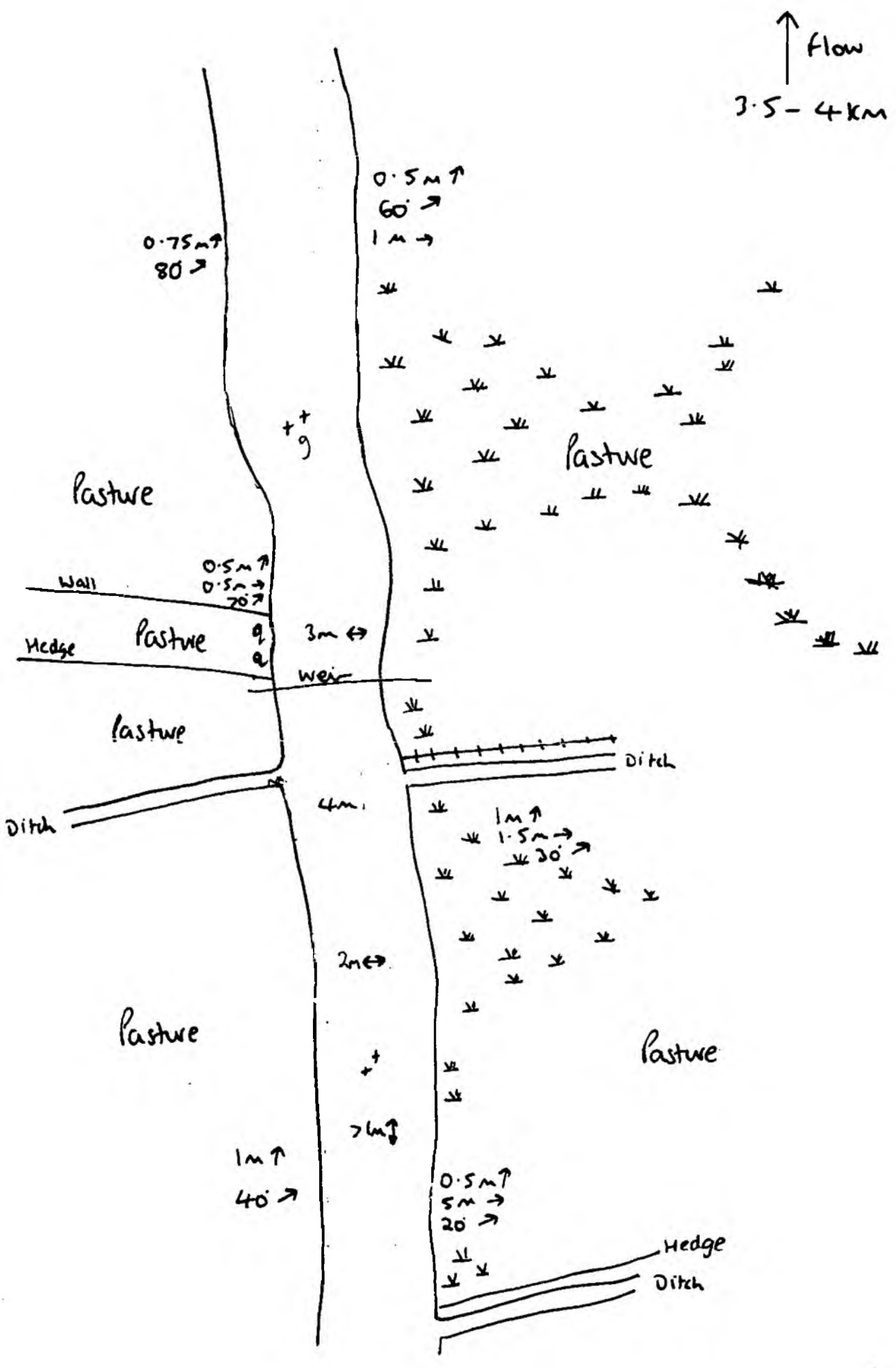
	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	10	
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland	90	100
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER BRAUNTON MARSH
Km No. 3 - 3·5 Km
Date 30/3/93
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal + (% of adj. land in each stretch)		
canal =		
ditch	1	1
dyke		
pond, pool, cut-off %	10	
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +		2
hedge =		
fence on bank	2	1
fence set back		
wall		
building		3
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (m ↑)		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank only		
FB flood bank set back levee		
Height <1m		10
1-<2m	100	90
>2m		
Width <1m		
1-<2.5m	100	80
2.5-<5m		
>5m		20
Slope <30°		20
30-<60°	50	80
60-<90°	50	20
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
O Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m	%	
.25-<.5		
.5-<1.0		100
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		30
s sand		
si silt/mud		70
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		total to 100%
E emergents		
A submerged		
F floating		
algae % of stretch		


Flow
3·5 – 4km
0·5m ↑
60 ↗
1m →
0·75m ↑
80 ↗
Pasture
Pasture
Wall
0·5m ↑
0·5m →
70 ↗
Hedge
Pasture
3m ↔
Weir
Pasture
Ditch
Ditch
4m
1m ↑
1·5m →
30 ↗
2m ↔
Pasture
Pasture
>1m ↕
1m ↑
40 ↗
0·5m ↑
5m →
20 ↗
Hedge
Ditch

	LB	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub – dense		
scattered		
Carr – alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		100
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other – tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub – dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires – bog		
Fen – reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp – single sp. dom.		
Tall mixed assemblage		

RIVER BRAUNTON MARSH

Rec No. 3-5- 4 Kms

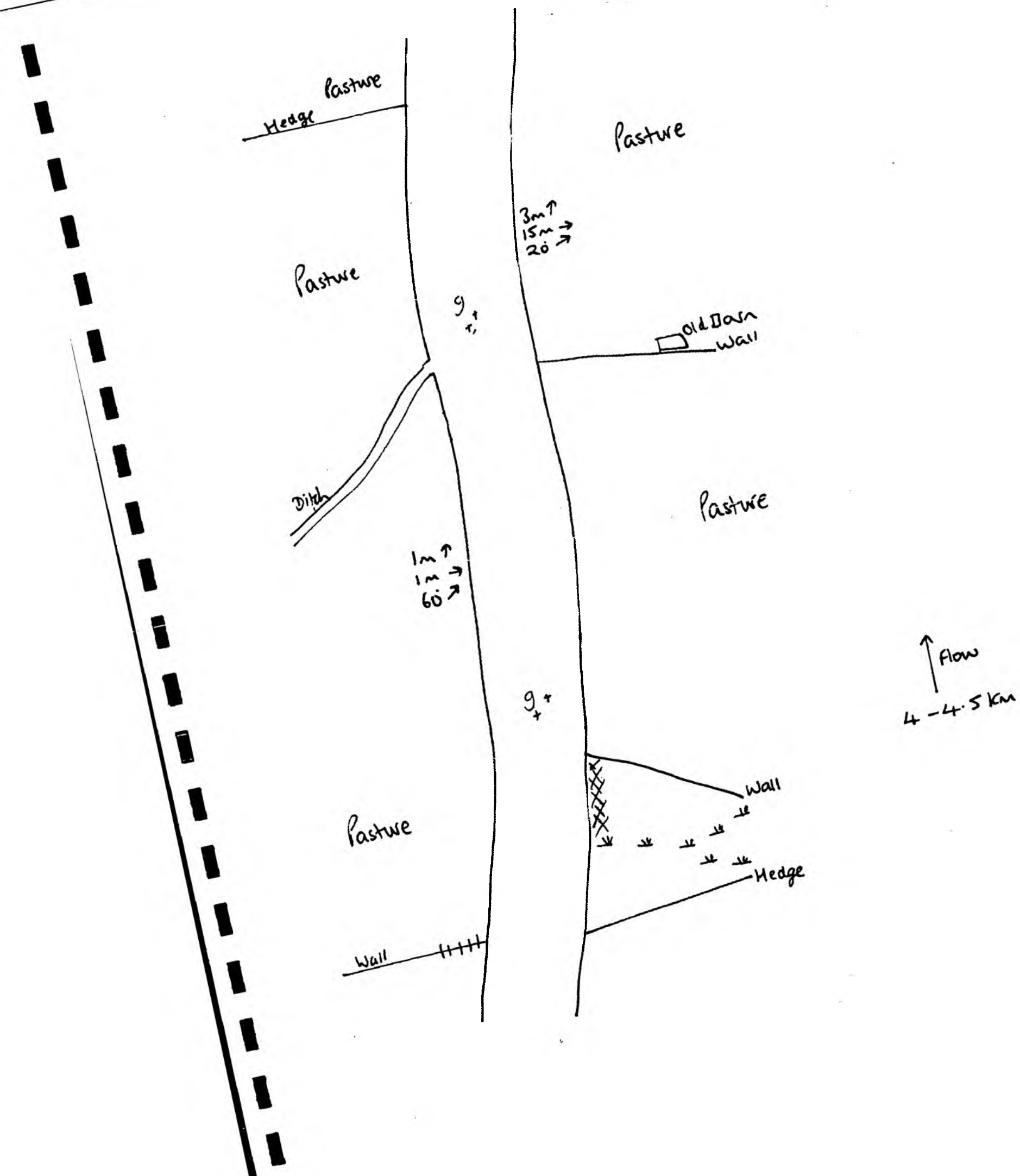
Date 30/3/93

Surveyor JALD.

	LB	RB
G. OPEN WATER		
1. Standing – canal + % of adj. land in each stretch		
canal =	1	2
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	2	1
hedge =		
fence on bank		1
fence set back		
wall		
building		
caravans		
field barn		
silage clamp		
sewage works		
garden		
stock pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1m↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m	100	40
1-<2m		60
>2m		
Width <1m	100	
1-<2.5m		80
2.5-<5m		20
>5m		
Slope <30°		
30-<60°	40	100
60-<90°	60	
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		
Dense open %	2	
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, 1 bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS		RIVER
bridges/500m		1
weirs/500m		
locks/500m		
inlet/500m		
Depth <.25m %		
.25-<.5		
0.5-<1.0		100
>1.0m		
Width <1		
1-<5		100
5-<10		
10-<20		
>20		
Substrates		
BR bed rock		
b boulders		
c cobbles		
p pebbles		
g gravel		
s sand		
si/mud		100
cl clay		
peat		
Habitats and Flow		
pool		
slack		100
riffle		
rapids		
run		
waterfall		
protruding rocks		
Margins		
shingle ± bare		
shingle, vegetated		
mud		
sand		
FLORA %		
emergent veg < 1m wide		
emergent 1-2m wide		
emergent >2m wide		
total veget. area		
B bryophytes		total 10 100%
E emergents		
A submerged		
F floating		
algae % of stretch		


Pasture
Hedge
Pasture
Pasture
3m ↑
15m →
20 ↗
Old Barn Wall
Ditch
Pasture
1m ↑
1m →
60 ↗
Flow
4 - 4.5 km
Wall
Hedge
Pasture
Wall

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	90
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/resseded		
5. Marsh/marshy grassland		10
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland - dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

River BRAUNTON MARSH

Km No. 4 - 4.5 km.

Date 30/3/93

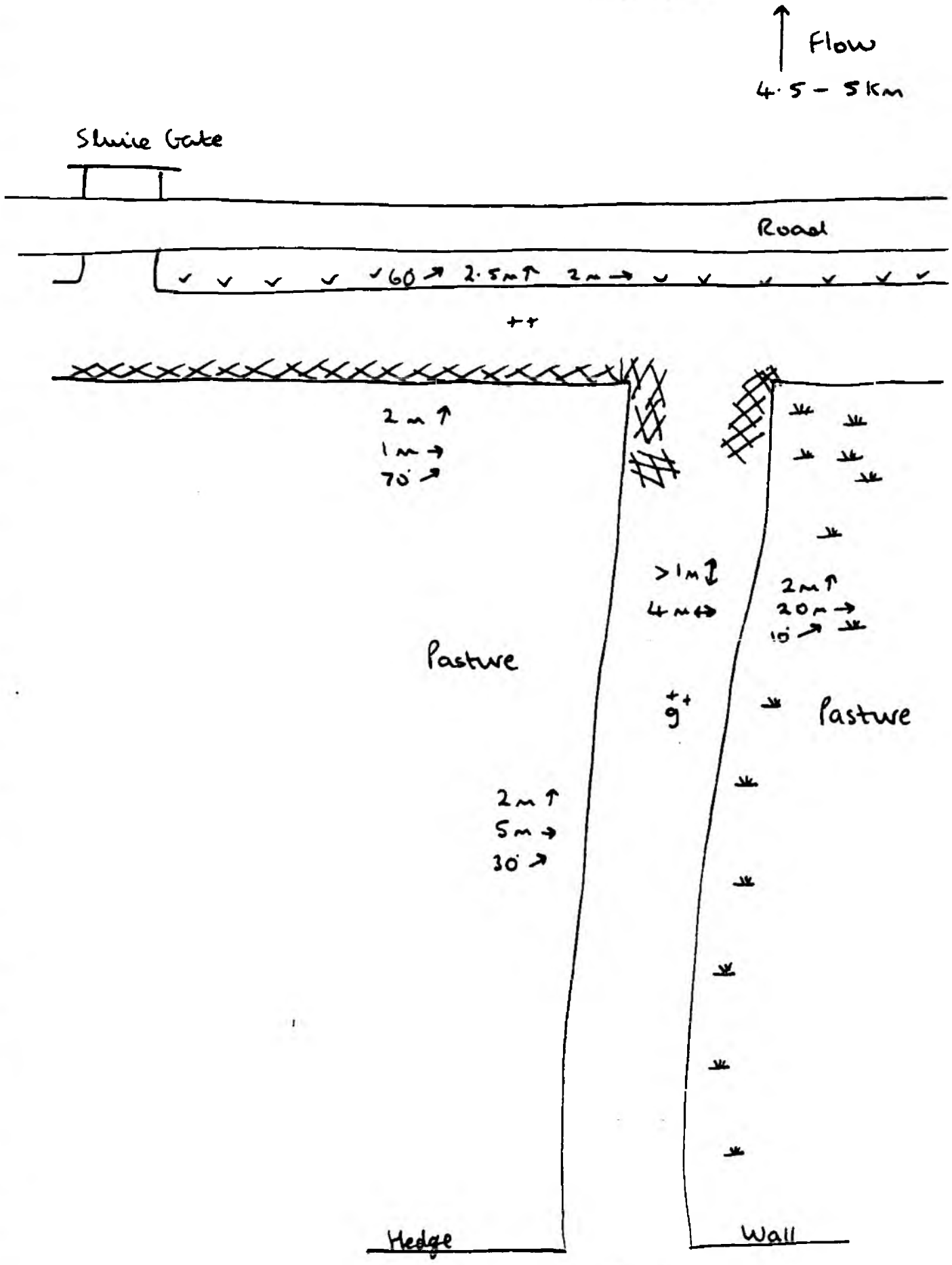
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal ↑ % of adj land in each stretch		
canal =	1	
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge ↑	1	1
hedge =		
fence on bank		
fence set back		
wall	1	2
building		2
caravans		
fish farm		
silage clamps		
sewage works		
garden		
stick pile		
flood debris		
road		
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shell %		
solid earth cliff (m↑)		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
↑ 1-<2m	100	
>2m		100
Width <1m		
1-<2.5m	100	
2.5-<5m		
>5m		100
Slope: <30°		
30-<60°	100	100
60-<90°		
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %		5
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, ↑ bare		
shingle and rock		
shingle, rock ↑ veg		
earth - maturing		
earth - with trees developed		

RIVER HABITATS	RIVER
badger/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	20
s sand	
si silt/mud	80
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	
E emergents	
A submerged	
F floating	
algae % of stretch	

total to 100%


Flow
4·5 – 5 Km
Sluice Gate
Road
60 →
2·5m ↑
2m →
2 m ↑
1 m →
70 →
>1m ↕
4m ↔
2m ↑
20m →
10 →
Pasture
Pasture
2m ↑
5m →
30 →
Hedge
Wall

	LG	RB
A. WOODLAND & SCRUB %		
1. Broad-leaved semi-nat. plantation		
Coniferous semi-nat. plantation		
Mixed semi-natural plantation		
2. Scrub - dense		
scattered		
Carr - alder		
willow		
3. Parkland		
4. Recently felled wood		
B. GRASSLAND & MARSH %		
1. Acidic unimproved		
semi-improved		
Neutral unimproved	100	
semi-improved		
Calcareous unimproved		
semi-improved		
4. Improved/reseeded		
5. Marsh/marshy grassland		60
C. TALL HERB & FERN %		
1. Bracken		
2. Upland spp. rich veget.		
3. Other - tall ruderal		
non ruderal		
D. HEATHLAND %		
1. Dwarf scrub - dry		
wet		
3. Lichen/bryophyte		
4. Montane		
5. Heath/grassland – dry		
6. wet		
E. MIRE, FLUSH AND SPRING %		
1. Mires - bog		
Fen - reed		
sedge		
sweet-grass		
mixed		
2. Bog flushes		
F. SWAMP/INUNDATION %		
1. Swamp - single sp. dom.		
Tall mixed assemblage		

RIVER BRAUNTON MARSH
Km No. 4·5 - 5 KM
Date 29/3/93
Surveyor JALD

	LB	RB
G. OPEN WATER		
1. Standing - canal +	% of adj. bank in each stretch	
canal =		
ditch		
dyke		
pond, pool, cut-off %		
lake %		
gravel pit %		
reservoir %		
marina %		
2. Running		
stream < 1m wide		
1-5m		
5-10m		
>10		
I. ROCK		
1. cliff		
scree		
limestone pavement		
cave		
other		
2. artificial/waste		
J. MISCELLANEOUS		
arable		
amenity grassland		
ephemeral/short herb		
hedge +	1	
hedge =		
fence on bank		
fence set back		
wall		1
bank/dry		
caravans		
fish farm		
silage clamp		
sewage works		
garden		
stick pile		
flood debris		
road		40
railway disused		
used		
other		

BANK FEATURES %	LB	RB
shelf %		
solid earth cliff 1M↑		
soft earth cliff >80°		
rock cliff		
artificial		
FB flood bank adj		
FB flood bank set back		
levee		
Height <1m		
1-<2m	100	100
>2m		
Width <1m		
1-<2.5m	40	100
2.5-<5m	60	
>5m		
Slope <30°		60
30-<60°	60	
60-<90°	40	40
>90°		
mud		
sand		
bare shingle		
vegetated shingle		
earth	100	100
natural cobbles		
natural boulders		
BANK VEGETATION		
Conifer		
Oak, Ash, Sycamore		
P Willow recent pollard		
W Willow old, not pollard		
S Standard willows		
A Alder		
Other trees		
Young trees		
Thick Scrub/shrubs %		
Sparse Scrub/shrubs %		
Reed/Sedge %	40	5
Dense open %		
Sparse open %		
Reseeded or mown %		
Exposed tree roots		
ISLANDS		
Rocky, vegetated		
rocky, + bare		
shingle and rock		
shingle, rock + veg		
earth - maturing		
earth - with trees		
developed		

RIVER HABITATS	RIVER
bridges/500m	
weirs/500m	
locks/500m	
inlet/500m	
Depth <.25m %	
.25-<.5	
0.5-<1.0	
>1.0m	100
Width <1	
1-<5	100
5-<10	
10-<20	
>20	
Substrates	
BR bed rock	
b boulders	
c cobbles	
p pebbles	
g gravel	40
s sand	
si silt/mud	60
cl clay	
peat	
Habitats and Flow	
pool	
slack	100
riffle	
rapids	
run	
waterfall	
protruding rocks	
Margins	
shingle ± bare	
shingle, vegetated	
mud	
sand	
FLORA %	
emergent veg < 1m wide	
emergent 1-2m wide	
emergent >2m wide	
total veget. area	
B bryophytes	
E emergents	
A submerged	
F floating	
algae % of stretch	total to 100%