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ENVIRONMENTAL PROTECTION

A STUDY TO INVESTIGATE AND PROPOSE REMEDIES FOR RIVER QUALITY PROBLEMS IN THE MADFORD CATCHMENT

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EXETER

This report has been produced as the result of co-operative effort between the Freshwater Investigation Team, Pollution Control Section (Exeter) and the East and Mid Devon Warden Service of the National Rivers Authority South West Region.

Fig. 1. Map of the Madford River Catchment

SUMMARY

The Madford River is a small tributary of the River Culm in East Devon and comprises of two sub-catchments, the Madford and Bolham. A study of this area was undertaken to identify existing and potential sources of pollution from farm, industrial, sewage treatment, waste disposal and housing development sites.

Chemical and biological surveys were used to assess the effects of known discharges and to determine water quality throughout the catchment.

The results indicated farm drainage is the main cause of pollution and this is considered to be the cause of non-compliance with objectives and standards at the routine monitoring points in the catchment. Twenty-five of the seventy-two farms (= 35%) visited were polluting watercourses with yard run-off being a common problem during heavy rainfall.

The Madford sub-catchment had inferior water quality to the Bolham sub-catchment which is probably related to the greater number and density of polluting farms in this area.

The industrial estate, sewage treatment works (STW) and waste disposal practises at Dunkeswell were identified as pollution risks. However, at the time of survey none of these were significantly affecting river water quality.

Considerable siltation of the upper reaches of the Madford River had occurred downstream of a housing development at Dunkeswell.

A survey of brown trout redds in the Madford sub-catchment indicated minimal spawning; only one redd was found. This may be as a result of low adult fish numbers following a major pollution incident from Westerhope Farm in July 1989. However, farm drainage and siltation of spawning sites is also likely to limit trout recruitment.

The consent for Dunkeswell STW requires review and a number of other discharges were identified which need consenting.

Recommendations and remedial actions are presented which should control or forestall pollution in order to protect the designated uses of watercourses in the catchment.

CONTENTS

A STUDY TO INVESTIGATE AND PROPOSE REMEDIES FOR RIVER QUALITY PROBLEMS IN THE MADFORD CATCHMENT

1. INTRODUCTION.

Following a major pollution incident in the Madford River involving the discharge of more than 100,000 gallons of pig slurry to a headwater tributary near Dunkeswell on 29 July 1989, a comprehensive environmental investigation of the catchment has been undertaken. The pollution event and recovery of the river is documented elsewhere (see FWI/89/002).

1.1. Aims and Objectives.

The objective of this study was to identify all existing and potential sources of pollution in the Madford Catchment and to ensure remedial action is undertaken where appropriate.

1.2. Catchment Description.

The Madford River is a small tributary of the River Culm in East Devon and comprises two sub-catchments, the Madford River and the Bolham River (see Fig. 1).

The main land use in the catchment is dairy farming. Pigs, sheep, poultry and rabbits are also farmed. A trout farm is located in the lower reaches of the Madford River at NGR ST 148120 which is not currently in production.

The area has a relatively high conservation value due to a high proportion of semi-natural habitats.

Dunkeswell is the only village of significant size in the catchment. The village is currently growing in size with developments at a housing estate (NGR ST 144068) and extension of the industrial estate (ST 139079). Dunkeswell Aerodrome is used for the spreading of waste products. Leisure aircraft use parts of the aerodrome and there is also a skydiving centre on the airfield.

1.3. Routine Monitoring.

The Madford and Bolham Rivers have a River Quality Objective of Class 1A and the National Rivers Authority South West Region (NRA SW) have adopted the following use related Environmental Quality Objectives for the river:

* Protection of Aesthetic Quality
* Protection of Salmonid Fish
* Protection of Other Aquatic Life/Dependent Organisms
* Protection for Livestock Watering
* Protection for Irrigation of Crops

Water quality is monitored at Culm Bridge on the Madford River. This sampling point monitors the water quality of the two sub-catchments. The Bolham River is routinely sampled at Five Bridges. Physical details and recent classifications using the National Water Council (NWC) water

quality system are given in Table 1.

TABLE 1. Routine monitoring points in the Madford Catchment.

Location	NGR	Reach Length (km)	Flow (cumecs) ADF	Q95	Annual Classification 1984	85	86	87	88	89
Culm Bridge	ST 144135	7.0	0.491	0.153	1B	1B	3	3	3	2
Five Bridges	ST 150125	5.0	0.230	0.076	1B	1B	2	2	2	2

N.B. Annual classification is based on three years of data.

Water quality has apparently deteriorated at both sampling points (Table 1). However, after 1986 a more rigorous statistical approach has been used in the NWC classification scheme. This is more likely to result in lower, but correct classifications and may, therefore, partially explain the apparent decline in water quality.

A more detailed examination of the data revealed that the classification procedure does not accept values which are identified as "greater than". This has led to an incorrect classification at the Five Bridges monitoring point on the River Bolham. On 21 April 1986 a BOD value of >18mg/l O was recorded but not included in the classification. Had it been accepted, the classification would have been NWC Class 4.

Non-compliant determinands were BOD, ammonia and dissolved oxygen indicating organic pollution. Water quality statistics are shown in Table 2.

TABLE 2. Maximum and minimum ammonia, BOD and dissolved oxygen concentrations at Culm Bridge on the Madford River and Five Bridges on the Bolham River.

		Madford River at Culm Bridge			Bolham River at Five Bridges		
Year	No. of Samples	Ammonia	BOD	DO	Ammonia	BOD	DO
1984	6	0.20-0.02	2.5-1.4	104-90	0.24-0.05	2.3-1.6	101-88
1985	8	0.48-0.02	5.4-1.1	111-90	0.50-0.02	6.3-1.1	108-90
1986	6	0.51-0.03	12.4-1.1	101-81	0.87-0.03	>18.0-1.5	96-78
1987	6	0.17-0.02	2.5-0.7	101-81	0.18-0.03	1.9-0.8	107-88
1988	7	0.66-0.02	9.0-0.7	106-86	0.44-0.02	4.5-1.2	106-84
1989	7	0.73-0.01	8.9-0.6	108-80	0.78-0.02	6.6-1.0	113-44

Peaks of ammonia and BOD monitored at Culm Bridge coincide with those monitored at Five Bridges on the Bolham River indicating the River Bolham is a source of poor water quality measured at Culm Bridge. Since the Madford sub-catchment is not sampled it is not possible to determine its contribution to non-compliance with standards at Culm Bridge.

1.4. Non-compliance Investigation.

Examination of rainfall data recorded at Marl Pit, Hemyock (NGR ST 138129) indicated a link between poor water quality at routine monitoring points and high rainfall. A chemical survey was therefore carried out during high flows throughout the Madford Catchment to identify the source of poor water quality.

Aquatic invertebrates were also sampled throughout the catchment.

1.4.1. Chemical Survey.

Water quality was lower in the Madford sub-catchment than the Bolham sub-catchment during spate conditions on 7 February 1990 (Table 3, see over). BOD concentrations complied with NWC Class 2 at two sites in the Madford sub-catchment and with NWC Class 1B at all sites in the Bolham sub-catchment. Ammonia concentrations throughout both sub-catchments were within NWC Class 1B.

Low water quality could generally be linked to drainage from farms identified as polluting during the farm campaign (see Section 4).

Suspended solids were found to be high throughout the catchment particularly downstream of the housing development at Dunkeswell (see section 6). Such high concentrations are due to run-off from the disturbed land following heavy rainfall.

1.4.2. Biological Survey.

The Madford sub-catchment was generally found to have an aquatic invertebrate fauna of poorer quality than the Bolham sub-catchment (Appendix 1). This is partly because the Madford River is still recovering from the Westerhope Farm pollution incident (see Report FWI/002) but may also be due to the higher organic input to this sub-catchment during spate conditions.

Considerable recovery of the aquatic invertebrate fauna had occurred by the 26 January 1990 on the Dunkeswell Stream, six months after the major pollution event, despite discharges from other farms identified during the farm campaign (section 4).

Sites in the upper reaches of the Madford River sampled on 23 October 1989 and 6 November 1989 had impoverished faunas due to a farm discharge entering the Highwood Tributary. Following temporary remedial measures carried out by the farmer, the invertebrate community sampled on 26 January 1990 showed a significant recovery.

The aquatic invertebrate fauna in the Bolham River was diverse and abundant indicating good water quality.

TABLE 3. Water quality of single samples taken during spate conditions in the Madford Catchment on 7 February 1990.

Site	BOD (mg/l O)	Ammonia (mg/l N)	Solids (mg/l 105C)	Dissolved Oxygen (%)
Madford River				
1 Culm Bridge	4.4	0.27	90	93
*4 Madford Bridge	4.6	0.48	73	92
5 Riverside Cottage	3.3	0.34	56	96
+6 Rough Grey Bottom	4.2	0.44	135	94
*9 U/S Housing estate	4.9	0.56	22	96
*10 Abbey Bridge	5.9	0.63	46	92
*11 Highwood tributary	4.4	0.55	44	97
*15 Dunkeswell Bridge	5.2	0.39	69	93
Bolham River				
16 Five Bridges	4.3	0.28	83	93
17 Bolham Water	3.4	0.22	53	94
18 Middleton Mill	2.2	0.18	29	94
19 Lemon's Hill Trib.	3.1	0.23	51	94
20 Knowle's Farm Trib.	4.4	0.24	40	94

* Immediately downstream of farm discharge.
+ Immediately downstream of housing estate.

2. INDUSTRY.

2.1. Inventory.

Eleven industrial units were found operating at the Dunkeswell Industrial Estate on 15 January 1990 (Table 4, see over). The industrial estate is currently expanding on unused parts of Dunkeswell Aerodrome and is being developed by Westward Developments (Totnes) Ltd.

Most industrial units visited did not store chemicals apart from diesel and heating oil, and only three companies had bunding to contain spillages.

Industrial discharges were identified from:

(i) Amphos Ltd.
(ii) Payne Electroprints Ltd.

Dye tracing revealed that both discharges are connected to the foul sewer.

2.2. Drainage.

Surface water drainage from the estate is connected to a surface water sewer that runs through Bluehayes Farm and discharges to the Dunkeswell Stream at ST 143078 (outfall 1 - Fig 1). This sewer belongs to the Ministry of Defence and is not consented.

2.2.1. Chemical Survey.

Spot samples taken 10m upstream and 20m downstream of the surface water outfall on 18 January 1990 during wet weather indicated a slight increase in concentrations of dissolved zinc and aluminium downstream of the discharge (Table 5). However these values complied with Environmental Quality Standards.

TABLE 5. Dissolved metals in spot samples taken upstream and downstream of the surface water outfall draining the industrial estate on 18 January 1990.

Site	Copper (mg/l)	Zinc (mg/l)	Cadmium (mg/l)	Aluminium (mg/l)	Nickel (mg/l)	Lead (mg/l)
U/S outfall.	<0.005	<0.005	<0.0007	<0.005	<0.005	<0.008
D/S outfall.	<0.005	0.011	<0.0007	0.031	<0.005	<0.008

2.2.2 Biological Survey.

The aquatic invertebrate fauna sampled on 26 January 1990 upstream and downstream of the surface water outfall did not appear to be significantly affected by drainage from the industrial estate (Appendix 1).

TABLE 4. Industrial units operating on the Dunkeswell Industrial Estate on 15 January 1990.

Name	Nature of Industry	Chemical Storage.
T.J. Coles	Timber Haulage Contractor.	Diesel*, heating oil
Peter Quinain	Timber Merchant.	Diesel.
Devon School of Flying	-	Aviation fuel*.
Honiton Woodware Ltd.	Furniture Manufacturers.	None.
F.R.M. Building Supplies Ltd.	Timber Merchants.	Chemicals for garden & building use.
Norcrest Ltd.	Timber Frame Manufacturers.	Protim treatment, diesel, heating oil.
Perry & Oakley Ltd.	Grain Handling Equip. Manufacturer.	Diesel*, heating oil*, kerosene*.
Amphos Ltd.	Cleaning Products Manufacturer.	Various detergents and surfactants.
Supacat Ltd.	Special Vehicle Manufacturers.	Diesel.
Beekeeper Honey Co. Ltd.	Honey Distributers.	Heating oil.
Payne Electroprints Ltd.	Electroplating.	Various acids and copper solutions.

* Bunded.

3. SEWAGE TREATMENT.

3.1. Dunkeswell Sewage Treatment Works (STW).

The final effluent from Dunkeswell STW is currently the subject of a descriptive consent. This study has identified the need for a numeric consent for this works for two reasons:

(i) Recent developments at Dunkeswell have now caused the connected population to exceed the 250 population equivalent criterion for descriptive consents.

(ii) The STW receives trade discharges (see section 2).

3.1.1. Chemical Survey.

Nine samples of final effluent were taken at 1.5 hour intervals between 0800 and 2000 hrs on the 18 January together with upstream and downstream samples. The downstream site was 300m below the outfall.

Water quality was found to be poorer at the upstream site where BOD values were equivalent to NWC Class 2 (Table 6). It is thought that this was caused by a farm discharge which was subsequently detected discharging upstream during the farm campaign (see section 4)

The results do not indicate any significant effect on river water quality as a result of the discharge from the STW. Determinands downstream of the STW complied with NWC Class 1A.

TABLE 6. Water quality of nine samples taken upstream and downstream of Dunkeswell STW and from the final effluent on 18 January 1990.

Site	BOD (mg/l O) mean (max-min)	Ammonia (mg/l N) mean (max-min)	Solids mg/l 105C mean (max-min)
U/S STW.	3.9 (5.3-3.2)	0.13 (0.21-0.09)	5 (8-3)
Final Effluent.	8.0 (9.0-7.0)	3.68 (3.80-3.30)	11 (15-6)
D/S STW.	1.7 (2.0-1.4)	0.04 (0.17-0.01)	6 (6-5)

Dissolved metals were analysed from single samples taken upstream, downstream and from the final effluent to assess any impact from the electroplating company which was connected to the foul sewer.

Results show a significant concentration of copper in the final effluent (Table 7). However, this did not appear to be affecting receiving water quality at the time of sampling.

At other times the loading of copper to the STW may be greater as a result of batch processing etc. Indeed, elevated levels of copper found in the sediments downstream of the STW (see Report FWI/002) may be as a result of the STW discharge although contamination by pig slurry during the Westerhope pollution cannot be discounted as a key or contributory factor.

TABLE 7. Dissolved metal concentrations in single samples taken from the Dunkeswell STW final effluent and Dunkeswell Stream on 18 January 1990.

Site	Copper (mg/l)	Zinc (mg/l)	Cadmium (mg/l)	Aluminium (mg/l)	Nickel (mg/l)	Lead (mg/l)
U/S STW.	<0.005	0.011	<0.0007	0.031	<0.005	<0.008
Final Effluent.	0.230	0.024	<0.0007	0.098	<0.030	0.08
D/S STW	<0.005	0.008	<0.0007	0.013	<0.005	<0.008

3.1.2. Biological Survey.

Diversity and abundance of aquatic invertebrates did not appear to be affected by the STW discharge.

The invertebrate fauna upstream of the STW did not appear to be significantly affected by the farm discharge identified during the farm campaign (see section 4).

3.2. Fishponds House Sewage Disposal.

Sewage disposal arrangements at Fishponds House (ST 152074) were inspected. The site is a tourist centre with holiday chalets, caravans, swimming pool and restaurant. The site is currently being developed further.

Sewage treatment for the site is via septic tank which discharges to soakaway. However, if the site is to support a greater residential population new sewage disposal arrangements may be necessary. The present discharge to soakaway is unconsented.

Discharges are presently made from the swimming pool to the septic tank. This is not considered appropriate and another method of treatment will need to be developed. At present it is possible for the overflow from the swimming pool to discharge to the river. If this is to continue consent will be required.

3.3. Disused Sewage Treatment Works.

A disused sewage treatment works (ST 148070) was recently visited following a complaint from a member of the public who mentioned that crude sewage had been seen discharging from this works. No evidence of a discharge could be found.

4. FARMS.

4.1. Farm Inventory.

Seventy-two of the ninety-nine premises visited in the Madford catchment stocked ten or more livestock and were classed as farms. The others were smallholdings or private houses and were not considered to pose a

pollution risk.

The majority of farms (93%) stocked more than ten cattle. Other farming was pigs, sheep, chickens and rabbits.

The mean number of cattle was 73 per farm and mean herd density was 0.82 per acre.

Twenty six percent of farms stored slurry (Table 8), with volumes up to 280,000 gallons.

Some farms stored fertilizer (2 to 60 tonnes), herbicides/pesticides (1 to 39 litres), sheep dip (1 to 25 litres) and detergents/disinfectants (10 to 50 litres).

Silage was kept on 33% of farms and the amount of clamped silage ranged from 150 to 1600 tonnes.

At other times of the year different farming practises and chemicals may be stored on these farms.

TABLE 8. Storage of slurry, chemicals and silage on farms in the Madford sub-catchment.

	Slurry storage			Chemicals				Silage
	Lagoons	Weeping Wall	Tank	Fert.	Herb./ Pest.	Sheep Dip.	Deter./ Disinf.	
No. farms	14	4	1	52	17	7	28	35
Farms (%)	19	6	1	72	24	10	39	49

4.2. Farm Campaign (see Fig. 2, over).

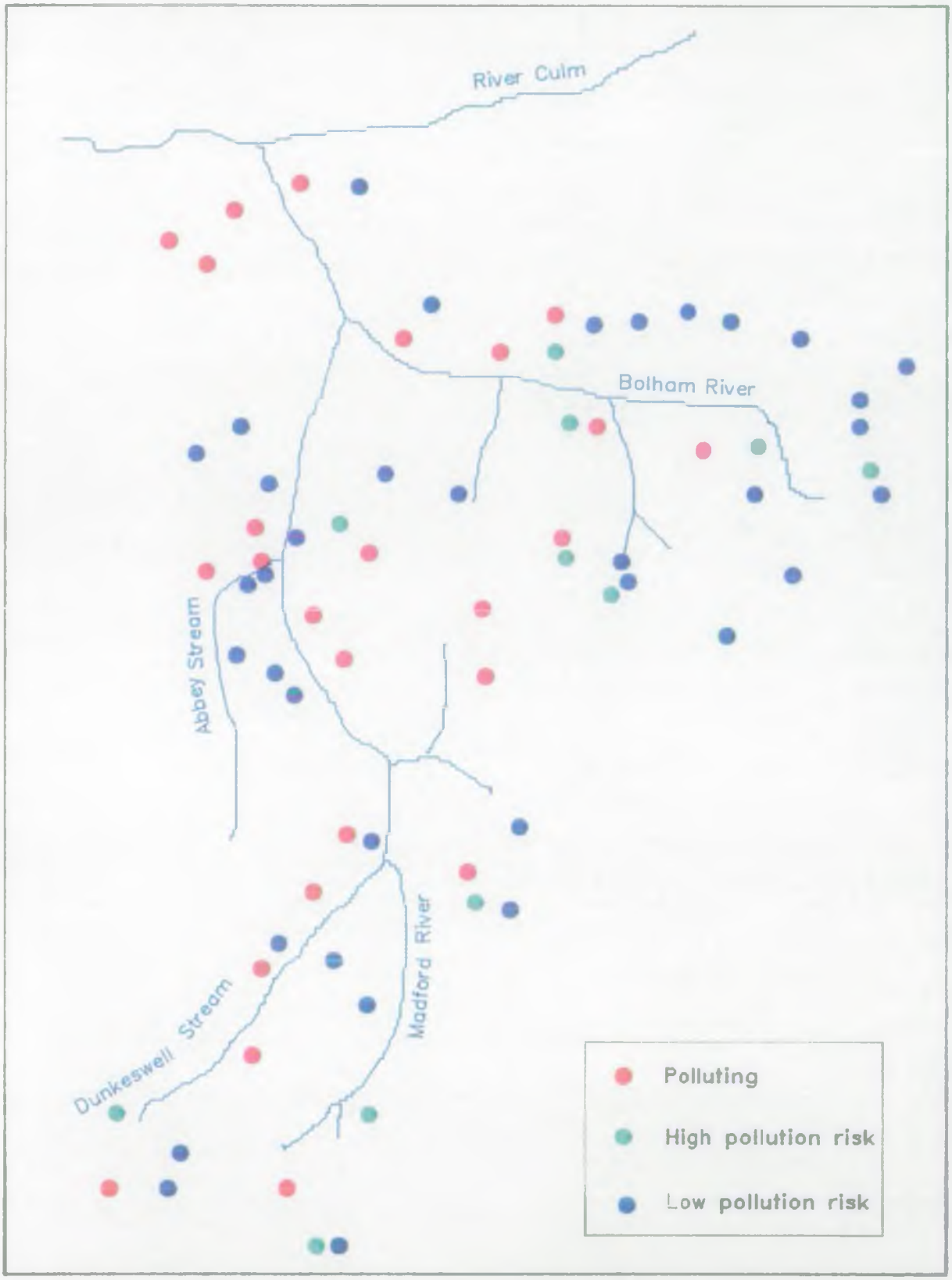
All farms within the Madford catchment were visited to assess their drainage using the farm campaign methods used in other parts of the Southwest Region. Farms were visited in February and March 1990 during very wet conditions.

A high percentage of farms (35%) were found to have discharges to watercourses and were given a red pollution code (Table 9). All polluting farms were dairy and/or beef farms.

A greater number and density of red farms (0.88 per km^2) were found in the Madford sub-catchment compared to the Bolham sub-catchment (0.43 per km^2). This may account for the poorer chemical and biological quality of the Madford sub-catchment compared to the Bolham sub-catchment (see section 1).

Farms found polluting had larger herds (mean = 93 cattle per farm) than those farms not polluting (mean = 53 cattle per farm). The major cause of pollution was yard run-off during heavy rainfall and dairy/parlour

Fig. 2 Pollution codes allocated to farms in the Madford Catchment.



washings discharging to watercourses.

Many farms are not properly designed to keep large herds and have not adapted to the increases in stock size in recent years. Farms therefore generally have inadequate facilities to cope with dirty yard-water particularly during heavy rainfall when cattle are kept indoors during winter.

TABLE 9. Farm pollution codes allocated to farms in the Madford sub-catchment (also see Fig. 2).

	RED (Polluting)	GREEN (High pollution risk)	BLUE (Low pollution risk)
Madford sub-catchment			
No. farms	15	5	19
Farms (%)	38	13	49
Bolham sub-catchment			
No. farms	6	6	16
Farms (%)	21	21	58
D/S of Bolham/Madford confluence			
No. farms	4	0	1
Farms (%)	80	0	20

5. WASTE DISPOSAL.

Waste is regularly disposed of on Dunkeswell Aerodrome. The type of wastes and their impact on the water quality of the Dunkeswell Stream was investigated.

The area of concern lies to the East of the main runway on the aerodrome (see Fig.1). The Dunkeswell Air Centre uses the land south of the Hemyock Road (ST 136076), and the land to the North is farmed by Brookside Farm (ST 138082). Land at Southayes Farm (ST132070) is not currently used for the disposal of waste.

Eight local contractors were contacted to determine whether they use Dunkeswell Aerodrome for waste disposal. Two contractors dispose of milk products from St Ivel Ltd Dairy Products, Hemyock. Pig slurry from Westerhope Farm is also disposed of on the aerodrome by a contractor although most of the disposal occurs outside the Madford catchment off the aerodrome.

5.1. Drainage.

Surface water from the aerodrome principally enters the Dunkeswell Stream at Bluehayes Farm (see section 2). There are two other outfalls at ST 131069 (outfalls 2 & 3 - Fig. 1) draining land around Southayes Farm. These were not considered because waste disposal has stopped in this area.

The outfalls at Southayes Farm have been monitored in the past when pig slurry was spread on surrounding fields. This work followed the major pollution in 1983 when pig slurry entered the river during spreading.

5.1.1. Chemical survey.

A survey was carried out on 1 February 1990. Samples were taken every three hours over a nine hour period from the outfall at Bluehayes Farm and at sites 10m upstream and 20m downstream. The last sample was taken during heavy rainfall when the outfall was discharging at a high rate. Pig slurry was being spread on Dunkeswell Aerodrome around the Dunkeswell Air Centre throughout the survey period.

A significant increase in suspended solids occurred in the discharge when rainfall increased flow rate in the surface water outfall (Table 10). However, BOD and ammonia concentrations were low at all times suggesting that slurry had not entered the drainage system or it had not reached the outfall during the survey period.

The Dunkeswell Stream upstream of the discharge showed a deterioration in water quality during heavy rainfall probably as result of farm discharges identified during the farm campaign (see section 4).

TABLE 10. Water quality of three samples taken upstream, downstream and from the surface water outfall at Bluehayes Farm on 1 February 1990.

Site	BOD (mg/l O)			Ammonia (mg/l N)			Solids (mg/l 105C)		
	1	2	3	1	2	3	1	2	3
U/S Outfall	0.9	1.3	6.6	0.18	0.10	0.70	10	11	65
Discharge.	1.2	2.4	2.6	0.04	0.03	0.07	6	92	124
D/S Outfall.	1.4	1.5	5.4	0.18	0.10	0.49	12	16	124

5.1.2. Biological Survey.

The aquatic invertebrate fauna monitored upstream and downstream of the surface water outfall at Bluehayes Farm did not show any significant signs of deterioration downstream of the discharge on 26 January 1990.

6. THE HOUSING ESTATE.

Westward Developments (Totnes) Ltd. is currently developing a housing estate (ST 144068) at Dunkeswell. The developer has outline planning permission for 401 dwellings of which 163 were completed on 30 November 1989.

6.1. Drainage.

The drainage system which has been constructed does not meet the specifications of the plans submitted to the NRA SW. Considerable

siltation of the river bed has occurred downstream of the development. Since the river was not silted upstream of the development it is assumed that siltation was due to developments which have disturbed large amounts of soil and also caused siltation by instream works.

6.1.1 Chemical Survey.

Chemical samples taken immediately upstream and 10m downstream of the surface water outfall draining the site during dry weather (6 November 1989) indicated good water quality (Table 11). All samples complied with NWC Class 1A

During wet weather on 7 February 1990 suspended solids were higher downstream of the outfall due to drainage from the development. It was not possible to sample the discharge on this occasion

BOD and ammonia concentrations upstream and downstream of the surface water outfall were higher during rainfall and were within NWC Class 2. This is probably a result of a farm discharge identified during the farm campaign (see section 4).

TABLE 11. Results of single samples taken upstream, downstream and from the surface water outfall on 6 November 1989 (dry weather) and 7 February 1990 (wet weather).

Site	Ammonia (mg/l N)		BOD (mg/l O)		Solids (mg/l 105C)	
	6.11.89	7.2.90	6.11.89	7.2.90	6.11.89	7.2.90
U/S Development.	0.16	0.56	1.4	4.9	6	22
Discharge.	0.01	-	1.1	-	5	-
D/S Development.	0.3	0.48	11.3	4.6	4	73

6.1.2. Biological Survey.

The aquatic invertebrate fauna surveyed on 6 November 1989 and 26 January 1990 upstream and downstream of the housing development was slightly impoverished at both sites presumably due to farm drainage (Appendix 1).

Although the river was heavily silted downstream of the development, this did not appear to affect the invertebrate community.

7. FISHERIES

A redd count was carried out on the Madford River between 1 and 4 December 1989 following the major pollution from Westerhope Farm.

The river was walked from its confluence with the River Culm (ST 143138) to Rough Grey Bottom (ST 148069). The Dunkeswell Stream was also surveyed to Dunkeswell (ST 140074).

Only one Brown Trout redd was found at ST 148125 immediately upstream of the Madford/Bolham confluence. Many riffles throughout the length of the river had not been used.

Trout production in the upper reaches of the Madford River is likely to be affected due to lack of spawning, siltation of spawning sites from the housing development (see Section 6) and from farm drainage (see Section 4).

8. OTHER PROBLEMS

8.1. Water Supply.

South West Water Services Ltd were contacted to ascertain where and how often water mains are flushed in the Madford catchment. This action follows concern that the discharge of mains water may affect river quality particularly if the water is flushed as a result of problems in the distribution system.

Water mains are flushed at three locations in the catchment (NGR ST 140072, ST 141079 ST 142078 - Fig. 1). Flushing is irregular and depends on customer complaints.

8.2. Impoundment Licences.

There is only one licensed impoundment within the catchment (ST 137073). This has an earth dam constructed in accordance with specified drawings. The capacity of the impoundment is 750,000 gallons (3,410 cm^3) and covers 0.303 hectares.

Three other ponds (ST 141076, ST 142077 & ST 151074) were checked to determine whether they complied with legal requirements.

The large trout pond at Pond House is embanked and is considered to need an impoundment licence and inspection to ensure the banks are adequately constructed to avoid the possibility of collapse.

9. CONCLUSIONS.

(1) The major influence on water quality in the Madford Catchment is farm drainage.

A high proportion of all farms visited in the catchment (25 out of 72 = 35%) were found to be polluting watercourses.

All the drainage problems identified were associated with dairy and beef farms. Farms with larger herds were more likely to be polluting.

The main cause of pollution from farms was yard run-off during heavy rainfall and dairy parlour washings entering watercourses.

(2) Heavy rainfall increases pollution which in turn causes deterioration in water quality in the Madford Catchment.

(3) Farm drainage problems are considered to be the main cause of non-compliance with river quality objectives assigned to routine river quality monitoring points at Culm Bridge and Five Bridges.

The principal source of poor water quality is most likely to be from the Madford sub-catchment.

(4) The final effluent from Dunkeswell STW did not significantly affect receiving water quality. However the present descriptive consent for the discharge is no longer appropriate and a numeric consent is required to control the domestic and industrial waste treated by the works.

(5) The industrial units at Dunkeswell Aerodrome are using and storing chemicals which pose a risk of pollution to the Dunkeswell Stream via a major surface water sewer.

(6) The surface water discharge from Dunkeswell Aerodrome was not found to significantly affect receiving water quality and no evidence was found that the use of the aerodrome for the disposal of waste was influencing the quality of the surface water drainage.

(7) Sewage disposal and impoundment at Fishponds House requires consenting and licensing respectively.

(8) The housing development at Dunkeswell has caused significant siltation of the upper reaches of the Madford River.

(10) Biological investigation of the Madford River indicates the aquatic invertebrate fauna in the Madford River has recovered well from the Westerhope Farm slurry spillage.

(11) A count of Brown Trout redds in the Madford sub-catchment during spawning in the 1989 season indicated very little recruitment of wild trout stocks could be expected in 1990.

(12) A number of mains water flushing points have been identified in the Madford Catchment which pose a potential risk to river water quality.

10. RECOMMENDATIONS.

(1) Formal samples must be taken at farms that fail to install remedial measures within an agreed timescale.

(2) A new routine river quality monitoring point must be established in the Madford River upstream of the Bolham confluence.

(3) SWW Services Ltd have been informed that it must apply for a new consent for Dunkeswell STW. When this is received numerical conditions must be applied.

NRA SW will liaise with the Ministry of Defence regarding the consenting of the surface water sewer that runs through Bluehayes Farm.

Consents are required for Fishponds House septic tank discharges and the surface water outfall from Dunkeswell housing estate.

(4) The impoundment at Pond House requires licensing.

(5) The industries storing chemicals at Dunkeswell Industrial Estate which pose a serious pollution risk must be informed of their proximity to the Dunkeswell Stream and requested to install bunding where appropriate.

(6) Silt traps are to be installed downstream of the housing development by Westward Developments (Totnes) Ltd. These must be inspected.

Rehabilitation of gravels should be undertaken if residual silt is not flushed naturally from the Madford River.

(7) Pollution risks posed by sites used for flushing mains water should be assessed and where necessary remedial actions or new sites agreed.

(8) A fish survey of the Madford Catchment should be carried out to assess the status of fish stocks.

(9) The Dunkeswell Stream requires constant surveillance at other times of the year.

APPENDIX 1. Aquatic invertebrate statistics for surveys on 23 October 1989, 6 November 1989, 26 January 1990 and 6 February 1990.

Site	Invertebrate Statistics							
	23.10.89		6.11.89.		26.1.90		6.2.90	
	BMWP	ASPT	BMWP	ASPT	BMWP	ASPT	BMWP	ASPT
Madford River								
1 Culm Bridge							129	5.86
2 D/S Bolham River							140	6.36
3 U/S Bolham River							141	6.13
4 Madford Bridge	133	6.04						
5 Riverside Cottage	75	5.77			104	6.12		
6 Rough Grey Bottom	54	4.91			126	6.00		
7 D/S Highwood Trib.			68	4.86	110	6.11		
8 D/S Housing estate			125	6.25	102	6.00		
9 U/S Housing estate			126	6.00	94	5.87		
Abbey Stream								
10 Abbey Bridge	141	6.13			156	6.50		
Highwood Tributary								
11 D/S Farm Discharge			26	3.71	91	5.69		
12 U/S Farm Discharge			114	5.43				
Dunkeswell Stream								
13 D/S STW					112	5.89		
14 U/S STW					119	6.61		
15 Dunkeswell Bridge	64	4.92			140	6.09		
Bolham River								
16 U/S Madford River							162	6.23
17 Bolham Water							142	6.17
18 Middleton Mill							168	6.46
19 Lemon's Hill Trib.							162	6.23
20 Knowle's Farm Trib.							155	6.74

BMWP = Biological Monitoring Working Party score.
ASPT = Average Score Per Taxon score.