Institute of Freshwater Ecology

Flow regime requirements River Darent

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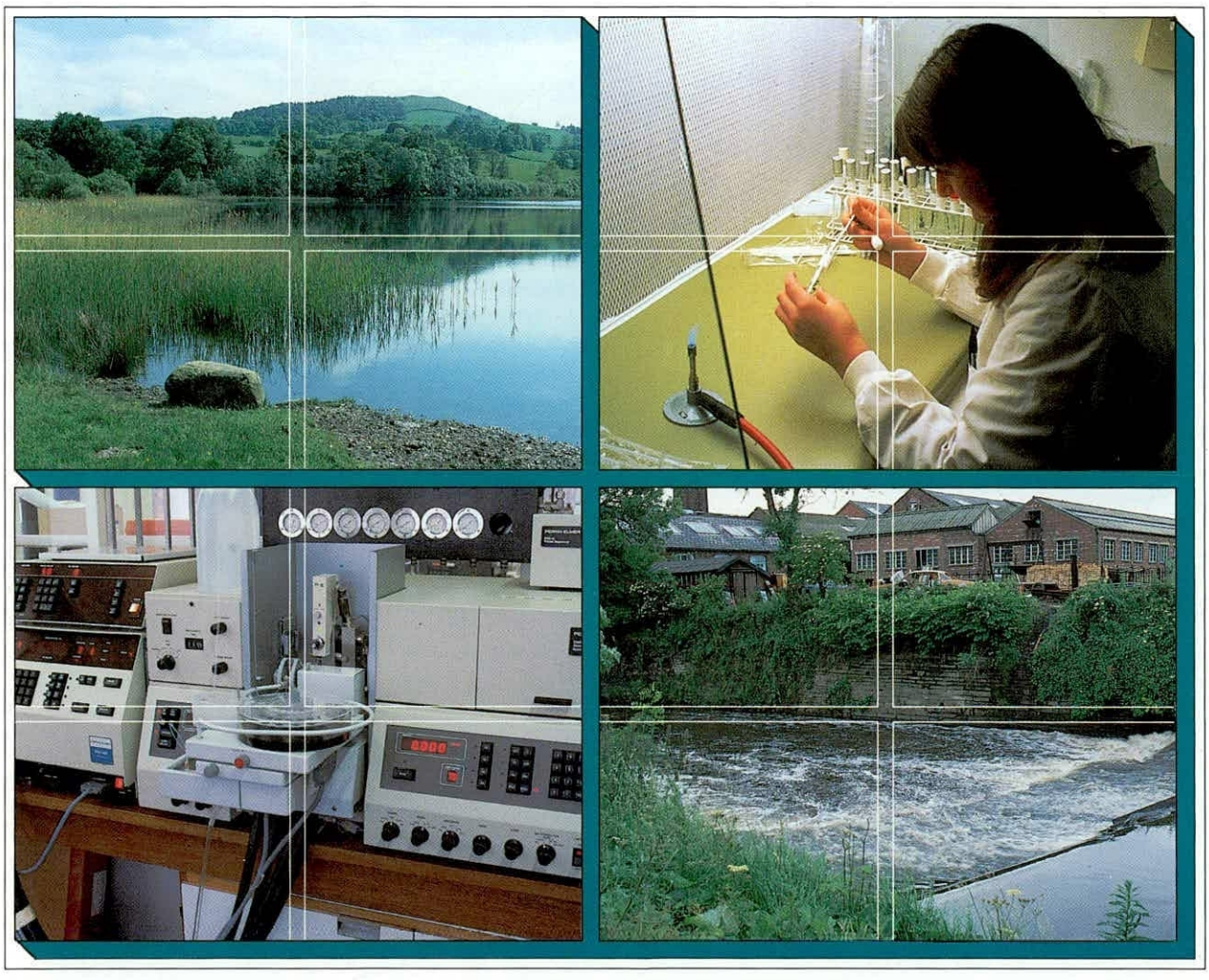

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INTRODUCTION

The river Darent, like many other south coast streams (Frome, Piddle, Avon, Test, Itchen, Meon, etc.), rises essentially in chalk downland and in its lower reaches flows through other geological formations including sandstones. In this regard it can be considered "typical" of such rivers and compared directly with them. The Darent, however, also gains substantial inputs from springs arising in greensand (similar to the Nadder and East Avon in Wiltshire).

(a) The feasibility of applying the presently available preference curve data for representative reaches of the river is outlined below:

Existing curves have been derived, using 'expert' opinion to modify the information from other contexts (published and unpublished), for a small number of invertebrates, some fishes and for *Ranunculus 'fluitans'*. Little work has yet been carried out to validate outputs from the PHABSIM model using existing curves. This must be taken into consideration in applying the curves to set an Ecologically Acceptable Flow Regime. The values given in the present report are based on subjective criteria and, as far as possible, have been modified to exclude extreme or widely divergent values.

(b) Data is presented in a tabular form as the preferred flow, depth and velocity for any particular species to "thrive":

In this instance the critical word is THRIVE. Many of the plants and animals concerned have wide ranges of TOLERANCE with regard to physical parameters and it is preferable to consider tolerance limits and optima rather than the vague concept implied by the word thrive. Even taking this into consideration, the critical values of velocity, depth or substrate for specific (frequently brief) life stages are often unknown.

The premise that the application of existing preference curves - "should give clear, quantitative, target bench marks for an EAFR in a natural chalk stream" - may not be tenable at this stage of curve development although the curves could provide useful information to assist in such an exercise. This investigation should be followed up by a detailed application of PHABSIM/RIVPACS to the entire river with a view to setting an EAFR. If the flows of the river Darent *are* to be restored it would seem to be critical to monitor in some detail the process of recovery of the flora and fauna.

METHODS

Site reconnaissance, of the approved list of watercourse crossing sites was undertaken to determine the relevant ecological or conservation characteristics of the river by an on-site assessment of the following:

- Flora and fauna
- Bank, sediment and bed characteristics
- Watercourse size
- Adjacent land use
- On-site evidence of recreational use

- Proximity to designated sites of conservation importance
- Other potential problems including reinstatement and long-term morphological changes

At each site a water sample was normally filtered for laboratory analysis.

The flora, including mosses, liverworts and macroscopic algae, was recorded within each 200 m section of watercourse and notes were made to assist in the assignment of a value for its relative quality. Separate assessments on a scale of 0-5, were made for submerged aquatic plants and for bank or emergent species; these two scores were added together to produced a score from 0-10 for flora for each site.

Invertebrates were sampled at each crossing point. All habitats were sampled where possible. Kick samples were taken when the water depth was <60cm at some point. The samples were sorted on the bank by spreading them out in a tray and picking out individuals of each family present and different species of each family where possible. A score (0-10) based on the results was assessed for each site in the field. In the laboratory, identifications were checked and scores amended where necessary.

Bank sediment and bed characteristics were assessed in two ways, by:

a) cover of the stream bed by each type of substratum in the invertebrate sample area

and by:

b) relative proportions of various materials and characteristics of the banks and adjacent areas in the general sample area.

In addition, the underlying rock, as bed rock or outcrops, was specifically searched for.

Reconnaissance survey data sheets contain information on:

1. watercourse name with nearest village etc., as necessary;
2. reconnaissance survey number - numeric order;
3. numeric National Grid Reference number (NGR);
4. distance from source of watercourse;
5. altitude of survey section to c. 5m;
6. latitude and longitude.

Physical characteristics (estimated):

7. Size is recorded as estimated mean width and mean depth of water at survey and at the bankfull condition of the watercourse. The mean depths of pools are recorded in brackets if appropriate. Additional comments relate to obvious recent events as seen from obvious flood debris stranded on the banks or adjacent vegetation and this is recorded as the additional height above that at survey. Mean width is clear water width without allowance for dense fringing vegetation, eg reedstands, the latter are accounted for in bank-full widths.
8. Flow of water in watercourse at survey in cubic metres per second.

9. Velocity of water (estimated mean).
10. Slope of channel bed over survey length (estimated to c1).
11. Type of bed or water flow - waterfall, stepped, long riffle, riffle-pool with sequence distance in metres, glide or run, smooth, static or ponded.
12. Relative stream power - estimated on scale of 0 to 10 based so as to cover the range of British rivers, broadly, 0-3 indicate bed and bank stable rivers and streams, 4-5 rivers or large streams with some bed scour or bank erosion or lateral migration, 6-8 active rivers with rock or worked gravels and erosion or migration or both; comments may be appended.
13. Channel form in plan - straight, meandering, braided.
14. Channel sinuosity as seen and by inference, as in a previous condition where the situation may have changed: for example - straightened, slight, moderate or extreme; with a value in meters of actual and previous amplitude - this relates to the constructional requirements of proposed works, such as, length of buried pipe.
15. Channel section - slope recorded as steep, vertical, or trapezoid. comments if managed, dredged or resectioned.
16. Erosion of stream bank as percentage of stream margin within section - described as incising, flake or slab, slump or slide, undercut or block fall, or depositions with type of material and position recorded.
17. Substratum as percentage within 10% for major components, or subjectively as proportions indicated by asterisks (* = c. 20%), of watercourse bed for - bedrock or outcrops, boulders (>256 mm), cobbles (65-255 mm), pebbles and gravel (2.1-64 mm), sand (.06-2 mm),silt and clays (.05-.004 mm), and organic or peat: occasionally, in addition, the adjacent soils of stream banks and appropriate adjacent areas where considered relevant or different.
18. The colour and nature of the water eg presence of particles etc.

Adjacent features:

19. Land use on watercourse banks together with visual features within .5km;
20. upstream features;
21. downstream features;
22. maintenance;
23. fishery interest including other data obtained from various sources.

Environmental data on physical parameters, flora and animals are summarised together with a score for environmental quality based on scales of 0-10 for flora and 0-10 for invertebrates together with a correction for maintenance. Maintenance effects were scored on a -2 to +2 scale broadly based on:

-2 for channel resectioning and realignment
-1 for either channel realignment/channel resectioning of both banks
-0.5 one bank
0 a neutral score, indicating possible or historical management
+1 for unmanaged but agricultural banks especially rough grazing etc.
+2 near natural conditions
(Combinations of these scores were also used.)

The overall score was calculated by adding floral (0-10) to invertebrate (0-10) scores and dividing by two. This value is then corrected by adding the maintenance score (-2.5 to +2). Where scores were not available through difficulty in sampling or inappropriateness, eg dry ditches, an estimate (in brackets) was made for the overall score. Artificial watercourses especially canals present difficulties and two scores are normally calculated, one incorporating the actual management (-2) and the other a null score (0) and given for example as '(1/3.5)'.

This method of assessment is still being developed but can in theory be seen to give values less than zero, for low biotic score (polluted) and highly managed sites, or higher than 10 for pristine sites; this scoring system has not been revised as it allows better discrimination among the middle range of sites. The ultimate score for pristine sites or indeed values over 10 have not yet been achieved in over 420 sites investigated within Britain.

A summary, at the bottom of each sheet, gives the advised method of construction (if appropriate), key points and further survey recommendations together with the overall score.

The use of question marks primarily indicates uncertainty about a value or statement eg water depth, where the river was too deep to measure without a boat.

Chemical analysis was carried out to determine the character of the water in order to indicate biotic potential. Water analysis at survey sites included:

- pH (Hydrogen ion concentration)
- total salts as conductivity

and later, on return to the laboratory, the filtered water was analysed:

- Anion to Cation balance for common ions (in milliequivalents per litre)
- The nutrients nitrate and phosphorus

Anions include alkalinity as bicarbonate (in milliequivalents per litre), chloride, sulphate, nitrate-nitrogen, phosphate-phosphorus (soluble or orthophosphate), silicate-silicon.

Cations include calcium, magnesium, sodium, and potassium, reported as milligrams per litre.

nb. *Ranunculus* spp will need to be identified when in flower.

It was possible to:

(1) Inspect twelve locations on the Darent. They are described on the basis of simple measurements of cross sectional widths, depths, features present and subjective determinations of substrate type and cover at each location.

(2) For *Ranunculus penicillatus (?fluitans),* some species of "chalk stream" invertebrates, trout and grayling, the appropriate preference ranges or features of the physical habitat characteristics are provided. Approximate times of year for relevant life stages are indicated and current gaps or deficiencies in knowledge are pointed out.

(3) Appropriate species for which data on habitat preferences might be sought are given. Some species characteristic of natural chalk streams are listed and those which might be preferable target organisms are indicated.

RESULTS

The physical and biological characteristics of the river Darent between Dartford Park and Westerham are summarised in appendix 1. Tables (1) and (2) list the taxa of plants and invertebrates recorded during the site visit and figures 1-3 summarise the relative abundance of selected invertebrate groups along the course of the river.

DISCUSSION

Chalk fed streams similar in dimensions and character to the Darent are fairly numerous in southern England. The flow regimes in such streams range from intermittent "bourne" type patterns in which the stream dries up, more or less regularly each year, to perennial watercourses with flow throughout the year. Typically these streams have substrata of flint gravel inhabited by a macrophyte community showing strong spatial and seasonal changes. Because of the substantial contribution of greensand water it is probable that the Darent was naturally characterised by relatively large differences between maximum and minimum flows (say 15:1 or 20:1 as opposed to 5:1 or 10:1 in mainly chalk fed streams).

The "water chemistry" in the Darent reflects its dual origins with high calcium concentrations (from the chalk) and relatively high chloride values (from the greensand). When sampled the phosphate and silica concentrations were, with the exception of the downstream sites, so low as to suggest the presence of a vigorous diatom bloom, these algae remove significant quantities of the above named nutrients from rivers of this nature.

All healthy natural streams of this type, whatever the flow regime, appear normally to have abundant growths of macrophytes. Intermittent streams are characterised by submergent plant species such as *Ranunculus peltatus* and *Apium nodiflorum*. Perennial streams, in contrast, although they have ecologically equivalent plant forms to such intermittent bournes, are generally dominated by asexually reproducing species of *Ranunculus*. Heavily silted reaches, often relatively deep and slow flowing, may contain the silt tolerant starworts *Callitriche*. Many other plant species (dropworts, veronicas, pondweeds) may be dominant or sub-dominant in particular situations.

Rich growths of aquatic plants tend to encourage sedimentation of fine particulate material. As a result, in the presence of plants, the superficial deposits of sand and silt are usually localised within the plant stands. Consequently, as discharge diminishes through the summer, the main flow of water becomes restricted to rather narrow, high velocity, gravel-bedded channels between the weed/fine sediment patches.

This entire range of stream flow regimes is characterised by more or less rich and diverse faunas. Typically the invertebrate community is representative of the habitat subdivisions within the stream so that, for example, weeds in fast flowing water will be dominated by Simuliidae, Orthocladiinae and Baetidae, sand and mud deposits by Tubificidae, Chironominae

and Sphaeriidae, gravel by a wide range of taxa with Gammaridae, Ephemeridae and cased Trichoptera often prominent. In the absence of macrophyte growth silt will often be widespread over streambed gravels and in consequence the fauna is likely to be much more restricted, with silt loving taxa (Tubificidae, Asellidae, Caenidae) relatively common. To provide a clear picture of habitat conditions selected species of these groups would need to be targeted. Figures (1),(2) and (3) depict the distribution patterns of certain Oligochaeta, Crustacea and Ephemeroptera respectively.

Comparative information from other hard water streams of similar dimensions to the Darent is as follows:

1. A small (<2.5 m wide) stream which dries in years of low precipitation had a maximum flow of 0.2 cumec and rich growths of *Ranunculus peltatus* and/or *Apium*, the latter being dominant following periods when the stream bed was dry (Figure 4).

2. A chalk stream having a channel width of 4-5 m with a flow range, in the study year, from 0.01 to 0.5 $m^3 s^{-1}$. Rich and abundant flora including heavy *Ranunculus* growth (Figure 5).

3. Further downstream, in a perennial section of stream 2, (mean width of 21 cross sections = 9 m), the mean discharge varies annually from about 1.6 $m^3 s^{-1}$ to 0.3 $m^3 s^{-1}$. Again the channel has abundant growths of submerged (*Ranunculus*) and emergent macrophytes except in sections heavily shaded by trees (Figure 6).

Table (3) gives approximate values of depth, velocity, sediment type and cover characteristics favoured by selected species of fish, plants and invertebrates. The seasonal variations in requirements are related to appropriate life stages for each species. With the exception of trout and grayling all the genera mentioned were recorded as present in the Darent. It should perhaps be noted that some genera/life stages are particularly sensitive to velocity and hence to discharge conditions. For example, overwintering *Ranunculus* and *Simulium* sp. may respond adversely to reduced velocities. In view of this substantial parts of the channel should sustain velocities in excess of 0.5 m s^{-1} and depths in excess of 0.3 m even in low discharge conditions.

CONCLUSIONS

The above figures illustrate the large range of flow regimes under which an acceptable "hard water stream ecosystem" can be sustained.

Much of the Darent, within the stretch examined for the present report, is of similar channel width to the examples (2 and 3). However, it should be borne in mind that the present channel of the Darent is certainly smaller than that which existed under the unabstracted flow regime and that the Darent catchment with a large component of greensand is probably "flashier" than a total chalk catchment. In view of this discrepancy and the requirements of rheophilous (current loving) species such as *Ranunculus* an appropriate flow regime for the lower reaches might range from >2 $m^3 s^{-1}$ (with spikes to perhaps 3-5 $m^3 s^{-1}$) to an absolute minimum value of 0.3 $m^3 s^{-1}$ in drought conditions. The highest peak values may be essential to flush out accumulated sediments in the prevailing conditions of geology/topography.

In the absence of heavy shading, pollution, non-gravel bed or excessive silt loading most sites on the Darent should be capable of supporting rich and diverse aquatic flora including species of *Ranunculus, Apium, Berula, Oenanthe, Veronica* and in the slower, deeper stretches, *Callitriche, Potamogeton, Elodea*, etc. In view of the almost total absence of aquatic macrophytes from many reaches it may well be necessary to replant and reintroduce selected species.

The growth pattern and vigour of the plants should be such as to restrict low summer flows mainly to narrow, gravel runs and thus to perpetuate the annual sequence of submergent growth-emergent growth-washout-regrowth.

Although management in the form of low retaining weirs and other permanent structures may hold back water in times of reduced flow, it is probable that the reduced velocities and silt trapping capacity of such structures delays recolonisation by rheophilous plants such as *Ranunculus* and prevents the establishment of a natural cycle of deposition and erosion which is associated with backing up of water in the summer months.

River Darent @ Dartford Park Site 1
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N, Log 'E

PHYSICAL CHARACTERISTICS

Size at survey:Width 10.4m; depth .93m
Height Board: - m; Water depth .42m
est. bank full: Width 14 m; depth 2 m

Flow at survey - discharge 0.18 $m^3 s^{-1}$
- velocity .041 $m s^{-1}$
Bed slope ≈ 0 °, type: depositing
Rel. Stream Power: 0-1
Channel- plan form: straightened
- sinuosity now: - , m
previous: - , m
- section: trapezoid
Erosion 0 %,type: -

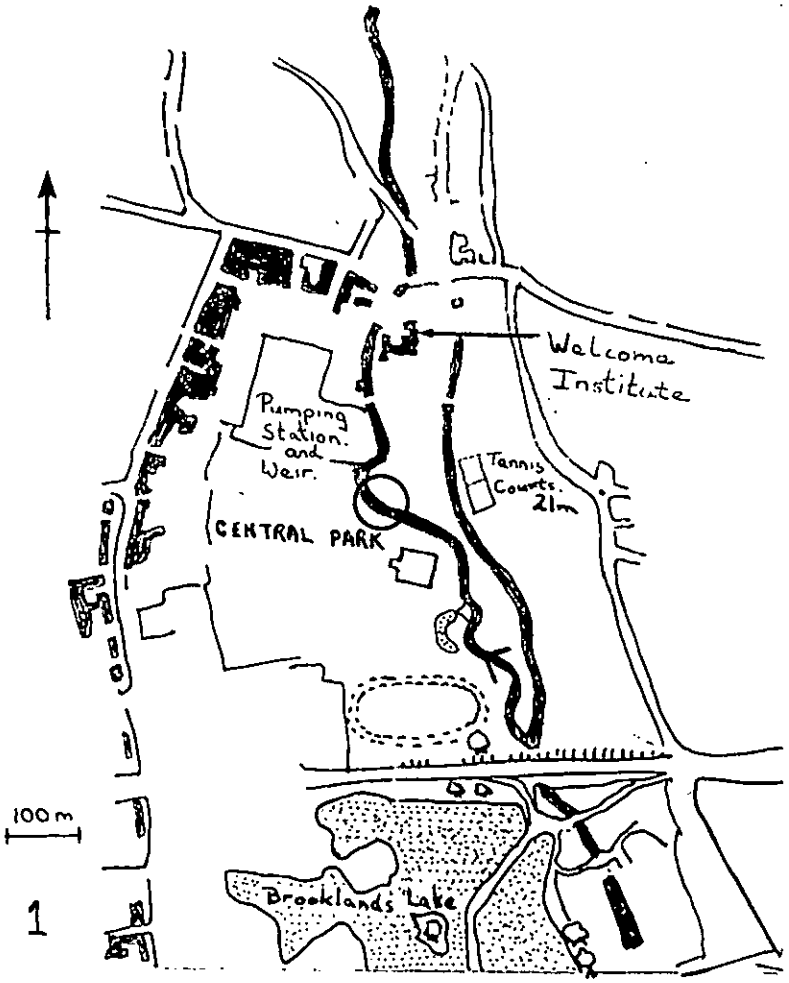
Substratum (cover)	bed	banks	adjacent
bed rock		(concrete bags)	
boulder/cobble			
pebbles/gravel		*	*
sand	*	*	**
silt/clay/(peat)		****	* *

WATER CHARACTERISTICS

Colour: clear
pH 8.2, Conductivity 540 µS cm^{-1}

Anions, mg l^{-1}		Cations, mg l^{-1}	
Alkalinity	169		
(Alkalinity 3.4mmol)		Calcium	93
Chloride	42	Magnesium	4.0
Sulphate	64	Sodium	22
Nitrate N	3.3	Potassium	3.6
Phosphate P	0.0016	(Iron)	
Silicate Si	1.5		

Ion balance 5.88 : 6.03 mmol
Assessment: enriched typical greensand/calcareous water with effects of probable diatom bloom



ADJACENT FEATURES etc.

Land use: ornamental park/playground, etc
Upstream: semi-urban, planted trees
Downstream: weir tennis courts
Maintenance: low but bagged banks to W
Fishery interest: low, could be improved

PHYSICAL

Maintenance Factor -0.5

A section of slow flow over deep (0.5m) depositing mud, resectioned, realigned and strengthened banks

PLANT (shade 20%; cover: algae 20%, moss 0%, macrophytes 15%) 2.5 + 3 = Score 5.5
A broad slow section with some shade by ash, weeping willow, sycamore, etc.
Aquatics moderate with Pondweed and Starwort but with good although sparse marginals except upper bank was weedy with nettles etc. Much dead algae on surface of mud.

ANIMAL Score 3

(20% outstreaming algae with reeds in stream 10%)

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
An urban park section, dammed below, with deep settled mud. (Dangerous to children!)

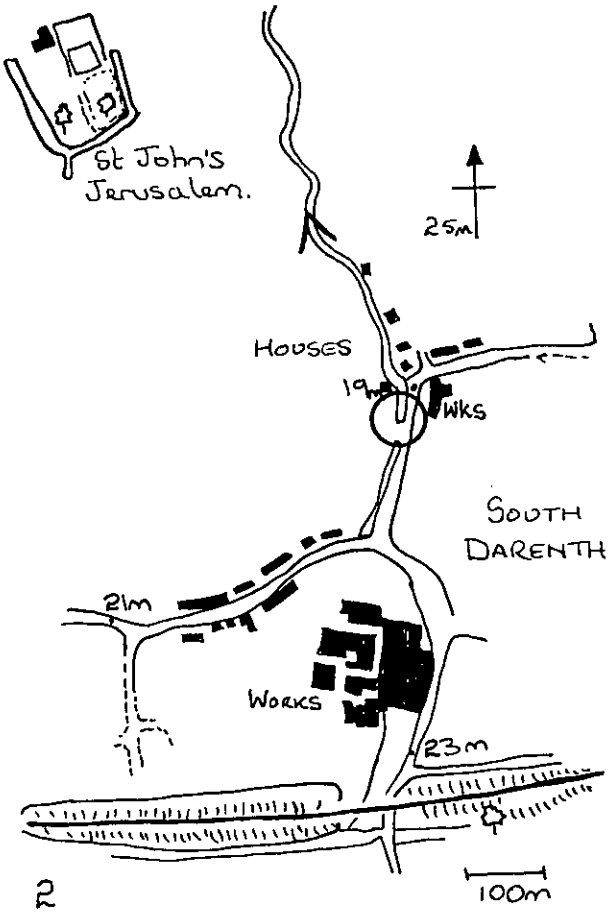
POTENTIAL IMPROVEMENT **OVERALL SCORE** 3.75
Desilting required after checking if tidal height limit downstream will allow.

River Darent @ Sutton at Hone **Site 2**
Date: 29.04.93 NGR: *
km from source * Altitude * m
Lat * 'N, Long 'E

PHYSICAL CHARACTERISTICS
Size at survey: Width 4.8m; depth .22m
Height Board: .22m; Water depth m
est. bank full: Width 6 m; depth .8 m

Flow at survey - discharge .81 $m^3 s^{-1}$
- velocity .77 $m s^{-1}$
Bed slope <1 ^{0}, type: long run
Rel. Stream Power: 3
Channel- plan form: straightened
- sinuosity now: - , m
previous: - , m
- section: trapezoid, concrete
Erosion (0)%,type: bags

Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble			
pebbles/gravel		***	**
sand	*	**	
silt/clay/(peat)		*	*



WATER CHARACTERISTICS
Colour: clear, can be 'dark'
pH - , Conduct. - $\mu S\ cm^{-1}$, Temp °C

Anions, mg l^{-1}	Cations, mg l^{-1}
Alkalinity	
(Alkalinity mmol)	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	

Ion balance : mmol
Assessment:

ADJACENT FEATURES etc.
Land use: town, by houses & road/factory
Upstream: house/mill & bridge sewage works?
Downstream: town
Maintenance: high with stabilised banks
Fishery interest: low

PHYSICAL Maintenance Factor -1

Straightened stream with good flow over gravels, little siltation.

PLANT (shade 5%; cover: algae 70%, moss 0 %, macrophytes 20%) 1 + 1.5 =Score 2.5
Narrow marginal band of vegetation with nettle to E. by road: good stands of aquatics incl. crowfoot and underwater forms of emergents which would be expected to grow and dominate later in year, but with large stands of filamentous algae probably stimulated by elevated but not excessive nutrient inputs, some grasses (5%)
('Flowering rush upstream by railway bridge').

ANIMAL Score 4
Animal poor despite good flows indicating intermittent pollution events ('water turns black on occasion but not a rain effect')

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Pollution events need investigation

POTENTIAL IMPROVEMENT **OVERALL SCORE 2.25**
Little chance of improvement except to avoid pollution; flow adequate as seen.

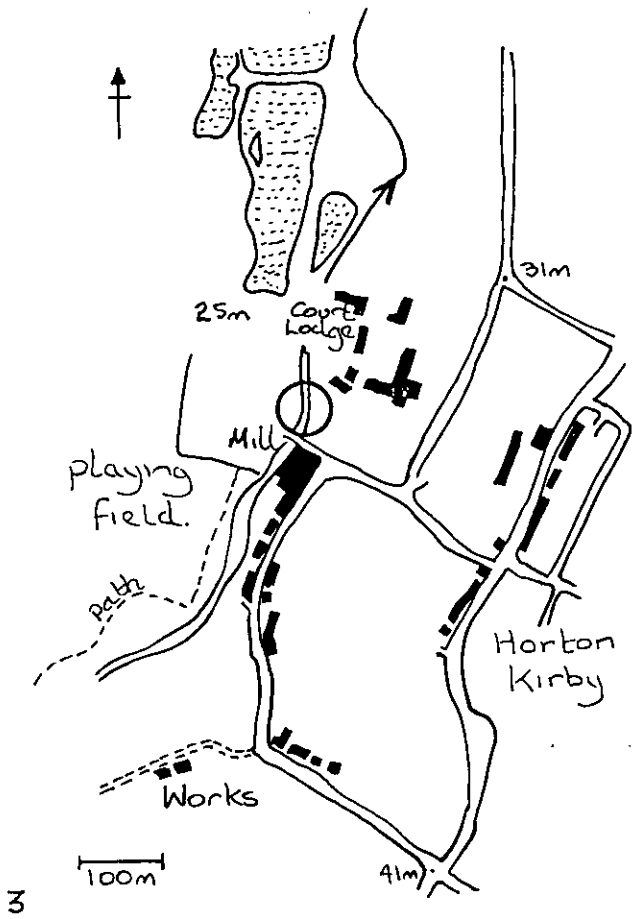
River Darent @ Winchester Mills **Site 3**
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N, Log 'E

PHYSICAL CHARACTERISTICS

Size at survey: Width 9 m; depth .25 m
Height Board: m; Water depth m
est. bank full: Width 15 m; depth 1 m

Flow at survey - discharge .61 $m^3 s^{-1}$
- velocity .27 $m s^{-1}$
Bed slope $<1^0$, type: near riffle pool
Rel. Stream Power: 2 but weir upstream
Channel- plan form: sl. meandering
- sinuosity now: , 3 m
previous: - , m
- section: variable
Erosion 10 %,type:

Substratum (cover)	bed	banks	adjacent
bed rock			
boulder/cobble	*		
pebbles/gravel	***	**	
sand		*	
silt/clay/(peat)	*	*	



WATER CHARACTERISTICS

Colour: clear
pH 7.9, Conduct. $\mu S\ cm^{-1}$, Temp °C
Alkalinity 3.5 mmol

Anions, mg l^{-1}		**Cations, mg l^{-1}**	
Alkalinity	175	Calcium	99
Chloride	42	Magnesium	4.3
Sulphate	65	Sodium	22
Nitrate N	3.8	Potassium	4
Phosphate P	.0043	(Iron)	
Silicate Si	1.2		

Ion balance 6.03 : 6.34 mmol
Assessment: enriched water, possible effects of diatom bloom increased

ADJACENT FEATURES etc.

Land use: grazing, playing fields
Upstream: weir, mill & sewage works?
Downstream: wooded
Maintenance: little, plans for lining section
Fishery interest: low but could be

PHYSICAL Maintenance Factor +0.5

Below mill & weir pool, large slabs in stream bed and other sunken debris. Gravel overlain with excessive quantities of fines.
('Residual water in weir pool in summer in previous years')

PLANT (shade 70%; cover: algae 1%, moss 0%, macrophytes 10%) 3.5 + 0 = Score 3.5
A pleasant section shaded by mature hawthorn, interesting banksides including some fringing vegetation but with weedy patches. Surprising absence of larger flowing water plants said to relate to regular seasonal drying out of section; no signs of invasion of other more drying tolerant species of Crowfoot
Signs of dumping alien waterplants esp. *Lagarosiphon.*

ANIMAL Score 5
Range of invertebrates including mayflies and snails. Dead Koi carp (Dumped?).

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Good fauna & bank flora, no aquatics but excessive fines.
('Classic site 3-5 years after restoration of flow')

POTENTIAL IMPROVEMENT **OVERALL SCORE 4.75**
Planting of submerged macrophytes should alter distribution of fines & elevating water velocities, promoting better habitat. Minimum flows (to be defined) must be maintained following planting.

River Darent @ Farningham Bridge **Site 4**
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N, Log 'E

PHYSICAL CHARACTERISTICS

Size at survey: Width 7 m; depth .29m
Height Board: .40 m; Water depth .27 m
est. bank full: Width 9m; depth 1-2?m

Flow at survey - discharge .36 $m^3 s^{-1}$
- velocity .19 $m s^{-1}$
Bed slope $<1^0$, type: pool & run
Rel. Stream Power: 1-2
Channel- plan form: straightened, aligned
- sinuosity now: -, m
previous: -, m
- section: variable
Erosion %,type: old ford

Substratum (cover) bed banks adjacent

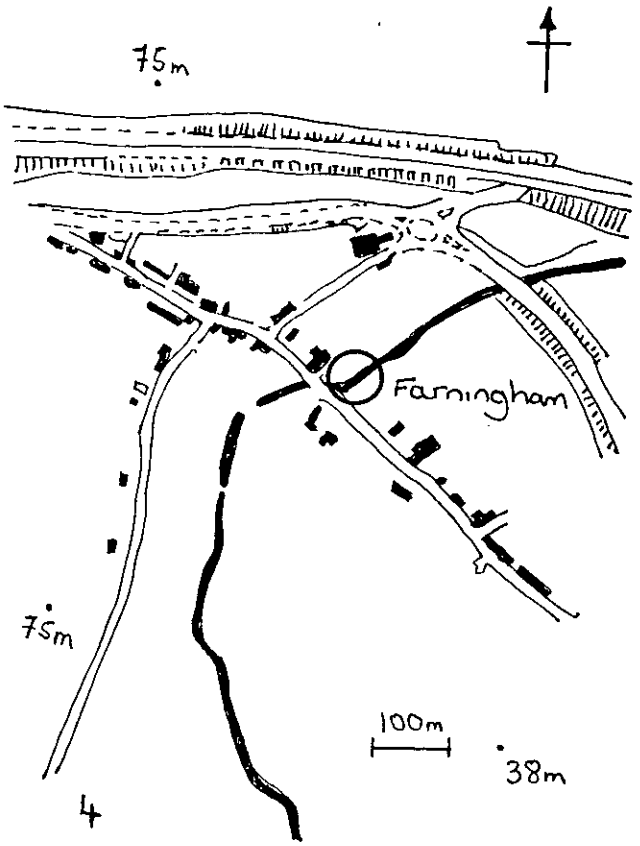
bed rock		
boulder/cobble	*	
pebbles/gravel	***	**
sand	*	***
silt/clay/(peat)	*	*

WATER CHARACTERISTICS

Colour: sl turbid
pH , Conduct. µS cm^{-1}, Temp °C
Alkalinity mmol

Anions, mg l^{-1}	**Cations, mg l^{-1}**
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	

Ion balance : mmol
Assessment:



ADJACENT FEATURES etc.

Land use: urban, park, grazing
Upstream: houses, walls
Downstream: old ford, ancient screen
Maintenance: straightened
Fishery interest: low, could be improved

PHYSICAL Maintenance Factor -1.5

Bridge & ford at lower end of town, channelised between houses upstream. Flow reduced by ford? allowing settlements of fines silt over medium gravels, much brick & debris esp. beer glass, in river.

PLANT (shade 60%; cover: algae -%, moss %, macrophytes %) 1 + 3 = Score 4
Stream shaded by trees or houses/walls which together with settled fine probably restrict submerged and also some emergent aquatic vegetation although Butterbur and another alien, the giant leaved Marsh Marigold (*Caltha polypetala*?) were seen in the margins.

ANIMAL Many *Caenis* mayfly larvae, *Gammarus* and Orthocladiinae Score 6
Shoals of minnows (100s), dace (approx 50) and chub (10) and a pike(?), were seen.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)

POTENTIAL IMPROVEMENT **OVERALL SCORE 2.5**
Needs more flushing flows and some channel resectioning to reduce siltation and encourage more submerged vegetation and a better habitat.

River Darent @ Eynsford Mill **Site 5**
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N, Log 'E

PHYSICAL CHARACTERISTICS

Size at survey: Width 8 m; depth .26m
Height Board: m; Water depth .25m
est. bank full: Width 12m; depth .7 m

Flow at survey - discharge 1.0 $m^3 s^{-1}$
- velocity .48 $m s^{-1}$
Bed slope ≈ 1^0, type: 1 run in 70 m
Rel. Stream Power: 3-4
Channel- plan form: sl sinuosity
- sinuosity now: 5m + bend
previous: artificial channel
- section: trapezoid + vegetated
erosion 5%,type: poached margins

Substratum (cover) bed banks adjacent

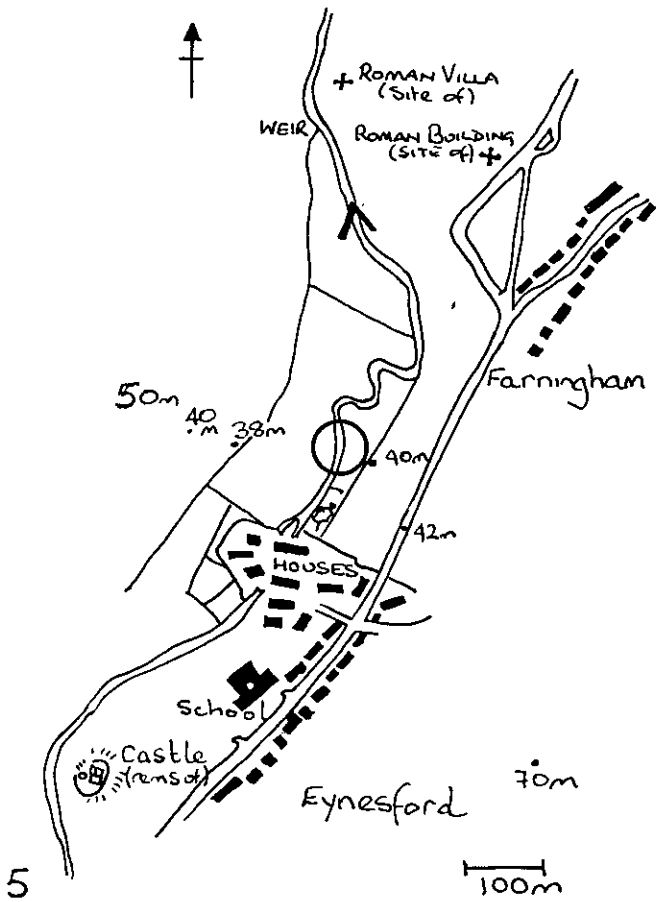
bed rock			
boulder/cobble			
pebbles/gravel	****	***	***
sand	*	**	**
silt/clay/(peat)		*	**

WATER CHARACTERISTICS

Colour: clear
pH 8.3, Conduct. 567 µS cm^{-1}, Temp °C
Alkalinity 3.4mmol

Anions, mg l^{-1}		**Cations, mg l^{-1}**	
Alkalinity	170	Calcium	98
Chloride	42	Magnesium	4.2
Sulphate	67	Sodium	21
Nitrate N	3.9	Potassium	4
Phosphate P	0.009	(Iron)	
Silicate Si	1.5		

Ion balance 5.96 : 6.25 mmol
Assessment:



ADJACENT FEATURES etc.

Land use: grazing
Upstream: housing estate, wood
Downstream: pasture, one side fenced
Maintenance: minimal
Fishery interest: low-medium

PHYSICAL Maintenance Factor (0)

An ancient mill leat ('mentioned in Doomsday') now the main channel which has developed some 'natural' meanders across meadows. Margin mud, partly from cattle poaching and partly from settlement by vegetation, otherwise clear gravels with good flows between near normal plant stands.

PLANT (shade 10%; cover: algae-dead 40%, moss 2%, macrophytes 30%) 2 + 4 = Score 6
Reasonably good (optimal) plant cover in central open section in modest water flows; complete identification of crowfoot is not possible without flowers although *Ranunculus c.f. aquatilis/fluitans* (!) been previously reported. Marginal plants much better on fenced than unfenced river bank.

ANIMAL Score 7
Shoals of minnows and dace, possibly trout and some chub observed.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Main channel is higher and to E of original course; this could lead to seasonal asymmetry of flows esp. at low summer flow.

POTENTIAL IMPROVEMENT **(artificial channel) OVERALL SCORE** (6.5)
Narrowing of stream could improve plant growth, etc., although this could be encouraged simply by fencing the stream (with cattle drinks) which would allow natural encroachment and a better natural flow to vegetation balance.

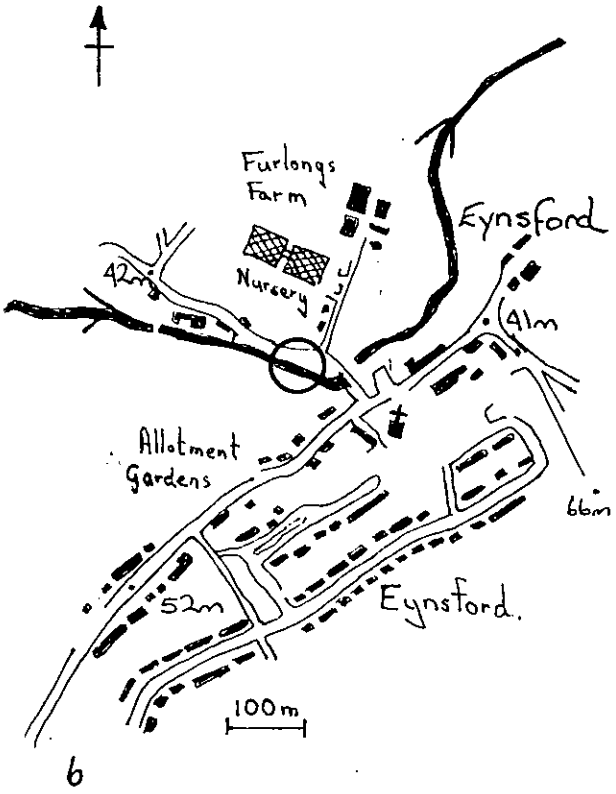
River Darent @ Eynsford Bridge **Site 6**
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N; Log 'E

PHYSICAL CHARACTERISTICS

Size at survey: Width 18 m; depth .14m
Height Board: .28 m; Water depth m
est. bank full: Width 18 m; depth .8 m
wide section visited mean width *c* 8 m
Flow at survey - discharge .73 $m^3 s^{-1}$
- velocity .29 m s^{-1}
Bed slope °, type: stepped (weirs)
Rel. Stream Power: 2-3
Channel- plan form: straightened, ford
- sinuosity now: - , m
previous: - , m
- section: near rectangular
Erosion %,type: concrete wall to W.
strengthened to E.

Substratum (cover) bed banks adjacent

bed rock			
boulder/cobble			
pebbles/gravel	***	***	***
sand	*	**	**
silt/clay/(peat)			*



WATER CHARACTERISTICS

Colour:
pH , Conduct. µS cm^{-1}, Temp °C
Alkalinity mmol

Anions, mg l^{-1}	**Cations, mg l^{-1}**
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	

Ion balance : mmol
Assessment:

ADJACENT FEATURES etc.

Land use: grazing, roadside mown grass
Upstream: rural, grazing
Downstream: urban, hatches by bridge
Maintenance: regular, weirs installed
Fishery interest: low could be improved

PHYSICAL Maintenance Factor -1.5

Little silt but some algae, mainly clear gravels below a succession of weirs, above hatches under bridge, to increase water depth, creating more turbulence and aeration of the water.

PLANT (shade 0%; cover: algae 10%, moss 0%, macrophytes 0%) 0 + 2 = Score 2

Spares but with a broad stand of reeds with occasional emergents, above bridge.

ANIMAL
Some of the more tolerant mayfly species present.

Score 5

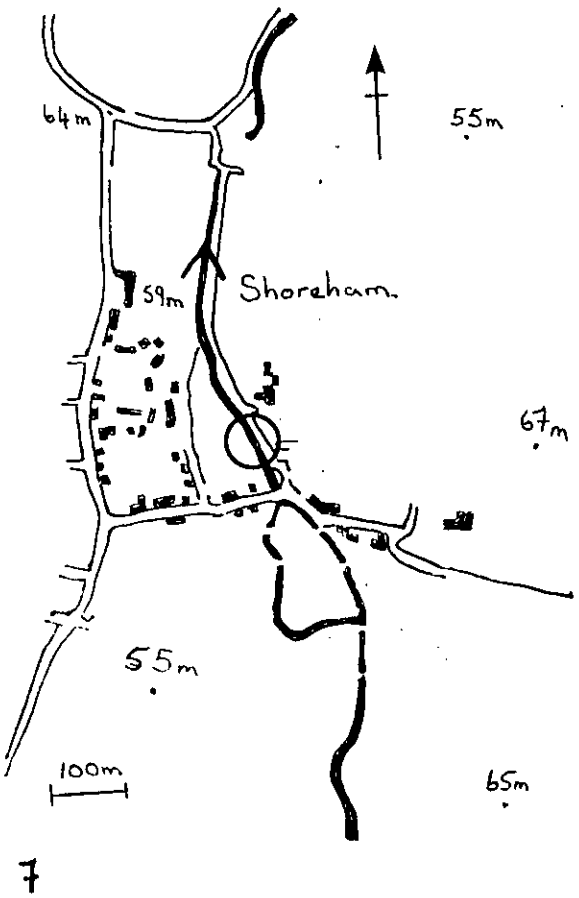
SUMMARY (incl. potential problems, conservation, long-term morphological changes)

POTENTIAL IMPROVEMENT **OVERALL SCORE 2**

River Darent @ Shoreham Village **Site 7**
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N, Log 'E

PHYSICAL CHARACTERISTICS
Size at survey: Width 8.4m; depth .25m
Height Board: m; Water depth m
est. bank full: Width 10 m; depth .7 m

Flow at survey - discharge $m^3 s^{-1}$
- velocity $m s^{-1}$
Bed slope ≈ 1^0, type: long run
Rel. Stream Power: 3/4
Channel- plan form: straight
- sinuosity now: - , m
previous: - , m
- section:
Erosion 0 %,type: strengthened bank
wooden piles to W., trees + veget. to E.
Substratum (cover) bed banks adjacent
bed rock
boulder/cobble
pebbles/gravel ***
sand *
silt/clay/(peat) *



WATER CHARACTERISTICS
Colour: clear
pH 8.2, Conduct. 576µS cm^{-1}, Temp °C
Alkalinity 3.5mmol

Anions, mg l^{-1}		**Cations, mg l^{-1}**	
Alkalinity	173	Calcium	103
Chloride	45	Magnesium	4.4
Sulphate	72	Sodium	22
Nitrate N	4.4	Potassium	4.2
Phosphate P	6.5	(Iron)	
Silicate Si	1.9		

Ion balance 6.22 : 6.54 mmol
Assessment: enriched water with poss. effects of diatom bloom

ADJACENT FEATURES etc.
Land use: urban downstream of bridge
Upstream: bridge, horse access
Downstream: maintained or gardens
Maintenance: moderate mainly bank
Fishery interest: low to medium

PHYSICAL Maintenance Factor -1
Shaded uniform section with fine gravels. Clean silt with reasonable stands of macrophytes in unshaded areas giving the stream a variety of water flows and some turbulence

PLANT (shade 70%; cover: algae 10%, moss -%, macrophytes 30%) 3 + 2 = Score 5
A Crowfoot without flowers or as yet surface leaves present, some algae and aquatic lichen present indicating stability and non settlement of fines.

ANIMAL Impoverished invertebrate fauna. Score 4
Stone loach but no crayfish seen.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
A moderately interesting section with adequate flow in keeping with requirements of locality.

POTENTIAL IMPROVEMENT **OVERALL SCORE 3.5**
Little required but seasonal changes in flow not investigated.

River Darent @ Filston Farm **Site 8**
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N, Log 'E

PHYSICAL CHARACTERISTICS

Size at survey: Width 6.7m; depth .61m
Height Board: .245 m; Water depth .51m
est. bank full: Width 8 m; depth 1.5m

Flow at survey - discharge .78 $m^3 s^{-1}$
- velocity .19 m s^{-1}
Bed slope $<1^0$, type: long run
Rel. Stream Power: 2
Channel- plan form: straightened
- sinuosity now: - , m
previous: ? , m
- section: near trapezoid
Erosion %,type:

Substratum (cover) bed banks adjacent

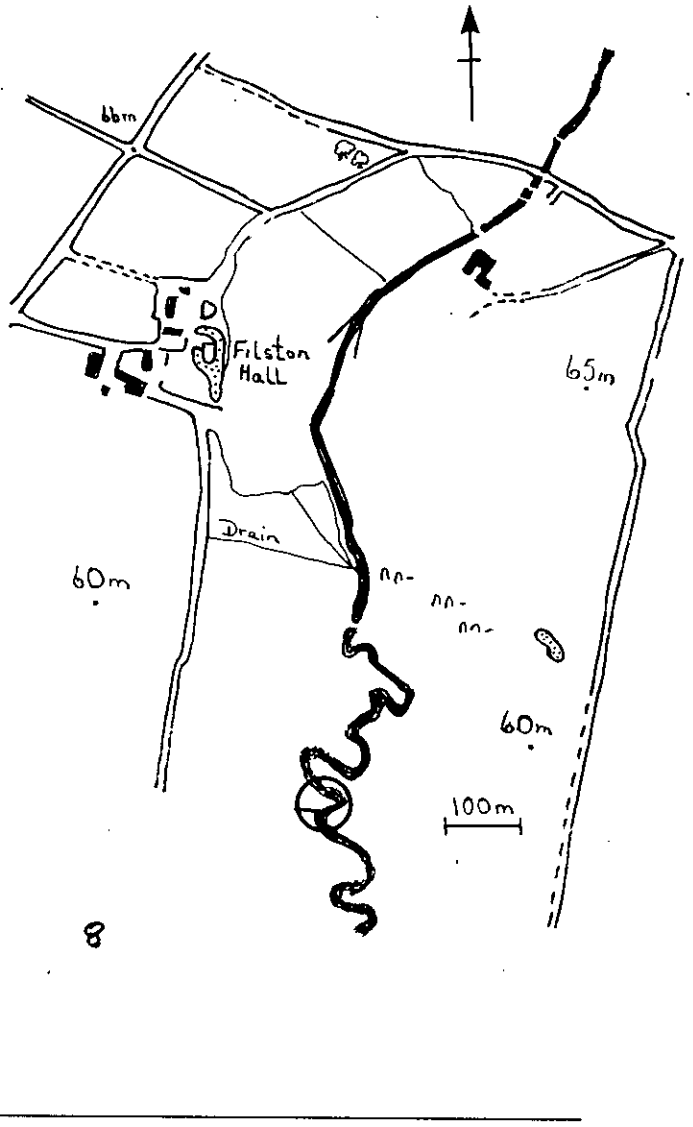
bed rock		
boulder/cobble		
pebbles/gravel	***	**
sand	*	*
silt/clay/(peat)		*

WATER CHARACTERISTICS

Colour:
pH , Conduct. µS cm^{-1}, Temp °C
Alkalinity mmol

Anions, mg l^{-1}	**Cations, mg l^{-1}**
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	

Ion balance : mmol
Assessment:



ADJACENT FEATURES etc.
Land use: agricultural either side of
Upstream: grazing, horses \riparian strip
Downstream: shaded, grazing, hay cropping
Maintenance: minimal, but old hatches seen
Fishery interest: low but could be increased

PHYSICAL Maintenance Factor +1

A deeper sediment-rich bed and naturally meandering stream said to be typical of a considerable distance upstream. Decayed brickwork probably used to control watering of meadows and also weirs and pipes such as feeding the back channel around the field on the farm side.

PLANT (shade 60%; cover: algae -%, moss 5%, macrophytes 4 %) 4.5 + 3 = Score 7.5
Submerged aquatics, Milfoil, Water Moss & Crowfoot, downstream in shallower broader more open area but limited in deeper siltier sections above. A rich and varied marginal and bank flora with only occasional weedy species.

ANIMAL *Ephemera* and *Agrion* high scoring genera. Score 5
Many minnow and possibly a pike observed; said to be stocked with trout.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
A fairly typical moderate to good quality shady section possibly either a little rich in sediment supply or a little reduced in flow; the seasonal pattern would need to be observed.

POTENTIAL IMPROVEMENT **OVERALL SCORE** 7.25
Reduce siltation by reducing supply or altering flow through by lowering bed level downstream.

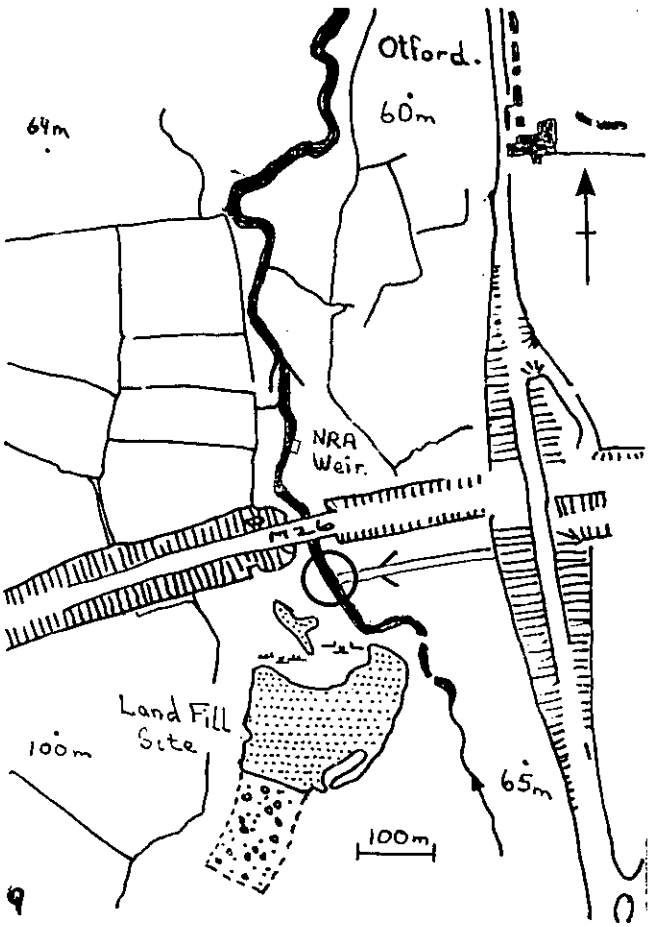
River Darent, Otford-Bradbourne **Site 9**
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N, Log 'E

PHYSICAL CHARACTERISTICS

Size at survey: Width 7.5m; depth .29m
NRA Ht Board: .19 m; Water depth .25m
est. bank full: Width 15 m; depth 1.5m

Flow at survey - discharge .66 $m^3 s^{-1}$
- velocity .35 $m s^{-1}$
Bed slope ≈ 1^0, type:
Rel. Stream Power: (3)
Channel- plan form: straightened, angular
- sinuosity now: - , m
previous: ? , m
- section: over-designed,trapezoid
Erosion 0 %,type: settlement in margins

Substratum (cover) bed banks adjacent
bed rock concrete matt
boulder/cobble
pebbles/gravel * reconstructed
sand **
silt/clay/(peat) *



WATER CHARACTERISTICS

Colour:
pH , Conduct. µS cm^{-1}, Temp °C
Alkalinity mmol

Anions, mg l^{-1}	**Cations, mg l^{-1}**
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	

Ion balance : mmol
Assessment: no effect of landfill observed but none tested for.

ADJACENT FEATURES etc.

Land use: grazing - sheep
Upstream: grazed but fenced, landfill
Downstream: grazed, NRA gauge, pipe cross.
Maintenance: low, over engineered
Fishery interest: low - medium

PHYSICAL Maintenance Factor -2

A resectioned, realigned & over-sized stream with concrete grid around and below an angular entrance from a tributary, also an realigned straight channel.

PLANT (shade 20%; cover: algae -%, moss %, macrophytes %) (4) + 3 = Score (7)
Appears that several different submerged plants (Crowfoot, Milfoil, a Broad-leaved Pondweed) have been introduced; these are growing well but do not appear to be spreading. Settled sediment in margins show a reasonable variety of fringing and emergent vegetation and are backed by regularly-spaced planted Willow.

ANIMAL Score
Dace, heron and kingfisher seen.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
Recently reconstructed section which has been rapidly revegetated giving a superficially good area not really typical of sections downstream. Any maintenance to bed will be very difficult.

POTENTIAL IMPROVEMENT **OVERALL SCORE**

River Darent @ Basted, **Site 10**
Moorcock Mead
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N, Log 'E

PHYSICAL CHARACTERISTICS

Size at survey: Width 4.2m; depth .14m
Height Board: m; Water depth m
est. bank full: Width 6 m; depth 1.2m

Flow at survey - discharge .19 $m^3 s^{-1}$
- velocity .33 $m s^{-1}$
Bed slope $\approx 1^0$, type:
Rel. Stream Power: (2-3)
Channel- plan form: realigned around dev
- sinuosity now: , m
previous: , m
- section:
Erosion 0%,type: (gravel filled gabions)

Substratum (cover) bed banks adjacent

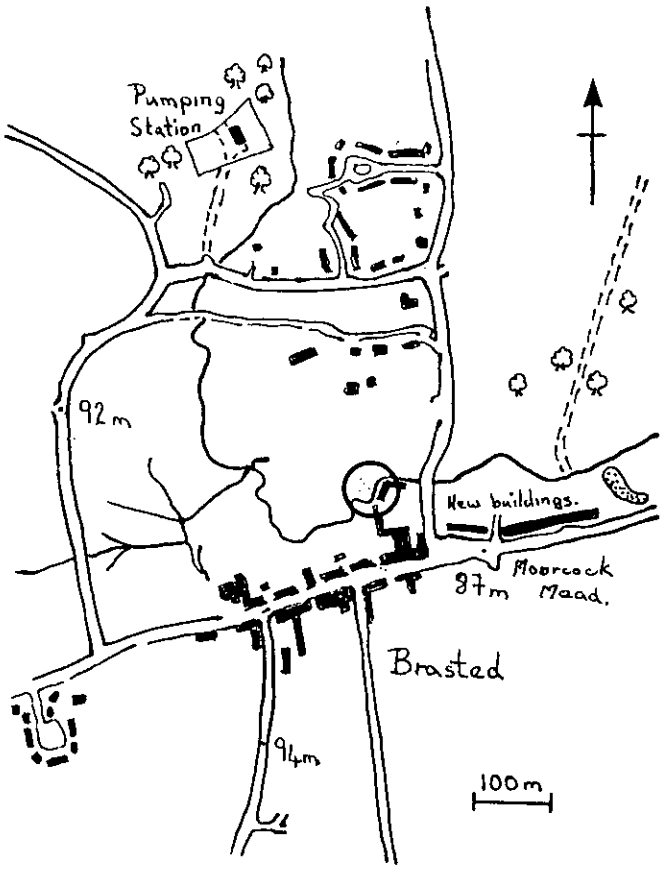
bed rock		gabion
boulder/cobble		
pebbles/gravel		**
sand	*	
silt/clay/(peat)		* soil topped to S.

WATER CHARACTERISTICS

Colour: turbid
pH 7.8, Conduct. 567 $\mu S\ cm^{-1}$, Temp °C
Alkalinity 3.3mmol

Anions, mg l^{-1}		**Cations, mg l^{-1}**	
Alkalinity	163	Calcium	102
Chloride	40	Magnesium	4.4
Sulphate	75	Sodium	18
Nitrate N	5.9	Potassium	3.3
Phosphate P	.042	(Iron)	
Silicate Si	4.8		

Ion balance 5.95 : 6.30 mmol
Assessment: Enriched water



ADJACENT FEATURES etc.

Land use: cultivated ornamental nr.
Upstream: Urban \mixed woodland
Downstream: urban
Maintenance: recently diverted
Fishery interest: low

PHYSICAL Maintenance Factor -2

A regular & recently resectioned channel with sharp bends reinforced with gabions to pass around new buildings; (possible flooding problems after thunder storms?). Gravel bed with some settled silt.

PLANT (shade 20%; cover: algae 20%, moss 0 %, macrophytes 20%) 2 + 1 = Score 3
A mixed fairly weedy and cultivated section of stream with some replanted(?) submerged waterplants (a Crowfoot) and filamentous algae but both of which suffering from a covering of fine sediment.

ANIMAL Agapetus, mayflies and molusces present. Score 6
No fish observed.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
An urbanised stream.

POTENTIAL IMPROVEMENT **OVERALL SCORE** 2.5
More sympathetic reconstruction, alignment and planting.

River Darent @ Edger Park Fm **Site 11**
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N, Log 'E

PHYSICAL CHARACTERISTICS
Size at survey: Width 1.5m; depth .2m
Height Board: m; Water depth m
est. bank full: Width 2 m; depth .4 m

Flow at survey - discharge .11 $m^3 s^{-1}$
- velocity .36 m s^{-1}
Bed slope 1^0, type: pools with riffles
Rel. Stream Power: 1-2
Channel- plan form: naturally sinuous
- sinuosity now: regular , 5 m
previous: - 5 m
- section: vegetated rectangular
Erosion 10%,type: cattle poached

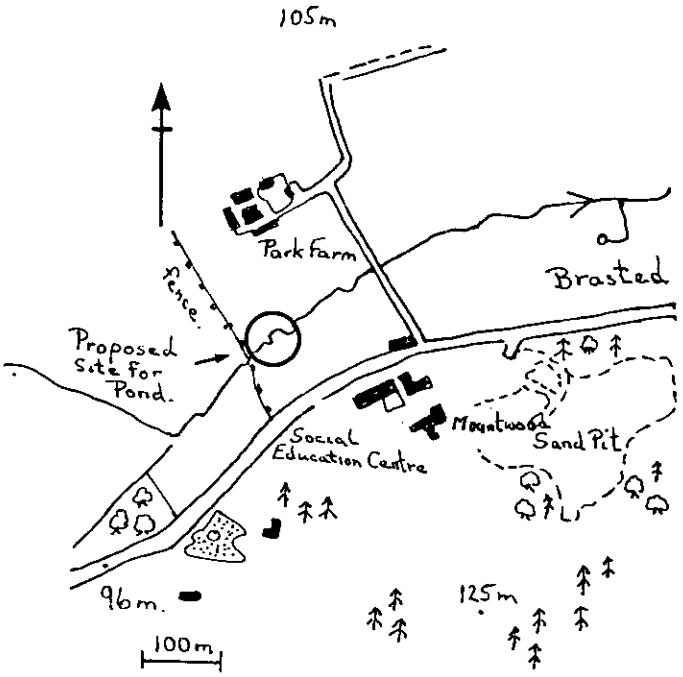
Substratum (cover) bed banks adjacent

bed rock		
boulder/cobble		
pebbles/gravel	***	*
sand	*	*
silt/clay/(peat)	*	*/***

WATER CHARACTERISTICS
Colour:
pH , Conduct. µS cm^{-1}, Temp °C
Alkalinity mmol

Anions, mg l^{-1}	**Cations, mg l^{-1}**
Alkalinity	Calcium
Chloride	Magnesium
Sulphate	Sodium
Nitrate N	Potassium
Phosphate P	(Iron)
Silicate Si	

Ion balance : mmol
Assessment:



ADJACENT FEATURES etc.
Land use: rough grazing, wet areas
Upstream: grazing
Downstream: grazing & road
Maintenance: minimal, poached banks
Fishery interest: almost nil

PHYSICAL Maintenance Factor +2
A small sinuous stream shaded by mature tree line in unfenced grazed meadows (quite wet at visit).

PLANT (shade 60%; cover: algae -%, moss %, macrophytes 0%) 0 + 1 = Score 1
A small shaded stream with unfenced grass banks, no aquatics and few marginals. Good line of mature trees.

ANIMAL *Hydropsyche*, *Centroptilum* and *Baetis*. Score 5
No crayfish seen.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
A small naturally sinuous stream with tree line, site visited as selected as proposed site for a relatively large pond.

POTENTIAL IMPROVEMENT **OVERALL SCORE** 5
Maintain by avoiding change, fencing stream may increase flora variety AND reduce fine silt supply downstream. If pond is constructed, ensure that facilities for silt are available, to avoid is not flushed downstream.

River Darent @ Westerham CP **Site 12**
Date: 29.04.93 NGR:
km from source Altitude m
Lat 'N, Log 'E

PHYSICAL CHARACTERISTICS
Size at survey: Width 1.2m; depth .14m
Height Board: m; Water depth m
est. bank full: Width 3 m; depth 2 m

Flow at survey - discharge .13 $m^3 s^{-1}$
- velocity .8 $m s^{-1}$
Bed slope 1-2°?, type: long run
Rel. Stream Power: 1+
Channel- plan form: straightened,artificial
- sinuosity now: - , m
previous: - , m
- section: deep trapezoidal
Erosion 30?%,type: slump & trampling

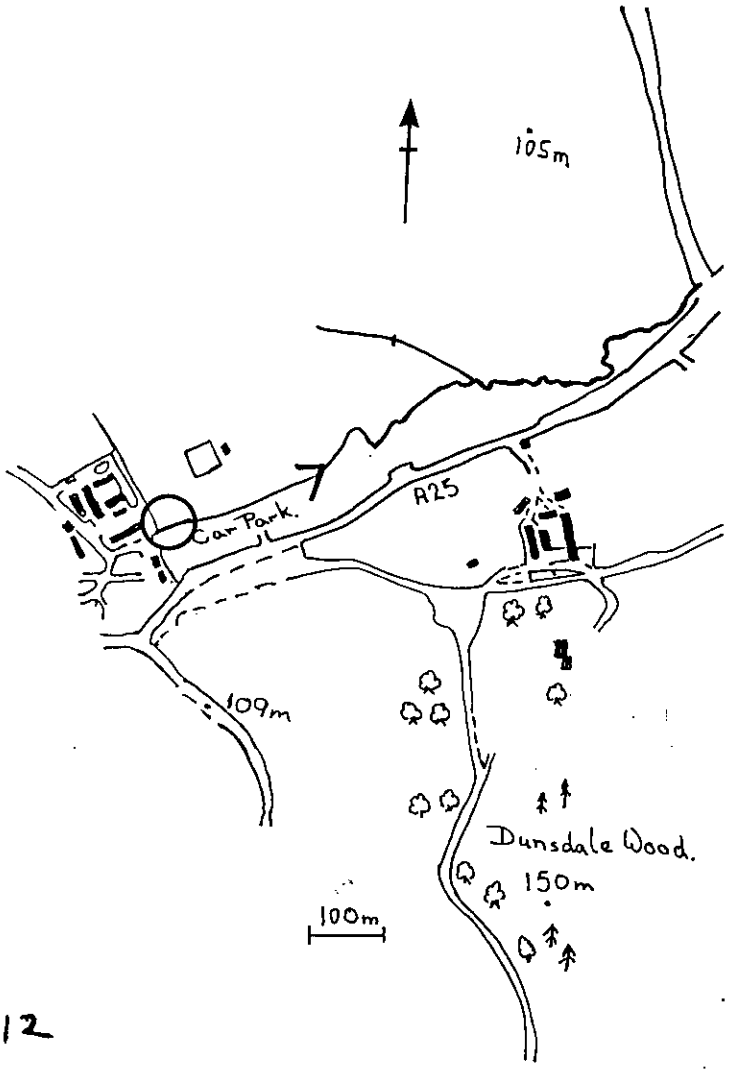
Substratum (cover) bed banks adjacent

bed rock		
boulder/cobble	*	
pebbles/gravel	***	** **
sand	*	** **
silt/clay/(peat)		* *

WATER CHARACTERISTICS
Colour: ?
pH 8.2, Conduct. 492 µS cm^{-1}, Temp °C
Alkalinity 1.4mmol

Anions, mg l^{-1}		**Cations, mg l^{-1}**
Alkalinity	70	Calcium
Chloride	64	Magnesium
Sulphate	85	Sodium
Nitrate N	4.7	Potassium
Phosphate P	.015	(Iron)
Silicate Si	4.0	

Ion balance 4.98 : 5.11 mmol
Assessment: enriched lower calcareous water, much rainwater input?



ADJACENT FEATURES etc.
Land use: park by car park
Upstream: housing estate
Downstream: park, grazing
Maintenance: much access but little maint.
Fishery interest: nil

PHYSICAL (artificial) Maintenance Factor (-1?)
A well trampled very small fast flowing gravel bed stream probably a diverted channel adjacent to open access park & playground; debris instream.

PLANT (shade 60%; cover: algae -%, moss %, macrophytes %) 0 + 1 = Score 1
No submerged aquatics, mainly weedy margins with planted deciduous & coniferous trees.

ANIMAL Impoverished fauna even for small stream. Score 3
No crayfish seen.

SUMMARY (incl. potential problems, conservation, long-term morphological changes)
A small stream downstream of urban estate.

POTENTIAL IMPROVEMENT **OVERALL SCORE** 0.5
Could be improved by reducing access.

Table 1. Genera of flora noted during surveys on 29.04.93 of River Darent

River Site	1	2	3	4	5	6	7	8	9	10	11	12
TREES/BUSHES												
Acer p/c	p		p	p	p			c				
Aesculus				+				+				
Alnus		+	+	+			+			+		
Betula	+											
Corylus												
Crataegus			+				+	+				+
Fraxinus	+	+										
Ilex												
Ligustrum								+				
Prunus												
Pinus											+	
Quercus												
Rosa												
Salix	bab			+	+	+	+	+	+			+
Sambucus				+				+				
Taxus												
Tilea							+					
Viburnum												

River Site	1	2	3	4	5	6	7	8	9	10	11	12
AQUATICS												
Callitriche	tr?						+					
Elodea c/n	10%n								5%n			
Fontinalis					+			5%				
Myriophyllum								1%	5%			
Oenanthe fl												
Potamogeton								perf				
Ranunculus					30%		30%	3%	10%			
Sparganium	2%er			em				+	+			

River Site	1	2	3	4	5	6	7	8	9	10	11	12
MARGINALS / BANK (* = recent alien species)												
Alisma			+									
Apium	1%							+	+			
Arum								+				
Caltha			+	+	!		+					
Cardamine									+			
Carex												
Catabrosa												
Cerastium												
Dipsacus	+										+	
Epilobium			+				+	+	+			
Euphorbia												
Galeopsis												
Galium				+	?					+		
Geum												
Glyceria			+		+	+		+	+			
Hedera			+				+					
Heracleum								+				

River Site	1	2	3	4	5	6	7	8	9	10	11	12
Humulus												
Iris				+				+	+			
Impatiens*												
Juncus									+		+	
Lycopus		+	+	+	+		+	+				
Lamium a/p		p	p				a	a	+			
Luzula				+								
Mentha			+		+							
Mercurialis												
Mimulus*												
Myosotis												
Oenanthe cr		+		+								
Nasturtium								+				
Petasites				+								
Phalaris	+		+		+							
Phragmites						+						
Prunella												
Rosa								+				
Sagittaria				+			+					
Silene												
Scrophularia												
Solanum								+				
Symphoricarpus								+				
Symphytum	+											
Ulmaria			+		?			+				
F. Umbelliferae			+	+			+	4		+		
Veronica		+									+	

River Site	1	2	3	4	5	6	7	8	9	10	11	12
RUDERALS												
Achillea	+											
Bellis												
Cirsium	+										+	
Geranium										+		
Plantago												
Polygonum												
Rubus		+									+	
Rumex			+									
Ranunculus				fic				fic		+	+	+
Reynoutria										+		
Senecio										+		
Urtica 20%	+	+				+	+	+		+		
Taraxacum	+						+					
Trifolium												
unid. seedlings												

(key: + = present; n% = estimated cover of stream bed; 'n' number of species found in genus; 'aa' abbreviation of the single species found in genus when unusual)

note *Ranunculus* spp. will need to be identified later when flowering

My personal opinion is that the Darent requires a detailed study on physical habitat characteristics along its entire length. Presumably there is already a hydrological model which (using PHABSIM software?) could be combined (by IH?) with such a survey to predict the probable habitat availability under a realistic range of flows. We could then make some assertions regarding the application of appropriate preference curves and, taking into account the time of year, advise on the likely results of restoring flows to a particular level.

Table 1. Preference curves of selected organisms

R.Darent pref. curve	Season	Depth	Velocity	Sediment	Cover
Brown trout spawning	Oct-Dec	0.1-0.3m	0.2-0.4m/s	Gravel	
Brown trout fry	Mar-Aug	0.05-0.5m	0.1-0.3m/s	Gravel	
Brown trout juvenile	Whole year	0.2-0.6m	0.05-0.4m/s	Gravel	50%oh50%Instream
Brown trout adult	Whole year	0.2-1.2m	0.1-0.6m/s	Sand-Cobble	50%oh50%Instream
Grayling spawning	Mar-May	0.1-0.3m	0.2-0.4m/s	Fine gravel	
Grayling fry	Jun-Aug	0.05-0.5m	0.05-0.2m/s	Silt-Sand	
Grayling juvenile	All year	0.3-1.0m	0.1-0.5m/s	Gravel-Sand	10%Instream
Grayling adult	All year	0.3-1.0m	0.1-0.5m/s	Gravel-Sand	10%Instream
Ranunculus overwinter	Nov-Feb	0.5-2.0m	0.5-1.5m/s	Gravel	
Ranunculus growing	Mar-Jun	0.1-2.0m	0.2-0.7m/s	Gravel-Sand	
Ranunculus flowering	May-Jun	0.1-2.0m	0.2-0.7m/s	Gravel-Sand	
Ranunculus rip out	Sept-Nov				
Ephemera oviposition	May-Jun				Bankside cover from wind
Ephemera young larvae	Jun-May	0.3-1.0m	0.2-0.5m/s	Sand-Gravel	
Ephemera larger larvae	All Year	0.3-1.0m	0.2-0.5m/s	Sand-Gravel	Not relevant
Ephemera emergence	May-Jun				Bankside cover from wind
Ephemera adult	May-Jun				Bankside cover from wind
Gammarus juvenile	Mar-Oct	0.05-0.2m	0.0-0.3m/s	Organic sediment	Emergent plants
Gammarus adult	All year	0.1-1.0m	0.0-0.7m/s	Cobbles-Sand	Ranunculus-Emergents
Baetis muticus ovipos	Mar-Jan				
Baetis muticus larvae	All year	0.1-0.5m	0.1-1.0m/s		Gravel
Baetis muticus adult	Apr-Sept				
Elmis aenea ovipos	Apr-Jul			Stones\Moss	Stones\Moss
Elmis aenea larva	all year	0.1-1.0m	0.1-1.0m/s	Stones\Moss	Stones\Moss
Elmis aenae pupae	Jul-Aug				
Elmis aenea adults	Aug-Mar	0.1-1.0m	0.1-1.0m/s	Stones\Moss	Stones\Moss
Simulium ornatum ovipos	Mar-Apr		0.5-1.5m/s		Bankside grasses\reeds
Simulium ornatum larvae	Jun	0.1-2.0m	0.5-1.5m/s	Ranunculus\submergents	
Simulium ornatum pupae	Aug	0.1-2.0m	0.5-1.5m/s	Ranunculus\submergents	
Simulium ornatum adults	Oct				Bankside vegetation

Table 2. Fauna of the R. Darent

River Darent Survey 29 4 93												
Taxon	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Turbellaria												
Naididae			2	1		1				3		4
Tubificidae								3			2	
Lumbriculidae			1		1	1						
Eisenlella											2	
Piscicola geometra						1						
Crangonyx pseudogracilis	3											
Gammarus pulex	2	4	2	4	5	3	3	2	3	3	3	3
Asellus aquaticus	3	1	3	3	2	2			2			
Eurycercus lamellatus						1						
Ephemera sp								2		1		
Paraleptophlebia submarginata			1							2		
Baetis spp		3	3		3	3	3		2	2	3	
Centroptilum luteolum			3			2			2		3	1
Caenis spp				4		3		3	1	2		
Ephemerella ignita			3							1		
Calopterygidae								1	1			
Coenagrildae?	1											
Sericostomatidae					1							
Leptoceridae					1							
Polycentropodidae			1									
Hydropsyche sp											2	
Agapetus sp									3			
Limnephilus lunatus				1						2		
Halesus sp			1									
Brachycentrus subnubilus					1							
Micronecta												
Potamonectes sp	1		1	3								
Agabus sp	1											
Elmis aenea					1							
Orthocladiinae	2	4	2	3	3	3	3	3	3	4	3	3
Tanypodinae		1		1								
Chironominae							1	1				
Simulium spp		3			3		2		3			
Ceratopogonidae		1	2			1						
Diptera			1									
Hydracarina								1				
Bythinia tentaculata	4											
Valvata sp									1			
Potamopyrgus sp									2			
Planorbis sp	4	2	1		1				1			
Lymnaea peregra			3									
Sphaerium corneum				1	3	2	2		2			

Figure 1. Distribution of Oligochaeta at 12 sites on the River Darent.

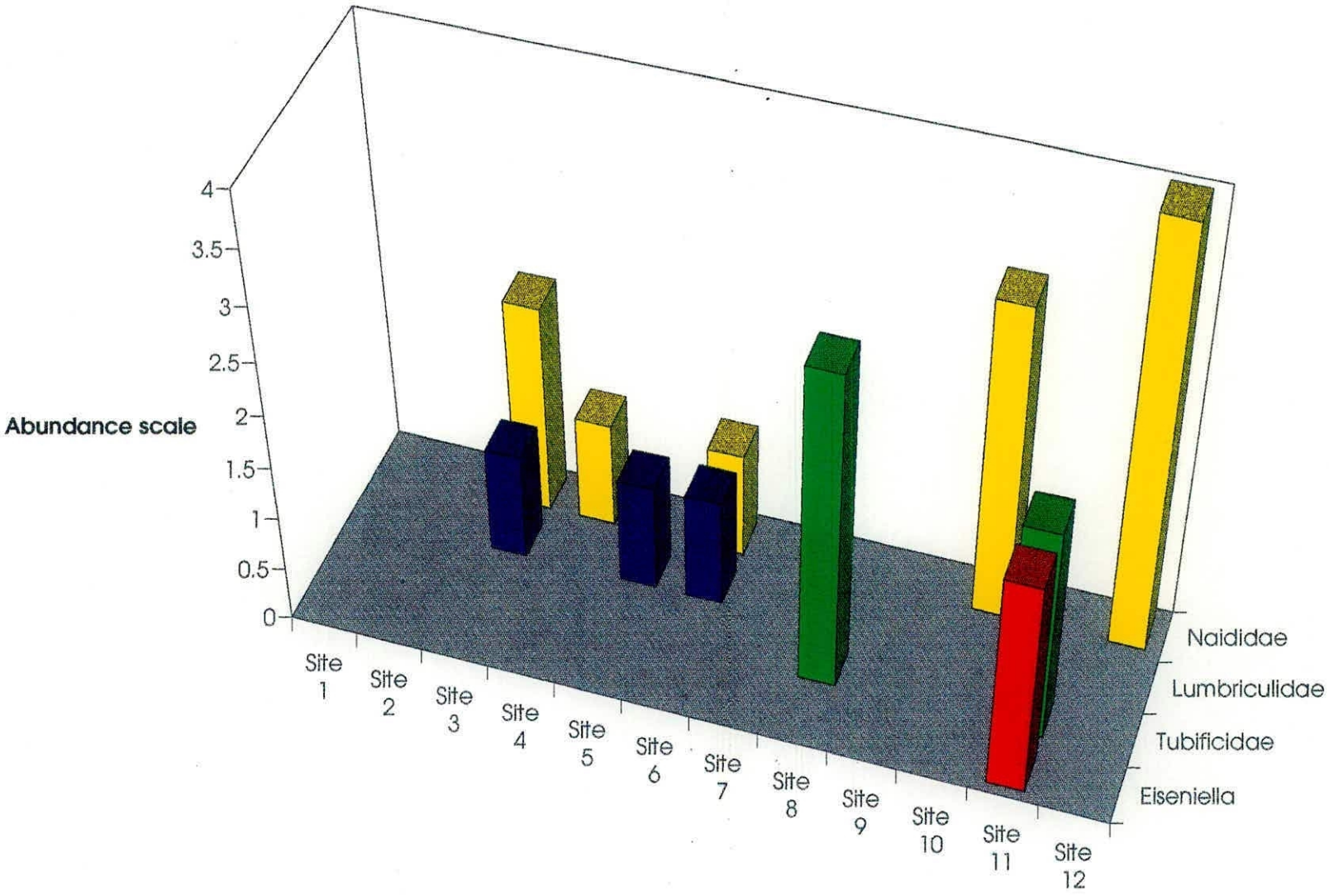


Figure 2. Distribution of Crustacea at 12 sites on the River Darent.

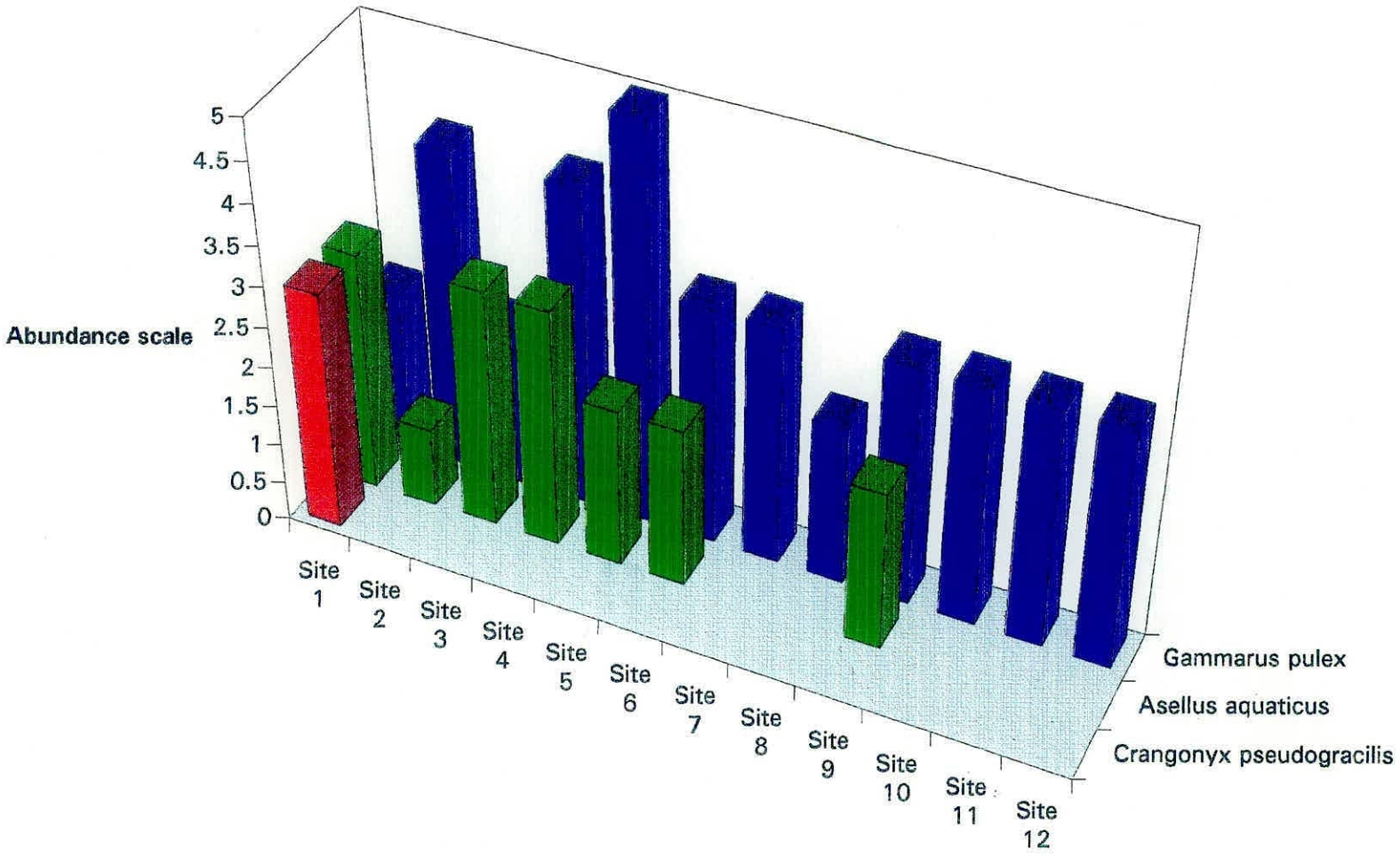


Figure 3. Distribution of Ephemeroptera at 12 sites on the River Darent.