Environmental Quality Appraisal of the River Ems




A Report to EA, Sussex Area, Worthing
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Executive Summary

The Environment Agency (EA) identified the Ems in 2003 as being potentially over-licensed for groundwater abstraction and potentially at risk of ecological damage. Being a chalk stream bestows greater status regarding its ecological importance because such systems are Biodiversity Action Plan (BAP) priority habitats. Continual development pressure also puts further strains on the environment and requires the EA to be able to protect the best, and enhance the rest, wherever possible. The prime driver for this investigative project was therefore to obtain as much information as possible to help the EA in this task. For each of the four reaches in the catchment, an assessment of the present-day ecological status was carried out alongside a review of contemporary and historic factors that could influence the ecological health of the river. This report presents the findings of the study.

A key conclusion from the study was that there has probably been significant degradation of ecological quality, but paucity of data makes totally objective conclusions on the 'cause' and 'effect', and the severity of them, virtually impossible. Therefore it has to be accepted that conclusions drawn are not always supported by firm facts, but have been derived from many disparate sources that, taken together, do provide very important evidence of 'damage'. In brief summary, the report has concluded the following.

- ***Natural*** **Flow Characteristics are very different in the four reaches assessed,** and this is still the key determinant of the assemblage of plants and animals found within the majority of the catchment.
- **Historic changes to alter the channel form** are considered to be a very influential anthropogenic factor impacting what would be 'natural' plant and animal communities in the catchment, but these have occurred over centuries and communities will have changed, and possibly become more diverse, as a result of these changes.
- **Routine Flood Defence Management** is only considered to have significant impacts on ecology in the middle and lower catchment where measures, in the past, have aimed at creating over-large, clean channels with limited structural diversity.
- **Siltation** is a problem that affects ecology greatly, especially fish and invertebrates, and in the permanently flowing reaches of the catchment is perceived to be a problem that may be on the increase.
- **Concerns relating to abstraction-induced low flows** has been one of the drivers for the study, and is considered to have impacted the plant and animal communities in the river, especially fish.
- **Present/recent water quality -** from reviewing data, it would appear that poor water quality is not an issue today, and no catastrophic pollution events have been reported to have affected the catchment in the past.
- **Alien species** are only implicated in impacting water voles, and the fragmented population remains on a knife-edge and vulnerable to re-appearance of this predator in the future.
- **Barriers to migration** is primarily an issue for fish; these have serious implications for sea trout, a species with a long history associated with the river and one that could be greatly enhanced by improved migration potential through the river

Based on the review of available information, the report makes a series of recommendations for actions. These include:

- Getting an objective resolution of the impacts of abstraction on flow [discharge] (already in hand by EA proposals, but may take 3 years) - without a clearer understanding of the effects the major abstractions have in causing flow to depart from naturalness, it will be difficult to objectively determine if, and where, most environmental gain could be achieved through changes to resource management.
- In parallel with the above, there is a need to determine more objectively how effective the present augmentation is in protecting both river landscape and ecology downstream of its inflow. Emergency measures are recommended for dry periods when the augmentation flow is not reaching its intended target.
- A Water Level Management Plan is deemed essential to enable sea trout to migrate into the system and maximize potential for increasing channel habitat diversity and decreasing flood risk.
- Modified river management measures (historical flood defence practices) are recommended; these have been presented to EA flood defence personnel for consideration and in-principle support for their implementation was indicated.
- Channel enhancements/restoration could be carried out at several locations; one opportunity has already been acted upon and there is fulsome landowner support for the major opportunities elsewhere.
- Targeted surveys in areas identified as potentially of very high, yet unconfirmed, conservation interest have been made, as have recommendations for controlling aliens and the possible introduction of crayfish to the catchment.

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1. Introduction

This report has been prepared for the Fisheries, Recreation & Biodiversity (FRB) team of the Sussex Area of the Environment Agency (EA). The study reported on here is a review of the environmental state of the River Ems historically, and at present, and draws together information on environmental factors that influence ecology. Together, this information provides a basis for determining what are the key factors influencing ecological status today, and what may be required to restore it to its historical health.

The study has developed from, and is intended to draw together, several initiatives that began around 2000. The Fisheries, Recreation and Biodiversity (FRB) team initiated a 'Sussex Chalk Rivers Project' primarily because little-known rivers such as the Ems and Lavant were increasingly under threat from development, despite being priority BAP habitat (chalk stream). At the same time, the Catchment Abstraction Management Strategy (CAMS) for the area identified that the rivers were 'over-licensed' (EA; 2003) and possibly impacted by abstraction, but the latter could not be quantified. It was also of great concern to ecologists that the CAMS process did not adequately cater for winterbourne (intermittently flowing) reaches; the same such reaches that were under threat from developers, often because they did not realize their ecological importance. These areas of concern for, and responsibility of, the EA provided a catalyst for different functions to work together to raise the profile of the streams and combine forces to undertake work to help understand them better so that actions could be brought to help 'protect the best and enhance the rest'.

The Water Framework Directive (WFD) has, in recent years, also become increasingly important as implications of its implementation become clearer. Rivers so physically altered as the Ems are designated 'heavily modified waterbodies (HMWBs)', but despite this the Directive requires measures to be put in place to help them achieve 'Maximum Ecological Potential (MEP)' or 'Good Ecological Potential (GEP)' through implementation of river basin management plans. The findings of this report are intended to help responsible authorities to achieve this.

In this study there is a focus on ecology as a surrogate for environmental quality. Therefore the aim is to provide a clearer understanding of the overall environmental health of the river primarily through information on biota.

The study of the Ems has been carried out concurrently with a similar study of the Lavant. Both the Ems and Lavant catchments are located in south-west Sussex (Figure 1a), and have many features in common. They both arise on chalk, are predominantly spring-fed rivers, and share, to a large degree, the same chalk aquifer (Halcrow, 1994; Entec, 2006). Figure 1b shows the catchment locations and main underlying geological characteristics, and Figure 1c shows example hydrographs for the years 1980-85 showing how closely the patterns of high and low flow in the rivers match one another. These data are from the lower sections of the rivers (Graylingwell on the Lavant and Westbourne on the Ems), where flow typically fails in most years at the former station but is sustained, albeit at very very low levels, at the latter. Both rivers discharge to harbours that are designated as internationally important sites (Special Areas of Conservation – SAC; Special Protection Area - SPA); however the rivers differ markedly in that:

- the Lavant has a more reliable winterbourne flow in its upper reaches than the Ems,
- the Ems has a perennial flow in its lower reaches whilst the Lavant has historically failed to flow for long periods through Chichester (Rudkin, 1984; Newbury, 1987).

The catchment is predominantly rural, with little urbanization until the lower reaches. The Sussex Biodiversity Records Centre holds maps showing catchment land-use; this shows mixed grass dominating the upper and middle catchment, with urban areas predominant in the lower reach.

Unlike many previous investigations on chalk rivers, no literature has been uncovered to indicate that the Ems has ever been an important recreational fishery in terms of major public participation, but several of the lower stretches have had active angling in the past by individual owners and their quests, and poaching within some stretches is reported to have been rife half a century ago. Southern Anglers used to fish Lord's Fishpond up until the end of the 1960s, and probably into the early 1970s.

No parts of the **freshwater** river system are designated as important UK (e.g. SSSI) or EU (e.g. SAC under Habitats Regulations [HR]) conservation sites. The upper river is in an AONB. Being a river deriving much of its flow from underlying chalk, the catchment is classified as a chalk river and as such is covered by England's Biodiversity Action Plan (BAP) to help protect vulnerable habitats and species (see JNCC web site for more details). The river also supports species that are covered by the Plan, such as Bullhead and Water Vole. In terms of legal protection for species, being a BAP Priority Species carries no legal protection but should be a material consideration in planning decisions, and the EA is committed to implementing a wide range of Species Action Plan (SAP) actions, particularly those for which they are Lead Contact in the UK. Most BAP species are, however, protected under the Wildlife and Countryside Act (WCA) 1981 (as amended) and/or HR legislation (regardless of whether they fall within a designated site).

The importance of protecting and enhancing biodiversity has recently been enshrined in the Natural Environment and Rural Communities Act (2006) which has given all public authorities a duty to have regard to the conservation of biodiversity in exercising their functions. Guidance on implementing these responsibilities has been provided by Defra (May 2007) – 'the duty aims to raise the profile and visibility of biodiversity, clarify existing commitments with regard to biodiversity, and make it a natural and integral part of policy and decision making'.

Due to low flows in the river below Westbourne, and periodic drying above it, there have been concerns that the Ems, and its biodiversity, has been impacted by abstraction. These concerns have been heightened by prolonged drying of the river in the more recent drought periods of 1989-92 and 1996/7, and in the past three summers 2004-6.

A summary of flow and abstraction data available for the catchment up from 1990 to 2004 has been reviewed (Entec; 2006). This was part of a larger study looking at the Hampshire and Chichester chalk block with a prime aim of providing a greater understanding of flows discharging to the harbour SAC/SPA. The study built upon a study by Sir William Halcrow (Halcrow, 1994) that was more focused on river flows in the Ems and Lavant that looked at flow data extending back to 1980. More details of this, and other, information will be presented later, but in summary, the following key points regarding abstraction within the catchment are (for locations see Fig. 3.2.2a):

- Abstraction from the Ems catchment was limited to c1Ml/d (from Woodmancote) until the early 1960s;
- The Walderton source was developed in 1962/3, and by 1966 the average daily abstraction had gone from zero to c25Ml/d;
- The CAMs for the catchment indicates it is over-licenced (EA, 2003), and the EA assessment of the river's status under the WFD is that it is at risk of failing GES due to abstraction.

There are also other factors that have fundamental effects on the environmental health of rivers. To successfully address degradations in rivers requires sound knowledge on the status of the environmental assets and character of the river in question, as well as the factors that have positive and negative influences on them. The EA's '*Environmental Vision*' (EA; 2001) states that there are four stages needed to successfully improve the environment:

- assess the **state** of the environment at any one time;
- identify **pressures** that affect it;
- consider **options;**

- make the appropriate **response.**

This study has been carried out to address the first three of these to assist the consultation with all other interested parties to fulfil the fourth (in the long-term) – namely, implement sustainable management and restoration on the Ems catchment. The study has excluded the tidal and estuarine sections which are designated Habitats Directive sites as these are assessed under other initiatives, and the focus here is the chalk river habitat.
The EA Local Environment Action Plan (LEAP 1999) listed the following, among other, key issues in relation to this study:

- *'Managing water resources to balance needs of abstractors with the protection and enhancement of the natural environment';*
- *Opportunities to further the protection and enhancement of Biodiversity need to be identified and forwarded;*
- *Loss and degradation of wetland and riverine habitats and opportunities for enhancement;*
- *The free passage of sea trout and coarse fish is restricted by obstacles in the rivers;*
- *Increase knowledge of headwater streams and their protection and improvement.*

The follow-up 2000 document outlines some actions that the EA might take in relation to the issues raised in the previous report – this document, like the 1999 one, makes very little reference to the Ems or Lavant and concentrates on the Rother. This confirmed one of the key concerns that triggered the onset of work on the catchments, (Ashworth, 2004) that the western streams were truly 'Cinderella' rivers and almost an afterthought!! Some important and relevant actions recommended included:

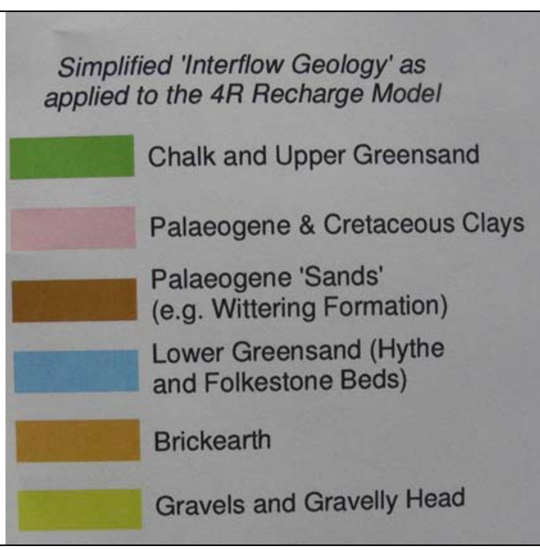
- Protecting and enhancing otter and water vole habitat was specifically cited as of relevance to the Ems and Lavant;
- Taking forward opportunities for protecting and enhancing biodiversity through land-use planning;
- The need to 'produce HAPs for …rivers and streams';
- 'Identify target areas for habitat protection, restoration and creation';
- Fishery recommendations included understanding the status better of sea trout, with improved enforcement, and to 'review the status and function of all in-river structures and potential for removal';
- 'Promote natural functioning of floodplains'.

The majority of this document reports on an assessment of the ecological status of the river catchment, its limitations and factors affecting its failure to meet its ecological potential. This has involved reviewing all available ecological data and the practices and pressures that influence river ecology. The report is intended to assist in the consultation process to enable the general public, and other project partners/stakeholders, to input their views so that a consensus can be reached on what the present status of the river is, and what is required to enable it to reach 'GEP', if the HMWB status is confirmed under the WFD. The findings also provide guidance and recommendations on immediate and more long-term actions that will either help refine our understanding of what is causing environmental degradation (cause and effect) and also practical actions that might be taken to address what are clearly existing known impacts.

The report suggests in chapter 7 what might be done to help catchment land-use, water resource use, flood defences and other activities be more integrated in the future, and operate in a more sustainable manner, and implement some central recommendations of the LEAP. This is needed to benefit the ecology of the river that has clearly been shown in this report to be degraded. It is also required to enhance natural landscape assets, its resources for recreation and amenity, yet at the same time provide cost-effective and sustainable water use and flood management.

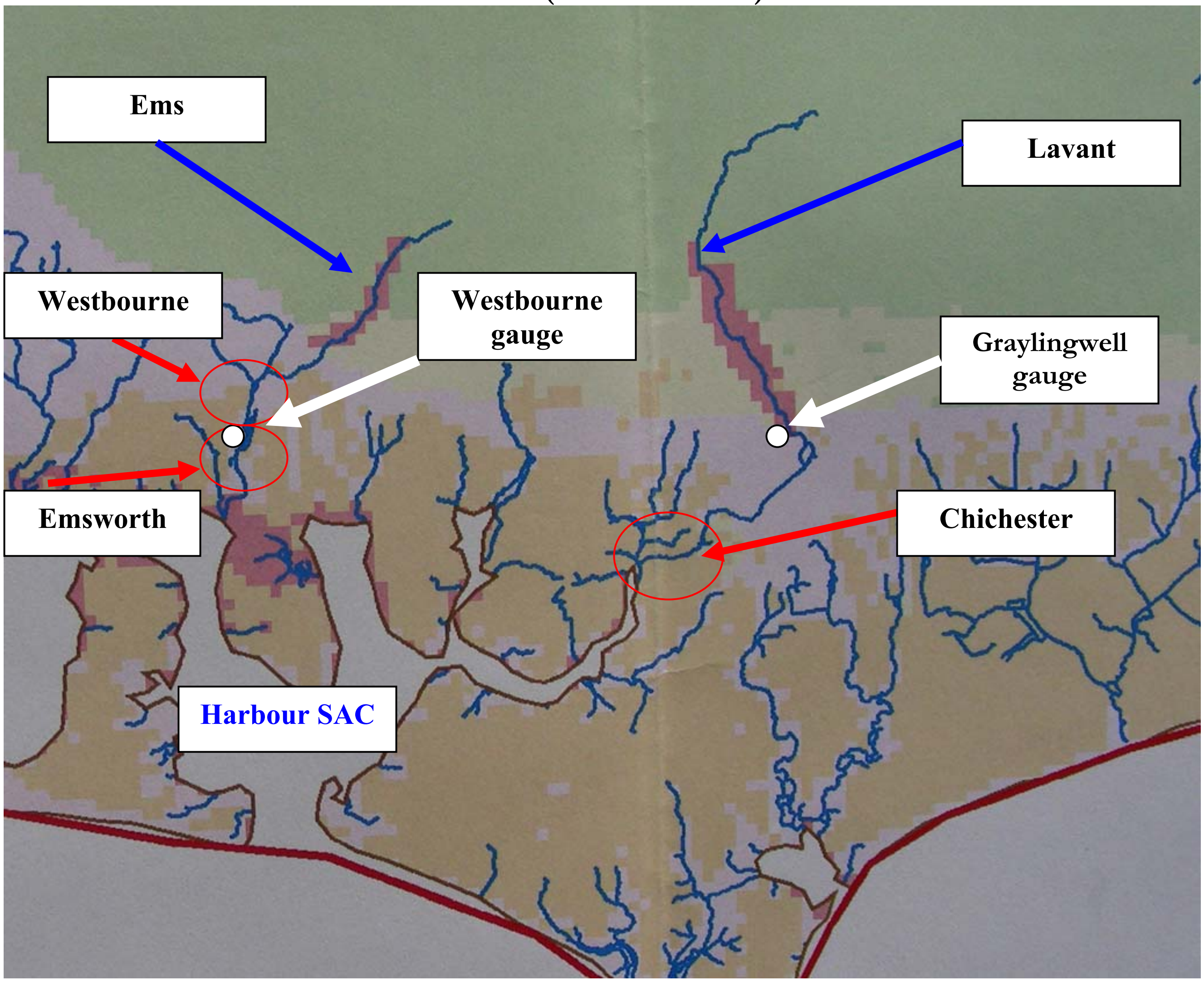
It is important to stress that it is possible that erroneous conclusions may have been drawn from looking at the system over a relatively short period of time, or not having sufficient quantitative data to substantiate views expressed (although recent initiatives are going a long way to determining more reliably the present-day status). It is hope that by expressing judgements based on experiences on working in similar rivers systems elsewhere, where there is doubt it provides an opportunity to encourage further information to be made available to either support or refute the conclusions. The report is therefore considered not the final status assessment, but a stepping stone to help develop consensus through an iterative process involving all who have either a professional or personal interest in the river. An important observation through the study was that there are many local people who take a very great interest in the river, and lament it's decline in recent decades.

Figure 1a Location of study area



Key to geology in Figure 1b – see over

Figure 1b Location of the River Ems catchment in West Sussex, also showing the solid geology of the area (from Entec 2006)



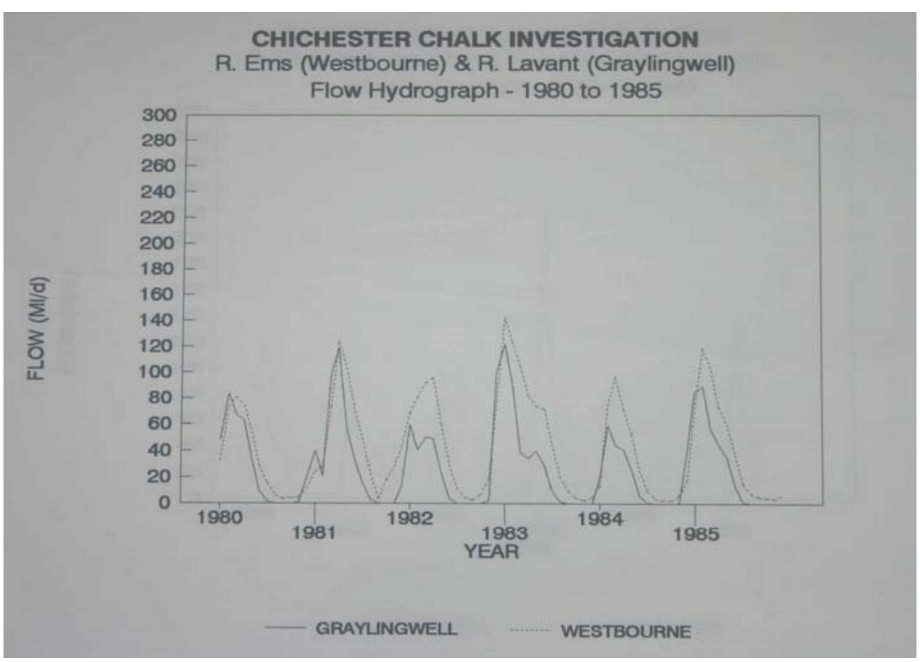


Figure 1c Example hydrograph showing closely related hydrographs of the Ems & Lavant (from Halcrow, 1994)

2. Approach

To assess the ecological status of the River Ems, the catchment has been divided into four contrasting reaches. These are shown very roughly in Figure 2a, and the justifications for the splitting the river into four will become clearer in subsequent sections, but is summarized in Box 2a below.

Box 2a Key characteristics of the four 'assessment reaches'

Reach Name	Key Characteristics
1. Upper Ems	Headwater reach from Stoughton to Broadwash. This is the reach that is, and always had been, a winterbourne. Flows are expected to fail for several months in most years, and no flow for periods exceeding two years is possible.
2. Middle Ems	Broadwash to Watersmeet in Westbourne. Flow has historically been more consistent from this point, Broadwash being the most upstream point reported to have been perennial in the past. Within 250m of the bridge commercial cressbeds historically operated, and by Ractonpark Dell, (c750m d/s) a fish pond was let to Anglers until the 1970s. Perennial flow might have been expected throughout the majority of the reach except in the most extreme droughts, with the 'Canal' probably never failing as it provided water for Stansted House until about 100 years ago.
3. Aldsworth Arm	A north-west tributary that has perennial artificial ponds close to the source (Brickkiln) and a series of online lakes that periodically dry. Historically cress beds were numerous here too, so failure to flow would have been rare.
4. Lower Ems	Watersmeet downstream. Historically flows are reported to have never failed until recent decades (and only in the top 3-400m). Downstream of Westbourne Mill there is no record of the flow ever failing, but the gauge within the reach indicates extreme low flows occur, and did so before significant groundwater abstraction occurred.

For each reach, ecological status (past and present) has been assessed by looking at the riverine mammal, fish, invertebrate and plants (macrophytes) of the river, and the habitat character/quality. This approach has been taken to give an over-view of the ecological health of the river at a community level; where good data are available for individual species, and this is helpful, more information is given. Of particular note are: i) Habitats Regulation species/habitats (Otter, Bullhead, Crayfish [no records of being ever known to be present], '*Ranunculus* habitat'); ii) BAP or Wildlife and Countryside Act species/habitats (water vole, chalk stream habitat); iii) characteristic species of chalk rivers (e.g. trout and some invertebrates); iv) good indicators of river 'quality' (e.g. invertebrates); and v) species of great socio-economic/recreational importance (e.g. fish such as trout and sea trout).

The rationale for this approach is that the focus is the general health of the river, not any particular rare or threatened species. There is particular interest because it is a chalk stream (BAP habitat), and there is a need from the regulators, managers and users of the river to improve it where possible, and provide a better asset for the local population (and improve/protect biodiversity).

In the future, the WFD will require waterbodies such as the River Ems catchment to be in 'good ecological status' (or measures to achieve this to be in place) by 2015, or, if designation of being heavily modified is confirmed, reach 'good ecological potential'. Fish, macrophytes, invertebrates and algae are all used in the assessment. Good status has yet to be precisely defined, but it should result in plant and animal communities being present that are only slightly different from those expected in natural, unmodified, conditions. The WFD requires the ecological status of water bodies to be determined, pressures identified, and programmes of measures put in place to achieve the maintenance of, or restoration to, good status.

As is often the case, sufficient data to perform a truly objective appraisal of the ecological status of the river were limited. The approach adopted was to review all survey data and literature that was readily available and then take account of *ad hoc* records and information. Of great importance in the process was the utilization of knowledge that EA specialists working in the Sussex Area have. Some local personnel with a long understanding of the ecology of the Ems were also contacted and asked for information and their views. To improve the efficiency of capturing additional information in the future, an interim evaluation has been made, prior to any public consultation on its findings, alongside other initiatives for the river. It is recommended that interested parties be invited to endorse or modify the assessments based on any additional information they hold.

The River catchment appraisal has adopted an approach shown in box 2b for assigning a **provisional** status of the five assessment groups (mammals, fish, invertebrates, macrophytes, habitat) for the four reaches shown in Figure 2a. A five band scale of quality has been used that is consistent with the WFD (using the same colour codes for quality, but these should not be confused with officially determined WFD status).

Box 2b Colour codes and descriptions of environmental quality bands used for reach assessment

Colour code	Water Framework Directive Status & Investigation Interpretations
RED:	Bad (severely degraded). Destroyed or at risk of being so.
ORANGE:	Poor (significantly changed from natural). Poor condition generally (has been much better in past), or if periodically recovering, not sustained sufficiently.
YELLOW:	Moderate (moderately changed from natural). Not reaching or maintaining potential or historic status.
GREEN:	Good (slightly departing from natural). Close to potential or historic conditions.
BLUE:	High (pristine or near-natural). Healthy and not at risk

In tandem with the assessment of ecological status, factors considered most influential in affecting the status (both good and bad) have been suggested. These have been generated through interpretation of the literature and consultation with the appropriate EA specialists. For this too, a five-point scale was adopted to rank the probable degree of influence factors have on the status of the feature interests: these are listed in box 2c.

Box 2c Descriptions of five bands of probable importance in affecting ecological status of the River reaches

Score	Description of extent of influence on status
5	Probably the, or one of the, key influence(s)
4	Major influence
3	Important influence
2	Moderate influence
1	Minor or no influence
N/K or N/R	**N**ot **K**nown or **N**ot **R**elevant

A standard reporting process has been used for each of the five categories of ecological interest assessed (for the four reaches), and combined in a final matrix. This matrix provides the basis for recommendations for immediate and long-term possible actions.

The process of evaluation has involved appraisal of literature from many sources, and flow data provided by consultants, and other information provided by the EA and contacts with local people and organisations. Box 2d below summarizes some of the main external groups and individuals consulted.

Box 2d Main external groups and individuals contacted during investigation of the Ems

Fisheries	Phil Maber (ex NRA/EA officer) Mr Fred Portwin, Hermitage
Brook Meadows Conservation Societies etc.	Dr Brian Fellows Ms Frances Jannaway
Local people with long knowledge of river	Mr & Mrs Rule, Westbourne Mill Mr and Mrs A Pearson, Ford Villas, Westbourne Sydney Morgan, Westbourne Mr and Mrs Schofield, Watersmeet, Westbourne Mr & Mrs Lafosse, Lumley Mill Mr Henry Denham, Lumley Mill Farm Cottages Simon Lush (Henry Adams) for Mrs Everall Mr Andrew Elms, Lordington Farm Ian Briffett, Walderton Neil Edden, Mitchmere Farm Jane Glue, Mitchmere Cottages David Todd, Westbourne Mr Shannon, Westbourne

What is presented in this report is an understanding of ecological health based on available information. Ideally all would be 'evidence-based' but for many reaches there is a complete lack of both historic and contemporary data-sets on biology, or factors such as flow, to allow this to be done properly. Therefore much is 'judgement-based', by making qualitative correlations between known changes in 'status/health' of the ecology of the river reaches, and the key factors that are known to affect these interests. Best judgments have been openly made and presented to be supported or challenged. The example of fisheries is a good one – taking many disparate sources of information together provides compelling evidence that the present status is a shadow of what it was 50 years ago. It is accepted that in some cases we are dealing with major uncertainties, but this draft assessment provides a starting point for building consensus on what might be considered wrong, what needs doing (and when, where and why).

If new information contradicts the assessment, or conditions change, the status categories should be revised. The priority is to help develop a consensus view on the diagnosis of the health of the river. Agreement on this provides a firmer basis for determining the key factors responsible for the status, and the actions needed to protect the best, and improve the rest.

Figure 2a Location of the Four Reaches of the Ems

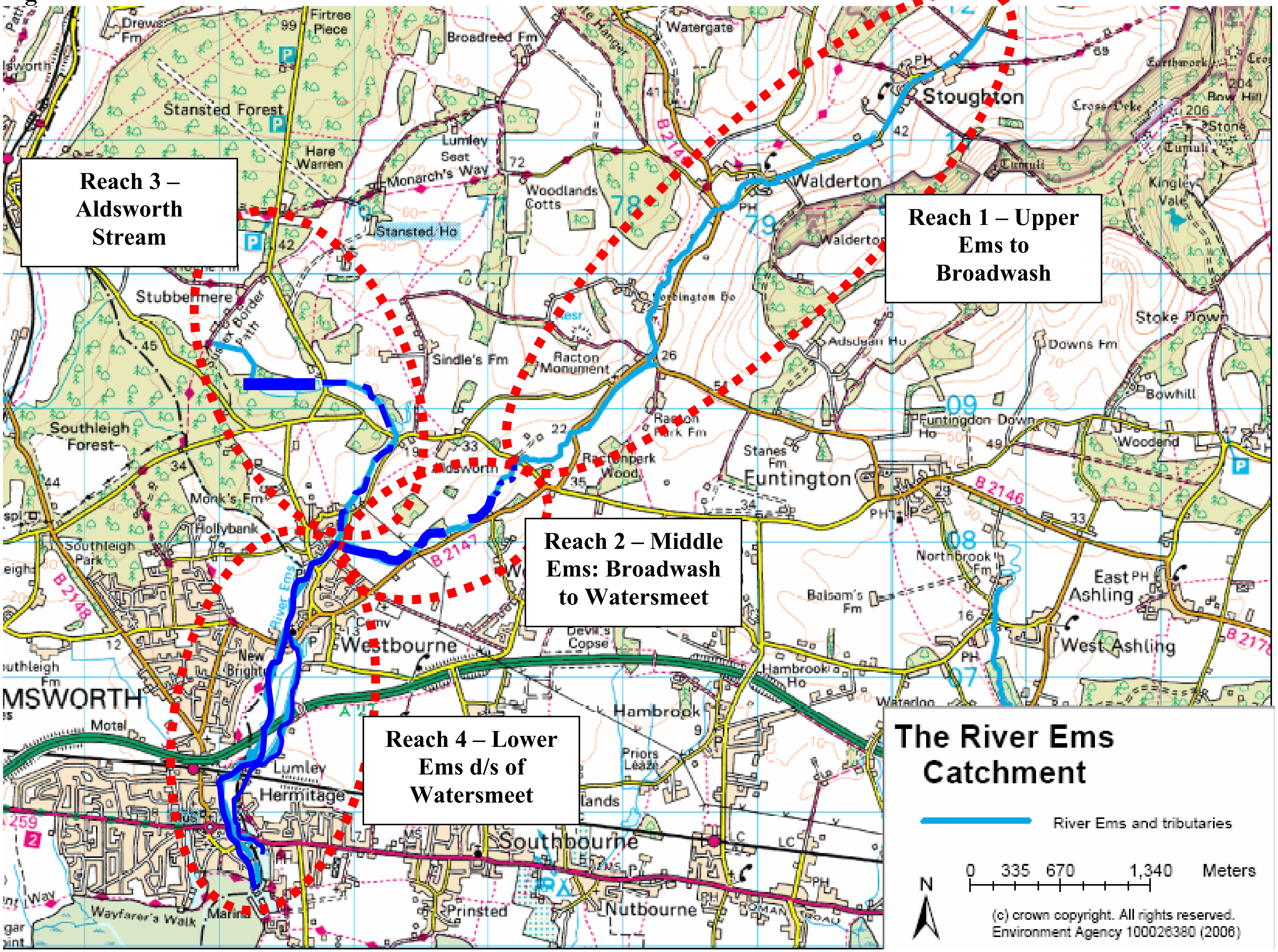
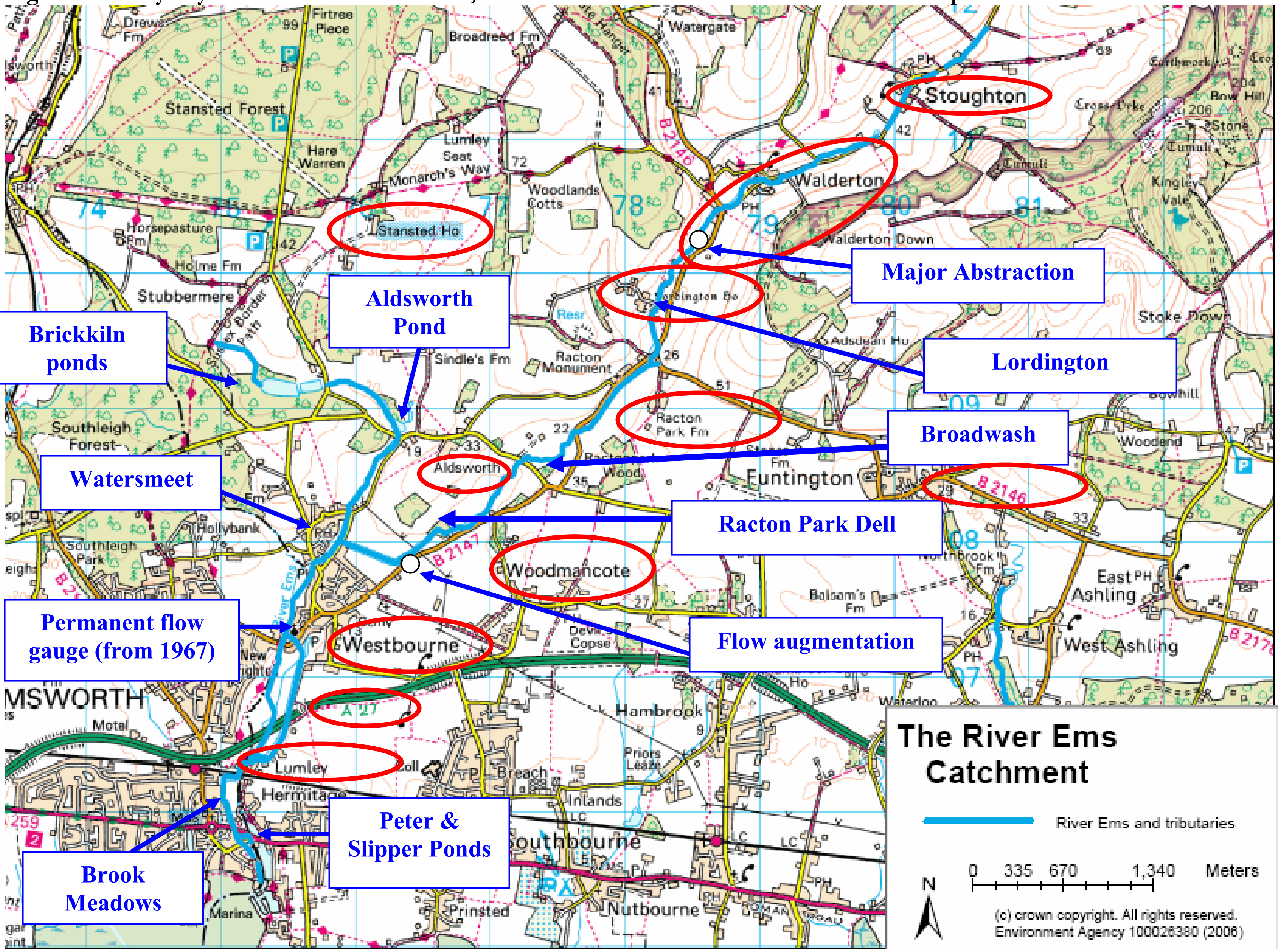


Figure 2b Many key locations cited in the text; more details are shown in individual reach maps in Section 5



3. Background Information on the Character of the River Catchment

3.1 Introduction

A very brief description of the river's history has been given in Chapter 1.

For present-day management to be most effective in addressing problems, knowledge of how it has changed, and why, in the past is important. Knowledge of the character of the catchment, and its pressures, enables a better understanding of its present-day ecological status. Natural and anthropogenic factors have shaped its character and ecology, some with greater influence than others. This chapter concentrates on the three most important characteristics that normally have greatest influence on the ecology of the river (the three points of a 'triangle of river health' [Madsen; 1995]):

- Water quantity – discharge (3.2);
- Water quality (3.3);
- Physical character – habitat (3.4).

Section 3.5 gives a brief account of other factors (e.g. biological interactions, catchment land-use issues) that also have significant influence on the ecology of the River catchment.

3.2 Discharge, and the Key Factors Influencing it

3.2.1 General Catchment Considerations

The Ems has a catchment dominated by chalk solid geology, but in the lower part of the catchment alluvium and gravels are present as sufficiently thick deposits to affect flow (for details of geology, and how it affects flows, see Entec; 2006).

What do we know about flows (strictly **discharge**) in the assessment reaches, and what is it based on? The most comprehensive picture is summarized by Entec (2006), drawing together known information for the catchment also gathered from a previous major study by Sir William Halcrow (1994). By necessity studies focus on data from 1967 onwards as this is the date from which permanent flow records for the catchment exist. However, the Entec report focussed more on post 1980 flow data. There is also good information contained within the many investigations carried out after the major floods of 1993/4 and 2001. (Rofe *et al.* 1996).

Between the completion of the Halcrow study and that of Entec, the Environment Agency developed it's Catchment Abstraction Management Strategies (CAMS), whereby strategies for management of water resources are developed at a local level. Through the process information on resources and licensing practices are made available to enable public consultation on the balance between the needs of abstractors, other water resource users and the aquatic environment. *The Arun and Western Streams Catchment Abstraction Management Strategy* (EA, 2003) covers both the Ems and Lavant.

The CAMS document provides a concise overview of the main factors affecting flow (e.g. main abstractions and discharges, solid geology etc.), and the locations of important monitoring points for the measurement of discharge, groundwater levels and rainfall. The report also makes reference to the '*Status of Fisheries and ecology in the CAMS area*', and identifies that '*Biological quality ….. data are used to gauge river water quality as well as identifying stresses on the river such as low flows.*' However the text on fisheries and ecology made no reference to the Ems, highlighting the relevance for, and importance of, the Area biologists beginning a major data gathering exercise on the river system.

The CAMS determined that the Chichester Chalk Groundwater Management Unit (CCGMU), which covers both the Ems and Lavant, and feeds the SAC harbour, is '*Over Licensed*'. The report acknowledged that the assessment had been '*somewhat basic*' due to limited data on which it could reliably determine status. It concluded that '*Urgent further studies are required to better define environmental needs. These will be carried out before the production of the next CAMS*'.

The first large abstractions within the catchment began relatively recently, in the early 1960s. Based on files held by the EA, in the lead up to the Statutory Instruments and Licences being granted in the 1960s, there were no records of objections on file. However, there were major challenges (determined from examining Portsmouth Water Ltd. [PWL] files and through public consultation) that led to a Public Inquiry. A modification to the original licence included a requirement to augment river flows once flows dropped in the river to low levels, and this was due to lobbying by local people (Nick Rule, pers. comm.). The extent to which abstraction has impacted flow will be explored in the next section.

Information on flows and abstraction have been provided by the EA through their hydrological monitoring team Gavin Sharpin, Chris Manning and Anne Wilkinson at the Sussex Area office in Worthing. They could supply abstraction data going back 25 years, but for early abstraction information was provided by PWL; however even using the combined sources of information there are gaps in our knowledge of the extent of abstraction in the early years of operation at Walderton (1960s).

Information on river flows are virtually non-existent until the end of 2006 for the upper Ems, and limited for the lower Ems until 1967 when a permanent gauge was installed downstream of Westbourne (see Figure 3.2.1a). The EA holds data from this station from 1967 to date, as well as information on spot gauging undertaken prior to this (supplied to author by Anne Wilkinson) as well as more recently collected data from the catchment. Figure 3.2.1a shows the location of points on the river from where there are flow data; this shows no data exist upstream of Westbourne that can give any clue to the flow character of the river in reaches 1-3. Until flows returned to the upper river in late 2006, no gauging had been done to determine onset of flow in the winterbourne sections etc. The permanent gauge between Westbourne and Emsworth, that has data for almost 40 years, shows that discharge in the lower river is characterised by very low flows each year (generally in autumn and early winter) followed by 'peaky' late winter and spring flows (see Figure 3.2.1b). Reference to this figure, and Figure 3.2.1c (hydrograph for the Itchen) shows the following of note:

- The cyclic annual periods of late autumn low flows and late spring high flows is typical of a chalk stream/river (i.e. discharge dominated by groundwater);
- The low flow periods are characterized by extremely low discharges, and they are exceedingly small in comparison with the high discharges;
- A classic chalk river hydrograph (e.g. Itchen – Figure 3.2.1c) has a much smaller range in low and high discharges than the Ems in the perennial flow reaches – the large range in discharges is more typical of small chalk streams, or larger chalk rivers in their headwaters.
- In a forty year period the hydrograph shows that the floods of 1993/4 and 2000/01 were exceptional, and in the order of magnitude of 5cumecs (for a consideration of high discharges *cf.* low discharges, see Flood Management section later).

Raw data on discharges are held by the EA, and for reference the data supplied to this project are attached in electronic form in Annex 3B. Determining what the flow of the river was in historical times prior to abstraction is difficult to determine, but some additional (but very limited) gauging data were found in PWL files (see Annex 3B). These data showed that the river was dry at Broadwash from September to December, 1961, but a trickle flow was present in the Aldsworth stream at Watersmeet, and discharge at Lumley was estimated at c0.5cusecs for three monthly readings. These data are for the period before any abstraction at Walderton, but included the influence of the much smaller Woodmancote abstractions. Figure 3.2.1d shows the early gauging for the Ems at Hampshire Bridge (very close to the Westbourne gauge, but the grid reference suggests it would have been measuring flows at a very similar location).

Figure 3.2.1d shows that the gauging period in 1961 covered by PWL, coincided with a very low flow period. Around 280 readings were taken between 1962-67 and only extremely rarely did flow drop below the present-day trigger of 0.25mgd (see later), even though the 1964/5 period had extremely low recharge.

This period followed the initial abstraction at Walderton at a rate of a maximum of 2mgd; the 1966/7 period of discharge measures covered the period prior to abstraction being increased to a maximum of 6mgd, but at a time when test pumping to determine yields was used for public water supply (see 3.2.2).

From information gathered from PWL files, Rudkin (1984) and talking to local people who have lived in the Ems valley for over 50 years has enabled a picture of flow character to be pieced together – see summary, 3.2.4. Much information from files has been summarized in Annex 3, but a few 'edited highlights' are produced here in relation to river flows (some linked to abstraction, others not).

- **Rudkin (1984) wrote that many local people said that '*extraction may have some adverse effect upon the River Ems, but after my research I consider that it is much less than generally imagined. I have spoken to local people who well remember times before 1963 when the river was dry as far down as Aldemoor'*.** This suggests strongly that flow did not fail below here until after that, confirming the commonly held view that the river had perennial flow through Reach 2 downstream.
- Even the PWL engineer gives credence to the view that the Ems was perennial from Broadwash downstream; in a letter to a very concerned member of the public in 1968 he wrote: '*it is of course well known that the upper course of the R Ems above Broadwash Bridge has always dried up except in very wet years'*.
- David Todd said until the mid 1960s the scouts and guides had their annual camping holiday in the field below Broadwash and always swam in the river as it never failed to flow there. He also reported his father had fishing and shooting rights on the Aldsworth pond, and until the 1960s this had dried up only once (author assumes 1949?) in his father's lifetime.
- PWL granted permission to abstract up to 2mgd from Walderton in January 1962 – test pumping linked to flow gauging in May that year showed that flow in the upper river failed very soon after pumping began.
- The inspector who presided over the Public Inquiry said that abstraction 'for the time being' should be limited to protect the environment and other users (set at 2mgd then).
- Despite some lack of clarity regarding the historical flow through/level in Lordington pond, a plethora of correspondence between the owner and PWL engineers showed that pumping could have almost immediate effects on the pond level, and that remediating lining of the pond, a new sluice and augmentation were all required to sustain levels in the 1960s following abstraction.
- Photos from Nick Rule confirm no flow in several recent years at Westbourne Mill – even when augmentation being made.
- Numerous records of trout caught in Lordington Pond and Mitchamer Pond suggest much more regular flow to upstream of Walderton, and the testimony of Jane Glue is very persuasive of this fact.
- Failed flow in the previous perennial reach upstream of Westbourne Mill are reported by local people to have never ever occurred prior to Walderton abstraction, and have been only saved by augmentation – but that this is insufficient in very dry years.
- A previous healthy fish population, dominated by trout, that now struggles to maintain itself in a fraction of the river (see later section) suggests a major reduction in discharges during low flow periods.

It is to be noted here that the modified abstraction licence for Walderton, granted in 1968, requires PWL to augment flows upstream of Watersmeet by 0.25mgd when flow measured at the Westbourne gauge falls to 0.5mgd (2.32 Ml/d or 0.032 cumec). EA files note that during periods of low flow, such as in the early 1990s (Rod Murchie; 1991) that augmented flows do not reach Westbourne Mill in dry years.

In his book Rudkin chronicles what he calls the 'resurgence of the Ems' in what he describes as 'the unusually dry summer, autumn and winter of 1983-84'. He reported that the Ems was completely dry at, and upstream of, Woodmancote, and Aldsworth Ponds were dry. A good flow remained from Brickkiln Ponds suggesting healthy perennial springs here (he could find no-one in his researches who recalled the ponds ever drying). With autumn rains, the middle of January heralded return of water to Aldsworth Pond and with it swans, shellduck, coots and moorhen. By January 23rd a copious flow discharged to the Westbourne Mill pond.

In a short period of less than a week from February 3rd (when he observed springs in the bed near Broadwash he noted breaking of springs, and flow, as far upstream as the source at Mitchamer Pond. On the 4th there was flow in the river within Racton Park, and a small flow from a spring below Walderton. On the 8th he noted a continuous flow from Stoughton the sea!! The author of this report observed return of flow to the upper river during late 2006 and early 2007 – Aldsworth pond filled rapidly after springs broke at Racton Park Dell, but flow returned up the Ems to Walderton very slowly, taking weeks to get there, and about two months to get to Mitchamer Pond.

.Figure 3.2.1a Flow gauging station records to 2005

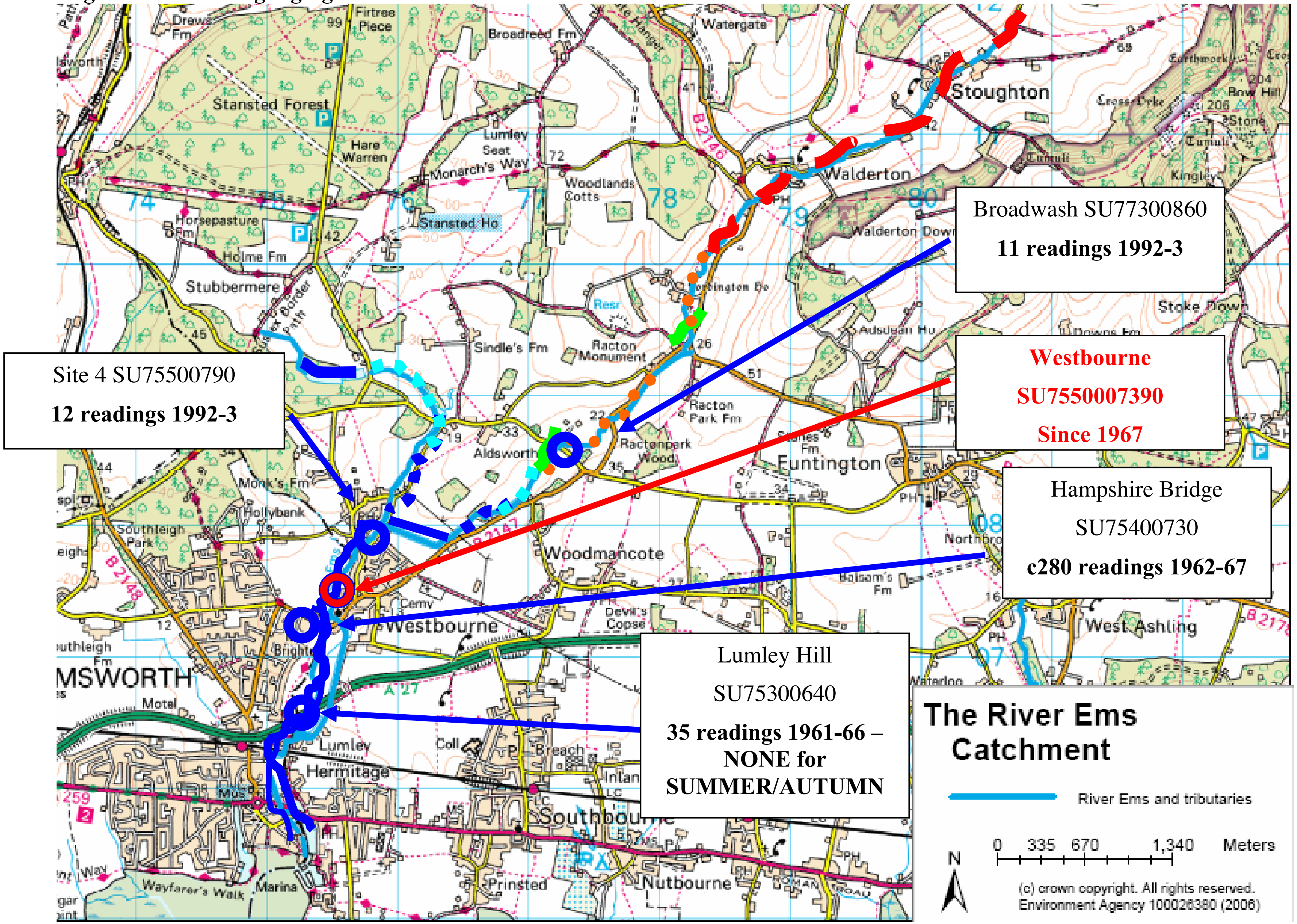


Figure 3.2.1b Flow gauged at Westbourne since 1967: Note Very 'peaky' hydrograph with very low annual minima *cf.* maxima

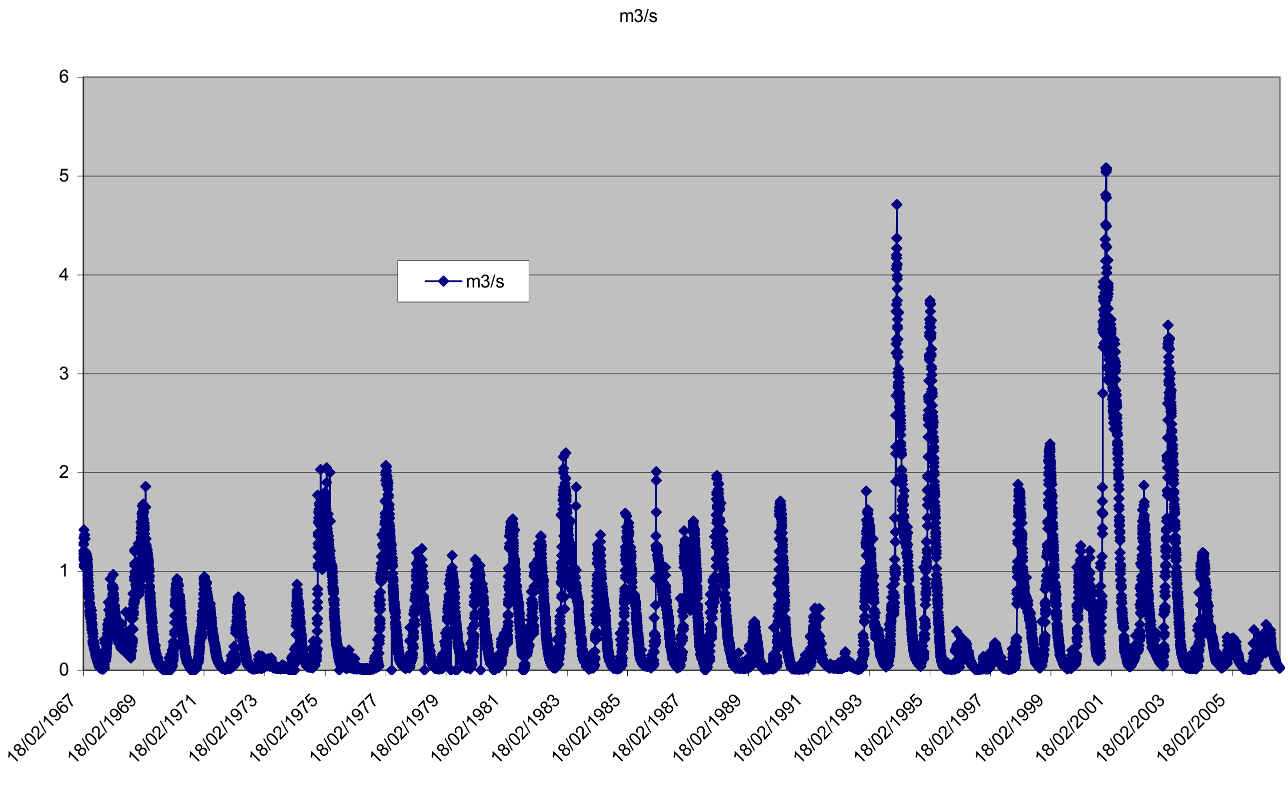


Figure 3.2.1c Hydrograph of flows in the Itchen, a classic chalk river – note smaller amplitude in low and high annual discharges compared with the Ems

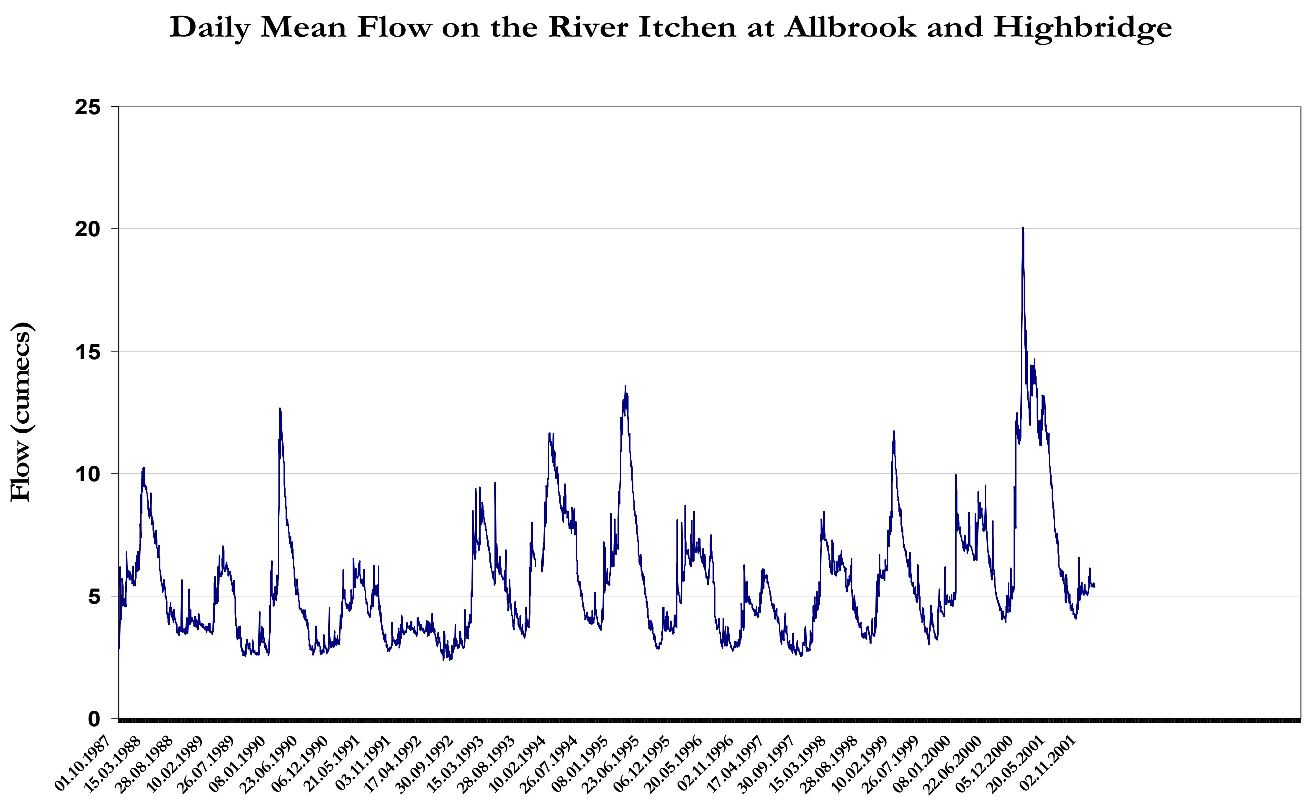
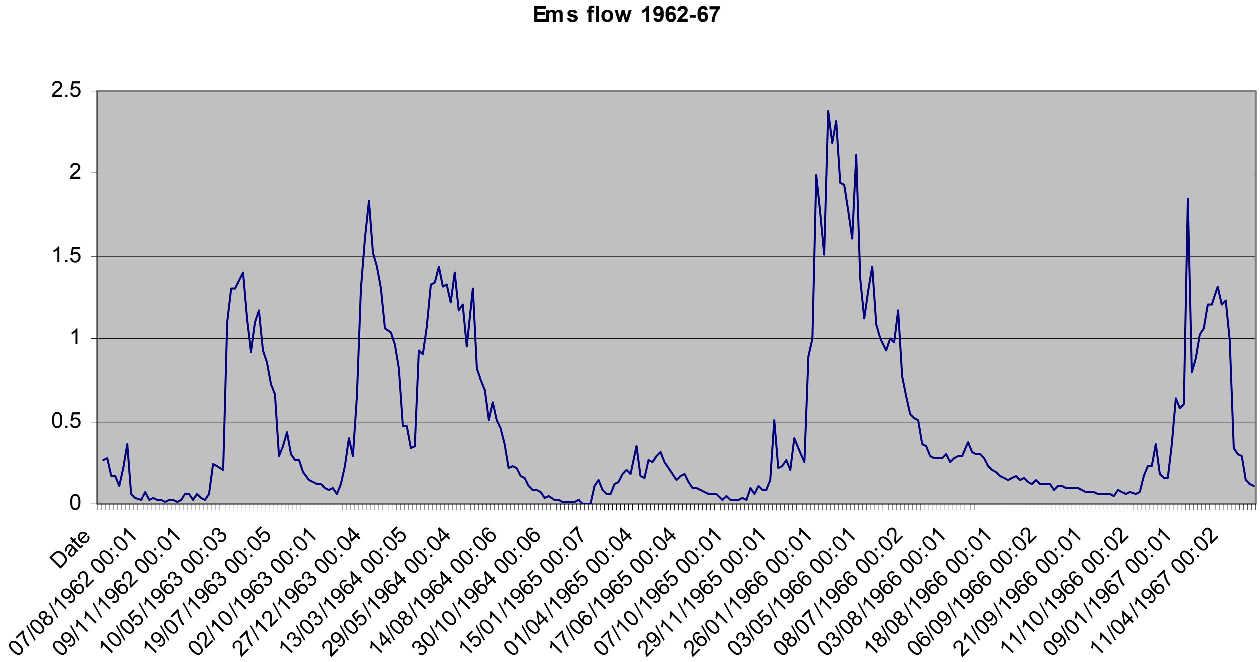


Figure 3.2.1d Flow (discharge in cumecs) close to the Westbourne gauge prior to installation of permanent gauge



3.2.2 Abstractions

There are only very minor abstractions (mostly not requiring consent) from the river itself, but abstraction from the underground aquifer is considerable. The major source is at Walderton, licensed since 1962, and Woodmancote that had been a supply source for many decades before that. (Woodmancote is licensed to abstract at a rate of 1mgd with a total annual take of 300mg.) Both public water supplies are operated by PWL, and these sources account for >99% of licensed abstractions in the catchment (Gavin Sharpin, EA). Figures 3.2.2a-c show the abstraction for the Ems catchment for the past 45 years; these show that from very minor abstractions up until 1964 (unreliable data from 1964-7) abstraction rose dramatically through the mid to late 1960s to be around 10 fold greater than it had been just over 5 years prior to this. The figures include data for the Lavant also, due to the sources for each being the same large aquifer – the Chichester Chalk Block (Halcrow, 1994; Entec, 2006)

As reference to the many file notes made in Annex 3B, and to Neave (2007) show, the desire to abstract water from the Ems for public water supply had existed for a long time prior to the successful license being granted in 1962 for Walderton – indeed unsuccessful bills were promoted in 1906 and 1930.

The first license for Walderton was granted in early 1962 for just 2mgd. This followed on from a Public Inquiry at which objectors noted their concerns for impacts on flows in the river (especially at Westbourne and upstream). Much information relating to the Inquiry was found in PWL's files, but nothing on the evidence submitted by opponents. With the license granted for 2mgd in January 1962, the PWL engineer wrote on 7th Feb 1962 that it was '*a fair decision*', but the desire to harness what was considered the full yield (then considered to be 4mgd) he wrote two weeks later to the minister seeking permission to build the infra-structures sufficient to accommodate this level of abstraction. From the files it is impossible to definite precisely the time when Walderton became fully operational, but file notes from the engineer to personnel such as Michael Hamilton (MP – Lordington Manor) suggest May 1964, when all infrastructure was in place; however Neave (2007) states that water was being pumped into supply by March 1963 (see Annex 3B). Interestingly, problems with water supply to Lordington Pond occurred in September 1964, necessitating a dam to be built to hold water in it.

Soon after Walderton become fully operational, there followed the dry winter of 1964/5 (see Figure 3.2.1d), necessitating PWL applying for, and being granted, a drought order to abstract up to 5mgd. According to the files this was not used significantly, but by the end of 1965 PWL wished to conduct pump tests to reveal potential increased abstraction yields. There were many objectors, and a hearing was held in December of that year. Two items of correspondence in the PWL files give concern that environmental considerations were given inadequate attention in the modification of the license in 1968, and that it was a forgone conclusion it would be granted by the regulator.

- In a letter to the Sussex River Authority (SRA), undated, the PWL engineer wrote in relation to the proposed plan to apply for an increase FROM 2 TO 6MGD..it ended….'*Whatever the outcome of the discussions with objectors I hope you will agree that we may immediately proceed with our application for the licence'*. (Note application was made 11th Jan 1968).

- Equally concerning is SRA response, following the tests: SRA wrote on Jan 19th 1968 – *'The increased pumping rate has not had any apparent harmful effect on flows in the R Ems or the aquifer nor has any indication been given that individuals have experienced any adverse effect'*. In the authors trawl through the files he found many examples of concerns, and also the numerous statements made by individuals in the course of this study. Unfortunately, any information on the pump tests has not been found from either EA or PWL sources.

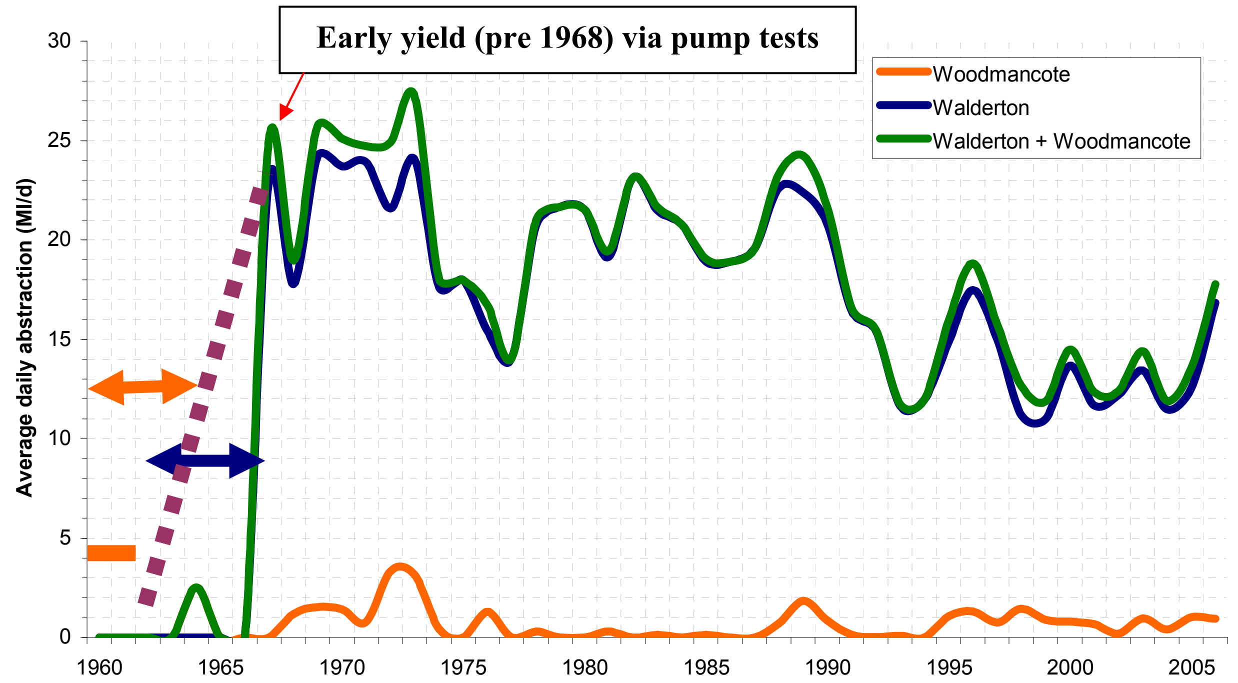
Interestingly, cress growers were one concerned group, and in 1975 after the increased abstraction had been going for many years, they were paid off, providing they did not attribute the cause of their problems to abstraction.

The decision letter by SRA to increase the abstraction was made in May 1968. The modification was to raise the average daily take to 6mgd, with no daily exceedence >8mgd. A condition of recognition that there may be an effect on river discharge downstream, required the authority to augment 0.25mgd when flow dropped to 0.5mgd at the Westbourne gauge – and to be continued until discharge rose again to 0.6mgd. Interrogation of PWL files revealed some additional water supply data that showed the extensive test pumping prior to the granting of the license modification provided water for supply almost to the yield of that granted in the license!!

Interrogation of the Lavant files at PWL revealed that in the 1970s a Chichester Chalk Block Steering Group had been set up and recommended that there was a need to examine the desirability of making additional compensation discharges to the Ems'; many local people feel today that this is most important.

More information on flow and abstraction can be obtained from Halcrow (1994) and Entec (2006). Neither study was able to prove quantitatively how abstraction impacts river flows; indeed the latter did not attempt to and the former drew tentative conclusions that require refinement before their value can be appreciated. The EA has recently contracted a study that is intended to build upon the previous studies and provide defensible links between abstraction and discharge. It is hoped that some additional abstraction and flow data obtained through this study will enable the modeling to be improved, or tested. The report of the diminution of flow in all reaches (longer dry periods in reach 1, failing flow in reaches 2 & 3, and reduced discharge in reach 4) requires critical assessment against **both** the Ems and Lavant catchment abstractions. Figure 3.3.2b shows reduced abstraction in the past 15 years from Walderton, but maintained abstraction from the Lavant as a whole, and an increase from Brickkiln (closest to the upper Ems).

Figure 3.2.2a Summary of abstraction from Ems Catchment (combined EA & PWL sources)



Missing Abstraction Data for Woodmancote; Missing Abstraction Data for Walderton

Maximum pre 1962 Ems catchment abstraction Increased abstraction 62-67

Figure 3.2.2b Summary of abstraction from Ems Catchment showing links to Lavant Abstraction

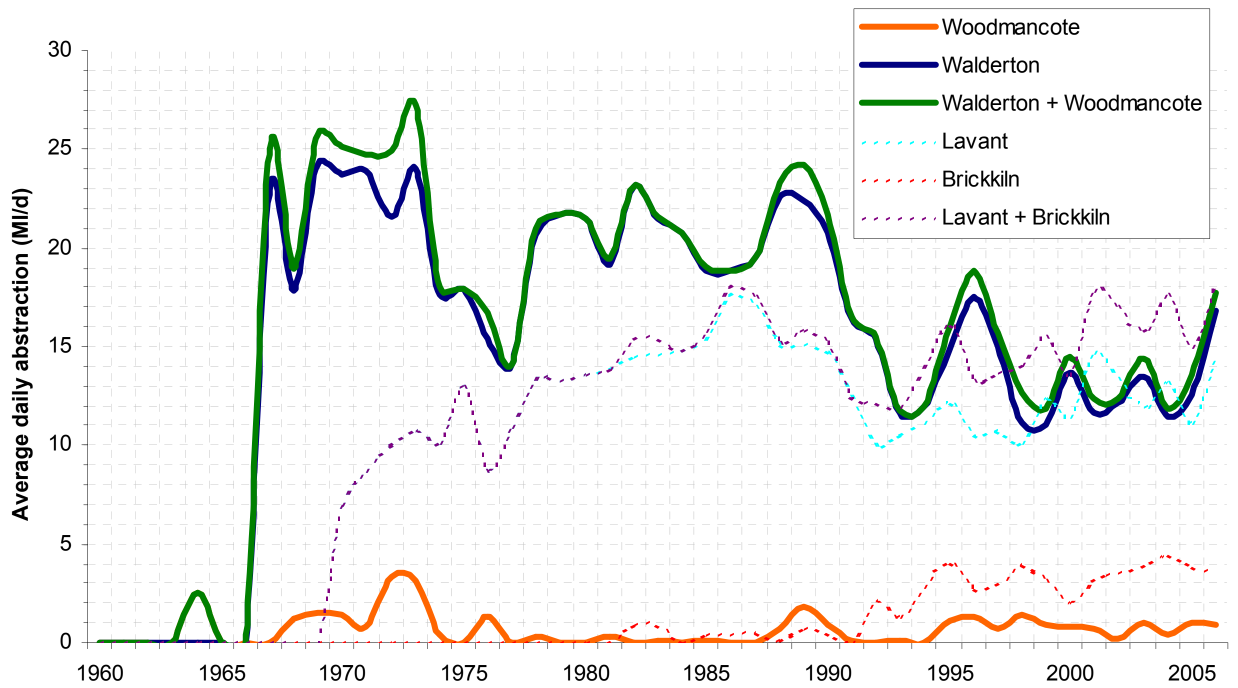
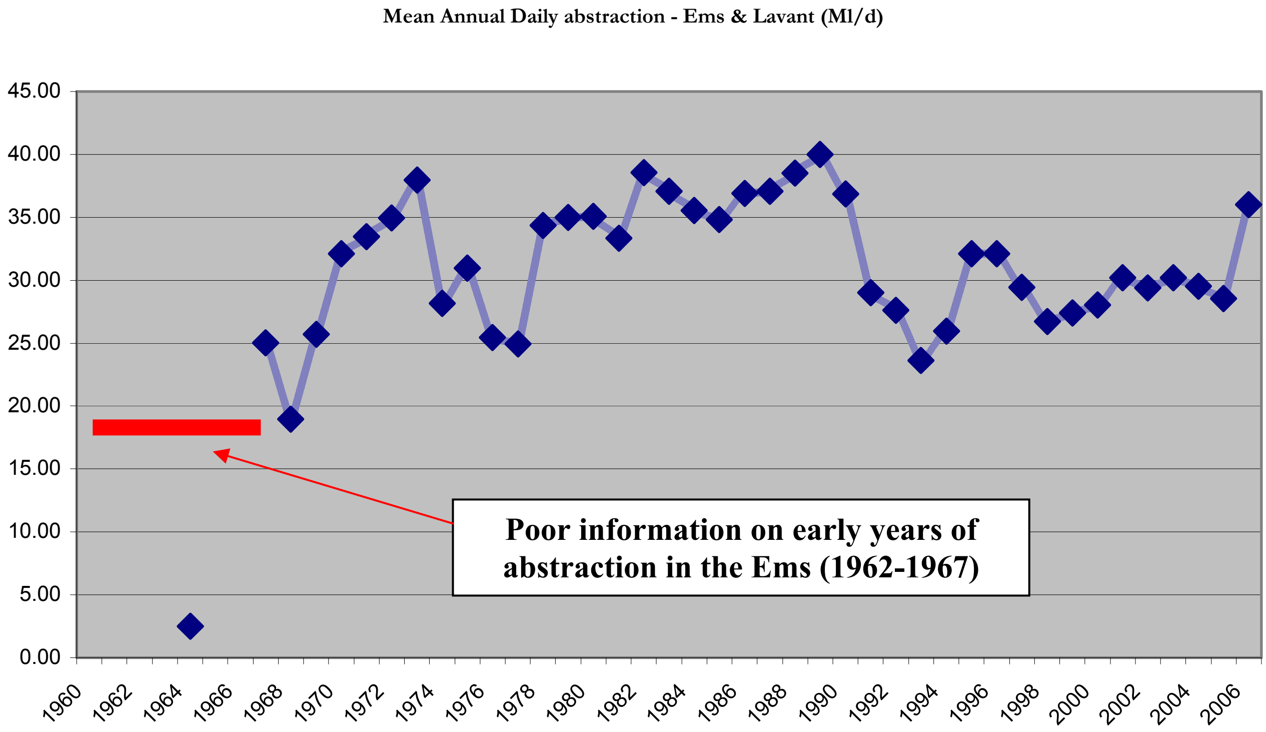


Figure 3.2.2c Summary of abstraction from Ems and Lavant Catchments



3.2.3 Discharges

In the Ems discharges make little difference to river flows, especially low flows as no sustained discharges from sewage treatment works (STWs) are present anywhere in the catchment (EA). Storm water discharges provide short-term, and very temporary, flows in the winterbourne headwaters when they are not flowing, and adds to perennial flow in other parts of the river periodically. Locations and details of point discharges were provided by the EA (Rob Cornell), but as the influence of these on river discharge is so minimal, and therefore on ecology too, details of these are not given here.

3.2.4 Summary

Lack of quantitative knowledge on the historical flow character of the lower perennial reach, and both historic and existing character of the middle and upper reaches, make it impossible to determine objectively to what extent discharge is affected by abstraction. However several disparate sources of information enable a reasonable picture to be suggested. The present character is illustrated in Figure 3.2.4a

Upper Ems – Reach 1 to Broadwash

a) From Stoughton to around the B2146 (d/s Walderton) the river is predominantly a ditch – historically flow was almost certainly present for less time than the bed was dry. It is highly likely that the Walderton abstraction has had a major impact on flows (length of time water is present in the river, and the proportion of the discharge at low flows), but the change from the historical past is unknown, and impossible to quantify, as is the potential to determine precisely if there has been any ecological impact. Whilst the file information on Lordington Pond (a little way downstream - see Annex 4B) is strongly supportive of the almost instant impact of abstractions in the 1960s, the interview with Mrs. Glue provided the most telling evidence. The fact that she reported that as a child, in the late 50s and early 60s, she walked through wet meadows every spring and summer to her grandmother's house from Mitchmere to Walderton could be discounted as a 'rosy nostalgic view of childhood'. It is not dismissed because she reported how she 'raided' the pond for tadpoles and small fish to keep in her fish tank, stating authoritatively that the fish were young trout, and that she saw adult trout too – when asked if she saw sticklebacks, the answer, after much thought, was never. As trout migrate, but stickleback do not, her evidence indicates a winterbourne that had regular flow. Her information must lead to there having been a substantial change in flow character of the river since Walderton became operational, and there having been a significant ecological impact. The Lordington pond correspondence is also supportive of impacts, but less convincing.

b) Racton Park – close to the B2146 there is a pond and this appears to have a more winterbourne character (in terms of its flora) than either upstream or downstream. It held water for longer than the rest of the river through 2006, and therefore it appears the bed may hold water for a bit longer here, and there is certainly a different flora. To what extent it has changed since 1960 is not known, and it is unlikely to be ever ascertained based on what appears to be available information from the past.

c) Racton to Broadwash – this has a typical 'modern-day' winterbourne stream structure – a deepened depression in a rural landscape, that flows intermittently. An erratic natural discharge is suspected, with an average of 'no-flow' days probably exceeding those when there is flow. In good re-charge years flow may be sustained for much longer. Again, almost certainly there has been a reduction in periodicity of flow, but it is not possible to quantify abstraction impacts on flora or ecology; not knowing what was there before makes rehabilitation a low priority.

Middle Ems - Reach 2; Broadwash to Watersmeet

a) This is a most interesting 2.5km of stream, with a west bank stream at Racton Park Dell also of interest. At the upstream end, today it is a typical wet winterbourne, but the transition to <u>almost</u> perennial stream is rapid. At Aldmoor Cottage (Ractonpark Dell) there is a structure that held water in a pond – re-constructed in 1969 by Southern Anglers who had the fishing rights; it is now intermittent (Rudkin; 1984). Upstream of this there was a cress bed feeding back to the Ems near Riverside Cottages. To the west there were more cress beds, and the concrete cills are still present. They all join in Ractonpark Dell, an amazing wetland with springs, flushes and red stones (*Hildenbrandia* in such abundance I have never seen the like of it before!).

b) Minimal attention to invertebrates has occurred here, but it must be very very important. Macrophytes indicate a perennial flow – but flow fails periodically, but not for long. I regard this as possibly the most ecologically significant area in the catchment, but this may not be a view shared by the local people who are mostly interested in the river through Westbourne and downstream. The presence of numerous historic cress beds, and the breaking of springs here almost in unison across the valley, suggests this was probably the historic perennial head, that might never have failed even in extreme droughts (local people, and Rudkin's text gives credence to this view) prior to post 1968 abstraction. Impacts on ecology must have resulted from abstraction, but their significance is impossible to determine due to lack of previous information.

c) Upstream of the point of flow augmentation the Ems macrophyte community suggests a generally reliable flow, and would not be expected to dry for long, or regularly (but there is ample evidence that it does dry in the autumn of poor re-charge years). The 'canal' probably holds water all the time as it probably has been clay-lined to protect the water that was historically pumped up to Stansted house (north of the Aldsworth stream); flow would fail now in drought periods without stream support, and this is almost certainly a new phenomena as reliable flow was required for water supply in previous centuries. The stream above the augmentation point is ripe for chalk stream enhancement through physical manipulation. The 'canal' downstream could also be enhanced considerably, and the main river channel also (see separate section).

Aldsworth Arm (Western arm) to 'Watersmeet' - Reach 3

a) Brickkiln lakes appear to have no recorded flow failures, even in the extreme drought of 1990-1992. They discharge to an intermittent stream that feeds Aldsworth Pond upstream of Aldsworth Bridge – the pond has numerous records of drying, as it did in 2006, but from being dry on 28th November, it was full, and flow was gushing over the weir on December 17th. Upstream of Watersmeet, the stream flows through another on-line pond; upstream of this the stream contains plants that suggest a generally regular flow, but it dries in most years; this suggests flow is less reliable than it used to be. Talking to local people (two aged 72 and another 92) indicates that drying is a regular feature in recent decades, but never previously occurred except in very rare, and exceptional, droughts – interestingly they did not know why, the 92 year old (Sidney Morgan) saying – 'that's got nothing to do with the abstraction' – but modeling the extent of the potential abstraction impacts is important to determine if this is a misconception. They also talk about this stretch between the fence and Watersmeet (c200m) often being black with young trout, and never ever drying except in the last few decades (NOTE: author observed it dry for many weeks in 2006 during Sept to Nov).

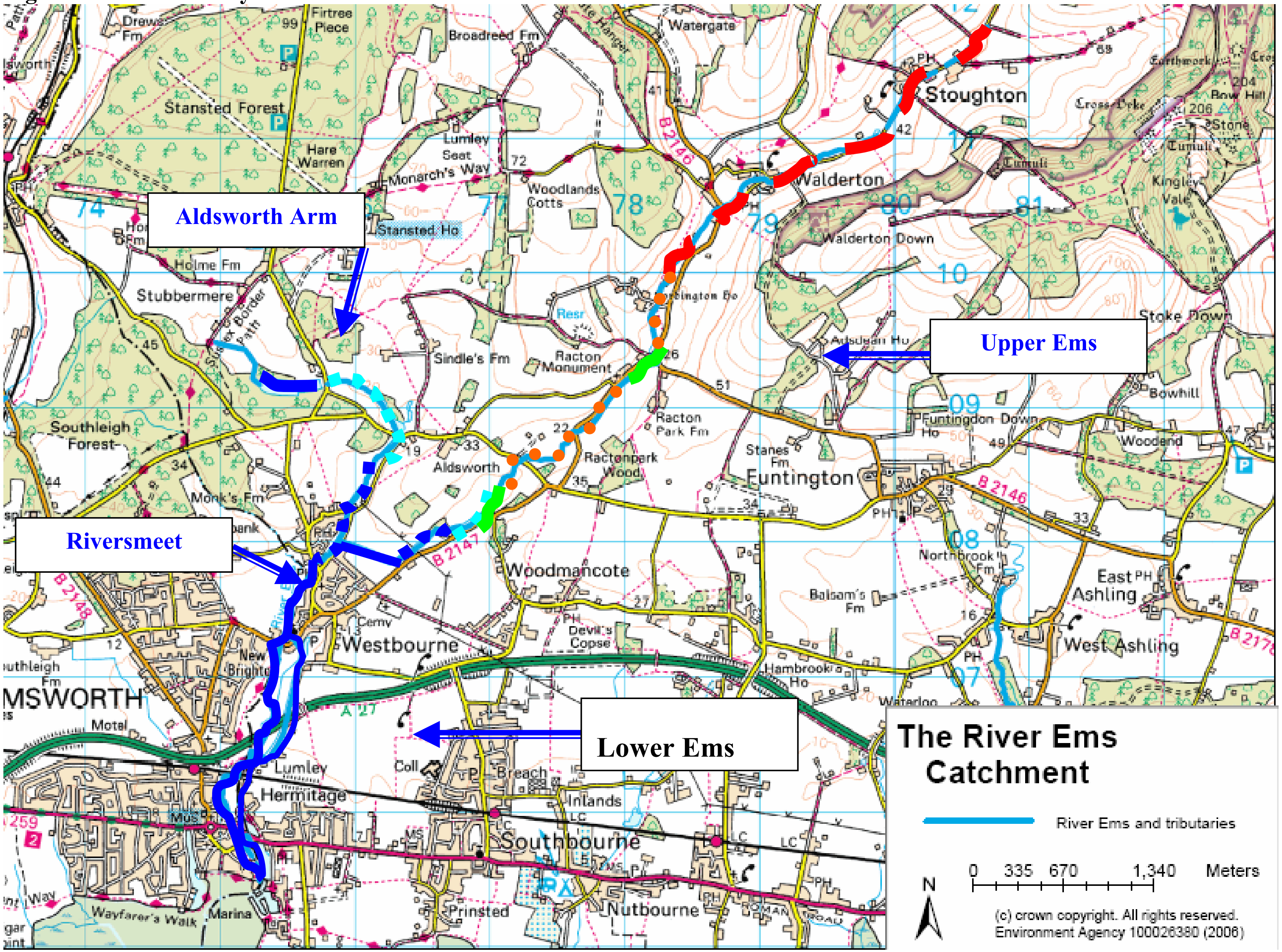
b) Flow failure, and drying of Aldsworth Pond, appears to be a regular occurrence since Walderton abstractions began. The old local residents reporting the regular poaching of sea trout being commonplace whilst attempting the jump the sluice into Aldsworth Pond is not evidence of flow failure, but the statement of David Todd, reporting his father's knowledge of the Pond only drying once before the 1960s is significant, and suggests the influence of the abstraction extends beyond the main stem of the Ems.

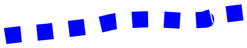
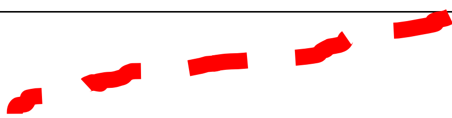
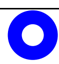
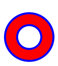
Lower Ems - Reach 4; Watersmeet Downstream

a) The ponded reach from Watersmeet is the millhead for Westbourne Mill; this has been in the same family ownership for over 75 years. Nick Rule lived there as boy, and has returned there to live. He recounts, as do several others spoken to, that the mill head level never ever dropped until the 1970s. Since then, it has been a regular event, and for the past three consecutive summers there has been just a puddle in the middle, surrounded by mud, extending downstream from Watersmeet (presumably sustained by the augmentation water) – he has photos to confirm this – see later sections. Spring flow at the base of the mill sluice has never failed, even in recent years, and when levels are maintained in the mill head, the spring flows in the two streams below have additional water provided from the mill pond. Flows appear to accrete through springs for the most part down to the Harbour, but at times flow is extremely meagre. Perennial flows are reflected in the fish, invertebrate and plant communities present.

b) The pre-abstraction flow gauging data, and personal accounts, indicate that the reach has always had some flow (perennial), even in very poor re-charge years downstream of Westbourne Mill. Abstraction at Walderton appears to have resulted in drying of the river upstream of the Mill that appears never to have happened until after abstraction began at Walderton. Augementation amounts have clearly been shown to be of insufficient volume in low-flow periods to meet the objectives of the licence condition. The extent to which discharge is reduced between Westbourne Mill and the Harbour is impossible to determine, but it is important to note that historical data (for the early years of abstraction when limited to 2mgd) indicate that discharge in poor re-charge years was reduced to very small amounts in this reach (but consideration should be made to the fact that Hampshire Bridge gauging did not take account of flow going down the Lumley Mill leat.

Figure 3.2.4a Summary Flow Character of the Ems Catchment



Key	
	Perennial
	**More or less perennial – if dries, does so for short periods in most years; never dry for >12 month period (? May in V extreme back to back groundwater droughts); may flow for several years without failure**
	**'Wet' Winterbourne – flows/holds water for majority of most years; flow fails in more years than does not, but only in extreme droughts does lack of flow prevail for many months**
	**'*Typical'* headwater Winterbournes - flows > 50% of time (typically up to 8 months) – often for shorter or longer periods depending on re-charge; as below, may be dry for >12 consecutive months but greater reliability and length of flow produces very different flora**
	**50:50 Winterbourne – flows up to 50% of time – often for shorter or longer periods depending on re-charge; may be dry for >12 consecutive months but more rarely flow for >12 months**
	**Very Dry Winterbourne – almost terrestrial habitat periodically inundated therefore dry longer than wet**
	**Spot gauging undertaken ≥10 times at a single location (excluding sites just for flood gauging)**
	**Permanent flow gauging stations**

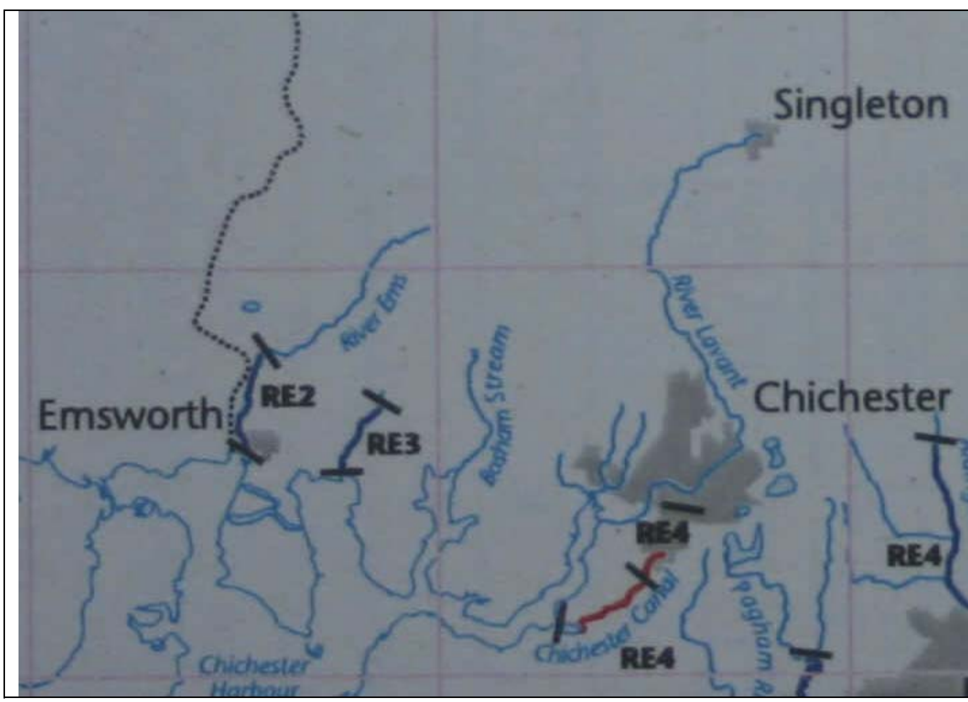
3.3 Water Quality

The EA and it's predecessor organization is/was responsible for chemical sampling data for the river. Following discussions at both the Worthing and Chichester offices, details were provided on the locations of sampling sites (Figure 3.3.1a) and a spreadsheet of the data. Updated versions of these are held by the EA. In addition to this, Rob Cornell provided a map identifying locations of licensed abstractions (surface and groundwater) and discharges as well as un-consented surface water outfalls. This information can be obtained relatively easily from the EA if required, but has not been shown in this report because, in general, water quality or serious pollution incidents have not been highlighted as seriously affecting the environmental quality of the river.

In addition to wishing to determine the present and past general water quality characteristics of the Ems, there was a desire to determine if there was knowledge of previous serious pollution or on-going risks; this information was provided by round-table discussions with EA personnel, in addition to some of these personnel interrogating the NIRS database. No one within the EA was aware at what point sewage effluent was exported from the catchment, but it had been for a long time.

The biological monitoring work (see later) has great relevance to water quality, with invertebrates particularly valuable in being sensitive to organic pollution. However data are extremely sparse prior to 2000. This confirmed the concerns of those within the EA Ecological Appraisal and FRB Teams that inadequate data existed at the time of the CAMS assessment (EA, 2003), or to make the required inputs to development pressures, to determine impacts and risks.

The Surface Waters Regulations (SI, 1994) prescribe a system for classifying the quality of rivers and canals to provide a basis for setting water quality objectives (WQOs). River reaches are assigned to one of five hierarchal classes (RE1 [best] to RE5), and samples taken within these reaches are required to satisfy certain standards. The EA searched through the RQO data and looked at the Water Quality Improvement Plan data for both the Ems and the Lavant. Only the lower reach (4) has a designated RE class [2] (Abigail Bean, EA; LEAP 1999 – see below); the same reach has been assigned a class B chemical GQA grade, and a class C biological grade.



Confirmation of RE Class 2 (compliant) in LEAP (1999) for the lower Ems. GQA for the same reach in the LEAP is shown as class B/C (good & fairly good). Note only Reach 4, the now perennial reach from the Aldsworth/Ems confluence at Westbourne is classified (presumably because upstream flow periodically now fails).

Long-term monitoring data (from a site on the 259 road bridge since 1978) show that the water quality RE2 standard is consistently met for most parameters (>70% dissolved oxygen [DO]; <4mg/l biological oxygen demand [BOD] and < 0.6mg/l ammonium-N). There are 'face-value' failures on the basis of wide diurnal fluctuations in DO. Thus the River Ems is generally compliant or experiences marginal failures only; this is thought to be due to ponding of water in the lower River Ems under low flow conditions. As the Ems is generally compliant there has also been little monitoring effort (Abergail Bean, EA, pers. comm.).

The majority of data on water quality are held by the EA, and summary information presented here on water quality monitoring has been obtained from Sean Ashworth, Abigail Bean and Katherine Holmes (EA, Sussex Area).

Figure 3.3a shows the location of the water quality monitoring stations on the Ems provided to the author by Katherine Holmes from the EA. Long-term datasets for the Ems are limited (two 1970s sites and a single 1978 to date site), but a catchment-wide programme of flow and water quality monitoring began in 2006 by the EA. From Watersmeet downstream there is flow for the majority of time for water quality monitoring, but upstream of here flow is intermittent and sampling is therefore limited to periods when there is flow. Surveys began in June 2006, and are planned to continue for the foreseeable future, so a good picture of water quality will emerge through 2007. Data so far for the upper river indicates low phosphate levels rarely exceeding 0.02mg/l, lower that the guidance issued by JNCC in the Common Standards Monitoring (see website for details) for small chalk river SSSIs. Consistent with the long term recorded sites, low levels are generally maintained during the summer, or once flows have been continuous for some time, but peak P levels occur in autumn and winter with the on-set of higher flows, or restoration of flow. Figure 3.3b shows the P levels for the site at the extreme downstream freshwater limit of the Ems that has a very good data record since 1978.

There are few recorded pollution incidents that are known to have caused significant environmental damage to the Ems; this was confirmed through meeting Rob Cornell, Paul Reynolds and Lisa Ashmore of the EA. None had any knowledge of serious pollution incidents in the river for the past 15 years, and this was confirmed by Richard Hammond (EA) who has had a longer association with the river, and knowledge covering several decades. The river has potential problems from:

- Industrial sites in lower reaches (perennial);
- Silt from agriculture – pig farms north of Westbourne on the Ems is a potential concern that do date has not caused great problems, but is an area of concern;
- Drainage from the A27.
- Storm over-flows may discharge to the river throughout the catchment. This occurred for a long period in the 2000/1 and 2003/4 floods. Dilution was very high, and no ecological problems were reported at the time

The number of reported incidents on the National Incident Recording System (NIRS) database are small (Katherine Holmes, EA; see Annex 3D), with the majority logged as the cause either not being known, or unauthorized discharges. Since the majority are also logged as occurring in late autumn/early winter, it is likely that low discharge (minimal dilution) is a contributory factor. This is consistent with reports of 'sick fish' in the lower reaches coming to the notice of Phil Maber and Paul Newman (EA) in autumn low flow periods in the 1990s. Generally good water quality is also consistent with no known impacts from water quality or pollution incidents being reported by the FRB and Ecological Appraisal teams. The same personnel rarely mentioned water quality as an issue (other than silt); therefore maintenance of the present quality, and protection from pollution incidents, is considered adequate to enable ecological recovery when other, more influential factors affecting the ecology of the river, are addressed.

There has been no catastrophic pollution incident reported to have hit this system in the same way as the Darent (Kent) was rendered virtually lifeless with tar pollution associated with A225 widening and re-surfacing of (Oaks; 2002; Halcrow; 1979) around 100 years ago. At the start of the 21st Century, therefore, water quality in the Ems is generally good in the river where flow is regular and water quality is measured, with the key nutrient, phosphorus, within JNCC target guidelines for chalk rivers (BAP target) and nitrate within drinking water standards. Phosphorous levels are lower than they are in the Itchen SSSI/SAC.

An indication of general water quality can also be gleaned from available biological monitoring using invertebrate and macrophyte data (see Appendix 2 for locations of data). The EA, and its predecessor organizations, have a long history of undertaking invertebrate monitoring for water quality, but attention to the Ems has been limited. At a workshop discussion held through the study with EA ecologists, it was agreed that what biological surveys had been undertaken suggested generally good water quality.

The issue of silt run-off from the catchment is considered by some local people, and ecologists who know the catchment well, to have detrimental effects on the river's biology. This may have serious effects on salmonid (trout/sea trout) recruitment, especially as the impacts of elevated silt levels arising from the land are amplified by low flows and over-wide channels. Blanketing silt also reduces the extent and quality of well-aerated gravels that are important for supporting many characteristic chalk river invertebrates.

No great effort has been made to track down possible data other than that provided by the EA in this study because the review of key factors affecting the ecology of the Ems catchment came to the conclusion that water quality in the past few decades has not been perceived as a key determining factor impacting biodiversity generally, or individual species. However, many local people are concerned, and local problems have been reported.

Figure 3.3b Phosphate levels at 259 Road Bridge from 1978. Levels of P are generally low (often very low and below detection limit of 0.02mg/l), with peaks associated with the first high flows early in the autumn/winter recharge cycle – for details, and updates of data collected, contact EA

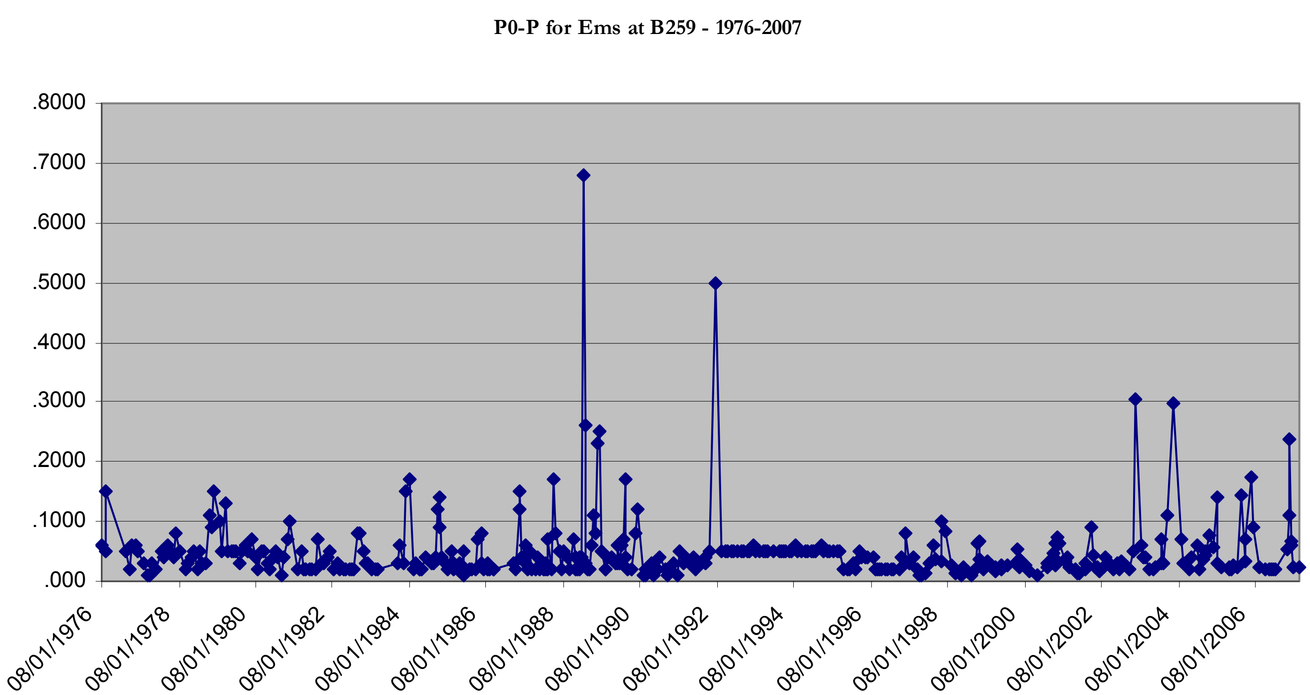
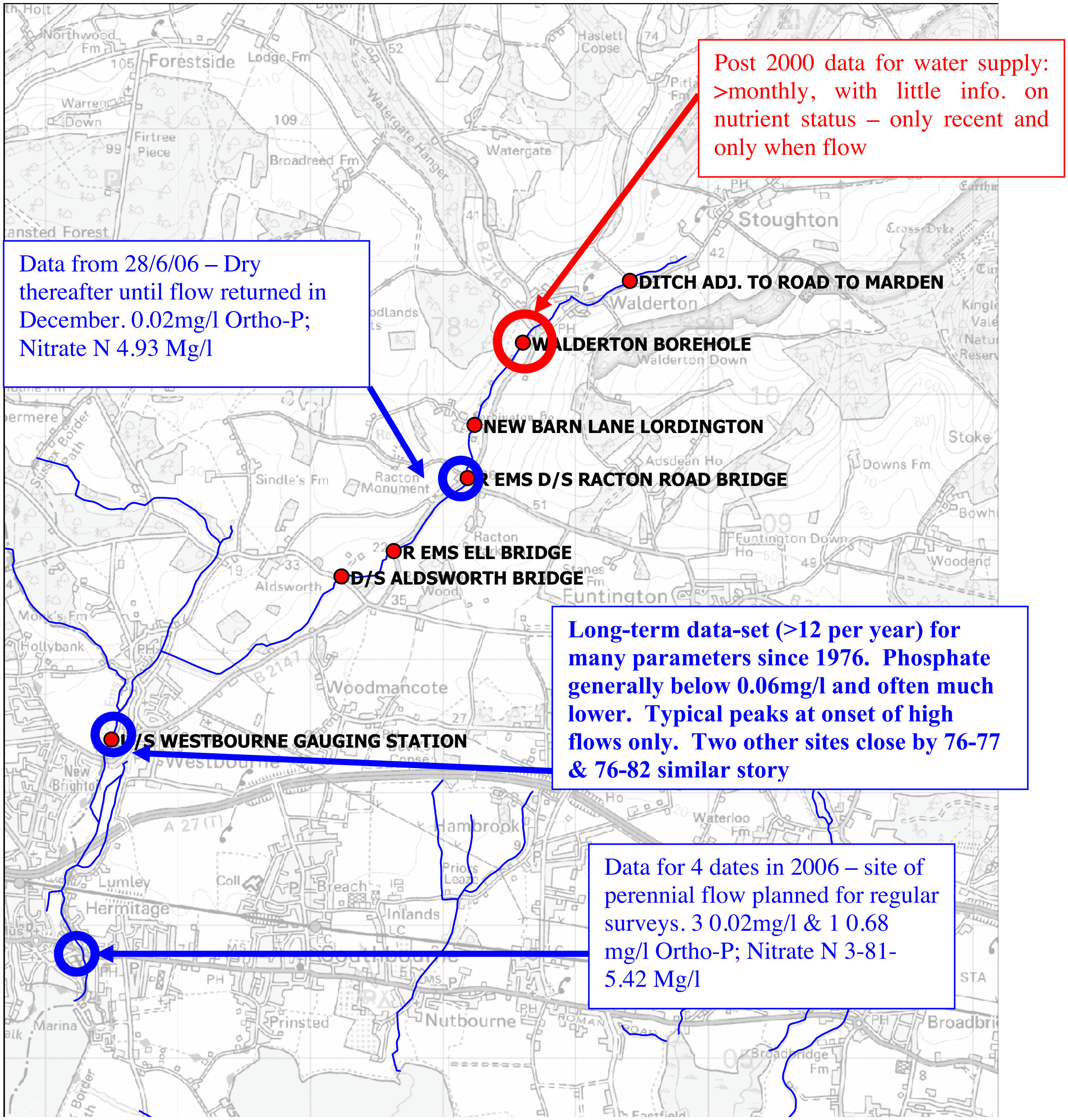


Figure 3.3a Water Quality Monitoring Sites on the Ems – base map from EA. Not all sites are shown that are now surveyed regularly when flow present - STOUGHTON, WALDERTON BRIDGE, LORDINGTON, RACTON, RACTON DOWNSREAM OF CONFLUENCE, FOXBURY LANE, ALDSWORTH BRIDGE, ELL BRIDGE AND WESTBOURNE COMMON, WESTBOURNE GAUGE, BROOK MEADOWS



3.4 Channel Form, Flood Risk and River Management

3.4.1 General Considerations

The catchment has been subject to major changes that have resulted in whole-sale modifications to its natural character. An admirable summary of the many changes that have affected the river over the centuries is described by Rudkin (1984). Despite research of the literature and West Sussex Records office, Rudkin acknowledged that much valuable information had been passed down from oral accounts of people living in the area for generations. In his lifetime (over 70 years) he recounts that the Ems had powered three corn mills and two pumping engines (see Annex 3C for summary). Information on more recent changes, and flood defence management, has been obtained primarily through discussions with personnel in the EA. The following summary has been determined through these sources of information, combined with knowledge gained through walking the river through the course of the study (see Annex 5 photos in accompanying CD) and talking to many local people with a long history of knowledge of the river character.

Rudkin began writing his book in 1983 when it had been unusually dry; as the winter came on he plotted the flow and springs returning up the river. In describing the physical character of the river, the historical periodicity of flow has been an important consideration when defining one of the cut-off locations of the four reaches. In discussions with local people with a long knowledge of the river, changes in flow character were cited by all as being very evident in the past 50 years, but only minor changes were reported for physical character.

In Rudkin's research he consulted, and reported on, no less than 12 maps dating from 1610 to 1913. These show many changes to the course of the river, with the majority of these in reaches 2 and 4 – the Ems from Deepsprings to the Harbour. The changes in course appear to have been mostly to accommodate the needs of water meadows and milling. In addition to this, centuries ago the course of the Ems appears to have been diverted from the east of Westbourne to flow via 'the canal' (to provide water for Stansted) and Westbourne Mill (to provide additional water to power the mill). Rudkin also cites Longcroft C J (1863) - *The Valley of the Ems*. Cited in Rudkin 1984 in relation to mills, but the original text has not been seen by the author. Milling was reported as having been associated with the river for centuries and often, this was to take advantage of reliable flow of the river. (Rudkin refers to a mill at Lordington, so this cannot be the case always.) The presence of mills has important implications for river channel habitat for two main ways:

- The mill head sections, to provide both a head and store of water, create deep and ponded water that is not a natural characteristic of chalk streams;

- The ponding is followed by a drop (usually >1m) through water wheels (or now sluices as wheels redundant) - the fall dissipates the energy that would naturally be used to scour silt from the bed, move sediment and create diversity in physical habitat;

- Often feeder channels form the mill leats, elevated above the river floodplain, and separate from the natural (or modified original) course – this has implications in terms of split river flows shared between two or more channels, as in channels feeding Lumley Mill.

A history of the mills can be found in Rudkin (1984) with some summary information in Annex 3C; no further information is given here, but where relevant in terms of impacts on the river habitat, this is given in individual reach assessments. It is important to note that the mill legacies have left many structures that impact, or preclude, migratory fish movements from the sea to the freshwater reaches of the river under most flow conditions.

3.4.2 Land Drainage, River Management and Flood Risk Management

The majority of information has come from meeting EA personnel: Andrew Gilham, Chris Smith, Tony, Davison, Patrick Butcher, Michael Ford, Anne Tanner, Andy Townsend & Keith Stanly. Inspection of EA files (through Michael Ford) revealed much information on the floods of 1993/4, and especially 2000/1 (with many extraordinary photos), as well as the main report on flood risk, and the 1993/4 floods by Rofe *et al.* (1996). To gain a good idea of river management in the 1980s and early 1990s, a visit was made to Phil Petts – who, as the Flood Defence officer, had the NRA/EA management responsibilities for the Ems at this time. Patrick Butcher provided a CD with detailed X-sections and photos of the majority of the catchment covered by the extensive physical surveys carried out mostly in 1993. The X-sections have been invaluable in assessing the feasibility of rehabilitation options in certain reaches – see later.

Until recently, the EA was responsible for the flood risk management (FRM) of the river as far upstream as Walderton (i.e. designated statutory Main River). Further upstream to the source, management was the responsibility of the local councils and riparian owners. Now the whole river Ems is under the jurisdiction of the EA, with the upstream section classified as 'Critical Open Watercourse', or COW. The EA therefore has permissive powers to undertake maintenance for the whole river Ems. Reach 2, the Aldsworth Stream, has no statutory designation for FRM, and is still under private responsibilities.

For strategic flood management, the EA often combines several small catchments in developing their Catchment Flood Management Plans (CFMPs) – the Ems is combined with the Arun, Lavant and some other small coastal streams. The FRM team assesses flood risks in different areas of the catchment and has produced a provisional flood envelope for a 1:100yr flood – from Patrick Butcher, see Figure 3.4.2a. This shows that floodplain flooding is extremely limited upstream of Westbourne (except the wetlands of Racton Park Dell) but is extensive in a major flood downstream of Watersmeet.

Reference to Figure 3.2.1b shows four major floods in the lower Ems since 1994. Rofe *et al.* (1996) estimated that the flood of 1994 was in the order of a 1:200yr event, and that of 1995 being c1:40. As the flood of 2001 was even larger, but the return period of such floods may well be adjusted in the future, it is important to note that these floods were all large, and not expected to occur regularly. The Rofe *et al.* report was charged with assessing the extent, degree, causes, consequences, damages and costs of the 1990s floods as well as identifying options to address problems (see Annex 3C for brief summary). The main conclusion was that despite a major event, very little property was at risk from fluvial flooding, and amazingly, the 1:200yr event was estimated to have only caused £100k of damage, but much disruption that was not costed.

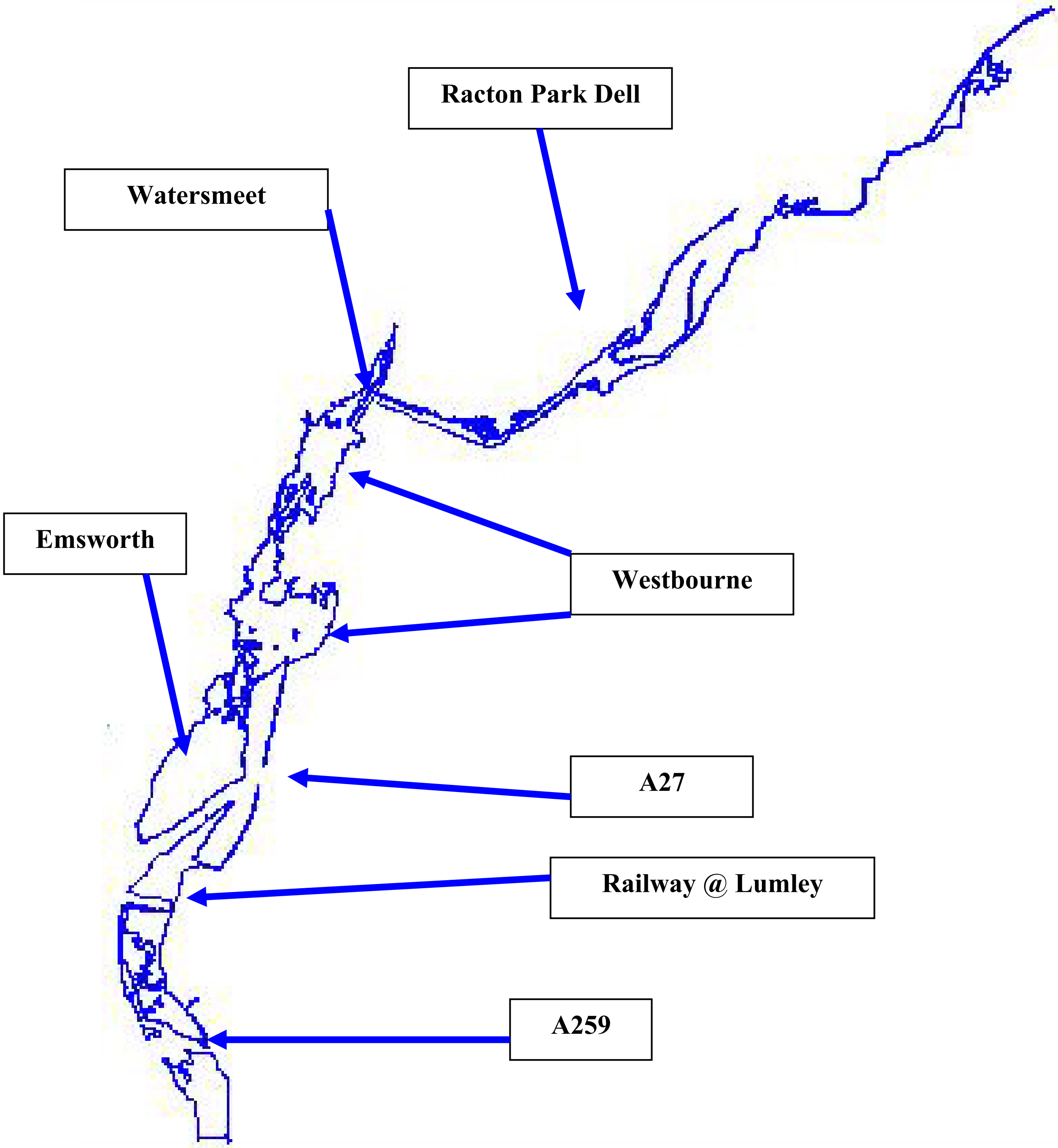
- Upstream in Walderton and Stoughton, sandbagging to protect properties was required, as were evacuations due to the road being flooded for six weeks, but property flooding was avoided despite channel size and culverts being considered too small to take such large floods.

- Flooding upstream of Westbourne can be avoided by having the mill sluice fully open (but is complicated by an historic channel running from Watersmeet to the east of Westbourne Mill – known as the bunny, that historically provided the head to wash the open roadside sewers The report confirmed the building of the low flood bund along the south side of the Canal, and also the de-silting of Westbourne Mill Pond in 1994 following the big flood.

- In the lower reaches flood risk is complicated by private sluices and structures. Regarding Lumley Road and Slipper Mill the report stated: *"There are a number of private sluices between Westbourne and this area. There is a lack of goodwill and coordination between the operators (which are not under EA control) with the result that they are not always managed in a fashion which works to the best advantage of all residents"*.

- The report noted problems for flooding if slipper mill pond levels are kept high. Subsequent reference to EA file notes indicate that very high tides, combined with high winds, can cause flood problem in the lower Ems – as on 10-13 Jan 1993, causing fluvial flood up to the new A27.

Figure 3.4.2a 1:100 year flood envelope from FRM, EA (i.e. flood with a 1% risk of occurring within any given year).



River management by the NRA and EA has evolved from practices inherited from those previously charged with managing rivers for 'flood defence' and 'land drainage – e.g. Southern Water, Sussex River Board etc. Responsibilities and priorities have changed drastically over the past 40 years, with the emphasis moving way from drainage to improve agriculture (usually involving channel degradation), to managing flood risk and delivering environmental gain through withdrawing or reducing management of watercourses, changing practices, or undertaking management in tandem with delivering river rehabilitation (see Annex 4c). Discussions with those responsible for past and present river management have indicated that the majority of the river channels received dredging to increase conveyance, and in the winterbourne sections above Westbourne to flatten the bed to enable easier machine cutting of the vegetation when the channel was dry. Petts (pers. comm.) said that only the Ems main channel downstream of Westbourne Mill 'escaped' the dredging as 'they couldn't get at it for the mature trees'. A consequence of this is that this short stretch is the only section (<1km) that can be considered in any way in a semi-natural state. The majority of the river has thus been subjected to major 'ditching' to deepen and widen the river. Unlike many chalk rivers and streams, management by angling interests is non-existent as there are now no formal fishing clubs using the river (although this was not the case until c1970). Habitat modifications to enhance habitats for fisheries have not occurred to date.

To reflect the need to undertake river management sensitively, the operational staff have been issued with flood risk sensitivity maps, and guidance on how much vegetation should be cut. This was introduced in 2002, with some experimental monitoring undertaken in the Watersmeet area. In essence, a 'rough and ready risk map' is colour-coded, so that the most flood-risk areas receive a 80%/20% cut, graded to a 50%/50% cut in least sensitive areas. These maps indicate broad brush approaches to management of a reduced nature, not planned stoppage of works. Additional guidance is provided to protect areas with 'water voles' and in the Brook Meadows area the EA now works closely with the Conservation Society, who like to see the majority of in-channel reeds cut, but the banks left alone (BMCS chair, pers. comm.)

During consultation with several local residents, comments were made relating to great concerns for environmental degradation associated with regular FD management, especially in areas where no justification for the works could be seen. The same conclusions were drawn by the author for work carried out in several stretches observed from September 2005. As a result a recommended plan for FD management was prepared as part of this project, and discussed with key EA personnel early in 2007. The proposals were prepared to enable maximum 'natural recovery' but with absolutely not additional flood risk; in fact, encouraging floodplain flooding in rural areas should reduce it in the low, more vulnerable, reaches. In essence, all were supportive, and it is hoped that the recommendations, presented in Chapter 7, will be adopted in the future. However there are still others who feel more clearance should be done, so introduction of new practices would be advisably introduced in tandem with public information leaflets etc.

3.4.3 Present-day Channel Form – Habitat Character

Assessing the physical character of the river in terms of habitat quality and degradation has been done from data collected by the EA for specific reaches of the catchment (River Habitat Survey [RHS]), and by many visits to the river from Autumn 2005 to winter 2006/7. Most detailed observations were made of the river in the lower reaches. In addition to RHS data, some information on channel form is available from River Corridor Surveys (RCS); despite requests to see these, they have not been reviewed. Under the WFD (EA website) the Ems is considered to be 'at risk of failure' due not only to abstraction, but to physical degradation (see Annex 3D). It is therefore likely to be confirmed as a Heavily Modified Water Body (HMWB).

RHS is designed to enable consistent recording of river characteristics of a river reach to be given through randomly selected survey sites. These data are held on a national EA database. Only a few sites within the catchment have been surveyed. The ad hoc observations of the author provided more details for the whole river, enabling a characterization of its habitat quality and the factors affecting the physical character. The data have been lodged with the EA in Sussex Area (Annex 1), including the full photographic record taken of all sites throughout the period of investigation (Annex 5).

From RHS data two scores of 'quality' can be derived. Habitat Quality Assessment (HQA) provides an indication of the diversity and quality of river features and habitats. Habitat Modification Scores (HMS) provide an insight into the extent of channel modifications within a site surveyed. Apart from the short stretch downstream of Westbourne, physical character of each reach is HQA scores are expected to be very low, and the HMS very high, reflecting poor habitat diversity and extensive modification way from natural form.

Descriptions of channel form, habitat diversity, and degree of modification is described for the four individual reaches in Chapter 5. This enables the importance of the physical habitat within these reaches to be put into context with the other environmental factors affecting the health of rivers, namely water quality and water quantity. Data for only two sites for the Ems are held on the national RHS database, so presentation of such information is not warranted here.

3.5 Other Key Factors Affecting Ecology

The most important biological interactions affecting the natural biodiversity of the catchment are alien species that have been stocked into the river (or have colonized it by escaping from cultivation), and diseases carried by them.

One alien species has probably had a major impact on one species of the River catchment. Escapee mink have probably been responsible for all but wiping out water voles. However water vole have been periodically reported by EA staff, and members of the public, in recent years, and records are held by the Sussex BRC. BMCS regularly coordinate water vole records, and residents in Westbourne have reported the recent loss of water voles and appearance of mink.

Alien crayfish, carrying plague, have not been implicated in eradicating the native white-clawed crayfish – there is no evidence that they have ever been present in the system. Why, is unknown, as typically crayfish would be expected to be present in such a river.

For the most part, the aquatic plant communities of the catchment are only marginally affected by introduced species. Rooted aliens such as Canadian pondweeds (*Elodea canadensis)* are present, as is the floating species minute duckweed (*Lemna minuta*), but no non-native species are so common as to impact the natural aquatic flora. Bankside species such as Indian balsam (*Impatiens glandulifera*), and the even more invasive Japanese Knotweed (*Fallopia japonica*) appear to not have spread into the catchment. If confirmed, keeping it that way should be a major conservation management priority as control is usually easy at the start of their establishment, but virtually impossible after they become widespread.

At the present time the invertebrate community of the catchment contains few alien species and none appear to be impacting the natural community. However knowledge of the invertebrates is very limited, but improving greatly with recent surveys of the winterbourne sections.

Typically the largest impacts of non-native species on natural communities is in relation to fish. Some residents report knowledge of local stocking by owners in the 1960s and 70s, but nothing has been found in relation to stocking by the EA and its predecessors. None is likely to have occurred as there is no public access for angling, and no re-stocking would have been required due to fish kills if there had not been catastrophic pollution. Due to some local stocking, the likelihood of trout in the catchment being of pure *in situ* provenance is probably unlikely, but should be investigated.

Another problem unique to fish is the influence of 'at sea' problems faced by species that complete their life cycles there. Eels are impacted by factors out to sea, and this needs to be taken into account in relation to the other impact stated to be impacting eels – namely, the structures.

Catchment land-use, be it urban or agricultural, affects run-off, and therefore the river. The major direct effect influencing the habitats, plants and animals of the river is siltation, but as most flow is from groundwater, and much of the river is winterbourne, this is primarily a problem in the lower Ems. Silt finds it way into the river from a variety of sources, the prime ones in the upper catchment being cultivated land, and trampled river banks of grasslands in the floodplain. Where new urban developments take place, disturbed ground also leads to elevated silt levels in the river after rainfall (this is relatively small in relation to the catchment as a whole).

Silt can be either a positive or negative feature of rivers. If the low-flow channel is wide in relation to the low-flow discharge, silt is likely to be deposited uniformly over the bed, and smother gravels from bank to bank. Silt can considerably reduce oxygen levels in gravels below, and ultimately may lead to the demise of some animal species living there. Where the low-flow channel is narrower, silt will usually be carried away downstream, or deposited on the reedy margins where velocity is less; here silt performs a valuable role in being the building block material to create **discrete**, as opposed to blanketing, silt deposit habitats.

There are free-range piggeries on a large scale in Reach 2 that affect potential Siltation and sediment enrichment in that reach, and downstream (see pictures in Section 5) and evidence of silt in low-gradient and over-wide, over-managed, reaches. The present position of silt as a potential pollutant affecting ecology will be assessed on a reach by reach basis in Chapter 5, but it is a good example of a problem that affects flood risk management (e.g. mill heads) and therefore should be linked to a proposed Water Level Management Plan (WLMP) and is a good example of how an holistic approach to catchment management is crucial, and addressing single issues in isolation is likely to lead to little success, or be futile.

4. Information Used for Assessment of Current and Past Ecological Status

4.1 Introduction

This section outlines the main sources of information used to assess the present and past ecological status of the Ems. It sets out where raw data that are interpreted in the text can be found, as well as summarizes some key information that is of broad contextual interest for the whole of the catchment; more detailed information is given in Section 5 for individual reaches. For each assessment group, the main sources of information are listed separately in subsequent sections below.

4.2 Mammals

Assistance in gaining information on mammals was sought from Graham Roberts (GR), the Otter and Rivers officer for SE England based at Winchester. He trawled through old hunt records for both the Courtenay Tracy and Crowhurst Otter hounds who both hunted around the area of the Lavant and Ems - he found no evidence of them hunting either river. It is noteworthy that Rudkin (1984) reports an old name of a structure downstream of Broadwash Bridge known as the 'Otter Hole' – he is in no doubt these animals used to be present on the river.

Graham Roberts also reported on the three National Otter surveys, 1984-1986, 1991-1994 and 2000-2002. Within the study area there were just 25 survey sites that included both the Lavant and Ems, and all proved negative for otter.

From personal observations, GR would not consider either the Ems or Lavant as potential rivers for otter colonisation. '*They are both very small catchments, often have very little water in them (especially winterbourne sections) are very disturbed. I do not know anything about their productivity but I doubt they could ever support a resident population. As always they could form part links to more important adjoining catchments, like the rivers Arun and Western Rother to the north and the Wallington to the West.'*

Following on from his surveys of the area, it was reassuring that GR reported that water voles appeared to be hanging on well on many of the small chalk rivers and ditch systems that feed down to Pagham, Chichester and Langstone Harbours, and that the BMCS regularly monitors a population of water voles on the meadows in Emsworth. '*We also have small amounts of evidence of water voles at OR SU754071 New Brighton and GR SU766080 NE Westbourne. There use to be good populations all along the Ems and with a raising (or retention of water levels and more sympathetic bankside management, I would think we could restore them to the whole of this catchment'*.

Brian Fellows coordinates reliable sitings of water voles in the lower Ems from North Street Bridge to the Harbour. In October 2005 he reported to the BMCS that it had been a good year for water voles, with 50 sitings, and several of these being photographed (from 2nd March –30th June). The records pointed to four breeding territories in the lower Ems. In contrast in 2006 he reported only 16 sitings (April 5th – July 21st). Ominously, mink scats were observed at one location on October 17th. Whilst no other formal recording of water voles has been reported via the consultation process, several people in the Watersmeet area report having seen water voles in recent years until 2006, when none were seen but mink were.

4.3 Fish

4.3.1 EA Information

Under the Freshwater Fish Directive (from 2003 – source Defra website) the river has neither a salmonid nor cyprinid designation. Fishery surveys by the EA, and its predecessor organisations, have been carried out at several sites, but these have been very infrequent. The information has been provided through the coordination of Damon Block from the EA's Sussex Area at Worthing.

Information on fish within the Ems comes from a variety of sources. The principal one is usually through staff within the EA, but in the case of the Ems the information from the EA is very limited, and far more can be gleaned from other sources. The EA provided information on the only data on systematic fish surveys, as well as some information from observations of past and present EA staff, and data provided to the EA from members of the public. In particular, Phil Maber (previously worked for the NRA/EA covering this patch), and Paul Newman (used to live in Westbourne and now works for the EA at Winchester) have provided very useful contextual information. This report has been fortunate to derive information from many local members of the community, as well as being able to take advantage of valuable research undertaken by Dr David Solomon for the Halcrow study of the river (Halcrow; 1994) – also see Annex 3.

The location of fish surveys undertaken on the Ems by the EA is shown in Appendix 2; this shows a very limited amount of formal survey work to date. Listed below is the information from fish surveys undertaken by the EA (# signify sites that are winterbourne but were surveyed when flow was present.

	Sea Trout	**Brown Trout**	**Eel**	**Bullhead**	**Stickleback (3) Spined**	**Gobi**	**Flounder**
Lumley 2001	1	27	many	p	p	p	p
Westbourne 2001 SU75700 07800		11	63	56			
Walderton 1 – 2004#							
Walderton 2 – 2004#			1				

The most up-to-date EA document relating to fisheries was prepared by Ashworth (2004). This has more comprehensive information on invertebrates than fish, and refers to surveys covering several spring-fed rivers and habitats. Of key importance is reference to a redd survey done in January 2004 (spawning areas of trout) – many were found while walking the lower Ems (see Appendix 2 for location). The report also refers to '*No other EA reports having been found*', and so the EA database is the main source of information for fish survey data since 2000.

A 'National Fish Monitoring Sites' (NFMS) has been set up downstream of Westbourne, and surveys are expected to take place in 2007; it is also hoped that other surveys in the lower Ems, such as at Lumley and Racton Park Dell will also be undertaken. It has been recommended that the NFMS site should be within the near-natural stretch of river, perhaps c200m downstream from where the first survey was undertake.

Paul Newman reported the following when discussions were held with him.

- Southampton University undertook a study of the genetics of sea trout and for this purpose the EA undertook a specific electro-fishing exercise on the lower Ems in 2001. Several large fish were caught (sea trout), but despite efforts by the EA, the information has not been made available to report here.
- Sea trout historically have managed to migrate up the river to as far as Westbourne, and commonly used to spawn in the river from Westbourne Mill downstream.
- He reported, like Phil Maber, that the river had deteriorated in terms of a healthy fishery in the past 20 or so years.

Phil Maber has now retired and lives in the Lavant catchment. He worked on the Ems from the mid 1980s and in the early 1990s and he wrote to his boss, copied to David Solomon, lamenting the demise of the river as a fishery. This note has been converted to electronic file and is contained in Annex 3A. In essence, the note referred to an informal '*look-see*' at the fishery through electro-fishing four sites informally in 1993 (i.e. not a formal NRA survey). The following is the gist of his note:

- *The Ems has deteriorated very significantly. Principal causes being drought; and over abstraction (compensation flow via six inch pipe accounting for virtually all the water for long periods). The new A27 road works have destroyed a significant potential. The various courses of the river, and numerous conflicting private riparian aspirations are a nightmare to any constructive management. Many other problems of obstruction and development exist.*

- *Bearing in mind that not one suitable site could be found for a fish survey in Summer due to low flow, and being overgrown - including duckweed; To-day's findings were extremely pleasing and reassuring of natures' ability to come back '! Remember also specimen roach population u/s Lumley Mill (lower watercourse.) 1975.*

- ***First Site : East branch Just upstream of Peter Pond : approx SU 752-061*** *Alongside Lumley Road. Found: small trout in VGC in fair number. Migratory fish can enter this stream with difficulty, via the Slipper Mill gate (at high Spring tide), then through Peter Pond. Access further up the stream is blocked by renovated private gates of "Constant Springs"; although a leat off another arm of the water course allows some potential for U/S migration under high flow conditions. Slipper Mill Pond is owned by a consortium of residents, and managed as a nature reserve. It is occasionally drained for management, when Salmon have been found. It is said to be a very unusual semi brackish habitat, with very rare tubeworms and other fauna. Peter Pond is Managed by Chichester Harbour Wildfowlers as a nature reserve. Several locals remember large numbers of salmon and some sea trout (splashing heard all night) before the War. Up to a few years ago sea trout frequently spawned in "Constant Springs" garden - which route these fish took is unclear. Mrs. Mitchell owner. Small flounders also been reported seen in the stream.*

- ***Second Site : on the main river Car park up to Gasometer area. SU 750-060*** *Found: small trout VGC, numbers better than expected. Migratory fish severe difficulty in reaching this area. Some years ago the water course was re-routed away from the Flour Mill (severe hydraulic problems with the structure!). The "new" route into Dolphin Quay is wholly unsuitable in construction and is necessarily screened - NRA maintain. This "new" route is currently being partially re-routed again. Structural information suggests that historical passage of fish (via the Flour mill) would have been virtually impossible. I believe Sea Trout were spawning in this general area up to around 10 years ago.*

- ***Third site : Hampshire Farm - Weir fish pass and upstream. SU 755-074.*** *Found: Good number of trout - rather on small side, VGC. one pike approx 1.25 lbs. The construction of the fish pass is praiseworthy.*

- ***Fourth site : U/S of Watersmeet - below compensation water outlet. SU 762-079.*** *Found: No fish even though water deep in "Canal" section. There was a trout mortality downstream of "Watersmeet" in recent years caused by drought, but I had hoped to find some fish in this deeper haven area. The bifurcated "Canal" watercourse is manually kept open by pulling rushes.*

- ***Conclusions*** *This wet Autumn has given the River Ems a reprieve, Probably 95% of the historic fishery potential is lost - much of it unretrievably so. The remnants are barely hanging on; although in much better shape than might have been expected.*

4.3.2 Information from Local People

In the course of the study several local people provided information regarding fish in the Ems, both contemporary and historical.

- Mr LaFosse (resident at Lumley Mill for many years) reported that the owners of the land to the north, stretching from Lumley Mill to Hampshire Bridge (Everall) used to allow two gentlemen from London to fish the river through his land. He used to have the river electro-fished in the 1980s, and sold the coarse fish and returned the trout. It is said the waters were a prolific natural trout breeding stretch. They reported a reduction in fish in 2006, as did Mr Shannon (living close to the Westbourne gauge) who reported trout of 20-30cm were normally a common site in his stretch, with especially large and numerous ones present following the high discharges of a few years ago.

- Discussions with members of the BMCS (e.g. Mr Portwin) confirmed that occasionally salmon have been found in Slipper Pond when it has been drained, but never reported to have ascended into the freshwater stretches of the Ems. This has been confirmed by some file notes held by the EA.
- Mr Henry Denham, who has operated the sluices affected water levels upstream of Lumley Mill since c1978, reports also that the stretch was good for trout, but was not aware of any angling.
- Mr Nick Rule, whose family have lived in Westbourne Mill for well over 50 years, reported the following fish as being present in the mill pond upstream in abundance up to the last c25 years: sea trout, trout, Bullhead, eel, stickleback and roach. In the past 25 years periods of very low flow result in mill pond being reduced to a puddle, and all but the minor fish (e.g. Bullhead in the wet mud) have to recolonize from the canal, or from downstream. Up to the 1960s and 70s the mill pond had never dried (Nick Rule was born there in 1958) and it '*was full of weed, and when dragged out it would drip with small fish and fry'*. Mrs Rule, Nick's mother, reported an abundance of Roach prior to the 1960s. There was also an abundance of naturally recruiting brown trout (her husband had intended to stock but did not need to), and was constantly having major problems with illegal angling.
- Mr and Mrs Pearson of Ford Villas in Westbourne report that prior to, and for many years after the war, trout bred in profusion, and often the shallow stretch of river upstream of watersmeet was 'black with the abundance of trout'.
- Sydney Morgan, aged 94, reported abundant sea trout in the river up until the 60s, with poaching common as they tried to ascend the sluice at Aldsworth Pond.
- Jane Glue, of Mitchmere (upstream Walderton) reported that as a child in the 1960s she used to catch fish (including eels) and keep them as pets – she was certain they were trout, and from her descriptions, they were.
- Independently, David Todd of Westbourne (aged 62), said he regularly 'tickled trout' in the river as far upstream as Mitchamer Pond. He confirmed runs of sea trout to Aldsworth Pond were common, and in good flow years sea trout and trout bred in stretches that are predominantly dry now.
- PWL files have several references (see Annex 3B) to large trout being caught in Lordington Pond, and several letters to Dr Forrest, Queen Mary College, London, to under-play the importance of the Ems as a fishery leading up to the Public Inquiry in 1961.

4.3.3 Information from Literature

The most useful document in the literature is the section written by David Solomon in the Halcrow (1994) report. In this he summarized all information on the Ems/Lavant that could be gleaned from the literature, and other information provided to him through the NRA. Some key information from his report is summarized below.

- "*Ems rises above Racton, where is good trouting, but preserved:*" (Where to Fish, 1928).
- "*....on the River Ems, the fishing appears to be preserved and the fishing rights let and for this purpose there are small dams and other obstructions to hold up the water....*" (Letter from Clerk of the South West Sussex Rivers Catchment Board to MAP, December 1940, held at County Records Office).

- "*....The canal on the Stansted Estate from which trout up to 4 lbs are taken...... A pool above Stansted in a few hours produced eleven and a half brace from 3/4 lb to 3 lb, taken by the writer....*" (GF Salter, writing in the Victorian County History of Sussex, 1973).
- Trout are known to have survived in the lower river until recent years (*as they still do*).
- It is likely that the Ems naturally held brown trout, eels, and a range of small fish species such as bullheads and minnows. However, for well over 100 years the river has been extensively managed as a trout fishery, which is likely to have involved some restocking. Although their original purpose is obscure, Aldsworth Pond and Brickkiln Pond are likely to have been stocked and fished. Several retaining weirs on the Aldsworth Stream downstream of the pond, and an impoundment known as Lords fish pond on the Ems itself, were apparently created specifically for fishing. The Canal and the Mill ponds also held good fish, as well as the stream itself in its lower reaches.
- Although Brickkiln ponds appear not to dry-out completely (Rudkin 1984), and the Canal is now protected by the discharge of a "compensation flow" at times of low natural flow, the other locations mentioned above have dried out in recent years. While there are likely to be small numbers of trout remaining in the lower reaches, few would appear upstream of Westbourne Mill Pond and the Canal.
- Problems with low flows affecting fishing are not an entirely new phenomenon, however"*Both streams were formerly more considerable than at present. Old people can remember trout-fishing where there is now only rain water-shed in winter. This change has, in part, been brought about by drainage.*"
- Roach occur in fair numbers in the Westbourne-Lumley area of the river, but their origin is unknown.

Rudkin (1984) reported that Southern Anglers fished the Lords fish pond (Racton Park Dell) and undertook remedial works to the dam in 1970 (soon after license to abstract more water granted). All efforts to track down members of the club, or records of their activities, have failed.

From various disparate sources, therefore, it can be concluded that the recent data from EA fish surveys is not reflective of a much richer community that existed historically. The level of survey detail is, at present, also limited, and almost certainly does not reflect the level of extant interest. Historical records exist for several fish not recorded recently; knowledge of whether these are still 'hanging on', or have been lost due to the combined effects of natural droughts, exacerbated by abstraction, in the past few decades is not known, but should be determined. For fish, sustaining a flow by augmentation may be extremely important.

4.4 Invertebrates

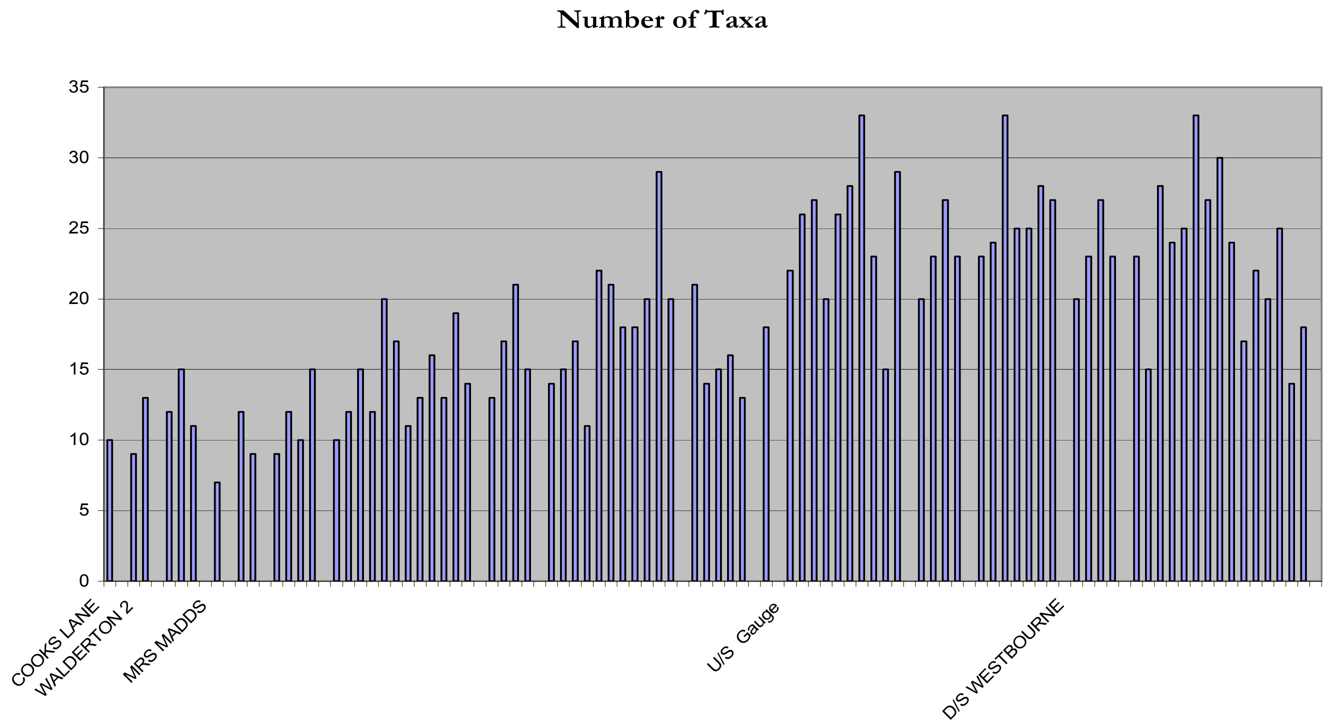
The EA through its staff, databases and reports has been the prime provider of data on invertebrates. Little else exists except from ad hoc surveys and observations of rare taxa that are provided to the Sussex BRC.

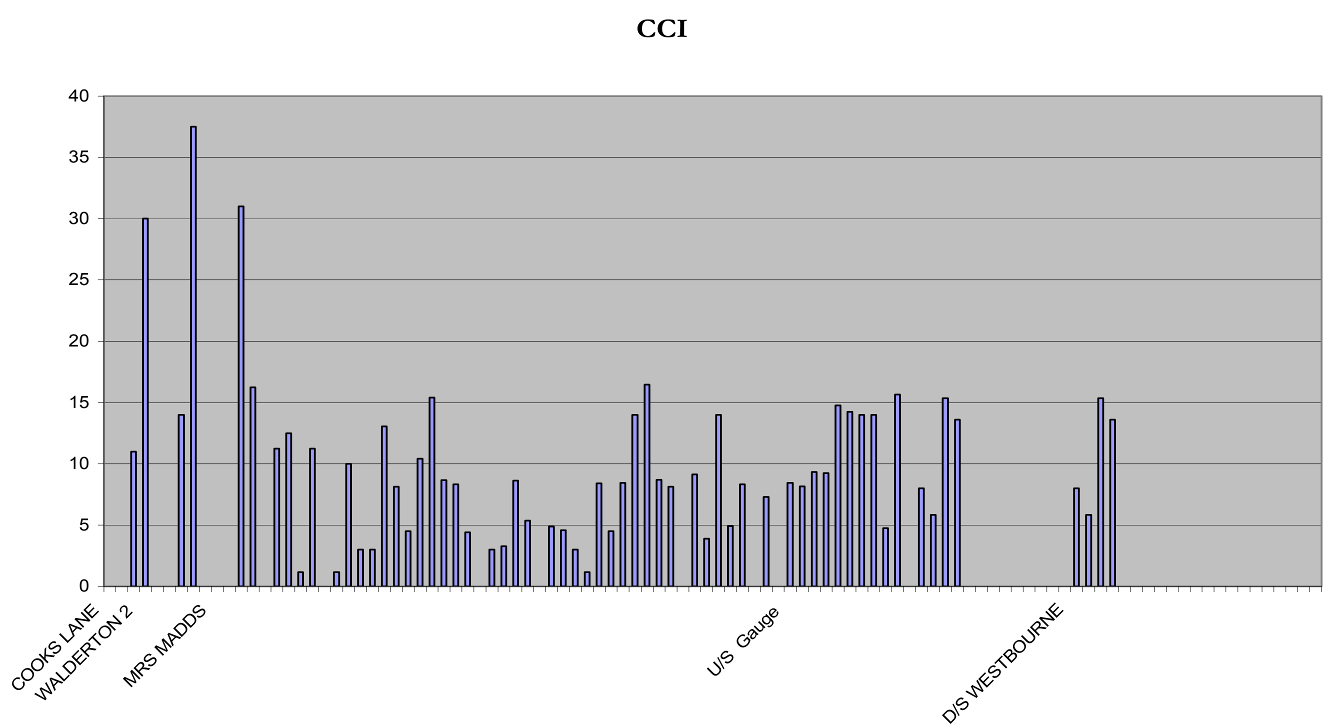
Maps in Appendix 2 show the location of EA invertebrate survey sites for which data have been provided for the investigation. Annex 4A contains a summary of the raw data from the surveys in excel spreadsheets. In addition to these surveys, the EA undertook invertebrate sampling prior to, and after, channel vegetation management at four sites in 2003 and 2004.

Due to the paucity of data until the past seven years there are few reports to draw useful text that summarize the overall character of the invertebrate communities of the river.

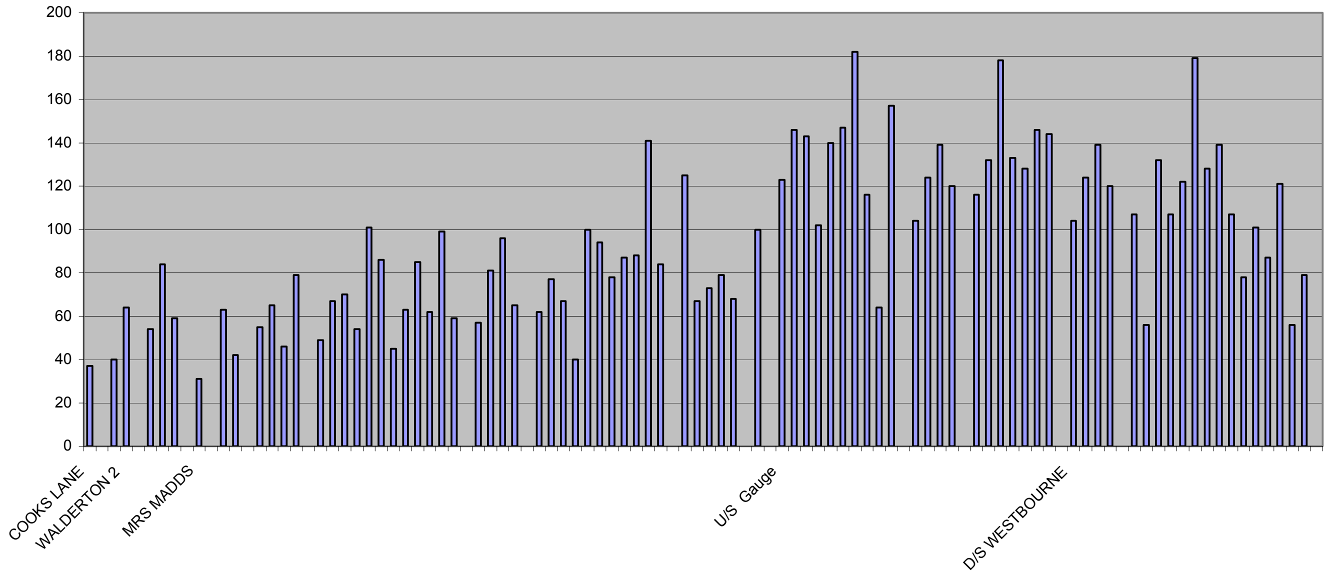
Using standard EA assessment methods applied to collected data, it is possible to describe the 'quality' of the invertebrate communities found during sampling. The typical ones that are used for water quality and general assessment are Average Score Per Taxon (ASPT) and Biological Monitoring Working Party (BMWP) scores. These are given in Figure 4.4a alongside two others: The diversity of taxa, and a relatively new score - The Community Conservation Index – CCI; (Chadd & Extence, 2004) This is an index derived from the conservation status of the individual invertebrate species that are collected in a sample and provides a comparative measure of conservation value between sampling locations, and takes account of taxa that are less numerous and may also not be particularly useful in water quality monitoring. A score of over 15 is considered 'good'.

Figure 4.4a Summary of four scoring/assessment methods applied to EA invertebrate date – some ICC scores for downstream sites have not been calculated. Charts show sites from upstream (left) to downstream (right)





BMWP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COOKS LANE
WALDERTON 2
MRS MADDS
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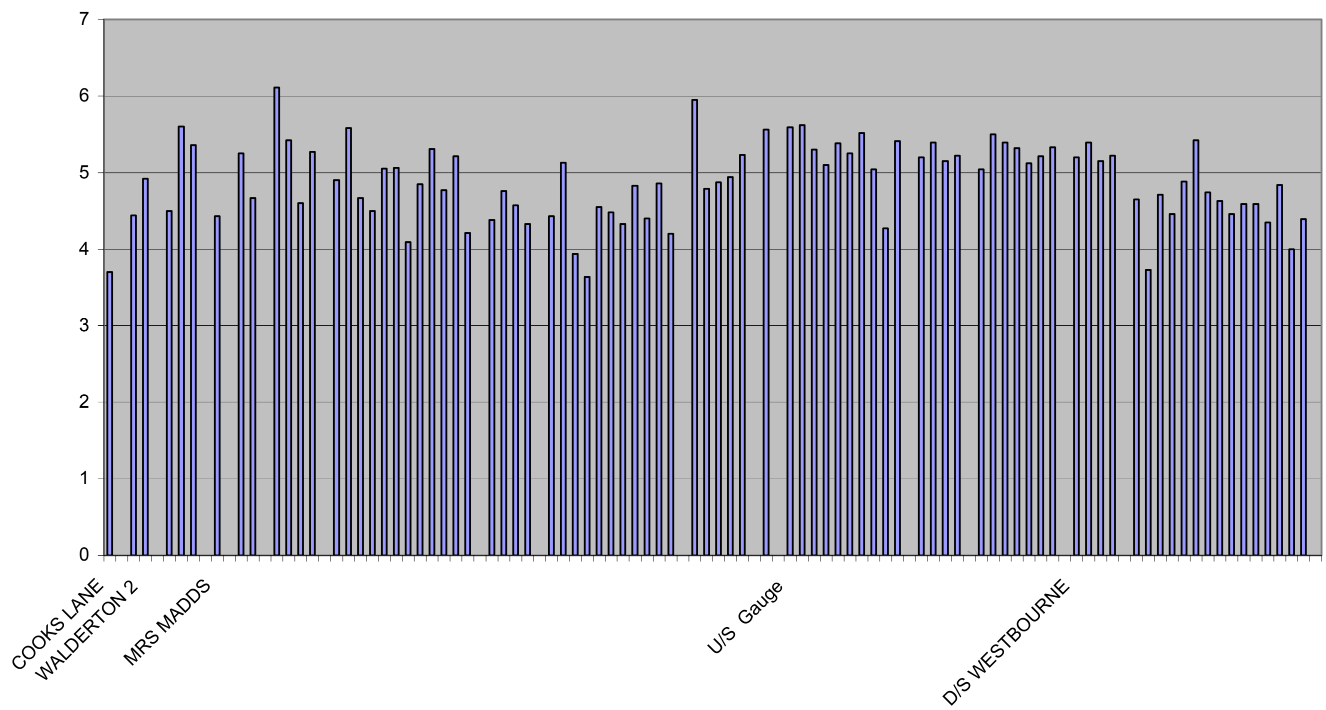
D/S WESTBOURNE

ASPT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WALDERTON 2
MRS MADDS
U/S Gauge
D/S WESTBOURNE

4.4 Macrophytes

The main source of information on macrophytes has been determined by surveys carried out by the author of this report; surveys have been carried out at seven sites five times from September 2005 to May 2007. Four additional sites have been surveyed in 2006 and 2007 to add to the coverage of data. Details of the survey data, and the location of the survey sites, are given in Annex 2 and Appendix 2 respectively. There is also some minor information held on RCS maps, observations made by the EA staff when undertaking invertebrate sampling (this information can be found in Annex 2), and a one-off survey programme in the Watersmeet area associated with an experimental weed cut there in 2002/3; none of these data sources add anything to the more comprehensive survey programme carried out from 2005-7.

The survey method used in 2005-7 was the dedicated EA Mean Trophic Rank (MTR) system (Holmes *et al.* 1999). This system requires taxa found on the river bed within 100m long stretches to be recorded using a nine-point scale. It was devised primarily for monitoring water quality, and normally is based primarily on recording a set suite of taxa on a check-list. Because the majority of the Ems is a winterbourne this taxa list was inappropriate, so all taxa that have any close affinity to water or wetlands were recorded, and other taxa noted as 'non-aquatic' grasses or herbs. Calculation of MTR scores to indicate water quality was therefore not possible, nor appropriate, for the majority of sites.

More details of the characteristic features of the flora are given in separate sections in Chapter 5, but a brief summary is given below. As an experiment, based on a modification of Ellenberg numbers (numbers given to taxa according to their association/requirements for aquatic/wetland/dry conditions – Ellenberg 1992), the data from the September 2005 to September 2006 surveys have been summarized in Figure 4.4a. The figure shows how dramatically different the flora is in different sections of the river.

- Upstream of Broadwash the flora is predominantly a dry land community, with 'wetland' taxa such as Hemlock Water-dropwort, Reed Canary-grass, Water-mint, Fool's Water-cress etc. that can grow in either dry or wet conditions, or complete their life cycle while there is temporary water. The community is more reflective of dry conditions on passing upstream apart from one location – Racton Farm Pond; here water is held for longer and a much richer community of classic winterbourne taxa are present that act as annuals and thrive only when there is water – *Ranunculus peltatus & Veronica anagallis-aquatica* being the classic examples.

- At Broadwash the community rapidly changes from being a typical one of an irregularly flowing winterbourne to one of near perennial flow at Racton Park Dell. The presence of taxa such as *Berula erecta, Ranunculus penicillatus* subsp. *pseudofluitans & Callitriche obtusangula* are indicative of perennial flow of chalk streams (Maidstone, 1999), even though flow fails periodically in dry years. The presence of these taxa is strongly indicative of flow historically having been perennial.

- At the 'Canal' reach, and a little upstream, the rare liverwort *Ricciocarpus* is present.

- Much of the stream channel of the Aldsworth stream downstream of the Aldsworth pond contains *Berula* - this suggests historic perennial flow that is again now known to fail regularly.

- The lower reach downstream of Westbourne mill has a flora indicative of perennial flow in a chalk stream.

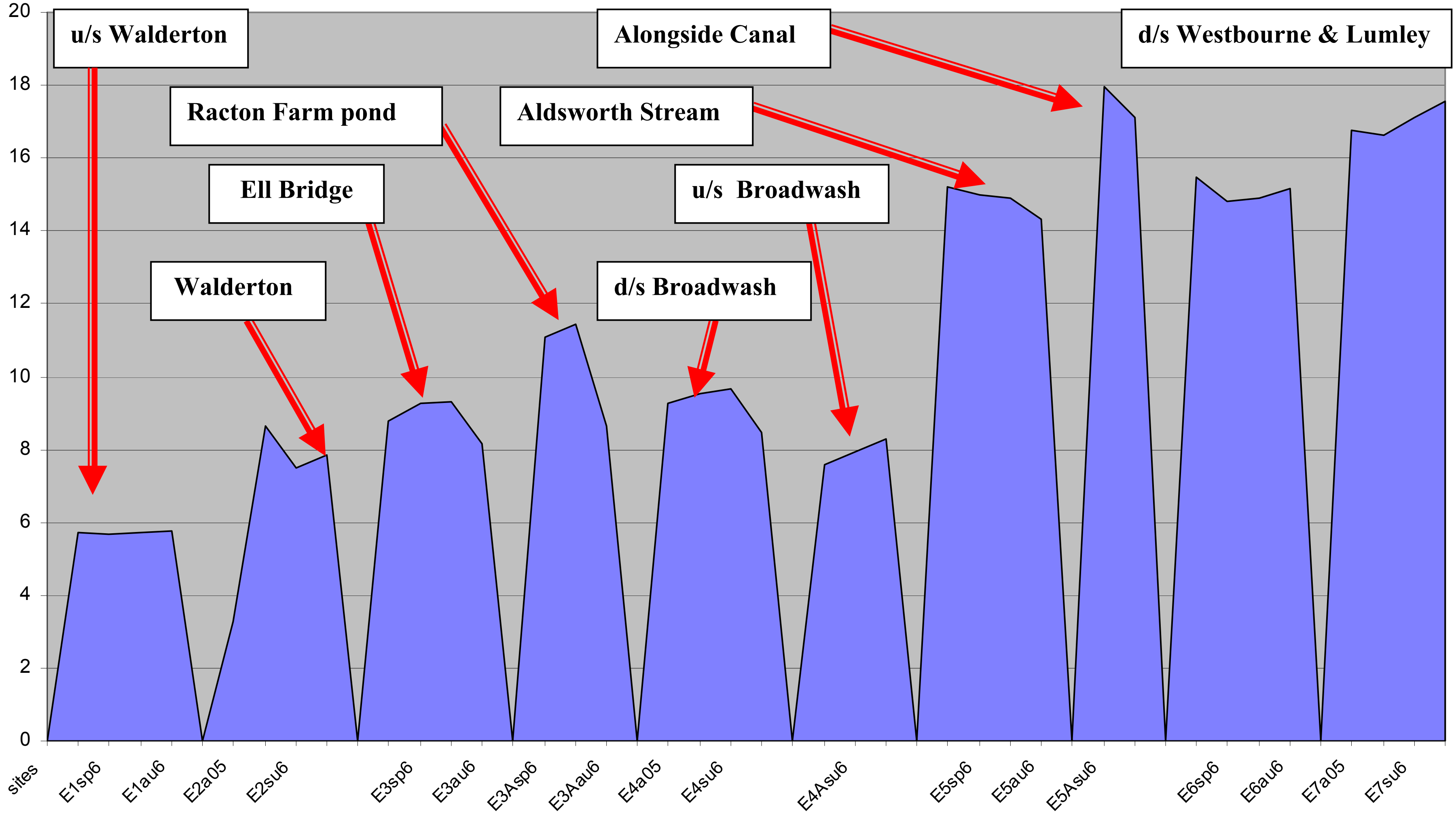

FIGURE 4.4A INDICATION OF DEGREE OF RELIABLE FLOW AS SHOWN BY FLORA – MODIFIED ELLENBERG SCORES WITH LOW SCORES RESULTING FROM A PREDOMINANCE OF DRY LAND TAXA, AND HIGH SCORES INDICATIVE OF COMMUNITIES DOMINATED BY AQUATIC TAXA.

4.5 Habitats and Habitat Quality

The EA holds data on habitat surveys of rivers using the River Habitat Survey (RHS) method. Summary RHS data from 1994 (data held by EA, Warrington) have been provided to the author for three sites on their database Box 4.5A below. Charlotte Murray undertook some further surveys in 2006, but these data have not been entered on to the database and so cannot be reported on here. To the author's knowledge, no other RHS data exist for the catchment.

Box 4.5A EA RHS Site Details

Survey Id (Survey)	Site Id (Site)	NGR Site	Year of Survey Date (Survey)	River (Site)
11075	6766	SU7540007300	1995	EMS
11076	6767	SU7550007100	1995	EMS
30706	17180	SU7940710841	2004	EMS

Raw data provided by the EA confirmed that the degree of channel modification is high in the catchment, and the habitat quality is low. RHS has two indices to describe habitat simply: habitat modification scores (HMS – five bands, with 5 the worst) and habitat quality scores (HQA – five bands also). The three sites on the HMS all had a HMS of 5, putting them in the most heavily physically modified rivers in the country. HQA scores were moderate in two sites (i.e. some habitat diversity despite being heavily modified - mainly due to habitat provided by bankside trees etc.) and the remaining one was in the worst band.

The author also walked much of the river and would add the following comments in relation to habitat quality.

- Reach 1 is primarily a roadside ditch or an open, wide, and wholly modified channel that has minimal habitat structure except locally where it has sharp bends and shoals of gravel have been thrown up on the inside, and a steep or vertical cliff may be present on the outside of the bend.

- Reach 2 starts as above, then it flows thorough a fabulous wetland habitat, albeit not pristine; this area would add to the RHS HQA but the river channel itself is modified, and in one place forms a major pond. From here it is over wide and shallow, before flowing partially in a pond 'canal' or a ditch running alongside (the 'Main River' to north).

- Reach 3 – starts as small lakes that never fail to have water – the edges have naturally infilled over the generations so the area of open water has been reduced. The river then forms a small ditch, then a periodic pond (used not to be, or only very very rarely would dry). On its passage to merge with the Ems it is first a ruler-straight ditch, with gravel associated with cress, then becomes another pond before a stretch of shallow water running alongside the road.

- Reach 4 has massively changed over the decades, and is very impounded almost throughout (ref Rudkin; 1984). From starting as the mill head for Westbourne Mill, it then passes through gardens etc. before flowing through open grassland for almost 1km – the only stretch that would have respectable HMS and HQA scores if RHS was carried out. Small weirs detract from the potential for several hundred metres of good quality chalk stream to develop upstream of Lumley. Beyond the A27 dual carriageway the river is impounded, as it is in several other locations. The presence of structures to control water level not only act as barriers to migration, but fundamentally alter the habitat character of the river. Within Brook Meadows a short stretch shows some semblance of recovery from past over-deepening and widening.

4.6 Biodiversity Action Plan and Red Data Book Species

Through arrangements the EA has with the Sussex Biodiversity Records Centre (SBRC) at the Sussex Wildlife Trust, information on Rare or Protected species, BAP species, designated sites (international, national, county) plus maps of habitat types and land-use have been provide to Charlotte Murray. A summary of the key listings are given in Annex 3, but the reader is referred to the original report held by the EA at Worthing. The search was limited to upstream of the estuary/harbour SSSI and SAC.

Whilst the SBRC report provided data for rare taxa as well as habitats of major significance – primarily Sites of Nature Conservation Importance (SNCIs), it is important to stress the importance of such designations, as well as non-designated habitats of high ecological quality. The SNCIs have been designated following county-wide surveys and assessment by a panel of experts; however some habitats of high ecological value may have been missed. Whilst none have statutory protection, under Planning Policy Guidance like PPS9 they are required to be considered in the planning process; **hence the importance of this project in providing independent information on status to support authorities and developers**. There is now a requirement that nature conservation issues be included in planning searches to ensure plans are based on information about habitats and species not just associated with designated sites (see Introduction and Defra 2007).

The SNCI and locally important habitat sites within the catchment are shown in a figure in Appendix 2. The SBRC report says otters have been recorded in 'all Sussex catchments' in the last few years, but provides no records for the Ems. Graham Roberts confirms there have been no recent signs. Listed below is information for rare taxa recorded for the Ems catchment provided by the SBRC.

Sussex rare Species Inventory (excluded Slipper Pond)					
Latin name	Common name	Grid ref	Recorder	Date	Location
Ricciocarpus natans	liverwort	SU762078	SAMLL	1992	Ems
Pilularia globulifera	Pillwort	SU7507	F H Arnold	1901	Westbourne common
Galium uliginosum	Fen Bedstraw	SU764079 SU764089	F Abraham G Roberts	2001 1990?	Westbourne Meadow east of Aldsworth
Segmentina nitida	Shining Ram's-horn snail	SU763088	M Palmer	1984	Aldsworth Pond
Orthotrichum cancellatum	Black-tailed Skimmer	SU764079	G Roberts	1991	R Ems & Meadows Westbourne
Sympetrum sanguineum	Ruddy Darter	several	G Roberts	1991	Aldsworth & Ems & meadows Westbourne
Arvicola terrestris	WCA Sch 9 Water Vole	SU7506 SU759080	Brian Fellows Paul Smith	2002 2001	Ems, Brook Meadows, Southbourne CP Westbourne

- Aldsworth Pond is noted for being important for many aquatic invertebrates, in addition to the above: *Helochares lividus & Enochrus melanocephalus* – water beetles.
- The Ems and Meadows at Westbourne has records for a rare water beetle - *Riolus cupreus*.
- Water voles are mentioned – but data from the BMCS reported elsewhere in this report supercedes the records held by the SBRC.
- It should be noted that recent surveys by a university highlight taxa of note not identified as present on the SBRC database from the Brook Meadows Area – these were not true aquatic taxa.

Maps in the area of search provided by the SBRC show:

- no SSSIs covering the freshwater river courses or immediate adjacent land;
- like the Lavant, upper catchment from Racton Monument area is ESA and AONB;
- Several SNCIs….relevant wetland and aquatics are C102 – Slipper Mill and Peter Ponds (saline); C22 river valley east and north of Westbourne (reach 2), and C02 & C86 on the Aldsworth arm (reach 3);
- Important habitat, but not SNCI, straddling the A27 - grazing marsh.

The SRBC report also refers to British Trust for Ornithology (BTO) sites: named as 'Aldsworth Pond Area, Westbourne' 4-76-8-76!! SU760087/…… 'This site is among the best areas for breeding birds in W Sussex'. Site contains SNCI C2, C22, c85 and part of c24.

The whole of the Ems system, being fed by springs from the chalk, is a Biodiversity Action Plan (BAP) priority habitat; this, most importantly, includes not only the perennial sections, but the intermittently-flowing headwaters too.

5. Reach Characterisation and Environmental Quality Assessment of the Ems

5.1 Introduction

The proceeding sections have been produced in a standard reporting format described below.

- Citation and interpretation of information sources for each of the five assessment categories, made in the following order of priority: i) dedicated surveys; ii) relevant references; iii) EA reported information; iv) anecdotal information and observations provided through the consultation/data gathering exercise; v) personal observations/records/surveys of the author.
- Status of interest, reported on a scale of 1-5 – High (H), Good (G), Moderate (M) Poor (P), Bad (B) (necessarily qualitative but with structured reasoning). Where the status of the interest is not known, this is coded as N/K.
- Assessment of how different the ecology is now from what it is concluded to have been c50 years ago.
- The main factors, listed in Box 5.1a, (**not necessarily impacts**) affecting the present-day status are given on a scale of 1-5: 1 = No, or minimal influence; 2 = minor influence; 3 = moderate/supporting influence; 4 = major influence; 5 = key factor; N/K or N/R indicate either not known, or not relevant. In some cases they are not objective judgements, but are based on interpretation of the available data, and the combined assessments of the author and the expert opinions sought.

Box 5.1a The main factors assessed for each reach in terms of their possible influence on the present-day ecological status

FACTORS	DESCRIPTION
Historic changes to channel	The probable influence that present-day channel alignment, depth, width changes (departure from 'natural') has on ecology
Flood Defence management	The perceived/reported/observed influence that flood defence channel management has on affecting habitat, and therefore river plants and animals
Siltation	The perceived/reported/observed effects of siltation on river habitat, and therefore river plants and animals (effects may be indirect by affecting other interests)
Natural flow character	The perceived/reported/observed effects of natural flow characterizing each reach, and the influence on river plant and animal communities
Abstraction-induced low flows	The perceived/reported/extrapolated effects of abstraction on river flows, and therefore river plants and animals
Present/recent water quality	The measured water quality parameters and the probable influence on river plants and animals based on change from historical quality
Historic pollution	Reported/inferred historic pollution, and potential impact on plants and animals
Alien species	The potential effects of alien species on river plants and animals
Catchment/floodplain Land-use	The perceived/reported/observed effects of catchment land-use on river habitat, and therefore river plants and animals
Other	Specific factors affecting individual groups, but not others

In each of the summary tables, where status of interests are assessed as being affected greatly, colour coding has been added - 3 = moderate/supporting influence; 4 = major influence; 5 = key influencing factor. In all tables the importance of **natural** flow characteristics shaping the plant and animal communities is highlighted as **RED** because it is so critical, but to reflect the influence is **natural,** the code number 5 is shown in blue**.**

5.2 Ems Reach 1 - Source to Broadwash Bridge

5.2.1 General Description

The upper reach of the Ems (1) flows from its source near Stoughton to Broadwash Bridge (Common Road) – **see Figure 5.2a at the end of this section showing locations within the Reach cited in this document**. This reach is now a winterbourne (flows only when the water-table is high) and there is no evidence to suggest it has not always behaved in this way. From its source above Stoughton it flows to Walderton, flowing via Mitchamer Pond. Rudkin (1984) has photos of the pond full of water, but acknowledges it dries; in January 2007 it had re-filled after being dry for several years. At Walderton groundwater abstraction has occurred since 1962/3 and potentially could have an influence on the physical character of the river (e.g. Ian Briffett reports bed dry for longer, and the terrestrial vegetation traps silt).

From Stoughton to Broadwash Bridge the Ems flows in a predominantly rural landscape with just isolated properties and the hamlets of Stoughton and Walderton. Despite this, the stream has been modified to form a relatively uniform channel to convey flows when they are present; for the most part the channel has a uniform cross section with minimal habitat diversity – local variation was rare and most evident just at the downstream end of the reach (see Figure 5.2b).

Walderton public water supply station was constructed in 1963 by PWL to enable the licensed 2mgd to be abstracted; in 1968 the license allowed an average daily abstraction of 6mgd (max in a day of 8mgd) to be extracted from three boreholes 400 feet down.

Rudkin (1984) concluded that at Lordington the first of five mills was located here (to mill corn). It is clear this could have only operated seasonally. Downstream of here the majority of the floodplain is grassland (Racton) before arable is present near Ell Bridge; the name is thought to be derived from 'eel', as so many locals recall eels were common in the river here, and especially at Walderton.

For the whole reach data on ecology, and even flow or water quality are extremely limited. Ecological surveys appear only to have taken place in recent years, and most are only undertaken when there is flow in the river. Maps showing the locations of where specific survey information has been obtained for fish, macrophytes or invertebrates, are shown in Appendix 2.

5.2.2 Ecological Status and Key Factors Affecting it

5.2.2.1 Mammals

No information. Otter and water vole may never have been present here, but we have no information to support or refute this. This is the only reach on the Ems catchment where no records for water voles exist. Assumed natural and no anthropogenic impacts of significance.

5.2.2.2 Fish

There is very limited information for this reach as no surveys have been carried out by the EA other than one ad hoc investigation at Walderton when there was flow in the river. Migratory eels have been reported to have once been common, and Rudkin mentions that the derivation of Ell Bridge could have come from the common occurrence of eels here. The Halcrow (1994) report, reviewing old literature, identifies that *"trout were not an uncommon site many decades ago; today it is a very rare occurrence as far as is known"*. Further research during this study supports this. Non-migratory fish could not be sustained now, nor probably would have been able to do so in the past, due to drying of the reach, and so re-establishment would be needed from downstream perennial parts. Trout were often caught at Lordington Pond (see Annex 4B) and Mrs Glue reported that in the 1960s eels were common at Mitchamer Pond – as were trout, toads, frogs and newts – all indicative of a seasonal pond that regularly filled, and was connected to perennial water downstream. Mr Todd's information on catching trout here up to the 1960s is also corroborative.

The assessment of the fish interest within this reach is one that is considered to have been significantly altered by perceived (almost certain) reductions of reliable flows, but the impact on the integrity of the relatively transitory community MAY be of less importance than elsewhere. It is not known if there has ever been a sustained use of this reach that has significance for the population in the river as a whole (except eel and use by migratory trout - possibly both sea and brown). The inability of fish such as bullhead or stickleback to migrate long distances following periods of no flow suggests this stretch has never been important for 'minor' fish species.

5.2.2.3 Invertebrates

Only recently have invertebrate surveys been carried out by the EA – before 2000 no information at all was available for the reach. Due to the regular, and often long, periods of no flow, it would only be expected to support winterbourne taxa – many with high Invertebrate Conservation Indices (Chadd & Extence, 2004) that are often specialist colonizers, and nationally uncommon. Reference to the species recorded by the EA in recent surveys does indeed reveal a high number of taxa indicative of intermittent, not perennial flows (e.g. *Agabus, Nemoura cinerea, Anisus leucostoma, Isoperla grammatica*). Several are nationally uncommon, giving the community an important conservation interest. The community is similar to invertebrates recorded from winterbourne in Wessex (Neil Punchard; pers. comm.). The conservation index for this reach is by far the highest of the reaches (see Figure 4.4a). The classic winterbourne community that existed decades ago has probably not been lost, but its extent will periodically be reduced due to the likely reduction in flow (periods without flow will have increased due to the abstraction) throughout the entire reach.

The conservation interest for invertebrates may therefore not have been impacted by abstraction – perhaps the greatest effect on invertebrates of the river will have been from historic changes to the river's physical form, changing from rivulets and micro-habitats to uniform drainage channels

5.2.2.4 Macrophytes

No information for macrophytes is available save for 2005-7 surveys of the author, and ad hoc observations from: a) EA biologists when doing invertebrate surveys in recent years; b) RCS surveyors. The recorded flora reflects a classic winterbourne character, with downstream progression from upstream of Walderton (where the flora is primarily terrestrial) to mixed wetland and annual aquatic taxa closer to Broadwash. Racton Farm pond, close to the road, is a backwater with a back-channel spring feed that appears to hold water longer than the rest of the reach, and has an interesting winterbourne flora with abundant crowfoot (macrophyte site 3A – see Annex 2). As with the invertebrates, surveying the river at different seasons and in different years will provide vastly contrasting taxa lists. Again, the conclusion is that winterbourne macrophytes will not have been lost from the reach, but non-natural, not-aquatic, taxa are likely to colonize far more of the river bed on a regular basis than probably previously occurred.

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5.2.2.5 River Habitat (Morphology)

The river has had historic modifications to enable enhanced drainage of the adjacent land – to this end the river has been changed to a ditch character for the majority of its length upstream of Racton Park pond. Downstream, the river has a well defined course in open farmland where it has been deepened and widened, and has few fluvial features such as cliffs, pools etc. Therefore using the standard RHS scoring systems, it would have a very low HQA scores (indicating limited habitat diversity) and high HMS (indicating high degree of modification). For character, see pictures in Figure 5.2a.

Historically the channel would have been a series of shallow, spring-fed, rivulets in woodland, with a wealth of microhabitats. Changes occurred not decades, but millennia, ago to create a very uniform channel where habitat degradation is significant.

There are no habitats highlighted in the SBRC report as SNCIs, or records for rare taxa. Observations during the study suggest that the pond backwater on a secondary channel at Racton Farm could be potentially important for sustaining winterbourne macrophyte species and probably supports rare invertebrates.

5.2.2.6 Ecological Status & Key Factors Affecting the Ecology in Reach 1 - Upper Ems

Box 5.2a summarizes the key factors assessed as affecting the different ecological elements of the reach. Overall, historic channel modifications will have been significant, but the natural flow regime is the most critical factor shaping the present and past ecological character of the reach.

The dominant influence on the ecology of this reach is considered to be the natural intermittent nature of flow, and for this reason, many of the factors affecting ecology noted in the table above are entered as '1' (Minor) or 'Not Relevant'. Whilst this might have changed within the past 40 years due to abstraction, there is the great probability that these changes have had no material effect on the majority of the ecology compared with natural extreme drought events. Even the major channel modifications for flood conveyance have had much less effect as the habitat is effectively an alternating terrestrial and wet habitat (and the channel is still open – not culverted). It therefore is concluded that the reach has never, at least in the past 100 years, ever supported, on a permanent basis, the ecological characteristics of a permanently flowing river. It may periodically have, as it does now, acted in a supporting role to the stretches downstream. The fact that the reach is a winterbourne naturally does not infer any less ecological importance than if it was a perennial stream; it is a different habitat and one that has probably been less seriously affected by abstraction causing a reduction in flow periodicity.

Siltation has the potential to cause problems in both a direct and indirect way. The photos show that siltation from heavily trampled land can find its way into the river, and Briffet (pers. comm.) has noted that during long dry periods grass and other terrestrial vegetation binds this to the bed and enhances their own growth. By being more established, when flow does return, dislodging them might take longer, and so the recovery of the winterbourne species may take longer. The reduced area of seasonal clean gravel would affect macrophytes and invertebrates.

Box 5.2a Summary of the key factors assessed as affecting the different ecological elements of reach 1 – the Upper Ems

FACTORS\Assessment GROUP	Mammals	Fish	Invertebrates	Macrophytes	Habitat
PRESENT STATUS	N/K	B	G	G	P
Factors Considered to Affect Status					
Historic changes to channel	1	2	2	2	5
(Flood Defence) management	1	1	1	1	1
Siltation	1	1	2	2	2
Natural flow character	5	5	5	5	5
Abstraction-induced low flows	1	4	2	2	2
Present/recent poor water quality	1	1	1	1	N/R
Historic pollution	1	1	1	1	N/R
Alien species	1	1	1	1	N/R
Catchment/floodplain Land-use	1	1	2	2	1


Close to the source – Mitchamer Pond – with rare occurrence of water, April 2007


Meadows d/s Mitchamer – again rare occurrence of water; Jane Glue says pre-60s water was common through most summers


u/s Walderton – dry ditch for most of the time


u/s Walderton as top left – water for <3 months 2006/7 (photo Feb 2007)


The Walderton Public Water supply abstraction site


The Ems adjacent to the Walderton PWS site – typically dry most of year

Despite no flow for long periods at Walderton – serious flooding of roads sporadically occurs - 2001


Lordington Pond 4/07 – new sluice and augmentation needed soon after abstraction began. Now mostly dry.


Pond on-stream at Racton Park Farm – holds water longer than rest of reach


Pond on-stream at Racton Park Farm – holds water longer than rest of reach – dry 08/2006


Pond on-stream at Racton Park Farm – *Ranunculus peltatus* as water held longer


Old course in field obvious when river flowing – new straight channel along road


upstream Ell Bridge – reed choked when flow present


upstream Ell Bridge – Note tilled land – typical land-use is pasture in valley floor


End of reach – Broadwash Bridge – dry in April 2006

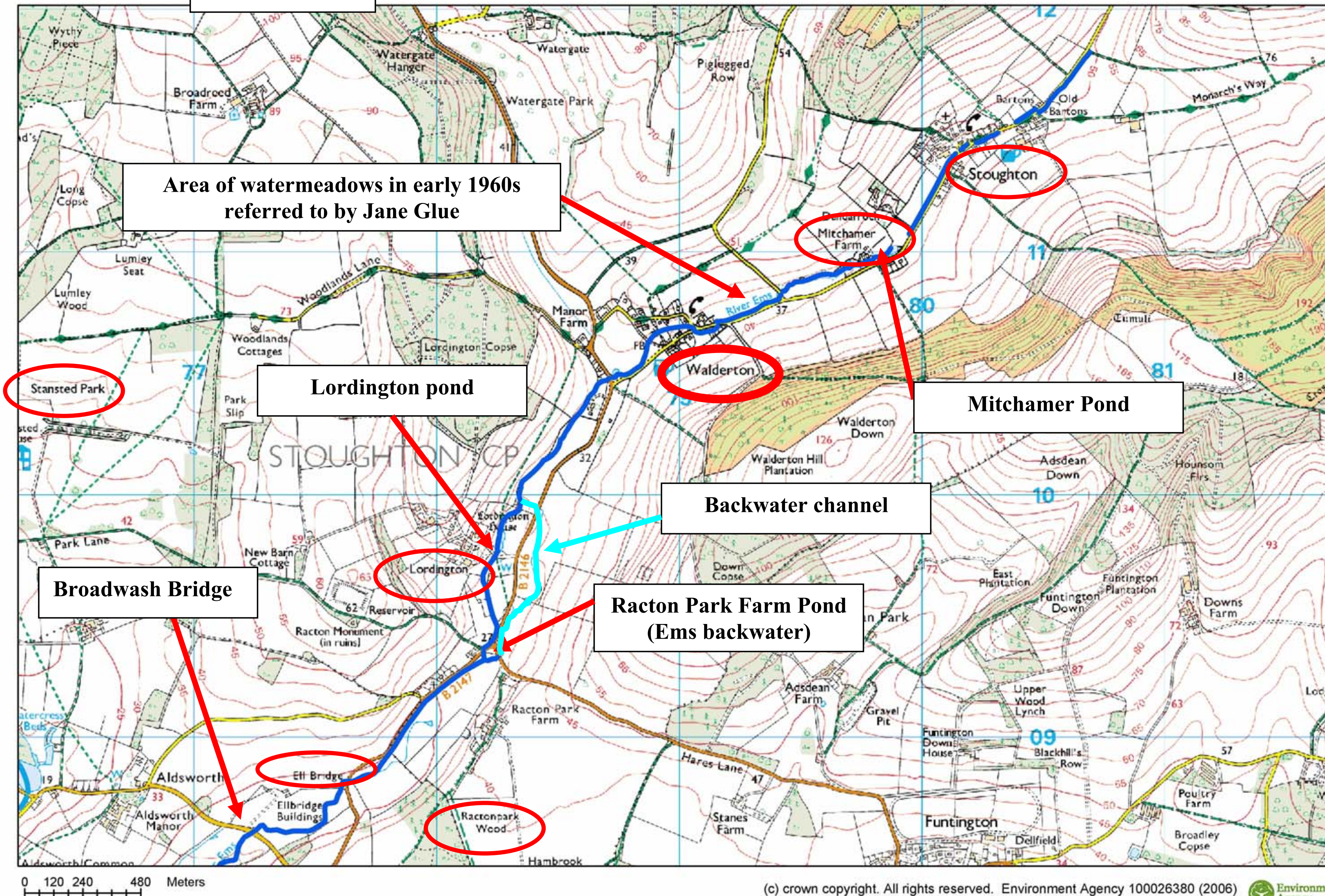

End of reach – Broadwash Bridge – standing water only in April 2006

End of reach – Broadwash Bridge – dry for long periods; still dry 29/11/06


Broadwash Bridge – generally now flows for a few months only; good flow in April 2007

Figure 5.2a Photos showing the character of the Ems, Reach 1.

Figure 5.2a The River Ems from its Source to Broadwash Bridge



Environment Agency

5.3 Ems Reach 2 - Broadwash Bridge to Riversmeet

5.3.1 General Description

Broadwash Bridge is named, according to Rudkin, because it was here that farmers are said to have brought their sheep in June before the annual shearing (to be washed only). Downstream of the sheepwash the river is relatively straight and deepened, with a series of watercress beds on the west (see photos – Figure 5.3a). In addition there was the 'Lords Fishpond' on line. The land was also watermeadows historically, with evidence of weirs and sluices down the watercourse from 100m below Broadwash Bridge. In October 1983, Rudkin walked from Broadwash bridge to Westbourne to discover where water was flowing from; it was dry at the top. He discovered a spring above 'Lords Fishpond', but by November it had ceased flowing. The location is close to the old Slaughterhouse (used 1925-30 and 1940-45) where a 'diminutive' flow also came from the west in a stream from the historic commercial cressbeds. Rudkin reports that Lords Fishpond was shown on Richard Lumley's 1640 map as a fishpond, and refers to a dam downstream that was re-constructed in 1969 by Southern Anglers 'to ensure a depth of water sufficient to maintain the fishing potential in the pond' – he reported they held the fishing rights of the Ems. He also says that the basic brick construction dates to the $18^{th}/19^{th}$ Century. There is another flowing stream entering below the dam – historically stepped to form cressbeds.

For November 1983, referring to the Fishpond, Rudkin stated '*the water was very low, yet high enough to keep the fry alive and provide a bonanza for herons and, no doubt, kingfishers'*. He refers to red stones on the river bed upstream of deepsprings – identified as *Hildenbrandia* (these red stones are still there today in great profusion). In relation to the pond, Rudkin makes a very important statement - he acknowledges views on the effects of the Walderton abstraction vary within the community, but says impacts are probably less than often stated – '*after my research I consider that it is much less than generally imagined (damage). I have spoken to local people who remember times before 1963 when the river was dry down to Aldemoor*'. Andrew Elms and Mr Todd also stated that up to the mid 1960s the scouts had their annual camping holidays downstream of Broadwater Bridge (July) and being able to swim in the river was part of the attraction for the location. **Although as author of this report I have no proof, everything I have read, been told, and observed (the flora) suggests the Lords Fishpond area, with the cressbeds, was the perennial head of the Ems, and that deep springs never failed (or if they did so it would have been an extreme event exceeding generations).** It clearly is not now, but again, observations and other information suggests it is perennial in years with good re-charge.

From researching several old map sources, Rudkin concluded that the canal stretch was dug between 1724 and 1778. He reports that it is conjecture that the Ems naturally flowed to the East of Westbourne, and the diversion was to provide an extra volume, and head, of water for Westbourne mill. Suffice to say that from north of Westbourne the Ems has had its course immeasurably moved.

There are no mills in this short reach of river, but the diverted 'canal' reach has a millpond character, and could not conceivably have been constructed to supply water to Stanstead House if historically the flow was not always sustained (which it is not now without augmentation). Floodplain grassland (Racton) dominates the floodplain, with wetlands an important ecological resources; Andrew Elms has an area of extensive sedge-grassland downstream of Racton Park Dell in stewardship, and the Racton Park Dell carr is probably an extremely important wetland relic of the area.

Maps showing the locations of where specific survey information has been obtained for fish, macrophytes or invertebrates, are shown in Appendix 2, and locations mentioned in the text shown in Figure 5.3b.

5.3.2 Ecological Status and Key Factors Affecting it

5.3.2.1 Mammals

No information is available from formal surveys. Otter may never have been present here, but there is no information to support or refute this. However, Rudkin (1984) refers to a deep stretch of river below Broadwater known as 'Otter Hole', and is under a clear impression otters were once present on the river. Andrew Elms supports the view that otters were historically present here. Water voles have been intermittently noted by local residents in the canal area (Rules & Schofields, pers. comm.), but the reported presence of mink in the past year (Nick Rule; pers. comm. 2006) has resulted in none being seen recently. No water shrews have been recorded. The present-day situation is therefore considered bad compared with the historic, and present land-use (roads in particular) limit opportunities for otter re-colonization.

5.3.2.2 Fish

Little or no formal information is available as no fishery surveys have been carried out. Migratory eels have been reported to have once been common. Any information is from statements made by local residents or from literature. Rudkin refers to Lord's Fishpond (Aldmoor/Ractonpark Dell area) that up to 1969 was under the jurisdiction of Southern Anglers who undertook sluice repair work then 'to protect their fishery interest'. In the view of the author, it is not without probable significance that this structure was modified just after the Walderton abstraction was increased to its maximum annual average daily take of 6mgd. Despite strenuous efforts by myself and EA fisheries staff to track down more information, none has been forthcoming.

Only the canal reach is now likely to have a sustained fish community at all time as it is the only location where permanent water is present (subject to augmentation in low-flow years); upstream to Lord's Fishpond small fish might be sustained most of the time – as even when flow fails small taxa might survive (e.g. bullhead, stickleback) for considerable time under gravel where water may be present all the time. The need to survey this area for fish is clear.

The canal itself has had species such as trout, roach, eels, bullhead and sticklebacks noted within it; the fact that pike are occasionally seen in Westbourne Mill pond suggests they must be maintained here alongside the minor species as the Westbourne Mill pond dries in poor re-charge years. Eel will migrate from sea, as must the sea trout reported to have been here historically too. The SNCI notation cites Bullhead and Three-spined Stickleback as present here. Charlotte Murray (pers. comm.) reported that in 2006 when she visited this stretch with EA colleagues they noted the presence of bullheads upstream of the canal.

Abstraction is highlighted here as the most critical factor affecting fish interest (only place where cited). This is because the lower part of the reach is considered to be naturally perennial, and periodic failure of flow now will almost certainly have severely, if not totally, destroyed the NATURAL assemblage of fish.

5.3.2.3 Invertebrates

Only recently have invertebrate surveys been carried out by the EA – before 2000 no information at all was available. In addition to the surveys undertaken over much of the Ems and Lavant from 2000-2006, special surveys were also carried out upstream and downstream of the augmentation point in 2002 and 2003 in relation to monitoring the effects of channel management. The limited data for the few sites surveyed indicate an interesting mix of species that are indicative of either perennial or intermittent flow regimes.

The canal is an SNCI partly for its invertebrates, and the notation cites Emperor Dragonfly, Ruddy Darter and Black-tailed skimmer as present here.

The springs at Ractonpark Dell are almost bound to be very very important, but lack of surveys makes this impossible to confirm. EA invertebrate data provide evidence of an interesting mix of species that are often considered typical of winterbournes, and others of perennial flow; this characterises it as being on the cusp very well!!

5.3.2.4 Macrophytes

There is virtually no information save for 2005-7 surveys of author (see Annex 2; sites NH5, 5A, 5B), and ad hoc observations from: a) EA biologists when doing invertebrate surveys in recent years; b) RCS surveyors; c) special surveys carried out upstream and downstream of the augmentation point in 2002 and 2003 in relation to monitoring the effects of channel management.

The flora reflects classic winterbourne character in the upstream parts of the site at Broadwash (Site NH5). In 2005-7 the river close to Racton Park Dell, and the feeder stream with the cressbeds, had a flora typical of perennial flow, even though it is known flow fails here at times now (*Berula & Hildenbrandia*).

Macrophytes d/s towards the augmentation were only recorded in a survey in November 2006 and May 2007 – the presence of *Ranunculus pseudofluitans, Berula erecta & Callitriche obtusangula* suggest perennial or rare failure to flow, or it stays at least damp most of the time. All these data point to the river from Racton Park Dell having a flora that still retains the historic elements of the natural perennial flora that almost certainly existed, in a more obvious form, prior to the mid-1960s.

The canal and side stream flora also suggest perennial flow. Both support an artificially very rich flora that includes the rare liverwort *Riccia.* The canal and main river (and the channel upstream to Racton Park Dell) are part of an SNCI - partly for its macrophytes, and the notation cites that Arnold's Sussex Flora (1907) '*suggests this site was once of outstanding botanical importance*'. The taxa cited do not include any species not recorded by the 2006-7 surveys of the author on the adjacent channel, but the crowfoot is given another (incorrect) name. Arnold's Flora does not list taxa for individual sites, but cites taxa occurrences at various locations.

5.3.2.5 River Habitat (Morphology)

The river has had historic modifications such as:

- Deepening and straightening to enhance drainage of adjacent land;
- historical 'penning' at Broadwash to create deeper water for washing sheep in summer;
- diversions and impounding to enable cressbed developments in the Racton Park Dell area;
- impounding at Lord's Fishpond, possibly as a source of fish as food, centuries ago;
- Diversion and impoundment centuries ago to form the 'canal' as a ponded, reliable, water source to be pumped to Stansted House.

No natural channels remain today, but the 'wetland habitat' associated with the Racton Park Dell area and cressbeds is exceptional and should be highlight for both protection, and further study to confirm this. The river channel between the Dell and the augmentation point suffers from over-widening (and therefore siltation is greater than is desirable, and simple rehabilitation works could enhance this channel to be a high quality chalk stream. The adjacent land is also wetland, dominated by extensive sedge beds – this is in STEWARDSHIP but the importance of the sedge grassland is not mentioned in the SNCI notation despite being within the site boundary. The impounded 'canal' reach is very artificial and subject to massive siltation problems; options to convert this to a lake and chalk stream have been discussed with the owners, and this might provide significant enhanced flood protection (see later for specific recommendations).

5.3.2.6 Ecological Status & Key Factors Affecting the Ecology in Reach 2

Box 5.3a summarizes the key factors assessed as affecting the different ecological elements of the reach 1. Historic channel modifications have been significant, with changes to the channel shape and form for sheep dipping, cressbeds and agricultural drainage/watermeadows, impounding for fish ponds, cress farming and water supply, and diversions for a variety of reasons, some incorporating the interests listed above. Therefore the natural channel form is greatly modified from what historically would have been shallow streams with a reasonable gradient from Broadwash to Watersmeet. The channel modifications, alone, will not have resulted in many taxa being lost from the reach, but changed the local community structure dramatically. Combined with catchment land-use changes, siltation will have increased in the enlarged channels.

The dominant influence is the ± natural nature of flow within this reach: i.e. at the extreme upstream end it was probably naturally intermittent in extreme droughts, with a flora and fauna to match. In a mere 750m section of river there probably was a transition from natural winterbourne above Broadwash to what is considered to be the historic perennial head at springs adjacent to Racton Park Dell. In years of above average re-charge flow is retained here year round, but in droughts it fails from here to the end of the reach unless the augmentation flow is in operation. The key impact of abstraction has been to make a reach periodically dry in droughts that typically retained at least some flow prior to the 1960s. The likely ecological consequences of this are:

- the majority of invertebrates requiring perennial flow recover from downstream (or from hiding below ground in lower numbers where water present);
- plants with similar needs recover from seeds or by surviving in terrestrial forms, but the predominant taxa are those of winterbournes, not perennial chalk rivers;
- the majority of fish are seriously impacted, and have been saved only by augmentation.

The augmentation was noted to cause some precipitation close to the discharge point, and a slight smell of chlorine was evident too. No studies are known to have been done to determine if there are any impacts from this on sensitive invertebrates, but the provision of water to an otherwise flow-depleted channel is clearly a positive amelioration of the lack of flow that would occur now due to abstraction in poor recharge years.

Siltation is a problem from Racton Park Dell downstream, with the over-wide channel upstream of the canal, and the canal itself, suffering from blanket covering of silt. Flood defence management has historically not helped in self-recovery of the stream, but usually had the opposite effect, and further increase silt.

A whole myriad of factors affect this reach, and the factors may have very different effects in different locations even within this very short reach. Natural flow, with the extreme effects of natural drought, is a universal key factor affecting the character of the reach, and the NATURAL differences within it.

Everyday management by Flood Defence is not as critical now as it might have been had the reach not been perceived to be impacted by reduced flows. Their practices in recent decades are considered to make habitats more degraded (apart from the clearing of silt from the Canal stretch and Lord's Fishpond in 1994) – a point made by both landowners who want the river channels to be left alone.

Box 5.3a Summary of the key factors assessed as affecting the different ecological elements of reach 1 – the Middle Ems

FACTORS\Assessment GROUP	Mammals	Fish	Invertebrates	Macrophytes	Habitat
PRESENT STATUS	B	B	M	M	P
Factors Considered to Affect Status					
Historic changes to channel	3	3	2/3	2/3	5
(Flood Defence) management	3	3[4]	2	2	3
Siltation	1	3[1]	3[1]	3[1]	3[1]
Natural flow character	5	5	5	5	3
Abstraction-induced low flows	3	5	3	3	2
Present/recent poor water quality	1	1	1	1	N/R
Historic pollution	1	1	1	1	N/R
Alien species	5[2]	1	1	1	N/R
Catchment/floodplain Land-use	3[3]	2	2/3	2/3	2

[1]Due to channel mods – widening, deepening and impounding in lower half
[2]Due to Mink impacts of Water voles
[3]Mixed habitat – upstream the land-use is relatively intense grazing – Racton Park and habitat d/s is good
[4]Sean Ashworth reports that dredging of the Canal has in the past left hundreds of bullhead on the bank to die

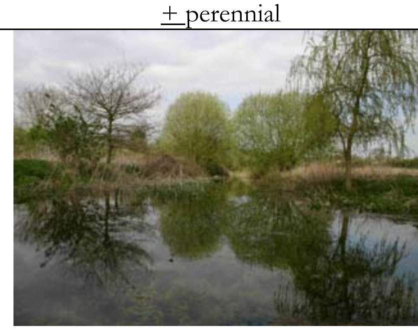

Top of Reach – the Sheepwash at Broadwash – used to have perennial flow


Broadwash – structures used to hold water for sheep dipping & scouts swimming


Downstream Broadwash open channel – now dry for long periods, but used to be ± perennial


Upstream Lords Fishpond river is wide – typical intermittent flow flora now


u/s Racton Park Dell – 2006 river veg cut by EA; example of needless management in relation to flood defence


Lords Fishpond – now looses water most years – previously a major fishing pond leased to Southern Anglers

Ems in Racton Park Dell has characteristic red alga on stones reported by Rudkin - *Hildenbrandia*

Racton Park Dell – location of important wetlands associated with springs – cress beds

Evidence of old cress beds at Racton Park Dell – strong support for perennial previous flow

Extensive free-range pig rearing in reach poses potential threat to river siltation

Silt present in river d/s Racton Park Dell – combined effect of increase in material and over-wide, non self-cleansing channel

Open, over-wide channel d/s Racton Dell – river and land on either side is SNCI

Historic character of the 'Canal' - ponded water – diversion to feed Westbourne Mill and ponded water to supply Stansted House from the 1700s (courtesy Mr. Schofield)

The canal had remediation work in 1994 to provide some flood protection – now ineffective

The 'Canal' now – very over-grown with 'weed' and covered by dense silt on the bed - proposed habitat restoration

The main river runs alongside the canal – subject to proposed chalk-stream restoration

Rare liverwort present in this reach - *Ricciocarpus*

Augmentation occurs during very low flows – does not always reach Westbourne Mill!!

Figure 5.3a Photos to show character of the Ems, Reach 2.

Figure 5.3b

The River Ems from Broadwash Bridge to the Confluence in Westbourne

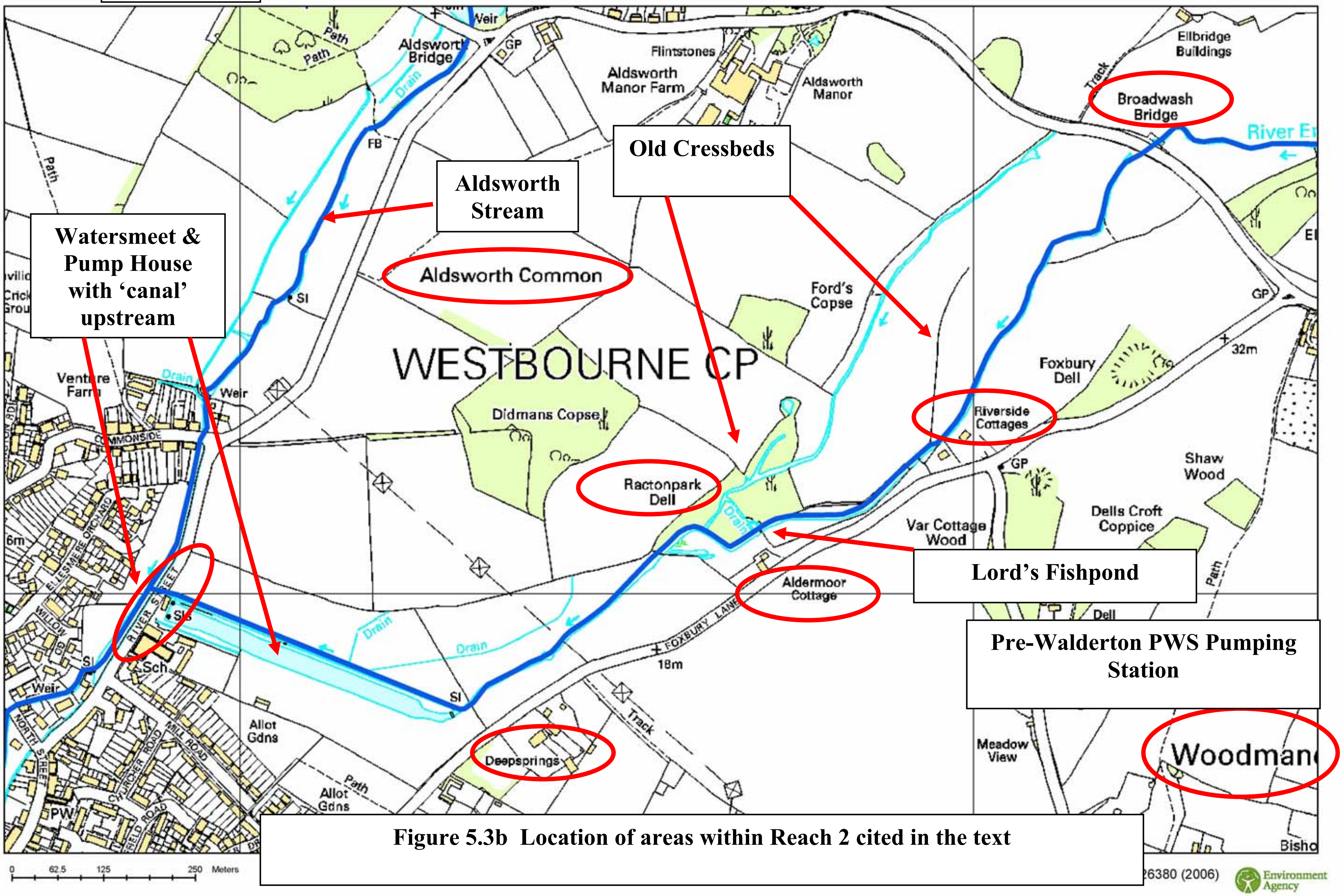


Figure 5.3b Location of areas within Reach 2 cited in the text

5.4 Reach 3 – Aldsworth Branch

5.4.1 General Description

Rudkin states that the source of this tributary of the Ems is Brickkiln ponds – their very artificial shape was noted on a 1778 map (Yeakell's & Gradners). He reported they discharge under the road and disappear underground to form springs – and thence to Aldsworth Pond, and noted that after a very dry period in 1983, there was still a good flow late in the year. 20 years ago it was in the hands of the Chichester Harbour Wildfowlers Association who deepened it. Adjacent to it is a pumping station that pumped water to Stanstead from 1907 until a supply main replaced it after the war. Rudkin also states the pond was important for shelduck. He at no times mentions the watercress beds marked on the maps.

Rukin also describes the river downstream of Aldsworth as having a muddy bottom as it is affected by a series of delapidated weirs, and that natural cress grew in abundance here. Before entering the mill pond (Westbourne Mill) it is reported to have a short stretch that is shallow and with a gravelly bottom where horses can splash and be watered. To this day, the same is true when water is present (see photos in Figure 5.4a).

Information from Mr. Todd, a born and bred local man, and several other local people, appear to independently give rise to the view that Aldsworth Pond, that now dries on a regular basis, dried only in exceptional years prior to the 1960s (i.e. the former said only once in living memory of his father – assumed to be 1949?). Further evidence of far more reliable spring flows previously is evidenced by the presence of cress-beds marked on old maps north-east of the Aldsworth Pond. Strangely some local people do not make the association of Aldsworth Pond drying with Walderton abstraction, so investigation on the extent it is affected is required.

Aldsworth pond and some of the surrounding meadows and part of the old cressbeds are included in the C2 SNCI called 'Aldsworth Pond and Meadows'. The pond supports many breeding dragonflies, common toad and frog, and an unremarkable range of wetland and aquatic plants. The pond is most noteworthy for its breeding wildfowl. The citation notes that the pond dries in drought periods. The meadows support many species typical of marsh or wet grassland, and the recommended management is to continue low-intensity grazing and have no fertilizer application – both are ideal for maintaining the ecological interest of the river.

Brickkiln ponds and some of the surrounding land is also an SNCI (C86). The ponds have breeding bird, amphibian and dragonfly interest. The flora noted in the citation is for common taxa, but Arnold's 1907 Flora refers several times to the flora of the ponds. The largest frog colony in Sussex is considered to exist at here, and the Emerald Damselfly and Ruddy Darter, both described as 'fairly localized species', occur in large numbers. Whilst not noted in either citation, it is thought that importance of Aldsworth pond for dragonflies may be dependent on recolonisation of some species from Brickkiln if it is dry for a long time.

5.4.2 Ecological Status and Key Factors Affecting it

5.4.2.1 Mammals

No information at all is available for this reach. Otter and water vole may never have been present here, but this would seem unlikely given the habitat, and permanent water in Brickkiln ponds. A survey for watervoles may well be justified here.

5.4.2.2 Fish

No quantitative data at all are available for this reach as no surveys appear to have ever been carried out. Migratory eels have been reported to have once been common. Local people also report trout as being exceptionally common up to the 1960s – at the downstream end alongside River Street they were described by one as being so numerous the river was black with them. Also it has been reported that sea trout were commonly poached as they attempted to jump the weir to Aldsworth Pond.

Structures must hamper migration, and eels, bullhead and stickleback are likely to be present in the lower reaches when flow persists. No information about fish in Brickkiln has been formally made available, but an incidence of low surface oxygen levels revealed that the owner had stocked it with large pike (EA [Incidents file], pers. comm.).

5.4.2.3 Invertebrates

In terms of survey this is a neglected stream. It probably has very good winterbourne community containing many relatively rare taxa. These would be associated with the old cressbeds, Aldsworth pond and the streams within the meadows between Aldsworth pond and Westbourne.

5.4.2.4 Macrophytes

No information is available save for 2005/7 surveys of author at a single site, and observations elsewhere. No information is available from such sources as ad hoc observations from EA biologists when doing invertebrate surveys in recent years, or RCS surveyors. Flora at the downstream end still reflects a near perennial character, perhaps a legacy from the times three decades ago when it rarely dried, and if so, only for short and very infrequent periods. The flora within Aldsworth Pond, and the streams immediately downstream, have a flora typical of an annually intermittent winterbourne flow; on passing downstream towards the northern boundary of Westbourne the flora reflects less regular failure of flow. Observations when walking downstream from Aldsworth pond revealed the presence of *Berula,* suggesting it is hanging on as evidence to corroborate the views of local people that it was indeed ± perennial prior to the 1960s.

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5.4.2.5 River Habitat (Morphology)

The short river course has had major historic modifications, with impoundments the most obvious at Brickkiln (includes major additional excavation also), Aldsworth Pond, and north of Westbourne it is impounded. At the downstream limit it is also affected by the tail back-up of Westbourne Mill head.

5.4.2.6 Summary of Ecological Status & Key Factors Affecting the Ecology in Reach 3 – Aldsworth Stream

This is a difficult reach to assess since more than half of the catchment has been affected by historic channel modifications to create either deep and perennial ponds, or a shallow pond that now periodically dries, from what would have been streams and floodplains. These changes will have had fundamental effects of the flora and fauna (increased diversity and created the high ornithological interest); this may not necessarily have led to loss of species, but it has reduced 'naturalness' and reduced the extent of chalk stream habitat. The presence of permanent water in Brickkiln lakes is natural and very important for sustaining taxa requiring perennial flow, as is the natural intermittent flow in the streams to Westbourne.

The fact that cressbeds used to exist by Aldsworth pond, and local people report flow did not use to fail where the stream runs alongside River Street, suggests abstraction has had a bigger impact than initially thought – but to what extent it has led to loss of taxa is unknown.

The factors that affect the environment of the reach may not all be considered to lead to ecological degradation – but change. For example, the Brickkiln pond may have provided safer refugia for amphibia, fish and many invertebrates during extreme droughts than would have occurred naturally; such changes will have resulted in a changed bird community, and possibly provided more conducive habitats for otter and water vole (Brickkiln indeed appears to be an ideal habitat for watervoles, but they may have not migrated from elsewhere to take advantage of the conditions. Abstraction would appear to have potentially impacted brown trout and other small fish that might have thrived decades ago in the shallow chalk stream habitats. Box 5.3a below summarizes the key factors affecting the reach – perhaps due to the author's concern that Walderton abstraction has had more impact here than many local people think, the category for fish might more accurately be '5'.

Siltation is noted as a 'not known' effect but Siltation does affected the impounded reaches. Following the 1993 floods the Westbourne mill pond was de-silted. In 2006 when it was dry, the owners removed silt too (see photo in Figure 5.3a). Tracking machines on the river bed would normally not be recommended in a chalk stream because of the risk of compacting gravels, but because a mill head has a sealed bed to stop leakage, tracking along the bed should not cause an ecological impact.

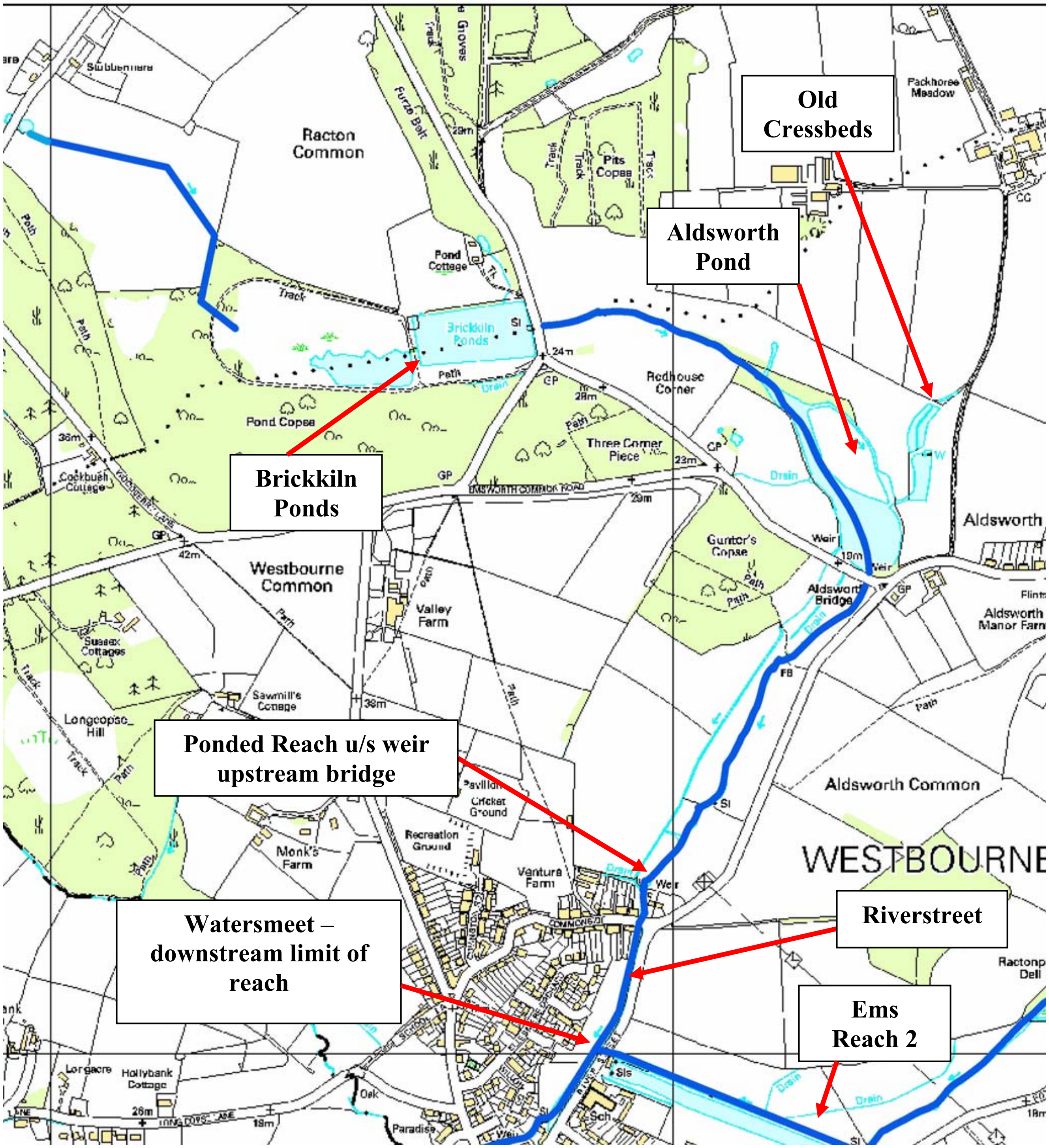
Box 5.3a Summary of the key factors affecting the reach

FACTORS\Assessment GROUP	**Mammals**	**Fish**	**Invertebrates**	**Macrophytes**	**Habitat**
PRESENT STATUS	N/K	N/K	N/K	M	P
Factors Considered to Affect Status					
Historic changes to channel	N/R	3	3	3	5
(Flood Defence) management	N/R	N/K	N/K	2	1
Siltation	N/R	N/K	N/K	3	1
Natural flow character	5	5	5	5	3
Abstraction-induced low flows	N/K	4	3	3	3
Present/recent poor water quality	N/K	1	1	1	N/R
Historic pollution	N/K	1	1	1	N/R
Alien species	N/K	1	1	1	N/R
Catchment/floodplain Land-use	N/R	2	2	2	1

 Brickkiln Ponds – perennial water and very important amphibian site in Sussex	 Aldsworth Pond – Nov 2006 – dries most years; prior to 1960s reported to retain water except once in 50 years	 Aldsworth Pond – Dec 2006 – rapidly fills – weir cited by many as where sea trout poached decades ago
 Open course between Aldsworth Pond and Westbourne	 Course between Aldsworth Pond and Westbourne – often occluded by shrubs	 Pond u/s Westbourne – April 2006
 Sluice ponding water u/s of Westbourne – dry pond in Nov 2006 – full April (see above)	 Channel u/s Westbourne – bed covered in Lesser Water Parsnip (*Berula*) – suggests historically perennial flow	 Aldsworth Stream, running along River Street – still used to cool horses feet as reported for the past (Rudkin)
 u/s Watersmeet 8/2006 – historically reported to be 'black with trout' and never dry	 End of reach u/s Watersmeet 9/2006 – historically reported never to dry – now does most years (courtesy N Rule)	 Flooding over road at Watersmeet – occurred in 2000/1 & 2003 – no property flooding but major traffic disruption

Figure 5.3a Photos to show the character of the Aldsworth Stream, Reach 3.

Figure 5.3b The Aldsworth Stream



5.5 Ems Reach 4 – Watersmeet (Westbourne Mill Pond) to Harbour

5.5.1 General description

The mill pond of Westbourne is where the waters of the Aldsworth Branch (Reach 3) and the Ems (Reaches 1 & 2) meet. According to Rudkin (1984), in 1640 the size of the pond appears from maps to be almost twice the size it is today. It provided the head to drive the second mill on the river, and was also thought to be a fine fishery. At the time of the Doomsday book (1086) four flour mills are mentioned for the parish of Westbourne. An impression of the character can be gained from the photos in Figure 5.5a.

The recent Character Appraisal and Conservation/Management plan prepared for Westbourne Parish Council (WPC; 2007) concluded that the key characteristics of the conservation area included the '*Large linear conservation area encompassing the former mill and mill pond.....The River Ems and its various mill leats and ponds are very important*'. '*Views over the mill leat of the river Ems and the back of the mill at the northern edge'* were also cited as important to conserve. This document also provides some interesting historical background to the area.

A chapter in Rudkin is dedicated to the Westbourne Mill to Lumley Mill stretch. In autumn 1983 he was surprised by the healthy flow approaching Hampshire Bridge. There are two more mill sites – Lumley Mill being u/s of the railway and downstream of the new A27 dual carriageway. His plate 58 is a sketch of the maize of watercourses in the floodplain here, with a meandering ditch marking a county boundary!! He outlines his theory for the third mill between Westbourne and Lumley Mill and identifies many changes in course the river has been subjected to. He says in 1983/4 he revisited Lumley Mill and pond – '*once a fisherman's paradise…….it is sad to see that the millpond is almost dry; this must reflect to some degree an adverse effect of extraction of water at Walderton…..about 70 or so years ago I stood on the public footbridge just below the millpond and watched a fly-fisherman casting into the river*'.

From Lumley Mill to the sea… '*we always called the fields here the watermeadows and springs do abound*'. Again maps show evidence of the course being changed, with the building of the railway having some influence. Also there were mills here in Doomsday period – Emsworth Mill. The 1665 coastal map shows that slipper Pond represented the estuary of the Ems…at the time of the Doomsday period one of three tidal mills. He also refers to sea trout entering, and being caught, in Slipper Pond between the wars.

Tom Byerley was born in the Westbourne Mill in 1915, and reported to Rudkin that it remained operable into the 1920s. Tom's family were fish merchants, and when King Edward VII stayed at Goodwood House c100 years ago, trout caught from the Ems were on the menu. Rudkin reports that the river was stocked with trout by a General Oldfield who held the fishing rights in the 1920s.

It is of importance to note the very special nature of Slipper/Peter Pond and Mill Pond at the downstream limit of the site. As they are brackish habitats, they have not been dealt with in this report. The value of the Brook Meadows reserve, under the protective eye of the BMCS is highly noteworthy – the area is both an important wildlife site and a valued public access area, made all the more important for being in an area of dense population. The short transition from freshwater chalk stream to brackish estuarine habitat is also important.

Reference to the most relevant biological information will be given in the following sections; maps showing the locations of where specific survey information has been obtained for fish, macrophytes or invertebrates, are shown in Appendix 2. Locations cited in the text are shown in Figure 5.5b.

5.5.2 Ecological Status and Key Factors Affecting it

5.5.2.1 Mammals

There is no information relating to the historic status of otter in the catchment, but none have been known to occur here for decades. Water vole have been recorded in good numbers in most recent years, (records coordinated by Brian Fellows – BMCS) who reports 2005 as a much better year than 2006. Despite reported sightings of mink in Westbourne (Nick Rule), Graham Roberts from the Hampshire Wildlife Trust has stated that annual fluctuations in water voles are common and mink may not be to blame. Brian Fellow's reports to the BMCS suggest that there are probably just four 'colonies', and the population probably remains very vulnerable.

The status is assessed as 'Moderate' due to water voles being recorded regularly, but under threat from mink, and there being no evidence of otter losses. Natural flow character is the key factor as this is a more or less pre-requisite for water voles to be present in the catchment. Historic channel changes have both impacted and benefited water voles – ponding water provides better habitat than simple and uniform shallow water, but armoured banks of brick, concrete and wood are a major impact. Flood Defence management has been reported by the BMCS as being of major concern in the past when both the channel and bankside vegetation was flayled – new agreements to limit annual clearance to channel vegetation only point to this being a minor or insignificant factor in the future if adhered to. Abstraction/very low flow is probably a relatively minor factor except in the top few 100m upstream of Westbourne Mill where the mill pond drops to a puddle in very dry years.

5.5.2.2 Fish

Considering the references made previously in this report it is amazing so few surveys have been carried out, and how little information there is on the present-day fish populations, considering their almost certain pre-eminence previously. The reach is still important for sea trout, simply for their tenacity to still colonize the river, but is a shadow of previous interest. Also other fish are known to occur, including bullhead (a Habitats Regulations species), three-spined stickleback, brown trout (a sport and 'poached' fish previously), pike, roach, eel and in the lower reaches periodic presence of estuarine fish after high tides (Fred Portwin, BMCS). People who have known the river over any length of time report major declines over the past 40 years, including NRA/EA staff. Abundance of fish made poaching a major issue in the past, which is unimaginable today, given its present state. Three years of poor flow, following some recovery in the 'good flow' years of 2000-2003 has meant that people have reported 2006 seems to have been a bad year for trout too!!

The status is assessed as 'Poor' due to very clear indications of decline since the 1960s. Natural flow character is the key factor as perennial flow is an absolute pre-requisite for the natural fish population to be sustained, and in other reaches flow is not guaranteed. Historic channel changes have primarily impacted, not benefited, fish – some of the mill structures and other water-level control structures seriously impede navigation through the freshwater system, and from/to the sea; they also 'pen' assemblages into a small sections of river. Low flows, almost certainly exacerbated by abstraction impacts, means during many summers water levels may be very low, gravels are not sustained free of silt, healthy growth is reduced and predation is increased. Flood Defence management that has historically cleared the river of vegetation across the whole channel width further decreases water depth, velocity and self-cleansing processes (and increases silt deposition) and reduces food sources, cover and suitable spawning habitat.

5.5.2.3 Invertebrates

Data indicate the community is reflective of a perennial flow and reasonable good water quality. The status is assessed as 'Moderate'. Natural flow character is the key factor as the community is very strongly reflective of a perennial discharge. Historic channel changes will have considerably reduced the natural abundance of classic chalk stream invertebrates that thrive in clear, well oxygenated, flowing water with gravel substrates; in contrast the community may have an increased diversity (unnatural) because of the introduction of ponded water with silt substrates upstream of structures. Low flows, probably exacerbated by abstraction impacts, means during many summers gravels will not remain free of silt and be oxygen-rich, so potentially impacting characteristic chalk stream invertebrates in favour of more cosmopolitan species. For the same reasons as for fish, historical management practices for Flood Defence would have an impact on invertebrates, and similarly the same suggested reduction in management would result in a positive effect but creating greater channel habitat diversity..

5.5.2.4 Macrophytes

The floral community from Westbourne Mill downstream is indicative of perennial chalk stream, with all three classic headwater perennial chalk stream indicators present – *Ranunculus pseudofluitans, Berula erecta & Callitriche obtusangula* (Brook Water-crowfoot, Lesser Water-parsnip & Blunt-fruited Water-starwort). The 'typical' chalk stream communities were limited within the short reach because of the excessive siltation and slow flows associated with the impounded mill heads – here the communities are totally dominated by reeds such as Branched Bur-reed (*Sparganium erectum*) and Reed Sweet-grass *(Glyceria maxima*). The alien species *Elodea & Lemna minuta* (Canadian Pondweed & Least Duckweed).

The status is assessed as 'Moderate'. There is no clear indications of a decline, but despite a relatively limited flora, it is not atypical for a perennial headwater area of a chalk stream. Had the flora had more *Ranunculus*, and less algae, the status would have been assigned as being in 'Good' condition. Natural flow character is the key factor as the community reflects a perennial flow. Channel form and management are both considered to have at least a moderate effect on impacting the flora, and act almost synergistically. The flora suffers from a major reduction in faster-flowing, well oxygenated, clean gravel-bedded sections – with factors listed in the table as having an impact, improvements in one may not result in huge benefits unless the other issues are addressed too.

5.5.2.5 River Habitat (Morphology)

The reach can be characterised as being highly modified, with channel form modified centuries ago. Impounding water and courses diverted from their natural channels epitomise the reach, with a semi-natural character only persisting where the channel appears not to have been moved downstream of Westbourne, and upstream of the Wren Centre. The importance of Brook Meadows as an area of wildlife should be noted, but the river channel is still impacted by historic channel modifications, reflecting the norm of being very wide/deep compared with what would have been the natural form. The impact that impoundments and structures have on the reach's ecology make the need for a WLMP imperative.

No freshwater/floodplain SNCIs exist in the reach (note the brackish Slipper/Mill/Peter Ponds are).

5.4.2.6 Summary of Ecological Status & Key Factors Affecting the Ecology in Reach 4 – Lower Ems

From the table below (Box 5.4a) it is clear that the key factor affecting the ecology is natural flow – the fact that this reach has plant and animal communities reflective of a small perennial chalk stream is noteworthy and again confirms the main driver shaping the communities is the natural flow character, but other factors have greater importance for some groups than others.

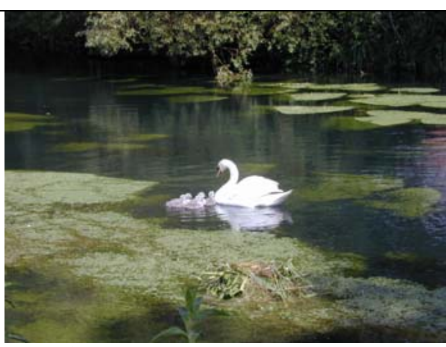
The greater degree of adjacent land management, and historical major modifications to the physical structure of the channel have a more major influence on the biota here than perhaps in any of the other three reaches. Mill structures are a serious concern in relation to migrating fish from the estuary to freshwater spawning grounds. Impacts of very significant changes to the channel morphology have then been further enhanced by all other factors such as the almost certain decrease in flows due to abstraction, increase in silt (from upstream), and historic Flood Defence management practices that synergistically results in the effects of lower discharge being amplified – shallower water, more silt, reduced velocities etc.

Box 5.4a Summary of key factors affecting ecology in Reach 4 of the Ems

FACTORS\Assessment GROUP (See box 4.1.1a)	Mammals	Fish	Invertebrates	Macrophytes	Habitat
PRESENT STATUS	M	P	M	M	P
Historic changes to channel	3	4	3	3	4[3]
(Flood Defence) management	3	3	3	3	3
Siltation	1	3[1]	3[1]	3[1]	3[1]
Natural flow character	5	5	5	5	5
Abstraction-induced low flows	2	4	3	3	2
Present/recent poor water quality	1	1	1	1	N/R
Historic pollution	1	1	1	1	N/R
Alien species	3[2]	1	1	1	N/R
Catchment/floodplain Land-use	2	2	2	2	1

[1]Indirect as a result of very heavily impounded channels
[2]Due to mink impacting water voles
[3]The majority of the habitat is severely degraded, but the stretch downstream of Westbourne is relatively natural

Figure 5.4a Photos to illustrate character of Reach 4, the Lower Ems



Top u/s Westbourne Mill Pond – May 2000

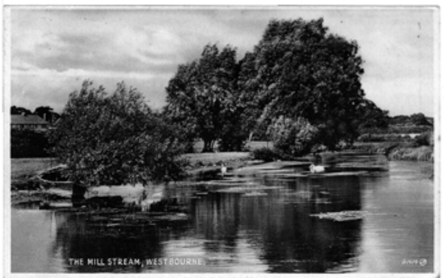
Top u/s Westbourne Mill Pond – flow failing August 2006

Westbourne Mill Pond –No flow despite augmentation – late 2005

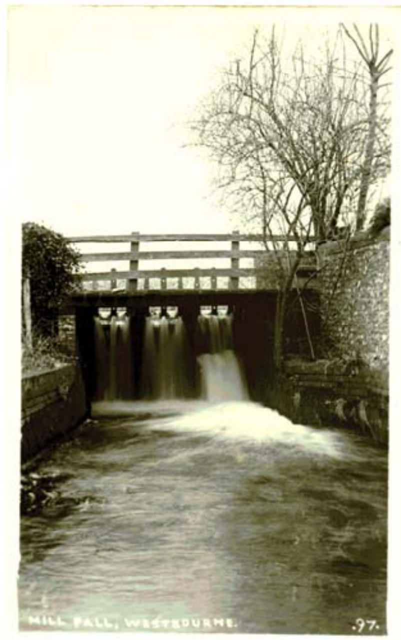

Main Channel d/s Westbourne Mill – the most natural stretch of the Ems


Minor Channel d/s River Street – flow from mill wheel, Westbourne


Fishery survey site at start of most 'natural' stretch of the Ems d/s Westbourne



Westbourne Mill Pond c 1900



Westbourne Mill sluice – shows big vertical drop and 'challenge' to sea trout


Control Structure on Ems (Wren Centre) d/s Lumley Leat – limits sea trout migration


Flow gauge u/s Hampshire Bridge (Westbourne gauge)


Lumley Mill Leat @ top – feeder for old Mill

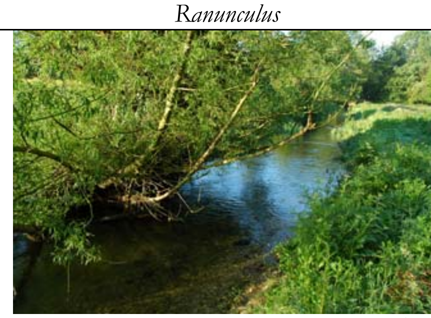

River d/s Westbourne u/s A27 – potential to form chalk stream habitat if weirs partially/wholly removed


Weir recommended for modification or removal to restore chalk stream habitat – not central slots could be removed


River (alongside) A27 – when d/s sluice open, good chalk stream habitat with *Ranunculus*


River (alongside) A27 – when d/s sluice


Ponded reach of Ems u/s Lumley – before


Previously ponded reach of Ems u/s

closed, chalk stream habitat non-existent	sluice left open to create natural channel character	Lumley –sluice left open to create natural chalk stream character
 Structure d/s Lumley – Peter Pond Channel; obstruction to sea trout migration for much of the time	 Peter Pond Channel d/s Lumley – starts totally constrained with vertical walls	 Peter Pond Channel d/s Lumley – parts are semi-natural
 Peter Pond Channel s/s Peter Pond– reed beds a feature of the margins	 Peter Pond – saline/brackish habitat at Emsworth	 Main Ems d/s Lumley is a maize of artificial channels
 Ems through Brook Meadows – more natural	 Culvert grill at Flour Mill – such structures are serious impediments to sea trout migration	 Brackish channel d/s Flour Mill culvert

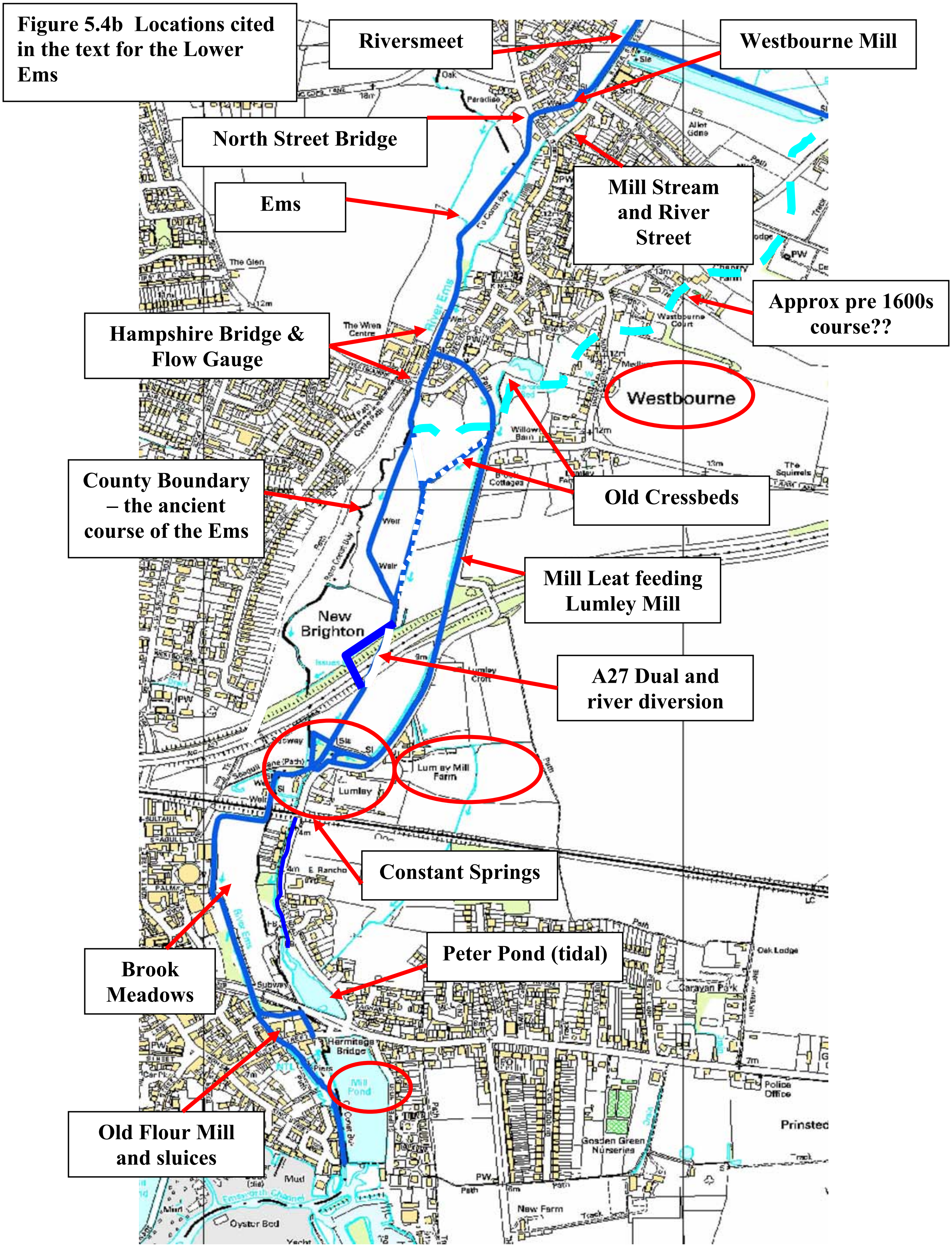


Figure 5.4b Locations cited in the text for the Lower Ems

6 Summary of Ecological Status and Key Factors Affecting it

A summary of the present status, as assessed in this study, of river mammals, fish, invertebrates, macrophytes and channel habitats in the whole of the Ems is given in the table below alongside the main factors affecting each of the interests.

FACTORS\ASSESSMENT GROUP	Mammals	Fish	Invertebrates	Macrophytes	Habitat
PRESENT STATUS	**(P)**	**P**	**M**	**M**	**P**
Historic changes to channel	2	4	2	2	5
Flood Defence management	2	4	3	3	3
Siltation	1	2[1]	2[1]	2[1]	2[1]
Natural flow character	5	5	5	5	5
Abstraction-induced low flows	2	4	2/3	2/3	2
Present/recent poor water quality	1	1	1	1	N/R
Historic pollution	1	1	1	1	N/R
Alien species	3[2]	2	1	1	N/R
Present Catchment/floodplain Land-use	3[3]	2	2	2	2
Barriers to fish migration	N/R	4	N/R	N/R	N/R

[1]Siltation primarily a secondary symptom resulting from management and the physical nature of mill heads
[2]Due to predation of Water voles by Mink
[3]Due to roads etc. making otter migration through system to suitable sites (e.g. Brickkiln) too treacherous

The 'status' assessment might be considered to differ from year to year. Following very good re-charge/discharge years that clean and refresh the whole system, it might be considered better than in the above table (more akin to conditions prevailing all the time at the turn of the century); after extremely poor recharge it might be worse than shown in the table (as reported by many for 2006). Therefore this summary is considered the 'status quo'. It would appear that the invertebrates and macrophytes recover reasonably well over a two year period following losses in very low flow periods (hence 2/3, the former reflecting less evidence of impacts after good re-charge years), but there is no confidence that fish could/would do the same.

Four factors work synergistically to affect the ecology, and, depending on your interpretation of available information, all four could be considered to have more effect that the others. These are:

- **Historic channel change** – this is considered to have one of the biggest affects (especially in the lower reach) because it has resulted in barriers to fish migration, and a shift in river course that exacerbates the impacts of natural low flows and abstraction. Over-wide and impounded channels do not exhibit natural chalk river character that this stretch would historically have had. Channel form, influenced by other factors, causes much silt deposition in this reach, and reduces the availability of suitable habitat for chalk stream species. Channel form changes probably have least affect on the biota in Reach 1, the upper Ems.

- **Natural drought & low flows** are important in shaping the resilience of river communities, but when these occur in tandem with abstraction from the groundwater, drying of the river (to Watersmeet) results, and very low flow may be sustained for longer in the downstream perennial section – but we know historically this has gone low for long periods in extreme droughts, and naturally would drop to a small flow even with no abstraction. Drought on its own, without abstraction, will resulted in the river drying from Racton Park Dell upstream; it would dry to Broadwater Bridge (d/s limit of reach 1) in normal years. Today, in 'normal flow years' river bed drying is typical to Racton Park Dell, and in poor years extends to Westbourne Mill (includes all of Reach 2 and upper extreme part of downstream Reach 4). Evidence suggests Aldsworth stream naturally had a perennial flow until the 1960s. In all tables the importance of **natural** flow characteristics shaping the plant and animal communities is highlighted as **RED** because it is so important (key factor), but to reflect the influence is **natural,** the code is shown in blue.

- **Abstraction** – see also above. The literature review, talking to local people, and the limited available flow data for pre-abstraction days, all point to Walderton having a big impact on flows in dry years. If abstraction is confirmed as being responsible for occasionally changing extreme low flows into bed drying (through the ongoing Entec project), this must be considered to be a very important factor shaping ecology. Drying has a more catastrophic effect on biota than reduced low flows, but it is important to note the 'in-combination' effects highlighted for Reach 4. Raising the amount of augmented flow to the lower river would help this reach considerably, especially for fish.

- **Management for flood defence –** channel shape (cross-section and gradient) is critical in maintaining clean substrate. With very large flows, it is possible to have clean gravels in sub-optimal reaches, but when discharge is low, and therefore velocity reduced, classic chalk stream substrate will be lost unless the river has been able to create a narrow low-flow channel. Historically flood defence management has cleared 'weed' across the whole channel width, therefore constantly stopping the river form a narrower low-flow, self-cleansing, width. Modified approaches to FD management could have the most positive effect for no money **–** also, any benefits from increased flows through increased augmentation or reduced abstraction will only be fully realised through having best management practices in place. For this reason recommendations for both changes in FD management and some rehabilitation measures have been proposed.

7. Recommended Short and Medium Term Actions (including Key Data Gathering needs)

Box 7A below lists the recommendations for research/monitoring and ecological survey actions in the short to medium term to safeguard the extant ecological interests of the Ems, and also help provide a firm basis for future actions to restore some of its former status. Perhaps it is important to stress that the whilst many references to deterioration in quality have been noted in the report, the Ems still has significant interest and has not deteriorated so far as to make it a lost cause – on the contrary, quite simple measures could restore much of its previous interest.

Box 7A Recommendations for research and survey actions in relation to flow/abstraction and ecological survey

Task	Justification
7.1 Determine the past and present flow characteristics of the Upper Ems	There is a lack of confidence on the extent of abstraction impacts on flow regime. Gaining a better understanding is proposed for the next few years by the EA's Entec project – the author of this report supports the desperate need to get a more objective handle on the changes to discharge resulting from abstraction. The Upper Ems is taken to be the **historical (naturally)** non-perennial section from Broadwater Bridge upstream (and perhaps a little way downstream to Racton Park Dell in extreme droughts). There is a need to utilize available pre- major abstraction rainfall and groundwater level data and determine model 'fit'. From rainfall data model groundwater levels for post-abstraction period and determine the effects on aquifer levels. Once this is known it will be possible to be more objective in determining how much the present ecology differs from what it used to be, and if this is sufficiently great to justify action.
7.2 Determine the past and present flow characteristics of the Middle Ems	As above for the now failing middle reach that has been assessed in this study as **previously having a perennial flow** (Reach 2 from Racton Park Dell and cressbeds). Determining much more precisely the extent discharge has been impacted will be important in guiding what level of abstraction at Walderton can occur without material change to the ecology. This report has highlighted that a combination of information indicates that a previously reliable flow, that never failed, now does so on a regular basis every time there is even a modest drought. The river is designated an SNCI, and is recommended to be extended further upstream to include Racton Park Dell.
7.3 Determine the past and present flow characteristics of the Lower Ems	As above for the now perennial reach from Westbourne downstream. Data from Hampshire Bridge (close to post 1967 gauging) from the early 1960s needs assessing, and critically appraising. At present we can only speculate to what extent discharge has been impacted; a modeled percentage of reduction in flows (say in autumn/early winter period inclusive) would inform discussions on how much augmentation would need to be increased above the canal to restore parity of low flows to pre-1960s levels; at present a ball-park suggestion made to PWL is a minimum of doubling it to 0.5mgd – the figure suggested by local opponents in the 1960s. The fact that augmented flows do not reach Westbourne Mill in serious drought years is significant.

7.4 Determine the past and present flow characteristics of the Aldsworth Stream	As above for the western tributary of the system. A combination of reported information from local people suggest that this stream only dried once (probably 1949) in the fifty years up to the 1970s. Now it dries regularly, as does the Aldsworth Pond, yet defunct cress-beds are marked on maps (indicative of perennial flow). Locals do not link it's demise to Walderton, thinking it is not within the impact zone. The Entec study needs to look critically at this stream and determine the zone of influences of all abstractions within the Chichester chalk block (it is considered by the author to be influenced by not only Walderton, but Brickkiln/Lavant abstractions too).
7.5 Development of models to enable generation of 'naturalised' flows, superimposed by different abstraction regimes for the various impacting fields	To date, it has not been possible to generate hydrographs for points on the River to show, with reasonable accuracy, what the flow (naturalized) would be for any year scenario in the absence of abstraction. This is probably not ecologically critical for u/s of Ractonpark Dell, but being able to develop similar outputs to the 'winterbourne signatures' of the Avon system (Neil Punchard, Wessex Water pers. Comm.) would be very valuable. Having such a model, in which there can be confidence in its accuracy, is critically important if the influences of different abstraction scenarios are to be considered to restore ecological interest. We need to know, with confidence, if changes were made, what the results in discharge would be so to put changes in perspective (to natural drought variations) and determines scenario priorities (e.g. how much more augmentation?). No solutions to addressing low flow problems are likely to be effective without major improvement in understanding.
7.6 Invert and Fish Survey at Ractonpark Dell	Need to understand more precisely if this area is 'hanging on', with vulnerable/special species etc. We know that it dried in Sept-Nov 2006 and during 2003 when EA physical surveys were undertaken, and all evidence suggests it NEVER dried before Walderton became operational.
7.7 Fish Surveys in the lower Ems	It is clear that very little is known about the fish populations of the lower Ems, despite an undoubted importance a century ago, and still the presence of sea trout and the HR species Bullhead. More information will be a critical need to help guide the recommendations for amending augmentation flows (if agreed a sensible approach).

Above some key tasks have been identified in relation to abstraction and flow, as well as survey. The expected outcomes of the former investigations would be to help understand the significance that abstraction, as opposed to natural flow extremes, has on reducing flows within the various reaches of the River. Items 7.6/7 relate directly to ecology, and addressing what is considered to be the most important areas of limited knowledge.

The following section is intended to provide a more holistic picture on actions that might need to be taken that will ultimately provide good opportunities for reversing degradations. The justification for the recommendations made here is an outcome of the appraisal carried out in this study (summarized in previous chapters). The list of nine 'work items' listed in Box 7B; are not in order of priority, nor considered to be so comprehensive that others should not be added. They are, however, considered to be realistic 'actions' that could be costed with reasonable accuracy, bring significant environmental benefit, and could be undertaken within a time-scale of five years. Most need not wait until abstraction issues are more objectively determined, since they would bring environmental gain in the absence of possible abstraction impacts being resolved.

Box 7B Actions Recommended to Improve Degradation, and Protect Existing Interests

Task	Description and Justification
7.8 Emergency actions if the reach between the augmentation and Westbourne Mill drying'	Water voles, fish (and some invertebrates) are likely to be the long-term casualties of the bed drying, as all the aquatic plant species recorded from the reach are known to reproduce well from seed when suitable conditions return (or they can persist in terrestrial forms). Very small fish and some invertebrates may survive below the surface, providing water remains here. Large fish such as trout are likely to either die or be predated on by herons etc. as they retreat to the diminishing puddles, and eels would migrate downstream. To help protect small fish and invertebrates, it would be recommended that augmentation be increased just for the period in which leakage exceeds augmentation – this may not be needed in many years, or for long. Cooperation of the landowners, EA and assistance of PWL would be required, but early signs are that this would be looked on favourably. **This is recommended to be implemented immediately, but present weather suggests will not be called upon in 2007.**
7.9 Improving migration/ passage for fish & Flood Defence Management	There is an urgent need for a WLMP. This is not only good (essential) for fish, but could resolve other issues such as flood risk and also incorporate habitat enhancement. The Rofe *et al.* (1995) report identified that cooperation in management of sluices is not as good as it should be, and it compromises FD management of flood risk.
7.10 Implementation of best practice vegetation management	There is often a dichotomy of opinions on what is the proper way to manage the river, but many personnel on the river expressed concern that more work was done than was necessary for flood defence that was environmentally damaging. The EA has guidance on good practice, which recommends leaving margins uncut to allow habitat to remain, and also enable the cleared part of the channel to have increased velocity to cleanse silt from the bed to keep gravel here clean. For water voles it is important to retain bankside vegetation as food and cover. A flood defence maintenance proposal was discussed with key FD personnel in early 2007, and in-principle agreement was given for its implementation. **This is presented in Appendix 4.** Obviously it cannot be expected that this would be implemented immediately, or without more in-depth consideration. However **the author has sufficient confidence that as it would meet approval of the majority of the community of the valley, and pose absolutely no additional flood risk, it should be adopted as soon as possible**. It is recommended that either internally, or with relatively minor assistance from consultants, the EA assesses critically if there are any areas of concern relating to hydraulic requirements for flood management that would be compromised by its adoption. Since some sections will be deemed not to require any maintenance at all, and others may be suitable for a very radical shift from traditional approaches, local land-owners and the local communities affected should be informed of the plans through invitations to public meetings and printing simple leaflets to explain what is proposed, and why. It would not be fair to state that I did not meet one person who thought the EA did not clear enough weed!! The implementation of the recommendations would be cost-neutral in the first year (off-set costs of reduced maintenance spent on consultation), and save money in the future. **Whatever is done in this area, it must be clearly demonstrated not to increase risk of property flooding – preferably reduce it by also utilizing floodplain conveyance where suitable.**

7.11 Programme of chalk stream rehabilitation	A programme of river rehabilitation, on selected stretches of the river, is proposed since this could make fundamental differences to the ecological health of typical chalk stream species within the catchment. Potential exists at two locations (**four separate projects)** for habitat enhancement with in-principle support from the landowners. Outline ideas for remediation measures have been prepared (see Appendix 3). These have been discussed with flood defence personnel and the majority of the owners/riparian interests so that implementation could be advanced very rapidly if funding became available. One of the two areas proposed requires virtually no cost **(maximum £2k for two projects)** but could make a difference to over 1km of potential improved chalk stream habitat (one project is upstream of benefits where the other **'no-cost improvement project'** has already been implemented – see Appendix 3). The other area for two projects has more problems to over-come, and would involve considerably more cost. It is a programme that would specifically fulfill many of the requirements set out in the chalk stream BAP targets (BAP Steering Group; 2005), help meet WFD obligations, and contribute significantly to the Public Service Level Agreement targets for biodiversity set for FRM actions to achieve.
7.12 Continued, and enhanced, programme of biological monitoring and analyses to help provide a clearer understanding of the biological response to natural and abstraction-induced low flows, river rehabilitation etc.	It is imperative that the present level of survey of invertebrates and fish continues, so that progress can be made to refine our understanding of the communities (especially fish and invertebrates) in the various stretches of river. In addition to invertebrate and fish monitoring, setting up permanent macrophyte monitoring on the river is also recommended. These should be ideally located where the physical characteristics are least impacted by other factors such as impoundments so that the more typical chalk stream '*Ranunculus*' community (Habitats Regulation feature interest) is monitored. Monitoring fish, invertebrates and macrophytes is also recommended to take place in tandem with any river rehabilitation works so that the effects of such works can be gauged in biological terms.
7.13 Seek urgent action to gain protection for the Racton Park Dell Area	Minimum recommendation is to extend the SNCI, or create an additional one. This is an action recommended for the Biodiversity team of EA in consultation with West Sussex County Council and the owner, and might progress in advance of gaining more information (recommendation 7.6) or await the results in the anticipation that it will support the case.
7.14 Acknowledge importance of winterbourne regarding rare inverts (ICI)	The very limited information from recent invertebrate surveys highlights that winterbournes, even if there is no flow in them for several years, are important for supporting rare invertebrate taxa. This provides strong support for protection of the channels from development pressures that could lead to loss (culverting) or degradation (e.g. oil pollution). Actions should include re-enforcing the message to the local planning authority and ensuring they fully understand their importance.
7.15 Eradication of Aliens	The time spent undertaking the study suggests that the bankside alien plants Japanese Knotweed (*Fallopia*) and Indian balsam (*Impatiens*) are not present in the catchment. Many catchments are seriously impacted by such plants, and once established they are virtually impossible to eradicate; however, if treatment is given once they first appear, their removal is relatively simple. It is therefore recommended that a programme of eradication is implemented immediately they appear, if they do so. Mink is an important predator that probably has the most influence on water voles – when they appear, a coordinated eradication programme is required. This could only succeed if the EA was supporting a locally coordinated action with the support of the whole community and landowners/users.

7.16 Consider lower Ems as a crayfish refugia	Whilst there have been no records found for native crayfish in the Ems, the lower reach appears very suitable (especially the semi-natural section between Westbourne and the gauge at the Wren Centre). The present lack of angling interest means there is no trout stocking. As populations are declining rapidly, refugia site (once shown to be free of signal crayfish and other risks) may be increasingly used. If so, the Ems is recommended as an ideal site for translocation from other sites within the same geographical area where numbers are healthy and numbers are kept in check by predation (e.g. crayfish common in otter spraints). Several surveys would be required to ensure there are no native crayfish in the catchment or risk of infection from the plague.

The recommendations, if implemented, would make a considerable contribution to many nationally significant initiatives and responsibilities. International obligations under the WFD would be put in place, as well as help meet FRM Service Level Agreement targets set by the EA. Being a stream, the Ems has special significance as a BAP habitat. BAP targets for such habitats have been set through consultation with JNCC – see summary below provided by the chalk stream steering group chairman, Lawrence Talks.

New UK BAP Chalk River Targets	
No.	Target description
DESIGNATED CHALK RIVERS	
T1	Achieve Favourable Condition (FC) for all Sites of Special Scientific Interest (562 kilometres)
NON-DESIGNATED CHALK RIVERS	
T2	Achieve at least good ecological quality
T2.1	Chalk river physical habitat restoration.
T2.2	Achieve ecologically acceptable target flow regimes
T2.3	Achieve high water quality objectives – GQA
T2.4	Achieve high water quality objectives - phosphorous (<0.06ug/l and 0.04 ug/l for headwaters)
T2.5	Control of key non-native species impacting - Signal crayfish, mink, Japanese knotweed & Himalyan balsam.

T1 is focussed on bringing designated chalk rivers up to 'favourable condition', and therefore is not of relevance to the Ems. T2.1-2.5 aims at protecting and improving non-designated chalk rivers, which are the principle objective of the BAP. These targets are based on the recommendations in The State of England's Chalk Rivers (2004). T2.3 and 2.4 are met on the Ems, and measures proposed should help to maintain this. T2.1,4,5 are addressed by the recommendations.

The EA has also promoted the **'Cinderella' Chalk Rivers Project**. This is about working with local communities, trusts, fishing clubs, landowners and others to restore our often forgotten 'Cinderella' chalk rivers. These are primarily non-designated chalk rivers such as the Ems, that are often under the greatest pressure, from housing and infrastructure development, water abstraction, effluent discharges, land drainage and climate change. Again the recommendations, if implemented, would achieve many of the aims of this project. There are now a number of active community based chalk river partnerships across the country. Perhaps an additional recommendation would be to establish such a partnership project for the whole of the Ems, building upon the existing BMCS to the south and the Westbourne Parish Council management proposals at the heart of the catchment. If this was set up on the Ems it would provide a more holistic focus for conservation efforts to protect one of Sussex's special rivers.

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Glossary of abbreviations

AONB	**Area of Outstanding National Beauty**
BAP	**Biodiversity Action Plan**
BMCS	**Brook Meadows Conservation Society**
BTO	**British Trust for Ornithology**
CAMS	**Catchment Abstraction Management Strategy**
CCGMU	**Chichester chalkblock groundwater management unit**
CFMP	**Catchment Flood Management Plan(s)**
COW	**Critical Open Watercourse**
Cubic metre (m^3)	**Cubic metre(s) = 1,000 litres**
Cumec(s)	**Cubic metre(s) per second (1 cubic metre = 86.4Ml/d)**
Defra	**Department of Environment, Farming and Rural Affairs**
EA	**Environment Agency**
EAFR	**Ecologically Acceptable Flow Regime**
ECSFDI	**England Catchment Sensitive Farming Delivery Initiative**
EN	**English Nature**
FD	**Flood defence (EA)**
FRB	**Fisheries, recreation and Biodiversity (EA)**
FRM	**Flood Risk Management**
GEP/MEP	**Good/Maximum Ecological Potential (WFD)**
H/SAP	**Habitat/Species Action Plan**
HMWB	**Heavily Modified water body (WFD)**
HR	**Habitats Regulations**
HR	**Habitats Regulations**
mgd	**Millions gallons a day (1mgd = 4.464Ml/d)**
Ml/d	**Megalitres per day (1 megalitre is 1,000,000 litres)**
Ml/d	**Megalitres per day (1 Ml/d = 0.01163 cumec)**
NERC	**National Environment and Rural Communities Act (2006)**
NFMS	**National Fish Monitoring site**
NRA	**National Rivers Authority**
PPS	**Policy Planning Statement**
PWL/Co	**Portsmouth Water Company/Ltd**
Q95	**River discharge value that is exceeded for 95% of the time**
RH/CS	**River Habitat/Corridor Habitat Survey**
RIVPACS	**River Invertebrate Prediction and Classification System**
SAC	**Special Area for Conservation**
SBRC	**Sussex Biological Records Centre**
SBRC	**Sussex Biological Records Centre**
SNCI	**Site of nature conservation interest**
SPA	**Special Protection Area**
SRA	**Sussex River Authority**
SSSI	**Site of Special Scientific Interest**
STW(s)	**Sewage Treatment Work(s)**
ToR	**Terms of Reference**
UWWTD	**Urban Waste Water Treatment directive**
WCA	**Wildlife and Countryside Act**
WFD	**Water Framework Directive**
WLMP	**Water Level Management Plan**

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