EMER BOG cSAC: Review of Consents

Surface water quality and hydro-ecological regime of Emer Bog cSAC

For
Environment Agency: Hampshire and Isle of Wight Area

In partnership with
English Nature: Hampshire and Isle of Wight Team
Test Valley Borough Council: Planning Service
Hampshire and Isle of Wight Wildlife Trust

R H Allen BSc Hons Geol (Lond), ARSM, EurProBiol, CBiol, MIBiol, MIEnvSc, MEWI
The Environmental Project Consulting Group
44A Winchester Road, Petersfield, Hampshire GU32 3PG
Tel: 01730 231019 Email: ra@epcg.co.uk
Fax: 01730 231021
Webpages: www.epcg.co.uk www.hydro-ecology.co.uk

22nd April 2003

EMER BOG cSAC: Review of Consents
Surface water quality and hydro-ecological regime of Emer Bog cSAC

CONTENTS

EMER BOG cSAC: Review of Consents
Surface water quality and hydro-ecological regime of Emer Bog cSAC

SUMMARY

Background

This report provides an account of the hydrology and hydrochemistry of the wetland part of Emer Bog (a candidate Special Area of Conservation cSAC) in south Hampshire. It provides a background study to the Environment Agency's Investigation into the water quality and hydrological regime of Emer Bog, part of their Review of Consents process, being conducted in accordance with the Habitats Regulations. .

This report builds on earlier hydrological field work (Ron Allen 1996), a vegetation survey (Neil Sanderson 1998) and a desk study (Ron Allen March 2002). New work undertaken for this report has included: an outline topographic survey; revision mapping of wetland habitat distribution; determining peat depths along two transects; and a detailed analysis of 64 water samples.

Ecology

Emer Bog is notified as cSAC on account of the presence of the Habitats Directive Annex 1 Transition Mires and Quaking Bogs. Broadly, the site comprises an open area of swamp and mire habitat together with two lakes and areas of reed bed and bounded by mature willow and birch woodland and open heathland. Emer Bog is part of a wider biodiverse cultural landscape and which holds other local ecological designations as well as providing a buffer to the surrounding managed agricultural land and the urban areas of Romsey, Chandler's Ford and North Baddesley.

The open wetlands at Emer are transition mires and quaking bogs, of types threatened in a European context and considered to be one of the best such areas in the UK (English Nature 02/03/01).

Previous studies have shown that the vegetation comprises plant communities typical of basin and valley mires, and areas of seepage that have developed in an area of high groundwater located within a shallow basin-like structure set into the flanks of a ridge, the water ultimately draining to the river Test. The wetland area may have developed from one-time open water, and which would explain the presence of quaking fen habitats. In contrast, are the acid grasslands on seasonally waterlogged soils at Baddesley Common and which include a flowing stream arising from springs outside of the site.

Geology

Land within, and around, Emer Bog is underlain by clays, and clayey sands, of the Tertiary Wittering Formation and which strata dip gently 1-2 degrees to the south. These deposits give rise to heavy seasonally waterlogged soils that are difficult to work for agriculture. Sandier deposits occur on higher land and give rise to springs feeding the wetlands. Springs in the east tend to be acidic and those to the south, circum-neutral or even slightly alkaline.

The main wetland area of Emer Bog is underlain by peat and loamy peat attaining more than 2m thickness in places. Peat deposits occur in two basins, a lower basin on level land and a higher basin set into the gently sloping valley side. Water levels in the wetlands vary and this creates flooding in winter and drier conditions in the summer.

Hydrology

Water is sourced from a small surface and subsurface catchment and passes into the site from small surface streams, springs and seepages, and also from perched groundwater. Water is lost from the site by surface flow towards a stream in the north, and possibly, also by summer percolation into underlying strata. The water in the wetlands varies from strongly acidic to mildly alkaline and is generally rich or very rich in plant nutrients such as phosphorus and nitrogen. The cause of this nutrient richness remains unknown but is presumed to arise from the soil and substrate materials through which groundwater passes to reach the wetlands.

It is concluded that much of the high fertility of the pools and wetland habitats is most likely to be generated from within the mire system rather than from external surface sources. Agricultural inputs could arise from the southeast of the site, but the evidence in this report is that these are relatively minor and are quickly assimilated into the wetland system.

Effects of consented discharges and abstractions

Six Environment Agency consented discharges occur to the east and northeast of the site, and one occurs to the south. Those discharges to the east and northeast are considered to be too small and remote to adversely affect the integrity of Emer Bog cSAC. Any surface flows arising from these discharges would be prevented from reaching the mire by intervening boundary drains.

Any groundwater discharges of plant nutrients from these sources that did reach the system are likely to be very small in relation to the existing nutrient loading within the mire system and so would be negligible/undetectable, when considered alone and in combination. The southern discharge point is not in use and the intended discharges are passed into a different sub-catchment, the outfall of which bypasses the mire system. There are no known licensed abstractions that are likely to significantly affect Emer Bog.

Habitat vulnerability

Of concern however, is the vulnerability of the small area of *Carex rostrata – Sphagnum squarrosum* Mire (NVC category M5). At Emer, this habitat is both particularly acidic and relatively rich in plant nutrients compared to more typical conditions. To one side of this habitat is a source of acidic water, and to the other a source of circum-neutral water. The acidity appears to support the plant communities, but the high nutrient levels are likely to be antagonistic to the community. This means that the community could be in decline, or could be very vulnerable to any increases in plant nutrients reaching the site.

Evidence is that the bog was more acidic in 1996 than in 2001 and the M5 community may have been more widespread prior to that time. If rising nutrient-rich groundwater fed surface waters spread eastward from the adjacent fen into the M5 community, that community could be degraded by unsuited water chemistry. It may be that the summer drying, and presence of acidifying *Sphagnum* bog-mosses, may restore acidity in the soils every summer, only to be replaced by less acidic and more nutrient-rich conditions as the area becomes wetter in winter. Whatever the situation, the M5 community is restricted in extent and particularly vulnerable to hydrochemical change.

Conclusion

This report concludes that the discharge licences being assessed in the Review of Consents process, when considered alone or in combination, are not adversely affecting the integrity of Emer Bog cSAC.

EMER BOG cSAC: Review of Consents
Suface water quality and hydro-ecological regime of Emer Bog cSAC

1.0 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

Emer Bog is part of Baddesley Common Site of Special Scientific Interest (SSSI), a candidate Special Area of Conservation (cSAC) (**Appendix 1**) and a nature reserve of the Hampshire Wildlife Trust.

The Environment Agency is undertaking a Review of Consents in accordance with the Habitats Regulations in order to assess possible conflicts between nearby discharge consents and the critical hydrology of the sensitive wetland wildlife habitats. This study compiles information from previous work and presents the results of new work commissioned by the Environment Agency and the Review Group, which also includes English Nature, Hampshire Wildlife Trust and Test Valley Borough Council.

The investigation reported on here is not intended to be rigorously scientific, but rather to provide pointers as to the hydro-ecological conditions pertaining to the site and any possible adverse impacts on ecology from licensed discharges.

On the basis of the information presented it is concluded that there are no consented discharges (or abstractions) within or outside of the site that are adversely affecting the integrity of Emer Bog cSAC, either alone or in combination.

Concern is expressed that the most sensitive plant communities are vulnerable to hydro-chemical change leading to higher than desirable levels of plant nutrients, especially of phosphorus.

A series of drawings are provided that illustrate the distribution of key water parameters together with a final drawing setting out a broad hydrological conceptual model.

1.2 ROLE OF THE ENVIRONMENT AGENCY, ENGLISH NATURE AND THE HAMPSHIRE WILDLIFE TRUST

The Environment Agency has a role under Regulation 50 of the Habitats Regulations to review extant consents and permissions (Review of Consents – RoC) that are likely to have a significant effect on a European site in order to determine if any are adversely effecting the integrity of the site. As a result of that process, the Agency must affirm, modify or revoke licences/permissions accordingly. This process is part of a pan-European effort to maintain at (or restore to) favourable condition natural habitats and wild flora and fauna. This study will inform the Environment Agency's decisions as part of their Review of Consents.

English Nature is the Government's statutory advisor on nature conservation issues. They have a responsibility to ensure that Special Areas of Conservation, such as Emer Bog, are maintained at a favourable conservation status and to advise public bodies such as Test Valley Borough Council and the Environment Agency regarding the implications of their activities on the conservation status of cSAC sites. This study will also inform English Nature about trends occurring on the site.

Hampshire Wildlife Trust is both the owner and manager of the site and has a responsibility to maintain the favourable status of the site for biodiversity by conservation management according to a management plan.

1.3 LEGISLATIVE BACKGROUND

Section 48 of the Conservation (Natural Habitats, &c.) Regulations 1994 requires, in respect of a plan or project likely to affect a European site, that an appropriate assessment be undertaken of the implications for the site in view of that site's conservation objectives. That plan or project should only be agreed where it will not adversely affect the integrity of the European site. Section 50 of the Conservation Regulations also requires a review of existing decisions that may affect a European site.

The explanatory notes to the Countryside and Rights of Way Act explains that Section 28G of Schedule 9:

> 'imposes a duty on "public bodies" in exercising their functions to take reasonable steps, consistent with the proper exercise of those functions, to further conservation and enhancement of special features on a SSSI. This applies where the public body is exercising its statutory function on a SSSI or on land outside of the SSSI where those functions might affect a SSSI.'

2.0 REGIONAL SETTING

2.1 LANDSCAPE, LANDUSE AND LANDFORM

2.1.1 Landscape

Examination of the 1:50 000 scale Ordnance Survey map reveals that Emer Bog lies within a wide area of undulating countryside between the south trending valleys of the river Test to the west and of the river Itchen to the east. However, the more detailed form of this land also reflects the major topographic distinctions between the higher **Chalklands** north of a west-east line between Michelmersh and Shawford about four miles north of Emer Bog and the **Lowland Mosaic** to the south (of which the land within and around Emer Bog is part).

Emer Bog is midway between the developed areas of Romsey in the west and Chandler's Ford/Eastleigh in the east (see **Drawing 1**). The City of Southampton is to the south while land to the north is more open and less developed. The Hampshire Landscape (HCC 1993) indicates that this area of countryside is divided into an eastern area of mixed farmland and woodland and a western 'ancient' landscape area (which includes Emer Bog) of heath associated pasture and woodland. This latter landscape is similar to the marginal areas of the New Forest and (together with other small areas of land between Portsmouth and Southampton), represents remnants of a one time much wider heathland landscape.

2.1.2 Landuse

The surrounding land is mostly cultivated for cereals or ley grassland. The site itself (together with land to the south) has a mixture of acid grassland, heathland and agriculturally unimproved neutral grasslands with scattered ancient woodlands and more recent secondary woodland and scrub. The land forms a large single area between Pound Lane in the east and Warren Farm in the west. Land-use of the surrounding area is more fully described in the March 2002 report for Test Valley Borough Council.

2.1.3 Landform

The land around Emer Bog occupies a lower landscape area at 35-40m AOD between significant higher land to the north around Ampfield, and to the dissected higher lands around Toothill and Chilworth to the south, which rise to about 55-60m AOD. The topographic relationships are more fully described in the March 2002 report for Test Valley Borough Council.

2.2 ECOLOGY

Much of the land in the vicinity of Emer Bog, especially to the south, is of ecological significance. The following sites have been identified, as being of special significance.

2.2.1 Sites of European and UK Significance

There are two sites, both of which have very similar (although not identical) boundaries.

Emer Bog candidate Special Area of Conservation (cSAC)
: This area (the subject of this report) has been recommended as a Special Area of Conservation (SAC) because it contains transition mires and quaking bogs that are rare or threatened within a European context.

Baddesley Common SSSI
: The SSSI citation explains that this is an extensive valley bog (Emer Bog) with associated damp acidic grassland, heathland, and developing woodland. Emer Bog is an excellent example of an ungrazed valley bog with a rich flora and fauna. To the south and west of Emer Bog, the SSSI includes remnants of former common land, now acidic grassland.

2.2.2 Sites of County Importance

There are many heathland, grassland and woodland **Sites of Importance for Nature Conservation** (SINCs) within the close vicinity of Emer Bog occurring often in clusters of contiguous or closely spaced sites. These sites, which comprise the ecological setting of Emer Bog, are further described in the March 2002 report for Test Valley Borough Council.

2.3 HYDROLOGY

Emer Bog is located just west of the north-south trending Pound Lane topographic ridge and which forms the divide between the major catchments of the Test and Itchen rivers (see **Drawing 1**). Higher land to the south, at

Chilworth and Toothill, divides these catchments from that which drains south through Southampton to the Solent.

The main watercourses in this broad area are the Tadburn Lake stream that flows west to the Test, the Monks Brook that flows east and northeast to the Itchen, and the Tanners Brook that flows south through Southampton.
The Tadburn Lake stream has a wide catchment extending from Ampfield Wood in the north to Baddesley Common in the south. Emer Bog occurs at the head of part of this system on the west facing slope of the Pound Lane ridge near Bucket Corner.

2.4 GEOLOGY

The geological setting and a cross section through Emer Bog are illustrated in **Drawing 2**.

2.4.1 Solid Geology

Solid geology refers to deposits laid down prior to the start of the Quaternary ice ages (**Table 1**). The large area of clayey and sandy lowland which includes Emer Bog and lies to the south of the Hampshire chalklands, forms a northern part of the Hampshire Tertiary Basin. This geological basin extends east from Dorset across to Portsmouth, and south to include the northern part of the Isle of Wight.

The geology of the Tertiary Basin is exceedingly complex and individual formations have sequences of different sandy, loamy and clayey lithologies and which vary laterally and with depth and thickness. In the area of Emer Bog, the angle of dip is likely to be between 1 and 2 degrees to the south.

The youngest strata in the vicinity of Emer Bog, are greenish sands (containing the mineral glauconite) of the Earnley Sand Formation (part of the Bracklesham Group). These strata crop out south of the Flexford Road. Cropping out from under the Earnley Sands are sands and clayey sands of the Wittering Formation (also part of the Bracklesham Group) and which form the surface in a broad swathe of land across the centre of the site, either side and to the south of the railway line.

Table 1. Stratigraphy within the wider area

Bracklesham Group	**Earnley Sand Formation** About 10m thick		Glauconitic sands
	Wittering Formation About 34m thick		Mainly brownish-grey laminated clays; sands with clay bands; clayey sands; beds of glauconitic sands. (underlies Emer Bog)
London Clay Formation	**London Clay** 53-114m thick	**Pebble Beds** 1-2m thick	Pebble beds
		Whitecliff Sand Member 0-14m thick	Yellowish brown medium to fine-grained sands
		Nursling Sand Member 0-20m thick	Very fine-grained sands to extremely silty and clayey very fine-grained sands
		London Clay 53-114m thick	Olive-grey sandy and silty clays
Reading Formation About 24m thick. (not exposed at surface)			Mainly mottled clays with some sand beds
Upper Chalk Over 60m thick (not exposed at surface)			Chalk with flints

2.4.2 Drift Geology

Drift deposits have been laid down since the start of the Ice Ages and up until the present time. The main drift deposits in the vicinity of Emer Bog shown on the published geological maps are:

River Alluvium
Clayey material occurring on river floodplains (also containing peat and tufa).

Head Gravel
Flinty loamy material infilling lower land locally, probably much more extensive than shown on the published maps.

River Terrace Deposits, mainly gravel
Mainly sandy and flinty deposits occurring on level land along the Test and Itchen valleys and on the Solent coastal strip. Higher and older inland terraces tend to be more clayey.

River Terrace Deposits, mainly loam and clay
Loamy and clayey deposits overlying gravelly terrace deposits.

River Terrace Deposits, undifferentiated
Isolated older terrace remnants on higher land and hill tops.

2.5 SOILS

The distribution of soil types (material within the rooting zone) is related to the geological substrates from which they have been formed although the character of individual soil types varies considerably according to the extent that different soil forming processes have acted including leaching, waterlogging, aeration, biochemical reactions and the accumulation and incorporation of organic matter.

The broad characteristics of the soil types in the wider area are shown on Sheet 6 of the 1:250 000 scale Soils of England and Wales published by the Ordnance Survey for the Soil Survey of England and Wales in1983, and in the accompanying Legend and Bulletin. This map shows the distribution of 'soil associations' and which are areas with a recognisable range of associated soil types. Unfortunately, the scale of the map precludes delineation of land parcels the size of Emer Bog.

Careful examination of the map and the accompanying Bulletin shows that the catchment of Emer Bog is characterised by slowly permeable seasonally waterlogged fine loamy over clayey and coarse loamy over clayey soils, and similar more permeable soils with slight waterlogging and some deep coarse loamy soils affected by groundwater. The component soils within this area are extremely varied but seasonal surface waterlogging, with areas of lesser and greater waterlogging, are characteristic.

Soils at Emer Bog show a considerable variation. Augering at various times on site has indicated the presence of various soils (after Avery 1980):

Podzolic soils
Gley podzols
Stagnogley podzols
On higher land with bleached and humus enriched sandy layers over slowly permeable compact loams.

Surface water gley soils
Stagnogley soils
Typical stagnogley soils
On lower slopes with seasonally waterlogged loamy over clayey soils
Stagnohumic gley soils
Cambic stagnohumic gley soils
Soils with prolonged seasonal waterlogging and thin humose topsoils over slowly permeable loamy over clayey soils

Groundwater gley soils
Argillic gley soils
Typical argillic gley soils
Mineral soils seasonally affected by high groundwater
Humic gley soils
Typical humic gley soils
Mineral soils with peaty surface layers affected by high groundwater for prolonged periods

Peat soils
Raw and earthy peat soils
Soils on deep peat usually with raw fibrous surface layers becoming humified at depth on the open mire and with deep humified peat from the surface below woodland on slopes.

2.6 LANDUSE

Woodland, much of it ancient, is well distributed across the study area and much of the remaining area is grassland of various types including permanent and ley grassland. There are also significant blocks of cultivated land, mostly down to cereals or managed grassland. The one-time common land at Baddesley Common contains a mixture of improved rough grassland, agriculturally unimproved grassland with small areas of fen, and tracts of acid grassland, *Molinia* grassland and heathland. Mire habitats occur within Emer Bog nature reserve. There is a golf course at Ampfield.

2.7 CLIMATE

Emer Bog cSAC is within about 25km of the south coast of the UK and is affected by proximity to the sea similar to a broad belt of land extending from Bournemouth in the west to Hastings in the east. The regional climate is unexposed moderately warm and slightly moist climate (Bendelow and Hartnup 1980) and has an average annual rainfall of about 800mm with rainfall well-distributed throughout the year peaking in November and December and with least rainfall in March, April and June.

3.0 EMER BOG cSAC

3.1 ECOLOGY

3.1.1 Site designation

Emer Bog candidate Special Area of Conservation

Emer Bog was recommended initially as a possible Special Area of Conservation (EN 18/05/00) and later as a candidate Special Area of Conservation (EN 02/03/01) because: **'it contains transition mires and quaking bogs which are rare or threatened within a European context and which are considered to be one of the best areas in the United Kingdom'.**

The 02/03/01 citation states that:

> Very wet mires often identified by an unstable 'quaking' surface. These are mires or fens that occur in waterlogged situations where they receive nutrients from the surrounding catchment as well as from rainfall. The vegetation is typically dominated by tall sedges *Carex* species and rushes *Juncus* species mixed with herbs over a ground layer of bog-mosses *Sphagnum* species or feather mosses such as *Calliergon* species.

The area is 37.5ha coincident with Baddesley Common SSSI but excludes a spur of woodland.

3.1.2 Management

Pond Construction

Ian Stone at the Hampshire Wildlife Trust has indicated that aerial photographs show that the two large ponds on the site were constructed between 1969 and 1971. Excavation and establishment of these ponds created a major change to a large part of the site, altering the way in which water flows towards the open wetlands today.

Removal of scrub

In the 1980's, what today is open mire and swamp was covered in willow scrub. The Hampshire Wildlife Trust has been gradually clearing the scrub to create the open area seen today. The woody arisings were burnt on site close to where they were cut. This would have led to minor nutrient enrichment, although this would be mainly of potassium salts and which are soluble and easily washed through the system.

3.1.3 Vegetation

Neil Sanderson's 1998 report provides a boundary to the wetland habitats and describes the vegetation of the northern wetland and wet woodland part of the SSSI as seen on 28th October that year. His report should be referred to for detailed discussion of the plant communities present.

Drawing 3 in this report provides a revised and more accurate base map on which the boundaries of wildlife habitats have been plotted and which also shows the most likely plant communities identified in Neil Sanderson's 1998 report. Re-survey is recommended using the new topographic survey base map.

The open part of Emer Bog comprises a swathe of wetland passing east-west across the site and bounded by woodland variously derived by invasion of trees and shrubs into one time open areas.

Neil Sanderson (1998) considers this to be an unusual mire system, which includes:

- A sizeable basin mire in the middle
- Seepage mires in the east; and a
- Valley mire to the west.

The occurrence of *Carex rostrata-Sphagnum squarrosa* Mire (NVC=M5) and *Carex-Potentilla* Tall Herb Fen (NVC=S27) are regarded by JNCC as forming part of the Habitats Directive Annex 1 54.5 **Transition Mires and Quaking Bogs**.

3.1.3.1 Open Swamp and Mire Communities

a. Western Open Area

S27 *Carex rostrata – Potentilla palustris* Tall Herb Fen with small open pool

The western part has a large area of open *Carex rostrata – Potentilla palustris* Tall Herb Fen (NVC=S27) with *Carex rostrata*, *Eriophorum angustifolia* and *Menyanthes trifoliata* with an understorey of grasses, mosses, sedges and some herbs including *Lycopus, Hydrocotyle, Epilobium palustre* and *Lotus pedunculatus*. This plant community includes species typical of more base-rich conditions as well as those of more acidic conditions and the inclusion of areas of *Sparganium erectum* Swamp (NVC=S14) further indicate a tendency to more mesotrophic or eutrophic conditions.

Some areas are *Juncus* dominated (NVC=S27j). Neil Sanderson suggests that this community is typical of the early stages of the development of peat from open water and that there is historic evidence for open water, perhaps originating from peat cutting of a former mire. This area includes a small permanent pool and is becoming invaded with young willow growth in places.

b. Eastern Open Area

This area includes poor fen in the western part, passing to rush-dominated poor fen and then *Molinia* grassland and represents a transition from more base-rich to more base-poor conditions.

The western area of wetland comprises at first Poor Fen (*Carex rostratum-Sphagnum* Mire NVC=M5) as the tall herb fen community becomes increasingly rich in *Sphagnum* bog-mosses. Sanderson indicates that this M5 community is very rare in lowland England. The most common bog-mosses here are typical of less strongly acidic conditions. Sanderson suggests that the community is typical of Basin Mires developing from the infilling of ponds and lakes and usually develops in succession to S27 Tall Herb Fen (Rodwell 1994).

Passing eastwards, the Poor Fen community becomes more rush dominated (*Carex echinata – Sphagnum* Mire *Juncus effusus* sub-community NVC=M6ci) where birch scrub has been cleared and lacks many species typical of the Poor Fen communities to the west but includes the more acid loving *Sphagnum recurvum*. There is perhaps a tendency towards a more calcifuge community here.

M5 *Carex rostratum-Sphagnum* Mire (Poor Fen)

The easternmost area of the mire complex has *Molinia* grassland with *Calluna vulgaris, Erica tetralix* and with *Sphagnum palustre* and *S.recurvum*. Sanderson suggests that this *Molinia-Potentilla erecta* Mire *Erica tetralix* community (NVC=M25a) may have developed from wet heath by lack of grazing.

c. Mire edge communities

At a few locations around the edges are fen meadow communities typical of acidic soils on shallow peats referable to *Juncus effusus/acutiflorus-Galium palustre* Rush Pasture (NVC=M23).

Near the two ponds are patches of Reed Bed (*Phragmites* swamp S4) that Sanderson suggests may have developed due to nutrient rich groundwater brought to the surface by the ponds.

To the south-west of the open mire is an area of Wet Heath (*Erica tetralix-Sphagnum compactum* wet heath NVC = M16) developing in areas of felled birch woodland and which may represent the one time typical surrounding vegetation to the site where the land is subject to seasonal rather than permanent waterlogging.

3.1.3.2 Woodland Mire Communities

The wooded areas have developed from the invasion of former wet open habitats and are divisible into those dominated by Alder and those with Sallow and Birch.

Alder Woods

Alder woods occur to the north and south of the open swamp and mire communities along the inflow and outflow axes.

The main outflow area in the north of the site has very swampy Alder over *Carex paniculata* tussocks (*Alnus-Carex paniculata* Wood NVC=W5). The inflowing flushed area in the northeast has Alder over *Carex remota* (*Alnus-Fraxinus-Lysimachia* Woodland NVC=W7). Somewhat similar woodland but with more Sallow occurs in the southern flushed mire margins.

Sallow and Sallow-Birch Woods

Only the woodland stands on the most base-rich seepages were mapped in 1870 and large areas of Sallow woodland have developed since that time.

Of the one-time large area of Sallow woodland, much has been cleared to restore areas of Tall Herb Fen and leaving only small remnants of *Salix cinerea-Galium palustre* Woodland (NVC=W1).

Around the edges of the wetland are other woodland communities developed from the more marginal poor fen and wet heathland communities.

Two areas of Downy Birch over *Molinia*, *Sphagnum palustre* and *S. recurvum* (*Betula pubescens-Molinia* woodland (NVC=W4)) occur on the eastern margins and (from the *Sphagnum* and *Juncus* species present) were probably derived from colonisation of rushy poor fen (M6), *Molinia* heath (M25a) or wet heath (M16). Thus these represent communities of more acidic conditions.

Where the Downy Birch over *Molinia* and *Sphagnum* woodland reaches the basin mire communities (M5 Poor Fen) it appears to have been derived from them and is less acidic in character.

In the south is an area of Sallow woodland transitional to *Alnus-Fraxinus-Lysimachia* Woodland (NVC=W7) and resulted from colonisation of Rush Pasture (NVC=M23).

The central part of this area is transitional to *Alnus-Carex paniculata* Woodland (NVC=W5) and may have resulted from colonisation of species-rich fen related to NVC M5 Poor Fen community.

3.2 TOPOGRAPHY

Emer Bog and the adjacent woodland occur within a broad U shaped structure set into the north to northwest facing slopes of the Pound Lane ridge and open to the north. The land slopes appreciably at first within woodland and grassland and then very gently across the open mire and towards the Tadburn Lake stream.

The overall topographic difference (relief) across Emer Bog from the highest to the lowest point is a little over 10m with the more gentle (and almost imperceptible) slopes across the central area of the open mire and towards the Tadburn Lake in the north.

Drawing 4 in this report shows the topography of Emer Bog in some detail based on an outline topographic survey. High and mostly wooded land in the east and south of Emer Bog falls rapidly over about 12m before levelling out to a broad almost flat area on which the open mire is developed. The total fall in relief across the site from the highest land to the Tadburn Lake stream is 13m.

Note that: topographic levels (spot heights and contours) on this plan are related to an arbitrary 30m datum and have not been set relative to Ordnance Datum.

3.3 GEOLOGY

3.3.1 Peat Deposits

The open mire and wet woodlands of Emer Bog are shown on the 1:10 000 scale and 1:50 000 scale geological maps as containing alluvium (**Drawing 2**) and which is not further described although often taken to include other floodplain deposits such as peat.

Auger borings undertaken in 1996 showed that much of this area is underlain by peat overlying Head deposits. The nature and location of the peat deposits however, suggests that the wetlands are not formed on a floodplain, but have developed within an area of seepage and accumulation of small surface flows held above slowly permeable substrates.

Auger borings undertaken in August 2002 along two transects at approximate right angles, have revealed two distinct peat basins. **Drawing 5** shows the location of auger borings and the depths of peat and loamy peat layers. **Drawing 6** provides two cross sections through the peat basins.

A lower basin developed on the level land, extends south across the Alder woodland and the open swamp and mire habitats. The peat is generally well-humified and is between 1m and over 2m thick.

The upper basin sits below Willow woodland on the southern valley side and extends almost to the upper margin of the site. The gently sloping surface of the basin rises a total of 5m and the peat depth varies from about 30cm to over 200cm. Interestingly, the deepest peats are on the middle - upper valley side.

3.3.2 Mineral Deposits

The surrounding area of heathland within the cSAC and including the acid grasslands of Baddesley Common is shown as being underlain by the Wittering Formation with the overlying Earnley Sand occurring to the south. This same material underlies the peaty deposits. The Wittering Formation is locally covered with thin loamy and flinty Head, arising from surface deposition during the Quaternary Ice Ages.

The Wittering Formation is described on the 1:10 000 scale Geological Map for the location as containing:

- mainly brownish grey laminated clays;
- sands with clay bands;
- clayey sands; and
- beds of glauconitic sands.

There are three boreholes near to the site within the Wittering Beds.

Borehole SU42 SW 39

This borehole is located on high ground to the south of the Bog near Body Farm at GR 4003 2098 at about 51mAOD and on the Junction of the Earnley Sand and the Wittering Beds. The borehole was 12.85m deep and extended to 38m AOD and so the lower part is equivalent to the strata near the highest land at Emer Bog.

At this depth the different horizons in Wittering beds are described variously as medium-grained sand with a few thin ((2-3mm) bands of extremely sandy clay, very sandy clay with lenticles and partings of very fine-grained sand, very sandy clay with thin lenses and partings of fine-grained sand, and sand with a few thin (2 to 3mm) bands and thicker bands of sandy clay.

Borehole SU32 SE 15

This borehole, located at the southern-most tip of Emer Bog near the northern tip of Lights Copse at GR 3976 2122 at about 40.5m AOD, penetrated 3m of Wittering Beds. These beds are described as clean sand with a few clayey sand bands.

Borehole SU32 SE 16

This borehole, located at about 7.5km west of the centre of Emer Bog at GR3898 2178 at 28m AOD revealed extremely clayey fine-grained sand over sandy clay and clayey sand.

Overall, the Wittering Beds appear to be of variable layers of fine sandy clay and clayey fine sand with bands of fine sandy and clayey material.

3.4 MINERAL AND PEAT SOILS

3.4.1 Mineral Soils

The land at Emer Bog cSAC is included with the Wickham 3 Soil Association described in outline in Section 2.4 above and which also includes much land in the New Forest. This land has a varied suite of soils, which in this area are developed over generally poorly drained substrates on thin loamy drift over Wittering Formation.

These soils, which were mapped for the Soil Survey of England and Wales by Ron Allen (Ordnance Survey 1983) and are described in Jarvis *et al* 1984, occur where thin loamy drift covers Tertiary clays and loams on gently undulating land. Fine loamy or fine silty over clayey poorly drained Wickham soils on slowly permeable substrates are the most widespread soil type, but similar coarse loamy over clayey Kings Newton soils occur widely where there is a source of superficial coarse loamy material. Footslopes and low-ways often have deeper loamy Curdridge soils that are affected by high groundwater. Similar deep loamy soils on upper valley slopes have better drained Bursledon soils that are affected by only slight seasonal waterlogging.

Most of these soils have slowly permeable subsoils and, after prolonged periods of heavy rain in winter, excess water is disposed of by lateral flow. Where the soils are undrained, such as on older pastures and unimproved grasslands, the loamy over clayey soils are waterlogged for long periods in winter. This waterlogging limits cultivations to the autumn and on the heavier areas, the land can be difficult to manage and is naturally acidic ensuring that much of the land is down to permanent or long term ley grassland or remains as unimproved grassland or woodland.

3.4.2 Peat Soils

The peat soils occupy too small an area to be separately depicted on the 1:250 000 scale soil map, but were examined in 1996 when 13 auger borings were made in the wetland area and again in 2002 when a further 33 auger borings were made.

Within the open mire, peat depths were typically 40-100cm from the surface. An area about 100m east of the boardwalk had 1m of peat and just to the north of this the deepest peat located was 1.6m thick. Peat depths increased to over 200cm below the alder woodland to the north of the open swamp and mire.

There was a relationship between peat depth and with the mire communities identified by Sanderson (1998). Within the area of *Carex-Potentilla* Tall Herb Fen (S27), peat depth varied from less than 20cm at the edges to 100cm in the northern part. Within the *Carex rostrata-Sphagnum* Mire (M5) with Poor Fen, the peat was of intermediate depth at 60cm. At the small area of *Juncus* dominated *Carex echinata-Sphagnum* Mire (M6) the peat had further thinned to between 18 and 39cm. Passing east out of the wetter land onto the *Molinia-Potentilla* Mire (M25a) the peat depth had reduced from 13cm to 3cm.

In the open tall herb and poor fen area (S27 and M5), surface peat layers tend to be rich in fibrous *Sphagnum* or *Molinia* fragments, but with depth the peat is always well humified sometimes with the soft remains of grasses or sedges and sometimes with *Phragmites* leaves. Woody peat with twigs occurs occasionally. Within the *Juncus* dominated Poor Fen (M6), the shallow peats tended to be composed of fibrous *Sphagnum* remains throughout but the profiles are disturbed by scrub clearance and layers have become mixed in places.

Within the birch, willow and alder woodland to the north of the open area, peat depths reached their maximum at over 200cm and the peat was well humified throughout.

Below the peat there is usually a layer of dark silty clay loam that is often rich in organic matter or has peaty layers, otherwise the peat usually passes to sandy clay loam, sometimes with flints. In places, the mineral substrate contained unidentified pale cream clayey material that was locally very slightly calcareous. When tested in 1996, the peat was typically strongly acidic (pH 4-5) in the surface but became neutral at depth.

Peat in the upper basin is almost wholly below wet willow woodland and at over 200cm deep in the upper part of the slope was surprisingly deep. Substrates tended to be fine grained loams and clays.

3.4.3 Soil water levels

Two perforated plastic dipwells (standpipe piezometers) have been installed at Emer Bog to about 1m deep.

Dipwell 1 is at the upper edge of the *Molinia-Potentilla* Mire close to the boundary with the *Agrostis Curtisii* grassland upslope in the east of the site.

Dipwell 2 is in the *Carex-Potentilla* Tall Herb Fen near the boardwalk in the west of the site.

Water levels at each site were recorded, at about two weekly intervals, during 2001 by the Hampshire Wildlife Trust. This period was atypically wet and it is recommended that the recording should be continued through a number of years to ascertain the more usually occurring water levels. The data indicated that:

- The groundwater table in the *Molinia-Potentilla* mire was at about ground level until the end of April, when water levels began to drop to a maximum depth of 65cm below ground level in August. By early October, water levels had recovered and remained at about ground level to the end of the year.
- The groundwater table in the *Carex Potentilla* tall herb fen was above ground level (ie.the site was flooded) to a height of 5-15cm above ground level until the end of June, after which the water table dropped to about 25cm below ground level during August after which levels again rose and the site became flooded from October Onwards.
- Groundwater fluctuations mirrored each other in both sites, but the *Molinia* mire site, which seldom flooded, was dry for about $4^1/_2$ months of that year and was considerably drier than the Tall Herb Fen site which was dry for about $2^1/_2$ months in that year and flooded for the remaining period.

3.4.4 Adjacent land-use

Ian Stone at Hampshire Wildlife Trust has explained that the fields to the southwest have been hay cropped and managed by a fertilising and liming and which could affect the quality of water appearing out of land drains feeding into the reserve. Also, that the fields to the southeast have been grazed by beef cattle and which may affect the quality of water appearing in the bounding ditches and drains.

3.5 HYDROLOGY

3.5.1 Catchments

The surface hydrology of land within Emer Bog is complex. The distribution of surface watercourses and shallow pools as seen in December 2002 is shown in **Drawing 7**.

Emer Bog is sourced from streams and seepages off the eastern side of the major divide separating the catchments of the Itchen and the Test (**Drawing 1**). Emer Bog itself is supplied by a relatively small surface sub-catchment, but the upper catchment of the Tadburn Lake, a very short section of which is included in the cSAC boundary, is very large.

3.5.2 Seepages and springs

The northern area of Emer Bog including the wetter open and wooded habitats appear to be fed by seasonally rising perched groundwater augmented by seepage and spring flows off the surrounding higher ground. In very wet winters much of the open lower basin mire is flooded to perhaps 20cm depending on season. This may be partly from rising ground water and in part from surface flows arising from winter springs in the south and east.

The whole of the upper seepage mire appears to be developed over an area of seepage taking water from the catchment to the south. In winter, water can be seen seeping out of some areas as flowing springs within the wooded valley side.

3.5.3 Open standing and flowing waters

Open water bodies are shown on **Drawing 7** and include:

Tadburn Lake
A permanent stream on north-western boundary;

The Tadburn Lake stream along north-western site boundary showing sampling location

Southern inflow stream A
A winter flowing small stream within wet woodland and sourced from a land drain and ditch off the grass field to the south and also with some surface water off the same field;

Secondary southern inflow stream B
Close to stream A and also sourced from a land drain off the field to the south; flows during wetter winter periods;

Western inflow stream C
A west flowing small drain arising off field edge drains;

Eastern inflow stream D
An artificial drain arising off woodland to the west, possibly originating off Pound Lane;

Northern outflow stream E
A small stream arising off the open mire surface and flowing during wet periods through Alder woodland;

Seasonal pool and drain F
A seasonally wet footslope non-functioning cut-off drain and pool;

Small spring fed pool F at base of eastern slope

Eastern internal drain G
A seasonal rather meandering drain strongly acidic drain taking water off springs arising on acid grassland towards the open mire;

Internal acidic drain G with sampling point

Eastern seasonal boundary drain H
A seasonally filled surface drain apparently arising from groundwater and flowing north where it is joined by drain D;

Flooded part of the eastern boundary drain

South-eastern boundary drain I
Forms part of southern boundary of reserve, dry in summer;

South-western boundary drain J
Forms part of south boundary of reserve along field edge, dry in summer;

East Pond
An artificial pond, mostly with reed bed but regularly cleared in the northern part to maintain open water;

East Pond with fringing reed beds

West Pond
An artificial pond with two islands bounded by willow car to north and reed bed to the east;

West pond with one of the two islands

Small seasonal surface pools
Deeper or shallower semi-permanent or temporary seasonal pools within open mire, wet heathland and wetter woodlands.

Water sampling within an area of typical seasonally flooded willow carr

3.5.4 Surface Water flows

Overall, the open mire and swamp habitats are fed by seepages and small streams arising from the south, east and west, and the water ultimately flows northwards into the Tadburn Lake stream and out of the system.

Flows from the south

The main surface flows into Emer Bog arise off two land drains along the southern boundary with a grass field. These flows form small winter streams (A and B) which variously spread and coalesce between trees and tussocks and join to flow northward to the East Pond.

Flows from the west

There is a further small winter stream (C) arising off boundary drains (J) in the west of the site and which feeds into pools just north of the West Pond and may at times flow into the West Pond. The West Pond appears to be fed by flows from shallow pools to the east of the pond.

Flows from the east

A very small short seasonal stream (G) arises off acid grassland in the east of the site.

Mire and outflows

All of these sources flow into the open mire causing saturation of the peat and very gentle surface flows northwards.

The main northern outflow stream E collects water from the open mire and passes through Alder and Willow Carr and feeds a flooded area in winter (adjacent the boardwalk).

Outflow stream E in Alder-Willow carr

From here, the stream passes to open tussock sedges below the Electricity Transmission Line and so outside of the site towards the Tadburn Lake stream.

Pools in the Alder Woodland, in the north-east of the site, flow in wet conditions north-eastwards towards the eastern seasonal drain D and so to the Tadburn Lake stream.

3.5.5 Historical aspects

Neil Sanderson (1998) indicates that the area of Emer Bog is shown on the 1588 Hursley Estate map as open water and called Enmoore Ponde, but that the name Emer relates to the former Enmoor indicating a bog and which could have predated the pond.

Careful examination of the 1870 Ordnance Survey Plan (**Drawing 8**), (which shows the land from Lights Copse to the Tadburn Lake as almost completely open), provides a clue that the wetland area then was in two tracts. One tract was to the west and the other to the east. Both tracts converged into a sinuous north-south marshy area with a small pond at their confluence, before shedding water north into a small drain feeding into the Tadburn Lake.

These flows broadly accord with those seen today and the small historic pond may equate with the small distinct pool in the open mire shown on **Drawing 7**.

There are no distinct drains shown within the area of Emer Bog while drains are shown in Lights Copse to the south. This suggests that the present day drains and watercourses within the open and wooded wetland areas are relatively modern.

3.6 HYDROGEOLOGY

Hydrogeology is about how water behaves below ground and how it is stored and flows within geological strata. Little is known of the hydrogeology of the vicinity of Emer Bog and there are no known recorded boreholes that can give information on groundwater levels.

The legend to the 1:50 000 scale geological map indicates that the strata in this area generally dip gently southwards at between 1 and 2 degrees. This would suggest that any flow of groundwater in the subsurface strata would be to the south, that is, away from Emer Bog. The general relationships of the strata can be seen in **Drawing 2**.

London Clay underlies the whole site and provides a slowly permeable layer or aquiclude and which prevents upward or downward movement of groundwater.

The overlying Wittering Formation, which underlies the site, is mainly of highly plastic clays and silts with sandy clays and clayey sands and is likely to have a low hydraulic conductivity. This means that water will pass through them only slowly. However, sandier seams do occur within the Wittering Formation and these could provide conduits for locally enhanced rates of subsurface flow. Borehole evidence indicates that the higher land at the south of the Emer Bog wetlands comprises a layer of sands.

The presence of springs and extensive areas of seepage around the eastern and southern edges of the wetland area suggests that, despite the southerly dip, the general flow of groundwater is indeed into the bog from the south. It appears that water from this seepage flows into the upper valley side peat basin which becomes saturated creating surface water flows north towards the level land of the lower peat basin.

The seasonal and somewhat irregular rise and fall of surface water over the lower peat basin, below the main open mire area, indicates that there is likely to be a groundwater component to the water here. This suggests that in winter, groundwater effectively rises by upward seepage out of the Wittering Formation (perhaps via sandier seams refered to above) into the peat layers below the lower basin causing seasonal flooding. This rising groundwater is supplemented by surface flows off the higher peat basin and adjacent land in the south and east. The relative proportion of surface flows to groundwater flows remains unknown. Excess water accumulates in streams and flows north towards the Tadburn Lake stream.

3.7 HYDROCHEMISTRY

3.7.1 Trophic State and Water sampling

3.7.1.1 Approach and rationale

This study takes account of surface waters in drains and spring outflows, ponds, and flooded areas of swamp and mire habitats. The objective has been to use a limited number of key chemical parameters across all of these habitats. No attempt has been made to use different techniques for different habitats. For instance, in the mires and swamps, water has been sampled from surface pools where flooded. No attempt has been made to sample from the root zone of peat deposits in the mires which would have been costly, time consuming and the results not easy to compare with open water samples.

3.7.1.2 Trophic state and chemical determinations

Trophic State

Relating the productivity of plants to water chemistry is difficult. Much work has been done on standing waters and which are commonly classified according to a subjective division of a continuum from their nutrient-poor to nutrient-rich conditions (Palmer and Roy 2001).

The terms 'dystrophic', 'oligotrophic', 'mesotrophic' and 'eutrophic' are used, representing recognisable levels in a fertility series. Trophic state is reflected in the composition of plant communities growing in waters of different fertility. Where sufficient vegetation is absent, chemical parameters have been proposed.

Newbold and Palmer (1979) attempted a chemical classification of trophic states using levels of total phosphorus, inorganic nitrogen, calcium carbonate alkalinity and pH. Such schemes have been developed for open waters.

Limitations in applying open water trophic states to mire systems

The extent to which these parameters for open waters apply to mires is a matter of conjecture.

In wetlands such as mires and fens, the plant communities may be more dependent on the fertility of the substrate in which they root and these sites may not have standing water in summer. Similarly, the chemistry of mires with peaty substrates (and often anaerobic) conditions means that classifications of open water systems may not be directly applicable to peatlands. Further, in pools of standing water, there is likely to be interchange of soluble substances between peat substrate and the water.

The extent to which measured levels of phosphorus and nitrogen are available to plants also remains unknown. Similarly the extent to which base-richness and fertility are related to each other remains a matter of debate.

System used in this report

In this report, the generalised scheme set out in **Table 2** below has been used and which is adapted in part from Ratcliffe 1997; Newbold and Palmer 1979; Palmer and Roy 2001; and Palmer, Bell and Butterfield 1992.

Table 2. Chemical parameters typical of trophic states of open waters

Trophic state (open waters)	Nutrient rating	Total P mg/l	Inorganic N (NO_3+NH_4) Mg/l	Alkalinity $CaCO_3$ mg/l	PH	Electrical conductivity Umhos/cm (EC units)	General characteristics
Ultra-oligotrophic	Very low	<0.004	<0.2	<5	<6 Strongly to moderately acidic	<100	Very soft clear water, very low productivity
Oligotrophic	Low	0.04-0.01	>0.2-0.4.	About 10	6-7 Slightly acidic	80-120	Clear soft water, low productivity
Mesotrophic	Moderate	>0.01-0.035	>0.4-0.6	>10-30	7 Circum-neutral	90-200	Water sometimes discoloured by planktonic algae in summer, moderate productivity
Eutrophic	High	>0.035-0.1	>0.6-1.5	>30	>7 Neutral to slightly alkaline	>200-1000	Water often strongly discoloured by algae in summer, high productivity, most organic matter generated within the water body
Hyper-eutrophic (Hypertrophic)	Very high	>0.1	>1.5	>30	>7 Slightly to moderately alkaline	>200-1000	Algal productivity extr high, few macrophytes able to compete with algae
Dystrophic	Variable		N-poor	Very low	<5 (typically 3-5) Highly acidic	Mostly about 100 generally <200	Water usually brown and peat stained, most organic matter derived from outside water body, very acidic, low productivity, species poor
Highly calcareous (including marl water and those depositing tufa		Variable (normally poor)	Variable	Mostly >100	>7.4 (Unless affected by summer transpiration when 6.5-9.5)	Variable (mostly 200-750)	Water very clear, variable nutrient status, macrophytes often restricted, spring sources may deposit tufa
Brackish Saline			Variable		Very high	>1500 > 30000	Coastal sites or associated with fossil marine deposits

3.7.1.3 Water determinations and sampling

Field sampling, laboratory determinations and methods

Wherever possible water samples were taken from areas of open water such as pools and watercourses. Water samples from the open mire were taken where there was surface standing water that could be sampled without taking up peaty sediment.

Water samples have been determined in the laboratory for:

- pH (by pH meter);
- electrical conductivity (by EC meter);
- calcium, potassium, magnesium, manganese, boron, copper, molybdenum, iron, zinc, sulphur, sodium (by Inductively Coupled Plasma analyser);
- total phosphorus (filtered to remove suspended materials and then by Inductively Coupled Plasma analyser)
- orthophosphate-phosphorus - total soluble phosphorus (filtered to remove suspended materials and then by Inductively Coupled Plasma analyser);
- nitrate and ammonia nitrogen (by ion selective electrode);
- chloride, and bicarbonate (by titration).

Alkalinity as equivalent calcium carbonate has been calculated from the calcium value;

Alkalinity as equivalent calcium bicarbonate has been calculated from the bicarbonate value;
Nitrate and ammonia have been calculated from the appropriate nitrogen values;
Total inorganic nitrogen has been calculated from the sum of nitrate and ammonia nitrogen.

Sampling dates

December 1996

Water sampling and field testing for pH had been undertaken in December 1996 when much of the site was found to be acidic. Location of field and laboratory tested samples are shown in **Drawing 11**.

1997-2000

Field tests during visits in 1997, 1998 and 1999 appeared to show that the site had become less acidic and this was cause for concern. In 1998 Neil Sanderson found that the much of the open mire had swamp habitats not requiring acidic conditions. In 2000, Ian Stone (Hampshire Wildlife Trust Reserves Officer) reported that much of the surface waters were acidic.

August 2002

In order to re-assess the situation, water samples were taken for laboratory analysis from most open water bodies in August 2002. The location of laboratory tested samples are shown in **Drawing 9**.

December 2002

In order to compare the results with the December 1996 sampling, the August sampling programme was repeated in December 2002 and additional samples taken from locations which were then wet. The location of laboratory tested samples are shown in **Drawing 10**.

3.7.2 pH (Acidity)

3.7.2.1 Acidity and the trophic status of fresh water

Acidity is one of the chemical characteristics of water that determines the trophic status of fresh water (Newbold and Palmer 1979). Assuming appropriate nutrient levels, ultra-oligotrophic to oligotrophic waters have pH levels below 6 and that eutrophic to hypertophic water have pH levels above 7 with highly calcareous waters having a pH value above 7.4.

Acidity values on their own are not a reliable guide to the trophic status of freshwater, especially in summer when algal photosynthesis may give rise to abnormally high values (Newbold and Palmer 1979).

Mire communities are well differentiated by pH as changes in heavy metal availability occur at around pH 5 (Haslam 1994). In Drawings 11, 12 and 13 this differentiation is picked out by the moderately acid category of pH 4.5 to 5.5.

3.7.2.2 Acidity in December 1996 (Drawing 11)

The southern inflow streams, seepages and pools were found to be mostly slightly acidic to circum-neutral with a pH range from 5.7 to 7.0 and with a few more acidic samples.

The open mire was moderately acidic with a pH range from 4.6 to 5.5.

The small pool in the open mire had a strongly acidic pH value of only 4.1. Note that a field pH measurement made in1998 showed an alkaline pH of about 7.5 at this same location.

Eastern parts of the site (two samples) were found to be strongly acidic with a pH range of 3.8 (in a woodland pool) to 4.2 (in a seepage within acidic grassland).

The West and East Ponds had pH values of 5.9 and 6.0 respectively.

This study showed a marked acidity gradient in surface waters from neutral or slightly acidic conditions in wooded seepages in the south of the site through moderately acidic water values in the central open mire to very acidic values in the north wooded area and in the eastern seepage area. The overall pH range was from 7.0 in the southern seepages down to 3.8 in the northern woodland. The two southern ponds had slightly acidic levels of pH 6. The woodland samples may have been affected by acidic leaf accumulation.

There thus appears to be a neutral southern seepage source and an acidic eastern seepage source acting on only slightly acidic ground waters (as seen in the ponds) and with a central mixing zone where pH values tend to be moderately acidic but which can vary quite widely.

Other field pH measurements made from time to time have indicated that parts of the central area of the *Carex-Potentilla* Tall Herb Fen can even be slightly alkaline giving an upward limit of perhaps about pH 7.5. One laboratory determination in 1996 indicated a pH value near to this same location of 4.1.

This remarkable range is thought to relate to different source seepage waters acting on groundwaters, all of different chemistry and varying between winter and summer as water levels rise and fall. This means that conditions may be seasonally affected by soil chemistry as well as by water level.

3.7.2.3 Acidity in August 2002 (Drawing 12)

Comparison of Drawings 11 and 12 shows that conditions had changed markedly and this reflected casual observations in the previous few years and which had caused concern that acidic conditions may be being lost.

The southern inflow streams, seepages and pools were found to have consistently raised pH levels compared to 1996. For example, the southern inflow stream was now 6.4 compared to 5.1 in 1996.

The western part of the open mire was found to be slightly acidic (5.9-6.3) and partly circum-neutral (6.6-6.8) as compared with a pH range from 4.6 to 5.5 in 1996.

The small pool in the open mire had a pH value of 6.1 compared to 4.1 in 1996.

The only sample that could be taken from the eastern part of the site was found to be moderately acidic with only slight change from 1996.

The West and East Ponds had pH values of about 7.0 compared to 6.0 in 1996, a rise of one pH point.

Overall, the site had become markedly less alkaline with large parts of the site now being circum-neutral.

3.7.2.4 Acidity in December 2002 (Drawing 13)

Sampling in December 2002 was designed to provide a winter comparison with the December 1996 sampling and in order to resolve two conflicting views of the sources of acidity.

It had been suggested in team discussions, that the greater amount of rainfall in winter might have led to the winter mire waters being more acidic than in the summer (rainwater being acidic). Alternatively, it had also been suggested that lowered water levels in summer would bring more of the available surface water into contact with acidic substrates and vegetation and which could lead to greater acidity in the summer.

Conditions in December 2002 were much wetter than in the previous August. The open mire had a greater level of flooding and all of the boundary drains were now infilled with water and often flowing. This allowed a more comprehensive sampling regime. Most of the August 2002 sites were re-sampled and many additional areas were also sampled.

Overall, the western and central parts of the open mire had remained slightly acidic (with a range of 6.0 to 6.4) and no longer had the circum-neutral values found in August. This suggested that pH values had reduced, but only slightly. The moderately acidic values of 1996 did no re-appear and the site did not have the pH values typical of oligotrophic mire communities (other in the east of the site).

Interestingly, the Tadburn Lake stream had an alkaline pH of 7.5 compared with a slightly acidic value of 5.9 in August.

More samples from the eastern part of the mire confirmed the greater acidity here with moderately acidic pH values of 4.5 to 5.5.

Stream and drain sources in acidic grassland and wet heathland areas in the east and southwest of the site were strongly acidic with pH values of 3.9 to 4.4.

Overall, the December 2002 sample results showed again that much of the site was not particularly acidic, although the higher circum-neutral results found in August did not re-appear.

3.7.3 Alkalinity

3.7.3.1 Alkalinity and the trophic status of fresh water

Alkalinity is one of the chemical characteristics of water that characterises the trophic status of fresh water (Newbold and Palmer 1979, Palmer and Roy 2001). Assuming appropriate nutrient levels, Ratcliffe (1977) suggests that ultra-oligotrophic waters have alkalinity values below about 2mg/l, oligotrophic waters have alkalinity values below 10 mg/l, mesotrophic waters between 10 and 30mg/l and eutrophic waters have alkalinity values above 30mg/l.

3.7.3.2 Alkalinity in December 1996

Seven samples were determined for equivalent Calcium carbonate (alkalinity) in December 1996 with the following values:

		Trophic level equivalent
A West Pond	125 mg/l	Hypertrophic Highly calcareous
B East Pond	95 mg/l	Eutrophic
C Feeder stream to East Pond	70 mg/l	Eutrophic
D Shallow pool in willow carr	73 mg/l	Eutrophic
E Pool in open mire	48 mg/l	Eutrophic
F Seepage in Molinia grassland	20 mg/l	Eutrophic
G Pool in *Carex paniculata* swamp	45 mg/l	Eutrophic

All had high or very high alkalinity values.

3.7.3.3 Alkalinity in August 2002 (Drawing 14)

Alkalinity values were almost all in the Eutrophic range with many being typical of highly calcareous water. The western and central parts of the open mire had alkalinity values of between 45 and 108 mg/l with the extreme eastern and southwest parts of the mire with Mesotrophic levels of 30 mg/l.

The shallow pool in the open had increased from 48 mg/l in 1996 to 75 mg/l in August 2002.

Drawing 14 also shows the area with highest alkalinity values (taken as >75 mg/l) and which neatly picks up the main water flow through the system.

3.7.3.4 Alkalinity in December 2002 (Drawing 15)

Alkalinity values in the open mire and wet woodlands have generally reduced from those in August 2002 and tend to be in the Mesotrophic-eutrophic range.

The new sample sites in wet heathland, and in the seepages in the east of the site, have detected low alkalinity values in these areas consistent with the higher acidity values found here.

3.7.4 Phosphorus

3.7.4.1 Phosphorus and the trophic status of fresh water

Phosphorus

Phosphorus is the main nutrient that determines the trophic status of fresh water (Newbold and Palmer 1979), that is: the productivity of plants growing in that water. It is also likely to be the limiting nutrient in freshwaters and phosphorus enrichment can lead to detrimental change in rivers, the main change being to algal and plant communities (Pitt, Phillips and Mainstone 2001). High phosphorus levels make habitats more vulnerable to damage.

Phosphorus chemistry is complex, especially in mire systems where phosphorus can be in the substrate, in the water, and in solids suspended in the water. Unlike water in river and lake systems, phosphorus levels in mire and fen water can be affected by phosphorus levels in the substrate. In particular, plants growing in wetlands will have their roots in the substrate and their upper parts partly in water and partly in the atmosphere.

Total phosphorus

It has been common practice to determine **total phosphorus** in natural waters. This involves an acid extraction prior to determination. Total phosphorus values quoted on **Drawing 16** for 1997 are from water samples that have been filtered to remove coarse particles. Those values on **Drawings 17 and 18** for 2002 are from samples that have been further filtered to remove fine suspended mineral and peat particles (because of the difficulty in sampling clean water from mire systems). After filtering, the samples have been dried, digested with acid, made up to volume, and phosphorus levels identified on an Inductively Coupled Plasma analyser.

Total (soluble) reactive phosphorus

It is Environment Agency practice to also determine phosphorus as the soluble orthophosphate, also known as soluble (or total) reactive phosphorus. This is the form in which phosphorus occurs when dissolved in water and is considered to be the form in which it is biologically active and available to aquatic vegetation. In this determination, the water samples have been filtered (to remove suspended mineral particles and peat) and analysed directly on an Inductively Coupled Plasma analyser.

The Environment Agency (29th August 2002) has set standards for rivers designated as Special Areas of Conservation (SAC). The best fit for Emer Bog in this system is River Class Size 1E: headwaters in Mesozoic Clay Vales and Tertiary Clays.

For this category, the 'natural' level of <0.02mg/l indicates the likely Total Reactive Phosphorus concentration in the absence of significant human presence. This level is equivalent to 'high status' under the Water Framework Directive.

The 'standard' level of 0.06mg/l represents that relating to an acceptable level of low human influence and above which adverse ecological changes are likely. This level is equivalent to 'good status' under the Water Framework Directive.

The 'threshold' level of 0.1mg/l indicates the phosphorus concentration above which no further ecological response might be expected. This level is equivalent to moderate status under the Water Framework Directive.

3.7.4.2 Total Phosphorus

Total Phosphorus values for December 1996, August 2002 and December 2002 are shown in **Drawings 16, 17 and 18** respectively.

In 1996 (**Drawing 16**) all samples determined had high or very high total phosphorus values typical of eutrophic or hypertrophic systems; far higher than would be expected from nutrient-poor Oligotrophic mire systems.

Very high levels were found in the two ponds. The small pool within the open mire had a total Phosphorus level of 0.11mg/l.

In August 2002 (**Drawing 17**), the larger number of sites sampled indicated that all of the surface waters present at that time had very high total phosphorus levels. Extremely high values between 0.38 and 1.08 mg/l were found in the western part of the open mire and in the outlet stream and the affected area is shown as pale purple shading on the drawing.

Further sampling of the wider area in December 2002 (**Drawing 18**) showed that total phosphorus levels remained very high with many sampled sites in the extremely high category. However, overall the values were very slightly lower and the extreme values noted in August were no longer present.

It is clear however, that total phosphorus values remain very high and so the wetland system would be expected to be highly productive unless other nutrients were deficient (which they are not).

3.7.4.3 Total (soluble) reactive phosphorus

Soluble reactive phosphorus was determined in both August and December 2002 to allow a comparison with standards set by the Environment Agency for the SAC headwaters of Special Areas of Conservation (see section **3.6.4.1** above).

August 2002 results

Levels of orthophosphate phosphorus from samples taken in August 2002 are shown in **Drawing 19**. This drawing also provides the guideline phosphorus levels for Special Area of Conservation (SAC) headwaters in Mesozoic clay vales and Tertiary clays.

Natural level:	no samples were within the 0.02 mg/l limit for natural waters.
Standard level:	only three samples (inflow stream and the East Lake) were at or within standard (acceptable) level shown in orange.
Ecological Threshold level:	the majority of samples were above the ecological threshold level.

The lowest levels, up to the ecological standard level, were in the southern inflowing stream and the two lakes. The sources of phosphorus are likely to be from drainage water off the agricultural fields to the south.

All other samples from within the open mire, and from pools and drains within the wetter woodlands, were above the ecological threshold level. These high levels are probably attributable to mire conditions and derived from within the site itself such as from soil and peat sources and not indicative any enrichment.

December 2002 results

Levels of orthophosphate phosphorus from samples taken in September 2002 are shown in **Drawing 20**. This drawing also provides the guideline phosphorus levels for Special Area of Conservation (SAC) headwaters in Mesozoic clay vales and Tertiary clays.

Natural level:	as in August 2002, no samples were within the 0.02 mg/l limit for natural waters.
Standard level:	most of the inflow stream and open mire were at or within standard (acceptable) level shown in orange.
Ecological Threshold level:	only two smaller areas exceeded the ecological threshold level.

Comparison of August and December 2002 results

A comparison of **Drawings 19 and 20** shows the dramatic change that occurred in orthophosphate phosphorus levels between the summer (when water levels were low) and in December (when water levels were higher).

While at neither times were the very low levels expected of natural systems present, the high and very high phosphorus levels found in August had reduced to low and moderate levels by December. This change is probably attributable to the dilution effect of rain water and the reduced contact of the free water with substrate soil and peat materials

3.7.5 Nitrogen

3.7.5.1 Inorganic nitrogen

Inorganic nitrogen is also very important in determining the plant productivity of wildlife habitats. Nitrogen occurs in solution mostly as nitrate and as ammonia. Both can be sourced from natural habitats, although much nitrate entering aquatic ecosystems does so from agricultural fertilisers. Ammonia can be generated directly from mire systems and many wetlands can be relatively rich in dissolved ammonia.

The nitrogen chemistry of wetlands is far more complex than that in open waters. Nitrogen interactions in wetlands are based more on reducing conditions within peat and saturated soils than the more oxidising conditions found in oxygen saturated open flowing waters.

Nitrogen has been determined as that contained within nitrate (NO_3-N) and within ammonia (NH_4-N). Summation of the two values provides a measure of total inorganic nitrogen. Nitrite nitrogen is assumed to occur in only very small amounts, although this has not been tested.

3.7.5.2 Total inorganic nitrogen

Total inorganic nitrogen values for December 1996, August 2002 and December 2002 are shown in **Drawings 21, 22 and 23.**

December 1996

In December 1996 (**Drawing 21**), all the samples had relatively high inorganic nitrogen levels. One sample had medium levels and the others were high, or very high. Two samples had exceptionally high levels, one from open water in the East Pond (5.23mg/l), and the other from a surface pool within alder woodland (5.46mg/l).

August 2002

The more detailed sampling in August 2002 (**Drawing 22**), confirmed the presence of high levels of inorganic nitrogen across the whole site with all samples being within the range typical of eutrophic and hypertrophic waters. Very high levels, in excess of 2mg/l, occurred though a wide swathe through the central and northern part of the of the site (shown in pink on **Drawing 22**).

Nitrogen levels in the East Pond had reduced considerably, although similarly high levels occurred at the source of the main southern inflow stream (A) off the grass field to the south as well as in the open mire.

December 2002

As in August, high levels of inorganic nitrogen were found across the whole site (**Drawing 23**). The exceptionally high levels found in August had reduced and overall the site had high levels rather than very high levels, but still remained typical of eutrophic systems even in locations that were moderately or very acidic.

The highest levels were in the two source streams where they arose off the field to the south and at the outfalls within alder woodland and in greater tussock sedge swamp in the north. These peaks may be explained by the large amounts of decaying leaf material here.

3.7.5.3 Nitrate nitrogen and nitrate

Nitrate nitrogen

In December 1996, nitrate nitrogen occurred in greater quantities than ammonia nitrogen with levels ranging from 0.35 to 5.13mg/l NO_3-N. In August 2002, nitrate levels remained high, but ammonia nitrogen was in many places almost as high. By December 2002, the ratio of nitrate to ammonia nitrogen had generally reverted.

Nitrate

The Environment Agency General Quality Assessment for nutrients in rivers uses nitrate values rather than nitrate-N values according to the following scale:

Nitrate Grade	Grade limit (mg NO_3/l) Average	Description
1	<5	Very low
2	>5-10	Low
3	>10-20	Moderately low
4	>20-30	Moderate
5	>30-40	High
6	>40	Very high

Nitrate levels have been calculated from determinations of Nitrate-N.

In December 1996, nitrate values ranged from very low (1.55) to moderate (22.42mg/l).

In August 2002 most nitrate levels were very low (mostly between 3 and 4mg/l) although some samples were notably higher with 17.8mg/l in the main southern source stream off the adjacent field, 22.73 in the East Pond and 22.442mg/l in a willow carr pool. In December 2002 nitrate levels were very variable but generally higher overall but without the peaks seen in December 1966 and in August 2002.

3.7.5.4 Ammonia nitrogen

General quality assessment values for ammonia nitrogen in rivers are given in the table below. These gradings relate to rivers and their ability to support salmoniid and cypriniid fish and grades A, B and C relate to rivers capable of supporting fish. Grades D, E and F are increasingly reduced in oxygen and ammonia.

Emer Bog does not contain permanent or stream water and so this classification is hardly appropriate, but it does provide a guide to ammonia levels in natural aquatic systems. Ammonia levels vary in waterlogged soils and the interpretation is offered here for what it may be worth.

GQA grade	Dissolved oxygen (% saturation) 10-percentile	Biochemical oxygen demand (mg/l) 90-percentile	Ammonia (mgN/l) 90-percentile
A Very good	80	2.5	0.25
B Good	70	4	0.6
C Fairly good	60	6	1.3
D Fair	50	8	2.5
E Poor	20	15	9.0
F Bad	<20	-	-

In December 1996 ammonia-N values ranged from 0.1 to 0.4 mg/l, generally in the good category. In August 2002 ammonia-N values ranged from 0.1 (very good) to 4.4 (fair to poor). In December 2002 ammonia-N values ranged from 0.1 (very good) to 1.9 (fairly good to fair).

These figures suggest that Emer Bog is unlikely to be polluted with excess ammonia and that the ammonia that does occur is almost certainly generated within the wetland soils of Emer Bog itself. It is interesting to note that using Environment Agency guidelines, the site appears to be less rich in nitrogen than would be suggested using the trophic level assessments discussed.

4.0 CHARACTERISTICS OF MAIN OPEN WETLAND AND OPEN WATER HABITATS

4.1 TROPHIC STATE PARAMETERS

Information in the drawings and appended tables of data provides information on a range of chemical parameters. Table 3 assess the values of these parameters according to the guideline levels for trophic state indicated in Table 2. These trophic states are also provided on the drawings where trends can be seen. Individual trends have been discussed in Section 3.

Table 3 Chemical concentration ranges and trophic state indications

Parameter	Sampling date	Habitat							
		Southwest sources C, J	**Southeast sources A, B**	**Eastern sources F, G**	**West Pond**	**East Pond**	**S27 *Carex/Potentilla* Tall Herb Fen**		**M5 *Sphagnum* mire**
							Main fen	**Open pool**	
PH	Dec 96	Not Sampled	Not sampled	4.2 Dystrophic	5.9 Oligotrophic	6.0 Oligotrophic	4.6-5.5 Ultra-oligotrophic	4.1 Dystrophic	4.6-4.7 Dystrophic
	Aug 02	Dry	5.8-6.2 Oligotrophic	Dry	6.9 Mesotrophic	6.7-7.0 Mesotrophic	5.9-6.8 Oligo-mesotrophic	6.1 Oligotrophic	4.7 Dystrophic
	Dec 02	5.9-6.1 Oligotrophic	6.1-6.4 Oligotrophic	4.0-4.4 Dystrophic	5.9-6.4 Oligotrophic	6.8 Oligo-mesotrophic	6.0-6.4 Oligotrophic	6.3 Oligotrophic	4.5-4.8 Dystrophic
Alkalinity	Dec 96	Not samples	Not sampled	20 Mesotrphic	50 Eutrophic	38 Eutrophic	47.5 Eutrophic		Not sampled
	Aug 02	Dry	30 Mesotrophic	Dry	43Eutrophic	85-128 Hypertrophic Calcareous	30-115 Eutro-hypertrophic Calcareous	75 Eutro-hypertrophic	30 Mesotrophic
	Dec 02	15-18 Mesotrophic	33-55 Eutrophic	5-13 Oligo-mesotrophic	18-28 Mesotrophic	48 Eutrophic	13-43 Meso-eutrophic	35 Eutrophic	8-10 Oligotrophic
Total P	Dec 96	Not sampled	Not sampled	0.05 Eutrophic	0.56 Hypertrophic	0.38 Hypertrophic	0.11 Hypertrophic		Not sampled
	Aug 02	Dry	0.15 Hypertrophic	Dry	0.22 Hypertrophic	0.17-0.37 Hypertrophic	0.16-0.58 Hypertrophic	0.44 Hypertrophic	0.23 Hypertrophic
	Dec 02	0.09-0.11 Eutro-Hypertrophic	0.08-0.11 Eutro-Hypertrophic	0.08 Eutrophic	0.14-0.24 Hypertrophic	0.14 Hypertrophic	0.09-0.13 Eutro-Hypertrophic	0.07 Eutrophic	0.11-0.12 Hypertrophic
Total Inorganic N	Dec 96	Not sampled	Not sampled	0.72 Eutrophic	1.00 Eutrophic	5.23 Hypertrophic	0.73 Eutrophic		Not sampled
	Aug 02	Dry	4.51 Hypertrophic	Dry	1.14 Eutrophic	0.97-1.18 Eutrophic	1.29-5.09 Eutro-Hypertrophic	0.98 Eutrophic	1.05 Eutrophic
	Dec 02	0.74-0.85 Eutrophic	2.00-2.46 Eutrophic	0.85-1.17 Eutrophic	1.09-1.41 Eutrophic	0.90 Eutrophic	0.73—0.85 Eutrophic	0.76 Eutrophic	0.79-0.89 Eutrophic
EC	Dec 96	Not sampled	Not sampled	158 Mesotrophic	492 Eutrophic	409 Eutrophic	295 Eutrophic		158 Mesotrophic
	Aug 02	Dry	185 Mesotrophic	Dry	217 Eutrophic	342-467 Eutro-Hypertrophic	181-492 Meso-Hypertrophic	343 Eutrophic	269-475 Eutro-Hypertrophic
	Dec 02	144-145 Mesotrophic	191-222 Meso-eutrophic	134-177 Mesotrophic	149-165 Mesotrophic	220 Eutrophic	112-199 Mesotrophic	191 Mesotrophic	111-132 Mesotrophic
Ortho P	Dec 96	Not determined							
	Aug 02	Dry	0.06 Low	Dry	0.08 Moderate	0.06-0.10 Low-Moderate	0.08-0.41 Moderate-High-Very high	0.41 Very high	0.11-0.16 High
	Dec 02	0.05-0.06 Low	0.04-0.05 Low	0.03-0.05 Low	0.10-0.15 High	0.09 Moderate	0.04-0.07 Low-moderate	0.04 Low	0.05 Low
Overall trophic state		**Eutrophic**	**Eutrophic to Hypertrophic**	**Mesotrophic to Eutrophic**	**Eutrophic to Hypertrophic**	**Hypertrophic**	**Eutrophic to Hypertrophic**	**Eutrophic to Hypertrophic**	**Eutrophic**

4.2 TROPHIC STATE INDICATIONS ACCORDING TO PHOSPHORUS AND NITROGEN LEVELS

Trophic state indications from Total Phosphorus

Mostly hypertrophic
Total phosphorus levels were universally high with most values indicative of Hypertrophic conditions and with only a few more typical of eutrophic conditions.

Trophic state indications from Total Inorganic Nitrogen

Mostly eutrophic
Most samples were eutrophic with some being hypertophic in Autum of 2002.

Trophic state indications from electrical conductivity

Mostly mesotrophic
Most samples were in the mesotrophic range with some extending in to the eutrophic and hypertrophic levels.

Trophic state indications from orthophosphate phosphorus

Mostly low to moderate values
While many samples were in the low range, others were moderate and a few were very high. None were in the very low or natural range expected of natural systems, most being in the standard range and some exceeding the ecological threshold value. This is indicative of samples in the mesotrophic through to hypertrophic ranges.

4.3 TROPHIC STATE INDICATIONS ACCORDING TO HABITAT

4.3.1 Water sources

Water entering the site from the southwest tended to have oligotrophic pH values, mesotrophic alkalinity values, eutrophic to hypertrophic total phosphorus values, eutrophic values for total inorganic nitrogen and mesotrophic levels for electrical conductivity and orthophosphate phosphorus.

Water entering the site from the southeast tended to have rather similar values with a tendency to increased levels of nitrogen and electrical conductivity.

Water entering the site from the east was generally lower in acidity and most other parameters. PH values were typical of dystrophic conditions expected in very acidic habitats, although phosphorus, nitrogen and electrical conductivity values were all very high and often in the eutrophic to hypertrophic range indicating nutrient-rich conditions.

4.3.2 The ponds

The ponds are thought to reflect groundwater conditions having been artificially excavated to some depth.

The West Pond had pH values in the oligotrophic to mesotrophic ranges, but total phosphorus and inorganic nitrogen levels were all high and indicative of nutrient-rich eutrophic and hypertrophic states.

The East Pond pH values in the oligotrophic to mesotrophic ranges, and again phosphorus and nitrogen values were all indicative of nutrient-rich conditions.

4.3.3 S27 tall herb fen and pool

Haslam 1994 indicates that this habitat:

- usually has peaty soils kept moist by mesotrophic to oligotrophic neutral to moderately base-rich waters;
- is rarely stagnant and most frequently occurs in topogenous mires;
- is sometimes flooded, usually with water near the surface;
- develops best where there is lateral flow near the outlets and inlets

Open fen

At Emer, the conditions are such that the surface waters tend to be mesotrophic to oligotrophic with often highly base-rich calcareous water. The hydrological conditions indicate at least a soligenous component to the mire (being fed by groundwater) as well having components of a topogenous system (dependent more on topography). The surface floodwaters are very nutrient-rich with high levels of total phosphorus and inorganic nitrogen that in open waters would be typical of eutrophic to hypertrophic conditions. Electrical conductivity and orthophosphorus levels are moderate.

Much of the peat is saturated with water and very spongy. The terrain can be treacherous to walk over and much of the vegetation appears to be floating on a very soft wet substrate and with many connecting surface pools in winter and spring.

Open pool

The small deep open pool within this habitat provides an indication of groundwater conditions in this lower peat basin area.

While pH values were low (4.6-6.4) (and indicative of dystrophic to oligotrophic conditions), alkalinity, phosphorus and nitrogen values indicated highly nutrient-rich conditions (in the eutrophic to hypertrophic range).

4.3.4 M5 *Sphagnum* mire

This is the habitat for which Emer Bog has been identified as a Special Area of Conservation (SAC) and Haslam (1994) indicates that this habitat usually has:

- a floating raft or on soft spongy peats;
- mildly acidic, slightly calcareous and rather nutrient-poor waters (pH about 4(-5), with dissolved calcium 5-15ppm;
- ground that may dry periodically; and

- tends to be frequent around still waters fed by moderately oligotrophic or mesotrophic water.

The M5 *Sphagnum* mire is one of the constituent vegetation types of the Transition Mires and Quaking Bogs community for which Emer is designated and has transitional ecological characteristics between acid bogs and alkaline fens in which the surface conditions range from markedly acidic to slightly base rich.

At Emer this community is developed on soft spongy peats, with highly acidic conditions (pH 4.6-4.8) but with nutrient-rich waters rich in phosphorus and nitrogen. Calcium levels are between 4 and 8ppm and fed by oligotrophic to dystrophic waters.

The example at Emer appears to be a more acidic and more nutrient-rich version of the habitat as compared with those in the north and west of the UK where they are more common. The M5 community at Emer is not quaking, although the adjacent S27 Tall Herb Fen certainly is.

5.0 CONSENTED DISCHARGES AND ABSTRACTIONS

5.1 DISCHARGES

The Environment Agency plan (**Drawing 1**) indicates six soakway discharges at Bucket Corner along Pound Lane and one at the north of Lights Copse, all of which are in the catchment of the Emer Bog wetlands.

<u>Bucket Corner, Pound Lane</u>

It is possible that discharged water could pass towards Emer Bog via groundwater flows in the substrate. There is no evidence from the studies reported here that these discharges are having any detectable effect on the Emer Bog wetlands. This is likely to be because of the:

1. small size of the discharges;
2. slow permeability of the substrate within the pathway; and the
3. dilution that would occur en-route.

<u>Lights Copse</u>

An inspection of the Lights Copse discharge has revealed that it is not in use and that the consented discharge is fed into a different sub-catchment and does not pass into Emer Bog.

<u>Pound Lane north at Ampfield</u>

In addition to the above, are five discharges to stream or river which appear to discharge to a tributary of the Tadburn Lake about 1km north of Emer Bog and which are too distant to have any significant effect. Small discharges to watercourses would lead to considerable dilution by the time they reached the vicinity of Emer Bog and there is no clear pathway from these streams into the wetland area because of intervening watercourses.

5.2 ABSTRACTIONS

It is understood from the Environment Agency that with regard to Emer Bog there are:

- no abstractions within the catchment,
- no abstrations within 1km of the site; and
- no other significant abstractions in the wider area.

6.0 HYDRO-ECOLOGY OF EMER BOG

Wetlands and open waters within Emer Bog cSAC include a sizable basin mire associated with seepage mires to the east and valley mire to the west (Sanderson 1998) together with associated surface source waters from drains and springs and two large artificial ponds. The peats have accumulated in an upper and a lower basin set on a gentle lower valley side as the result of the accumulation within an area of high perched groundwater and seasonal seepage.

The origin of the wetland vegetation is uncertain but appears to post-date 1588 when historical evidence suggests this may have been an area of open water.

Sandy clays and clayey sands of the Tertiary Wittering Formation underlie the peat. This formation is generally of slow permeability but does contain sandier layers forming very minor confined aquifers. While seepages occur at upper layers in the valley side just above the main peat body, these are likely to be winter features created as upper sandy layers become surcharged.

These characteristics indicate that there is likely to be contrasted ground water, perched water and surface water components to the hydrological system, as well as direct wetting from rainfall.

The open waters and wetlands outfall through alder woodland to a stream known as the Tadburn Lake to the north and of which, a short section of the stream is included within the cSAC. This stream also has an extensive catchment to the northeast.

The two main seepages are of contrasted chemistry. The eastern area of seepage arises off land with humid and wet heathland having very acidic slowly permeable soils. These give rise to a sedge-bog-moss plant community that is unusual in lowland England. The south-western seepage area arises within secondary woodland and is partly sourced by two winter streams fed from land drains off the adjacent grass field. This water supports a more circum-neutral fen community.

The varied chemistry of the water, both in the seepages and across the flooded ground in winter, has led to the development of a suite of plant communities that are dependent both upon ground water conditions and on soil and peat conditions. The soils appear to be naturally acidic and so it is only when the site becomes flooded in winter with less acidic groundwater, that the complex water relations of the site become apparent.

Most of the wetland water bodies are rich in phosphorus and nitrogen and so tend to be very nutrient-rich. These waters fit into the eutrophic and hypertrophic states, conditions that lead to high plant growth rates and more related to fen conditions that nutrient-poor acid mires (bogs).

The reason for high phosphorus levels is not known and may be related to unknown past conditions. High nitrogen levels can be characteristic of waters within bogs, although at Emer they also apply to pond and small stream habitats suggesting that the levels here may be related to external sources as well as being generated from within the saturated peat deposits of the mire substrate. Some external drain sources arise of productive agricultural grass fields and these could provide a source of higher nutrients, although there is no direct evidence of this from the samples taken.

To summarise, Emer Bog cSAC is dependent upon the following physical and chemical support factors:

1. Topographic position;
2. Rainfall drainage within surface catchment;
3. Rainfall infiltration within the groundwater catchments;
4. Soil and substrate permeability;
5. Extent of waterlogged and flooded organic soils;
6. Stream flows;
7. Any surface drainage off highways and urban areas;
8. Outfall characteristics;
9. Fluctuating high groundwater conditions;
10. pH and macro and micro-nutrient level variation.

A hydrological conceptual model is presented in the final drawing (24) appended to this report.

7.0 RECOMMENDATIONS FOR FURTHER STUDIES, MONITORING AND MANAGEMENT

7.1 NEED FOR RESEARCH AND MONITORING

As with all such studies, this investigation has thrown up a number of questions: why is so much of the mire water apparently nutrient-rich and so little nutrient-poor and acidic; to what extent is the sensitive M5 acidic plant community threatened by its peculiar hydrological situation; are the hydrochemical conditions changing seasonally and/or over the long term; and if there is change, what will be implications for critical aspects of the site's biodiversity.

The answers to these questions are important when English Nature assess and report upon site (SSSI and cSAC) condition. To start to answer these questions will require a further and continuing programme of work.

This same data is necessary to establish an effective monitoring and management regime. Monitoring is important, not only to detect adverse change, but also to relate change to external conditions such as rainfall and temperature.

It could be argued that research into mire systems using the techniques discussed here is not easy and that the results can be difficult to interpret.

However, combining the results of chemical analysis of surface waters with plant community studies, topography, investigations of surface water flows and of substrate conditions can be a very powerful tool in understanding the basic parameters of habitat hydrology. Such a pragmatic approach is proposed here rather than any rigorous research-based scientific study.

7.2 VEGETATION SURVEY DATA

It is strongly recommended that a more detailed survey of the M5 and adjacent community distribution is undertaken using the accurate topographic base map that is now available.

This survey should not only distinguish the boundary of the communities but also details of their composition using quadrat information against which change in critical species abundance can be assessed over time.

7.3 HYDROCHEMICAL SURVEY DATA

7.3.1 Discussion

There are several ways in which nutrients can reach wetland plants including: from the water directly; from the water within the substrate peat; and from interactions with the thin films of water occurring between particles in mineral substrates. Each of these require different sampling methods. A full study of mire water systems requires a research approach outside of the scope of this study.

It is suggested that repeating the water studies undertaken in this study will give a good approach to understanding how nutrients levels vary from place to place, and at minimum cost. A research investigation would be lengthy and costly.

7.3.2 Open Water sampling

On completion of the vegetation survey, a hydro-chemical investigation can be targeted at the conditions that are supporting or are antagonistic to the more sensitive plant communities.

Reporting should aim at interpreting the nature of the vegetation in relation to the parameters examined and considering any adverse impact on habitats and how they might be alleviated or otherwise mitigated.

<u>Minimum scheme: pH only</u>

The minimum scheme would involve checking the pH of represented water bodies and wetland habitats monthly, preferably every two weeks. Sites should include locations within and around the critical M5 community and taking in the feeder streams and drains, and also the ponds.

The number of potential sample points will decrease as summer progresses and the site becomes drier. It would be important to survey the extent of open water on the site throughout the year.

Intermediate scheme: water chemistry

It is important to consider how nutrient values ascertained from water analysis relate to plant community composition and to distinguish those parts of the site with lower values of nutrients from those parts with higher values and to relate these to plant community distribution.

Water samples should ideally be taken at least quarterly from:

1. key source streams, springs and drains; and
2. along a transect from the acidic to the less acidic habitats.

The suite of analyses should be similar to those already taken (including soluble reactive phosphorus) and undertaken by the same laboratory as before to ensure continuity of methodology.

Advanced scheme

In addition to the regular determinations of pH and water chemistry proposed above, water samples can be taken from holes excavated in the saturated deposits to better determine conditions within the rooting zone.

7.3.3 Research investigation

Given funding, a full investigation of the relationships between plant communities and their hydrological system would be advantageous in assessing the sustainability of the critical plant communities.

Such a scheme would utilise more detailed investigations of hydrogeology, surface hydrology, water chemistry and substrate chemistry than could be used during the study currently being reported and using a variety of techniques with conclusions validated by statistical analysis.

Comparison of surface water conditions with groundwater conditions from a deep borehole would provide information about the extent to which groundwater chemistry affects substrate and surface water chemistry.

It is beyond this report to provide a programme of such research.

7.4 MONITORING

It is recommended that a programme of monitoring be considered to include:

1. Determining of pH of from key water bodies monthly (or every 2 weeks if resources permit);
2. Minimum quarterly (preferably monthly) monitoring of soil-water and surface-water levels within the open wetlands from the locations of a series of about ten 1.5m deep dipwells laid in a transect as in 7.2 above;
3. Quarterly monitoring from at least one deeper borehole to check on groundwater levels and groundwater chemistry;
4. Monitoring every two years of critical flora (especially the more strongly calcifuge or calcicole species) to ascertain changes in plant communities with time;

5. Sampling and determination of pH and macro and micro-nutrient levels from open waters, dipwells and boreholes.
6. Photography of key features from which to compare any future change.

7.5 EFFECTIVE MANAGEMENT

The results of this study, and of the programme of research and monitoring set out above, should be used to determine management necessary to maintain and extend the critical mire and swamp habitats.

Key management is to keep the open habitats free from excessive shading by willow and alder scrub. It is also important to keep the area of acidic open habitats free of rush (*Juncus* spp.) growth, which has a similar shading effect. This may require selective grazing and/or manual cutting.

Once the extent of key habitats has been determined, and the supporting hydrological system established, it will be necessary to design a management regime to maintain, enhance and increase the area of those habitats. This may mean controlling and enhancing, redirecting, or retaining surface flows.

8.0 DISCUSSION

The final drawing in the set appended to this report provides a hydrological conceptual model showing the main features of the site and their interactions

Land within, and around, Emer Bog is underlain by clays and clayey sands of the Tertiary Wittering Formation. These mostly slowly permeable deposits give rise to heavy seasonally waterlogged soils and, at Emer, the hydrological situation is such that extensive areas of wetland have developed over peat. The peat occurs within an upper and a lower basin and exceeds 2m thickness in places.

Water is sourced from a small surface and subsurface catchment and passes into the site from seasonal surface streams, springs and seepages, and also from perched groundwater within the peat bodies. Sandier seams and deposits occur on higher land and give rise to springs feeding the wetlands. Springs in the eastern part tend to be acidic and those to the south, circum-neutral or even slightly alkaline. The southern sources arise in part from off a drained grass agricultural field.

Water levels in the wetlands vary and this creates flooding in winter and drier conditions in the summer. Water is lost from the site by surface flow towards a stream in the north, and possibly (by summer percolation) into underlying strata.

The surface water in the wetlands and open water bodies varies laterally from strongly acidic to mildly alkaline.

Both phosphorus and nitrogen levels are high in open water habitats suggesting possible enrichment. Phosphorus levels are particularly high in the mire surface waters, although the high levels of nitrogen (compared to open waters) are likely to be derived from natural processes operating within the mire and may, or may not, be indicative of enrichment.

The cause of this nutrient richness remains unknown but is presumed to arise from the soil and substrate materials within the site and through which groundwater passes to reach the wetlands. The levels of phosphorus and nitrogen nutrients appear to decrease slightly in the winter when water levels are high.

It is concluded, on current evidence, that much of the high fertility of the pools and wetland habitats is most likely to be generated from within the mire system rather than from external surface sources, although background levels of nutrients in groundwaters at Emer remain unknown. There is no evidence that significant nutrient inputs from external sources, although there could be small agricultural sources arising from land drains and ditches associated with fields to the south. The evidence in this report is that possible current agricultural sources are likely to be relatively minor (if any) and will be quickly assimilated into the wetland system. It is possible that past fertiliser inputs to the fields could have been greater in the past and that the current high fertility of the mire is the cumulative result of such inputs over a number of years.

Six Environment Agency consented discharges occur to the east and northeast of the site, and one discharge occurs to the south. Those discharges to the east and northeast are likely to be too small and remote to cause ecologically significant adverse effects on Emer Bog. Any surface flows arising from these discharges would be prevented from reaching the mire by intervening boundary drains. Any groundwater discharges of plant nutrients from these sources that did reach the system are likely to be very small in relation to the existing nutrient loading within the mire system and so would be negligible. The southern discharge point is not in use and the intended discharges are passed into a different sub-catchment, the outfall of which bypasses the mire system.

Of particular concern, is the vulnerability of the small area of *Carex rostrata – Sphagnum squarrosum* Mire (NVC category M5). At Emer, this habitat is both particularly acidic and relatively rich in plant nutrients compared to more typical conditions. To one side of this habitat is a source of acidic water, and to the other a source of circum-neutral water. The acidity appears to support the plant communities, but the high nutrient levels are likely to be antagonistic to the community. Because the peat within the rooting zone is in hydrological continuity with the adjacent contrasted habits, this community could be very vulnerable to any increases in plant nutrients reaching the site, and could even be in decline.

Evidence is that the bog was much more acidic in 1996 than in 2001 and the M5 community may have been more widespread prior to that time. If rising nutrient-rich groundwater fed surface waters spread eastward from the adjacent fen into the M5 community, that community could be degraded by unsuited water. It may be that the summer drying, and presence of acidifying *Sphagnum* bog-mosses, may restore acidity in the soils every summer, only to be replaced by less acidic and more nutrient-rich conditions as the area becomes wetter in winter. Whatever the situation, the M5 community is restricted in extent and particularly vulnerable to hydrochemical change.

9.0 SUMMARY OF GENERAL CONCLUSIONS

A hydrological conceptual model is provided in the final drawing appended to this report.

1. Peat deposits at Emer Bog are in two basins and hold water perched above a slowly permeable substrate.

2. Water is sourced from a small surface catchment via seasonal streams, springs and seepages, some of which are acidic and others are more neutral. Some, drain managed grasslands.

3. Water levels in the wetlands vary seasonally and are reduced in summer by drainage to the north and/or by slow downward percolation.

4. The water in the mire and associated wetlands varies from strongly acidic to mildly alkaline and is rich in phosphorus and nitrogen creating highly fertile conditions. Phosphorus and nitrogen levels are both high in open water habitats suggesting possible enrichment. Phosphorus levels are particularly high in the mire surface waters, although the high levels of nitrogen (compared to open waters) are likely to be derived from natural processes operating within the mire and may or may not be indicative of enrichment.

5. High fertility in the mire water is likely to be mostly generated within the mire system with only small inputs from surface waters arising from agricultural land outside of the site. The reason for high fertility remains unknown, although it could be the result of accumulations from off the agricultural land over time.

6. Acidic mire habitats for which Emer Bog is scheduled could be vulnerable to any increase in plant nutrients and/or flooding with nutrient rich water.

7. Monitoring of pH and water chemistry should continue coupled with detailed plotting of plant communities and followed by an assessment of any impacts of altered chemistry on those communities.

10.0 CONCLUSION RELATING TO REVIEW OF CONSENTS

This report concludes that, in terms of the Environment Agency Review of Consents, that there are no licences (for discharge or abstraction) within or outside of the catchment, when considered alone or in combination, that are adversely affecting the integrity of Emer Bog cSAC.

11.0 REFERENCES

1. Allen R H (1996), Emer Bog and Baddesley Common: Reconnaissance Hydro-ecological Study, for Hampshire Wildlife Trust.
2. Avery B W (1980) Soil Classification for England and Wales (Higher Categories), Soil Surv. Tech.Mon No.14 Harpenden.
3. Allen R H (2002) Desk Study: Hydro-ecological appraisal of Emer Bog cSAC, North Baddesley, Hampshire, for Test Valley Borough Council: Planning Service.
4. Bendelow V C and Hartnup R, Climatic Classification of England and Wales, Soil Survey Technical Monograph No 15, Harpenden 1980.
5. Biodiversity: The UK Action Plan.
6. Biodiversity Action Plan for Hampshire.
7. British Geological Survey 1:50 000 scale Sheet 315 Southampton.
8. Conservation (Natural Habitats, &c.) Regulations 1994.
9. Countryside and Rights of Way Act 2000.
10. Countryside and Rights of Way Act 2000 – Explanatory Notes.
11. Criteria for selecting Sites of Importance for Nature Conservation in Hampshire, Hampshire County Structure Plan 1996-2011 (Review) November 2000.
12. Dames and Moor (December 2000) Phase I/II Assessment Works, Borden Chemical UK Ltd.
13. English Nature, 1982 SSSI Citation Baddesley Common.
14. English Nature, 18/05/00, Reasons for recommendation as a possible Special Area of Conservation.
15. English Nature, 02/03/01, Reasons for recommendation as a candidate Special Area of Conservation.
16. Environment Agency: General Quality Assessment of Rivers 2002
17. Environment Agency: Phosphorus standards for rivers in England and Wales Pitt J, Phillips G and Mainstone C. 2002
18. Geological Survey of Great Britain 1:10 000 scale Sheet SU32 SE.
19. Geological Survey of Great Britain 1:10 000 scale Sheet SU42SW.
20. Geological Survey of Great Britain 1:50 000 scale Sheet 299 Winchester.
21. Hampshire County Council, Biological Record.
22. Hampshire Landscape, Hampshire County Council 1993.
23. Hampshire Wildlife Trust, Water Level Records 2000.
24. Haslam S M (1994) Wetland differentiation and sensitivity to chemical pollutants (non-open water wetlands) DoE Report No DoE/HMIP/RR/040.
25. Jarvis M G, Allen R H, Fordham S J, Hazleden J, Moffat A J and Sturdy R G, Soils and their use in South East England, Soil survey of England and Wales Bulletin No 15, Harpenden 1984.
26. Legend to the 1:250,000 Soil Map of England and Wales, Soil Survey of England and Wales 1983.
27. MAFF Reference Book 435, The Agricultural Climate of England and Wales, HMSO.
28. Ordnance Survey 1:25 000 scale Explorer Sheet 131 Romsey, Andover and Test Valley.
29. Ordnance Survey 1:25 000 scale Explorer Sheet 132 Winchester.
30. Ordnance Survey 1:50 000 scale Landranger Sheet 185 Winchester and Basingstoke.
31. Ordnance Survey 1:50 000 scale Landranger Sheet 196 Solent and Isle of Wight.
32. Newbold C and Palmer M A (1979) Trophic Adaptions of Aquatic Plants, NCC CST Notes No. 18.
33. Palmer M A, Bell S L and Butterfield I (1992) A botanical classification of standing waters in Britain, applications for conservation and monitoring, Aquatic Conservation: Marine and Freshwater Ecosystems, Vol 2 125-143.
34. Palmer M A and Roy D B (2001) A method for estimating the extent of standing fresh waters of different trophic state in Great Britain, Aquatic Conservation: Marine and Freshwater Ecosystems Vol. 11 199-216.
35. Palmer M A and Roy D B (2001) An estimate of the extent of dystrophic, oligotrophic, mesotrophic and eutrophic standing freshwater in Great Britain, JNCC Report No 317

36. Rodwell J S (1994) British Plant Communities. Vol 4, Aquatic communities, swamnps and tall-herb fens. Cambridge University Press.
37. Sanderson NA December 1998, Vegetation Survey of Emer Bog, Hampshire, for Hampshire Wildlife Trust.
38. Shaw SC and Wheeler BD (1990) Contract Surveys No 129. Comparative survey of habitat conditions and management characteristics of herbaceous poor-fen vegetation types. Nature Conservancy Council, Peterborough.
39. Test Valley Borough Council Aerial Photographs.
40. 1:25,000 Soils of England and Wales, Sheet 6, South East England, Ordnance Survey for Soil Survey of England and Wales 1983.

APPENDICES

Tables of water chemistry data

Plans showing the physical and chemical characteristics of Emer Bog

Hydrological conceptual model

RESULTS OF WATER ANALYSIS for EMER BOG
Samples taken 14th December 1996

Analysis See notes at end of table for derivation of calculated values		**Site Number**						
		Open Water: West Pond	Open Water: East Pond	Sthrn inflow stream A; lower part	Shallow pool in willow carr	Pool in open mire	Pool F in cut off drain	Pool with *Carex paniculata* swamp
		A	**B**	**C**	**D**	**E**	**F**	**G**
pH		5.9	6.0	5.1	3.8	4.1	4.2	6.4
Electrical Conductivity	mmhos /cm	0.492	0.409	0.343	0.45	0.295	0.158	0.232
Electrical Conductivity	umhos /cm	492	409	343	450	295	158	232
Calcium	mg/l	50	38	28	29	19	8	18
Alkalinity (as equivalent $CaCo_3$)	mg/l	125.0	95.0	70.0	72.5	47.5	20.0	45.0
Alkalinity (as equivalent $CaHCO_3$)	mg/l	19.9	29.9	10.0	<0.001	10.0	10.0	91.3
Magnesium	mg/l	10	7	6	14	5	3	3
Manganese	mg/l	1.84	0.10	0.05	0.65	0.40	0.43	0.02
Boron	mg/l	0.11	0.1	0.08	0.08	0.09	0.44	0.08
Copper	mg/l	0.05	0.05	0.05	0.06	0.05	0.06	0.06
Molybdenum	mg/l	0.03	0.02	0.02	0.03	0.02	0.02	0.02
Iron	mg/l	0.810	0.620	0.550	0.570	0.550	0.490	1.310
Zinc	mg/l	0.14	0.04	0.04	0.05	0.05	0.07	0.01
Sulphur	mg/l	53.0	29.0	25.0	45.0	20.0	8.0	4.0
Total Phosphorus (filtered)	mg/l	0.560	0.380	0.180	0.120	0.110	0.050	0.040
Orthophosphate-P (filtered)	mg/l	Not Determined						
Potassium	mg/l	11.00	9.00	8.00	7.00	7.00	5.00	6.00
Nitrate-N	mg/l	0.90	5.13	1.27	5.06	0.63	0.52	0.35
Ammonia-N	mg/l	0.10	0.10	0.10	0.40	0.10	0.20	0.10
Total Inorganic N (by addition)	mg/l	1.00	5.23	1.37	5.46	0.73	0.72	0.45
Nitrate NO_3	mg/l	3.99	22.73	5.63	22.42	2.79	2.30	1.55
Ammonia NH_4	mg/l	0.13	0.13	0.13	0.52	0.13	0.26	0.13
Sodium	mg/l	16	18	19	27	17	12	15
Chloride	mg/l	39	45	48	45	42	30	36
Bicarbonate HCO_3	mg/l	12	18	6	<0.001	6	6	55

Ron Allen
'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield, Hants. GU32 3PG

Notes:
Nitrate and Ammonia Values calculated from Nitrate-N and Ammonia-N values.
Calcium carbonate alkalinity calculated from Calcium value.
Calcium bicarbonate alkalinity calculated from bicarbonate value.
Total Inorganic N calculated by addition of Nitrate-N and Ammonia-N.

[redacted]SUL[redacted] OF [redacted]TER[redacted]ALY[redacted] for [redacted]R B[redacted]

Samples taken 3rd August 2002

Analysis See notes at end of table for derivation of calculated values		Site Number										
		Pool: head of sthn inflow stream A. Pool at source	Reed Bed: East Pond	Open Water: East Pond	Pool: willow carr	Open water: West Pond	Shallow pool: willow carr	Shallow pool in open mire	Pool in open mire	Shallow pool in open mire	Shallow pool in open mire	Reed Bed
		A	B	C	D	E	F	G	H	I	J	K
pH		5.8	6.7	7.0	6.4	6.9	6.4	5.9	6.1	6.6	6.3	6.7
Electrical Conductivity	mmhos /cm	0.185	0.467	0.342	0.268	0.217	0.266	0.181	0.343	0.492	0.303	0.453
Electrical Conductivity	umhos /cm	185	467	342	268	217	266	181	343	492	303	453
Calcium	mg/l	12	51	34	25	17	22	12	30	46	18	42
Alkalinity (as equivalent $CaCo_3$)	mg/l	30.0	127.5	85.0	62.5	42.5	55.0	30.0	75.0	115.0	45.0	105.0
Alkalinity (as equivalent $CaHCO_3$)	mg/l	39.8	273.9	192.6	202.5	111.2	242.4	91.3	283.9	343.6	293.8	567.7
Magnesium	mg/l	4	7	6	6	4	5	3	7	7	4	6
Manganese	mg/l	0.03	0.01	<0.001	1.23	<0.001	0.92	0.31	4.13	0.97	0.53	1.08
Boron	mg/l	0.08	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.06	0.05
Copper	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	mg/l	1.570	3.710	1.170	17.620	1.630	72.300	8.710	42.640	56.730	104.380	123.220
Zinc	mg/l	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	<0.001
Sulphur	mg/l	8.0	6.0	6.0	4.0	3.0	5.0	4.0	8.0	4.0	5.0	4.0
Total Phosphorus	mg/l	0.1	0.3	0.1	3.2	0.2	2.6	0.5	2.4	7.5	3.4	9.5
Total Phosphorus (filtered)	mg/l	0.151	0.371	0.165	0.383	0.220	0.229	0.533	0.442	0.158	0.285	1.084
Orthophosphate-P (filtered)	mg/l	0.064	0.102	0.055	0.253	0.076	0.143	0.080	0.412	0.086	0.197	0.678
Potassium	mg/l	2.00	1.00	1.00	1.00	2.00	1.00	2.00	3.00	1.00	1.00	2.00
Nitrate-N	mg/l	4.01	0.88	0.77	0.78	0.74	0.82	0.79	0.78	0.71	0.79	0.77
Ammonia-N	mg/l	0.50	0.30	0.20	2.00	0.40	1.20	0.50	0.20	0.90	0.70	1.30
Total Inorganic N (by addition)	mg/l	4.51	1.18	0.97	2.78	1.14	2.02	1.29	0.98	1.61	1.49	2.07
Nitrate NO_3	mg/l	17.76	3.90	3.41	3.46	3.28	3.63	3.50	3.46	3.15	3.50	3.41
Ammonia NH_4	mg/l	0.65	0.39	0.26	2.58	0.52	1.55	0.65	0.26	1.16	0.90	1.68
Sodium	mg/l	13	22	20	20	16	19	18	30	25	28	27
Chloride	mg/l	25	44	42	44	39	47	36	47	44	47	44
Bicarbonate HCO_3	mg/l	24	165	116	122	67	146	55	171	207	177	342

Ron Allen
'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield, Hants. GU32 3PG

RESULTS OF WATER ANALYSIS for EMER BOG

Samples taken 3rd August 2002

Analysis See notes at end of table for derivation of calculated values		Site Number										
		Shallow pool in open mire	Shallow pool in open mire	Shallow pool in open mire	Nthrn outflow stream E: lower part	Pool in willow carr	Shallow pool in open mire	Shallow pool in open mire	Shallow pool in open mire	Shallow pool in open mire	Shallow pool in open mire	Shallow pool in open carr
		L	M	N	O	P	Q	R	S	T	U	V
pH		6.7	6.8	6.8	6.2	6.7	4.7	6.8	6.1	6.6	6.3	6.2
Electrical Conductivity	mmhos /cm	0.475	0.52	0.54	0.311	0.332	0.269	0.466	0.287	0.417	0.474	0.247
Electrical Conductivity	umhos /cm	475	520	540	311	332	269	466	287	417	474	247
Calcium	mg/l	39	38	43	44	38	12	40	18	41	36	17
Alkalinity (as equivalent $CaCO_3$)	mg/l	97.5	95.0	107.5	80.0	95.0	30.0	100.0	45.0	102.5	90.0	42.5
Alkalinity (as equivalent $CaHCO_3$)	mg/l	607.6	659.0	607.6	273.9	232.4	39.8	567.7	162.7	456.5	365.2	182.6
Magnesium	mg/l	8	6	6	7	6	4	8	4	6	8	4
Manganese	mg/l	2.11	0.89	1.34	0.79	0.31	0.37	1.58	0.34	1.1	2.19	1.04
Boron	mg/l	0.06	0.05	0.05	0.06	0.06	0.08	0.06	0.06	0.06	0.07	0.06
Copper	mg/l	<0.001	<0.001	<0.001	<0.001	0.01	0.02	<0.001	0.01	<0.001	<0.001	<0.001
Molybdenum	mg/l	<0.001	<0.001	<0.001	0.06	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	mg/l	142.510	85.640	106.720	50.610	15.810	13.180	123.830	25.940	85.830	35.800	45.810
Zinc	mg/l	0.01	<0.001	<0.001	<0.001	0.01	0.03	0.01	<0.001	<0.001	<0.001	<0.001
Sulphur	mg/l	6.0	4.0	4.0	6.0	3.0	12.0	11.0	5.0	5.0	6.0	5.0
Total Phosphorus	mg/l	21.3	52.7	68.3	2.1	0.3	6.3	29.7	3.8	12.7	11.8	4.2
Total Phosphorus (filtered)	mg/l	0.229	0.424	0.195	0.183	0.384	0.232	0.250	0.179	0.263	0.582	0.290
Orthophosphate-P (filtered)	mg/l	0.163	0.390	0.107	0.152	0.154	0.114	0.139	0.091	0.115	0.340	0.234
Potassium	mg/l	3.00	1.00	3.00	3.00	3.00	4.00	2.00	1.00	2.00	7.00	2.00
Nitrate-N	mg/l	0.74	1.13	0.78	0.77	0.66	0.95	0.78	0.83	0.71	0.69	0.74
Ammonia-N	mg/l	2.30	1.50	2.90	2.60	0.70	0.10	1.60	0.60	2.20	4.40	1.20
Total Inorganic N (by addition)	mg/l	3.04	2.63	3.68	3.37	1.36	1.05	2.38	1.43	2.91	5.09	1.94
Nitrate NO_3	mg/l	3.28	5.01	3.46	3.41	2.92	4.21	3.46	3.68	3.15	3.06	3.28
Ammonia NH_4	mg/l	2.97	1.94	3.74	3.35	0.90	0.13	2.06	0.77	2.84	5.68	1.55
Sodium	mg/l	28	23	28	28	21	39	32	35	31	32	17
Chloride	mg/l	53	42	47	42	42	61	53	50	53	53	42
Bicarbonate HCO_3	mg/l	366	397	366	165	140	24	342	98	275	220	110

Ron Allen
'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A [illegible]heste[illegible]d, Pe[illegible]ld, H[illegible] GU3[illegible]

RESULTS OF WATER ANALYSIS for EMER BOG

Samples taken 3rd August 2002

Analysis See notes at end of table for derivation of calculated values		Site Number				
		Shallow pool: willow carr	Nthrn outflow stream E: central part	Tadburn Lake (stream)	Pool with Carex paniculata swamp	Sthrn inflow stream A: lower part
		W	X	Y	Z	AA
pH		6.7	6.0	7.5	6.2	6.4
Electrical Conductivity	mmhos /cm	0.602	0.286	0.423	0.363	0.357
Electrical Conductivity	umhos /cm	602	286	423	363	357
Calcium	mg/l	41	22	52	33	36
Alkalinity (as equivalent $CaCO_3$)	mg/l	102.5	55.0	130.0	82.5	90.0
Alkalinity (as equivalent $CaHCO_3$)	mg/l	659.0	162.6	202.5	192.6	232.4
Magnesium	mg/l	8	6	7	7	7
Manganese	mg/l	1.58	0.59	<0.001	0.61	0.28
Boron	mg/l	0.05	0.05	0.07	0.07	0.06
Copper	mg/l	<0.001	0.01	<0.001	<0.001	<0.001
Molybdenum	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	mg/l	174.160	44.420	0.930	27.860	11.750
Zinc	mg/l	0.02	0.01	<0.001	<0.001	0.01
Sulphur	mg/l	6.0	6.0	14.0	10.0	6.0
Total Phosphorus	mg/l	12.9	4.9	0.2	1.1	1.1
Total Phosphorus (filtered)	mg/l	0.671	0.424	0.206	0.141	0.120
Orthophosphate-P (filtered)	mg/l	0.471	0.365	0.073	0.091	0.064
Potassium	mg/l	7.00	3.00	3.00	3.00	5.00
Nitrate-N	mg/l	0.85	0.77	5.50	0.89	0.79
Ammonia-N	mg/l	1.50	2.20	0.10	0.60	0.10
Total Inorganic N (by addition)	mg/l	2.35	2.97	5.60	1.49	0.89
Nitrate NO_3	mg/l	3.77	3.41	24.37	3.94	3.50
Ammonia NH_4	mg/l	1.94	2.84	0.13	0.77	0.13
Sodium	mg/l	27	30	22	32	24
Chloride	mg/l	58	42	42	44	44
Bicarbonate HCO_3	mg/l	397	98	122	116	140

Notes:

Nitrate and Ammonia Values calculated from Nitrate-N and Ammonia-N values.
Calcium carbonate alkalinity calculated from Calcium value.
Calcium bicarbonate alkalinity calculated from bicarbonate value.
Total Inorganic N calculated by addition of Nitrate-N and Ammonia-N.

Ron Allen
'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield, Hants. GU32 3PG

RESULTS OF WATER ANALYSIS for EMER BOG
Samples taken 19th December 2002

Analysis See notes at end of table for derivation of calculated values		Site Number										
		Small pool F in cut off drain	Estrn boundary drain H	Estrn internal drain G	Pool in alder carr	Estrn internal drain D	Tadburn Lake (stream)	Nthrn outflow stream E: central part	Nthrn outflow stream E: lower part	Nthrn outflow stream E: upper part	Shallow pool in open mire	Shallow pool in open carr
		AB	AC	AD	AE	AF	AG	Ahi	Ahii	Ahiii	AI	AJ
pH		4.4	3.9	4.0	5.6	6.3	5.9	6.2	6.8	6.0	6.1	5.3
Electrical Conductivity	mmhos /cm	0.134	0.178	0.177	0.374	0.236	0.173	0.171	0.255	0.151	0.176	0.135
Electrical Conductivity	umhos /cm	134	178	177	374	236	173	171	255	151	176	135
Calcium	mg/l	2	4	5	35	20	10	11	25	8	12	5
Alkalinity (as equivalent $CaCo_3$)	mg/l	5.0	10.0	12.5	87.5	50.0	25.0	27.5	62.5	20.0	30.0	12.5
Alkalinity (as equivalent $CaHCO_3$)	mg/l	19.9	10.0	10.0	97.6	71.4	71.4	71.4	111.2	51.5	61.4	29.9
Magnesium	mg/l	2	3	3	9	3	3	3	4	2	3	2
Manganese	mg/l	0.24	0.20	0.26	0.10	0.05	0.05	<0.001	0.03	0.01	<0.001	0.04
Boron	mg/l	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.02
Copper	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	mg/l	0.080	0.520	0.490	26.650	0.650	12.490	2.830	1.930	5.090	0.660	3.210
Zinc	mg/l	0.01	0.02	0.01	0.01	0.01	<0.001	<0.001	0.01	<0.001	<0.001	0.01
Sulphur	mg/l	4.0	6.0	6.0	32.0	9.0	3.0	3.0	8.0	3.0	4.0	3.0
Total Phosphorus (filtered)	mg/l	0.084	0.079	0.083	0.236	0.125	0.218	0.116	0.154	0.130	0.122	0.187
Orthophosphate-P (filtered)	mg/l	0.032	0.044	0.048	0.176	0.063	0.118	0.065	0.070	0.074	0.041	0.057
Potassium	mg/l	1.00	1.00	1.00	2.00	4.00	2.00	2.00	3.00	2.00	2.00	2.00
Nitrate-N	mg/l	0.67	0.79	0.75	1.38	0.84	0.70	0.63	2.30	0.82	0.62	0.61
Ammonia-N	mg/l	0.50	0.10	0.10	1.90	0.10	0.30	0.20	0.10	0.10	0.10	0.10
Total Inorganic N (by addition)	mg/l	1.17	0.89	0.85	3.28	0.94	1.00	0.83	2.40	0.92	0.72	0.71
Nitrate NO_3	mg/l	2.97	3.50	3.32	6.11	3.72	3.10	2.79	10.19	3.63	2.75	2.70
Ammonia NH_4	mg/l	0.65	0.13	0.13	2.45	0.13	0.39	0.26	0.13	0.13	0.13	0.13
Sodium	mg/l	6	12	12	21	13	10	10	12	9	11	9
Chloride	mg/l	22	36	36	36	36	31	34	31	28	34	31
Bicarbonate HCO_3	mg/l	12	6	6	61	43	43	43	67	31	37	18

Ron Allen
'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield, Hants. GU32 3PG

Analysis See notes at end of table for derivation of calculated values		Site Number										
		Shallow pool in open carr	Shallow pool in open mire	Shallow pool in open mire	Pool in open mire	Shallow pool in open mire	Shallow pool in open mire	Shallow pool in open mire	Shallow pool in open mire	Shallow pool in open mire	Shallow pool in open mire	Shallow pool in open mire
		AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
pH		5.3	6.2	6.0	6.3	6.4	6.4	6.1	5.5	6.4	4.8	5.1
Electrical Conductivity	mmhos /cm	0.134	0.188	0.163	0.191	0.199	0.197	0.146	0.138	0.153	0.111	0.112
Electrical Conductivity	umhos /cm	134	188	163	191	199	197	146	138	153	111	112
Calcium	mg/l	5	14	9	14	17	14	8	6	9	3	3
Alkalinity (as equivalent $CaCO_3$)	mg/l	12.5	35.0	22.5	35.0	42.5	35.0	20.0	15.0	22.5	7.5	7.5
Alkalinity (as equivalent $CaHCO_3$)	mg/l	29.9	81.3	51.5	78.4	111.2	111.2	61.4	39.8	81.3	10.0	19.9
Magnesium	mg/l	2	3	3	3	3	4	2	2	3	1	1
Manganese	mg/l	0.05	<0.001	<0.001	0.01	<0.001	0.03	0.01	0.01	0.01	0.18	0.15
Boron	mg/l	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Copper	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	mg/l	3.770	0.440	1.710	0.520	0.850	6.830	4.860	10.480	2.760	1.790	2.800
Zinc	mg/l	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.01
Sulphur	mg/l	3.0	4.0	3.0	3.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0
Total Phosphorus (filtered)	mg/l	0.127	0.092	0.108	0.067	0.103	0.117	0.118	0.121	0.121	0.122	0.111
Orthophosphate-P (filtered)	mg/l	0.071	0.049	0.062	0.044	0.048	0.054	0.056	0.067	0.074	0.049	0.056
Potassium	mg/l	2.00	2.00	2.00	2.00	2.00	3.00	1.00	1.00	1.00	1.00	1.00
Nitrate-N	mg/l	0.58	0.55	0.56	0.56	0.55	0.53	0.54	0.91	0.70	0.69	0.68
Ammonia-N	mg/l	0.20	0.30	0.20	0.20	0.20	0.20	0.20	0.20	0.10	0.10	0.20
Total Inorganic N (by addition)	mg/l	0.78	0.85	0.76	0.76	0.75	0.73	0.74	1.11	0.80	0.79	0.88
Nitrate NO_3	mg/l	2.57	2.44	2.48	2.48	0.24	2.35	2.39	4.03	3.10	3.06	3.01
Ammonia NH_4	mg/l	0.26	0.39	0.26	0.26	0.26	0.26	0.26	0.26	0.13	0.13	0.26
Sodium	mg/l	9	11	10	11	11	13	9	7	11	8	9
Chloride	mg/l	28	31	34	36	36	34	31	28	31	34	31
Bicarbonate HCO_3	mg/l	18	49	31	49	67	67	37	24	49	6	12

Ron Allen
'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield, Hants. GU32 3PG

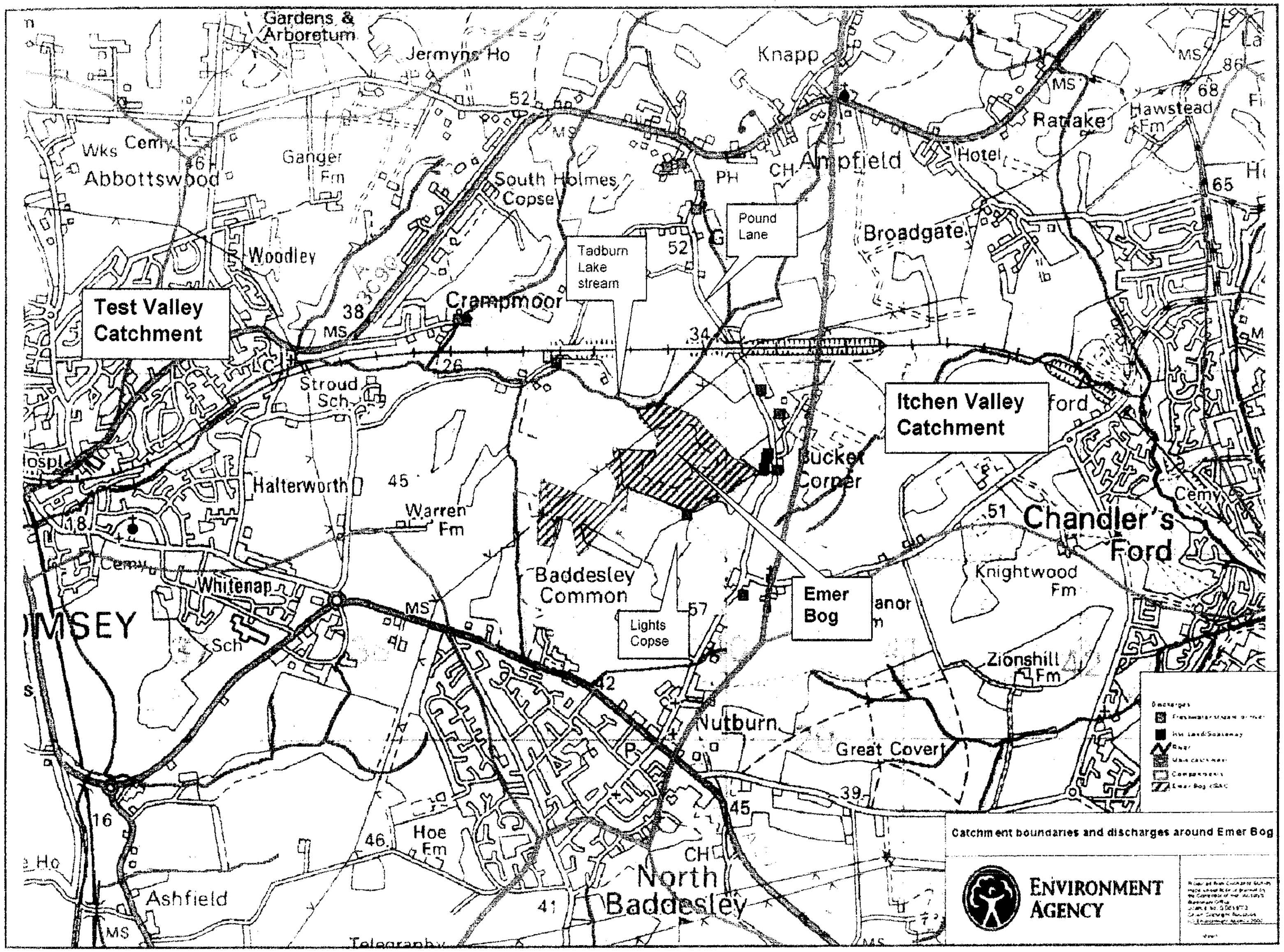
Analysis See notes at end of table for derivation of calculated values		**Site Number**										
		Shallow pool in open mire	Sthrn inflow stream B adj. site boundary	Sthrn inflow stream A: lower part	Pool with *Carex paniculata* swamp	Pool: head of sthrn inflow stream A	Pool in wet heath	Open water: West Pond south	Pool: willow carr	Sthrn inflor stream A: lower part	Open Water: East Pond	South wstrn boundary drain J
		AV	**AW**	**AX**	**AY**	**AZ**	**BA**	**BB**	**BC**	**BD**	**BE**	**BF**
pH		4.5	6.1	6.7	6.0	6.4	4.3	6.4	6.5	6.9	6.8	6.1
Electrical Conductivity	mmhos /cm	0.132	0.222	0.188	0.191	0.157	0.14	0.165	0.228	0.19	0.22	0.144
Electrical Conductivity	umhos /cm	132	222	188	191	157	140	165	228	190	220	144
Calcium	mg/l	4	14	13	10	13	2	11	17	14	19	7
Alkalinity (as equivalent $CaCO_3$)	mg/l	10.0	35.0	32.5	25.0	32.5	5.0	27.5	42.5	35.0	47.5	17.5
Alkalinity (as equivalent $CaHCO_3$)	mg/l	10.0	61.4	81.3	59.2	81.3	10.0	61.4	81.3	91.3	91.3	39.8
Magnesium	mg/l	2	4	3	3	3	2	3	4	3	3	3
Manganese	mg/l	0.19	0.06	0.01	0.01	<0.001	0.12	0.17	<0.001	<0.001	0.01	0.02
Boron	mg/l	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Copper	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	mg/l	1.810	0.350	1.760	4.690	1.200	1.450	7.810	0.990	0.680	3.700	1.980
Zinc	mg/l	0.01	0.02	<0.001	<0.001	0.01	0.02	0.01	<0.001	<0.001	<0.001	0.01
Sulphur	mg/l	3.0	8.0	4.0	5.0	4.0	3.0	5.0	5.0	4.0	5.0	5.0
Total Phosphorus (filtered)	mg/l	0.107	0.109	0.092	0.094	0.082	0.098	0.237	0.094	0.082	0.140	0.091
Orthophosphate-P (filtered)	mg/l	0.045	0.040	0.045	0.063	0.045	0.041	0.149	0.048	0.026	0.085	0.057
Potassium	mg/l	1.00	4.00	2.00	4.00	1.00	4.00	2.00	2.00	2.00	2.00	2.00
Nitrate-N	mg/l	0.67	2.26	0.80	0.68	1.80	0.70	0.81	0.68	0.72	0.70	0.64
Ammonia-N	mg/l	0.20	0.20	0.10	0.30	0.20	0.20	0.60	0.10	0.10	0.20	0.10
Total Inorganic N (by addition)	mg/l	0.87	2.46	0.90	0.98	2.00	0.90	1.41	0.78	0.82	0.90	0.74
Nitrate NO_3	mg/l	2.97	10.01	3.54	3.01	7.97	3.10	3.59	3.01	3.19	3.10	2.84
Ammonia NH_4	mg/l	0.26	0.26	0.13	0.39	0.26	0.26	0.77	0.13	0.13	0.26	0.13
Sodium	mg/l	10	14	11	14	5	10	9	16	11	11	7
Chloride	mg/l	36	36	31	34	17	31	31	42	34	34	22
Bicarbonate HCO_3	mg/l	6	37	49	37	49	6	37	49	55	55	24

Ron Allen
'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield, Hants. GU32 3PG

Analysis See notes at end of table for derivation of calculated values		**Site Number**				
		Wstrn inflow stream C	Nthrn outflow stream E: central part	Open Water: west pond north	Seasonal pool in willow carr	Drain passing below lane
		BG	**BH**	**BI**	**BJ**	**Pound Lane**
pH		5.9	5.9	5.9	6.1	6.9
Electrical Conductivity	mmhos /cm	0.145	0.15	0.149	0.157	0.287
Electrical Conductivity	umhos /cm	145	150	149	157	287
Calcium	mg/l	6	7	7	9	34
Alkalinity (as equivalent $CaCO_3$)	mg/l	15.0	17.5	17.5	22.5	85.0
Alkalinity (as equivalent $CaHCO_3$)	mg/l	29.9	39.8	39.8	49.6	152.7
Magnesium	mg/l	3	2	3	3	3
Manganese	mg/l	0.01	0.04	0.03	0.07	0.01
Boron	mg/l	0.02	0.02	0.02	0.02	0.03
Copper	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	mg/l	1.320	9.220	5.170	7.920	1.090
Zinc	mg/l	0.02	0.01	0.01	0.01	0.02
Sulphur	mg/l	5.0	3.0	3.0	3.0	9.0
Total Phosphorus (filtered)	mg/l	0.111	0.198	0.135	0.208	0.210
Orthophosphate-P (filtered)	mg/l	0.047	0.150	0.097	0.165	0.115
Potassium	mg/l	2.00	2.00	2.00	2.00	5.00
Nitrate-N	mg/l	0.65	0.73	0.79	0.70	1.01
Ammonia-N	mg/l	0.20	0.70	0.30	0.30	0.80
Total Inorganic N (by addition)	mg/l	0.85	1.43	1.09	1.00	1.81
Nitrate NO_3	mg/l	2.88	3.23	3.50	3.10	4.47
Ammonia NH_4	mg/l	0.26	0.90	0.39	0.39	1.03
Sodium	mg/l	9	10	10	10	13
Chloride	mg/l	31	28	31	34	36
Bicarbonate HCO_3	mg/l	18	24	24	31	92

Notes:
Nitrate and Ammonia Values calculated from Nitrate-N and Ammonia-N values.
Calcium carbonate alkalinity calculated from Calcium value.
Calcium bicarbonate alkalinity calculated from bicarbonate value.
Total Inorganic N calculated by addition of Nitrate-N and Ammonia-N.

Ron Allen
'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield, Hants. GU32 3PG



Based upon a plan provided by the Environment Agency

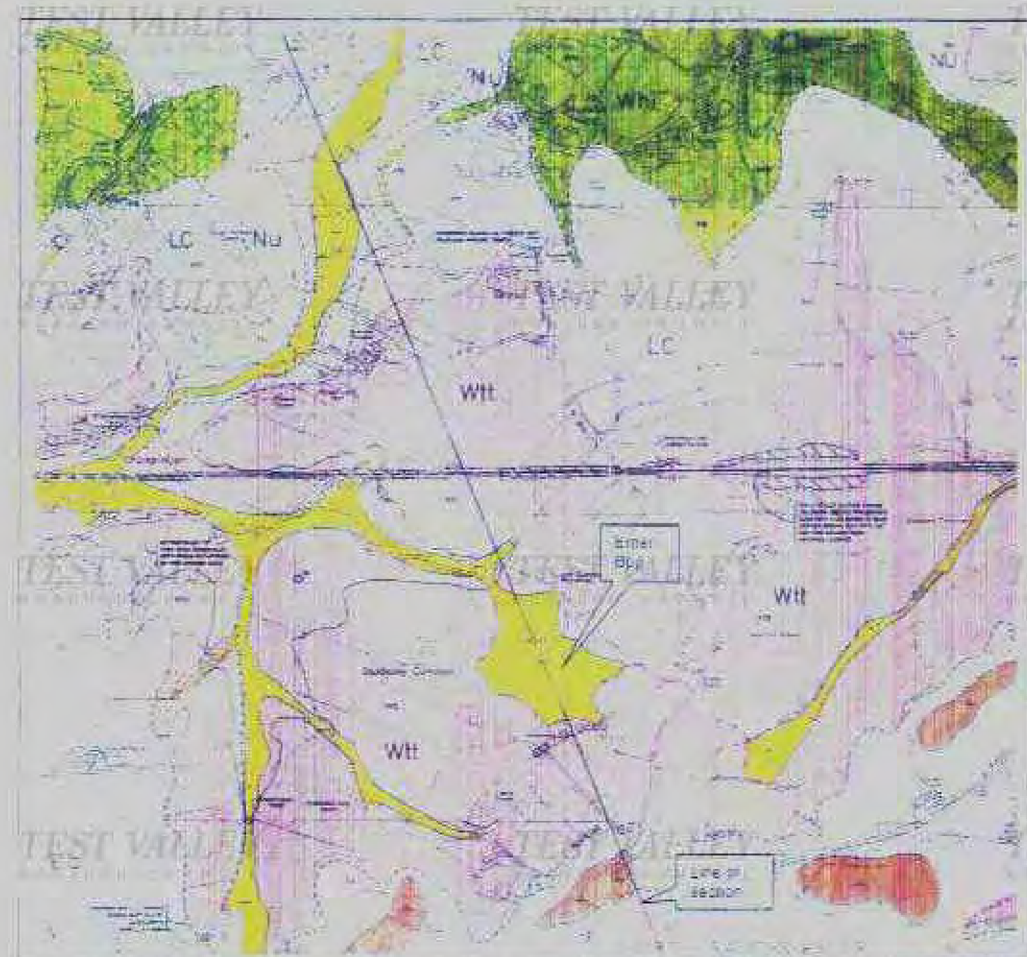
Dwg: 1 LOCATION AND CATCHMENTS

Site: Emer Bog cSAC

Client: Environment Agency and English Nature

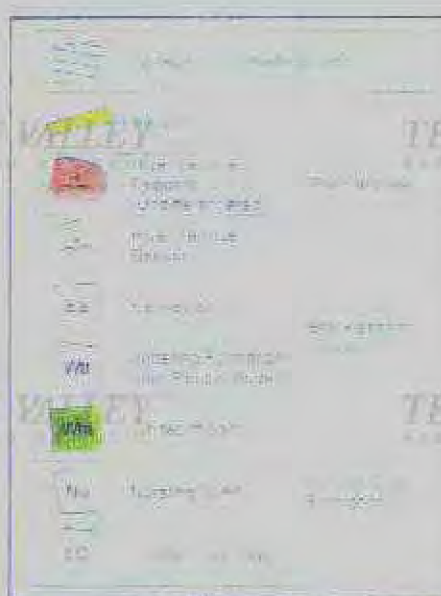
Dwn: R H Allen November 2002

'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield
Hampshire GU32 3PG
Tel. 01730 231019 Fax. 01730 231021
Email. ra@epcg.co.uk
Web. www.hydro-ecology.co.uk
www.epcg.co.uk



Coloured extract from 1:10,000 scale Geological Map

North-South geological section along line on geological map left. This section has considerable vertical exaggeration leading to an apparent increase in the dip of strata which is likely to be only 1-2 degrees to the south

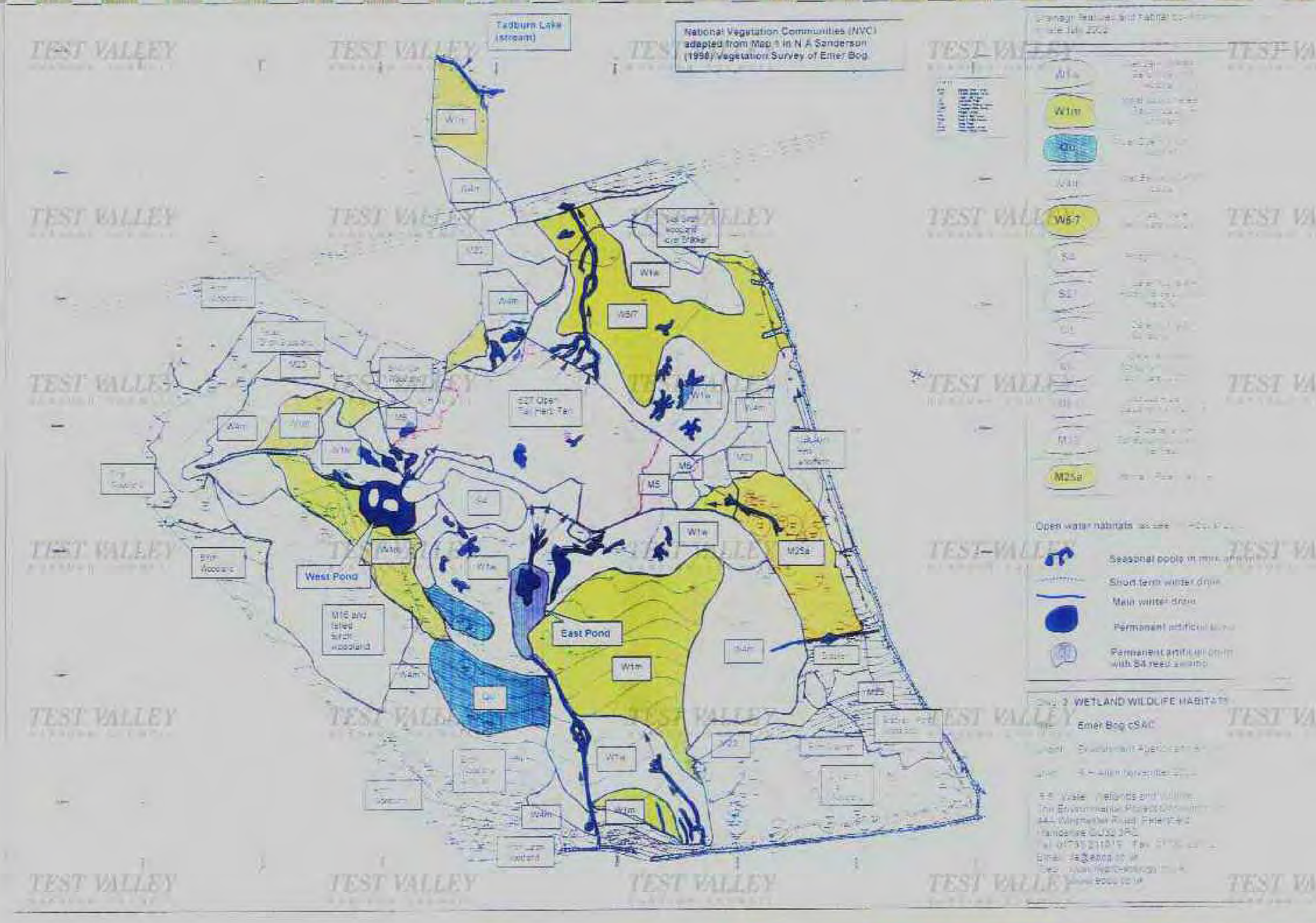


Legend to Geological Map and Section

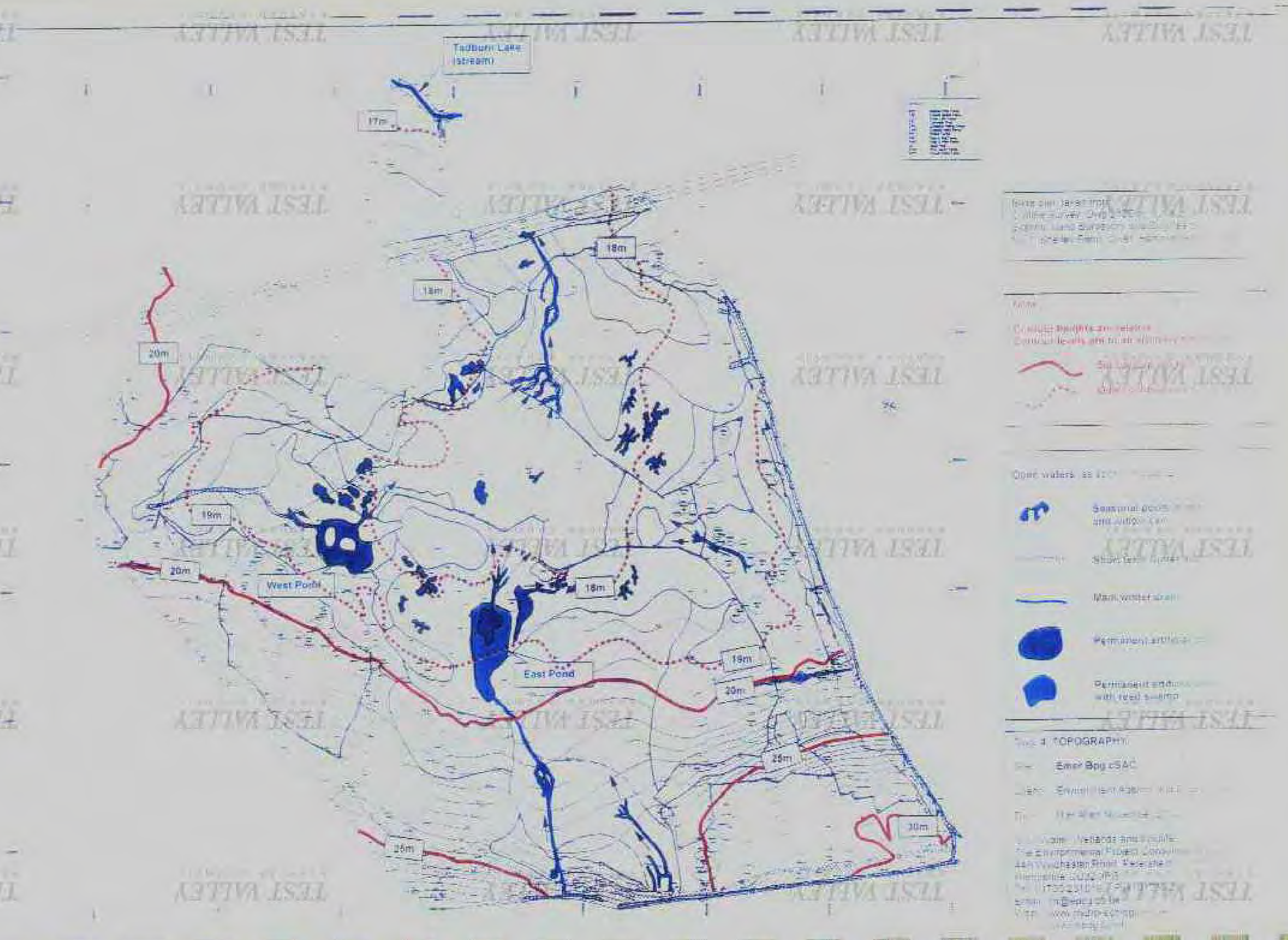
Extracts from drawings ... Hydro-ecological Appraisal of Emer Bog, North Baddesley, Hampshire ... Borough Council Planning Se...

Dwg. 2 - GEOLOGICAL SETTING

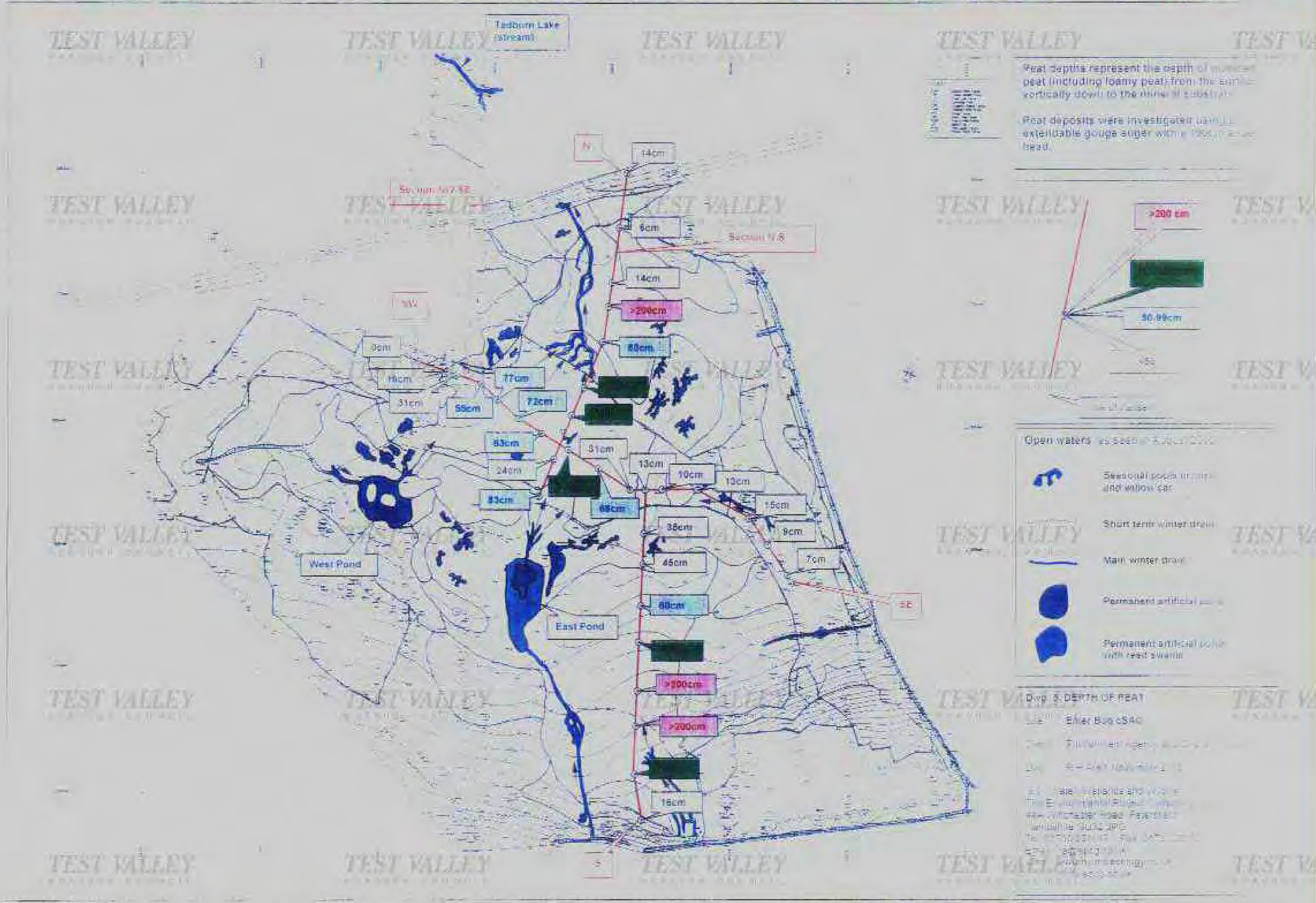
Site: Emer Bog cSAC

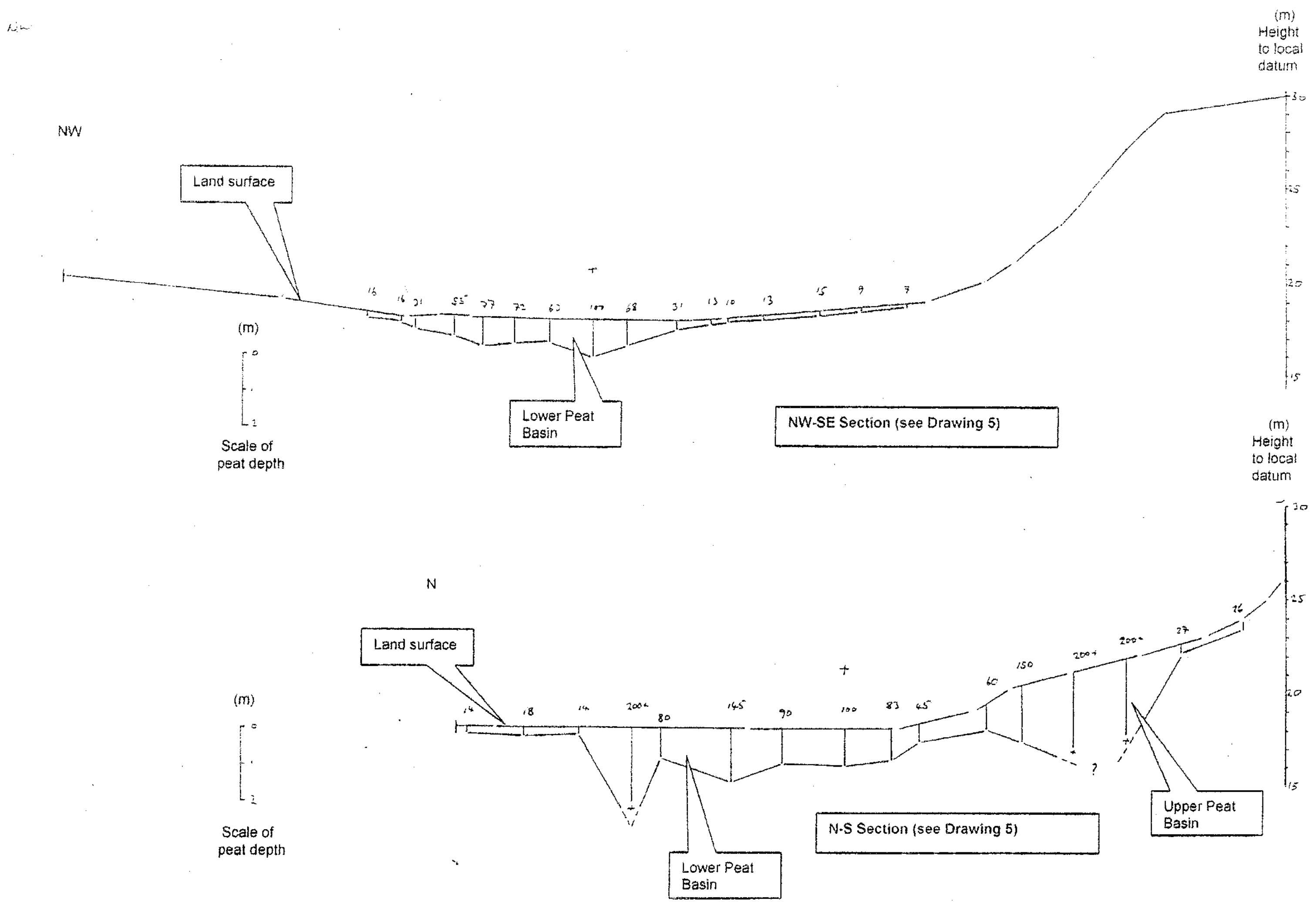


Tadburn Lake (stream)
National Vegetation Communities (NVC) adapted from Map 1 in N A Sanderson (1998) Vegetation Survey of Emer Bog.
W1m
W4m
W5/7
W1w
M25
M5
M23
M25a
S27 Open Tall Herb Fen
West Pond
East Pond
Open water habitats
Seasonal pools in mire
Short term winter drain
Main winter drain
Permanent artificial pond with S4 reed swamp
WETLAND WILDLIFE HABITATS
Emer Bog cSAC



Tadburn Lake (stream)
17m
18m
18m
20m
19m
20m
West Pond
18m
East Pond
19m
20m
25m
25m
30m
TEST VALLEY
Open waters
Seasonal pools
Main water drain
Permanent artificial
Permanent artificial with reed swamp
4 TOPOGRAPHY
Emer Bog cSAC


Tadburn Lake (stream)
N
14cm
6cm
14cm
>200cm
80cm
3cm
16cm
31cm
77cm
72cm
55cm
83cm
31cm
24cm
13cm
10cm
13cm
15cm
83cm
68cm
36cm
9cm
7cm
45cm
West Pond
East Pond
80cm
SE
>200cm
>200cm
16cm
Peat depths represent the depth of peat (including loamy peat) from the surface vertically down to the mineral substrate.
Peat deposits were investigated using extendable gouge auger
>200 cm
50-99cm
Open waters
Seasonal pools and willow carr
Short term winter drain
Main winter drain
Permanent artificial pond
Permanent artificial pond with reed swamp
Dwg 5 DEPTH OF PEAT
Emer Bog cSAC



Upper Section

This NW – SE transect shows the peat basin developed on the lower land at Emer Bog with thin peaty deposits on lower valley side only.

Lower Section

This N – S transect shows the development of an additional peat basin on the southern valley side.

Notes:

It is assumed that:

- the lower basin is at least partly fed by perched groundwater; and that
- the upper valley side basin is seepage water fed.

Peat depths represent the depth of humified peat (including loamy peat) from the surface vertically down to the mineral substrate.

Peat deposits were investigated using an extendable gouge auger with a 100cm auger head.

Lines of section are shown on Drawing 5.

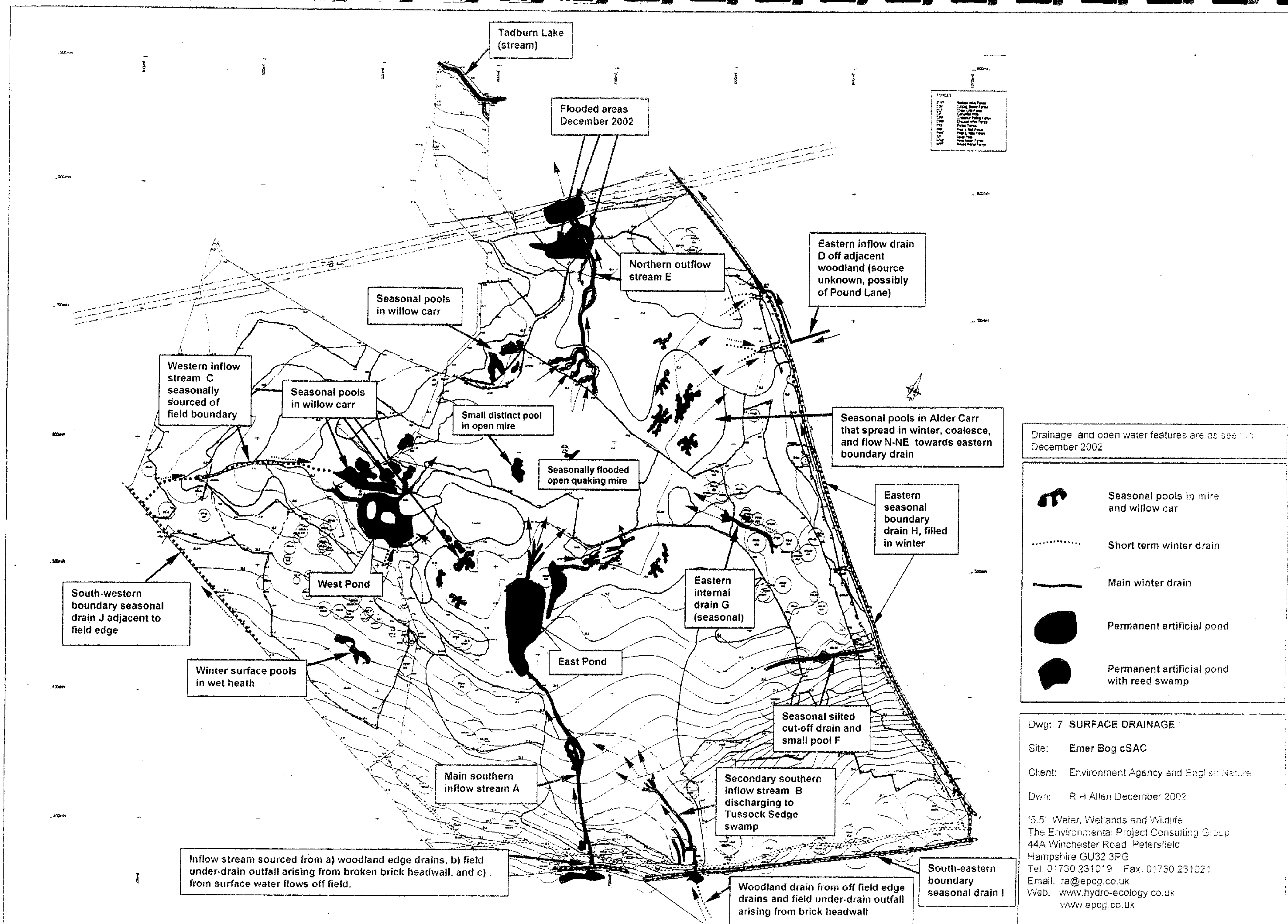
Dwg: 6 TOPOGRAPHIC AND PEAT DEPTH TRANSECTS

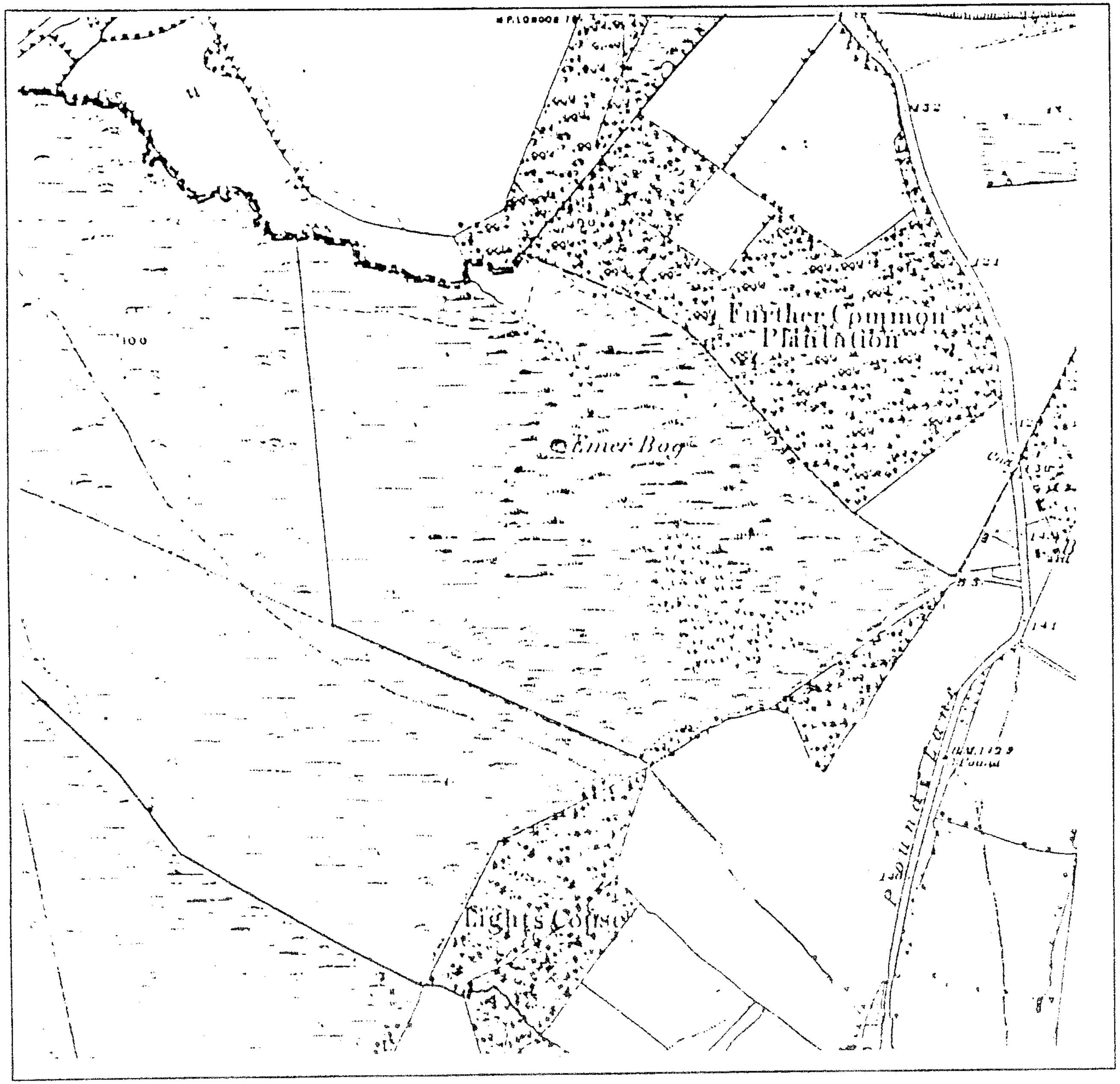
Site: Emer Bog cSAC

Client: Environment Agency and English Nature

Dwn: R H Allen November 2002

'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield
Hampshire GU32 3PG
Tel. 01730 231019 Fax. 01730 231021
Email. ra@epcg.co.uk
Web. www.hydro-ecology.co.uk
www.epcg.co.uk


Tadburn Lake (stream)
Flooded areas December 2002
Northern outflow stream E
Eastern inflow drain D off adjacent woodland (source unknown, possibly of Pound Lane)
Seasonal pools in willow carr
Western inflow stream C seasonally sourced of field boundary
Seasonal pools in willow carr
Small distinct pool in open mire
Seasonally flooded open quaking mire
Seasonal pools in Alder Carr that spread in winter, coalesce, and flow N-NE towards eastern boundary drain
Eastern seasonal boundary drain H, filled in winter
Eastern internal drain G (seasonal)
West Pond
South-western boundary seasonal drain J adjacent to field edge
East Pond
Winter surface pools in wet heath
Seasonal silted cut-off drain and small pool F
Main southern inflow stream A
Secondary southern inflow stream B discharging to Tussock Sedge swamp
Inflow stream sourced from a) woodland edge drains, b) field under-drain outfall arising from broken brick headwall, and c) from surface water flows off field.
Woodland drain from off field edge drains and field under-drain outfall arising from brick headwall
South-eastern boundary seasonal drain I
Drainage and open water features are as seen in December 2002
Seasonal pools in mire and willow car
Short term winter drain
Main winter drain
Permanent artificial pond
Permanent artificial pond with reed swamp
Dwg: 7 SURFACE DRAINAGE
Site: Emer Bog cSAC
Client: Environment Agency and English Nature
Dwn: R H Allen December 2002
'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield
Hampshire GU32 3PG
Tel. 01730 231019 Fax. 01730 231021
Email. ra@epcg.co.uk
Web. www.hydro-ecology.co.uk
www.epcg.co.uk



Extract from the 1870 Ordnance Survey Map.

The map appears to show a sinuous north – south area of possible wetland, also a small pond (to left of word Emer).

In 1870, the whole area appears to have been open heathland and bog with some scrub in a small area in the southeast.

It is possible that the small pond marks the confluence of an eastern and a western wetland tract.

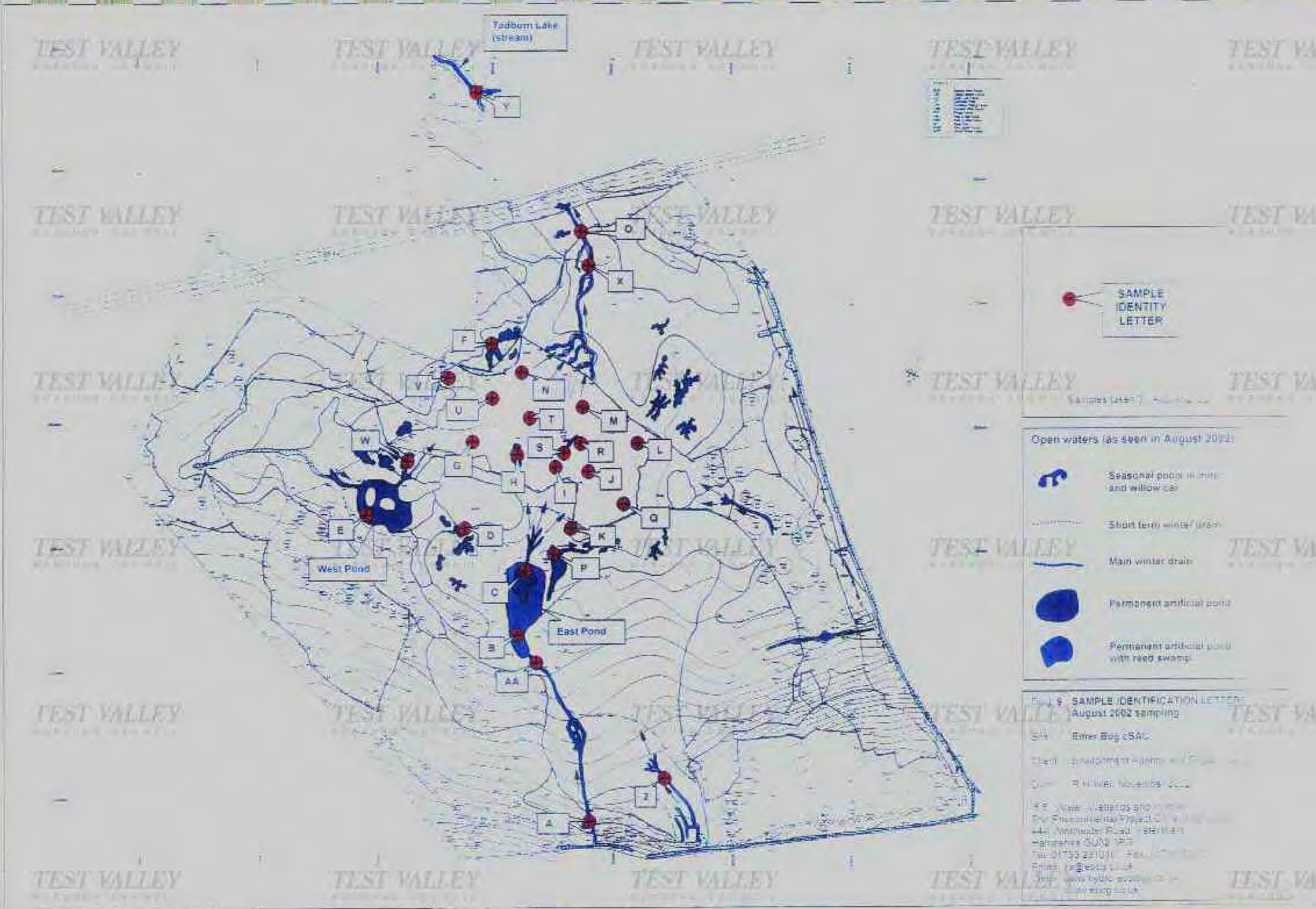
Dwg: 8 **HISTORIC MAP**

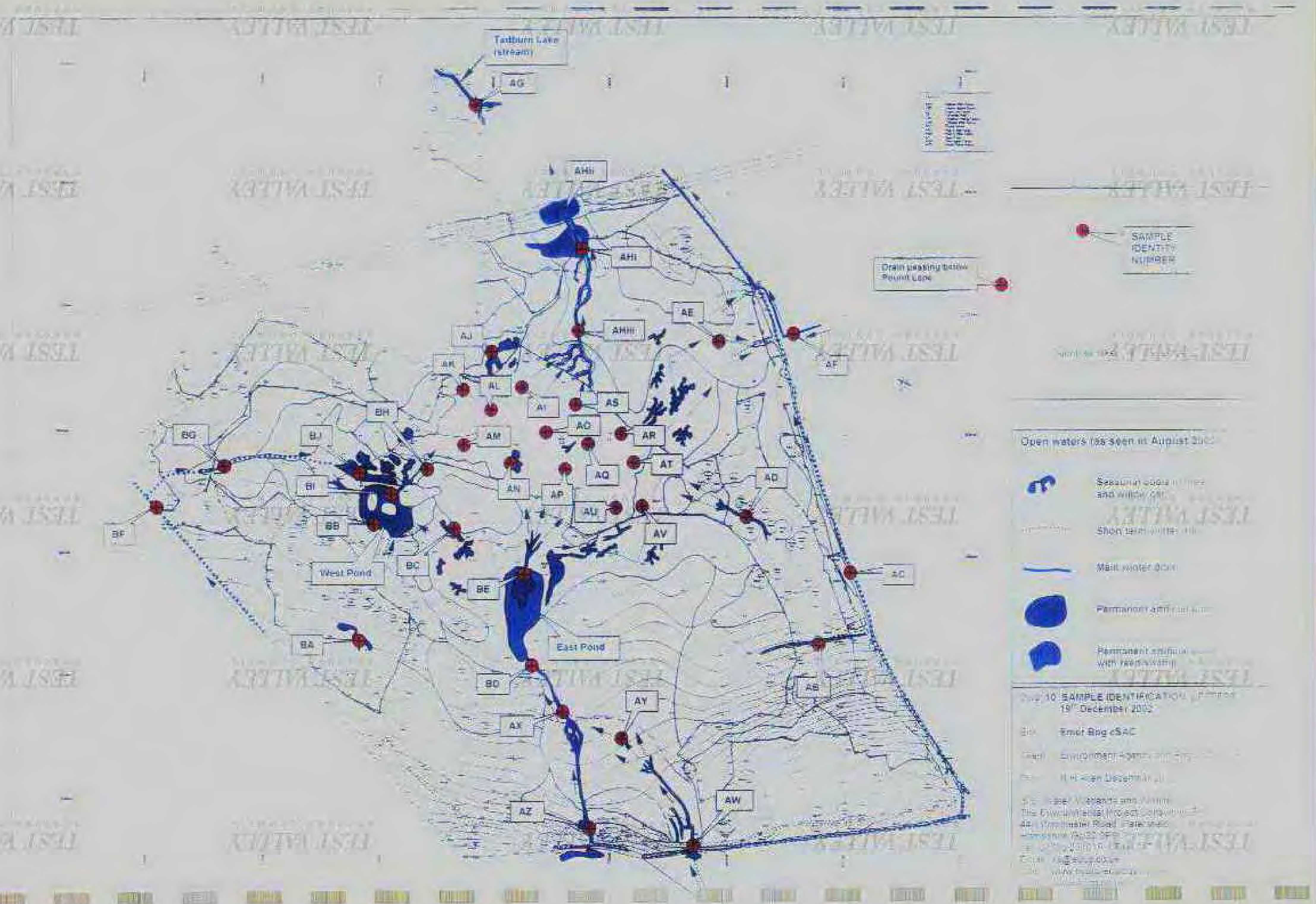
Site: **Emer Bog cSAC**

Client: Environment Agency and English Nature

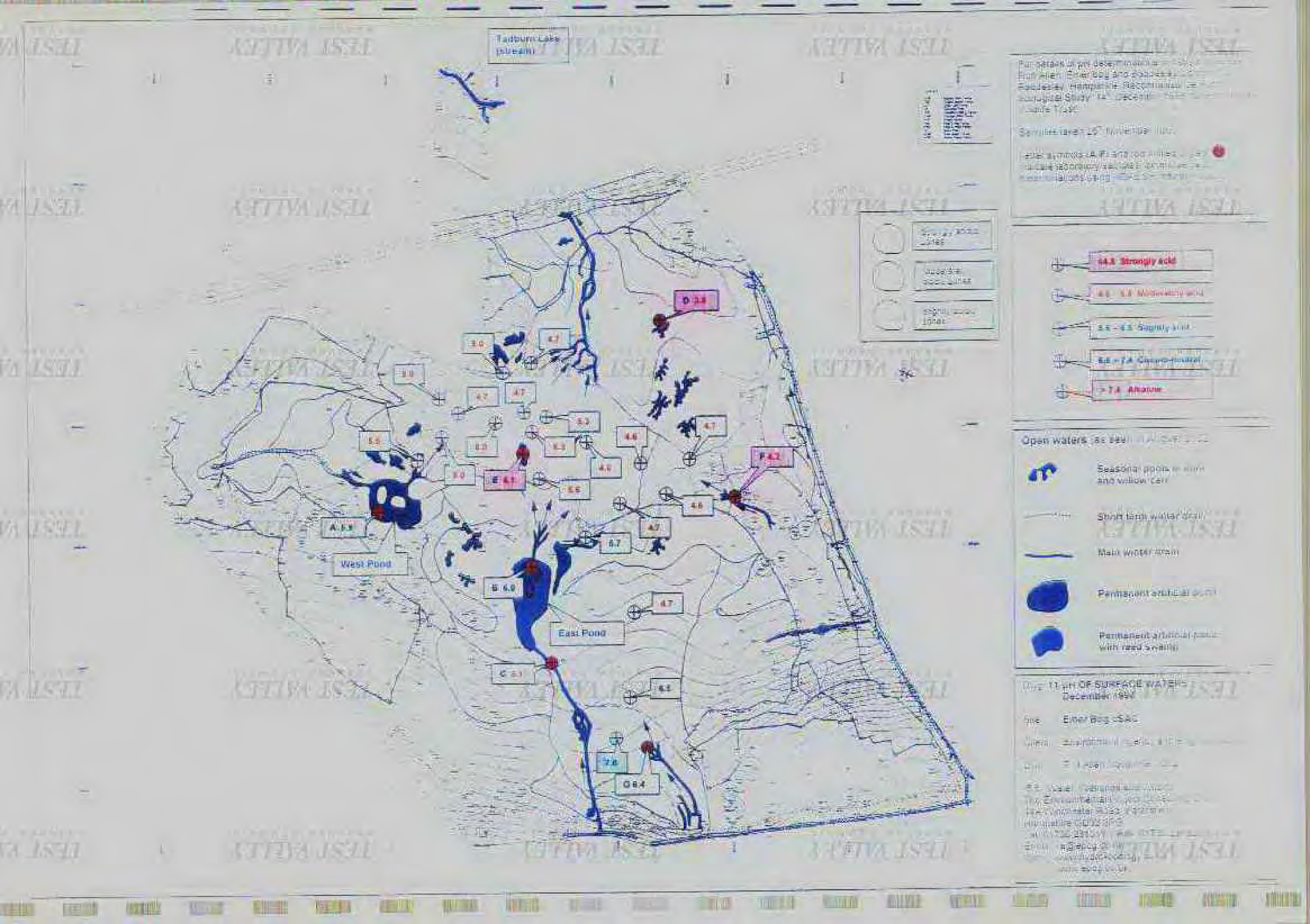
Dwn: R H Allen November 2002

'5.5' Water, Wetlands and Wildlife
The Environmental Project Consulting Group
44A Winchester Road, Petersfield
Hampshire GU32 3PG
Tel. 01730 231019 . Fax. 01730 231021
Email. ra@epcg.co.uk
Web. www.hydro-ecology.co.uk
www.epcg.co.uk

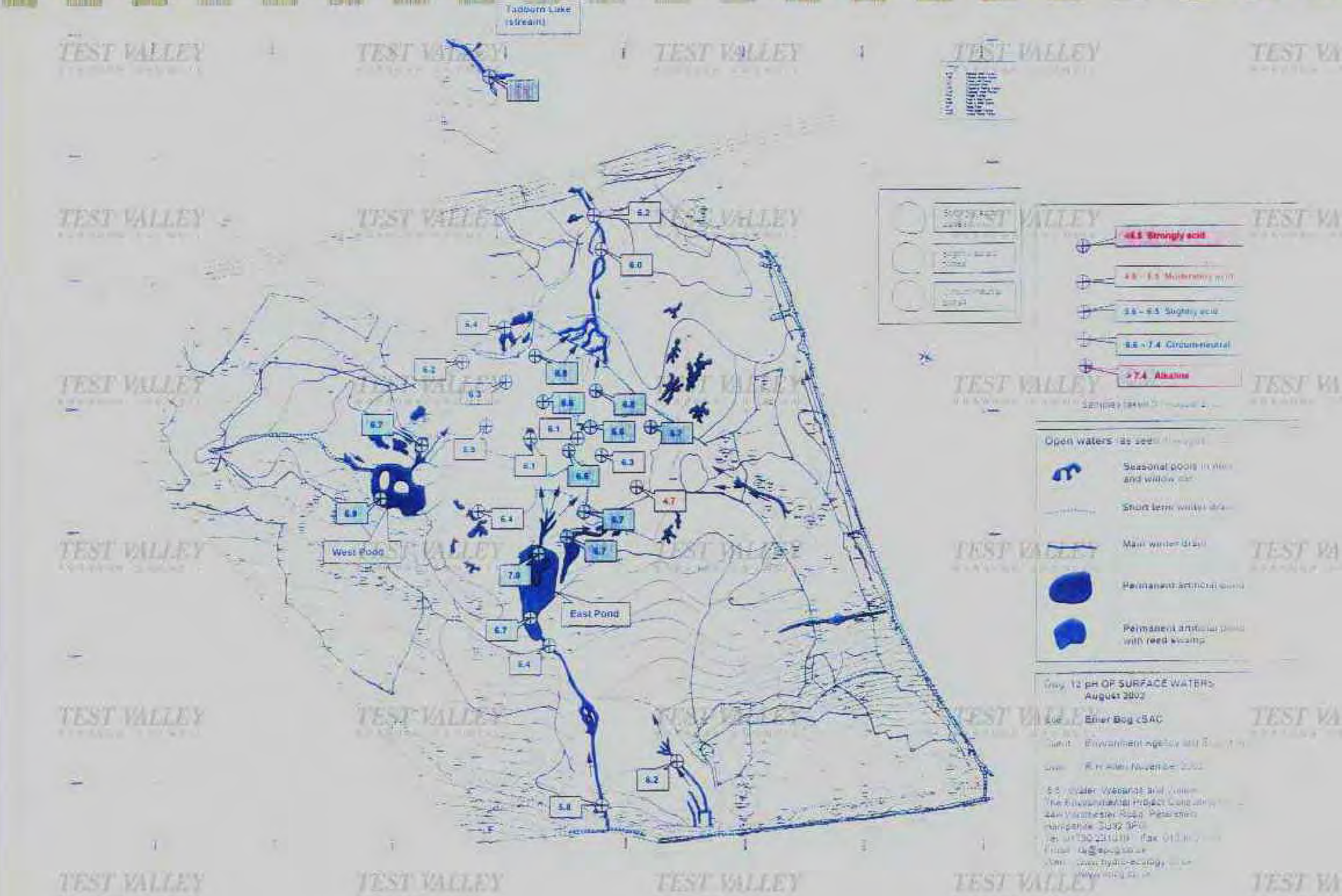

Tadburn Lake (stream)
Y
O
X
F
V
U
N
T
M
W
S
R
L
G
H
J
I
Q
E
D
K
West Pond
P
C
East Pond
B
AA
Z
A
SAMPLE IDENTITY LETTER
Open waters (as seen in August 2002)
Seasonal pool
and willow car
Short term winter drain
Main winter drain
Permanent artificial pond
SAMPLE IDENTIFICATION LETTERS
August 2002 sampling
Emer Bog cSAC

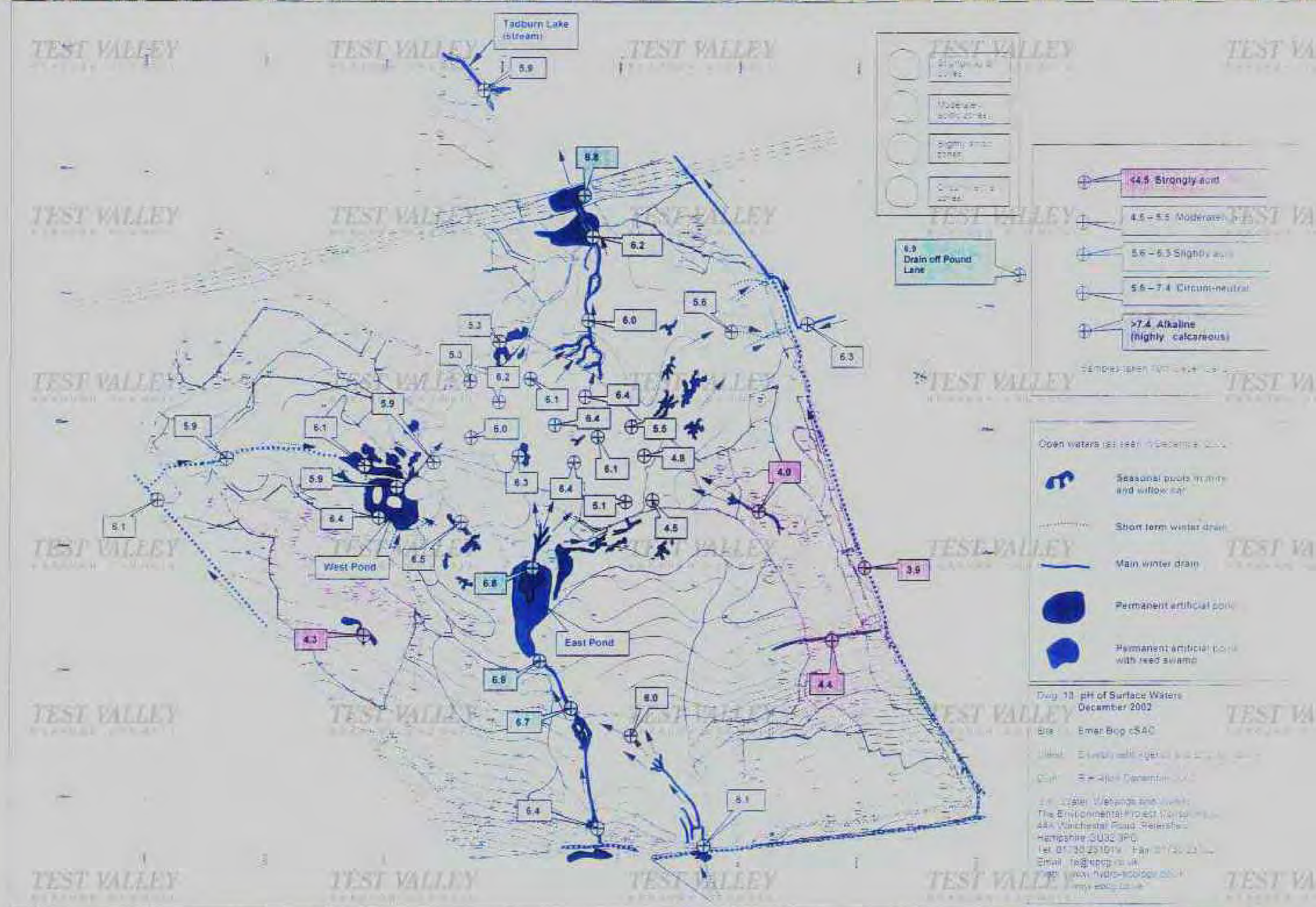


Tadburn Lake (stream)
AG
AHii
AHi
AHiii
AE
AF
Drain passing below Pound Lane
SAMPLE IDENTITY NUMBER
AJ
AK
AL
AI
AS
AO
AR
AM
BH
BJ
BG
AT
AQ
AN
AP
AU
AD
BI
BF
BB
AV
West Pond
BC
BE
AC
BA
East Pond
BD
AB
AY
AX
AZ
AW
Open waters (as seen in August 200
Main water body
Map 10 SAMPLE IDENTIFICATION
19th December 2002
Emer Bog cSAC

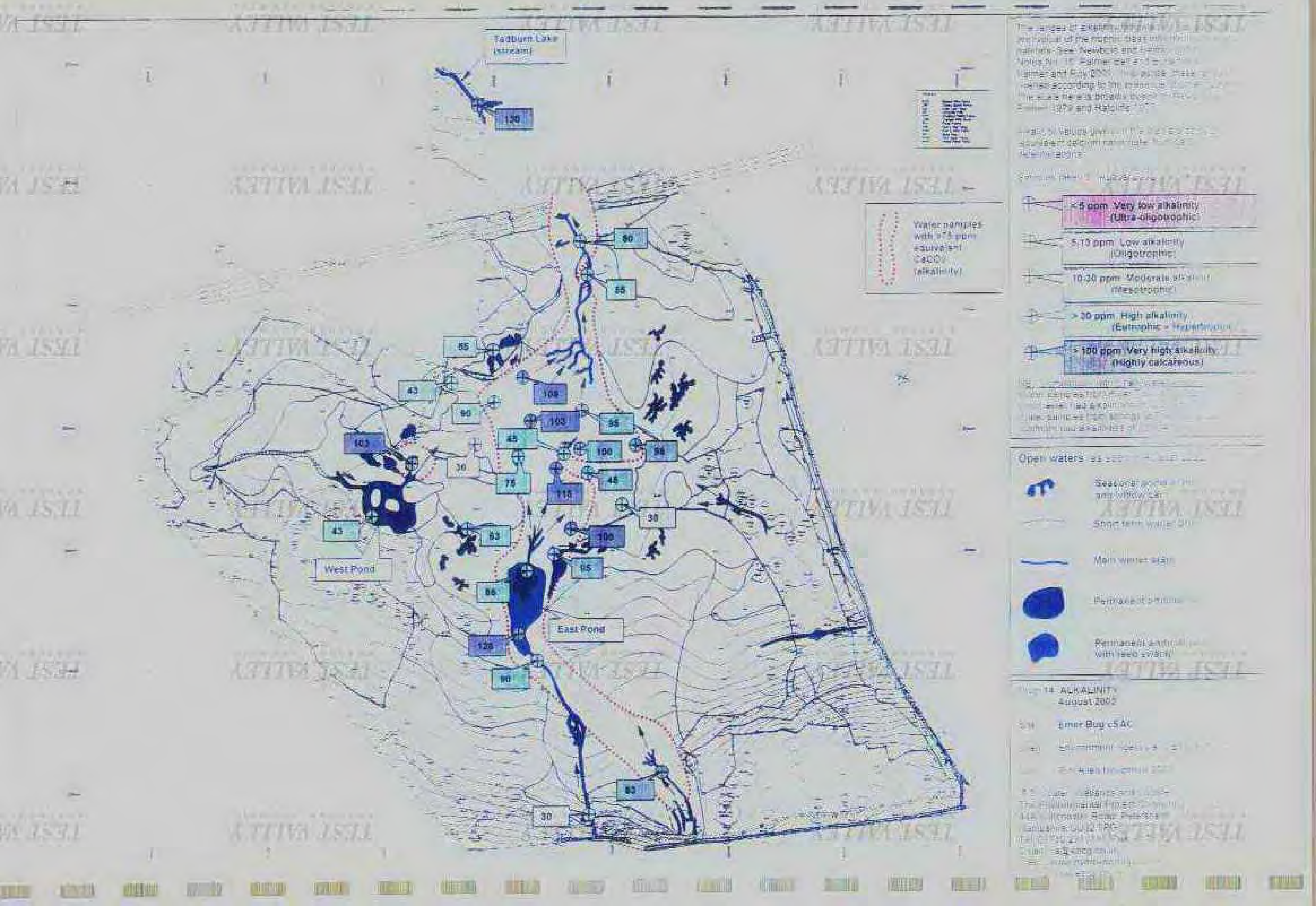


Tadburn Lake (stream)
D 3.8
E 6.1
F 6.2
A 6.5
B 6.9
G 6.4
7.8
West Pond
East Pond
≤4.5 Strongly acid
4.6 – 5.5 Moderately acid
5.6 – 6.5 Slightly acid
6.6 – 7.4 Circum-neutral
> 7.4 Alkaline
Open waters
Seasonal pools in birch and willow carr
Short term water drain
Main water drain
Permanent artificial pond
Permanent artificial pond with reed swamp
pH OF SURFACE WATERS
December 1997
Emer Bog cSAC

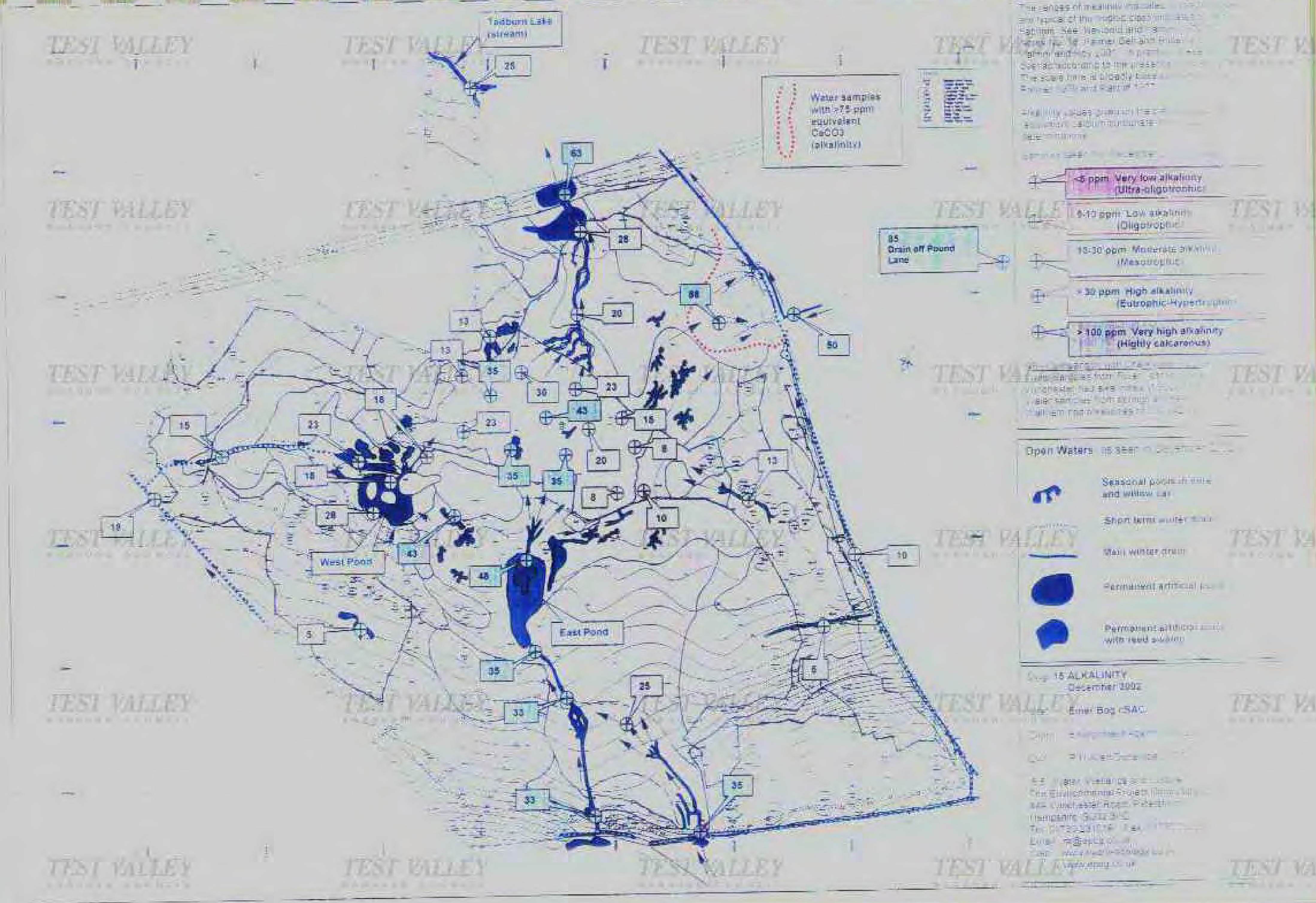

Tadburn Lake (stream)
West Pond
East Pond
<4.5 Strongly acid
5.6 – 6.5 Slightly acid
6.6 – 7.4 Circumneutral
>7.4 Alkaline
Open waters
Seasonal pools
Main water drain
Permanent artificial pond
Permanent artificial pond with reed swamp
pH OF SURFACE WATERS
August 2002
Emer Bog cSAC

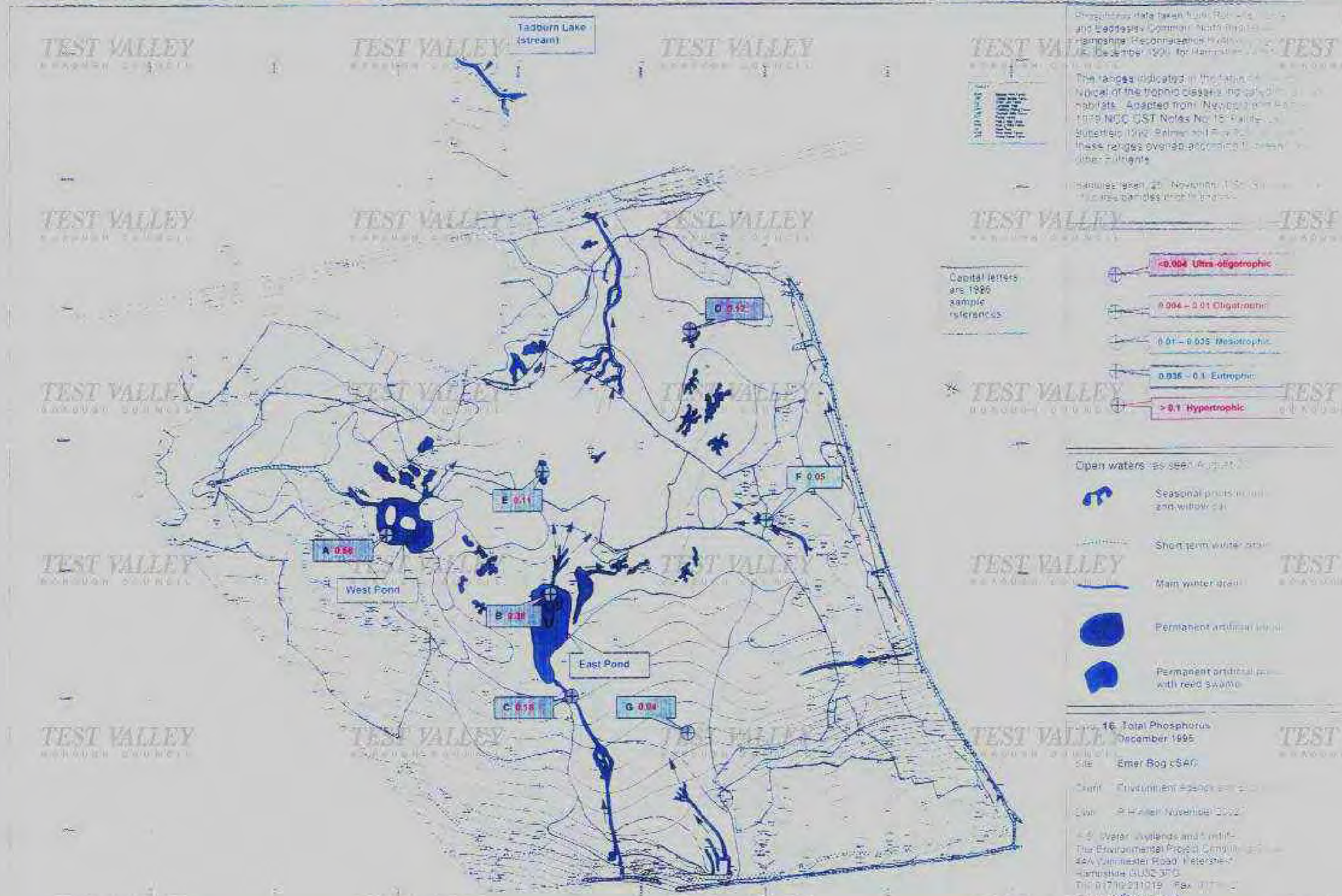


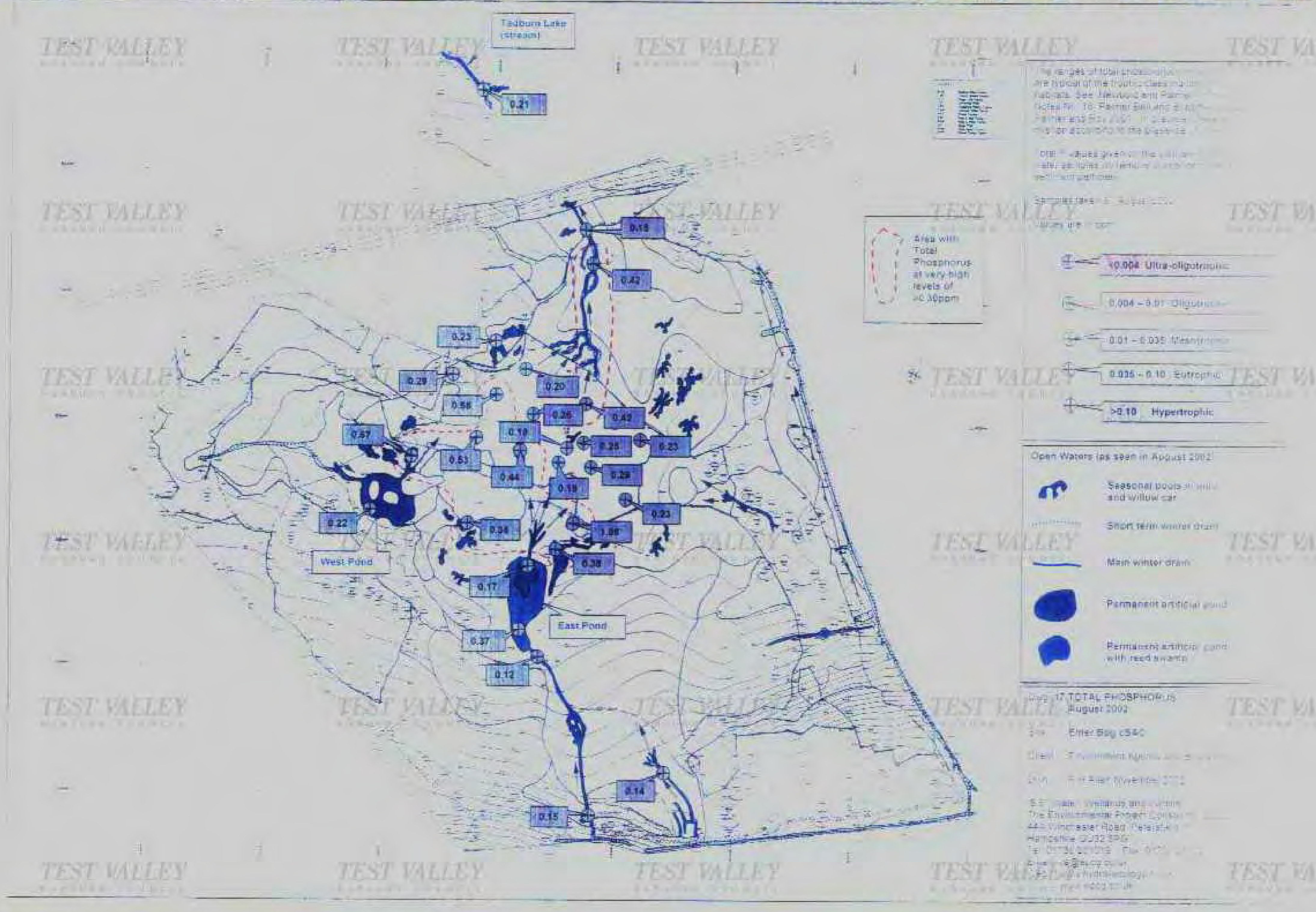
Tadburn Lake (stream)
5.9
6.8
6.2
6.9 Drain off Pound Lane
5.6
6.0
5.3
5.3
6.2
6.1
6.3
6.4
6.4
5.5
5.9
5.9
6.1
6.0
4.8
4.0
5.9
6.3
6.4
6.1
6.4
5.1
4.5
6.1
West Pond
6.5
6.8
3.9
4.3
East Pond
4.4
6.8
6.0
6.7
6.4
6.1
<4.5 Strongly acid
4.5 – 5.5 Moderately acid
5.6 – 6.3 Slightly acid
6.6 – 7.4 Circum-neutral
>7.4 Alkaline (highly calcareous)
Open waters (as seen in December 2002)
Seasonal pools in alder and willow carr
Short term winter drain
Main winter drain
Permanent artificial pond
Permanent artificial pond with reed swamp
Dwg. 10 pH of Surface Waters December 2002
Site: Emer Bog cSAC
TEST VALLEY

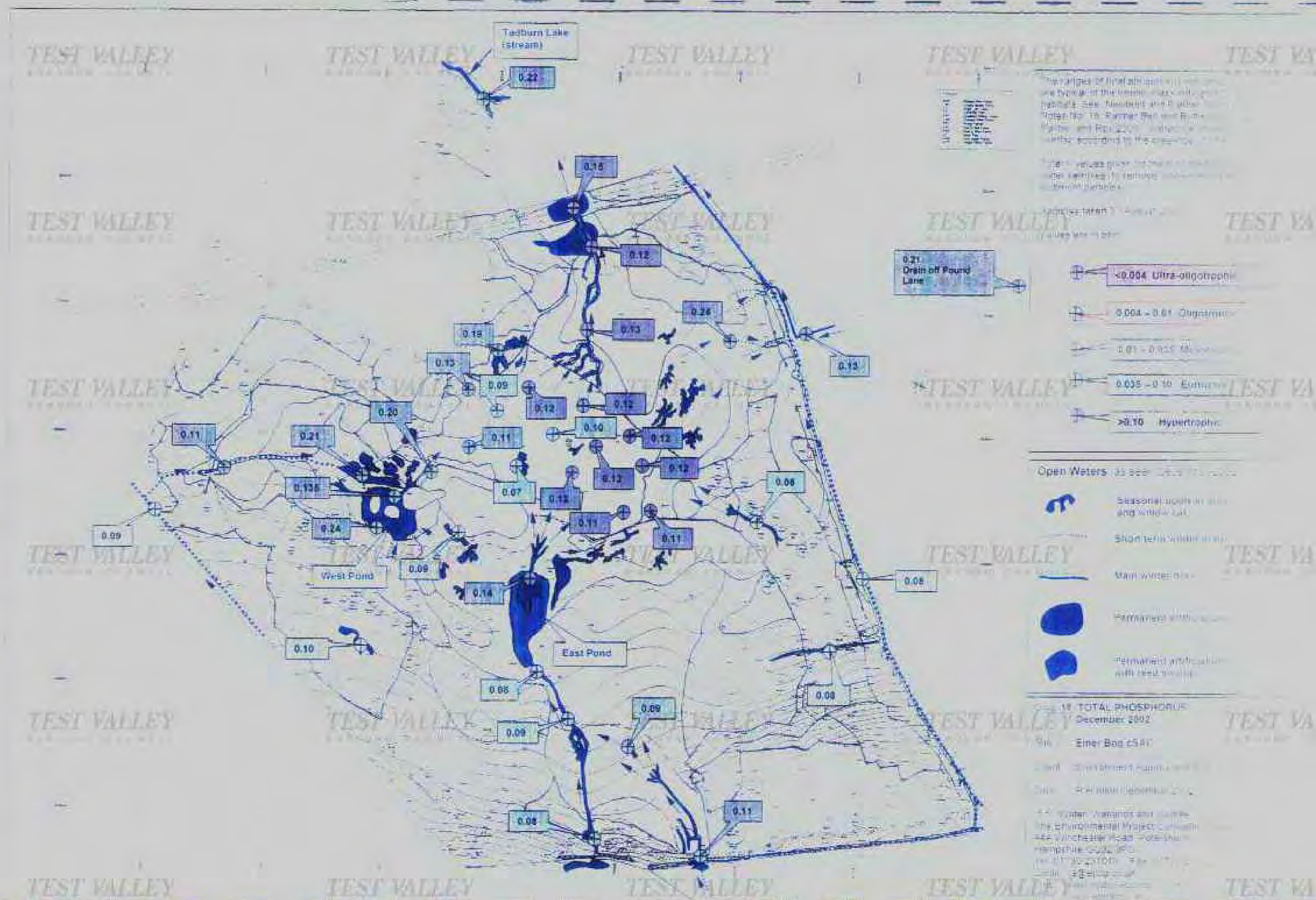


Tadburn Lake (stream)
120
80
55
65
43
90
108
103
55
45
103
30
75
100
98
115
45
30
43
63
100
West Pond
95
86
East Pond
120
90
83
30
Water samples with >75 ppm equivalent CaCO3 (alkalinity)
< 5 ppm Very low alkalinity (Ultra-oligotrophic)
5-10 ppm Low alkalinity (Oligotrophic)
10-30 ppm Moderate alkalinity (Mesotrophic)
> 30 ppm High alkalinity (Eutrophic > Hypertrophic)
> 100 ppm Very high alkalinity (Highly calcareous)
Open waters
Main winter drain
14 ALKALINITY
August 2002
Emer Bog cSAC

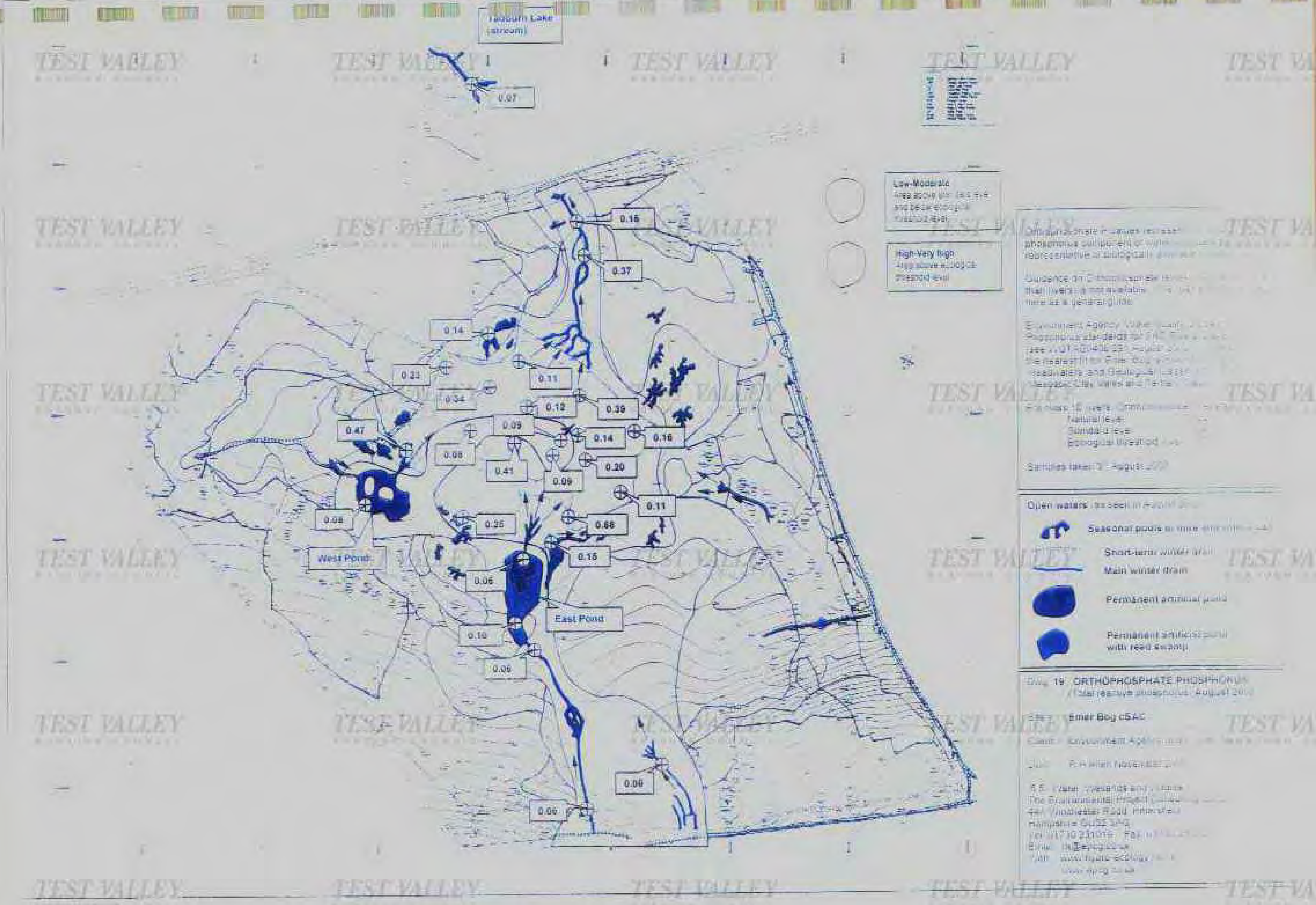

Tadburn Lake (stream)
Water samples with >75 ppm equivalent CaCO3 (alkalinity)
<5 ppm Very low alkalinity (Ultra-oligotrophic)
5-10 ppm Low alkalinity (Oligotrophic)
10-30 ppm Moderate alkalinity (Mesotrophic)
>30 ppm High alkalinity (Eutrophic-Hypertrophic)
>100 ppm Very high alkalinity (Highly calcareous)
85 Drain off Pound Lane
West Pond
East Pond
Open Waters
Seasonal pools in alder and willow carr
Short term winter drain
Main winter drain
Permanent artificial pond
Permanent artificial pond with reed swamp
15 ALKALINITY
December 2002
Emer Bog cSAC
63
28
25
20
88
50
13
13
35
30
23
16
43
23
15
23
16
8
20
13
18
35
35
8
10
19
28
43
48
10
5
35
25
33
6
33
35

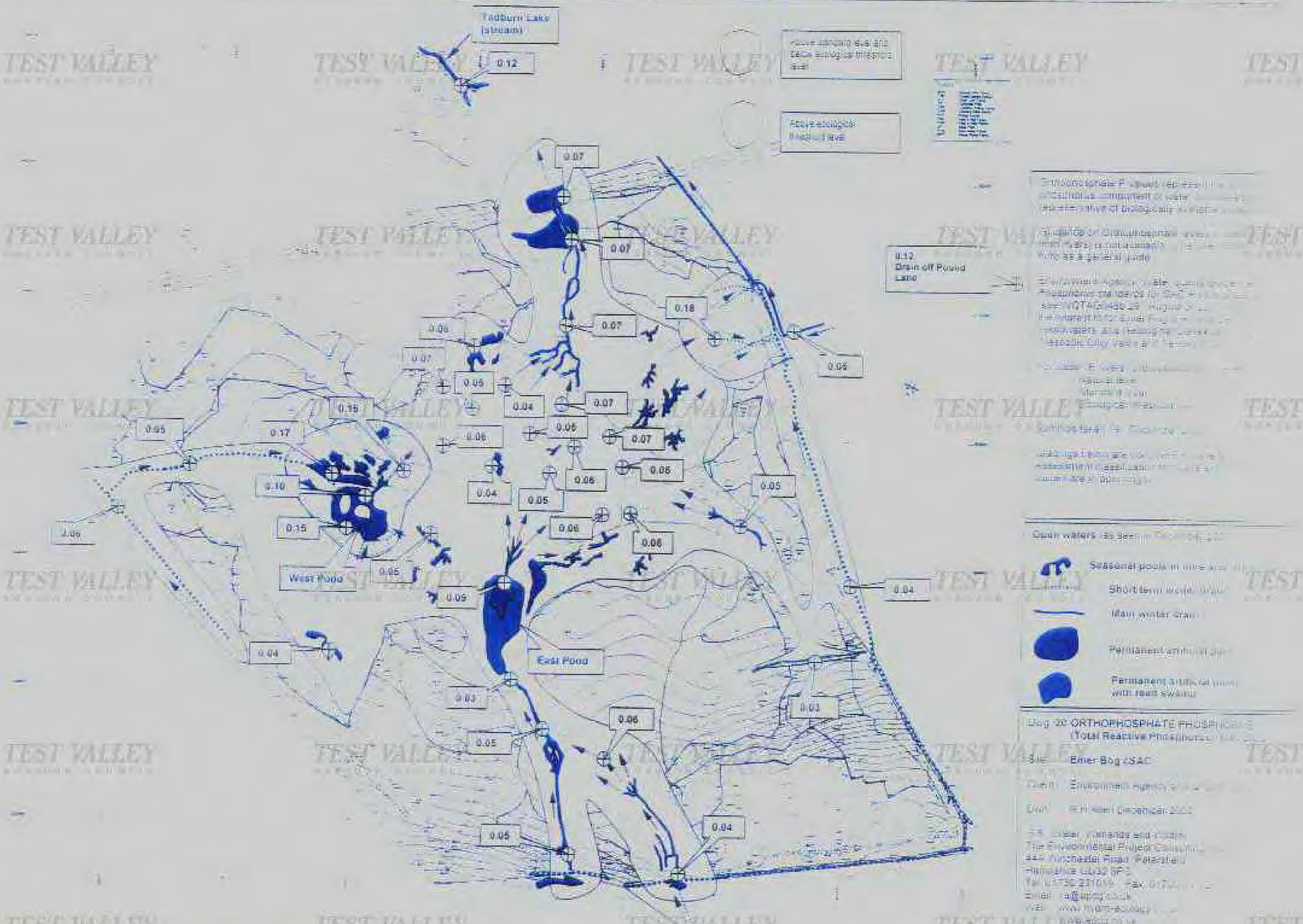

Tadburn Lake (stream)
Capital letters are 1995 sample references
<0.004 Ultra-oligotrophic
0.004 – 0.01 Oligotrophic
0.01 – 0.035 Mesotrophic
0.035 – 0.1 Eutrophic
> 0.1 Hypertrophic
D 0.12
F 0.05
E 0.11
A 0.56
West Pond
B 0.38
East Pond
C 0.18
G 0.08
Open waters
Short term winter drain
Main winter drain
Permanent artificial pond
16 Total Phosphorus
December 1995
Emer Bog cSAC


Tadburn Lake (stream)
0.21
0.18
0.42
0.23
0.29
0.20
0.58
0.26
0.42
0.67
0.19
0.25
0.23
0.53
0.44
0.29
0.19
0.22
0.34
0.23
1.09
0.38
West Pond
0.17
East Pond
0.37
0.12
0.14
0.15
Area with Total Phosphorus at very high levels of >0.30ppm
<0.004 Ultra-oligotrophic
0.004 – 0.01 Oligotrophic
0.01 – 0.035 Mesotrophic
0.035 – 0.10 Eutrophic
>0.10 Hypertrophic
Open Waters (as seen in August 2002)
Seasonal pools and willow carr
Short term winter drain
Main winter drain
Permanent artificial pond
Permanent artificial pond with reed swamp
TOTAL PHOSPHORUS August 2002
Emer Bog cSAC

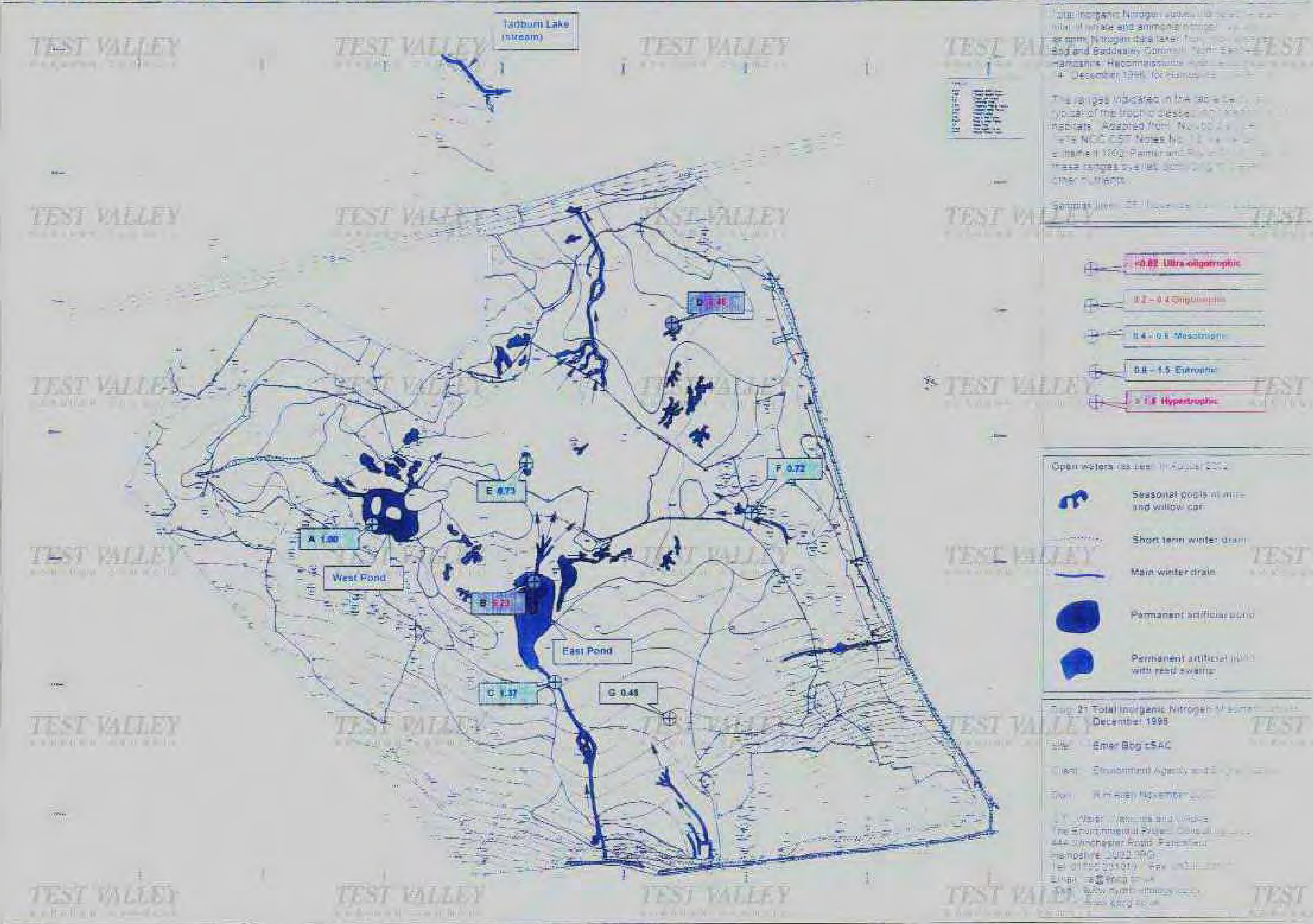


Tadburn Lake (stream)
0.22
0.15
0.12
0.21
Drain off Pound Lane
0.26
0.13
0.19
0.13
0.09
0.12
0.12
0.20
0.10
0.11
0.11
0.21
0.12
0.12
0.07
0.12
0.135
0.12
0.08
0.11
0.24
0.11
0.09
West Pond
0.09
0.14
0.08
0.10
East Pond
0.08
0.08
0.09
0.09
0.08
0.11
<0.004 Ultra-oligotrophic
0.004 - 0.01 Oligotrophic
0.035 - 0.10 Eutrophic
>0.10 Hypertrophic
Open Waters
TOTAL PHOSPHORUS
December 2002
Emer Bog cSAC

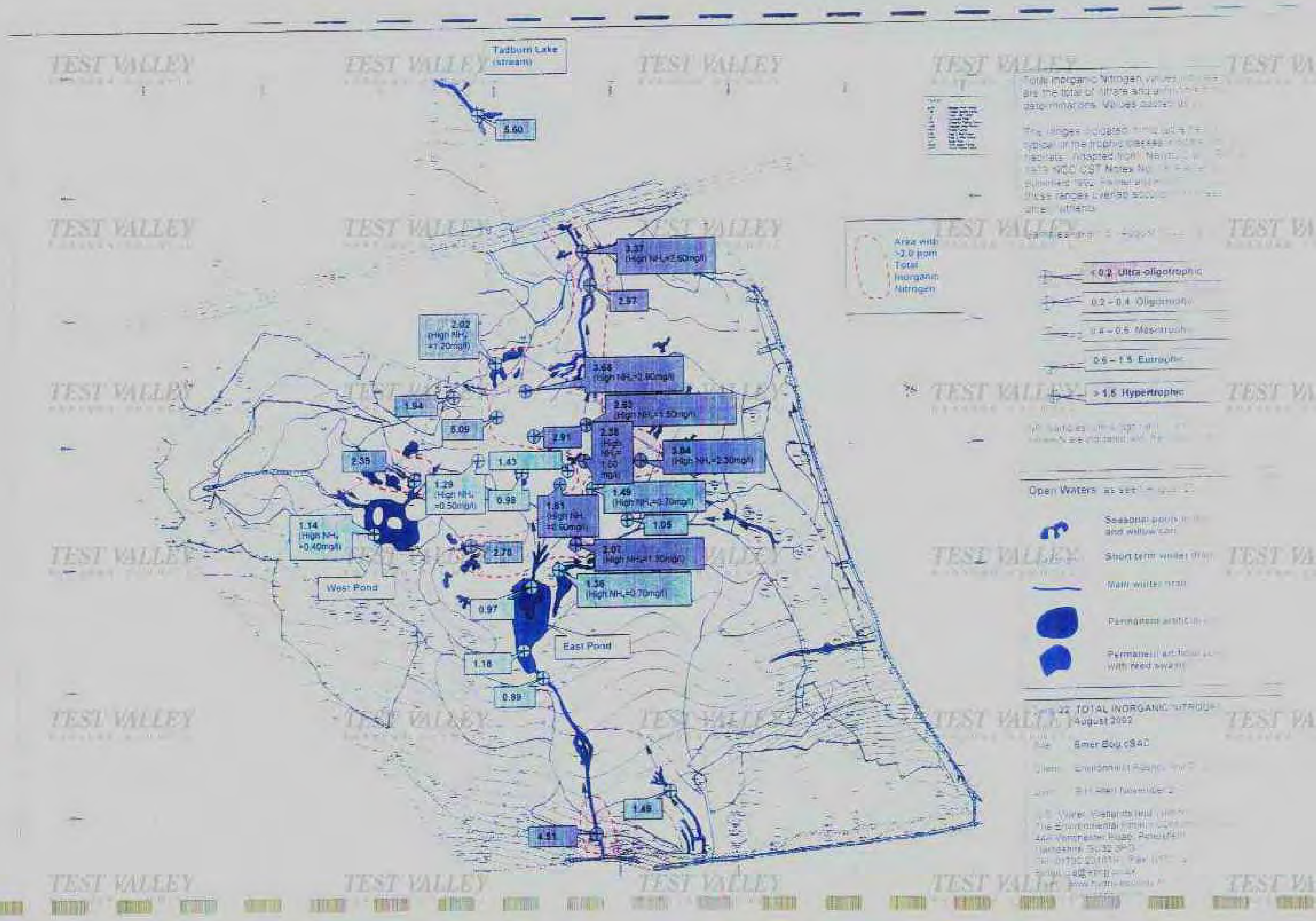

Tadburn Lake (stream)
0.07
0.15
0.37
0.14
0.23
0.11
0.34
0.12
0.39
0.47
0.09
0.14
0.16
0.08
0.20
0.41
0.09
0.11
0.08
0.25
0.66
West Pond
0.15
0.06
East Pond
0.10
0.05
0.09
0.06
Low-Moderate
High-Very high
Guidance on Orthophosphate
here as a general guide
Natural level
Standard level
Ecological threshold
Open waters
Seasonal pools
Main winter drain
Permanent artificial pond
Permanent artificial pond with reed swamp
19 ORTHOPHOSPHATE PHOSPHORUS
Emer Bog cSAC
Hampshire



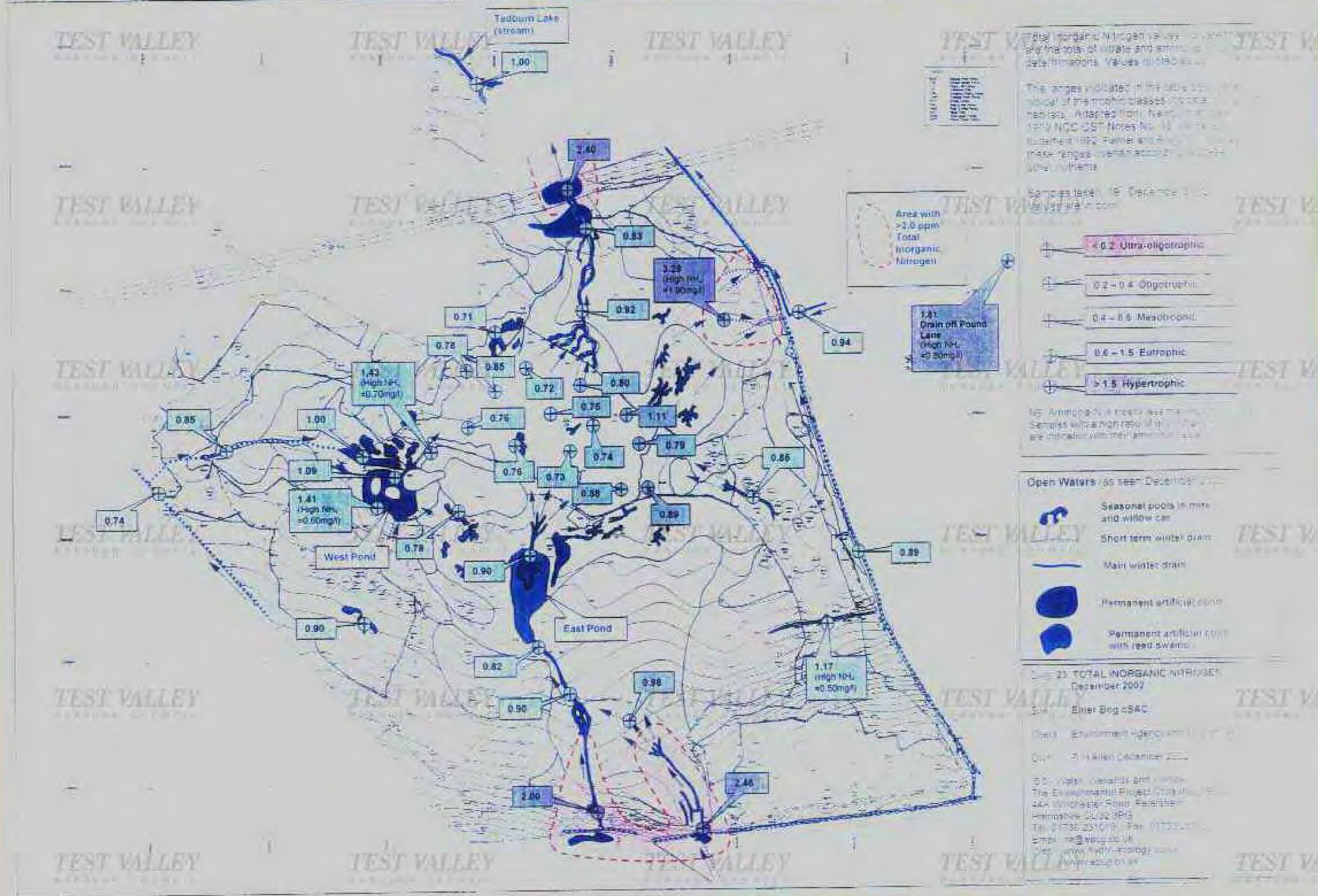
Tadburn Lake (stream)
0.12
Above ecological threshold level
0.12 Drain off Pound Lane
0.07
0.16
0.06
0.05
0.04
0.17
0.10
0.15
West Pond
East Pond
0.09
0.03
0.08
Open waters (as seen in December 2002)
Seasonal pools in mire and wet heath
Short term water drains
Main winter drain
Permanent artificial pond
Permanent artificial pond with reed swamp
ORTHOPHOSPHATE PHOSPHORUS
(Total Reactive Phosphorus)
Site: Emer Bog cSAC



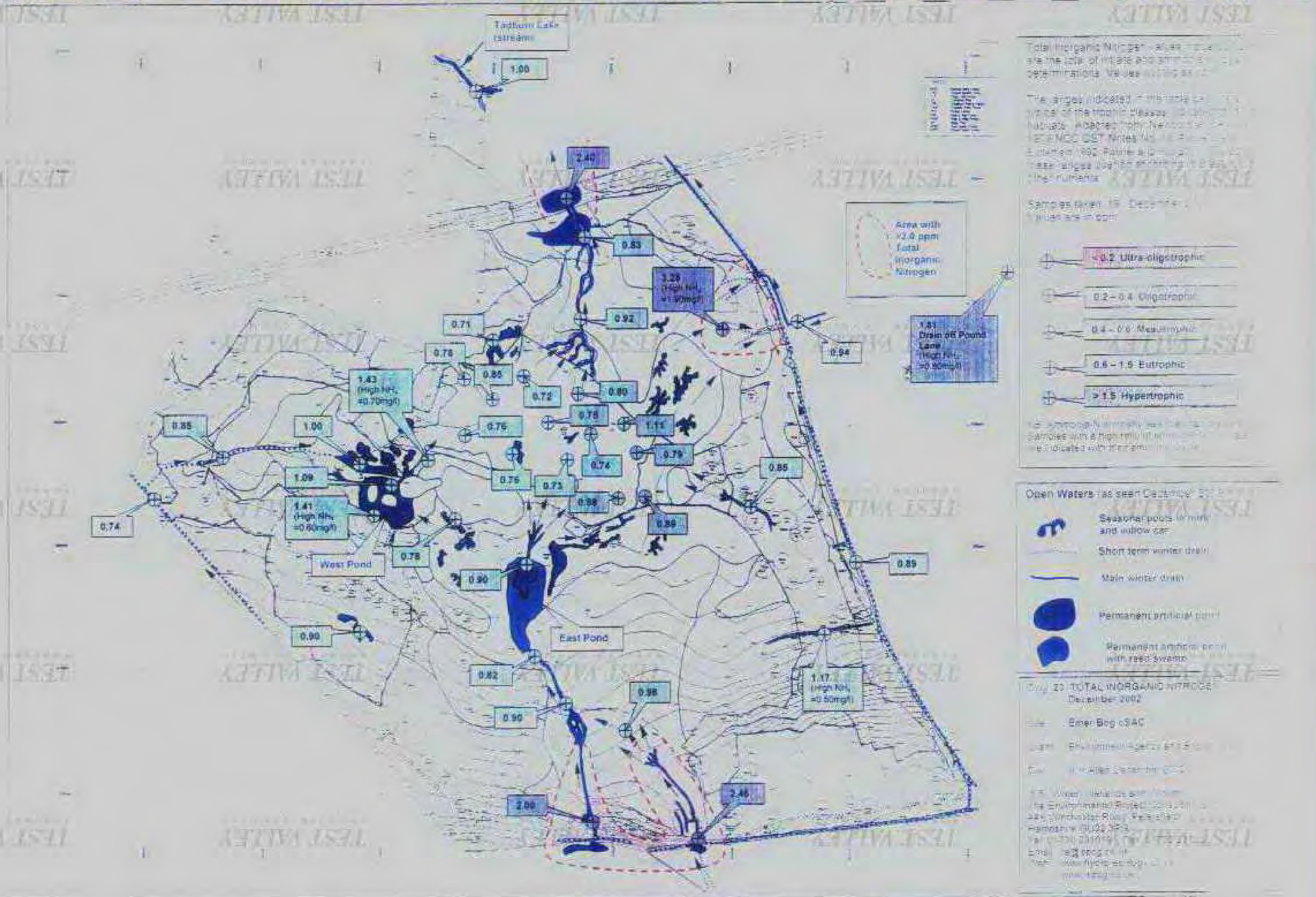
Tadburn Lake (stream)
D 0.46
E 0.73
F 0.72
A 1.00
West Pond
B 0.23
East Pond
C 1.37
G 0.48
0.2 - 0.4 Oligotrophic
0.4 - 0.6 Mesotrophic
0.6 - 1.5 Eutrophic
> 1.5 Hypertrophic
Seasonal pools in
and willow carr
Short term winter drain
Main winter drain
Permanent artificial pond
Permanent artificial pond
with reed swamp
Total Inorganic Nitrogen
December 1998
Emer Bog cSAC



Tadburn Lake (stream)
5.60
3.37 (High NH_4=2.60mg/l)
2.97
2.02 (High NH_4 =1.20mg/l)
3.68 (High NH_4=2.90mg/l)
2.63 (High NH_4=1.50mg/l)
1.94
5.09
2.91
2.35 (High NH_4= 1.60 mg/l)
3.84 (High NH_4=2.30mg/l)
2.35
1.43
1.29 (High NH_4 =0.50mg/l)
0.98
1.49 (High NH_4=0.70mg/l)
1.81 (High NH_4 =0.90mg/l)
1.06
1.14 (High NH_4 =0.40mg/l)
2.78
2.07 (High NH_4=1.30mg/l)
West Pond
1.36 (High NH_4=0.70mg/l)
0.97
East Pond
1.18
0.89
1.46
4.51
Area with >2.0 ppm Total Inorganic Nitrogen
< 0.2 Ultra-oligotrophic
0.2 – 0.4 Oligotrophic
0.6 – 1.5 Eutrophic
> 1.5 Hypertrophic
Open Waters
Seasonal pools
Short term water
Main water
Permanent artificial
Permanent artificial with reed swamp
TOTAL INORGANIC NITROGEN
August 2002



Tadburn Lake (stream)
1.00
2.40
0.83
3.29 (High NH4 =1.90mg/l)
0.92
0.94
1.61 Drain off Pound Lane (High NH4 =0.80mg/l)
Area with >2.0 ppm Total Inorganic Nitrogen
0.71
0.78
1.43 (High NH4 =0.70mg/l)
0.85
0.72
0.80
0.75
0.76
1.11
0.85
1.00
0.79
0.74
0.76
0.73
0.98
0.86
1.09
1.41 (High NH4 =0.60mg/l)
0.89
0.74
0.78
West Pond
0.90
0.89
0.90
East Pond
0.82
1.17 (High NH4 =0.50mg/l)
0.98
0.90
2.00
2.46
<0.2 Ultra-oligotrophic
0.2 – 0.4 Oligotrophic
0.4 – 0.6 Mesotrophic
0.6 – 1.5 Eutrophic
>1.5 Hypertrophic
Open Waters
Seasonal pools in mire and willow carr
Short term winter drain
Main winter drain
Permanent artificial pond
TOTAL INORGANIC NITROGEN
December 2002
Emer Bog cSAC



Tadburn Lake stream
1.00
2.40
0.83
3.28 (High NH₄ =1.90mg/l)
0.92
Area with >2.0 ppm Total Inorganic Nitrogen
0.94
1.81 Drain off Pound Lane (High NH₄ =0.80mg/l)
0.71
0.76
0.85
1.43 (High NH₄ =0.70mg/l)
0.72
0.80
0.78
1.11
0.85
1.00
0.76
0.74
0.79
1.09
0.76
0.73
0.88
0.85
1.41 (High NH₄ =0.60mg/l)
0.86
0.74
West Pond
0.78
0.90
0.89
0.90
East Pond
0.82
1.17 (High NH₄ =0.50mg/l)
0.98
0.90
2.00
2.46
0.2 – 0.4 Oligotrophic
0.6 – 1.5 Eutrophic
> 1.5 Hypertrophic
Open Waters
Seasonal pools
Short term winter drain
Main winter drain
Permanent artificial pond
TOTAL INORGANIC NITROGEN
December 2002
Emer Bog cSAC