fhrc

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The complexity of sediment-associated contaminant transfer in a small North London stream

implications for amenity planning in engineered settings.

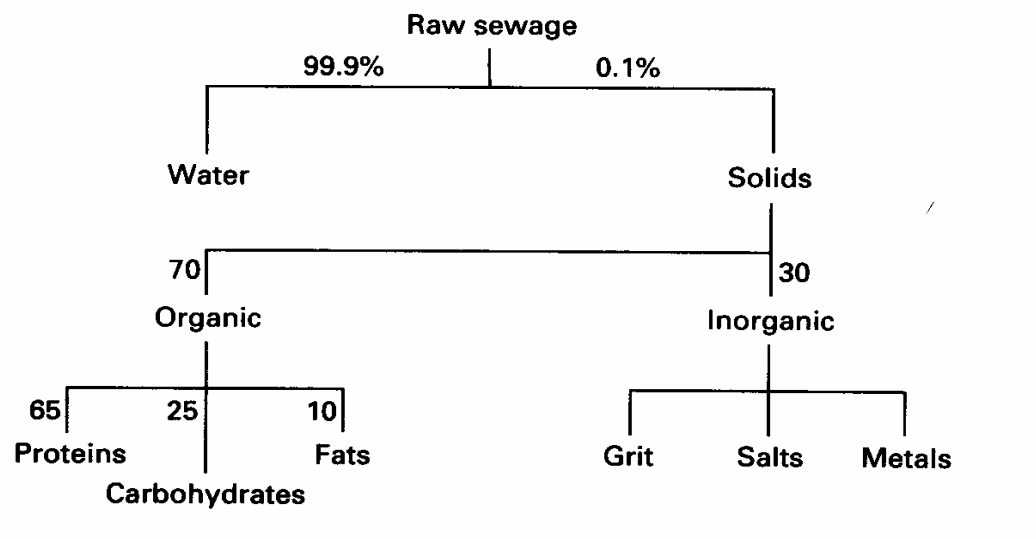
Heavy metals

Sewage

Both bound to sediments

Not routinely monitored in water quality assessments

The composition of sewage



Composition of sewage

...mostly organic.

Important indicators of sewage in water

Typical Sewage Analyses

	Source		
	Crude	Settled	Final effluent
BOD	300	175	20
COD	700	400	90
TOC	200	90	30
SS	400	200	30
Amm.N	40	40	5
NO_3N	<1	<1	20

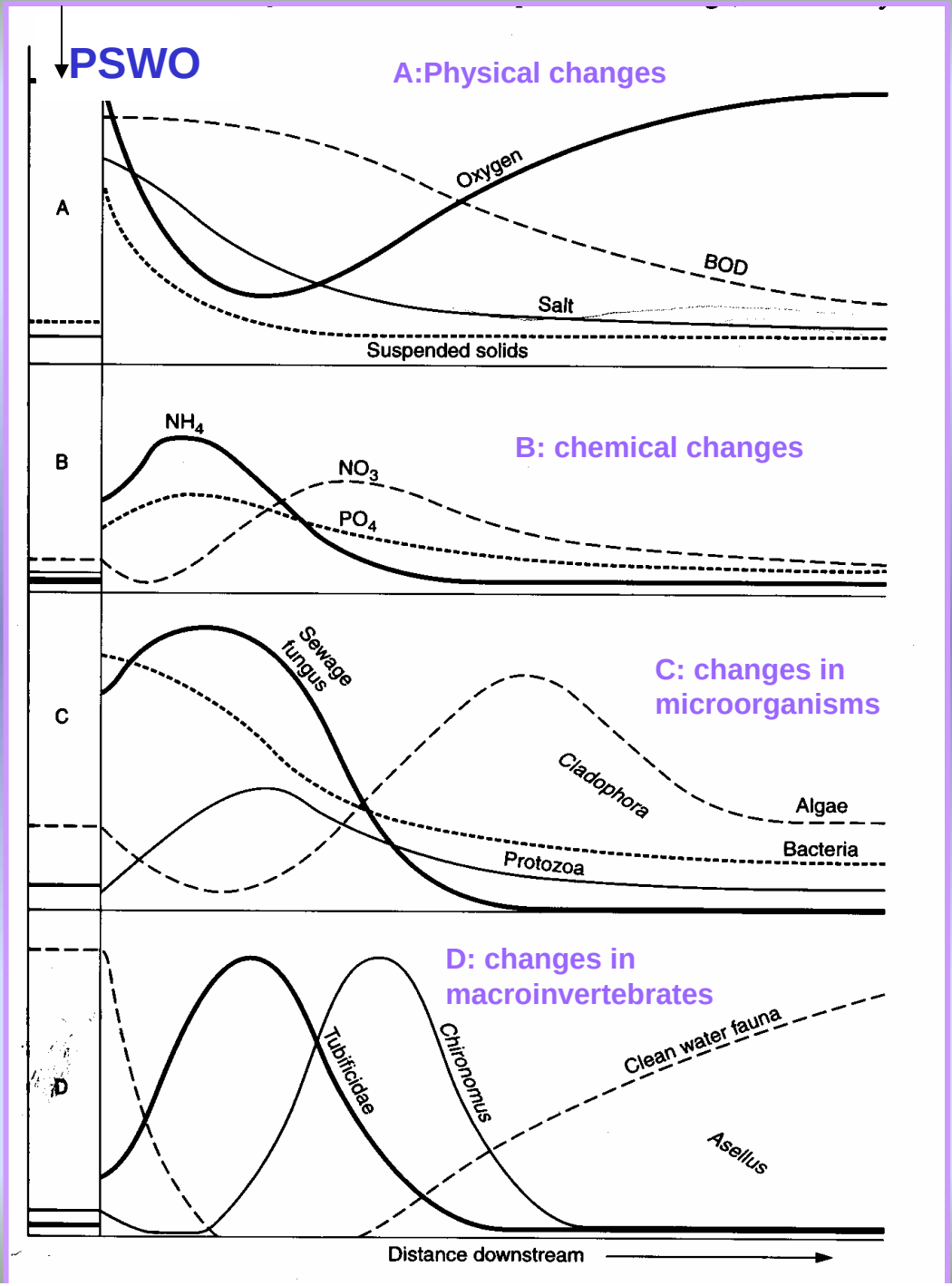
- The eutrophic effects of organic material create an oxygen demand **(Biological Oxygen demand, BOD)** in mg/litre.
- So does the chemical content **(COD)** in mg/litre.
- It gives off **ammonia** and contains **nitrates and nitrites.**
- It increases the **suspended solids in the river (SS).**
- It may also contain viruses and pathogens – and ***Eschericia Coli-*** a gut bacteria.

URBAN WATER & SEDIMENT QUALITY

Water supply to urban areas is a major part of UK river management. In the urban area, as well as dealing with ***storm water***, the ***foulwater*** (including sewage and dirty water from washing machines and baths) has to be dealt with.

Sewerage systems are installed to do these two jobs. These are of two kinds:

- Separate sewerage schemes (better, newer)
- Combined sewerage schemes . These are in places joined, designed to overtop from storm to foul during storms….now frequently operate the other way… Those that do are called Polluted surface water outfalls **(PSWOs)**



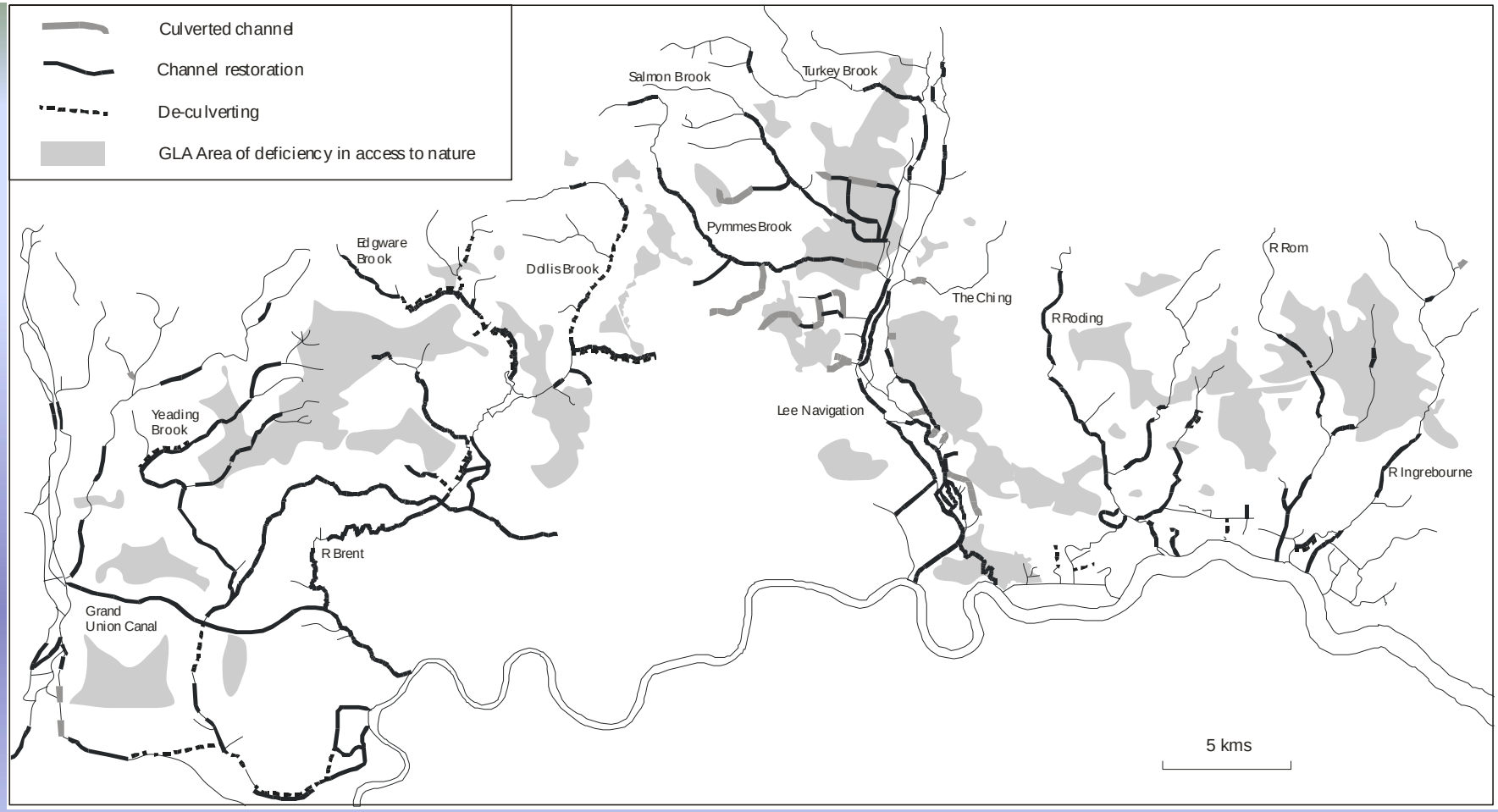
Local effect of sewage contamination on a stream

Hyne's (1960) diagram explains schematically the changes that occur in water quality and the population of organisms in a river below a PSWO

Along with the colloidally-locked heavy metal content, excessive organic loads are a potentially ‘missed’ source of contamination

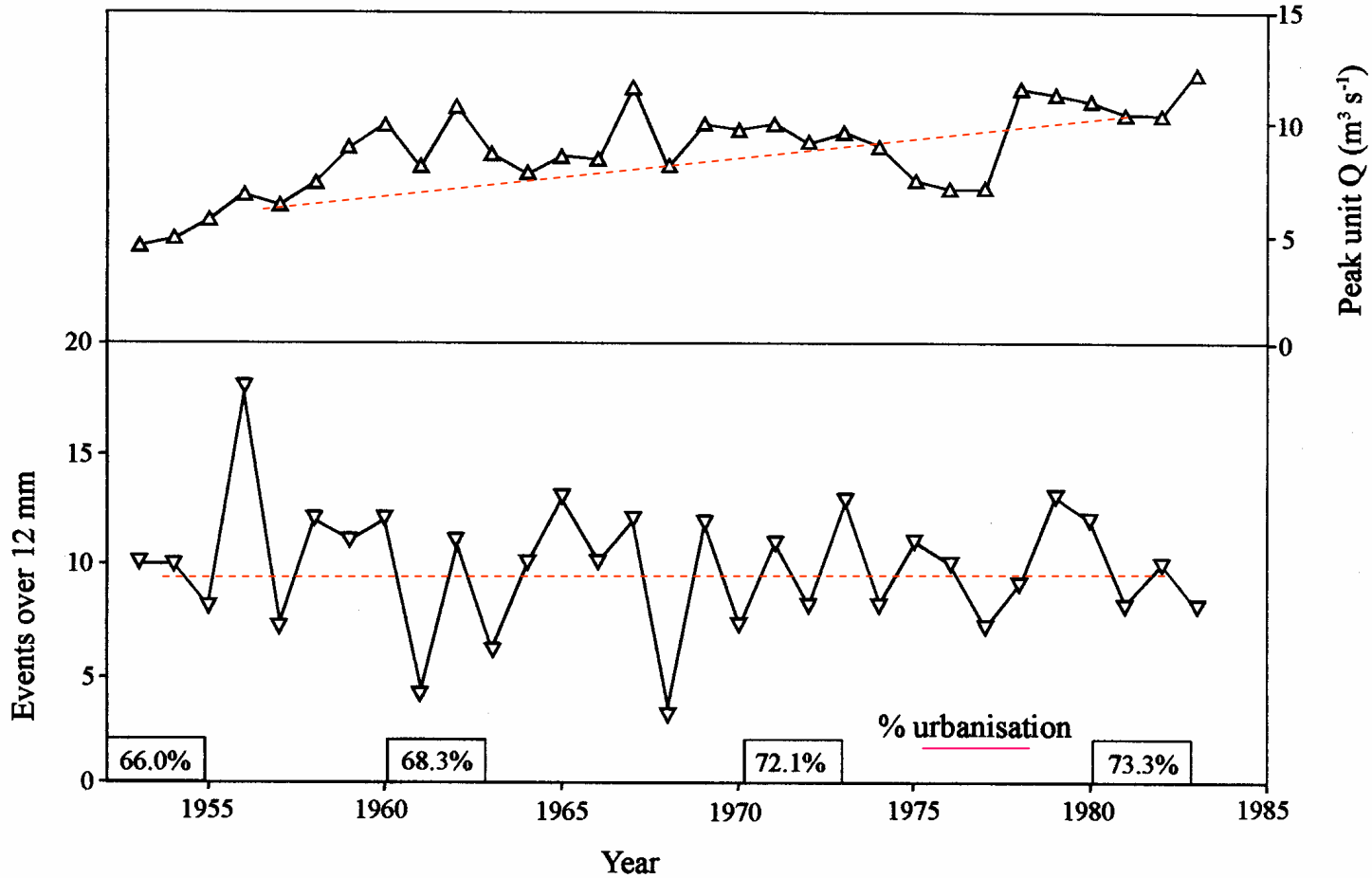
A case study in Urban Water & sediment contamination:

PYMME'S BROOK, North LONDON



- Rising in Hadley wood, Pymme's brook forms part of London's heavily managed river system
- The basin is 4km^2 in area before it joins with Salmon's Brook.
- Has no point sources or sewage works on it, i.e. it is diffusely polluted, having an ancient poorly connected combined sewerage system, which backs up producing **PSWOs** during storm events

Progressive urbanisation of the catchment has had inevitable effects



trend in unit hydrograph with progressive urbanisation

..despite no trend in rainfall event size

Research Questions:

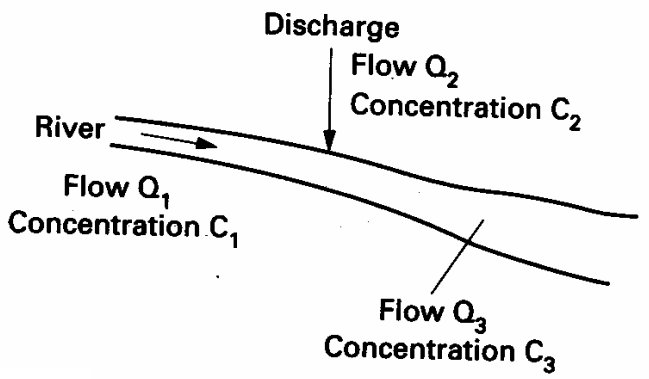
- What effect does the pattern of downstream entry of contamination have on downstream water quality parameters, sediment quality, and macroinvertebrate community structure?
- is the effect worse during high or low flows?
- What are the implications of this spatial and temporal variability for :

(a) river audit schedules;

(b) public access to natural sites on the stream?

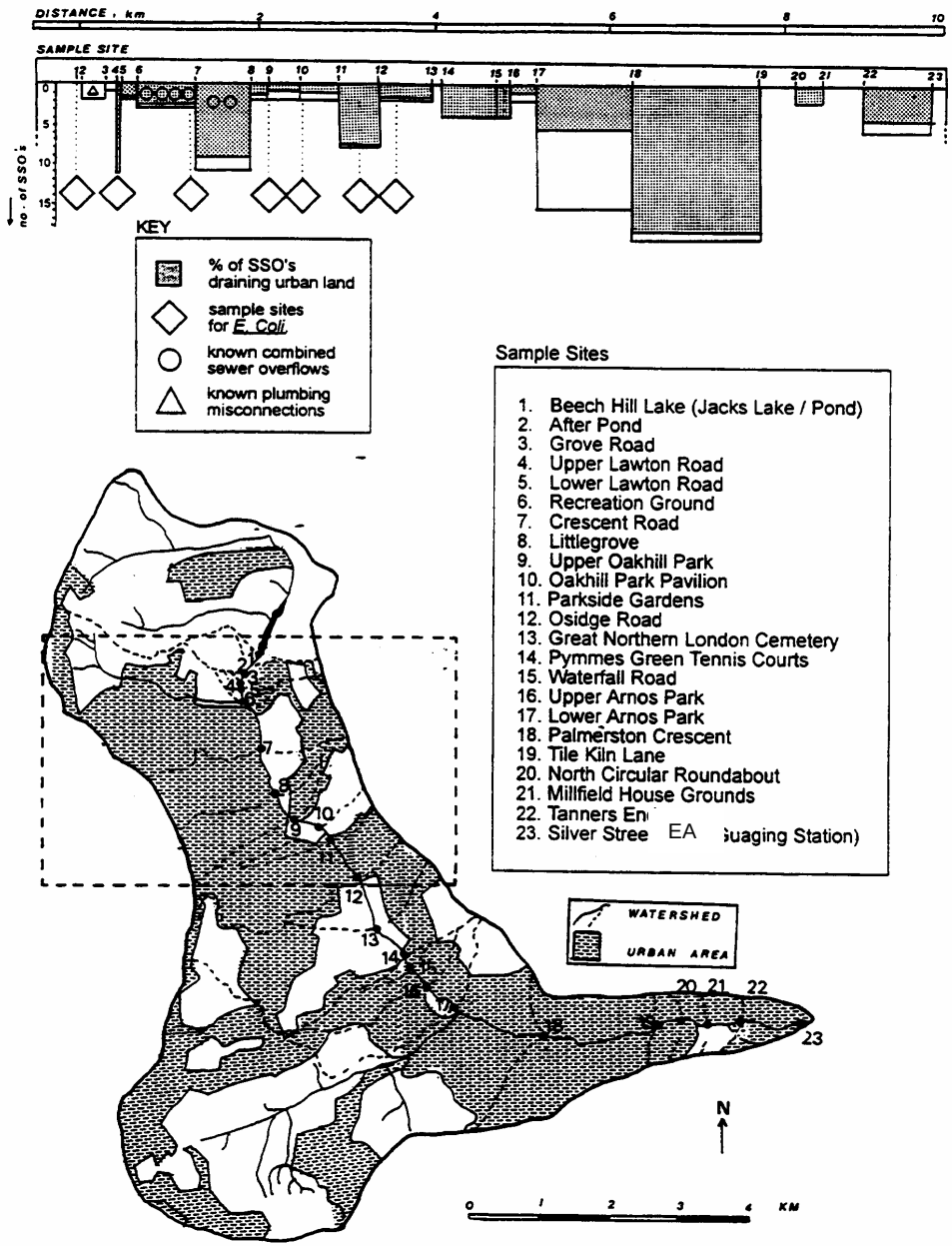
Downstream patterns in polluted storm water overflows (PSWOs)

At each entry point, mixing occurs.



The mass balance concept in river pollution.

i.e. $Q_1C_1 + Q_2C_2 = Q_3C_3$

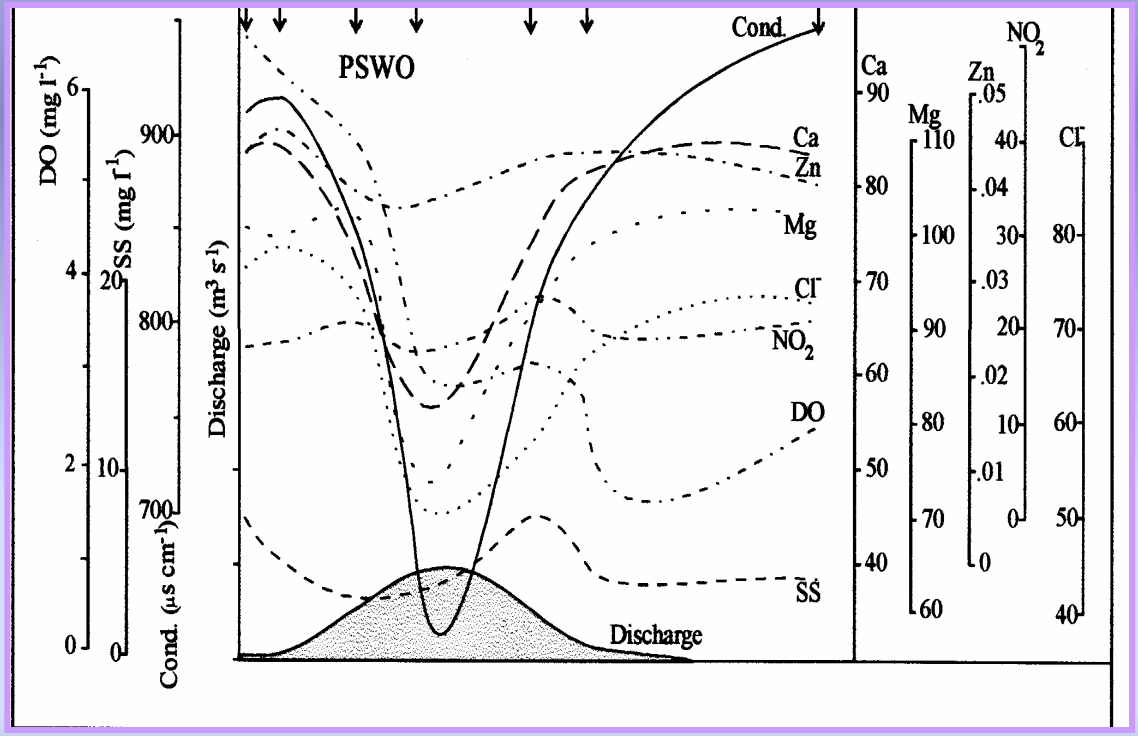


The Pymme's brook catchment area, showing extent of urban SSO provision and sample sites 1 to 23.

The Cat Hill PSWO

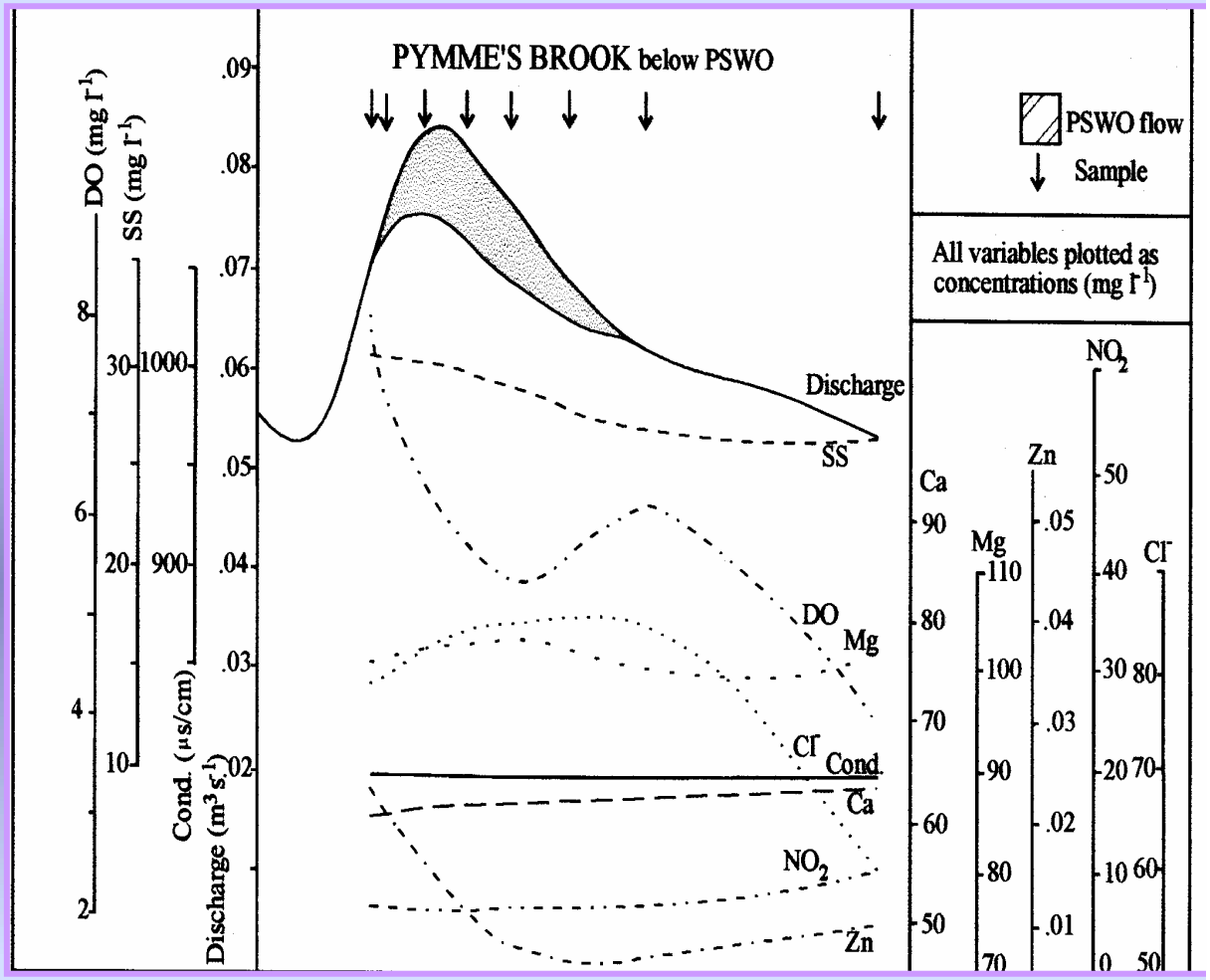
- Cat Hill **PSWO** (polluted surface water outfall) was studied before construction of the East Barnet Low Level intersecting foulwater Sewerage scheme
- Aimed to see how well the entering contaminants are dispersed by the river during an ‘event’.

Cat Hill PSWO before construction of the East Barnet Low Level intersecting foulwater Sewerage scheme



….the Cat Hill hydrograph & contamination variability

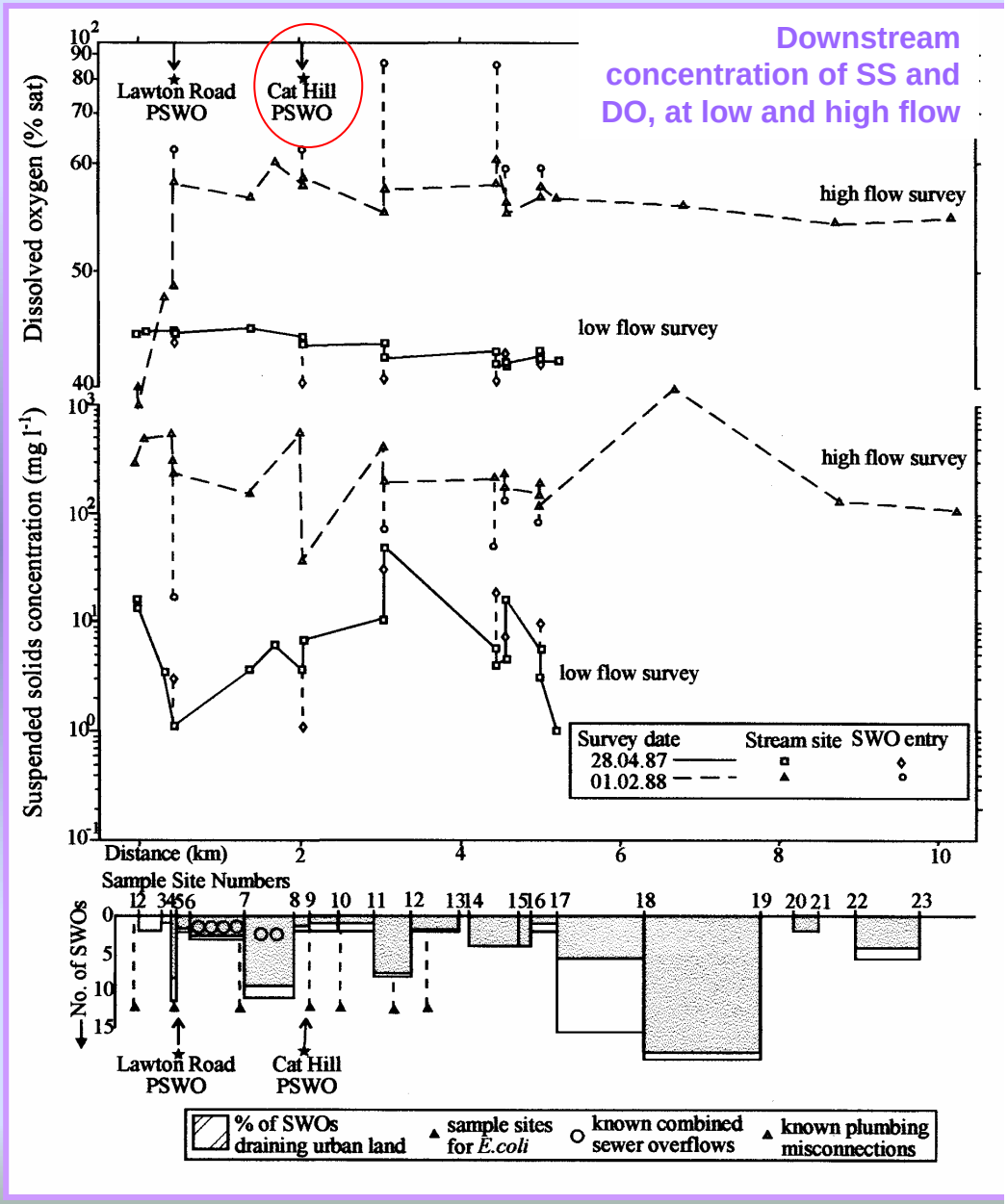
Cat Hill PSWO before construction of the East Barnet Low Level intersecting foulwater Sewerage scheme



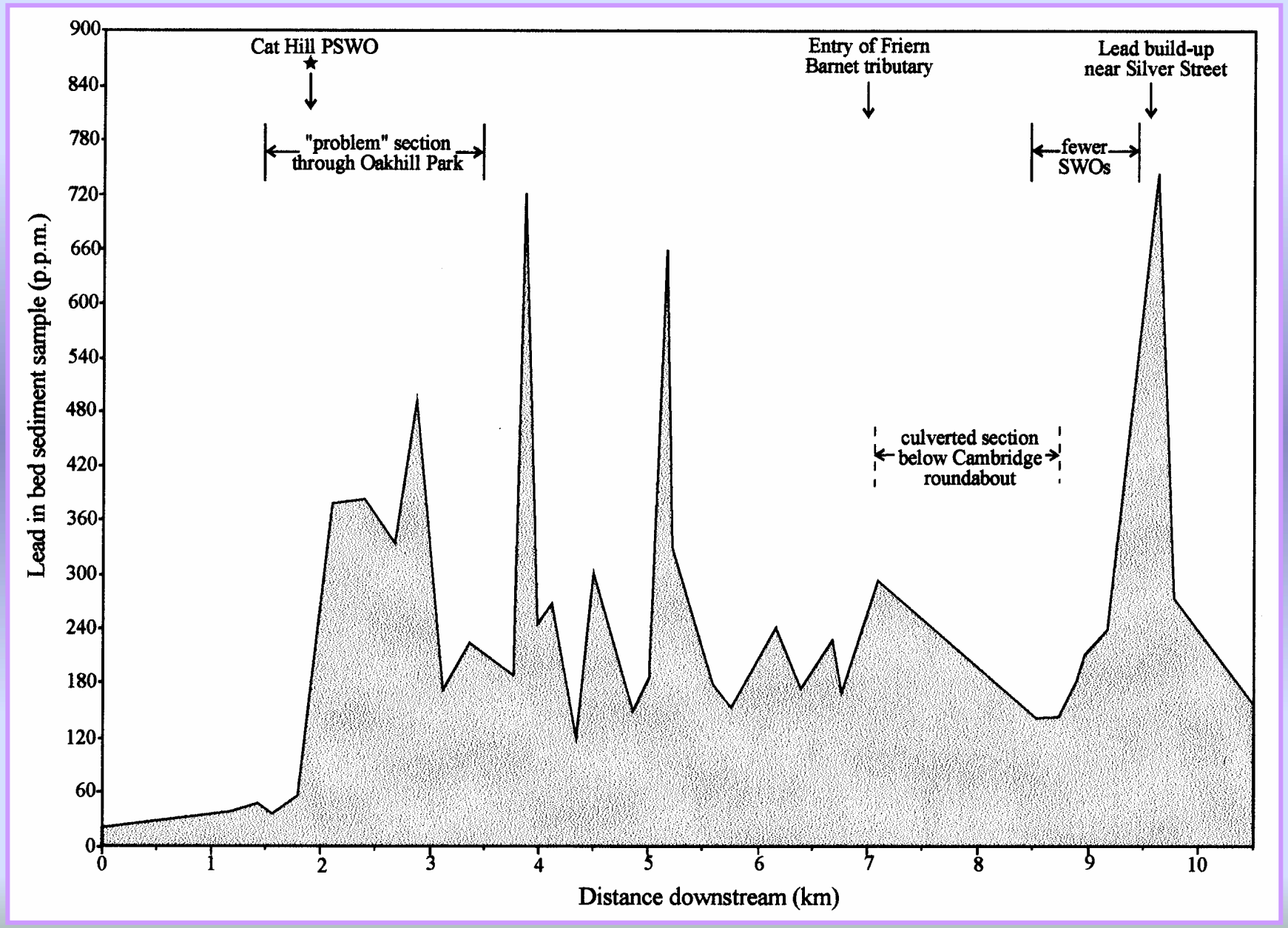
➢The brook at high flow copes well with the entry of chemical pollutants. However, deoxygenation is an obvious local effect

Downstream (spatial) quality: (a) inputs from PSWOs

- We sampled downstream, at both low and high flow, looking for trends..

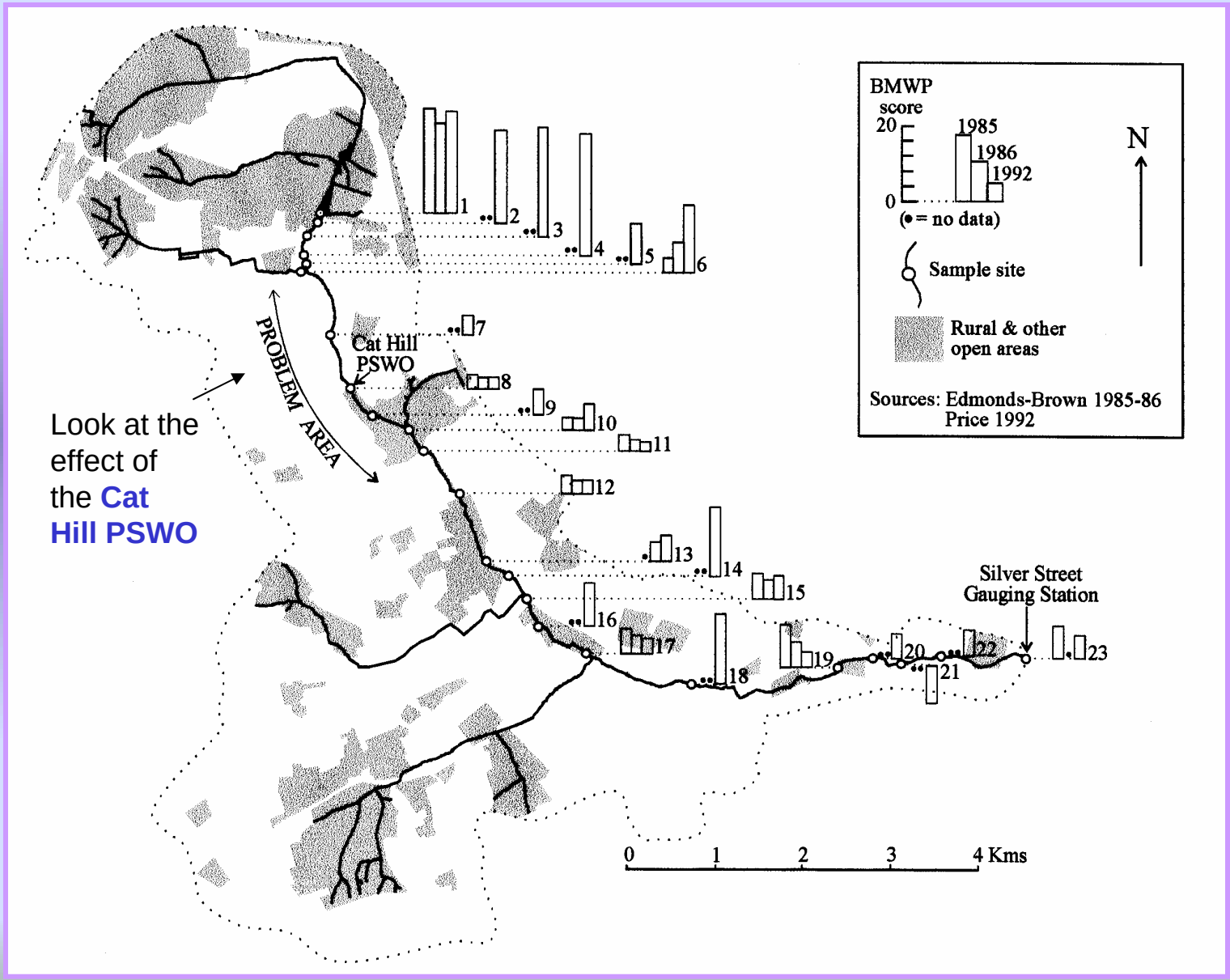


Downstream (spatial) quality (b) heavy metals in bed sediments



Downstream bed sediment Lead concentrations

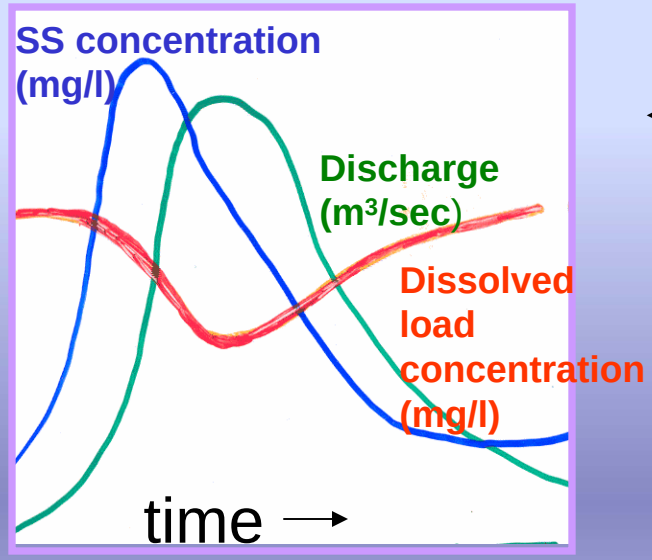
Downstream (spatial) deterioration in macroinvertebrate community matched the heavy metal and deoxgenation patterns…



Look at the effect of the **Cat Hill PSWO**

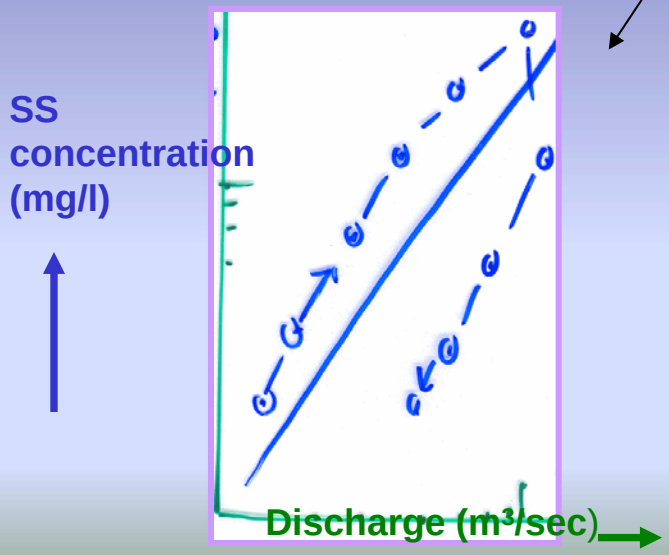
- The bed sediments were found to be contaminated with heavy metals, sewage-related contaminants (***E. Coli*** levels high), and are deoxygenated at low flow.
- The mapped quality deterioration downstream is unique, reflecting the pattern of lateral inputs and their relative concentration in relation to the channel they are joining, and this is very spatially and temporally variable.
- Thus, quality deterioration can be closely linked to what is entering as lateral inputs, and in a sense could have been anticipated from the map and pattern of inputs….

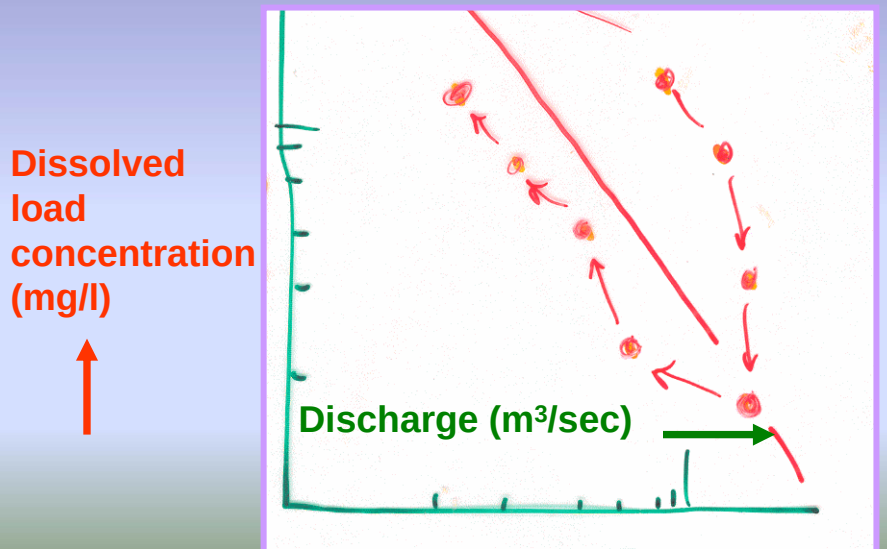
Temporal variation in water quality determinants : the 'first flush' effect



Idealised version of variability in SS and dissolved contaminants during a storm

SS and dissolved contaminants -this time plotted against changes in Q during the storm





Plotting determinand concentrations during the“ first flush”

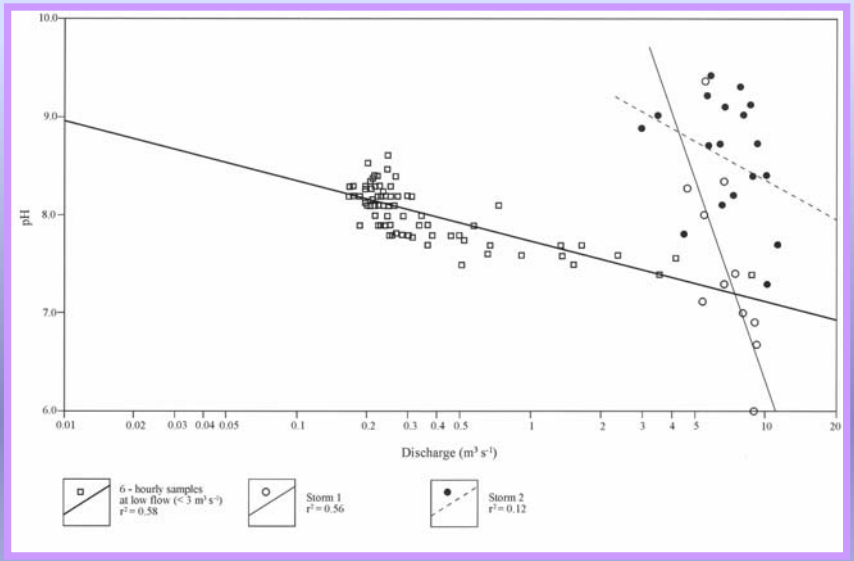
data 1986-2000

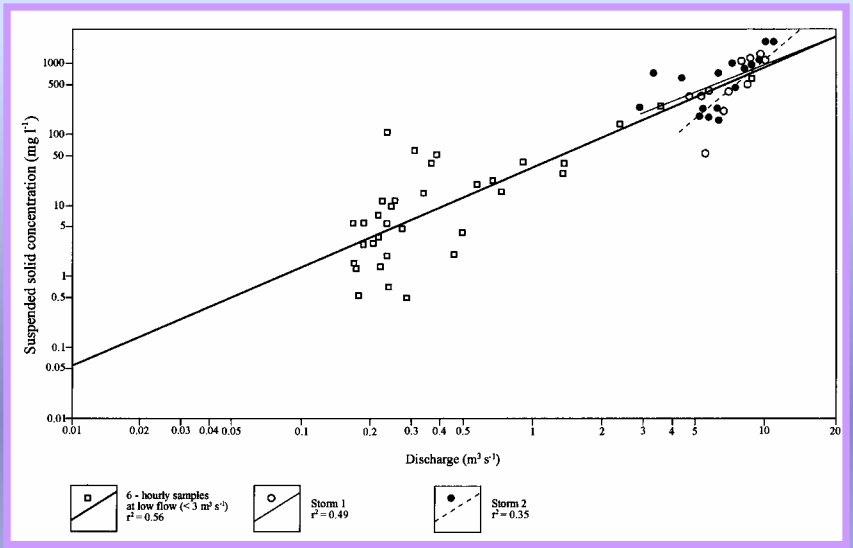
← Discharges measured continuously by the EA

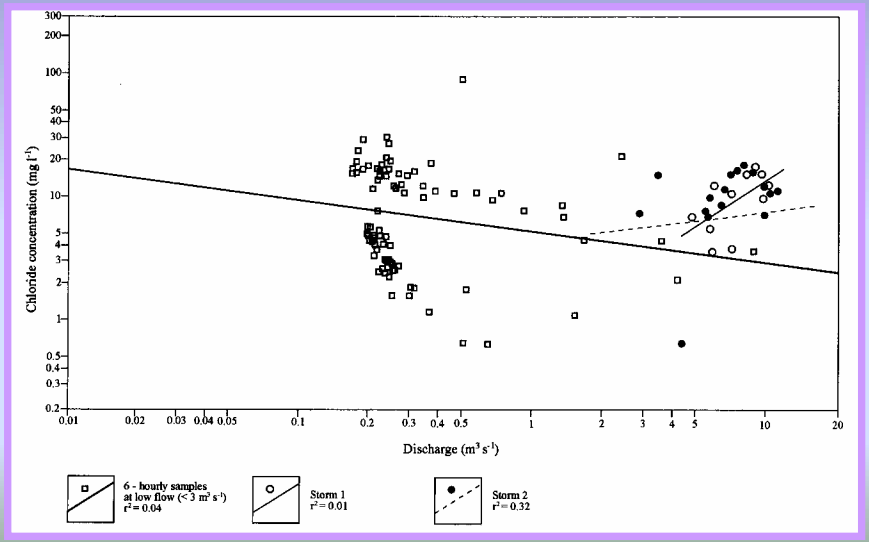
Rock and Taylor sampler at Silver Street gauging station – taking water quality samples at known discharges

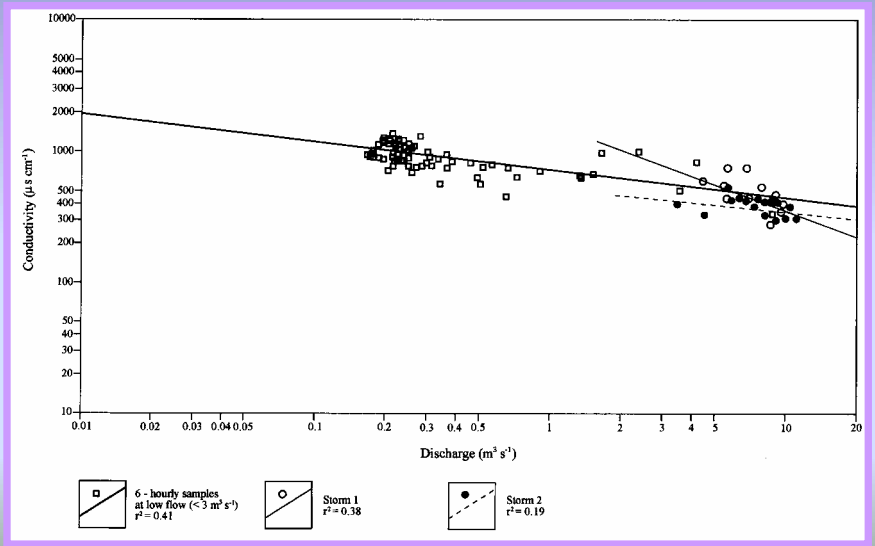
Sediment rating curves at Silver Street gauging station

those sediment-bound heavy metals and organic contaminants are moving during high flow

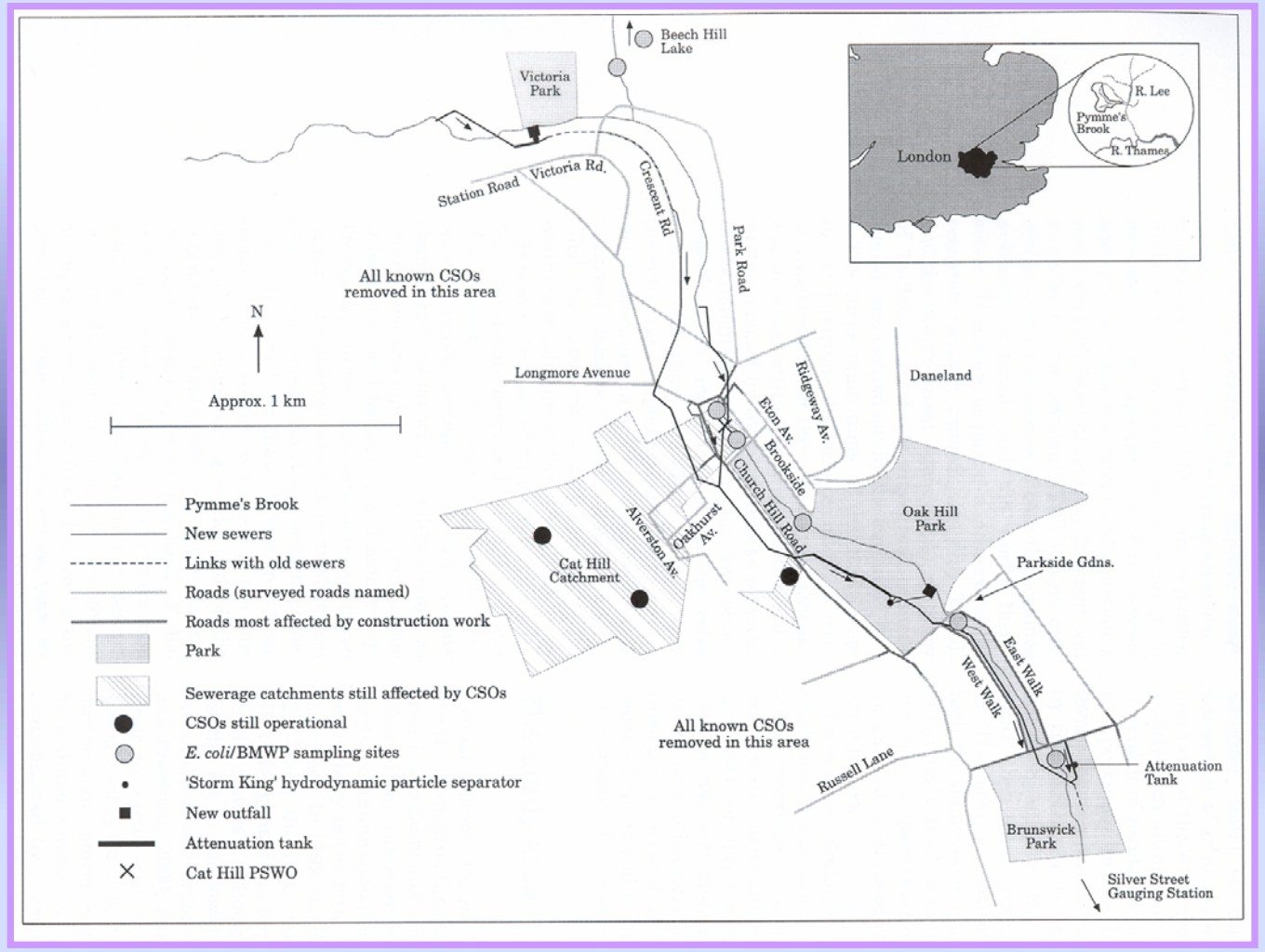








The TWUL Low level intersecting foul-water sewerage scheme: Post-project assessment



Upper section of the Pymme's Brook study catchment section showing the section addressed by the 1995 scheme ; the planform of the pipe network, and the streets included in the residents' survey as well as those affecetd by engineeringdisruption are also shown

Trends in:

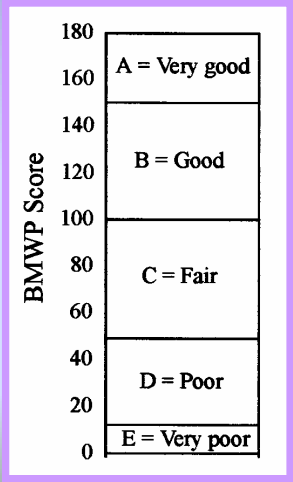
(a)

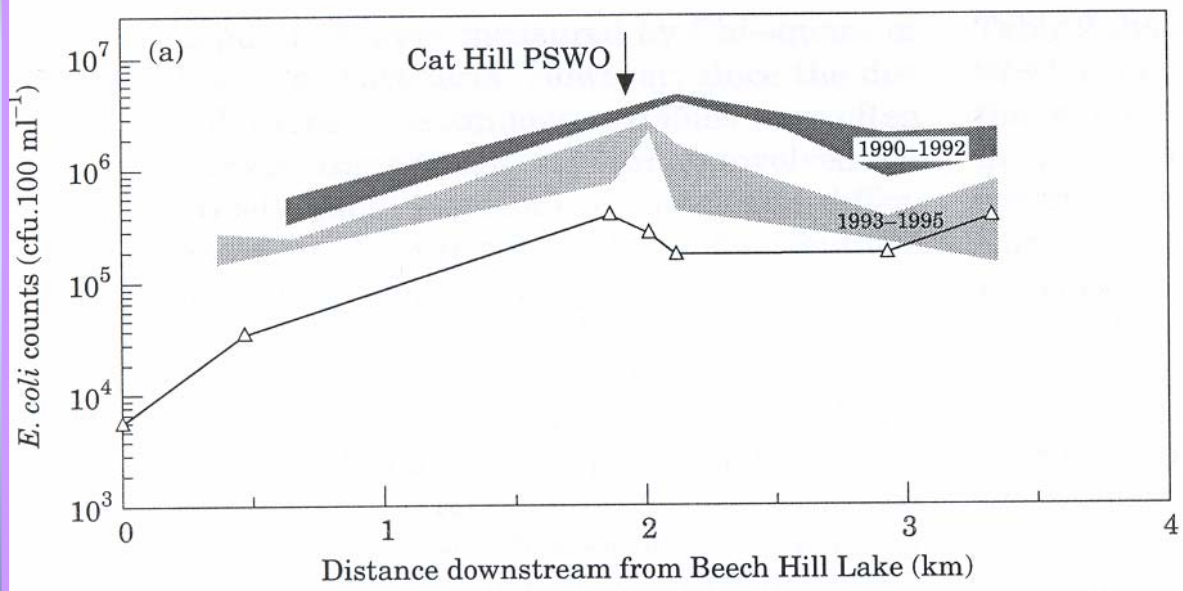
Escherichia coli

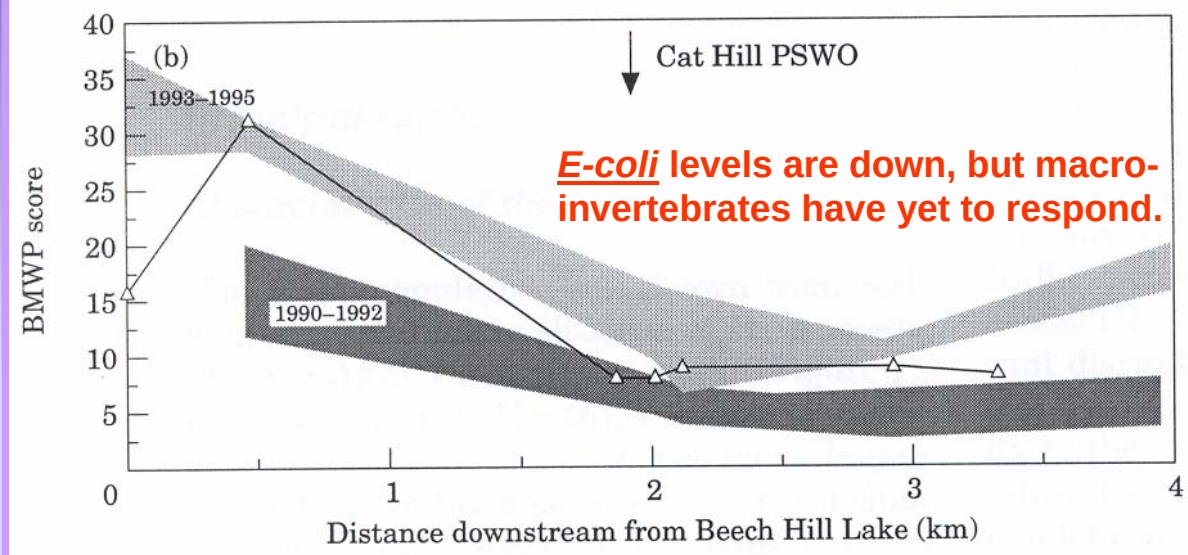
in cfu.ml^{-1}

(b) BMWP score

In the 'problem section' between 1990 and 1992; 1993 and 1995, and post-project data (since 1996)







E-coli **levels are down, but macro-invertebrates have yet to respond.**

a) *Eschenichia coli* and (b) BMWP trends in the upper reaches of Pymme's Brook 1990–1992 ■; spread of annual data; 1993–1995 ■; post-project data (1996) (—△—)

- Spatial and temporal variability of sediment-bound contaminants is considerable

- The low flow, chemically-based monitoring system which has been adopted by the Environment Agency has identified some long-term changes in water quality, which may be a result of the construction of the East Barnet sewerage scheme;

- fails to pick up a reduction in the input of organic matter to the watercourse

Spatial and temporal complexity: audit

- The method of assessing river-water quality using chemical determinants sampled at low flow is flawed with respect to urban catchments, because it fails to assess conditions during storms, when contamination is likely to be at its worst.

- Macroinvertebrate community structure is a sensitive indicator of change, but reacts relatively slowly.

Spatial and temporal complexity : public access and amenity

- Pymme's Brook is contaminated through the sections where there is a considerable degree of public access

- Pre- deculverting assay of sediment delivery might allow those sites that are less contaminated to be the sites of access, and to restrict the degree of 'opening-up' top those sections that are chronically contaminated

- requires planning that incorporates these temporally-sensitive pre-management methodologies to inform management

References:

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