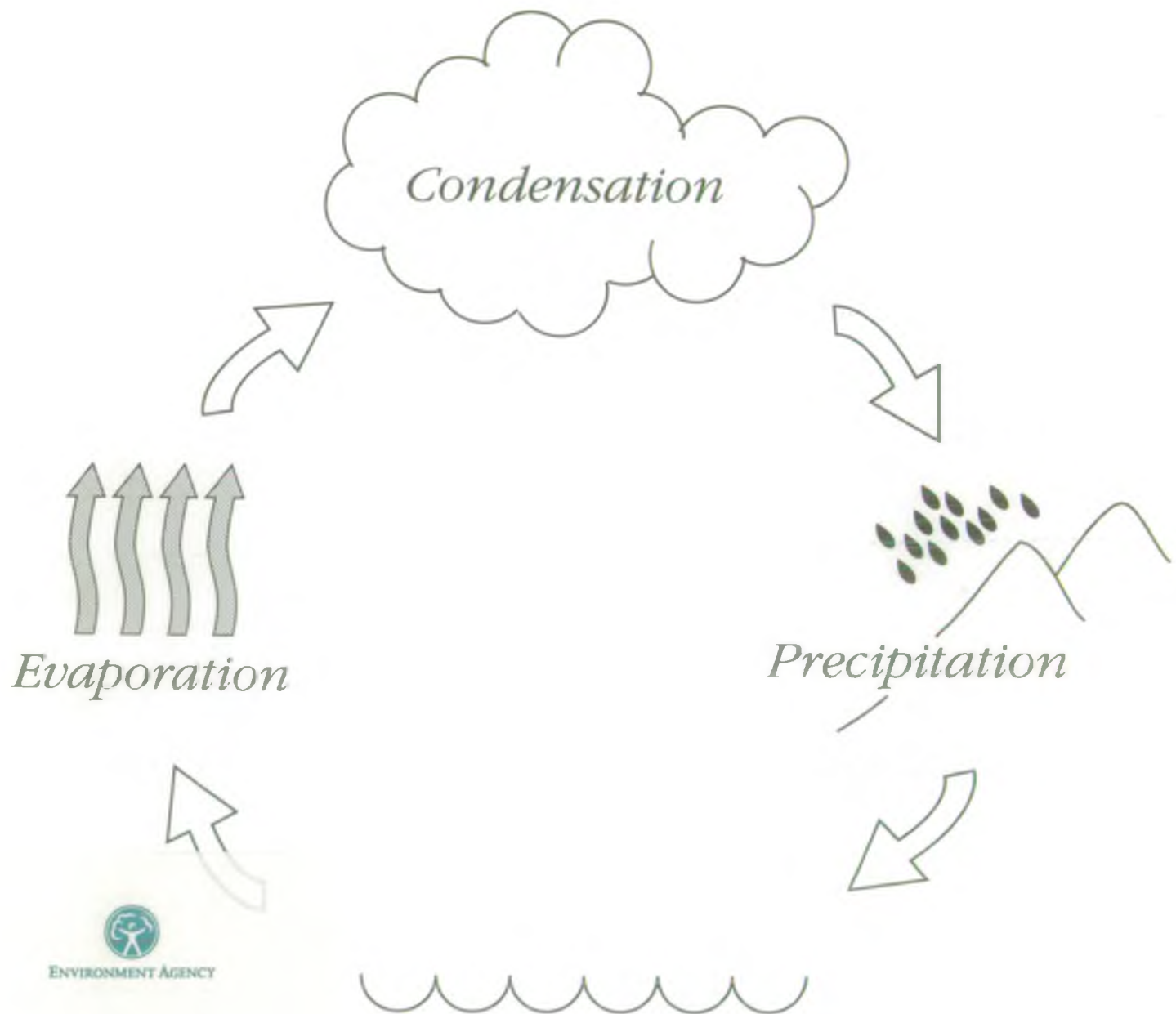


The Water Cycle



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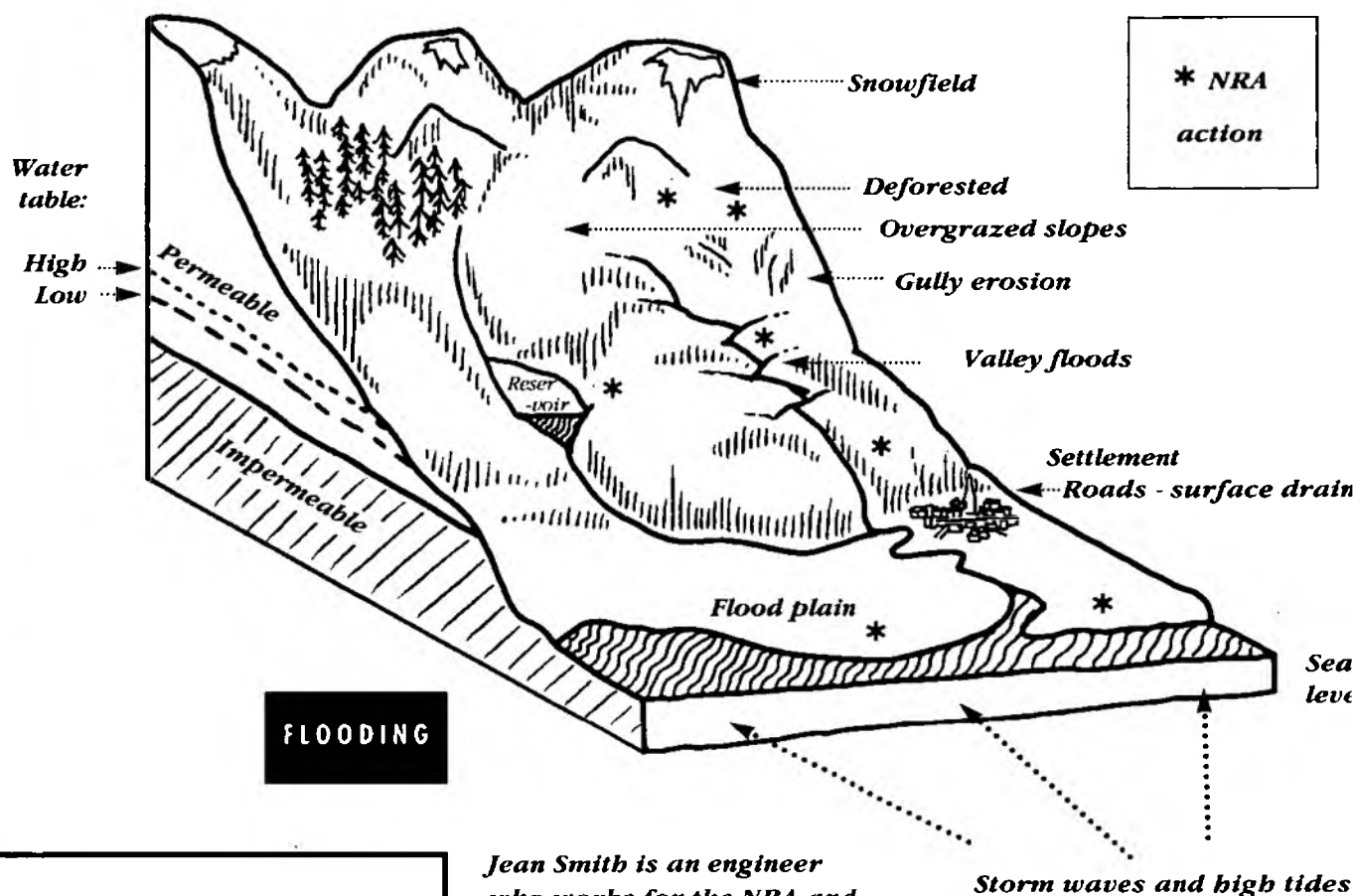
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Bristol BS32 4UD

THE NRA REGIONS IN ENGLAND AND WALES



NRA SOUTH WEST AND WESSEX REGION Regional Headquarters and Areas





We often read about parts of the region being flooded. Where was it? Why did it happen? What can the NRA do about it? Could the flooding have been prevented? Why do some people continue to live in such areas when they know flooding could happen again?

Jean Smith is an engineer who works for the NRA and she regularly faces all these questions - and then tries to find the answers so that flooding is only a very small problem in the future.

WHY DO FLOODS HAPPEN?

Flooding occurs when water is flowing into an area faster than it is draining away. This can happen in a number of different ways.

In **coastal** areas this excess water can either be coming in from the sea or draining off the land. The main danger from the sea is when the sea level reaches an abnormal height - for example during the period of 'spring tides' (when the tidal range is at its greatest and so the high tide level at its highest) and especially if there are strong winds bringing storm waves on to the shore at the same time.

There are many reasons why rivers may cause flooding in some **inland** areas (see diagram) and this hazard can be particularly dangerous when they combine over a short timespan, giving insufficient time for the water to drain away naturally.

Storm waves and high tides

WHERE DOES FLOODING HAPPEN IN THE REGION?

- (a) Along the coast - especially along the Bristol Channel where the normal tidal range is very high (up to 12 metres) because of the way that the estuary narrows.
- (b) On flat low-lying river 'flood plains'.

Flood risks are heightened where two areas meet, such as at Burnham-on-Sea where the Somerset Levels reach the coast.

Jean has the overall responsibility to see that this flooding occurs as rarely as possible and is constantly working to achieve this. Even though no-one can control rain, winds and tides, there are ways of reducing the effect of flooding by adding controls (for example on housing development) and constraints like sea-walls.

THE COASTLINE

There are 1985km of coastline in the South West and Wessex Region. The district councils are responsible for coastal protection work to prevent erosion by the sea but the NRA is required to prevent any tidal flooding inland. Joint operations are therefore often essential where coastal lands are low-lying.

New tidal defences have to be both effective barriers and environmentally sensitive, that is pleasing to look at and fitting in with the area.

In urban areas, concrete sea walls can be built in conjunction with the development of amenities for recreation and tourism. At Burnham-on-Sea for example, a sea wall has been protecting many square kms of Somerset Levels for centuries and the 1983-88 concrete structure has been designed to act as a sea-front asset with its new promenade.

Where a natural defence is assessed as being more appropriate, natural sand dunes or shingle ridges are strengthened by introducing timber groynes or planting types of vegetation like spartina grass on the foreshore to limit erosion. Beach nourishment - that is putting more sand on a denuded beach - can also create an effective sea defence.

INLAND

Rivers are effective land drainage channels, but building settlements on the flood plain will increase the risk of floods. These risks can be minimised by enlarged and improved channels, flood banks and walls, detention reservoirs and flood control sluices. Another way of lessening the risk of floods is to

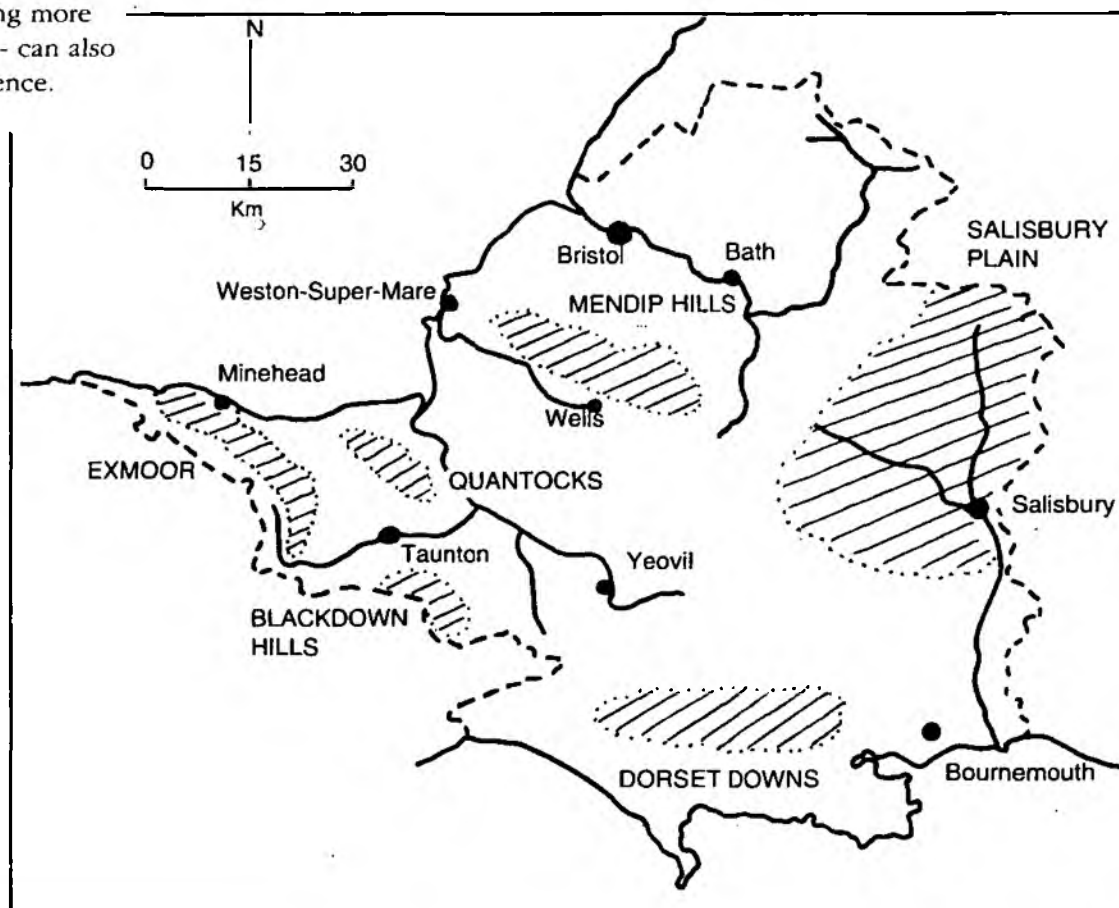
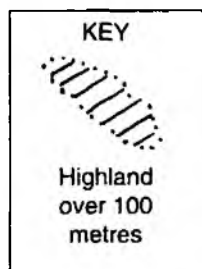
ensure that new housing development has as little effect as possible on rivers.

The Land Drainage Act requires anyone wishing to make changes which might affect the flow of water to obtain permission from the NRA - for example, building a new dam or drainage culvert, or even building a house close to a watercourse.

TWO STORMS 13 DECEMBER 1981 AND 26 FEBRUARY 1990.

As an example of how the work of the NRA improves conditions, the table below shows the number of properties and hectares flooded at the time of the two storms with almost identical conditions of sea level and waves in the Bristol Channel.

LOCATION	FLOODING			
	1981		1990	
	PROPERTIES	HECTARES	PROPERTIES	HECTARES
Clevedon	318	40	Nil	3
Uphill	216	60	15	Nil
Burnham	350	60	Nil	Nil

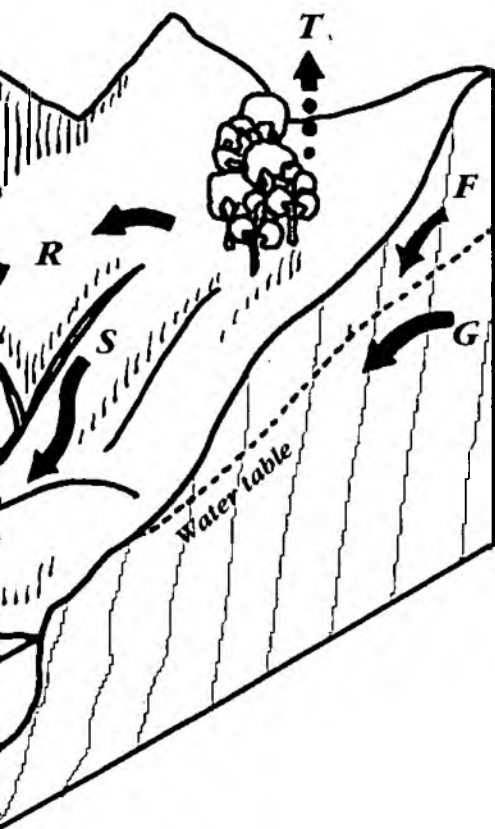


Water Cycle

However, it is when people's activities cause problems that the NRA is more able to help - for example, in limiting the amount of water abstracted by industry or controlling forest removal from upland catchment areas.

The table opposite lists some of the possible ways in which the natural movement may be affected, where they are most likely to occur, effects they might have on other sections of the cycle and ways in which some (not all) types of disruption could be prevented or minimised.

Problems such as these are found in the region. It is very important that we all understand what is happening - and consider how we can help to make sure that water is available whenever needed and is then used properly.



HOW	WHERE	EFFECTS	NRA REMEDIES
Deforestation & overgrazing	Upland slopes	Increased soil erosion, rapid surface run-off & flooding	Reafforestation to slow run-off & improve drainage
Damming a river	Anywhere along its course	Loss of water downstream	Controlled flow by sluices
Water abstraction for irrigation or industry	Along river course	Loss of water downstream	Control of abstraction by issuing a licence
Industrial waste Farm slurry Domestic effluent	In rivers	Pollution Loss of water quality	Prevention by law
Quarrying & gravel pits	On hills & river flood plains	Reduce aquifer storage Impede flows	Influence planning regulations

TRADE EFFLUENT PLANT FAILURE

_____ were fined £1800 with costs of £750 after causing pollution to a tributary of the River Stour. The incident occurred when the company's trade effluent plant broke down.

HEADLINES FROM 'RIVERWISE'

Published by the NRA.

WILTSHIRE FARMER FINED

A Wiltshire farmer has been fined £1000 for polluting a stream in Kingston St Michael. Parlour washings and yard run-off entered a surface water drain leading to the stream. The discharge seriously affected the quality of the water.

SEWAGE WORKS FINED

_____ has been fined £1000 and ordered to pay £700 costs after pleading guilty to causing the pollution of the River Avon at Sherston, Wiltshire.

The case was brought by the NRA under section 107 of the Water Act 1989 and was heard at Wootton Bassett Magistrates Court.

The prosecution took place after an NRA officer, on a routine visit, noticed that the final effluent was blue and the filter beds were not operating correctly. Formal samples were taken, and when analysed they showed that the constant limits were being greatly exceeded.

RIVER OF SLURRY LEADS TO FINE

An Avon farmer faced a fine of nearly £6000 after admitting to polluting a brook in Bath. The incident occurred when the valve of a slurry storage tank jammed in the open position. A river of slurry two metres wide ran into the water course causing pollution.

£6000 FINE

_____ have been fined £6000 at Frome Magistrates Court for exceeding their consent to discharge limits. This resulted in the pollution of a tributary of the Somerset Frome.

LEAK CAUSES POLLUTION

The dairy firm _____ has been fined £800 with £706 costs for causing pollution to a Somerset river. The incident occurred as the result of a leak from the company's premises.

OPERATION OIL SLICK

NRA to take legal action against _____ following major spill in Severn Estuary. The company will appear at Newport Magistrates Court on 5 April to face charges of causing pollution.

NOT SO PRETTY....

_____ a cosmetic company has been found guilty of polluting the River Swan at Swanage. The company was fined £750 with over £1000 in costs.

Round and round it goes! The

The Public Relations Manager for the South West and Wessex Region of the National Rivers Authority is responsible for making the public - that is all of us! - aware of the NRA and how its activities affect our lives. He wants us to understand why our water resources need to be managed and to know what the NRA is doing, as well as how!

WHY IS THIS NECESSARY AT ALL?

First of all we need to ask ourselves why it is so important that such an organisation as the NRA is needed to watch over our water resources. After all, there is supposed to be enough water in the world to provide sufficient for many more people than live here at present. So why is it that so many people are often desperately in need of water? By contrast, why are there sometimes problems in getting rid of it?

SUPPLY AND DEMAND

One reason is the fact that resources like water have an uneven pattern of **supply** - whether we are looking at the whole world or a single country or one region alone.

To make the problem even more difficult, the **second reason** is that there is a similar uneven pattern of **demand** because the rate water is used varies immensely from place to place.

THE WATER CYCLE

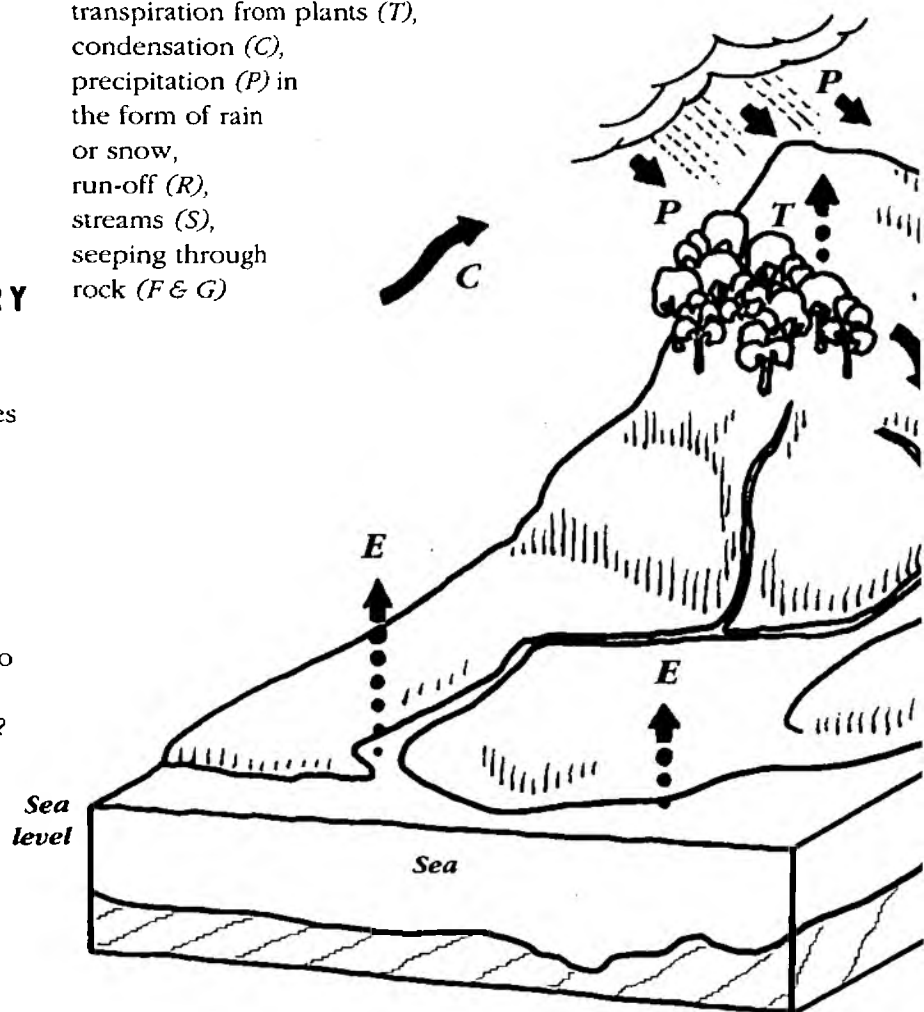
As the diagrams show (below and on the folder cover) the water moves round the Water Cycle in many different ways -

evaporation (E),
transpiration from plants (T),
condensation (C),
precipitation (P) in
the form of rain
or snow,
run-off (R),
streams (S),
seeping through
rock (F & G)

BREAKS IN THE WATER FLOW

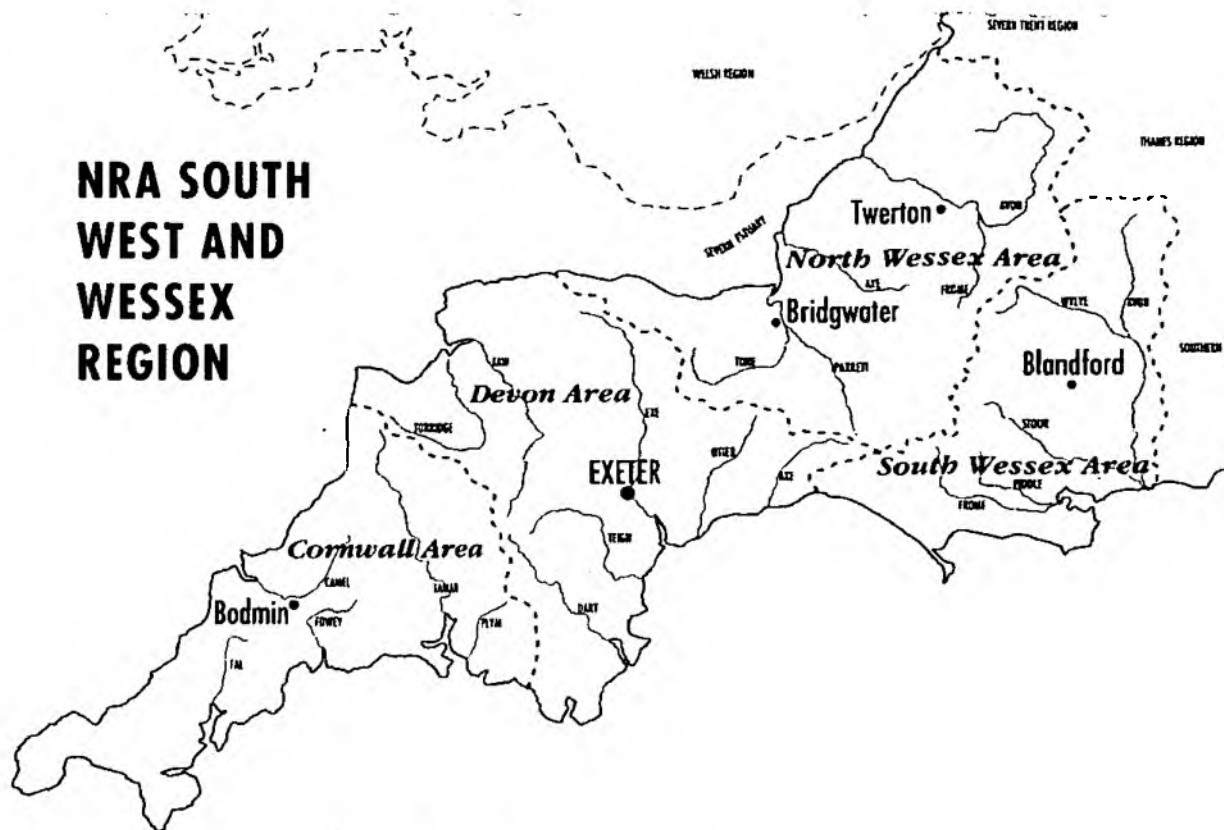
However, this water flow can be interrupted by natural or human action in such a way that a regular water supply is not possible. Whenever there is any action which changes the smooth flow in one place, the effect is also felt further along the route of the cycle and these breaks in movement which often cause the major problem.

Sometimes such interruptions can be from natural causes - for example, a landslide may dam a river, form a new lake and delay the area downstream of water.



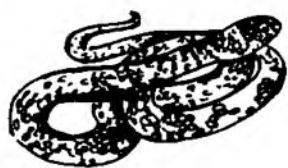
I am a Fisheries Officer with the NRA. My home is in Bridgwater, but my work takes me nearly everywhere on this map. My main task, a giant one, is to keep a careful check on the quantity and quality of fish in local streams, canals, rivers, ponds, lakes and estuaries.

NRA SOUTH WEST AND WESSEX REGION



CLEAN WATER

I was walking yesterday, near Taunton, along the River Tone. There was no doubt about the quality of the water, as it was crystal clear. Rings from rising trout were everywhere and I was lucky enough to see a kingfisher hunting for its breakfast.



PREDATORS

Those kingfishers are fierce predators. Predators hunt, kill and eat other animals, in this case fish. Healthy water systems support healthy predators, big and small.



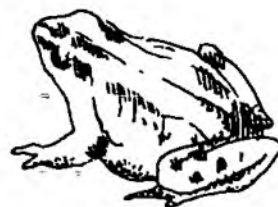
WHY DO PREDATORS NEED MEAT?

Meat contains three classes of foods - fat, protein and carbohydrate: all are energy sources and the energy is highly concentrated. Animals' bodies combine food with oxygen to release that essential energy, without which all would die.



MEAT EATERS

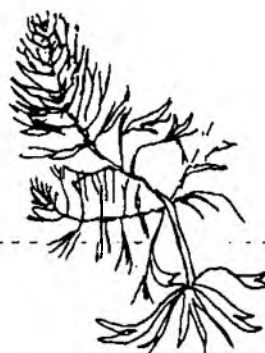
At the large and artificial Chew Valley Lake there are millions of predators. If I tell you that they include herons, spiders, trout, frogs, grass snakes and human beings, you will probably be able to think of many more.



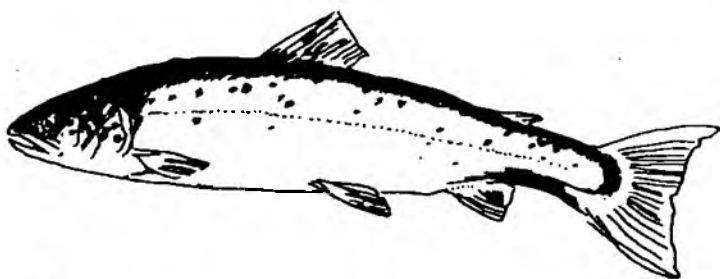
HOW IS ENERGY TRAPPED IN FOOD?

Nearly all our energy comes from the sun but animals, including ourselves, cannot make direct use of it. However, plants that contain chlorophyll can. These green plants absorb and store the sun's radiant energy by combining it with carbon dioxide and water to form carbohydrates and oxygen. The process is called "photosynthesis".

Most animals make use of this stored energy by either eating plants or by eating animals that have eaten these plants.



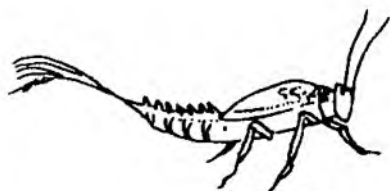
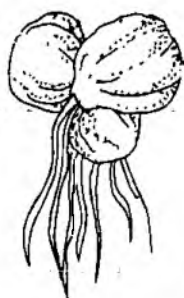
In this region, we monitor game fishing rivers, with their trout and salmon, and coarse fisheries which include pike, chub, perch, roach, eel, tench and minnow.



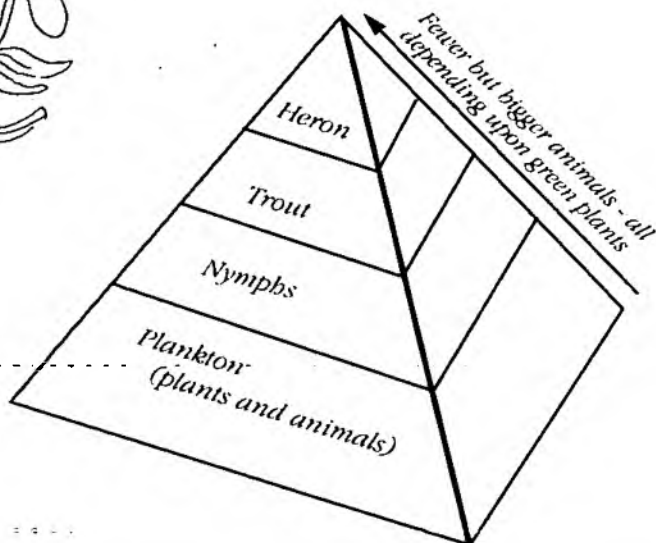
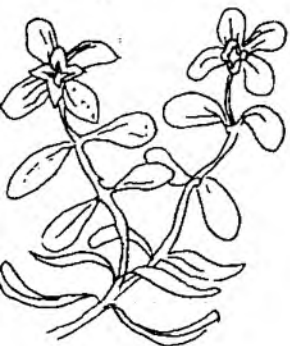
A FOOD CHAIN

The lakes, rivers and ponds watched over by the NRA are battlefields, where death is natural and commonplace.

In Chew Valley Lake millions of tiny green plants and animals, called plankton, float here and there. The green plants make carbohydrates and, in turn, become the food for animals, including other plankton, water snails, midge larvae, cased caddis and the nymphs of stonefly and mayfly. All can be eaten by predators, such as the trout, which can, in turn, be eaten by, perhaps, the fiercest predator of all, ourselves!



A simple system that connects this eating and being eaten is called a food chain. Hopefully, you will be able to see why the numbers of animals at any one stage in the chain gradually decreases as we move up the chain. That's an example of a pyramid of numbers.



BACK TO NRA

Birds that eat Fish are high on a food chain

If kingfishers, grebes and herons can be seen fishing in our water systems, then there must be many other healthy animals below them in the food chain. And, right at the bottom of the chain, working away, will be the green plants, photosynthesising. Something only they can do!

We try to look after all these organisms.

NEWS FLASH!

A local farmer has decided to breed trout in his pond for sale. The pond is filled by a freshwater stream. He has decided to give his trout a good start by eliminating all green plants that, he reports, compete for the oxygen in the water. Is this being foolish ?

I live in Bath with my wife and three children and work for the NRA as a Water Quality Officer.

I know my job is important. Had we lived one hundred years ago at least one of my children would have died from some disease caught through drinking sewage-polluted water. Then, during the summer time, the stench of decaying sewage would have been unbearable.

Nowadays, waste water cannot legally be poured into any watercourse without the consent of the NRA but we have the extra problems of waste chemicals and pesticides. In addition, some people still throw rubbish and even oil into our streams, rivers and ponds. They just don't think!



1

SOURCES OF POLLUTION

Sewage

In a few places untreated sewage is pumped into rivers or the sea. If this dumping were on a large scale, we would be back to the nineteenth century and its plagues of cholera, typhoid and dysentery. Though watercourses have a capacity to deal with some sewage and to dispose of it safely, most local water companies treat sewage before it is discharged.

Industrial Effluent

In industry, most water is used for cooling, but even that can cause heat pollution if it reaches a watercourse. Any water which comes into direct contact with other production materials can become contaminated water and needs to be treated before being returned to a river as 'effluent'. All toxic materials need to be removed because natural waters cannot change them - only dilute them.

Agriculture

Large areas of agricultural land are being treated by fertilisers and pesticides. When heavily used, they can leach out into watercourses.

Drain Water

Some places are still polluted by long-closed factories. Rain water soaking through the ground will wash out (leach) metals, including lead, copper, cadmium and other dangerous substances.

Pesticides can kill plants and even move up a food chain to kill animals for which they were not intended.

In some cases the concentration in plant and animals can reach such a level that they would be poisonous if eaten by people.



Fertilisers cause plants and algae to grow vigorously, using up some of the water's dissolved oxygen. When they die the bacteria that complete their decomposition can multiply enormously and use up even more of the oxygen. This 'eutrophication' can kill other water animals.

oxygen

detergents

metals

hardn

2

DETECTING POLLUTION

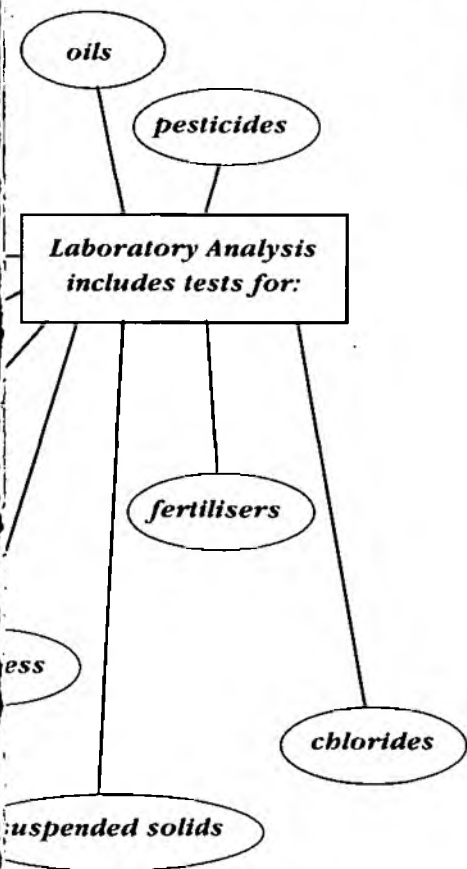
Biological Analysis

Some organisms are less resistant to pollution than others. The organisms which can live in the water tell how polluted it is.

To take samples, I stand upstream of my net, shuffle my waders and wait for a minute for animals to collect. I do that twice more and so have a three-minute sample for that section of river.

Chemical Analysis

NRA regularly take water samples from a large number of survey points throughout the country. In the South West and Wessex Region alone, more than 100,000 samples are taken annually.



LEVELS OF POLLUTION

ORGANISMS SEEN IN SUMMER

No Pollution

mayfly, stonefly, swan mussel, water snail, pea mussel, caddis larva



Light Pollution

above become replaced by: water shrimp, water hog-louse, water boatman



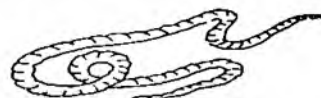
Moderate Pollution

above become replaced by: bloodworm, leach, midges, rat-tailed maggot, fly larva



Heavy Pollution

perhaps some small worm-like creatures



Finding the Source

The pollutants are then examined to identify and locate the actual sources. We then talk to the owner of offending premises and seek and set time limits for improvement. All results are placed on a public register and our findings are reported to relevant local authorities, industrialists and farmers so that they can see how their discharges are affecting water-courses.

3

AFTER POLLUTION IS DETECTED

Reducing the Damage

When NRA detects pollution, we trace the source and attempt to reduce damage. Sometimes we soak up the pollutant using absorbent materials. Sometimes we put a boom across the watercourse to contain the pollution and then pump it out. In addition, we can pump air through the water to breathe life back into the polluted stretch.

Punishing the Offender

If the pollution is not sufficiently reduced, or if there are signs of carelessness or negligence, the NRA may decide to prosecute the polluter. Fines of up to £20,000 may be imposed in Magistrate Courts. More serious offenders end up in the Crown Court.

I am a Water Resources Officer with the NRA.

My job is to make sure that water, in the right amount and of the right quality, is available when and where it is needed.

We make sure that this water can be taken from its natural location without affecting other people and without harming the environment.



WATER FOR AGRICULTURE

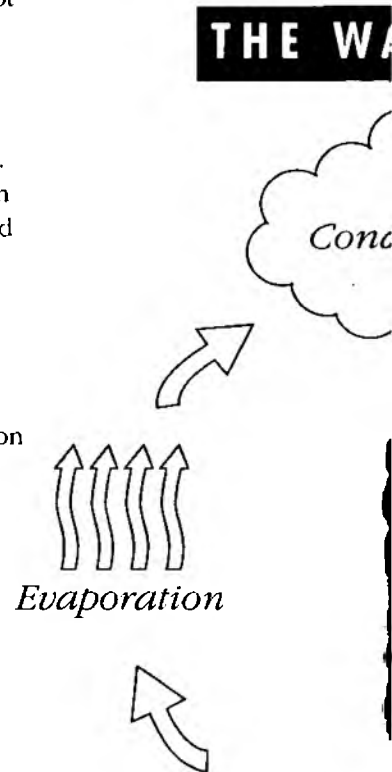
While farm animals need water throughout the year, that is not true for most crops. They need their water during the growing season and a good supply can increase yields by as much as 50%.

Spray irrigation is the taking of water from nearby watercourses and using it to water crops. Once, this type of watering was used only in very dry years, now many farmers use spray irrigation to increase crop yields in years of average rainfall. However, in parts of the region, especially on the Avon and Somerset Levels, farming is only economically possible when some of the abundant water is drained away - perhaps affecting other plants and animals.

ENOUGH WATER FOR ALL

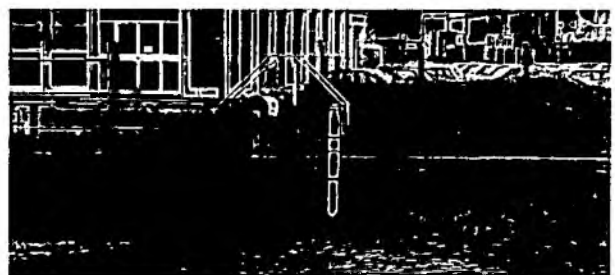
Although there is enough water on the planet for everyone, it is not always available for use in the right place and at the right time. In this country, sometimes there is just not enough.

Places like Bristol and Bath could not support their populations without an adequate water supply. In addition these cities would soon become grossly polluted if they did not possess an efficient way to dispose of their waste water. The water cycle ensures that water can be used time and time again. But the increase in use by people and the increasing problems of pollution make the task of the NRA in managing water vitally important.



WATER IN INDUSTRY

Industry in the United Kingdom needs plenty of water. It uses every day about 4500 megalitres. The manufacture of a tonne of steel needs about 15000 litres of water and a litre of water is used when every 100 gram bar of chocolate is manufactured.

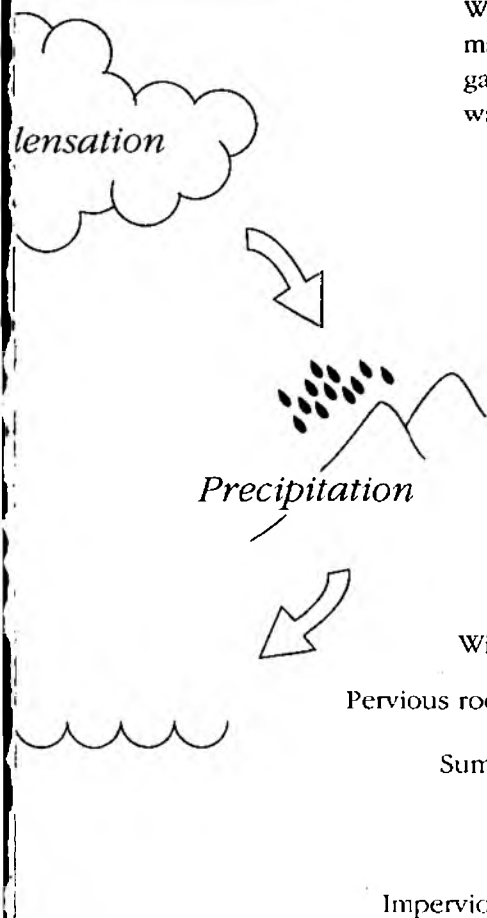


WATER FOR HOMES AND OFFICES

On average, everybody in Britain uses about 150 litres of water a day. Most of this is used for washing and for flushing lavatories, an average flush takes 9.5 litres. About 100 litres of water are needed for a bath and about 30 litres for a shower. Perhaps you can now think of one way to save water.



WATER CYCLE



OBTAINING SUFFICIENT, SUITABLE WATER

WATER - A GOOD SOLVENT

Water is very good at dissolving the many different solids, liquids and gases that are naturally present in watercourses, land and aquifers.

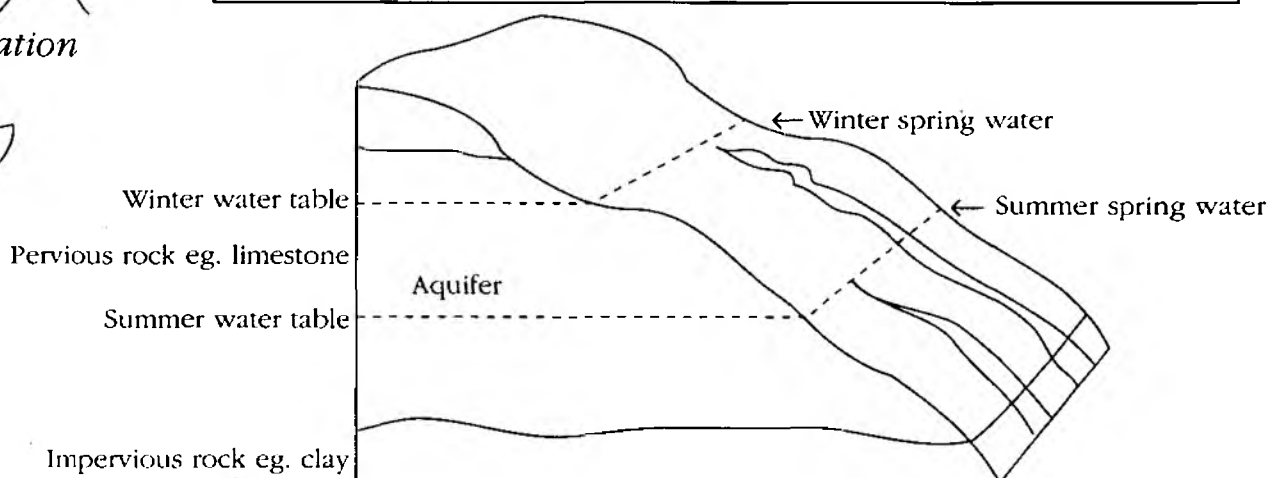
WATER SUPPLIES

Some water supplies come from wells and boreholes which collect their water from 'aquifers'. Spring water, running from these aquifers, forms the basis of river water in Summer. From there, water can be pumped out for storage for public, industrial, and agricultural uses.

WATER SUPPLY AND STORAGE

As there are some times of the year when there is plenty of water, a means of storage and purification is essential. Reservoirs such as Chew Valley Lake and Blagdon Lake are artificial and store many megalitres of water.

WATER TABLE: Rain water settles into the Earth's rock layers until it reaches a point where it can move no further. Above this point water begins to fill the spaces in the rocks. The highest level of this collecting water is called the 'water table'.



BUILDING RESERVOIRS

The idea of building a dam across a river to form a large lake is a simple one. However, the environmental and social problems of such a construction are immense. When demand for water exceeds supply, the debate about where additional reservoirs are to be sited is often fierce. Inevitably farmland, buildings and even villages may be drowned, habitats destroyed and the appearance of the countryside changed drastically.

STORING WATER

As there are times when water is in abundance, a means of storage and purification is essential. Reservoirs, such as Chew Valley and Blagdon Lake, are artificial and store many megalitres of water.

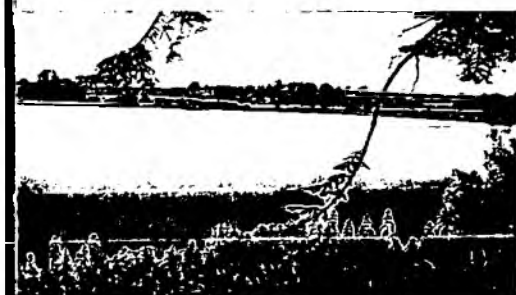
PURIFYING WATER

Just storing the water until needed is, of course, not sufficient. A water supply has to be made pure enough to suit the purpose for which it is intended. So, Government Regulations, applied by NRA and other regulatory bodies, are intended to ensure water is fit for its intended use.

DISPOSING OF WASTE WATER

Disposal of waste water from households, industry and agriculture into our waterways, without any treatment, would soon cause severe pollution.

There are EC and Government Regulations about the quality of water that can be passed into our watercourses. The NRA checks that these regulations are being observed.



Janet Green is a Conservation Officer for the NRA.

This is a job which is both fascinating and difficult, rarely boring but very demanding!

Janet often has to consider very complicated conservation issues and has to look for what he thinks is the best solution in each particular case.

Very often the ways in which different people see the environment will be in direct conflict. How can a naturalist's wish to preserve the wild-life habitat of the short-tailed voles in the Somerset Levels be agreed with if there is an urgent need to build up the bank to stop flooding? How can the engineer's plan to construct a dam for a water supply reservoir be agreed with if the resultant lake would drown a large area of high quality valuable farmland? What would you decide to do?

GUARDIAN OF THE WATER ENVIRONMENT

The NRA continually has to strike a balance between competing interests. The basic duty is always to protect the water environment in a

landscape which is part of our heritage. At the same time, realising that it is both necessary and inevitable on occasions to introduce changes, the NRA is responsible for checking the effects of such changes.

CONSERVATION

The NRA recognises that changes in the environment **can** be made but they must be both sensitive to the past and of value to the future. For example, it could be generally agreed that some of the natural sand-dune seashore of great scenic beauty in Somerset needs to be strengthened in order to become an effective barrier against high tides - but, as a conservation issue, the problem is then in deciding how this improvement can be carried out in practice. This calls for a team

NEW TECHNOLOGY FOR OLD

Up to date NRA technology is being used to save one of the oldest forms of technology - a water mill.

Sturminster Newton Mill, one of the oldest cornmills in operation, is under threat from river eroding and undercutting its foundations.

FLOOD DEFENCES UNCOVER RELICS

The discovery of Saxon pottery, arrowhead flints and even human remains must be one of the **most** bizarre side effects of NRA flood defence work.

But when the NRA took aerial photographs of the site at Sturminster Marshall - with a view to carrying out flood defence work along the River Stour - what showed up was as interesting to the archaeologists as it was to the surveyors.

For the photographs showed ridges in a field - tell-tale signs of an ancient Saxon settlement. Following consultations with East Dorset District Council it was agreed that an archaeological dig be carried out before work started.

A wide variety of objects have been passed to the county museum in Dorchester. But recently there were some grisly discoveries as the remains of Saxon residents were uncovered.

When the archaeological work is complete, the £370,000 NRA flood alleviation scheme will begin. This involves the construction of an earth embankment along the riverside to protect 100 properties from flooding.

WETLAND BIRDS U

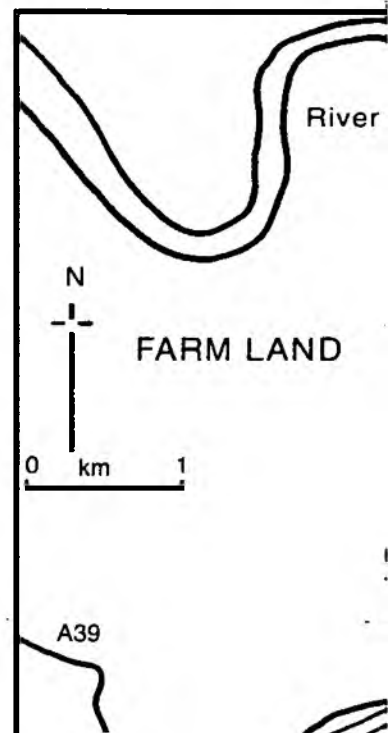
The falling water table in the existence of many wetland wading birds have already been conservationists who are called managed.

The Levels have been described as a habitat in Britain renowned for

The Levels and Moors of today were once an inlet of the sea. Gradually over the centuries sea walls and banks have been constructed, tidal sluices built and rhynes and ditches cut to contain flooding, and drainage channels such as the Huntspill R

approach and in such a case Janet works with hydrologists, engineers and scientists with specialist knowledge of the ecology of the dunes for some time before they decide what should be done.

Through its concern with the water environment, the NRA becomes involved with issues related to various aspects of the environment, natural and manmade. As well as being concerned with activities which

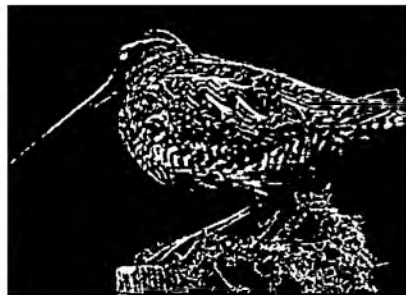


UNDER THREAT

Somerset Levels and Moors is threatening d birds. In certain areas, some species of come extinct. This is the view of some ing for change in the way water levels are

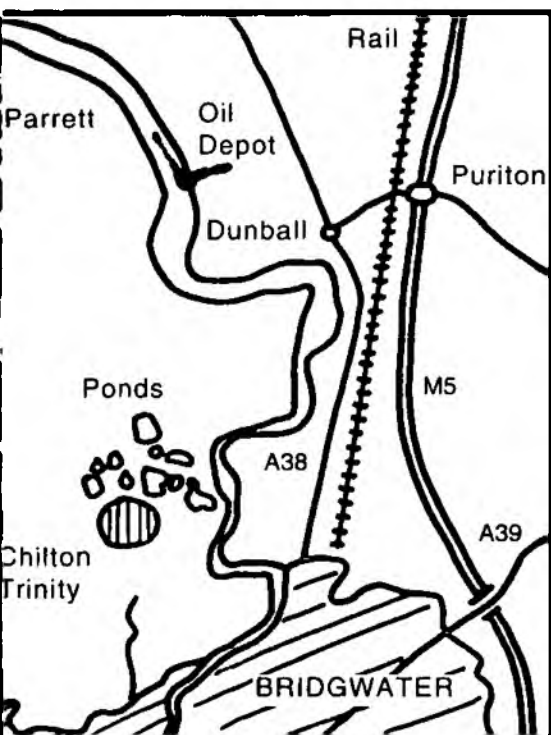
as the most important remaining wetland ts characteristic plants and animals.

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could affect the natural scenery and the wildlife of an area, Janet and her colleagues also have a duty to protect evidences of past human activity. Ancient settlement sites on the Somerset Levels could be as much in need of protection from flooding as buildings of great architectural merit near the flood plain of the River Avon in Bath.



RECREATION

The success of the NRA and other organisations in improving public awareness of environmental issues has, to some extent, resulted in more people looking to the countryside for recreation. More people own cars - some have more time available for leisure - many have an increased interest in personal fitness - and these are all reasons why so many people now wish to spend more time in the countryside.

Although the NRA Conservation Officers have actively promoted this interest in the countryside, they now have to look for ways in which the growing pressure can be catered for without damaging the environment.

Inevitably the increased demand has led to conflicts of interest even

where such activities as rambling or fishing may only need limited extra facilities - the siting of a car park may well prove to be a very difficult environmental issue. Other facilities may cause increased problems in terms of competing viewpoints. People seeking access to bird watching hides may cause problems for anglers - landing areas for canoes or larger boats may be difficult to site without disturbing the wildlife of a section of river bank. There is rarely a solution which is immediately apparent - the final decisions in such cases call for careful balancing of the different viewpoints and the implications for future use. Usually it is not the NRA but a landowner who makes the final decision. As the 'regulator', the NRA is always seeking to be 'Guardian of the Water Environment'.

CHILTON TRINITY PONDS

A case study for Conservation Activity No.1

- Location: Grid ref: 298396 (O.S.1 50 000 Sheet 182)
- History: Former clay pits supplying local brickworks until 1960s- now owned by Chilton Development Company but currently leased to the National Rivers Authority.
- Present use: NRA fish stock holding ponds - important natural site for wildlife - 3 ponds leased by angling clubs - one pond used for water sports - adjacent camp site open to the public with toilet block & cold water facility plus several drinking water stand pipes.
- Future ? Among those interested in owning or leasing the area are:

Group:	Reasons & future use:
NRA	Fisheries - conservation - recreation
Marina Development Corporation	Boat Marina Village linked by canal to River Parrett
Taylor Homes Ltd	Landscaped luxury home development
Witham Waste Disposal	Refuse disposal by landfill
Somerset Wildlife Trust	Preservation of existing wildlife - 30 varieties of bird, otter, coarse fish, & protected Great Crested Newts - plant life including spikerush, reedmace & coltsfoot
Local farmers	Grazing land
Youth Work Group	Scouts, YMCA & other organisations - campsite and water sports
Angling Clubs	Angling for carp
Local residents	Mixed viewpoints!

TEACHERS' NOTES

S t u d y P r o g r a m e s



NRA

National Rivers Authority

TEACHERS' NOTES



NRA

National Rivers Authority

THE NATIONAL RIVERS AUTHORITY

The National Rivers Authority is a non-departmental public body (sponsored by the Department of the Environment) which was formed in July 1989 with statutory duties and powers in relation to water resources, pollution control, flood defence, fisheries, recreation, conservation and navigation in England and Wales.

It is thus a 'watchdog' over the many extremely important elements in our life which relate to WATER. In acting as a guardian on behalf of the whole nation, the NRA is continually having to balance the different, sometimes directly opposing, needs of the various sections of society. The farmer's search for effective waste disposal has to be weighed against the preservation of water quality in the streams - the demands of the water authorities have to be evaluated in terms of recreational opportunity - the structural design of badly needed sea defences must be judged aesthetically as well as for efficiency.

With the 'teeth' of legal backing, this watchdog has been created to ensure that future development of the water environment takes place both sensibly and sensitively.

National Rivers Authority, 30 - 34 Albert Embankment, London SE1 7TL

THE SOUTH WEST & WESSEX REGION

The NRA operates through 8 regions (see map). The South West and Wessex Region covers Avon, Cornwall, Devon, Dorset, Somerset and Wiltshire.

THIS PACK

The purpose of this pack is to provide an informative introduction to some of the work of the NRA - primarily designed for use in schools but also in a form which could be of interest to members of the general public.

Included are:

- (a)** lists of Programmes of Study for both Geography and Science that relate to this pack and;
- (b)** some activities for pupils to complete using the Theme sheets;
- (c)** Theme sheets.

The first Theme Sheet sets out to provide an explanation of The Water Cycle, the major system which underlies all the other activities involving water movement and control. Each of the other five Theme Sheets takes as its focus one or more of the major responsibilities of the NRA, offering a summary of the main activities involved.

The Water Cycle

Water Management

Water Quality

Fishery Protection

Floods

Conservation

RELEVANT GEOGRAPHY PROGRAMMES OF STUDY FOR KEY STAGES 3 & 4**Geographical Skills**

Many of the skills listed for Key Stage 3 (KS3) & Key Stage 4 (KS4) could be practised when pupils are carrying out the activities. Of particular relevance, however, is the first skill for KS3;

"An enquiry approach should be adopted for classroom activities and work outside the classroom should be undertaken when appropriate. Enquiry should be supported by the use of secondary sources. Pupils should develop skills in interpreting data from statistics, diagrams and maps. Pupils should be given opportunities to use information technology (IT)."

Physical Geography**Pupils should be taught:**

- physical processes which can give rise to one type of natural hazard and how people respond to that hazard;
- the main features of river systems and basins; the factors that influence stream flow in a river basin:
-and the causes and effects of river floods and methods used to reduce flood risk;
- how the hydrological processes operating in a drainage basin can be considered as a system, comprising inputs, stores, flows, and outputs;
- the main components and links in the hydrological cycle.

Attainment targets

3.4c, 3.5c, 3.6c, 3.6d, 3.7b, 3.8b

Environmental Geography**Pupils should be taught:**

- about fresh water sources and means of ensuring a reliable supply:
- why rivers, lakes and seas are vulnerable to pollution;
- and to investigate ways in which pollution problems have been addressed;
- the differences between renewable and non-renewable resources;
- the effects of developments in technology on the exploitation of natural resources and the management of environments:
- and how attempts to plan and manage environments can have unintended effects, using case studies;
- ways in which people look after and improve the environment:
- and to consider whether some types of environment need special protection and some of the ways in which damaged environments can be restored and damage prevented;
- how areas of great scenic attraction can give rise to conflicting demands on them and the issues which arise as a result;
- how some leisure activities can harm the very areas which are the source of attraction, and to analyse solutions to this problem:
- to analyse, with particular attention to one system, why some major environmental systems are fragile.

Attainment targets

5.4a, 5.5a, 5.6b, 5.8b, 5.10a

Floods

Reading the theme sheet 'Floods' will help you to complete these activities.

Activity 1

At Ge 3.5c

Many flood prevention schemes have been built for urban areas in the region. Some are large (for example the River Avon flowing through the City of Bath) and others much smaller in scale (such as where the River Frome flows through the town).

Explain why you think that flooding has become a greater problem in many places over recent years and have so required these prevention schemes.

Activity 2

AT Ge 3.5c

- (a) Make a list of places in your own area where you know that floods have occurred. In each case, give the reasons why you think they took place.
- (b) Has any action been taken to prevent flooding in the future? What do you think should be done?
- (c) Can you suggest possible reasons why some people might not be in favour of some of your proposals.

Activity 3

AT Ge3.5c

- (a) Where else in Great Britain do you think flooding could be a real hazard? Why is there a problem there?
- (b) Keep a careful watch on newspapers and magazines for articles and illustrations about flood activity in Great Britain. You could then build up a scrap-book collection to help you answer the following questions.
 - (i) Why does flooding take place?
 - (ii) In what sort of areas is it most likely to occur?
 - (iii) What are the NRA and other organisations doing to prevent future problems?
 - (iv) Why do people continue to live in areas which they know are likely to be flooded?

Use an atlas and any other resources you can find to assist you.

Conservation

Reading the theme sheet "Conservation - Making Choices" will help you to complete these activities.

Activity 1

Geog AT -5.6b

You have been invited to attend the Public Inquiry which has been arranged to consider the future of Chilton Trinity Ponds, referred to in the theme sheet "Making Choices".

- (i) Make a list of the different groups of people that you expect to be present at the Inquiry in order to give their views.
- (ii) List the reasons **for** and **against** the ideas of each of the different groups.
- (iii) Choose one of these groups and, as its leader, write a letter to the local press which explains your views.

Activity 2

AT Ge 5.6b

Programme of Study Stage 3 Skill 1 **Sc 2.8d**

- (a) Identify a conservation issue in **your local** area which might involve the NRA.
- (b) Carry out an investigation and present your findings in a way which would be useful at a Public Inquiry.

Activity 3

At Sc 2.8d

Design a poster which is intended to show how the NRA has a very important part to play in many conservation matters.

QUESTIONNAIRE

Now that you have received this information pack, it would be very helpful if you could send in your comments on its value - preferably after its use with pupils. However, any interim judgement on its possible future use would also be valuable guidance for further resource development.

On returning this completed form (address below), you will be placed on the NRA circulation list and receive future available information.

Please reply to:

**Public Relations, NRA South West and Wessex Region, Manley House,
Kestrel Way, Exeter EX2 7LQ**

NAME AND ADDRESS

OF SCHOOL:

NAME OF TEACHER:

SUBJECT(S) TAUGHT:

Use of NRA Pack

ESTIMATED PUPIL AGE RANGE FOR WHICH IT COULD BE USEFUL:

ACTUAL AGE RANGE OF PUPILS WITH WHOM IT HAS BEEN USED:

Comments on the value of:

(a) THE LIST OF ATTAINMENT TARGETS WHICH RELATE TO THE RESOURCES.
.....

(b) THE SUGGESTIONS FOR PUPIL'S ACTIVITIES
.....

(c) THE THEME SHEETS
.....

(d) THE PACK DESIGN (AS A FREE SOURCE OF BASIC INFORMATION)
.....

Questionnaire

Please mark the particular types of resources which you would find most useful in future

- ☐ (a) CASE STUDIES OF ACTUAL NRA ACTIVITIES CONCERNING SPECIFIC PROBLEMS.
- ☐ (b) CASE STUDIES OF NRA PERSONNEL WITH SPECIALIST RESPONSIBILITIES
E.G. HYDROLOGIST, BIOLOGIST, ENGINEER, CONSERVATIONIST.
- ☐ (c) DETAILED CURRICULUM UNITS INCLUDING OBJECTIVES, RESOURCES, SUGGESTED
POSSIBLE TEACHING METHODS AND PUPIL WORKSHEETS.
- ☐ (d) STATISTICAL DATA - WITH REGULAR UP-DATING FACILITY.

(e) SUPPORTING VISUAL AIDS:

- ☐ VIDEO CASSETTES ☐ TRANSPARENCIES
- ☐ POSTERS ☐ BOOKLETS.

(f) OTHERS - PLEASE SPECIFY

.....

.....

WHICH IS THE MOST SUITABLE TARGET AGE RANGE?

- ☐ 11-14 ☐ 14-16 ☐ 16-19

IN WHAT AREAS OF THE CURRICULUM OTHER THAN GEOGRAPHY AND SCIENCE DO YOU
THINK SUCH RESOURCES COULD BE USEFUL?

- ☐ PRE-VOCATIONAL ☐ CITIZENSHIP ☐ GENERAL STUDIES
- ☐ CDT ☐ HOME ECONOMICS ☐ OTHER

SHOULD SUCH RESOURCES AS THESE ALWAYS BE AVAILABLE FREE OF COST?

Yes ☐ No ☐

RELEVANT SCIENCE PROGRAMMES OF STUDY FOR KEY STAGES 3 & 4

Fishery Protection

Key Stage 4

- should investigate limiting factors in photosynthesis and the use of photosynthetic products in plants;
- should use keys to assign organisms to their major groups and have opportunities to measure the difference between the individuals;
- should consider energy transfer through an ecosystem and how photosynthesis initiates this process.

Attainment targets

2.4b, 2.4c, 2.4d, 2.5c, 2.6d, 2.7b, 2.7e, 3.8g, 4.6c.

Water Management

Key Stage 3

- the water cycle, conservation of water resources and the effect of water on the earth's surface.

Attainment targets

2.8d, 3.5d, 3.9d

Pollution Control

Key Stage 4

- should have opportunities, through fieldwork and investigations, to consider current concerns about human activity leading to pollution and effects on the environment, including the use of fertilisers in agriculture, the exploitation of resources, and the disposal of waste products on the Earth, into its oceans and in the atmosphere;
- should relate the environmental impact of human activity to the size of population, economic factors and industrial requirements;
- should relate their scientific knowledge to the impact of human activity on these cycles and ecosystems and to the disposal of waste materials.

Attainment targets

2.5c

ACTIVITIES

Water Cycle

Reading the theme sheet "Water Cycle" will help you to complete these activities

Activity 1

AT Ge 3.6c Ge 3.8b Ge 5.5a Sc 3.5d

- (a) Draw a flow chart to illustrate the Water Cycle
- (b) Mark and number points on the cycle where people's activities can cause a problem to the cycle
- (c) Make a table which
 - (i) lists all these points
 - (ii) explains how the problems arise
 - (iii) notes the normal NRA response in each case
 - (iv) suggests other possible actions to reduce the problem

Activity 2

AT Ge 3.6c Ge 3.7b Ge 3.8b Ge 5.5a Sc 3.5a

Make a list of examples of possible interruptions in the Water Cycle in your local area - that is, where problems occur which affect the natural flow of the cycle. In each case, try to explain how the break happened and how you think that the problem should be corrected.

Use newspaper items, sketch maps, diagrams and other illustrations wherever possible.

Activity 3

AT Ge 5.4a Sc 2.5c Sc 2.8d

- (a) Draw a simple sketch map to show the location of:
 - (i) the main source of fresh water for your neighbourhood
 and (ii) your local region.
- (b) List any factors that could make this supply unreliable, giving your reasons.

Pollution Control

Reading the theme sheet "Pollution Control" will help you to complete these activities.

Activity 1

AT Sc 2.5c Ge 5.5a

In the theme sheet you will find the sources of several types of water pollution. Find and list them. Now complete one of the following tasks.

- (i) Make a poster from drawings, paintings, newspaper cuttings, magazine cuttings to illustrate the sources of water pollution.
- (ii) Describe the problems that pollution can cause and how they can be reduced.

Activity 2

AT Sc 2.5d Ge 5.8b

Some animals will tolerate greater levels of pollution than others. As a result, the level of pollution in river water can be measured by identifying the animals that live within the water.

- (a) Use a reference book to make sketches of some of the animals that cannot tolerate any pollution and those that can tolerate light, moderate, and heavy pollution levels.
- (b) Next time you are at a river bank you could look carefully at the variety of plants and animals to estimate the level of pollution of the water.

Activity 3

AT Sc2.7b

Imagine that you are walking along a river bank on a warm summer's day. The river is smelling of rotten plants: there are some dead fish, with many other struggling on the surface apparently suffering from a lack of oxygen.

Explain what might have been the cause of this tragedy and how the NRA would proceed to help the fish and reduce the chances of the pollution being repeated.

Water Management

Reading the theme sheet "Water Management" will help you to complete these activities.

Activity 1

AT Sc 3.5D Ge 3.6c

The world's water supply is constantly changing its form and moving from place to place. None can be lost for ever!

Draw a diagram to illustrate this water cycle using every one of the following labels: heating - cooling - evaporating - condensing - precipitating - transpiring - sea - lakes - rivers - streams - clouds - mountains - sun - rain - plants.

Activity 2

AT Sc 3.5d

Draw a flow sheet to illustrate:

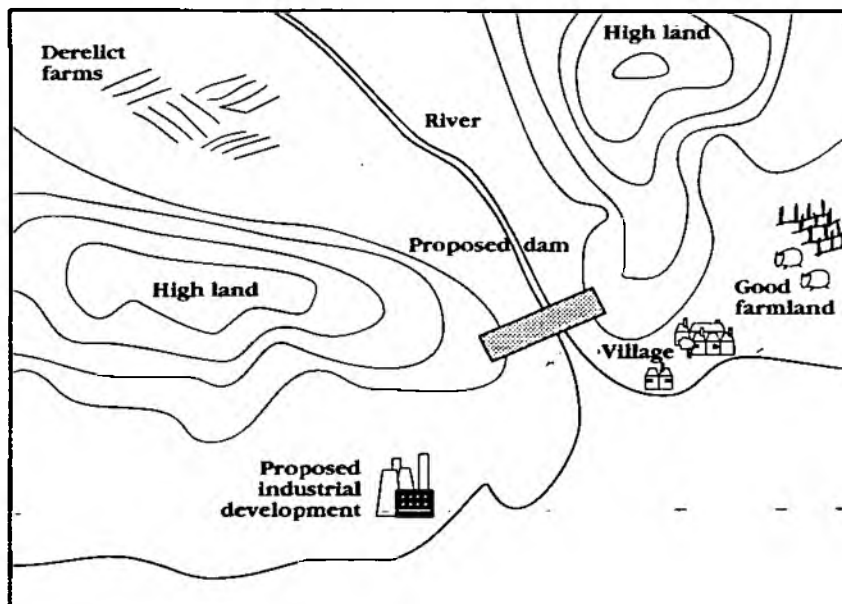
- (a) that rain water is collected, purified and distributed to your home.
- and (b) that waste water is collected from your home, treated and piped away to the sea.

Activity 3

AT Sc 2.8d Sc 3.9d Ge 3.6c Ge 5.4a Ge 5.10a

Suppose that a large reservoir is to be formed in the area in which you live by building a dam across a river that runs out of a valley. The intention is that the water that collects behind the dam will be available throughout the year.

The valley is some distance from the nearest village, where there are many people unemployed. A company wishes to build a factory for manufacturing chocolate on a nearby, disused industrial site near the village and needs a good water supply throughout the year. The valley attracts walkers because of its beauty. If plans go ahead, several derelict farms will be flooded. The flooding will immerse a species of plant that occurs in only three other places in the UK. Nearby farms need a better supply of water to introduce spray irrigation to their fields and so increase productivity.



Describe the advantages and disadvantages of going ahead with building the dam and flooding the valley. Decide whether you will or will not support the scheme to flood the valley.

ACTIVITIES

Fishery Protection

Reading the theme sheet "Fishery Protection" will help you to complete these activities.

Activity 1

AT Sc 2.4b

Scientists use keys to identify plants and animals.

This is a simple example of a key that you could use to distinguish between knives, spoons and forks - should you ever need to do so!

Has a sharp, cutting edge?

yes - a knife

no - either a spoon or a fork

Can be used for eating soup?

yes - a spoon

no - a fork

At first, animals are grouped into those with and those without a backbone, vertebrates and invertebrates. For this activity, you should concentrate on those with backbones, ie vertebrates.

Vertebrates can be grouped into five different classes. If you are not sure what they are you will find an example of each class in the theme sheet - one of the groups is "fishes".

Try to make a simple key to classify any vertebrate into one of the classes - this isn't very easy to do! It would help if you include somewhere in the key "whether or not the animals lay eggs" and, if they lay eggs, "where they are laid".

Activity 2

AT Sc 2.4d

Most animals eat a variety of different foods. As a result, there are few simple food chains. In practice, the chains interlock into food webs.

(i) Make a food web out of these organisms.

beetles, frogs, grebe, algae and other green plants

kingfishers, mayfly nymphs, foxes, freshwater

shrimps, snails, hawks, trout, water boatmen, worms

(ii) Use your food web to explain why there need be far more fresh water shrimps than there are fish in an unpolluted and healthy lake.

(iii) Use a text book to help you to place each member of your food web into one of the groups:

Producer - plants

Consumer - herbivore

Consumer - omnivore

Consumer - carnivore

Activity 3

AT 2.4c 2.4d

Find the "Newsflash" in the theme sheet. Write a letter to the trout farmer involved which explains why you think his plan is likely to cause problems.

THE NATIONAL RIVERS AUTHORITY AND SCHOOLS

As the national "watchdog" of all water resources in the country, the National Rivers Authority has a responsibility to ensure that all young people know why it is needed and how it operates.

The purpose of this pack is to provide an informative introduction to some of the work of the NRA.

The Teachers' Guide includes:

- (a) *some basic information about the NRA and operational framework;*
- (b) *Programmes of Study (Key Stages 3 & 4) for Geography and Science which relate to the work of the NRA;*
- (c) *suggestions for ways in which pupils could use the resources supplied in the six theme sheets supplied in this pack.*

The first Theme Sheet provides a simple explanation of The Water Cycle, the major system which underlies all the other activities which involve water movement and control in the environment.

Each of the other five Theme Sheets takes as its focus one of the major responsibilities of the NRA. Each topic is explained by reference to the kinds of issues involved and the type of action normally taken by the NRA. A number of examples of 'real life' situations which have already been dealt with by the NRA are included to illustrate this work.

THE SOUTH WEST AND WESSEX REGION:

The map opposite shows how the NRA operates through 8 regions and the South West and Wessex Region covers the area formed by the counties of Avon, Cornwall, Devon, Dorset, Somerset and Wiltshire.

The main regional office is in Exeter (address below) and there are a number of smaller offices responsible for local areas.



National Rivers Authority
South West and Wessex Region
Manley House, Kestrel Way, Exeter, EX2 7LQ

National Rivers Authority Information Centre Head Office
Session No 1234

ENVIRONMENT AGENCY



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GUARDIANS OF THE WATER ENVIRONMENT

This resource pack includes
a Teacher's Guide
and Information Sheets
on 6 Themes

The Water Cycle

Water Management

Water Quality

Fishery Protection

Flood Control

Conservation



NRA

National Rivers Authority